

EnerLinksIII™ Video Data Link Configuration and Operation Guide

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1 About This Manual

This Operator Manual provides information on the configuration and operation of the EnerLinksIII™ Video Data Link System.

For information on installation and setup of the EnerLinksIII Video Data Link System see the *EnerLinksIII Installation and Setup Guide*.

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2 EnerLinksIII™ Data Link System Overview

EnerLinksIII™ is a full duplex data link intended for air-to-ground communication of high-bandwidth downlink telemetry data and moderate-bandwidth uplink command and control data.

As shown in Figure 1 and Figure 2, the EnerLinksIII system consists of an Aircraft segment and a Ground segment. In each case, external modules provided by ViaSat implement the RF power amplifier function and the LNA/front end filter function. The EnerLinksIII allows a ground-based user to view video captured by up to four distant cameras, providing all necessary equipment for both ends of the link except the cameras and the communication antennas. The EnerLinksIII Airborne Modem Transceiver (AMT) digitizes and compresses the video and employs error-resistant digital communication techniques that deliver video whose quality does not degrade until the very edge of radio coverage is reached. In addition to compressed video, the AMT will collect and multiplex the following data types for transmission on the downlink:

- Data from an Ethernet port, which can be either TCP or UDP
- Up to two channels of audio data
- Up to two channels of GPS data in NMEA 0183 format
- Up to six channels of asynchronous data
- Up to two channels of synchronous data

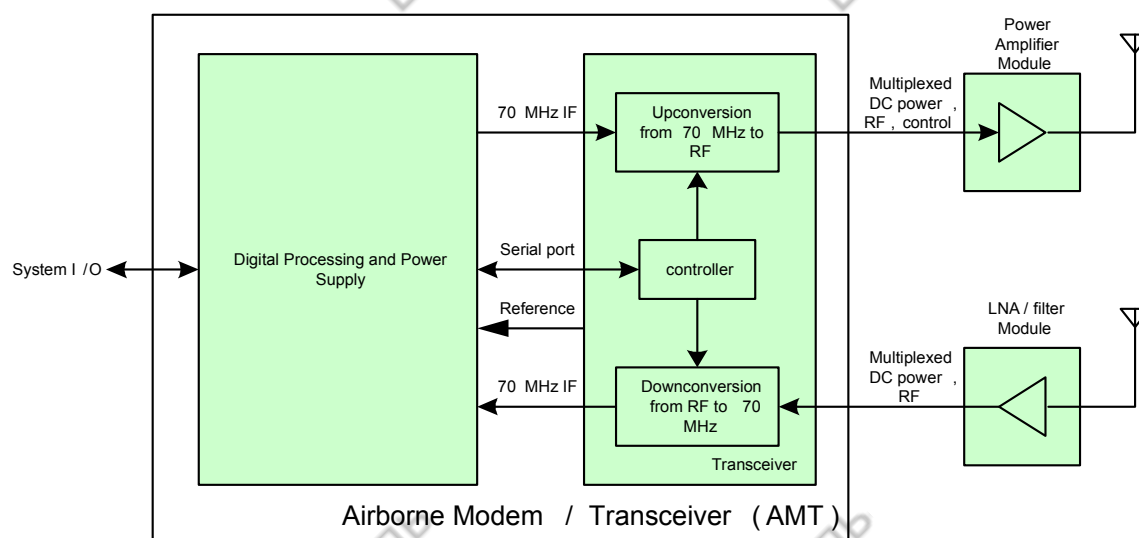
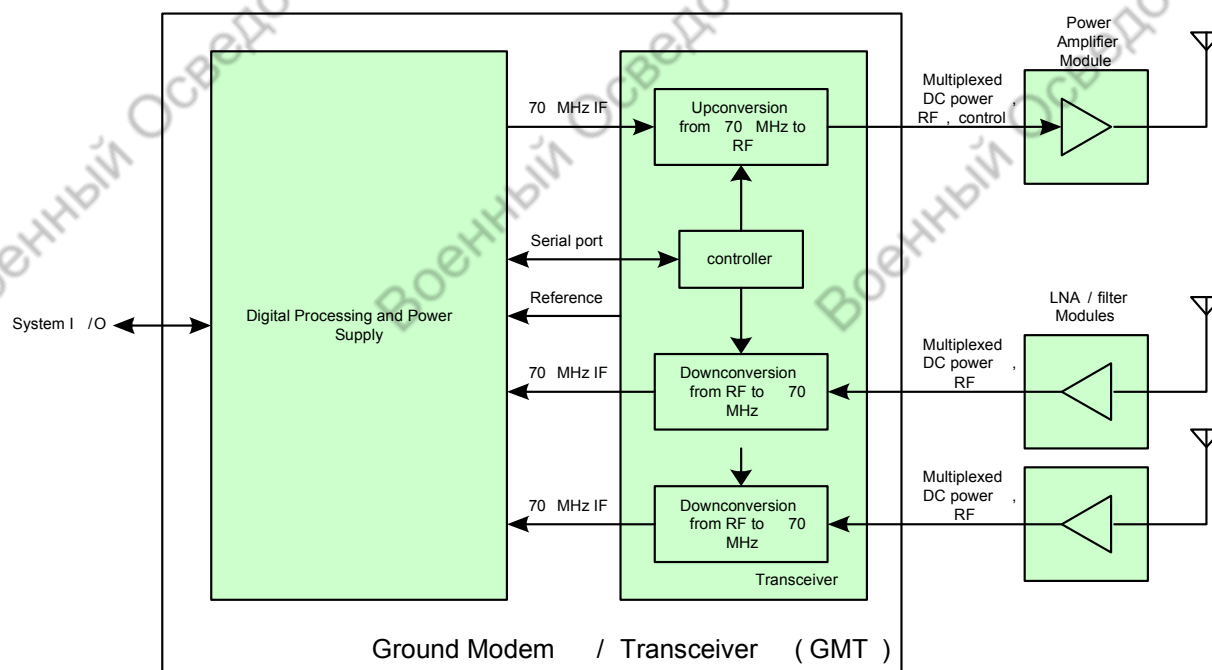
The Ground Modem Transceiver (GMT) will receive the radio signal generated by the AMT and use digital communication techniques to recover the multiplexed data generated by the AMT. The data is demultiplexed and distributed to ports which correspond to the different input ports used at the AMT¹. The GMT also provides the ability to distribute the data to a PC based application, EnerView™. EnerView can display the received video in real time and archive all of the received data.

As mentioned above, the EnerLinksIII provides a two way data link, so that the GMT can collect data from different sources and transmit that data to the AMT. The EnerLinksIII uplink employs the same radio technology and digital communication techniques which are available on the downlink. The GMT will accept the following data types for transmission on the uplink:

- Data from an Ethernet port, which can be either TCP or UDP
- Up to two channels of audio data
- Up to six channels of asynchronous data
- One channel of synchronous data

The Ground segment differs from the Aircraft segment in that it has two down converters so that it can receive two RF signals, operating in either antenna space diversity mode or frequency diversity mode. In space diversity mode, the two are always tuned to the same frequency where as in frequency diversity mode, each converter is tuned to independent frequencies.

¹ The GMT does not have output ports for digital (high definition) video, but rather streams the compressed video via MPEG-2 TS out the Ethernet port.

**Figure 1: Aircraft Segment****Figure 2: Ground segment**

The EnerLinksIII AMT is available with an L/S band radio transceiver or a C-Band radio transceiver. The EnerLinksIII GMT is available with an L/S band radio transceiver or a C-Band radio transceiver, or both. When both the L/S band and C-band transceivers are installed in the GMT, you can select which transceiver to use for communication while the unit is operating. Only one transceiver may be active at a time. In order to support full-duplex radio operation, each EnerLinksIII radio transceiver has two operating bands; upper and lower band. The user has the flexibility of assigning the TX band or the RX band to either the upper band or lower band of the transceiver. Although swappable, the band assignments are constrained so that both the TX and the RX bands cannot operate in the same band.

The operating bands for each EnerLinksIII system are shown below. Specific frequency ranges supported within each band may vary based on the radio model installed.

L/S band radio

- L band: 1700-1850 MHz
- S band: 2200-2500 MHz

C band radio

- Lower C-band: 4400-4950 MHz
- Upper C-band: 5250-5850 MHz

2.1 Components of the EnerLinksIII System

- The Airborne Modem Transceiver (AMT) incorporates both uplink and downlink functions. The AMT receiver chain down converts the RF input signal to the AMT to the 70MHz IF that is then passed to the MODEM. The MODEM employs baseband demodulation signal processing including a bit synchronizer and FEC decoding and demultiplexing. The downlink functions include video compression, multiplexing, and baseband transmit signal processing consisting of FEC encoding, interleaving and pre-modulation filtering. The AMT transmit chain receives its baseband signal from the MODEM section and then upconverts the signal to the TX frequency at the transceiver. The transceiver output is then amplified by the external Power Amplifier (PA) module.
- The Ground Modem Transceiver (GMT) also incorporates both uplink and downlink functions. The downlink functions include an RF receiver, receive signal processing functions including a bit synchronizer and FEC decoding, demultiplexing, and video decompression. The uplink functions include multiplexing and baseband signal processing consisting of FEC encoding, interleaving, and pre-modulation filtering, as well as RF transmission. Up to two transceivers may be installed in the GMT, with only one active at any time.

Note that there are two models of the AMT available, the AMT and the AMT HD. The AMT HD model includes all the capabilities of the AMT model but includes two additional HD-SDI digital video ports that can be enabled through a separately purchased feature license. In general, “AMT” is used to refer to both models in this User Guide. Where differences exist between the two models, the AMT HD model will be called out specifically.

In addition to these components, a desktop or laptop PC may be used with either the AMT or the GMT. The laptop is used to configure and monitor the EnerLinksIII components using a graphical user interface. A command line interface is also provided, but the GUI is far more intuitive and easier to use and is thus recommended for most users.

The remainder of this document is focused on the configuring and operating the EnerLinksIII systems using either the GUI interface or command line interface.

3 Graphical User Interface (GUI)

The AMT and GMT each can be controlled by a Graphical User Interface (GUI).

Important Note: The GUI operates using a web based interface. The web interface may not operate until the networking characteristics of the AMT or GMT are configured. This is done using commands from the Command Line Interface over the Serial Port or the USB Port. The complete Command Line Interface is described in section 4 of this document. The specific commands required to configure the network so that the GUI can be operated are described in section 3.1. The GUI only supports Internet Explorer version 6 and later.

3.1 Configuring the IP address of the AMT or the GMT

When an AMT or GMT is first used with the GUI, or when it is connected to a new network, it may be necessary to reconfigure the network settings for the AMT or GMT using the command line interface command set. The command line interface command set is described in detail in section 4, but for simplicity the complete procedure for setting the network settings is described here.

Connect a laptop PC to the AMT or GMT either using the control serial port or the USB connection. Use the terminal emulation program HyperTerminal (provided with the laptop) with the baud rate set to 38,400 bps, 8 bits, one stop bit, no parity, no flow control. Type the Enter key until a prompt appears (either “AMT” or “GMT” depending on which unit the PC is connected to).

Use the “IP” command to specify the IP address. The IP command has the syntax:

```
IP [dhcp/static] <IP address> <subnet mask> <default gateway>
```

3.1.1 Static IP addresses

In some networks, the network administrator will specify a fixed IP address that the AMT or GMT should use. An example of specifying the IP address for an AMT is shown below:

```
AMT> IP static 192.168.1.254 255.255.255.0 192.168.1.1
```

3.1.2 Obtaining an IP address automatically

In other networks, a protocol called Dynamic Host Configuration Protocol, or DHCP, allows devices on the network to obtain IP addresses automatically. If your network supports DHCP, the AMT or GMT may be configured to obtain an IP address automatically.

If the network also contains a DNS server, and the DHCP server is configured for dynamic DNS updating, the EnerLinksIII™ can be accessed by its host name instead of the IP address. To do this, use the NAME command to set the host name and domain name. The syntax of this command is: NAME <host name> <domain name>

For example:

```
AMT> NAME EnerLinksIII_A network.gov
```

To set the IP address mode to DHCP, use the IP command as follows:

```
AMT> IP dhcp
```

If the network does not contain a DNS server, setting the host name is optional.

3.2 Accessing the GUI

The GUI can be accessed over a TCP/IP network via Ethernet. To access the GUI via an Ethernet connection, enter either the IP address or the EnerLinksIII host name in the Address window of your internet Explorer browser and click the “Go” button. The browser will then display a Login pop-up screen.

Host Name

The network administrator may assign a host name and domain name to the AMT or GMT. If the host name is unknown, it can be obtained by connecting an RS-232 or USB cable to the unit, opening a HyperTerminal connection, and typing the command NAME. This command returns the host and domain names.

For example:

```
AMT> NAME
Current config:
network name:  "EnerLinksIII_A"
domain name:   "network.gov"
```

In this example, the user would enter EnerLinksIII_A.network.gov in the Explorer address window. Note that the host and domain names need to be joined by a period. The IP address for the host name can be resolved by your PC using either the Domain Name System (DNS) or NetBIOS Name Service (NNS).

DNS may be used by adding a name server resource record for your AMT or GMT to a DNS server that serves your domain. When your PC attempts to resolve the IP address for your AMT or GMT's host name, it will send a query to the DNS server, which will return the associated IP address. If the domain configured for your PC matches the domain name configured for your AMT or GMT, only the host name needs to be entered in the Explorer address window. Otherwise, the host and domain name must be entered, separated by a period. Note that EnerLinksIII does not support dynamic DNS updates.

When NetBIOS is used, the host name does not need to be added to any central server. This means that the host name can be used to access the EnerLinksIII unit without any further configuration. The AMT or GMT will respond to broadcast NetBIOS name query requests that match its configured host name. In this case, the AMT or GMT must be on the same subnet as the PC trying to contact it. When using NetBIOS, the host name is restricted to no more than 15

characters, and the domain name is not used. Only the host name should be entered in the Explorer address window when NetBIOS is used. EnerLinksIII only supports the name service portion of the NetBIOS system, and only the name query portion of the NNS. It does not support registration with a NetBIOS name server.

Your PC will typically attempt to resolve your host name using DNS first, and then NetBIOS.

IP Address

If the IP address is unknown, it can be obtained by connecting an RS-232 or USB cable to the unit, opening a HyperTerminal connection, and typing the command IP. This command returns the method of obtaining an IP address (DHCP or static) and the IP address, subnet mask, and gateway address.

For example:

```
AMT> IP
Current config:
Static IP      192.168.1.254
Subnet Mask    255.255.255.0
Default Gateway 192.168.1.1
```

In this example the user would enter 192.168.1.254 in the Explorer address window.

For remote units, the network administrator must provide the IP address or host and domain name of the EnerLinksIII AMT or GMT.

3.3 GUI User Access Modes

The GUI supports three modes of access: a full access mode, a view-only access mode, and a restricted access mode. The access mode granted to a user is determined by the user name and password combination used to log in to the GUI.

Full Access User

A Full access user can modify all system parameters, including user names and passwords. To avoid confusion about configuration it is recommended that only one user at a time should be granted Full access. The “Administrator” user name cannot be changed, though the password can be changed. Therefore, it is recommended that the one Full access user should be “Administrator”.

View-Only Access User

A View-Only access user can view all of the pages accessible by the full access user, but cannot make any configuration changes.

Restricted Access User

A restricted access user can view a single page representing the entire system status, and has the ability to only select different configuration templates, select the RF transmit and receive frequencies, adjust the video picture, and configure the audio headphones.

3.4 Logging in to the GUI

The user enters the GUI via the Login pop-up screen. Password protected login is required on the Ethernet interface to prevent unauthorized persons from viewing the status of the AMT or GMT and to prevent them from changing the system configuration.

In the login pop-up screen, enter the user name and password and click the OK button. The access mode associated with the user name and password pair is set by the administrator when the user name is created.

When first shipped from the factory, the AMT and GMT each have a default Full access username and password combination. The password should be changed before the system is put into service (this can be done using the system page of either the AMT or GMT). The default username is “Administrator” and the default password is “1Cap1Num”. These passwords are case sensitive.

Navigation Controls

If the login is successful, the Downlink Status page will appear for full access and view-only users. The Config page will appear for restricted access users. These pages and the other pages in the GUI are described in detail in individual sections discussing the AMT and GMT below.

By default, a navigation tree is placed across the left side of the GUI page. Clicking on a tab in the tree launches the indicated control/status page. The set of controls in the tree is the same no matter what page of the GUI is accessed. However, when orderwire connection is established additional control tabs are added to the GMT GUI page to support control of the remote AMT.

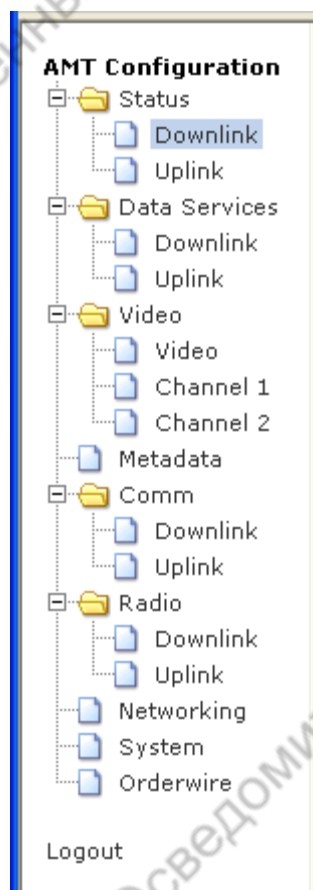


Figure 3: EnerLinksIII Navigation Menu

The different navigation tabs available to the full access and view-only users have the following purpose:

- **Status:** Provides a one-page summary of all significant system configuration and status values. A separate page is provided for the uplink and the downlink status. No entries can be modified on this page.
- **Data Services:** Defines the characteristics for all the different data service inputs to the multiplexed data stream and displays the status of each demultiplexed data service. A separate page is provided for the uplink and the downlink data services.
- **Video:** Defines all characteristics of the video, including compression type, format, input jack, color control, resolution, crop, compression ratio, and text overlay. A separate GUI page is provided for controlling each video channel.
- **Metadata:** Provides the ability to synchronize metadata messages with video.
- **Comm:** Defines the characteristics of the RF communications signal processing, including transmitted bit rate, FEC coding, and interleaving. Provides an ability to conduct BER tests as well. A separate page is provided for configuration of uplink and downlink communications.
- **Radio:** Provides configuration and status of the radio transmitter and receiver, which is primarily the carrier frequency. Separate pages are provided for configuration of uplink

and downlink radios. A separate page is also provided on the GMT for configuration of the antenna steering system.

- **Networking:** Provides the ability for the user to configure the EnerLinksIII network interface for communication with an IP network and configure the EnerLinksIII system to provide an IP proxy ARP bridge or gateway capability. This page also includes the configuration of the IP ports and addresses used to send data to the EnerView application or an MPEG-2 transport stream.
- **System:** Provides information about the unit being controlled including serial numbers of subassemblies, and revision levels of firmware and hardware. User/password accounts are changed through this page as well as configuration templates. This page also includes the ability to set and see the system clock.
- **Orderwire:** Provides configuration and status of the Orderwire service.
- **Flight Test (GMT Only):** Provides a single page summarizing information that is often used during a flight test.
- **Logout:** Logs the user out of the system. Clicking this tab causes the user to be logged out of the system. The user should close the GUI window after logging out.

Application of Configuration

The EnerLinksIII configuration changes immediately in response to the following actions:

- clicking on a radio button
- changing the check status of a checkbox
- moving a slider
- selecting a value from a drop down window
- dragging a value for the on-screen display
- typing a number or text in a box and typing Enter, or clicking the mouse anywhere else on the same page

When typing a value into an entry box, the user must hit the “Enter” key or click the mouse anywhere else on the same page to make the value take effect.

A small number of configuration changes require the user to press a “Start Test” or “Apply” button. These are called out in the manual wherever they occur.

Automatic Page Updates

Several GUI pages contain fields that are automatically refreshed without having to reload the page. These fields include counter values and status indicators. Fields that are automatically updated are noted in the detailed page descriptions below. In order to update these fields, the GUI will continuously communicate with the AMT or GMT via HTTP. On each page supporting automatic refresh, an LED image is displayed in the navigation bar to indicate the status of the GUI connection to the AMT or GMT. The indicator will be green if the connection to the AMT or GMT is functioning properly, and it will be red if the connection is lost. The indicator will pulsate green each time a message is successfully received from the AMT or GMT, and it will pulsate red whenever a request is determined to have failed. The location of this indicator is highlighted in Figure 4 below.

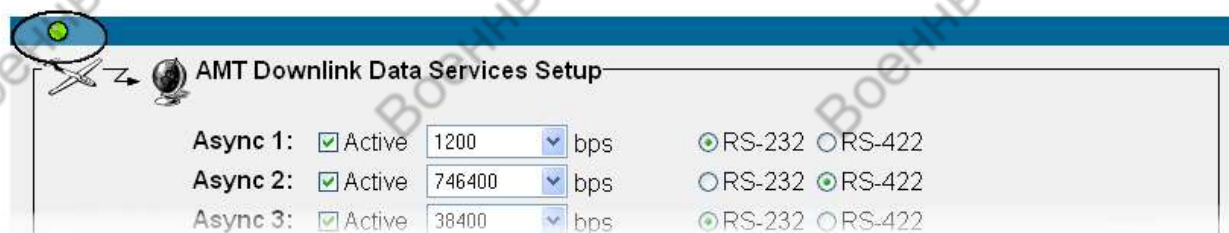


Figure 4: GUI Connection Indicator

Navigation Bar Color

The color of the navigation bar at the top of each GUI page indicates whether AES is enabled. AES is an optional licensed feature on EnerLinksIII. A detailed description of this feature is provided in section 6 of this document. If AES encryption is not enabled for the transmitted or received multiplexed data stream, the navigation bar is blue. This is how the navigation bar is displayed in most of the figures throughout this document. If AES encryption is enabled for the transmitted data stream, or clear text messages in the received data stream indicate that AES is enabled for that stream, the navigation bar changes to red. An example of this can be seen in Figure 5.

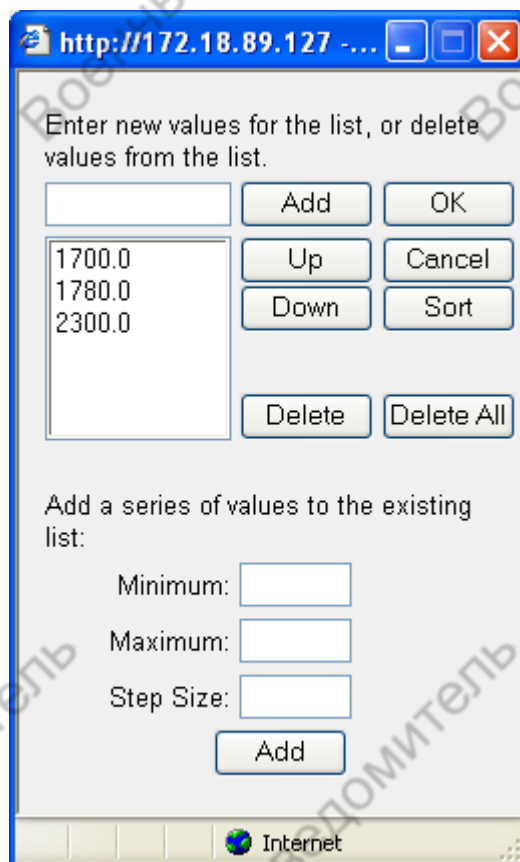
Note that the AES feature license does not have to be enabled for an EnerLinksIII unit to detect that the received data stream is encrypted. If an encrypted stream is received by a unit that does not have the AES feature license enabled, the navigation bar will become red, and the “Lost Crypto Sync” and “Invalid AES Password” faults will be set.



Figure 5: GUI Navigation Bar with AES Enabled

Edit List Popup

The option “Edit list...” appears in many drop down selection windows. It is used for fields such as radio frequency, where the system stores several values the user has previously entered. Figure 6 shows the Edit List pop up box.

**Figure 6: Edit List Pop Up Box**

When Edit List is chosen, the following options appear in a new configuration box:

- **Add:** To add a new value, type the value in the text field and click the Add button. Some fields such as radio frequency allow the value to have a decimal point. If a new value is typed and the Enter key is pressed, the new value is added to the list, selected as the current configuration value, and the popup box is closed. If an invalid value is entered, the closest valid value is added to the list.
- **Up/Down:** To reorder the list, highlight a value and click the Up or Down button.
- **Sort:** To reorder the entire list in ascending order, click the Sort button.
- **Delete:** To delete a single value, highlight the value and click the Delete button. Multiple values may be highlighted and deleted with a single click. Highlight the first value to be deleted, then hold down the Shift key while highlighting the last value to be deleted. The display should show the entire range of values highlighted. Click the Delete button to delete all highlighted values from the list.
- **Delete All:** To delete the entire list, click the Delete All button.

- **OK:** The OK button accepts changes to the list and closes the popup. The value currently displayed in the box next to the Add button is used as the new configuration. Double-clicking on an item in the list causes it to be selected, and the popup box is closed.
- **Cancel:** The Cancel button closes the pop-up window without changing the list or the current configuration.

3.5 AMT GUI Pages for Full Access and View-Only Users

3.5.1 AMT Downlink Status and Configuration

The AMT Downlink Status page is shown in Figure 7. This page summarizes the configuration of the downlink parameters in the AMT. However, no configuration changes can be made on the status page. Detailed explanations of the various status and configuration values are provided in sections describing the specific pages that the values are drawn from.

The status page includes a bar chart graphic that shows the allocation of bandwidth among the different data sources served by the downlink multiplexer. This page also provides system status for the AMT.

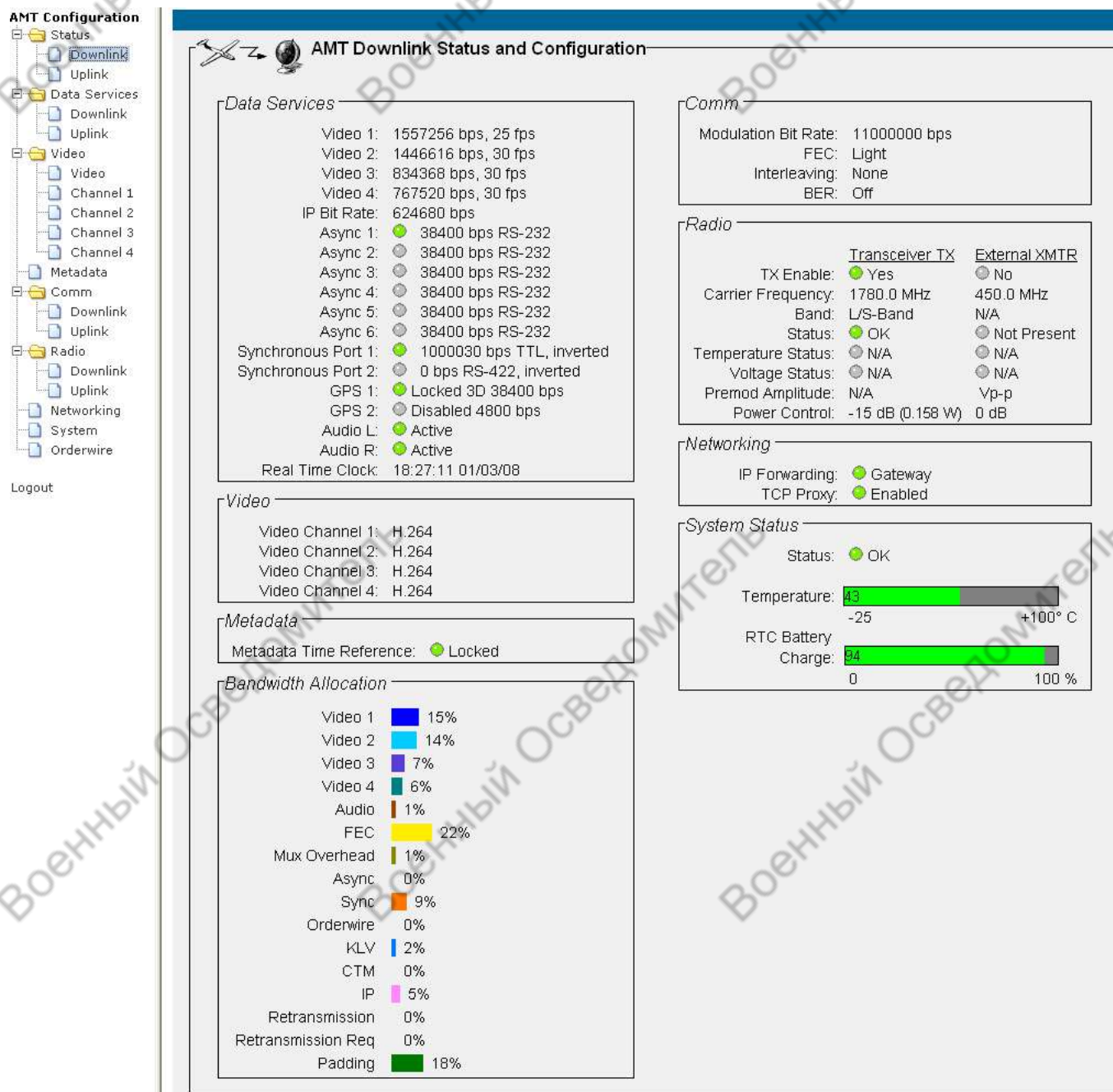


Figure 7: AMT Downlink Status and Configuration Page

Data Services

This section provides a summary of the configuration for each data service.

Video 1 through 4 provides an estimate of the bit rate and frame rate for each video channel. The rate is dependent upon the video compression type selected for each channel, the video content, the compression specific video settings (like the GOP setting in H.264), the data rates of the other data ports in the system, the downlink modulation bit rate, and the forward error

correction (FEC) and interleaver overhead. The displayed bit rate and frame rate are averaged over the past 10 seconds. If a video channel is disabled then its bit rate and frame rate will be 0.

IP Bit Rate displays the rate of IP data transmitted over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of each port. Green indicates that the port is enabled. The configured port rate and interface type are also shown.

Synchronous Port 1 and 2 provide an indicator for the status of each sync port. Green indicates that the port is enabled. The data rate (accurate within 100 bps) and the interface type are listed.

GPS 1 and 2 indicates the current status of each GPS port, which may be connected to an external GPS receiver. Not Responding indicates a fault in the GPS hardware. Not Locked indicates the GPS device is functioning, but does not have valid position lock. Locked 2D or Locked 3D indicate the GPS device has a valid position lock. The configured rate for the port is also listed.

Audio L and Audio R indicate the status for the two audio channels. Green indicates that the audio channel is enabled.

Real Time Clock provides the current system time and date of the AMT.

Video

This section displays the video compression mode selected for each video channel.

Metadata

This section displays the status of the metadata time reference used to synchronize metadata and video. The status may be Disabled, Locked, Sync Lost, or Invalid TOD. Sync Lost indicates that the system is not receiving time reference messages or the one PPS signal associated with those messages. Invalid TOD indicates that the TOD valid flag was not set in the most recent time message received.

Bandwidth Allocation

This section provides a bar chart graphic showing an estimate of the allocation of bandwidth among the different data sources served by the downlink multiplexer. This graph also displays the bandwidth required to support any FEC, as well as the overhead used by the system.

Comm

This section shows the current downlink communication settings for the modulation bit rate, forward error correction (FEC), interleaving, and bit-error rate testing (BER).

Radio

This section provides information about the configuration and status of the radio transmitters. The AMT operates with one internal transceiver, and will support one external transmitter for analog bypass mode. Support for the external transmitter is not provided at this time. The first

signal indicates if a transmitter is enabled. The configured carrier frequency is listed next, followed by the frequency band of the transmitter. The second signal indicates the status of the radio. The third signal indicates the Temperature status of the radio, Normal or Hot, if a temperature sensor is available on the external transmitter. The fourth signal displays the voltage status as reported by the external transmitter, Normal or Low, if the transmitter model supports voltage status monitoring. The next item provides the configured amplitude of the pre-mod output signal sent to the external transmitter. The final item displays the power control level setting for the transceiver and external transmitters that support power control.

Networking

This section displays the status of the IP forwarding and TCP Proxy configuration.

System Status

This section shows an indication of overall system status and two status bars which indicate system wide parameters.

System Temperature

The first bar shows the system temperature in degrees Centigrade. The color of the bar indicates any affect this may have on the system performance. If the bar is green, the temperature is in the normal operational range of the AMT.

Real Time Clock (RTC) Battery Charge

This bar graph indicates the charge remaining in the Real Time Clock battery. If the charge is low, the system time may be lost if the AMT is powered down for an extended amount of time.

3.5.2 AMT Uplink Status and Configuration

The AMT Uplink Status page is shown in Figure 8. This page summarizes the configuration of the uplink parameters in the AMT. However, no configuration changes can be made on the status page. Detailed explanations of the various status and configuration values are provided in sections describing the specific pages that the values are drawn from.

The status page includes a bar chart graphic that shows the allocation of bandwidth among the different data sources served by the uplink multiplexer. This page also provides system status for the AMT.

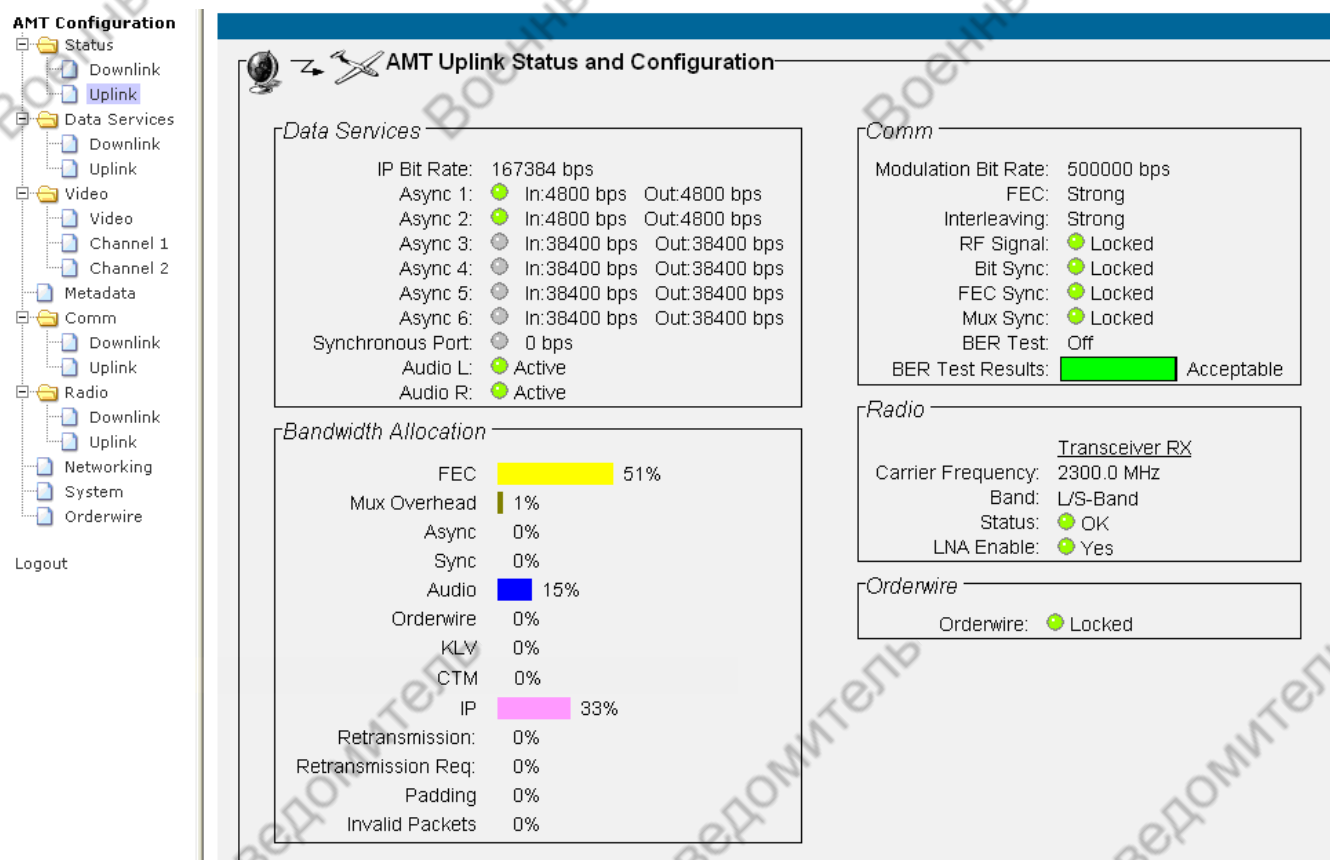


Figure 8: AMT Uplink Status and Configuration Page

Data Services

This section provides a summary of the configuration for each data service available in the uplink.

IP Bit Rate displays the rate of IP data received over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of the port. Green indicates that the port is enabled at the GMT. The configured port rate of both the input at the GMT and the output at the AMT are provided.

Synchronous Port provides an indicator for the status of this port. Green indicates that the port is enabled at the GMT. The data rate (accurate within 100 bps) is listed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled at the GMT.

Bandwidth Allocation

This section provides a bar chart graphic showing an estimate of the allocation of bandwidth among the different data sources served by the multiplexer. This graph also displays the bandwidth required to support any FEC, as well as the overhead used by the system.

Comm

This section shows the current communication settings for the modulation bit rate, forward error correction (FEC), and interleaving. The AMT also shows if it has detected a bit-error rate (BER) test initiated at the GMT. The current status of RF Signal detection, Bit Sync Lock, FEC lock, and the Mux Sync are also displayed. A bar graph indicator shows a qualitative assessment of the bit error rate in the received signal.

Radio

This section provides information about the receive configuration and status of the transceiver which is contained in the AMT. The configured carrier frequency is listed, followed by the frequency band of the receiver. A signal indicates the status of the transceiver. The final item provides the status of the LNA control line, enabled or disabled.

Orderwire

This section provides the status of the orderwire connection. The status is either Disabled, Locked, or Not Locked.

3.5.3 AMT Downlink Data Services

The EnerLinksIII AMT provides the ability to combine, or multiplex, data from a variety of sources into a single transmitted bit stream that the EnerLinksIII GMT is able to separate, or demultiplex, into the original separate streams. The Downlink Data Services page of the GUI is shown in Figure 9. This page allows the user to configure the various data sources to be multiplexed and also provides related status.

All controls on the Downlink Data Services page are accessible only by users with Full access privileges. All parameters are visible to both full access and view-only users. These users may also clear the packet counters.

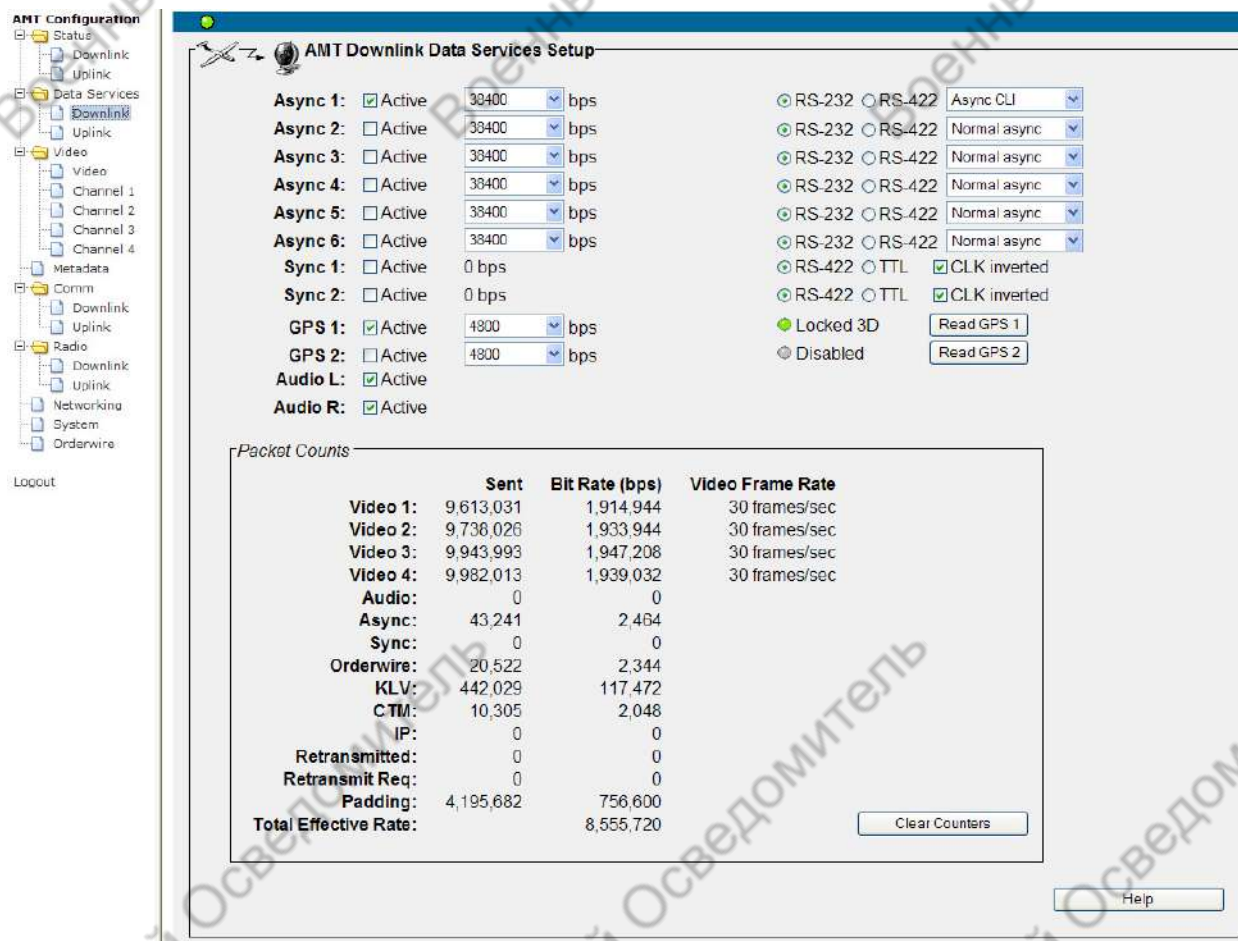


Figure 9: AMT Downlink Data Services Setup Page

Async Data Ports

The EnerLinksIII AMT supports up to 6 asynchronous data ports in the downlink, used for serial type data such as that provided from a UART in a typical “COM Port” from a PC. The AMT supports either RS-232 or RS-422 (differential) signal levels for these data ports. The range of allowed baud rates is from 300 bps to 115.2 kbps using the RS-232 interface, and from 300 to 921.6 kbps using the RS-422 interface. The source device must be set to 8 data bits, 1 stop bit, no parity and no flow control.

To enable an asynchronous data port, click the “Active” checkbox so that it shows a checkmark. Select the baud rate from the drop down menu. Select the appropriate interface (RS-232 or RS-422) using the radio buttons.

Because the data line for Async port 6 may be used as an input for the 1 pulse-per-second metadata time reference signal, this port cannot be enabled when metadata time reference is enabled. Similarly, it must be disabled before the metadata time reference can be enabled.

Async CLI

Async ports 1 and 2 may be used as command line interface ports by selecting “Async CLI” from the associated drop down menus. When Async CLI is enabled for a port, the AMT will react to commands received over those async ports as though they are received over the console port. The AMT will receive commands over the downlink async input pins, and return responses on the uplink async output pins. When Async CLI is enabled, the baud rate configured for downlink async data service will be used for both transmit and receive command line interface communication. Commands will be processed in the order that they are received from either of the Async CLI ports or the standard console port.

When the Async CLI is enabled on an async port, a standard GPS device which outputs NMEA-0183 sentences may be connected to the async port. Any NMEA-0183 sentences received on an Async CLI port which begin with \$GPRMC, \$GPGGA, or \$GPGLL are reflected to the GPS 1 downlink port if the GPS 1 downlink port is also enabled. The Async CLI ports can also auto-detect if they are connected to a camera ball by checking for the start of message and end of message markers (which are camera ball manufacturer specific). If a camera ball is detected on an Async CLI port, the AMT will generate the equivalent NMEA-0183 \$GPRMC, \$GPGGA, and \$GPGLL sentences and send them on the GPS 1 downlink port if the GPS 1 downlink port is also enabled.

When connecting a GPS device or camera ball to an Async CLI port, remember that the baud rate used on the async port is the baud rate configured for the async port, not the baud rate configured for the GPS 1 port. The AMT does not generate any protocol on an async CLI port which is intended to be used as an input to a GPS device or a camera ball. If used for either of these purposes, the AMT’s uplink output pins for the Async CLI port should not be connected to the GPS device or the camera ball.

Camera Control

Separate from the Async CLI feature, any of the async ports may be used to connect to a camera ball for full duplex communication, status, and control. A hand controller is then connected to the GMT’s uplink async port, and the commands from the hand controller are sent to the camera ball. Different camera balls and hand controllers are supported, but the correct combination must be selected from the drop-down box. When using an async port for camera ball control, both the uplink and downlink async ports are used. The baud rates and physical interface (RS-232 vs. RS-422) are selected as usual. If the camera ball supplies GPS information, the AMT will generate NMEA-0183 \$GPRMC, \$GPGGA, and \$GPGLL sentences and send them on the GPS 1 downlink port if the GPS 1 downlink port is also enabled.

Async TCP/IP Configuration

The AMT listens for a TCP/IP connection on specific ports. When an application is connected to one of the AMT’s TCP/IP ports, the AMT sends all data received over the TCP/IP socket as downlink async data, and sends all uplink async data over the TCP/IP socket. The AMT can support up to ten clients at a time connected to each port. For the six async ports, the AMT listens on TCP/IP port numbers 1031 through 1036.

Sync

The EnerLinksIII system supports two channels of Synchronous data in the downlink. Synchronous data is a data stream provided at a continuous bit rate and accompanied by a clock. Synchronous data is supported at bit rates up to 10 Mbps using either an RS-422 (differential) or single ended TTL interface.

To enable a synchronous data port, click the “Active” checkbox so that it shows a checkmark. Use the radio buttons to specify whether the interface is RS-422 or TTL, and also select the “CLK inverted” check box if the falling edge of the clock is active.

If a synchronous data port is enabled, the AMT will automatically determine the input data rate and display it within 100 bps accuracy. The current input data rate is automatically refreshed in the GUI display approximately once a second.

GPS

The EnerLinksIII AMT includes two RS-232 GPS ports which may be connected to GPS receivers. The AMT is able to receive and interpret GPS data provided in an NMEA 0183 data format. The following parametric sentences are interpreted by the EnerLinksIII system:

GGA – Global Positioning System Fix Data

GLL – Geographic Position – Latitude/Longitude

RMC – Recommended Minimum Specific GNSS Data

To enable a GPS port, click the “Active” checkbox so that it shows a checkmark. The data rate can be set to either 4800 bps, 9600 bps, or 38.4 kbps. This page also provides status indicators for the GPS interfaces. Not Locked indicates the GPS device is functioning, but does not have valid position lock. Locked 2D or Locked 3D indicate the GPS device has a valid position lock. Not Responding indicates a fault in the GPS hardware. The current GPS status is automatically refreshed in the GUI display approximately once a second. Clicking the Read GPS button will pop-up the latest latitude, longitude, and altitude readings from the GPS module.

When GPS port 1 is enabled, GGA, GLL and RMC sentences may also be sent to any of the AMT CLI interfaces (the console port or an Async CLI port) to be included in the GPS port 1 data stream. When sent to the console port, GPS messages should be sent using the RS-232 signal type at 38400 bps. When sent on an Async CLI port, they should be sent using the signal type (RS-232 or RS-422) configured for the port and at the rate configured for the port. To avoid conflict, GPS messages intended for the GPS port 1 data stream should only be sent on one interface at a time.

Note that the data rate setting for GPS port 1 does not have to match the rate setting for the Async CLI port or console port for the EnerLinksIII to be able to receive and interpret GPS data from these interfaces. However, to prevent data overflow at the GMT GPS port 1 output, the rate of GPS data written to any CLI port should not exceed the GPS port 1 output data rate setting on the GMT.

GPS TCP/IP Configuration

The AMT listens for a TCP/IP connection on specific ports. Applications such as FalconView can be configured to connect over the network to the AMT's IP address and the TCP/IP port number. When an application is connected to one of the AMT's TCP/IP ports, the AMT sends all of the NMEA 0183 GPS data for the corresponding GPS port to the application over the network. The AMT can support up to ten clients at a time connected to each port. For the two GPS ports, the AMT listens on TCP/IP port numbers 1041 and 1042.

Audio L and Audio R

The EnerLinksIII AMT has two audio ports that accept an analog line level input. The audio ports can be stereo inputs, completely separate audio sources, or only one port can be used in a mono mode. The audio ports provide voice grade, toll quality (meaning that it is as good as voice transmitted over a standard wireline phone system) digitized at 8 ksamp/sec and uLaw compressed to create a 64 kbps bit stream for each audio channel.

Clicking the “Active” checkbox so that it shows a checkmark causes the corresponding audio signal to be digitized and multiplexed into the transmitted bit stream.

Packet Counts

The Packet Counts table displays the number of packets sent and the transmit bit rate for each type of data sent by the AMT. All values in this table are read from the AMT and automatically refreshed in the GUI display approximately once a second.

All packet counts in this table refer to the variable-size 8 to 256 byte EnerLinksIII packets sent in the multiplexed data stream between the AMT and GMT. Each EnerLinksIII mux packet contains information indicating the packet type, sequence number, length and CRC.

The bit rates displayed represent the rate of data transmitted over the multiplexed data stream averaged over the last 10 seconds.

Video Data Counters

The video bit rate displayed in the Packet Counts table shows the rate of video data being transmitted for each video channel that is currently enabled. The method of allocating bandwidth for video data is selected on the AMT Video Setup page. When the Variable Bit Rate method is selected, video data is always transmitted at the highest rate possible given the AMT configuration of the other data services. When the Fixed Bit Rate method is selected, video data is limited so that it never exceeds a specified maximum bit rate, and it is given priority over IP traffic.

The bandwidth available for carrying the entire multiplexed bit stream is a function of the modulation bit rate and FEC parameters specified in the downlink communications GUI page. In Variable Bit Rate mode, the bit rate requirements of all of the other data services are met by the multiplexer before it includes video in the multiplexed bit stream. The video streams are allocated all of the remaining bandwidth.

In Fixed Bit Rate mode, video data is given priority over forwarded IP traffic. The bit rate requirements of all of the data services other than IP are still met by the multiplexer before it includes video in the multiplexed bit stream. The video streams are then allocated all of the remaining bandwidth up to the specified maximum bit rate. The AMT adjusts the video quality of each video channel to adjust the video bit rate to fit into this remaining bandwidth.

The H.264 algorithm used by the EnerLinksIII system uses individual frame compression as well as inter-picture prediction to perform compression on a video stream. This takes advantage of frame-to-frame similarity of pixels in a given area. This algorithm provides good video quality at substantially lower bit rates than can be achieved with MJPEG. The bit rate of a video stream compressed with H.264 will be reduced to fit the available bandwidth remaining for the stream when all other data services have been handled. The frame rate of an H.264 video stream will typically be kept constant: 30 fps for NTSC channels, and 25 fps for PAL. To reduce the bit rate while keeping the frame rate constant, the amount of compression will be increased. Thus as the available bit rate for a video channel is reduced, the quality of the video is reduced. As the bit rate for a channel is reduced below a certain level, the amount of compression that can be performed reaches a maximum level and the frame rate must be reduced to meet the rate requirements. This frame rate reduction begins to take effect at around 600 Kbps for standard definition video standards and 1.2 Mbps for high definition video standards.

Sync Data Counters

Note that the bit rate for sync data displayed in the Packet Counts table will typically be higher than the sync rate displayed in the section above. The rate in the previous section reflects the input data rate of each sync channel, while the rate in the Packet Counts table includes the overhead associated with the EnerLinksIII mux packets used to carry that data.

CTM Data Counters

The CTM data counter indicates the number of clear text messages transmitted. Clear text messages are sent when the optional AES feature license is enabled. These messages include the “salt” to be used in decryption, as well as information indicating whether AES is enabled at the encoder, to tell the decoder whether AES decryption needs to be performed at all. The clear text message is sent at a regular interval, as specified by the AESCTI command.

IP Data Counters

Ethernet protocol packets forwarded over the multiplexed data stream are segmented as necessary and sent within EnerLinksIII mux packets. Counters for the number of Ethernet and IP protocol packets sent and received over the multiplexed data stream are provided on the Networking GUI page.

Clear Counters Button

This button resets all of the packet counts provided on this GUI page.

3.5.4 AMT Uplink Data Services Setup

The EnerLinksIII GMT provides the ability to combine, or multiplex, data from a variety of sources into a single transmitted bit stream that the EnerLinksIII AMT is able to separate, or de-

multiplex, into the original separate streams. This set of services is very similar to the data services available on the downlink, with the exception that video and GPS services are NOT available on the uplink.

When using the uplink, it is necessary for the user to set the configuration of all the various potential inputs to the GMT Data Services function. This is not necessary at the AMT, because the EnerLinksIII data protocol includes embedded information about the GMT uplink configuration so that the AMT uplink configuration is for the most part automatic.

Figure 10 shows the AMT Uplink Data Services page. All configurable parameters on this page can be modified only by users with Full access privileges. All parameters are visible to both a full access and a view-only user. Both types of users may clear packet counts.

AMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video
 - Channel 1
 - Channel 2
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Networking
- System
- Orderwire

Logout

AMT Uplink Data Services Setup

| | Status | GMT Input Rate | AMT Output Rate |
|-----------|-------------|----------------|--|
| Async 1: | Unavailable | 2400 bps | <input type="checkbox"/> Match Input Rate 38400 bps |
| Async 2: | Active | 115200 bps | 115200 bps |
| Async 3: | Active | 38400 bps | 57600 bps |
| Async 4: | Active | 38400 bps | 38400 bps |
| Async 5: | Not Active | 38400 bps | 38400 bps |
| Async 6: | Not Active | 38400 bps | 38400 bps |
| Sync: | Active | 0 bps | |
| Audio L: | Active | | <input checked="" type="checkbox"/> Headphone Out |
| Audio R: | Active | | <input checked="" type="checkbox"/> Headphone Out |
| Mux Sync: | Locked | | |

Headphone Volume: 41 (0 to 59)

| | Good | Bad | Lost | Bit Rate (bps) |
|------------------------------|---------|-----|------|------------------|
| Async: | 145 | 0 | 0 | 392 |
| Sync: | 0 | 0 | 0 | 0 |
| Audio: | 9,081 | 0 | 0 | 75,152 |
| Orderwire: | 0 | 0 | 0 | 0 |
| KLK: | 0 | 0 | 0 | 0 |
| CTM: | 146 | 0 | 0 | 2,048 |
| IP: | 0 | 0 | 0 | 0 |
| Retransmitted: | 0 | 0 | 0 | 0 |
| Retransmit Req: | 0 | 0 | 0 | 0 |
| Padding: | 270,983 | | | 3,811,152 |
| Invalid: | 0 | | | 0 |
| Total Effective Rate: | | | | 3,888,744 |

Clear Counters

Help

Figure 10: AMT Uplink Data Services Setup Page

Async Data Ports

The EnerLinksIII System supports up to 6 asynchronous data ports on the uplink. These ports are used for serial type data such as that provided from a UART in a typical “COM Port” from a PC.

If any of the Asynchronous ports is active at the GMT, the corresponding Async status indicator will indicate Active on this page, and the baud rate used at the GMT will be displayed in the GMT Input Rate window. The AMT Output Rate is set by selecting a value from the drop-down box. This is the baud rate used to output the Asynchronous port data received from the GMT. This rate must be greater than or equal to the GMT Input Rate value to ensure data integrity. The destination device must be set to 8 data bits, 1 stop bit, no parity and no flow control.

If the AMT Output Rate is too low for the input rate, the AMT will reconfigure the Output Rate to the same as the GMT Input Rate.

There is no configuration required for the output data format for these ports. Data is generated in both RS-232 and RS-422 format.

Note that the rate of all the asynchronous uplink data ports can be set to the exact rate configured at the GMT. Clicking the “Match input rates” checkbox so that it shows a checkmark causes the rate of all asynchronous data ports to match the configuration at the GMT.

If async port 1 or 2 is configured for use as a command line interface on the downlink data services page, the baud rate configured for downlink async data service will be used for both transmit and receive command line interface communication on this port. Thus the rate displayed on this page for the AMT Output Rate will match the downlink rate configured for the port. When Async CLI is enabled for a port, the drop down box for configuring the AMT Output Rate will be disabled and the status will be represented as “unavailable”.

The current status and GMT input baud rate for each Async port are automatically refreshed in the GUI display approximately once a second.

Async TCP/IP Configuration

The AMT listens for a TCP/IP connection on specific ports. When an application is connected to one of the AMT’s TCP/IP ports, the AMT sends all data received over the TCP/IP socket as downlink async data, and sends all uplink async data over the TCP/IP socket. The AMT can support up to ten clients at a time connected to each port. For the six async ports, the AMT listens on TCP/IP port numbers 1031 through 1036.

Sync

The EnerLinksIII system supports one channel of Synchronous data on the uplink. Synchronous data is a data stream provided at a continuous bit rate and accompanied by a clock. Synchronous data is supported at bit rates up to 10 Mbps.

If the synchronous data port is active at the GMT, the corresponding Sync indicator will be set to Active at the AMT and the GMT Input Rate window will show the bit rate of the synchronous

data stream. The user cannot configure the AMT Output Rate for Sync data. The AMT Output Rate always matches the GMT Input Rate exactly.

The current status and bit rate for the Sync port are automatically refreshed in the GUI display approximately once a second.

Audio L and Audio R

The EnerLinksIII GMT has two audio ports that accept an analog line level input for use on the uplink. The audio ports can be stereo inputs, completely separate audio sources, or only one port can be used in a mono mode. The audio ports provide voice grade, toll quality (meaning that it is as good as voice transmitted over a standard wireline phone system) digitized at 8 ksamp/sec and uLaw compressed to create a 64 kbps bit stream for each audio channel.

If one or both Audio ports are active at the GMT, the corresponding Audio indicator will be set to Active at the AMT. The Audio indicators are automatically refreshed in the GUI display approximately once a second.

Headphone Volume

In cases where the audio ports are enabled at the GMT, an AMT user can enable headphone outputs by clicking the “Headphone out” checkbox so that it shows a checkmark for the appropriate audio channel. The headphone volume can be adjusted by using the slider or by manually typing in a volume in the headphone volume box. Valid settings range from 0 to 59, with 59 corresponding to the loudest volume. When only one of the “Headphone Out” check boxes is selected, the enabled audio signal is output to both the left and right headphone channels.

Mux Sync Lock

The Mux Sync Lock indicator is set when the AMT is able to correctly read the data for the different services. Mux Sync Lock status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Packet Counts

The Packet Counts table displays the number of good, bad, and lost packets received by the AMT for each type of data, as well as the received bit rate for each data type. Lost packets are detected by gaps in received sequence numbers. Note that if the sending unit is restarted, the sequence numbers will be reinitialized and a large number of lost packets will be indicated in this display.

All packet counts in this table refer to the variable-size 8 to 256 byte EnerLinksIII packets sent in the multiplexed data stream between the AMT and GMT. Each EnerLinksIII mux packet contains information indicating the packet type, sequence number, length and CRC.

The bit rates displayed represent the rate of data transmitted over the multiplexed data stream averaged over the last 10 seconds. All values in this table are read from the AMT and automatically refreshed in the GUI display approximately once a second.

Sync Data Counters

Note that the bit rate for sync data displayed in the Packet Counts table will typically be higher than the sync rate displayed in the section above. The rate in the previous section reflects the input data rate of the sync channel at the GMT, while the rate in the Packet Counts table includes the overhead associated with the EnerLinksIII mux packets used to carry that data.

CTM Data Counters

The CTM data counter indicates the number of clear text messages received. Clear text messages are sent from the GMT when the optional AES feature license is enabled on that unit. These messages include the “salt” to be used in decryption, as well as information indicating whether AES is enabled at the encoder, to tell the decoder whether AES decryption needs to be performed at all. The clear text message is sent at a regular interval, as specified by the AESCTI command.

IP Data Counters

Ethernet protocol packets forwarded over the multiplexed data stream are segmented as necessary and sent within EnerLinksIII mux packets. Counters for the number of Ethernet and IP protocol packets sent and received over the multiplexed data stream are provided on the Networking GUI page.

Clear Counters Button

This button resets all of the packet counts provided on this GUI page.

3.5.5 AMT Video Setup

The EnerLinksIII system provides the capability to send up to two channels of compressed video data in the downlink transmission stream from the AMT, and four channels of compressed video data from the AMT HD. Three to five pages are provided in the EnerLinksIII GUI to configure the AMT Video parameters. The AMT Video Setup page includes configuration parameters that are associated with all video channels, while the AMT Video Channel Setup pages are used to control channel specific parameters.

Figure 11 shows the Video Setup page for the AMT, and Figure 12 shows this page for the AMT HD. All video configuration parameters are only available to a user with full access privileges.

AMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video**
 - Channel 1
 - Channel 2
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Networking
- System
- Orderwire

Logout

AMT Video Setup

Video Compression

| Video Channel 1 | Video Channel 2 |
|--|---|
| <input type="radio"/> Disabled | <input checked="" type="radio"/> Disabled |
| <input checked="" type="radio"/> H.264 | <input type="radio"/> H.264 |

Video Bit Rate

☐ Variable Bit Rate Maximum Bit Rate bps

☒ Fixed Bit Rate

Video Rate Sharing

Minimum Percent of Video Bandwidth Available to Channel 1

0 % 100

AMT Title

Enter the AMT title strings for display on the GMT, and hit ENTER:

| | |
|------------|--|
| AMT Text 1 | <input type="text" value="Mission One - Test Flight"/> |
| AMT Text 2 | <input type="text" value="Tail Number VB554RT"/> |
| AMT Text 3 | <input type="text" value="123456789012345678901234567890123456789"/> |
| AMT Text 4 | <input type="text"/> |
| AMT Text 5 | <input type="text"/> |
| AMT Text 6 | <input type="text"/> |
| AMT Text 7 | <input type="text"/> |
| AMT Text 8 | <input type="text"/> |

[Help](#)

Figure 11: AMT Video Setup Page

AMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Networking
- System
- Orderwire

Logout

AMT Video Setup

Video Input

| Video Channel 1 | Video Channel 2 | Video Channel 3 | Video Channel 4 |
|--|--|---|---|
| Video Compression | Video Compression | Video Compression | Video Compression |
| <input type="radio"/> Disabled | <input type="radio"/> Disabled | <input checked="" type="radio"/> Disabled | <input checked="" type="radio"/> Disabled |
| <input checked="" type="radio"/> H.264 | <input checked="" type="radio"/> H.264 | <input type="radio"/> H.264 | <input type="radio"/> H.264 |

Video Bit Rate

☒ Variable Bit Rate
☐ Fixed Bit Rate

Video Rate Sharing

Minimum Percent of Video Bandwidth Available to Each Channel

| | | |
|------------|----------------------------------|---|
| Channel 1: | <input type="text" value="25"/> | % |
| Channel 2: | <input type="text" value="25"/> | % |
| Channel 3: | <input type="text" value="25"/> | % |
| Channel 4: | <input type="text" value="25"/> | % |
| Total: | <input type="text" value="100"/> | % |

AMT Title

Enter the AMT title strings for display on the GMT, and hit ENTER:

| | |
|------------|---|
| AMT Text 1 | Mission Two - Test Flight Beta |
| AMT Text 2 | Tail Number VB554RT2 |
| AMT Text 3 | 123456789012345678901234567890123456789 |
| AMT Text 4 | |
| AMT Text 5 | |
| AMT Text 6 | |
| AMT Text 7 | |
| AMT Text 8 | |

Figure 12: AMT HD Video Setup Page

Video Compression

The EnerLinksIII system provides the capability to send up to two channels of compressed video data in the downlink transmission stream from the AMT, and four channels of compressed video data from the AMT HD. The radio buttons in this section allow you to select the video compression standard to use for each video channel, or to disable each video channel. The AMT and AMT HD support only H.264 video compression.

Note that some components are shared between the video channels. Because of this, whenever the video compression of one channel is changed, video processing on another channel may be momentarily suspended as well.

Detailed video channel configuration, including the selection of video source and compression-specific parameters, may be performed in the AMT Video Channel Setup pages described in section 3.5.6 below.

Video Bit Rate

The Video Bit Rate radio buttons are used to select the method of allocating bandwidth for all video data. When the Variable Bit Rate method is selected, video data is always transmitted at the highest rate possible given the AMT configuration of the other data services. When the Fixed Bit Rate method is selected, video data is limited so that it never exceeds a specified maximum bit rate, and it is given priority over IP traffic.

The bandwidth available for carrying the entire multiplexed bit stream is a function of the modulation bit rate and FEC parameters specified in the downlink communications GUI page. In Variable Bit Rate mode, the bit rate requirements of all of the other data services are met by the multiplexer before it includes video in the multiplexed bit stream. The video streams are allocated all of the remaining bandwidth.

In Fixed Bit Rate mode, video data is given priority over forwarded IP traffic. The bit rate requirements of all of the data services other than IP are still met by the multiplexer before it includes video in the multiplexed bit stream. The video streams are then allocated all of the remaining bandwidth up to the specified maximum bit rate. The AMT adjusts the video quality of each video channel to adjust the video bit rate to fit into this remaining bandwidth. This mode may be used to limit the effects of extremely bursty IP traffic on video.

The H.264 algorithm used by the EnerLinksIII system uses individual frame compression as well as inter-picture prediction to perform compression on a video stream. This takes advantage of frame-to-frame similarity of pixels in a given area. This algorithm provides good video quality at substantially lower bit rates than can be achieved with MJPEG. The bit rate of a video stream compressed with H.264 will be reduced to fit the available bandwidth remaining for the stream when all other data services have been handled. The frame rate of an H.264 video stream will typically be kept constant: 30 fps for NTSC channels, and 25 fps for PAL. To reduce the bit rate while keeping the frame rate constant, the amount of compression will be increased. Thus as the available bit rate for a video channel is reduced, the quality of the video is reduced. As the bit rate for a channel is reduced below a certain level, the amount of compression that can be performed reaches a maximum level and the frame rate must be reduced to meet the rate requirements. This frame rate reduction begins to take effect at around 600 Kbps for standard definition video standards and 1.2 Mbps for high definition video standards.

Video Rate Sharing

The Video Rate Sharing control is used to set the percentage of the available video bandwidth that is allocated to each video channel.

This configuration does not define a specific data rate for each channel, but is taken into consideration by the AMT when determining how to apportion available bandwidth. In general, a H.264 video channel will not use more than the percentage of available video bandwidth

assigned to it. A channel may use less than its assigned bandwidth, depending on its compression configuration and the complexity of the video currently being processed.

When entering the percentage of video bandwidth for each channel on the AMT HD, you must hit the “Apply” button for changes to take effect. The total must equal 100% before changes can be applied. You may use the “Distribute Evenly” button to evenly distribute the bandwidth between all four channels.

When a video channel is disabled, the video bandwidth will be distributed among each of the remaining enabled video channels according to their relative percentage within the set of all enabled channels. For instance, if video channels 1 through 4 on the AMT HD are configured to use 10, 20, 30 and 40% of the available bandwidth respectively, then when Video Channel 2 is disabled, the bandwidth will be redistributed among channels 1, 3 and 4 as 12.5, 37.5, and 50 % respectively.

AMT Title

The user can enter up to 8 arbitrary text strings of up to 39 characters each that will be transmitted to the GMT for display using the text overlay feature. Double-quotes are not allowed. The display of this string is enabled on the GMT Video Channel Setup pages, which are described in section 3.6.6 of this document.

3.5.6 AMT Video Channel Setup

A separate GUI page is provided for configuring each video channel. Each video channel setup page contains sections that allow you to configure the video mode, video source, and picture adjustment. It also contains a section that lets you configure parameters that are specific to the video compression type selected for that channel. The contents of this last section will change depending on the video compression standard selected. If the video channel is disabled, this last section will not be displayed, as seen in Figure 13 below.

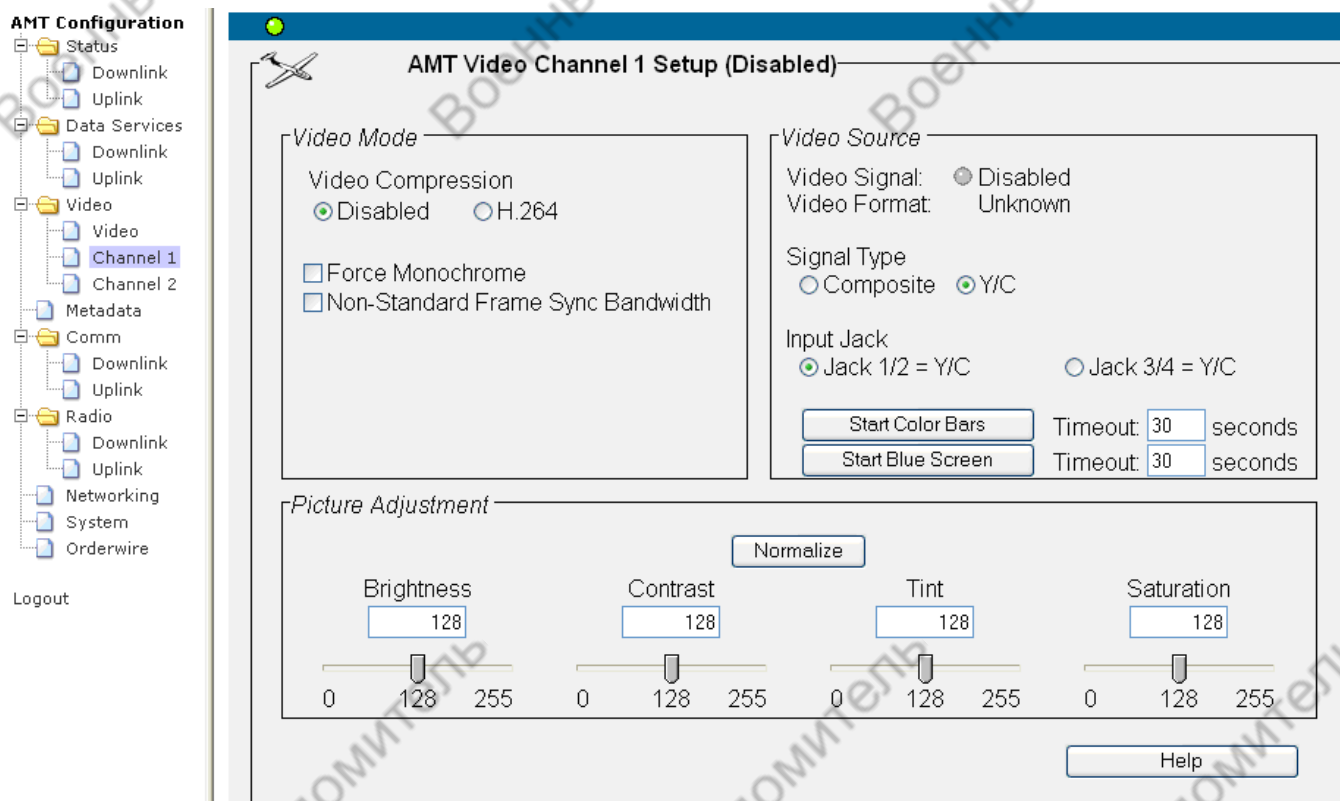


Figure 13: AMT Video Channel 1 (Disabled) Setup Page

Video Compression

The radio buttons in this section allow you to select the video compression standard to use for this video channel, or to disable the video channel. The AMT and AMT HD support only H.264 video compression.

Force Monochrome

This checkbox is used to force the input video signal to monochrome before compression. This may reduce the complexity of the image, providing better image quality at a lower data rate.

Non-Standard Frame Sync Bandwidth

The video mode section also contains a checkbox to enable the “Non-Standard Frame Sync Bandwidth”. This option is available for use with IR cameras which operate at an NTSC frame rate which is slightly different from DVD players or color NTSC video cameras.

Video Signal

When a video channel is enabled, the EnerLinksIII system automatically detects whether a video signal is present for that channel. The Video Signal indicator will illuminate green and present a status of “Locked” if a valid video signal is detected. It will illuminate red and present a status of “No Signal Present” if no signal is detected, or “Unsupported Format” when an unsupported format is detected. If the channel is disabled, the Video Signal status will indicate “Disabled” and the indicator will be gray.

The video signal status will be read from the AMT and automatically refreshed in the GUI display approximately once a second.

Video Format

The EnerLinksIII System supports two widely used video formats. These are:

- NTSC: the standard for color television used in most of North America
- PAL: the standard for color television used in most of Europe. Note that there are several varieties of PAL that are used outside of Europe. The EnerLinksIII supports the PAL-B standard that is most widely used in Europe. It does not support other PAL standards.

When a video channel is enabled, the EnerLinksIII System will automatically detect and display the video format of the input video signal. If no video signal is detected, the last video format detected will be displayed. If the video channel is disabled, the format will be displayed as “Unknown”.

The detected video format will be read from the AMT and automatically refreshed in the GUI display approximately once a second.

Signal Type

Both PAL and NTSC signals can be accepted in composite format, which is a single signal that contains the entire video stream (and potentially audio as well, although the EnerLinksIII does not use the audio), or in Y/C mode in which there are two signals, a luminance (Y) signal and a chrominance (C) signal. Y/C typically provides better quality. To select a signal type, select the appropriate radio button.

Input Jack

The EnerLinksIII AMT and AMT HD are designed with four analog video input jacks used to connect to video sources (typically video cameras). The AMT HD also provides two digital video input jacks which may only be used when the HD Video feature license has been enabled. Configuration of these digital video inputs is discussed in section 7.

If a Y/C input video signal type is selected, jack selection is performed as a pair: “Jack 1/2” may be selected, in which case luminance (Y) must be on Jack 1, and chrominance (C) must be on Jack 2, or “Jack 3/4” may be selected, in which case luminance (Y) must be on Jack 3, and chrominance (C) must be on Jack 4. On the AMT HD, the analog video input jacks are designated as “AV-1” through “AV-4” instead of “Jack 1” through “Jack 4” to distinguish them from the digital video input jacks.

In the Composite mode, all four jacks provide the same function, and the AMT can be connected to as many as four different analog video sources. In this case, the user selects the desired source using the radio buttons.

Start Color Bars and Start Blue Screen Buttons

Under the Video Source heading the user can also choose an internal Color Bar generator or Blue Screen as the source. This mode is useful for testing. To prevent a situation where the color bars

or blue screen are inadvertently left on during operational use, a timeout is provided that can be configured by the user. The input reverts to the last used jack when the timeout expires. To leave the test pattern on indefinitely, set the timeout value to zero (0) seconds. To end the test pattern and revert to an input jack early, simply click on the desired input jack button.

Picture Adjustment

These features allow adjustment of the picture brightness, contrast, tint, and saturation in the same fashion that typical color television sets operate. Each parameter is configured either by use of the slider underneath the parameter or by entering a numeric value in the data box for the parameter. Each of the picture adjustment parameters can be in the range from 0 to 255.

3.5.6.1 AMT H.264 Video Channel Setup

When H.264 video compression is selected on one of the AMT Video Channel Setup GUI pages, a section labeled “H.264 Parameters” will appear at the bottom of this page as seen in Figure 14. This section supports configuration of parameters specific to the H.264 compression format.

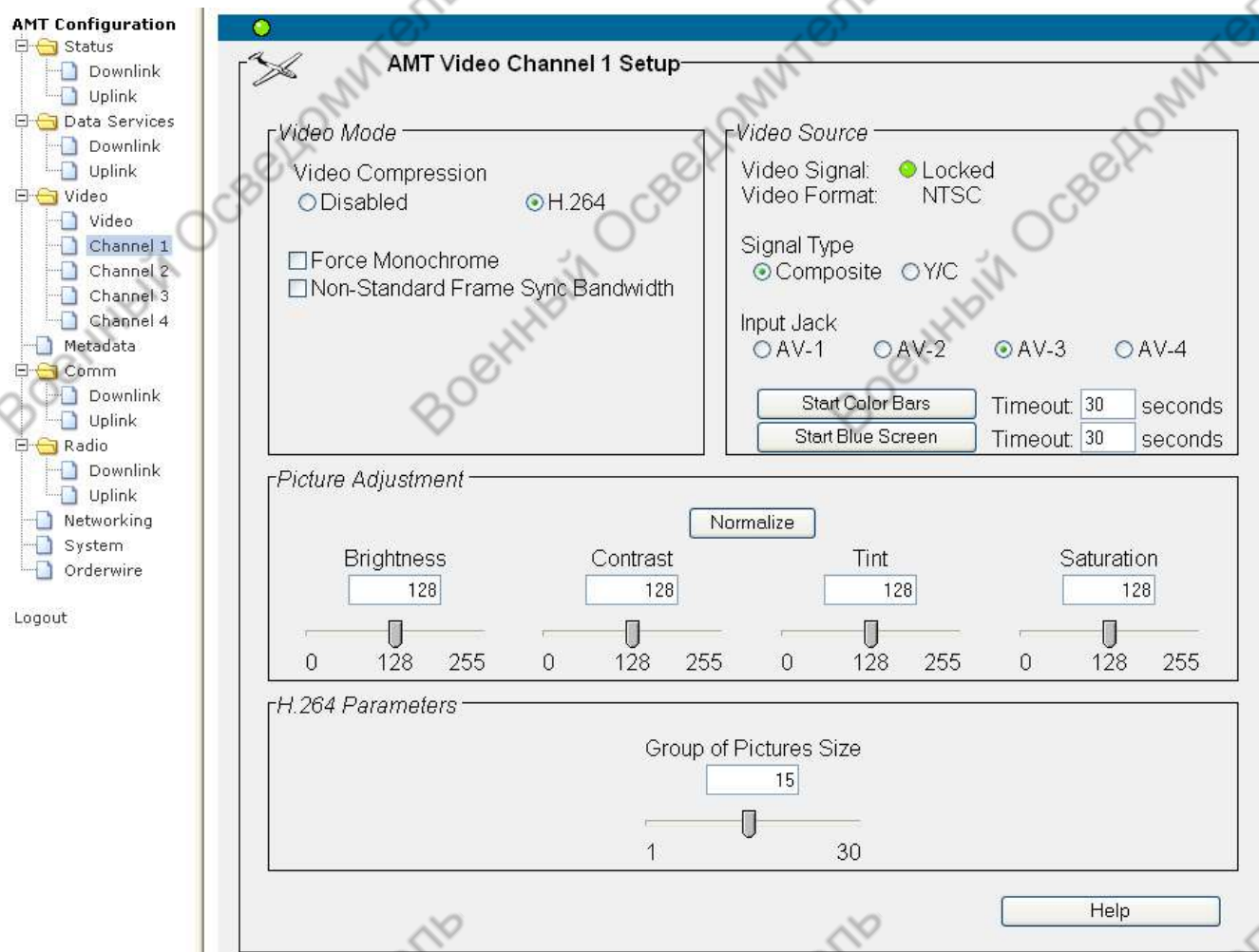


Figure 14: AMT Video Channel 1 (H.264) Setup Page

Group of Pictures Size

The GOP size used by the H.264 video encoder may be set either by use of the provided slider or by entering a numeric value in the data box for the parameter. The range of accepted values is from 1 to 30. A typical GOP size is 15. A group of pictures consists of one intra coded (I-frame) reference picture followed by multiple predictive coded (P-frame) pictures. A GOP size of 1 will result in an all I-frame stream. The I-frame represents a complete picture similar to a JPEG image, which is independent from the other pictures in the group. P-frames contain motion-compensated difference information from the preceding I-frame or P-frame. Since P-frames are typically smaller than I-frames, an increased GOP size will generally reduce the bit rate required to send a video stream. However, any errors in the video stream will be propagated by P-frames until the next I-frame. Thus, increases in GOP size will increase error propagation. Also, increasing the GOP size makes editing the video stream more difficult once it is stored on the ground system, because the stream is limited to being cut at particular frames unless it is re-encoded.

3.5.7 AMT Metadata Setup

The EnerLinksIII system provides the ability to align received metadata messages with their associated video frames so that the aligned video and metadata messages are tagged with the same Presentation Time Stamp (PTS) when they are output in a MPEG-2 TS from the GMT or AMT. A detailed description of the metadata / video time alignment theory of operation is provided in section 8.4 of this document. The AMT Metadata Setup page supports configuration of the metadata time reference, metadata / video frame time synchronization, and camera latency.

The time reference status and all statistics and counters on this GUI page will be read from the AMT and automatically refreshed in the GUI display approximately once a second.

Full access privileges are required to modify any Metadata Setup page setting.

AMT Metadata Setup

Metadata Time Reference

Metadata 1 PPS Time Reference: ☒ Active ☒ Locked

Metadata/Video Frame Time Synchronization

| | Video Channel 1 | Video Channel 2 | Video Channel 3 | Video Channel 4 |
|---|--|--|--|--|
| Video Compression: | H.264 | H.264 | H.264 | H.264 |
| Input Jack: | AV-3 | AV-3 | AV-3 | AV-3 |
| Video Time Sync Status: | <input checked="" type="checkbox"/> Locked | <input checked="" type="checkbox"/> Locked | <input checked="" type="checkbox"/> Locked | <input checked="" type="checkbox"/> Locked |
| Max Match Time Difference: | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default |
| Avg Match Time Difference: | -705 usec | -705 usec | -705 usec | -705 usec |
| Last Match Time Difference: | -714 usec | -714 usec | -714 usec | -714 usec |
| Rx UDP Metadata Messages: | 1959927 | 1959927 | 1959927 | 1959927 |
| Rx UDP Meta Messages Dropped (Invalid UTC): | 0 | 0 | 0 | 0 |
| Rx UDP Meta Messages Dropped (Mux Overrun): | 0 | 0 | 0 | 0 |
| Rx UDP Time Aligned Metadata Messages: | 1959927 | 1959927 | 1959927 | 1959927 |
| Rx UDP Misaligned Metadata Messages: | 0 | 0 | 0 | 0 |
| MPEG2-TS Metadata Misalign Action: | Send msg without PTS | Send msg without PTS | Send msg without PTS | Send msg without PTS |
| MPEG2-TS Meta Messages Queued: | 1959927 | 1959927 | 0 | 0 |
| MPEG2-TS Meta Messages Dropped (Overrun): | 0 | 0 | 0 | 0 |
| MPEG2-TS Time Aligned Meta Messages: | 1959927 | 1959927 | 0 | 0 |
| MPEG2-TS Misaligned Meta Messages: | 0 | 0 | 0 | 0 |

Camera Latency

Jack AV-1: 0 usec Jack AV-2: 0 usec Jack AV-3: 0 usec Jack AV-4: 0 usec

SDI-1: 0 usec SDI-2: 0 usec

Figure 15: AMT Metadata Setup Page

Metadata Time Reference

The AMT Metadata Setup GUI page supports configuration of the reference time signal that is used by the AMT to determine the time at which video frames arrive. This allows the AMT to synchronize the time that it records for each received video frame with the reference time that is included in the received metadata message headers. This in turn will allow it to match the metadata messages with their associated video frames.

The metadata time reference is provided to the AMT as a one Pulse-Per-Second (PPS) signal applied to the Async Port 6 RS232 input line, along with a “time” message in the format specified in section 8.4.4.1 of this document sent over UDP giving the time of the previous PPS signal in 64 bit UTC format. To enable the metadata time reference input, check the select box.

Note that if Async Port 6 is currently enabled as an input on the Downlink Data Services GUI page, this port will not be available for receiving the 1 PPS signal. If you try to enable the time reference in this condition, an alert box will be displayed as displayed in Figure 16, and the configuration will be rejected.

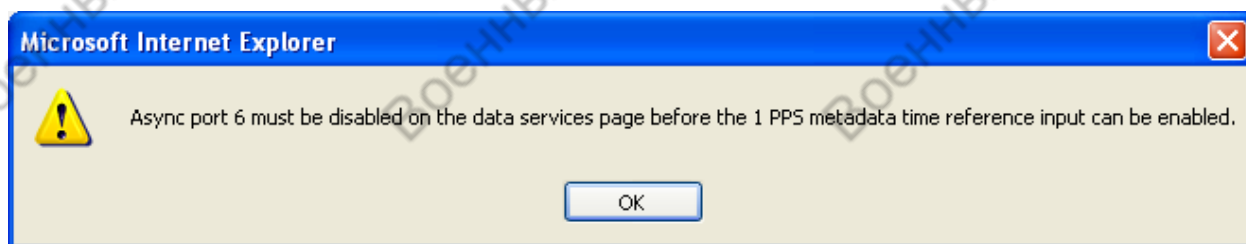


Figure 16: Metadata Time Reference Config Conflict Alert Box

The current status of the time reference is displayed in this section.

- *Locked* indicates that the time reference is locked.
- *Disabled* indicates that the time reference is disabled by configuration.
- *Sync Lost* indicates that the time reference sync has been lost. This occurs when a time message has not been received within two seconds, or no PPS signal was received between the last two time messages, or more than one PPS signal is received between two time messages, or the time between the last two PPS signals was more than 10 msec off from one second.
- *Invalid TOD* indicates that the last “time” message received did not have the “ToD valid flag” (bit 2 in the Flags field) set to 1.

Read Metadata Time

If the time reference is locked, clicking this button will pop-up the current time reference value.

Metadata / Video Time Synchronization

This section provides the ability to configure the metadata / video time synchronization feature, as well as the handling of unaligned metadata in MPEG-2 Transport Streams. It also provides statistics for messages received on the metadata UDP port, and transmitted in the MPEG-2 Transport Streams. Configuration and statistics are provided for each video channel. Note that configuration of the metadata UDP ports and MPEG-2 TS destination addresses is performed on the Networking GUI page described in section 3.5.12 of this document.

Video Compression

The current video compression standard configured for each video channel is displayed here.

Input Jack

The current input jack configured for each video channel is displayed here. This is useful for finding the associated camera latency assigned to the jack at the bottom of this page.

Video Time Sync Status

The current status of the H.264 video frame time synchronization algorithm is displayed here. This synchronization allows the AMT to assign a UTC time stamp to each video frame for inclusion in the MPEG-2 transport stream. This UTC time stamp is used by the algorithm that matches metadata messages with video frames. The status will be displayed as follows:

- *Locked* indicates that the video channel is synchronized with the 1 PPS time reference and the AMT is assigning a UTC time stamp to each video frame that is locked to this reference.
- *Not Locked* indicates that the video channel is not synchronized with the 1 PPS time reference.
- *N/A* indicates that video time synchronization is not enabled because the channel is not configured for H.264 video compression.

Max Match Time Difference

The UTC time difference that will result in a video/metadata match for each video channel is user configurable in units of msec. The range is from 0 to 40 msec. This value defines a match window that is centered on the video frame time. If a metadata packet's UTC is within +/- the configured value of a video frame that hasn't been matched before then it is a good match. This allowable time difference may be set for each video channel using the text box in this section. Clicking on the "Default" check box will cause the default match time difference to be used. The default match time difference is ½ of a video frame time, or roughly 16.67 msec for NTSC and 20 msec for PAL.

Avg Match Time Difference

This is the average offset in microseconds between the UTC value in recently received metadata messages, and the UTC value of video frames that those messages were matched with. The average is produced using an exponential moving average with a smoothing factor of 1/16. Positive values indicate that the UTC value in the video frame is before the UTC in the metadata message, while negative values indicate that the UTC value in the video frame is after the UTC in the metadata message.

Last Match Time Difference

The UTC offset of the most recently matched metadata / video frame pair for each video channel. This offset is the difference in microseconds between the UTC value of the metadata message, and the UTC value of the video frame that the message was matched with.

Rx UDP Metadata Messages

The number of metadata messages received by the AMT on the metadata UDP port assigned to each video channel.

Rx UDP Meta Messages Dropped (Invalid UTC)

The number of UDP metadata messages received that had the "UTC field valid" flag (bit 2 in the Flags field) set to 0, and the "aligned with video" flag (bit 3 in the Flags field) set to 1 in their header. These messages are dropped by the AMT.

Rx UDP Meta Messages Dropped (Mux Overrun)

The number of UDP metadata messages that are not sent to the GMT due to insufficient bandwidth to transmit them over the multiplexed data stream. These messages may still be sent in the MPEG-2 TS from the AMT.

Rx UDP Time Aligned Metadata Messages

The number of UDP metadata messages that have been successfully time aligned with a video frame.

Rx UDP Misaligned Metadata Messages

The number of UDP metadata messages that were not successfully time aligned with a video frame. These are considered misaligned.

MPEG-2 TS Metadata Misalign Action

When the AMT determines that a metadata message cannot be matched to a video frame, it places the PTS from the video frame with the closest UTC value in the Internal ViaSat header for the metadata message, and clears the “PTS valid” flag in the header. When these messages are received by the software module that is responsible for sending messages in the MPEG2-Transport Streams, that module must decide what action to take on these messages.

This Metadata Misalign Action drop down selection box is used to select the action to take on metadata messages in the MPEG2-Transport Stream when they are misaligned with video frames. If “Drop metadata message” is selected, the message will be dropped, and not included in the MPEG-2 TS. If “Send msg without PTS” is selected, the message will be included in the MPEG-2 TS stream, but no PTS field will be included in the Packetized Elementary Stream (PES) packet header for the message. If “Send msg with closest PTS” is selected, the message will be included in the MPEG-2 TS stream, and the PTS value from the metadata packet header will be written into the PES packet header for the message.

MPEG-2 TS Metadata Messages Queued

The number of metadata messages that have been queued for delivery from the AMT in an MPEG2-Transport Stream.

MPEG-2 TS Metadata Messages Dropped (Overflow)

The number of metadata messages that have been dropped when the MPEG-2 TS delivery queue size is exceeded. These messages are not included in the MPEG-2 TS Metadata Messages Queued count above.

MPEG-2 TS Time Aligned Meta Messages

The number of metadata messages that were sent in the MPEG-2 TS that had the “PTS valid” flag set to “1” in the ViaSat internal metadata header. For each of these messages, the PTS value from the metadata packet header will be written into the Packetized Elementary Stream (PES) packet header of the metadata message when it is included in the MPEG-2 TS stream.

MPEG-2 TS Misaligned Meta Messages

The number of metadata messages processed by the MPEG-2 TS module in the AMT that had the “PTS valid” flag set to “0” in the ViaSat internal metadata header. Each of these messages will be dropped or forwarded in the MPEG-2 TS according to the configured MPEG-2 TS Metadata Misalign Action.

Clear Counters

This button resets all of the message counters provided on this GUI page.

Camera Latency

This section allows you to enter the camera latency associated with the video input attached to each video jack. This value is used to adjust the time reference for each video channel receiving video from that jack. By subtracting this latency offset from the time reference, the UTC time value assigned to each video frame by the AMT will match the time that the camera generated the video frame. Values are entered in microseconds and may range from 0 to 250,000.

3.5.8 AMT Downlink Communications Setup

The multiplexing module of the EnerLinksIII AMT generates a single multiplexed bit stream composed of contributions from all the different sources configured in the Downlink Data Services, Video, Metadata, and Networking pages. The Communication module accepts this multiplexed bit stream and performs two operations on it that are configured by the Downlink Communications page (see Figure 17). These are:

- Forward error correction coding (FEC) – this is a technique by which the multiplexed bit stream is used to generate additional data which is added into the bit stream at the AMT side of the link and which allow the GMT to correct most bit errors that are induced by degradation resulting from transmission over the communication channel.
- Interleaving – a technique that shuffles the order in which bits are transmitted by the AMT and reverses the shuffling at the GMT, in the process shuffling the bit positions of errors that might occur consecutively on the channel due to bursts of interference. This function is important because the FEC works best when errors are uniformly distributed.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block configuration of FEC, Interleaving, and Modulation Bit Rate while Orderwire is enabled. To change these configuration items, first disable the Orderwire service from the AMT Orderwire Setup Page.

Full access privileges are required to modify any Communications page setting. Users with View-Only access can view all parameters on the page.

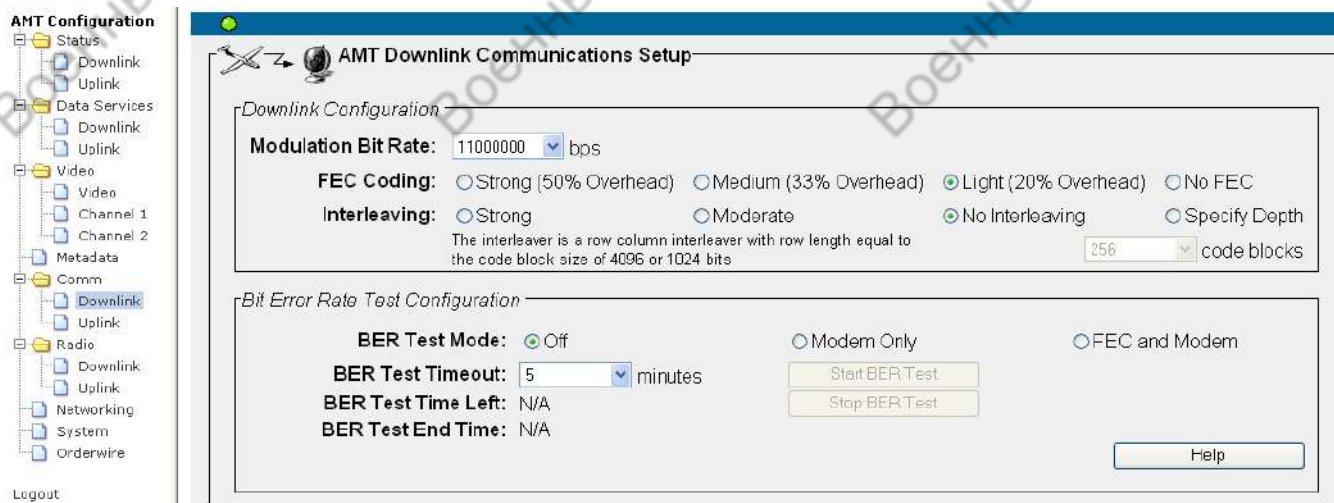


Figure 17: AMT Downlink Communications Setup Page

Modulation Bit Rate

The modulation bit rate is the rate of the final bit stream that includes the complete multiplexed bit stream and all other overhead such as FEC parity bits or sync headers.

Select the modulation bit rate from the drop down menu or select “Edit list...” to enter a new value. Supported rates are from 32,000 to 11,000,000 bps.

FEC Coding

Click the appropriate radio button to choose from the four FEC coding options. See section 8.3.2 for a detailed description of the Turbo Product Code (TPC) FEC.

In addition to the FEC, an error detecting code is also used. This code is always present and is not selectable. It adds a 32 bit cyclic redundancy check (CRC) code to each code block and is used by the receiver at the GMT to determine when the receiver path has produced good data for each block.

Note: The FEC coding configuration of the GMT must be configured to match that of the AMT or the GMT will be unable to recover the transmitted data.

The FEC coding choices are:

Strong (50% overhead)

The Strong code is a three dimensional TPC. In this code, three blocks are encoded using a $(32,26)^2$ code, and then a fourth block is generated in which each bit position is the parity of the bits in the corresponding position of the first three code blocks. This code has a block size of 4,096 bits and a code rate of 0.495. It provides a range improvement of more than a factor of three compared to operating without FEC.

Medium (33% overhead)

The Medium code is a $(32,26)^2$ code having a rate of 0.66. This code has a block size of 1,024 bits and provides a range improvement of more than a factor of 2.5 compared to operating without FEC.

Light (20% overhead)

The Light code is a $(64,57)^2$ code having a rate of 0.793. This code has a block size of 4,096 bits and provides a range improvement of more than a factor of 2.0 compared to operating without FEC at the same modulation bit rate. This code is probably the best choice in the majority of operating scenarios since it provides a very substantial performance improvement with relatively little overhead penalty.

No FEC

In this selection forward error correction is not used. Data is organized into blocks of 4,096 bits to add the CRC code even though FEC is not used.

The overhead introduced by each code type is shown in the table of Figure 18. The reason that the “Off” mode still adds overhead is that a 32 bit CRC is added each 4096 bits even when FEC is not used.

| Code | Overhead |
|--------|----------|
| Strong | 51% |
| Medium | 37% |
| Light | 21% |
| Off | 1% |

Figure 18: Overheads of the FEC coding options

Interleaving

The burst error protection provided by the interleaver comes at a price of added latency. This is because the interleaver works by filling a buffer up with bits and then reading them out in a shuffled order. Because the interleaver has to wait to fill the buffer before it can start reading them out, the bits are delayed by the size of the buffer on the AMT side. The GMT works in the reverse fashion, writing the received bits into a buffer in shuffled order and then reading them out consecutively. Thus the GMT also adds a buffer of delay.

Protecting against larger burst errors requires a larger buffer so that the bits can be shuffled further apart.

The GUI allows the user to select the interleaver in either a descriptive manner (Strong or Moderate) or in a precisely specified manner.

Strong

In the Strong setting, the interleaver buffer size in bits is maintained at 1 Mbit for all bit rates. At a modulation bit rate of 5 Mbps, this is the same as the Moderate setting, but the latency and the length of burst that the interleaving will protect against increase in inverse proportion to bit rate.

Thus in the Strong setting at 1 Mbps, the end-to-end latency is 2 seconds and the interleaver will provide fair burst protection for bursts up to 5 msec in length, and excellent protection for bursts up to 250 usec in length.

Generally speaking, if latency is not important, then the strong interleaving setting should be selected, although the user should be aware that at very low rates, the latency can be well over a minute. If latency is important, then the Moderate setting should be considered. If even 400 msec of latency is too much, the Specify Depth mode (see below) can be used to select a reduced level of interleaving.

Moderate

In the Moderate setting, the interleaver size is adjusted as a function of bit rate to result in an end-to-end latency due to interleaving of about 400 msec for all bit rates up to 5 Mbps. At 5 Mbps and above, the Moderate setting is identical to the Strong setting, maintaining a buffer size of 1 Mbit. This provides fair burst protection for bursts up to 1 msec in length, and excellent protection for bursts up to 50 usec in length. The interleaver depth in this case is 1 Mbit at 5 Mbps and above, but it drops to 7 kbits at 35 kbps.

No Interleaving

In this setting, the interleaving is turned off. If FEC is not enabled, interleaving does not help system performance, so the No Interleaving setting is forced in this case.

Specify Depth

If the Specify Depth setting is chosen, the drop down window allows the user to specify the depth of the interleaver buffer. The depth is specified in FEC code blocks, and corresponds to the maximum burst length (in bits) that the interleaver is intended to disperse.

The latency introduced by each interleaver type is a function of the modulation bit rate chosen. The latency resulting from the use of interleaving is shown in Figure 19 for a variety of bit rates and interleaving configurations. These latencies are given in msec. Note that the latency for the “specify depth” mode is given per row. To determine the actual latency in this case, the value in the table must be multiplied by the number of rows selected in the GUI.

| Bit rate (bps) | Interleaver latency in msec for various interleaver modes | | | | |
|----------------|---|-----------------------|----------------|--------------------------------|----------------|
| | Strong Interleaving | Moderate Interleaving | | Specify rows (latency per row) | |
| | | FEC=strong | FEC = moderate | FEC=strong | FEC = moderate |
| 11000000 | 190 | 190 | 190 | 0.74 | 0.19 |
| 10000000 | 210 | 210 | 210 | 0.82 | 0.21 |
| 9000000 | 230 | 230 | 230 | 0.90 | 0.22 |
| 8000000 | 260 | 260 | 260 | 1.0 | 0.25 |
| 7000000 | 300 | 300 | 300 | 1.2 | 0.29 |
| 6000000 | 350 | 350 | 350 | 1.4 | 0.34 |
| 5000000 | 420 | 420 | 420 | 1.6 | 0.41 |
| 4000000 | 520 | 420 | 420 | 2.0 | 0.51 |
| 3000000 | 700 | 420 | 420 | 2.7 | 0.68 |
| 2000000 | 1050 | 420 | 420 | 4.1 | 1.0 |
| 1000000 | 2100 | 420 | 420 | 8.2 | 2.0 |
| 900000 | 2330 | 420 | 420 | 9.1 | 2.3 |
| 800000 | 2620 | 420 | 420 | 10.2 | 2.6 |
| 700000 | 3000 | 420 | 420 | 11.7 | 2.9 |
| 600000 | 3500 | 420 | 420 | 13.7 | 3.4 |
| 500000 | 4190 | 430 | 420 | 16.4 | 4.1 |
| 400000 | 5240 | 410 | 420 | 20.5 | 5.1 |
| 300000 | 6990 | 410 | 420 | 27.3 | 6.8 |
| 200000 | 10490 | 410 | 420 | 41.0 | 10.2 |
| 100000 | 20970 | 410 | 410 | 81.9 | 20.5 |
| 90000 | 23300 | 460 | 410 | 91.0 | 22.8 |
| 80000 | 26210 | 410 | 410 | 102.4 | 25.6 |
| 70000 | 29960 | 470 | 410 | 117.0 | 29.3 |
| 60000 | 34950 | 410 | 410 | 136.5 | 34.1 |
| 50000 | 41940 | 490 | 410 | 163.8 | 41.0 |
| 40000 | 52430 | 410 | 410 | 204.8 | 51.2 |
| 35000 | 59920 | 470 | 410 | 234.1 | 58.5 |

Figure 19: Interleaver latencies for each interleaving mode

For example, if the system is operating at a modulation bit rate of 1.5 Mbps with Medium FEC where the block size is 1024 bits, and there is a burst noise process (such as a swept radar) that is expected to make interference bursts as long as 100 usec, then to achieve excellent protection (in which the error bits have no worse impact than if they were independently distributed) requires the number of rows to be $(1.5 \text{ Mbps})(100 \text{ usec}) = 150$.

The size of the interleaver buffer is the product of the number of rows and the code block size. In the example, this would be $(150)(1024) = 153,600$ bits.

The latency introduced by the interleaver in seconds is two times the latency in bits divided by the bit rate. In the example, this would be $(153,600)/(1.5e6) = 102.4 \text{ msec}$.

If the latency requirements force the interleaver size to be less than sufficient to make the error bits appear to be fully independently distributed to the FEC decoder, a smaller interleaver can

still provide substantial performance gain since it is much better to have two or three errors in a code block than to have 150.

Note: The interleaving configuration of the GMT must be configured to match that of the AMT or the GMT will be unable to recover the transmitted data.

BER Test Mode

If the BER test mode is enabled, the AMT injects a special test data sequence into one of two different points in the data path of the Communication module. This test data sequence is designed so that the GMT can easily synchronize to it, and can then measure the bit error rate experienced by the EnerLinksIII system by comparing the received data to the test data sequence. This is a very useful feature for test and evaluation purposes.

Note: The BER test does not begin until the Start BER Test button is clicked.

The states of the BER test mode are:

Off - In the Off state, the AMT operates normally – the special test data sequence is disabled and the multiplexed data stream is processed and transmitted by the communication module.

Modem Only - In the Modem Only state, the special test data sequence is injected after the FEC coding. This enables measurement of the performance of the data link from the input to the modulator to the output of the demodulator without including the improvement that results from FEC.

FEC and Modem - In the FEC and Modem state, the special test data sequence is injected just prior to the FEC coding. This enables measurement of the performance of the data link including the improvement provided by the FEC. It also allows measurement of the improvement provided by the diversity receiver.

BER Test Timeout

To prevent a situation where the BER Test Mode is inadvertently left on during operational use, a BER Test Timeout is provided. If the AMT power is removed and then restored before the timeout completes, the AMT will power up in the BER test mode.

Start BER Test

This button is disabled until the user chooses one of the BER Test Modes (see above). Clicking this button starts the BER test and starts the BER Test Timeout counter. When a BER test is in progress, the remaining timeout and expected end time are displayed, and the Stop BER Test button is enabled.

Until the Start BER Test button is depressed, the EnerLinksIII System continues to pass operational data regardless of the selected BER Test Mode state. If a BER Test Mode state other than Off is selected and the Start BER Test button is not pressed within one minute, the BER Test Mode indication will revert to Off.

Stop BER Test

This button is disabled when the BER test is off. A BER test will stop automatically at the timeout or end time. A BER test can be stopped at any time by the user clicking this button.

BER Test Time Left

This status display shows the time remaining in the current BER test. N/A is displayed when no BER test is active.

BER Test End Time

This status display shows the calendar time that the current BER test will expire. N/A is displayed when no BER test is active.

3.5.9 AMT Uplink Communications Setup

The Uplink Communication module of the EnerLinksIII AMT accepts an analog signal from the internal receiver module, and recovers the multiplexed bit stream from the signal. There are four major operations in this process:

- Bit synchronization – this operation recovers the modulation bit rate clock from the analog signal and adjusts its phase to sample the analog signal at as close to the optimal phase alignment as possible.
- Mux sync detection – this operation finds a “sync” pattern embedded in the recovered data stream. This pattern is used to exactly determine where data blocks begin in the data stream so that the data can be properly interpreted.
- Deinterleaving – this operation reverses the shuffling of bit order that occurred in the Interleaver function of the GMT. It thus restores the original bit order and in the process, shuffles the positions of any errors occurring from burst interference so that these errors are more uniformly distributed in the deinterleaved bit stream. This function is important because the FEC is more effective at correcting errors when the errors are uniformly distributed.
- Forward error correction decoding – undoes the FEC coding provided by the GMT, in the process correcting a very large percentage of bit errors that have been introduced by interference and noise on the channel. The FEC operates on blocks of data, each of which includes a cyclic redundancy check (CRC) code that enables the AMT to determine with a high degree of accuracy when any given block still contains errors after the FEC decoding.

The AMT Uplink Communications page, shown in Figure 20, allows configuration of these functions. The configuration of these parameters can only be modified by users with Full access privileges. Users with view-only access can view all parameters on the page and can also reset the BER and BLER counters.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block configuration of FEC, Interleaving, and Modulation Bit Rate while Orderwire is enabled. To

change these configuration items, first disable the Orderwire service from the AMT Orderwire Setup Page.

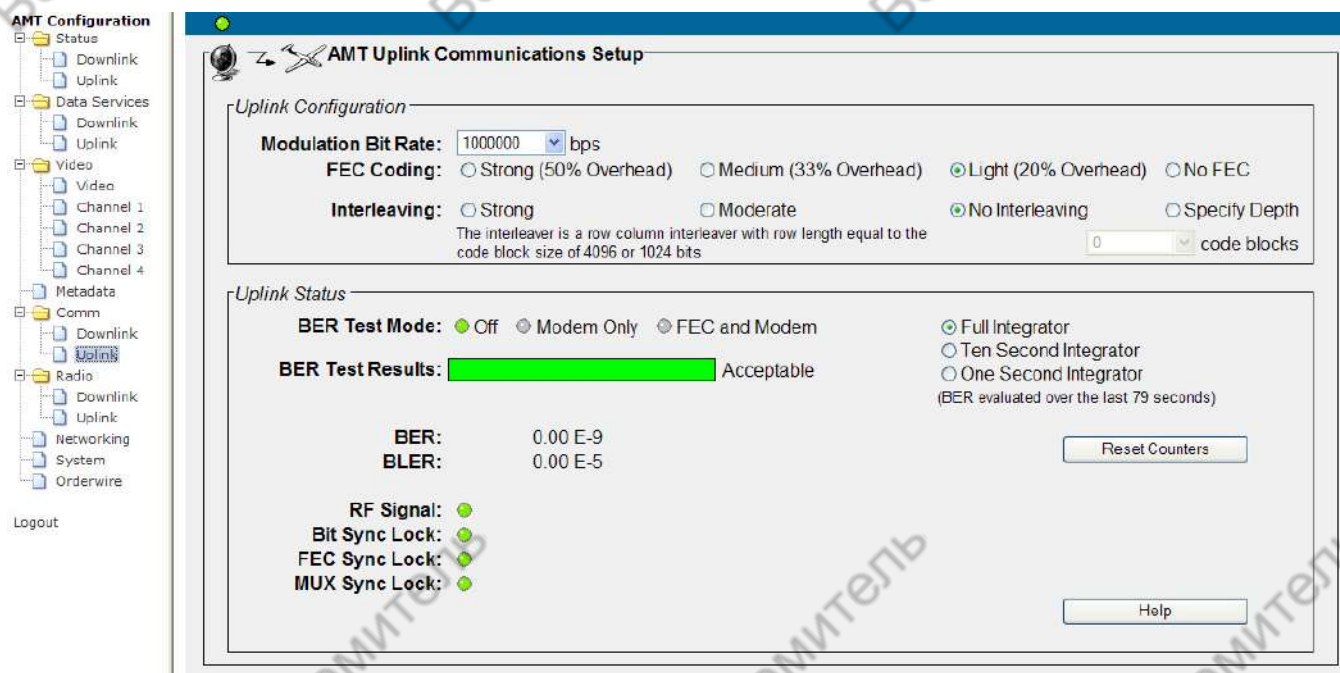


Figure 20: AMT Uplink Communications Page

Modulation Bit Rate

The modulation bit rate is the rate of the final bit stream that includes the complete multiplexed bit stream and all other overhead such as FEC parity bits or sync headers. It must be set to match the Modulation Bit Rate of the GMT that generates the signal being received.

Note: If the AMT and GMT modulation bit rates are not set to the same value, the AMT will in most cases be unable to recover the data being transmitted.

The modulation bit rate may be selected from the drop-down menu, or a new rate may be entered by selecting “Edit list...”. Supported rates are from 32,000 to 11,000,000 bps.

FEC Coding

Click the appropriate radio button to choose from the four FEC coding options. Note that the FEC options available on the uplink are exactly the same as those available on the downlink. For a complete description of these options, please refer to the FEC coding parameter described in Section 3.5.8. The four options available to the user are:

- Strong (50% overhead)
- Medium (33% overhead)
- Light (20% overhead)
- No FEC

In addition to the FEC, an error detecting code is also used on each FEC code block. This code is always calculated by the GMT and inserted into the data stream. The code adds a 32 bit cyclic redundancy check (CRC) code to each FEC code block and is used by the AMT to determine whether the receiver path has produced good data for each block.

Note: The FEC coding configuration of the AMT must be configured to match that of the GMT or the AMT will be unable to recover the transmitted data.

Interleaver Depth

Click the appropriate radio button to select the desired interleaver buffer depth. Note that the interleaver options available on the uplink are exactly the same as those available on the downlink. For a complete description of these options, please refer to the Interleaver parameter described in Section 3.5.8.

Note: The interleaving configuration of the AMT must be configured to match that of the GMT or the AMT will be unable to recover the transmitted data.

BER Test Mode

If the BER test mode is enabled in the GMT, the GMT injects a special test data sequence into one of two different points in the data path of the Communication module. This test data sequence is designed so that the AMT can easily synchronize to it, and can then measure the bit error rate experienced by the EnerLinksIII system by comparing the received data to the test data sequence. This is a very useful feature for test and evaluation purposes.

The AMT automatically determines if the test data sequence is being transmitted and sets an indicator to show the injection point. The possible bit error rate test modes are:

Off - If the status is Off, then the AMT has determined that the GMT is not transmitting the test data sequence.

Modem Only - If the status is Modem Only, then the AMT has determined that the special test data sequence is active and is injected after the FEC coding. This enables measurement of the performance of the data link from the input to the modulator to the output of the demodulator without including the improvement that results from FEC.

FEC and Modem - If the status is FEC and Modem, then the AMT has determined that the special test data sequence is active and injected just prior to the FEC coding. This enables measurement of the performance of the data link including the improvement provided by the FEC.

Integrator Selection

Click the appropriate radio button to cause this page to display the Full Integrator BER statistics, the Ten Second Integrator BER statistics, or the One Second Integrator BER statistics. If the Full Integrator statistics are selected, then the displayed BER/BLER values are evaluated over the entire period from the last time the BER counters were cleared to the present. Note that the BER counters are cleared whenever a reset is requested from the GUI or CLI, or when the

system detects that a BER Test has started or stopped. If the One Second or Ten Second Integrator statistics are selected, then the displayed values are evaluated over the previous one or ten seconds.

BER Test Results

This indicator gives an assessment of the quality of the received signal, and reports it as “Unacceptable”, “Marginal”, or “Acceptable”. The assessment takes into account both the received bit-error rate and the BER Test mode. “Acceptable” approximately corresponds to an error rate such that less than one received data packet is corrupted each 30 seconds. “Marginal” approximately corresponds to an error rate such that less than one received data packet is corrupted each 3 seconds. “Unacceptable” corresponds to any higher error rate.

When no BER test is active, this indicator continues to give an assessment of the quality of the received signal based on detected CRC errors.

If the BER Test Mode is Modem Only, the quality assessment is based on the measured BLER, as adjusted to reflect the expected rate after error correction.

If the BER Test Mode is FEC and Modem, the quality assessment is based on the measured BER.

The BER test result is read from the AMT and automatically refreshed in the GUI display approximately once a second.

BER and BLER

BER

The BER (bit error rate) column displays the bit error rate measured by the AMT when the BER test mode has been activated at the GMT.

If the BER Test Mode is Off and FEC is disabled, no BER values will be displayed. If the BER Test Mode is Off and FEC is enabled, the BER values represent the rate of corrections made by the FEC.

If the BER Test Mode is Modem Only, the AMT measures the BER for the receiver internal to the AMT before error correction. When FEC is enabled, the BER displayed in this mode is adjusted to show the expected error rate after error correction.

If the BER Test Mode is FEC and Modem, then the displayed values represent the directly measured bit error rate.

BER rates are read from the AMT and automatically refreshed in the GUI display approximately once a second.

BLER

The BLER (block error rate) column displays the block error rate measured by the AMT. This measurement is made by counting the number of FEC code blocks with bit errors and dividing

by the total number of FEC code blocks received. Because each code block includes a CRC code for error detection, this measurement can be made without the need for special test sequences, so BLER values are displayed even when the BER Test Mode is Off. The BLER measurement also operates when the special test data sequence is used and the injection point is anywhere prior to the FEC (that is, anything but the Modem Only mode). If the BER test mode is modem only, then an estimated BLER value is calculated based on the BER value described above.

BLER rates are read from the AMT and automatically refreshed in the GUI display approximately once a second.

Reset Counters

This button resets the counts of received bits and errors used to compute the BER and BLER. This button is only displayed when the Full Integrator BER statistics are selected.

Signal

The “Signal” indicator shows whether the radio determines that a radio signal is present in the configured radio band. When set to green, this signal indicates that enough energy is present in the band so that establishing a link should be possible.

The signal status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Bit Sync Lock

The bit sync lock indicator shows whether the bit synchronizer has acquired symbol timing. The bit sync lock indicator on this page is set to green to indicate lock if the bit timing is detected.

Bit sync lock status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

FEC Sync Lock

Because the FEC operates on blocks of data, the communication module has to determine where the boundaries of the blocks lie. The GMT periodically injects a sync word into the data stream with a repetition rate that is a multiple of the number of bits in a code block and the AMT then searches the received data to find the sync word. The FEC Sync Lock indicator is set to green to show that the AMT has found the sync word position.

FEC Sync Lock status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Mux Sync Lock

After determining where interleaver blocks begin and end, the communication module has to determine where the data for different data services are. The GMT injects different data patterns in the data stream to allow the data stream to be de-multiplexed by the AMT. When the AMT is able to correctly read the data for the different services, the Mux Sync Lock indicator is set to green.

Mux Sync Lock status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

3.5.10 AMT Downlink Radio Setup

The AMT Downlink Radio page provides control for the RF transmission capability of the AMT. The EnerLinksIII AMT will use the TX side of the internal transceiver for RF transmission by default. An external transmitter may be used to support the analog video bypass feature which will be supported in a future release. This GUI page provides the control and status for the TX side of the internal transceiver and the external transmitter in side-by-side columns.

All downlink radio configuration parameters are only available to users with full access privileges.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block the configuration of radio frequencies and disabling of transmitters while Orderwire is enabled. To change these configuration items, first disable the Orderwire service from the AMT Orderwire Setup Page.

The AMT Downlink Radio page is shown in Figure 21.

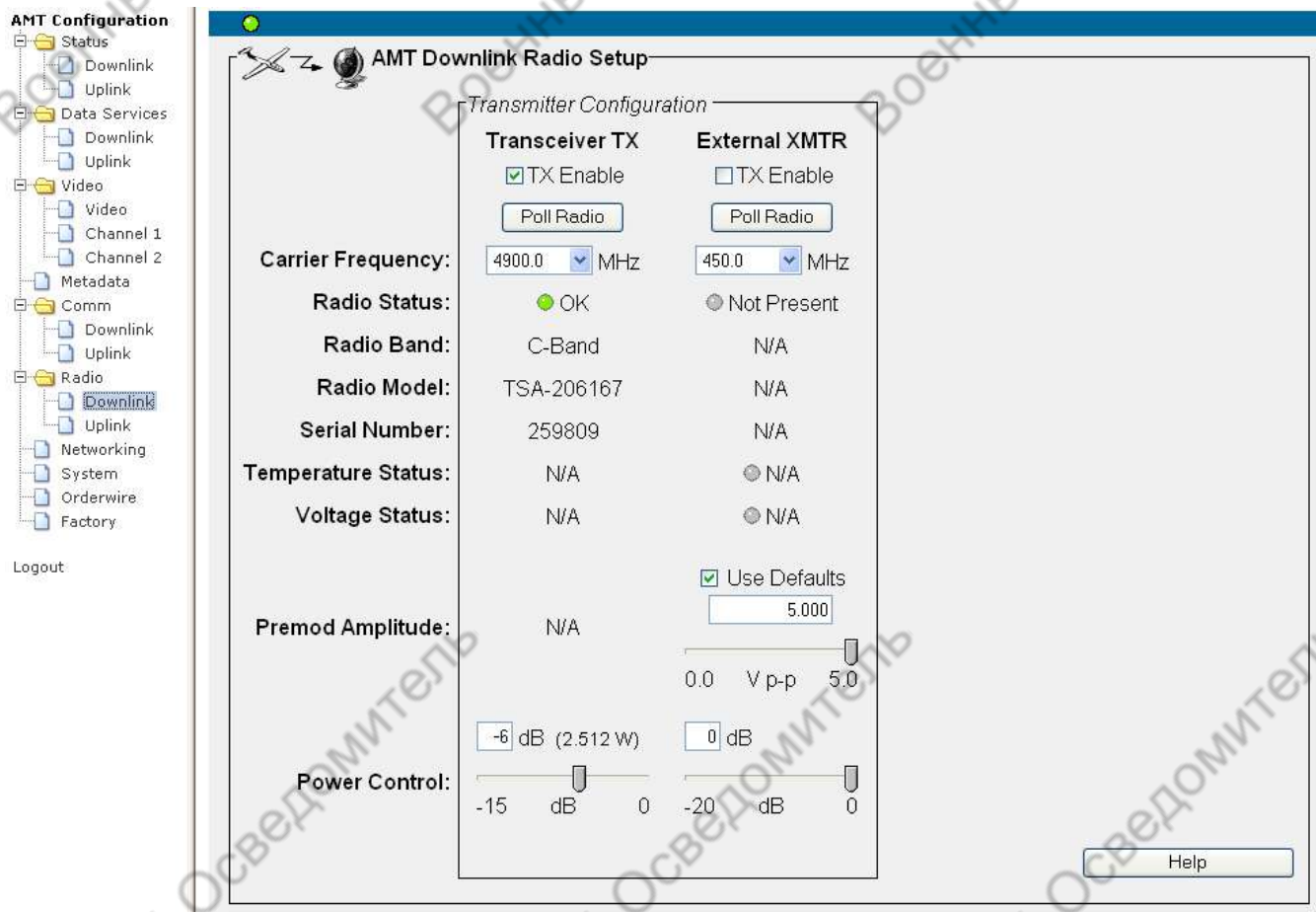


Figure 21: AMT Downlink Radio Setup Page

TX Enable

To enable the transmit function of the internal transceiver or the external transmitter module, set the check in its enable check box.

Transmission may also be disabled by a fault condition. Such a fault condition is indicated by the Radio Status (see below).

Poll Radio Button

Querying an external transmitter for status makes it stop operating momentarily. This makes it undesirable for the AMT to periodically poll the external transmitter for status. The AMT thus polls the transmitter status (and updates the GUI page) on power up, on change of any transmitter configuration parameter, and when the user clicks the Poll Radio button on the GUI.

The transmitter status of the internal transceiver is polled once a second. The Poll Radio button may be used to request an immediate poll of the status and refresh of this page.

Carrier Frequency

Select the transmitter carrier frequency from this drop down menu. If the desired value is not in the drop down list, select “Edit list...” from the drop down menu to enter a new value.

The allowed range of transmitter carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported TX Frequency Range(s) |
|-----------------------------------|--|
| L/S Band Transceiver TSA-206123 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206167 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208167 | Lower C-Band: 4900 – 4950 |

The allowed range of transmitter carrier frequencies for the external transmitter is:

- UHF: 400 – 450 MHz
- L-Band: 1710 – 1850 MHz
- S-Band: 2200 – 2400 MHz

The frequency must be entered in MHz with a resolution of 500 kHz. If no decimal point is used, the frequency is an integer number of MHz. If a decimal point is used, it may be followed by either a “0” or a “5”.

Note that use of the same frequency band in both the uplink and downlink may cause substantial interference to both communication channels and although possible, is not recommended.

If the receive frequency configured at the GMT does not match the configuration on this page, data will not be received by the GMT.

Radio Status

This status indicator shows the status of each transmitter, depending on the AMT configuration and the status reported by the radio, if present.

- *Not Present* indicates the AMT is not able to communicate with the transmitter.
- *Fault* indicates the transmitter is not providing expected responses. In the case of the external transmitter, this may indicate that it is an unsupported model.
- *Band Mismatch* indicates the carrier frequency specified on this GUI page for the transmitter is not within the band supported by the transmitter.
- *Insufficient Frequency Differential* indicates the transmit carrier frequencies specified for the internal transceiver and external transmitter are too close together, and signal interference may occur.
- *PLL Not Locked* indicates the transmitter has not tuned to the specified frequency. This is normal for short periods of time, when changing frequencies or first turning on the AMT and transmitter. Click the Poll Radio button and wait a few seconds for the GUI

page to refresh. If the transmitter repeatedly reports it is Unlocked, there may be a problem with the transmitter or with the carrier frequency that has been configured.

- *Disabled* indicates that the transmitter has not been enabled.
- *OK* is the normal operating mode for a transmitter.

Radio status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Radio Band

This line shows the frequency band(s) supported by the transmitter module.

The Radio Band is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Radio Model

This line shows the model number of the transmitter module.

The Radio Model is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Serial Number

This line shows the serial number of the transmitter module.

The Serial Number is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Temperature Status

This line displays the temperature status as reported by the external transmitter module, Normal or Hot. If the temperature is Hot, the transmitter will automatically disable itself until it cools to an acceptable level in order to prevent damage to the unit. If the transmitter model does not support temperature monitoring, the status will indicate N/A.

The temperature status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Voltage Status

This line displays the voltage status as reported by the external transmitter module, Normal or Low. If the voltage is Low, the transmitter will automatically disable its power amplifier until it detects an acceptable voltage level to prevent damage to the unit. If the transmitter does not support voltage status monitoring, the status will indicate N/A.

The voltage status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Premod Amplitude

This parameter allows the user to program the amplitude of the Premodulation video output signal from the AMT for the analog bypass feature. This capability is provided to support the use of non-EnerLinksII frequency modulated radio transmitters that might have a different voltage/frequency deviation characteristic than EnerLinksII transmitters. The slider allows adjustment of the peak-to-peak voltage of the video output signal. Alternatively, the user can type the desired voltage followed by an “Enter” keystroke in the box above the slider. The maximum amplitude that can be selected is 5.0 V peak-to-peak.

If EnerLinksII transmitters are used, it is strongly recommended that the “Use Defaults” check box should be selected. The AMT then selects the best amplitude for the transmitter.

Power Control

This parameter is used to control the Power Amplifier (PA) that boosts the transmit signal from the internal transceiver, and to control the output power level of the External transmitter. Set the level of power reduction desired based on the maximum power output of your transmitter. E.g. to reduce the output level of a 10 Watt transmitter to about 5 Watts, set the power control level to -3 dB. If your external transmitter model does not support power control, this field will indicate N/A.

3.5.11 AMT Uplink Radio Setup

The AMT Uplink Radio Page (see Figure 22) provides control for the RF receiver module. The RF receiver in the EnerLinksIII AMT supports channels in the L and S-Band or upper and lower C-Band, depending on the transceiver model installed in your AMT.

All Radio Page parameters can only be modified by users with Full access.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block the configuration of radio frequencies or the receiver mode while Orderwire is enabled. To change these configuration items, first disable the Orderwire service from the AMT Orderwire Setup Page.

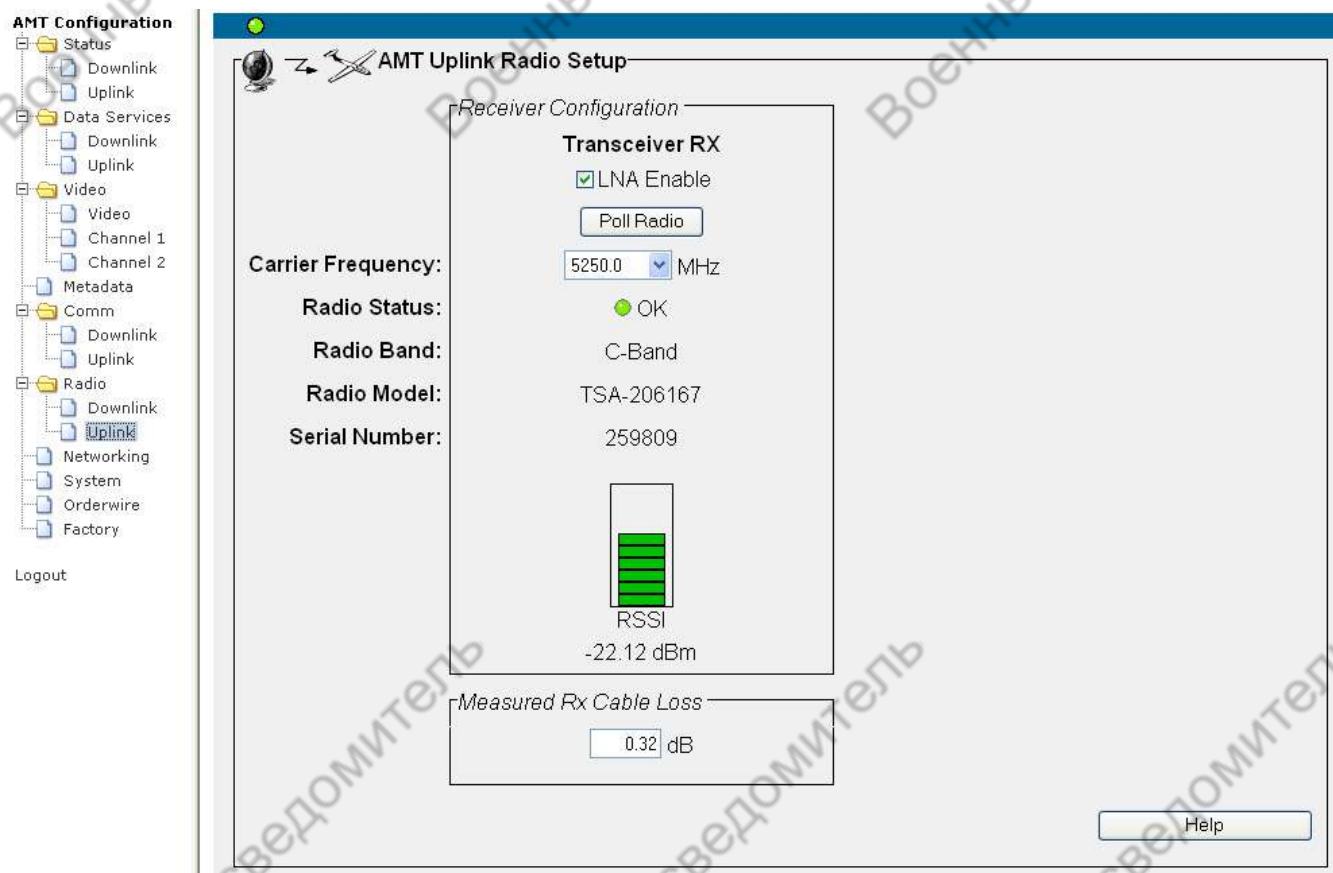


Figure 22: AMT Uplink Radio Setup Page

LNA Enable

Use this checkbox to enable the external Low Noise Amplifier (LNA).

Poll Radio Button

The receiver status of the internal transceiver is polled once a second. The Poll Radio button may be used to request an immediate poll of the status and refresh of this page.

Carrier Frequency

Select the receiver carrier frequency from this drop down menu or select “Edit list...” to enter a new value.

The allowed range of receiver carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported RX Frequency Range(s) |
|---------------------------------|--|
| L/S Band Transceiver TSA-206123 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206167 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |

| | |
|-------------------------------|---------------------------|
| C Band Transceiver TSA-208167 | Upper C-Band: 5250 – 5530 |
|-------------------------------|---------------------------|

The frequency must be entered in MHz with a resolution of 500 kHz. If no decimal point is used, the frequency is an integer number of MHz. If a decimal point is used, it may be followed by either a “0” or a “5”.

Note that use of the same frequency band in both the uplink and downlink may cause substantial interference to both communication channels and although possible, is not recommended.

If the transmit frequency configured at the GMT does not match the configuration on this page, data will not be received by the AMT.

Radio Status

This status indicator shows the status of the receiver, depending on the AMT configuration and the status reported.

- *Not Present* indicates the AMT is not able to communicate with the receiver radio.
- *Fault* indicates the receiver is not providing expected responses, and may be non-operational.
- *Band Mismatch* indicates the carrier frequency specified on this GUI page for the receiver is not within the band supported by the receiver.
- *PLL Not Locked* indicates the receiver has not tuned to the specified frequency. This is normal for short periods of time, when changing frequencies or first turning on the AMT and receiver. Click the Poll Radio button and wait a few seconds for the GUI page to refresh. If the receiver repeatedly reports it is Unlocked, there may be a problem with the receiver or with the carrier frequency that has been configured.
- *OK* is the normal operating mode for the receiver.

Radio status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Radio Band

This line shows the supported frequency band(s) for the receiver.

The Radio Band is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Radio Model

This line shows the model of the receiver module.

The Radio Model is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Serial Number

This line shows the serial number of the receiver module.

The Serial Number is read from the AMT and automatically refreshed in the GUI display approximately once a second.

RSSI

This chart provides the Received Signal Strength Indication of the signal being received in the configured frequency band. The stronger the signal, the higher the green bar will be within this chart. The lowest bar on the chart is displayed when the received signal strength is likely to be good enough to demodulate successfully. The remaining bars are illuminated to represent approximately 10 dB per bar.

The approximate value of the detected RSSI is displayed below the chart in dBm. This value is intended to represent the signal strength measured at the antenna port, and therefore includes a correction for the Measured Rx Cable Loss entered below.

The RSSI is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Measured Rx Cable Loss

The measured receive cable loss may be entered in decimal notation to the nearest 1/100th dB. The maximum value that may be entered is 100 dB. This value will be accounted for in the displayed RSSI value above.

3.5.12 AMT Networking Setup

The AMT Networking Page (see Figure 23) allows the user to configure the IP parameters of the AMT. This includes configuration of the IP forwarding capability, remote viewer access, and metadata. Modification of settings on this page is restricted to users with Full access privileges only.

AMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Networking**
- System
- Orderwire

Logout

AMT Networking Setup

IP Configuration

☐ Obtain IP address automatically

Host Name: ronamt

Domain Name: network.gov

☒ Use the following IP address

IP Address: 10.100.0.1

Subnet Mask: 255.255.255.0

Default Gateway: 10.100.0.3

☒ Forward IP to GMT

Forwarding Scheme: Gateway

Downlink Subnet: 172.18.88.0

Downlink Mask: 255.255.254.0

Downlink Rate Limit: Not Limited bps

☒ Forward broadcast packets

☒ Forward multicast packets

☒ Filter multicast packets

Forwarded Multicast Group Addresses:

233.3.3.3
233.3.3.4
233.3.3.5
233.3.3.6

New Address:

Add

Delete

☒ Enable TCP Proxy

Port: 5005

EnerView Configuration

☒ Enable EnerView access

☐ Enable multicast

Data Source: ☒ Downlink ☐ Uplink

Multicast IP Address: 230.1.2.3

Port: 5001

MPEG-2 TS Configuration

| | IP Address | Port |
|---|------------|------|
| <input checked="" type="checkbox"/> Video Channel 1 | 10.100.0.2 | 7011 |
| <input checked="" type="checkbox"/> Video Channel 2 | 10.100.0.2 | 7012 |
| <input checked="" type="checkbox"/> Video Channel 3 | 10.100.0.2 | 7013 |
| <input checked="" type="checkbox"/> Video Channel 4 | 10.100.0.2 | 7014 |

Metadata Port Configuration

| | |
|-------------------------------|------|
| Video Channel 1 Metadata Port | 7001 |
| Video Channel 2 Metadata Port | 7002 |
| Video Channel 3 Metadata Port | 7003 |
| Video Channel 4 Metadata Port | 7004 |

Apply

IP Properties

IP Address: 10.100.0.1
Physical Address: 00-12-65-00-06-00
Subnet Mask: 255.255.255.0
Default Gateway: 10.100.0.3

IP Statistics

| | |
|-----------------------------|-----------------------------|
| Tx Ethernet Packets: 370178 | Rx Ethernet Packets: 170898 |
| Tx ARP Packets: 8 | Rx ARP Packets: 4 |
| Tx IP Packets: 374519 | Rx IP Packets: 170894 |

DHCP Properties

Server Address:
Lease Obtained:
Lease Expires:

IP Forwarding Statistics

| | |
|-----------------------|----------------------|
| Tx MAC Packets: 90342 | Rx MAC Packets: 3868 |
| Tx ARP Packets: 0 | Rx ARP Packets: 0 |
| Tx IP Packets: 90342 | Rx IP Packets: 3868 |

Help

IP Forwarding Details

Figure 23: AMT Networking Setup Page

IP Configuration

Obtain an IP address automatically

In networks that support Dynamic Host Configuration Protocol (DHCP), the user should click the radio button for “Obtain an IP address automatically”. The DHCP server will select an IP address, subnet, and default gateway and configure the unit automatically. If the DHCP server is configured to interact with a DNS server, it will update the DNS server with the Host Name and Domain Name (if configured) and the selected IP address.

Host Name

This optional name should be provided by the network administrator when DNS is used in the network. It is chosen to uniquely identify the AMT within the subnet. It may be left blank if updating the DNS server is not desired.

This name may also be used to identify the AMT using the NetBIOS name service. The unit will respond to broadcast NetBIOS name query messages that match the provided name. When accessing the unit using NetBIOS name service, only the Host Name is used, without the Domain Name suffix. The host name must be no longer than 15 characters to be used by the NetBIOS name service.

Domain Name

This optional name should be provided by the network administrator when DNS is used in the network. It is set to the subnet name configured on the DNS server. It may be left blank if updating the DNS server is not desired.

Use the following IP address

If address management is not automated, the user should click the radio button “Use the following IP address”.

IP Address

This field assigns an IP address to the Ethernet interface on the AMT.

Subnet Mask

This field assigns an IP subnet mask to the Ethernet interface on the AMT. This defines the scope of the local subnet. Together with the IP Address, the subnet mask identifies the range of IP addresses directly accessible over the Ethernet interface. For example, an IP address / Subnet Mask combination of 172.18.89.146 / 255.255.255.0 indicates that all addresses from 172.18.89.1 through 172.18.89.254 are directly accessible from the Ethernet interface, while a configuration of 172.18.89.146 / 255.255.254.0 indicates that all addresses from 172.18.88.1 through 172.18.89.254 are directly accessible. See Appendix A1 for an overview of how a subnet mask is used to define the scope of a subnet.

Default Gateway

This optional field assigns a default gateway to the AMT. This identifies the IP address of a Gateway to use when sending a packet to an address not directly accessible on either the local or remote network. It may be set to 255.255.255.255 if there is no default gateway on the network.

Note: If the default gateway is not accessible with the configured interface IP address and subnet mask, the AMT will not be able to communicate with any devices beyond the local subnet. E.g. with an IP address configuration of 172.18.89.146, a subnet mask configuration of 255.255.255.0, and a default gateway configuration of 172.18.82.10, the AMT cannot reach the gateway.

Forward IP to GMT

Check this box to enable IP data forwarding.

Forwarding Scheme

When IP forwarding is enabled, this field is used to select the forwarding scheme, either Bridge (Proxy ARP) or Gateway. When configured as a proxy ARP bridge, EnerLinksIII can be used to transparently forward packets between the networks attached to the AMT and GMT. In this mode, hosts on the AMT network can reach hosts on the GMT network without being “aware” that they are communicating over a proxy ARP bridge. When configured as a gateway, EnerLinksIII will still forward packets between the AMT and GMT’s networks, but hosts using the gateway must be specifically configured to use the EnerLinksIII gateway to access the remote network.

Downlink Subnet

This is the network IP address of the subnet on the GMT side of the data link that is made accessible through the EnerLinksIII proxy ARP bridge or gateway.

Downlink Subnet Mask

This defines the scope of the remote network. Together with the downlink subnet IP Address, this identifies the range of IP addresses accessible over the EnerLinksIII proxy ARP bridge or gateway. For example, a Subnet / Subnet Mask combination of 10.1.2.0 / 255.255.255.0 indicates that all addresses from 10.1.2.1 through 10.1.2.254 are accessible through the bridge/gateway, while a configuration of 10.1.2.144 / 255.255.255.248 indicates that only addresses from 10.1.2.145 through 10.1.2.150 are accessible. In general, the scope should be set as restrictively as possible to avoid unnecessary traffic being sent over the EnerLinksIII communication link.

Note that the Subnet / Subnet Mask definitions must be compatible. This means that none of the host bits identified by the subnet mask may be set. E.g. 10.1.2.1 would not be a valid subnet definition if the subnet mask were set to 255.255.255.0, because the last byte, “1”, is not contained within the range of Subnet bits defined by the mask. See Appendix A1 for an overview of how a subnet mask is used to define the scope of a subnet.

Tips for Configuring a Downlink Subnet for a Gateway Configuration

When a gateway scheme is used to connect the airborne and ground networks, the networks must be configured to be on separate, non-overlapping subnets. If the subnet definitions overlap, then the EnerLinksIII gateway will be unable to resolve the appropriate destination for packets that it generates. E.g. if the Ethernet IP address and mask on your AMT were set to 10.1.2.1/255.255.255.0 and the downlink subnet and mask were set to 10.1.2.144/255.255.255.248, then the gateway would not know where to send a packet destined for 10.1.2.146.

Tips for Configuring a Downlink Subnet for a Proxy ARP Bridge Configuration

When a proxy ARP bridge scheme is used to connect the airborne and ground networks, the networks must be configured as identical or overlapping subnets to allow access between machines on the two networks. E.g. if the Ethernet IP address and mask on your

AMT were set to 10.1.2.1/255.255.255.0, then the downlink subnet and mask should be set to provide access to the same network, or a subset of it. A downlink subnet and mask of 10.1.2.0/255.255.255.0 would be a valid choice.

A better choice would be 10.1.2.144/255.255.255.248. This would limit the range of IP packets forwarded to only those in the range of 10.1.2.145 to 10.1.2.150, reducing the amount of IP traffic unnecessarily being forwarded over the EnerLinksIII communication link. It is a good idea to assign IP addresses in a consecutive group on the ground network to allow the downlink subnet to be defined as tightly as possible.

Note that the proxy ARP bridge configuration requires bi-directional communication for the system to fill out the ARP tables that the system uses to forward IP data. Thus, proxy ARP bridging cannot be used in an EnerLinksIII system configured for downlink only communication.

Also note that data transmitted through the EnerLinksIII proxy ARP bridge cannot be sent to remote network elements through a gateway or router. Since network elements on the far side of a gateway or router are not on the same subnet as the EnerLinksIII unit, the unit will not develop ARP table entries for those units.

WARNING

Operation of both the AMT and GMT on the same network with IP forwarding enabled can cause network disruption.

If the AMT and GMT are placed on the same network while IP forwarding is enabled, the pair will respond to requests for all IP addresses on the network, causing IP address conflicts. This can bring down your network. Care should be taken to ensure that the airborne network and ground network are completely isolated, and that the only path for traffic between the two networks is through the EnerLinksIII.

Note that if this rule is violated, and the AMT and GMT are even temporarily placed on the same network while the proxy ARP bridging forwarding scheme is enabled, each unit will maintain ARP entries for the entire network until they are both either powered down or IP Forwarding is disabled. Thus, if you remove only one unit from your network the bridge will continue to respond to all addresses on the network, causing network disruption. To recover, both units should be powered down or have IP Forwarding disabled.

For detailed information on the operation of the EnerLinksIII IP forwarding feature, see section 8.5.

Downlink Rate Limit

This field is used to limit the rate of IP data that is forwarded to the downlink subnet. When this field is set to any value other than “Not Limited”, the EnerLinksIII will drop IP packets as necessary to ensure that the rate of IP data sent over the multiplexed data stream never exceeds the specified limit. Note that when data services are multiplexed into the downlink data stream,

they are added to the stream based on a weighted priority. Each time the Multiplexer is ready to send a new packet, it sends one from the data service with the highest priority that has a packet ready to transmit. Time critical data services, like sync and audio are given the highest priority, while IP and video are given the lowest. When the video bit rate mode is set to Variable on the AMT Video Setup GUI page, video is given the absolute lowest priority so that it can dynamically change its frame rate to consume all bandwidth not used by the other data services. However, if excessive IP traffic is delivered over the downlink, no video packets will be sent at all. The Downlink Rate Limit field can be used to place a limit on the IP, which effectively reserves bandwidth for video. When the video bit rate mode is set to Fixed, IP is given the absolute lowest priority.

Forward Broadcast Packets

Checking this box enables the forwarding of broadcast IP packets from the AMT network to the GMT network. This option must be independently enabled on the GMT for broadcast messages to be delivered in the uplink direction through the EnerLinksIII system.

Note that on many networks broadcast messages are frequently seen in relatively high volume. You should be aware of the traffic on your network before enabling this feature.

Enabling broadcast packet forwarding is not generally required for most communication between the airborne and ground networks, but may be useful for certain applications, for instance obtaining an IP address via DHCP.

Forward Multicast Packets

Checking this box enables the forwarding of multicast IP packets from the AMT network to the GMT network. This option must be independently enabled on the GMT for multicast messages to be delivered in the uplink direction through the EnerLinksIII system.

Filter Multicast Packets

When this box is checked, the AMT will only forward multicast IP packets that are destined for multicast group addresses included in the list of Forwarded Multicast Group Addresses.

Forwarded Multicast Group Addresses

This window lists all of the multicast group addresses for which the AMT will forward multicast IP packets when the Filter Multicast Packets checkbox is checked. Note that this window is only displayed when the Filter Multicast Packets checkbox is checked.

Adding Multicast Group Address Entries

To add an entry to the list of Forwarded Multicast Group Addresses, enter the group IP address in the New Address text box and click the Add button. This list may contain up to 12 entries.

Deleting Multicast Group Address Entries

To delete an entry from the list of Forwarded Multicast Group Addresses, highlight the entry and click the Delete button.

Enable TCP Proxy

Check this box to enable TCP Proxy IP data forwarding. This feature allows an application to attach to the specified TCP port on the AMT and send or receive data over this port to/from another application on the remote ground network. This provides a reliable transport stream between your airborne application and the AMT, and between your ground based application and the GMT. It also provides a means of flow control so that your application can fully utilize the available uplink or downlink bandwidth.

Port

The Port field defines the TCP port that the AMT will listen on while waiting for a connection request from your application. When the AMT receives a connection request on the TCP Proxy port, it will accept the connection and begin reading data from it. Any data received will be sent over the air downlink to the GMT. On the GMT, this data will be delivered to an application that has connected to the GMT TCP Proxy port. In the other direction, any data received on the GMT TCP Proxy port will be sent on the air uplink to the AMT and delivered from the AMT TCP Proxy port to the attached airborne application.

The AMT will accept only one connection on the TCP Proxy port at a time. If a second connection attempt is made, it will be accepted, and the original connection will be shut down, with a TCP reset packet sent to the remote application.

The AMT will use TCP to limit the flow of data from the attached application. When the rate of data sent from the application exceeds the rate that can be delivered over the air downlink, the AMT will stop reading from the TCP socket, and the TCP Window size reported to the attached application will reduce to zero, indicating that the AMT can't accept any more data. The socket used by the transmitting application will buffer some of the data being sent, but when the transmit buffer on the transmitting application's socket is full, the socket "send" routine will indicate to the application that it could not send any data, and the transmitting application will need to hold onto that data. As the AMT sends its data, it will send a TCP message with a new TCP Window size that will permit the attached application to send more data.

Note that TCP Proxy is a separate feature from the Gateway / Proxy ARP Bridge IP Forwarding feature described above. Either feature may be enabled or disabled independently from the other. The only thing that the two features share is the maximum downlink IP data rate configured on the AMT and the maximum uplink IP data rate configured on the GMT. Since both features send IP data over the airlink, the maximum data rate refers to the maximum rate of IP data from both features.

EnerView Configuration**Enable EnerView Access**

Checking this box allows an EnerView application running on a laptop or PC to receive the various data services received by the AMT. Unchecking this box denies access to all remote clients attempting to access the EnerView features of the AMT.

Enable Multicast

When checked, data from all data services will be sent to the multicast address and port configured in the boxes below.

When unchecked, a single remote EnerView application can register with the AMT to receive all data services, which will be sent to EnerView's unicast address.

Data Source

Use this radio button to select the source for data to be sent to the remote EnerView application. Either Downlink or Uplink data may be sent.

Multicast IP Address

This multicast address is the IP address used by the AMT for transmission of EnerView data to multiple remote clients. This address should be provided by the network administrator. If used in this mode, the remote EnerView applications must be configured for this multicast addresses as well.

Port

The Port window is used to define the source UDP Port number on the AMT for EnerView data.

MPEG-2 TS Configuration***Enable Video Channel MPEG-2 TS***

Use these check boxes to enable or disable sending video channel data to a remote viewer in an MPEG2 Transport Stream. Data sent to the remote viewer includes video as well as associated metadata. Separate boxes are provided to enable each video channel independently. Only video on channels configured for H.264 video compression will be included in an MPEG2 Transport Stream.

IP Address and Port

This is the destination IP address and port that the AMT uses for transmission of MPEG2 Transport Stream data for each video channel.

Metadata Port Configuration***Video Channel Metadata Port***

These boxes are used to configure the local UDP ports that the AMT will use for reception of metadata messages for each video channel. A detailed description of the metadata / video time alignment theory of operation is provided in section 8.4 of this document.

Apply

The user must click the Apply button for changes to the IP configuration to take effect.

Async TCP/IP Configuration

The AMT listens for a TCP/IP connection on specific ports. When an application is connected to one of the AMT's TCP/IP ports, the AMT sends all data received over the TCP/IP socket as

downlink async data, and sends all uplink async data over the TCP/IP socket. The AMT can support up to ten clients at a time connected to each port. For the six async ports, the AMT listens on TCP/IP port numbers 1031 through 1036. Note that no user configuration is required to enable this feature.

GPS TCP/IP Configuration

The AMT listens for a TCP/IP connection on specific ports. Applications such as FalconView can be configured to connect over the network to the AMT's IP address and the TCP/IP port number. When an application is connected to one of the AMT's TCP/IP ports, the AMT sends all of the NMEA 0183 GPS data for the corresponding GPS port to the application over the network. The AMT can support up to ten clients at a time connected to each port. For the two GPS ports, the AMT listens on TCP/IP port numbers 1041 and 1042. Note that no user configuration is required to enable this feature.

IP Properties

IP Address

This field reports the address assigned to the AMT.

Physical Address

The Physical (MAC) Address is the 48 bit machine level Ethernet address for the AMT.

Subnet Mask

This is the subnet mask assigned to the AMT.

Default Gateway

This is the IP address for the Default Gateway assigned to the AMT.

DHCP Properties

These properties are only displayed when DHCP is used.

Server Address

This is the IP address for the DHCP server.

Lease Obtained

This field provides the date and time at which the AMT was assigned its IP address by the DHCP server.

Lease Expires

This field provides the data and time at which the IP address assigned to the AMT by the DHCP server will expire.

IP Statistics

IP statistics are provided for both outgoing (TX) and incoming (RX) packets.

Ethernet Packets

The total number of packets sent or received on the Ethernet interface since the AMT was powered up.

ARP Packets

The total number of ARP packets sent or received on the Ethernet interface since the AMT was powered up.

IP Packets

The total number of IP packets sent or received on the Ethernet interface since the AMT was powered up.

IP Forwarding Statistics

IP statistics are provided for packets forwarded across the multiplexed data stream between the AMT and GMT. The packet counts in this table refer to the number of packets delivered at the Link (MAC) Layer, IP layer and ARP layer. Note that packets forwarded over the multiplexed data stream are segmented as necessary and sent within the variable-size 8 to 256 byte EnerLinksIII packets. Counters for the number of EnerLinksIII packets delivered between the AMT and GMT containing IP data are provided on the Data Services GUI pages.

MAC Packets

The total number of Link Layer packets sent to or received from the GMT since the AMT was powered up. Each EnerLinksIII packet sent/received that contains TCP Proxy data is counted as one MAC packet.

ARP Packets

The total number of ARP packets sent to or received from the GMT since the AMT was powered up.

IP Packets

The total number of IP packets sent to or received from the GMT since the AMT was powered up. Since TCP Proxy data is sent as a stream over the EnerLinksIII airlink, this counter does not include TCP Proxy packets.

3.5.13 AMT System

The AMT System page (see Figure 24) provides a variety of information about the AMT configuration as well as control functions for self test and maintenance features. Full access users can modify all parameters on this page. View-only access users can view all parameters, including status details. They can also change their own password on this page. They cannot otherwise modify any other page parameters.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block saving and loading of templates and configuration files while Orderwire is enabled. To use these features, first disable the Orderwire service from the AMT Orderwire Setup Page.

AMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video
 - Channel 1
 - Channel 2
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Networking
- System**
- Orderwire

Logout

AMT System

AMT Assemblies

| | S/N | Rev |
|--------------------|--------|-------|
| Unit: | 75365 | 1 |
| Main Board: | 57638 | 1 |
| Power Board: | 58484 | 6 |
| AV Board: | 57638 | 7 |
| Radio Transceiver: | 263585 | 003 |
| External Radio Tx: | N/A | |
| Software Revision: | | 4.0.5 |
| Boot Revision: | | 0.0.1 |
| MM FPGA Revision: | | V5E18 |
| AV FPGA Revision: | | V2 |
| MG FW Revision: | | 24557 |

AMT Self Test

Disruptive Self Test:

Status: ● OK

Real Time Clock

| | AMT Clock | GPS Clock 1 | GPS Clock 2 | Metadata Time Reference |
|----------------------|--|--|-------------|-------------------------|
| Current Time: | 23:53:35 01/02/08 | 23:23:44 | Unknown | 23:53:36 01/02/08 |
| Clock Sync: | Clock is in sync with metadata time reference. | | | |
| New Time: | <input type="text" value="23:53:35 01/02/08"/> | <input type="button" value="Set Clock"/> | | |

Configuration Templates

Current Template: template1

Saved Templates:

default_template

template1

Manage Users

Username:

Password:

Confirm:

Access Level: ☐ View Only Access ☐ Restricted Access ☐ Full Access

Save Complete Configuration to File

[Right-click on this link and choose "Save Target As" to download file](#)

Restore Complete Configuration from File

Feature License Configuration

Saved Feature Licenses:

Enabled Feature Licenses:

Feature Name:

License Key:

Figure 24: AMT System Page

The configuration information is comprised of the following items:

AMT Assemblies**S/N (Serial Number)**

A list of the serial numbers and revision levels of all the major AMT subassemblies appears under this heading. Access to these serial numbers without opening the unit can be very convenient for logistics and maintenance activities.

Rev (Revision Level)

A list of the revision level for each of the major AMT software/firmware modules appears under this heading.

In addition, the System page provides a number of control functions. These are:

AMT Self Test**Disruptive Self Test**

Clicking the Start Test button launches a system self test. The system self test is a disruptive test that will interrupt normal operation of the AMT. Clicking the Start Test button causes a confirmation dialog box to appear, giving the user a chance to cancel the action if it was inadvertent.

Results of the self test are displayed in the Result window. The Result window automatically “pops up” to report the results of the self test. Any result other than “Passed” indicates a problem that may require corrective action. When a result other than passed occurs, a brief description of the failure appears in the window.

Note that the displayed information is a summary of the test results. Full test details may be obtained by running the system test from the command line with the verbose option. The following system components are tested:

| System Component | Test Description |
|------------------|---|
| Reported Status | Check system status table for any components reporting a fault. |
| RTOS Components | Operating system diagnostic tests. |
| Stack | Check all task stack margins. |
| Mem Size | Check system RAM size margins. |
| Voltage Levels | Check maximum and minimum system voltages. |
| FPGA | FPGA ID and read/write test. |
| UART | Loopback test on each active UART. |
| Ethernet | Ethernet memory and loopback tests. |
| RTC | Check status of the real time clock device. |
| Radio | Check status of the radios, as reported on the radio GUI page. |
| Temperature | Temperature measurement range check. |
| Comm | Validate all configuration settings. |
| EEPROM | Checksum test, read/write test and cache comparison test. |
| Flash | Test read of flash manufacturer and device ID. |
| Orderwire Config | Checks for orderwire configuration conflicts. E.g. If IP forwarding is enabled on the AMT but not supported on the GMT this test will fail. |

| | |
|-------------|--|
| ADF4360 | Check the status of the ADF4360 Integrated Synthesizer/VCO. |
| AD9957 | Check status and perform read/write test on the quadrature digital up converter device. |
| Video Input | Checks for video signal input and performs a read/write test on the Cx25836 video decoder. |
| H264 Codec | Perform communication test on the MG1264/MG3500 video/audio compression device. |

Figure 25: Tested System Components

The Start Test button is available to only Full access users.

Status

Background health and status monitoring is performed on the AMT during normal operation. If a problem is detected during this monitoring, an entry is made in the system status table. The “Details” button provides access to this table.

Problems are classified as either a “Fault” or “Warning” in the status table. A status of “Fault” indicates a condition that requires immediate attention, and a status of “Warning” indicates a potential problem that may require corrective action.

The system status is read from the AMT and the Status indicator is automatically refreshed in the GUI display approximately once a second.

Clicking the Details button retrieves the system status table from the AMT. Note that unlike the Start Test button, clicking the Details button is non-disruptive and will not interrupt the normal operation of the AMT.

The system status table is displayed in a separate Result window. The table includes the current status (“OK”, “Fault”, or “Warning”) of each monitored system component as well as a count of the number of times that each component has previously had a status of “Fault” or “Warning”.

Status indication of “Fault” or “Warning” indicates a problem that may require corrective action. Running a system self test may provide more detailed information about the condition that may be used to isolate the problem.

The following system components are monitored:

| System Component | Monitored Information | Problem Status |
|------------------|--|----------------|
| System Voltage | Maximum and minimum system voltages. | Fault |
| RTOS Components | Operating system diagnostic tests. | Fault |
| Stack | Task stack margins. | Fault |
| Memory Size | System RAM size margins. | Fault |
| FPGA | FPGA ID and read/write test results. | Fault |
| Comm | Comm configuration validation. | Fault |
| I2C Bus | I2C bus read/write timeout. | Fault |
| Ethernet | Ethernet memory and loopback test results. | Fault |

| | | |
|----------------------|--|---------|
| UART | UART loopback test results. | Fault |
| Lost Crypto Sync | Uplink datastream is AES encrypted, and cannot be decrypted. | Fault |
| Invalid AES Password | AES encryption is enabled on the uplink or downlink datastream, and no AES password is stored. | Fault |
| SPI Bus | SPI bus read/write timeout. | Fault |
| ADF4360 | Integrated Synthesizer/VCO initialization status and phase lock status. | Fault |
| AD9957 | Quadrature digital up converter device test results. | Fault |
| CX25836 | Video decoder device test results. | Fault |
| PA Overcurrent | TX Power Amplifier overcurrent check. | Fault |
| LNA Overcurrent | RX Low Noise Amplifier overcurrent check. | Fault |
| H264 Codec | Video / audio compression device test results. | Fault |
| Video Time Sync | Status of H.264 video frame time synchronization algorithm, which allows the AMT to assign a UTC time stamp to each video frame for inclusion in the MPEG2 transport stream. | Fault |
| Temperature | Temperature measurements. | Warning |
| EEPROM | EEPROM read/write and checksum errors. | Warning |
| FLASH | Flash programming errors and test results. | Warning |
| OW Config Conflict | AMT and GMT orderwire configuration conflict. | Warning |
| IP Address Conflict | Configured IP address in use by another unit on network. | Warning |
| Video Signal Lost | Video signal presence on active video channels. | Warning |
| RTC | Real Time Clock device status. | Warning |
| Metadata Timing | Metadata timing reference status. | Warning |

Figure 26: Monitored System Components

The Details button is available to both Full and View-only access users.

Reset AMT

The Reset AMT button causes the AMT to undergo a complete re-boot. This re-boot is not quite as exhaustive as a power cycle, but does cause the following:

- A complete re-load of system software from flash memory
- Re-load of all programmable devices in the design from flash memory
- Execution of power on self test, if enabled

Clicking the Reset AMT button causes a confirmation dialog box to appear, giving the user a chance to cancel the action if it was inadvertent.

Resetting the AMT will interrupt any operational usage of the AMT and result in loss of data in both the downlink and uplink.

The Reset AMT button is available to only Full access users.

Real Time Clock

The EnerLinksIII System includes a Real Time Clock feature that maintains the time on the AMT, which is displayed here. The time provided by the AMT Real Time Clock is always multiplexed into the transmitted bit stream for transmission to the GMT. The GMT will display the AMT time on its System GUI page. Additionally, the GMT may display the AMT time overlaid on the output video image (see section 3.6.5). The Real Time Clock can only be modified by Full Access users.

The real time clock is powered by an internal battery and can maintain time through powered down periods as long as twelve years. The battery is discharged more slowly when the AMT is powered.

Current AMT Clock

The time displayed here is the current RTC value contained within the AMT.

Current GPS Clock 1 and GPS Clock 2

If either of the GPS receivers has a valid lock, the time read from the GPS receiver is displayed here. The time is usually GMT or Universal Time and does not include a correction for the local time zone.

Current Metadata Time Reference

When the metadata time reference feature is enabled on the Metadata GUI page, the AMT will synchronize the time that it records for each received video frame with an external time reference. The current time reference value is displayed here. If the feature is disabled, or synchronization with the time reference has been lost, “Unknown” will be displayed.

Clock Sync

The AMT will automatically synchronize its RTC to the time supplied in the Metadata Time Reference, GPS Clock 1 or GPS Clock 2, if any is present. The Metadata Time Reference is most preferred, since it is synchronized to a 1PPS signal. The GPS Clock 1 is next most preferred, and the GPS Clock 2 is least preferred. If none of these clocks is present, the user may enter a new RTC time manually.

New Time

The Real Time Clock window normally displays the current time from the Real Time Clock. If the user clicks on the text entry window, the display stops changing, and the user can then type in a value in HH:MM:SS MM:DD:YY format.

Set Clock

The value contained within the “New Time” window takes effect when the user clicks the “Set Clock” button, or types Enter. This method of time setting allows fairly tight synchronization to a wristwatch, if desired.

Configuration Templates

When the EnerLinksIII AMT is powered up, it comes up with the configuration that was active in the unit the last time it was powered down. The AMT also includes an ability to assign names to configurations and to store those configurations within the AMT's non-volatile memory for later recall and use. A saved configuration is called a template. Templates can be handy when there are several modes in which the equipment is frequently used. The EnerLinksIII AMT can save up to 20 templates, including the default_template.

Templates do NOT include IP networking configuration information. The IP configuration is not changed when a template is loaded.

One of the templates in the Saved Templates window is named "default_template". This template cannot be deleted. It is a very simple configuration intended to allow the user to make the equipment work very quickly out of the box. The default configurations are compatible between the AMT and GMT so that the two units will operate properly right away. It should be noted however that the RF frequencies and transmission bit rate are not likely to match assigned frequencies for a given mission, and as a result the default_template is best suited for training and for bench testing and evaluation.

The downlink default configuration has the following settings:

- Only the video data services are enabled.
- Video channel 1 is set to H.264, color, composite, Jack 1 (or AV-1). Color adjustments are set to neutral and GOP size is set to 15.
- Video channels 2, 3 and 4 are disabled. Video rate sharing is set to evenly distribute video bandwidth among all channels. Video bit rate is set to variable.
- The metadata time reference input is disabled.
- The modulation bit rate is 11 Mbps. FEC is light, BER test is off.
- The transceiver TX carrier frequency is set to 4900 MHz if a C-Band transceiver is installed and 1780 MHz if an L/S-Band transceiver is installed.
- The external transmitter frequency is set to 450 MHz.

The uplink default configuration has the following settings:

- Input rate matching is disabled, but all async port output rates are set to 300 bps, so that they will automatically be adjusted to match whatever input rate is configured at the GMT when the AMT begins receiving uplink data.
- The modulation bit rate is 1.0 Mbps. FEC is light.
- The transceiver RX carrier frequency is set to 5250 MHz if a C-Band transceiver is installed and 2300 MHz if an L/S Band transceiver is installed.

Note that if the system is not used on a test bench where the RF connection from transmitter to receiver is via coaxial cable, then it is important to be sure that using the default frequencies will not disrupt other operational users of the RF spectrum.

Templates can only be modified, saved, or loaded by full access users. They cannot be modified, saved, or loaded when Orderwire is enabled.

Current Template

This field lists the most recent template that was loaded into the system. Note that the actual configuration may be different from the “current template” configuration if changes have occurred since the template was loaded. On power cycle, the unit will restore the current configuration (not the template configuration.)

Saved Templates

This window lists all the templates available on the system.

Load

To load an existing template as the current configuration, select the template name from the Saved Templates window and click Load or double-click on the template name in the Saved Templates window. The selected template will become the current configuration and its name will appear in the Current Template field.

Save As

To create a template from the current configuration, type a name for the configuration into the window and click the Save As button. If the chosen name already exists in the Saved Templates list, this process will overwrite the template for the chosen name.

Rename

To rename an existing template, select the template name from the Saved Templates window, type a new name into the window and click the Rename button.

Delete

To delete a template, select the template name from the Saved Templates window and click the Delete button. The existing configuration will not be changed by this action, even if the template being deleted is the current template.

Manage Users

The EnerLinksIII AMT and GMT each support one default Full access account (named “Administrator”) and up to eight additional accounts. Any Full access user may add and delete users, and change any user’s password. View-only access users are not allowed to add or delete users, and are only allowed to change their own password. Restricted access users do not have access to this page.

Passwords are case sensitive and must be entered the same way twice to take effect. Passwords must conform to the following rules:

1. Passwords must be at least 8 characters long.
2. Passwords must have at least one capital letter and one lowercase letter.
3. Passwords must have at least one number or special character.

Username

For the Full access user, this window shows all the usernames, and an entry for “Add new user”. For the Minimum access user, this window shows only the current user’s name.

Adding a User

To add a new user, highlight “Add new user” in the Usernames window. Enter the Username and Password in the labeled text windows, repeat the password exactly in the Confirm window, and then click Apply.

Changing Password

To change a user’s password, highlight the user in the Usernames window. Enter the Password in the labeled text window, repeat the password exactly in the Confirm window, and then click Apply.

Deleting a User

To delete a user, highlight the user in the Usernames window, and click Delete. The user named “Administrator” cannot be deleted.

Save Complete Configuration to a File

The AMT provides the capability to save the complete configuration to a file on the PC or laptop used to configure the AMT. This can be used to backup a configuration external to the AMT. It can also be used to copy the configuration of one AMT to another AMT which may use a very similar configuration. Note that the IP configuration is saved in the file created by this operation. If the configuration file is used with multiple units, the IP configuration must be modified to insure that multiple units do not share the same IP address.

Restore Complete Configuration from File

The AMT provides this capability to restore a configuration file which was previously uploaded to a PC or laptop. To restore a configuration file, use the “Upload” button.

Feature License Configuration

This section of the GUI page is used to enable or disable optional licensed features in the EnerLinksIII System. When support for a licensed feature is purchased, ViaSat will provide a license key that must be entered into each EnerLinksIII unit to unlock that feature on the unit. A unique license key will be provided for each unit. License keys may be entered via the GUI on this page, or through the CLI using the “FEATURE” command, or through TFTP by sending the license.txt file provided by ViaSat directly to the unit.

Saved Feature Licenses

This window lists all of the features whose licenses that have been stored to EEPROM on the AMT.

Enabled Feature Licenses

This window lists all of the features whose licenses are currently enabled and active on the AMT. Note that when a license key is added, the associated feature will not become active until after the AMT is reset. Likewise, when a license key is deleted, the associated feature will not

become inactive until after a reset. Note that if a license key is added for a feature that is not supported by the version of software loaded on the system, the feature will not appear in this list.

Deleting a Feature License

To delete the license for a feature, highlight the feature name in the Saved Feature Licenses window, and click Delete. The feature will not be disabled until the AMT is reset.

Adding a Feature License

To add the license for a feature, enter the feature name and license key exactly as provided by ViaSat in the Feature Name and License Key text boxes, and click Add Feature. The feature will not be enabled until the AMT is reset.

3.5.14 AMT Orderwire

The AMT Orderwire page provides the mechanism for enabling or disabling the Orderwire functionality in the EnerLinksIII system. Orderwire allows a user at the GMT to configure data port parameters at the AMT, as long as both an uplink and downlink have already been established. Figure 27 shows the AMT Orderwire GUI page.

For an Orderwire connection to be established, the versions of software running on the AMT and GMT must be compatible. As of the writing of this Configuration and Operation Guide, EnerLinksIII software release 4.1.0 is the latest release. Any AMT or GMT running software release 4.1.0 and above will require that the remote AMT or GMT is running software release 3.3.4 or greater for a connection to be established.

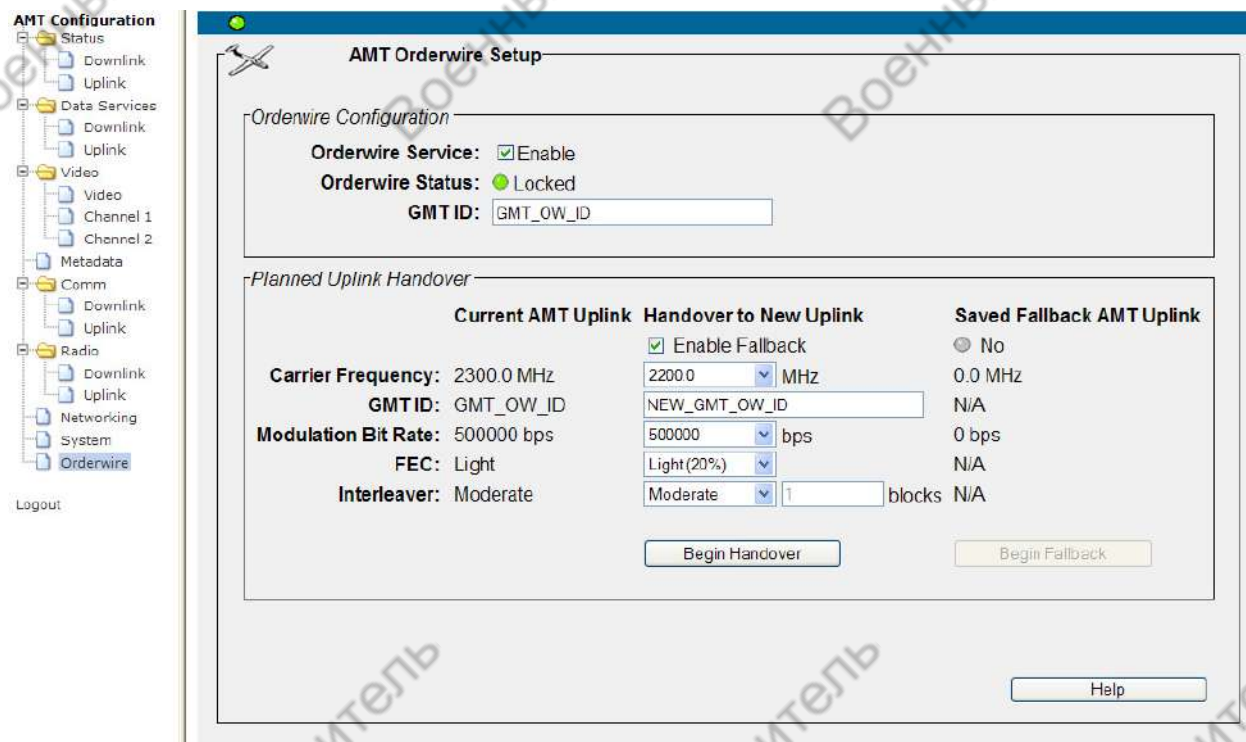


Figure 27: AMT Orderwire Page

Orderwire Service

The Orderwire Service parameter enables or disables the orderwire functionality. When this box is checked, the AMT will attempt to establish an orderwire connection with the GMT it is talking to. In order for this session to be established, the AMT must be configured with a GMT ID that matches the configuration at the GMT.

Orderwire Status

The Orderwire Status LED indicates the status of the Orderwire link. If Orderwire Service is disabled at the AMT, this LED will be gray. If Orderwire Service is enabled, but the link has not been established, this LED will be red. If Orderwire Service is enabled and the AMT and GMT have established a link, the LED will be green.

GMT ID

The GMT ID is a password which must be set to the exact same value at the AMT and GMT. This parameter insures that an AMT receives configuration information only from a GMT it has been configured to communicate with.

Planned Uplink Handover

This section controls the AMT's uplink handover/fallback feature. The orderwire service does not need to have a valid connection to use this feature when initiated from the AMT.

Current AMT Uplink

This section displays the current AMT uplink configuration. This display is provided for easy reference while configuring the new AMT handover uplink parameters.

Handover to New Uplink

This section allows entry of new uplink parameters which will be used by the AMT. By default, they are all set to match the current uplink configuration when the GUI page is first loaded. At a minimum, a new uplink frequency must be selected in order to use the handover feature.

Enable Fallback

If this box is checked, then the AMT saves its current uplink configuration in EEPROM before beginning the handover. After the uplink handover, if the AMT cannot find a new uplink using the new uplink parameters within about 10 to 15 seconds, it will fallback to the current uplink configuration and re-establish its uplink with the current GMT. Also, even after the AMT finds a good uplink signal with the new parameters, if it loses the uplink signal for a whole minute, or if the AMT is power-cycled, it will fallback to the saved uplink configuration.

Carrier Frequency

Use this box to select the AMT's new uplink receive frequency. This does not change the GMT's uplink transmit frequency. The new carrier frequency must be in the same frequency band as the current uplink carrier frequency.

GMT ID

Optionally enter a new GMT ID to be used when connecting the orderwire service on the new uplink. This field does not have to change during an uplink handover if the GMT the AMT will be connecting to is using the same orderwire GMT ID as the current GMT.

Modulation Bit Rate, FEC, and Interleaver

Optionally enter a new modulation bit rate, FEC, or interleaver settings for the new uplink. These fields do not have to change during an uplink handover if the GMT the AMT will be connecting to is using the same uplink communications parameters as the current GMT.

Begin Handover

Click on this button to begin the handover process to the new uplink described on this page. This AMT will lose its orderwire service connection with the current GMT when it changes its uplink, and will automatically establish an orderwire service connection with the new GMT if enabled, and if the GMT ID matches. The downlink from the AMT is not affected by this.

If the Enable Fallback box is not checked, the AMT will change its uplink parameters and remain there.

If the Enable Fallback box is checked, the AMT will change its uplink parameters and search for a valid uplink signal. If a valid uplink signal is found, the AMT will remain on the new uplink frequency and communications settings until:

- It is told to fallback to the saved configuration by an orderwire command sent from the new GMT.

- It is told to fallback to the saved configuration by a local AMT command.
- The AMT loses the uplink signal for more than a minute. This might happen if the new GMT is simply turned off without commanding a handover/fallback explicitly.
- The AMT is power cycled. This always restores the saved fallback uplink configuration.

Saved Fallback AMT Uplink

This section describes the saved fallback uplink configuration at the AMT.

Begin Fallback

Click on this button to begin the handover/fallback process to the saved fallback uplink described on this page. This AMT will lose its orderwire service connection with the current GMT when it changes its uplink, and will automatically establish an orderwire service connection with the new GMT if enabled, and if the GMT ID matches. The downlink from the AMT is not affected by this.

Regardless of whether the AMT finds a valid uplink signal using the fallback uplink configuration, it remains there.

3.5.15 AMT Logout

The user logs out by clicking the Logout tab (see Figure 28). The acknowledgment screen shown in Figure 29 will be displayed in response. Click the underlined text to log back in. The username and password must be re-entered to log back into the unit. Your internet browser may ask you if you would like it to save your username and password. It is recommended that you DO NOT allow the browser to store this information.

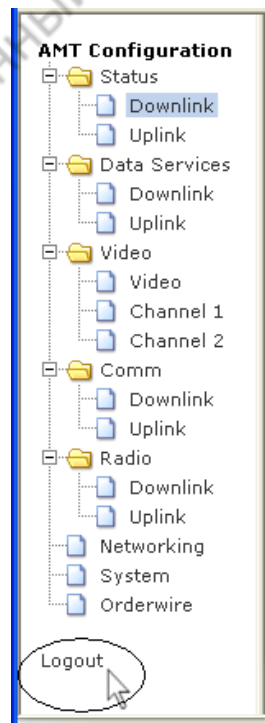
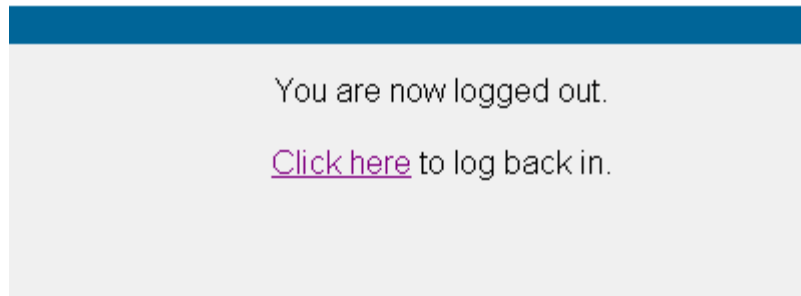


Figure 28: AMT Logout Tab**Figure 29: AMT Logout Acknowledgment Screen**

3.6 GMT GUI Pages for Full Access and View-Only Users

3.6.1 GMT Downlink Status and Configuration

The GMT Downlink Status page is shown in Figure 30. This page summarizes the configuration of the downlink parameters in the GMT. However, no configuration changes can be made on the status page. Detailed explanations of the various status and configuration values are provided in sections describing the specific pages that the values are drawn from.

The status page includes a bar chart graphic that shows the allocation of bandwidth among the different data sources served by the downlink multiplexer. This page also provides system status for the GMT.

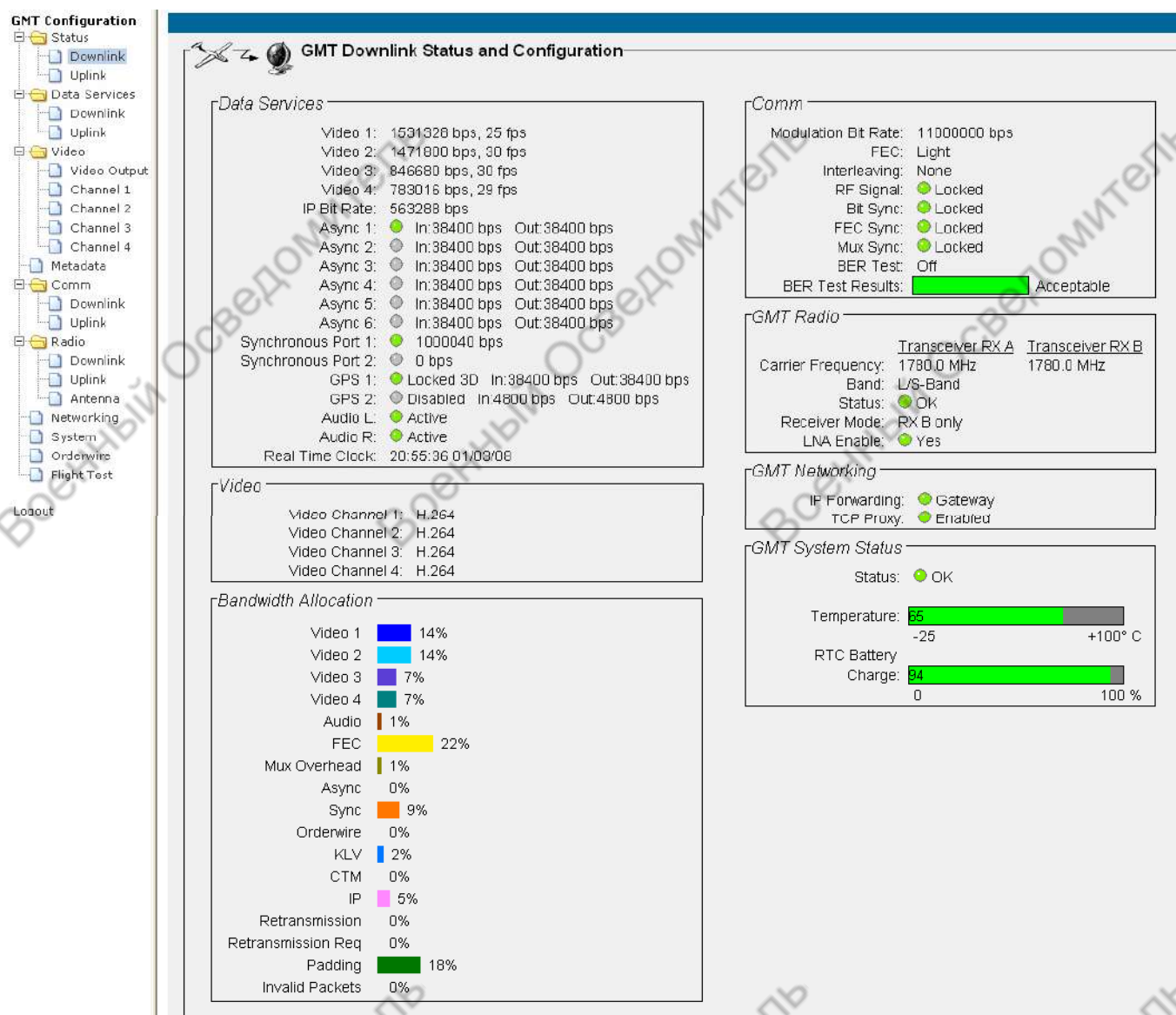


Figure 30: GMT Downlink Status and Configuration Page

Data Services

This section provides a summary of the configuration for each data service available in the downlink.

Video 1 through 4 provides an estimate of the bit rate and frame rate for each video channel. The rate is dependent upon the video compression type selected for each channel, the video content, the compression specific video settings (like the GOP setting in H.264), the data rates of the other data ports in the system, the downlink modulation bit rate, and the forward error correction (FEC) and interleaver overhead. The displayed bit rate and frame rate are averaged over the past 10 seconds. If a video channel is disabled then its bit rate and frame rate will be 0.

IP Bit Rate displays the rate of IP data received over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of the port. Green indicates that the port is enabled. The configured input port rate at the AMT and the configured output port rate at the GMT are also displayed.

Synchronous Port provides an indicator for the status of this port. Green indicates that the port is enabled. The data rate (accurate within 100 bps) of the port is also listed.

GPS 1 and 2 indicates the current status of each GPS port at the AMT, which may be connected to an external GPS receiver. Not Responding indicates the GMT does not have Mux Sync with the AMT, or a fault in the GPS hardware at the AMT. Not Locked indicates the GPS device is functioning, but does not have valid position lock. Locked 2D or Locked 3D indicate the GPS device has a valid position lock. The configured input port rate at the AMT and the configured output port rate at the GMT are also displayed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled.

Real Time Clock provides the current system time and date of the GMT.

Video

This section displays the video compression mode selected for each video channel.

Bandwidth Allocation

This section provides a bar chart graphic showing an estimate of the allocation of bandwidth among the different data sources served by the downlink multiplexer. This graph also displays the bandwidth required to support any FEC, as well as the overhead used by the system.

Comm

This section shows the current communication settings for the modulation bit rate, forward error correction (FEC), and interleaving. The GMT also shows if it has detected a bit-error rate (BER) test initiated at the AMT. The current status of RF Signal detection, Bit Sync Lock, FEC lock,

and Mux Sync are also displayed. A bar graph indicator shows a qualitative assessment of the bit error rate in the received signal.

Radio

This section provides information about the receive configuration and status of the active transceiver contained in the GMT. The configured carrier frequency of each arm of the diversity receiver is listed, followed by the supported frequency band of the transceiver. The status indicator provides the receive status of the transceiver. The receiver mode is displayed followed by the LNA control line status, enabled or disabled.

Networking

This section displays the status of the IP forwarding and TCP Proxy configuration.

System Status

This section shows an indication of overall system status and two bars which indicate system wide parameters.

System Temperature

The first bar shows the system temperature in degrees Centigrade. The color of the bar indicates any affect this may have on the system performance. If the bar is green, the temperature is in the normal operational range of the GMT.

Real Time Clock (RTC) Battery Charge

This bar graph indicates the charge remaining in the Real Time Clock battery. If the charge is low, the system time may be lost if the GMT is powered down for an extended amount of time.

3.6.2 GMT Uplink Status and Configuration

The GMT Uplink Status page is shown in Figure 31. This page summarizes the configuration of the uplink parameters in the GMT. However, no configuration changes can be made on the status page. Detailed explanations of the various status and configuration values are provided in sections describing the specific pages that the values are drawn from.

The status page includes a bar chart graphic that shows the allocation of bandwidth among the different data sources served by the uplink multiplexer.

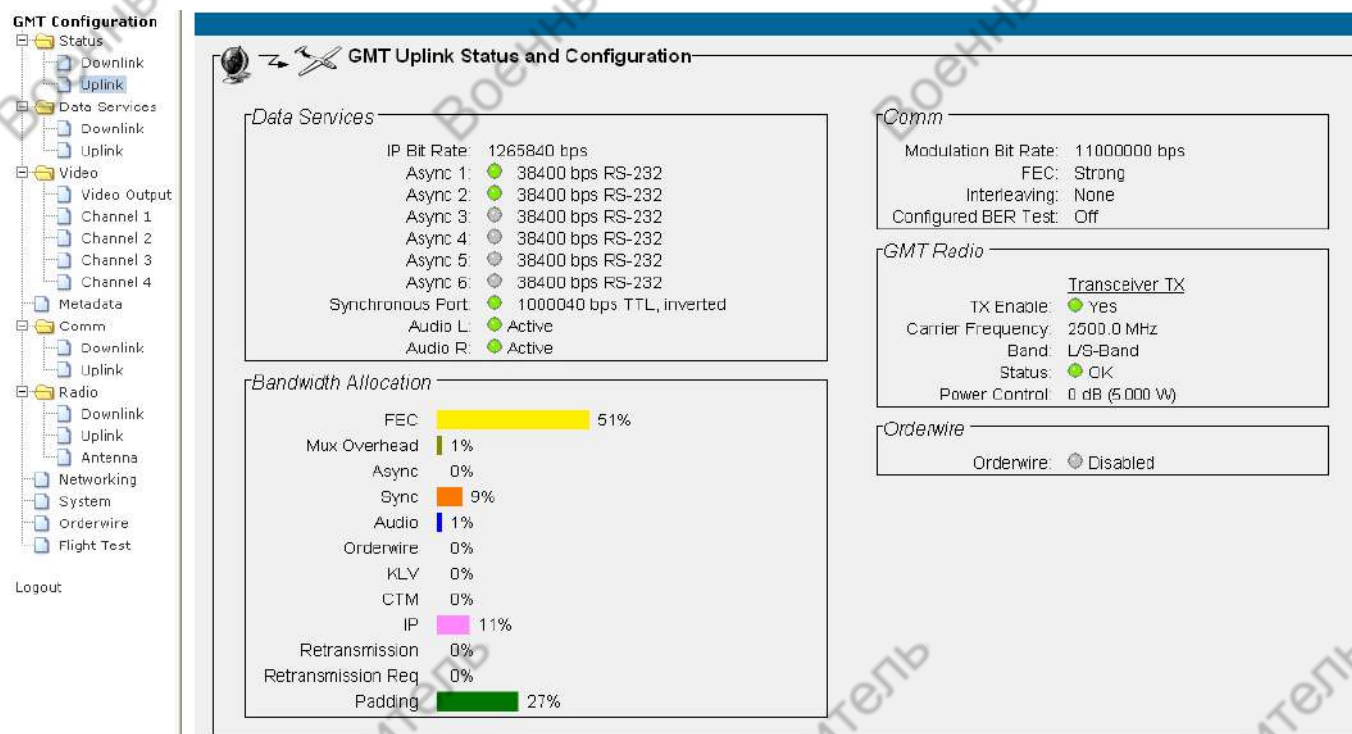


Figure 31: GMT Uplink Status and Configuration Page

Data Services

This section provides a summary of the configuration for each data service available in the uplink.

IP Bit Rate displays the rate of IP data transmitted over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of the port. Green indicates that the port is enabled. The configured port rate and interface type are also listed.

Synchronous Port provides an indicator for the status of this port. Green indicates that the port is enabled. The data rate (accurate within 100 bps), the interface type, and the clock inversion configuration are also listed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled.

Bandwidth Allocation

This section provides a bar chart graphic showing an estimate of the allocation of bandwidth among the different data sources served by the multiplexer. This graph also displays the bandwidth required to support any FEC, as well as the overhead used by the system.

Comm

This section shows the current uplink communication settings for the modulation bit rate, forward error correction (FEC), interleaving, and bit-error rate testing (BER).

Radio

This section provides information about the configuration and status of the radio transmitter used on the uplink. The first signal indicates if the transmitter is enabled. The configured carrier frequency is listed next, followed by the frequency band of the active transceiver. The second signal indicates the status of the transmitter. The final item displays the transmit power control level setting.

Orderwire

The Orderwire Status LED indicates the status of the Orderwire link. If Orderwire Service is disabled at the GMT, this LED will be gray. If Orderwire Service is enabled, but the link has not been established, this LED will be red. If Orderwire Service is enabled and the AMT and GMT have established a link, the LED will be green.

3.6.3 GMT Downlink Data Services Setup

The downlink data link in the EnerLinksIII system is primarily controlled by the settings of the AMT. The configuration is sent from the AMT to the GMT and the data service settings are displayed on this page. Additionally, the user is provided with a few configuration options on how the data is output by the GMT. Finally, the packet counts for data received by the GMT are displayed on this page.

Figure 32 shows the GMT Downlink Data Services page. All configurable parameters on this page can be modified only by users with Full access privileges. All parameters are visible to both a full access and a view-only access user. Either user type can clear packet counters.

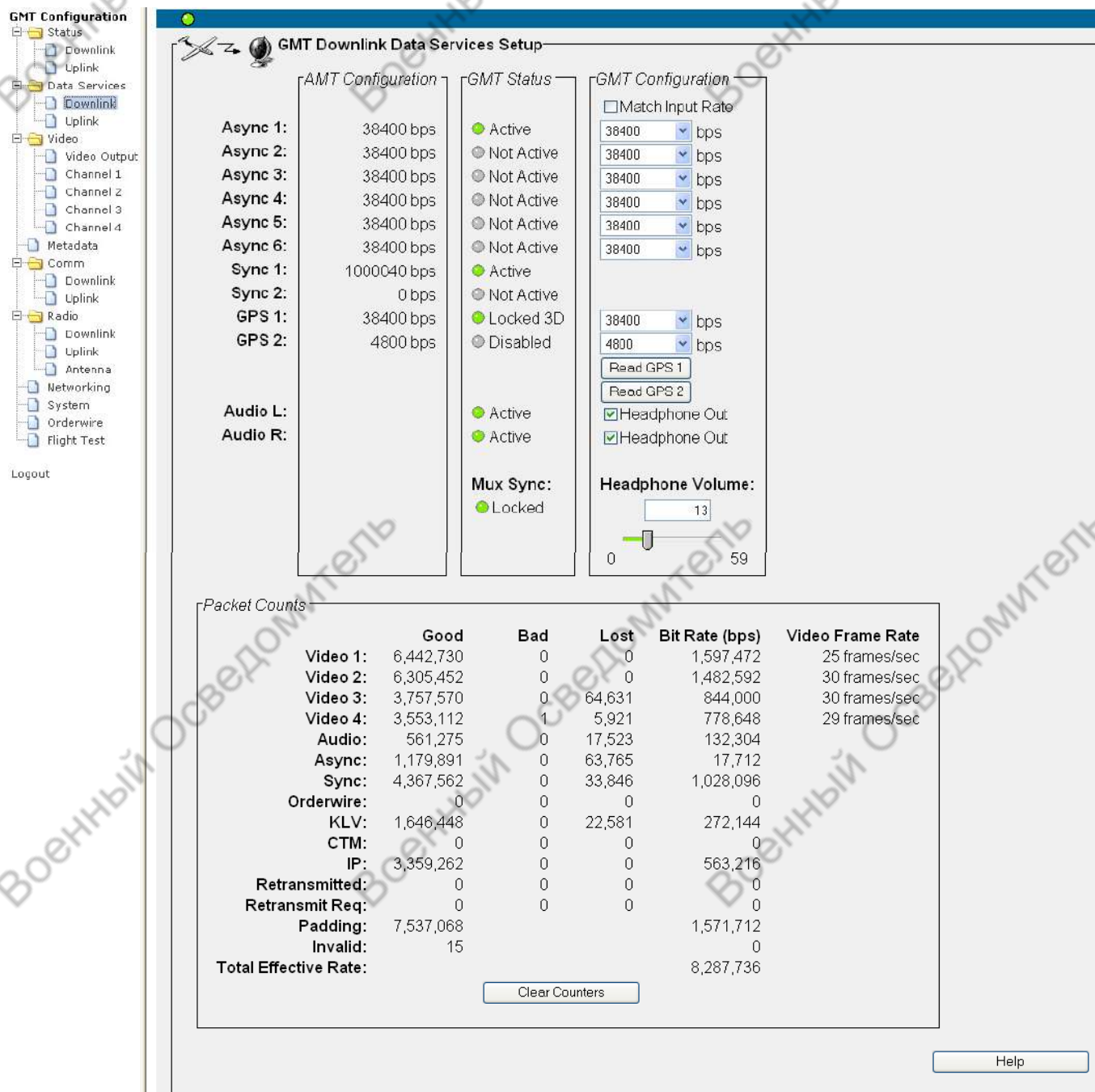


Figure 32: GMT Downlink Data Services Setup Page

Async Data Ports

The EnerLinksIII System supports up to 6 asynchronous data ports on the downlink. These ports are used for serial type data such as that provided from a UART in a typical “COM Port” from a PC.

If any of the Asynchronous ports is active at the AMT, the corresponding Async status indicator will indicate Active on this page. In the same way, the baud rate used at the AMT will be displayed in the AMT Configuration window. The GMT Output Rate is set by selecting a value

from the drop-down box. This is the baud rate used to output the Asynchronous port data from the GMT. This rate must be greater than or equal to the AMT Input Rate value to ensure data integrity. The destination device must be set to 8 data bits, 1 stop bit, no parity and no flow control.

If the GMT Output Rate is too low for the input rate, the GMT will reconfigure the Output Rate to the same as the AMT Input Rate.

The data for all asynchronous data ports is output in both RS-232 and RS-422 data formats.

Note that the rate of all the asynchronous downlink data ports can be set to the exact rate configured at the AMT. Clicking the “Match input rates” checkbox so that it shows a checkmark causes the rate of all asynchronous data ports to match the configuration at the AMT.

When Antenna Steering is enabled on the Antenna GUI page, Async ports 5 and 6 on the GMT are used for antenna steering and are unavailable for uplink or downlink multiplexed data. In this case, the status on this page will indicate “Unavailable” and the output rate selection boxes will be disabled for each of these ports.

The current status and AMT input baud rate for each Async port are automatically refreshed in the GUI display approximately once a second.

Async TCP/IP Configuration

The GMT listens for a TCP/IP connection on specific ports. When an application is connected to one of the GMT's TCP/IP ports, the GMT sends all data received over the TCP/IP socket as uplink async data, and sends all downlink async data over the TCP/IP socket. The GMT can support up to ten clients at a time connected to each port. For the six async ports, the GMT listens on TCP/IP port numbers 1031 through 1036.

Sync

The EnerLinksIII downlink supports two channels of Synchronous data. Synchronous data is a data stream provided at a continuous bit rate and accompanied by a clock. Synchronous data is supported at bit rates up to 10 Mbps.

If a synchronous data port is active at the AMT, the corresponding Sync indicator will be set to Active on this page and the AMT Configuration window will show the bit rate of the synchronous data stream within 100 bps accuracy. The user cannot configure the GMT Output Rate for Sync data. The GMT Output Rate always matches the AMT Input Rate.

The current status and bit rate for each Sync port is automatically refreshed in the GUI display approximately once a second.

GPS

The EnerLinksIII AMT includes two RS-232 GPS ports which may be connected to GPS receivers. The AMT is able to receive and interpret GPS data provided in an NMEA 0183 data format.

The GPS status indicator for each port provides the current status of the GPS receivers connected to the AMT. “Not Responding” indicates the GMT does not have Mux Sync with the AMT or a fault in the GPS hardware at the AMT. “Not Locked” indicates the GPS device is functioning, but does not have valid position lock. “Locked 2D” or “Locked 3D” indicate the GPS device has a valid position lock. The current GPS status is automatically refreshed in the GUI display approximately once a second.

The data rate of the GPS streams provided to the AMT is displayed in the “AMT Configuration” field. The GMT user can select the baud rate used to output the GPS port data from the GMT. The current AMT input baud rate for each GPS port is automatically refreshed in the GUI display approximately once a second.

Clicking the “Read GPS” button for each port will pop-up the latest latitude, longitude, and altitude readings from the GPS receivers connected to the AMT.

GPS TCP/IP Configuration

The GMT listens for a TCP/IP connection on specific ports. Applications such as FalconView can be configured to connect over the network to the GMT’s IP address and the TCP/IP port number. When an application is connected to one of the GMT’s TCP/IP ports, the GMT sends all of the NMEA 0183 GPS data for the corresponding GPS port to the application over the network. The GMT can support up to ten clients at a time connected to each port. For the two GPS ports, the GMT listens on TCP/IP port numbers 1041 and 1042.

Audio L and Audio R

The EnerLinksIII AMT has two audio ports that accept an analog line level input for use on the downlink. The audio ports can be stereo inputs, completely separate audio sources, or only one port can be used in a mono mode. The audio ports provide voice grade, toll quality (meaning that it is as good as voice transmitted over a standard wireline phone system) digitized at 8 ksamp/sec and uLaw compressed to create a 64 kbps bit stream for each audio channel.

If one or both Audio ports are active at the AMT, the corresponding Audio indicator will be set to Active at the GMT. In cases where the audio ports are enabled at the AMT, a GMT user can enable headphone outputs by clicking the “Headphone out” checkbox so that it shows a checkmark for the appropriate audio channel. When only one “Headphone Out” check box is selected, the associated audio signal is sent to both the left and right headphone channels. The headphone volume can be adjusted by using the slider or by manually typing in a volume in the headphone volume box. Valid settings range from 0 to 59, with 59 corresponding to the loudest volume.

The Audio indicators are automatically refreshed in the GUI display approximately once a second.

Mux Sync Lock

The Mux Sync Lock indicator is set when the GMT is able to correctly read the data for the different services. Mux Sync Lock status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Packet Counts

The Packet Counts table displays the number of good, bad, and lost packets received and the receive bit rate for each type of data received by the GMT. Lost packets are detected by gaps in received sequence numbers. All values in this table are read from the GMT and automatically refreshed in the GUI display approximately once a second.

All packet counts in this table refer to the variable-size 8 to 256 byte EnerLinksIII packets sent in the multiplexed data stream between the AMT and GMT. Each EnerLinksIII mux packet contains information indicating the packet type, sequence number, length and CRC.

The bit rates displayed represent the rate of data transmitted over the multiplexed data stream averaged over the last 10 seconds. The frame rate of each video channel averaged over the last 10 seconds is also displayed in this table.

Video Data Counters

The video bit rate displayed in the Packet Counts table shows the rate of video data being received for each video channel that is currently enabled at the AMT. The method of allocating bandwidth for video data is selected on the AMT Video Setup page. When the Variable Bit Rate method is selected, video data is always transmitted at the highest rate possible given the AMT configuration of the other data services. When the Fixed Bit Rate method is selected, video data is limited so that it never exceeds a specified maximum bit rate, and it is given priority over IP traffic.

The bandwidth available for carrying the entire multiplexed bit stream is a function of the modulation bit rate and FEC parameters specified in the downlink communications GUI page. In Variable Bit Rate mode, the bit rate requirements of all of the other data services are met by the multiplexer before it includes video in the multiplexed bit stream. The video streams are allocated all of the remaining bandwidth.

In Fixed Bit Rate mode, video data is given priority over forwarded IP traffic. The bit rate requirements of all of the data services other than IP are still met by the multiplexer before it includes video in the multiplexed bit stream. The video streams are then allocated all of the remaining bandwidth up to the specified maximum bit rate.

Depending on the video compression type for each active video channel, the AMT either drops video frames or adjusts the video quality to adjust the video bit rate to fit into this remaining bandwidth. The GMT supports video data compressed using either the H.264 or Motion JPEG (MJPEG) video compression standard.

The Motion JPEG algorithm used by the EnerLinksIII system treats each frame of the video as an individual image and compresses that image using the industry standard JPEG algorithm based on the quality factors configured for the compression. If the compression is set to be light, the amount of data in each of these images may be large, while heavy compression reduces the number of bits substantially. The size of each image also depends very heavily on the video content, since complex images require more bits per image. If the bandwidth available for an MJPEG video channel is insufficient to carry all the images, then images are discarded by the AMT and the frame rate decreases.

In addition to individual frame compression, the H.264 algorithm used by the EnerLinksIII system uses inter-picture prediction to perform compression on a video stream. This takes advantage of frame-to-frame similarity of pixels in a given area. This algorithm provides good video quality at substantially lower bit rates than can be achieved with MJPEG. As with MJPEG, the bit rate of a video stream compressed with H.264 will be reduced to fit the available bandwidth remaining for the stream when all other data services have been handled. Unlike MJPEG, the frame rate of an H.264 video stream will be kept constant: 30 fps for NTSC channels, and 25 fps for PAL. To reduce the bit rate while keeping the frame rate constant, the amount of compression will be increased. Thus as the available bit rate for a video channel is reduced, the quality of the video is reduced. As the bit rate for a channel is reduced below a certain level, the amount of compression that can be performed reaches a maximum level and the frame rate must be reduced to meet the rate requirements. This frame rate reduction begins to take effect at around 600 Kbps for standard definition video standards and 1.2 Mbps for high definition video standards.

Sync Data Counters

Note that the bit rate for sync data displayed in the Packet Counts table will typically be higher than the sync rate displayed in the section above. The rate in the previous section reflects the input data rate of each sync channel, while the rate in the Packet Counts table includes the overhead associated with the EnerLinksIII mux packets used to carry that data.

CTM Data Counters

The CTM data counter indicates the number of clear text messages received. Clear text messages are sent from the AMT when the optional AES feature license is enabled on that unit. These messages include the “salt” to be used in decryption, as well as information indicating whether AES is enabled at the encoder, to tell the decoder whether AES decryption needs to be performed at all. The clear text message is sent at a regular interval, as specified by the AESCTI command.

IP Data Counters

Ethernet protocol packets forwarded over the multiplexed data stream are segmented as necessary and sent within EnerLinksIII mux packets. Counters for the number of Ethernet and IP protocol packets sent and received over the multiplexed data stream are provided on the Networking GUI page.

Clear Counters

This button resets all of the packet counts provided on this GUI page.

3.6.4 GMT Uplink Data Services Setup

The EnerLinksIII GMT provides the ability to combine, or multiplex, data from a variety of sources into a single transmitted bit stream that the EnerLinksIII AMT is able to separate, or demultiplex, into the original separate streams. The Uplink Data Services page of the GMT GUI is shown in Figure 33. This page allows the user to configure the various data sources to be multiplexed and also provides related status. Note that the uplink provides many of the same data services as the downlink from the AMT, with the exception that no video or GPS input ports are available at the GMT.

All controls on the GMT Uplink Data Services page are accessible only by users with Full access privileges, but View-Only access users can also clear packet counters. All parameters are visible to both Full access and View-Only access users.

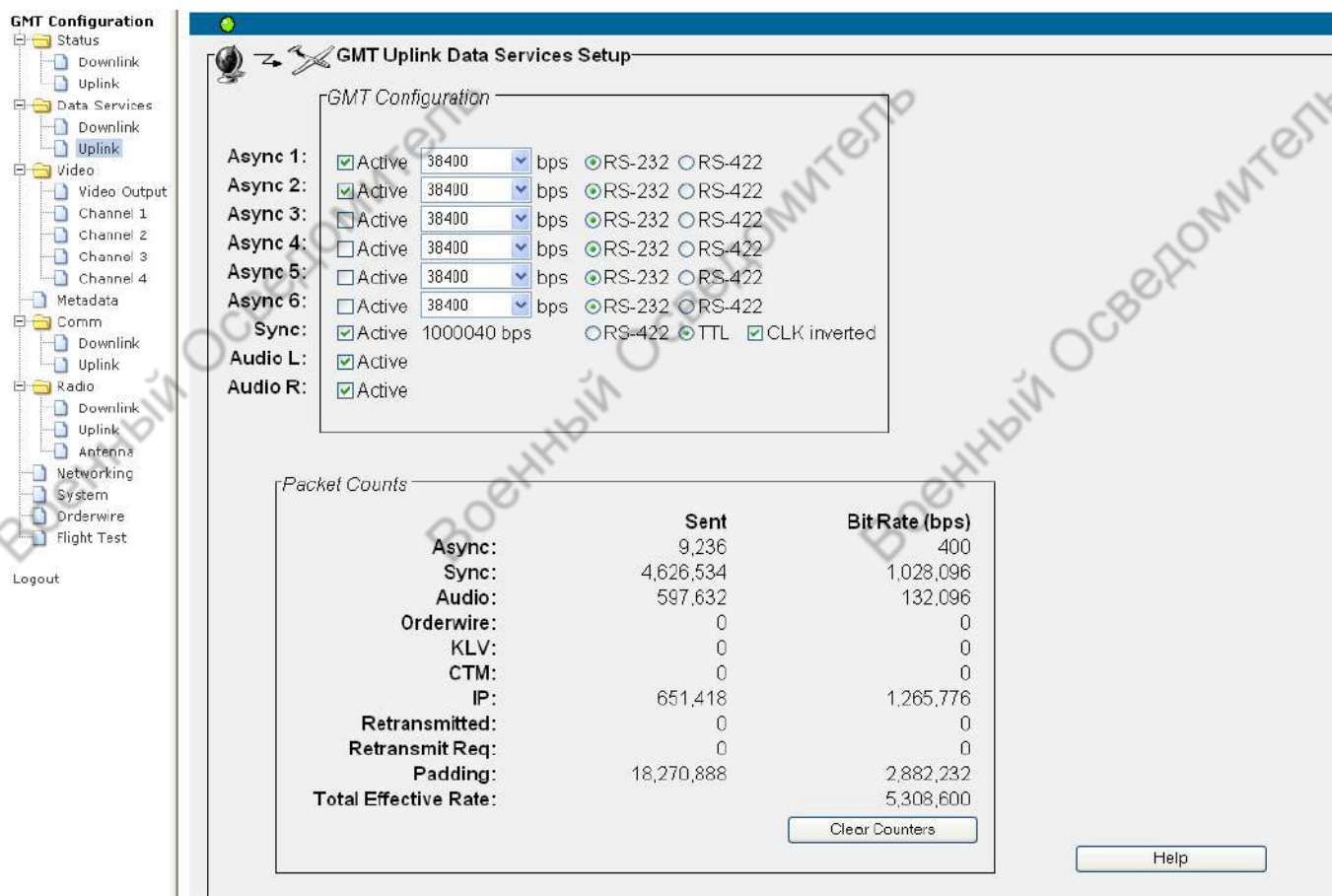


Figure 33: GMT Uplink Data Services Setup Page

Async Data Ports

The EnerLinksIII GMT supports up to 6 asynchronous data ports in the uplink, used for serial type data such as that provided from a UART in a typical “COM Port” from a PC. The GMT supports either RS-232 or RS-422 (differential) signal levels for these data ports. The range of

allowed baud rates is from 300 bps to 115.2 kbps using the RS-232 interface, and from 300 to 921.6 kbps using the RS-422 interface. The source device must be set to 8 data bits, 1 stop bit, no parity and no flow control.

To enable an asynchronous data port, click the “Active” checkbox so that it shows a checkmark. Select the baud rate from the drop down menu. Select the appropriate interface (RS-232 or RS-422) using the radio buttons.

When Antenna Steering is enabled on the Antenna GUI page, Async ports 5 and 6 on the GMT are used for antenna steering and are unavailable for uplink or downlink multiplexed data. In this case, the “Active” checkboxes, the input rate selection, and the interface type selection boxes will be disabled for each of these ports.

Async TCP/IP Configuration

The GMT listens for a TCP/IP connection on specific ports. When an application is connected to one of the GMT's TCP/IP ports, the GMT sends all data received over the TCP/IP socket as uplink async data, and sends all downlink async data over the TCP/IP socket. The GMT can support up to ten clients at a time connected to each port. For the six async ports, the GMT listens on TCP/IP port numbers 1031 through 1036.

Sync

The EnerLinksIII system supports one channel of Synchronous data in the uplink. Synchronous data is a data stream provided at a continuous bit rate and accompanied by a clock. Synchronous data is supported at bit rates up to 10 Mbps using either an RS-422 (differential) or single ended TTL interface.

To enable the synchronous data port, click the “Active” checkbox so that it shows a checkmark. Use the radio buttons to specify whether the interface is RS-422 or TTL, and also select the “CLK inverted” check box if the falling edge of the clock is active.

If the port is enabled, the GMT will automatically determine the input data rate and display it within 100 bps accuracy. The current input data rate is automatically refreshed in the GUI display approximately once a second.

Audio L and Audio R

The EnerLinksIII GMT has two audio ports that accept an analog line level input. The audio ports can be stereo inputs, completely separate audio sources, or only one port can be used in a mono mode. The audio ports provide voice grade, toll quality (meaning that it is as good as voice transmitted over a standard wireline phone system) digitized at 8 ksamp/sec and uLaw compressed to create a 64 kbps bit stream for each audio channel.

Clicking the “Active” checkbox so that it shows a checkmark causes the corresponding audio signal to be digitized and multiplexed into the transmitted bit stream.

Packet Counts

The Packet Counts table displays the number of packets sent and the transmit bit rate for each type of data sent by the GMT. All values in this table are read from the GMT and automatically refreshed in the GUI display approximately once a second.

All packet counts in this table refer to variable-size 8 to 256 byte EnerLinksIII packets sent in the multiplexed data stream between the AMT and GMT. Each EnerLinksIII mux packet contains information indicating the packet type, sequence number, length and CRC.

Sync Data Counters

Note that the bit rate for sync data displayed in the Packet Counts table will typically be higher than the sync rate displayed in the section above. The rate in the previous section reflects the input data rate of the sync channel, while the rate in the Packet Counts table includes the overhead associated with the EnerLinksIII mux packets used to carry that data.

CTM Data Counters

The CTM data counter indicates the number of clear text messages transmitted. Clear text messages are sent when the optional AES feature license is enabled. These messages include the “salt” to be used in decryption, as well as information indicating whether AES is enabled at the encoder, to tell the decoder whether AES decryption needs to be performed at all. The clear text message is sent at a regular interval, as specified by the AESCTI command.

IP Data Counters

Ethernet protocol packets forwarded over the multiplexed data stream are segmented as necessary and sent within EnerLinksIII mux packets. Counters for the number of Ethernet and IP protocol packets sent and received over the multiplexed data stream are provided on the Networking GUI page.

Clear Counters Button

This button resets all of the packet counts provided on this GUI page.

3.6.5 GMT Video Output Setup

The GMT Video Output Setup Page (see Figure 34) allows the user to configure the video output to be displayed on each video jack on the GMT. All features of this page may only be modified by users with Full access privileges.

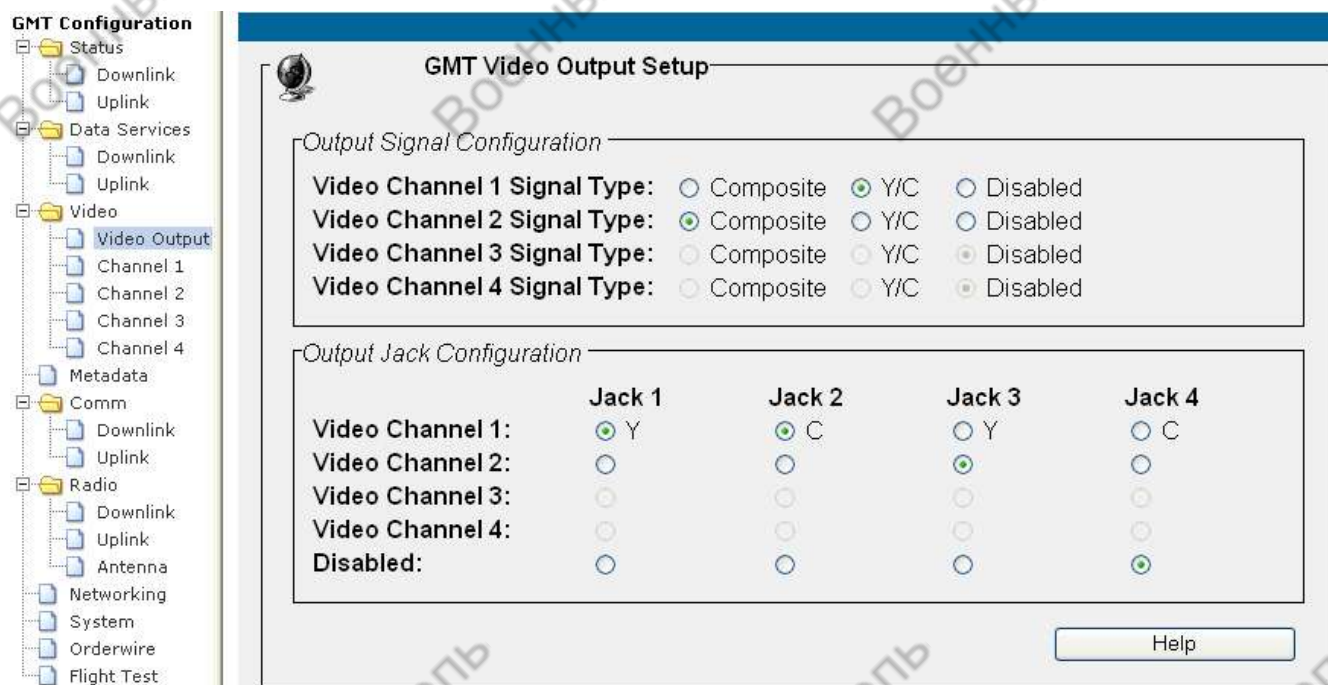


Figure 34: GMT Video Output Setup Page

Output Signal Configuration

Use the radio buttons in this section to enable the video channels to be output from the analog video jacks on the GMT. Only two video channels may be enabled for output at a time. Enable each video channel by selecting the video signal type to be displayed for the channel. Video may be presented in composite format, which is a single signal that contains the entire video stream, or in Y/C mode in which there are two signals, a luminance (Y) signal and a chrominance (C) signal. Y/C typically provides better quality.

Note that the GMT will not prevent you from enabling a video channel for analog output when that channel is disabled at the AMT, or it is processing a digital video input. In either case, however, no analog output will be displayed by the GMT for such channels.

Output Jack Configuration

The EnerLinksIII GMT is designed with four output video jacks used to connect to video terminals or recording devices. This section provides the ability to select the source of the video that will be displayed on each of these jacks. Each jack can be configured to output any of the four video channels, or can be disabled. Only a video channel that has been enabled in the Output Signal Configuration section above can be selected for output on one of the jacks.

If the Y/C output video signal type is selected for either of the video channels, the output jack selection for that video channel must be performed as a pair. Jacks 1 and 2 form one Y/C pair, and Jacks 3 and 4 form another. Jacks 1 and 3 will display luminance (Y), while jacks 2 and 4 will display chrominance (C). For instance, if Video Channel 1 is configured for Y/C mode as seen in Figure 34, then whenever you select channel 1 as the video source for any jack, the selection for the other jack in the Y/C pair will be automatically switched to the same source.

The GUI display will present the appropriate Y and C symbols next to the radio buttons associated with a Y/C video signal.

In the configuration displayed in Figure 34, Jacks 1 and 2 are configured to display the Y and C components of the video channel 1 signal, Jack 3 is configured to display the composite video channel 2 signal, and Jack 4 is disabled.

3.6.6 GMT Video Channel Setup

A separate GUI page is provided for configuring each video channel. Each page contains sections that display the current video mode and allow you to configure various parameters related to the analog video output for the video channel.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video Output
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
- System
- Orderwire
- Flight Test

Logout

GMT Video Channel 1 Setup

Video Mode

Video Compression: ☒ H.264

Video Input Format: ☒ PAL

Video Output Format: ☒ PAL

Force Monochrome: ☐ Disabled

Video Picture Coding: ☒ Frame

Video Output Control

☐ Freeze

Display color bars if no frames received for seconds

MJPEG Frame Select †

☒ Display all frames

☐ Display only error-free frames

H.264 Video Display Mode ‡

☐ Scaled image display

☒ Standard image display

Picture Adjustment

Brightness Contrast Tint Saturation

0 128 255 0 128 255 0 128 255 0 128 255

Normalize

Text Overlay

☐ Disable Overlay

☒ Enable Overlay

video title 1

video title 2

Display Text

☒ GPS 1

☒ GPS 2

☒ AMT Title 1

☒ AMT Title 2

☒ AMT Title 3

☒ AMT Title 4

☒ AMT Title 5

☒ AMT Title 6

☒ AMT Title 7

☒ AMT Title 8

☒ AMT Time

☒ AMT Date

☒ GMT Time

☒ GMT Date

Text Color:

H.264 Font Size §:

Click and drag to reposition overlay text

Figure 35: GMT Video Channel Setup Page

Video Mode

The current AMT video compression, video input format, output format, color/monochrome configuration, and video picture coding configuration for each video channel is provided to the GMT in status information packets carried in the multiplexed data stream. This information is displayed in the Video Mode section of this GUI page, and does not require any configuration by the user. The status displayed in this section is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Video Compression

The video compression used for each video channel may be set to Disabled, MJPEG, or H.264 at the AMT.

Video Input Format

An indicator light and text string are provided in this section. The indicator light represents video signal status: blank indicating that the channel is disabled, green indicating video signal lock, and red indicating video signal not present or not locked due to an unsupported format detected. The video format will be displayed as text next to the video signal light. “Disabled” will be displayed if the channel is disabled, “No Signal Present” will be displayed if no signal is present, and “Unsupported Format” will be displayed if an unsupported format is detected.

The following two widely used video formats are supported by the EnerLinksIII:

- NTSC: the standard for color television used in most of North America
- PAL: the standard for color television used in most of Europe. Note that there are several varieties of PAL that are used outside of Europe. The EnerLinksIII supports the PAL-B standard that is most widely used in Europe. It does not support other PAL standards.

When the license for the HD video feature is enabled at the AMT, the EnerLinksIII System also supports three digital formats. These are:

- 1920x1080p29.97
- 1280x720p59.94
- 1280x720p60

Video Output Format

The format of the video available for output for this channel is displayed here. Only two output formats are possible, NTSC and PAL. If the input video format cannot be converted to one of these formats, then no output will be displayed, and the “Disabled” indicator will be illuminated. Such is the case when the High Definition Video feature is enabled, and an HD input is selected. Note that the video channel does not have to be selected for output on the Video Output Setup GUI page for its output format to be displayed here.

Force Monochrome

The setting of this configuration on the AMT is displayed here.

Video Picture Coding

The picture coding methods that may be configured at the AMT are associated with the video compression type selected. For an MJPEG channel, frame and field picture coding methods may be used. For an H.264 channel, the field and frame methods may be used, and the Adaptive Field/Frame (AFF) coding method may be used as well.

In the Frame picture coding method the two fields provided in the interlaced video input, one field representing all of the even and the other all of the odd lines, are combined to make a single frame, alternating the even and odd lines, and this frame is then encoded. In Field picture coding the fields are encoded separately. If the Adaptive Field/Frame picture coding method is selected, the H.264 encoder will dynamically choose the picture coding method that provides the best compression.

Video Output Control

This section includes controls to freeze the analog video display, and set a colorbar timeout.

Freeze

Check this box to temporarily freeze the analog video display for this video channel. This holds the last received frame on the screen until this box is unchecked. The freeze configuration is not stored through a system reset.

If the video compression selected for a channel is changed at the AMT while video display is frozen, the video decoder displaying the last frame will necessarily be reset, and real-time analog video display will resume. Also, because some components are shared between the video channels, whenever the video compression of one channel is changed, real-time analog video display on the other channel may be resumed as well.

For H.264 video channels, significant errors in the downlink data stream or a loss of communication with the AMT may cause the H.264 decoder to reinitialize. When this occurs, the last frame displayed will be lost and real-time analog video display will resume.

Display color bars

This value sets the amount of time to wait for lost video frames before declaring the video connection to be lost and reverting to a colorbar display. If this value is 0, color bars will not be displayed upon loss of video.

Note: For an MJPEG channel, if the current system configuration results in a very low video frame rate, it is possible for the timeout configured here to expire in between valid video frames, causing the video output to alternate between color bars and video frames.

MJPEG Frame Select

The EnerLinksIII GMT has two modes for video display when a channel is configured for MJPEG video compression. The desired mode is selected via a radio button. The choice of video display mode affects only the local display provided by the analog video outputs on the GMT front panel. Video transported via IP network is unaffected by the mode choice on this

page. If the channel is not configured for MJPEG video compression, this configuration has no effect.

Display all frames

In this mode all received frames are displayed whether they contain errors or not.

Display only error-free frames

In this mode, frames that contain any bit errors are not displayed. This can make the video easier to view if there are only sporadic errors in the video data. When there are significant numbers of errors, choosing this mode may result in long gaps between displayed viewed frames.

H.264 Video Display Mode

The EnerLinksIII GMT has two modes for video display when a channel is configured for H.264 video compression. The desired mode is selected via a radio button. The choice of video display mode affects only the local display provided by the analog video outputs on the GMT front panel. Video transported via IP network is unaffected by the mode choice on this page. If the channel is not configured for H.264 video compression, this configuration has no effect.

Scaled image display

In this mode video is adjusted to minimize the amount of active video cut off along the edges of standard monitors.

Standard image display

In this mode, scaling is disabled so that the GMT video output closely matches the video input to the AMT. The output display matches what it would be if the airborne camera was connected directly to the ground monitor.

Picture Adjustment

These features allow adjustment of the picture brightness, contrast, tint, and saturation in the same fashion that typical color television sets operate. The settings on this page do not change the images sent over an IP network to EnerView. These settings only change the analog video output of the GMT.

Note that the AMT contains picture adjustment options which are implemented prior to video compression. The settings at the AMT cannot be undone at the GMT or EnerView application.

Text Overlay

The On Screen Display (OSD) text overlay feature allows the user to place text on top of the analog video output from the video connectors on the GMT front panel. The user selects which data should appear in the OSD and then positions the data by clicking and dragging it on a sample screen display that appears on the Video Channel Setup page.

Note that text displayed on the OSD may not overlap. When moving text entries on the sample screen display, the GUI will prevent you from placing text entries ovetop of each other. However, when an entry is disabled it will not be displayed on the sample screen and other entries may be moved over it. If you enable an entry that has another entry over it, a conflict

occurs. The newly enabled entry will be displayed in the GUI sample screen, but it will not be enabled in the GMT configuration, or on the analog video output, until the conflict is resolved by moving one of the conflicting entries. Conflicting entries will be noted in the GUI with an asterisk (*) next to the entry's listing in the left hand column.

When determining overlap, the AMT text strings are considered to encompass the entire line that they reside on. This allows you to position the text string with assurance that no overlap will occur if a user at the AMT changes the length of the string.

Another case where a display text conflict can occur is when text is configured to be placed outside of the screen boundaries. The GUI will prevent you from placing text outside the screen area when you are moving text around. However, text may be repositioned outside the screen boundaries when the font size increases due to a change from H.264 video compression to MJPEG video compression, or when the H.264 font size is changed from Small to Large. When this occurs, an asterisk (*) will appear next to the listing in the left hand column for any entry that extends beyond the screen boundaries.

Enable/Disable Overlay

This radio button pair allows the entire OSD overlay to be removed or restored with a single mouse click. Disabling the overlay does not immediately destroy the selections, text entries and placement information already selected, but simply stops the display of this information on the video output. Enabling the overlay makes all the selected features re-appear on the video output. If the GMT is reset while overlay is disabled, the current selections, text entries, and placement information are still retained when overlay is enabled again.

Video Title 1 and 2

The user can enter up to two arbitrary text strings that will appear on the screen as a title for the video channel. Double-quotes will not be displayed. The maximum string length depends upon the video compression used for the channel, the font size selected, and the starting position of the text on the screen. Text strings may not be entered that would extend beyond the screen boundaries. Due to the size of the font when MJPEG video compression is used, the maximum string length for a MJPEG video channel is 30 characters. H.264 video compression allows selection of two font sizes, Small and Large. When the Small font size is selected, the maximum string length for a H.264 video channel is 39 characters. When the Large font size is selected, the maximum string length for a H.264 video channel is 25 characters.

GPS 1 and 2

Clicking the check box for GPS 1 or GPS 2 enables display of the GPS position of the GPS receiver connected to the AMT in Lat/Long/Alt format. If the GPS is not accurate (because the GPS receiver at the AMT is not tracking or has some other fault condition) the GPS data displayed on the video output will contain the last valid position information received, with an asterisk (*) appended to the end of each line of the GPS display. If the problem persists for more than 5 minutes, or no valid position information has been received since the AMT was initialized, the GPS data is given as "No GPS data". If the GPS port is disabled at the AMT, the GPS data is displayed as "GPS disabled".

AMT Title 1 through 8

Clicking any of these check boxes enables display of the associated AMT Title text string that was configured on the AMT.

AMT Time

Clicking the check box enables display of the AMT Real Time Clock time value.

AMT Date

Clicking the check box enables display of the AMT Real Time Clock date value.

GMT Time

Clicking the check box enables display of the GMT Real Time Clock time value.

GMT Date

Clicking the check box enables display of the GMT Real Time Clock date value.

Text Color

This drop down window allows the user to specify the color of the text characters.

H.264 Font Size

This drop down window allows the user to select the font size when the video channel is configured for H.264 video compression. The available sizes are Small and Large. Note that when changing from small to large video size, OSD text may be repositioned outside the visible screen boundaries. An asterisk will appear next to the entry name in the left hand column for any entry that extends beyond the screen boundaries. This configuration has no effect when the channel is using MJPEG video compression.

3.6.7 GMT Metadata Setup

The EnerLinksIII system provides the ability to align received metadata messages with their associated video frames so that the aligned video and metadata messages are tagged with the same Presentation Time Stamp (PTS) when they are output in a MPEG-2 TS stream from the GMT. A detailed description of the metadata / video time alignment theory of operation is provided in section 8.4 of this document. Figure 36 shows the GMT Metadata Setup page.

All statistics and counters on this GUI page will be read from the AMT and automatically refreshed in the GUI display approximately once a second.

Full access privileges are required to modify any Metadata Setup page setting.

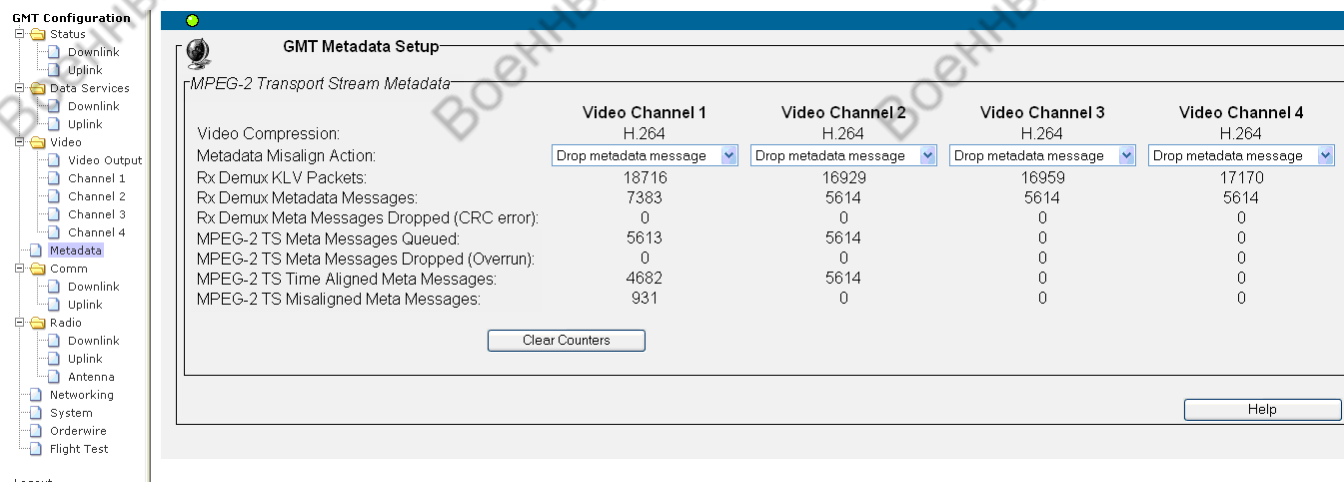


Figure 36: GMT Metadata Setup Page

MPEG2-Transport Stream Metadata

This section provides the ability to configure the handling of unaligned metadata in MPEG2-Transport Streams. It also provides statistics for metadata messages received from the AMT, and transmitted in the MPEG2-Transport Streams. Configuration and statistics are provided for each video channel. Note that configuration of the MPEG-2 TS destination addresses is performed on the Networking GUI page described in section 3.6.13 of this document.

Video Compression

The current video compression standard configured for each video channel is displayed here.

MPEG-2 TS Metadata Misalign Action

When the AMT determines that a metadata message cannot be matched to a video frame, it places the PTS from the video frame with the closest UTC value in the Internal ViaSat header for the metadata message, and clears the “PTS valid” flag in the header. When these messages are received by the GMT software module that is responsible for sending messages in the MPEG2-Transport Streams, that module must decide what action to take on these messages.

This Metadata Misalign Action drop down selection box is used to select the action to take on metadata messages in the MPEG2-Transport Stream when they are misaligned with video frames. If “Drop metadata message” is selected, the message will be dropped, and not included in the MPEG-2 TS. If “Send msg without PTS” is selected, the message will be included in the MPEG-2 TS stream, but no PTS field will be included in the Packetized Elementary Stream (PES) packet header for the message. If “Send msg with closest PTS” is selected, the message will be included in the MPEG-2 TS stream, and the PTS value from the metadata packet header will be written into the PES packet header for the message.

Rx Demux KLV Packets

The number of 8 to 256 byte EnerLinksIII packets containing KLV metadata that have been received from the multiplexed data stream for each video channel.

Rx Demux Metadata Messages

The number of metadata messages received from the multiplexed data stream. This count includes metadata messages that were sent to the AMT from user applications as well as KLV messages generated by the AMT to inform the GMT of the current AMT RTC.

Rx Demux Meta Messages Dropped (CRC error)

The number of metadata messages received from the multiplexed data stream that had a CRC error detected. These messages are not included in the Rx Demux Metadata Messages count above.

MPEG-2 TS Metadata Messages Queued

The number of metadata messages that have been queued for delivery from the GMT in an MPEG2-Transport Stream.

MPEG-2 TS Metadata Messages Dropped (Overflow)

The number of metadata messages that have been dropped when the MPEG-2 TS delivery queue size is exceeded. These messages are not included in the MPEG-2 TS Metadata Messages Queued count above.

MPEG-2 TS Time Aligned Meta Messages

The number of metadata messages that were sent in the MPEG-2 TS that had the “PTS valid” flag set to “1” in the ViaSat internal metadata header. For each of these messages, the PTS value from the metadata packet header will be written into the Packetized Elementary Stream (PES) packet header of the metadata message when it is included in the MPEG-2 TS stream.

MPEG-2 TS Misaligned Meta Messages

The number of metadata messages processed by the MPEG-2 TS module in the AMT that had the “PTS valid” flag set to “0” in the ViaSat internal metadata header. Each of these messages will be dropped or forwarded in the MPEG-2 TS according to the configured MPEG-2 TS Metadata Misalign Action.

Clear Counters

This button resets all of the message counters provided on this GUI page.

3.6.8 GMT Downlink Communications Setup

The Downlink Communication module of the EnerLinksIII GMT accepts an analog signal from the internal receiver module, and recovers the multiplexed bit stream from the signal. There are four major operations in this process:

- Bit synchronization – this operation recovers the modulation bit rate clock from the analog signal and adjusts its phase to sample the analog signal at as close to the optimal phase alignment as possible.
- Mux sync detection – this operation finds a “sync” pattern embedded in the recovered data stream. This pattern is used to exactly determine where data blocks begin in the data stream so that the data can be properly interpreted.

- Deinterleaving – this operation reverses the shuffling of bit order that occurred in the Interleaver function of the AMT. It thus restores the original bit order and in the process, shuffles the positions of any errors occurring from burst interference so that these errors are more uniformly distributed in the deinterleaved bit stream. This function is important because the FEC is more effective at correcting errors when the errors are uniformly distributed.
- Forward error correction decoding – undoes the FEC coding provided by the AMT, in the process correcting a very large percentage of bit errors that have been introduced by interference and noise on the channel. The FEC operates on blocks of data, each of which includes a cyclic redundancy check (CRC) code that enables the GMT to determine with a high degree of accuracy when any given block still contains errors after the FEC decoding.

The GMT Downlink Communications page, shown in Figure 37, allows configuration of these functions. The configuration of these parameters can only be modified by users with Full access privileges. Users with view-only access can view all parameters on the page and can also reset the BER and BLER counters.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block configuration of FEC, Interleaving, and Modulation Bit Rate while Orderwire is enabled. To change these configuration items, first disable the Orderwire service from the GMT Orderwire Setup Page.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video Output
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
- System
- Orderwire
- Flight Test

Logout

GMT Downlink Communications Setup

Downlink Configuration

Modulation Bit Rate: 11000000 bps

FEC Coding: ☐ Strong (50% Overhead) ☐ Medium (33% Overhead) ☒ Light (20% Overhead) ☐ No FEC

Interleaving: ☐ Strong ☐ Moderate ☒ No Interleaving ☐ Specify Depth

The interleaver is a row column interleaver with row length equal to the code block size of 4096 or 1024 bits

256 code blocks

GMT Downlink Status

BER Test Mode: ☒ Off ☐ Modem Only ☐ FEC and Modem

BER Test Results: Acceptable

Full Integrator
☐ Ten Second Integrator
☐ One Second Integrator
 (BER evaluated over the last 45 seconds)

| | Receiver A | Receiver B | Combined |
|--------------|------------|------------|----------|
| BER: | 1.73 E-7 | 5.15 E-4 | n/a |
| BLER: | 0.00 E-6 | 0.00 E-6 | 0.00 E-6 |

Reset Counters

RF Signal: ☒ Receiver A ☒ Receiver B

Bit Sync Lock: ☒ Receiver A ☒ Receiver B

FEC Sync Lock: ☒ Receiver A ☒ Receiver B

MUX Sync Lock: ☒

Help

Figure 37: GMT Downlink Communications Setup Page

Modulation Bit Rate

The modulation bit rate is the rate of the final bit stream that includes the complete multiplexed bit stream and all other overhead such as FEC parity bits or sync headers. It must be set to match the Modulation Bit Rate of the AMT that generates the signal being received.

Note: If the AMT and GMT modulation bit rates are not set to the same value, the GMT will in most cases be unable to recover the data being received.

The modulation bit rate may be selected from the drop-down menu, or a new rate may be entered by selecting “Edit list...”. Supported rates are from 32,000 to 11,000,000 bps.

FEC Coding

Click the appropriate radio button to choose from the four FEC coding options. Please see section 8.3.2 for a more detailed description of how FEC is implemented in the EnerLinksIII.

In addition to the FEC, an error detecting code is also used on each FEC code block. This code is always calculated by the AMT and inserted into the data stream. The code adds a 32 bit cyclic redundancy check (CRC) code to each FEC code block and is used by the diversity receiver in the GMT to determine which receiver path has produced good data for each block.

Note: The FEC coding configuration of the AMT must be configured to match that of the GMT or the GMT will be unable to recover the transmitted data.

The FEC coding choices are:

Strong (50% overhead)

The Strong code is a three dimensional TPC. In this code, three blocks are encoded using a $(32,26)^2$ code, and then a fourth block is generated in which each bit position is the parity of the bits in the corresponding position of the first three code blocks. This code has a block size of 4,096 bits and a code rate of 0.495. It provides a range improvement of more than a factor of three compared to operating without FEC.

Medium (33% overhead)

The Medium code is a $(32,26)^2$ code having a rate of 0.66. This code has a block size of 1,024 bits and provides a range improvement of more than a factor of 2.5 compared to operating without FEC.

Light (20% overhead)

The Light code is a $(64,57)^2$ code having a rate of 0.793. This code has a block size of 4,096 bits and provides a range improvement of more than a factor of 2.0 compared to operating without FEC at the same modulation bit rate. This code is probably the best choice in the majority of operating scenarios since it provides a very substantial performance improvement with relatively little overhead penalty.

No FEC

In this selection forward error correction is not used. Data is organized into blocks of 4,096 bits to add the CRC code even though FEC is not used.

The overhead introduced by each code type is shown in the table of Figure 38. The reason that the “Off” mode still adds overhead is that a 32 bit CRC is added each 4096 bits even when FEC is not used.

| Code | Overhead |
|--------|----------|
| Strong | 51% |
| Medium | 35% |
| Light | 21% |
| Off | 1% |

Figure 38: Overheads of the FEC coding options

Interleaving

The burst error protection provided by the interleaver comes at a price of added latency. This is because the interleaver works by filling a buffer up with bits and then reading them out in a shuffled order. Because the interleaver has to wait to fill the buffer before it can start reading them out, the bits are delayed by the size of the buffer on the AMT side. The GMT works in the reverse fashion, writing the received bits into a buffer in shuffled order and then reading them out consecutively. Thus the GMT also adds a buffer of delay.

Protecting against larger burst errors requires a larger interleaver buffer so that the bits can be shuffled further apart.

The GUI allows the user to select the interleaver in either a descriptive manner (Strong or Moderate) or in a precisely specified manner.

Strong

In the Strong setting, the interleaver buffer size in bits is maintained at 1 Mbit for all bit rates. At a modulation bit rate of 5 Mbps, this is the same as the Moderate setting, but the latency and the length of burst that the interleaving will protect against increase in inverse proportion to bit rate. Thus in the Strong setting at 1 Mbps, the end-to-end latency is 2 seconds and the interleaver will provide fair burst protection for bursts up to 5 msec in length, and excellent protection for bursts up to 250 usec in length.

Generally speaking, if latency is not important, then the strong interleaving setting should be selected, although the user should be aware that at very low rates, the latency can be well over a minute. If latency is important, then the Moderate setting should be considered. If even 400 msec of latency is too much, the Specify Depth mode (see below) can be used to select a reduced level of interleaving.

Moderate

In the Moderate setting, the interleaver size is adjusted as a function of bit rate to result in an end-to-end latency due to interleaving of about 400 msec for all bit rates up to 5 Mbps. At 5

Mbps and above, the Moderate setting is identical to the Strong setting, maintaining a buffer size of 1 Mbit. This provides fair burst protection for bursts up to 1 msec in length, and excellent protection for bursts up to 50 usec in length. The interleaver depth in this case is 1 Mbit at 5 Mbps and above, but it drops to 7 kbits at 35 kbps.

No Interleaving

In this setting, the interleaving is turned off. If FEC is not enabled, interleaving does not help system performance, so the No Interleaving setting is forced in this case.

Specify Depth

If the Specify Depth setting is chosen, the drop down window allows the user to specify the depth of the interleaver buffer. The depth is specified in FEC code blocks, and corresponds to the maximum burst length (in bits) that the interleaver is intended to disperse.

The latency introduced by each interleaver type is a function of the modulation bit rate chosen. The latency resulting from the use of interleaving is shown in Figure 39 for a variety of bit rates and interleaving configurations. These latencies are given in msec. Note that the latency for the “specify depth” mode is given per row. To determine the actual latency in this case, the value in the table must be multiplied by the number of rows selected in the GUI.

| Bit rate (bps) | Interleaver latency in msec for various interleaver modes | | | | |
|----------------|---|------------|-----------------------|------------|--------------------------------|
| | Strong | | Moderate Interleaving | | Specify rows (latency per row) |
| | Interleaving | FEC=strong | FEC = moderate | FEC=strong | FEC = moderate |
| 11000000 | 190 | 190 | 190 | 0.74 | 0.19 |
| 10000000 | 210 | 210 | 210 | 0.82 | 0.21 |
| 9000000 | 230 | 230 | 230 | 0.90 | 0.22 |
| 8000000 | 260 | 260 | 260 | 1.0 | 0.25 |
| 7000000 | 300 | 300 | 300 | 1.2 | 0.29 |
| 6000000 | 350 | 350 | 350 | 1.4 | 0.34 |
| 5000000 | 420 | 420 | 420 | 1.6 | 0.41 |
| 4000000 | 520 | 420 | 420 | 2.0 | 0.51 |
| 3000000 | 700 | 420 | 420 | 2.7 | 0.68 |
| 2000000 | 1050 | 420 | 420 | 4.1 | 1.0 |
| 1000000 | 2100 | 420 | 420 | 8.2 | 2.0 |
| 900000 | 2330 | 420 | 420 | 9.1 | 2.3 |
| 800000 | 2620 | 420 | 420 | 10.2 | 2.6 |
| 700000 | 3000 | 420 | 420 | 11.7 | 2.9 |
| 600000 | 3500 | 420 | 420 | 13.7 | 3.4 |
| 500000 | 4190 | 430 | 420 | 16.4 | 4.1 |
| 400000 | 5240 | 410 | 420 | 20.5 | 5.1 |
| 300000 | 6990 | 410 | 420 | 27.3 | 6.8 |
| 200000 | 10490 | 410 | 420 | 41.0 | 10.2 |
| 100000 | 20970 | 410 | 410 | 81.9 | 20.5 |
| 90000 | 23300 | 460 | 410 | 91.0 | 22.8 |
| 80000 | 26210 | 410 | 410 | 102.4 | 25.6 |
| 70000 | 29960 | 470 | 410 | 117.0 | 29.3 |
| 60000 | 34950 | 410 | 410 | 136.5 | 34.1 |
| 50000 | 41940 | 490 | 410 | 163.8 | 41.0 |

| | | | | | |
|-------|-------|-----|-----|-------|------|
| 40000 | 52430 | 410 | 410 | 204.8 | 51.2 |
| 35000 | 59920 | 470 | 410 | 234.1 | 58.5 |

Figure 39: Interleaver latencies for each interleaving mode

For example, if the system is operating at a modulation bit rate of 1.5 Mbps with Medium FEC where the block size is 1024 bits, and there is a burst noise process (such as a swept radar) that is expected to make interference bursts as long as 100 usec, then to achieve excellent protection (in which the error bits have no worse impact than if they were independently distributed) requires the number of rows to be $(1.5 \text{ Mbps})(100 \text{ usec}) = 150$.

The size of the interleaver buffer is the product of the number of rows and the code block size. In the example, this would be $(150)(1024) = 153,600$ bits.

The latency introduced by the interleaver in seconds is two times the latency in bits divided by the bit rate. In the example, this would be $(153,600)/(1.5\text{e}6) = 102.4 \text{ msec}$.

If the latency requirements force the interleaver size to be less than sufficient to make the error bits appear to be fully independently distributed to the FEC decoder, a smaller interleaver can still provide substantial performance gain since it is much better to have two or three errors in a code block than to have 150.

Note: The interleaving configuration of the GMT must be configured to match that of the AMT or the GMT will be unable to recover the transmitted data.

BER Test Mode

If the BER test mode is enabled in the AMT, the AMT injects a special test data sequence into one of two different points in the data path of the Communication module. This test data sequence is designed so that the GMT can easily synchronize to it, and can then measure the bit error rate experienced by the EnerLinksIII system by comparing the received data to the test data sequence. This is a very useful feature for test and evaluation purposes.

The GMT automatically determines if the test data sequence is being transmitted and sets an indicator to show the injection point. The possible bit error rate test modes are:

Off - If the status is Off, then the GMT has determined that the AMT is not transmitting the test data sequence.

Modem Only - If the status is Modem Only, then the GMT has determined that the special test data sequence is active and is injected after the FEC coding. This enables measurement of the performance of the data link from the input to the modulator to the output of the demodulator without including the improvement that results from FEC.

FEC and Modem - If the status is FEC and Modem, then the GMT has determined that the special test data sequence is active and injected just prior to the FEC coding. This enables measurement of the performance of the data link including the improvement provided by the FEC. It also allows measurement of the improvement provided by the diversity receiver.

Integrator Selection

Click the appropriate radio button to cause this page to display the Full Integrator BER statistics, the Ten Second Integrator BER statistics, or the One Second Integrator BER statistics. If the Full Integrator statistics are selected, then the displayed BER/BLER values are evaluated over the entire period from the last time the BER counters were cleared to the present. Note that the BER counters are cleared whenever a reset is requested from the GUI or CLI, or when the system detects that a BER Test has started or stopped. If the One Second or Ten Second Integrator statistics are selected, then the displayed values are evaluated over the previous one or ten seconds.

BER Test Results

This indicator gives an assessment of the quality of the received signal, and reports it as “Unacceptable”, “Marginal”, or “Acceptable”. The assessment takes into account both the received bit-error rate and the BER Test mode. “Acceptable” approximately corresponds to an error rate such that less than one received data packet is corrupted each 30 seconds. “Marginal” approximately corresponds to an error rate such that less than one received data packet is corrupted each 3 seconds. “Unacceptable” corresponds to any higher error rate.

When no BER test is active, this indicator continues to give an assessment of the quality of the received signal based on detected CRC errors.

If the BER Test Mode is Modem Only, the quality assessment is based on the calculated combined BLER when the diversity receiver mode is selected, and based on the adjusted per-channel BLER when any other receiver mode is selected. BLER calculations are adjusted to reflect the expected rate after error correction.

If the BER Test Mode is FEC and Modem, the quality assessment is based on the measured BER.

The BER test result is read from the GMT and automatically refreshed in the GUI display approximately once a second.

BER and BLER

BER

The BER (bit error rate) column displays the bit error rate measured by the GMT when the BER test mode has been activated at the AMT. Depending on the point in the circuit where the special test data sequence has been injected by the AMT, the BER can be measured for each receiver independently or for the output of the diversity selection.

If the BER Test Mode is Off and FEC is disabled, no BER values will be displayed. If the BER Test Mode is Off and FEC is enabled, the BER values represent the rate of corrections made by the FEC. No combined BER value will be displayed.

If the BER Test Mode is Modem Only, then the GMT can measure the BER for each of the two receivers, but it cannot measure the BER after diversity selection since the test data hasn't been

subject to FEC coding at the AMT and thus cannot pass through the FEC in the GMT. No combined BER is displayed in this mode. When FEC is enabled, the per-channel BER displayed in this mode is adjusted to show the expected error rate after error correction.

If the BER Test Mode is FEC and Modem, then the BER can be measured both before and after diversity selection, so the values are displayed for each active receive channel as well as the combined BER.

BER rates are read from the GMT and automatically refreshed in the GUI display approximately once a second.

BLER

The BLER (block error rate) column displays the block error rate measured by the GMT. This measurement is made by counting the number of FEC code blocks with bit errors and dividing by the total number of FEC code blocks received. Because each code block includes a CRC code for error detection, this measurement can be made without the need for special test sequences, so BLER values are displayed even when the BER Test Mode is Off. The BLER measurement also operates when the special test data sequence is used and the injection point is anywhere prior to the FEC (that is, anything but the Modem Only mode). If the BER test mode is modem only, then an estimated BLER value is calculated based on the BER value described above.

BLER rates are read from the GMT and automatically refreshed in the GUI display approximately once a second.

Receiver A and Receiver B

These columns show the BER and BLER for the signal processing path driven by the specified half of the receiver. If the GMT receiver mode is set to RX A or RX B instead of diversity mode, the values for the disabled receiver path will be displayed as “n/a”.

Combined

This column shows the BER and BLER measured after the selection diversity processing. If the sources of degradation encountered by signals on each receiver arm are independent, the combined error rate should be much better than the error rate on an individual receiver.

Reset Counters

This button resets the counts of received bits and errors used to compute the BER and BLER. This button is only displayed when the Full Integrator BER statistics are selected.

Signal

The “Signal” indicator shows whether the radio determines that a radio signal is present in the configured radio band. The signal strength is measured and reported independently for each antenna arm of the receiver. When set to green, this signal indicates that enough energy is present in the band so that establishing a link should be possible.

The signal status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Bit Sync Lock

The bit sync lock indicators show whether the bit synchronizer has acquired symbol timing. The signal from each receiver drives a separate and independent bit synchronizer, and thus there is a lock indicator for each. The bit sync lock indicators on this page are set to green to indicate lock if the bit timing is detected.

Bit sync lock status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

FEC Sync Lock

Because the FEC operates on blocks of data, the communication module has to determine where the boundaries of the blocks lie. The AMT periodically injects a sync word into the data stream with a repetition rate that is a multiple of the number of bits in a code block and the GMT then searches the received data to find the sync word. The FEC Sync Lock indicators are set to green to show that the GMT has found the sync word position for each receiver channel.

FEC Sync Lock status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Mux Sync Lock

After determining where interleaver blocks begin and end, the communication module has to determine where the data for different data services are. The AMT injects different data patterns in the data stream to allow the data stream to be de-multiplexed by the GMT. When the GMT is able to correctly read the data for the different services, the Mux Sync Lock indicator is set to green.

Because de-multiplexing is performed after diversity selection, only one Mux Sync Lock indicator is displayed.

Mux Sync Lock status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

3.6.9 GMT Uplink Communications Setup

The multiplexing module of the EnerLinksIII GMT generates a single multiplexed bit stream composed of contributions from all the different sources configured in the Uplink Data Services and Networking pages. The Communication module accepts this multiplexed bit stream and performs two operations on it that are configured by the Uplink Communications page (see Figure 40). These are:

- Forward error correction coding (FEC) – this is a technique by which the multiplexed bit stream is used to generate additional data which is added into the bit stream at the GMT

side of the link and which allow the AMT to correct most bit errors that are induced by degradation resulting from transmission over the communication channel.

- Interleaving – a technique that shuffles the order in which bits are transmitted by the GMT and reverses the shuffling at the AMT, in the process shuffling the bit positions of errors that might occur consecutively on the channel due to bursts of interference. This function is important because the FEC works best when errors are uniformly distributed.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block configuration of FEC, Interleaving, and Modulation Bit Rate while Orderwire is enabled. To change these configuration items, first disable the Orderwire service from the GMT Orderwire Setup Page.

Full access privileges are required to modify any Communications page setting. Users with View-Only access can view all parameters on the page.

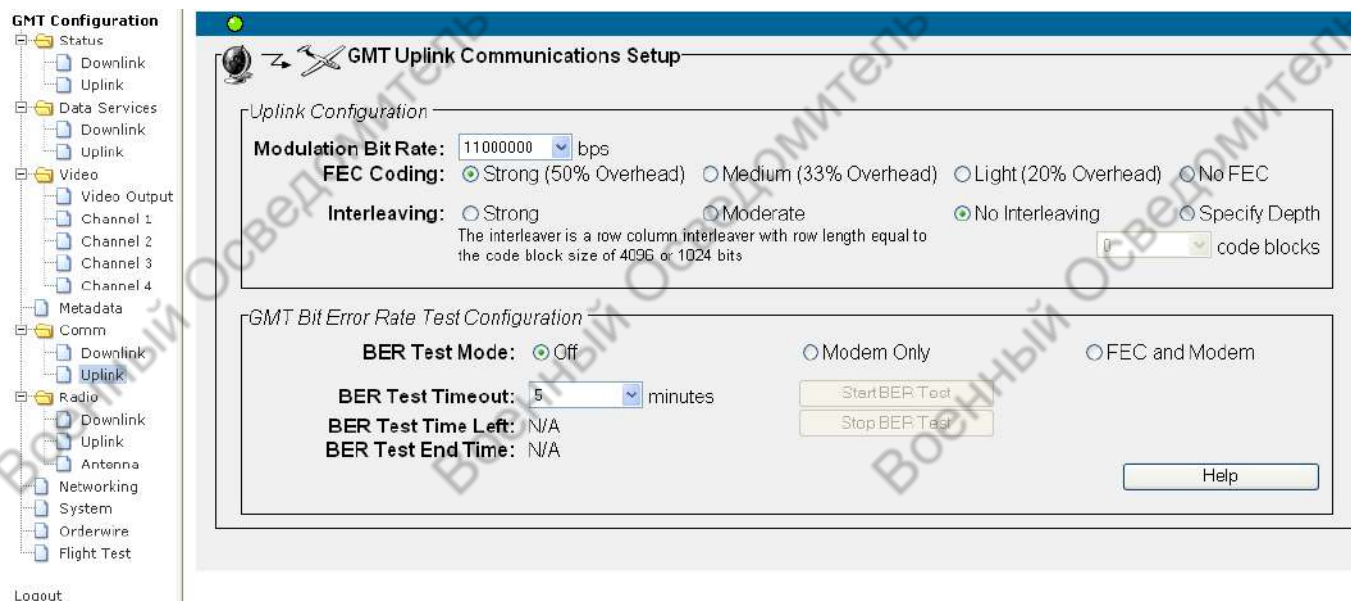


Figure 40: GMT Uplink Communications Setup Page

Modulation Bit Rate

The modulation bit rate is the rate of the final bit stream that includes the complete multiplexed bit stream and all other overhead such as FEC parity bits or sync headers.

Select the modulation bit rate from the drop down menu or select “Edit list...” to enter a new value. Supported rates are from 32,000 to 11,000,000 bps.

FEC Coding

Click the appropriate radio button to choose from the four FEC coding options. Note that the FEC options available on the uplink are exactly the same as those available on the downlink. For

a complete description of these options, please refer to the FEC coding parameter described in Section 3.6.8. The four options available to the user are:

- Strong (50% overhead)
- Medium (33% overhead)
- Light (20% overhead)
- No FEC

In addition to the FEC, an error detecting code is also used. This code is always present and is not selectable. It adds a 32 bit cyclic redundancy check (CRC) code to each code block and is used by the receiver at the AMT to determine when the receiver path has produced good data for each block.

Note: The FEC coding configuration of the AMT must be configured to match that of the GMT or the AMT will be unable to recover the transmitted data.

Interleaver Depth

Click the appropriate radio button to select the desired interleaver buffer depth. Note that the interleaver options available on the uplink are exactly the same as those available on the downlink. For a complete description of these options, please refer to the Interleaver parameter described in Section 3.6.8.

Note: The interleaving configuration of the AMT must be configured to match that of the GMT or the AMT will be unable to recover the transmitted data.

BER Test Mode

If the BER test mode is enabled, the GMT injects a special test data sequence into one of two different points in the data path of the Communication module. This test data sequence is designed so that the AMT can easily synchronize to it, and can then measure the bit error rate experienced by the EnerLinksIII system by comparing the received data to the test data sequence. This is a very useful feature for test and evaluation purposes.

Note: The BER test does not begin until the Start BER Test button is clicked.

The states of the BER test mode are:

Off - In the Off state, the GMT operates normally – the special test data sequence is disabled and the multiplexed data stream is processed and transmitted by the communication module.

Modem Only - In the Modem Only state, the special test data sequence is injected after the FEC coding. This enables measurement of the performance of the data link from the input to the modulator to the output of the demodulator without including the improvement that results from FEC.

FEC and Modem - In the FEC and Modem state, the special test data sequence is injected just prior to the FEC coding. This enables measurement of the performance of the data link including the improvement provided by the FEC. It also allows measurement of the improvement provided by the diversity receiver.

BER Test Timeout

To prevent a situation where the BER Test Mode is inadvertently left on during operational use, a BER Test Timeout is provided. If the GMT power is removed and then restored before the timeout completes, the GMT will power up in the BER test mode.

Start BER Test

This button is disabled until the user chooses one of the BER Test Modes (see above). Clicking this button starts the BER test and starts the BER Test Timeout counter. When a BER test is in progress, the remaining timeout and expected end time are displayed, and the Stop BER Test button is enabled.

Until the Start BER Test button is depressed, the EnerLinksIII System continues to pass operational data regardless of the selected BER Test Mode state. If a BER Test Mode state other than Off is selected and the Start BER Test button is not pressed within one minute, the BER Test Mode indication will revert to Off.

Stop BER Test

This button is disabled when the BER test is off. A BER test will stop automatically at the timeout or end time. A BER test can be stopped at any time by the user clicking this button.

BER Test Time Left

This status display shows the time remaining in the current BER test. N/A is displayed when no BER test is active.

BER Test End Time

This status display shows the calendar time that the current BER test will expire. N/A is displayed when no BER test is active.

3.6.10 GMT Downlink Radio Setup

The Radio Page (see Figure 41) provides control for the RF receiver functionality in the GMT. Up to two transceivers may be installed in the GMT. Each transceiver includes an RF receiver module as well as an RF transmitter module. One transceiver supports L and S-Band frequencies and the other supports upper and lower C-Band frequencies. The active transceiver is selected by the user. The RF receiver module in each transceiver supports two RF receiver channels. These can be used for spatial diversity if the two channels are configured for the same frequency, or frequency diversity if they are configured for different frequencies. Optionally, the receiver module can be configured to use only one of the receive channels. This GUI page can be used to select the active transceiver, configure the receiver mode, and set the receive frequencies.

All Radio Page parameters can only be modified by Full access users.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block the configuration of radio frequencies or the receiver mode while Orderwire is enabled. To change these configuration items, first disable the Orderwire service on the GMT Orderwire Setup Page.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video Output
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Antenna
- Networking
- System
- Orderwire
- Flight Test

Logout

GMT Downlink Radio Setup

GMT Transceiver RX Configuration

RX A **RX B**

☒ LNA Enable

Carrier Frequency: 1780.0 MHz 1780.0 MHz

Radio Status: OK

Radio Band: L/S-Band

Radio Model: TSA-206142

Serial Number: 54321

☒ RSSI Output Enable

RSSI: -75.45 dBm -41.55 dBm

GMT Receiver Mode

☐ Diversity enabled
☐ RX A only
☒ RX B only

GMT Transceiver Select

☒ L/S Band Transceiver
☐ C Band Transceiver

Measured Rx Cable Loss

RX A **RX B**

0.00 dB 0.00 dB

Figure 41: GMT Downlink Radio Setup Page

GMT Transceiver RX Configuration

LNA Enable

Use this checkbox to enable the external Low Noise Amplifier (LNA).

Poll Radio Button

The receiver status of the internal transceiver is polled once a second. The Poll Radio button may be used to request an immediate poll of the status and refresh of this page.

Carrier Frequency

Select the receiver carrier frequency for each receive channel from these drop down menus or select “Edit list...” to enter a new value.

The allowed range of receiver carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported RX Frequency Range(s) |
|---------------------------------|--|
| L/S Band Transceiver TSA-206142 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206168 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208168 | Lower C-Band: 4900 – 4950 |

The frequency must be entered in MHz with a resolution of 500 kHz. If no decimal point is used, the frequency is an integer number of MHz. If a decimal point is used, it may be followed by either a “0” or a “5”.

Both receive channels must be configured to the same band (L, S, Upper-C, or Lower-C). Whenever a new frequency for one channel is selected that is in a different band than the previous configuration, the frequency of the other channel is automatically changed to a default value within the range of the new frequency band.

Note that use of the same frequency band in both the uplink and downlink may cause substantial interference to both communication channels and although possible, is not recommended.

If the transmit frequency configured at the AMT does not match the configuration on this page, data will not be received by the GMT.

Radio Status

This status indicator shows the status of the currently active receiver, depending on the GMT configuration and the status reported.

- *Not Present* indicates the GMT is not able to communicate with the receiver radio.
- *Fault* indicates the receiver is not providing expected responses, and may be non-operational.
- *Band Mismatch* indicates the carrier frequency specified on this GUI page for the receiver is not within the band supported by the receiver.
- *PLL Not Locked* indicates the receiver has not tuned to the specified frequency. This is normal for short periods of time, when changing frequencies or first turning on the GMT and receiver. Click the Poll Radio button and wait a few seconds for the GUI page to refresh. If the receiver repeatedly reports it is Unlocked, there may be a problem with the receiver or with the carrier frequency that has been configured.
- *OK* is the normal operating mode for the receiver.

Radio status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Radio Band

This line shows the supported frequency band(s) for the currently active receiver.

The Radio Band is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Radio Model

This line shows the model of the currently active receiver module.

The Radio Model is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Serial Number

This line shows the serial number of the currently active receiver module.

The Serial Number is read from the GMT and automatically refreshed in the GUI display approximately once a second.

RSSI Output Enable

When this box is checked, the RSSI output to the front panel connectors is enabled.

The RSSI front panel connectors output a single ended analog signal that indicates the received signal strength for each channel and is intended to assist in pointing steerable antennas. The signal voltage ranges from 0 to 5 volts, with the voltage increasing monotonically with increasing signal strength. The voltage range represents RSSI signal levels between the threshold and a point 80 dB above the threshold, with the RSSI signal increasing at a rate of approximately 62 mv/dB.

RSSI

These charts provide the Received Signal Strength Indication of the signal being received at each of the configured receive channel frequencies. The stronger the signal, the higher the green bar will be within this chart. The lowest bar on the chart is displayed when the received signal strength is likely to be good enough to demodulate successfully. The remaining bars are illuminated to represent approximately 10 dB per bar.

The approximate value of the detected RSSI levels is displayed below the chart in dBm. These values are intended to represent the signal strength measured at the antenna ports, and therefore include a correction for the expected LNA gain, the transceiver receive gain, and the Measured Rx Cable Loss values entered below.

The RSSI is read from the GMT and automatically refreshed in the GUI display approximately once a second.

GMT Receiver Mode

This set of radio buttons allows selection of the receiver mode.

Diversity enabled

In this mode, diversity selection is enabled and the GMT automatically chooses the best data provided by the two receiver channels on a block-by-block basis.

RX A only

In this mode, the GMT processes only the data from receiver channel A.

RX B only

In this mode, the GMT processes only the data from receiver channel B.

GMT Transceiver Select

This set of radio buttons allows selection of the active transceiver. Power is only applied to the active transceiver, so when the transceiver selection is changed, power is removed from the previously selected transceiver and applied to the newly selected one. It will take a few moments for the new transceiver to initialize and present its status. It is normal for the GUI display to indicate a status of Fault (indicating inability to communicate with the transceiver) while the transceiver is initializing. When the transceiver completes its initialization, the GUI page will be automatically reloaded. This is because some of the configuration elements on this page are specific to the transceiver model that is installed and must be refreshed to match the new configuration.

If a transceiver is selected that is not installed in the GMT, its status will indicate fault.

L/S Band Transceiver

Use this radio button to select the L/S band transceiver as the active transceiver.

C Band Transceiver

Use this radio button to select the C band transceiver as the active transceiver.

Measured Rx Cable Loss

The measured receive cable loss for each receiver channel may be entered in decimal notation to the nearest 1/100th dB. The maximum value that may be entered is 100 dB. This value will be accounted for in the displayed RSSI values above.

3.6.11 GMT Uplink Radio Setup

The Radio Page (see Figure 42) provides control for the RF transmitter functionality in the GMT. Up to two transceivers may be installed in the GMT. Each transceiver includes an RF receiver module as well as an RF transmitter module. One transceiver supports L and S-Band frequencies and the other supports upper and lower C-Band frequencies. The active transceiver is selected by the user. This GUI page can be used to select the active transceiver, and set the RF transmit frequency.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block the configuration of radio frequencies and disabling of transmitters while Orderwire is enabled. To change these configuration items, first disable the Orderwire service from the GMT Orderwire Setup Page.

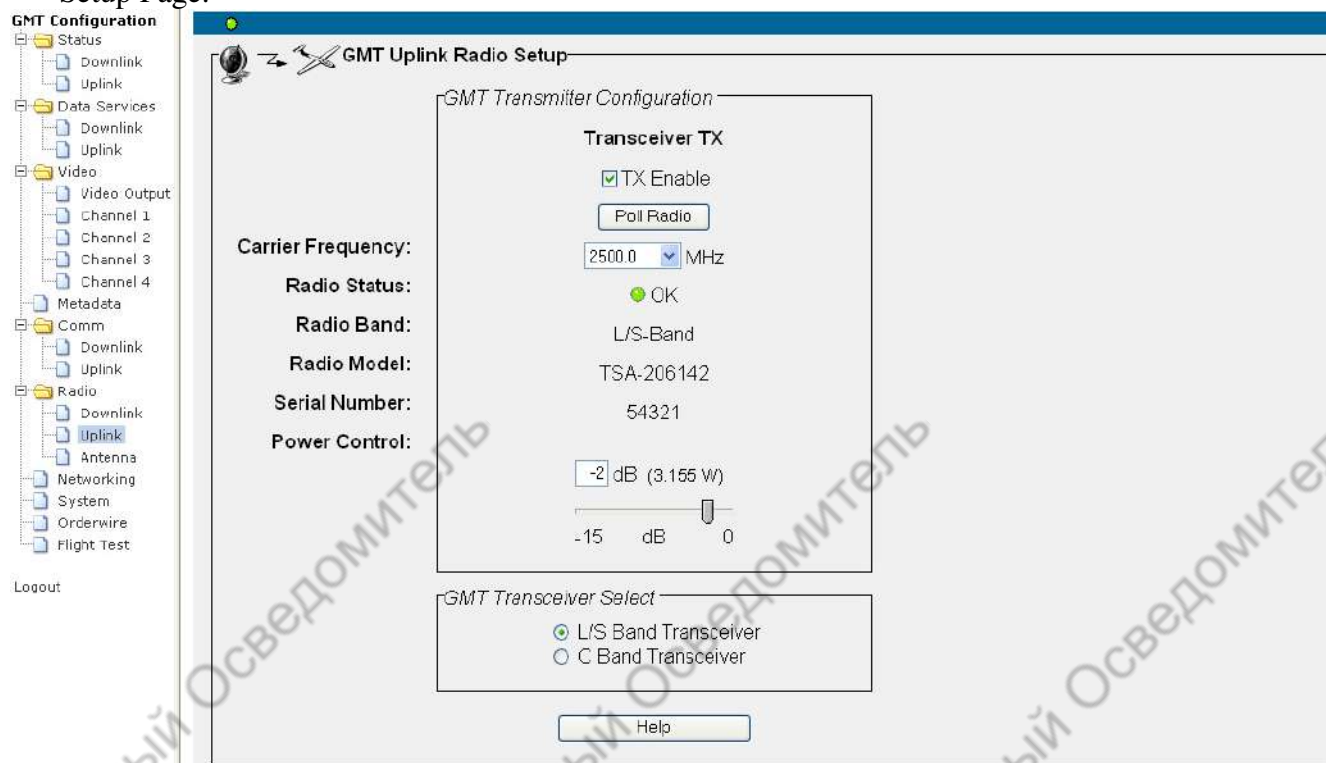


Figure 42: GMT Uplink Radio Setup Page

TX Enable

To enable the transmit function of the internal transceiver, set the check in its enable check box.

Transmission may also be disabled by a fault condition. Such a fault condition is indicated by the Radio Status (see below).

Poll Radio Button

The transmitter status of the internal transceiver is polled once a second. The Poll Radio button may be used to request an immediate poll of the status and refresh of this page.

Carrier Frequency

Select the transmitter carrier frequency from this drop down menu. If the desired value is not in the drop down list, select “Edit list...” from the drop down menu to enter a new value.

The allowed range of transmitter carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported TX Frequency Range(s) |
|----------------------------|---------------------------------|
|----------------------------|---------------------------------|

| | |
|---------------------------------|--|
| L/S Band Transceiver TSA-206142 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206168 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208168 | Upper C-Band: 5250 – 5530 |

The frequency must be entered in MHz with a resolution of 500 kHz. If no decimal point is used, the frequency is an integer number of MHz. If a decimal point is used, it may be followed by either a “0” or a “5”.

Note that use of the same frequency band in both the uplink and downlink may cause substantial interference to both communication channels and although possible, is not recommended.

If the receive frequency configured at the AMT does not match the configuration on this page, data will not be received by the AMT.

Radio Status

This status indicator shows the status of the transmitter, depending on the GMT configuration and the status reported by the radio, if present.

- *Not Present* indicates the GMT is not able to communicate with the transmitter.
- *Fault* indicates the transmitter is not providing expected responses, and may be non-operational.
- *Band Mismatch* indicates the carrier frequency specified on this GUI page for the transmitter is not within the band supported by the transmitter.
- *PLL Not Locked* indicates the transmitter has not tuned to the specified frequency. This is normal for short periods of time, when changing frequencies or first turning on the GMT and transmitter. Click the Poll Radio button and wait a few seconds for the GUI page to refresh. If the transmitter repeatedly reports it is Unlocked, there may be a problem with the transmitter or with the carrier frequency that has been configured.
- *Disabled* indicates that the transmitter has not been enabled.
- *OK* is the normal operating mode for a transmitter.

Radio status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Radio Band

This line shows the frequency band(s) supported by the transmitter module.

The Radio Band is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Radio Model

This line shows the model number of the transmitter module.

The Radio Model is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Serial Number

This line shows the serial number of the transmitter module.

The Serial Number is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Power Control

This parameter is used to control the Power Amplifier (PA) that boosts the transmit signal from the internal transceiver. Set the level of power reduction desired based on the maximum power output of your transmitter. E.g. to reduce the output level of a 5 Watt transmitter to about 2.5 Watts, set the power control level to -3 dB.

GMT Transceiver Select

This set of radio buttons allows selection of the active transceiver. Power is only applied to the active transceiver, so when the transceiver selection is changed, power is removed from the previously selected transceiver and applied to the newly selected one. It will take a few moments for the new transceiver to initialize and present its status. It is normal for the GUI display to indicate a status of Fault (indicating inability to communicate with the transceiver) while the transceiver is initializing. When the transceiver completes its initialization, the GUI page will be automatically reloaded. This is because some of the configuration elements on this page are specific to the transceiver model that is installed and must be refreshed to match the new configuration.

If a transceiver is selected that is not installed in the GMT, its status will indicate fault.

L/S Band Transceiver

Use this radio button to select the L/S band transceiver as the active transceiver.

C Band Transceiver

Use this radio button to select the C band transceiver as the active transceiver.

3.6.12 GMT Antenna Steering

The GMT Antenna Steering Page (see Figure 43) allows the user to configure the antenna steering system and to view the current status. Modification of settings on this page is restricted to users with Full access privileges only.

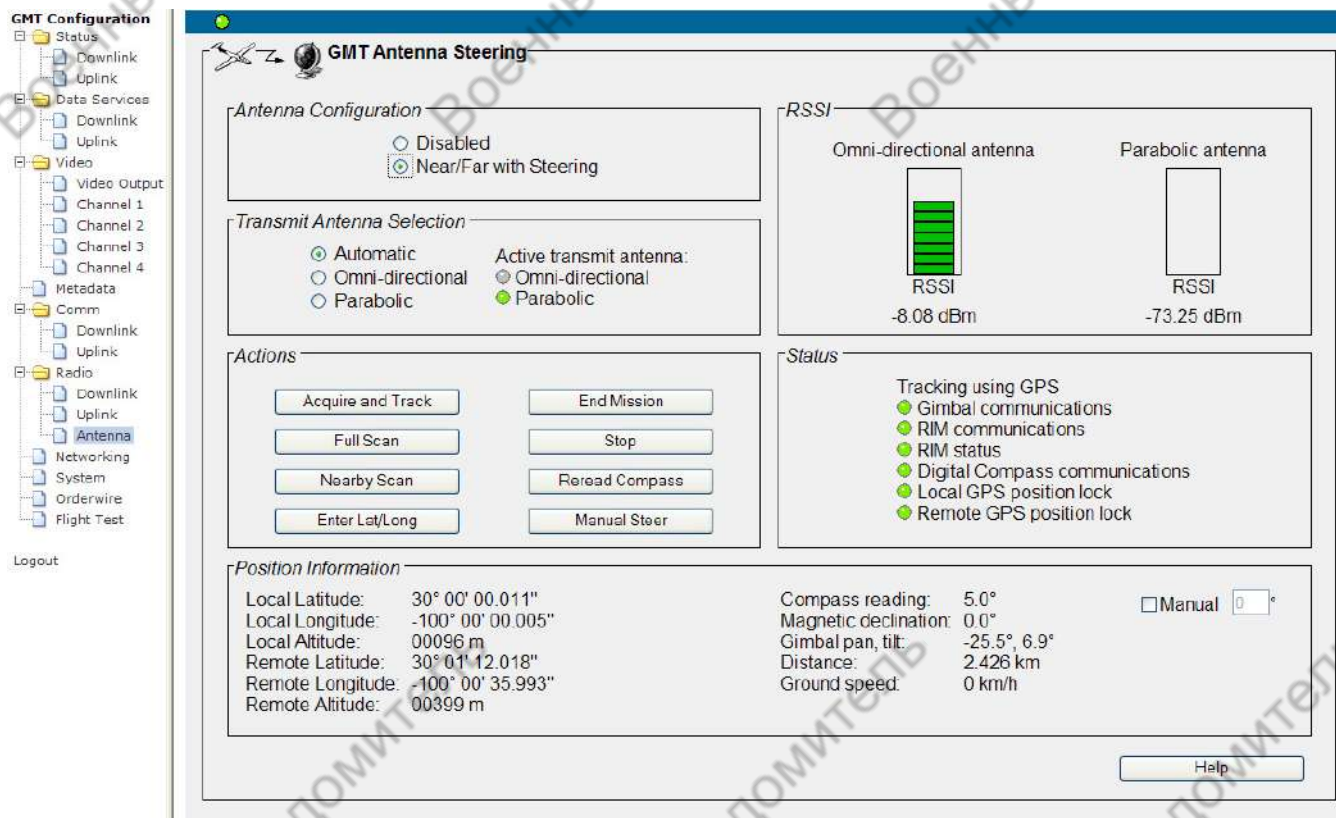


Figure 43: GMT Antenna Steering Page

Antenna Configuration

The radio buttons in this section allow the user to select between several physical configurations of the antenna steering system. Only one configuration is currently supported, or the antenna steering feature may be disabled.

Disabled

When disabled, no part of the antenna steering system is active. The gimbal cannot be moved (either manually or automatically), the RSSI meters on the RIM are inactive, and the transmit antenna path cannot be controlled.

Near/Far with Steering

This is the standard configuration for the antenna steering system. When enabled, two async ports on the GMT are used for antenna steering and are unavailable for uplink or downlink multiplexed data. These are disabled on the Data Services GUI pages. The receiver mode is forced to Diversity on the GMT Downlink Radio GUI page. The GMT manages the gimbal movement and the transmit antenna selection based on RSSI and GPS information. The physical configuration associated with this option consists of a GMT, a RIM, and a tripod with a gimbal, an omni-directional antenna, a parabolic antenna, and a GPS antenna.

Transmit Antenna Selection

This section allows configuration of the transmit antenna and display of the currently active transmit antenna.

Automatic

This option is the recommended configuration for transmit antenna selection. When selected, the GMT automatically selects which antenna to use for transmitting based on a combination of RSSI, GPS, and operational mode. In general the GMT will use the omni-directional antenna in all cases except when the parabolic antenna is locked on to the aircraft at a distance of at least 250m, and the RSSI on the parabolic antenna exceeds the RSSI on the omni-directional antenna by at least 5dB.

Omni-directional

Selecting this option forces the GMT to use the omni-directional antenna for transmission at all times. This may cause problems for closing the uplink if the link budget is marginal.

Parabolic

Selecting this option forces the GMT to use the parabolic antenna for transmission at all times. This can improve uplink margin when the parabolic antenna is pointed at the aircraft, but can cause loss of uplink in other cases (e.g., if the aircraft is too close to the ground station, and the antenna steering software is not actively steering the antenna).

Actions (in Auto Steer mode)

This section allows control of the antenna steering software and the automatic steering algorithms.

Acquire and Track

This button initiates a general algorithm to find the aircraft and begin tracking it. The actual behavior depends on a number of factors. If the omni-directional antenna is receiving a downlink signal, and the GMT can get the GPS of the aircraft, it will begin tracking using GPS once the distance between the aircraft and the ground station is between 250m and 300m. For shorter distances, the omni-directional antenna is used for uplink and downlink, and no steering is necessary. If the GMT is not able to receive any downlink signal, it will begin a full scan of the sky and will try to acquire the downlink using the high-gain parabolic antenna.

Note that at power-up, the GMT will automatically acquire and begin tracking the aircraft if the downlink is being received by either antenna and the antenna steering feature is enabled. In this case, it is not necessary to click the Acquire and Track button. However, if the downlink signal is too weak to be received by either antenna, or if the user has previously clicked the Home or Stop buttons, then it is necessary to click the Acquire and Track button to re-enable the automatic antenna steering algorithms and begin a scan with the parabolic antenna as necessary.

Home

This button causes the gimbal to move to its home position and stop. No further active steering is executed until the user re-enables it (e.g., by power-cycling the GMT or clicking the Acquire

and Track button). This button should be used before powering down the GMT so that the antenna system can be disassembled and put into the transit cases.

Stop

This button causes the gimbal to stop moving at its current location. No further active steering is executed until the user re-enables it (e.g., by power-cycling the GMT or clicking the Acquire and Track button).

Full Scan

This button initiates a full scan of the sky, from -100° to $+100^{\circ}$ in the pan direction, and from -10° to $+30^{\circ}$ in the tilt direction. This generally takes about 1 minute for L-band or S-band downlink frequencies and about 2 minutes for C-band downlink frequencies. Once the scan is complete, the antenna is pointed at the strongest signal in the sky and a narrower scan is initiated.

Nearby Scan

This button initiates a scan nearby the current antenna location. The actual dimensions of the scan depend on how narrow the beamwidth is for the parabolic antenna. If no signal is found, the antenna returns to its location from before the scan and waits for a signal. If a signal is found but it is on the edge of the scan region, a new nearby scan is initiated centered on the strongest signal. Once the scan is complete, the antenna is pointed at the strongest signal in the sky and a narrower scan is initiated.

Reread Compass

This button causes the digital compass on the User Interface Panel (UIP) to be reread. Please see the EnerLinks™ Antenna Station User Guide for a complete description of the UIP. This might be necessary if the user knows the physical orientation of the tripod has changed. Reading the compass takes about 20 seconds and includes stopping the fans near the power amplifier and temporarily suspending gimbal movements in order to reduce magnetic interference from motors.

Manual Steer

This button stops all automatic steering of the gimbal, and changes the GUI layout to include manual steering buttons.

Actions (in Manual Steer mode)

This section allows manual control of the antenna steering.

Step Size (1° , 5° , 10°)

These radio buttons control the amount of gimbal movement each click of one of the up, down, left, or right buttons causes.

Up, Down, Left, Right

Each click on any of these buttons causes the gimbal to move by the selected step size in one direction. The gimbal's movement has hard limits and clicking these buttons will not move the gimbal beyond those limits.

Home

This button causes the gimbal to move to its home position and stop. No further active steering is executed until the user re-enables it (e.g., by power-cycling the GMT or clicking the Acquire and Track button). This button should be used before powering down the GMT so that the antenna system can be disassembled and put into the transit cases.

Auto Steer

This button resumes automatic steering of the gimbal, and changes the GUI layout to include auto steering buttons. As part of re-enabling antenna steering, this button also executes the initial acquisition algorithm, which can begin tracking the aircraft if the downlink signal is already being received. Otherwise, the user may need to click either the Acquire and Track button, the Nearby Scan button, or the Full Scan button to find the aircraft and begin tracking it.

Status

This section displays status information about the current state of the antenna steering.

Main Status Line (First Line)

The text in the first line describes the current state of the tracking algorithms.

- *Disabled* indicates that the antenna steering feature is disabled.
- *Inactive* indicates that the automatic steering of the antenna is disabled. This can occur because the user is in manual steering mode or has clicked the Home or Stop buttons.
- *Scanning, not locked* indicates that the parabolic antenna is actively scanning the sky, and the gimbal should be sweeping in a zigzag pattern. This can occur because the user clicked the Nearby Scan or Full Scan buttons, or because a scan was automatically initiated due to loss of signal, or during acquisition.
- *No Signal* indicates that a scan was completed but no acceptable signal was found.
- *Weak Signal* indicates that the system can find a signal, but cannot find a location where the parabolic antenna's RSSI exceeds the omni-directional antenna's RSSI by the expected amount. This may indicate a cabling problem or other problem with the parabolic antenna, or could also occur due to either shadowing of the signal at the parabolic antenna or multi-path interference.
- *Using omni-directional antenna* indicates that the aircraft's GPS location is known and it is too close to the ground station to track actively. This typically occurs if the ground distance between the ground station and the aircraft is less than about 250m or 300m. The omni-directional antenna is used for both uplink and downlink, and if or when the aircraft moves beyond 300m from the ground station, active tracking with the parabolic antenna will begin automatically.
- *Tracking using RSSI* indicates that the parabolic antenna is locked on a strong signal, but the antenna steering system does not have enough information to track with GPS. Three things are necessary for GPS tracking: local GPS location (of the RIM), remote GPS location (of the aircraft), and a compass reading (from the UIP). When tracking with RSSI, only very small angular velocities can be tracked, and the basic tracking algorithm involves a repeating up-down-left-right pattern to try to find the strongest signal.

- *Tracking using GPS* indicates that the parabolic antenna is locked on a strong signal and GPS coordinates are being used to steer the parabolic antenna. When tracking with GPS, fairly large angular velocities can be tracked.

Gimbal communications

This light is green if the GMT can communicate with the gimbal or red otherwise. This may be red briefly during startup, but should not remain red for more than a few seconds if everything is functioning correctly.

RIM communications

This light is green if the GMT can communicate with the RIM or red otherwise. This may be red briefly during startup, but should not remain red for more than a few seconds if everything is functioning correctly.

RIM status

This light is green if the RIM reports no faults or red otherwise. The most common RIM fault is that the fans on the power amplifier are not spinning when they should be.

Digital Compass communications

This light is green if a valid compass reading has been taken, gray while a compass reading is being taken, or red if the GMT cannot communicate with the digital compass. Clicking the Reread Compass button will cause this to go to red, then gray, then green during the process of re-reading the compass.

Local GPS position lock

This light is green if the GPS receiver on the RIM is reporting a valid position lock or red otherwise. Problems that can cause a failure here include: obstruction of the GPS antenna on the tripod, a problem on the GPS antenna cable to the RIM, a RIM fault, or a cabling problem between the GMT and RIM (which would also be reported as a RIM communications fault).

Remote GPS position lock

This light is green if the GPS receiver on the aircraft is reporting a valid position lock or red otherwise. Problems that can cause a failure here include: obstruction of the GPS antenna or other problems on the aircraft, GPS port 1 is not enabled on the AMT's Downlink Data Services GUI page, or loss of downlink communications (which can be observed from the Mux Sync light on the front panel of the GMT or on the GMT Downlink Comm GUI page).

Position Information

This section includes text displaying more detailed information about the local and remote positions and the gimbal location.

Local Latitude, Longitude, Altitude

These display the GPS position information from the RIM. The latitude and longitude are in degrees, minutes, and seconds. The altitude is in meters.

Remote Latitude, Longitude, Altitude

These display the GPS position information from the aircraft. The latitude and longitude are in degrees, minutes, and seconds. The altitude is in meters.

Compass reading

This indicates the reading from the digital compass on the UIP, and should indicate which direction relative to magnetic north the antenna is pointing when in the “home” position. This value is in “degrees east of north” meaning that 0° is magnetic north, 90° is east, 180° is south, and 270° is west.

The compass on the UIP may read inaccurate headings if it is in the presence of a magnetic field or near a large metal object. In this case, it may be necessary to override the compass reading with a user-entered value. To do this, check the “Manual” box and enter a number between -180° and +360°, then hit ENTER.

When taking a manual compass reading, be sure that the object/field that is interfering with the ETAS UIP’s compass does not also interfere with the compass being used to take the manual reading. With the ETAS gimbal in the home position, position a compass parallel to the UIP with the direction-of-travel arrow pointing towards the antenna.

Magnetic declination

This value is computed based on the local GPS position of the RIM and indicates how far magnetic north is offset from geographic north.

Gimbal pan, tilt

These indicate the current physical location of the gimbal. A location of “0.0°, 0.0°” is the gimbal’s home position. Pan angles can range from about -210° to +210°, and tilt angles can range from about -10° to +50°.

Distance

This indicates the computed ground distance between the local GPS position of the RIM and the remote GPS position of the aircraft. This does not include differences in altitude.

Ground speed

This indicates an estimate of the ground speed of the aircraft, in kilometers per hour. The speed is computed based on the remote GPS position information from the aircraft, and is filtered over several seconds. If the aircraft is changing speeds it may take this field several seconds to settle on the new speed.

3.6.13 GMT Networking Setup

The GMT Networking Page (see Figure 44) allows the user to configure the IP parameters of the GMT. This includes configuration of the IP forwarding capability and remote viewer access. Modification of settings on this page is restricted to users with Full access privileges only.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video Output
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking**
- System
- Orderwire
- Flight Test

Logout

GMT Networking Setup

IP Configuration

☐ Obtain IP address automatically

Host Name: board1

Domain Name: network.gov

☒ Use the following IP address

IP Address: 172.18.89.164

Subnet Mask: 255.255.254.0

Default Gateway: 172.18.89.254

☒ Forward IP to AMT

Forwarding Scheme: Gateway

Uplink Subnet: 10.100.0.0

Uplink Mask: 255.255.254.0

Uplink Rate Limit: Not Limited bps

☐ Forward broadcast packets

☒ Forward multicast packets

☒ Filter multicast packets

Forwarded Multicast Group Addresses:

232.3.3.3

239.9.9.9

New Address: 239.9.9.9

Add

Delete

☒ Enable TCP Proxy

Port: 5005

EnerView Configuration

☒ Enable EnerView access

☐ Enable multicast

Data Source: Downlink Uplink

Multicast IP Address: 230.1.2.3

Port: 5001

MPEG-2 TS Configuration

| | IP Address | Port |
|---|--------------|------|
| <input checked="" type="checkbox"/> Video Channel 1 | 172.18.88.59 | 7000 |
| <input type="checkbox"/> Video Channel 2 | 192.168.1.2 | 7001 |
| <input type="checkbox"/> Video Channel 3 | 192.168.1.2 | 7002 |
| <input type="checkbox"/> Video Channel 4 | 192.168.1.2 | 7003 |

Apply

IP Properties

IP Address: 172.18.89.164

Physical Address: 00-12-65-00-06-01

Subnet Mask: 255.255.254.0

Default Gateway: 172.18.89.254

IP Statistics

| | |
|--------------------------|---------------------------|
| Tx Ethernet Packets: 171 | Rx Ethernet Packets: 1240 |
| Tx ARP Packets: 5 | Rx ARP Packets: 859 |
| Tx IP Packets: 166 | Rx IP Packets: 359 |

DHCP Properties

Server Address:

Lease Obtained:

Lease Expires:

IP Forwarding Statistics

| | |
|-------------------|-------------------|
| Tx MAC Packets: 0 | Rx MAC Packets: 0 |
| Tx ARP Packets: 0 | Rx ARP Packets: 0 |
| Tx IP Packets: 0 | Rx IP Packets: 0 |

Help

IP Forwarding Details

Figure 44: GMT Networking Setup Page

IP Configuration

Obtain an IP address automatically

In networks that support Dynamic Host Configuration Protocol (DHCP), the user should click the radio button for “Obtain an IP address automatically”. The DHCP server will select an IP address, subnet, and default gateway and configure the unit automatically. If the DHCP server is configured to interact with a DNS server, it will update the DNS server with the Host Name and Domain Name (if configured) and the selected IP address.

Host Name

This optional name should be provided by the network administrator when DNS is used in the network. It is chosen to uniquely identify the GMT within the subnet. It may be left blank if updating the DNS server is not desired.

This name may also be used to identify the GMT using the NetBIOS name service. The unit will respond to broadcast NetBIOS name query messages that match the provided name. When accessing the unit using NetBIOS name service, only the Host Name is used, without the Domain Name suffix. The host name must be no longer than 15 characters to be used by the NetBIOS name service.

Domain Name

This optional name should be provided by the network administrator when DNS is used in the network. It is set to the subnet name configured on the DNS server. It may be left blank if updating the DNS server is not desired.

Use the following IP address

If address management is not automated, the user should click the radio button “Use the following IP address”.

IP Address

This field assigns an IP address to the Ethernet interface on the GMT.

Subnet Mask

This field assigns an IP subnet mask to the Ethernet interface on the GMT. This defines the scope of the local subnet. Together with the IP Address, the subnet mask identifies the range of IP addresses directly accessible over the Ethernet interface. For example, an IP address / Subnet Mask combination of 172.18.89.128 / 255.255.255.0 indicates that all addresses from 172.18.89.1 through 172.18.89.254 are directly accessible from the Ethernet interface, while a configuration of 172.18.89.128 / 255.255.254.0 indicates that all addresses from 172.18.88.1 through 172.18.89.254 are directly accessible. See Appendix A1 for an overview of how a subnet mask is used to define the scope of a subnet.

Default Gateway

This optional field assigns a default gateway to the GMT. This identifies the IP address of a Gateway to use when sending a packet to an address not directly accessible on either the local or remote network. It may be set to 255.255.255.255 if there is no default gateway on the network.

Note: If the default gateway is not accessible with the configured interface IP address and subnet mask, the GMT will not be able to communicate with any devices beyond the local subnet. E.g. with an IP address configuration of 172.18.89.128, a subnet mask configuration of 255.255.255.0, and a default gateway configuration of 172.18.82.10, the GMT cannot reach the gateway.

Forward IP to GMT

Check this box to enable IP data forwarding.

Forwarding Scheme

When IP forwarding is enabled, this field is used to select the forwarding scheme, either Bridge (Proxy ARP) or Gateway. When configured as a proxy ARP bridge, EnerLinksIII can be used to

transparently forward packets between the networks attached to the AMT and GMT. In this mode, hosts on the GMT network can reach hosts on the AMT network without being “aware” that they are communicating over a proxy ARP bridge. When configured as a gateway, EnerLinksIII will still forward packets between the AMT and GMT’s networks, but hosts using the gateway must be specifically configured to use the EnerLinksIII gateway to access the remote network.

Uplink Subnet

This is the network IP address of the subnet on the AMT side of the data link that is made accessible through the EnerLinksIII proxy ARP bridge or gateway.

Uplink Subnet Mask

This defines the scope of the remote network. Together with the uplink subnet IP Address, this identifies the range of IP addresses accessible over the EnerLinksIII proxy ARP bridge or gateway. For example, a Subnet / Subnet Mask combination of 10.1.2.0 / 255.255.255.0 indicates that all addresses from 10.1.2.1 through 10.1.2.254 are accessible through the bridge/gateway, while a configuration of 10.1.2.144 / 255.255.255.248 indicates that only addresses from 10.1.2.145 through 10.1.2.150 are accessible. In general, the scope should be set as restrictively as possible to avoid unnecessary traffic being sent over the EnerLinksIII communication link.

Note that the Subnet / Subnet Mask definitions must be compatible. This means that none of the host bits identified by the subnet mask may be set. E.g. 10.1.2.1 would not be a valid subnet definition if the subnet mask were set to 255.255.255.0, because the last byte, “1”, is not contained within the range of Subnet bits defined by the mask. See Appendix A1 for an overview of how a subnet mask is used to define the scope of a subnet.

Tips for Configuring an Uplink Subnet for a Gateway Configuration

When a gateway scheme is used to connect the airborne and ground networks, the networks should be configured to be on separate, non-overlapping subnets. If the subnet definitions overlap, then the EnerLinksIII gateway will be unable to resolve the appropriate destination for packets that it generates. E.g. if the Ethernet IP address and mask on your GMT were set to 10.1.2.1/255.255.255.0 and the uplink subnet and mask were set to 10.1.2.144/255.255.255.248, then the gateway would not know where to send a packet destined for 10.1.2.146.

Tips for Configuring an Uplink Subnet for a Proxy ARP Bridge Configuration

When a proxy ARP bridge scheme is used to connect the airborne and ground networks, the networks should be configured as identical or overlapping subnets to allow access between machines on the two networks. E.g. if the Ethernet IP address and mask on your GMT were set to 10.1.2.1/255.255.255.0, then the uplink subnet and mask should be set to provide access to the same network, or a subset of it. An uplink subnet and mask of 10.1.2.0/255.255.255.0 would be a valid choice.

A better choice would be 10.1.2.144/255.255.255.248. This would limit the range of IP packets forwarded to only those in the range of 10.1.2.145 to 10.1.2.150, reducing the

amount of IP traffic unnecessarily being forwarded over the EnerLinksIII communication link. It is a good idea to assign IP addresses in a consecutive group on the airborne network to allow the uplink subnet to be defined as tightly as possible.

Note that the proxy ARP bridge configuration requires bi-directional communication for the system to fill out the ARP tables that the system uses to forward IP data. Thus, proxy ARP bridging cannot be used in an EnerLinksIII system configured for downlink only communication.

Also note that data transmitted through the EnerLinksIII proxy ARP bridge cannot be sent to remote network elements through a gateway or router. Since network elements on the far side of a gateway or router are not on the same subnet as the EnerLinksIII unit, the unit will not develop ARP table entries for those units.

WARNING

Operation of both the AMT and GMT on the same network with IP forwarding enabled can cause network disruption.

If the AMT and GMT are placed on the same network while IP forwarding is enabled, the pair will respond to requests for all IP addresses on the network, causing IP address conflicts. This can bring down your network. Care should be taken to ensure that the airborne network and ground network are completely isolated, and that the only path for traffic between the two networks is through the EnerLinksIII.

Note that if this rule is violated, and the AMT and GMT are even temporarily placed on the same network while the proxy ARP bridging forwarding scheme is enabled, each unit will maintain ARP entries for the entire network until they are both either powered down or IP Forwarding is disabled. Thus, if you remove only one unit from your network the bridge will continue to respond to all addresses on the network, causing network disruption. To recover, both units should be powered down or have IP Forwarding disabled.

For detailed information on the operation of the EnerLinksIII IP forwarding feature, see section 8.5.

Uplink Rate Limit

This field is used to limit the rate of IP data that is forwarded to the uplink subnet. When this field is set to any value other than “Not Limited”, the EnerLinksIII will drop IP packets as necessary to ensure that the rate of IP data sent over the multiplexed data stream never exceeds the specified limit. Note that when data services are multiplexed into the uplink data stream, they are added to the stream based on a weighted priority. Each time the Multiplexer is ready to send a new packet, it sends one from the data service with the highest priority that has a packet ready to transmit. Time critical data services, like sync and audio are given the highest priority, while IP is given the lowest.

Forward Broadcast Packets

Checking this box enables the forwarding of broadcast IP packets from the GMT network to the AMT network. This option must be independently enabled on the AMT for broadcast messages to be delivered in the downlink direction through the EnerLinksIII system.

Note that on many networks broadcast messages are frequently seen in relatively high volume. You should be aware of the traffic on your network before enabling this feature.

Enabling broadcast packet forwarding is not generally required for most communication between the airborne and ground networks, but may be useful for certain applications, for instance obtaining an IP address via DHCP.

Forward Multicast Packets

Checking this box enables the forwarding of multicast IP packets from the GMT network to the AMT network. This option must be independently enabled on the AMT for multicast messages to be delivered in the downlink direction through the EnerLinksIII system.

Filter Multicast Packets

When this box is checked, the GMT will only forward multicast IP packets that are destined for multicast group addresses included in the list of Forwarded Multicast Group Addresses.

Forwarded Multicast Group Addresses

This window lists all of the multicast group addresses for which the GMT will forward multicast IP packets when the Filter Multicast Packets checkbox is checked. Note that this window is only displayed when the Filter Multicast Packets checkbox is checked.

Adding Multicast Group Address Entries

To add an entry to the list of Forwarded Multicast Group Addresses, enter the group IP address in the New Address text box and click the Add button. This list may contain up to 12 entries.

Deleting Multicast Group Address Entries

To delete an entry from the list of Forwarded Multicast Group Addresses, highlight the entry and click the Delete button.

Enable TCP Proxy

Check this box to enable TCP Proxy IP data forwarding. This feature allows an application to attach to the specified TCP port on the GMT and send or receive data over this port to/from another application on the remote airborne network. This provides a reliable transport stream between your airborne application and the AMT, and between your ground based application and the GMT. It also provides a means of flow control so that your application can fully utilize the available uplink or downlink bandwidth.

Port

The Port field defines the TCP port that the GMT will listen on while waiting for a connection request from your application. When the GMT receives a connection request on the TCP Proxy port, it will accept the connection and begin reading data from it. Any data received will be sent

over the air uplink to the AMT. On the AMT, this data will be delivered to an application that has connected to the AMT TCP Proxy port. In the other direction, any data received on the AMT TCP Proxy port will be sent on the air downlink to the GMT and delivered from the GMT TCP Proxy port to the attached ground application.

The GMT will accept only one connection on the TCP Proxy port at a time. If a second connection attempt is made, it will be accepted, and the original connection will be shut down, with a TCP reset packet sent to the remote application.

The GMT will use TCP to limit the flow of data from the attached application. When the rate of data sent from the application exceeds the rate that can be delivered over the air uplink, the GMT will stop reading from the TCP socket, and the TCP Window size reported to the attached application will reduce to zero, indicating that the GMT can't accept any more data. The socket used by the transmitting application will buffer some of the data being sent, but when the transmit buffer on the transmitting application's socket is full, the socket "send" routine will indicate to the application that it could not send any data, and the transmitting application will need to hold onto that data. As the GMT sends its data, it will send a TCP message with a new TCP Window size that will permit the attached application to send more data.

Note that TCP Proxy is a separate feature from the Gateway / Proxy ARP Bridge IP Forwarding feature described above. Either feature may be enabled or disabled independently from the other. The only thing that the two features share is the maximum downlink IP data rate configured on the AMT and the maximum uplink IP data rate configured on the GMT. Since both features send IP data over the airlink, the maximum data rate refers to the maximum rate of IP data from both features.

EnerView Configuration

Enable EnerView Access

Checking this box allows an EnerView application running on a laptop or PC to receive the various data services received by the GMT. Unchecking this box denies access to all remote clients attempting to access the EnerView features of the GMT.

Enable Multicast

When checked, data from all data services will be sent to the multicast address and port configured in the boxes below.

When unchecked, a single remote EnerView application can register with the GMT to receive all data services, which will be sent to EnerView's unicast address.

Data Source

Use this radio button to select the source for data to be sent to the remote EnerView application. Either Downlink or Uplink data may be sent.

Multicast IP Address

This multicast address is the IP address used by the GMT for transmission of EnerView data to multiple remote clients. This address should be provided by the network administrator. If used

in this mode, the remote EnerView applications must be configured for this multicast addresses as well.

Port

The Port window is used to define the source UDP Port number on the GMT for EnerView data.

MPEG-2 TS Configuration***Enable Video Channel MPEG-2 TS***

Use the check boxes in this section to enable or disable sending video channel data to a remote viewer in an MPEG2 Transport Stream. Data sent to the remote viewer includes video as well as associated metadata. Separate boxes are provided to enable each video channel independently. Only video on channels configured for H.264 video compression will be included in an MPEG2 Transport Stream.

IP Address and Port

This is the destination IP address and port that the GMT uses for transmission of MPEG2 Transport Stream data for each video channel.

Apply

The user must click the Apply button for changes to the IP configuration to take effect.

Async TCP/IP Configuration

The GMT listens for a TCP/IP connection on specific ports. When an application is connected to one of the GMT's TCP/IP ports, the GMT sends all data received over the TCP/IP socket as uplink async data, and sends all downlink async data over the TCP/IP socket. The GMT can support up to ten clients at a time connected to each port. For the six async ports, the GMT listens on TCP/IP port numbers 1031 through 1036. Note that no user configuration is required to enable this feature.

GPS TCP/IP Configuration

The GMT listens for a TCP/IP connection on specific ports. Applications such as FalconView can be configured to connect over the network to the GMT's IP address and the TCP/IP port number. When an application is connected to one of the GMT's TCP/IP ports, the GMT sends all of the NMEA 0183 GPS data for the corresponding GPS port to the application over the network. The GMT can support up to ten clients at a time connected to each port. For the two GPS ports, the GMT listens on TCP/IP port numbers 1041 and 1042. Note that no user configuration is required to enable this feature.

IP Properties**IP Address**

This field reports the address assigned to the GMT.

Physical Address

The Physical (MAC) Address is the 48 bit machine level Ethernet address for the GMT.

Subnet Mask

This is the subnet mask assigned to the GMT.

Default Gateway

This is the IP address for the Default Gateway assigned to the GMT.

DHCP Properties

These properties are only displayed when DHCP is used.

Server Address

This is the IP address for the DHCP server.

Lease Obtained

This field provides the date and time at which the GMT was assigned its IP address by the DHCP server.

Lease Expires

This field provides the data and time at which the IP address assigned to the GMT by the DHCP server will expire.

IP Statistics

IP statistics are provided for both outgoing (TX) and incoming (RX) packets.

Ethernet Packets

The total number of packets sent or received on the Ethernet interface since the GMT was powered up.

ARP Packets

The total number of ARP packets sent or received on the Ethernet interface since the GMT was powered up.

IP Packets

The total number of IP packets sent or received on the Ethernet interface since the GMT was powered up.

IP Forwarding Statistics

IP statistics are provided for packets forwarded across the multiplexed data stream between the AMT and GMT. The packet counts in this table refer to the number of packets delivered at the Link (MAC) Layer, IP layer and ARP layer. Note that packets forwarded over the multiplexed data stream are segmented as necessary and sent within the variable-size 8 to 256 byte EnerLinksIII packets. Counters for the number of EnerLinksIII packets delivered between the AMT and GMT containing IP data are provided on the Data Services GUI pages.

MAC Packets

The total number of Link Layer packets sent to or received from the AMT since the GMT was powered up. Each EnerLinksIII packet sent/received that contains TCP Proxy data is counted as one MAC packet.

ARP Packets

The total number of ARP packets sent to or received from the AMT since the GMT was powered up.

IP Packets

The total number of IP packets sent to or received from the AMT since the GMT was powered up. Since TCP Proxy data is sent as a stream over the EnerLinksIII airlink, this counter does not include TCP Proxy packets.

3.6.14 GMT System Setup

The GMT System page (see Figure 45) provides a variety of information about the GMT configuration as well as control functions for self test and maintenance features. Full access users can modify all parameters on this page. View-Only access users can view all parameters including status details and may change their own passwords on this page. They cannot, however, modify any of the other page parameters.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block enabling DVA mode or saving and loading of templates and configuration files while Orderwire is enabled. To use these features, first disable the Orderwire service on the GMT Orderwire Setup Page.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video Output
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
- System**
 - Orderwire
 - Flight Test

Logout

GMT System Setup

GMT Assemblies

| | S/N | Rev |
|---------------------|-------|-----|
| Unit: | 53199 | 002 |
| Main Board: | 76543 | 009 |
| Power Board: | 87654 | 001 |
| AV Board: | 98765 | 004 |
| Front Panel: | 53164 | 007 |
| Radio Transceiver: | 54321 | 4 |
| Software Revision: | 4.0.5 | |
| Boot Revision: | 0.0.1 | |
| MM FPGA Revision: | V5E18 | |
| AV FPGA Revision: | V5E5 | |
| MG1264 FW Revision: | 16961 | |

GMT Self Test

Disruptive Self Test:

Status: ● OK

☐ DVA Mode

Real Time Clock

| | GMT Clock | AMT Clock | GPS Clock 1 | GPS Clock 2 |
|----------------------|--|-------------------|-------------|-------------|
| Current Time: | 23:48:48 01/03/08 | 23:48:49 01/03/08 | 23:18:57 | Unknown |
| Clock Sync: | Clock is in sync with metadata time reference. | | | |
| New Time: | <input type="text" value="23:48:48 01/03/08"/> <input type="button" value="Set Clock"/> <input type="button" value="Sync Clock to AMT"/> | | | |

Configuration Templates

Current Template: default_template

Saved Templates:

Manage Users

Username:

Password:

Confirm:

Access Level:
☐ View Only Access
☐ Restricted Access
☐ Full Access

Save Complete Configuration to File

[Right-click on this link and choose "Save Target As" to download file](#)

Restore Complete Configuration from File

Feature License Configuration

Saved Feature Licenses:

Enabled Feature Licenses:

Feature Name:

License Key:

Figure 45: GMT System Page

The configuration information is comprised of the following items:

GMT Assemblies**S/N (Serial Number)**

A list of the serial numbers and revision levels of all the major GMT subassemblies appears under this heading. Access to these serial numbers without opening the unit can be very convenient for logistics and maintenance activities.

Rev (Revision Level)

A list of the revision level for each of the major GMT software/firmware modules appears under this heading.

In addition, the System page provides a number of control functions. These are:

GMT Self Test**Disruptive Self Test**

Clicking the Start Test button launches a system self test. The system self test is a disruptive test that will interrupt normal operation of the GMT. Clicking the Start Test button causes a confirmation dialog box to appear, giving the user a chance to cancel the action if it was inadvertent.

Results of the self test are displayed in the Result window. The Result window automatically “pops up” to display the results of the GMT self test. Any result other than “Passed” indicates a problem that may require corrective action. When a result other than passed occurs, a brief description of the failure appears in the window.

Note that the displayed information is a summary of the test results. Full test details may be obtained by running the system test from the command line with the verbose option. The following system components are tested:

| System Component | Test Description |
|------------------|--|
| Reported Status | Check system status table for any components reporting a fault. |
| RTOS Components | Operating system diagnostic tests. |
| Stack | Check all task stack margins. |
| Mem Size | Check system RAM size margins. |
| Voltage Levels | Check maximum and minimum system voltages. |
| FPGA | FPGA ID and read/write test. |
| UART | Loopback test on each active UART. |
| Ethernet | Ethernet memory and loopback tests. |
| RTC | Check status of the real time clock device. |
| Radio | Check status of the radios, as reported on the radio GUI page. |
| Temperature | Temperature measurement range check. |
| Comm | Validate all configuration settings. |
| EEPROM | Checksum test, read/write test and cache comparison test. |
| Flash | Test read of flash manufacturer and device ID. |
| Orderwire Config | Checks for orderwire configuration conflicts. E.g. If IP forwarding is enabled on the AMT but not supported on the |

| | |
|--------------|--|
| | GMT this test will fail. |
| ADF4360 | Check the status of the ADF4360 Integrated Synthesizer/VCO. |
| AD9957 | Check status and perform read/write test on the quadrature digital up converter device. |
| Video Input | Checks for video signal input and performs a read/write test on the Cx25836 video decoder. |
| H264 Codec | Perform communication test on the MG1264 video/audio compression device. |
| Video Output | Performs a read/write test on the CX25874 video encoder. |

Figure 46: Tested System Components

The Start Test button is available to only Full access users.

Status

Background health and status monitoring is performed on the GMT during normal operation. If a problem is detected during this monitoring, an entry is made in the system status table. The “Details” button provides access to this table.

Problems are classified as either a “Fault” or “Warning” in the status table. A status of “Fault” indicates a condition that requires immediate attention, and a status of “Warning” indicates a potential problem that may require corrective action.

The system status is read from the GMT and the Status indicator is automatically refreshed in the GUI display approximately once a second.

Clicking the Details button retrieves the system status table from the GMT. Note that unlike the Start Test button, clicking the Details button is non-disruptive and will not interrupt the normal operation of the GMT.

The system status table is displayed in a separate Result window. The table includes the current status (“OK”, “Fault”, or “Warning”) of each monitored system component as well as a count of the number of times that each component has previously had a status of “Fault” or “Warning”.

Status indication of “Fault” or “Warning” indicates a problem that may require corrective action. Running a system self test may provide more detailed information about the condition that may be used to isolate the problem.

The following system components are monitored:

| System Component | Monitored Information | Problem Status |
|------------------|--------------------------------------|----------------|
| System Voltage | Maximum and minimum system voltages. | Fault |
| RTOS Components | Operating system diagnostic tests. | Fault |
| Stack | Task stack margins. | Fault |
| Memory Size | System RAM size margins. | Fault |
| FPGA | FPGA ID and read/write test results. | Fault |
| Comm | Comm configuration validation. | Fault |

| | | |
|----------------------|--|---------|
| I2C Bus | I2C bus read/write timeout. | Fault |
| Ethernet | Ethernet memory and loopback test results. | Fault |
| UART | UART loopback test results. | Fault |
| Lost Crypto Sync | Downlink datastream is AES encrypted, and cannot be decrypted. | Fault |
| Invalid AES Password | AES encryption is enabled on the uplink or downlink datastream, and no AES password is stored. | Fault |
| SPI Bus | SPI bus read/write timeout. | Fault |
| ADF4360 | Integrated Synthesizer/VCO initialization status and phase lock status. | Fault |
| AD9957 | Quadrature digital up converter device test results. | Fault |
| CX25836 | Video decoder device test results. | Fault |
| CX25874 | Video encoder device test results. | Fault |
| PA Overcurrent | TX Power Amplifier overcurrent check. | Fault |
| LNA Overcurrent | RX Low Noise Amplifier overcurrent check. | Fault |
| H264 Codec | Video / audio compression device test results. | Fault |
| Temperature | Temperature measurements. | Warning |
| EEPROM | EEPROM read/write and checksum errors. | Warning |
| FLASH | Flash programming errors and test results. | Warning |
| OW Config Conflict | AMT and GMT orderwire configuration conflict. | Warning |
| IP Address Conflict | Configured IP address in use by another unit on network. | Warning |
| Video Signal Lost | Video signal presence on active video channels. | Warning |
| RTC | Real Time Clock device status. | Warning |

Figure 47: Monitored System Components

The Details button is available to both Full and View-only access users.

DVA Mode

When this checkbox is clicked so that it shows a checkmark, the GMT is placed in DVA compatibility mode. In this mode, the modulation scheme used by the GMT communications module is configured to be interoperable with the Digital Video over Analog (DVA) Video Data Link. In DVA mode, the GMT may receive and process an RF signal from a DVA. The GMT configuration is not changed when DVA mode is entered, and the format of the GUI pages is not modified.

Reset GMT

The Reset GMT button causes the GMT to undergo a complete re-boot. This re-boot is not quite as exhaustive as a power cycle, but does cause the following:

- A complete re-load of system software from flash memory
- Re-load of all programmable devices in the design from flash memory
- Execution of power on self test, if enabled

Clicking the Reset GMT button causes a confirmation dialog box to appear, giving the user a chance to cancel the action if it was inadvertent.

Resetting the GMT will interrupt any operational usage of the GMT and result in loss of data in both the downlink and uplink.

The Reset GMT button is available to only Full access users.

Real Time Clock

The EnerLinksIII System includes a Real Time Clock feature that maintains the time on the GMT, which is displayed here. Additionally, the time provided by the AMT Real Time Clock is always multiplexed into the transmitted bit stream for transmission to the GMT. The Real Time Clock can only be modified by Full Access users.

The real time clock is powered by an internal battery and can maintain time through powered down periods as long as twelve years. The battery is discharged more slowly when the GMT is powered.

Current GMT Clock

The time displayed here is the current RTC value contained within the GMT.

Current AMT Clock

This field displays the AMT time received from the AMT in the multiplexed data stream. The GUI application reads this value from the GMT once per second. The value displayed here contains the last RTC reading received by the GMT.

Current GPS Clock 1 and GPS Clock 2

This field displays an estimation of the latest time received at a GPS receiver connected to each of the GPS ports at the AMT. This is only present if GPS functionality is enabled and if the GPS receiver provides timestamp information. The GUI application reads this value from the GMT once per second.

Clock Sync

The GMT will automatically synchronize its RTC to the time supplied in the Metadata Time Reference, GPS Clock 1 or GPS Clock 2, if any is present. The Metadata Time Reference is most preferred, since it is synchronized to a 1PPS signal at the AMT. The GPS Clock 1 is next most preferred, and the GPS Clock 2 is least preferred. If none of these clocks is present, the user may enter a new RTC time manually, or may command the GMT to synchronize its RTC with the AMT's clock.

New Time

The Real Time Clock window normally displays the current time from the Real Time Clock. If the user clicks on the text entry window, the display stops changing, and the user can then type in a value in HH:MM:SS MM:DD:YY format.

Set Clock

The value contained within the “New Time” window takes effect when the user clicks the “Set Clock” button, or types Enter. This method of time setting allows fairly tight synchronization to a wristwatch, if desired.

Sync Clock to AMT

If the GMT is receiving RTC status packets from the AMT, the GMT clock may be synchronized to the RTC value received from the AMT. Clicking on this button immediately synchronizes the GMT's RTC to the time received from the AMT.

Configuration Templates

When the EnerLinksIII GMT is powered up, it comes up with the configuration that was active in the unit the last time it was powered down. The GMT also includes an ability to assign names to configurations and to store those configurations within the GMT's non-volatile memory for later recall and use. A saved configuration is called a template. Templates can be handy when there are several modes in which the equipment is frequently used. The EnerLinksIII GMT can save up to 20 templates, including the default_template.

Templates do NOT include IP networking configuration information. The IP configuration is not changed when a template is loaded.

One of the templates in the Saved Templates window is named “default_template”. This template cannot be deleted. It is a very simple configuration intended to allow the user to make the equipment work very quickly out of the box. The default configurations are compatible between the AMT and GMT so that the two units will operate properly right away. It should be noted however that the RF frequencies and transmission bit rate are not likely to match assigned frequencies for a given mission, and as a result the default_template is best suited for training and for bench testing and evaluation.

The downlink default configuration has the following settings:

- The modulation bit rate is 11 Mbps. FEC is light, BER test is off.
- The transceiver RX carrier frequency is set to 4900 MHz if a C-Band transceiver is installed and 1780 MHz if an L/S-Band transceiver is installed.
- Input rate matching is disabled, but all async port output rates are set to 300 bps, so that they will automatically be adjusted to match whatever input rate is configured at the AMT when the GMT begins receiving downlink data.
- Video channel 1 is configured for composite output on all video output jacks. Output of all other video channels is disabled.

The uplink default configuration has the following settings:

- Only the audio data service is enabled.
- The modulation bit rate is 1.0 Mbps. FEC is light.
- The transceiver TX carrier frequency is set to 5250 MHz if a C-Band transceiver is installed and 2300 MHz if an L/S Band transceiver is installed.

Note that if the system is not used on a test bench where the RF connection from transmitter to receiver is via coaxial cable, then it is important to be sure that using the default frequencies will not disrupt other operational users of the RF spectrum.

Templates can only be modified, saved, or loaded by full access users. They cannot be modified, saved, or loaded when Orderwire is enabled.

Current Template

This field lists the most recent template that was loaded into the system. Note that the actual configuration may be different from the “current template” configuration if changes have occurred since the template was loaded. On power cycle, the unit will restore the current configuration (not the template configuration.)

Saved Templates

This window lists all the templates available on the system.

Load

To load an existing template as the current configuration, select the template name from the Saved Templates window and click Load or double-click on the template name in the Saved Templates window. The selected template will become the current configuration and its name will appear in the Current Template field.

Save As

To create a template from the current configuration, type a name for the configuration into the window and click the Save As button. If the chosen name already exists in the Saved Templates list, this process will overwrite the template for the chosen name.

Rename

To rename an existing template, select the template name from the Saved Templates window, type a new name into the window and click the Rename button.

Delete

To delete a template, select the template name from the Saved Templates window and click the Delete button. The existing configuration will not be changed by this action, even if the template being deleted is the current template.

Manage Users

The EnerLinksIII AMT and GMT each support one default Full access account (named “Administrator”) and up to eight additional accounts. Any Full access user may add and delete users, and change any user’s password. View-only access users are not allowed to add or delete users, and are only allowed to change their own password. Restricted access users do not have access to this page.

Passwords are case sensitive and must be entered the same way twice to take effect. Passwords must conform to the following rules:

1. Passwords must be at least 8 characters long.
2. Passwords must have at least one capital letter and one lowercase letter.
3. Passwords must have at least one number or special character.

Username

For the Full access user, this window shows all the usernames, and an entry for “Add new user”. For the Minimum access user, this window shows only the current user’s name.

Adding a User

To add a new user, highlight “Add new user” in the Usernames window. Enter the Username and Password in the labeled text windows, repeat the password exactly in the Confirm window, and then click Apply.

Changing Password

To change a user’s password, highlight the user in the Usernames window. Enter the Password in the labeled text window, repeat the password exactly in the Confirm window, and then click Apply.

Deleting a User

To delete a user, highlight the user in the Usernames window, and click Delete. The user named “Administrator” cannot be deleted.

Save Complete Configuration to a File

The GMT provides the capability to save the complete configuration to a file on the PC or laptop used to configure the GMT. This can be used to backup a configuration external to the GMT. It can also be used to copy the configuration of one GMT to another GMT which may use a very similar configuration. Note that the IP configuration is saved in the file created by this operation. If the configuration file is used with multiple units, the IP configuration must be modified to insure that multiple units do not share the same IP address.

Restore Complete Configuration from File

The GMT provides this capability to restore a configuration file which was previously uploaded to a PC or laptop. To restore a configuration file, use the “Upload” button.

Feature License Configuration

This section of the GUI page is used to enable or disable optional licensed features in the EnerLinksIII System. When support for a licensed feature is purchased, ViaSat will provide a license key that must be entered into each EnerLinksIII unit to unlock that feature on the unit. A unique license key will be provided for each unit. License keys may be entered via the GUI on this page, or through the CLI using the “FEATURE” command, or through TFTP by sending the license.txt file provided by ViaSat directly to the unit.

Saved Feature Licenses

This window lists all of the features whose licenses that have been stored to EEPROM on the GMT.

Enabled Feature Licenses

This window lists all of the features whose licenses are currently enabled and active on the GMT. Note that when a license key is added, the associated feature will not become active until after the GMT is reset. Likewise, when a license key is deleted, the associated feature will not become inactive until after a reset. Note that if a license key is added for a feature that is not supported by the version of software loaded on the system, the feature will not appear in this list.

Deleting a Feature License

To delete the license for a feature, highlight the feature name in the Saved Feature Licenses window, and click Delete. The feature will not be disabled until the GMT is reset.

Adding a Feature License

To add the license for a feature, enter the feature name and license key exactly as provided by ViaSat in the Feature Name and License Key text boxes, and click Add Feature. The feature will not be enabled until the GMT is reset.

3.6.15 GMT Orderwire Page

The GMT Orderwire page provides the mechanism for enabling or disabling the Orderwire functionality in the EnerLinksIII system. Orderwire allows a user at the GMT to configure data port parameters at the AMT, as long as both an uplink and downlink have already been established. Figure 48 shows the GMT Orderwire GUI page.

For an Orderwire connection to be established, the versions of software running on the AMT and GMT must be compatible. As of the writing of this Configuration and Operation Guide, EnerLinksIII software release 4.1.0 is the latest release. Any AMT or GMT running software release 4.1.0 and above will require that the remote AMT or GMT is running software release 3.3.4 or greater for a connection to be established.

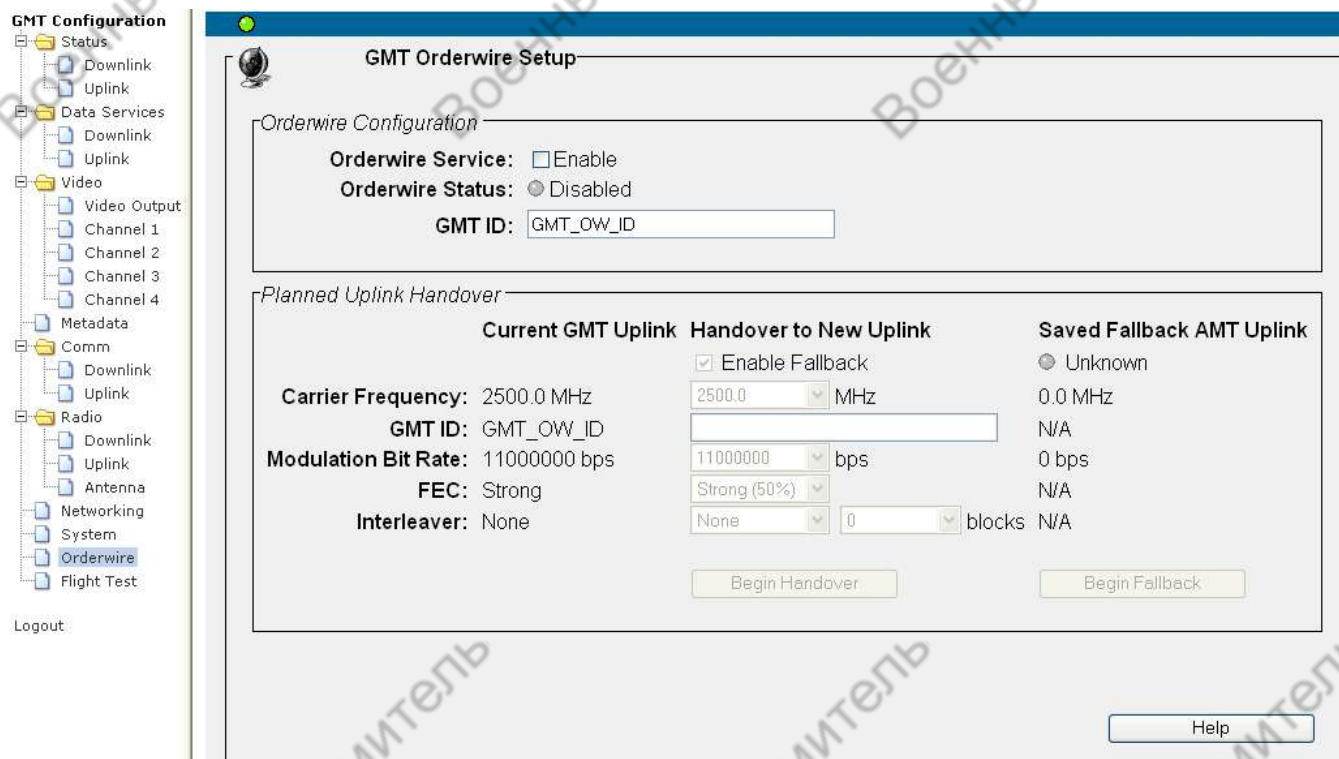


Figure 48: GMT Orderwire Page

Orderwire Service

The Orderwire Service parameter enables or disables the orderwire functionality. When this box is checked, the GMT will attempt to establish an orderwire connection with the AMT it is talking to. In order for this session to be established, the GMT must be configured with a GMT ID that matches the configuration at the AMT.

Orderwire Status

The Orderwire Status LED indicates the status of the Orderwire link. If Orderwire Service is disabled at the GMT, this LED will be gray. If Orderwire Service is enabled, but the link has not been established, this LED will be red. If Orderwire Service is enabled and the AMT and GMT have established a link, the LED will be green.

GMT ID

The GMT ID is a password which must be set to the exact same value at the AMT and GMT. This parameter insures that an AMT receives configuration information only from a GMT it has been configured to communicate with.

Planned Uplink Handover

To use this feature, the orderwire service must be enabled and connected. See section 3.9.14 for a description of the handover feature when orderwire is connected.

3.6.16 GMT Flight Test and Performance Page

The GMT Flight Test and Performance page provides a single page with information that is often used during flight test. Log files can be created and downloaded into a spreadsheet program such as Microsoft Excel. Figure 49 shows the GMT Flight Test and Performance GUI page.

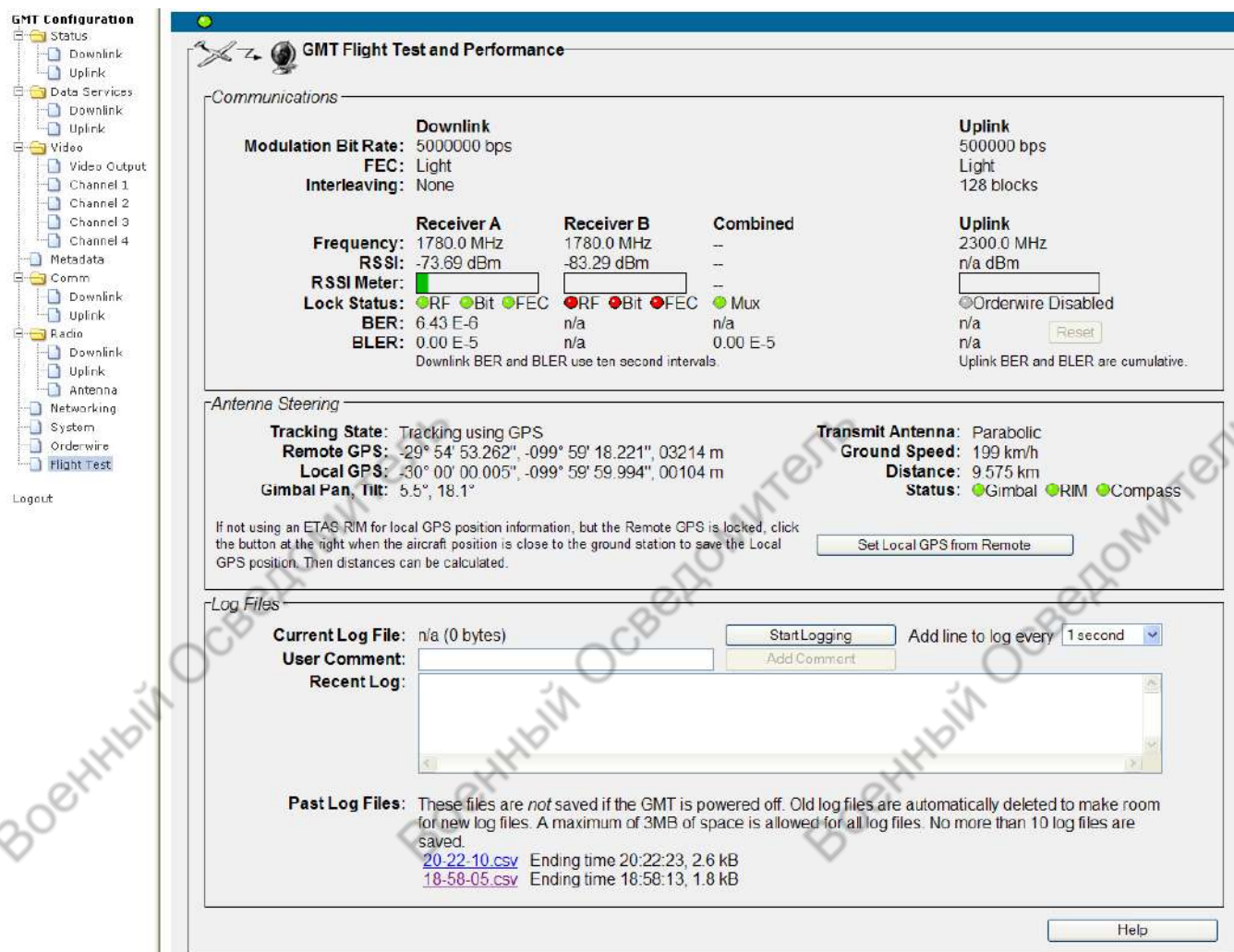


Figure 49: GMT Flight Test and Performance Page

Communications

This section describes the communications parameters used by the modem and radio. There are also RSSI meters, lock status indicators, and BER and BLER numbers which are updated once every second.

The downlink lock status indicators are tri-state fields, and are aggregated for ten seconds. The three states are described below:

- A red light indicates that the unit was unlocked for the entire ten seconds.
- A green light indicates that the unit was locked for the entire ten seconds.

- An amber light indicates that the unit was sometimes locked and sometimes unlocked during the ten seconds.

The downlink BER and BLER numbers represent the last ten seconds. The uplink BER and BLER numbers represent the last ten seconds if the AMT supports this feature. Otherwise, the uplink BER and BLER numbers are cumulative since the last time they were reset. Clicking the Reset button next to the uplink BER and BLER will send an orderwire command to the AMT to reset its BER and BLER counters.

Antenna Steering

This section describes the relevant information from the antenna steering feature, if it is enabled. Even if antenna steering is disabled, the AMT's GPS location information and estimated ground speed are shown here.

Set Local GPS from Remote GPS

When not using an ETAS with a RIM, the GMT does not have a source for its local GPS location, and cannot compute the distance between the ground station and the aircraft. However, if the aircraft has GPS, and is launched from nearby the ground station, it is possible to use the aircraft's GPS receiver to get the location of the ground station. When the aircraft is near the ground station and has GPS position lock, click the "Set Local GPS from Remote GPS" button. This will save the current Remote GPS location as the Local GPS location until it is changed.

Log Files

This section allows the operator to generate log files and download them to the PC. The format of the log files is a comma-separated values file, or *.CSV, which can be imported into Microsoft Excel or other spreadsheet programs.

Log files created by a GMT are stored in the GMT's RAM only, and are *not* saved if the GMT is turned off or reset. They must be downloaded to the PC for safe storage. 3Mbytes of RAM are reserved for saving log files. If that limit is reached, older log files are deleted automatically. If the current log file reaches the 3MByte limit, meaning all other past log files have already been deleted, the oldest entries in the current log file are deleted automatically to make room for newer entries. Logging does not stop just because the 3MByte limit is reached. Each line in a log file uses approximately 200 bytes, and the amount of logging that can be saved in the 3MByte limit is summarized below:

- If writing one log line every second, approximately 4.5 hours can be logged.
- If writing one log line every five seconds, approximately 22 hours can be logged.
- If writing one log line every ten seconds, approximately 44 hours can be logged.

One strategy for logging longer periods of time is to occasionally stop and restart the logging, which will move the current log file to the Past Log Files section where it can be downloaded to the PC. For example, if writing a log line every second, once every hour or two (well before the 4.5 hour limit), stop and restart the log very quickly so that only a couple of seconds of data is missed, then download the log file that was just stopped to the PC, and continue logging.

Automatic Log File Archiving to Hard Drive

The GMT will send all log data over TCP/IP to any application which connects to port number 1040 on the GMT. The GMT can support up to 10 simultaneous connections on this port. Instead of manually downloading the log files after they are created in the GMT's RAM (and possibly forgetting to download them before turning off the GMT), the TcpCapture.exe application can be run on any PC connected to the GMT via Ethernet. Simply open a Windows command prompt and change to the directory with the TcpCapture.exe application. Then type:

```
TcpCapture <GMT IP address>
```

This application will continue to run until it is closed. It will connect to the GMT automatically, and reconnect if it loses its connection. All log file data is saved in text files on the PC's hard drive in the same directory, and the file names are timestamped with the date and time they were created plus the IP address of the GMT.

When running TcpCapture.exe, as soon as it connects to a GMT the GMT begins logging as if the operator had clicked the Start Logging button on the GUI page. If the user clicks the Stop Logging button on the GUI page, it disconnects the network connection to TcpCapture.exe, but TcpCapture.exe will try to reconnect to the GMT. When TcpCapture.exe reconnects to the GMT, the GMT will begin logging again.

Current Log File

If a log file is being created, the file name is shown, and the file size is updated regularly. The file name is created from the time the log file is started, e.g., HH-MM-SS.csv. There is also an option to select how frequently a new line is added to the current log file.

Start/Stop Logging

The Start Logging button will change to the Stop Logging button after a log file is started.

Log File Format

Each line in a log file is a collection of fields separated by commas. The fields include a date and time stamp, the AMT's GPS location information, all of the lock status indicators, RSSI, and BER and BLER numbers, and an optional user comment.

The fields for the downlink RF signal status, bit sync lock, FEC sync lock, and mux sync lock are tri-state fields, and are aggregated for the time period in between log file lines. For example, if writing a log line every ten seconds, each of these indicators describes what happened over the previous ten seconds. The three states are described below:

- A value of 0 indicates that the unit was unlocked for the entire aggregation period.
- A value of 1 indicates that the unit was locked for the entire aggregation period.
- A value of 2 indicates that the unit was sometimes locked and sometimes unlocked during the aggregation period.

The fields for the downlink BER and BLER are aggregated for the time period in between log file lines. Note that this differs slightly from the values displayed on the GUI page, which are always aggregated for ten seconds.

User Comment

A user comment of up to 63 characters can be entered. When the Add Comment button is clicked, the text edit field and the Add Comment button are disabled until the next log file line is generated which includes the comment.

Recent Log

The last 5 lines written to the log file are shown scrolling through this text area. This is merely informative, and allows the user to see an example of what is being written to the log file, including the user comment text.

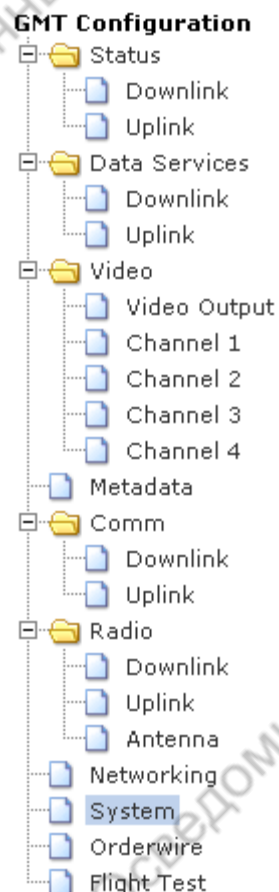
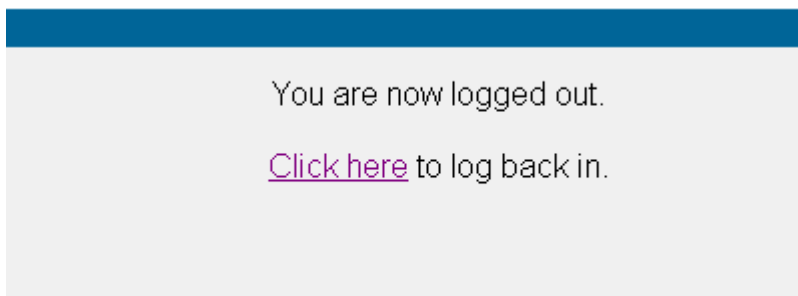
Past Log Files

Up to ten past log files can be saved in RAM. Each file is named based on its starting time in HH-MM-SS.csv format. The ending times and file sizes are also listed. Clicking on any of the file names will open up a new browser window with an option to open or save the file. If Microsoft Excel is installed on the PC, clicking Open will embed an Excel version of the CSV file in the new browser window. Clicking Save will save the log file to the PC's hard drive as a text file, which can then be copied or opened in a spreadsheet, text editor, or other program.

These log files cannot be manually deleted from the GMT. They will be automatically deleted to make room for new log files. All past log files are saved only in RAM, and are lost if the GMT is turned off or reset.

3.6.17 GMT Logout

The user logs out by clicking the Logout tab (see Figure 50). The acknowledgment screen shown in Figure 51 will be displayed in response. Click the underlined text to log back in. The username and password must be re-entered to log back into the unit. Your internet browser may ask you if you would like it to save your username and password. It is recommended that you DO NOT allow the browser to store this information.

**Figure 50: GMT Logout Tab****Figure 51: GMT Logout Acknowledgment Screen**

3.7 AMT GUI Pages for Restricted Access Users

Restricted access user's have access to two GUI pages on the AMT. One page allows the user to perform limited configuration changes, and the other displays the entire system status.

3.7.1 AMT Restricted Access Configuration Page

The restricted access AMT Configuration page is shown in Figure 52. This page allows the user to select different configuration templates, select the RF transmit and receive frequencies, adjust the video picture, and configure the uplink audio headphones.

AMT Configuration

- Status
- Config
- Logout

The screenshot shows the 'AMT Configuration' web interface. It is divided into several sections: 'System Config', 'Radio', and four 'Video Channel' sections (1-4), followed by 'Uplink Audio Headphones'. The 'System Config' section shows 'System Status' as OK and 'Uplink Connection' as Locked. The 'Radio' section shows carrier frequencies for Transceiver TX (1780.0 MHz), External Transmitter (450.0 MHz), and Transceiver RX (2500.0 MHz). The 'Video Channel' sections each have sliders for Brightness, Contrast, Tint, and Saturation, all set to 128. The 'Uplink Audio Headphones' section has checkboxes for 'Left Headphone Out' and 'Right Headphone Out' (both checked) and a volume slider set to 20.

AMT Configuration

System Config

System Status: ● OK [Details](#)

Uplink Connection: ● Locked

Current Template: template1

Saved Templates: [Apply](#)

Radio

Carrier Frequency: Transceiver TX: 1780.0 MHz External Transmitter: 450.0 MHz Transceiver RX: 2500.0 MHz

Radio Status: ● OK ● Not Present ● OK

[Poll Radio](#) [Poll Radio](#) [Poll Radio](#)

Video Channel 1

[Normalize](#)

Brightness: 128 Contrast: 128 Tint: 128 Saturation: 128

Video Channel 2

[Normalize](#)

Brightness: 128 Contrast: 128 Tint: 128 Saturation: 128

Video Channel 3

[Normalize](#)

Brightness: 128 Contrast: 128 Tint: 128 Saturation: 128

Video Channel 4

[Normalize](#)

Brightness: 128 Contrast: 128 Tint: 128 Saturation: 128

Uplink Audio Headphones

☒ Left Headphone Out ☒ Right Headphone Out

Volume: 20

0 59

Figure 52: AMT Restricted Access Configuration Page

System Config

This section provides an indication of overall system status and supports the application of pre-defined configuration templates.

System Status

Background health and status monitoring is performed on the AMT during normal operation. If a problem is detected during this monitoring, an entry is made in the system status table and the status displayed here is updated accordingly. The “Details” button provides access to this table.

Problems are classified as either a “Fault” or “Warning” in the status table. A status of “Fault” indicates a condition that requires immediate attention, and a status of “Warning” indicates a potential problem that may require corrective action.

The system status is read from the AMT and the System Status indicator is automatically refreshed in the GUI display approximately once a second.

Clicking the Details button retrieves the system status table from the AMT. The system status table is displayed in a separate Result window. The table includes the current status (“OK”, “Fault”, or “Warning”) of each monitored system component as well as a count of the number of times that each component has previously had a status of “Fault” or “Warning”.

Status indication of “Fault” or “Warning” indicates a problem that may require corrective action. Running a system self test may provide more detailed information about the condition that may be used to isolate the problem.

The following system components are monitored:

| System Component | Monitored Information | Problem Status |
|-------------------------|--|-----------------------|
| System Voltage | Maximum and minimum system voltages. | Fault |
| RTOS Components | Operating system diagnostic tests. | Fault |
| Stack | Task stack margins. | Fault |
| Memory Size | System RAM size margins. | Fault |
| FPGA | FPGA ID and read/write test results. | Fault |
| Comm | Comm configuration validation. | Fault |
| I2C Bus | I2C bus read/write timeout. | Fault |
| Ethernet | Ethernet memory and loopback test results. | Fault |
| UART | UART loopback test results. | Fault |
| Lost Crypto Sync | Uplink datastream is AES encrypted, and cannot be decrypted. | Fault |
| Invalid AES Password | AES encryption is enabled on the uplink or downlink datastream, and no AES password is stored. | Fault |
| SPI Bus | SPI bus read/write timeout. | Fault |
| ADF4360 | Integrated Synthesizer/VCO initialization status and phase lock status. | Fault |
| AD9957 | Quadrature digital up converter device test results. | Fault |

| | | |
|---------------------|--|---------|
| CX25836 | Video decoder device test results. | Fault |
| PA Overcurrent | TX Power Amplifier overcurrent check. | Fault |
| LNA Overcurrent | RX Low Noise Amplifier overcurrent check. | Fault |
| H264 Codec | Video / audio compression device test results. | Fault |
| Video Time Sync | Status of H.264 video frame time synchronization algorithm, which allows the AMT to assign a UTC time stamp to each video frame for inclusion in the MPEG2 transport stream. | Fault |
| Temperature | Temperature measurements. | Warning |
| EEPROM | EEPROM read/write and checksum errors. | Warning |
| FLASH | Flash programming errors and test results. | Warning |
| OW Config Conflict | AMT and GMT orderwire configuration conflict. | Warning |
| IP Address Conflict | Configured IP address in use by another unit on network. | Warning |
| Video Signal Lost | Video signal presence on active video channels. | Warning |
| RTC | Real Time Clock device status. | Warning |
| Metadata Timing | Metadata timing reference status. | Warning |

Figure 53: Monitored System Components**Uplink Connection**

When the AMT is able to correctly read data from the uplink for the different data services, the Uplink Connection status is set to Locked.

Uplink Connection status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Configuration Templates

When the EnerLinksIII AMT is powered up, it comes up with the configuration that was active in the unit the last time it was powered down. The AMT also includes an ability to assign names to configurations and to store those configurations for later recall and use. A saved configuration is called a template. Templates can be handy when there are several modes in which the equipment is frequently used. The EnerLinksIII AMT can save up to 20 templates, including the default_template.

Templates do NOT include IP networking configuration information. The IP configuration is not changed when a template is loaded.

One of the templates in the Saved Templates window is named “default_template”. This template cannot be deleted. It is a very simple configuration intended to allow the user to make the equipment work very quickly out of the box. The default configurations are compatible between the AMT and GMT so that the two units will operate properly right away. It should be noted however that the RF frequencies and transmission bit rate are not likely to match assigned frequencies for a given mission, and as a result the default_template is best suited for training and for bench testing and evaluation.

The downlink default configuration has the following settings:

- Only the audio and video data services are enabled.
- Video channel 1 is set to H.264, color, composite, Jack 1 (AV-1). Color adjustments are set to neutral and GOP size is set to 15.
- Video channels 2, 3 and 4 are disabled. Video rate sharing is set to evenly distribute video bandwidth among all channels. Video bit rate is set to variable.
- The metadata time reference input is disabled.
- The modulation bit rate is 11 Mbps. FEC is light, BER test is off.
- The transceiver TX carrier frequency is set to 4900 MHz if a C-Band transceiver is installed and 1780 MHz if an L/S-Band transceiver is installed.
- The external transmitter frequency is set to 450 MHz.

The uplink default configuration has the following settings:

- Input rate matching is disabled, but all async port output rates are set to 300 bps, so that they will automatically be adjusted to match whatever input rate is configured at the GMT when the AMT begins receiving uplink data.
- The modulation bit rate is 1.0 Mbps. FEC is light.
- The transceiver RX carrier frequency is set to 5250 MHz if a C-Band transceiver is installed and 2300 MHz if an L/S Band transceiver is installed.

Note that if the system is not used on a test bench where the RF connection from transmitter to receiver is via coaxial cable, then it is important to be sure that using the default frequencies will not disrupt other operational users of the RF spectrum.

Restricted access users can only load templates. Templates cannot be loaded when Orderwire is enabled.

Current Template

This field lists the most recent template that was loaded into the system. Note that the actual configuration may be different from the “current template” configuration if changes have occurred since the template was loaded. On power cycle, the unit will restore the current configuration (not the template configuration.)

Saved Templates

This window lists all the templates available on the system.

Apply

To load an existing template as the current configuration, select the template name from the Saved Templates window and click Apply. The selected template will become the current configuration and its name will appear in the Current Template field.

Radio

This section provides control for the RF transmit and receive capabilities of the AMT. The EnerLinksIII AMT will use the TX side of the internal transceiver for RF transmission by

default. An external transmitter may be used to support the analog video bypass feature which will be supported in a future release. This GUI page provides the control and status for the TX side of the internal transceiver and the external transmitter in side-by-side columns.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block the configuration of radio frequencies while Orderwire is enabled.

Carrier Frequency

Select the transmitter and receiver carrier frequencies from the drop down menus. If the desired value is not in the drop down list, select “Edit list...” from the drop down menu to enter a new value.

The allowed range of transmitter carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported TX Frequency Range(s) |
|---------------------------------|--|
| L/S Band Transceiver TSA-206123 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206167 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208167 | Lower C-Band: 4900 – 4950 |

The allowed range of transmitter carrier frequencies for the external transmitter is:

- UHF: 400 – 450 MHz
- L-Band: 1710 – 1850 MHz
- S-Band: 2200 – 2400 MHz

The allowed range of receiver carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported RX Frequency Range(s) |
|---------------------------------|--|
| L/S Band Transceiver TSA-206123 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206167 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208167 | Upper C-Band: 5250 – 5530 |

The frequency must be entered in MHz with a resolution of 500 kHz. If no decimal point is used, the frequency is an integer number of MHz. If a decimal point is used, it may be followed by either a “0” or a “5”.

Note that use of the same frequency band in both the uplink and downlink may cause substantial interference to both communication channels and although possible, is not recommended.

If the receive frequency configured at the GMT does not match the transmit configuration on this page, data will not be received by the GMT. Likewise, if the transmit frequency configured at the GMT does not match the receive configuration on this page, data will not be received by the AMT.

Radio Status

This status indicator shows the status of each transmitter and receiver, depending on the AMT configuration and the status reported by the radio, if present.

- *Not Present* indicates the AMT is not able to communicate with the transceiver or external transmitter.
- *Fault* indicates the transceiver or external transmitter is not providing expected responses. In the case of the external transmitter, this may indicate that it is an unsupported model.
- *Band Mismatch* indicates the carrier frequency specified on this GUI page is not within the band supported by the transceiver or external transmitter.
- *Insufficient Frequency Differential* indicates the transmit carrier frequencies specified for the internal transceiver and external transmitter are too close together, and signal interference may occur.
- *PLL Not Locked* indicates the transmitter or receiver has not tuned to the specified frequency. This is normal for short periods of time, when changing frequencies or first turning on the AMT, transceiver and external transmitter. Click the Poll Radio button and wait a few seconds for the GUI page to refresh. If the radio repeatedly reports it is Unlocked, there may be a problem with the radio or with the carrier frequency that has been configured.
- *Disabled* indicates that the transmitter has not been enabled.
- *OK* is the normal operating mode for the radio.

Radio status is read from the AMT and automatically refreshed in the GUI display approximately once a second.

Poll Radio Button

Querying an external transmitter for status makes it stop operating momentarily. This makes it undesirable for the AMT to periodically poll the external transmitter for status. The AMT thus polls the transmitter status (and updates the GUI page) on power up, on change of any transmitter configuration parameter, and when the user clicks the Poll Radio button on the GUI.

The transmitter and receiver status of the internal transceiver is polled once a second. The Poll Radio button may be used to request an immediate poll of the status and refresh of this page.

Video Channel Picture Adjustment

These features allow adjustment of the picture brightness, contrast, tint, and saturation in the same fashion that typical color television sets operate for each video channel. Each parameter is configured either by use of the slider underneath the parameter or by entering a numeric value in

the data box for the parameter. Each of the picture adjustment parameters can be in the range from 0 to 255.

Uplink Audio Headphones

In cases where the audio ports are enabled at the GMT, an AMT user can enable headphone outputs by clicking the “Headphone Out” checkbox so that it shows a checkmark for the appropriate audio channel. The headphone volume can be adjusted by using the slider or by manually typing in a volume in the headphone volume box. Valid settings range from 0 to 59, with 59 corresponding to the loudest volume. When only one of the “Headphone Out” check boxes is selected, the enabled audio signal is output to both the left and right headphone channels.

3.7.2 AMT Restricted Access Status Page

The restricted access AMT Status page is shown in Figure 54. This page summarizes the configuration and status of the AMT. However, no configuration changes can be made on the status page. The information displayed on this page is static. The page must be manually refreshed to update the status.

AMT Configuration
 Status
 Config
 Logout

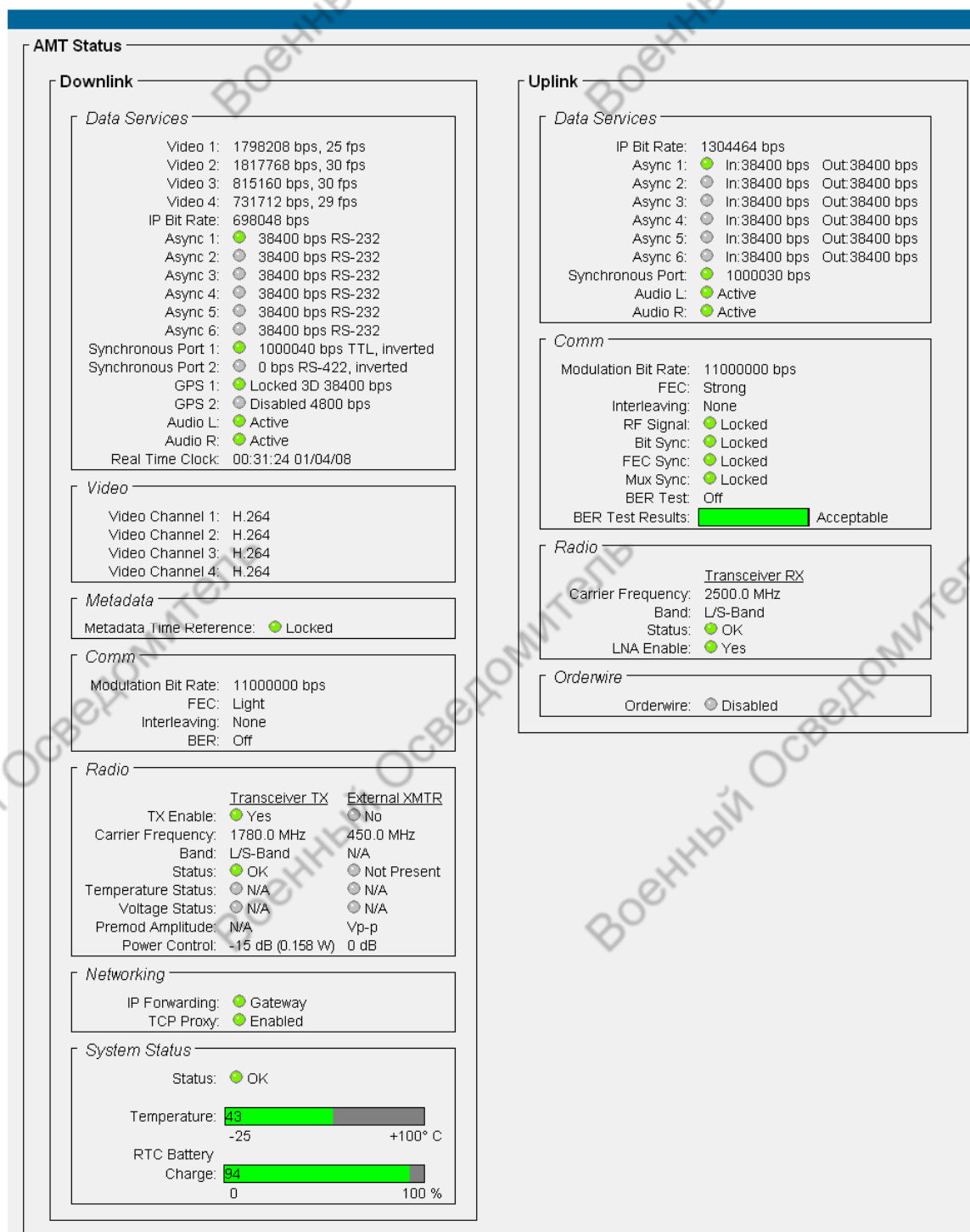


Figure 54: AMT Restricted Access Status Page

3.7.2.1 AMT Downlink Status and Configuration

This section summarizes the configuration and status of the downlink parameters in the AMT.

Data Services

This section provides a summary of the configuration for each data service.

Video 1 through 4 provides an estimate of the bit rate and frame rate for each video channel. The rate is dependent upon the video compression type selected for each channel, the video content, the compression specific video settings (like the GOP compression setting in H.264), the data rates of the other data ports in the system, the downlink modulation bit rate, and the forward error correction (FEC) and interleaver overhead. The displayed bit rate and frame rate are averaged over the past 10 seconds. If a video channel is disabled then its bit rate and frame rate will be 0.

IP Bit Rate displays the rate of IP data transmitted over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of each port. Green indicates that the port is enabled. The configured port rate and interface type are also shown.

Synchronous Port 1 and 2 provide an indicator for the status of each sync port. Green indicates that the port is enabled. The data rate (accurate within 100 bps) and the interface type are listed.

GPS 1 and 2 indicates the current status of each GPS port, which may be connected to an external GPS receiver. Not Responding indicates a fault in the GPS hardware. Not Locked indicates the GPS device is functioning, but does not have valid position lock. Locked 2D or Locked 3D indicate the GPS device has a valid position lock. The configured rate for the port is also listed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled.

Real Time Clock provides the current system time and date of the AMT.

Video

This section displays the video compression mode selected for each video channel.

Metadata

This section displays the status of the metadata time reference used to synchronize metadata and video. The status may be Disabled, Locked, Sync Lost, or Invalid TOD. Sync Lost indicates that the system is not receiving time reference messages or the one PPS signal associated with those messages. Invalid TOD indicates that the TOD valid flag was not set in the most recent time message received.

Comm

This section shows the current downlink communication settings for the modulation bit rate, forward error correction (FEC), interleaving, and bit-error rate testing (BER).

Radio

This section provides information about the configuration and status of the radio transmitters. The AMT operates with one internal transceiver, and will support one external transmitter for analog bypass mode. Support for the external transmitter is not provided at this time. The first signal indicates if a transmitter is enabled. The configured carrier frequency is listed next, followed by the frequency band of the transmitter. The second signal indicates the status of the radio. The third signal indicates the Temperature status of the radio, Normal or Hot, if a temperature sensor is available on the external transmitter. The fourth signal displays the voltage status as reported by the external transmitter, Normal or Low, if the transmitter model supports voltage status monitoring. The next item provides the configured amplitude of the pre-mod output signal sent to the external transmitter. The final item displays the power control level setting for the transceiver and external transmitters that support power control.

Networking

This section displays the status of the IP forwarding and TCP Proxy configuration.

System Status

This section shows an indication of overall system status and two status bars which indicate system wide parameters.

System Temperature

The first bar shows the system temperature in degrees Centigrade. The color of the bar indicates any affect this may have on the system performance. If the bar is green, the temperature is in the normal operational range of the AMT.

Real Time Clock (RTC) Battery Charge

This bar graph indicates the charge remaining in the Real Time Clock battery. If the charge is low, the system time may be lost if the AMT is powered down for an extended amount of time.

3.7.2.2 AMT Uplink Status and Configuration

This section summarizes the status configuration of the uplink parameters in the AMT.

Data Services

This section provides a summary of the configuration for each data service available in the uplink.

IP Bit Rate displays the rate of IP data received over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of the port. Green indicates that the port is enabled at the GMT. The configured port rate of both the input at the GMT and the output at the AMT are provided.

Synchronous Port provides an indicator for the status of this port. Green indicates that the port is enabled at the GMT. The data rate (accurate within 100 bps) is listed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled at the GMT.

Comm

This section shows the current communication settings for the modulation bit rate, forward error correction (FEC), and interleaving. The current status of RF Signal detection, Bit Sync Lock, FEC lock, and Mux Sync are also displayed. The AMT also shows if it has detected a bit-error rate (BER) test initiated at the GMT. A bar graph indicator shows a qualitative assessment of the bit error rate in the received signal.

Radio

This section provides information about the receive configuration and status of the transceiver which is contained in the AMT. The configured carrier frequency is listed, followed by the frequency band of the receiver. An indicator provides the status of the transceiver. The final item provides the status of the LNA control line, enabled or disabled.

Orderwire

This section provides the status of the orderwire connection. The status is either Disabled, Locked, or Not Locked.

3.8 GMT GUI Pages for Restricted Access Users

Restricted access user's have access to two GUI pages on the GMT. One page allows the user to perform limited configuration changes, and the other displays the entire system status.

3.8.1 GMT Restricted Access Configuration Page

The restricted access GMT Configuration page is shown in Figure 55. This page allows the user to select different configuration templates, select the RF transmit and receive frequencies, adjust the video picture, and configure the uplink audio headphones.

GMT Configuration

- Status
- Config
- Logout

GMT Configuration

System Config

System Status: ● OK Details

Downlink Connection: ● Locked

Current Template: template1

Saved Templates: ▼ Apply

Radio

| | | | |
|--------------------|---|---|-------------------------|
| | Transceiver TX | Transceiver RX A | Transceiver RX B |
| Carrier Frequency: | 2500.0 MHz | 1780.0 MHz | 1780.0 MHz |
| Radio Status: | ● OK Poll Radio | ● OK Poll Radio | |

Video Channel 1

Brightness 128 0 128 255
Contrast 128 0 128 255
Tint 128 0 128 255
Saturation 128 0 128 255
Normalize

Video Channel 2

Brightness 128 0 128 255
Contrast 128 0 128 255
Tint 128 0 128 255
Saturation 128 0 128 255
Normalize

Video Channel 3

Brightness 128 0 128 255
Contrast 128 0 128 255
Tint 128 0 128 255
Saturation 128 0 128 255
Normalize

Video Channel 4

Brightness 128 0 128 255
Contrast 128 0 128 255
Tint 128 0 128 255
Saturation 128 0 128 255
Normalize

Downlink Audio Headphones

☒ Left Headphone Out

☒ Right Headphone Out

Volume 13 0 59

Figure 55: GMT Restricted Access Configuration Page

System Config

This section provides an indication of overall system status and supports the application of pre-defined configuration templates.

System Status

Background health and status monitoring is performed on the GMT during normal operation. If a problem is detected during this monitoring, an entry is made in the system status table and the status displayed here is updated accordingly. The “Details” button provides access to this table.

Problems are classified as either a “Fault” or “Warning” in the status table. A status of “Fault” indicates a condition that requires immediate attention, and a status of “Warning” indicates a potential problem that may require corrective action.

The system status is read from the GMT and the System Status indicator is automatically refreshed in the GUI display approximately once a second.

Clicking the Details button retrieves the system status table from the GMT. The system status table is displayed in a separate Result window. The table includes the current status (“OK”, “Fault”, or “Warning”) of each monitored system component as well as a count of the number of times that each component has previously had a status of “Fault” or “Warning”.

Status indication of “Fault” or “Warning” indicates a problem that may require corrective action. Running a system self test may provide more detailed information about the condition that may be used to isolate the problem.

The following system components are monitored:

| System Component | Monitored Information | Problem Status |
|-------------------------|--|-----------------------|
| System Voltage | Maximum and minimum system voltages. | Fault |
| RTOS Components | Operating system diagnostic tests. | Fault |
| Stack | Task stack margins. | Fault |
| Memory Size | System RAM size margins. | Fault |
| FPGA | FPGA ID and read/write test results. | Fault |
| Comm | Comm configuration validation. | Fault |
| I2C Bus | I2C bus read/write timeout. | Fault |
| Ethernet | Ethernet memory and loopback test results. | Fault |
| UART | UART loopback test results. | Fault |
| Lost Crypto Sync | Uplink datastream is AES encrypted, and cannot be decrypted. | Fault |
| Invalid AES Password | AES encryption is enabled on the uplink or downlink datastream, and no AES password is stored. | Fault |
| SPI Bus | SPI bus read/write timeout. | Fault |
| ADF4360 | Integrated Synthesizer/VCO initialization status and phase lock status. | Fault |

| | | |
|---------------------|--|---------|
| AD9957 | Quadrature digital up converter device test results. | Fault |
| CX25836 | Video decoder device test results. | Fault |
| PA Overcurrent | TX Power Amplifier overcurrent check. | Fault |
| LNA Overcurrent | RX Low Noise Amplifier overcurrent check. | Fault |
| H264 Codec | Video / audio compression device test results. | Fault |
| Temperature | Temperature measurements. | Warning |
| EEPROM | EEPROM read/write and checksum errors. | Warning |
| FLASH | Flash programming errors and test results. | Warning |
| OW Config Conflict | AMT and GMT orderwire configuration conflict. | Warning |
| IP Address Conflict | Configured IP address in use by another unit on network. | Warning |
| Video Signal Lost | Video signal presence on active video channels. | Warning |
| RTC | Real Time Clock device status. | Warning |

Figure 56: Monitored System Components**Downlink Connection**

When the GMT is able to correctly read data from the downlink for the different data services, the Downlink Connection status is set to Locked.

Downlink Connection status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Configuration Templates

When the EnerLinksIII GMT is powered up, it comes up with the configuration that was active in the unit the last time it was powered down. The GMT also includes an ability to assign names to configurations and to store those configurations for later recall and use. A saved configuration is called a template. Templates can be handy when there are several modes in which the equipment is frequently used. The EnerLinksIII GMT can save up to 20 templates, including the default_template.

Templates do NOT include IP networking configuration information. The IP configuration is not changed when a template is loaded.

One of the templates in the Saved Templates window is named “default_template”. This template cannot be deleted. It is a very simple configuration intended to allow the user to make the equipment work very quickly out of the box. The default configurations are compatible between the AMT and GMT so that the two units will operate properly right away. It should be noted however that the RF frequencies and transmission bit rate are not likely to match assigned frequencies for a given mission, and as a result the default_template is best suited for training and for bench testing and evaluation.

The downlink default configuration has the following settings:

- The modulation bit rate is 11 Mbps. FEC is light, BER test is off.

- The transceiver RX carrier frequency is set to 4900 MHz if a C-Band transceiver is installed and 1780 MHz if an L/S-Band transceiver is installed.
- Input rate matching is disabled, but all async port output rates are set to 300 bps, so that they will automatically be adjusted to match whatever input rate is configured at the AMT when the GMT begins receiving downlink data.
- Video channel 1 is configured for composite output on all video output jacks. Output of all other video channels is disabled.

The uplink default configuration has the following settings:

- Only the audio data service is enabled.
- The modulation bit rate is 1.0 Mbps. FEC is light.
- The transceiver TX carrier frequency is set to 5250 MHz if a C-Band transceiver is installed and 2300 MHz if an L/S Band transceiver is installed.

Note that if the system is not used on a test bench where the RF connection from transmitter to receiver is via coaxial cable, then it is important to be sure that using the default frequencies will not disrupt other operational users of the RF spectrum.

Restricted access users can only load templates. Templates cannot be loaded when Orderwire is enabled.

Current Template

This field lists the most recent template that was loaded into the system. Note that the actual configuration may be different from the “current template” configuration if changes have occurred since the template was loaded. On power cycle, the unit will restore the current configuration (not the template configuration.)

Saved Templates

This window lists all the templates available on the system.

Apply

To load an existing template as the current configuration, select the template name from the Saved Templates window and click Apply. The selected template will become the current configuration and its name will appear in the Current Template field.

Radio

This section provides control for the RF transmit and receive capabilities of the GMT. Up to two transceivers may be installed in the GMT. Each transceiver includes an RF receiver module as well as an RF transmitter module. One transceiver supports L and S-Band frequencies and the other supports upper and lower C-Band frequencies. Only the active transceiver may be controlled by the restricted access user. The RF receiver module in each transceiver supports two RF receiver channels. These can be used for spatial diversity if the two channels are configured for the same frequency, or frequency diversity if they are configured for different frequencies. Optionally, the receiver module can be configured to use only one of the receive channels. This GUI page can be used to set the transmit and receive frequencies.

Note that no configuration changes affecting the communication path between the AMT and GMT may be made while Orderwire is enabled. This page will automatically block the configuration of radio frequencies while Orderwire is enabled.

Carrier Frequency

Select the transmitter and receiver carrier frequencies from the drop down menus. If the desired value is not in the drop down list, select “Edit list...” from the drop down menu to enter a new value.

The allowed range of receiver carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported RX Frequency Range(s) |
|---------------------------------|--|
| L/S Band Transceiver TSA-206142 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206168 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208168 | Lower C-Band: 4900 – 4950 |

Both receive channels must be configured to the same band (L, S, Upper-C, or Lower-C). Whenever a new frequency for one channel is selected that is in a different band than the previous configuration, the frequency of the other channel is automatically changed to a default value within the range of the new frequency band.

The allowed range of transmitter carrier frequencies for the internal transceiver is:

| Transceiver / Model Number | Supported TX Frequency Range(s) |
|---------------------------------|--|
| L/S Band Transceiver TSA-206142 | L-Band: 1700 – 1850 MHz S-Band: 2200 – 2500 MHz |
| C Band Transceiver TSA-206168 | Lower C-Band: 4400 – 4950 Upper C-Band: 5250 – 5850 |
| C Band Transceiver TSA-208168 | Upper C-Band: 5250 – 5530 |

The frequency must be entered in MHz with a resolution of 500 kHz. If no decimal point is used, the frequency is an integer number of MHz. If a decimal point is used, it may be followed by either a “0” or a “5”.

Note that use of the same frequency band in both the uplink and downlink may cause substantial interference to both communication channels and although possible, is not recommended.

If the transmit frequency configured at the AMT does not match the receive configuration on this page, data will not be received by the GMT. Likewise, if the receive frequency configured at the

AMT does not match the transmit configuration on this page, data will not be received by the AMT.

Radio Status

This status indicator shows the status of each transmitter and receiver, depending on the GMT configuration and the status reported by the radio, if present.

- *Not Present* indicates the GMT is not able to communicate with the transceiver.
- *Fault* indicates the transceiver is not providing expected responses, and may be non-operational.
- *Band Mismatch* indicates the carrier frequency specified on this GUI page is not within the band supported by the transceiver.
- *PLL Not Locked* indicates the transmitter or receiver has not tuned to the specified frequency. This is normal for short periods of time, when changing frequencies or first turning on the GMT or transceiver. Click the Poll Radio button and wait a few seconds for the GUI page to refresh. If the transceiver repeatedly reports it is Unlocked, there may be a problem with the transceiver or with the carrier frequency that has been configured.
- *Disabled* indicates that the transmitter has not been enabled.
- *OK* is the normal operating mode for the transceiver.

Radio status is read from the GMT and automatically refreshed in the GUI display approximately once a second.

Poll Radio Button

The transmitter and receiver status of the internal transceiver is polled once a second. The Poll Radio button may be used to request an immediate poll of the status and refresh of this page.

Video Channel Picture Adjustment

These features allow adjustment of the picture brightness, contrast, tint, and saturation in the same fashion that typical color television sets operate for each video channel. Each parameter is configured either by use of the slider underneath the parameter or by entering a numeric value in the data box for the parameter. Each of the picture adjustment parameters can be in the range from 0 to 255.

The settings on this page do not change the images sent over an IP network to EnerView. These settings only change the analog video output of the GMT.

Note that the AMT contains picture adjustment options which are implemented prior to video compression. The settings at the AMT cannot be undone at the GMT or EnerView application.

Downlink Audio Headphones

In cases where the audio ports are enabled at the AMT, a GMT user can enable headphone outputs by clicking the “Headphone Out” checkbox so that it shows a checkmark for the appropriate audio channel. The headphone volume can be adjusted by using the slider or by manually typing in a volume in the headphone volume box. Valid settings range from 0 to 59,

with 59 corresponding to the loudest volume. When only one of the “Headphone Out” check boxes is selected, the enabled audio signal is output to both the left and right headphone channels.

3.8.2 GMT Restricted Access Status Page

The restricted access GMT Status page is shown in Figure 57. This page summarizes the configuration and status of the GMT. However, no configuration changes can be made on the status page. The information displayed on this page is static. The page must be manually refreshed to update the status.

GMT Configuration

Status

Config

Logout

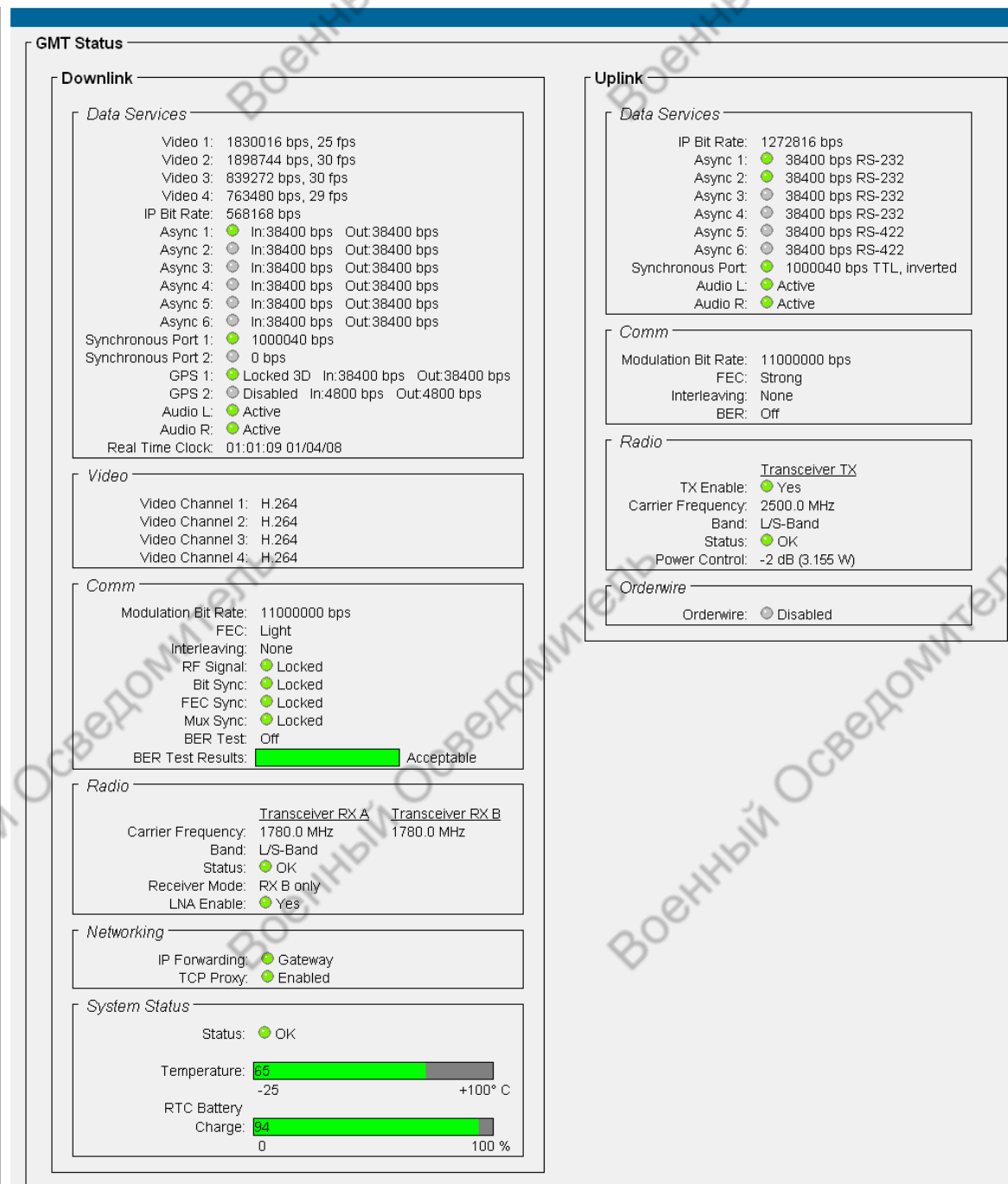


Figure 57: GMT Restricted Access Status Page

3.8.2.1 GMT Downlink Status and Configuration

This section summarizes the configuration and status of the downlink parameters in the GMT.

Data Services

This section provides a summary of the configuration for each data service.

Video 1 through 4 provides an estimate of the bit rate and frame rate for each video channel. The rate is dependent upon the video compression type selected for each channel, the video content, the compression specific video settings (like the GOP compression setting in H.264), the data rates of the other data ports in the system, the modulation bit rate, and the forward error correction (FEC) and interleaver overhead. The displayed bit rate and frame rate are averaged over the past 10 seconds. If a video channel is disabled then its bit rate and frame rate will be 0.

IP Bit Rate displays the rate of IP data received over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of the port. Green indicates that the port is enabled. The configured input port rate at the AMT and the configured output port rate at the GMT are also displayed.

Synchronous Port provides an indicator for the status of this port. Green indicates that the port is enabled. The data rate (accurate within 100 bps) of the port is also listed.

GPS 1 and 2 indicates the current status of each GPS port at the AMT, which may be connected to an external GPS receiver. Not Responding indicates the GMT does not have Mux Sync with the AMT, or a fault in the GPS hardware at the AMT. Not Locked indicates the GPS device is functioning, but does not have valid position lock. Locked 2D or Locked 3D indicate the GPS device has a valid position lock. The configured input port rate at the AMT and the configured output port rate at the GMT are also displayed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled.

Real Time Clock provides the current system time and date of the GMT.

Video

This section displays the video compression mode selected for each video channel.

Comm

This section shows the current communication settings for the modulation bit rate, forward error correction (FEC), and interleaving. The GMT also shows if it has detected a bit-error rate (BER) test initiated at the AMT. The current status of RF Signal detection, Bit Sync Lock, FEC lock, and Mux Sync are also displayed. A bar graph indicator shows a qualitative assessment of the bit error rate in the received signal.

Radio

This section provides information about the receive configuration and status of the active transceiver contained in the GMT. The configured carrier frequency of each arm of the diversity receiver is listed, followed by the supported frequency band of the transceiver. The status indicator provides the receive status of the transceiver. The receiver mode is displayed followed by the LNA control line status, enabled or disabled.

Networking

This section displays the status of the IP forwarding and TCP Proxy configuration.

System Status

This section shows an indication of overall system status and two bars which indicate system wide parameters.

System Temperature

The first bar shows the system temperature in degrees Centigrade. The color of the bar indicates any affect this may have on the system performance. If the bar is green, the temperature is in the normal operational range of the GMT.

Real Time Clock (RTC) Battery Charge

This bar graph indicates the charge remaining in the Real Time Clock battery. If the charge is low, the system time may be lost if the GMT is powered down for an extended amount of time.

3.8.2.2 GMT Uplink Status and Configuration

This section summarizes the status configuration of the uplink parameters in the GMT.

Data Services

This section provides a summary of the configuration for each data service available in the uplink.

IP Bit Rate displays the rate of IP data transmitted over the multiplexed data stream averaged over the last 10 seconds.

Async 1 through 6 provides an indicator for the status of the port. Green indicates that the port is enabled. The configured port rate and interface type are also listed.

Synchronous Port provides an indicator for the status of this port. Green indicates that the port is enabled. The data rate (accurate within 100 bps), the interface type, and the clock inversion configuration are also listed.

Audio L and **Audio R** indicate the status for the two audio channels. Green indicates that the audio channel is enabled.

Comm

This section shows the current uplink communication settings for the modulation bit rate, forward error correction (FEC), interleaving, and bit-error rate testing (BER).

Radio

This section provides information about the configuration and status of the radio transmitter used on the uplink. The first signal indicates if the transmitter is enabled. The configured carrier frequency is listed next, followed by the frequency band of the active transceiver. The second

signal indicates the status of the transmitter. The final item displays the transmit power control level setting.

Orderwire

The Orderwire Status LED indicates the status of the Orderwire link. If Orderwire Service is disabled at the GMT, this LED will be gray. If Orderwire Service is enabled, but the link has not been established, this LED will be red. If Orderwire Service is enabled and the AMT and GMT have established a link, the LED will be green.

3.9 GMT Orderwire GUI Pages for Full Access and View-Only Users

Orderwire functionality allows a user at the GMT to monitor AMT status and configure AMT data service parameters. This is valuable when the AMT cannot be physically accessed. To enable Orderwire, the AMT and GMT uplink and downlink parameters must be configured identically. This is done via the Communications Setup and Radio Setup GUI pages on both the AMT and GMT. After the data link has been established in both directions, Orderwire can be enabled. This is accomplished by going to the AMT Orderwire Setup GUI page on the AMT and the GMT Orderwire Setup GUI page on the GMT. These GUI pages are described in sections 3.5.14 and 3.6.15 of this manual. The Orderwire Service checkbox must be enabled on both the AMT and GMT. Additionally, the user must configure a GMT ID which is identical on both the AMT and GMT. This ASCII string should be unique for any AMT/GMT pair using the Orderwire capability. If the uplink and downlink are both operating correctly and Orderwire is configured correctly at both the AMT and GMT, the Orderwire Status LED will be green on both GUI pages to indicate that the Orderwire link is established. The GMT GUI pages will now provide access to an expanded set of configuration and status options. These GUI pages are described in this section. However, these pages contain parameters which have been already described in previous sections of this document. This section will therefore refer to other sections of the document for complete descriptions of the parameters available.

Note that the Orderwire capability cannot be used to change data link parameters on either the uplink or the downlink. This means that a user at the AMT or GMT cannot re-configure the data links while orderwire functionality is enabled. In order to modify uplink or downlink parameters, the user must first make sure Orderwire is disabled (via the AMT Orderwire Setup page or the GMT Orderwire Setup page). The configuration parameter for the data link can then be modified. Recall that data link parameters must be modified at both the AMT and GMT for the data link to operate correctly. After the data link configuration is complete, the Orderwire functionality can be enabled.

When changing the configuration of the remote AMT, the GMT must send an Orderwire request message to the AMT and wait for a response to tell if the configuration was successful. The time it takes to receive a response is dependent on the uplink and downlink data rates and selected comm processing, especially interleaving. When an AMT configuration change is made from the GMT GUI, a window will pop up indicating the maximum time expected for a response to be received. When the response is received, the status of the configuration reply received from the AMT will be presented in this window. You are not required to wait for the configuration reply. The pop-up window may be closed, and you may exit the GUI page before the response is

received without cancelling the configuration request. However, you will be prevented from making any other changes to the group of configuration items associated with that window until the outstanding request has completed.

If a configuration request is currently being processed by the AMT for any configuration item in the GUI window when you try to change the AMT configuration, the configuration reply status will indicate that there was a configuration conflict and you will have to try the configuration request again. This may occur if changes are being made by another user from the GMT CLI, another GMT GUI window, the AMT CLI or the AMT GUI.

Note that in order to minimize the number of Orderwire messages sent and the time spent waiting on replies, AMT configuration changes made through the GMT GUI will generally require you to click an associated “Apply” button. Changes made to the AMT configuration in the GUI window prior to clicking the “Apply” button will be lost as soon as you exit or refresh the page.

3.9.1 GMT/Remote AMT Downlink Status and Configuration

The GMT/Remote AMT Downlink Status and Configuration page is shown in Figure 58. This page summarizes the configuration of the downlink parameters in the GMT and the AMT. However, no configuration changes can be made on the status page. Detailed explanations of the various status and configuration values are provided in sections describing the specific pages that the values are drawn from.

The status page includes a bar chart graphic that shows the allocation of bandwidth among the different data sources served by the downlink multiplexer. This page also provides system status for the GMT and AMT.

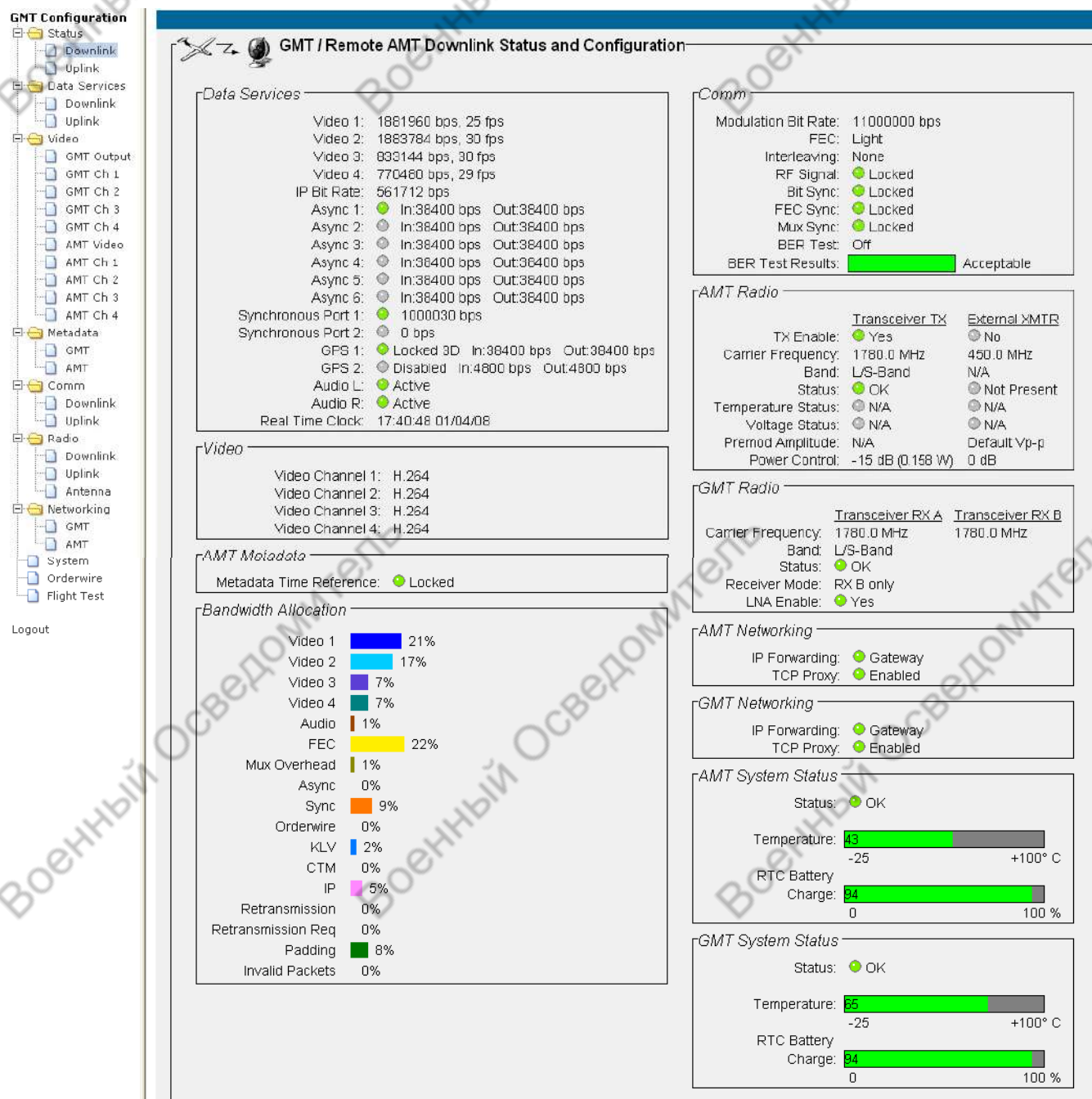


Figure 58: GMT/Remote AMT Downlink Status and Configuration Page

Data Services

The parameters in this section of the screen are described in Section 3.6.1 of this document.

Video

The parameters in this section of the screen are described in Section 3.6.1 of this document.

AMT Metadata

The parameters in this section of the screen are described in Section 3.5.1 of this document.

Bandwidth Allocation

The parameters in this section of the screen are described in Section 3.6.1 of this document.

Comm

The parameters in this section of the screen are described in Section 3.6.1 of this document.

AMT Radio

The parameters in this section of the screen are described in Section 3.5.1 of this document.

GMT Radio

The parameters in this section of the screen are described in Section 3.6.1 of this document.

AMT Networking

The parameters in this section of the screen are described in Section 3.5.1 of this document. When orderwire is enabled, the IP forwarding configuration indicator may be illuminated Amber to indicate that there is a conflict between the AMT and GMT configurations. The IP forwarding scheme, IP broadcast forwarding, and IP multicast forwarding configurations should match on the AMT and GMT for proper interoperability. Similarly, the TCP Proxy configuration indicator may be illuminated Amber to indicate that there is a conflict between the AMT and GMT configurations.

GMT Networking

The parameters in this section of the screen are described in Section 3.6.1 of this document. As described above, the IP forwarding configuration indicator or TCP Proxy configuration indicator may be illuminated Amber to indicate that there is a conflict between the AMT and GMT configurations when orderwire is enabled.

AMT System Status

The parameters in this section of the screen are described in Section 3.5.1 of this document.

GMT System Status

The parameters in this section of the screen are described in Section 3.6.1 of this document.

3.9.2 GMT/Remote AMT Uplink Status and Configuration

The GMT/Remote AMT Uplink Status and Configuration page is shown in Figure 59. This page summarizes the configuration of the uplink parameters in the GMT and the AMT. However, no configuration changes can be made on the status page. Detailed explanations of the various status and configuration values are provided in sections describing the specific pages that the values are drawn from.

The status page includes a bar chart graphic that shows the allocation of bandwidth among the different data sources served by the uplink multiplexer. This page also provides Orderwire status for the GMT and AMT.

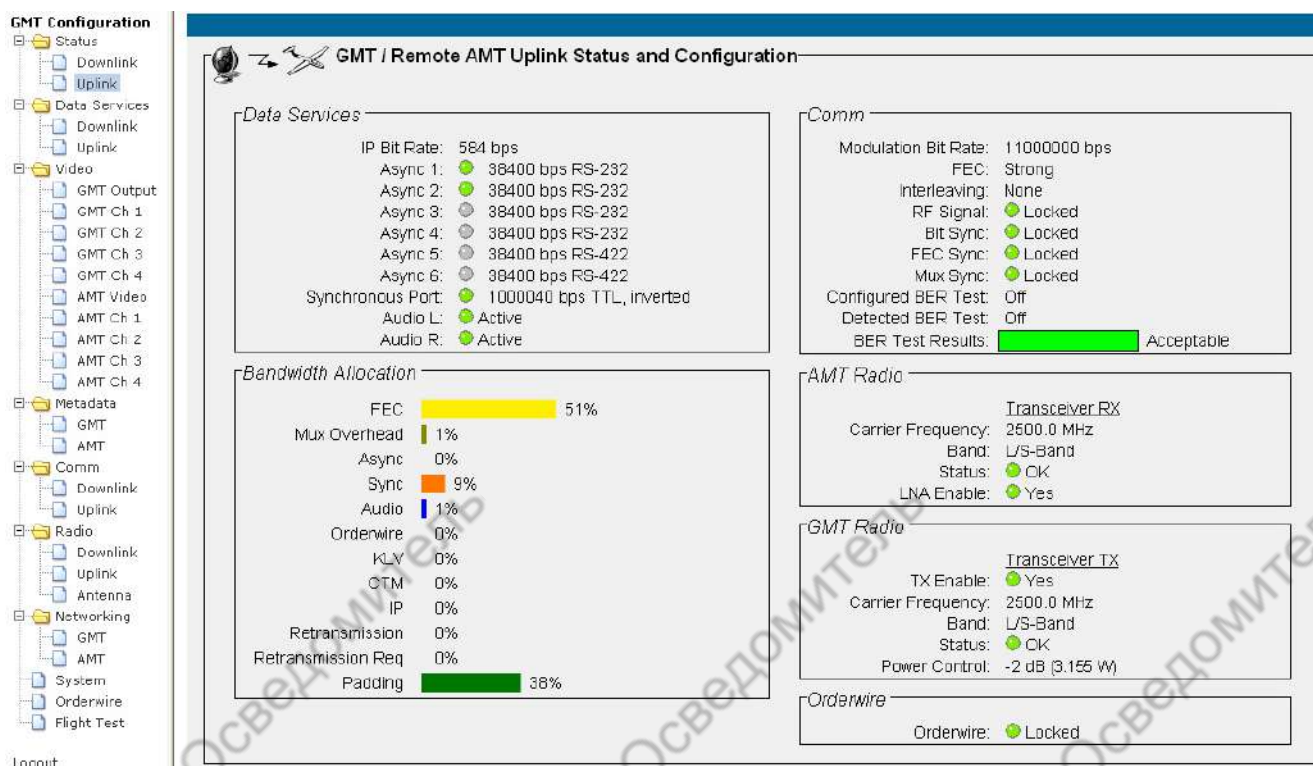


Figure 59: GMT/Remote AMT Uplink Status and Configuration Page

Data Services

The parameters in this section of the screen are described in Section 3.6.2 of this document.

Bandwidth Allocation

The parameters in this section of the screen are described in Section 3.6.2 of this document.

Comm

The parameters in this section of the screen are described in Section 3.5.2 of this document.

AMT Radio

The parameters in this section of the screen are described in Section 3.5.2 of this document.

GMT Radio

The parameters in this section of the screen are described in Section 3.6.2 of this document.

Orderwire

The parameters in this section of the screen are described in Section 3.6.15 of this document.

3.9.3 GMT/Remote AMT Downlink Data Services Setup

The EnerLinksIII AMT provides the ability to combine, or multiplex, data from a variety of sources into a single transmitted bit stream that the EnerLinksIII GMT is able to separate, or demultiplex, into the original separate streams. The GUI page to configure these services at the GMT during Orderwire mode is shown in Figure 60. This page allows the user to configure the various data sources to be multiplexed and also provides related status.

All controls on the Downlink Data Services page are accessible only by users with Full access privileges. All parameters are visible to both Full access and View-Only users. These users may also clear the packet counters.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT
 - System
 - Orderwire
 - Flight Test
- Logout

GMT / Remote AMT Downlink Data Services Setup

AMT Configuration

Async 1: ☒ Active 38400 bps RS-232 RS-422 Async CLI

Async 2: ☐ Active 38400 bps RS-232 RS-422 Normal async

Async 3: ☐ Active 38400 bps RS-232 RS-422 Normal async

Async 4: ☐ Active 38400 bps RS-232 RS-422 Normal async

Async 5: ☐ Active 38400 bps RS-232 RS-422 Normal async

Async 6: ☐ Active 38400 bps RS-232 RS-422 Normal async

Sync 1: ☐ Active 0 bps RS-422 TTL ☒ CLK inverted

Sync 2: ☐ Active 0 bps RS-422 TTL ☒ CLK inverted

GPS 1: ☒ Active 4800 bps

GPS 2: ☐ Active 4800 bps

Audio L: ☒ Active

Audio R: ☒ Active

GMT Status

Not Active

Not Active

Not Active

Not Active

Unavailable

Unavailable

Not Active

Not Active

Locked 3D

Disabled

Active

Active

Mux Sync:

Locked

GMT Configuration

☐ Match Input Rate

38400 bps

38400 bps

38400 bps

38400 bps

38400 bps

38400 bps

Read GPS 1

Read GPS 2

☒ Headphone Out

☒ Headphone Out

Headphone Volume:

0 50

Packet Counts

| | AMT Sent | GMT Good | Bad | Lost | Bit Rate (bps) | Video Frame Rate |
|------------------------------|-----------|-----------|-----|------|----------------|------------------|
| Video 1: | 9,126,676 | 9,128,522 | 0 | 0 | 1,893,288 | 30 frames/sec |
| Video 2: | 9,245,909 | 9,247,807 | 0 | 0 | 1,890,088 | 30 frames/sec |
| Video 3: | 9,441,841 | 9,443,807 | 0 | 0 | 1,918,904 | 30 frames/sec |
| Video 4: | 9,477,793 | 9,479,832 | 0 | 0 | 1,901,720 | 30 frames/sec |
| Audio: | 0 | 0 | 0 | 0 | 0 | |
| Async: | 41,046 | 41,054 | 0 | 0 | 2,440 | |
| Sync: | 0 | 0 | 0 | 0 | 0 | |
| Orderwire: | 19,483 | 19,485 | 0 | 0 | 2,608 | |
| KLW: | 419,705 | 419,794 | 0 | 0 | 117,856 | |
| CTM: | 9,783 | 9,785 | 0 | 0 | 2,048 | |
| IP: | 0 | 0 | 0 | 0 | 0 | |
| Retransmitted: | 0 | 0 | 0 | 0 | 0 | |
| Retransmit Req: | 0 | 0 | 0 | 0 | 0 | |
| Padding: | 3,979,528 | 3,980,566 | | | 884,832 | |
| Invalid: | | 0 | | | 0 | |
| Total Effective Rate: | | | | | 8,555,736 | |

Clear Counters

Help

Figure 60: GMT/Remote AMT Downlink Data Services Setup Page

AMT Configuration

The parameters in this section of the screen are described in Section 3.5.3, of this document.

The user must hit the apply button for AMT configuration changes to be sent to the AMT.

GMT Status

The parameters in this section of the screen are described in Section 3.6.3, of this document.

GMT Configuration

The parameters in this section of the screen are described in Section 3.6.3, of this document.

Packet Counts

The parameters in this section of the screen are described in Sections 3.5.3 and 3.6.3, of this document. Note that when the Clear Counters button is pressed, the local GMT counters are cleared immediately and an Orderwire message is sent to the AMT for it to clear its counters as well.

3.9.4 GMT/Remote AMT Uplink Data Services Setup

The EnerLinksIII GMT provides the ability to combine, or multiplex, data from a variety of sources into a single transmitted bit stream that the EnerLinksIII AMT is able to separate, or demultiplex, into the original separate streams. The GUI page at the GMT during Orderwire mode is shown in Figure 61. This page allows the user to configure the various data sources to be multiplexed and also provides related status. Note that the uplink provides many of the same data services as the downlink from the AMT, with the exception that no video or GPS input ports are available at the GMT.

All controls on the Uplink Data Services page are accessible only by users with Full access privileges, but View-Only access users can also clear packet counters. All parameters are visible to both Full access and View-Only access users.

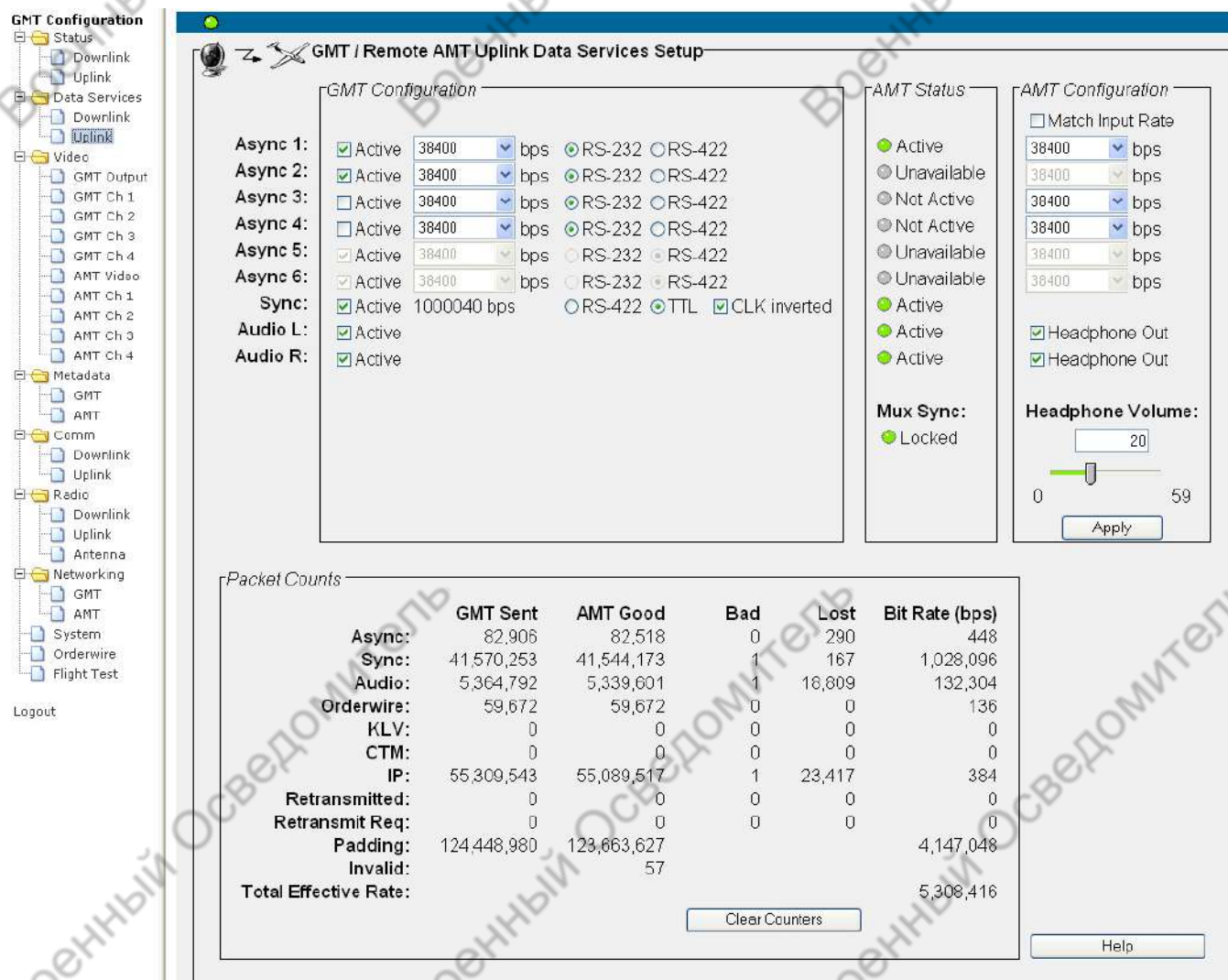


Figure 61: GMT/Remote AMT Uplink Data Services Setup Page

GMT Configuration

The parameters in this section of the screen are described in Section 3.6.4, of this document.

AMT Status

The parameters in this section of the screen are described in Section 3.5.4, of this document.

AMT Configuration

The parameters in this section of the screen are described in Section 3.5.4, of this document.

The user must hit the apply button for AMT configuration changes to be sent to the AMT.

Packet Counts

The parameters in this section of the screen are described in Sections 3.5.4 and 3.6.4, of this document. Note that when the Clear Counters button is pressed, the local GMT counters are

cleared immediately and an orderwire message is sent to the AMT for it to clear its counters as well.

3.9.5 Remote AMT Video Setup

The EnerLinksIII system provides the ability to send up to two channels of compressed video data in the downlink transmission stream from the AMT, and four channels of compressed video data from the AMT HD. When Orderwire is enabled, three pages are provided in the EnerLinksIII GMT GUI to configure the remote AMT video parameters, or five pages are provided to configure the remote AMT HD video parameters. The Remote AMT Video Setup page includes configuration parameters that are associated with all of the video channels, while the Remote AMT Video Channel Setup pages are used to control channel specific parameters.

The Remote AMT Video page displayed when an Orderwire connection is made with an AMT is shown in Figure 62. The Remote AMT Video page displayed when connected to an AMT HD is shown in Figure 63. The Remote AMT Video page contains the exact same set of configuration options as the AMT Video page displayed by the AMT or AMT HD. For a complete description of the AMT video parameters, see section 3.5.5. Note that changing AMT video parameters on this page does not lead to an instantaneous configuration change. The AMT configuration is only changed after the “Apply” button is clicked. When the “Apply” button is clicked, all parameter changes are aggregated and sent to the AMT at one time.

When using this page to configure an AMT that has an older version of software that does not support Fixed video bit rate mode, the Video Bit Rate selection will be disabled.

Older versions of the AMT software supported the use of the Motion JPEG (MJPEG) video compression standard. When using this page to configure an AMT that has an older version of software that includes this support, controls will be displayed allowing the selection of MJPEG compression as seen in Figure 62.

The Motion JPEG algorithm used by the EnerLinksIII system treats each frame of the video as an individual image and compresses that image using the industry standard JPEG algorithm based on the quality factors configured for the compression. If the compression is set to be light, the amount of data in each of these images may be large, while heavy compression reduces the number of bits substantially. The size of each image also depends very heavily on the video content, since complex images require more bits per image. If the bandwidth available for an MJPEG video channel is insufficient to carry all the images, then images are discarded by the AMT and the frame rate decreases.

Only one video channel may be configured to use the MJPEG compression standard at a time on the AMT. Whenever one channel is configured for MJPEG operation, the MJPEG radio button for the other video channel will be disabled.

Full access privileges are required to modify any remote AMT video page settings.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video**
 - AMT Ch 1
 - AMT Ch 2
- Metadata
 - GMT
 - AMT
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT
- System
- Orderwire
- Flight Test

Logout

Remote AMT Video Setup

Video Input

| Video Channel 1 | Video Channel 2 |
|---|---|
| Video Compression | Video Compression |
| <input type="radio"/> Disabled <input type="radio"/> H.264 <input checked="" type="radio"/> MJPEG | <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 <input type="radio"/> MJPEG |

Video Bit Rate

☐ Variable Bit Rate
☒ Fixed Bit Rate

Maximum Bit Rate: bps

Video Rate Sharing

Minimum Percent of Video Bandwidth Available to Channel 1

0 % 100

AMT Title

Enter the AMT title strings for display on the GMT, and hit ENTER:

| | |
|------------|---|
| AMT Text 1 | Mission One - Test Flight |
| AMT Text 2 | Tail Number VB554RT |
| AMT Text 3 | 123456789012345678901234567890123456789 |
| AMT Text 4 | |
| AMT Text 5 | |
| AMT Text 6 | |
| AMT Text 7 | |
| AMT Text 8 | |

Apply

Help

Figure 62: Remote AMT Video Setup Page

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
 - AMT
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT
 - System
 - Orderwire
 - Flight Test

Logout

Remote AMT Video Setup

Video Input

| Video Channel 1 | Video Channel 2 | Video Channel 3 | Video Channel 4 |
|---|---|---|---|
| Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 | Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 | Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 | Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 |

Video Bit Rate

☒ Variable Bit Rate
☐ Fixed Bit Rate

Video Rate Sharing

Minimum Percent of Video Bandwidth Available to Each Channel

| | |
|------------|-----------------------------------|
| Channel 1: | <input type="text" value="35"/> % |
| Channel 2: | <input type="text" value="35"/> % |
| Channel 3: | <input type="text" value="15"/> % |
| Channel 4: | <input type="text" value="15"/> % |
| Total: | 100 % |

AMT Title

Enter the AMT title strings for display on the GMT, and hit ENTER:

| | |
|------------|--|
| AMT Text 1 | <input type="text" value="Mission Two - Test Flight"/> |
| AMT Text 2 | <input type="text" value="Tail Number VC554RT2"/> |
| AMT Text 3 | <input type="text" value="123456789012345678901234567890123456789"/> |
| AMT Text 4 | <input type="text"/> |
| AMT Text 5 | <input type="text"/> |
| AMT Text 6 | <input type="text"/> |
| AMT Text 7 | <input type="text"/> |
| AMT Text 8 | <input type="text"/> |

Figure 63: Remote AMT HD Video Setup Page

3.9.6 Remote AMT Video Channel Setup

A separate Remote AMT GUI page is provided for configuring each video channel. Each video channel setup page contains sections that allow you to configure the video mode, video source, and picture adjustment. It also contains a section that lets you configure parameters that are specific to the video compression type selected for that channel. The contents of this last section will change depending on the video compression standard selected. If the video channel is disabled, this last section will not be displayed, as seen in Figure 64 below.

This GUI page contains the exact same set of configuration options as the AMT Video Channel Setup pages. For a complete description of these configuration parameters, see section 3.5.6 of this document. Note that changing AMT video parameters does not lead to an instantaneous configuration change. The AMT configuration is only changed after the “Apply” button is clicked. When the “Apply” button is clicked, all parameter changes are aggregated and sent to the AMT at one time.

Older versions of the AMT software supported the use of the Motion JPEG (MJPEG) video compression standard. When using this page to configure an AMT that has an older version of software that includes this support, controls will be displayed allowing the selection of MJPEG compression as seen in Figure 64.

Only one video channel may be configured to use the MJPEG compression standard at a time on the AMT. Whenever one channel is configured for MJPEG operation, the MJPEG radio button for the other video channel will be disabled.

Full access privileges are required to modify any remote AMT video page settings.

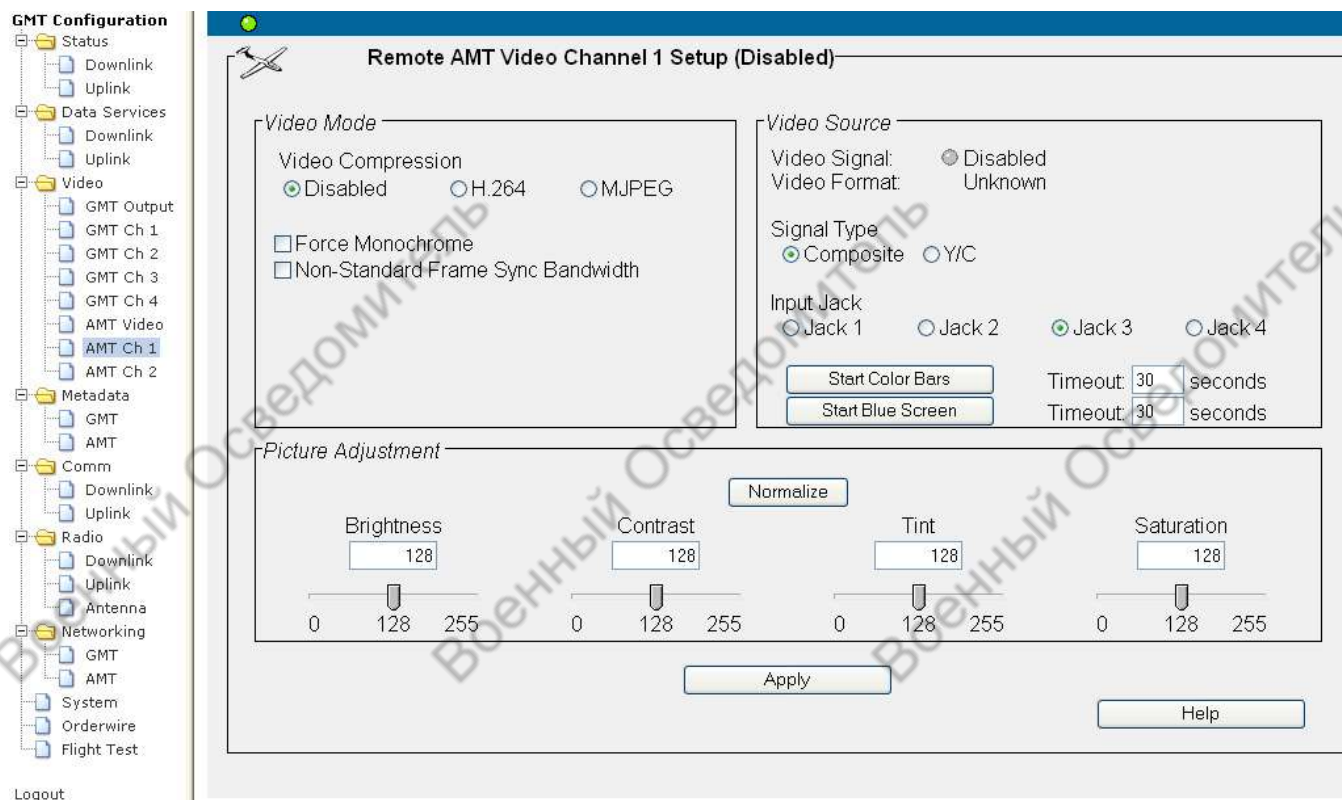


Figure 64: Remote AMT Video Channel 1 (Disabled) Setup Page

3.9.6.1 Remote AMT H.264 Video Channel Setup

When H.264 video compression is selected on one of the Remote AMT Video Channel Setup GUI pages, a section labeled “H.264 Parameters” will appear at the bottom of this page as seen in Figure 65. This section supports configuration of parameters specific to the H.264 compression format.

This GUI page contains the exact same set of configuration options as the AMT Video Channel pages with H.264 video compression selected. For a complete description of these configuration parameters, see section 3.5.6.1 of this document. Note that changing AMT video parameters

does not lead to an instantaneous configuration change. The AMT configuration is only changed after the “Apply” button is clicked. When the “Apply” button is clicked, all parameter changes on the page are aggregated and sent to the AMT at one time.

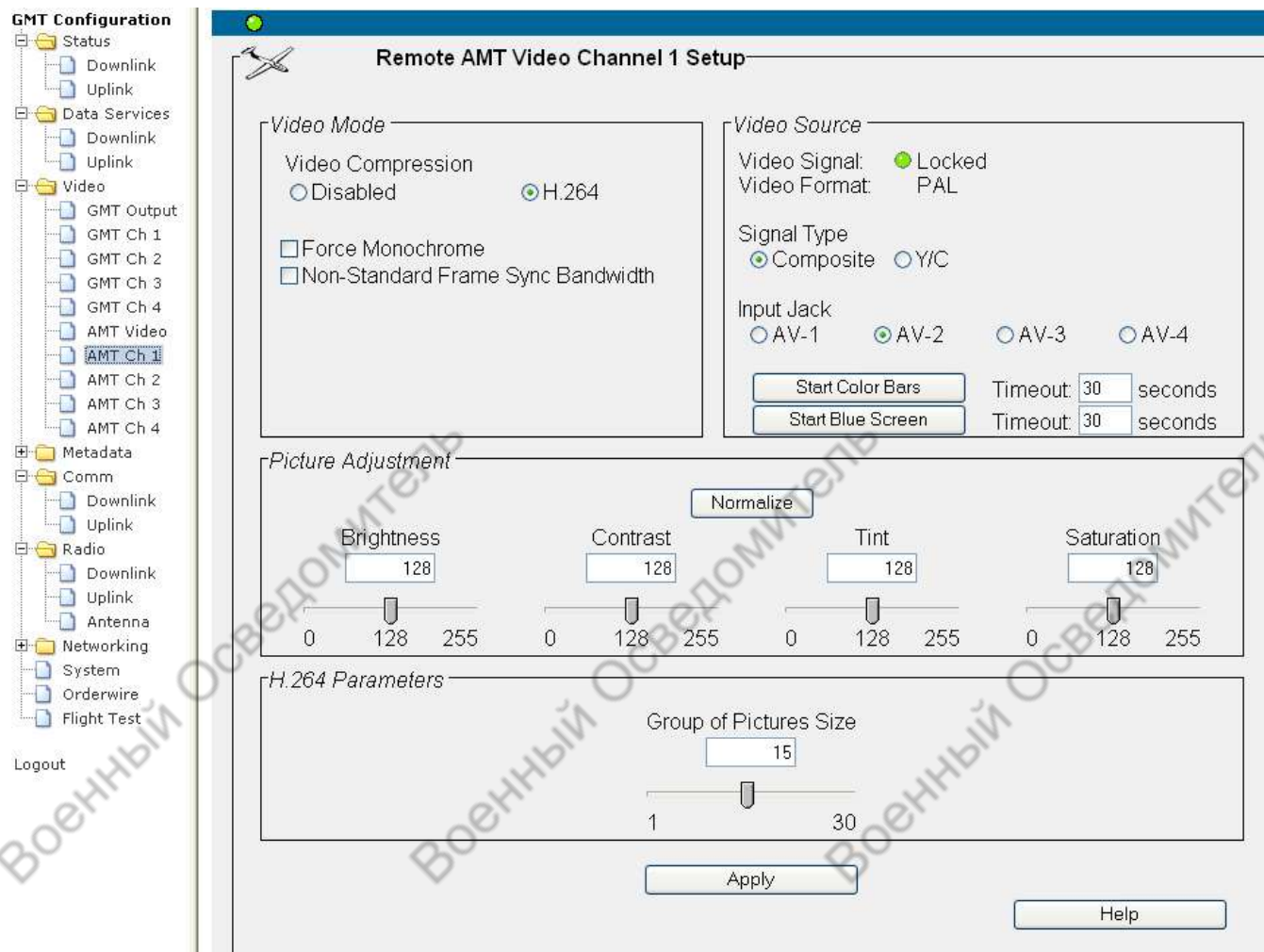


Figure 65: Remote AMT Video Channel 1 (H.264) Setup Page

3.9.6.2 Remote AMT MJPEG Video Channel Setup

Older versions of the AMT software supported the use of the Motion JPEG (MJPEG) video compression standard. When MJPEG video compression is selected on the Remote AMT Video Channel 1 or 2 Setup GUI page, a section labeled “MJPEG Parameters” will appear at the bottom of this page as seen in Figure 66. This section supports configuration of parameters specific to the MJPEG compression format.

Note that changing AMT video parameters does not lead to an instantaneous configuration change. The parameters are only changed after the “Apply” button is clicked. When the

“Apply” button is clicked, all parameter changes are aggregated and sent to the AMT at one time.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
- Metadata
 - Downlink
 - Uplink
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - System
 - Orderwire
 - Flight Test

Logout

Remote AMT Video Channel 1 Setup

Video Mode

Video Compression
☐ Disabled ☐ H.264 ☒ MJPEG

☐ Force Monochrome
☐ Non-Standard Frame Sync Bandwidth

Video Source

Video Signal: ☒ Locked
 Video Format: NTSC

Signal Type
☒ Composite ☐ Y/C

Input Jack
☐ Jack 1 ☐ Jack 2 ☒ Jack 3 ☐ Jack 4

Start Color Bars Timeout: 30 seconds
 Start Blue Screen Timeout: 30 seconds

Picture Adjustment

Brightness 128 Contrast 128 Tint 128 Saturation 128

0 128 255 0 128 255 0 128 255 0 128 255

Normalize

MJPEG Parameters

Resolution
☒ Full Resolution
☐ Half Resolution
☐ Quarter Resolution

Image Crop
☒ No crop
☐ Crop to 82%
☐ Crop to 63%

JPEG Compression 16
 Low High Off Frequent

Restart Marker Interval 100
 Off Frequent

Picture Coding
☒ Field
☐ Frame

Apply Help

Figure 66: Remote AMT Video Channel 1 (MJPEG) Setup Page

Resolution

These radio buttons allow the user to change the resolution of the compressed image. A value of Full gives the best resolution. A value of Half or Quarter provides substantial reduction in required bandwidth at a significant price in resolution, however, these choices may be useful in circumstances where high frame rates are much more important than resolution. Half Resolution sends only one field per frame, so only half as many horizontal lines are sent in the compressed image. Quarter Resolution sends only every other vertical column out of only one field per frame.

For resolutions other than full, picture coding must be performed in Field mode. The Picture Coding configuration will automatically be set to this mode when appropriate.

Picture Coding

The two video signal types supported by the EnerLinksIII System, NTSC and PAL, both use an interlaced frame format. In the interlaced format, each video frame is represented as two fields. The first field contains all of the even lines and the second contains all of the odd lines of the frame. The fields are captured at twice the frame rate, which means that the even and odd fields are not captured at the same time. Interlaced video can be compressed by the MJPEG encoder in one of two ways: Frame and Field picture coding. In the Frame picture coding method the two fields are combined to make a single frame, alternating the even and odd lines, and this frame is then encoded. In Field picture coding the fields are encoded separately. Better compression performance can generally be achieved with Field picture coding if the video has a lot of motion in it, because the even and odd lines tend to have less correlation in this case. Conversely, if there is a limited amount of motion in the video, Frame picture coding will generally produce better compression performance.

When Field picture coding is selected, Full Resolution must be used. If the Resolution setting is changed, picture coding may be set to Frame mode automatically.

Image Crop

Image Crop allows the AMT to be configured to discard a portion of each frame. Cropping reduces the bit rate required to support a given image quality at the expense of a corresponding reduction in the size of the field of view.

JPEG Compression

This slider determines how heavily the images are compressed. Low compression results in higher quality images but also requires greater bandwidth for a given frame rate. Low compression should be used in cases where image quality is more important than frame rate. When frame rate is important, setting the compression higher may be more appropriate. Valid values are 16 – 255.

Restart Marker Interval

Restart markers are flags inserted into the JPEG bit stream by the JPEG compression processing to allow the JPEG de-compression to recover from errors that make it lose sync. Without restart markers, most errors in the bit stream cause the image to be corrupted from the point of the error all the way to the end of the frame. Inserting restart markers can limit such damage to a few lines of video. However, restart markers also introduce as much as 10% overhead into the bit stream, which may translate into a reduction in maximum supported frame rate. Valid values are 0 – 480 markers per frame. A value of 0 means no restart markers are sent at all. Typically values in the range of 50 to 100 give very good results in an environment with bit errors.

Note that when Forward Error Correction is enabled on the Comm GUI page, single bit errors will be eliminated, and any errors that cannot be corrected will result in corruption of complete packets of data up to 256 bytes long. Since restart markers will provide little benefit in such cases, it is recommended that the Restart Marker Interval be set to zero (off) when Forward Error Correction is enabled.

3.9.7 Remote AMT Metadata Setup

The EnerLinksIII system provides the ability to align received metadata messages with their associated video frames so that the aligned video and metadata messages are tagged with the same Presentation Time Stamp (PTS) when they are output in a MPEG-2 TS stream from the GMT or AMT. A detailed description of the metadata / video time alignment theory of operation is provided in section 8.4 of this document. The Remote AMT Metadata Setup page supports configuration of the metadata time reference, metadata / video frame time synchronization, and camera latency.

The time reference status on this GUI page will be read from the GMT and automatically refreshed in the GUI display approximately once a second.

Full access privileges are required to modify any Metadata Setup page setting.

This GUI page contains the same set of configuration options as the AMT Metadata Setup page. For a complete description of the AMT Metadata Setup parameters, see section 3.5.7. The message counters displayed on the AMT GUI page are not provided on this GMT page. Note that changing AMT metadata parameters does not lead to an instantaneous configuration change. The parameters are only changed after the “Apply” button is clicked. When the “Apply” button is clicked, all parameter changes are aggregated and sent to the AMT at one time.

Full access privileges are required to modify any remote AMT metadata page settings.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
 - AMT**
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT
 - System
 - Orderwire
 - Flight Test

Logout

Remote AMT Metadata Setup

Metadata Time Reference

Metadata 1 PPS Time Reference: ☒ Active ☒ Locked [Read Metadata Time](#)

Metadata/Video Frame Time Synchronization

| | Video Channel 1 | Video Channel 2 | Video Channel 3 | Video Channel 4 |
|-------------------------------------|--|--|--|--|
| Video Compression: | H.264 | H.264 | Disabled | Disabled |
| Input Jack: | AV-2 | AV-3 | AV-3 | AV-3 |
| Max Match Time Difference: | 20.00 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default |
| MPEG-2 TS Metadata Misalign Action: | Send msg without PTS | Send msg without PTS | Send msg without PTS | Send msg without PTS |

Camera Latency

| Jack AV-1 | Jack AV-2 | Jack AV-3 | Jack AV-4 |
|-----------|-----------|-----------|-----------|
| 0 usec | 0 usec | 700 usec | 300 usec |

[Apply](#) [Help](#)

Figure 67: Remote AMT Metadata Setup Page

3.9.8 GMT/Remote AMT Downlink Communications Setup

During Orderwire mode, the GMT downlink communications setup page provides a display of the downlink configuration, a display of the GMT's ability to receive the downlink, and a configuration option to enable/disable BER test modes on the remote AMT. Figure 68 shows this GUI page. Since Orderwire functionality can only be used when both the downlink and uplink for the AMT and GMT are fully operational and synchronized, the actual physical and link layer parameters in use on the downlink cannot be modified while Orderwire is operational.

Full access privileges are required to modify the BER test settings.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
 - AMT
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - System
 - Orderwire
 - Flight Test
- Logout

GMT / Remote AMT Downlink Communications Setup

Downlink Configuration

Modulation Bit Rate: 11000000 bps

FEC Coding: ☒ Strong (50% Overhead) ☐ Medium (33% Overhead) ☐ Light (20% Overhead) ☐ No FEC

Interleaving: ☐ Strong ☐ Moderate ☒ No Interleaving ☐ Specify Depth

The interleaver is a row column interleaver with row length equal to the code block size of 4096 or 1024 bits

Downlink AES Configuration

Encryption: ☒ Disabled ☐ Enabled

Crypto Sync: ☒ N/A ☐ Sync

New Password: (8 characters min)

Saved in RAM: ☒ No ☐ Yes

Saved in EEPROM: ☒ No ☐ Yes

Remote AMT Bit Error Rate Test Configuration

BER Test Mode: ☒ Off ☐ Modem Only ☐ FEC and Modem

BER Test Timeout: 5 minutes

GMT Downlink Status

BER Test Mode: ☒ Off ☐ Modem Only ☐ FEC and Modem

BER Test Results: Acceptable

Full Integrator ☒ Ten Second Integrator ☐ One Second Integrator (BER evaluated over the last 1187 seconds)

| | Receiver A | Receiver B | Combined |
|-------|------------|------------|----------|
| BER: | n/a | 0.00 E-11 | n/a |
| BLER: | n/a | 0.00 E-7 | n/a |

RF Signal: ☒ Receiver A ☒ Receiver B

Bit Sync Lock: ☒ Receiver A ☒ Receiver B

FEC Sync Lock: ☒ Receiver A ☒ Receiver B

MUX Sync Lock: ☒

Reset Counters

Help

Figure 68: GMT/Remote AMT Downlink Communications Setup Page

Downlink Configuration

The parameters in this section of the page are read only. They are described in sections 3.5.8 and 3.6.8 of this manual.

Remote AMT Configuration

The configuration of the BER test parameters is described in section 3.5.8 of this manual. Note that while a BER test is active, the AMT will not be able to send orderwire reply messages, and the ability to configure the remote AMT will be lost.

GMT Status

The parameters in this portion of the GUI are described in section 3.6.8 of this manual.

3.9.9 GMT/Remote AMT Uplink Communications Setup

During Orderwire mode, the GMT uplink communications setup page provides a display of the uplink configuration, a display of the AMT's ability to receive the uplink, and a configuration option to enable/disable BER test modes. Figure 69 shows this GUI page. Since Orderwire functionality can only be used when both the downlink and uplink for the AMT and GMT are fully operational and synchronized, the actual physical and link layer parameters in use on the uplink cannot be modified while Orderwire is operational.

Full access privileges are required to modify the BER test settings.

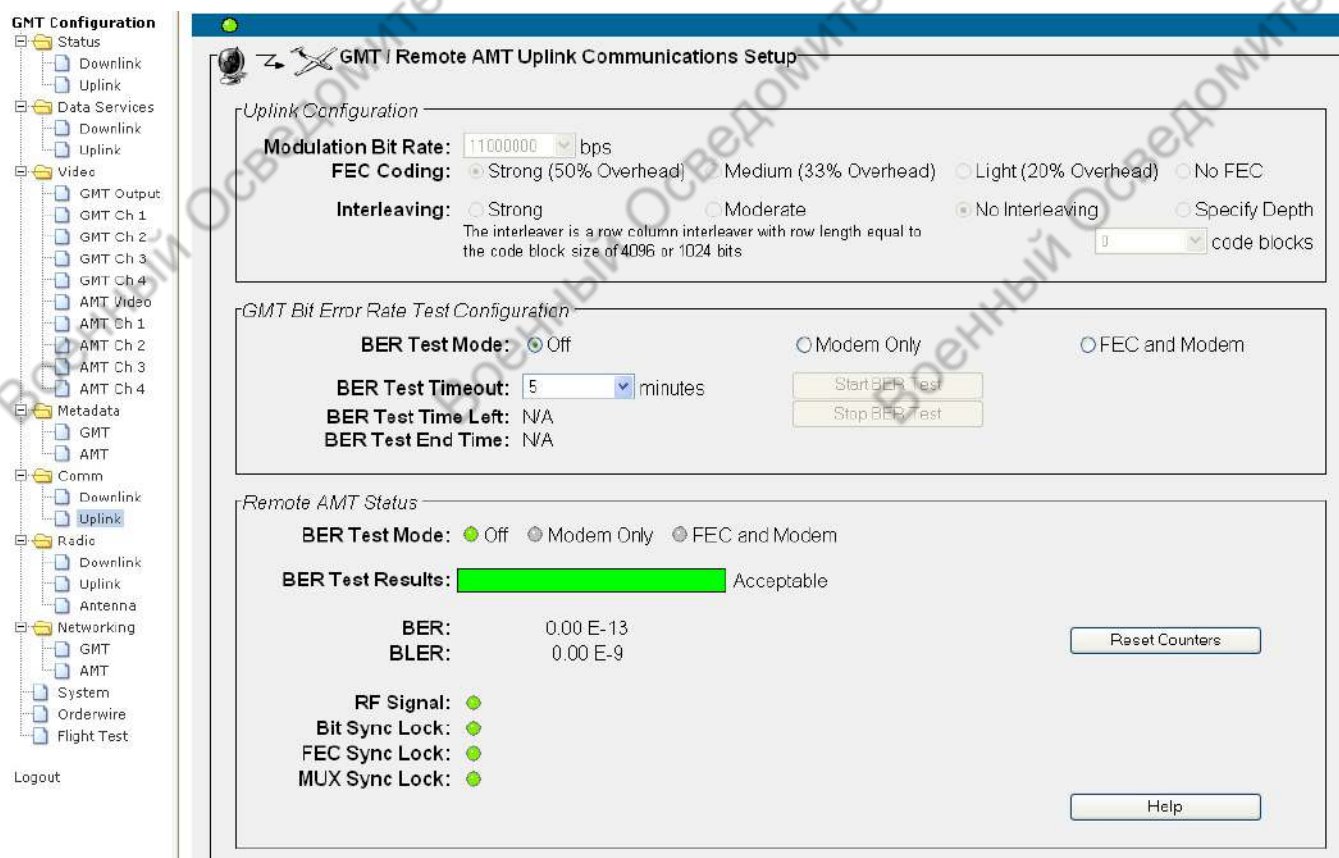


Figure 69: GMT/Remote AMT Uplink Communications Setup Page

Uplink Configuration

The parameters in this section of the page are read only. They are described in sections 3.5.9 and 3.6.9 of this manual.

GMT Configuration

The configuration of the BER test parameters is described in section 3.6.9 of this manual. Note that while a BER test is active, the GMT will not be able to send Orderwire messages, and the ability to configure the remote AMT will be lost.

Remote AMT Status

The parameters in this portion of the GUI are described in section 3.5.9 of this manual.

3.9.10 GMT/Remote AMT Downlink Radio Setup

In Orderwire mode, the GMT Downlink Radio page primarily provides read-only access to the configuration parameters for the AMT transmitters and the GMT receiver. Parameters that can be modified include the power control levels of the AMT transmitters, the premod amplitude value of the AMT external transmitter, the RSSI Output Enable on the GMT, and the measured RX cable loss on the GMT. The AMT external transmitter may be enabled or disabled, and the transmit function of the internal transceiver in the AMT may be enabled, but not disabled. Similarly, the external LNA on the GMT may be enabled, but not disabled. These configuration changes can only be performed by a Full access user. Additionally, the user is able to poll any radio used in the downlink. The GUI page is shown in Figure 70.

GMT Configuration

- Status
 - Download
 - Uplink
- Data Services
 - Download
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
 - AMT
- Comm
 - Download
 - Uplink
- Radio
 - Download
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT
- System
 - Orderwire
 - Flight Test
- Logout

GMT / Remote AMT Downlink Radio Setup

AMT Transmitter Configuration

| Transceiver TX | External XMTR |
|---|---|
| <input checked="" type="checkbox"/> TX Enable | <input type="checkbox"/> TX Enable |
| <input type="button" value="Poll Radio"/> | <input type="button" value="Poll Radio"/> |
| Carrier Frequency: 1780.0 MHz | 450.0 MHz |
| Radio Status: ● OK | ● Not Present |
| Radio Band: L/S-Band | N/A |
| Radio Model: TSA-206123 | N/A |
| Serial Number: 263583 | N/A |
| Temperature Status: N/A | ● N/A |
| Voltage Status: N/A | ● N/A |
| Premod Amplitude: N/A | <input checked="" type="checkbox"/> Use Defaults 5.000 |
| Power Control: -15 dB (0.158 W) | 0 dB |
| <input type="button" value="Apply"/> | <input type="button" value="Help"/> |

GMT Transceiver RX Configuration

| RX A | RX B |
|--|------------------|
| <input checked="" type="checkbox"/> LNA Enable | |
| <input type="button" value="Poll Radio"/> | |
| Carrier Frequency: 1780.0 MHz | 1780.0 MHz |
| Radio Status: ● OK | |
| Radio Band: L/S-Band | |
| Radio Model: TSA-206142 | |
| Serial Number: 54321 | |
| <input checked="" type="checkbox"/> RSSI Output Enable | |
| RSSI: -75.45 dBm | RSSI: -41.55 dBm |

GMT Receiver Mode

☐ Diversity enabled
☐ RX A only
☐ RX B only

GMT Transceiver Select

☒ L/S Band Transceiver
☐ C Band Transceiver

Measured Rx Cable Loss

| RX A | RX B |
|---------|---------|
| 0.00 dB | 0.00 dB |

Figure 70: GMT/Remote AMT Downlink Radio Setup Page

AMT Transmitter Configuration

The parameters in this portion of the page are read-only, with the exception of the transmitter enable radio buttons and the premod amplitude and power control parameters. All parameters are described in section 3.5.10 of this manual.

The user must hit the apply button for AMT configuration changes to be sent to the AMT.

GMT Transceiver RX Configuration

All parameters in this portion of the page are read-only with the exception of the LNA enable and RSSI Output Enable controls, and are described in section 3.6.10 of this manual.

GMT Receiver Mode

The receiver mode is a read-only parameter and is described in section 3.6.10 of this manual.

GMT Transceiver Select

GMT transceiver selection is a read-only parameter and is described in section 3.6.10 of this manual.

Measured Rx Cable Loss

GMT measured RX cable loss is a read-write parameter and is described in section 3.6.10 of this manual.

3.9.11 GMT/Remote AMT Uplink Radio Setup

In Orderwire mode, the GMT Uplink Radio page primarily provides read-only access to the configuration parameters for the GMT transmitter and the AMT receiver. Parameters that can be modified include the power control level of the GMT transmitter and the Measured RX cable loss on the AMT. Also, the GMT transmitter and AMT LNA may be enabled, but not disabled. These configuration changes can only be done by a Full access user. Additionally, the user is able to poll any radio used in the downlink. The GUI page is shown in Figure 71.

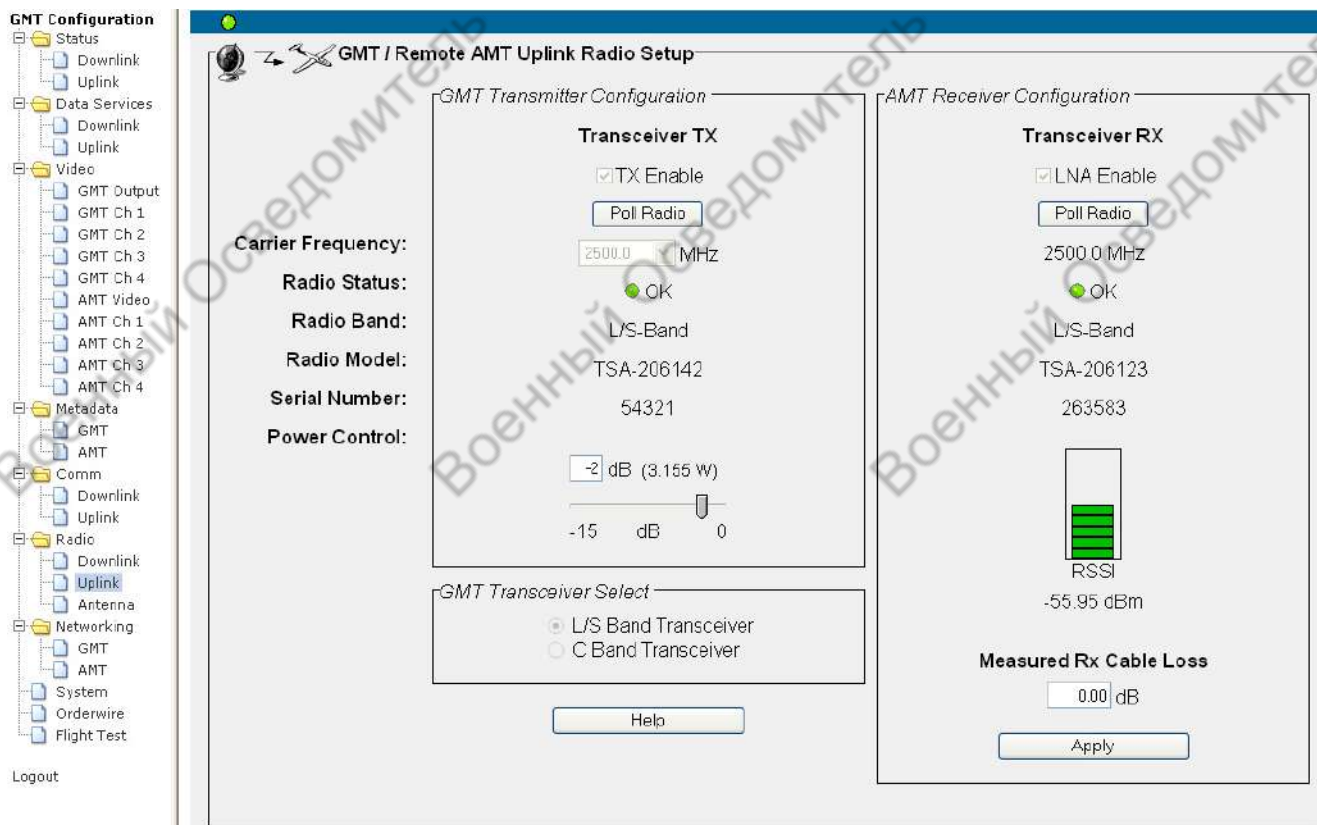


Figure 71: GMT/Remote AMT Uplink Radio Setup Page

GMT Transmitter Configuration

The parameters in this portion of the page are read-only, with the exception of the transmitter enable radio button and the power control parameters. All parameters are described in section 3.6.11 of this manual.

AMT Receiver Configuration

All parameters in this portion of the page are read-only, with the exception of the LNA enable radio button and the measured RX cable loss. All parameters are described in section 3.5.11 of this manual.

3.9.12 Remote AMT Networking Setup

The Remote AMT Networking page is shown in Figure 72. This GUI page contains the exact same set of configuration options as the AMT Networking page which is available to a user at the AMT. For a complete description of the AMT networking parameters, see section 3.5.12. Note that changing AMT networking parameters does not lead to an instantaneous configuration change. The parameters are only changed after the “Apply” button is clicked. When the “Apply” button is clicked, all parameter changes are aggregated and sent to the AMT at one time.

Full access privileges are required to modify any remote AMT networking page settings.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
 - AMT
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT**
 - System
 - Orderwire
 - Flight Test

Logout

Remote AMT Networking Setup

IP Configuration

☐ Obtain IP address automatically

Host Name:

Domain Name:

☒ Use the following IP address

IP Address:

Subnet Mask:

Default Gateway:

☒ Forward IP to GMT

Forwarding Scheme:

Downlink Subnet:

Downlink Mask:

Downlink Rate Limit: bps

☒ Forward broadcast packets

☒ Forward multicast packets

☒ Filter multicast packets

Forwarded Multicast Group Addresses:

| |
|-----------|
| 233.3.3.3 |
| 233.3.3.4 |
| 233.3.3.5 |

New Address:

☒ Enable TCP Proxy **Port:**

EnerView Configuration

☒ Enable EnerView access

☐ Enable multicast

Data Source: ☒ Downlink ☐ Uplink

Multicast IP Address: **Port:**

MPEG-2 TS Configuration

| | IP Address | Port |
|---|--|-----------------------------------|
| <input checked="" type="checkbox"/> Video Channel 1 | <input type="text" value="172.18.89.147"/> | <input type="text" value="8000"/> |
| <input checked="" type="checkbox"/> Video Channel 2 | <input type="text" value="172.18.88.66"/> | <input type="text" value="7001"/> |
| <input type="checkbox"/> Video Channel 3 | <input type="text" value="192.168.1.2"/> | <input type="text" value="7002"/> |
| <input type="checkbox"/> Video Channel 4 | <input type="text" value="192.168.1.2"/> | <input type="text" value="7003"/> |

Metadata Port Configuration

| | |
|-------------------------------|-----------------------------------|
| Video Channel 1 Metadata Port | <input type="text" value="7001"/> |
| Video Channel 2 Metadata Port | <input type="text" value="7002"/> |
| Video Channel 3 Metadata Port | <input type="text" value="7003"/> |
| Video Channel 4 Metadata Port | <input type="text" value="7004"/> |

IP Properties

IP Address: 172.18.89.140
Physical Address: 00-12-65-00-06-00
Subnet Mask: 255.255.254.0
Default Gateway: 172.18.89.254

IP Statistics

| | |
|----------------------------|------------------------------|
| Tx Ethernet Packets: 33761 | Rx Ethernet Packets: 1845251 |
| Tx ARP Packets: 23 | Rx ARP Packets: 13253 |
| Tx IP Packets: 33738 | Rx IP Packets: 1831188 |

DHCP Properties

Server Address:
Lease Obtained:
Lease Expires:

IP Forwarding Statistics

| | |
|-------------------|-------------------|
| Tx MAC Packets: 0 | Rx MAC Packets: 0 |
| Tx ARP Packets: 0 | Rx ARP Packets: 0 |
| Tx IP Packets: 0 | Rx IP Packets: 0 |

Figure 72: Remote AMT Networking Setup Page

3.9.13 GMT/Remote AMT System Setup

The GMT/Remote AMT System page (see Figure 73) provides a variety of information about the components in the GMT and AMT as well as control functions for self test and maintenance features. When Orderwire is enabled, templates cannot be saved or loaded and the user cannot switch to DVA mode. Full access users can modify all other parameters on this page. View-Only access users can view all parameters including status details and may change their own passwords on this page. They cannot, however, modify any of the other page parameters.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - GMT Output
 - GMT Ch 1
 - GMT Ch 2
 - GMT Ch 3
 - GMT Ch 4
 - AMT Video
 - AMT Ch 1
 - AMT Ch 2
 - AMT Ch 3
 - AMT Ch 4
- Metadata
 - GMT
 - AMT
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
 - GMT
 - AMT
 - System
 - Orderwire
 - Flight Test

Logout

GMT / Remote AMT System Setup

GMT Assemblies

| Unit: | S/N | Rev |
|---------------------|-------|-------|
| Unit: | 53199 | 002 |
| Main Board: | 76543 | 009 |
| Power Board: | 87654 | 001 |
| AV Board: | 98765 | 004 |
| Front Panel: | 53164 | 007 |
| Radio Transceiver: | 54321 | 4 |
| Software Revision: | | 4.0.5 |
| Boot Revision: | | 0.0.1 |
| MM FPGA Revision: | | V5E18 |
| AV FPGA Revision: | | V5E5 |
| MG1264 FW Revision: | | 16961 |

AMT Assemblies

| Unit: | S/N | Rev |
|--------------------|--------|-------|
| Unit: | 12345 | 1 |
| Main Board: | 23456 | 1 |
| Power Board: | 34567 | 1 |
| AV Board: | | |
| Radio Transceiver: | 263583 | 003 |
| External Radio Tx: | N/A | |
| Software Revision: | | 4.0.5 |
| Boot Revision: | | 0.0.1 |
| MM FPGA Revision: | | V5E18 |
| AV FPGA Revision: | | V2 |
| MG FW Revision: | | 24557 |

GMT Self Test

Disruptive Self Test:

Status: ● OK

AMT Self Test

Disruptive Self Test:

Status: ● OK

☐ DVA Mode

Real Time Clock

| | GMT Clock | AMT Clock | GPS Clock 1 | GPS Clock 2 | Metadata Time Reference |
|---------------|--|--|-------------|-------------|-------------------------|
| Current Time: | 20:56:48 01/04/08 | 20:56:48 01/04/08 | 20:26:54 | Unknown | 20:56:47 01/04/08 |
| Clock Sync: | Clock is in sync with metadata time reference. | | | | |
| New Time: | <input type="text" value="20:56:48 01/04/08"/> | <input type="text" value="20:56:48 01/04/08"/> | | | |
| | <input type="button" value="Set Clock"/> | <input type="button" value="Set Clock"/> | | | |
| | <input type="button" value="Sync Clock to AMT"/> | | | | |

Configuration Templates

Current Template: template1

Saved Templates:

Manage Users

Usernames:

Username:

Password:

Confirm:

Access Level:

☐ View Only Access
☐ Restricted Access
☐ Full Access

Feature License Configuration

Saved Feature Licenses:

Enabled Feature Licenses:

Feature Name:

License Key:

Figure 73: GMT/Remote AMT System Setup Page

GMT Assemblies

The parameters in this portion of the GUI are described in section 3.6.14 of this manual.

AMT Assemblies

The parameters in this portion of the GUI are described in section 3.5.13 of this manual.

GMT Self Test

The parameters in this portion of the GUI are described in section 3.6.14 of this manual.

AMT Self Test

The parameters in this portion of the GUI are described in section 3.5.13 of this manual.

DVA Mode

The DVA Mode radio selection in this portion of the GUI is described in section 3.6.14 of this manual.

Reset AMT and Reset GMT

The Reset AMT button is described in section 3.5.13 of this manual. The Reset GMT button is described in section 3.6.14 of this manual.

Real Time Clock

The Real Time Clock settings for the GMT are described in section 3.6.14 of this manual. The Real Time Clock settings for the AMT are described in section 3.5.13 of this manual.

Configuration Templates

The parameters in this portion of the GUI are described in section 3.6.14 of this manual.

Manage Users

The parameters in this portion of the GUI are described in section 3.6.14 of this manual.

Feature License Configuration

The parameters in this portion of the GUI are described in section 3.6.14 of this manual.

3.9.14 GMT Orderwire Page

The GMT Orderwire page provides the mechanism for enabling or disabling the Orderwire functionality in the EnerLinksIII system. Orderwire allows a user at the GMT to configure data port parameters at the AMT, as long as both an uplink and downlink have already been established. Figure 74 shows the GMT Orderwire GUI page.

For an Orderwire connection to be established, the versions of software running on the AMT and GMT must be compatible. As of the writing of this Configuration and Operation Guide, EnerLinksIII software release 4.1.0 is the latest release. Any AMT or GMT running software release 4.1.0 and above will require that the remote AMT or GMT is running software release 3.3.4 or greater for a connection to be established.

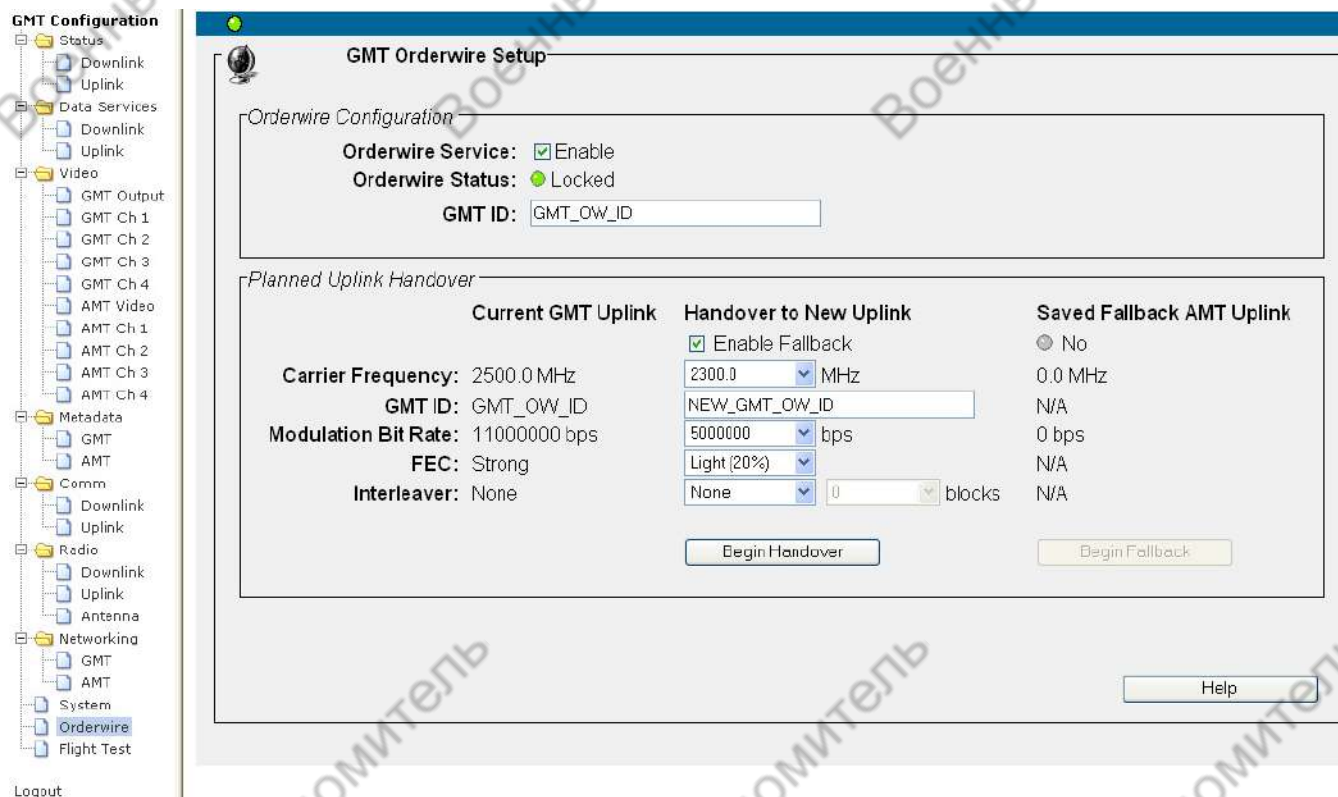


Figure 74: GMT Orderwire Page

Orderwire Service

The Orderwire Service parameter enables or disables the orderwire functionality. When this box is checked, the GMT will attempt to establish an orderwire connection with the AMT it is talking to. In order for this session to be established, the GMT must be configured with a GMT ID that matches the configuration at the AMT.

Orderwire Status

The Orderwire Status LED indicates the status of the Orderwire link. If Orderwire Service is disabled at the GMT, this LED will be gray. If Orderwire Service is enabled, but the link has not been established, this LED will be red. If Orderwire Service is enabled and the AMT and GMT have established a link, the LED will be green.

GMT ID

The GMT ID is a password which must be set to the exact same value at the AMT and GMT. This parameter insures that an AMT receives configuration information only from a GMT it has been configured to communicate with.

Planned Uplink Handover

This section controls the AMT's uplink handover/fallback feature. To use this feature, the orderwire service must be enabled and connected.

Current GMT Uplink

This section displays the current GMT uplink configuration. If the orderwire service is enabled and connected, then the current AMT uplink configuration must match. This display is provided for easy reference while configuring the new AMT handover uplink parameters.

Handover to New Uplink

This section allows entry of new uplink parameters which will be sent to the AMT. By default, they are all set to match the current uplink configuration when the GUI page is first loaded. At a minimum, a new uplink frequency must be selected in order to use the handover feature.

Enable Fallback

If this box is checked, then the AMT saves its current uplink configuration in EEPROM before beginning the handover. After the uplink handover, if the AMT cannot find a new uplink using the new uplink parameters within about 10 to 15 seconds, it will fallback to the current uplink configuration and re-establish its uplink with the current GMT. Also, even after the AMT finds a good uplink signal with the new parameters, if it loses the uplink signal for a whole minute, or if the AMT is power-cycled, it will fallback to the saved uplink configuration.

Carrier Frequency

Use this box to select the AMT's new uplink receive frequency. This does not change the GMT's uplink transmit frequency. The new carrier frequency must be in the same frequency band as the current uplink carrier frequency.

GMT ID

Optionally enter a new GMT ID to be used when connecting the orderwire service on the new uplink. This field does not have to change during an uplink handover if the GMT the AMT will be connecting to is using the same orderwire GMT ID as the current GMT.

Modulation Bit Rate, FEC, and Interleaver

Optionally enter a new modulation bit rate, FEC, or interleaver settings for the new uplink. These fields do not have to change during an uplink handover if the GMT the AMT will be connecting to is using the same uplink communications parameters as the current GMT.

Begin Handover

Click on this button to send an orderwire command up to the remote AMT, telling it to begin the handover process to the new uplink described on this page. This GMT will lose its orderwire service connection when the AMT changes its uplink. The downlink from the AMT is not affected by this.

If the Enable Fallback box is not checked, the AMT will change its uplink parameters and remain there.

If the Enable Fallback box is checked, the AMT will change its uplink parameters and search for a valid uplink signal. If a valid uplink signal is found, the AMT will remain on the new uplink frequency and communications settings until:

- It is told to fallback to the saved configuration by another orderwire command sent from the new GMT.
- It is told to fallback to the saved configuration by a local AMT command.
- The AMT loses the uplink signal for more than a minute. This might happen if the new GMT is simply turned off without commanding a handover/fallback explicitly.
- The AMT is power cycled. This always restores the saved fallback uplink configuration.

Saved Fallback AMT Uplink

This section describes the saved fallback uplink configuration at the AMT. These fields are only valid if this GMT is connected over the orderwire service to the AMT, in order to retrieve these values.

Begin Fallback

Click on this button to send an orderwire command up to the remote AMT, telling it to begin the handover/fallback process to the saved fallback uplink described on this page. This GMT will lose its orderwire service connection when the AMT changes its uplink. The downlink from the AMT is not affected by this.

Regardless of whether the AMT finds a valid uplink signal using the fallback uplink configuration, it remains there.

4 Command Line Interface

This section provides the commands available at the command line interface via the serial port.

4.1 AMT Command Line Definitions

Many of the EL-III commands are defined to operate on either encoder or decoder functionality. On the AMT, encoder specific commands affect the downlink, and decoder specific commands affect the uplink. The following commands are available at the AMT command line interface.

| Description | Command | Meaning |
|-------------------------------|-------------------------------|--|
| HELP | | |
| Help | HELP <category/command> | If no parameter is present, provides a list of all available command categories. If the parameter matches a category, provides a list of all available commands within that category, along with their syntax and brief descriptions. If the parameter matches a command, only the syntax and brief description for that command are displayed. |
| DATA SERVICES | | |
| Configure async CLI | ACLI [1-2] [onloff] | Configures the use of the specified [1-2] async port as a command line interface. When an async port is used for CLI, no data received on that port will be sent over the airlink, and data received over the airlink destined for that port will be dropped. The encoder baud rate configured for a port will be used for both the transmit and receive rate when Async CLI is enabled. |
| Configure Camera control | CAM [1-6] [disable FlirTypeA] | Configures the specified [1-6] async port to be used for talking to a camera ball. The second parameter describes the type of camera ball and/or type or hand controller. The GMT's corresponding uplink async port should also be enabled, and should be set for the same baud rate. |
| Configure decoder async ports | DAS [1-6] (baud) | Configures the specified [1-6] decoder asynchronous data port baud rate in bits/sec. If just the port number is provided, returns encoder and decoder status for the specified |

| Description | Command | Meaning |
|------------------------------------|---|---|
| | | port. Note that the decoder baud rate may not be set below the encoder baud rate. |
| Decoder async port rate matching | DASM [on/off] | Configures the AMT to set all active async port output data rates to match the input rate of the corresponding port at the GMT. |
| Query audio configuration | DAU | Reads the AMT configuration for the decoder (uplink) audio ports |
| Audio headphone configuration | DAUH [r/l/rl/off] [0-59] | Sets the headphone parameters on the headphone output of the AMT. The first parameter sets the output for either the right audio channel, the left channel, right and left channels, or off. The second parameter sets the headphone volume level between 0 (off) and 59 (loud). |
| Decoder data service packet counts | DC [reset details] | If no parameter is present, this command displays the decoder (uplink) data service packet counts. If the parameter “reset” is entered, the counts are reset. If the parameter “details” is entered, detailed rate information is provided for each packet type, including the average bit rate over the last 10 seconds. |
| Query sync port | DS | Reads the AMT configuration for the decoder (uplink) synchronous data ports. |
| Configure encoder async port | EAS [1-6] [on/off] (baud) [rs232/rs422] | Configures the encoder (downlink) configuration parameters for the synchronous data ports of the AMT. The first parameter specifies the port number, the second indicates if the port should be enabled or disabled. If the port is enabled, the baud rate and signal types are then configured. |
| Configure encoder audio ports | EAU [left/right] [on/off] | Configures the encoder (downlink) audio ports. The first parameter specifies which of the two audio ports. The second turns the port on or off. |
| Encoder data service packet | EC [reset details] | If no parameter is present, this command displays the encoder |

| Description | Command | Meaning |
|---------------------------------------|---|---|
| counts | | (downlink) data service packet counts. If the parameter “reset” is entered, the counts are reset. If the parameter “details” is entered, detailed rate information is provided for each packet type, including the average bit rate over the last 10 seconds. |
| GPS port configuration | EG [1/2] [on/off] (baud) | When Async port #1 is being used as the GPS port, the command enables the port and sets the baud rate for the incoming NMEA 0183 messages. |
| Encoder sync port configuration | ES [1/2] [on/off] [rs422/ttl] [inverted/normal] | Sets the configuration parameters for the downlink synchronous data port. |
| CLOCK | | |
| Set (or read) the AMT real-time clock | RTC (hh) (mm) (ss) (MM) (DD) (YY) | Displays the system time when no parameters are included. Sets the system time to match the input clock value when parameters are included. The AMT will automatically synchronize its RTC to the time supplied in the Metadata Time Reference, GPS Clock 1 or GPS Clock 2, if any is present. The Metadata Time Reference is most preferred, since it is synchronized to a 1PPS signal. The GPS Clock 1 is next most preferred, and the GPS Clock 2 is least preferred. If none of these clocks is present, the user may enter a new RTC time manually. |
| Display clock battery status | RTCBS | Displays the local RTC battery status. |
| VIDEO | | |
| Set frame sync bandwidth | FSBW [1-4] [standard/wide] | Allows the AMT to receive video signals which generate frames at rates outside the expected frequency. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| Set video brightness | VB [1-4] (value) | Configures video brightness for the specified video channel. Note that the AMT supports only |

| Description | Command | Meaning |
|--|---|---|
| | | two video channels, and the AMT HD supports four. |
| Set video bit rate mode | VBR [variable/fixed] (maximum bit rate in bps) | <p>Sets video bit rate mode and maximum bit rate.</p> <p>variable - allow video bit rate to vary with available bandwidth.</p> <p>fixed - set maximum video bit rate to the specified fixed value.</p> <p>The maximum bit rate parameter should only be set when fixed video bit rate mode is selected. Valid bit rate values are from 100000 to 11000000.</p> |
| Set video contrast | VC [1-4] (value) | <p>Configures video contrast for the specified video channel.</p> <p>Note that the AMT supports only two video channels, and the AMT HD supports four.</p> |
| Set video compression | VCM [1-4] [disable/H264] | <p>This configures the video compression mode for the specified video channel. Select 'disable' to disable the video channel.</p> <p>Note that the AMT supports only two video channels, and the AMT HD supports four.</p> |
| Set “group of picture” size for H.264 mode | VGOP [1-4] (gop size) | <p>This configures H.264 group of pictures size.</p> <p>Note that the AMT supports only two video channels, and the AMT HD supports four.</p> |
| Set video input | VJ [1-4] [1/2/3/4/colorbars/bluescreen] (timeout) | <p>Configures video input jack for the specified video channel. Can also be used to apply a test pattern with a timeout. The input reverts to the last used jack when the timeout expires. To leave the test pattern on indefinitely, set the timeout value to zero (0) seconds. To end the test pattern and revert to an input jack early, set the video input to the desired input jack.</p> <p>Note that the AMT supports only two video channels, and the AMT HD supports four.</p> |

| Description | Command | Meaning |
|------------------------------|--|---|
| Set video mode | VM [1-4] [color/monochrome] [composite/yc] | Configures or queries input video mode for the specified video channel. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| Show video bit rate | VR | Displays video bit rate and frame rate |
| Configure video rate sharing | VRS (value) (on the AMT HD there are four parameters instead of one) VRS (VC1 bandwidth) (VC2 bandwidth) (VC3 bandwidth) (VC4 bandwidth) | On the AMT, sets the percentage of video bandwidth available for video channel 1. Range is 0 to 100. On the AMT HD, sets the percentage of video bandwidth available for each video channel. The sum of all bandwidth rates must equal 100 %. |
| Set video saturation | VS [1-4] (value) | Configures video saturation for the specified video channel. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| Check video signal status | VSIG | Displays video input signal status |
| Set video tint | VT [1-4] (value) | Configures video tint for the specified video channel. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| Set video text string | VTXT [1-8] "<string>" | Configures one of the eight AMT title strings which may be overlaid on the video at the GMT. |
| METADATA SETUP | | |
| Set metadata misalign action | METAMA [1-4] [drop/nopts/closest] | Configures the action to take on metadata messages that are not uniquely time aligned with a video frame when sending the messages in an MPEG2 Transport Stream. drop - Drop the metadata message nopts - Send the message with no presentation time stamp closest - Send the message with the PTS of the video frame sent in the last 1/2 second that is most closely aligned with the message Note that the AMT supports only two video channels, and the AMT |

| Description | Command | Meaning |
|--|--|---|
| | | HD supports four. |
| Set metadata match difference | METAMD [1-4] <milliseconds> | Sets the maximum number of milliseconds that a video frame and metadata message may differ and still be associated. Select '0' to use the default match difference: 1/2 of a frame time The maximum supported metadata match difference time is 40 milliseconds. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| Displays or resets metadata statistics | METASTATS [reset/details/list] | Displays or clears metadata statistics. See Appendix A3 for a detailed description of these statistics. |
| Configure metadata time reference | METATIME [enable/disable] | Enables or disables the metadata time reference input. |
| Set camera latency | VL [1-4] <latency in usecs> | Enters the camera latency associated with the video input attached to the specified video jack. This value is used to adjust the time reference for each video channel receiving video from that jack. |
| COMMUNICATION SETUP | | |
| Check BER status | DCB [reset] | Queries or resets decoder (uplink) Bit Error Rate status |
| Configure decoder FEC | DCF [none/light/medium/strong] | Configures decoder (uplink) Forward Error Correction (FEC) |
| Configure decoder interleaver depth | DCI [none/specify/moderate/strong] (depth in FEC blocks) | Configures decoder (uplink) interleaver depth |
| Set decoder modulation bit rate | DCM (value) | Configures decoder (uplink) modulation bit rate (includes FEC bits and multiplexer overhead) |
| Check comm. status | DCS | Queries comm status |
| BER test control | ECB [off/modem/fec] (timeout in minutes) | Begins or ends an encoder (downlink) BER test |
| Configure encoder FEC | ECF [none/light/medium/strong] | Configures encoder (downlink) Forward Error Correction (FEC) |
| Configure | ECI [none/specify/moderate/strong] | Configures encoder (downlink) |

| Description | Command | Meaning |
|---|---|--|
| encoder interleaver depth | (depth in FEC blocks) | interleaver depth |
| Set encoder modulation bit rate | ECM (value) | Configures encoder (downlink) modulation bit rate (includes FEC bits and multiplexer overhead) |
| Use sync port for multiplexed data port | SB [disable/ttl/rs422] | Enables or disables baseband modem data over sync port 1 (this is a test mode to bypass the modem), and configures the signal type to use. |
| RADIO | | |
| Enable LNA | LNA [enable/disable] | Enables or disables receive LNAs. |
| Radio Handover | RHO [fallback/(frequency in KHz)] <enable fallback> (new GMT ID) (new uplink mod bit rate) <new FEC> <new interleaving> (new interleaver depth) | Configures uplink radio handover. A new uplink frequency (or the “fallback” option) is required, but all other parameters are optional. |
| Poll radio | RP [etx/tcvr] | Polls radio to update status of external transmitter or transceiver |
| Enter radio passthrough mode | RPM [etx/tcvr] | Enter radio passthrough mode to selected radio (etx - external radio transmitter, tcvr - radio transceiver) |
| Show RSSI value | RSSI | Displays current RSSI value in dBm. |
| Set receive radio frequency | RXF (frequency in KHz) | Configures/displays receive (uplink) radio frequency |
| Set cable loss value | RXLOSS (cable loss in 1/100 dB) | Configures/displays measured RX cable loss. |
| Enable radio transmitter | TXE [etx/tcvr] [enable/disable] | Configures transmit (downlink) radio enable |
| Set transmit radio frequency | TXF [etx/tcvr] (frequency in KHz) | Configures transmit (downlink) radio frequency |
| Set premod amplitude | TXP [dynamic/specific] (voltage in mV) | Configures premod amplitude going to external transmitter |
| Set transmitter power level | TXPC [etx/tcvr] (power level in dB) | Configures transmitter (downlink) power control level in dB: e.g. "TXPC etx -6" to reduce the power level of transmitter by 6 dB |
| External xmtr temperature | TXTEMP | Displays external transmitter temperature status. |
| External xmtr voltage | TXV | Displays external transmitter voltage status. |

| Description | Command | Meaning |
|--|---|---|
| NETWORK | | |
| View the ARP table | ARP [reset list] <num_entries> | Display or reset the ARP table. Optional second parameter may be used when the first parameter is set to "list" to specify the maximum number of entries to display. |
| Multicast EnerView configuration | IM [enable/disable] <multicast ip address> | Enable or disable multicast viewer data transmission |
| Setup the IP parameters for the AMT | IP [dhcp/static] <ip address> <subnet mask> <gateway> | Enable DHCP or specify IP address |
| Setup IP Gateway configuration | IPF [disable/gateway/bridge] <network ip address> <subnet mask> | Enable IP Forwarding and specify network IP address/mask |
| View the IP forwarding ARP table | IPFARP [reset list] <num_entries> | Display or reset the IP forwarding ARP table. Optional second parameter may be used when the first parameter is set to "list" to specify the maximum number of entries to display. |
| IP broadcast configuration | IPFB [enable/disable] | Enable forwarding of IP broadcast packets |
| IP multicast configuration | IPFM [none/all/filtered] | Enable/disable forwarding of IP multicast packets with or without filtering as follows: <ul style="list-style-type: none"> • none - disable forwarding of multicast IP packets • all - forward all multicast IP packets • filtered - forward only multicast IP packets destined for multicast group addresses in the table configured with the IPFMG command |
| IP multicast forwarded group addresses | IPFMG [add/delete] <multicast_group_ip_address> | Adds or removes the specified address to/from a list of multicast group addresses that will have their data forwarded when IPFM is set to "filtered". Note that multicast packets are only forwarded when IP forwarding is enabled via the IPF command and multicast forwarding is enabled via |

| Description | Command | Meaning |
|--------------------------------|--|--|
| | | the IPFM command. |
| IP rate limiting | IPFR (value) | Set the maximum IP forwarding transmission data rate in bits per second (select '0' for no rate limiting) |
| Check IP forwarding statistics | IPFS [reset/details] | Queries or resets IP forwarding statistics. Also allows for the display of more in depth statistics. |
| Enable remote viewer | IV [enable/disable] | Enables or disables the remote viewer |
| Viewer UDP port configuration | IVP (port) | Sets viewer UDP port |
| IP data source configuration | IVS [uplink/downlink] | Sets the source for data sent to the remote viewer |
| MPEG-2 TS config | MP2 [1-4] [enable/disable] <ip address> <port> | Enables/disables transmission of an MPEG-2 transport stream for the specified video channel. Sets the destination IP address and port for the stream. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| Metadata UDP port | METAPORT [1-4] <port> | Configures the UDP port number that the AMT will use to receive metadata for the specified video channel. Note that the AMT supports only two video channels, and the AMT HD supports four. |
| IP host configuration | NAME <host name> <domain name> | Sets host and domain names |
| Check networking statistics | NS [reset/details] | Reads or resets network statistics |
| Ping | PING <ip address> <timeout seconds> <ping count> | Pings an IP address |
| Set PPP IP address | PPP <local server ip address> <remote peer ip address> | Specifies PPP IP addresses |
| Display IP route table | ROUTE | Displays IP route table |
| TCP proxy configuration | TCPP [enable/disable] [port] | Enables TCP Proxy and specify port |
| Check TCP proxy status | TCPPS [reset/details] | Displays or resets the TCP Proxy connection status. Also allows for |

| Description | Command | Meaning |
|--------------------------------|--|--|
| | | the display of more in-depth status by including the details parameter. |
| SYSTEM | | |
| User account configuration | AC [list/full/restricted/view-only/delete] <username> <password> | Adds, modifies, or deletes a user account |
| Code download enable | DL [enable/disable] | Enables or disables downloading to this unit through TFTP |
| Licensed Feature Configuration | FEATURE [add/delete/list] <feature_name> <license_key> | Adds, deletes, or lists feature licenses. Feature name and license key must be provided to add a feature license. Feature name must be provided to delete a license. |
| Power On Self Test control | POST [enable/disable] | Enables or disables Power On Self Test (POST) |
| Configure relay role | RELAY [disable/single/upward/downward] <IP address> | Configures the relay role. The <IP address> is only necessary in upward or downward mode. |
| Set defaults | SD | Resets to factory default configuration |
| Show firmware revisions | SFR | Queries for firmware revision levels |
| Show hardware revisions | SHR | Queries hardware revision levels |
| System reset | SRESET | Resets the AMT |
| Show system | SS | Queries hardware serial numbers |
| Self test | ST [verbose] | Performs a system self-test, optional parameter enables verbose output |
| Show status | STATUS | Displays current system status |
| Component self test | STEST <component name or ID> <number of times to run> | Performs a self-test on the specified system component |
| System temperature | TEMP | Displays current system temperature |
| TEMPLATES | | |
| Template delete | TD <template name> | Deletes a saved template |
| Template load | TL <template name> | Loads a saved template |
| Template load default | TLD | Loads the default template |
| Template restore | TR | Restores the last template loaded |
| Template save | TS <template name> | Saves the current configuration as a template |
| ORDERWIRE | | |
| Orderwire | OW [enable/disable] | Enables or disables in-band order- |

| Description | Command | Meaning |
|---------------------------|------------------|--|
| enable | | wire configuration of the AMT. |
| GMT identification string | GMTID "<string>" | Configures the GMT ID string which the AMT uses to verify a connection |

4.2 GMT Command Line Definitions

Many of the EL-III commands are defined to operate on either encoder or decoder functionality. On the GMT, encoder specific commands affect the uplink, and decoder specific commands affect the downlink. The following commands are available at the GMT command line interface.

| Description | Command | Meaning |
|------------------------------------|--------------------------|---|
| HELP | | |
| help | HELP <category/command> | If no parameter is present, provides a list of all available command categories. If the parameter matches a category, provides a list of all available commands within that category, along with their syntax and brief descriptions. If the parameter matches a command, only the syntax and brief description for that command are displayed. |
| DATA SERVICES | | |
| Configure decoder async ports | DAS [1-6] (baud) | Configures the specified [1-6] decoder asynchronous data port baud rate in bits/sec. If just the port number is provided, returns encoder and decoder status for the specified port. Note that the decoder baud rate may not be set below the encoder baud rate. |
| Decoder async port rate matching | DASM [on/off] | Configures the GMT to set all active async port output data rates to match the input rate of the corresponding port at the AMT. |
| Query audio configuration | DAU | Reads the GMT configuration for the decoder (downlink) audio ports |
| Audio headphone configuration | DAUH [r/l/rl/off] [0-59] | Sets the headphone parameters on the headphone output of the GMT. The first parameter sets the output for either the right audio channel, the left channel, right and left channels, or off. The second parameter sets the headphone volume level between 0 (off) and 59 (loud). |
| Decoder data service packet counts | DC [reset/details] | If no parameter is present, this command displays the decoder (downlink) data service packet counts. If the parameter “reset” is entered, the counts are reset. If the parameter “details” is entered, detailed rate information is provided for each packet type, including the average |

| Description | Command | Meaning |
|--|--|---|
| | | bit rate over the last 10 seconds. |
| Configure GPS Port rate | DG [1/2] (baud) | Configures the output data rate for GPS port. |
| Query sync port | DS | Reads the GMT configuration for the decoder (downlink) synchronous data ports. |
| Configure encoder async port | EAS [1-6] [on/off] (baud) [rs232/rs422] | Configures the encoder (uplink) configuration parameters for the synchronous data ports of the GMT. The first parameter specifies the port number, the second indicates of the port should be enabled or disabled. If the port is enabled, the baud rate and signal types are then configured. |
| Configure encoder audio ports | EAU [left/right] [on/off] | Configures the encoder (uplink) audio ports. The first parameter specifies which of the two audio ports. The second turns the port on or off. |
| Encoder data service packet counts | EC [reset/details] | If no parameter is present, this command displays the encoder (uplink) data service packet counts. If the parameter “reset” is entered, the counts are reset. If the parameter “details” is entered, detailed rate information is provided for each packet type, including the average bit rate over the last 10 seconds. |
| Encoder sync port configuration | ES [on/off] [rs422/ttl] [inverted/normal] | Sets the configuration parameters for the encoder (uplink) synchronous data port. |
| CLOCK | | |
| Set the GMT time to match the AMT time | RS | Synchronize the GMT RTC to the time received in the next valid message received from the AMT |
| Set (or read) the AMT real-time clock | RTC (hh) (mm) (ss) (MM) (DD) (YY) | Displays the system time when no parameters are included. Sets the system time to match the input clock value when parameters are included. The GMT will automatically synchronize its RTC to the time supplied in the Metadata Time Reference, GPS Clock 1 or GPS Clock 2, if any is present. The Metadata Time Reference is most preferred, since it is synchronized to a 1PPS signal at the |

| Description | Command | Meaning |
|---------------------------------|-----------------------------|--|
| | | AMT. The GPS Clock 1 is next most preferred, and the GPS Clock 2 is least preferred. If none of these clocks is present, the user may enter a new RTC time manually. |
| Display clock battery status | RTCBS | Displays the local RTC battery status. |
| VIDEO | | |
| Set video brightness | VB [1-4] (value) | Configures video brightness for the specified video channel. |
| Set video contrast | VC [1-4] (value) | Configures video contrast for the specified video channel. |
| Display color bars | VCD [1-4] (timeout) | Configures the GMT to display color bars for the specified video channel if video is not received on that channel for <i>timeout</i> seconds. If this value is 0, color bars will not be displayed upon loss of video. |
| Display compression mode | VCM [1-4] | Displays current video compression mode for the specified video channel. |
| Set H.264 video display mode | VDM [1-4] [scaled/standard] | Sets how H.264 video gets displayed on the GMT video outputs. scaled - Scaled image display. Video adjusted to minimize the active video cut off along edges of standard monitors. standard - Standard image display. Video adjusted so that display matches what it would be if camera was connected directly to the monitor. |
| Video freeze | VF [1-4] [enable/disable] | Freezes the output video for the specified video channel. |
| MJPEG display of errored frames | VFS [1-4] [all/good] | Selects which MJPEG video frames to display for the specified video channel. |
| Video jack outputs | VJO [1-4] [disable/1/2/3/4] | Configures video channel to display on each video output jack. The first parameter specifies the jack to configure, and the second indicates the channel to display on that jack, or indicates that the jack should be disabled. Note that a video channel cannot be selected for output on a jack unless its |

| Description | Command | Meaning |
|--|--|--|
| | | output has been enabled with the VM command. |
| Video output mode | VM [1-4] [composite/yc/disable] | Configures or queries output video mode for the specified video channel. Only two channels may be enabled for output from the GMT at one time. |
| Video overlay | VO [1-4] [title1/title2/ amttitle[1-8]/amttime/amtdate/ gmttime/gmtdate/gps1/gps2] [on/off] (xpos 0-38) (ypos 0-14) “<text>” | Configures overlay text on the video images. |
| Video overlay color | VOC [1-4] [red/green/blue/white/yellow/ magenta/cyan/black] | Configures the OSD text color for the specified video channel. |
| Video overlay enable | VOE [1-4] [on/off] | Enables or disables all OSD text for the specified video channel. |
| Video overlay font size | VOF [1-4] [small/large] | Sets the OSD text font size for H.264 video channels. |
| Show video bit rate | VR | Displays video bit rate and frame rate |
| Set video saturation | VS [1-4] (value) | Configures video saturation for the specified video channel. |
| Set video tint | VT [1-4] (value) | Configures video tint for the specified video channel. |
| METADATA SETUP | | |
| Set metadata misalign action | METAMA [1-4] [drop/nopts/closest] | Configures the action to take on metadata messages that are not uniquely time aligned with a video frame when sending the messages in an MPEG2 Transport Stream. drop - Drop the metadata message nopts - Send the message with no presentation time stamp closest - Send the message with the PTS of the video frame sent in the last 1/2 second that is most closely aligned with the message |
| Displays or resets metadata statistics | METASTATS [reset] | Displays or clears metadata statistics. See Appendix A3 for a detailed description of these statistics. |
| COMMUNICATION SETUP | | |
| Check BER status | DCB [persist/reset] <period in seconds> | Queries or resets decoder (downlink) Bit Error Rate status. The optional second parameter specifies repetition frequency |

| Description | Command | Meaning |
|---|--|---|
| | | when the 'persist' option is used to repeatedly display BER status. |
| Configure decoder FEC | DCF [none/light/medium/strong] | Configures decoder (downlink) Forward Error Correction (FEC) |
| Configure decoder interleaver depth | DCI [none/specify/moderate/strong] (depth in FEC blocks) | Configures decoder (downlink) interleaver depth |
| Set decoder modulation bit rate | DCM (value) | Configures decoder (downlink) modulation bit rate (includes FEC bits and multiplexer overhead) |
| Check comm. status | DCS | Queries comm status |
| BER test control | ECB [off/modem/fec] (timeout in minutes) | Begins or ends an encoder (uplink) BER test |
| Configure encoder FEC | ECF [none/light/medium/strong] | Configures encoder (uplink) Forward Error Correction (FEC) |
| Configure encoder interleaver depth | ECI [none/specify/moderate/strong] (depth in FEC blocks) | Configures encoder (uplink) interleaver depth |
| Set encoder modulation bit rate | ECM (value) | Configures encoder (uplink) modulation bit rate (includes FEC bits and multiplexer overhead) |
| Use sync port for multiplexed data port | SB [disable/ttl/rs422] | Enables or disables baseband modem data over sync port 1 (this is a test mode to bypass the modem) and configures the signal type to use. |
| RADIO | | |
| Enable LNA | LNA [enable/disable] | Enables or disables receive LNAs. |
| Configure antenna steering | RAS <option> | For <option> select: disable - to disable all antenna tracking and switching freqomniC - to use an omni antenna on port C with frequency diversity and active steering (THIS OPTION IS NOT FULLY SUPPORTED) freqdirC - to use a directional antenna on port C with frequency diversity and active steering (THIS OPTION IS NOT FULLY SUPPORTED) freqdirD - to use a directional antenna on port D with frequency diversity and active steering (THIS OPTION IS NOT FULLY SUPPORTED) |

| Description | Command | Meaning |
|-----------------------------|---|---|
| | | <p>nearfarfixed - to use an omni on port C and a directional on port D, with diversity, but no steering (THIS OPTION IS NOT FULLY SUPPORTED)</p> <p>nearfarsteer - to use an omni on port C and a directional on port D, with diversity and active steering</p> <p>nearfarspatial - to use a switched omni/directional on port C and a directional on port D, diversity and active steering (THIS OPTION IS NOT FULLY SUPPORTED)</p> <p>If nothing is specified for <option>, then current configuration and information are displayed.</p> |
| Manual compass override | RASC [auto/manual] <-180 to 360> | Sets the compass to the value read directly from the digital compass, or overrides that value with a heading entered by the user. |
| Point antenna | RASLL <latitude> <longitude> <altitude> | <p>Points the antenna toward a specific latitude and longitude.</p> <p><latitude> and <longitude> are both in degrees. Fractional degrees may be entered with a decimal. Use positive numbers for northern latitude and eastern longitude. Use negative numbers for southern latitude and western longitude.</p> <p><altitude> is in meters</p> |
| Begin antenna scan | RASSCAN <option> | <p>Begins an antenna scan searching for signal.</p> <p>For <option> select:</p> <p>acquire - to use all available information and best effort in order to acquire the transmit signal</p> <p>full - to scan 100 degrees on either side</p> <p>near - to scan nearby the current location</p> <p>fine - to fine tune the pointing with small adjustments</p> |
| Read digital compass | RASRC | Requests a re-read of the digital compass. |
| Config tx antenna selection | RASTX <option> | <p>Configures transmitter antenna selection</p> <p>For <option> select:</p> <p>auto - to automatically select the antenna</p> |

| Description | Command | Meaning |
|------------------------------|---|--|
| | | <p>with the best RSSI</p> <p>omni - to use the omni antenna on port C</p> <p>dir - to use a directional antenna on either port</p> <p>dirC - to use the directional antenna on port C</p> <p>dirD - to use the directional antenna on port D</p> |
| Radio Handover | RHO [fallback/(frequency in KHz)] <enable fallback> (new GMT ID) (new uplink mod bit rate) <new FEC> <new interleaving> (new interleaver depth) | <p>Configures uplink radio handover. A new uplink frequency (or the “fallback” option) is required, but all other parameters are optional.</p> <p>For <enable fallback>: [disable/enable]</p> <p>For <new FEC>: [none/light/medium/strong]</p> <p>For <new interleaving>: [none/specify/moderate/strong]</p> |
| Poll radio | RP | Polls radio to update status of transceiver |
| Enter radio passthrough mode | RPM | Enter radio passthrough mode to the radio transceiver. |
| RSSI output enable | RSSI [enable/disable] | Enables or disables the RSSI output ports. Also displays current RSSI value in dBm for each radio channel. |
| Set receive radio frequency | RXF [A/B] (frequency in KHz) | Configures/displays receive (downlink) radio frequency |
| Set cable loss value | RXLOSS [A/B] (cable loss in 1/100 dB) | Configures/displays measured RX cable loss. |
| Receiver mode | RXM [diversity/A/B] | Configures receiver mode |
| Select transceiver | TCVRSEL [LS/C] | Selects which transceiver is enabled. |
| Enable radio transmitter | TXE [enable/disable] | Configures transmit radio enable |
| Set transmit radio frequency | TXF (frequency in KHz) | Configures transmit (uplink) radio frequency |
| Set transmitter power level | TXPC (power level in dB) | <p>Configures transmitter (uplink) power control level in dB:</p> <p>e.g. "TXPC -6" to reduce the power level of transmitter by 6 dB</p> |

| Description | Command | Meaning |
|--|---|---|
| NETWORK | | |
| View the ARP table | ARP [reset list] <num_entries> | Display or reset the ARP table. Optional second parameter may be used when the first parameter is set to "list" to specify the maximum number of entries to display. |
| Multicast EnerView configuration | IM [enable/disable] <multicast ip address> | Enable or disable multicast viewer data transmission |
| Setup the IP parameters for the GMT | IP [dhcp/static] <ip address> <subnet mask> <gateway> | Enable DHCP or specify IP address |
| Setup IP Gateway configuration | IPF [disable/gateway/bridge] <network ip address> <subnet mask> | Enable IP Forwarding and specify network IP address/mask |
| View the IP forwarding ARP table | IPFARP [reset list] <num_entries> | Display or reset the IP forwarding ARP table. Optional second parameter may be used when the first parameter is set to "list" to specify the maximum number of entries to display. |
| IP broadcast configuration | IPFB [enable/disable] | Enable forwarding of IP broadcast packets |
| IP multicast configuration | IPFM [none/all/filtered] | Enable/disable forwarding of IP multicast packets with or without filtering as follows: <ul style="list-style-type: none"> • none - disable forwarding of multicast IP packets • all - forward all multicast IP packets • filtered - forward only multicast IP packets destined for multicast group addresses in the table configured with the IPFMG command |
| IP multicast forwarded group addresses | IPFMG [add/delete] <multicast_group_ip_address> | Adds or removes the specified address to/from a list of multicast group addresses that will have their data forwarded when IPFM is set to "filtered". Note that multicast packets are only forwarded when IP forwarding is enabled via the IPF command and multicast forwarding is enabled via the IPFM command. |
| IP rate limiting | IPFR (value) | Set the maximum IP forwarding transmission data rate in bits per second |

| Description | Command | Meaning |
|--------------------------------|--|---|
| | | (select '0' for no rate limiting) |
| Check IP forwarding statistics | IPFS [reset/details] | Queries or resets IP forwarding statistics. Also allows for the display of more in depth statistics. |
| Enable remote viewer | IV [enable/disable] | Enables or disables the remote viewer |
| Viewer UDP port configuration | IVP (port) | Sets viewer UDP port |
| IP data source configuration | IVS [uplink/downlink] | Sets the source for data sent to the remote viewer |
| MPEG-2 TS config | MP2 [1-4] [enable/disable] <ip address> <port> | Enables/disables transmission of an MPEG-2 transport stream for the specified video channel. Sets the destination IP address and port for the stream. |
| IP host configuration | NAME <host name> <domain name> | Sets host and domain names |
| Check networking statistics | NS [reset/details] | Reads or resets network statistics |
| Ping | PING <ip address> <timeout seconds> <ping count> | Pings an IP address |
| Set PPP IP address | PPP <local server ip address> <remote peer ip address> | Specifies PPP IP addresses |
| Display IP route table | ROUTE | Displays IP route table |
| TCP proxy configuration | TCPP [enable/disable] [port] | Enables TCP Proxy and specify port |
| Check TCP proxy status | TCPPS [reset/details] | Displays or resets the TCP Proxy connection status. Also allows for the display of more in-depth status by including the details parameter. |
| SYSTEM | | |
| User account configuration | AC [list/full/restricted/view-only/delete] <username> <password> | Adds, modifies, or deletes a user account |
| Code download enable | DL [enable/disable] | Enables or disables downloading to this unit through TFTP |
| Enable DVA mode | DVAMODE [enable/disable] | Enables or disables DVA compatibility mode |
| Licensed Feature Configuration | FEATURE [add/delete/list] <feature_name> <license_key> | Adds, deletes, or lists feature licenses. Feature name and license key must be provided to add a feature license. |

| Description | Command | Meaning |
|----------------------------|---|---|
| | | Feature name must be provided to delete a license. |
| Power On Self Test control | POST [enable/disable] | Enables or disables Power On Self Test (POST) |
| Configure relay role | RELAY [disable/single/upward/downward] <IP address> | Configures the relay role. The <IP address> is only necessary in upward or downward mode. |
| Set defaults | SD | Resets to factory default configuration |
| Show firmware revisions | SFR | Queries for firmware revision levels |
| Show hardware revisions | SHR | Queries hardware revision levels |
| System reset | SRESET | Resets the AMT |
| Show system | SS | Queries hardware serial numbers |
| Self test | ST [verbose] | Performs a system self-test, optional parameter enables verbose output |
| Show status | STATUS | Displays current system status |
| Component self test | STEST <component name or ID> <number of times to run> | Performs a self-test on the specified system component |
| System temperature | TEMP | Displays current system temperature |
| TEMPLATES | | |
| Template delete | TD <template name> | Deletes a saved template |
| Template load | TL <template name> | Loads a saved template |
| Template load default | TLD | Loads the default template |
| Template restore | TR | Restores the last template loaded |
| Template save | TS <template name> | Saves the current configuration as a template |
| ORDERWIRE | | |
| Orderwire enable | OW [enable/disable] | Enables or disables in-band order-wire configuration of the AMT. |
| GMT identification string | GMTID "<string>" | Configures the GMT ID string which the AMT uses to verify a connection |
| Enter remote AMT mode | AMT <command> | This command may be used to place the GMT console in remote AMT mode. While in this mode, the user prompt is changed from "GMT>" to "Remote AMT>". In this mode, any commands entered on the command line are |

| Description | Command | Meaning |
|-------------|---------|---|
| | | processed as orderwire commands to the AMT. To exit AMT mode, enter the command “GMT” on the command line. If a command parameter is provided, that command only is sent to the remote AMT. |

4.3 AMT configuration through the GMT CLI using Orderwire

In general, commands entered on the AMT CLI affect the AMT configuration and commands entered on the GMT CLI affect the GMT configuration only. However, when Orderwire configuration is enabled, commands may be entered on the GMT to affect the configuration of the AMT as well. Such commands, and their responses, will be sent between the AMT and GMT over the in-band order-wire interface.

As a rule, when Orderwire control is enabled, the EnerLinksIII™ will not allow a user to make configuration changes that affect the communication link between the AMT and GMT. This includes modulation rate, FEC, interleaving, and radio frequency.

Most of the AMT CLI commands may be issued from the GMT CLI when Orderwire is enabled on both the AMT and GMT using the “OW enable” command. To send a command to the AMT from the GMT CLI, prefix the command with the word “AMT”. E.g. the following command is used at the GMT CLI to set the input video jack for video channel 1 on the AMT to 3:

```
GMT> AMT VJ 1 3
OK: Current video channel 1 config: jack 3
```

Unless otherwise noted here, each AMT command described in section 4.1 may be run from the GMT command line in this way.

Note that each configuration request will be forwarded to the AMT for execution and the CLI will not return until a response has been received. Due to the latency involved in the in-band Orderwire communication (especially when interleaving is enabled) each request may take several seconds to respond. When using a command to read a configuration parameter, the local cached value of that parameter will generally be returned immediately.

4.3.1 Remote AMT Mode

Another way to access the AMT commands via the GMT is using the remote AMT mode. Simply typing the command “AMT” without any parameters places the console into remote AMT mode. While in the remote AMT mode, the user prompt is changed from “GMT>” to “Remote AMT>”. In this mode, any commands entered on the command line are processed as Orderwire commands to the AMT. To exit remote AMT mode, enter the command “GMT” on the command line.

4.3.2 Read-Only AMT Commands

The following AMT commands may only be used to read the current AMT configuration when run from the GMT CLI. They may not be used to change the configuration.

| | |
|------|----------------------------------|
| IPFS | IP forwarding network statistics |
| NS | Ethernet network statistics |
| RXF | receiver frequency |
| TXF | transmitter frequency |

4.3.3 Modified AMT Commands

The behavior of the following AMT commands is changed when accessed through the GMT. The change is described below.

| | |
|------|--|
| HELP | displays help for AMT commands available via the GMT |
| DC | cannot display detailed rate information |
| EC | cannot display detailed rate information |
| DCB | only the Full Integrator BER statistics are displayed |
| IPFS | cannot display detailed AMT IP forwarding network statistics on GMT |
| NS | cannot display detailed AMT Ethernet network statistics on GMT |
| ST | only the non-verbose system test is supported |
| LNA | receiver LNA enable – may only be used to enable, not disable, LNA |
| TXE | transmitter enable – may only be used to enable, not disable, transmitters |

4.3.4 Unsupported Remote AMT Commands

The following AMT commands may not be run from the GMT CLI.

| | |
|-----------|---|
| DCM | decoder comm modulation rate |
| DCF | decoder comm fec |
| DCI | decoder comm interleaver |
| ECM | encoder comm modulation rate |
| ECF | encoder comm fec |
| ECI | encoder comm interleaver |
| SB | baseband modem data over sync port |
| METASTATS | display metadata statistics |
| RPM | radio pass-thru mode |
| ARP | address resolution protocol table for Ethernet |
| IPFARP | address resolution protocol table for IP forwarding |

| | |
|---------|---|
| PING | ping an IP address |
| PPP | PPP IP addresses configuration |
| ROUTE | IP route table |
| AC | user account configuration |
| DL | download enable |
| FEATURE | add or delete feature licenses |
| RELAY | configures the relay role |
| SD | system set default |
| STEST | perform self test of specified system component |
| TD | template delete |
| TL | template load |
| TLD | template default |
| TR | template restore |
| TS | template save |
| OW | order-wire enable/disable |
| GMTID | configures the orderwire GMT ID string |

4.3.5 Remote AMT Commands for MJPEG

Older versions of the AMT software supported the use of the Motion JPEG (MJPEG) video compression standard. When using Orderwire to configure an AMT that supports MJPEG, the VCM command is modified to support the MJPEG compression standard as follows:

| Description | Command | Meaning |
|-----------------------|--------------------------------|---|
| Set video compression | VCM [1/2] [disable/MJPEG/H264] | This configures the video compression mode for the specified video channel. Select 'disable' to disable the video channel. Note that only one video channel may be configured to use the MJPEG compression standard at a time on the AMT. |

When using Orderwire to configure an AMT that supports MJPEG, the following additional AMT commands may be run from the GMT CLI.

| Description | Command | Meaning |
|-----------------------------|-----------------------|--|
| Set MJPEG video crop | VCR [1/2] [100/82/63] | Sets the Motion JPEG video cropping so that the percentage of the image provided by the parameter is compressed. |
| Set Motion JPEG compression | VJC [1/2] (value) | Configures Motion JPEG compression (low values mean low compression, which means higher |

| Description | Command | Meaning |
|-----------------------------|------------------------------|--|
| | | image quality). |
| Set MJPEG restart markers | VJR [1/2] (value) | Sets the number of restart markers inserted into compressed video frames. This allows the later part of images to be recovered in the presence of bit errors at the cost of up to 10% overhead for video frames. |
| Set video picture code mode | VPC [1/2] [frame/field] | This configures MJPEG picture coding: <ul style="list-style-type: none"> • frame - process an image at a time • field - process sets of interlaced lines at a time |
| Set MJPEG video resolution | VRES [1/2] [low/medium/high] | Configures the MJPEG video resolution. |

5 Optional GMT Legacy Analog Video Receive Capability

The GMT legacy analog video receive capability provides the ability on the GMT to receive one or two legacy analog video signals through its transceiver module. This capability is used for downlink only communication. The analog video received using this mode of operation is available for local display on an external monitor as a composite signal.

The GMT legacy analog video receive capability is a licensed feature. This means that this capability requires a feature-specific license to be purchased for the GMT and the associated license key to be entered on the unit. Before the key is entered, the controls for this feature will not be available from the command line or GUI.

To use this mode, enable the analog bypass mode using the “VAB” command. Select the analog video signal to display on each output jack using the “VJO” command. You can select between the signals on receiver channel A and receiver channel B.

In order to provide appropriate filtering of the analog video signal on the GMT, the video standard for each receive channel must be configured using the “VAS” command.

If the transmitter sending each analog video signal uses a pre-emphasis filter, set the de-emphasis filter to “enable” for the corresponding receiver channel using the “DEF” or “VAD” command.

If the transmitter is inverting the analog video signal (reversing its polarity), then enable video signal inversion for the corresponding receiver channel using the “VAI” command.

You can adjust the gain applied to the video signal using the “VAG” command.

To view one of the analog video bypass signals on a remote viewer, use the “VTC” and “MP2” commands. The “VTC” command selects the analog video receiver channel that will be transcoded to H.264, and the target bit rate in kbps from 100 kbps to 10 Mbps. The “MP2” command specifies the remote viewer IP address and port for the MPEG-2 TS.

Note that when analog bypass mode is disabled on the GMT, the existing “RXM” command is used to select the active receiver arm(s), but this configuration is unused when analog bypass mode is enabled.

The functionality of the existing “RXF” command used to control receiver frequency has not changed, and is not affected by enabling or disabling analog video bypass mode.

5.1 GMT Legacy Analog Video Command Line Definitions

The following new and modified commands are made available at the GMT command line interface when the license for this feature is enabled:

| Description | Command | Meaning |
|--------------------------------------|-------------------------------------|--|
| VIDEO | | |
| video - analog bypass mode (new) | VAB [A/B] [enable/disable] | <p>This enables analog video bypass mode on selected receive path</p> <p>Note: Enabling analog video on both paths is allowed.</p> |
| video jack output (modified) | VJO [1-4] [disable/1/2/3/4/BPA/BPB] | <p>Selects the source for the video output jack.</p> <p>The first parameter specifies the jack to configure and the second indicates the video to display on that jack, or indicates that the jack should be disabled. Select 1 through 4 for the second parameter to identify the video channel to display on the jack.</p> <p>Select BPA or BPB for the second parameter to indicate the analog video bypass receiver channel to display on the jack.</p> <p>Note that a video channel cannot be selected for output on a jack unless its output has been enabled with the VM command.</p> |
| video standard – analog bypass (new) | VAS [A/B] [NTSC/PAL] | <p>Configures the video standard (NTSC/PAL) of the video being received on each analog bypass receiver channel. This is used to optimize signal filtering in the GMT.</p> <p>This configuration parameter is only used when analog video bypass mode is enabled.</p> <p><i>NOTE: Only NTSC mode will be available in the first release.</i></p> |
| de-emphasis filter (new) | VAD [A/B] [enable/disable] | <p>Enables or disables the de-emphasis filter on the specified receiver channel.</p> <p>This configuration parameter is only</p> |

| Description | Command | Meaning |
|--|--|--|
| | | used when analog video bypass mode is enabled. Note: The DEF and VAD commands are functionally identical. |
| video gain adjustment – analog bypass (new) | VAG [A/B] [value] value - Gain value between -10 and 10 | Adjusts gain applied to the analog bypass video signal. The nominal value of zero is intended to provide optimum video quality when the video signal retrieved from the received carrier is at the standard level for NTSC or PAL. This value may be increased or decreased to adjust the gain applied to the video signal to accommodate a signal that is weaker or stronger than desired. |
| video signal inversion - analog bypass (new) | VAI [A/B] [enable/disable] | Enables or disables inversion of the analog video signal on the specified receiver channel. This configuration parameter is only used when analog video bypass mode is enabled. |
| video transcoding – analog bypass (new) | VTC [disable/BPA/BPB] <bitrate in kbps> | Selects which analog video bypass receiver channel (disable, BPA, or BPB) will be converted to an H.264 video stream and sent to a remote viewer using an MPEG-2 transport stream. Also specifies the target bit rate in kbps for the video stream, from 100 (100 kbps) to 10000 (10 Mbps). This configuration parameter is only used when analog video bypass mode is enabled. Note: The IP address and port associated with the transcoded MPEG-2 transport stream is set up via the “MP2” command, or on the Networking GUI page. |

| Description | Command | Meaning |
|-----------------------------|--|---|
| RADIO | | |
| de-emphasis filter (new) | DEF [A/B] [enable/disable] | <p>Enables or disables the de-emphasis filter on the specified receiver channel.</p> <p>This configuration parameter is only used when analog video bypass mode is enabled.</p> <p>Note: The DEF and VAD commands are functionally identical.</p> |
| NETWORK | | |
| MPEG-2 TS config (modified) | MP2 [1/2/3/4/T] [enable/disable] <ip address> <port> | Enables/disables MPEG-2 transport streams for the specified video channel (1/2/3/4) or the transcoded analog video channel (T). Sets the destination IP address and port for the stream. |

5.2 GMT Legacy Analog Video GUI Changes

When the license for the GMT legacy analog video receive feature is enabled, the GUI display for the GMT Video Output setup page and GMT Networking setup page are changed to include controls for this feature. The changes to these pages are described below.

5.2.1 GMT Video Output GUI Page with Legacy Analog Video Support

When the license for the GMT legacy analog video receive feature is enabled, the GUI display for the GMT Video Output setup page (originally described in paragraph 3.6.5) is changed to include controls for this feature as seen in Figure 75.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video**
 - Video Output**
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
- Networking
- System
- Orderwire
- Flight Test

Logout

GMT Video Output Setup

Analog Video Bypass Configuration

| Analog Video Path A | Analog Video Path B |
|---|---|
| <input checked="" type="checkbox"/> Enable | <input type="checkbox"/> Enable |
| <input checked="" type="checkbox"/> De-emphasis filter | <input checked="" type="checkbox"/> De-emphasis filter |
| <input checked="" type="checkbox"/> Inverted video signal | <input checked="" type="checkbox"/> Inverted video signal |
| <input checked="" type="radio"/> NTSC <input type="radio"/> PAL | <input checked="" type="radio"/> NTSC <input type="radio"/> PAL |
| Video Gain: <input type="text" value="1"/> -10 0 10 | Video Gain: <input type="text" value="0"/> -10 0 10 |

Video Transcoding Configuration

Transcoding Source: ☐ Disable ☒ Analog Video Path A ☐ Analog Video Path B

Target Bit Rate: kbps

Output Signal Configuration

| Video Channel | Signal Type | Composite | Y/C | Disabled |
|-----------------|--------------|----------------------------------|-----------------------|----------------------------------|
| Video Channel 1 | Signal Type: | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Video Channel 2 | Signal Type: | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| Video Channel 3 | Signal Type: | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| Video Channel 4 | Signal Type: | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Output Jack Configuration

| | Jack 1 | Jack 2 | Jack 3 | Jack 4 |
|----------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Video Channel 1: | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Video Channel 2: | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Video Channel 3: | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Video Channel 4: | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Analog Video Path A: | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |
| Analog Video Path B: | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Disabled: | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |

Help

Figure 75: GMT Video Output Setup Page with Legacy Analog Video Support

Analog Video Bypass Configuration

Use the check boxes, radio buttons, and sliders in this section to:

- enable/disable analog bypass mode for each receive path
- enable/disable the de-emphasis filter for each receiver channel
- enable/disable inversion of the analog video signal
- select the video standard for each receive channel
- adjust gain applied to the analog bypass video signal

Video Transcoding Configuration

Use the radio buttons in this section to select which analog video bypass receiver channel (Path A or Path B) will be converted to an H.264 video stream, and sent to a remote viewer using an MPEG-2 transport stream. Transcoding is only performed when the selected analog video bypass path is enabled. Transcoding may also be disabled in this section.

Use the drop down box in this section to specify the target bit rate in kbps for the transcoded video stream, from 100 (100 kbps) to 10000 (10 Mbps).

Note: The IP address and port associated with the transcoded MPEG-2 transport stream are set up via the “MP2” command, or on the Networking GUI page.

Output Signal Configuration

Use the radio buttons in this section to enable the digital video channels to be output from the analog video jacks on the GMT. Only two video channels may be enabled for output at a time. Enable each video channel by selecting the video signal type to be displayed for the channel. Video may be presented in composite format, which is a single signal that contains the entire video stream, or in Y/C mode in which there are two signals, a luminance (Y) signal and a chrominance (C) signal. Y/C typically provides better quality.

Note that the GMT will not prevent you from enabling a video channel for analog output when that channel is disabled at the AMT, or it is processing a digital video input. In either case, however, no analog output will be displayed by the GMT for such channels.

Note that only composite format is supported for the legacy analog video paths.

Output Jack Configuration

The EnerLinksIII GMT is designed with four output video jacks used to connect to video terminals or recording devices. This section provides the ability to select the source of the video that will be displayed on each of these jacks. When the license for the GMT legacy analog video receive feature is enabled, the options for each jack include Video Channel 1 through 4, Analog Video Path A, Analog Video Path B, or Disabled. A digital video channel can only be selected for output on one of the jacks if it has been enabled in the Output Signal Configuration section above.

If the Y/C output video signal type is selected for any of the digital video channels, the output jack selection for that video channel must be performed as a pair. Jacks 1 and 2 form one Y/C pair, and Jacks 3 and 4 form another. Jacks 1 and 3 will display luminance (Y), while Jacks 2 and 4 will display chrominance (C). For instance, if Video Channel 1 is configured for Y/C mode, then whenever you select channel 1 as the video source for any jack, the selection for the other jack in the Y/C pair will be automatically switched to the same source. The GUI display will present the appropriate Y and C symbols next to the radio buttons associated with a Y/C video signal.

In the configuration displayed in Figure 75, Jack 3 is configured to display legacy analog video from receive Channel A, and Jacks 1 and 2 are configured to display video signals in composite format from digital video Channels 1 and 4.

5.2.2 GMT Networking Setup GUI Page with Legacy Analog Video Support

When the license for the GMT legacy analog video receive feature is enabled, the GUI display for the GMT Networking setup page (originally described in paragraph 3.6.13) is changed to include controls for this feature as seen in Figure 76.

GMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video Output
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
 - Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
 - Antenna
 - Networking**
 - System
 - Orderwire
 - Flight Test
- Logout

GMT Networking Setup

IP Configuration

☐ Obtain IP address automatically

Host Name: board1

Domain Name: network.gov

☒ Use the following IP address

IP Address: 192.168.1.5

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.1.1

☒ Forward IP to AMT

Forwarding Scheme: Gateway

Uplink Subnet: 207.55.2.0

Uplink Mask: 255.255.255.0

Uplink Rate Limit: 1000000 bps

☐ Forward broadcast packets

☒ Forward multicast packets

☒ Filter multicast packets

Forwarded Multicast Group Addresses:

232.9.9.9
233.2.3.4

New Address:

Add

Delete

☒ Enable TCP Proxy **Port:** 5004

EnerView Configuration

☒ Enable EnerView access

☒ Enable multicast

Data Source: ☒ Downlink ☐ Uplink

Multicast IP Address: 225.1.1.100

Port: 5000

MPEG-2 TS Configuration

| | IP Address | Port |
|---|-------------|------|
| <input checked="" type="checkbox"/> Video Channel 1 | 192.168.1.2 | 6001 |
| <input type="checkbox"/> Video Channel 2 | 192.168.1.2 | 6002 |
| <input type="checkbox"/> Video Channel 3 | 192.168.1.2 | 6003 |
| <input checked="" type="checkbox"/> Video Channel 4 | 192.168.1.2 | 6004 |
| <input checked="" type="checkbox"/> Transcoded | 192.168.1.2 | 6005 |

GPS TCP/IP Configuration

☐ GPS Port 1 **Port:** 7005

☐ GPS Port 2 **Port:** 7006

Apply

IP Properties

IP Address: 192.168.1.5
Physical Address: 00-0F-1F-9E-53-70
Subnet Mask: 255.255.255.0
Default Gateway: 192.168.1.1

IP Statistics

Tx Ethernet Packets: 158343 Rx Ethernet Packets: 145
Tx ARP Packets: 31200 Rx ARP Packets: 12
Tx IP Packets: 123344 Rx IP Packets: 133

DHCP Properties

Server Address: 192.168.1.24
Lease Obtained: 5/27/2004 8:43:39
Lease Expires: 5/29/2004 8:43:39

IP Forwarding Statistics

Tx MAC Packets: 634 Rx MAC Packets: 19
Tx ARP Packets: 13 Rx ARP Packets: 1
Tx IP Packets: 621 Rx IP Packets: 18

Help

Figure 76: GMT Networking Setup Page with Legacy Analog Video Support**MPEG-2 TS Configuration**

When the license for the GMT legacy analog video receive feature is enabled, controls are displayed in the MPEG-2 TS Configuration box for configuring the MPEG-2 transport stream associated with the transcoded video stream configured on the GMT Output Video setup page.

Enable Transcoded MPEG-2 TS

Use the Transcoded check box in this section to enable or disable sending transcoded video data to a remote viewer in an MPEG2 Transport Stream. Data will only be included in the MPEG2 Transport Stream if the transcoding source is set to analog video path A or B, and that analog video path is enabled.

IP Address and Port

This is the destination IP address and port that the GMT uses for transmission of the MPEG2 Transport Stream data for the transcoded video.

6 Optional Advanced Encryption Standard (AES) Capability

The EnerLinksIII™ system provides the option to use AES 256 (AES using a 256-bit encryption key) to encrypt all data in the uplink and/or downlink multiplexed data streams. The AES encryption capability is a licensed feature. This means that this capability requires a feature-specific license to be purchased for the AMT and GMT, and the associated license key to be entered on each unit. Before the key is entered, the controls for this feature will not be available from the command line or GUI.

Encryption may be independently enabled on the uplink and downlink data streams. Separate AES keys are used for encryption and decryption of these streams. Each key is generated by mathematically combining a user specified password with a “salt”. The “salt” is a pseudorandom number generated at the unit performing the encryption (the encoder) and passed to the unit performing the decryption (the decoder) in clear text messages so that the decoder can reconstruct the key. Since the decoder builds the decryption key from the received “salt” and the AES password configured at the decoder, the password entered at both units must be exactly the same. No key exchange of any kind is performed between the AMT and GMT.

A single AES password is entered by the user and stored in each unit. This password is used in generating both the encryption and decryption keys.

To enable AES encryption at the encoder, there are two steps required:

- 1) Enter a valid password (where the length of the password must also be valid) using the AESP or AESP2 command, or the GUI.
- 2) Enter “AES enable” from the CLI, or click the Encryption Enabled checkbox on the downlink (on the AMT) or uplink (on the GMT) communications setup GUI page. These two steps can be implemented in any order.

Once these steps are implemented, the encoder begins encrypting all data on the transmit data stream and sending its pseudo randomly generated “salt” in clear text messages. This means that a decoder can only decrypt the data stream if it has been configured with the exact same password as was configured at the encoder. Note that the “AES enable” or “AES disable” setting will be retained after a system restart (i.e. the setting is always stored in EEPROM).

To enable AES decryption at the decoder, all that is required is for the exact same password to be configured as was configured at the encoder. All other information required to build the encryption key is contained in clear text messages generated by the encoder. These clear text messages include the “salt” to be used in decryption, as well as information indicating whether AES is enabled at the encoder, to tell the decoder whether AES decryption needs to be performed at all. The clear text message is sent at a regular interval, as specified by the AESCTI command.

If encryption is enabled, but a valid password is not available, the encoder will transmit a scrambled data stream that cannot be decrypted by the decoder. In this case, the “Invalid AES Password” system status fault will be reported. Similarly, if a clear text message is received on a decoder indicating that the received multiplexed data stream is encrypted, and no valid password

is available, the decoder will not attempt to decrypt the data and will set the “Invalid AES Password” system status fault.

If AES encryption is enabled, and the encoder and decoder do not have the same password stored, then the decoder will not be able to decrypt the multiplexed data stream. In this state, the decoder status will indicate that bit sync, FEC sync, and mux sync are “locked”, but crypto sync will be “not locked”. A “Lost Crypto Sync” system status fault will be set. If the GMT loses crypto sync the bit sync, FEC sync and mux sync lights on the front panel will be illuminated green, and the fault light will be illuminated red. When crypto sync is lost, all packets received will be counted as invalid.

Note that the AES password is NOT saved in EEPROM unless commanded by the user with the “AES save” CLI command or the “Save in EEPROM” button on one of the communications setup GUI pages. If the password is not saved in EEPROM, a reset of the AMT or GMT will clear the password and encryption will NOT be operational. If there is a need to clear the password from the system, the “AES clear” command erases any password stored in EEPROM and RAM. “AES clear” does not reset the AES enable state. Entering a new password also erases any password stored in EEPROM.

The AES keys used in the EnerLinksIII are built per the following specifications:

- 1) PBKDF2 from RFC 2898
- 2) HMAC from RFC 2104
- 3) SHA-1 from FIPS PUB 180-1

6.1 AES and Templates

When a working configuration is saved as a named template, the working AES information is NOT saved. This implementation ensures that no password is ever saved in a template. One impact is that the AES settings are not template dependent and the AES configuration will remain unchanged when a new template is loaded. For example, if AES is enabled with a valid password and a new template is loaded then AES is still enabled with that same password. In the same way, when AES is disabled and a template is loaded, AES is still disabled.

The one exception to this rule occurs when loading the “default_template”. When this template is loaded, AES encryption will be disabled. This allows a user to quickly get two systems to communicate by applying the “default_template” to each unit without performing any other configuration changes.

Note that neither the RAM nor the EEPROM copies of the password is affected by the template load.

6.2 AES Command Line Definitions

The following new and modified commands are made available at the EnerLinksIII command line interface for both the AMT and GMT when the license for this feature is enabled:

| Description | Command | Meaning |
|---------------------------------|--|---|
| ENCRYPTION (ENC) | | |
| AES encryption enabling | AES [save clear enable disable reset] | <p>Top level configuration for AES encryption. Optional settings and their effects are:</p> <ul style="list-style-type: none"> ➤ <i>Save</i>: writes the password to EEPROM so it will be used on reset. If a password is entered and not saved then on reboot no password will be available. ➤ <i>Clear</i>: erases EEPROM passwords and RAM copies as well. It doesn't alter an enable or disable setting. ➤ <i>Enable</i>: this enables encryption of the transmitted multiplexed data stream (as long as a valid password is stored in RAM). This setting is always saved in EEPROM so remains the same on reboot. ➤ <i>Disable</i>: this disables encryption of the transmitted multiplexed data stream. Everything is sent in plain text mode. This is always saved in EEPROM so remains the same on reboot. ➤ <i>Reset</i>: This resets the AES encryption key by changing the SALT and recalculating the key. It changes the SALT that is passed to the decoder in clear text messages so that the decoder can then also reset its AES decryption key. |
| AES clear text message interval | AESCTI [200-100000 ms] | Sets the time interval between clear text messages in milliseconds. Clear text messages are used by the encoder to tell the decoder the "salt" setting which is used with the password to generate the AES encryption/decryption key. Default setting is 1000 ms. |
| AES encryption password | AESP [hit enter] Then answer prompts. | Used to set the password for AES encryption. When AESP is used, the |

| Description | Command | Meaning |
|------------------------------------|--------------------------|--|
| (human user) | | <p>user is prompted for the password two times. The passwords must be exactly the same in both cases and must be at least as long as the AESPML setting, or the password will not be accepted. This version of the AES password command is provided for human operators, to verify that the intended password is provided.</p> <p>The password can be any printable keyboard characters, with a maximum length of 64 characters.</p> |
| AES encryption password (computer) | AESP2 <password> | Used to set the password for AES encryption, with no prompting. This version of the AES password command is provided for computer applications, to present a simplified command/response interface. The password length only is verified. |
| AES password minimum length | AESPML [8-64] | Sets the minimum AES password length required. |
| AES statistics | AESSTATS [reset details] | Displays various statistics related to AES. Also provides the option to display or reset detailed AES statistics and counters. |

6.3 AES GUI Changes

When the license for the AES feature is enabled, the GUI display for the Status and Configuration pages and Communications Setup pages available to Full Access and View Only Access users are changed to include status and controls for this feature. The Status and Config GUI pages available to Restricted Access users are changed similarly. The changes to these pages are described below.

6.3.1 Navigation Bar Color Changes

The color of the navigation bar at the top of each GUI page indicates whether AES is enabled. If AES encryption is not enabled for the transmitted or received multiplexed data stream, the navigation bar is blue. This is how the navigation bar is displayed in all of the figures throughout the rest of this document. If AES encryption is enabled for the transmitted data stream, or clear text messages in the received data stream indicate that AES is enabled for that stream, the navigation bar changes to red. An example of this can be seen in Figure 77.

Note that the AES feature license does not have to be enabled for an EnerLinksIII unit to detect that the received data stream is encrypted. If an encrypted stream is received by a unit that does not have the AES feature license enabled, the navigation bar will become red, and the “Lost Crypto Sync” and “Invalid AES Password” faults will be set.

6.3.2 AMT Downlink Status and Configuration with AES

When the license for the AES feature is enabled, the GUI display for the AMT Downlink Status and Configuration page (originally described in paragraph 3.5.1) is changed to include status for this feature as seen in Figure 77.

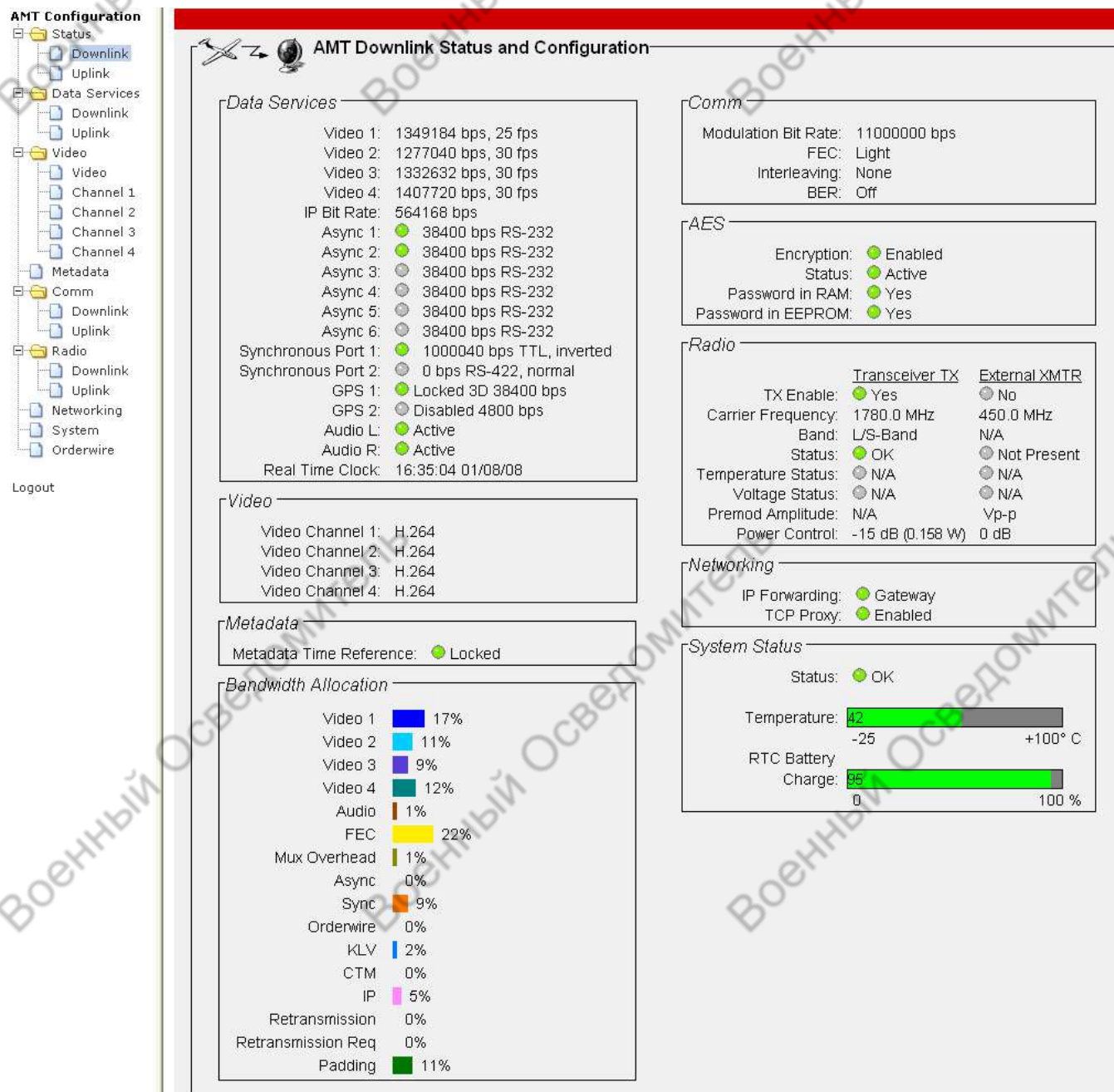


Figure 77: AMT Downlink Status and Configuration Page with AES

When the license for the AES feature is enabled, the AES configuration box shown in Figure 77 is displayed in the AMT Downlink Status and Configuration Page. This box displays the current AES encryption configuration. Otherwise, the information displayed on this page is identical to that displayed when the AES feature is not enabled. See paragraph 3.5.1 for a complete description of all of the information displayed on this page that is not related to AES.

6.3.3 AMT Uplink Status and Configuration with AES

When the license for the AES feature is enabled, the GUI display for the AMT Uplink Status and Configuration page (originally described in paragraph 3.5.2) is changed to include status for this feature as seen in Figure 78.

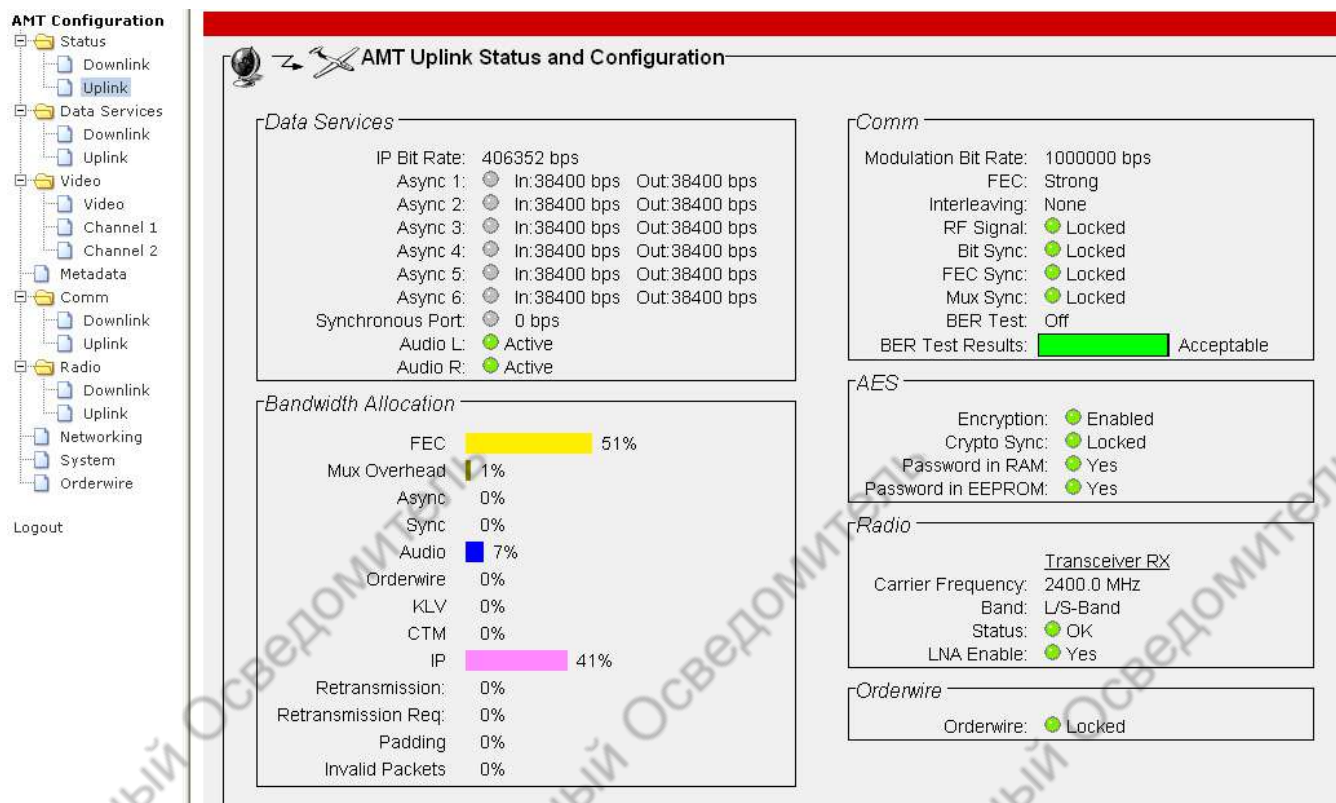


Figure 78: AMT Uplink Status and Configuration Page with AES

When the license for the AES feature is enabled, the AES configuration box shown in Figure 78 is displayed in the AMT Uplink Status and Configuration Page. This box displays the current AES encryption configuration. Otherwise, the information displayed on this page is identical to that displayed when the AES feature is not enabled. See paragraph 3.5.2 for a complete description of all of the information displayed on this page that is not related to AES.

6.3.4 AMT Downlink Communications Setup with AES

When the license for the AES feature is enabled, the GUI display for the AMT Downlink Communications Setup page (originally described in paragraph 3.5.8) is changed to include controls for this feature as seen in Figure 79.

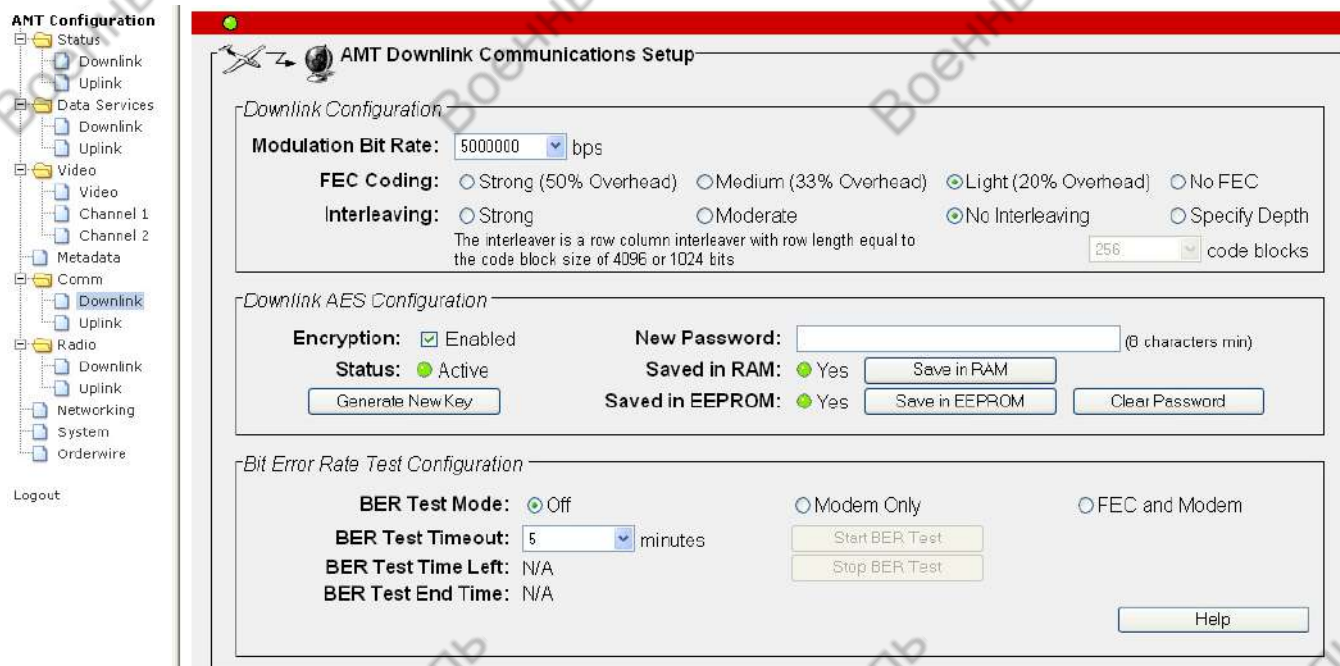


Figure 79: AMT Downlink Communications Setup Page with AES

The Downlink Configuration and Bit Error Rate Test Configuration boxes contain the exact same set of configuration options that are available on this page when the license for the AES feature is not enabled. These configuration options are described in paragraph 3.5.8 of this document.

Downlink AES Configuration

To enable AES encryption of the downlink multiplexed data stream, a valid password must be entered and saved either in RAM or in non-volatile EEPROM, and the Encryption Enabled checkbox must be checked on this page. All downlink data except a periodic clear-text message is encrypted using the AES 256 encryption algorithm in the cipher feedback mode. AES 256 uses a 256 bit key to encrypt blocks of 128 bits at a time. The GMT must have the same password entered in order to decrypt the data correctly.

If encryption is enabled but a valid password has not been entered, the AMT does not send any valid data unencrypted. Instead, it transmits a scrambled data stream that cannot be decrypted by the GMT. When encryption is enabled, the AMT never sends unencrypted data.

Note that the same password is used for generating both the encryption and decryption AES keys. Any change made to the password on this page (setting, storing, or clearing) affects both the uplink and downlink AES configuration.

Encryption Enabled

This checkbox enables or disables encryption of the downlink multiplexed data stream. During the transition to encrypted or unencrypted mode a GMT will briefly lose some of the data in the

downlink data stream, since the AMT and GMT will not switch encryption modes at exactly the same time.

Status

This field and its gray/red/green LED indicate the status of AES encryption. In addition to this field, if AES is enabled the navigation band across the top of all GUI pages changes color. This status field can show the following indications:

- *Disabled* with gray LED indicates the Encryption Enabled checkbox is not checked.
- *Active* with a green LED indicates that encryption is enabled with a valid password, and all downlink data is actively being encrypted.
- *Fault* with a red LED indicates that encryption is enabled but some problem is causing encryption not to function. The most likely problem is an invalid password. In this case, no valid unencrypted data is sent from the AMT.

Generate New Key

Clicking this button causes the AMT to generate a new random SALT and use the new SALT with the existing user-entered password to generate a new 256 bit key for AES encryption. The new SALT is sent to the GMT in the periodic clear-text messages, but the GMT may not receive the new SALT immediately, and thus may go a short period of time where it is unable to decrypt the data.

New Password

Type a new password in this box and type the ENTER key or click on the Save in RAM button to save the new password in RAM while erasing any password saved in EEPROM. Or, type a new password in this box and click on the Save in EEPROM button to save the new password in RAM and EEPROM, overwriting any previously saved password in EEPROM. In either case, if encryption is already enabled the new password will immediately cause a new 256 bit key to be generated for AES encryption. Until the same password is entered at the GMT, the GMT will not be able to decrypt the downlink stream.

Saved in RAM

This indicator shows whether a valid password is currently in RAM. This is necessary for encryption to function at all.

Saved in EEPROM

This indicator shows whether a valid password is currently in non-volatile EEPROM. This is not necessary for encryption to function, but if a password is saved in EEPROM then the AMT can begin sending encrypted data on its own after a power-cycle or a reboot, because it already has a valid password. If no password is saved in EEPROM, this is not an error condition, but the next time the AMT is power-cycled or rebooted any password saved only in RAM is lost, and the AMT will be unable to send encrypted data. In that case, if encryption is enabled the AMT will send a scrambled downlink data stream that cannot be decrypted by the GMT, or if encryption is disabled the AMT will send all data unencrypted.

Save in RAM

Clicking this button after entering a new password saves the new password in RAM while erasing any password saved in EEPROM. If the Encryption checkbox is already checked, the AMT begins encrypting with the new password immediately.

Save in EEPROM

Clicking this button while the New Password box is empty saves the current password from RAM into non-volatile EEPROM, so that the AMT can be rebooted and will remember the password. Clicking this button after typing a password in the New Password box saves the newly entered password in both RAM and EEPROM, and if the Encryption checkbox is already checked, the AMT begins encrypting with the new password immediately.

Clear Password

Clicking this button clears any saved password from both RAM and EEPROM. If encryption is enabled, it remains enabled but because the AMT no longer has a valid password it sends a scrambled downlink data stream that cannot be decrypted by the GMT.

6.3.5 AMT Uplink Communications Setup with AES

When the license for the AES feature is enabled, the GUI display for the AMT Uplink Communications Setup page (originally described in paragraph 3.5.9) is changed to include controls for this feature as seen in Figure 80.

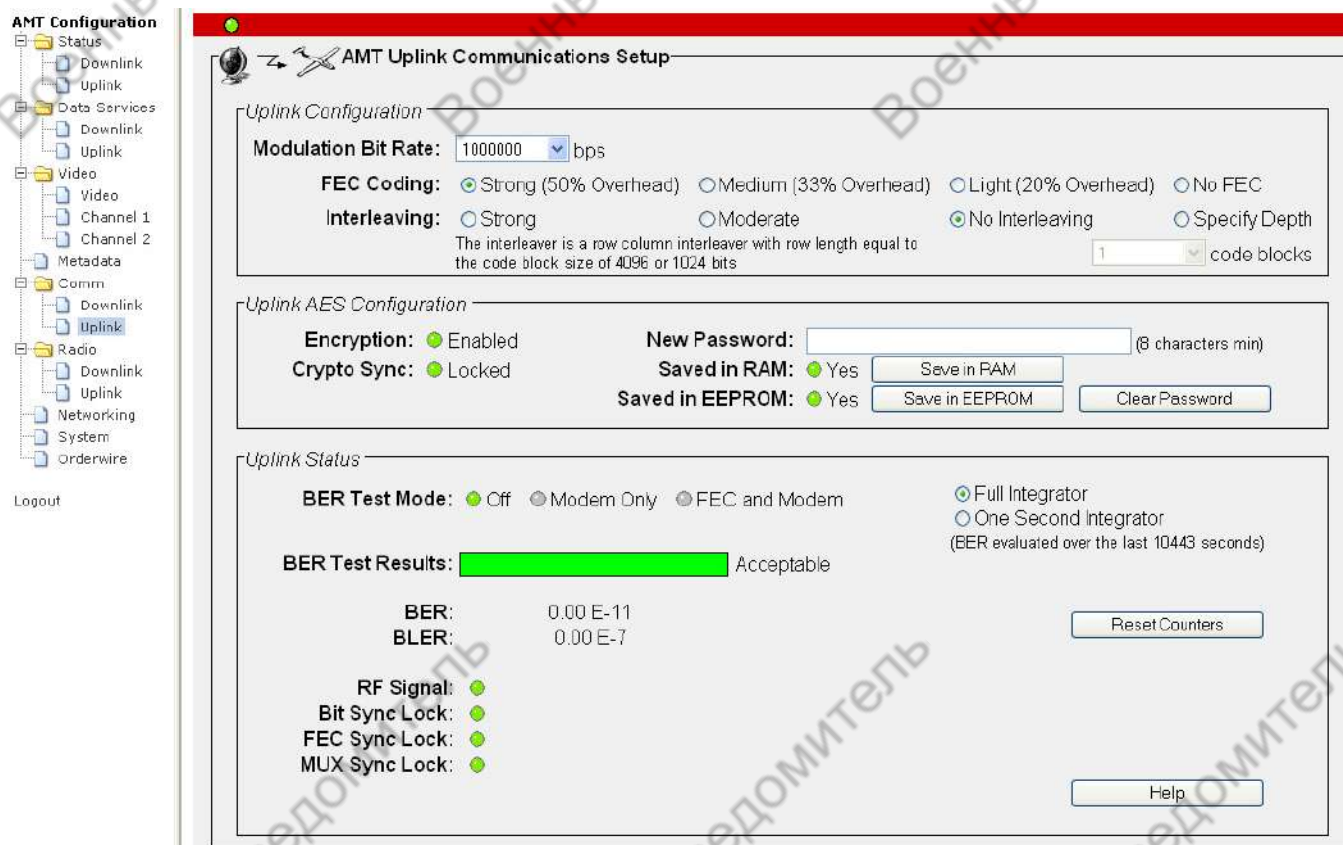


Figure 80: AMT Uplink Communications Setup Page with AES

The Uplink Configuration and Uplink Status boxes contain the exact same set of configuration options that are available on this page when the license for the AES feature is not enabled. These configuration options are described in paragraph 3.5.9 of this document.

Uplink AES Configuration

The AMT's AES decryption is automatically enabled when encryption is enabled at the GMT and the AMT has Mux Sync Lock (see paragraph 3.5.9), but the operator must enter the same password at the AMT as was entered at the GMT in order to get usable uplink data.

To use AES decryption, a valid password must be entered and saved either in RAM or in non-volatile EEPROM, and the Encryption Enabled checkbox must be checked at the GMT. All uplink data except a periodic clear-text message is encrypted using the AES 256 encryption algorithm in the cipher feedback mode. AES 256 uses a 256 bit key to encrypt blocks of 128 bits at a time.

Note that the same password is used for generating both the encryption and decryption AES keys. Any change made to the password on this page (setting, storing, or clearing) affects both the uplink and downlink AES configuration.

Encryption Enabled

This indicates if encryption is enabled at the GMT. During the transition to encrypted or unencrypted mode an AMT will briefly lose some of the data in the uplink data stream, since the GMT and AMT will not switch encryption modes at exactly the same time.

Crypto Sync

This indicates if uplink data appears to be decrypted properly. The AMT makes this determination by looking for the expected packet types in the decrypted data stream. If enough valid packet types are found within a one second window, the crypto sync indicator is green. This means it can take a second to show valid crypto sync even after encryption and decryption are enabled and the AMT has the correct password. In the meantime, this indicator will be red. If this indicator remains red, the most likely cause is the wrong password entered at the AMT.

New Password

Type a new password in this box and type the ENTER key or click on the Save in RAM button to save the new password in RAM while erasing any password saved in EEPROM. Or, type a new password in this box and click on the Save in EEPROM button to save the new password in RAM and EEPROM, overwriting any previously saved password in EEPROM. In either case, if encryption is already enabled the new password will immediately cause a new 256 bit key to be generated for AES decryption. Unless the same password is entered at the GMT, the AMT will not be able to decrypt the uplink stream.

Saved in RAM and Save in RAM

This indicator shows whether a valid password is currently in RAM. This is necessary for decryption to function at all. Clicking the Save in RAM button after entering a new password saves the new password in RAM while erasing any password saved in EEPROM.

Saved in EEPROM and Save in EEPROM

This indicator shows whether a valid password is currently in non-volatile EEPROM. This is not necessary for decryption to function, but if a password is saved in EEPROM then the AMT can begin decrypting data on its own after a power-cycle or a reboot, because it already has a valid password. If no password is saved in EEPROM, this is not an error condition, but the next time the AMT is power-cycled or rebooted any password saved only in RAM is lost, and the AMT will be unable to decrypt uplink data.

Clear Password

Clicking this button clears any saved password from both RAM and EEPROM. If encryption is enabled at the GMT, the AMT will lose crypto sync.

6.3.6 GMT Downlink Status and Configuration with AES

When the license for the AES feature is enabled, the GUI display for the GMT Downlink Status and Configuration page (originally described in paragraph 3.6.1) is changed to include status for this feature as seen in Figure 81.

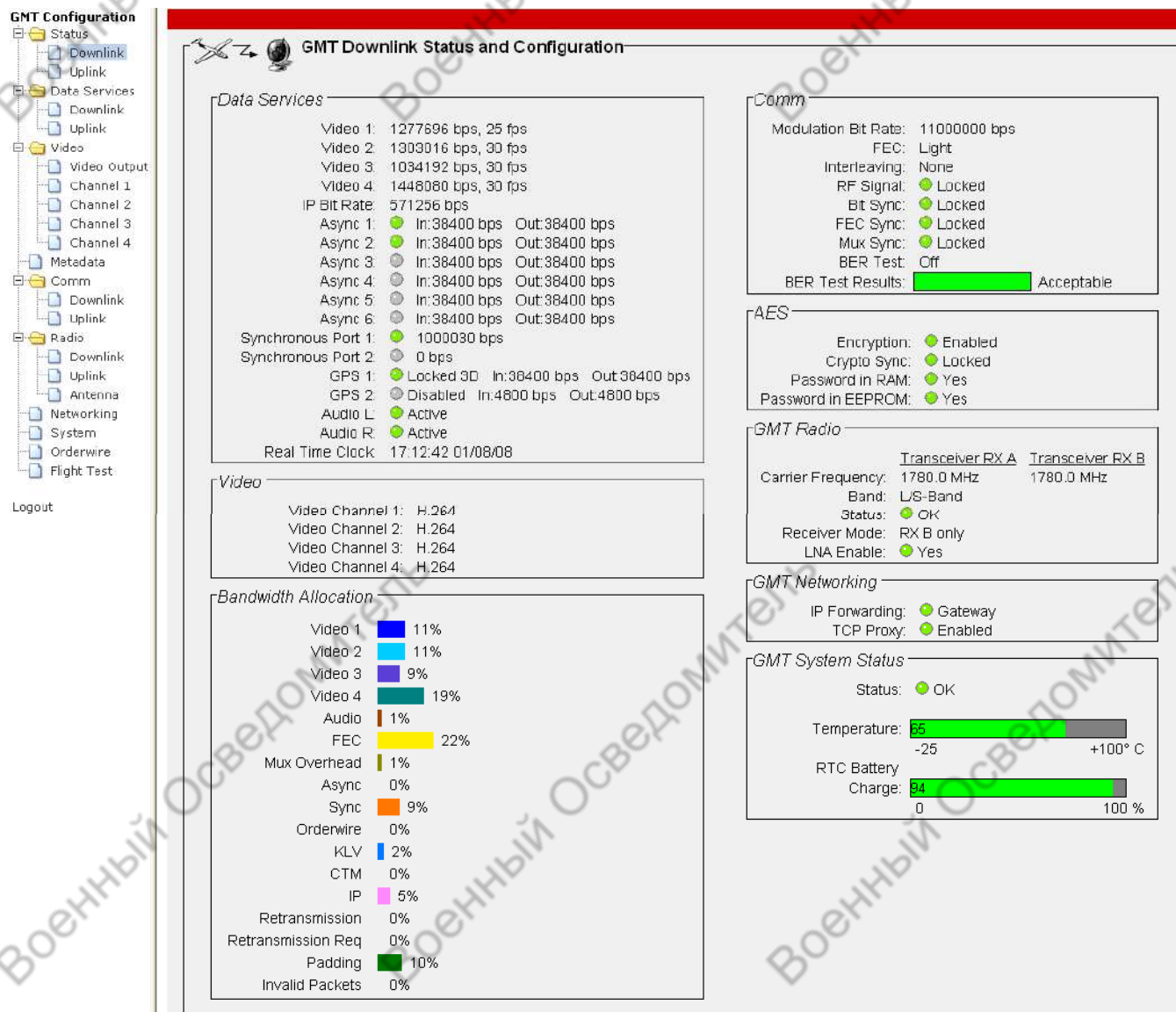


Figure 81: GMT Downlink Status and Configuration Page with AES

When the license for the AES feature is enabled, the AES configuration box shown in Figure 81 is displayed in the GMT Downlink Status and Configuration Page. This box displays the current AES encryption configuration. Otherwise, the information displayed on this page is identical to that displayed when the license for the AES feature is not enabled. See paragraph 3.6.1 for a complete description of all of the information displayed on this page that is not related to AES.

6.3.7 GMT Uplink Status and Configuration with AES

When the license for the AES feature is enabled, the GUI display for the GMT Uplink Status and Configuration page (originally described in paragraph 3.6.2) is changed to include status for this feature as seen in Figure 82.

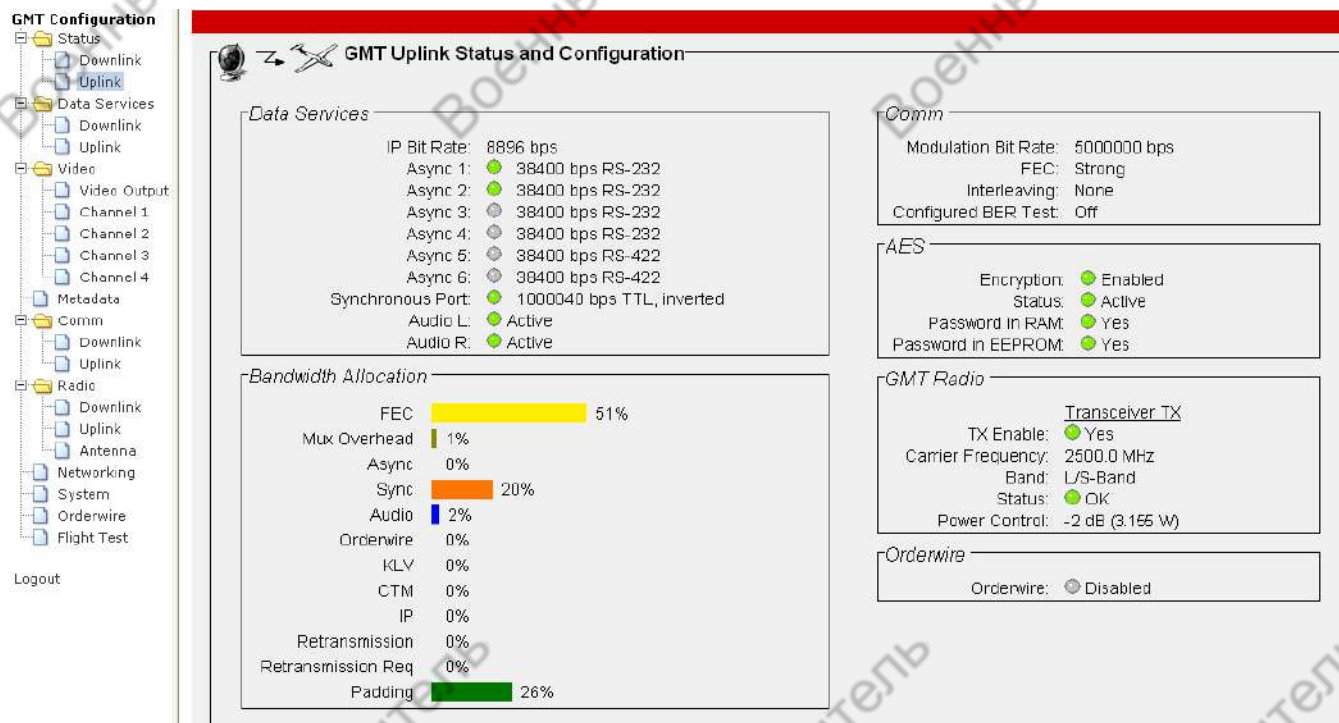


Figure 82: GMT Uplink Status and Configuration Page with AES

When the license for the AES feature is enabled, the AES configuration box shown in Figure 82 is displayed in the GMT Uplink Status and Configuration Page. This box displays the current AES encryption configuration. Otherwise, the information displayed on this page is identical to that displayed when the license for the AES feature is not enabled. See paragraph 3.6.2 for a complete description of all of the information displayed on this page that is not related to AES.

6.3.8 GMT Downlink Communications Setup with AES

When the license for the AES feature is enabled, the GUI display for the GMT Downlink Communications Setup page (originally described in paragraph 3.6.8) is changed to include controls for this feature as seen in Figure 83.

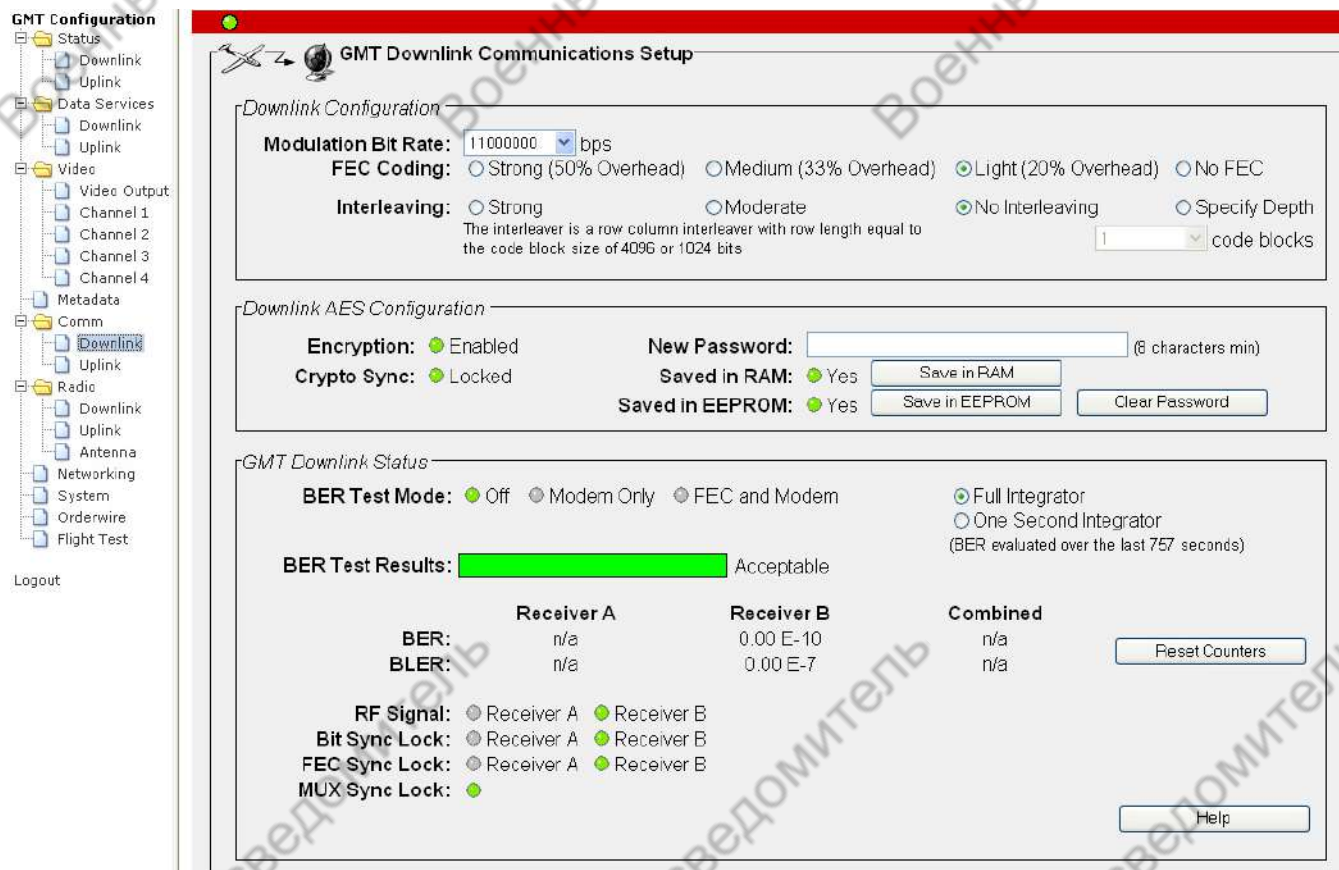


Figure 83: GMT Downlink Communications Setup Page with AES

The Downlink Configuration and GMT Downlink Status boxes contain the exact same set of configuration options that are available on this page when the license for the AES feature is not enabled. These configuration options are described in paragraph 3.6.8 of this document.

Downlink AES Configuration

The GMT's AES decryption is automatically enabled when encryption is enabled at the AMT and the GMT has Mux Sync Lock (see paragraph 3.6.8), but the operator must enter the same password at the GMT as was entered at the AMT in order to get usable downlink data.

To use AES decryption, a valid password must be entered and saved either in RAM or in non-volatile EEPROM, and the Encryption Enabled checkbox must be checked at the AMT. All downlink data except a periodic clear-text message is encrypted using the AES 256 encryption algorithm in the cipher feedback mode. AES 256 uses a 256 bit key to encrypt blocks of 128 bits at a time.

Note that the same password is used for generating both the encryption and decryption AES keys. Any change made to the password on this page (setting, storing, or clearing) affects both the uplink and downlink AES configuration.

Encryption Enabled

This indicates if encryption is enabled at the AMT. During the transition to encrypted or unencrypted mode a GMT will briefly lose some of the data in the downlink data stream, since the AMT and GMT will not switch encryption modes at exactly the same time.

Crypto Sync

This indicates if downlink data appears to be decrypted properly. The GMT makes this determination by looking for the expected packet types in the decrypted data stream. If enough valid packet types are found within a one second window, the crypto sync indicator is green. This means it can take a second to show valid crypto sync even after encryption and decryption are enabled and the GMT has the correct password. In the meantime, this indicator will be red. If this indicator remains red, the most likely cause is the wrong password entered at the GMT.

New Password

Type a new password in this box and type the ENTER key or click on the Save in RAM button to save the new password in RAM while erasing any password saved in EEPROM. Or, type a new password in this box and click on the Save in EEPROM button to save the new password in RAM and EEPROM, overwriting any previously saved password in EEPROM. In either case, if encryption is already enabled the new password will immediately cause a new 256 bit key to be generated for AES decryption. Unless the same password is entered at the AMT, the GMT will not be able to decrypt the downlink stream.

Saved in RAM and Save in RAM

This indicator shows whether a valid password is currently in RAM. This is necessary for decryption to function at all. Clicking the Save in RAM button after entering a new password saves the new password in RAM while erasing any password saved in EEPROM.

Saved in EEPROM and Save in EEPROM

This indicator shows whether a valid password is currently in non-volatile EEPROM. This is not necessary for decryption to function, but if a password is saved in EEPROM then the GMT can begin decrypting data on its own after a power-cycle or a reboot, because it already has a valid password. If no password is saved in EEPROM, this is not an error condition, but the next time the GMT is power-cycled or rebooted any password saved only in RAM is lost, and the GMT will be unable to decrypt downlink data.

Clear Password

Clicking this button clears any saved password from both RAM and EEPROM. If encryption is enabled at the AMT, the GMT will lose crypto sync.

6.3.9 GMT Uplink Communications Setup with AES

When the license for the AES feature is enabled, the GUI display for the GMT Uplink Communications Setup page (originally described in paragraph 3.6.9) is changed to include controls for this feature as seen in Figure 84.

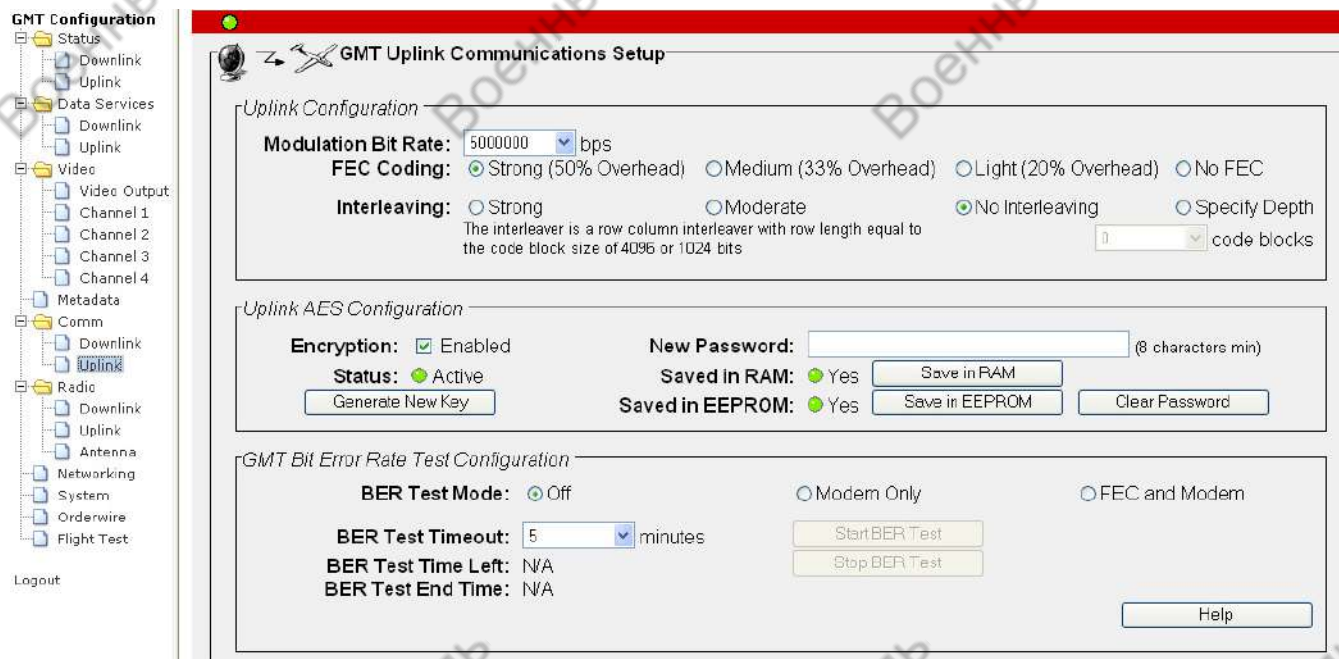


Figure 84: GMT Uplink Communications Setup Page with AES

The Uplink Configuration and Bit Error Rate Test Configuration boxes contain the exact same set of configuration options that are available on this page when the license for the AES feature is not enabled. These configuration options are described in paragraph 3.6.9 of this document.

Uplink AES Configuration

To enable AES encryption of the uplink multiplexed data stream, a valid password must be entered and saved either in RAM or in non-volatile EEPROM, and the Encryption Enabled checkbox must be checked on this page. All uplink data except a periodic clear-text message is encrypted using the AES 256 encryption algorithm in the cipher feedback mode. AES 256 uses a 256 bit key to encrypt blocks of 128 bits at a time. The AMT must have the same password entered in order to decrypt the data correctly.

If encryption is enabled but a valid password has not been entered, the GMT does not send any valid data unencrypted. Instead, it transmits a scrambled data stream that cannot be decrypted by the AMT. When encryption is enabled, the GMT never sends unencrypted data.

Note that the same password is used for generating both the encryption and decryption AES keys. Any change made to the password on this page (setting, storing, or clearing) affects both the uplink and downlink AES configuration.

Encryption Enabled

This checkbox enables or disables encryption of the uplink multiplexed data stream. During the transition to encrypted or unencrypted mode an AMT will briefly lose some of the data in the uplink data stream, since the GMT and AMT will not switch encryption modes at exactly the same time.

Status

This field and its gray/red/green LED indicate the status of AES encryption. In addition to this field, if AES is enabled the navigation band across the top of all GUI pages changes color. This status field can show the following indications:

- *Disabled* with gray LED indicates the Encryption Enabled checkbox is not checked.
- *Active* with a green LED indicates that encryption is enabled with a valid password, and all uplink data is actively being encrypted.
- *Fault* with a red LED indicates that encryption is enabled but some problem is causing encryption not to function. The most likely problem is an invalid password. In this case, no valid unencrypted data is sent from the GMT.

Generate New Key

Clicking this button causes the GMT to generate a new random SALT and use the new SALT with the existing user-entered password to generate a new 256 bit key for AES encryption. The new SALT is sent to the AMT in the periodic clear-text messages, but the AMT may not receive the new SALT immediately, and thus may go a short period of time where it is unable to decrypt the data.

New Password

Type a new password in this box and type the ENTER key or click on the Save in RAM button to save the new password in RAM while erasing any password saved in EEPROM. Or, type a new password in this box and click on the Save in EEPROM button to save the new password in RAM and EEPROM, overwriting any previously saved password in EEPROM. In either case, if encryption is already enabled the new password will immediately cause a new 256 bit key to be generated for AES encryption. Until the same password is entered at the AMT, the AMT will not be able to decrypt the uplink stream.

Saved in RAM

This indicator shows whether a valid password is currently in RAM. This is necessary for encryption to function at all.

Saved in EEPROM

This indicator shows whether a valid password is currently in non-volatile EEPROM. This is not necessary for encryption to function, but if a password is saved in EEPROM then the GMT can begin sending encrypted data on its own after a power-cycle or a reboot, because it already has a valid password. If no password is saved in EEPROM, this is not an error condition, but the next time the GMT is power-cycled or rebooted any password saved only in RAM is lost, and the GMT will be unable to send encrypted data. In that case, if encryption is enabled the GMT will send a scrambled uplink data stream that cannot be decrypted by the AMT, or if encryption is disabled the GMT will send all data unencrypted.

Save in RAM

Clicking this button after entering a new password saves the new password in RAM while erasing any password saved in EEPROM. If the Encryption checkbox is already checked, the GMT begins encrypting with the new password immediately.

Save in EEPROM

Clicking this button while the New Password box is empty saves the current password from RAM into non-volatile EEPROM, so that the GMT can be rebooted and will remember the password. Clicking this button after typing a password in the New Password box saves the newly entered password in both RAM and EEPROM, and if the Encryption checkbox is already checked, the GMT begins encrypting with the new password immediately.

Clear Password

Clicking this button clears any saved password from both RAM and EEPROM. If encryption is enabled, it remains enabled but because the GMT no longer has a valid password it sends a scrambled uplink data stream that cannot be decrypted by the AMT.

7 **Optional High Definition Video Capability**

The EnerLinksIII™ AMT HD provides the option to send up to two channels of High Definition video in the downlink transmission stream. The HD video capability is a licensed feature. This means that this capability requires a feature-specific license to be purchased for the AMT HD, and the associated license key to be entered on the unit. Before the key is entered, the controls for this feature will not be available from the command line or GUI.

Two mini-BNC connectors are included on the AMT HD which can receive digital video inputs in the HD-SDI format. The SDI-1 connector is associated with video channel (VC) 1, and the SDI-2 connector is associated with VC 2. When either of these channels is configured for HD-SDI input, the associated input jack is automatically selected for that channel.

When only analog video signals are selected for input, the AMT HD can support up to four channels of video input. However, for each digital video input selected, one less channel can be supported. Thus the system can support up to four analog video inputs, or two analog and one digital video input, or two digital inputs. Whenever VC 1 is configured for digital input, VC 3 cannot be enabled, and whenever VC 2 is configured for digital input, VC 4 cannot be enabled. Likewise, if VC 3 is enabled VC 1 cannot be configured for digital input, and if VC 4 is enabled VC 2 cannot be configured for digital input. H.264 is the only video compression type supported for the HD-SDI inputs.

The AMT HD is capable of auto-detecting the format and resolution of the input digital video signal. The input digital signal resolution is maintained for the compressed video stream (i.e. there is no up or down conversion). The following digital signal resolutions are supported by the AMT HD:

- 1920x1080p29.97
- 1280x720p59.94
- 1280x720p60

7.1 **High Definition Video Command Line Definitions**

The following modified commands are made available at the AMT command line interface when the license for this feature is enabled:

| Description | Command | Meaning |
|---------------------------|---|--|
| VIDEO | | |
| Set video mode (modified) | VM [1-4] [color/monochrome] [composite/yc/hdsdi] | Configures or queries input video mode. The first parameter specifies the video channel to configure. The second parameter may be set to monochrome to force the input video signal to monochrome before compression. The third parameter sets the input signal type for the channel: composite, YC or HD-SDI. |

| Description | Command | Meaning |
|-------------------------------|---|--|
| METADATA SETUP | | |
| Set camera latency (modified) | VL [1/2/3/4/SDI1/SDI2] <latency in usecs> | Enters the camera latency associated with the video input attached to the specified video jack. This value is used to adjust the time reference for each video channel receiving video from that jack. |

7.2 High Definition Video GUI Changes

When the license for the HD video feature is enabled on the AMT HD, the GUI display for the AMT Video Setup page, AMT Video Channel Setup page, and Metadata Setup page are changed to include controls for this feature. The changes to these pages are described below.

7.2.1 AMT Video Setup Page with HD Video Support

When the license for the HD video feature is enabled, the GUI display for the AMT Video Setup page (originally described in paragraph 3.5.5) is changed to include controls for this feature as seen in Figure 85. The ability to select the Signal Type is added to this page. The remainder of the page is unchanged.

AMT Configuration

- Status
 - Downlink
 - Uplink
- Data Services
 - Downlink
 - Uplink
- Video
 - Video
 - Channel 1
 - Channel 2
 - Channel 3
 - Channel 4
- Metadata
- Comm
 - Downlink
 - Uplink
- Radio
 - Downlink
 - Uplink
- Networking
- System
- Orderwire

Logout

AMT Video Setup

Video Input

| Video Channel 1 | Video Channel 2 | Video Channel 3 | Video Channel 4 |
|--|--|--|--|
| Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 | Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 | Video Compression <input checked="" type="radio"/> Disabled <input type="radio"/> H.264 | Video Compression <input type="radio"/> Disabled <input checked="" type="radio"/> H.264 |
| Signal Type <input type="radio"/> Composite <input type="radio"/> Y/C <input checked="" type="radio"/> HD-SDI | Signal Type <input checked="" type="radio"/> Composite <input type="radio"/> Y/C <input type="radio"/> HD-SDI | Signal Type <input checked="" type="radio"/> Composite <input type="radio"/> Y/C <input type="radio"/> HD-SDI | Signal Type <input checked="" type="radio"/> Composite <input type="radio"/> Y/C <input type="radio"/> HD-SDI |

Video Bit Rate

☒ Variable Bit Rate
☐ Fixed Bit Rate

Video Rate Sharing

Minimum Percent of Video Bandwidth Available to Each Channel

| | |
|------------|-------|
| Channel 1: | 25 % |
| Channel 2: | 25 % |
| Channel 3: | 25 % |
| Channel 4: | 25 % |
| Total: | 100 % |

AMT Title

Enter the AMT title strings for display on the GMT, and hit ENTER:

| | |
|------------|---|
| AMT Text 1 | Mission Three - HD Test Flight |
| AMT Text 2 | Tail Number VD554RT3 |
| AMT Text 3 | 123456789012345678901234567890123456789 |
| AMT Text 4 | |
| AMT Text 5 | |
| AMT Text 6 | |
| AMT Text 7 | |
| AMT Text 8 | |

Figure 85: AMT Video Setup Page with HD Video Support

Signal Type

The signal type can be set to Composite or Y/C for each video channel. HD-SDI input can only be selected for VC 1 and 2. When VC 1 is configured for HD-SDI input VC 3 cannot be enabled, and when VC 2 is configured for HD-SDI input VC 4 cannot be enabled. Likewise, if VC 3 is enabled VC 1 cannot be configured for HD-SDI input, and if VC 4 is enabled VC 2 cannot be configured for HD-SDI input.

7.2.2 AMT Video Channel Setup Page with HD Video Support

When the license for the HD video feature is enabled, the GUI display for the AMT Video Channel Setup pages (originally described in paragraph 3.5.6) is changed to include controls for this feature as seen in Figure 86. The Video Source section of this page is modified to display the HD video formats, to include the ability to select the HD-SDI Signal Type, and to display the SDI input jack when the HD-SDI Signal Type is selected. The H.264 Parameters section of the page is modified to increase the maximum supported Group of Pictures size from 30 to 60. The remainder of the page is unchanged.

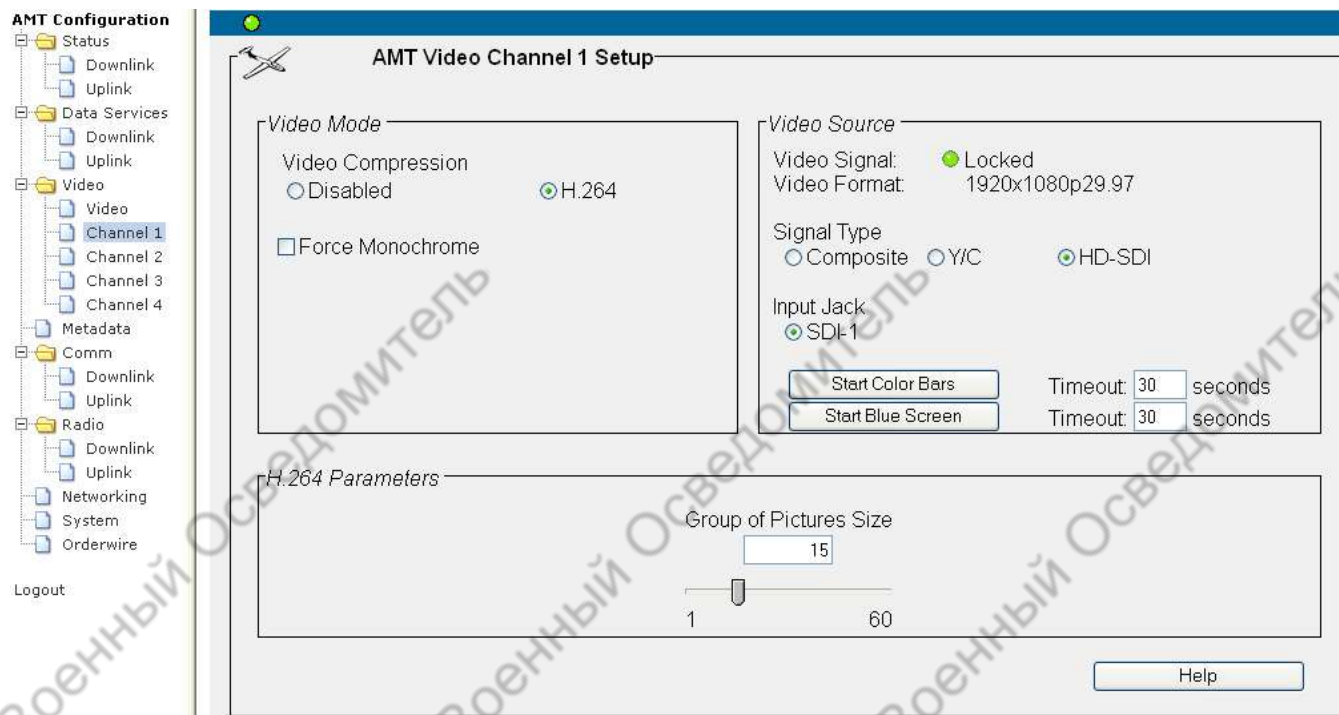


Figure 86: AMT Video Channel Setup Page with HD Video Support

Video Format

The EnerLinksIII System supports two widely used analog video formats. These are:

- NTSC: the standard for color television used in most of North America
- PAL: the standard for color television used in most of Europe. Note that there are several varieties of PAL that are used outside of Europe. The EnerLinksIII™ supports the PAL-B standard that is most widely used in Europe. It does not support other PAL standards.

When the license for the HD video feature is enabled, the EnerLinksIII System also supports three digital formats. These are:

- 1920x1080p29.97
- 1280x720p59.94
- 1280x720p60

When a video channel is enabled, the EnerLinksIII System will automatically detect and display the video format of the input video signal. If no video signal is detected, the last video format detected will be displayed. If the video channel is disabled, the format will be displayed as “Unknown”.

The detected video format will be read from the AMT and automatically refreshed in the GUI display approximately once a second.

Signal Type

The signal type can be set to Composite, Y/C, or HD-SDI for each video channel by selecting the appropriate radio button. When Composite or Y/C signal types are selected, video input for the channel comes from one of the analog input jacks. When HD-SDI is selected, the input comes from one of the digital input jacks.

Both PAL and NTSC signals can be accepted in composite format, which is a single signal that contains the entire video stream (and potentially audio as well, although the EnerLinksIII does not use the audio), or in Y/C mode in which there are two signals, a luminance (Y) signal and a chrominance (C) signal. Y/C typically provides better quality.

HD-SDI input can only be selected for VC 1 and 2. When VC 1 is configured for HD-SDI input VC 3 cannot be enabled, and when VC 2 is configured for HD-SDI input VC 4 cannot be enabled. Likewise, if VC 3 is enabled VC 1 cannot be configured for HD-SDI input, and if VC 4 is enabled VC 2 cannot be configured for HD-SDI input.

Input Jack

The EnerLinksIII AMT and AMT HD are designed with four analog video input jacks used to connect to video sources (typically video cameras). The AMT HD also provides two digital video input jacks which may only be used when the HD Video feature license has been enabled.

If a Y/C input video signal type is selected, jack selection is performed as a pair: “Jack 1/2” may be selected, in which case luminance (Y) must be on Jack 1, and chrominance (C) must be on Jack 2, or “Jack 3/4” may be selected, in which case luminance (Y) must be on Jack 3, and chrominance (C) must be on Jack 4. On the AMT HD, the analog video input jacks are designated as “AV-1” through “AV-4” instead of “Jack 1” through “Jack 4” to distinguish them from the digital video input jacks.

In the Composite mode, all four jacks provide the same function, and the AMT can be connected to as many as four different analog video sources. In this case, the user selects the desired source using the radio buttons.

When Video Channel 1 or 2 is configured for HD-SDI input, the input jack associated with the channel is automatically selected for that channel and displayed on the GUI page. The SDI-1 connector is associated with Video Channel 1, and the SDI-2 connector is associated with Video Channel 2.

Group of Pictures Size

The GOP size parameter in the H.264 Parameters section of the page is described in paragraph 3.5.6.1. When the license for the HD video feature is enabled, the maximum value for this parameter is increased from 30 to 60 frames. This allows the duration for a group of pictures to be set to one full second when a 60 frame-per-second video signal is received.

7.2.3 AMT Metadata Setup Page with HD Video Support

When the license for the HD video feature is enabled, the GUI display for the AMT Metadata Setup page (originally described in paragraph 3.5.7) is changed to include controls for this feature as seen in Figure 87.

The Metadata/Video Frame Time Synchronization section of this page will display the digital input jack associated with the video channel if a channel is configured for HD-SDI input. Also, the default max match time difference displayed in this section will be updated to accommodate the different frame rates available with digital video.

The Camera Latency section of this page is modified to allow latency values to be entered for the digital input jacks.

The screenshot displays the 'AMT Metadata Setup' window. On the left is a tree view with 'AMT Configuration' expanded, showing 'Status', 'Data Services', 'Video', 'Metadata', 'Comm', 'Radio', 'Networking', 'System', and 'Orderwire'. The 'Metadata' section is selected.

AMT Metadata Setup

Metadata Time Reference

Metadata 1 PPS Time Reference: ☒ Active ☒ Locked Read Metadata Time

Metadata/Video Frame Time Synchronization

| | Video Channel 1 | Video Channel 2 | Video Channel 3 | Video Channel 4 |
|---|---|--|--|--|
| Video Compression: | H.264 | H.264 | Disabled | H.264 |
| Input Jack: | SDI-1 | AV-3 | AV-1 | AV-3 |
| Max Match Time Difference: | 0.34 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default | 16.68 msec <input checked="" type="checkbox"/> Default |
| Avg Match Time Difference: | -495 usec | -7 usec | 0 usec | -7 usec |
| Last Match Time Difference: | -502 usec | -6 usec | 0 usec | -6 usec |
| Rx UDP Metadata Messages: | 1076 | 1076 | 1076 | 1076 |
| Rx UDP Meta Messages Dropped (Invalid UTC): | 0 | 0 | 0 | 0 |
| Rx UDP Meta Messages Dropped (Mux Overrun): | 0 | 0 | 0 | 0 |
| Rx UDP Time Aligned Metadata Messages: | 1076 | 1076 | 0 | 1076 |
| Rx UDP Misaligned Metadata Messages: | 0 | 0 | 1076 | 0 |
| MPEG2-TS Metadata Misalign Action: | Send msg without PTS | Send msg without PTS | Send msg without PTS | Send msg without PTS |
| MPEG2-TS Meta Messages Queued: | 0 | 0 | 0 | 0 |
| MPEG2-TS Meta Messages Dropped (Overrun): | 0 | 0 | 0 | 0 |
| MPEG2-TS Time Aligned Meta Messages: | 0 | 0 | 0 | 0 |
| MPEG2-TS Misaligned Meta Messages: | 0 | 0 | 0 | 0 |

Clear Counters

Camera Latency

| Jack AV-1 | Jack AV-2 | Jack AV-3 | Jack AV-4 |
|-----------|-----------|-----------|-----------|
| 0 usec | 0 usec | 700 usec | 300 usec |
| SDI-1 | SDI-2 | | |
| 0 usec | 0 usec | | |

Help

Figure 87: AMT Metadata Setup Page with HD Video Support

8 Advanced Theory of Operation

This section provides more detailed explanations of how the EnerLinksIII™ System works, with special focus on the details of the video processing, the multiplexing capabilities, and the communications capabilities.

8.1 Video Theory of Operation

The EnerLinksIII System is a digital video compression and communications system that provides a high quality and reliable transport of video over air-to-ground RF communication links.

There are several fundamental reasons for transmitting the video in digital format. These include:

- **Robustness.** Modern digital communication techniques can be designed with forward error correcting (FEC) coding that actually repairs bit errors in the transmitted data stream. In the EnerLinksIII System, FEC coding is combined with diversity and interleaving to make a system in which the performance will generally be as good at the edge of coverage as it is when the AMT and GMT are co-located. Only when the edge of coverage is passed does the system degrade, and then it essentially ceases to operate at all. This is in marked contrast to analog systems, in which the quality gradually degrades as the distance increases until at the edge of coverage the quality is unusable.
- **Versatility.** When the video is in a digital format, data from other sources can be multiplexed with it and transmitted over a single communications link. This saves payload size, weight, power consumption and cost. Moreover, digitized video provides the ability to make tradeoffs between resolution, frame rate and available bandwidth that can't be made with analog video.

To transmit digital video efficiently, it is absolutely essential to use a compression algorithm to reduce the number of bits required to represent the video signal. For example, analog video at 30 frames per second, with 560 pixels per line, 480 lines per frame and 8 bits per pixel, the required bit rate is nearly 65 Mbps. Compression allows this rate to be reduced by a factor of 30 to 60 with little loss in image quality. The reduction in bit rate saves precious RF bandwidth, and it also allows improvement in range since with all else being equal, range varies inversely as the square root of the bit rate.

Compression works by taking advantage of the fact that neighboring pixels in an image tend to have very similar values. Some compression techniques also take advantage of the frame-to-frame similarity of pixels in a given area. This correlation makes huge reductions in bit rate possible.

8.2 Multiplexer Theory of Operation

The EnerLinksIII Multiplexer located in both the AMT and the GMT works by organizing data into variable sized packets with a maximum size of 256 bytes. These packets have up to five components:

- A service identifier used to identify the type of data in the packet

- An optional length field if a packet type associated with a full sized (256 byte) packet is not used
- A sequence number used to detect when packets are missing (due to errors induced by transmission over the channel)
- A cyclic redundancy check (CRC) code used to determine whether there are errors in the data in a packet
- The data to be transported

Each Multiplexer service – synchronous data, asynchronous data, audio, orderwire data, IP and video – has a packet FIFO associated with it where packets are stored pending transmission. The behavior of the Multiplexer is dependant on the configured Video Bit Rate method. When the Variable Bit Rate method is selected, each time the Multiplexer is ready to send a new packet, it sends the oldest completed packet for any service other than video. Only if there are no other completed packets to send is a video packet sent. This approach allows video (on the downlink only) to consume all bandwidth not used by the other Multiplexer services.

When the Fixed Bit Rate method is selected, video data is given priority over forwarded IP traffic. The bit rate requirements of all of the data services other than IP are still met by the Multiplexer before it includes video in the multiplexed bit stream. The video streams are then allocated all of the remaining bandwidth up to the specified maximum bit rate. This mode may be used to limit the effects of extremely bursty IP traffic on video.

8.2.1 Audio data

The two audio channels are band limited to 3 kHz and sampled using telco grade 64 kbps uLaw codecs. This approach provides toll quality voice grade audio, but is not very well suited to sounds with significant high frequency content. The audio bit streams are formed into packets, and byte alignment of the audio samples is maintained by aligning bytes with the Multiplexer packet structure. The sampling clock for the audio is derived from the same reference as the modulation clock, and as a result, a clock can be recovered at the Decoder end of the link using a phase locked loop driven by the bit clock recovered by the bit synchronizer.

If audio packets are received with bit errors, they are used regardless since the bit errors probably will have relatively little perceptible effect in most cases, unless there are a large number of errors. If an audio packet is lost (as indicated by the sequence numbers), then the last in-sequence audio packet to be received is repeated. This tends to have a more pleasant effect than the obvious alternative of muting the audio for the packet duration.

8.2.2 Asynchronous data

Asynchronous data is received at the Encoder by UART. The bytes from the UART are each tagged with a port address and written into the Async packet FIFO. The port address allows all asynchronous data to be sent with a single FIFO at the cost of some additional overhead.

At the Decoder, the Async data packets are parsed and the bytes in them are routed to the appropriate Async data port. The port rates at the Decoder do not have to match the port rates at the Encoder, but they must be at least as fast or there is a risk that the Decoder will be unable to keep up. The GUI disallows choice of a port rate that is less than that used by the Encoder.

Transport of the Async data packets is straightforward with the exception of one issue: what happens when activity on the Async ports halts for a while? In this event, the Async packet FIFO probably contains a partially completed packet, and this packet will not be transmitted until it is complete. The data in the packet could thus potentially become very stale.

To circumvent this, the EnerLinksIII Encoder has an ability to generate “null bytes” to add to the packets in the Async packet FIFO. The purpose of these null bytes is to fill up the packet so that it will be transmitted – they serve no purpose at the receiver and are discarded. The null bytes are inserted based on a timeout: if the timeout elapses without a byte being added to the Async data packet, a null byte will be added. Thus when Async data port traffic is consistent, null bytes are not transmitted, but when the traffic slows, the null bytes ensure that the Async data packets will be transmitted at some guaranteed minimum rate. The shorter the timeout, the less latency an Async port byte will endure if it is the last byte sent by the data source.

The user can control the timeout for these null packets using the Async Port Padding control on the Data Services setup page at the originating end of the data link. Setting the slider to its highest setting makes the timeout such that the minimum packet rate will be equal to the packet rate resulting from the highest rate asynchronous port running at its maximum baud rate. Setting the slider to the lower end results in a minimum packet rate of 1/10 times the maximum packet rate.

8.2.3 GPS data (downlink only)

The EnerLinksIII AMT may be connected to a GPS receiver which generates data in the NMEA 0183 format. When this occurs, GPS location data is multiplexed by the AMT in two ways. It is sent at a rate specified by the user (subject to the maximum rate provided for by the NMEA 0183 standard) using an asynchronous data service that works in an identical fashion to the method used for the Asynchronous data ports and described in section 8.2.2. This data is the GPS data output on the GPS serial port at the GMT front panel and can also be configured to be sent out of the GMT as IP Packets.

In addition, when a frame has been compressed and is ready to transmit, the AMT tags the frame with the most recently sampled GPS location data. If on-screen display of GPS data is enabled at the GMT, the GPS location data is overlaid on the frame with which it is associated.

8.2.4 Synchronous data

Synchronous data is the most difficult service to provide over the Multiplexer because the clock rate for the output of the data at the Decoder must be matched exactly to the clock rate of the input at the Encoder. Since the Synchronous data arrives at the Decoder in packets, a rate buffer is provided that smoothes out the flow of data bits output by the Decoder. Matching the recovered clock at the Decoder to the source clock input to the Encoder is critical: if the recovered clock is too slow, the rate buffer will ultimately overflow and bits will be lost. If the recovered clock is too fast, the rate buffer will empty out and bits will be repeated.

The clock recovery in the Decoder uses a sophisticated all digital phase locked loop approach to match the Encoder clock rate very closely over the short term and precisely over the long term.

8.2.5 Orderwire data

Orderwire data is passed between the AMT and GMT to provide status monitoring and configuration of the AMT via the GMT GUI and command line interface. Configuration and status packets are written to the orderwire packet FIFO by the software on a periodic basis when the orderwire service is enabled. After orderwire connection is established, the orderwire service is designed to send no more than one packet per second in both the uplink and downlink directions.

8.2.6 IP data

IP data is sent between the AMT and GMT when IP forwarding is enabled. IP packets received on the Ethernet interface are sent to the IP packet FIFO when their destination is determined to be on the remote network. See section 8.4 for a detailed description of the IP forwarding feature.

8.2.7 Ancillary data

The Multiplexer also includes an internal service called Ancillary Data. The Ancillary Data service carries all the configuration information needed by the demultiplexer (and the video processing for the downlink) at the Decoder. This makes it unnecessary for the user to set many configuration items in the Decoder to match the Encoder. Unfortunately, this approach cannot be extended to communication related functions, since these have to already be configured properly in order for the Demultiplexer to be able to extract the Ancillary data packets.

8.2.8 Real time clock

The AMT and GMT each include a Real Time Clock (RTC) circuit similar to the circuits used to track time in most personal computers. This device includes a small battery backup and charger sufficient to allow the RTC to maintain time for powered down periods as long as one year. The RTC circuit maintains time to one second resolution, and this is extended in software to 10 msec resolution. The RTC also maintains the date in mm:dd:yy format.

The AMT RTC information is used to tag each video frame in much the same way as that used for the GPS data. The AMT time can be used as part of the text overlay if enabled at the GUI.

8.3 Communication System Theory of Operation

8.3.1 Modulation and RF Section

8.3.2 Forward Error Correcting (FEC) Coding

FEC Coding refers to a class of techniques widely used in digital communications to greatly improve the quality of communications on error-prone channels. In a typical application, the signal transmitted by the EnerLinksIII is degraded during its propagation to the receiver by a variety of factors, including intentional and unintentional interference, multipath reflections, and thermal noise of the receiver front end. These sources of degradation can cause the receiver to incorrectly interpret some bits that were intended to be set to one as zero and vice versa. Such errors degrade the video and may also have very negative consequences to the applications using the data bit streams multiplexed in the transmitted signal.

FEC is a technique in which the application data bits to be transmitted are processed in a way that increases the transmitted bit rate by adding more bits (often called “parity” bits) that are derived from the application data bits. The result of adding these bits is that not all combinations of bits can occur at the encoder output, since a given set of data bits results in only one specific set of parity bits. The situation is analogous to written text – a dictionary contains only a limited set of the number of possible combinations of letters, and because of this, a reader can often correct written text with errors in it. The reader’s mind acts as an error correcting decoder – finding the acceptable combination of letters that most closely matches what was received. In a like manner, the FEC decoder finds the closest acceptable bit sequence to the sequence received.

If too many errors occur in transmission, a received bit pattern can end up looking more like some other acceptable bit pattern to the receiver than it does like the original bit pattern. In this case, the decoder will make an error in the decision about what the data was. For good codes, this happens far less often than the event where the decoder is able to make the correction.

In general, the more parity bits are added, the more bit errors are needed to make one acceptable bit pattern look like some other acceptable bit pattern, and thus the code is able to produce a substantially lower bit error rate at its output for a given bit error rate at its input. The penalty of course is that the parity bits are overhead that make the system require more bandwidth to support a given bit rate, or conversely if the bandwidth available is fixed, the overhead reduces the throughput that the system can support. The ratio of the number of application bits to the total bits sent (application bits plus parity bits) is called the code rate. Thus for a rate $\frac{1}{2}$ code, there are two bits transmitted for every application bit.

The art in FEC is in determining the method by which the parity bits are computed. For a given code rate, two different methods for computing parity bits can produce drastically different amounts of improvement in bit error rate. The EnerLinksIII uses a very effective technique called Turbo Product Coding. In this approach, a group of bits are arranged in a square block, as shown by the shaded area of Figure 88. Each row of the square is then extended by computing a set of parity bits using a code called a Hamming code as indicated by the right-pointing arrows. Then the same Hamming code is used to produce more parity bits by operating down the columns of the square and of the parity bits just created to the right of the square.

The Hamming code used in this design has the property that if there are p parity bits added to a row, then the row must be $2^{(p-1)}$ bits in length. As an example, if there are 7 parity bits, the row must be 64 bits long, which means that there are 57 application bits in the row. For this code the rate is then $(57)(57)/(64)(64) = 0.793$, or roughly $4/5$. The code block length in this case is 4096 bits. This code is the code that results when the user selects the “Light” FEC coding option on the GUI.

A somewhat stronger code option is the “Moderate” option. Here the rows of application data are 26 bits long and the coded block row length is 32 bits. The resulting code rate is $(26)(26)/(32)(32)$ or 0.66. This is very nearly $2/3$. The code block length in this case is 1024 bits.

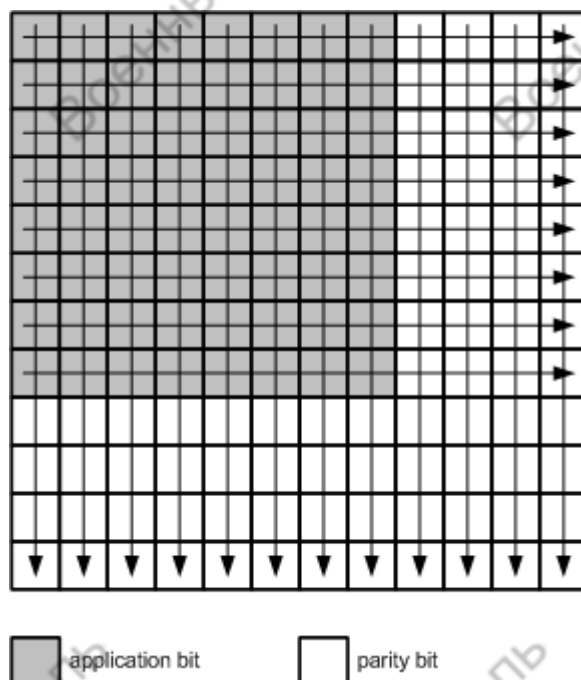


Figure 88: Turbo Product Code Concept

A simple extension of the turbo product code can be made to add more correcting power. In this extension, we encode a number of code blocks like the one in Figure 88. We then create one additional block of the same size in which each bit position is set to zero if the number of ones in the corresponding bit position of all the other blocks is an even number, and is set to one otherwise. The decoder then operates on complete sets of blocks.

In the EnerLinksIII, this approach is used to encode 3 blocks generated with the same code used for the “Moderate” option, generating a fourth code block to make a complete set comprising 4096 transmitted bits. Since there are $(3)(26)(26) = 2028$ application bits in this set, the code rate is 0.495, or nearly $\frac{1}{2}$. This is the “Strong” option in the user interface.

The relative performance of these codes can be predicted with very good accuracy when the channel impairment is receiver front end noise alone. In this case, the Strong code can provide acceptable performance with a signal 3 dB weaker than the Light code. This means that for line of sight channels, the maximum allowable range can be 40% greater with the Strong code than with the Light code. The cost of this improvement is that the amount of application data that can be carried using the Strong code is only about 60% of what it would be with the Light code. The Moderate code falls roughly between these two cases in performance and efficiency.

In channels subjected to other impairments, the tradeoff between coding options is much less clear, and the coding options may provide either dramatically different performance or very similar performance depending on the channel specifics.

8.3.3 Interleaving

In the previous section, an analogy was drawn between the effect of FEC coding and the ability to correct spelling errors. Here this analogy is extended to consider what happens when noise or

interference occurs in bursts. There are many sources of noise that have this behavior – a common source is from traditional radars whose rotating antennas can cause a burst of interference each rotation.

Suppose for example that a full printed page has 25 letters in error and that these are distributed more or less uniformly across the page. The reader is very likely to be able to correct all of these errors. Now suppose that there are 25 characters in error but that they all occur in a group of 25 consecutive characters. It then becomes much less certain that the reader will be able to reliably determine what was sent. This is comparable to the impact of burst errors on the process of FEC decoding.

Interleaving is a way to get around this. In the text analogy, the text characters could be transmitted by columns – first sending the first character in each row of text, then the second character of each row, and so on until all columns of characters are sent. This process of changing the order of the characters is interleaving.

As long as the receiver knows that characters were transmitted this way it can easily restore the original character order (deinterleaving) by writing down the characters in columns as they are received. Now when a block of errors whose length is shorter than a column occurs, these errors occur in the characters of a column. When the text is read, each row is impacted by only one error from the burst, and the reader is very likely to be able to correct all the errors.

In the case of data, the FEC code blocks are written into a memory organized in rows and columns. The row length is equal to the code block size, and the column length is ideally set equal to the maximum expected burst length. The data is read out one column at a time and transmitted as it is read. The deinterleaver at the receiver reverses the process. Figure 89 shows a deinterleaver memory with boxes marked with an x where errors occurred in the received bit stream. Here a burst of R errors results in only one error in each code block, and the FEC decoder can easily correct them all.

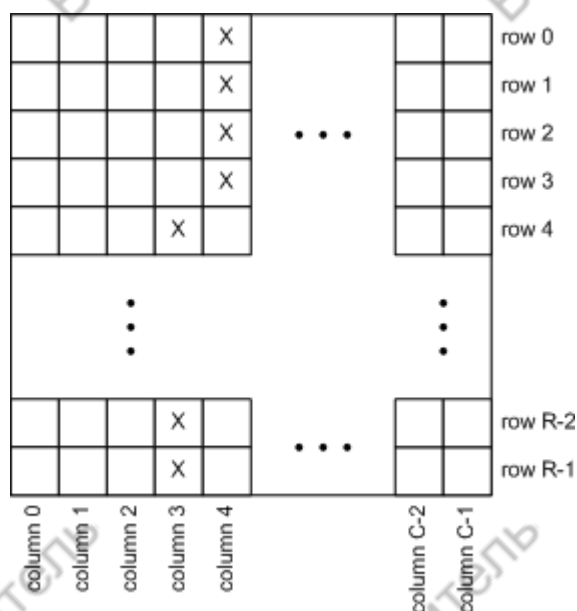


Figure 89: Interleaver Example

8.3.4 Frequency Diversity (downlink only)

Diversity is another technique for improving the reliability of transmission. A diversity system is a system that provides more than one way to transmit or receive the signal, with the idea that if the probability of success for each way is not closely correlated to the probability of success in the other ways, then the overall probability of successful transmission is higher. As an analog, suppose a man wants to send a message to his brother. If the chances of a letter being lost in the mail are 5%, he might send the same message in two different envelopes from two different post offices. In this case, the chances that both letters are lost are the square of 5%, or 0.25%.

The diversity method used in the EnerLinksIII allows the signal to be transmitted by the AMT at two different carrier frequencies. The GMT receiver has two channels and thus can receive at both frequencies at the same time. Within the EnerLinksIII GMT, the signals from the two receivers are demodulated independently. The FEC code blocks described in section 8.3.1 have an additional type of code called an error detection code embedded within them that allows the GMT to determine whether the FEC has left any uncorrected errors in the decoded block. On each block, the GMT determines the quality of the block produced from either receiver. If both receivers produce good blocks, they will have the same data and it doesn't matter which block is selected. If both receivers produce bad blocks, it again doesn't matter which block is selected. However, if one receiver produces a good block, and the other produces a bad block, then only the good block is passed forward.

It is not unusual in a communication system to encounter interference that impacts one frequency band very badly but has little effect on another. Diversity is a very effective tool for countering this kind of situation. As with the letter analogy, if the probability of an error in a block with just one receiver is p , and the error probabilities are independent on the two frequencies, then the probability that neither block is received correctly is the square of p . Thus if the block error rate is $1e-4$ before diversity, it will be $1e-8$ afterwards.

8.4 Metadata / Video Time Alignment Theory of Operation

The EnerLinksIII system provides the ability to align received metadata messages with their associated video frames so that the aligned video and metadata messages are tagged with the same Presentation Time Stamp (PTS) when they are output in a MPEG-2 TS stream. This capability is only supported on video channels configured with H.264 video compression.

In order to support this capability, a one Pulse-Per-Second signal and synchronized "time" messages must be delivered to the AMT from the camera/sensor equipment in the UAV. These provide a time reference that will allow the AMT to assign a UTC time stamp to each uncompressed video frame, which is synchronized with the time in the camera/sensor equipment. The AMT will compare the UTC value in the received metadata message headers with the UTC value assigned to each received video frame to match the two. When a match is found, the PTS value assigned to the video frame by the H.264 encoder will be written into the Packetized Elementary Stream (PES) packet header of the metadata message when it is included in the MPEG-2 TS stream. This same PTS value will be written in the PES packet header for the associated video AVC access units in the MPEG-2 TS stream. Applications receiving the

MPEG-2 TS stream can use these PTS values to associate metadata information and video information contained in the stream.

8.4.1 Timing Input Requirements to the AMT

The AMT requires the following inputs from user devices:

- A one Pulse-Per-Second time reference signal provided on the AMT's Async Port 6 RS232 input line.
- A "time" message in the format specified in section 8.4.4.1 sent over UDP giving the time of the previous PPS signal in 64 bit UTC format.
- A metadata UDP packet stream where the metadata packet headers contain a UTC value aligned with their associated video frames.

8.4.2 Metadata Input Requirements to the AMT

Metadata packets received by the AMT must arrive in the format defined in section 8.4.4.2 of this document. The header of each of these packets must contain the UTC value of the video frame that it matched at generation time in the user device.

In order to ensure that the AMT can match the metadata message with its associated video frame, it must arrive no more than ¼ second before or after that video frame.

Not every video frame need have a valid metadata packet for the EnerLinksIII system to operate. However, the definition of a synchronous MPEG-2 TS does assume such a one-to-one relationship, and viewer behavior is unknown if this is not the case.

8.4.3 EnerLinksIII Metadata / Video Time Alignment Procedure

- 1) Using the input one PPS signal and "time" message, the AMT defines a clock reference that is synchronized with the user camera/sensor equipment.
- 2) For each video channel, this time reference is adjusted by the camera latency associated with the channel's input jack. This latency value is provided by the user, and may be entered using the "VL" CLI command. By subtracting this latency offset from the time reference, the UTC time value assigned to each video frame by the AMT will match the time that the camera generated the video frame.
- 3) When the AMT receives an uncompressed video frame, it creates a UTC time stamp for that frame using the reference clock derived from steps 1 and 2. It also creates a unique Presentation Time Stamp (PTS) value based on the local AMT clock reference that identifies that video frame.
- 4) The AMT keeps a list of its recent video frame UTC and PTS time stamps. Note that video frames themselves are not delayed due to the matching algorithm. Video is passed through the

EnerLinksIII system as quickly as possible. For the matching algorithm the AMT just keeps a list of uncompressed video frame time stamps.

5) The AMT receives metadata packets associated with each video frame, each with a UTC in its header. These entire metadata packets are put in a list. Unlike video, a metadata packet could be held up if it arrives before the video frame. It is kept in a list waiting for its associated video frame.

6) When the AMT receives a metadata packet it searches the video time list for a match. Likewise, when a video frame arrives it searches the metadata list looking for a match.

In general a good match is one where the UTC time difference between the selected video frame and selected metadata packet is less than $\frac{1}{2}$ of a video frame time (or roughly 16.67 msec for NTSC and 20 msec for PAL.)

The UTC time difference that will result in a video/metadata match is user settable in units of msec. The range is from 0 to 40 msec. This value defines a match window that is centered on the video frame time. If a metadata packet's UTC is within +/- the configured value of a video frame that hasn't been matched before then it is a good match. This allowable time difference may be set using the "METAMD" CLI command.

If no video frame arrives within a half second that is within the configured time difference, the AMT will pick the entry from its video frame time list that has the closest UTC value and declare that to be the closest matching frame. In this case, it will clear a flag in the ViaSat internal metadata header (called the "PTS valid" flag) to indicate that the PTS value does not reflect a valid match.

If two metadata messages are received that are both within the configured time difference of the same video frame, the second message received will be considered to have an invalid match. Again, the "PTS valid" flag will be cleared in the ViaSat internal metadata header to indicate the mismatch.

7) When a match is made the AMT copies the video frame PTS to the ViaSat internal metadata packet header. After the copy the video frame and metadata packet contain exactly the same PTS value. This allows the viewer to unambiguously associate video and metadata.

8) The AMT forwards the metadata packet to the GMT. If an MPEG-2 TS is enabled for the video channel on the AMT or GMT, the metadata packet is sent from that unit over the transmit stream. The PTS value from the metadata packet header will be written into the Packetized Elementary Stream (PES) packet header of the metadata message when it is included in the MPEG-2 TS.

The action to take if the PTS value does not reflect a valid match (as indicated by the "PTS valid" flag in the metadata packet header) may be configured at the AMT or GMT. The misaligned metadata message may be dropped, the message may be sent with no PTS in the PES header, or it may be sent with the PTS value that was included in the metadata header in step 6

above representing the time of the video frame that was determined to be the closest match. This is configured with the “METAMA” CLI command.

9) If the clock and camera offset have been set properly on the AMT and the metadata packet timed correctly, then the match will be correct.

8.4.4 Format of Timing and Metadata Messages

The packet formats described here are the payload of UDP datagrams. The destination port addresses for these messages may be configured using the “METAPORT” CLI command or using the Metadata Port entry boxes on the Networking GUI page on the AMT. One destination port is configured for the metadata associated with each video channel. A single timing message must be sent to the AMT once each second, providing a timing reference for both video channels. This timing message may be sent to the metadata port assigned to either video channel.

Each UDP datagram may contain exactly one timing message or exactly one metadata group message (not both). The total amount of metadata may be longer than will fit in one Ethernet packet, so the IP protocol stack must support fragmentation of UDP datagrams into multiple fragments.

Endianness

Bytes within a field shall be inserted in big endian order (meaning the most significant byte is placed first).

8.4.4.1 Timing Message

The timing message is passed once a second and indicates the time of the last one second (hardware) pulse that precedes the timing message.

Requirements

The timing message must be sent soon enough after the one second pulse to allow the AMT to unambiguously determine which pulse the message corresponds to. The time must be expressed in two formats:

- 1) Coordinated Universal Time (UTC) in units of microseconds since 1970
- 2) Time of Day (ToD) such that the AMT can extract the time in hours, minutes, seconds, and sub-seconds with sub-seconds in units corresponding to 90 kHz cycles

UTC will be used in the AMT to relate the metadata group to a video frame.

Either or both UTC and ToD may be inserted into the AVC (H.264) video stream to indicate picture time.

Time Message Format

| Field | Contents | Number of bytes |
|---------------------|--|-----------------|
| Header | 0x74696D65 ("time") | 4 |
| Length | Length of this message in bytes from header to end inclusive | 2 |
| Version | 0 (version of message format) | 1 |
| Flags | f7 to f3: 0 f2: ToD fields valid flag (1 = valid; 0 = not valid) f1: continuity flag (1 = time measure is continuous with time in last message. 0 = time measure was reset) f0: time lock flag (1 = locked to GPS, 0 = not locked to GPS) | 1 |
| time message number | a modulo 256 count that increments once per time message | 1 |
| UTC | UTC in units of microseconds since 1970 (INT64) | 8 |
| TOD: hours | hours in day from 0 to 23 | 1 |
| TOD: minutes | minutes in hour from 0 to 59 | 1 |
| TOD: seconds | seconds in minute from 0 to 59 | 1 |
| TOD: sub-seconds | sub-seconds in second in units corresponding to 90 kHz clock cycles; from 0 to 89,999 | 3 |

Example

Assume:

- UTC time in seconds is 1,202,992,200. (This time corresponds to February 14, 2008 at 12:30 pm UTC.)
- Local time is 12:30:00 pm.
- Time is locked to GPS
- Continuity is maintained
- Time message number is 255

UTC in microseconds since 1970 will have a decimal value of 1,202,992,200,000,000, which in hex is 0x4461D72BFA200 (in INT64 this is 0x00.04.46.1D.72.BF.A2.00).

The time of day in hex is 0C:1E:00:000000.

The length of the packet is 23 (0x17) bytes.

The message as a byte stream will be:

```
74 69 6D 65 00 17 00 07  FF 00 04 46 1D 72 BF A2
00 0C 1E 00 00 00 00
```

8.4.4.2 Metadata Group Message

The metadata group message contains metadata units associated with each other and with a video frame.

Requirements

The metadata group message must contain:

- 1) All the metadata units associated with a video frame
- 2) An indication of the format of that metadata
- 3) The UTC of the metadata

The format of the metadata will be used by the AMT to determine the boundaries between metadata units. The AMT will also pass the metadata format over the airlink to enable the GMT to construct the metadata descriptor in the MPEG-2 transport stream.

Metadata Message Format

| Field | Contents | Number of Bytes |
|-------------------------|---|-------------------------|
| Header | 0x6D657461 ("meta") | 4 |
| Length | Length of this message in bytes from header to end inclusive | 2 |
| Version | 0 (version of message format) | 1 |
| Flags | f7 to f5: 0 f4: random access indicator f3: aligned with video (1 = aligned with video frame, 0 = not aligned with video frame) f2: UTC field valid flag (1 = valid; 0 = not valid) f1: continuity flag (1 = time measure is continuous with time in last message, 0 = time measure was reset) f0: time lock flag (1 = locked to GPS, 0 = not locked to GPS) | 1 |
| metadata message number | a modulo 256 count that increments once per metadata message | 1 |
| UTC | UTC in units of microseconds since 1970 (INT64) | 8 |
| metadata type | 255 to 2: not defined 1: KLV (predator metadata set) 0: KLV (general) | 1 |
| metadata | contiguous byte-aligned metadata units | Variable (1 – 10000) |

Note 1: The f3 flag allows sending a metadata group that is not aligned with any picture. If such a metadata group is received, the presentation time stamp will not necessarily correspond with the timestamp of a video frame and may be somewhat arbitrary. In the current product release, the PTS will be set to zero when the f3 flag is set to 0.

Note 2: If the UTC field is not valid (the f2 flag is set to 0) then the AMT will not be able to associate video with metadata. If the f2 flag is set to 0, the AMT will have to follow the unsynchronized metadata transport method of SMPTE RP 217. This unsynchronized metadata transport method will not be supported in the current product releases, in which case metadata passed to the AMT with the f2 flag set to 0 will be dropped.

Note 3: If the KLV type is predator metadata set, the AMT may use key compression to reduce the size of the metadata items over the air links

Note 4: The random access indicator is true (set to 1) if a the metadata stream contains sufficient information to allow a receiver to parse the metadata stream fully beginning with the metadata contained in this message without reference to any previous metadata items; otherwise the random access indicator is false (set to 0). (In principle, all metadata dictionary information should be resent periodically, and the random access indicator should be set before sending this dictionary.)

Example

Assume:

- UTC time of the message is 1,202,992,200,010,000 in microseconds
- Metadata is aligned with video, UTC field is valid, continuity is maintained, and timing is locked to GPS. The random access indicator is true.
- Metadata message number is 100 (0x64)
- KLV type is general (not necessarily the predator set)
- There are three KLV metadata items in the group (all associated with the same picture)
 - First metadata item is:
 - Key 0x06.0E.2B.34.01.01.01.01.01.01.11.01.00.00.00.00
 - BER 0x05 (payload of 5 bytes)
 - Value 0x1F.3E.B2.A0.91
 - Second metadata item is:
 - Key 0x06.0E.2B.34.01.01.01.07.07.01.10.01.04.00.00.00
 - BER 0x02 (payload of 2 bytes)
 - Value 0xAA.77
 - Third metadata item is:
 - Key: 0x06.0E.2B.34.01.01.01.01.07.01.02.01.03.02.00.00
 - BER 0x0A (payload of 10 bytes)
 - Value 0x10.E4.41.67.23.9A.C5.DD.A0.01

UTC In hex will be 0x00.04.46.1D.72.BF.C9.10

Length will be 18 (header) + 22 (first metadata item) + 19 (second metadata item) + 27 (third metadata item) = 86 (0x56)

The message as a byte stream will be:

```

6D 65 74 61 00 56 00 1F 64 00 04 46 1D 72 BF C9
10 00 06 0E 2B 34 01 01 01 01 01 01 11 01 00 00
00 00 05 1F 3E B2 A0 91 06 0E 2B 34 01 01 01 07
07 01 10 01 04 00 00 00 02 AA 77 06 0E 2B 34 01
01 01 01 07 01 02 01 03 02 00 00 0A 10 E4 41 67
23 9A C5 DD A0 01

```

8.5 IP Forwarding Theory of Operation

The EnerLinksIII provides the capability to forward IP traffic between the networks attached to the AMT and GMT over its two-way RF interface. This capability may be configured to operate as a proxy ARP bridge or a gateway.

Connectivity between two network segments can traditionally be provided with either a gateway or a bridge. Both devices are able to connect these segments and to forward packets in between. However, these devices traditionally operate on different networking layers. A bridge operates on layer 2, forwarding packets on the link layer based on the MAC address. A gateway operates on layer 3 and forwards the packets based on the destination IP address.

If a gateway is used to connect the network segments, each segment needs to be configured as its own logical network consisting of its own IP subnet, and a common netmask. Each host machine on the segment must have an entry in its routing table identifying the gateway. Whenever one host tries to contact another host, it uses its netmask to distinguish between hosts it can reach directly and hosts it needs to reach by the use of a gateway.

If the destination host is on the same network, the source host will issue an Address Resolution Protocol (ARP) request to retrieve its MAC address. This request will be broadcast to all network devices on the same network. All network devices will see the ARP request and the appropriate device will answer using an ARP reply. Then the two hosts may communicate directly.

If the destination host is on a different network, the source host checks its routing table to see if it has a gateway entry that it can use to access the destination address. If none exists, then it will use its default gateway entry. Once it has determined the appropriate gateway to use, the source host generates an ARP request to get the MAC address of the gateway. The gateway will answer with an ARP reply and the original request packet will be sent to the gateway using the IP address of the real destination as the destination IP address and the MAC address of the gateway as the MAC destination address.

If a bridge is used to connect two segments of a network, both segments are defined to be on the same subnet. In this case, the source machine will determine that it can reach the destination machine locally even though it is on the remote segment. Because of this, the source machine will use an ARP request to retrieve the destination machine's MAC address. When the bridge is set up, it will forward packets between the two segments, including the ARP request. While doing this it will learn the MAC addresses of the different devices in the connected segments. Based on this knowledge it will construct an ARP table which it will use to forward packets to the remote segment only when the hosts are known to be located on that segment.

8.5.1 Proxy ARP Bridge Capability

8.5.1.1 Bridge Definition

A network bridge interconnects LAN segments at the Network Interface layer and forwards frames between them. A bridge performs the function of a MAC relay, and is independent of any

higher layer protocol. Its use is generally to cut down on traffic on either side of the bridge by selectively forwarding traffic to devices on the far side of the bridge.

A bridge can be said to be *transparent* to IP. That is, when a host sends an IP datagram to another host on a network connected by a bridge, it sends the datagram directly to the host and the datagram “crosses” the bridge without the sending host being aware of it.

One common feature of a bridge is the “learning” capability. With this capability the bridge learns the MAC addresses of the different devices on the segment associated with each interface. Based on this knowledge a table can be constructed which then is used to forward the packets only to those segments where the hosts are located.

8.5.1.2 EnerLinksIII Proxy ARP Bridging Implementation

In the case of the EnerLinksIII, a proxy ARP bridging capability will allow IP traffic to pass between elements on the airborne network and ground network as though the two were on the same subnet. An example of traffic passing through the EnerLinksIII acting as a proxy ARP bridge may be seen in Figure 90.

A remote subnet address and mask will be configured on the AMT and GMT to define the range of remote addresses accessible through the EL-III proxy ARP bridge. This will help limit the amount of traffic sent on the multiplexed data stream. E.g. if a user configures the GMT's IP address as 17.2.3.2 and defines the uplink subnet address and mask as 17.2.3.0/255.255.255.0, the system will provide access to IP addresses 17.2.3.1 through 17.2.3.254 on the AMT network through the GMT.

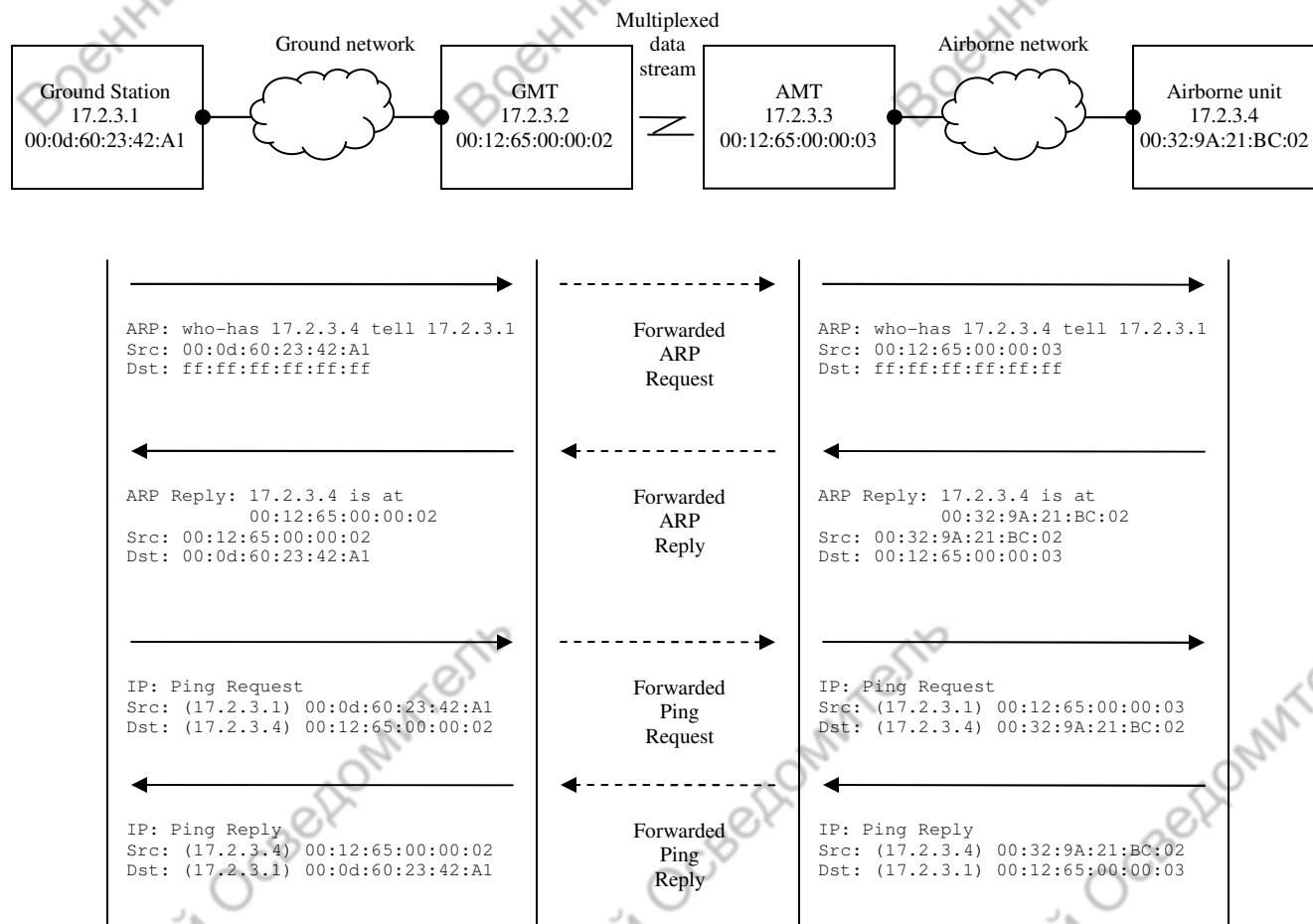


Figure 90: Proxy ARP Bridge IP Forwarding Example – Ping Request

Proxy ARP

In the EnerLinksIII implementation, the GMT and AMT will act as a proxy agent rather than a traditional bridge. A traditional bridge would forward all packets with the source MAC address unchanged, and drop packets with destination MAC addresses that it knows are not on the remote side of the interface. As a proxy agent, the AMT and GMT will send all messages with its own address as the source MAC address, so that to other units the EnerLinksIII looks like it is the final destination. When sending messages to a remote destination, senders will then use the MAC address of the AMT or GMT as the destination. This practice is called proxy ARP, and it is used to implement a pseudo bridge.

Implementing a proxy ARP pseudo-bridge uses considerably less processing on the EnerLinksIII than a traditional bridge. Normally, an Ethernet device will be configured to only forward packets that it receives to the Ethernet driver if they match the device's own address or a broadcast address. Since a bridge looks at the MAC address to decide where and whether to forward packets, it must be able to process all packets that are received by its Ethernet interface. In this case the Ethernet device is placed in promiscuous mode so that it forwards all received packets to the driver. Processing every packet on the network is typically a heavy load for

software to accomplish. Using proxy ARP allows us to provide bridging functionality without having to place the Ethernet device in promiscuous mode.

Local and Remote ARP tables

Each AMT and GMT maintains two ARP tables, one containing MAC and IP addresses associated with the local segment and one with addresses on the remote segment. We will call them the local and remote ARP tables. These are used to identify whether received packets should be forwarded to the remote segment.

Each entry in the ARP tables will include timeout information so that it can be aged and removed from the table after it expires. ARP entries expire in 20 minutes if they are not refreshed. If an entry has been used to direct outgoing traffic, but it has not been refreshed in 17 minutes, ARP requests will be sent at increasing intervals from 5 to 30 seconds apart to attempt to refresh it for three minutes. However, if the entry is not used in 17 minutes, no ARP requests are made and the entry will be allowed to expire in three minutes if no messages are received to refresh it.

Whenever a packet is received on an Ethernet port and it causes a message to be forwarded to the remote subnet, an entry for the received packet's source address will be added to the local ARP table. If the ARP entry already exists, its age will be reset.

Similarly, whenever a packet is received from the multiplexed data stream, an entry for the received packet's source address will be added to the remote ARP table, or the age of the existing remote ARP table entry will be reset.

Note that in a traditional bridge, the destination MAC address in a received packet is compared against entries in the ARP table to decide whether to forward the packet. In the case of the pseudo-bridge, the destination IP address will be compared against entries in the ARP table to make this decision. The ARP table will also be used to insert the "real" destination MAC address in the forwarded message.

Handling Packets Received on the Ethernet Interface

When a packet is received by the Ethernet driver, if it is destined for the unit's own IP address, it is processed as usual. Otherwise, if the packet's destination matches the remote subnet, the software will check its ARP tables to see if the destination IP address is known to exist on the local or remote segment. If the address is known to be accessible from the local interface, the packet is dropped. If it is known to be on the remote interface, it is forwarded. If it is not recognized, the packet is dropped and an ARP packet will be generated and forwarded to search for the address on the remote network segment. Forwarded packets will be sent to the remote EnerLinksIII unit over the multiplexed data stream.

One exception to the above rule is that if the received packet is an ARP request, and the destination matches an entry in the remote ARP table, an ARP reply with the AMT or GMT's MAC address is generated and sent back out the interface from which it was received.

Handling Packets Received on the IP Forwarding Interface

When a packet is received from the multiplexed data stream, the receiving EnerLinksIII unit overwrites the source MAC address with its own address and forwards the packet out the Ethernet interface, unless the destination matches the unit's own IP address. If the packet is destined for the unit's IP address, the packet is handed to the IP stack to be processed as usual.

Handling Packets Received from the Network Stack

When a packet is generated by the unit itself, it is passed to the IP stack to be delivered out the appropriate interface. Both the local and remote ARP tables will be checked for the destination address. If the destination address entry exists, it will be sent out the appropriate interface. If it doesn't exist, ARP requests will be sent to both the Airborne and Ground network segments with a timeout before attempting to send the packet. In general, any traffic originating from the EL-III that is destined for the remote network segment will be in response to some request from a host on that segment. In this case, an ARP entry should exist to identify that remote host.

Other Bridging Protocols

Note that because there is only one path between the airborne and ground networks, there is no need for the EnerLinksIII proxy ARP bridge functionality to support the spanning tree algorithm, which is commonly implemented on bridges to handle multiple hops and avoid cyclic routes.

Proxy ARP Bridging Configuration

Configurable parameters associated with proxy ARP bridging on the EnerLinksIII are as follows:

- Remote IP subnet address and mask, restricting the address range of packets to be forwarded.
- Enable/Disable forwarding of broadcast and multicast IP packets.
- Maximum allowable data rate to be consumed by forwarded IP packets. This can be used to prevent IP data from consuming the entire available bandwidth in the multiplexed data stream and blocking the transmission of video data. Note that if the data rate is set below that of the data being sent to the EnerLinksIII, data packets will be silently dropped to limit the rate.
- Manual clearing of ARP table entries. If the EnerLinksIII has entered an IP address in its ARP table, and that IP address is moved to another host, then the EnerLinksIII will be unable to talk to that host until it receives a message from that host, or the ARP table entry times out. As long as the original IP/MAC address mapping exists the EnerLinksIII will continue sending messages to the original (wrong) MAC address. Clearing the ARP table will clear this problem. Note this will rarely be a problem since IP addresses are seldom moved between machines.

Typical Configuration

A typical configuration for elements on the airborne and ground networks communicating through an EnerLinksIII datalink using the Proxy ARP Bridge IP forwarding scheme is shown in Figure 91. Note that the Uplink Subnet and Mask are configured to be very restrictive, only allowing packets destined for addresses 17.2.3.1 through 17.2.3.6 to be forwarded.

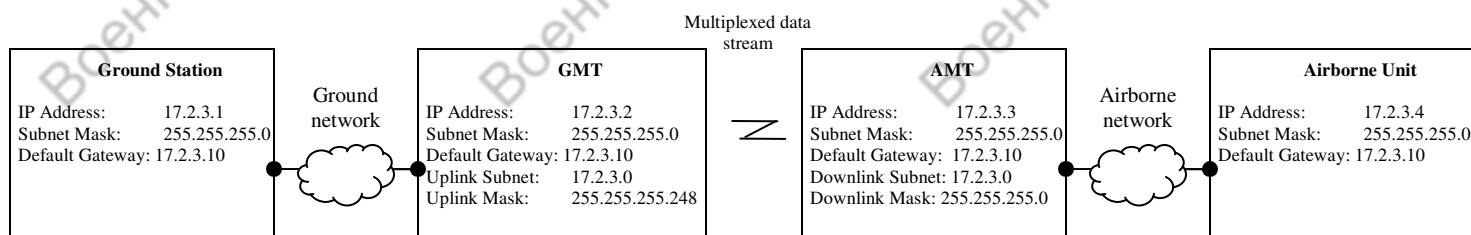


Figure 91: Typical Proxy ARP Bridge IP Forwarding Configuration

Proxy ARP Bridging Restrictions

Proxy ARP bridging requires that all network elements that will communicate on each side of the bridge are on the same sub-network. Thus, the IP addresses of hosts on the airborne network cannot be assigned independently of the ground network that is communicating with them. Airborne and ground network IP address assignment must be coordinated to prevent address conflicts.

Another limitation of the proxy ARP bridge configuration is that data transmitted through the bridge cannot be sent to remote network elements through a gateway or router. Since network elements on the far side of a gateway or router are not on the same subnet as the EnerLinksIII unit, the unit will not develop ARP table entries for those units.

A system configured for proxy ARP bridge IP forwarding imposes slightly more data traffic overhead compared to the gateway IP forwarding configuration due to transmission of ARP messages between the AMT and GMT. To implement bridge functionality, ARP requests to destinations that are not in the ARP table must be forwarded over the multiplexed data stream. Traffic over this interface should be limited as much as possible. Transmission of these ARP requests can be minimized by setting the IP forwarding network mask to be as restrictive as possible.

A final disadvantage of the proxy ARP bridge configuration is that it requires bi-directional communication for the system to fill out the ARP tables that the system uses to forward IP data. Thus, proxy ARP bridging cannot be used in an EnerLinksIII system configured for downlink only communication.

8.5.2 Gateway Capability

8.5.2.1 Gateway Definition

A network gateway is an internetworking system that joins two networks together. Depending on their implementation, network gateways can operate at any level of the OSI model from application protocols to low-level signaling. The gateway implemented by the EnerLinksIII system operates at the IP layer. This can also be thought of as a two port router with no dynamic routing protocols.

Unlike a bridge, the two sides of a gateway are independent networks. Each host talking over a gateway must be aware of the gateway in order to use it. When a host wants to send a message to an IP address that is not on its local network (as identified by its own IP address and subnet mask), then it uses a gateway to access it. To do this, it sends IP packets with the real address set as the destination IP address, but the MAC address of the gateway set as the destination MAC address. The MAC address of the gateway is discovered using the ARP protocol.

When a gateway receives a packet delivered to its own MAC address, but with an IP destination address that is not its own, it routes the packet. It first checks its routing table to see if it has a specific route designated for the destination, then checks to see which interface it should use to send the received packet based on the address and mask associated with each interface. Note that the networks associated with each interface are statically defined, so the gateway does not have to “learn” the configuration of the network.

8.5.2.2 EnerLinksIII Gateway Implementation

A gateway capability may be used to pass IP traffic between elements on the airborne network and ground network using the EnerLinksIII as a gateway. An example of traffic passing through the EnerLinksIII acting as a gateway may be seen in Figure 92.

A remote subnet address and mask will be configured on the AMT and GMT to define the range of remote addresses accessible through the EL-III gateway. E.g. if a user configures the GMT's IP address as 17.2.3.2 and defines the uplink subnet address and mask as 11.1.1.0/255.255.255.0, the system would provide access to IP addresses 11.1.1.1 through 11.1.1.254 on the AMT network through the GMT.

When an AMT or GMT is configured to operate as a gateway, an entry is placed in the unit's route table associated with the remote subnet. This entry is used to route packets to the remote EL-III unit over the multiplexed data stream.

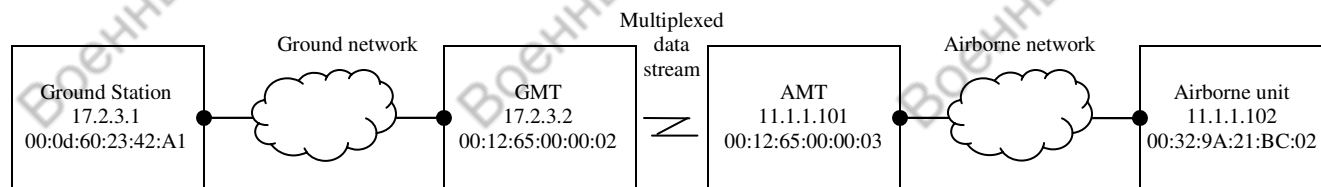


Figure 92: Gateway IP Forwarding Example – Ping Request

Handling Packets Received on the Ethernet Interface

When a packet is received on the Ethernet interface, it will be sent to the IP stack, which has been configured to support IP forwarding. If the destination IP address of the received packet does not match the unit's local IP address, the IP stack will search in its route table for an entry identifying where to forward the packet. If the destination IP address matches the range of addresses associated with the remote subnet, the IP stack will send the packet to the remote unit over the multiplexed data stream.

Handling Packets Received on the IP Forwarding Interface

When a packet is received from the multiplexed data stream, it will be sent to the IP stack, which has been configured to support IP forwarding. If the destination IP address of the received packet does not match the unit's local IP address, the IP stack will search in its route table for an entry identifying where to forward the packet. If the destination IP address matches the network associated with the Ethernet interface, the IP stack will send the packet to the Ethernet driver which will then send it to its destination over the IP network.

Handling Packets Received from the Network Stack

When a packet is generated by the EnerLinksIII unit itself, it is passed to the network stack to be delivered out the appropriate interface identified by the route table. Note that if the range of addresses accessible from the Ethernet interface and the remote subnet overlap, the destination for packets generated by the EnerLinksIII will be ambiguous. In this case, successive packets will be alternately sent to the local and remote networks. For this reason, care should be taken when defining your remote subnet address and mask, and your Ethernet interface address and mask.

Configuring Network Elements to Operate With a Gateway

As stated earlier, each host that wants to communicate over a gateway must be aware of the gateway. This means that the gateway's address must be configured on each host communicating through it.

Even the simplest machines generally have the ability to configure at least three parameters to operate on an IP network:

1. an IP address to identify the unit
2. a network mask to identify the local network that the unit resides on
3. a default gateway address to identify where to send data that is not destined for the local network

Configuring the AMT as the default gateway should be sufficient for all units on the AMT network.

It is likely that hosts on the ground network will require access to more than one network. The default gateway definition for these units will generally be defined to identify a router providing access to addresses outside of the company network infrastructure or internet. In this case, an additional gateway definition will need to be added to use the EnerLinksIII to access the airborne network. This is straightforward for most reasonably sophisticated network devices. The most common equipment expected to access the EnerLinksIII gateway on the GMT network is a PC. The gateway can be configured on a PC with a single command, or via the Network Connections control panel.

E.g. if the AMT network was 157.2.3.0 and our GMT was 10.1.30.4, the following command would set the appropriate route on the user's PC to access the airborne network:

destination
mask
gateway

route add 157.2.3.0
mask 255.255.255.0
10.1.30.4

Gateway Configuration

Configurable parameters associated with the EL-III gateway are as follows:

- Remote IP subnet address and mask, identifying the address range of packets to be forwarded.
- Enable/Disable forwarding of broadcast and multicast IP packets.
- Maximum allowable data rate to be consumed by forwarded IP packets. This can be used to prevent IP data from consuming the entire available bandwidth in the multiplexed data stream and blocking the transmission of video data. Note that if the data rate is set below that of the data being sent to the EnerLinksIII, data packets will be silently dropped to limit the rate.

Typical Configuration

A typical configuration for elements on the airborne and ground networks communicating through an EnerLinksIII datalink using the Gateway IP forwarding scheme is shown in Figure 93.

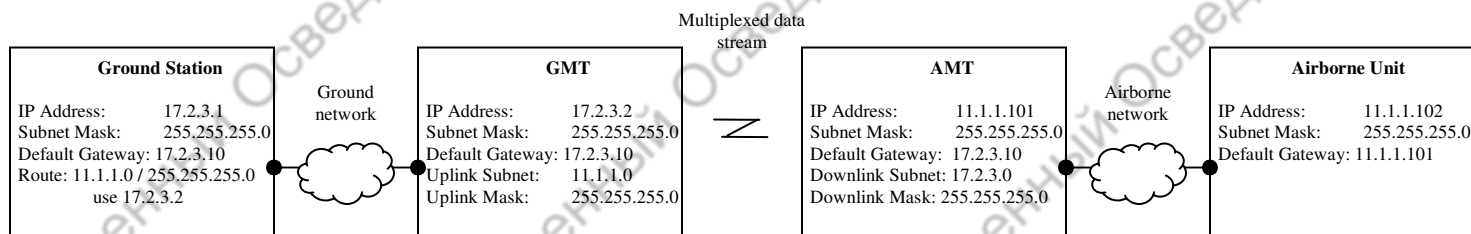


Figure 93: Typical Gateway IP Forwarding Configuration

Gateway Restrictions

With the EnerLinksIII acting as a gateway, only traffic sent directly to the EnerLinksIII will be forwarded to the far side. A gateway address must be configured on each network element that will communicate over the EnerLinksIII gateway.

8.5.3 IP Forwarding Throughput and Latency

The expected throughput and latency of IP traffic forwarded through an EnerLinksIII gateway or proxy ARP bridge depends on a number of factors. These include the modulation bit rate, Forward Error Correction and interleaving configurations, the amount of bandwidth consumed by other data services, and the size of the IP packets being forwarded.

8.5.3.1 IP Forwarding Throughput

The modulation bit rate, FEC, and interleaving configuration define the maximum bandwidth available to all data services. Based on these three parameters, the effective bit rate is given as:

FEC = strong:

$$\text{effective_bit_rate} = \text{modulation_bit_rate} \cdot 0.4873 \cdot \left(\frac{\text{interleaver_depth}}{\text{interleaver_depth} + 32} \right)$$

FEC = medium:

$$\text{effective_bit_rate} = \text{modulation_bit_rate} \cdot 0.6289 \cdot \left(\frac{\text{interleaver_depth}}{\text{interleaver_depth} + 32} \right)$$

FEC = light:

$$\text{effective_bit_rate} = \text{modulation_bit_rate} \cdot 0.7854 \cdot \left(\frac{\text{interleaver_depth}}{\text{interleaver_depth} + 32} \right)$$

FEC = off:

$$\text{effective_bit_rate} = \text{modulation_bit_rate} \cdot 0.9922 \cdot \left(\frac{\text{interleaver_depth}}{\text{interleaver_depth} + 32} \right)$$

The amount of this bandwidth that is available to the IP data service depends on the bandwidth taken up by the other data services. With the exception of Video data, IP is given the lowest priority in the multiplexed data services. This means that IP packets are only transmitted if there are no other packets to send of another data type. This approach allows IP to consume all bandwidth not used by the other Multiplexer services. The excess bandwidth left over after IP data is included in the stream is available for video data on the downlink. The minimum load presented by the other data services occurs when they are all disabled. In this case the only data sent across the multiplexed bit stream is the Ancillary data, described in section 8.2.7. This represents a load of 2048 bits per second in each direction.

The efficiency of transmitting IP data packets over the multiplexed bit stream is dependent on the size of the packets. When EnerLinksIII forwards an IP packet, it transmits the entire Ethernet message, without the 6 byte source and destination MAC addresses or the 4 byte CRC. This presents a savings of 16 bytes per packet. It sends the packets over the multiplexed data stream in data blocks with a maximum size of 256 bytes. When an Ethernet packet is forwarded that does not fit within a single data block, it is divided and sent in multiple blocks.

Within the first 256 byte block containing part of an Ethernet packet, 8 bytes of overhead are reserved to identify the block type, sequence number, CRC and other information. Subsequent blocks containing the remainder of the data for the same Ethernet packet have only 7 bytes of overhead reserved. Thus, the first data block can hold up to 248 bytes and the remaining can hold up to 249 bytes.

8.5.3.2 IP Forwarding Latency

Modulation bit rate, FEC, and interleaving configuration all play a role in determining the latency associated with sending a single data packet across the EnerLinksIII proxy ARP bridge or gateway.

Modulation bit rate will directly influence the time it takes to send packets through the system. FEC also affects the effective data rate, as described in section 8.5.3.1 above, but also creates about 5 code blocks worth of delay both transmitting and receiving. The size of the code block then determines the latency imposed by FEC. Note that the code block size is 4096 for all FEC modes except medium, which has a code block size of 1024. Interleaving is typically a much larger contributor to latency than FEC. In the Moderate Interleaving setting, the interleaver size is adjusted as a function of bit rate to result in a one-way end-to-end latency due to interleaving of about 400 msec for all bit rates up to 5 Mbps. At 5 Mbps and above, the Moderate setting is identical to the Strong setting. In the Strong Interleaving setting, the interleaver buffer size is maintained at 1 Mbit for all bit rates. At a modulation bit rate of 5 Mbps, this is the same as the Moderate setting, but at 1 Mbps, the one-way end-to-end latency due to interleaving is 2 seconds.

The expected one-way latency for various bit rate, FEC and interleaving configurations is shown in Figure 94.

| Bit rate (bps) | One-Way Latency in Milliseconds for Various Interleaver and FEC Modes | | | | | | | | | |
|----------------|---|-----------|------------|------------|-----------------------|------------|------------|---------------------|------------|------------|
| | No Interleaving | | | | Moderate Interleaving | | | Strong Interleaving | | |
| | no fec | light fec | medium fec | strong fec | light fec | medium fec | strong fec | light fec | medium fec | strong fec |
| 11000000 | 9.47 | 9.67 | 7.12 | 10.25 | 199.67 | 197.12 | 200.25 | 199.67 | 197.12 | 200.25 |
| 10000000 | 9.92 | 10.14 | 7.33 | 10.78 | 220.14 | 217.33 | 220.78 | 220.14 | 217.33 | 220.78 |
| 9000000 | 10.47 | 10.71 | 7.59 | 11.42 | 240.71 | 237.59 | 241.42 | 240.71 | 237.59 | 241.42 |
| 8000000 | 11.15 | 11.42 | 7.91 | 12.22 | 271.42 | 267.91 | 272.22 | 271.42 | 267.91 | 272.22 |
| 7000000 | 12.03 | 12.34 | 8.32 | 13.25 | 312.34 | 308.32 | 313.25 | 312.34 | 308.32 | 313.25 |
| 6000000 | 13.20 | 13.57 | 8.88 | 14.63 | 363.57 | 358.88 | 364.63 | 363.57 | 358.88 | 364.63 |
| 5000000 | 14.84 | 15.28 | 9.65 | 16.55 | 435.28 | 429.65 | 436.55 | 435.28 | 429.65 | 436.55 |
| 4000000 | 17.30 | 17.85 | 8.26 | 19.44 | 437.85 | 428.26 | 439.44 | 537.85 | 530.82 | 539.44 |
| 3000000 | 21.41 | 22.13 | 12.76 | 24.26 | 442.13 | 432.76 | 444.26 | 722.13 | 712.76 | 724.26 |
| 2500000 | 24.69 | 25.56 | 14.31 | 28.11 | 445.56 | 434.31 | 448.11 | 865.56 | 854.31 | 868.11 |
| 1000000 | 54.22 | 56.39 | 28.27 | 62.77 | 476.39 | 448.27 | 482.77 | 1,080.70 | 1,066.63 | 1,083.89 |
| 500000 | 103.43 | 107.78 | 51.53 | 120.54 | 537.78 | 481.53 | 550.54 | 2,156.39 | 2,128.27 | 2,162.77 |
| 200000 | 251.08 | 261.95 | 121.33 | 293.85 | 671.95 | 531.33 | 703.85 | 4,297.78 | 4,241.53 | 4,310.54 |
| 100000 | 497.16 | 518.90 | 237.66 | 582.71 | 928.90 | 647.66 | 992.71 | 10,751.95 | 10,611.33 | 10,783.85 |
| 35000 | 1,411.18 | 1,473.30 | 669.74 | 1,655.60 | 1,943.30 | 1,139.74 | 2,125.60 | 21,488.90 | 21,207.66 | 21,552.71 |

Figure 94: One-Way IP Data Latency in Milliseconds

A1. Appendix A1 - Subnet Mask Definition

What is a subnet mask?

To answer that, we first need to describe the anatomy of an IP address. An IP address consists of 4 bytes of information containing two parts: the network portion and the host portion. The network portion defines the network that the address is available on, and the host portion identifies the specific host within that network. Three standard classes of networks are defined, Class A, B and C. In Class A addresses, the first byte identifies the network portion, in Class B networks, the first two bytes identify the network portion and in Class C addresses, the first three bytes identify the network portion. When groups of IP addresses are given out to companies that request them, they are given out as a group, the size of which is determined based on need. A Class A network contains about 33 million addresses, a Class B network contains about 33 thousand addresses and a Class C network contains 255 addresses. Each class of networks is recognized by its first byte, as follows:

| Network class | Usable range of first byte values (decimal) |
|---------------|---|
| A | 1 to 126 |
| B | 128 to 191 |
| C | 192 to 254 |

The network information in an address is used to route data to the appropriate sub-network on which a host is located. A router will know that all traffic bound for a specific network should be sent to a specific router. Sometimes an organization will not want to co-locate all of the network addresses assigned to them and may need to split up their network into smaller subsets. They may only want a subset of the total network to be routed to a single location, and another subset to be routed to another location. This is where sub-networking, and the subnet mask come in. A subnet mask is used to explicitly identify the network and host portions of an address. The subnet mask is all the network bits in an address set to '1' and all the host bits set to '0'. This means that the standard network masks for the three classes of networks are:-

A Class network mask: 255.0.0.0

B Class network mask: 255.255.0.0

C Class network mask: 255.255.255.0

The way sub-networking operates is to borrow one or more of the available host bits and then make interfaces interpret these borrowed bits as part of the network bits. So to divide a network number into two sub-networks, we would borrow one host bit by setting the appropriate bit in the network mask of the first (normal) host bit to '1'. For a C Class address, this would result in a netmask of 11111111.11111111.11111111.10000000 or 255.255.255.128. This would split the class c address space into two subnets, each with 126 addresses. For a C Class network number of 192.168.1.0, you would have two sub-network addresses, 192.168.1.0 and 192.168.1.128, with an available range of 0 - 127 for the last byte in the first sub-network and a range of 128 - 255 in the last byte for the second sub-network.

How is a subnet mask used?

Network elements with multiple interfaces such as routers and gateways determine which interface to send traffic on based on the network associated with that interface. Networks are

associated with an interface by the IP address of the interface, and the subnet mask of the interface. As described above, the subnet mask identifies the network portion of the address. So any traffic being delivered by a network element is sent out the interface that matches the network associated with the destination. For instance, if a device has two interfaces on it, one with an address of 121.3.4.5 and a subnet mask of 255.255.255.0 and one with a address of 121.88.61.14 and a mask of 255.255.0.0, a message destined for address 121.88.23.1 will be sent out the second interface. Addresses not included in any network associated with an interface are generally sent to a defined default gateway.

For further information on the definition and use of network masks, refer to RFC 4632 Classless Inter-domain Routing (CIDR): The Internet Address Assignment and Aggregation Plan.

A2. Appendix A2 – Networking Statistics

Detailed networking statistics may be obtained for the Ethernet interface and IP forwarding interface by using the “details” argument in the “ns” and “ipfs” CLI commands. Additionally, detailed statistics associated with the TCP Proxy connection may be retrieved using the “details” argument with the “tcpps” CLI command. This appendix provides a guide to interpreting the information provided.

A2.1 Ethernet Interface Statistics

Detailed networking statistics for the Ethernet interface may be obtained from the “ns details” CLI command. These statistics are described below.

| Ethernet Statistics | |
|----------------------------|--|
| Tx Total Packets | Packets written to the Ethernet device for transmission. |
| Tx Errored Packets | Errors during packet transmission. |
| Tx Discarded Packets | Packets dropped due to malformed packets representing an internal error. (Not included in Tx Total Packets) |
| Tx Missed Packets | Packets dropped due to failure to allocate a transmit buffer in the Ethernet device. (Not included in Tx Total Packets) |
| Tx Heartbeat lost | Heartbeat lost. Signal Quality Error Test detected error. |
| Tx Deferred | Transmission deferred because carrier was detected during the first 6.4 μ s of the inter frame gap. (Not included in Tx Errored Packets) |
| Tx Underrun | Transmission DMA underrun. (Included in Tx Errored Packets) |
| Tx Carrier Lost | Lost carrier sense. (Included in Tx Errored Packets) |
| Tx Late Collisions | Late collisions (later than 64 byte times into the frame) detected on a frame. (Included in Tx Errored Packets) |
| Tx Excess Collisions | Excessive collisions (16+) detected. (Included in Tx Errored Packets) |
| Tx Single Collisions | Single collision detected on a frame. (Not included in Tx Errored Packets) |
| Tx Multi Collisions | Multiple collisions detected on a frame. (Not included in Tx Errored Packets) |
| Tx Ring Buffers Free | Count of available, unused transmit buffers. |
| Tx Ring Buffers Used | Count of transmit buffers queued for transmission. |
| Rx Total Packets | Total packets received on the Ethernet interface. |
| Rx Errored Packets | Errored packets received and dropped. (Included in Rx Total count) |
| Rx Discarded Packets | Packets dropped because they are of an unknown type (neither IP nor ARP), or they are destined for a multicast address to which the unit has not joined, and multicast forwarding is not enabled. (Included in Rx Total count) |
| Rx Missed Packets | Good packets received but dropped when there were no receive buffers to place them into. (Included in Rx Total count) |
| Rx Align Errors | Packets received unaligned. (Included in Rx Errored count) |

| | |
|----------------------|---|
| Rx FCS Errors | Packets received with CRC errors. (Included in Rx Errored count) |
| Rx Runt Packets | Packets received that are too short. (Included in Rx Errored count) |
| Rx Giant Packets | Packets received that are too long. (Included in Errored count) |
| Rx Overrun | Ethernet receiver DMA overruns. (Not included in Rx Total count) |
| Rx Ring Buffers Free | Receive buffers currently available. |
| Rx Ring Buffers Used | Receive buffers currently used. |

Internet Layer Statistics

| | |
|----------------------|---|
| Tx Total Packets | All packets intended to be sent out the Ethernet interface. Includes both IP and ARP packets. |
| Tx Errored Packets | Packets that were not sent due to lack of resources. E.g. Failure to allocate TX buffer. (Included in Tx Total count) |
| Tx Discarded Packets | Packets that were discarded because they could not be resolved before timing out or being replaced by another packet sent to the same destination IP address. (Included in Tx Total count and ARP stats count of “Dropped pkts no arp”) |
| Tx Missed Packets | Packets that were discarded because of failure to allocate an ARP entry to wait on ARP resolution. (Included in Tx Total count and ARP stats count of “Dropped pkts no arp”) |
| Tx Unicast Packets | Unicast packets sent. (Included in Tx Total count. Includes packets that were errored, discarded, and missed.) |
| Tx Multicast Packets | Multicast packets sent. (Included in Tx Total count. Includes packets that were errored, discarded, and missed.) |
| Tx Broadcast Packets | Broadcast packets sent. (Included in Tx Total count. Includes packets that were errored, discarded, and missed.) |
| Tx Octets | Total Octets in all packets sent. Does not include size of Discarded and Missed packets, but does include Errored packets. |
| Rx Total Packets | All packets received by the Ethernet interface and passed to the internet layer. Includes both IP and ARP packets. |
| Rx Errored Packets | Packets received with fragmentation errors. May represent an internal error. (Included in Rx Total count) |
| Rx Discarded Packets | Discarded for other reasons. (Not currently used.) |
| Rx Missed Packets | Packets dropped when unable to allocate protocol control blocks for them or unable to allocate message structures to pass to the IP and ARP services. (Included in Rx Total count) |
| Rx Unicast Packets | Unicast packets received. (Included in Rx Total count) |
| Rx Multicast Packets | Multicast packets received. (Included in Rx Total count) |
| Rx Broadcast Packets | Broadcast packets received. (Included in Rx Total count) |
| Rx Octets | Total octets in all packets included in Rx Total packets, even if they are errored or discarded. |

ARP Statistics

| | |
|------------------|---|
| Tx Total Packets | Total ARP packets sent on this interface. |
| Tx Requests | Total ARP Requests sent on this interface. This includes requests generated by this unit to resolve IP packets being sent out the |

| | |
|----------------------|--|
| | Ethernet interface, as well as ARP requests received on the IPF interface that were forwarded across the Ethernet interface. |
| Tx Replies | Total ARP Replies sent on this interface. This includes replies generated by this unit in response to requests received over the Ethernet interface (including replies for the local IP address and proxy addresses), as well as replies that were received on the IPF interface and forwarded across the Ethernet interface. |
| Tx Proxy Replies | Total Proxy ARP Replies sent on this interface. These are ARP replies sent for hosts known to exist on the far side of the Proxy ARP bridge provided by the EnerLinksIII. (Included in Tx Replies) |
| Tx Packet Errored | ARP packets that could not be sent due to failure to form the packet or failure to send the packet at the Ethernet layer. (Included in Tx Total Packets and Tx Replies or Tx Requests) |
| Tx Packets Discarded | Unused counter. |
| Tx Packets Missed | ARP requests that could not be sent due to failure to allocate resources for the packet. (Included in Tx Total Packets and Tx Requests) |
| Rx Total Packets | Total packets received by the Internet layer and passed to the ARP stack for this interface. |
| Rx Requests | ARP requests received with destinations that match either the local IP address or an entry in the remote ARP table when proxy ARP is enabled. (Included in Rx Total count) |
| Rx Replies | ARP replies received with destinations that match either the local IP address or an entry in the remote ARP table when proxy ARP is enabled. (Included in Rx Total count) |
| Rx Packet Errored | Packets received by the ARP stack that had an invalid ARP header and were dropped. (Included in Rx Total count) |
| Rx Packets Discarded | ARP packets received with destinations that don't match the local IP address or any entries in the remote ARP table when proxy ARP is enabled. (Included in Rx Total count) |
| Rx Packets Missed | ARP packets received which would have been used to create an entry in the ARP table, but didn't because the entry allocation failed. |
| Allocs Failed | Number of failures to allocate an ARP table entry. |
| Cache hits | Number of times an IP packet transmit was attempted and there was a completed ARP table entry for the destination. |
| Cache misses | Number of times an IP packet transmit was attempted and there was no completed ARP table entry for the destination. |
| Dropped pkts no arp | Tx IP Packets dropped while waiting for an ARP reply. Includes packets that were waiting on an ARP reply when the associated ARP entry expired, and packets that were waiting on an ARP reply when another IP packet to the same destination was transmitted. Only one packet will be held at a time waiting for an ARP reply. |

IP Statistics

| | |
|------------------|--|
| Tx Total Packets | IP Packets sent on the Ethernet interface. |
| Rx Total Packets | IP Packets received on the Ethernet interface. |

| Transport Layer Statistics | |
|-----------------------------------|---|
| Tx Total Packets | The total number of IP packets generated locally and sent out any interface. |
| Tx TCP Packets | The total number of TCP packets generated locally and sent out any interface. (Included in Tx Total count) |
| Tx UDP Packets | The total number of UDP packets generated locally and sent out any interface. (Included in Tx Total count) |
| Tx Errored Packets | The total number of packets unsent due to internal errors. Includes packets generated locally and forwarded. (Locally generated packets are included in Tx Total count.) |
| Tx Discarded Packets | The total number of locally generated packets that were discarded because of an invalid destination IP address (first byte set to zero). (Included in Tx Total count) |
| Tx Missed Packets | The number of packets that could not be sent due to failure to allocate resources for the packet while fragmenting it or while being duplicated to be sent out multiple interfaces. (Locally generated packets are included in Tx Total count.) |
| Rx Total Packets | The total number of IP packets received on all interfaces. |
| Rx TCP Packets | The total number of TCP packets received on all interfaces that are destined for the local host. |
| Rx UDP Packets | The total number of UDP packets received on all interfaces that are destined for the local host. |
| Rx Errored Packets | IP packets received from all interfaces discarded due to internal errors. |
| Rx Discarded Packets | IP packets received from all interfaces discarded due to packet errors. E.g. invalid IP version, invalid packet length or IP header length, invalid source or destination IP address, or incorrect IP checksum. Also includes packets that would have been forwarded but were discarded because their TTL was less than or equal to 1. Note that both the AMT and GMT will decrement an IP packet's TTL while forwarding that packet across the EnerLinksIII proxy ARP bridge or gateway. |
| Rx Missed Packets | Locally generated IP packets that were destined for the local host that could not be processed due to failure to allocate resources. |
| Rx Packets Forwarded | The total number of IP packets forwarded by the EnerLinksIII proxy ARP bridge or gateway. |

A2.2 IP Forwarding Interface Statistics

When IP Forwarding is enabled, the IP data service used to send packets across the EnerLinksIII data link is treated as a logical IP interface. Detailed networking statistics for this IP Forwarding (IPF) interface may be obtained from the “ipfs details” CLI command. These statistics are described below.

| Link (MAC) Layer Statistics | |
|------------------------------------|---|
| Tx Total Packets | Total number of link layer packets successfully sent on the IPF interface. |
| Tx Errored Packets | This counter is currently unused. |
| Tx Discarded Packets | Packets dropped due to malformed packets representing an internal error. (Not included in Tx Total Packets) |
| Tx Missed Packets | Packets dropped due to failure to allocate a packet processing buffer to send out the IPF interface, or the queue of packets to be sent out the interface is too large. Also includes packets that are pending transmission and get flushed when IP forwarding or TCP Proxy is disabled. (Not included in Tx Total Packets) |
| Rx Total Packets | Total packets received on the IPF interface. |
| Rx Errored Packets | Errored packets received and dropped. (Included in Total count) |
| Rx Discarded Packets | Packets dropped because they are of an unknown type (neither IP nor ARP), or they are destined for a multicast address to which the unit has not joined, and multicast forwarding is not enabled. (Included in Total count) |
| Rx Missed Packets | Good packets received but dropped when there were no receive buffers to place them into. (Included in Total count) |
| Rx FCS Errors | Packets received with CRC errors. (Included in Errored count) |
| Rx Runt Packets | Packets received that are too short. (Included in Errored count) |
| Rx Giant Packets | Packets received that are too long. (Included in Errored count) |
| Rx Ring Buffers Free | Receive buffers currently available. |
| Rx Ring Buffers Used | Receive buffers currently used. |

| Internet Layer Statistics | |
|----------------------------------|---|
| Tx Total Packets | All packets intended to be sent out the IPF interface. Includes both IP and ARP packets. |
| Tx Errored Packets | Packets that were not sent due to lack of resources. E.g. Failure to allocate TX buffer. Also includes broadcast and unicast packets that were dropped because forwarding of those packet types was not enabled. . (Included in Tx Total count) |
| Tx Discarded Packets | Packets that were discarded because they could not be resolved before timing out or being replaced by another packet sent to the same destination IP address. (Included in Tx Total count and ARP stats count of "Dropped pkts no arp") |
| Tx Missed Packets | Packets that were discarded because of failure to allocate an ARP entry to wait on ARP resolution. (Included in Tx Total count and ARP stats count of "Dropped pkts no arp") |
| Tx Unicast Packets | Unicast packets sent. (Included in Tx Total count. Includes packets that were errored, discarded, and missed.) |
| Tx Multicast Packets | Multicast packets sent. (Included in Tx Total count. Includes packets that were errored, discarded, and missed.) |
| Tx Broadcast Packets | Broadcast packets sent. (Included in Tx Total count. Includes packets that were errored, discarded, and missed.) |

| | |
|----------------------|--|
| Tx Octets | Total Octets in all packets sent. Does not include size of Discarded and Missed packets, but does include Errored packets. |
| Rx Total Packets | All packets received by the IPF interface and passed to the internet layer. Includes both IP and ARP packets. |
| Rx Errored Packets | Packets received with fragmentation errors. May represent an internal error. (Included in Rx Total Packets) |
| Rx Discarded Packets | Discarded ARP messages received when configured as a Gateway. Also includes packets dropped because they are of an unknown type (neither IP nor ARP), or they are destined for a multicast address and multicast forwarding is not enabled, or they are destined for a broadcast address and broadcast forwarding is not enabled. (Included in Rx Total Packets) |
| Rx Missed Packets | Rx Packets missed due to failure to allocate an RTCS buffer to receive the packet into. Also includes failure to allocate a message object to post the packet to the IP or ARP service routines. (Included in Rx Total Packets) |
| Rx Unicast Packets | Unicast packets received. (Included in Rx Total count) |
| Rx Multicast Packets | Multicast packets received. (Included in Rx Total count) |
| Rx Broadcast Packets | Broadcast packets received. (Included in Rx Total count) |
| Rx Octets | Total octets in all packets included in Rx Total packets, even if they are errored or discarded. |

| ARP Statistics | |
|-----------------------|--|
| Tx Total Packets | Total ARP packets sent on this interface. |
| Tx Requests | Total ARP Requests sent on this interface. This includes requests generated by this unit to resolve IP packets being sent out the IPF interface, as well as ARP requests received on the Ethernet interface that were forwarded across the IP forwarding interface. |
| Tx Replies | Total ARP Replies sent on this interface. This includes replies generated by this unit in response to requests received over the IPF interface (including replies for the local IP address and proxy addresses), as well as replies that were received on the Ethernet interface and forwarded across the IP forwarding interface. |
| Tx Proxy Replies | Total Proxy ARP Replies sent on this interface. These are ARP replies sent for hosts known to exist on the far side of the Proxy ARP bridge provided by the EnerLinksIII. (Included in Tx Replies) |
| Tx Packet Errored | ARP packets that could not be sent due to failure to form the packet or failure to send the packet at the Link layer. (Included in Tx Total Packets and Tx Replies or Tx Requests, unless the failure occurred on a packet being forwarded from the Ethernet interface) |
| Tx Packets Discarded | Unused counter. |
| Tx Packets Missed | ARP requests that could not be sent due to failure to allocate resources for the packet. (Included in Tx Total Packets and Tx Requests) |
| Rx Total Packets | Total packets received by the Internet layer and passed to the ARP stack for this interface. |

| | |
|----------------------|--|
| Rx Requests | ARP requests received with destinations that match either the local IP address or an entry in the remote ARP table when proxy ARP is enabled. (Included in Rx Total count) |
| Rx Replies | ARP replies received with destinations that match either the local IP address or an entry in the remote ARP table when proxy ARP is enabled. (Included in Rx Total count) |
| Rx Packet Errored | Packets received by the ARP stack that had an invalid ARP header and were dropped. (Included in Rx Total count) |
| Rx Packets Discarded | ARP packets received with destinations that don't match the local IP address nor any entries in the remote ARP table when proxy ARP is enabled. (Included in Rx Total count) |
| Rx Packets Missed | ARP packets received which would have been used to create an entry in the ARP table, but didn't because the entry allocation failed. |
| Allocs Failed | Number of failures to allocate an ARP table entry. |
| Cache hits | Number of times an IP packet transmit was attempted and there was a completed ARP table entry for the destination. |
| Cache misses | Number of times an IP packet transmit was attempted and there was no completed ARP table entry for the destination. |
| Dropped pkts no arp | Tx IP Packets dropped while waiting for an ARP reply. Includes packets that were waiting on an ARP reply when the associated ARP entry expired, and packets that were waiting on an ARP reply when another IP packet to the same destination was transmitted. Only one packet will be held at a time waiting for an ARP reply. |

IP Statistics

| | |
|------------------|--|
| Tx Total Packets | IP Packets sent on the interface. |
| Rx Total Packets | IP Packets rcvd on the interface. (Included in Internet layer Rx Total Packets. Doesn't include discarded and errored packets, but does include missed packets.) |

Mux Interface Statistics

| | |
|-------------------|---|
| IPOA Packets sent | EnerLinksIII packets containing forwarded IP data sent in the multiplexed data stream. This count is equivalent to the information displayed for IP packets in the results for the "EC" CLI command. |
| IPOA Packets good | Good EnerLinksIII packets containing forwarded IP data received from the multiplexed data stream. This count is equivalent to the information displayed for IP packets in the results for the "DC" CLI command. |
| IPOA Packets bad | EnerLinksIII packets containing forwarded IP data received from the multiplexed data stream that had a CRC error detected. This count is equivalent to the information displayed for IP packets in the results for the "DC" CLI command. |
| IPOA Packets lost | EnerLinksIII packets containing forwarded IP data that were determined to be lost from the multiplexed data stream. Lost packets are detected by gaps in received sequence numbers. This count is equivalent to the information displayed for IP packets in the |

| | |
|-------------------|---|
| | results for the “DC” CLI command. |
| IPOA Tx overruns | EnerLinksIII transmit packets dropped due to failure to allocate a packet processing buffer to send out the multiplexed data stream, or the queue of packets to be sent out the interface is too large. |
| TCP Tx queue full | Number of times a free packet processing buffer couldn't be allocated for TCP proxy data, preventing the transmission of TCP proxy data over the multiplexed data stream. Note that this does not indicate that the data is dropped. To prevent dropping TCP proxy data, the EnerLinksIII unit will hold off on reading from the TCP proxy connection until it is able to obtain a free buffer to transmit that data. |
| IPOA Rx overruns | EnerLinksIII packets received from the multiplexed data stream that are dropped due to failure to allocate a packet processing buffer to copy the buffer into. |
| IPOA Write Errors | Internal error delivering an Ethernet packet over the multiplexed data stream. This only occurs if the EnerLinksIII multiplexing scheme causes an Ethernet packet to be split into over 100 packets for transmission. |
| IpoaTxBufferList | Provides information about the list of EnerLinksIII packets containing forwarded IP data that are queued for transmission on the multiplexed data stream. The current list size and maximum list size are displayed. These values are not initialized when the IP forwarding counters are reset. |
| TcppTxBufferList | Provides information about the list of EnerLinksIII packets containing forwarded TCP proxy data that are queued for transmission on the multiplexed data stream. The current list size and maximum list size are displayed. These values are not initialized when the IP forwarding counters are reset. |
| RxBufferList | Provides information about the list of EnerLinksIII packets containing forwarded IP data that have been received from the multiplexed data stream and are awaiting processing by the IP forwarding or TCP Proxy tasks. The current list size and maximum list size are displayed. These values are not initialized when the IP forwarding counters are reset. |
| FreeTxBufferList | Provides information about the pool of free EnerLinksIII packet buffers that are available for forwarded IP data to be sent over the multiplexed data stream. The current list size, maximum list size, and minimum list size are displayed. These values are not initialized when the IP forwarding counters are reset. |
| FreeRxBufferList | Provides information about the pool of free EnerLinksIII packet buffers that are available for forwarded IP data from the multiplexed data stream to be received into. The current list size, maximum list size, and minimum list size are displayed. These values are not initialized when the IP forwarding counters are reset. |

A2.3 TCP Proxy Statistics

Detailed networking statistics associated with the TCP Proxy connection may be obtained from the “tcpops details” CLI command. These statistics are described below.

| TCP Proxy Statistics | |
|----------------------------|--|
| Tx Buffer List Size | The number of EL-III packets containing TCP Proxy data that have been received from the air link and are currently held in a linked list waiting to be transmitted via TCP to the user's application. |
| Tx Buffer List Max Size | The maximum size that the Tx Buffer List described above has achieved since the last reset of the TCP Proxy statistics. |
| Tx Buffer List Max Allowed | The maximum size that the Tx Buffer List described above may achieve before it is considered “full” and incoming EL-III packets are dropped. |
| Tx Buffer List Full | The number of times that the Tx Buffer List was full when an EL-III packet was received over the air link and had to be dropped. |
| Rx Buffer List Full | Number of times a free packet processing buffer couldn't be allocated, preventing the TCP Proxy task from reading more data from the TCP proxy connection. Note that this does not indicate that any data is dropped. To prevent dropping TCP proxy data, the EnerLinksIII unit will hold off on reading from the TCP proxy connection until it is able to obtain a free buffer to receive that data into. |
| TCP Conn Accept | The number of times a TCP Proxy socket connection was accepted. |
| TCP Conn Accept Error | The number of times that an accept call on the TCP Proxy socket failed. |
| TCP Bytes Sent | The number of bytes of data sent on the TCP Proxy socket. |
| TCP Send Error | The number of times that the socket send command returned an error while attempting to transmit data on the TCP Proxy socket. |
| TCP Send Zero Bytes | The number of times that the socket send command returned with no error while attempting to transmit data on the TCP Proxy socket, and indicated that zero bytes of data had been sent. |
| TCP Bytes Rcvd | The number of bytes of data received from the TCP Proxy socket. |
| TCP Recv Error | The number of times that the socket recv command returned an error while attempting to receive data from the TCP Proxy socket. |
| TCP Recv Unknown Conn | The number of times that a socket select call indicated that data had been received on an unknown TCP connection. (This may occur when one application preempts another by opening a new TCP Proxy connection when one is already connected.) |
| TCP Recv Zero Bytes | The number of times that a socket select call indicated that data had been received on the TCP Proxy connection, but the recv command indicated that zero bytes of data had been received. |
| IPOA Packets Sent | The number of EL-III packets that have been filled with data received from the TCP connection and transmitted via the air link to the remote application. |
| IPOA Packets Rcvd | The number of EL-III packets containing TCP Proxy data that have |

| | |
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| | been received from the air link. |
|--|----------------------------------|

A3. Appendix A3 – Metadata Statistics

Detailed metadata statistics may be obtained using the “METASTATS” CLI command on both the AMT and GMT. This appendix provides a guide to interpreting the information provided. See section 8.4 for a detailed description of the metadata theory of operation.

A3.1 AMT Metadata Statistics

Detailed metadata statistics may be obtained from the “METASTATS” CLI command on the AMT using the “details” and “list” arguments. Using the “details” argument, you can retrieve statistics relating to data received on the configured metadata UDP port, the results of attempting to align received metadata with processed video frames, transmission of metadata in MPEG-2 TS streams, and the status of the metadata time reference. Using the “list” argument, all of this same information obtained from the “details” argument is provided, along with a list of statistics for recently processed H.264 video frames.

The parameters returned from the “METASTATS” command with both the “details” and “list” arguments are described below.

| Metadata Statistics for each Video Channel | |
|--|---|
| Video Time Sync Status | <p>The current status of the H.264 video frame time synchronization algorithm is displayed here. This synchronization allows the AMT to assign a UTC time stamp to each video frame for inclusion in the MPEG-2 transport stream. This UTC time stamp is used by the algorithm that matches metadata messages with video frames. The status will be displayed as follows:</p> <ul style="list-style-type: none"> • <i>Locked</i> indicates that the video channel is synchronized with the 1 PPS time reference and the AMT is assigning a UTC time stamp to each video frame that is locked to this reference. • <i>Not Locked</i> indicates that the video channel is not synchronized with the 1 PPS time reference. • <i>N/A</i> indicates that video time synchronization is not enabled because the channel is not configured for H.264 video compression. |
| UDP Port | The configured UDP port number associated with this video channel that the EnerLinksIII unit will receive metadata packets on. |
| UDP last known peer addr | The IP address from which metadata was last received for this video channel. |
| Rx UDP count | The number of UDP messages received on the UDP port associated with this video channel. |
| Rx UDP meta messages | The number of UDP messages received with the “meta” start code in the header. |
| Rx UDP time messages | The number of UDP messages received with the “time” start code in the header. |
| Rx UDP invalid TOD time | The number of UDP “time” messages received with the “TOD |

| | |
|--|--|
| msgs | Valid” flag (bit 2 in the Flags field) set to 0 in their header. |
| Rx UDP errors | The number of errors returned from the metadata UDP socket while attempting to receive data from the socket. |
| Rx UDP bad start | The number of UDP messages received with neither the “meta” start code nor the “time” start code in the header. |
| Rx UDP bad length | The number of UDP messages received that are either not large enough to contain a “time” or “meta” start code, or are not large enough to contain the header associated with the start code found in the message. |
| Rx UDP dropped meta msgs (Invalid UTC) | The number of UDP metadata messages received that had the “UTC field valid” flag (bit 2 in the Flags field) set to 0, and the “aligned with video” flag (bit 3 in the Flags field) set to 1 in their header. These messages are dropped by the AMT. |
| Rx UDP dropped meta msgs (Mux Overrun) | The number of UDP metadata messages that are not sent to the GMT due to insufficient bandwidth to transmit them over the multiplexed data stream. These are not included in the Tx Mux Count below. These messages may still be sent in the MPEG-2 TS from the AMT. |
| Rx UDP time aligned meta messages | The number of UDP metadata messages that are successfully time aligned with a video frame. |
| Rx UDP misaligned meta messages | The number of UDP metadata messages that were not successfully time aligned with a video frame. These are considered misaligned. |
| Rx UDP misaligned – align flag clear | The number of metadata messages that were declared misaligned because the “aligned with video” flag (bit 3 in the Flags field) is set to 0 in their header. In this case, the PTS value associated with the metadata is set to zero and the “PTS valid” flag is cleared in the ViaSat internal metadata header so that the message can be dropped or forwarded in the MPEG-2 TS according to the configured misaligned metadata action. |
| Rx UDP misaligned – no video frames | The number of metadata messages that were declared misaligned because the video frame list associated with the video channel was empty when the message was received. This will occur when the video signal lock is lost for the channel, when the video channel is not configured for H.264 compression, and while the video encoder is being initialized on startup. In this case, the PTS value associated with the metadata is set to zero and the “PTS valid” flag is cleared in the ViaSat internal metadata header so that the message can be dropped or forwarded in the MPEG-2 TS according to the configured misaligned metadata action. |
| Rx UDP misaligned – multiple matches | The number of metadata messages that were declared misaligned because the video frame that they have been determined to match has already been associated with a metadata message. In this case, the PTS value associated with the matched video frame is still set in the ViaSat internal metadata header and the “PTS valid” flag is cleared in the header so that the message can be dropped or forwarded in the MPEG-2 TS according to the configured |

| | |
|--|---|
| | misaligned metadata action. |
| Rx UDP misaligned – no time reference | The number of metadata messages that were declared misaligned because the video frames they were matched with were not synchronized with a 1 PPS time reference. |
| Rx UDP misaligned – forced match | The number of metadata messages that were declared misaligned because no video frame arrived within ½ a second that had a UTC value that was within the configured maximum match time difference of the UTC value in the message header. In such a case, the video frame with the closest matching UTC value will be selected as a match, and the PTS value associated with the matched video frame will be set in the ViaSat internal metadata header. The “PTS valid” flag will be cleared in the header so that the message can be dropped or forwarded in the MPEG-2 TS according to the configured misaligned metadata action. |
| Tx Mux count | The number of metadata messages copied to the multiplexed data stream to be sent to the GMT. |
| MPEG-2 TS meta msgs queued | The number of metadata messages that have been queued for delivery from the AMT in an MPEG-2 Transport Stream. |
| MPEG-2 TS meta msgs dropped (overflow) | The number of metadata messages that have been dropped when the MPEG-2 TS delivery queue size is exceeded. These messages are not included in the MPEG-2 TS meta msgs queued count above. |
| MPEG-2 TS meta msgs time aligned | The number of metadata messages that were sent in the MPEG-2 TS that had the “PTS valid” flag set to “1” in the ViaSat internal metadata header. For each of these messages, the PTS value from the metadata packet header will be written into the Packetized Elementary Stream (PES) packet header of the metadata message when it is included in the MPEG-2 TS stream. |
| MPEG-2 TS meta msgs misaligned | The number of metadata messages processed by the MPEG-2 TS module in the AMT that had the “PTS valid” flag set to “0” in the ViaSat internal metadata header. Each of these messages will be dropped or forwarded in the MPEG-2 TS according to the configured misaligned metadata action (set with the “METAMA” CLI command). |
| Metadata/Video frame match diff | The configured maximum match time difference. This is the UTC time difference that will result in a video/metadata match for each video channel in units of msec. This value defines a match window that is centered on the video frame time. |
| Metadata/Video frame avg offset | This is the average offset in microseconds between the UTC value in recently received metadata messages, and the UTC value of video frames that those messages were matched with. The average is produced using an exponential moving average with a smoothing factor of 1/16. Positive values indicate that the UTC value in the video frame is before the UTC in the metadata message, while negative values indicate that the UTC value in the video frame is after the UTC in the metadata message. |
| Metadata/Video frame last | The UTC offset of the most recently matched metadata / video |

| | |
|---------------------------------------|--|
| offset | frame pair. This offset is the difference in microseconds between the UTC value of the metadata message, and the UTC value of the video frame that the message was matched with. |
| Metadata/Video frame max offset | The maximum UTC offset of any matched metadata / video frame pair. This offset is the difference in microseconds between the UTC value of the metadata message, and the UTC value of the video frame that the message was matched with. |
| Metadata/Video frame min offset | The minimum UTC offset of any matched metadata / video frame pair. This offset is the difference in microseconds between the UTC value of the metadata message, and the UTC value of the video frame that the message was matched with. |
| Msgs w/ offset < -15 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was more than 15 msec later than the UTC value in the metadata message. |
| Msgs w/ offset ≥ -15 & < -10 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was between than 10 and 15 msec later than the UTC value in the metadata message. |
| Msgs w/ offset ≥ -10 & < -5 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was between than 5 and 10 msec later than the UTC value in the metadata message. |
| Msgs w/ offset ≥ -5 & < 0 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was between than 0 and 5 msec later than the UTC value in the metadata message. |
| Msgs w/ offset ≥ 0 & ≤ 5 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was between than 0 and 5 msec earlier than the UTC value in the metadata message. |
| Msgs w/ offset > 5 & ≤ 10 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was between than 5 and 10 msec earlier than the UTC value in the metadata message. |
| Msgs w/ offset > 10 & ≤ 15 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was between than 10 and 15 msec earlier than the UTC value in the metadata message. |
| Msgs w/ offset > 15 ms | The number of metadata messages that have been matched with video frames that had a UTC value that was greater than 15 msec earlier than the UTC value in the metadata message. |
| Free Rx Buffer List | This is the list of free buffers that may be used to receive metadata messages into. When buffer entries are removed from this list, a metadata message is read into them. If a match for the metadata message cannot be immediately made from the current video frame list spanning the last 16 video frames, the buffer is placed on the Unresolved Rx Msg List. The statistics for this list include the current size (or number of entries), the maximum size the list has reached, and the minimum size the list has reached. |
| Unresolved Rx Msg List | This is the list of received metadata messages that have not been matched with a video frame. Entries are removed from this list when any of the following occur: |

| | |
|--|---|
| | <ul style="list-style-type: none"> • A video frame arrives that has a UTC value that is within the configured maximum match time difference of the UTC value in the message header and a match is made. • A video frame arrives that has a UTC value that is after the UTC value in the message header. In this case it is assumed that no video frame will arrive with a closer UTC value. • The entry has been on the list for more than ½ a second. • A new metadata message arrives and the Free Rx Buffer List is empty. • The input video signal is lost. <p>The statistics for this list include the current size (or number of entries), the maximum size the list has reached, and the minimum size the list has reached.</p> |
|--|---|

| Metadata time reference stats | |
|--|---|
| Current time reference status | <p>Current time reference status. Possible states include:</p> <p>Locked – Time reference is locked</p> <p>Disabled – Time reference is disabled by configuration</p> <p>Sync Lost – Time reference sync has been lost. This occurs when a time message has not been received within two seconds, or no PPS signal was received between the last two time messages, or more than one PPS signal is received between two time messages, or the time between the last two PPS signals was more than 10 msec off from one second.</p> <p>Invalid TOD – The last “time” message received did not have the “ToD valid flag” (bit 2 in the Flags field) set to 1.</p> |
| Time Sync PPS signals received | Number of PPS signals received. |
| Time Sync PPS signals missed (between 2 time messages) | Number of times two time messages were received with no PPS signal received between them. |
| Time Sync PPS interval errors (>10 msec deviation) | Number of times the interval between successive PPS signals was more than 10 msec off from one second. |
| Time Sync “time” message timeouts (no msg in 2 sec) | Number of times no “time” message was received in two seconds. |
| Time Sync “time” messages missed (between 2 pulses) | Number of times two PPS signals were received with no “time” message received between them. |
| Basic AMT RTC KLV messages sent | Number of KLV messages generated by the AMT to inform the GMT of the current AMT RTC. |
| Metadata Timing PPS | Indicates “Warning” if the PPS sync lost status is active, otherwise |

| | |
|--|--|
| sync lost warning status | “OK” |
| Metadata Timing msg invalid TOD warning status | Indicates “Warning” if the Invalid TOD status is active, otherwise “OK”. Note that if both the PPS sync lost status and Invalid TOD status are active, the Current time reference status will display the status as Sync Lost. |

When the “list” argument is provided with the “METASTATS” command, a number of frame time lists are displayed. Each list contains information for up to 31 of the most recent video frames displayed for a video channel or video encoder. On the AMT HD each list is associated with a video channel, while on the AMT each list is associated with one of the two H.264 video encoders on the AMT, listed as Device A and Device B. If only one video channel is currently configured for H.264 on the AMT, that channel will use Device A. If both video channels are configured for H.264 on the AMT, video channel 1 will use Device A and video channel 2 will use Device B.

Note that if an H.264 video encoder is not being used, or no video signal is present for the channel associated with the device, the frame time list for that device will be empty.

| Video Channel (AMT HD) or H.264 Device (AMT) Frame Time List | |
|---|--|
| Time Sync Missed Frames | Number of video frames that were received, but whose UTC times were not put into the video frame list for matching with metadata messages. |
| Time Sync Frames | Number of video frames received whose UTC times were put into the video frame list for matching with metadata messages. |
| Frame List Information: | One line is displayed for each entry in the video frame list, with the following information: |
| Usage Indicator | The first character in the line is used to indicate if the video frame has been matched to any metadata messages. If it has been matched, a plus sign (+) will be displayed. If it has been matched more than once (indicating an error) an asterisk (*) will be displayed. If it has not been matched, a space character will be displayed. |
| PTS | This is the 33 bit presentation time stamp (PTS) value assigned to the video frame, represented in hexadecimal format. |
| UTC | This is the 64 bit universal time code (UTC) in units of microseconds since 1970 indicating the time that the AMT has determined that the video frame was generated after adjusting for camera latency. |
| Frame ID | This is the uncompressed frame ID assigned to the frame by the H.264 video encoder. |
| CFrID | This is the uncompressed frame ID of the most recent frame to be compressed when this frame was received. |
| UTC Change (usec) | This is the number of microseconds between the UTC of the last frame and this frame. |
| TOD fr UTC | This is a time-of-day representation of the UTC value associated with the video frame, displayed with millisecond precision. |
| Last Matched Message | The contents of the header from the last metadata message to be |

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|--------|---|
| Header | matched to a video frame are displayed here. The PTS assigned to the message, the UTC value from the message, and the ID of the video frame that the message was mapped to are displayed as well. |
|--------|---|

A3.2 GMT Metadata Statistics

Metadata statistics may be obtained using the “METASTATS” CLI command on the GMT. Using this command, you can retrieve statistics relating to metadata received on the multiplexed data stream, and transmission of metadata in MPEG-2 TS streams.

The parameters returned from the “METASTATS” command are described below.

| Metadata Statistics for each Video Channel | |
|--|---|
| Rx Demux KLV packet count | The number of 8 to 256 byte EnerLinksIII packets containing KLCV metadata that have been received from the multiplexed data stream. |
| Rx Demux meta msgs | The number of metadata messages received from the multiplexed data stream. This count includes metadata messages that were sent to the AMT from user applications as well as KLV messages generated by the AMT to inform the GMT of the current AMT RTC. |
| Rx Demux meta msgs dropped (CRC error) | The number of metadata messages received from the multiplexed data stream that had a CRC error detected. These messages are not included in the Rx Demux meta msgs count above. |
| Rx Demux AMT RTC KLV msgs | The number of KLV messages received from the AMT that were sent to inform the GMT of the current AMT RTC. |
| MPEG-2 TS meta msgs queued | The number of metadata messages that have been queued for delivery from the GMT in an MPEG-2 Transport Stream. |
| MPEG-2 TS meta msgs dropped (overrun) | The number of metadata messages that have been dropped when the MPEG-2 TS delivery queue size is exceeded. These messages are not included in the MPEG-2 TS meta msgs queued count above. |
| MPEG-2 TS meta msgs time aligned | The number of metadata messages that were sent in the MPEG-2 TS that had the “PTS valid” flag set to “1” in the ViaSat internal metadata header. For each of these messages, the PTS value from the metadata packet header will be written into the Packetized Elementary Stream (PES) packet header of the metadata message when it is included in the MPEG-2 TS stream. |
| MPEG-2 TS meta msgs misaligned | The number of metadata messages processed by the MPEG-2 TS module in the GMT that had the “PTS valid” flag set to “0” in the ViaSat internal metadata header. Each of these messages will be dropped or forwarded in the MPEG-2 TS according to the configured misaligned metadata action (set with the “METAMA” CLI command). |