2 Product Description

2.1 Product Overview

The indoor/outdoor 400 Watt DVB-H L-Band transmitter is fully compliant with the DVB-T/H standard and is designed for an operating range of 1670 MHz to 1675 MHz. The transport stream input for the unit may either be a DVB-ASI signal or an Gb Ethernet (IP) input (Pro-MPEG CoP #3 / SMPTE 2022).

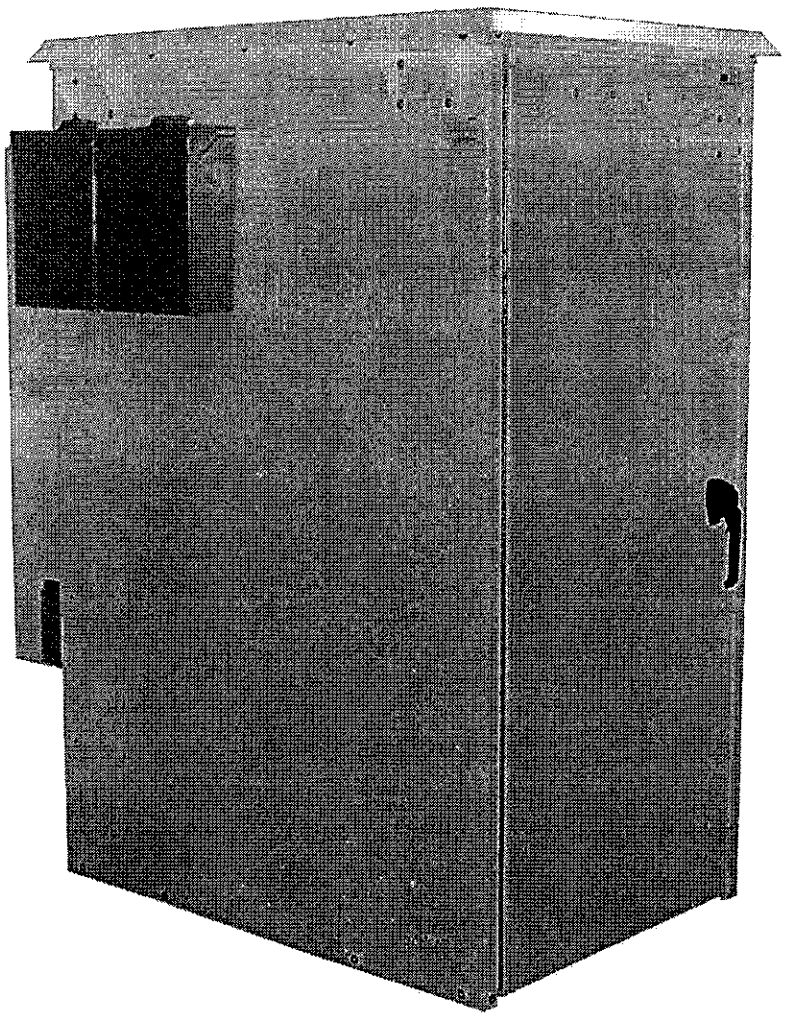


Figure 2-1 400 Watt DVB-H Transmitter

The compact design is a complete DVB-H transmitter system. Included in the indoor/outdoor cabinet is a modulator and high power amplifier (HPA). The transmitter system is also designed to accommodate a customer installed bandpass filter. In addition to a digital modulator board, the modulator system also includes an amplifier, bandpass filter, internal GPS receiver, I/O extension board and a system controller. The system controller is responsible for transmitter operation, configuration, management and status reporting with support for a SNMP-based Network Management System.

The cabinet also includes a 1350 Watt / 1500 VA UPS intended to supply backup power to a playout server and the modulator. This will ensure site monitoring will continue during a power outage as well as signal generation to ensure a fast recovery time once power is restored.

Key highlights of the system include

- Compact, self-contained 400 Watt transmitter
- Operating frequency range of 1670 MHz to 1675 MHz
- DVB-T/H Compliant
- Modular construction for easy maintenance
- Modulator with DVB-H modulator/system controller, amplifier, bandpass filter, on-board GPS receiver and I/O extension board
- High performance LDMOS power amplifier
- RF overdrive, high VSWR and over-temperature protection
- Variable speed (temperature controlled) DC fans
- Linear and Non-linear Digital Pre-correction
- Web interface for remote control and monitoring
- SNMP for network management of the transmitter
- Air conditioned indoor/outdoor cabinet with smoke detector (customer furnished)
- Playout server (customer furnished)
- 1350 Watt / 1500 VA UPS (customer furnished)

2.2 Cabinet Tour

The front view of the closed cabinet is shown below.

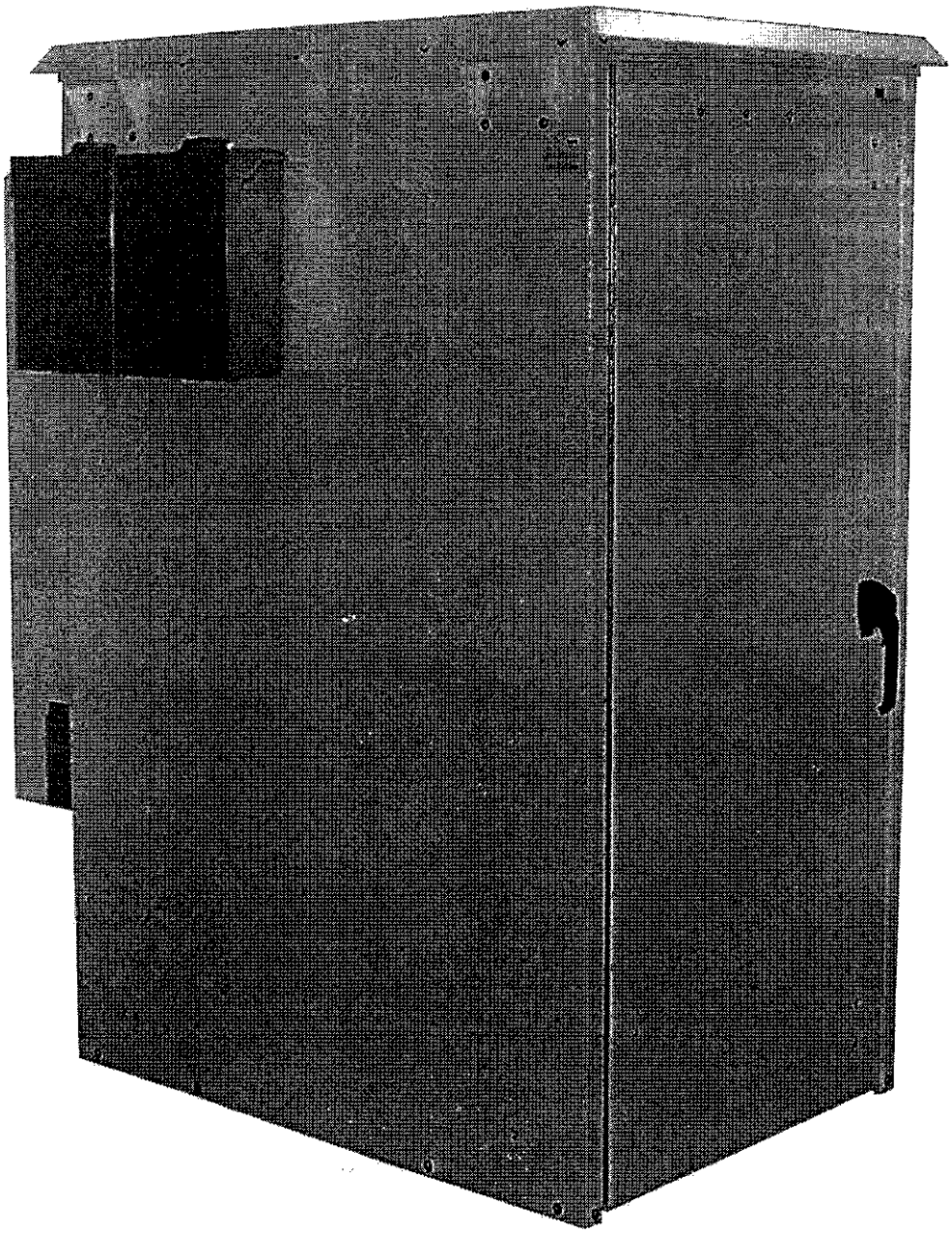


Figure 2-2 Front View of Closed Cabinet

The front view of the open cabinet is shown below:

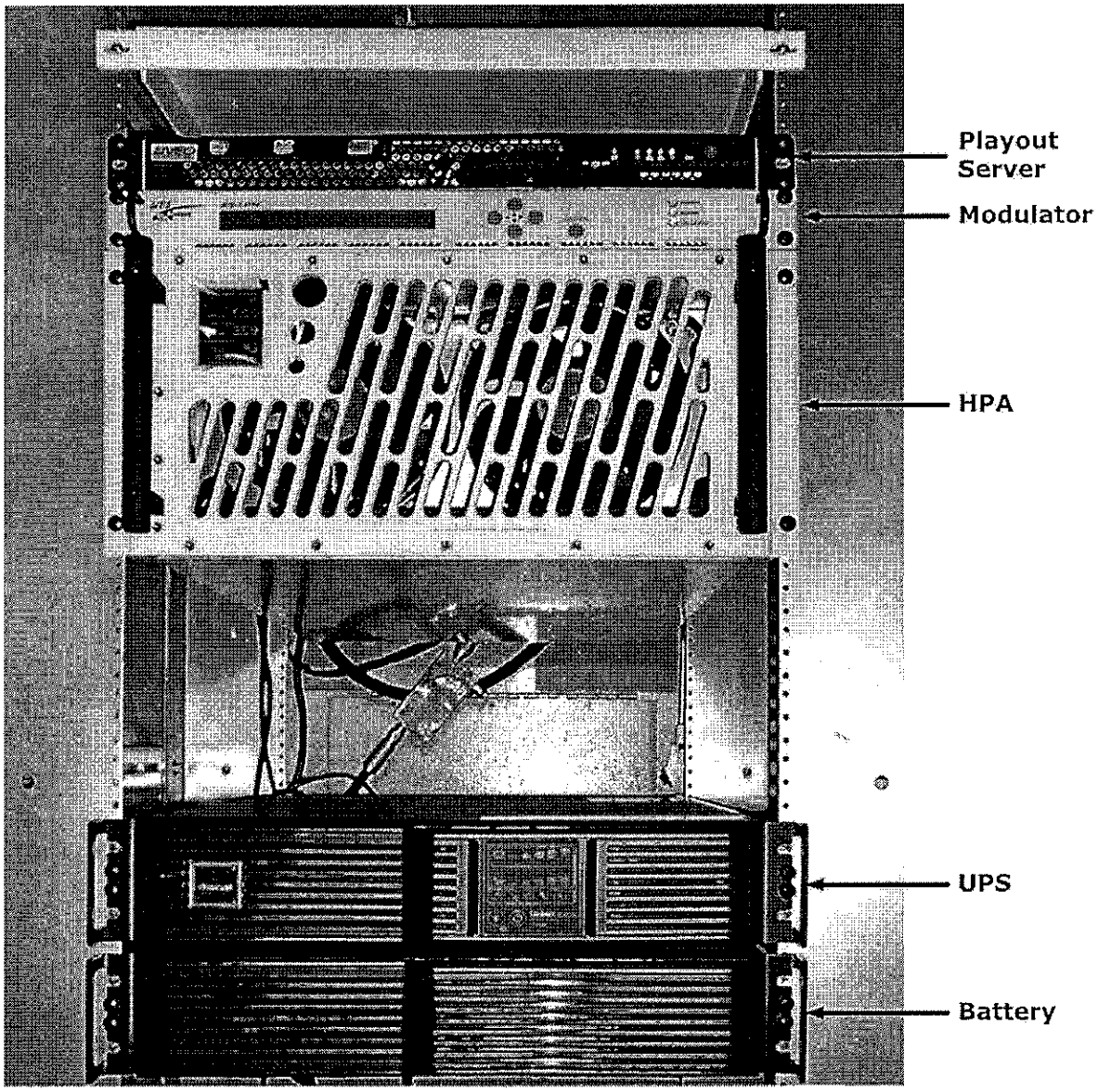


Figure 2-3 Front View of Open Cabinet

The rear view of the closed cabinet is shown below.

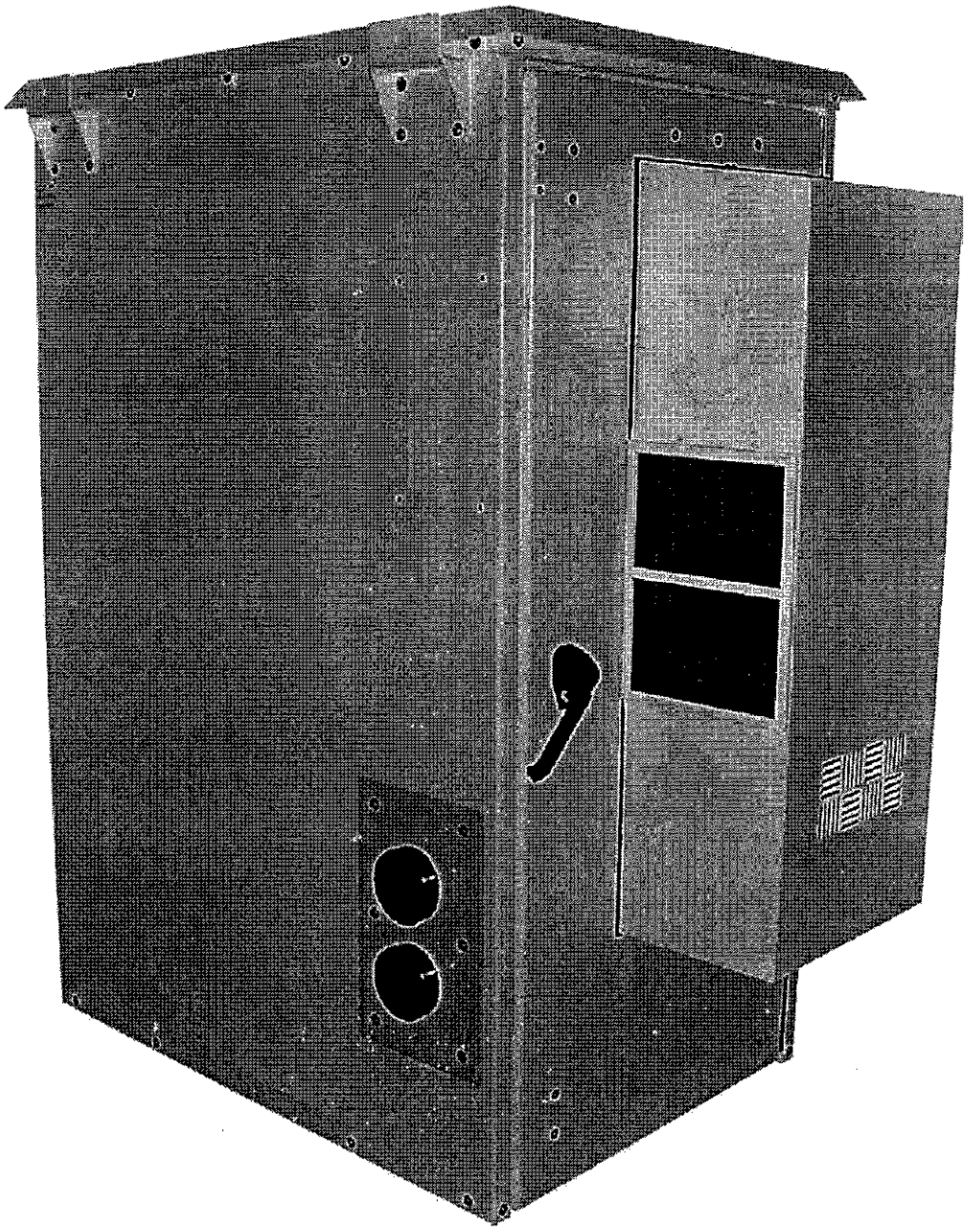


Figure 2-4 Rear View of Closed Cabinet

The rear view of the open cabinet is shown below.

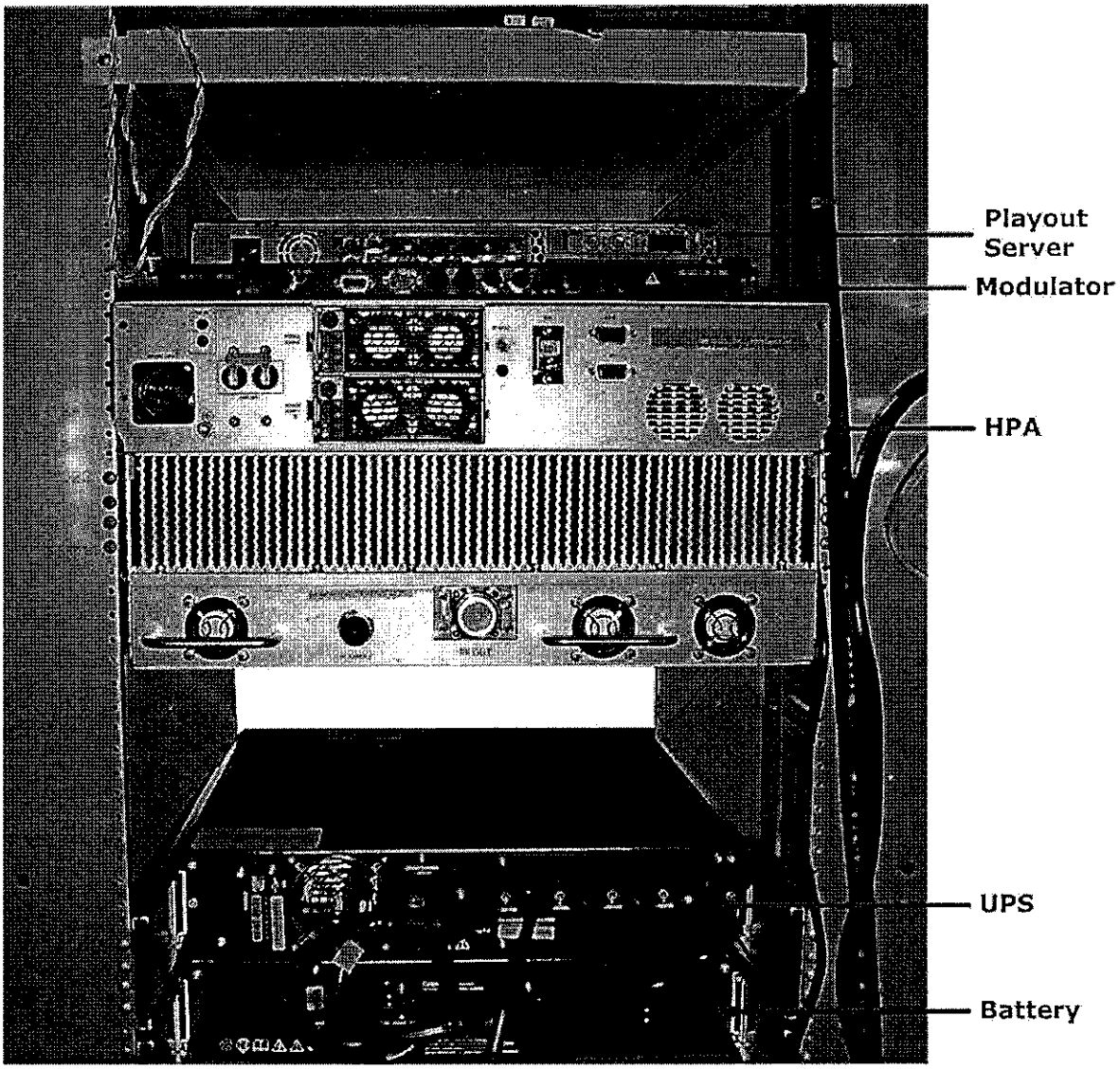


Figure 2-5 Rear View of Open Cabinet

2.3 Product Architecture

2.3.1 Transmitter Overview

The DVB-H transmitter is a compact, indoor/outdoor cabinet that comes equipped with:

- UPS (customer furnished)
- Playout Server (customer furnished)
- Modulator
- HPA

A block diagram of the system is presented in Figure 2-6. Figure 2-6 also identifies the connector types used for the various modules as well as signal levels and losses throughout the signal chain.

2.3.2 UPS

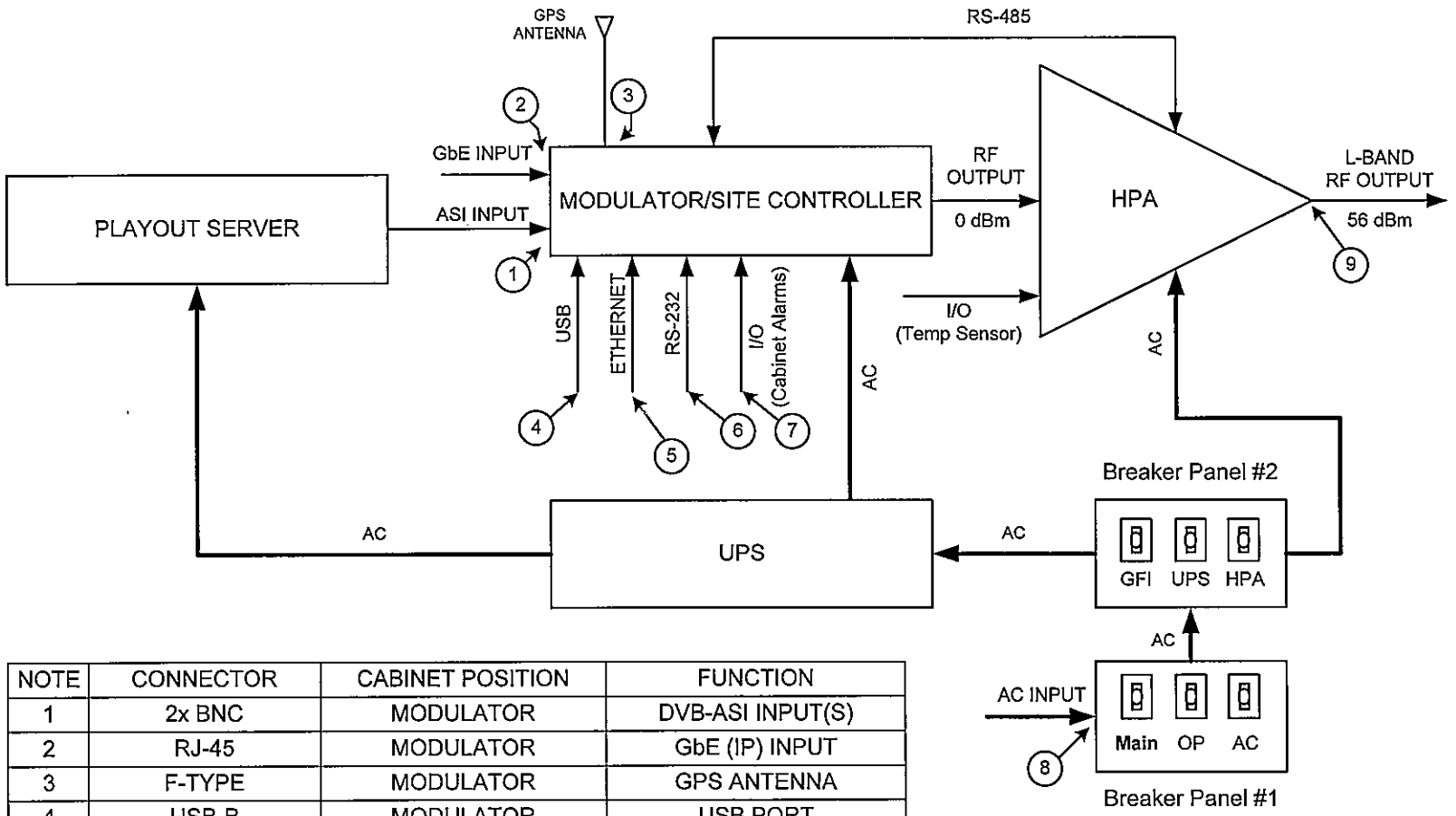
A UPS is employed to provide backup power to the playout server and modulator in the event of a power outage. This ensures that site communications and monitoring will continue during the outage and to maintain signal generation to ensure a fast recovery time once power is restored.

For details on UPS operation, please refer to the manufacturer's product manual.

2.3.3 Playout Server

The playout server provides the modulator with a transports stream over ASI.

For details on playout server operation, please refer to the manufacturer's product manual.



NOTE	CONNECTOR	CABINET POSITION	FUNCTION
1	2x BNC	MODULATOR	DVB-ASI INPUT(S)
2	RJ-45	MODULATOR	GbE (IP) INPUT
3	F-TYPE	MODULATOR	GPS ANTENNA
4	USB-B	MODULATOR	USB PORT
5	RJ-45	MODULATOR	ETHERNET PORT
6	DB-9(M)	MODULATOR	SERIAL PORT (RS-232)
7	DB-9(M)	MODULATOR	SERIAL PORT (I/O)
8	AC	CB PANEL #1	CB PANEL #2 AC POWER
9	7/16" DIN (F)	HPA	RF OUTPUT

Figure 2-6 DVB-H Transmitter Block Diagram

2.3.4 Modulator

The modulator includes

- DVB-H modulator
- Amplifier
- Bandpass filter
- GPS receiver
- I/O extension board
- System controller

Power to the modulator is protected using a UPS power backup (see Figure 2-6). This will ensure site monitoring will continue during a power outage as well as continued signal generation to ensure a fast recovery time once power is restored.

2.3.4.1 DVB-H Modulator

- The module performs DVB-H signal encoding, OFDM waveform generation and has the ability to synchronize with other stations to provide Single Frequency Network (SFN) operation.
- The module performs the frequency conversion of the OFDM signal into the required L-Band channel frequency, to drive the high power amplifier (HPA).
- Digital Linear and Non-linear pre-correctors provide compensation for the group delay introduced by the HPA output filter and the non-linear distortions produced by HPA.

The DVB-H Modulator receives a MPEG-2 structured Transport Stream on the ASI input or an IP encapsulated MPEG-2 structured Transport Stream on either of the RJ-45 Ethernet ports. The IP input is according to MPEG PRO CoP #3 FEC / SMPTE 2022 protocol.

The modulator converts the digital input streams (ASI or IP) to an OFDM waveform in accordance with DVB-T/H standards. A direct conversion process provides a single analog RF output from 1670 MHz to 1675 MHz, suitable for amplification in the high power amplifier (HPA).

Digital linear and non-linear pre-correctors (pre-distorters) significantly improve the performance of the high power amplifier. The Non-linear pre-corrector compensates for the HPA non-linearity and is able to provide separate adjustment for the low and high frequency shoulders of the wide channel spectrum. The Linear pre-corrector compensates for the group delay created by an output filter.

2.3.4.2 Amplifier

The amplifier provides up to 20 dB of gain, allowing the modulator to provide an RF output power level from -10 dBm to 0 dBm with shoulders $\geq$ 55dBc.

2.3.4.3 Bandpass Filter

Each modulator is equipped with a narrow-band output filter specifically tuned to the frequency channel assigned to the transmitter. The bandpass filter is intended to limit out-of-band emissions at the output of the modulator's internal amplifier.

2.3.4.4 GPS Receiver

The onboard GPS receiver provides accurate, high quality 10 MHz and 1PPS reference signals for transmitter synchronization and has the capability to track 12 satellites. The 10 MHz and 1PPS reference signals are provided for the modulator board as well as one 10 MHz and one 1 PPS reference signal for external devices.

The GPS receiver supports the NMEA formatted message protocol as well as the proprietary NavMan binary messages. A subset of the protocols is used by the processor in order to control the receiver.

The user has the option to set the Max GPS Holdover time, updated the system clock from the GPS and set the time zone. Following a loss of signal lock (to the GPS satellite network), the Max GPS Holdover time is the maximum length of time the system will continue to operate in a free-running mode before an alarm is issued.

2.3.4.5 I/O Extension Board

The I/O extension board provides four (4) analog pull down inputs and four (4) analog pull up inputs, which are available on the rear panel I/O port. The analog inputs are monitored by the system controller permitting the user to set the polarity and voltage threshold that trigger an alarm.

NOTE: For this application, Pin 6 has been connected to the cabinet door switch contacts, Pin 7 has been connected to the cabinet smoke detector and the Web interface has been configured accordingly.

2.3.4.6 Transmitter Controller Module

- Provides all primary site control and management functionality.
- Manages all control interfaces of the transmitter.

The modulator and HPA are connected by a RS-485 serial cable for control and monitoring (see Figure 2-6). The system controller supports transmitter operation, configuration, management and status reporting. The control includes power up, power down, RF control processes, control commands for status requests and operating parameters, etc. The transmitter identity (name, password, local IP address, SNMP, etc.) can be configured remotely or locally. Remote upgrade of the transmitter software is supported.

The system controller supports a web interface (Web GUI) for its user interface and is responsible for software and configuration management. Remote control of the transmitter is typically managed via an SNMP agent.

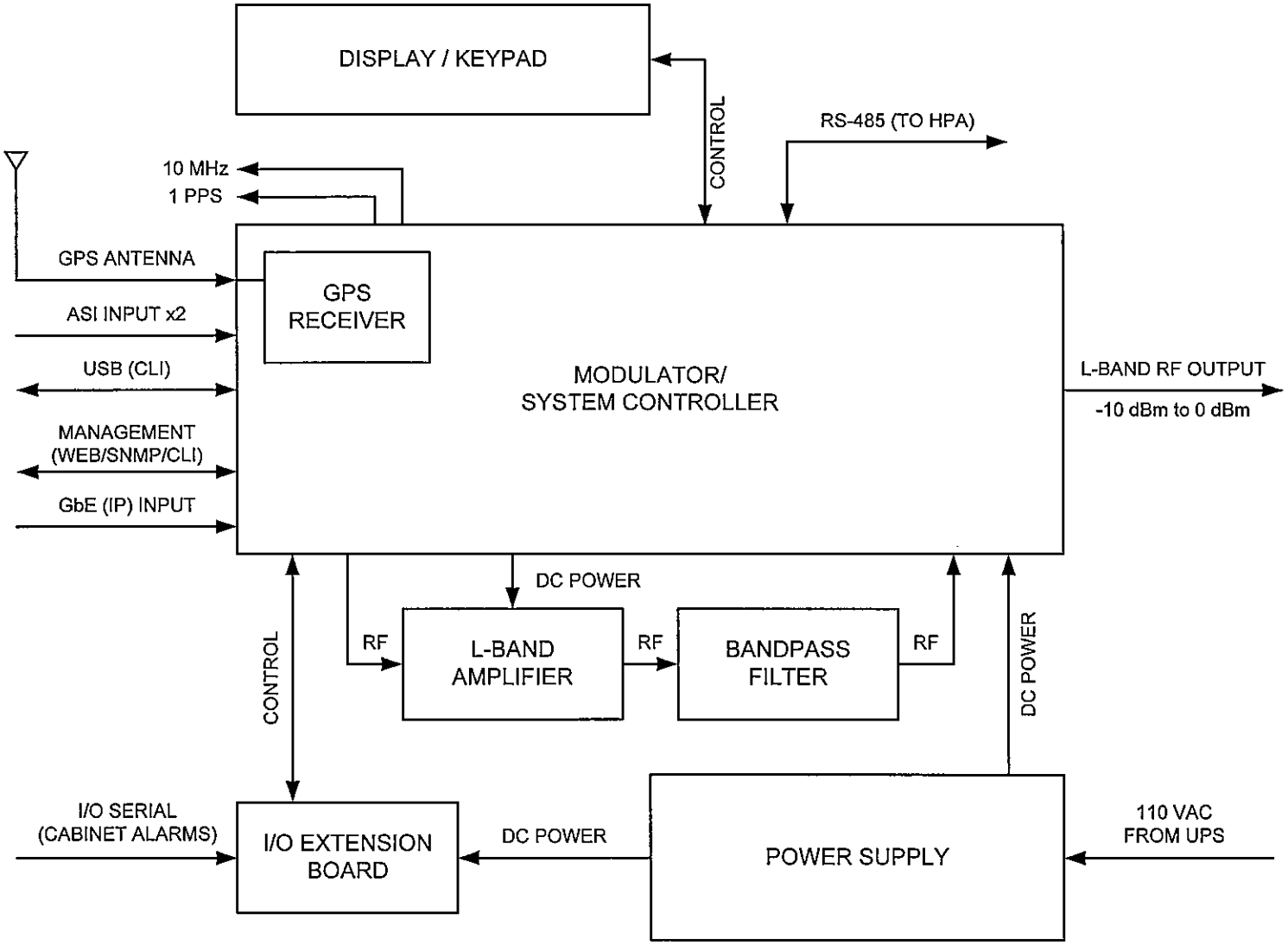


Figure 2-7 Modulator Block Diagram

2.3.5 High Power Amplifier (HPA)

- The module provides RF signal amplification up to the required 400 Watts output power level at the HPA RF output.
- The output power level is maintained via an ALC loop.
- The output forward and reverse power levels are measured by the integrated output coupler and reported to the system controller.

The main system diagram for the High Power Amplifier (HPA) is shown in Figure 2-8. This compact design employs a high efficiency LDMOS technology with a 400 Watt power rating. The HPA includes a LCD display for status messages. The HPA also includes two power supplies and has two variable speed DC fans for forced air cooling.

The HPA is designed to operate as a final amplification stage for the terrestrial L-Band transmitter system. It amplifies the L-Band terrestrial signal from the modulator up to a power level of 400 Watts, while maintaining acceptable output emission levels.

The HPA is a field-replaceable system component that includes integrated AC/DC power supplies. The HPA is designed for installation in an indoor or environmentally protected outdoor cabinet.

The HPA architecture is based on a solid state design operating in the Class A/AB linear mode over a frequency range from 1670 MHz to 1675MHz. The amplifier is fully protected against input overdrive, overheating and output load VSWR conditions. The protection circuits are all self-correcting, allowing restoration of the amplifier to the normal operational state upon removal of the fault condition.

The HPA incorporates an internal automatic self-leveling loop to maintain a constant output power level. The automatic level control (ALC) circuit will compensate for the input signal level variations and gain variations affected by changes in temperature as well as for the gain change due to devices aging.

The HPA main driver chain signal is split and feeds six individual LDMOS power modules. The output of each module is combined and fed into the combiner/coupler which includes a RF monitor port and RF detectors to measure forward and reflected power levels. The HPA controller monitors the operation parameters of the HPA, provides protection against abnormal operation conditions and communicates with the modulator system controller via a RS-485 serial link.

There are six output power modules in parallel configuration in the 400W DVB-H HPA. The rated output power level of the HPA during normal operation is 56 dBm (400W). In the event of a partial failure (the lowest current reading on one of the power modules is less than 20% of the highest current reading on one of the power modules), the HPA is capable of operating with a maximum output power level of 53 dBm. If the output power level is greater than 53 dBm, it will be automatically reduced to 53 dBm. If the output power level is less than 53 dBm, no reduction will occur.

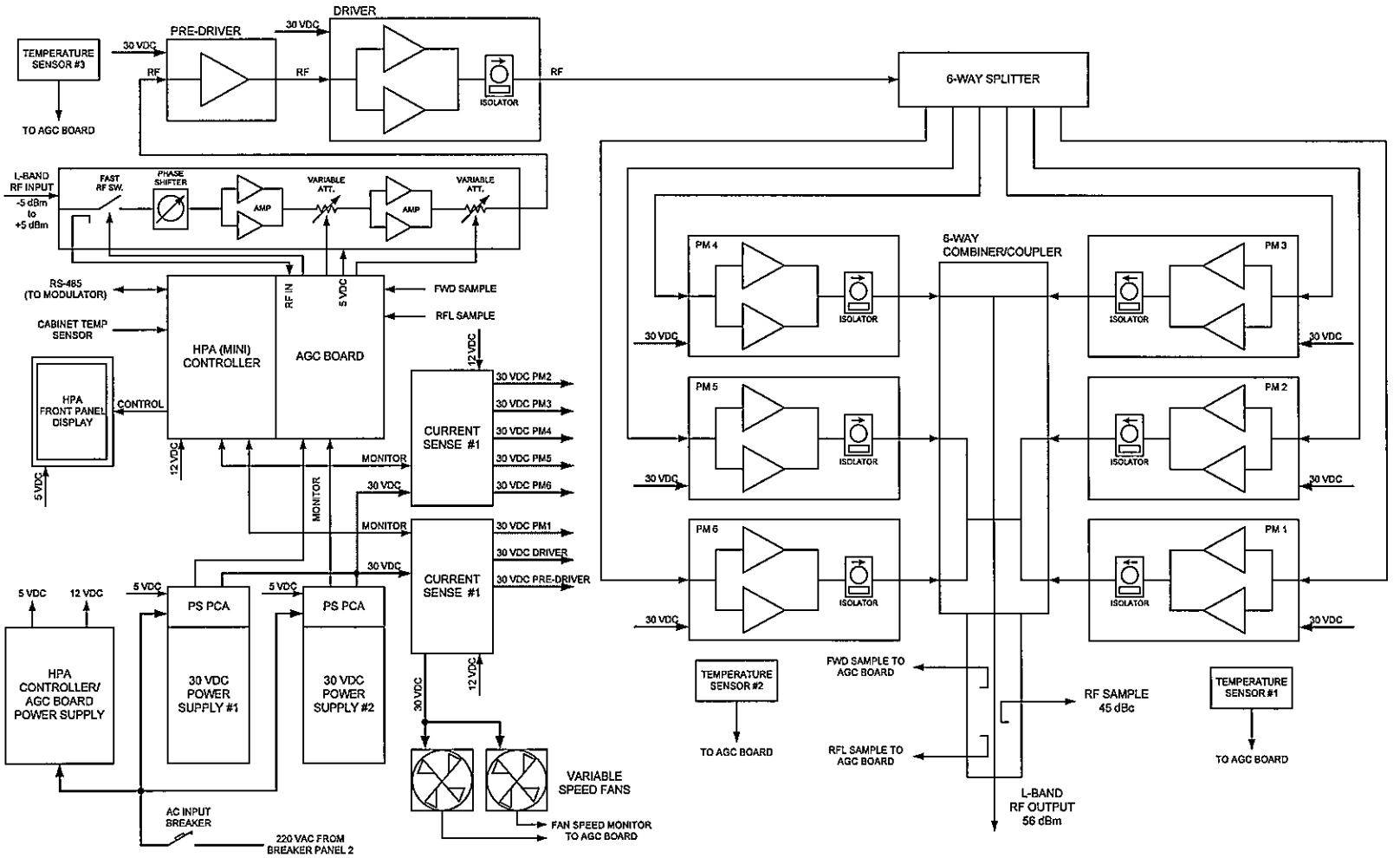


Figure 2-8 400W HPA Block Diagram

2.3.5.1 HPA Enhanced Features and Design Concepts

The HPA utilizes several innovative features designed to enhance its performance and reliability of the amplifier.

- Enhanced Heat Sink Design
- Thermally Enhanced Power Transistors
- Variable speed (temperature controlled) DC fans

The HPA employs a heat sink design that permits more equal heat distribution across the heat sink, thus reducing the maximum operating temperature. Distribution of the main heat source elements within the HPA is optimized in order to utilize the maximum thermal efficiency from the heat sink, also resulting in lower operating temperatures.

The HPA design incorporates the latest generation high power LDMOS transistors which employ a thermally enhanced package. The significant reduction in thermal resistance will allow these new generation power devices to operate with a lower junction temperature thus improving overall amplifier reliability.

The variable speed fans allow the fan speed to be increased or decreased as the HPA temperature increases or decreases. This improves overall efficiency of the HPA and the lifetime of the fans.

2.3.5.2 HPA Controller

The HPA embedded controller monitors all operating parameters and provides amplifier protection and control. It communicates with the main system controller via the RS485 interface and reports the following parameters and statuses:

- HPA input power level
- HPA forward power level
- HPA reflected power level
- HPA power supply DC voltage levels
- HPA pre-driver, driver and power module current consumption
- HPA temperature
- HPA fan speed
- HPA RF power inhibit
- HPA input overdrive alarm
- HPA output overdrive alarm
- HPA output reflected power (VSWR) alarm
- HPA failure alarm
- Over-temperature fault
- Pre-drive and driver device (current) fault
- Power module current misbalance fault (results is output power limitation)
- Power module device (current) fault
- Power Supply DC Fault
- Fan stalled alarm

The following HPA factory control commands are available via USB:

- RF Power enable/disable
- Attenuator control

The HPA is a constant gain block, which is individually calibrated in order to maintain the RF performance while operating in various conditions. The calibration is performed on the forward power sensor, reflected power sensor and input power sensor. A calibration table is stored in the internal EEPROM of the HPA controller.

The HPA controller reports alarms to the system controller and maintains an internal log of alarms. Each alarm entry in this log contains the alarm ID itself along with monitored parameters prior to an alarm. This alarm log is saved in an internal EEPROM.

2.4 Breaker Panels

The two (2) breaker panels are mounted on the left wall of the cabinet (when looking at the front of the cabinet) in the top-left corner of the wall.

Circuit breaker panel 1 receives the input AC power and distributes the required power to circuit breaker panel 2, as well as the air conditioner.

Circuit breaker panel 2 receives AC power (from circuit breaker panel 1) and distributes the required power two (2) receptacles as well as the HPA. One of the receptacle provides AC power to the UPS, internal lights and smoke detector; the other is a GFI.

2.5 Control Interfaces

The modulator serves as the primary system controller responsible for configuration and management of the entire transmitter and interfaces. The physical interface for system management is the modulator Ethernet port, which supports Web, SNMP v3 (secure SNMP), and Telnet.

The modulator hosts an internal web interface (Web-GUI) accessible through its Ethernet management port. The Web-GUI is an intuitive interface allowing the user to access the current transmitter status and configure the operational parameters of the system. The Web interface uses a simple hierarchical menu structure which provides access to all transmitter parameters. Below is a snapshot of the main status screen of the Web-GUI.

The transmitter SNMP interface provides the means for remote management of the transmitter and to accept alarm traps. The notification options can be configured on a per-alarm basis. The user may decide to mask certain alarms, increase/decrease integration time to declare an alarm, etc. Alarm and logs are available via the SNMP interface and are stored in Non Volatile Memory

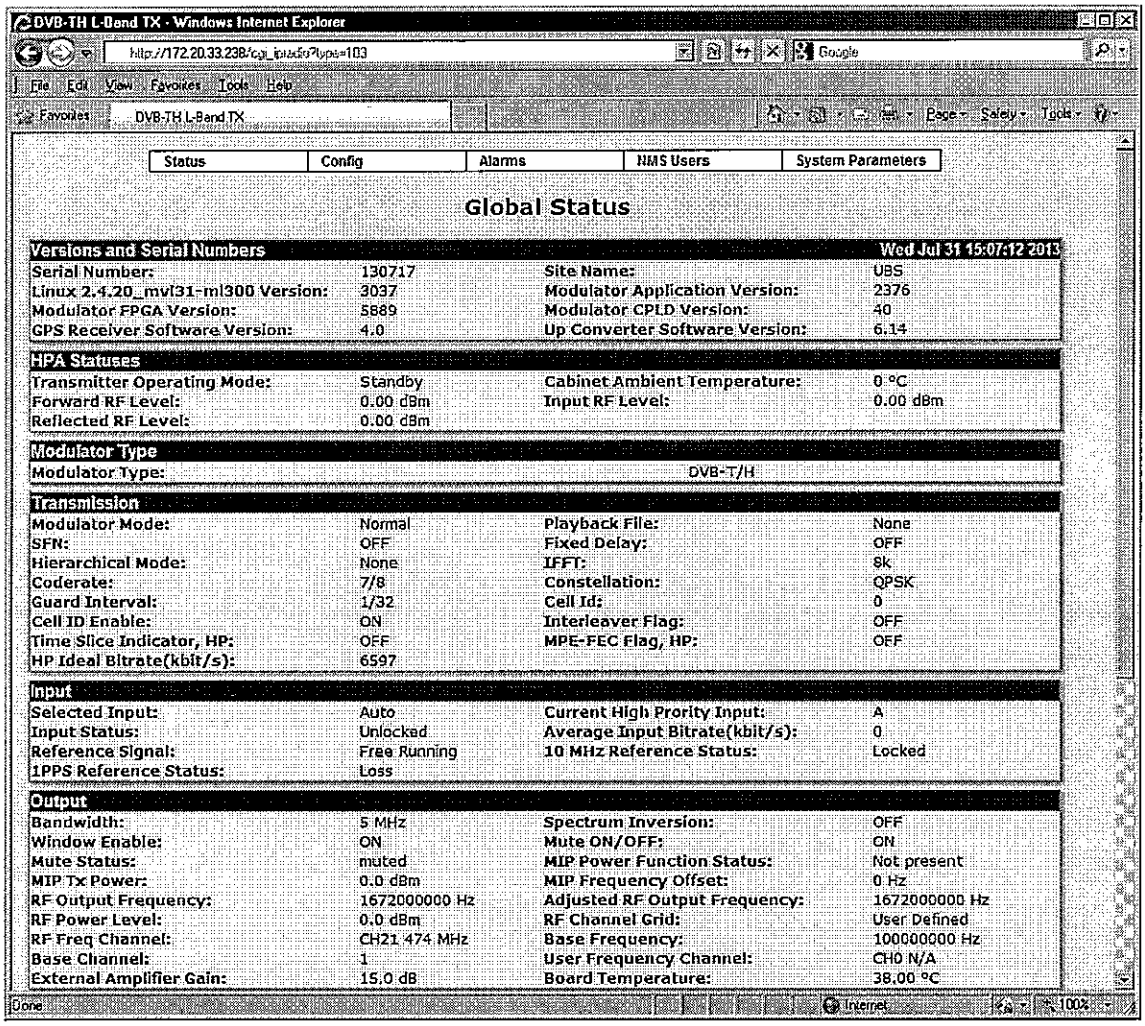


Figure 2-9 Web-GUI Main Status Page

2.6 Remote Upgrades

The main software components in the transmitter are remotely upgradeable via the modulator management interface.

3 Transmitter Technical Specifications

3.1 Modulation Standard

DVB-TH (ETSI EN 300 704 V1.6.1)	
Supported Modes IFFT	2k, 4k, 8k
Guard Intervals	1/4, 1/8, 1/16, 1/32
Code Rates	1/2, 2/3, 3/4, 5/6, 7/8
Constellations	QPSK, 16-QAM, 64-QAM
Hierarchical Mode	None, **α** = 1, 2, 4
Network Mode	SFN and MFN
Bandwidth	5MHz

3.2 Modulator Control Interfaces

Modulator Control Interfaces	
Front Panel	LCD display and cursor/execute keys
Ethernet	Connectors: 2x RJ45 Speed: 10/100/1000 Base-T
USB	Connector: USB Type B
RS232 Interface	Connector: 9-pin SUB-D (M)
RS485 Interface	Connector: 9-pin SUB-D (F) Must be connected to the HPA Serial interface
I/O Interface	Connector: 9-pin SUB-D (M) Pin 1 to Pin 4 Voltage: 0 to 10 VDC (analog input – pull down) Pin 5 to Pin 8 Voltage: 5 VDC (analog input – pull up) Must be connected to cabinet alarms
Web GUI	Internet Explorer 6.0+, Firefox, etc. Connector: Ethernet
SNMP Control Interface	Connector: Ethernet
CLI (Command Line Interface)	Connector: USB (HyperTerminal) or Ethernet (HyperTerminal or Telnet)
Alarm Relays	Connector: RS232 Two Dry Contact alarm relays, triggered by any major alarm.

3.3 Modulator Inputs

Modulator Inputs	
DVB-ASI	2 DVB-ASI inputs: BNC (F), 75 Ohm
Ethernet	2 RJ-45 Ports: Port A is active, Port B is disabled 1) GbE Transport Stream - Pro-MPEG CoP #3 / SMPTE 2022 2) Management port Protocol: WEB/Telnet/SNMP
GPS Antenna	F-type (F), 75 Ohm

3.4 Modulator Monitoring Outputs

Modulator Monitoring Outputs	
DVB-ASI	2 DVB-ASI outputs: BNC (F), 75 Ohm
RF Monitor	Connector: SMA (M), 50 Ohm Level: 30 dB below the RF output level
Clock Reference - 10 MHz	Connector: BNC (F) Frequency: 10 MHz Level: 10 dBm, ±2.5 dB Impedance: 50 Ohm or High Impedance (user selectable)
Time Reference - 1 PPS	Connector: BNC (F) Frequency: 1 PPS Level: TTL Trigger: Positive transition Impedance: 50 Ohm or High Impedance (user selectable)

3.5 Modulator RF

Modulator RF	
Connector	N-type (F), 50 Ohm
Frequency	1670 MHz to 1675 MHz
Power Level	-10 dBm to 0.0 dBm in 0.1 dB steps
Spectrum Polarity	Inverted or non-inverted, selectable
Level Stability	± 0.3 dB
Shoulder Level	< -55 dBc
Spurious Level Outside Channel	< -60 dBm at 0 dBm output power level
MER	≥ 43 dB
Amplitude Flatness Center frequency ±2.3 MHz	±0.5 dB
Group delay response: Center frequency ±2.3 MHz	300 ns, ±100ns
Phase Noise SSB (measured @ 474 MHz)	100 Hz: < -80 dBc/Hz 1 kHz: < -95 dBc/Hz 10 kHz: < -100 dBc/Hz 100 kHz: < -115 dBc/Hz 1 MHz: < -120 dBc/Hz
Return Loss	≥ 20 dB

3.6 HPA Control Interfaces

HPA Control Interfaces	
Front Panel	LCD display
USB Interface	Connector: USB Type B HPA Monitor PC GUI
Serial Interface	Connector: 9-pin SUB-D (M) Must be connected to the modulator RS485 interface
I/O Interface	Connector: 9-pin SUB-D (F) Must be connected to the cabinet temperature sensor

3.7 HPA RF Input

HPA RF Input	
Connector	SMA (F), 50 Ohm
Frequency	1670 to 1675 MHz
Power Level	-5.0 dBm to 0.0 dBm
Return Loss	≤ 1.9:1

3.8 HPA/Transmitter RF Output

HPA/Transmitter RF Output	
Connector	7/16 DIN (F), 50 Ohm
Frequency	1670 to 1675 MHz
Digital Average Output Power (before customer installed filter)	400 Watts (56 dBm)
Power Level Accuracy	± 0.5 dB
Gain	61 dB (max.)
Gain Variation over Temperature	≤ ± 1 dB
Gain Variation over 5 MHz Bandwidth	≤ 0.5 dB
In-band IMD	≤ -27 dBc
Spectral Regrowth (at rated output power)	≤ -30 dBc
Frequency Stability	Internal GPS is used for synchronization
VSWR	≤ 1.2:1
RF Sample	Connector: N-type (F), 50 Ohm Coupling Factor: 45.0 dB, ± 1 dB

3.9 Modulator Digital Pre-Correction

Pre-Correction (non-adaptive)	
Linear Pre-Correction	
Correction Points	61
Point Spacing	1/60 of nominal spectrum BW
Amplitude Correction	±10 dB
Amplitude Resolution	0.01 dB
Group Delay Correction	±2000 ns
Group Delay Resolution	1 ns
Non-Linear Pre-Correction	
Curve Formats	S 21 and VO/VI
Amplitude Scale	Linear and Logarithmic
Correction Points	Max. 256, user-defined position
Gain Correction	Max. 12 dB, subject to available headroom
Phase Correction	-6 to +30 degrees, subject to available headroom
Peak Power Clip Level	+17 dB to +7 dB (peak power relative to average RMS level)

3.10 GPS

GPS	
Recommended Antenna	Bullet III GPS antenna -Trimble model no. 57860-10 or equivalent
Receiver Architecture	L1 1575.42 MHz
12 Parallel Channels	C/A code (1.023 MHz chip rate) Code plus carrier tracking (carrier aided tracking)
Tracking Capability	12 simultaneous satellite vehicles
Acquisition Time (Time To First Fix, TTFF)	< 15 seconds typical TTFF-hot (with current almanac, position, time and ephemeris) < 150 seconds typical TTFF-cold (no stored information)
Positioning Accuracy	< 5 m, 1 – sigma < 10 m, 2 - sigma
Timing Accuracy	< 2 ns, 1 – sigma < 6 ns, 6 - sigma
Holdover Time	±1 µsec during 2 hours
10 MHz Output Signal	Internally connected to the modulator input Level: 10 dBm ±2.5 dBm, sine wave Harmonic Level: -40 dBc max.
Phase Noise	1 Hz: < -75 dBc/Hz 10 Hz: < -110 dBc/Hz 100 Hz: < -125 dBc/Hz 1 kHz: < -135 dBc/Hz 10 kHz: < -155 dBc/Hz 100 kHz: < -155 dBc/Hz
1PPS Output Signal	Internally connected to the modulator input Level: TTL

3.11 Power Supply

3.11.1 Modulator

Modulator Power Supply	
Voltage	100 - 240 VAC
Frequency	50-60 Hz
Power Consumption max	50 W max.

3.11.2 HPA

HPA Power Supply	
Voltage	195-240 VAC (220 VAC ±10%)
Frequency	50-60 Hz
Power Consumption max	2.5 kW

3.12 Environmental

Environmental	
Operating Temperature	+41° F to +113° F (+5° C to +45° C)
Storage Temperature	-40° F to +149° F (-40° C to +65° C)
Relative Humidity	max. 95%, non condensing
Cooling	Forced air

3.13 Mechanical

3.13.1 Modulator

Modulator Mechanical	
Dimensions (W x H x D)	19" x 1.73" x 20.5" (48.3 cm x 4.4 cm x 52.1 cm)
Weight (unpacked)	15 lbs. (6.8 kg)

3.13.2 HPA

HPA Mechanical	
Dimensions (W x H x D)	19" x 8.72" x 30.8" (48.3 cm x 22.2 cm x 78.2 cm)
Weight (unpacked)	77 lbs. (35 kg)