

8. OPERATIONAL DESCRIPTION - MODEL Axcera-CU150BTD

8.1 General Description

The CU150BTD is a complete 150-watt UHF solid-state, digital television transmitter. It operates at a nominal output power of 150 watts average.

8.2 Technical Specifications

Type of Emission 6M00K1D
Frequency Range 722 MHz to 728 MHz
Output Power..... 150 watts average

8.3 Performance Specifications

Operating Frequency Range 722 MHz to 728 MHz
RF output - Nominal:
 Power 150 watts average
 Impedance 50 ohms
 Connector "N"
Regulation of Output 3%
Signal-to-Noise Ratio (SNR) 30 dB or better
Carrier Frequency Stability ± 1000 Hz

Data Interface:
Input Rate..... 19.39 Mbps, 6 MHz Channel
Input Interface..... SMPTE 310M (ASI optional)

Electrical Requirements

Power Line Voltage 115/230 volts, 50/60 Hz
Power Consumption..... 900 watts

Environmental

Maximum Altitude 8,500 feet
Operational Temperature Range 0°C to +50°C

Mechanical

Dimensions:

Width 19" (Rack mount)
Height 3RU
Weight..... 38 lbs

8.4. System Overview

The CU150BTD is made up of the trays/assemblies listed in Table 8-1.

Table 8-1. CU150BTD Major Trays and Assemblies

MAJOR ASSEMBLY DESIGNATOR	TRAY/ASSEMBLY NAME
A1	Axciter Digital Modulator
A2	Digital Transmitter (Driver)

8.4.1 Axciter Digital Modulator

The Axciter 8-VSB modulator accepts an ASTC transport stream in SMPTE 310 Format input and outputs an 8-VSB IF signal centered at 44 MHz.

The 44 MHz IF signal is upconverted to the desired channel by the upconverter located in the upconverter tray or, in a sled-based system, as an upconverter sled mounted in the driver/amplifier chassis assembly.

The signal generation function of the Axciter is also referred to as the "forward signal path" in this manual. There is also a "reverse signal path" that is used for automatic adaptive equalization.

Two transmitter output samples are taken from directional couplers located before and after the channel mask filter and are applied to the upconverter tray or the external Relay. The upconverter tray also contains a downconverter that converts the RF sample to an IF output. In a sled-based system, the downconverter sled is mounted in the driver/amplifier chassis assembly.

The downconverted IF transmitter sample is digitized by the Axciter modulator. It is then demodulated in non-real time software. The result is analyzed to calculate linear and nonlinear adaptive equalizers to improve the transmitted signal quality by compensating for the nonlinear compression of the power amplifier, and the linear distortions (mostly group delay effects) of the channel filter.

When a linear adaptive equalizer is being calculated, the transmitter sample is taken after the channel mask filter so that its linear distortions can be "seen."

When a nonlinear adaptive equalizer is being calculated, the transmitter sample is taken before the channel mask filter, so that the distortion sidebands being generated by the power amplifier can be seen (the channel filter would remove the out-of-band sidebands).

The Axciter modulator contains a standard Personal Computer. The PC performs user interface functions and the numerical processing necessary for the adaptive linear and nonlinear equalization. The PC is not in the forward signal path; if it fails the exciter will continue to generate a signal with the most recently calculated equalization.

8.4.2 Digital Transmitter (Driver)

The Transmitter Driver provides an On Channel output signal at 150 Watts.

8.4.2.1 (A4) Frequency Agile Upconverter Board (1309695)

The board takes a 44 MHz or 36 MHz IF signal and converts it to a TV channel in the range of 54-860 MHz. The IF input signal, (\approx -8dBm level), is connected to J6 on the board. The IF first passes through a frequency response pre-corrector, consisting of R145, C188, R 146 and C189. The pre-corrector circuit compensates for any response variation in the ceramic filter used to pick the appropriate conversion sideband. The pre-corrected signal is then converted to a second IF centered at 1044 MHz using U16, U18 and associated components. The signal is next applied to a second mixer, U15, where it is converted to the final RF channel frequency. The signal is then sent to a low pass filter that removes unwanted conversion products above 1 GHz., amplified by U21 passed to another low pass filter that removes unwanted conversion products above 1 GHz, amplified by U20 and connected to J7 the RF output jack for the board (\approx -3dBm level).

The upconverter has two local oscillators, LO1 and LO2. The LO1 oscillator, consists of U1, U2, U5, U6 and amplifiers U3 and U4. The LO1 oscillator operates at 1 GHz for 44 MHz IF inputs and is used to convert the signal to 1044 MHz. In 36 MHz IF systems, this oscillator circuit operates at 1.008 GHz. The Red LED DS4 will light if the PLL for the LO1 oscillator is not locked.

The second LO, LO2, consists of two VCOs, U26 and U31, that are used to generate the second LO. One VCO operates from 1.1-1.5 GHz and the second from 1.5-1.9 GHz. The Red LED DS2 will light if the PLL for the LO2 oscillator is not locked.

Both of the LOs, LO1 and LO2, are locked to an on board 10 MHz VCXO. The 10 MHz VCXO circuit consists of U36, U39, the VCTCXO Y1 and associated components. When an external 10 MHz signal is applied to J10 on the board, the internal VCXO is locked to the external 10 MHz, otherwise, it is free-running. The Red LED DS6 will light if an External 10 MHz reference is present. The Red LED DS3 will light if the PLL for the 10 MHz oscillator is not locked.

8.4.2.2 (A5) ALC Board (1308570)

The ALC Board, Innovator CX Series, is used to control the RF drive power to the RF amplifier chain in the CU30, CU50 and CU100 transmitters. The board accepts an 8-VSB RF input signal at a nominal input level of -3 dBm average power and amplifies it to whatever drive level is necessary to drive the final RF amplifier in the tray to full power. The input signal to the board at J1 is split by U4, with one half of the signal driving a PIN diode attenuator, DS1 and DS2, and the other half driving a detector, U13, that is used to mute the PIN attenuator when there is no input signal. The output of the PIN attenuator is sent to two cascaded amplifiers, U2 and U3, which are capable of generating +10 dBm average power from the board at J2.

The PIN attenuator is driven by an ALC circuit or by a manual fixed voltage bias, depending on the position of switch S1. When the switch is pointing to the left, looking from the front of the tray, the ALC circuit is enabled. When the switch is pointing to the right, the ALC circuit is disabled and the PIN attenuator is controlled through the Manual gain pot R62. When the switch is in either ALC or manual, the

voltage in the unused circuit is preset low by the circuitry connected to pins 4-6 on SW1. This allows the RF power to ramp up slowly to full power when the switch changes positions. CR8, C33 and associated components control the ramp up speed of the manual gain circuit. CR9, C42 and their associated circuits do the same thing for the ALC circuit. The practical effect of this is to preset the RF drive power to near zero output power when enabling and disabling the ALC, followed by a slow controlled ramp up of power.

The ALC circuit normally attempts to hold the tray output power constant, but there are four faults that can override this. These faults are Input Fault, VSWR Cutback Fault, VSWR Shutdown Fault and Overdrive Fault.

The Input Fault is generated by comparator U7C and presets the PIN attenuator and ALC circuit to maximum attenuation whenever the input signal drops below about -7 dBm. Test point TP2 allows the user to measure the detected input voltage.

The VSWR cutback circuit is set so that the ALC circuit will start reducing RF drive once the Reflected power reaches a level of about 6% and will keep reducing the drive to maintain that level. U8A, U8B and their associated components diode-or the metering voltages, which generates this cutback. The forward power is scaled to $2V = 100\%$ and the reflected power is scaled to $2V = 25\%$. The Reflected metering voltage is doubled again by U8B so that when the voltage of U8B exceeds the voltage at the output of U8A, the reflected power takes over the ALC circuit. Once the U8B voltage drops below the forward power at U8A, the forward power takes over again.

The VSWR shutdown circuit will shut the tray down if the Reflected power increases to 15% or higher, which can happen if the tray sees reflected power when the ALC is in manual.

The Overdrive protection looks at a sample of the RF signal that is applied to J1 of the board. The peak level of this signal is detected and can be measured on TP1. This voltage is applied to a comparator with the threshold set by R38. If this threshold is exceeded, the ALC circuit mutes then ramps up to try again. This circuit also works in manual gain as well.

8.4.2.3 (A6) Amplifier Assembly (1312827)

The (A6) Amplifier Assembly (1312827) is made up of (A6-A1) the 1 Watt Amplifier Board (1310282), (A6-A2) the BL871 Single Stage Amplifier Board (1311041), and (A6-A3) the Dual 878 Pallet Assembly (1310138). The entire amplifier assembly has approximately 36 dB of gain.

8.4.2.4 (A6-A1) 1 Watt UHF Amplifier Module (1311170)

This board is a broadband UHF amplifier capable of producing an output power in excess of 1W Peak. It is normally operated at an average power of 100 mW 8VSB or lower. It consists of two AH202 MMICs operating in parallel. The board is powered by +12 VDC and has no adjustments. The board has a gain of approximately 16 dB.

8.4.2.5 (A6-A2) BL871 Single Stage Amplifier Board (1311041)

This board consists of a single stage amplifier operating at +42 VDC. The board has an overall gain of about 16 dB. The input to the board passes through a 3 dB attenuator consisting of R11-R13, and then is applied to the gain stage, which consists of a single LDMOS transistor Q1 operating in Class AB. The bias voltage for the transistor is generated through the voltage regulator U1, and is adjusted using pots R2 and R3. The Diode CR1 provides temperature compensation for the transistor. The transistor will output over 20 Watts DVB, but is typically used in a driver application at much lower output powers. The Directional Coupler U1 provides a 20 dB down sample of the RF output.

8.4.2.6 (A6-A3) Dual 878 Pallet Assembly (1310138)

This board is a UHF LDMOS power amplifier consisting of two power transistors operating in parallel. The board operates on a power supply voltage of +42 VDC. The voltage regulator U1 steps down the voltage to provide a bias voltage to each transistor. The diodes CR1 and CR3 are used to temperature compensate the bias voltage. As the RF transistors heat up, the diodes also heat up, causing the voltage across them to drop, lowering the bias voltage to the RF transistors so that it remains constant with device temperature.

The board has a gain of approximately 17 dB, and can operate at an output power of 150 Watts average power DVB, 220 Watts average power ATSC, or 440 Watts Peak Sync plus sound in analog operation. The transistors are operated in quadrature, with one transistor operating 90 degrees out of phase of the other, which provides for a very good return loss across the UHF band on both the input and output of the board.

8.4.2.7 (A7) Output Detector Board (1312207)

The (A7) Output Detector Board (1312207) provides forward (2V=100%) and reflected (2V=100%) power samples to the transmitter's Control Board for metering and monitoring purposes. R7 is the reflected power calibration pot and R23 is the forward power calibration pot. A Forward power sample, -10 dBm, connects to J4 on the board, which is cabled to the front panel sample jack of the tray. The RF output of the board, typically +50 dBm, is at J2, which is cabled to J9 the RF Output Jack of the tray.

8.4.5 AC Input

The 220VAC, needed to operate the tray, connects through the AC power cord at J10, the power entry module located on the rear panel of the tray. An On/Off switch is part of the power entry module. With the switch switched On, the (L) line input is wired to F1 a 10 Amp fuse for over current protection. The AC lines are connected to terminal block TB1, which distributes the AC to (A9 and A10) the two DC power supplies. Voltages for the operation of the boards in the tray are generated by (A9) a +5VDC and ± 12 VDC power supply and (A10) a +42VDC power supply. There are two varistors, mounted on TB1, connected from the line input to neutral and to ground for surge protection. The AC also connects to the (A11) fan mounted on the rear panel of the tray. The fan will run when AC is applied to the tray. The +5VDC and ± 12 VDC outputs of the (A9) power supply connects to the terminal block (TB2) that distributes the DC to the boards in the tray. The +5VDC and ± 12 VDC outputs connect directly to the transmitter's Control Board, Downconverter, the Digital Upconverter, the ALC, the Amplifier Assembly and the Output Detector Boards. The +42VDC power supply outputs connect to the (A8) Control Board, which then supplies the switched +42VDC to the (A6) Amplifier Assembly.

8.4.6 Control & Status

Table 1: Transmitter LCD Display

DISPLAY	FUNCTION
LCD	Provides a two-line readout of the input received channel, internal functions, status, and fault conditions.

The front panel has seven pushbuttons for the two for the control of the transmitter and five for control of the displayed menus.

Table 2: Transmitter Control Pushbuttons

PUSHBUTTON	FUNCTION
OPR	When pushed switches the transmitter to Operate.
STBY	When pushed switches the transmitter to Standby.
ENTER	Selects the changes made in the menus and submenus.
Left & Right Arrow	Scrolls through the main menus
Up & Down Arrow	Scrolls through submenus of the main menu when they are present.

Table 3: Transmitter Status and Operate/Standby Indicators

LED	FUNCTION
OPERATE/STANDBY (Green/Amber)	A Green LED indicates that the system is in Operate. An Amber LED indicates that the system is in Standby.
STATUS (Green/Red/ Amber)	A Green LED indicates that the system is functioning normally. A flashing Red LED indicates a fault is occurring at this time. An Amber LED indicates a fault occurred in the past but the system is now operating normally.

8.4.7 Input and Output Connections

The input connections to the transmitter are made to the jacks mounted on the rear of the tray. The tray accepts an On Channel RF signal at J1, the RF input jack, and outputs a digital RF ON Channel signal at J2, the RF Output Jack. A 10 MHz reference input connects to J3 on the tray. Refer to Figure 2 and to Table 4 that follow for detailed information.

Table 4: Rear Chassis Connections for the Transmitter.

Port	Type	Function	Impedance
J1	BNC	Input A: On Channel RF Input (BRD) –78 to –8 dBm or SMPTE-310 Input (BTD)	50 Ohms
J2	BNC	Input B: On Channel RF Input (BRD) –78 to –8 dBm or SMPTE-310 Input (BTD)	50 Ohms
J6	BNC	10 MHz Input: Optional External 10 MHz Reference Input	50 Ohms
J7	BNC	1 PPS Input: Optional External 1 PPS Reference Input	50 Ohms
J9	N	RF Output: On Channel RF Output	50 Ohms
J10	IEC	AC Input: AC input connection to 85-264VAC Source and On/Off circuit breaker	N/A
J11	9 Pos Male D	External Amplifier: Interface to System and external amplifier trays, if present. Also provides two interlocks, one for RF System and one for Reject Load. If the interlocks are not used, jumpers from J11-5 to J11-9, ground, for RF system Interlock and from J11-6 to J11-9 are needed to allow the transmitter to go to operate.	N/A
J12	15 Pos Female D	Remote: Remote control and status indications	N/A
J13	RJ-45	Serial: Provides communication to System and to external amplifier trays, if present.	N/A
J14	RJ-45	Ethernet: Optional Ethernet connection. May not be present in your tray.	N/A
J15 Front Panel	BNC	RF Sample: Output Sample from Output Detector Board. In a CU50, the sample level at J15 is approximately 60dB down from the output power level of the tray.	50 Ohms
J16 Front Panel	9 Pos Female D	Serial: Used to load equalizer taps into the modulator.	N/A

Table 4: Rear Chassis Connections for the Transmitter.

8.4.8 Remote Connections

The remote connections for the transmitter are made to the Remote 16 Pos "D" connector Jack J5 located on the rear panel of the tray.

Table 5: Remote Connections to J12, 15 Pos Female D Connector, for CX Series transmitter.

Signal Name	Pin Designations	Signal Type	Description
RMT Transmitter Operate	J12-1	Discrete Open Collector Input - A pull down to ground on this line indicates that the Transmitter is to be placed into the operate mode.	Command
RMT Transmitter Standby	J12-2	Discrete Open Collector Input - A pull down to ground on this line indicates that the Transmitter is to be placed into the standby mode.	Command
RMT Power Raise	J12-3	Discrete Open Collector Input - A pull down to ground on this line indicates that the Power of the Transmitter is to be Raised.	Command
RMT Power Lower	J12-4	Discrete Open Collector Input - A pull down to ground on this line indicates that the Power of the Transmitter is to be Lowered.	Command
Spare RMT Input	J12-5	For future use	
RMT Set to Modulation Type	J12-6	Discrete Open Collector Input - A pull down to ground on this line indicates that the Modulation type is set to Analog, or floating sets to Digital.	Command
RMT Set Channel	J12-7	Discrete Open Collector Input - A pull down to ground on this line indicates that the Channel is set to Channel 2, or floating sets to Channel 1.	Command
RMT Ground	J12-8	Ground	
RMT System Forward Power Level	J12-9	Analog Output - 0 to 4.0 V- This is a buffered loop through of the calibrated "System Forward Power". Indicates the Transmitter Forward power. Scale factor is 100 % / 3.2V.	Metering
RMT System Aural Power Level	J12-10	Analog Output - 0 to 4.0 V- This is a buffered loop through of the calibrated "System Aural Power". Indicates the Transmitter Aural power. Scale factor is 100 % / 3.2V. (Not used in Digital)	Metering
RMT System Reflected Power Level	J12-11	Analog Output - 0 to 4.0 V- This is a buffered loop through of the calibrated "System Reflected Power". Indicates the Transmitter Reflected power. Scale factor is 100 % / 3.2V.	Metering
RMT	J12-12	Discrete Open Collector Output - A low	Status

Signal Name	Pin Designations	Signal Type	Description
Input Status		indicates that the Input to the Transmitter is OK. Floating indicates an Input Fault.	
RMT Fault Status	J12-13	Discrete Open Collector Output - A low indicates that the Transmitter is OK. Floating indicates a Fault has occurred.	Status
RMT Operate Status	J12-14	Discrete Open Collector Output - A low indicates that the Transmitter is in Standby. Floating indicates the Transmitter is in Operate.	Status
RMT Ground	J12-15	Ground	

8.4.9 Front Panel Screens

A LCD display located on the front of the transmitter displays the current operating status of the transmitter. The screens are scrolled through using the buttons to the right of the display. The Left & Right Arrows scroll through the Main Menus, which are shown below aligned on the left side. The Up & Down Arrows scroll through the Submenus of the Main Menus, when they are present, which are shown below indented under the Main Menu in which they are contained. The ENTER button selects the changes made. Please refer to the Users Manual for more information regarding front panel screens.