10.1.3 General Description

Sirius is a digital TV transmitter Signal Processing Unit sub-assembly that receives an MPEG-2 data stream, and transmits a pre-corrected DVB-H RF signal to the pre-amplifier and power amplifier. The pre-amplifier is required for high power transmitters.

10.1.4 Main Features

Channel Modulation: The DVB-H channel modulator utilizes a very similar hardware platform to the ATSC and DRM architectures.

Linear and Non linear pre-correction: by way of an integrated Digital Pre-corrector, a Linear Equalizer enables correction of the linear distortions caused by the cavities, filters, and antenna combiner following the HPA power amplifier.

Clipping: allows the reduction of the signal peak-to-average ratio at a programmable value, and the associated digital filter of the shoulders. This allows a significant reduction of the Back-Off in the HPA depending on the allowed quality degradation of the signal in terms of END or EVM.

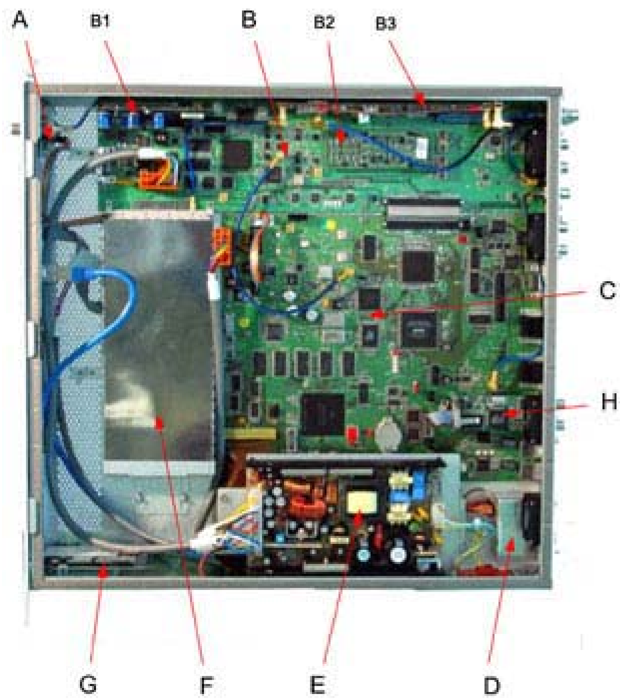
UHF IV/V: A synthesizer generates the output frequency.

Internal air-cooling: Provides adequate cooling to ensure proper operation across specified temperature range.

10.1.5 Sirius Subassembly Description

The Sirius DVB-H Exciter is housed in a “19” 2U EIA rack unit and is populated with the following assemblies:

- A- LED board
- B- TS board
  - B1- Enhanced QoS measurement board
  - B2- IF Filter board
  - B3- UHF transmitter board
- C- Digital board
- D- AC Transformer
- E- Power Supply
- F- Synthesizer
- G- PC Slot
- H- GPS Receiver



10.1.5.1 Digital Board

Functional Description of Digital Board

The “Digital Board” is built around the combination of an FPGA and a powerful microprocessor. It supports most of the input/output interfaces and base-band processing from the incoming data stream up to an I/Q base-band output.

The transport stream input signal is based on the DVB-H Digital Television Standard. The exciter includes Dual A and B asynchronous serial interface (ASI) inputs in a 75-ohm BNC female connector, conforming to DVB-ASI (TR 101211). The ASI format is a 188, 214 burst or byte mode. The equipment adapts automatically to the net input rate since the input rate is lower than the channel capacity. The dual inputs can be configured as redundant ASI switched inputs. The DVB-H RF exciter has built in capability to monitor the presence and consistency (synchronization bytes) of the incoming TS, and produce appropriate alarms. This feature includes MIP identification (DVB standard), in single frequency network (SFN) as well as multi frequency network (MFN) modes. This function is performed simultaneously on each different ASI input.

The equipment is able to manage MFN or SFN operation. The incoming serial data stream signal is processed by the DVB-H channel encoder, which performs the following functions:

- Removal of the MPEG sync byte

- Transport Stream Identification
- Data Randomization
- Reed-Solomon Encoding
- Data Interleaving
- Trellis Coding
- Grey mapping
- FFT
- Pilot Insertion
- Guard interval insertion

The main objective of the Digital Board is to generate an output complex signal in the form of parallel I and Q digital signals. In addition, the Digital Board provides the clock reference for all the other boards within the DVB-H exciter. The system is fully compliant with the EN 300-744 1.5.2 Digital Television Standard.

Additional optional functions such as a built in GPS receiver, or DVB receiver, are supported by additional daughter boards managed by the embedded microprocessor.

This version is designed 3-Mgate FPGA hardware and is dedicated to DVB-H. The incoming serial data stream signal is processed by the channel encoder, which provides an output complex digital signal in the form of parallel I and Q digital signals, and a clock reference. The channel encoder has a hardware version allowing performance of DVB-H modulation. For DVB-H, all standard modes are supported including hierarchical modes. The equipment can support redundant switching input for DVB operation. The equipment is also capable of managing either single frequency networks (SFN) or multi frequency networks (MFN) operation. Bit Rate Adaptation with PCR re-stamping is used for MFN operation. An embedded microprocessor manages daughter boards such as a global positioning satellite (GPS) receiver, DVB-H receiver and TS Board. RS232, I2C and SPI buses are used for internal control and monitoring of the daughter boards. External control and monitoring is done through RS232 and/or Ethernet and/or CAN bus. The digital board distributes pilot clocks to Sirius boards, 10MHz to the synthesizer and TS Board, and system clock to the TS Board.

10.1.5.2 TS Board

Functional Description of TS Board

The “TS Board” is also equipped with an FPGA. It supports the up-conversion and adaptive pre-correction processing. The TS Board receives the I/Q base-band signal and the clock reference from the Digital Board. The TS Board performs the following processing:

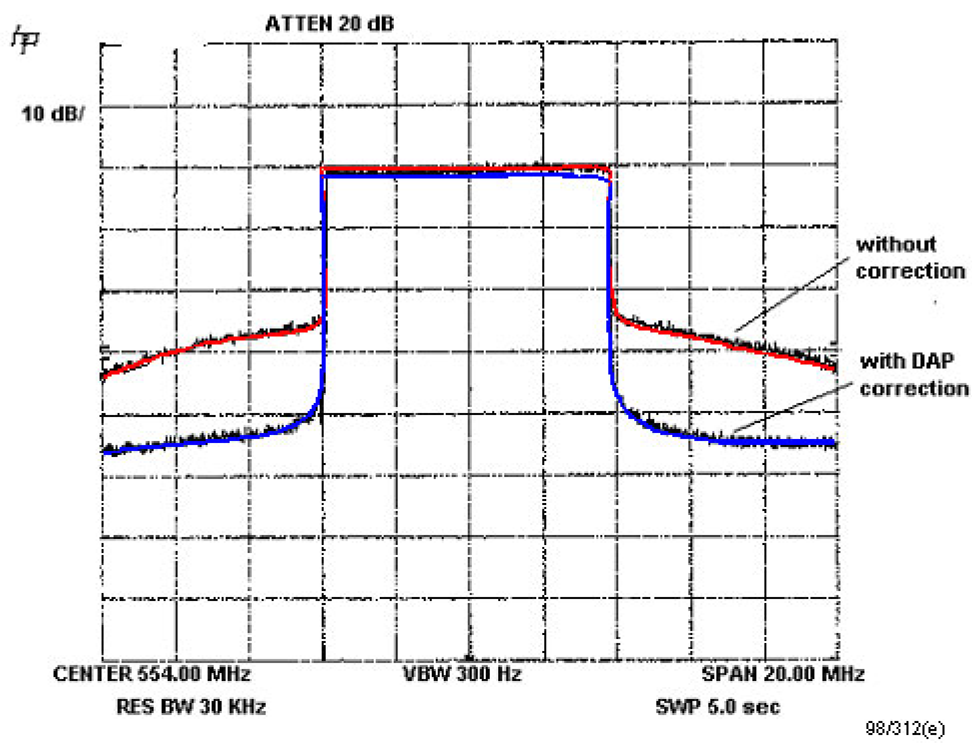
- Clipping
- Non-Linear Digital Adaptive Precorrection
- Linear Equalization

The proprietary clipping function limits the magnitude of the vector above a given threshold. The magnitudes higher than the threshold are replaced by the threshold complex value. This allows for a better quality output signal at a lower back-off compared to other transmitters.

The non-linear automatic precorrection function computes the best shoulder level at the output of the transmitter. The process is based on a Look Up Table (LUT) that is loaded from an iterative measurement of the shoulder level. The Digital Adaptive Pre-correction (DAP™) inputs the I and Q signals from the Digital board and compares them to reference I and Q signals derived from the output of the transmitter. The DAP™ precisely calculates the correction needed to make the output signals match the original input signals, and then updates the forward path in both amplitude and phase to compensate for any differences. The outputs of the DAP™ board are the fully corrected I and Q signals.

The DAP™ compensates for non-linear distortions, and is able to adapt to drift changes in the transmitter. Since the correction is adaptive, the set-up and maintenance of the transmitter will not require a significant investment in time and test equipment, unlike equipment without adaptive features, the DAP™ signal quality is maintained at all times. Over the lifetime of the equipment, DAP™ is proven to save operators time and money with lower maintenance costs.

The complex base-band outputs of the LUT are then up-converted to an intermediate frequency (IF). The complex IF frequency signals are converted to the analog domain, amplified and transposed to the proper VHF, UHF, or RF band.



A daughter board located on the TS Board performs the Complex Up/Down Conversion (CUDC) function. The Complex Up/Down Converter (CUDC) receives the pre-corrected signals from the

DAP™ and converts them to an analog on-channel RF signal. An internal synthesizer controls the conversion frequency. The RF local oscillator is always locked by means of a very precise internal 10 MHz Oven Controlled Crystal Oscillator (OCXO). It can also be locked to an external 10 MHz frequency reference. This synthesizer module also provides the 1000MHz RF local oscillator for a second upconversion within the transmitter. In this conversion stage, the 670-675MHz UHF output is translated to the proper on-channel output frequency of 1670-1675MHz

A feedback sample from the RF signal at the output of the transmitter is used to control the shoulders, the linear correction process, and to monitor the quality of the signal.

The CUDC also receives a gain control command from the return path interface for automatic gain control (AGC). The modulator has the capability to adjust its output power in manual mode (when AGC is disabled). The AGC signal is used to adjust the output power of the RF signal from the exciter and to maintain it within specified limits.

The RF signal output of the transmitter is sampled, down converted back to UHF, using the same 1000MHz local oscillator, and fed back to the exciter. This RF output sample is fed into the return path interface contained in the CUDU where it is demodulated. The I and Q reference signals are derived from a reference demodulator also contained in the return path interface. They are the base-band I and Q signals of the transmitter output sample. These signals are fed into the DAP™ processing function in order to correct the transmitter system for linear and non-linear distortions.

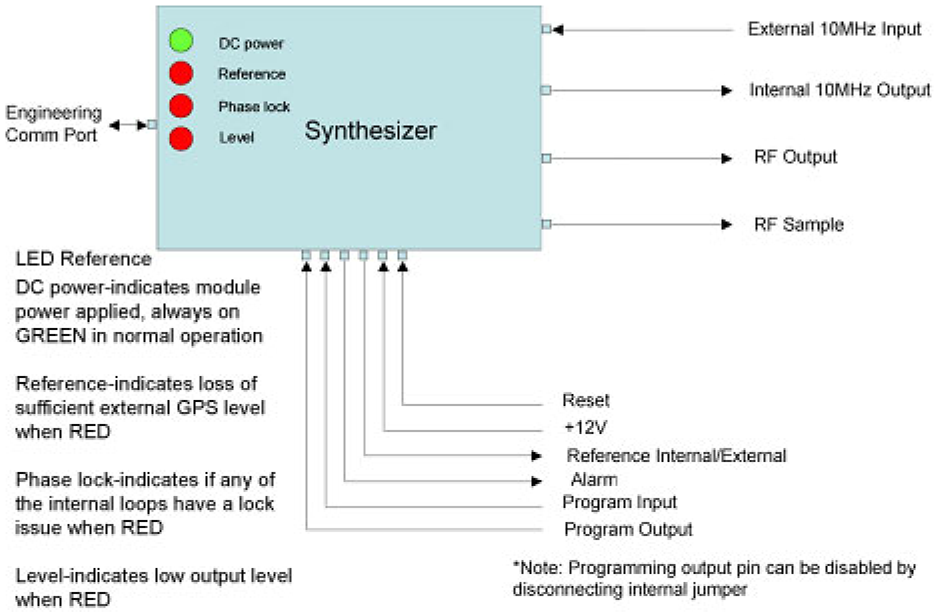
The TS Board receives I & Q output signals and a clock reference from the digital board. These I & Q signals are processed by the TS Board including: Clipping, Linear Equalization, Non Linear adaptive pre-correction. The Clipping function limits the magnitude of the vector above a given threshold. The magnitudes higher than the threshold are replaced by the threshold complex value. The non-linear automatic pre-correction function computes the best shoulder level at the output of the transmitter. The process is based on a Look Up Table (LUT) that is loaded from an iterative measurement of the shoulder level. The complex base-band outputs of the LUT are up-converted to the IF frequency. The complex IF frequency signals are converted in the analog domain, filtered, amplified and transposed to the UHF Tx Board. A daughter board installed on the TS Board performs the up conversion function. External feedback from the RF signal at the output of the transmitter is used to control the shoulder, the linear correction process, and to monitor the quality of the signal. The TS Board then processes the feedback. A DVB-H Enhanced QoS measurement board (optional) is plugged into the TS Board. It is a real time demodulator board used to efficiently monitor the incoming stream. An additional DVB-H hardware demodulator can be used for quality measurement at the output of the transmitter (optional).

10.1.5.3 Power Supply

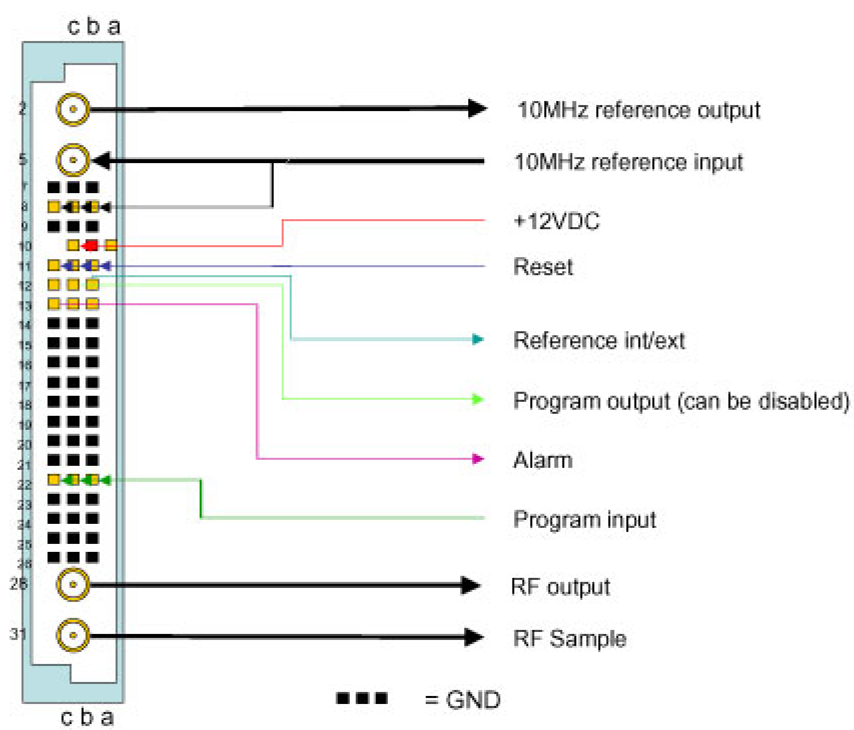
An internal power supply provides +12volts, -12 volts, +5 volts and + 3,3 volts to the exciter subassemblies.

10.1.5.4 UHF Synthesizer

A digitally programmable synthesizer is provided to deliver a sinusoidal signal at the transmitting frequency of between 430 and 900 MHz, with an output level of 10 dBm / 50 ohms. This module also provides a second fixed LO frequency of 1GHz; this is used to upconvert the UHF channel frequency in double conversion microwave applications.



Synthesizer I/O diagram



External synthesizer interfaces

The synthesizer sub-module design combines Direct Digital Synthesizer (DDS), and Phase Lock Loop (PLL) technology to allow for wideband, low resolution, and low phase noise performance. Combining a DDS with a PLL in an RF synthesizer allows frequency resolution and controllability of the DDS while maintaining the frequency range of the PLL system. The PLL can reduce DDS spurious, whereas the DDS can decrease PLL multiplication factor, enhancing phase noise performance of the overall system. Together they provide for a high performance RF synthesizer. This design is a modified translation loop approach containing three phase locked loops, however its core operation depends on a single main loop with an embedded direct digital synthesizer, allowing a simpler overall architecture as compared to traditional multi loop synthesizers, a design method previously hard to achieve without the use of a custom ASIC or complex multistage architecture. The highly integrated direct digital synthesizer incorporates many of the design stages necessary for the translation loop approach such as integrated PLL and mixer stages. Proprietary circuits and techniques allowing wideband operation with fine step size resolution are applied.

To maintain frequency stability the synthesizer requires a reference frequency. Two options are offered in this design, a 10MHz external reference and/or an internal reference. In the internal reference, a PLL system locks an on-board voltage controlled Oven Controlled Crystal Oscillator (OCXO) to the incoming reference input allowing the external reference to control the internal reference while present, and allows minimal system impact in the event that the external reference is lost. The internal reference oscillator circuitry will sense the presence of the external source and select this source as the primary frequency stability determining input. In the event that the external reference is absent, the synthesizer will automatically substitute a voltage on the OCXO V-tune input. This methodology is more complex and costly but adds reliability to SFN transmission systems by allowing a phase continuous input to the synthesizer. Usually, the external reference frequency is a signal that is obtained from a GPS or Loran C broadcast. These navigational broadcasts frequencies are driven from a master reference oscillator that is traceable to a NIST level-1 frequency clock. The external reference enters the module through an RF female coaxial contact of the DIN41612-M connector. The input is matched using a resistive load for 50-ohm impedance. An output of the PLL processed internal reference is also offered on a separate RF female coaxial contact of the DIN41612-M connector. The incoming signal is sampled and detected by a logarithmic amplifier detector. This information, in the form of an analog DC voltage proportional to the signal level, is sent to the MCU for diagnostics. An LED present on the front panel indicates reference status. The reference signal is limited so that the level at the input connector can be as high as +30dBm with no damage to the input circuitry, however, a nominal level of +5dBm is recommended and a level above -5dBm should always be maintained. Note that the phase noise of the reference will affect phase noise performance of the LO outputs. The main Phase Lock Loop (PLL) uses a wide loop bandwidth, and reference noise is one of the dominating factors determining phase noise at close offsets to the carrier below the loop filter cutoff. The client should exercise caution when selecting the reference source if the internal OCXO option is not installed. In order to minimize cost impacts, the high stability internal OCXO reference will remain an option that the client must request at time of order. The 10MHz signal also forms the reference input to the 1000MHz PLO.

The Synthesizer Menu System:

The synthesizer is equipped with a menu system that can be accessed via the RS232 port located on the front panel. Any terminal application can be used. A serial interface cable (consult cable drawing 47267081-040 for construction details) is connected from the front panel RS-232 RJ11 connector to an available serial communication port on a PC (set to 9600baud). Open the terminal application and ensure proper communication settings. To display the current module status type ":?" followed by a carriage return. The current status and list of available commands will appear; the following example illustrates the display activity:

```
Thales B&M.
:?
***************************************************************
Synthesizer Status
***************************************************************
Current frequency setting:          700000000Hz
On-board OCXO:                      Yes
Reference INT/EXT:                  Internal
Reference Level:                    Optimal
Reference ATD value:                72 (threshold=119)
Free running OCXO control value:    691
10MHz PLL Health:                   Locked
1000MHz PLL Health:                 Locked
Main PLL Health:                    Unlocked
Current loop filter switch:         Engaged
RF output ATD value:                72 (threshold=160)
Mute switch state:                  Muted
Current attenuator value:           255 (default=255)
Alarm status:                       Alarm (state = 8)

******************** Synthesizer Commands ********************

:?  Show Status             :V  Show Version             :L  Test LEDs
:a  Show Attenuation        :A<atten>  Set Attenuation   :X   Set OCXO
:R  Reset Synthesizer       :E<freq>  Set Frequency      :F  Toggle LFC
:0  Show A2D 0              :1  Show A2D 1               :2  Show A2D 2
```

NOTE: Use the commands in the same way you invoke the status screen; type ":" then the appropriate letter for the desired command followed by a carriage return.

Command functions (front port only):

:? Show Status

To get current module status, type ":"; then "?"; then press enter.

This command will display the current status of the module

:V Show Version

To get module version info, type ":"; then capital "V"; then press enter.

This command will display the Module part number, firmware revision, build date, and other version information.

:L Test LEDs

To check LED status and run lamp test, type ":";L then press enter.

This command invokes a lamp test routine.

:a Show Attenuation

To check current attenuator value, type ":"; small "a", then press enter.

This command displays the current attenuator setting.

:A<atten> Set Attenuation

To set the attenuator, type ":"; capital "A" then 3-digit attenuator setting 0-255 then press enter.

This command allows adjustment of the output level. The valid setting range is 0-255, 0 having the maximum RF level and 255 having the lowest. The typical value will be around 190 to achieve the proper nominal level. The RF output can be adjusted to work with a +17dBm mixer as well as today's 12dBm output level.

:X Set OCXO

To set the free-running OCXO frequency, type ":"; capital "X" then the setting.

This command allows adjustment of the free running OCXO. Meaning if the external reference is not present and the module is equipped with the internal oscillator the tuning port voltage can be adjusted to compensate the frequency of the internal oscillator. This acts as the hardware potentiometer adjustment used in OEM models. The typical value will be between 690 and 850 to achieve the proper RF frequency.

:R Reset Synthesizer

To reset the module, type ":"; capital "R" then press enter.

This performs a software reset, be aware that invoking reset will force a temporary mute of the output.

:E<freq> Set Frequency

To set frequency, type ":"; capital E then 10 digit frequency ex: 0500000000; then press enter

Use this command to change the frequency of operation. Always enter a full 10-digit frequency after the command character.

:F Toggle LFC

To set LFC: type, ":"; capital "F"; then hit enter. (Toggles current value engages or disengages the circuit)

This allows the user control over the loop filter bandwidth, and can be used to override the default setting. The user should use caution, and be monitoring the phase noise characteristics of the output during this adjustment.

:0 Show A2D 0

To check reference detector ATD value, type ":";0 then press enter.

This displays the external reference level after the analog to digital conversion.

:1 Show A2D 1

To check RF level ATD value, type ":";1 then press enter

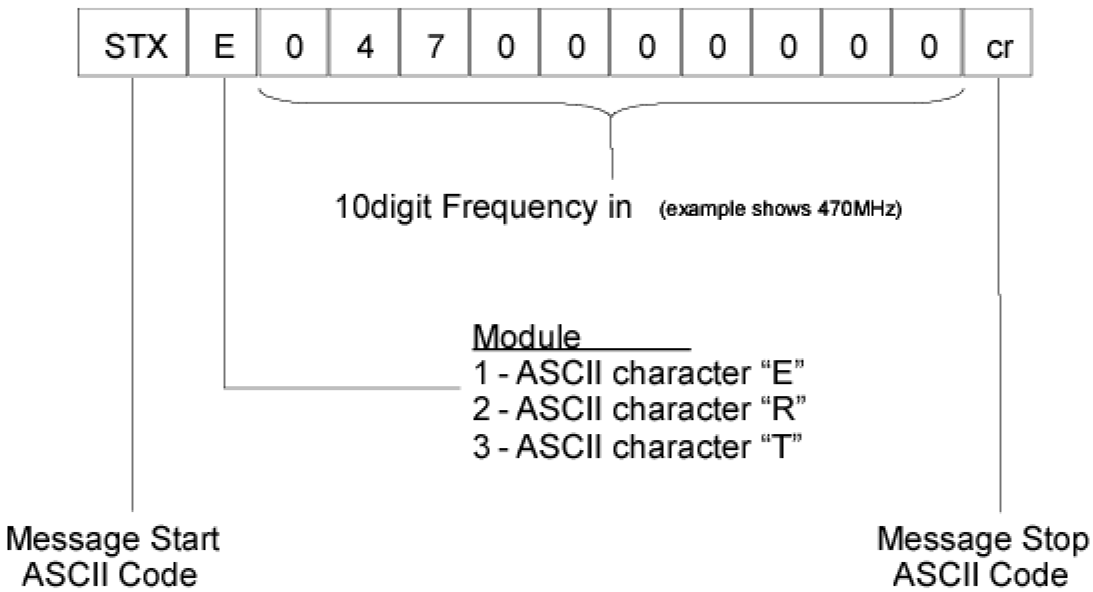
This displays the output level after the analog to digital conversion.

:2 Show A2D 2

Unused at this time

Command functions (REAR port only):

The rear panel RS232 communication port operates at 1200baud, and can be interfaced via any terminal application. This port is limited to changing the output frequency. Selection of the output frequency is made by using a proprietary protocol that sends a 10 digit ASCII character string across the rear panel serial bus at a transfer rate of 1200baud, No parity, 1 stop bit. The synthesizer firmware will not accept alpha or symbolic characters as part of the frequency data. The Figure below demonstrates the messaging sequence:



To manually set a new frequency: type cntrl b; capital "E"; then type the10-digit frequency (ex: 0500000000), and press enter.

DC Power Requirements / Synthesizer Specifications

The module requires a single 12VDC source entering on pin B10 of the 60-pin DIN connector.

Parameter	Specification	Comments / Notes
Voltages / Currents	+12 V_{DC} ±.5 @ 850mA max. +12 V_{DC} ±.5 @ 1.5A max.	w/o internal reference w/ internal reference
Ripple	<1mV Pk-Pk	Allowable on external source
Connector	DIN41612 type M connector. 60 conductor, 2amp / circuit; performance level 1	Interfaces to back-plane

Reference Specifications (applies to external reference except where indicated)

Parameter	Specification	Comments / Notes
Frequency	10MHz	External or optional internal
Input Level	0 dBm +15 /-5dB (+48 dBmV nominal)	+30dBm no damage
Format	Sinusoidal	
Stability vs. temp. External MRO Internal OCXO	$1x10^{-7}$ PPM minimum 0°-50°C $\pm 2x10^{-8}$ PPB minimum 0°-50°C	After 60 minute warm up; Refer to Temex specification/datasheet for long term ageing specifications (valid for free-running mode only)
Non-Harmonic Spurious	10Hz < f_{offset} < 5MHz < -104dBc beyond 5MHz < 75dBc	
Connector / Impedance	DIN connector coaxial contact / 50 Ω	For external input and internal output; Mates with back-plane connector

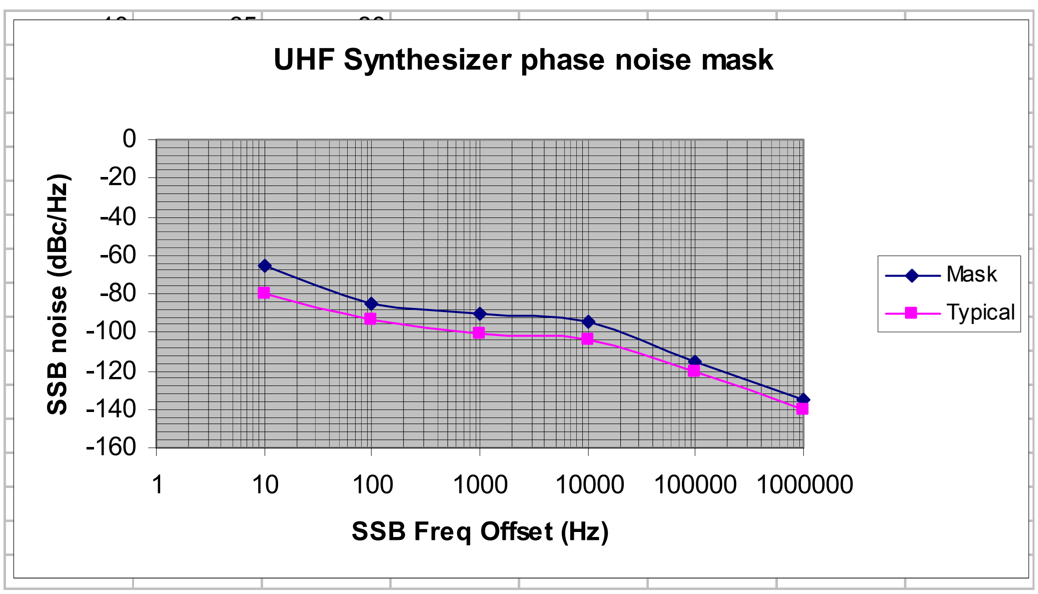
RF output specifications

UHF Band430-900MHz		
Parameters	**Specifications**	**Comments / Notes**
Frequency Tuning Range	430-900MHz	Covers UHF Band
Tuning Step Size Coarse Fine	 N/A 1Hz	
Non-Harmonic Spurious	100Hz < f_{offset} < 10MHz, 65dBc beyond 10MHz < 65dBc	
SSB Phase Noise (typical) See UHF mask for guaranteed limits	≤65 dBc/Hz @ 10Hz offset ≤85 dBc/Hz @ 100Hz offset ≤90 dBc/Hz @ 1kHz offset ≤104 dBc/Hz @ 10kHz offset ≤115 dBc/Hz @ 100kHz offset ≤130 dBc/Hz @ 1MHz offset	Depends on frequency reference source. The reference must be ≤140 dBc/Hz @ 100Hz offset; Measured with Thales standard OCXO based MRO. Phase noise specifications below loop bandwidth based on system noise floor = $-213+10\log f_{comp} + 20\log N$.

VHF Band 54-300MHz		
Parameters	**Specifications**	**Comments / Notes**
Frequency Tuning Range	54-300MHz	Covers VHF Bands I,II,&III
Tuning Step Size Coarse Fine	 N/A 1Hz	
Non-Harmonic Spurious	100Hz < f_{offset} < 10KHz, 65dBc 10KHz < f_{offset} < 10MHz, 60dBc beyond 10MHz < 60dBc	
SSB Phase Noise (typical)	≤65 dBc/Hz @ 10Hz offset ≤85 dBc/Hz @ 100Hz offset ≤101 dBc/Hz @ 1kHz offset ≤107 dBc/Hz @ 10kHz offset ≤120 dBc/Hz @ 100kHz offset ≤135 dBc/Hz @ 1MHz offset	Depends on frequency reference source. The reference must be ≤140 dBc/Hz @ 100Hz offset. Measured with Thales standard OCXO based MRO.

General		
Parameters	**Specifications**	**Comments / Notes**
Power Level Main output Sample output	+12dBm, ±2dB -7dBm, ±3dB	No ALC
Power Level (muted) Main output Sample output	<-25dBm <-43dBm	
Time to mute	<2ms	Hardware controlled
Frequency settling time After switch on After last character is received in a channel change event	<1s <700ms	
Stability	Based on frequency reference; 10^{-9} to Allan variance	
Harmonics	10dBc minimum	
Connector / Impedance Main output Sample	DIN connector female coaxial contact / 50 Ω DIN connector female coaxial contact / 50 Ω	Mates with backplane
I/O VSWR	2:1 Ratio	

The UHF phase noise mask is shown in the following figure:



UHF phase noise mask

Alarms / Indicators / Adjustments / Controls

Alarms/ Indicators/Adjustments/Controls		
Parameters	**Specifications**	**Comments / Notes**
DC PWR Presence Indicator	Green LED, ON= +12VDC power present; trips when + 12 VDC signal is absent	Visible via front panel
Frequency reference Indicator	Red LED, ON = External Frequency reference fault; trips when signal < -5dBm; normally unlit	Visible via front panel
Level Indicator	Red LED, ON= output muted or at low power; trips when signal <+6dBm; normally unlit	Visible via front panel
Phase (∅) Lock Indicator	Red LED, ON= Loss of ∅ Lock or loss of frequency programming data; normally unlit	Visible via front panel
Frequency Control	Serial interface; Selection of the output frequency is made by serial programming using ANACAD proprietary protocol, which sends ASCII character string across serial bus operating at 1200buad; no parity.	Accessible via rear panel serial connections on 60pin DIN; It will also be possible to read back the frequency setting of the synthesizer.
Frequency Reference adjustment (internal reference option only)	Firmware controlled user adjustment of internal OCXO reference oscillator for frequency alignment	Accessible via RJ11 front panel port use external computer with LO calibrator application
Front panel communication/ Control port	RS-232 interface; used for firmware upload, setup, calibration, control, and diagnostics purposes.	Accessible via RJ11 front panel port use external computer with LO calibrator application
Reset	Control signal input to module; pull-up to +5V = reset condition	Signal available at rear-panel of module
Reference int/ext	TTL Low = internal ref; HIGH=external ref	Signal available at rear-panel of module
LO Fault	TTL Low = fault condition; HIGH=Normal	Signal available at rear-panel of module

Environmental

Environmental		
Parameters	**Specifications**	**Comments / Notes**
Operating Temperature	-10°C to 50°C	Frequency stability and functionality guaranteed
Storage Temperature	-20°C to 70°C	
Specified Temperature Range	0° to +50°C	All specified parameters guaranteed
Cooling	Natural convection	
Relative Humidity	0 to 95% non-condensing	

NOTE: Under normal operation Sirius handles all interfacing with the onboard synthesizer therefore manual interface is rarely utilized and is explained here as reference only.

10.1.5.5 GPS Receiver

The optional low power miniature GPS board enables the onboard 1 PPS signal 10 µs pulse, UTC, and 10 MHz signals. Refer to The GPS manual for details on this optional device.

10.1.6 Exciter Rack

The frame of the exciter includes two complementary devices:

- Exciter Front Panel Assembly
- PC Card Slot Assembly (optional) used to house a memory board capable of saving exciter parameters.

Front Panel Designators

A-Monitoring- Output sample to monitor the RF signal output

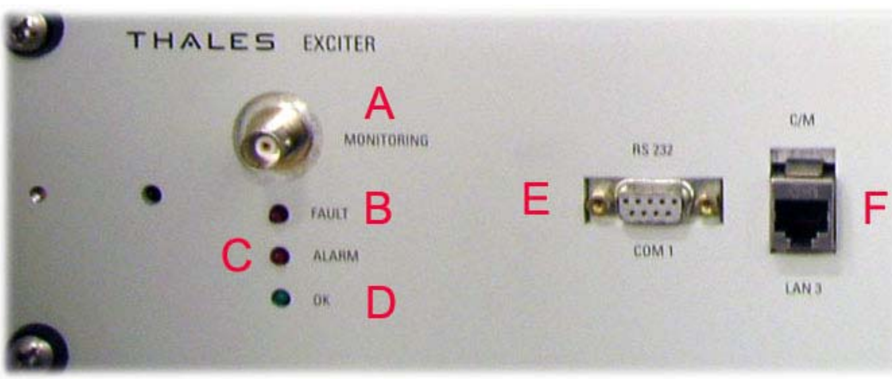
B-Fault (LED)- Global detection---checks for faulty boards

C-Alarm (LED)- Checks input data stream and GPS operation

D-OK (LED)- LED has two functions: (1) Power supply presence voltage (2) Start-up of exciter

E-Com1 RS232- RS232 input for programming the Digital Board.

F-LAN- Ethernet access for programming the Digital Board

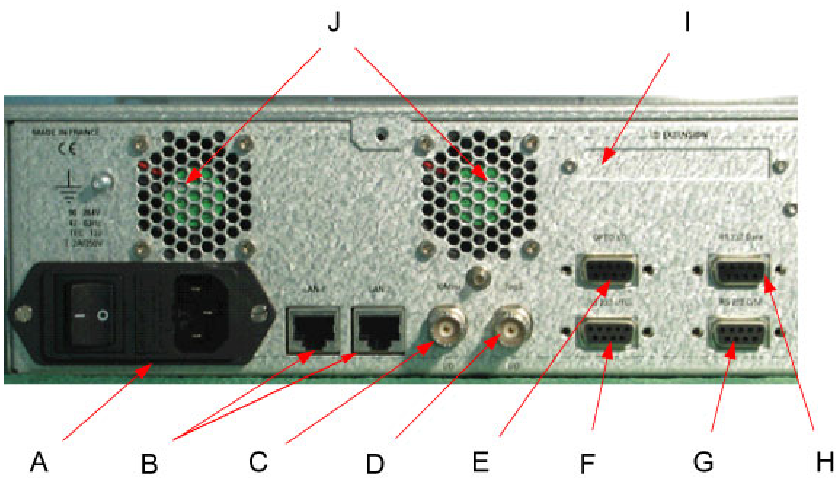


PC Card Slot (optional)

10.1.7 Exciter Connectivity

Located at the backside of the exciter are the interconnection points used by the operator to control the driver function in the transmitter.

Left side of Rack



A- Main power supply input: 90 to 254 volts AC, 47 to 53 hertz

B- 2 RJ45 connections for Ethernet

C- 10 MHz 50 ohm frequency reference input connected to Digital Board

D- Timing reference 1 PPS connected to Digital Board

E- Double input and double output opto-coupled ports in connection with Digital Board

F- DB9 RS232 UTC reference input for GPS

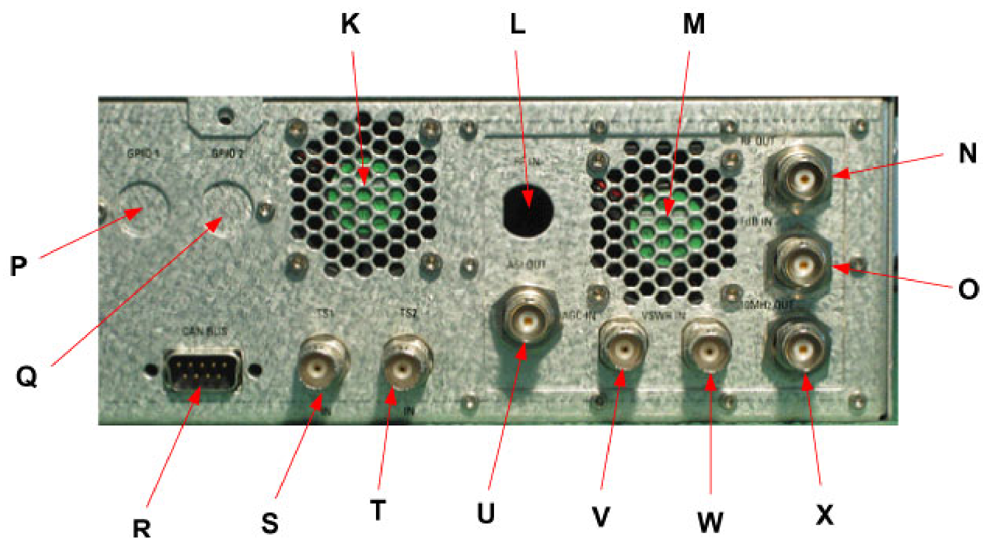
G- DB9 RS232 Local CM in connection with Digital Board.

H- DB9 RS232 data for Digital Board.

I- Multipoint connection I/O extension, monitoring and control interface via contact closure (optional)

J- Cooling

Right side of Rack



K-	Cooling
L-	Synthesizer 1GHz LO output
M-	Cooling
N-	0 dBm with 45dB shoulder RF output (without precorrection)
O-	Feedback RF input (-15dBm+/-5dB) for linear and no linear automatic correction.
P-	GPIO connection (*not used*)
Q-	GPIO connection (*not used*)
R-	CAN bus in connection with Digital Board (*not used*)
S-	DVB-ASI input TS #1
T-	DVB ASI input TS #2
U-	Optional ASI output
V-	Automatic gain control input (*not used*)
W-	VSWR input in connection to TS Board (*not used*)
X-	10 MHz output signal (*not used*)

10.1.8 General Characteristics of Exciter

Transmission Characteristics

Emission Standard:	DVB-H
Norm:	ETS 300-744 v1.3.1 or the last at the date of this specification
Modulation scheme:	COFDM
Signal Bandwidth:	5,6, 7, 8, MHz
UHF IV & V	470 @ 862 MHz

Environmental Conditions and Safety

Performance:	0° to 45° C up to 3000 m		-10° C to + 50°C
with derating:	Tmax - 5°C by 1000 m	Maximum altitude:	4000 m max
Storage temperature:	-30° C to +60° C	Relative Humidity:	≤ 95% sans condensation
EMC:	Standard ETS 300-385	Safety:	IEC 215, IEC 1010
CE Label:	Compliant	Acoustic noise:	IEC 179: < 65dBa

General Electrical Mechanical and Cooling Characteristics

Rack:	19" 2RU, depth < 600mm
Main Consumption:	< 200 VA
Cooling:	Internal Fan, air input on the front panel
Finish:	Thales Standard

Mains Power Supply

Voltage	230 V / 105 V ± 15%
Frequency	47 to 63 Hz
Power Factor (at nominal operation)	> 0.90
Button ON/OFF on the rear panel	
Accessible fuse	

10.1.9 Input/Output Characteristics

Input Characteristics

TS Input

DVB-H version

Dual A and B ASI inputs

Auto, manual, remote switchable for TS securization OR HP and LP inputs for hierarchical mode

- Standard	MPEG 2 TS
- Format:	TM 1449: 8 bits/10 bits encoded
- Max. level	800 m Vpp
- Min. level	200 mVpp
- Baud rate	270 Mbaud ± 100ppm
- ASI format	188, 204, 188+16
- Impedance	75 Ω
- Return loss	15 dB from 5 to 270 MHz
- Connector	BNC female

- Maximum length of cable between Network adapter and TX input: < 50m

Dual ASI for Hierarchical mode (optional)

- 4 BNC connectors for 2 HP and 2 LP ASI inputs

Dual A and B PDH inputs (ETS 300 813)

Dual A and B SDH inputs (ETS 300 814)

Ancillary Inputs

External 10 MHz Frequency Reference

- Standard	10 MHz
- Format:	Sinus and TTL
- Level	7 dBm ±1 dB
-Return loss	17 dB
- Connector:	BNC female
-Impedance	50 Ω

- Phase noise DVB-H compliant: at 10 Hz ≤ –110 dBc/Hz, at 100 Hz ≤ – 130 dBc/Hz. Spurious ≤ –104 dBc/Hz from 10Hz to 5 MHz.

External Timing Reference (1 PPS)

- Pulse width min	50 µs
- Level	TTL

- Frequency 1pps
- Active Edge choice for leading or falling edge
- Connector BNC female
- Impedance 50 Ω

Input for non linear correction (feedback)
- Input level: -26 < N < -20 dBm
- Connector BNC female
- Impedance 50 ohms
- Return Loss >15 dB

AGC Input
- Average detected voltage: 1 < N < 2,5V -
- Connector BNC female
- Impedance > 3 K ohms
- Range: 10 dB
- Rise time and fall time < 1s
- Switch over threshold for MGC 200mV

RF Output Characteristics

Standard
- DVB-H 8/7/6/5 MHz Capability to follow possible modifications of the standards

Power
- Output power (rms) 0 dBm
- Adjustable between +0 and –10 dB by 0.1 dB steps
- Output power stability ± 0.2 dB

Output connector
- Impedance 50 Ω
- Connector BNC
- Return loss ≥ 20 dB

Frequency
- Frequency range (RF Output) frequency agile, without tuning, from 470 to 862 MHz
- Step 1 Hz
- Intrinsic Frequency stability < 1.10^{-7}/year

- Phase noise compliant with Validate mask

Intrinsic In Band Output signal quality

Modulation shall be generated digitally

- Global MER (DVB-H) ≥ 36 dB
- MER per carrier (DVB-H): ≥ 33 dB
- EVM on each carrier: < 1%
- Central carrier rejection 60 dB under the DVB-H power or ≥ 30 dB under the central pilot amplitude
- BER before Viterbi (DVB-H) $\leq 1\ 10^{-6}$
- END ≤ 0.1 dB
- In Band spectrum flatness ≤± 0.2 dB
- Group delay ripple ≤± 10ns

11 Driver Section Description

The **Driver Section** up-converts and pre-amplifies the IF input signal from the modulator to the levels required to excite subsequent stages. The Power Supply Plug-in Module and the Upconverter Module sub-assemblies make up the Driver Section. These sub-assembly modules are accessible through detachable covers. The covers, which direct airflow through the Driver, together with the rear panel fan-assembly, are part of the Driver Section forced-air convection cooling system.

Driver Assembly (Front view)

Driver Assembly (Rear view)

Power Supply Plug-In Module

Upconverter Module

11.1 Power Supply Plug-In Module

The **Power Supply Plug-In Module** provides the required DC voltage levels for the various transmitting system assemblies. The Front-End DC Power Supply Module provides the 48VDC source required for the operation of the Power Supply Plug-In Module.

The Power Supply Plug-In Module contains a DC converter board that converts 48VDC to the output voltage levels used for the various circuits within the Driver Section and transmitter assemblies. The Power Supply Plug-In Module generates +24VDC, +12VDC, +8VDC, +5VDC, and -12VDC. The enable logic of the controller directs the on and off functionality of the +24VDC, +12VDC and +8VDC supplies. The -12VDC and +5VDC supplies are independent and not switched by the positive enable logic.

+12VDC: A DC-to-DC converter within the Power Supply Module transforms the 48VDC to 12VDC. The 12VDC supply is fuse protected. The 12VDC supply is filtered on the output to attenuate ripple from the input source and DC-to-DC converter. An LED located on the front panel of the Power Supply Plug-In Module confirms the DC-to-DC converter operation. This DC-to-DC converter provides all of the remaining power requirements of the Driver. The converter is mounted underneath the DC converter PCB, and directly onto the extrusion. This extrusion facilitates the thermal dissipation of energy from the DC-to-DC converter.

A positive voltage enabled switch controls the application of +12VDC to the remaining plug-ins within the Driver. Additionally, the positive voltage enabled switch controls the application of the 12VDC to the 24VDC, and the +8VDC power supplies. These supplies also provide the operational power to the rest of the system.

+24VDC: A switching power supply steps-up, filters and regulates the 12VDC to generate the 24VDC. Diodes protect the regulator from reverse and over-voltage load conditions. The output of this power supply is fused to prevent damage to the power supply circuit during transitional overloads. Since the positive voltage enabled switch controls the supply voltage to this power supply section, the output voltage will shut down when commanded by the microcontroller. The output of this power supply section is only used to power the remote interface circuitry on the user interface module in the exciter.

+8VDC: A linear regulator provides the +8VDC from the +12VDC power supply section. This regulator is filtered to clean any AC component coupled across/induced from the regulator. Diodes protect the regulator from over-voltage and reverse-voltage load conditions. A resetable fuse further protects the regulator during overload conditions. Since the positive voltage enabled switch controls the supply voltage to this power supply section, the output voltage will shutdown when commanded by the microcontroller. The output of this power supply section is only used within other sections of the Driver.

+5VDC: A linear regulator provides a +5VDC output from the +12VDC power supply section. This power is used with the Power Supply Plug-in for powering the digital monitoring circuits of the power supply plug-in, and the Master Control Interface (MSI). To assure continuous operation of the controlling circuitry, this voltage is not controlled by the positive voltage enable.

-12VDC: A switching power supply converts voltage from the +12VDC supply to approximately –16VDC. This voltage level is filtered and regulated to -12VDC. Diodes protect the regulator from reverse and over-voltage load conditions. The output of this power supply is fused to prevent damage to the power supply circuit during transitional overloads.

Similar to the +12VDC power supply section, a negative voltage enabled switch controls the application of -12VDC to the remaining plug-ins within the Driver.

Power Supply Enable: The positive and negative power supplies work identically, with the exception of the direction of current flow and type of MOSFET transistor switching the power to the system. TTL logic from the embedded controller is applied to NPN transistors that supply sufficient current to drive optocouplers.

The optocouplers have a Darlington-pair transistor drive that when enabled, create a current draw from the supply voltage, across two resistors, through the optocoupler and ground. This current draw across the resistors provides a voltage drop.

A tie-point in between the resistors takes the difference in potential to the gate of the transistor. The difference of potential between the source and drain causes the MOSFET to conduct, turning on the voltage to the rest of the circuitry behind the switch.

When there is no current flow across the resistors (when the optocoupler is not conducting), there is no current flow through the resistors, no voltage drop across the resistors, and the potential from the gate to source remains the same. The MOSFET will not conduct and will switch off the power to the remaining circuitry behind the transistor.

Current and Voltage monitoring: Current sampling is accomplished by measuring the voltage drop across a resistor in series with the load. The voltages from both sides of the resistor are scaled down in order to keep the measured voltages from the supply voltages of the operational amplifiers. The voltage differences are buffered and applied to an operational amplifier configured to measure the difference of the two input voltages.

The output of the differential amplifier is applied to a non-inverting amplifier to increase the voltage near the middle of the system controller 5-volt analog-to-digital converter range. An integrated circuit containing Zener and Shottkey diodes protect the inputs of the system controller. The system controller compares this value against previously calibrated values to determine if the power supply is operating outside of specified parameters.

The input buffers for the current sampling provides the voltage samples. Dividing resistors scale down the buffer outputs. This provides a sample voltage to the analog-to-digital converters that is mid-range between 0 and 5 volts.

All of the power supply sections operate in a similar manner. The -12VDC power supply section uses inverting amplifiers (instead of buffers) with unity gain to convert the sample values to positive representations of the sampled voltages.

The current and voltage sample outputs are applied to an analog multiplexer integrated circuit. This chip selects the group of signals that are applied to the microprocessor from a control provided from the microprocessor.

An onboard Master Control Unit (MCU) with programmable firmware provides monitor and control functionality. The MCU monitors the voltages and current from the power supply and controls the output based on reference measurements. The MCU will switch off positive voltages to the Driver Section when a loss of negative voltage is detected. This feature protects the amplification devices located within the Upconverter and Power Amplifier modules.

The Power Supply Plug-In Module controller routes RS-485 multi dropped network communications to other modules on the network.

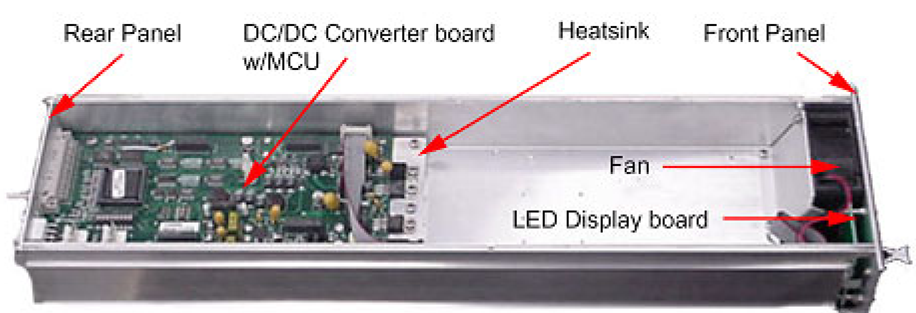
A temperature sensor within the Power Supply Plug-In Module provides input to the microcontroller proportional to the ambient temperature of the module. If the Power Supply Plug-In Module operates over the temperature specification, a controlled shutdown of all supplies will occur.

The Power Supply module contains an RS232 interface located on the front panel. This EIA standard interface allows for connectivity with a serial host such as a desktop computer.

The Power Supply Plug-In Module is "Hot Swap" compatible allowing for module replacement without the need of powering down the module or transmitter.

NOTE: During the "Hot Swap" process as the Power Supply Plug-In Module is removed, the transmitter will go off air until the replacement Power Supply Plug-In Module is plugged back into the chassis.

The Power Supply Plug-In Module is cooled by a single fan and is mounted in an extrusion that is designed to dissipate the heat generated from the components within. The fans of the Sub-Chassis also ventilate the Power Supply-Plug-In Module.



Power Supply Plug-in Module

11.1.1 Power Supply Plug-In Module Specifications

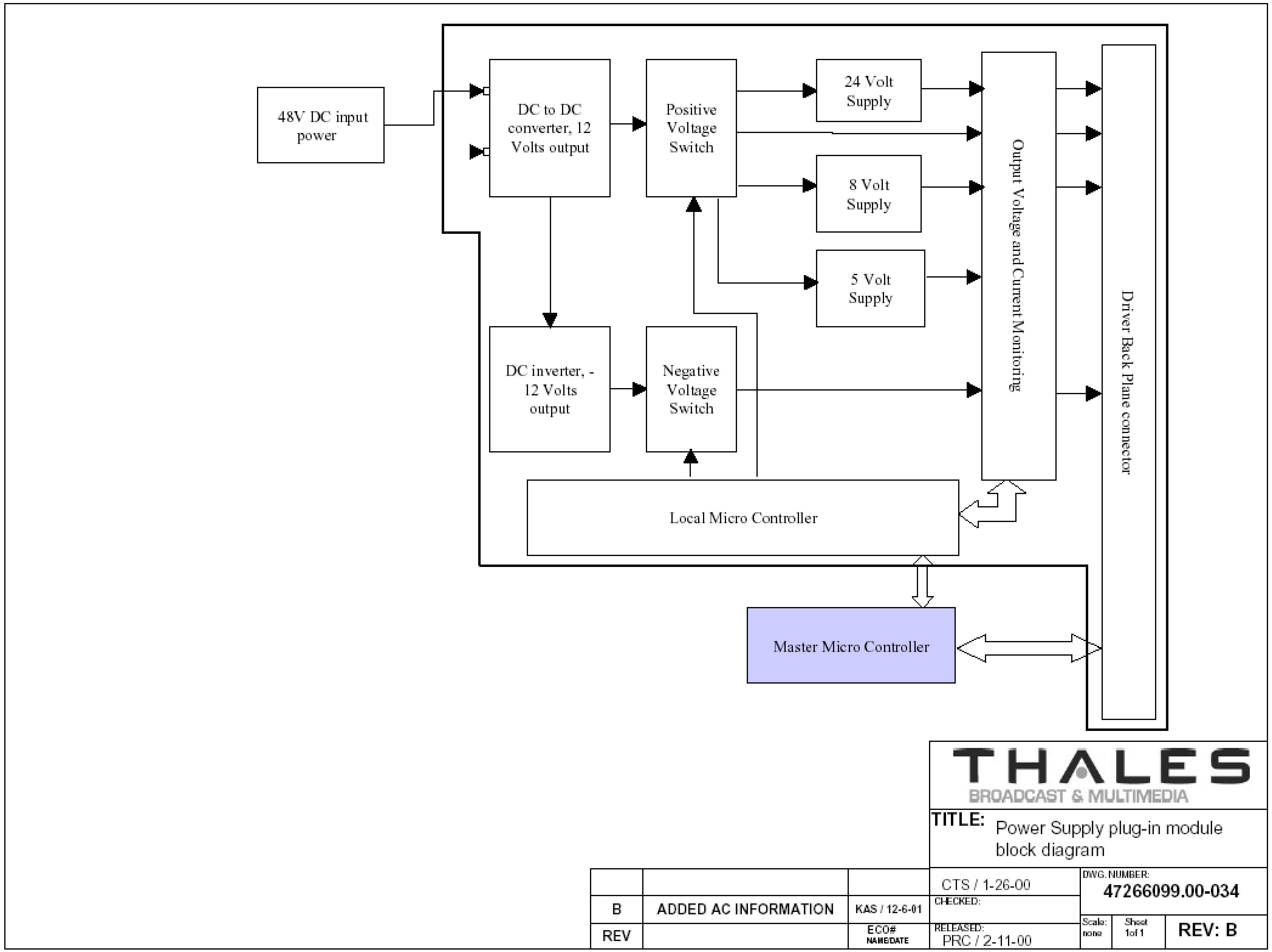
Parameter	Specification	Notes
	Input	
Input voltage	48VDC	
Input current	4 amps, maximum	Low line @ full rated power
Peak inrush current	≤ 6 amps	
Efficiency	85% typical	Full load
	Output	
Output voltage	Main Output 12VDC ± .5 +8VDC ± .5 +24VDC ± .5 -12VDC ± .5	All voltages are fixed
Output current	Main Output +12V @ 3.5 amps +8V @ 3.0 amps -12V @ 0.185 amps +24V @ 0.240 amps	Output supply interruption will occur during overload conditions
Output power	Main Output +12V @ 42 watts +8V @ 24 watts -12V @ 2.2 watts +24V @ 5.8 watts	Output supply interruption will occur during overload conditions
Ripple & noise	≤ 200 mv pp	20 MHz BW
Load regulation	.4% no load to full load	
	Protection	
Over voltage	Power supply will shut down if voltage exceeds nominal voltage by 20%	
Over current	Power supply will shut down if current exceeds maximum value	
Over Temperature	Power supply will shut down if temperature exceeds 70°C. Restart is automatic when power supply returns to normal operating temperature. If over temperature condition occurs twice, power supply will latch in a shutdown condition.	

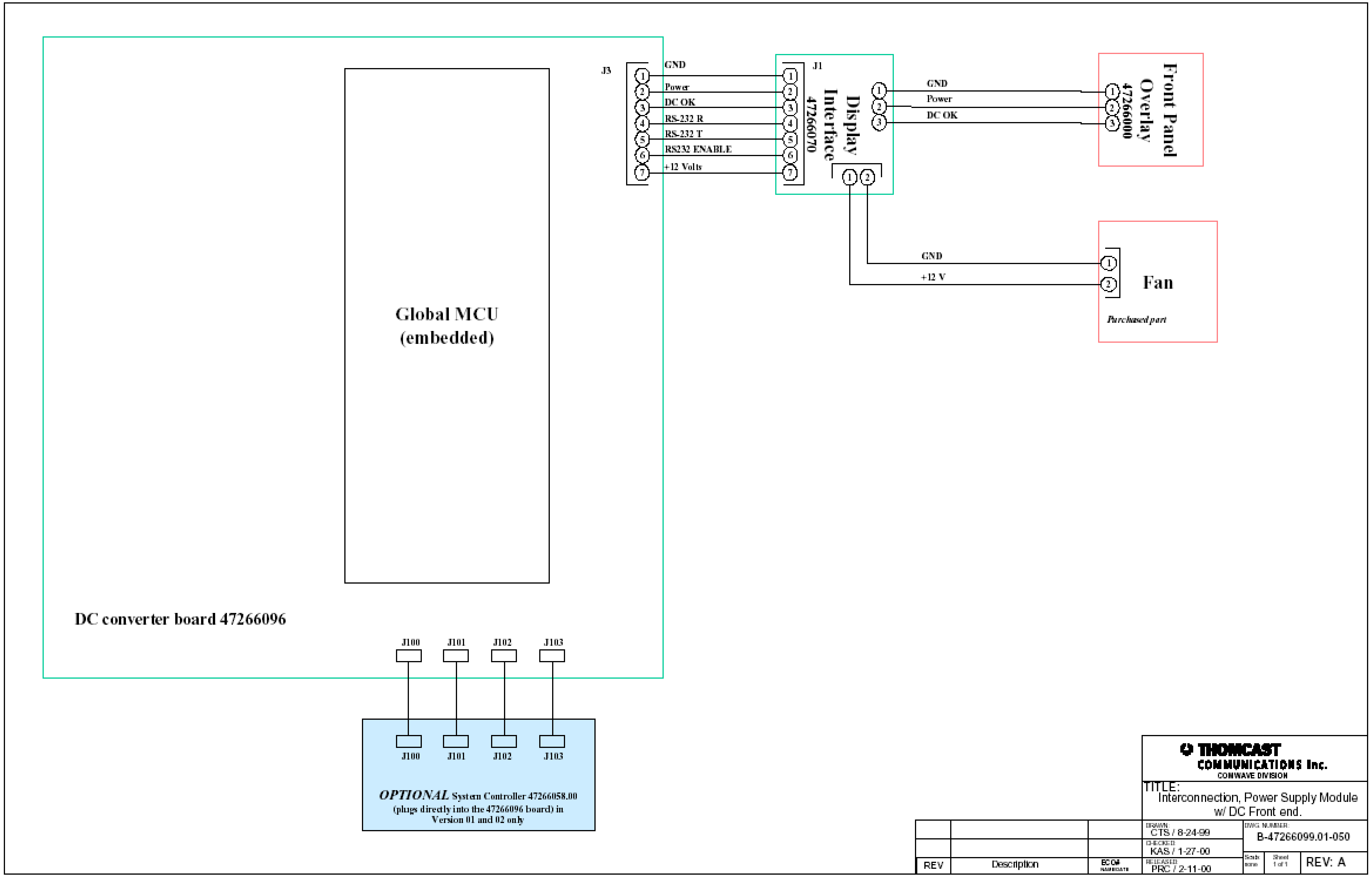
Power input interlock	All voltage outputs are disabled when a negative supply is overloaded to prevent damage to equipment.	
Internal Fuse (F1)		Thales P/N 750082-01

Power Supply Plug-In Module Specifications (cont.)

	Environmental	
Cooling	Forced air-cooled, minimum of 8 CFM required	Forced air-cooled drawing ambient air through the intake on the front of the power supply and exhausting out the rear.
Operating temperature	0° to 50° C	
Relative humidity	0 to 95% non-condensing	
	Alarms/Indicators/Adjustments/Controls	
DC output failure alarm	TTL Low=DC output failure	Signal available at backplane
DC OK indicator	A lit Green LED=DC is within tolerance	Visible via front panel
	Agency Compliance	
Safety	Meets UL and CSA approvals	Pending
	Physical	
Weight	4.5 lbs (2.04 Kg)	
Front panel color	Matches Sherwin William's Paint#: Light gray-F63TXA2555	Paint mix number 4303 identifies store locations when added to paint number Lexan overlay color matched as indicated.
Mechanical dimensions	4.75"H x 3.0"W x 17.5" D (12.07cm H x 7.62cm W x 44.45cm D)	

Power Supply Firmware P/N (Programmed onto 47266096 DC converter board)	**File name**
47266093.01-525	PWRSUP1_1.s19


48V DC input power
DC to DC converter, 12 Volts output
Positive Voltage Switch
24 Volt Supply
8 Volt Supply
5 Volt Supply
Output Voltage and Current Monitoring
Driver Back Plane connector
DC inverter, -12 Volts output
Negative Voltage Switch
Local Micro Controller
Master Micro Controller
THALES
BROADCAST & MULTIMEDIA
TITLE: Power Supply plug-in module block diagram
B
ADDED AC INFORMATION
KAS / 12-6-01
REV
ECO# NAME/DATE
CTS / 1-26-00
CHECKED:
RELEASED:
PRC / 2-11-00
DWG. NUMBER:
47266099.00-034
Scale: none
Sheet 1of 1
REV: B


J3
GND
Power
DC OK
RS-232 R
RS-232 T
RS232 ENABLE
+12 Volts
J1
Display Interface 47266070
GND
Power
DC OK
Front Panel Overlay 47266000
GND
+12 V
Fan
Purchased part
Global MCU (embedded)
DC converter board 47266096
J100
J101
J102
J103
OPTIONAL System Controller 47266058.00 (plugs directly into the 47266096 board) in Version 01 and 02 only
THOMCAST COMMUNICATIONS Inc.
COMWAVE DIVISION
TITLE: Interconnection, Power Supply Module w/ DC Front end.
CTS / 8-24-99
KAS / 1-27-00
PRC / 2-11-00
B-47266099.01-050
REV: A
REV
Description
ECO#

11.1.2 Power Supply Module Front and Rear Panel Descriptions

Thumbscrews: This hardware secures the module to the sub-chassis and provides a reliable ground connection. Loosen to remove the module for replacement or repair.

Fan: An 18-CFM VDC fan used for plug-in module cooling.

Communication Port: The RS-232 serial communication port is used for setup and diagnostics.

Power LEDs: The Power LEDs are a visual indication used for status monitoring of the operating power parameters.

- Power: Green indicates power from the Front-End Power Supply. An unlit LED indicates no power from the Front-End Power Supply.
- DC Power: Green indicates Power Supply Plug-In Module output voltage is present. An unlit LED indicates no output power from the Power Supply Plug-In Module.

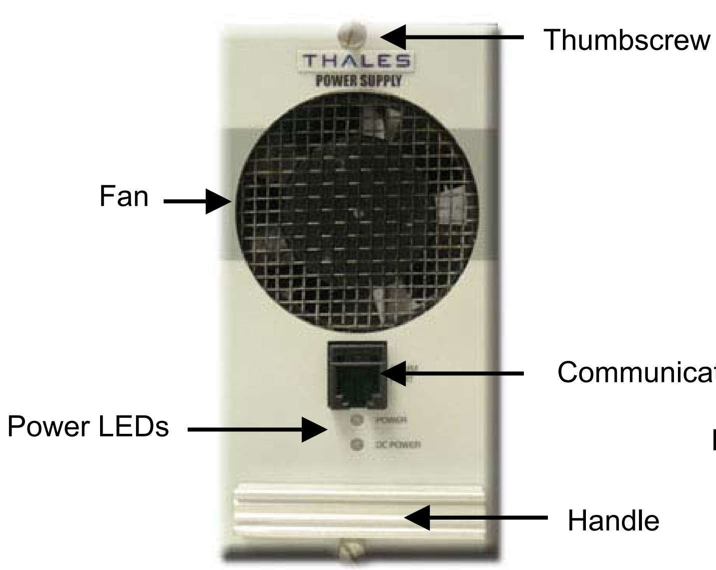
Handle: The handle assists in removing the Power Supply from the sub-chassis.

Heatsink: The heatsink aids in heat dissipation generated within the Power Supply.

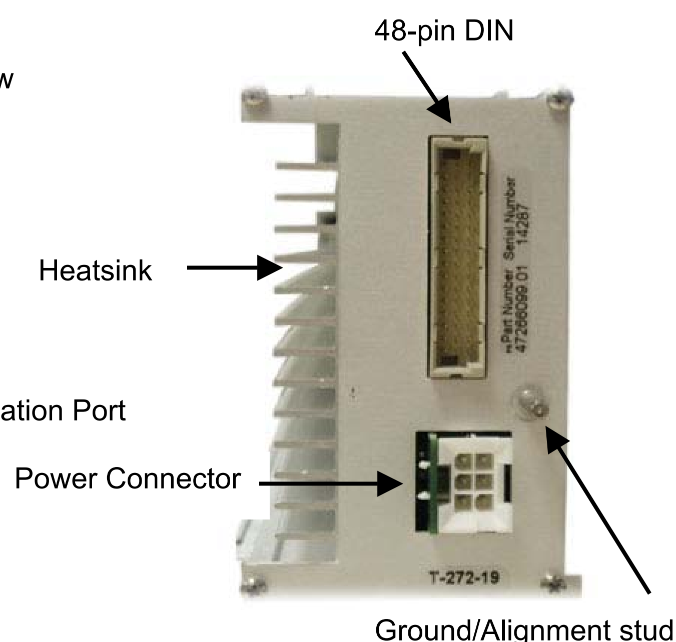
Power Connector: The 6-pin header power connector is used to input power from the Front-End Power Supply.

48-Pin DIN: The 48-pin DIN connecter is an interface point to the backplane (power, control, and diagnostics).

Ground/Alignment stud: The Ground/Alignment stud ensures proper grounding is achieved, and aids in the alignment of the Power Supply module within the sub-chassis. The stud also ensures that circuit grounding is made before the engagement of the 48-pin DIN connector.

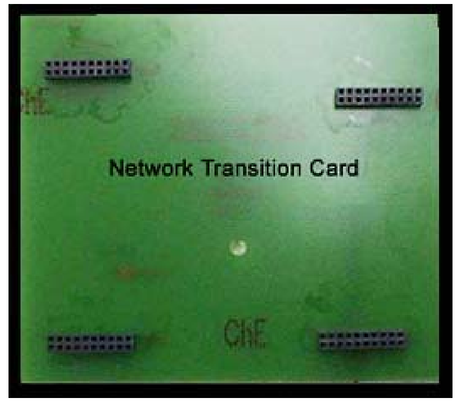


Front Panel



Rear Panel

Network Transition Card



The power supply module, like all modules within the Affinity chassis and Ancillary rack, are networked through an RS-485 network.

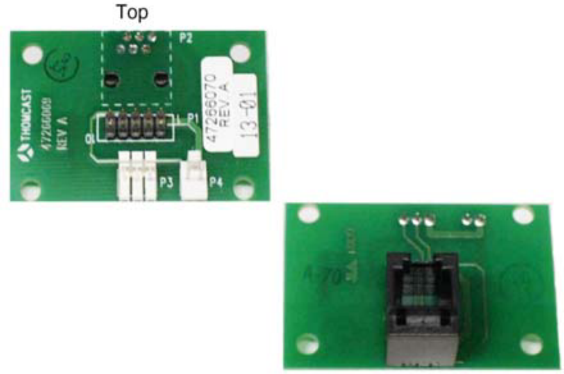
This Printed Circuit Board (PCB) is housed within the Power Supply plug-in module, (only specific versions) in systems where network management is located outside of the plug-in module. The sole function of this board is to route the RS-485 signals directly from the Remote RS-485 buss on the rear panel connector directly to the DC Converter PCB.

Display Board

The display board routes the LED display signals to the DC converter board, supports the front panel communications port, routes the communications signals to the DC converter board, and provides power to the front panel fan.

Display Board

Top



Bottom

11.2 Upconverter Module

The Upconverter Module is a plug-in assembly mounted within the Driver Section of the Affinity®. The basic function of the Upconverter Module is to convert and amplify the exciter output to the proper power level required to drive the subsequent final amplification stage. To accomplish this, the appropriate level IF signal, local oscillator signal(s), and power supply voltages must be present on this plug-in.

The Upconverter performs ALC on the RF signal maintaining a constant drive level after the first conversion stage. The Upconverter Module is attached to the main chassis via three slide-rails and two thumbscrews. Several internal assemblies make up the Upconverter Module including:

- Microcontroller Unit (MCU)
- Front panel board
- Distribution board
- ALC Module
- Converter Sub Module
- Band Pass Filter
- Temperature Sensor Board
- Intermediate Power Amplifier
- Connector Interface
- LCD board

These internal boards are accessible through two detachable covers. The covers, together with the rear panel Fan Assembly, are part of the forced-convection cooling system.

Theory of Operation

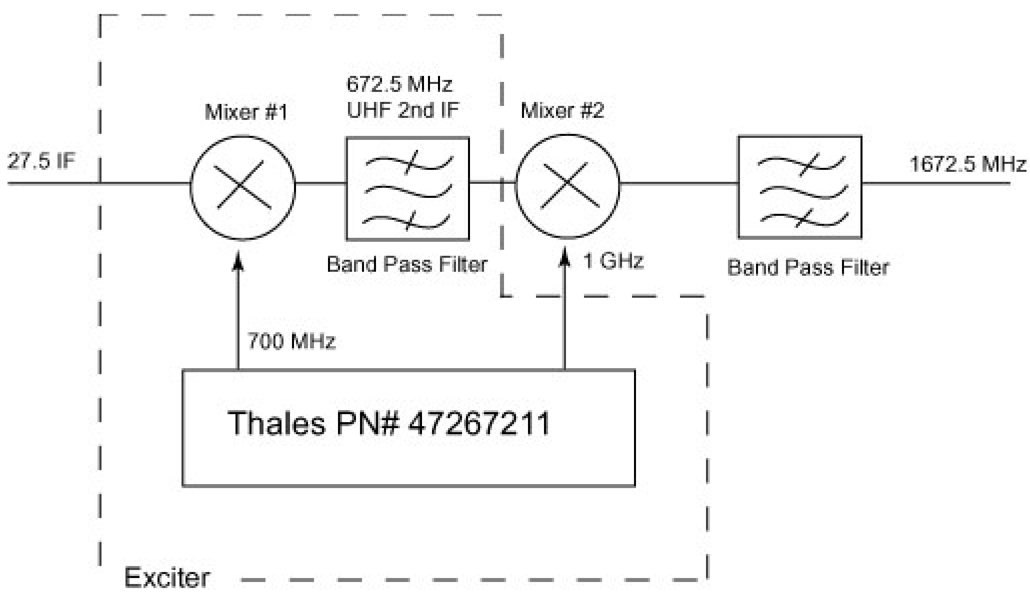
RF signals are sent to and from the Upconverter Module through coaxial connectors and cables on the back panel. Power and communication signals go through a 48-pin connector interface located on the rear panel. RF signal is delivered to the internal modules of the Upconverter via coaxial cables utilizing floating connectors. Signal traffic other than RF, such as power supply voltages, detected power voltages, and serial data from the Microcontroller Unit, are distributed between the modules using the Distribution board and connecting harnesses.

The Microcontroller Unit (MCU) contains firmware that controls and monitors the top-level status of the transmitter, and indicates status of the Driver Power Supply and Upconverter modules, and the transmitter forward and reflected power. The MCU provides an interface to the Front panel board switch assembly and the LCD board. The switch assembly is used to scroll through, and enter the user-interface options. The front panel switch assembly (keypad) has limited ability to make system or Upconverter module control functions; main calibration is done via the RS-232 port on the Upconverter. The LCD assembly provides a visual status of the menu navigation. The UHF signal from the output of the exciter is delivered to the UHF input of the Upconverter and then routed to the Converter sub-module.

UHF – IF Upconverter sub-module

The UHF– IF Upconverter sub-module is responsible for amplifying, filtering, and in conjunction with the second LO which enters the rear of the module, upconverting the UHF input signal. The module houses a single upconverter board, which besides the upconverter function, has a voltage variable attenuator for performing ALC, a detector for sensing UHF input presence, and a sample for front panel monitoring.

The synthesizer module within the Sirius DVB-H assembly is responsible for producing the two Local Oscillator (LO) outputs. In the following figure, application of the LO is shown. The first LO is mixed with an intermediate frequency (IF) that is filtered to produce a second IF. This LO will also determine the output spectrum orientation by utilizing high or low band conversion in this stage. The second IF frequency is heterodyned with the second LO resulting in the final output frequency. In single conversion applications the first LO is not required.



Inside the module, the UHF input signal enters the upconverter board where it is filtered and then mixed with a 1GHz LO to produce an RF signal at 1672.5MHz. The LO signal used in the upconversion is generated by the synthesizer within the Thales exciter. The LO frequency is fixed and the actual channel is set by the incoming UHF frequency, for example, if the UHF is 672.5MHz the LO will be 1000MHz. This means no frequency inversion will occur in the second conversion stage. The up-converted UHF signal is bandpass filtered to attenuate unwanted mixing products. A notch filter provides additional attenuation to the LO.

Intermediate Power Amplifier (IPA) sub-module

After exiting the ALC module the signal is amplified by 13 dB by the IPA. The IPA Sub-Module contains a temperature sensing circuit that outputs to the MCU, via the Distribution board, voltage levels that are proportional to the temperature of the upconverter plug-in. The final RF signal exits the rear of the upconverter plug-in.

ALC Sub-Module

The ALC Sub-Module located internally in the Upconverter Module, containing both integrator and Positive Intrinsic Negative (PIN) attenuators, uses a closed-loop level controller to compensate for PA Module gain variation, and regulates overall output power. The closed-loop level controller works by receiving voltage samples from the output of the Envelope Detector Module proportional to the transmitter output power, comparing this voltage to an internal reference, and adjusting the gain to compensate for PA Module output gain variation. This compensation ensures the transmitter power level remains constant. Indication of forward and reflected power levels of the transmitter and forward power level of the Upconverter module are displayed on the LCD assembly once information originated in respective power detection modules are routed to, and then processed by, the MCU.

The **Connector Interface board** provides +12, -12, and +8VDC to the respective sub-modules and routes forward and reflected detected power voltages for further processing. This board is also the conduit through which serial data is exchanged between the Upconverter Plug-In Module and the rest of the system.

Temperature Sensor board

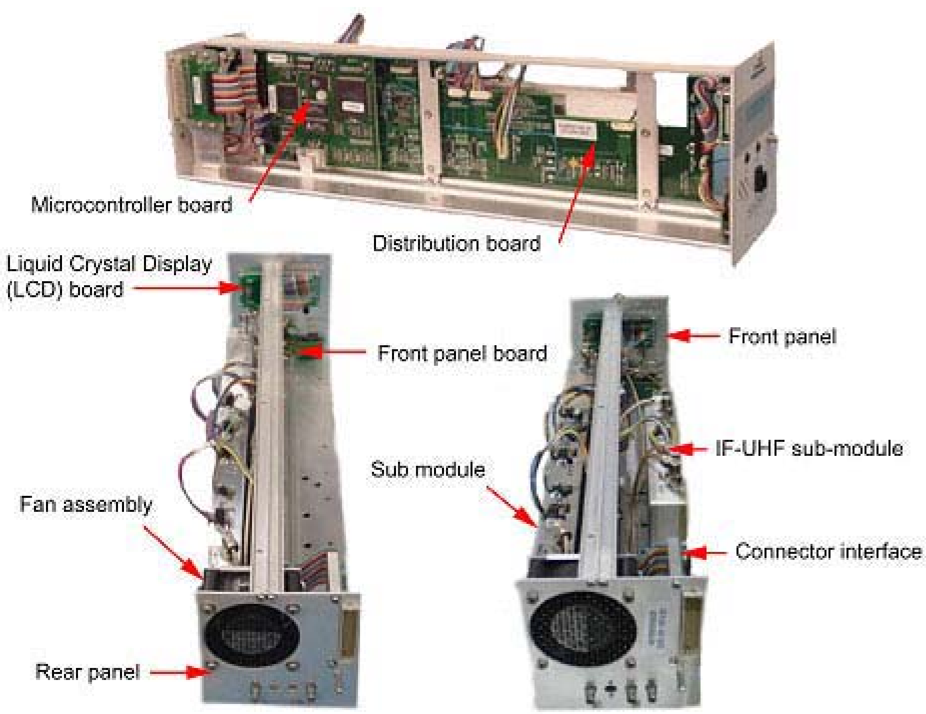
Receives voltage proportional to the temperature generated by a temperature sensor typically placed on the last power amplification stage.

The **Front panel PCB** has a serial port that can be used for testing, adjusting or controlling most of the plug-in functions. A personal computer and application program is required to accomplish this task. The front panel keyboard and display board provide a user interface capable of controlling a limited number of functions inside the Upconverter, and for the presentation of a series of measurements in the LCD display. See Table below for a list of user interfaces.

Menu display		**Description**
Greeting		Displays “Thales Broadcast & Multimedia”
State Control		
	Mode	Local/Remote
	Operate State	On-Air/Standby
System Status		Displays the Upconverter Module status
	Power Supply Status	Displays the top level status of the Power Supply Plug-In Module
	Upconverter Module “In Signal”	Displays the ON/OFF status of “In Signal”
	Upconverter Module “System Forward Power”	Displays the value of “System Forward Power” in percentage
	Upconverter Module “System Reflected Power”	Displays the value of the “System Reflected Power” in percentage
	Upconverter Module “Forward Power”	Displays the value of the Upconverter Module internal “Forward Power” in percentage

List of User Interfaces

Upconverter Module Architecture



11.2.1 Upconverter Plug-In Module Specifications

Parameter	Specification	Test Conditions/Notes
	IF Input	
	Digital	
Average Input Power	-15dBm ±3 dB	2^{23}-1 PN data sequence (at transmitter output)
Input Frequency	672.5MHz	
Connector/Impedance	Blind Mate/50Ω	Mates with floating back-plane connector
	RF Output	
	Digital	
Average Output Power	20mW to 200mW	Function of A.L.C. settings-2^{23}-1PN data sequence (at driver output)
Output Frequency	1672.5 MHz	
Frequency Response	±0.25 dB	Fc±4 MHz Measured at sub-rack output
IM_3 (dBc)	<50	20dBm RF output power (64QAM; COFDM) Relative to in-band average PSD measured @ 100 KHz RBW
Carrier to Noise (C/N)	<55dB	
Hum and Noise	<-60 dBc	
Group Delay	±20ns	Fc± 4 MHz
Digital Modulation Error Vector Magnitude (EVM)	<2.0%	64-QAM/8-VSB @ 5.06 Msps RMS average over 12,500 symbols Measured at Sub-rack output
Digital Modulation Signal to Noise Ratio (SNR)	<35dB	64-QAM/8-VSB @ 5.06 Msps RMS average over 12,500 symbols Measured at sub-rack output
Magnitude Linearity (AM-AM conversion)	±0.125dB	Measured at sub-rack output
Phase Linearity (AM-PM conversion)	±0.75°	Measured at sub-rack
RF Output Regulation	±0.2dB	Measured at Sub-rack output
Connector Impedance	Blind Mate 50Ω	Located at the back panel of the plug in. Mates with floating back-plane connector

	Front Panel Samples	
Sample Name	Coupling Factor	
2nd IF Sample	-45+/ -2 dB	Front Panel access through an SMA 50Ω Female Connector Loaded with 50Ω termination when not is use
RF Sample 470 MHz 860 MHz	-30+/-4 dB	Front Panel access through an SMA 50Ω termination when not in use
	DC Power Requirements	
Voltages/Current	+12VDC ± .5 @ 2.8A max +8VDC ± .5 @ 1.0A max -12VDC ± .5 @ 150ma max	
Connector	48 conductor, 3amps/circuit minimum	Interfaces to back-plane
	Environmental	
Cooling	Forced air-cooled, minimum of 18 CFM required	Forced air-cooled drawing ambient air through the intake on the front of the Pre-Amplifier Plug-In Module and exhausting out the rear of the module
Operating Temperature	0°C to 50°C	
Relative Humidity	0 to 95% non-condensing	
Alarms	**Indicators/Adjustments**	**Controls**
RF Output Failure Alarm	DRIVER FAILURE Low (TTL Low)=RF Output Failure	Signal available at back-plane
Over Temperature Alarm	DRIVER FAILURE Low (TTL Low)=Over Temperature	Signal available at back-plane
In Signal Indicator	YES (when present) or NO (when absent)	Visible via LCD Display
Transmit Indicator	XMIT (when RF power is present) or No Pwr (when RF power reads 0%)	Visible via LCD Display
Power Supply Status/Measurements	PASS or FAIL/ V scale	Visible via LCD Display
RF Power Measurements	% Scale	Visible via LCD Display

Parameter	Specification	Test Conditions/Notes
Input Level Control	RS-232 interface	
Frequency Response (low side) Control	RS-232 interface	
Frequency Response (high side) Control	RS-232 interface	
ALC Level Control	RS-232 interface	
Stand-by Control	RS-232 interface	
Reset Control	RS-232 interface	
	Environmental	
Operating Temperature	0 to 50° C	Guaranteed operation over temperature range
Relative Humidity	95% non-condensing	
	Physical	
Mechanical Dimensions	4.75”H x 4.2”W x 17.5” D	
Approximate Weight	5 lbs (3Kg)	
	General	
Front Panel Color	Matches Sherwin William’s Paint No. Light Gray F63TXA2555 Medium Gray F63TXA4841	Paint mix number 4303 identifies store location when added to Paint No. Lexan overlay color matched as indicated

11.2.2 Upconverter Internal Interconnect Drawing

Insert 47266889-050 Upconverter interconnect drawing

11.2.3 Upconverter RF Block Diagram

Insert 47266889-034 RF block Diagram

11.2.4 Upconverter Module Front and Rear Panel Description

Front Panel

Thumbscrews: This hardware secures the module to the sub-chassis and provides a reliable ground connection. Loosen to remove the module for replacement or repair.

Liquid Crystal Display (LCD): The LCD displays a series of measurements, user adjustments, and general status information.

RF Sample: The RF Sample port is a female SMA 50Ω connector used to test the output level.

NOTE: The RF Sample contains pre-distortion and is not representative of output signal. The RF sample is a reference point for testing only.

RS-232 Communication Port: The Communication port is an EIA standard RS-232 port used for communicating with a PC.

Keypad: The Upconverter Keypad assembly contains user selection keys.

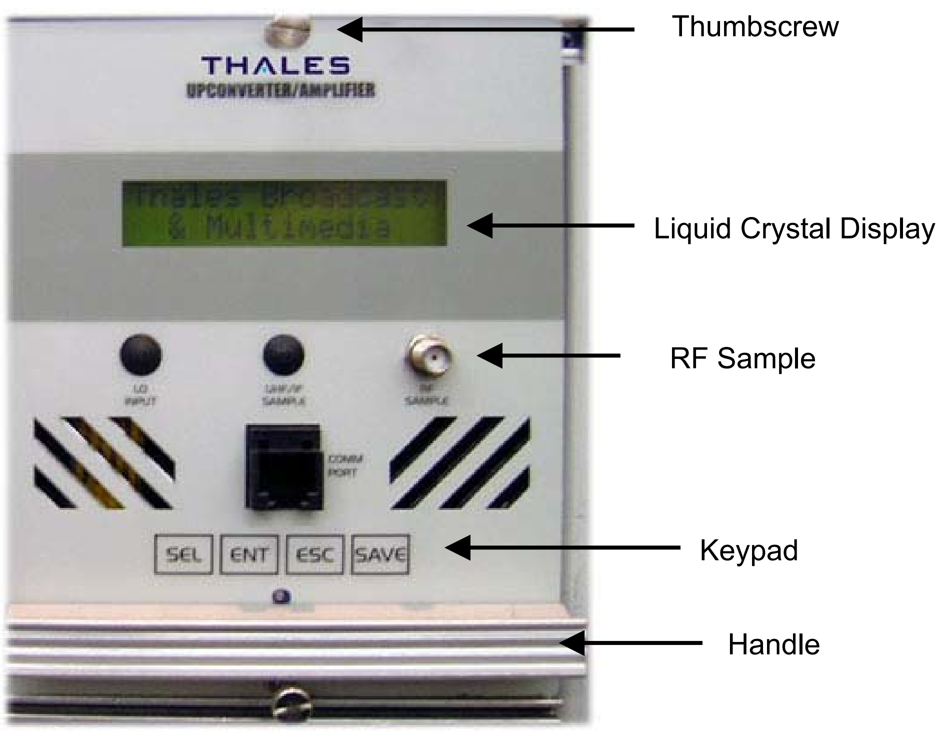
SEL: Select provides the user with scrolling capabilities.

ENT: Enter allows the user to choose an option.

ESC: Escape allows the user to go back to the previous screen

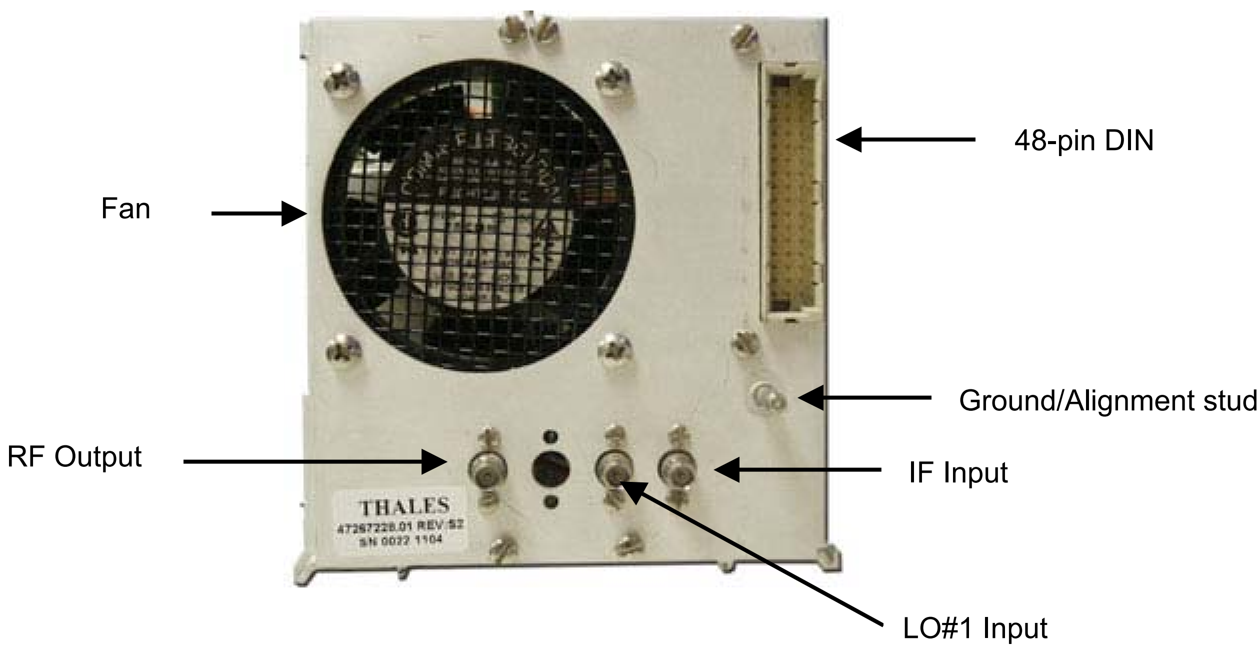
SAVE: Save allows the user to store new settings or adjustments

Handle: The Handle is used to assists with the removal of the module from the Sub-Chassis.



Upconverter Plug-in Module Front View

Rear Panel



Upconverter Plug-in Module Rear View

FAN: The 18 CFM Fan assembly is used as a cooling device for the Upconverter Module. The Fan is powered by DC voltage.

48-PIN DIN: The 48-pin DIN connector is an interface point to the Driver Section backplane that includes the power, control, and diagnostics functions of the Driver.

GROUND/ALIGNMENT STUD: The Ground and Alignment Stud ensure proper electrical grounding is achieved before engaging the 48-pin DIN connector. It also aids in the alignment of the module within the Sub-Chassis.

IF INPUT: Male 50Ω blind mate provides interface to the backplane and allows passage for the IF input signal from the exciter.

LO#1 INPUT: Male 50Ω blind mate provides interface to the backplane and allows passage for the LO#1 input from LO Plug-In

RF OUTPUT: The RF Output is a male 50Ω blind mate connector that is used to supply the RF output signal to the Power Amplifier Segments.

11.2.5 Upconverter Module Power-On Sequence

When power is applied to the Upconverter Module, a display test is performed. The front panel of the LCD is illuminated for approximately one second then extinguished. This sequence provides verification that the front panel LCD and MCU logic is functioning. Upon completion of the display test, the LCD will display the Upconverter Module status as determined by the firmware tests.

Navigating the front panel assembly:

THALES BROADCAST & MULTIMEDIA is the default display

To view the status of the system and each plug-in module, press the **SEL** button as many times as necessary.

Press **SEL** once=Local/Remote Mode

Press **SEL** once = Status menu

Status=Xmit, Fail or NoPwr

Press **ENT** once to enter the TX Control state

Press **ENT** or **SEL** to choose Xmit or Stdby or **ESC** to Quit to Status Menu

Press **Save** to store chosen state of operation; TX enters state then exits to Status menu.

From Status menu; Press **SEL** once=Power Supply

Status=Pass or Fail

From Status menu; Press **SEL** twice =Local Oscillator

Status=Pass or Fail

From Status menu; Press **SEL** three times = Upconverter

Status=Pass or Fail

Press **ENT** to examine lower level parameters, **ESC** to return to Upconverter menu

Press **SEL** four times=Back to Power supply. From this point, pressing **SEL** will scroll through the list again.

When at the desired Upconverter status, press **ENT** followed by **SEL** as many times as necessary to view additional information about the plug-in module parameters.

The first **ENT**=[In Signal]

Yes or No

Press **SEL** once= [System Fwd Power]

Power=100

Press **SEL** twice=[System Ref Power]

Power = 0

Press **SEL** three times=[Upconv Fwd Power]

Power=100

Press **SEL** four times=[Back to In Signal]

From this point, pressing **SEL** will scroll through the list again.

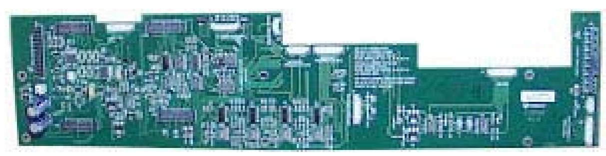
At any point to exit and return to the default display, press the **ESC** key as many times as necessary.

Distribution Board

The Distribution board consists of a 14-1/4” x 3-1/2” circuit board that is screwed to the Upconverter chassis. The circuitry on this board permits the processing of signals, and the control over the flow between the Upconverter plug-in IF/RF modules and the microprocessor board, the front panel through connector J2, and the display boards through J6. The Distribution board and Interface board, via connector J1, allow communication between the Upconverter Plug-In Module and the Backplane board. The module is divided into two parts: digital processing and analog processing.

Digital Processing Circuits

U3 (when present), U4, U6, U8, U9, U10 and U11 and related passive components form the digital portion of this module. An extension of the microprocessor board capabilities would sufficiently classify their function.



Analog Processing Circuits

All components, other than those listed above, are classified as the analog-processing block. Amplification and flow control of signals, as well as sensing of current and power levels, are the main tasks performed by these components.

Working principle

After powered up, the Distribution board starts receiving commands from the microprocessor via connectors J100-J103. One-by-one the voltages needed to control the IF/RF modules are set to a pre-working level. IF AGC reference, IF threshold, IF equalization, RF ALC reference, reflected power threshold, and power limiter voltages are set through the D/A converters U6, U8, U9 and U10 as well as the operational amplifiers U13, U14, U15 and U16. The commands originating from the microprocessor board are processed and delivered to Q3 and Q4, which turn on the GaA medium power devices present in the UHF Driver Amp assembly and IF-UHF sub module (if present).

Voltages proportional to the current drawn by the UHF Driver Amp assembly are generated by sampling resistors R74, R75 and R77 and delivered to the microprocessor. Resistors R83, R84 and R85 send the current consumption information of the IF-UHF sub module. External or internal power level information of the plug-in is processed by U5 to either: generate power measurement voltages, or generate ALC voltage at U7 pin 4. Temperature proportional voltage is routed from the UHF Driver Amp assembly, through J11, to the processing board. All voltages proportional to current values or power levels are forwarded to the microprocessor board. With these voltages, pass or fail conditions and measurements can be displayed or reported to the MSI controller module by the microprocessor board (See additional documentation on the MSI circuit description). Besides helping the processor card monitor the status of the IF/RF modules, the distribution board also routes data from the front panel board (specifically the RS-232 port and keyboard switches) and data to the LCD module.

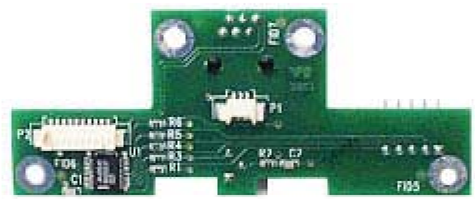
Specifications

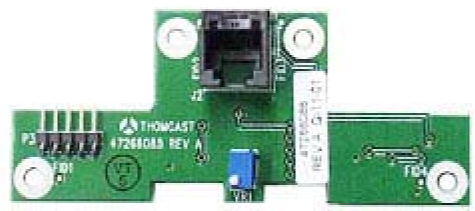
Parameter	Specification	Notes
Power Supply Requirements	+8V ± .3V @ 1.1A (max) +12V ± .5V @ 2.5A (max) -12V ± .5V @ 100mA (max) +24V (not used)	All 47266889 module loaded
Operating Temperature	0°C to 50°C	
Control Signals Voltages (part A) AGC_MAN_CTL AGC_AUTO_CTL IF_THRESHOLD_CTL1 PWR_LIMIT ALC_MAN_CTL ALC_AUTO_CTL1	≤.02 V to ≥9.2 V	Voltages measured at connectors providing signals to respective modules
Control Signals Voltages (part B) FREQ_RESP#1 FREQ_RESP#2	≤.05 V to ≥10.5 V	Voltages measured at connectors providing signals to respective modules
Filtered Fan noise	.02 Vpp. max	Measured at J11

Front Panel Driver Board Description

The Front Panel Driver Board acts as an interface between the Upconverter front panel and the Distribution board. This board features an RS-232 port, which utilizes a telephone type (RJ11) phone jack connector. Serial port signals are routed through the board to the Distribution board. Also present on this board is a de-bounce circuit that processes the front panel soft keypad strokes.

Parameter	Specification
Power supply	5V @ 10 mA
Connectors	Serial Port RJ11

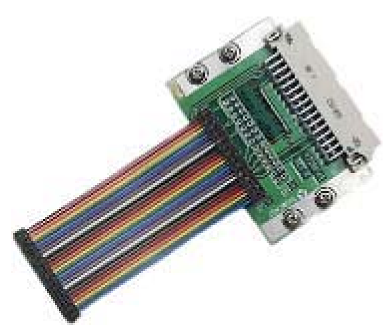




Connector Interface Board Description

The Connector Interface Board is used to connect the 48-pin connector, located on the back panel, to the two 26-pin connectors located on the Distribution board.

Parameter	Specification
Maximum current per connector	2A @ 80º C



12 UPS System Description

Pending

13 Downconverter Module Description

Pending

14 Power Amplifier Module Description

The **Power Amplifier (PA) Module** amplifies the inputted Driver signal to the power level required for transmission. The PA Modules operate in tandem with other PA Modules to obtain the required power level for the transmitter. The PA Modules are plugged into the backplane of the Sub-Chassis assembly and operate in an RS-485 multi-drop environment. Each module contains a unique logical address that allows for operation, control, and monitor activities within the transmitter system. An RS-232 port located on the front panel of the PA Module is provided for module setup, historical record extraction, and diagnostic feedback. A POWER/FAULT status indicator and the ON/LOCKED, OFF/UNLOCKED key assembly is also located on the front panel of each PA Module. The key-lock assembly provides physical and electrical connection.

Operational power required by the PA Module is derived from the Front-End Power Supply. This 48VDC drives the voltage regulators that produce the voltage levels for the analog and digital circuitry contained within the PA Module.

The diagnostics, operation, and monitoring features of the PA Module are controlled by a firmware driven microcontroller system.

The PA Modules are "Hot Swap" compatible. Defective PA Modules, accessible from the front of the cabinet, may be removed and replaced while on-air, and without shutting the entire transmitter system down.

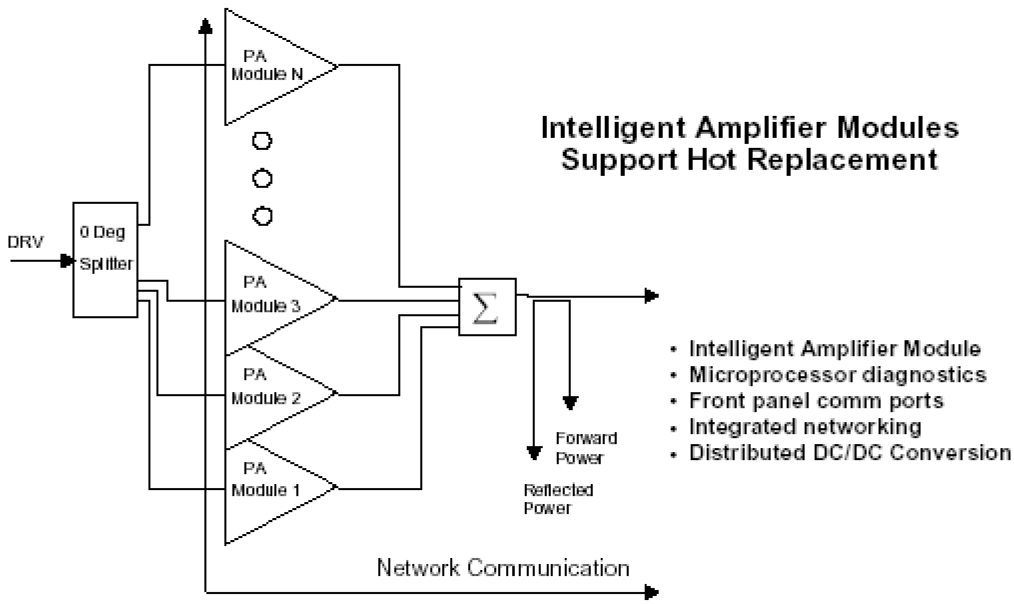
NOTE: During this procedure an automatic power reduction will occur to ensure transmitter protection.

Power Amplifier (PA) Module

The PA chain uses segmented power amplifiers in parallel that are directly interchangeable. Affinity® amplifiers utilize a design that is optimized for the 1670-1675MHz range. Each amplifier module is also gain and phase matched for consistent performance from module to module.

The high gain RF amplifier module uses GaAs FET high reliability transistors that are biased for class AB operation. The inherent linearity of these amplifiers, and the quality of the associated correction circuits, combine to product excellent linearity performance. Each final power amplifier module has protection systems for high temperature and over-current. The final power amplifier assembly has a protection system for excessive VSWR conditions.

Due to transistor redundancy, the standby arrangements are such that an abrupt and total shutdown of the transmitter due to failure of one or more transistors is implausible; the same is true of power supplies.



Block diagram of final RF Power Amplifier

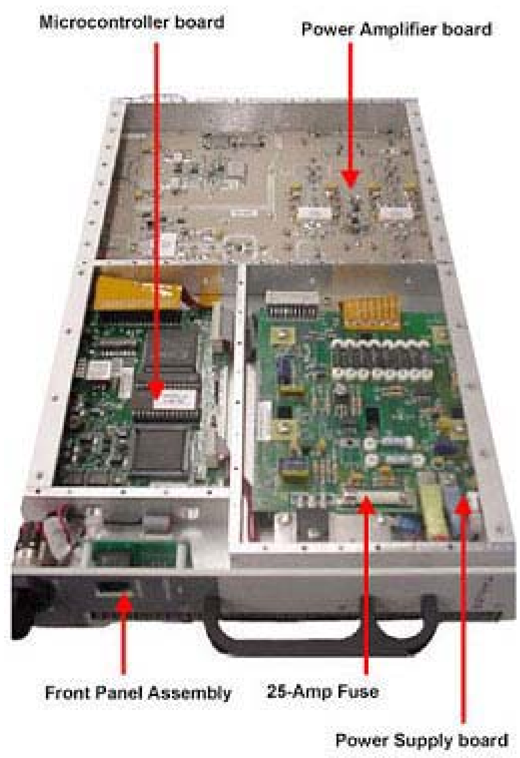
The power amplifier assembly uses “n” number of power amplifier modules in parallel to achieve the required output power. Amplifier combining is through the very low-loss patented passive combining system exclusively available from Thales. This combiner technology allows for any number of amplifier combinations without restriction, which provides flexibility in system design, and reduces cost by putting power scalability at the customer’s fingertips. Thales also allows the customer to select the desired margin built into the power amplifier stage; options of 0.3 and 1.5 dB are offered giving cost control options to the system designer. Typically two power amplifier modules are used to achieve 50 watts, 16 power amplifiers are used to achieve 400 watts building in 1.5dB margin (or headroom). A controlled soft fail method is applied in the event of a faulted amplifier(s) safely reducing transmitter power while maintaining on-air availability. Power reduction ranges from 1.5dB to 6dB and is dependant on the total number of amplifiers in the system verses the number of faulted modules. A transmitter is deemed to be unrecoverable when the output power has fallen by more than 6dB and a controlled shut down occurs.

The following table (given for example) shows analysis of the consequences of the failure of a number (from 1 to n) of amplifier modules (theoretical values) for 50 to 400 watt RMS transmitters.

	"n" number of amplifiers	Number of faulty power amplifiers				
		1	2	3	4	6 to 8
PA – 400 watts	12	-1.5dB	-1.5dB	-3.0dB	-3.0dB	-6.0dB
PA – 200 watts	6	-1.5dB	-3.0dB	-6.0dB	-6.0dB	
PA – 100 Watts	3	-3.0dB	-6.0dB			
PA – 50 Watts	2	-6.0dB				

PA Module Layout

The PA Module segment consists of a Power Amplifier board, a Microcontroller board, a Power Supply board, and a Front Panel board.



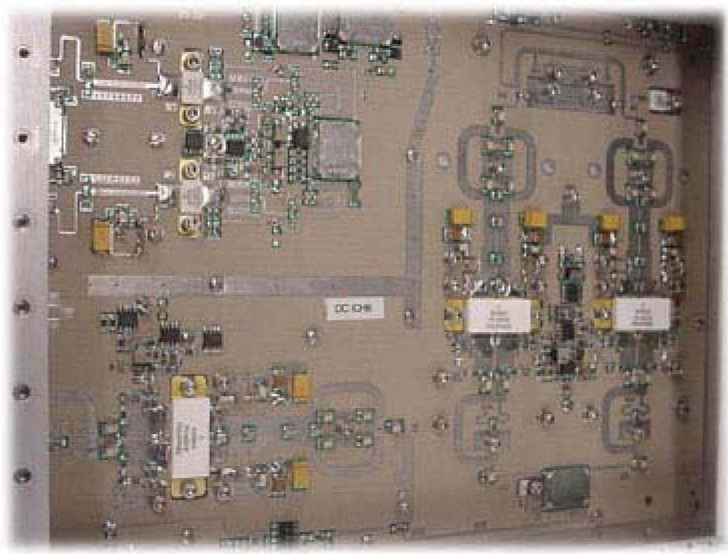
Power Amplifier Board

The Power Amplifier Board amplifies the RF INPUT signal from the upconverter assembly to the output power requirement of the transmitter.

The Power Amplifier Board has a high-gain architecture providing 38.5 dB of gain, an output of 1-dB, and compression of 53.5 dBm. The signal passes through a pin diode attenuator that sets the overall gain of the amplifier. A variable phase shifter sets the overall phase insertion.

In the first stage of the amplifier, a 3-dB hybrid provides a reliable load to the driver and a flat broadband frequency response to the amplifier. The second and third stages of amplification efficiently provide the proper output power with a minimum of distortion.

A 3 dB combining system provides for a low output Voltage Standing Wave Ratio (VSWR). The directional coupler provides a sample signal proportional to the forward and reflected power. This measurement ensures that the amplifier delivers the correct power. An IC measures the operating temperature of the amplifier that is monitored by the microcontroller. The amplifier is placed in a faulted state if the temperature exceeds a limit set by the microcontroller.



Power Amplifier board

Power Amplifier Board Specifications

Parameter	Specification
Input Voltage	48VDC
Input Current	19.8 Amps
RF Gain	38.5 dB
Output Power	47 dBm (COFDM signal)
Flatness (BW 392 MHz)	± 0.75 dB
Input VSWR	1: 1.6
Output VSWR	1: 1.5
Operating Temperature	0°to 43°C

Microcontroller Board

Control and monitoring functions of the PA Module segment is accomplished through the Microcontroller Board located within the PA Module segment housing. The Microcontroller Board uses an 8-bit microcontroller unit (MCU) with on-board memory to perform the control and monitoring functions. The microcontroller board includes analog signal conditioning, A/D and D/A converters, supply voltage regulation, and serial data interfaces.

Monitoring operations involve collecting analog signals and logic data from the power amplifier segments. Analog inputs, forward power, reflected power, and temperature, are received from the RF power amp connector J1. The analog input drain supply voltage (VDD), and high voltage DC is received from power supply connector J2. Forward power and reflected power inputs are amplified by operational amplifiers with a gain of approximately two, while temperature, drain supply voltage, and high voltage DC is buffered by unity gain stages. Following the VDD buffer stage, a resistor divider network scales VDD to ¼ of the input voltage followed by a second unity gain buffering stage. Each of these inputs is voltage-limited to 5.1 VDC by means of Zener diodes at the input to the microcontroller board.

The Microcontroller Board monitors drain current drawn by Field Effect Transistors (FET) in the RF power amplifier section of the PA Module. The microcontroller achieves this by monitoring the voltages dropped across series resistors in the drain supply circuits on the power supply board. The control board from the power supply connector J2 receives these eight voltages.

Each signal is selected by the MCU, and related CPLD logic, through an eight-channel analog multiplexer (MUX) IC, and in turn compared to VDD by a differential amp/gain op-amp stage.

The resulting outputs are 10-times greater than the voltages dropped across the series monitoring resistors. These outputs are protected from voltages greater than 5.1VDC by Zener diodes and from voltages more negative than –0.4 VDC by Schottky diodes. The resulting signal is connected to input AN0/IDSMON on the MCU A/D converter. This signal varies through time with each of the eight monitored signals as selected by the MCU.

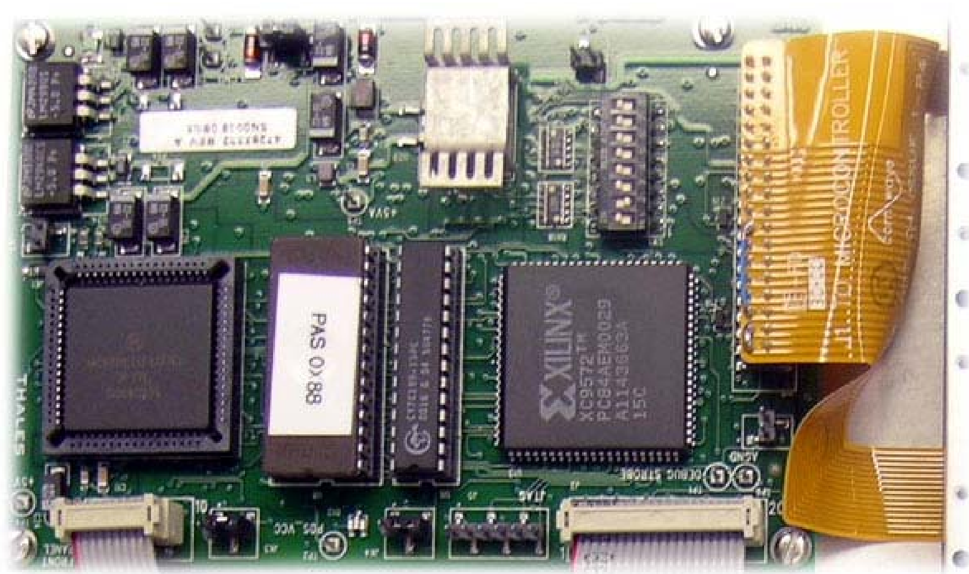
The control board provides various logic inputs and outputs. A drain supply enable signal, PS_ENABLE, is outputted from the microcontroller board on J2. The state of PS_ENABLE is controlled by the MCU, which tests other signals such as Standby, Maximum drain currents, VDD voltage, and temperature of the heat sink to determine if it is safe to enable the power supply. The MCU outputs the Enable Signal to the CPLD, which in turn outputs the OS_ENABLE on J2. If the MCU detects a condition unsafe to allow the drain supply to operate, the CPLD will output a logic-LOW on the PS_ENABLE control output.

Output signals that control the RF power amplifier attenuator, and the Phase Shifter, are generated on the control board. Signal RF_ATTEN_CTRL1 and Phase Shifter are analog outputs that control the branches of the RF attenuator and RF Phase Shifter network located in the RF amplifier section. These analog voltages are developed in a D/A converter IC, NPN, PNP, and MOSFET transistors. The serial input/output (I/O) capabilities of the Power Amplifier Segment originate on the control board and the MCU SCI port.

In general, the Power Amplifier segment may be connected to an RS-485 multidrop network as an individually addressed node with other amplifier segments. Node address switch SW1 is a DIP multi-pole switch that is programmed with a PA segment’s unique node address in binary form. While present on the network, a PA Module may be issued specific commands from, and return formatted responses to, a master communication device. By default the RS-485 driver IC is enabled. The RS-485 serial I/O is available on J3 of the backplane connector. An RS-232 serial I/O port is also available, but the RS-232 driver is disabled by default. This port is interfaced through an RJ-11 connector on the PA Module front panel. When the ENA_RS-232 control input line is given a logic-LOW (i.e. interface cable plugged into the PA Module RJ-11 connector), the RS-232 port is enabled. At this time the RS-485 port is disabled causing a loss of communication with the RS-485 network. The same PA Module command and response capabilities available on the RS-485 port are provided on the RS-232 port.

A 'watchdog' function is provided on the control board to safeguard against loss of MCU program control. Under normal circumstances, MCU IC input lines RESET and XIRQ will be provided with a logic-HIGH by an on-board watchdog IC. If Jumper JK3 is in place, the CPLD device must provide a toggle in the CPLD WDI Output line every 1.6 seconds to indicate to the watchdog that the MCU is operating properly. The CPLD will interpret a PG3/WDI input from the MCU, or activity on the UC_RS485_ENA control line, or activity on the RS-485 communications lines, as indications that the MCU is operating properly, and will toggle the CPLD WDI output line. If a toggle in the WDI line does not occur within 1.6 seconds it is assumed that MCU is no longer executing the desired program properly. The watchdog will drive low the XORZ signal, which will ultimately result in a reset of the MCU and a restart to the MCU program.

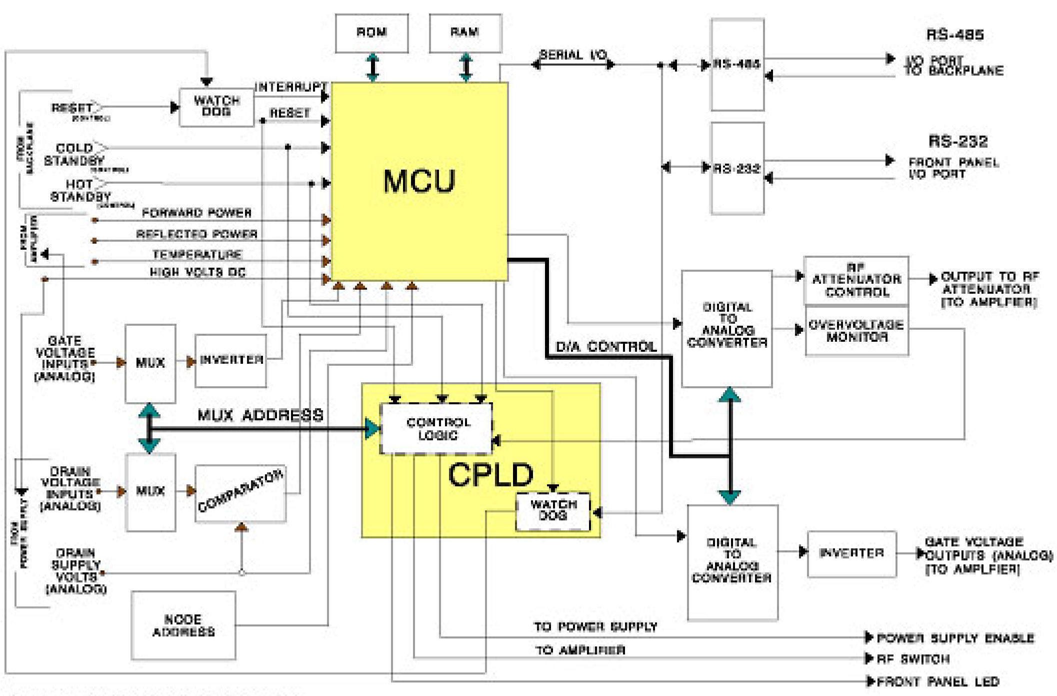
Two power supply inputs of approximately +10VDC are provided to the Microcontroller Board to supply the digital and analog regulator circuits. The digital regulator circuits are fused by F1 at the +10VDC input. A linear voltage regulator provides the +5VDC used for the digital circuitry. The +5VDC digital circuit has a separate ground plane for the digital devices. A switching regulator and associated components develop DC output voltages of approximately ±14.5VDC, which is regulated by linear regulators to +12VDC and –12VDC for various digital and analog circuits. The +5VDC analog regulator is supplied from a +10VDC separate from the digital +10VDC input, and is fused by F2. Another linear voltage regulator develops +5VDC for the analog circuits. The +5VDC analog circuits have a separate ground-plane for analog devices.



Microcontroller board

Microcontroller Board Specifications:

Parameter	Specification
Microcontroller type	8-bit MCU with 64K address space
Input Voltage	10VDC±0.5VDC
Input Current	400 mA typical @ 10VDC
Communication Ports	RS-485 and RS-232
Program stall time before COP Watchdog Reset	1.6 seconds
Number of Analog Inputs	13
Number of Logic Inputs	7
Number of Analog Outputs	2
Number of Logic Outputs	6
Operating Temperature	0° C to 50° C
Physical Dimensions	5.125” H x 3.50” W x 0.58” D 13.0 cm H x 8.9 cm W x 1.5 cm D

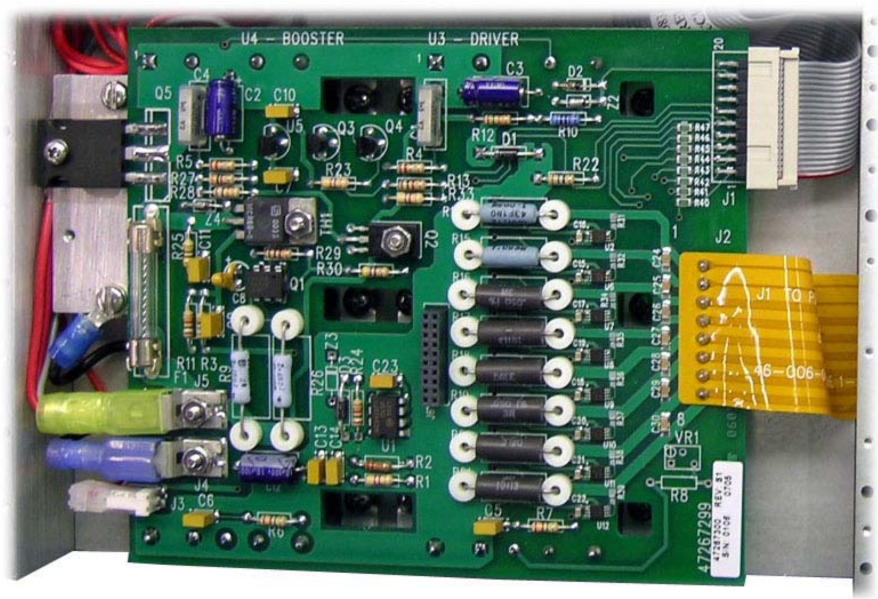


Control Board Block Diagram

Power Supply Board

The Power Supply Board consists of input and output voltage monitoring, standby switching, over-voltage protection, and current sensing. All functions of the Power Supply Board are interfaced with the Microcontroller Board.

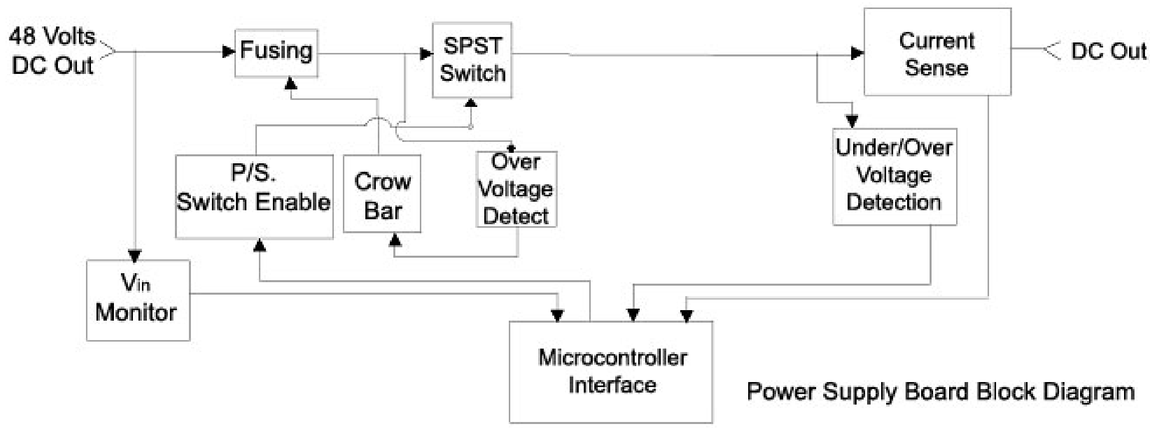
The Power Supply Board switches the Front-End 48VDC Power Supply ON/OFF using a power FET. After engaging the PA Module, the control board checks the input voltage and turns the FET switch on. The microcontroller board will then detect the switched voltage. If the voltage goes above or below the preset value, the microcontroller board will disable the standby switch. The power supply distributes eight lines of power with current sensing. These lines are used for current protection and are monitored by the microcontroller board.



Power Supply board

Power Supply Board Specifications

Parameter	Specification
Primary Input Voltage	48VDC
Primary Input Voltage Range	48VDC +2.0V –1.0V
Primary Input Current	13A DC @ 32VDC +48DBM COFDM signal
Primary Input Current Range	13A DC @ 32VDC +48DBM COFDM signal
Output Power	70W maximum
Output Current Limit	≈2A above maximum @ 48 dBm COFDM signal
Efficiency	≈90%
Operating Temperature	0°C to 50°C



Power Supply Board Block Diagram

PA Module Front Panel Assembly

The PA Module Front Panel Assembly houses an RS-232 COMM PORT, a bi-color POWER/FAULT LED, and the ON/LOCKED--OFF/UNLOCKED key lock assembly. The PA Module is also equipped with a heatsink, installation handle and thumbscrews.

The **RS-232 COMM PORT** 6-pin RJ11 telephone type connector is used to interface with a serial host computer. This interface allows a host computer to control and monitor functions of the PA Module.

The bi-color **POWER/FAULT LED** is used as a visual indicator for PA Module power and fault conditions. A green LED indicates power to the PA Module. A red LED indicates a fault condition.

The key lock assembly is used to secure the PA Module to the Chassis assembly.

In the **ON/LOCKED** position, the PA Module is locked into the chassis assembly and receiving power. The PA Module cannot be removed from the chassis while in the locked position.

In the **OFF/UNLOCKED** position, operating power to the PA Module is disabled and the PA Module may be removed from the chassis for service or “Hot Swap” replacement. This key lock assembly does not affect Affinity® transmitter power.

The **Heatsink** is a folded-fin heat-sinking device used to dissipate heat generated by the PA Module.

The **Handle** is used to insert and remove the PA Module segment.

The **Thumbscrews** are used to secure the PA Module segment to the Chassis.