8. OPERATIONAL DESCRIPTION - MODEL Axcera-CU150BTD

8.1 General Description

The CLV2RD is a complete 1000-watt Low Band VHF solid-state, digital television transmitter. It operates at a nominal output power of up to 1000 watts average.

8.2 Technical Specifications

Type of Emission 6M00K1D

Frequency Range ..... 54 MHz to 88 MHz

Output Power..... 1000 watts average

8.3 Performance Specifications

Operating Frequency Range ..... 54 MHz to 88 MHz

RF output - Nominal:
- Power ..... 1000 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 or ASI

Electrical Requirements

Power Line Voltage ..... 208 - 240 volts, 50/60 Hz
Power Consumption ..... 4,600 watts

Environmental

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

Mechanical

Dimensions:

Width ..... 22”
Height ..... 76”
Depth ..... 34”
Weight ..... 650 lbs

8.4. System Overview

The CHV4TD is made up of the trays/assemblies listed in Table 8-1.

Table 8-1. HLV2RD Major Trays and Assemblies

MAJOR ASSEMBLY DESIGNATOR	TRAY/ASSEMBLY NAME
A1	Digital Transmitter (Driver)
A2	Amplifier
A3	Amplifier

8.4.1 Digital Modulator

The modulator accepts an ASTC transport stream in SMPTE 310 or ASI Format input and outputs an 8-VSB RF signal at the desired center frequency.

The signal generation function of the modulator 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 modulator or the external relay. The modulator contains a down-converter that converts the RF sample to a digital sample.

The down-converted sample is digitized by the 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 modulator contains an embedded computer. The computer performs user interface functions and the numerical processing necessary for the adaptive linear and nonlinear equalization.

8.4.2 Digital Transmitter (Driver)

The Transmitter Driver provides an On Channel output signal and is used as the pre-driver for the external amplifiers.

8.4.2.1 (A5) ALC Board (1315006)

The ALC Board of the Innovator CX is used to control the RF drive power to the RF amplifier chain in the HLV2RD. The board accepts a digital 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.

8.4.2.2 (A6) Amplifier Assembly (1316805)

The (A6) Amplifier Assembly (1316805) is made up of (A6-A1) the 35 Watt Amplifier Board (1307141). The entire amplifier assembly has approximately 35 dB of gain.

8.4.2.6 (A7) Metering Board (1313747)

The (A7) Output Detector Board (1313747) 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 +54 dBm, is at J2, which is cabled to J9 the RF Output Jack of the tray.

8.4.7 AC Input

The 230VAC 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 ±12VDC power supply and (A10) a +48VDC 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 ±12VDC 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 ±12VDC outputs connect directly to the transmitter's Control Board, modulator, the ALC, the Amplifier Assembly and the Output Detector Boards.

8.4.8 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.

8.4.9 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 (RD) –78 to –8 dBm or SMPTE-310 Input (TD) or ASI Input	50 Ohms
J2	BNC	Input B: On Channel RF Input (RD) –78 to –8 dBm or SMPTE-310 Input (TD) or ASI Input	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 CHV0TD-4, 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 5: Rear Chassis Connections for the Power Amplifier.

Port	Type	Function	Impedance
J1	N	RF Input: On Channel RF from CU driver tray	50Ω
J2	7/16" (1.1cm) Din	RF Output: On Channel RF Output	50Ω
J3	IEC	AC Input: AC input connection to 230VAC Source	N/A
J4	9 Pos D	Remote: Amplifier Control Interface (Connects to J11 on the driver tray)	N/A
J5	RJ-45	Serial data	N/A
J8 Front Panel	BNC	RF Sample: Output Sample from Combiner thru Control Board. The sample level on the external amplifier is approximately 70dB down from the output power level of the tray.	50Ω

8.4.10 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

Signal Name	Pin Designations	Signal Type	Description
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 Input Status	J12-12	Discrete Open Collector Output - A low indicates that the Input to the Transmitter is OK. Floating indicates an Input Fault.	Status
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	

8.4.11 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.

8.5.1 Power Amplifier Tray

8.5.1.1 Amplifier Control Board (1307918)

The Amplifier Control Board uses a Programmable logic device to control the amplifier tray. It takes an enable signal from an external driver tray, and turns the power supplies on whenever the driver has told it to turn on, unless it detects faults internal to the tray. The board monitors the forward and reflected power, the heatsink temperature, the pallet currents, and the power supply voltage and will generate alarm signals if any of those parameters exceed safe limits. The amplifier tray has no front panel display other than a two LEDs, one for Status and one for Enable. The board sends all its output information,

including the forward and reflected levels, back to the driver tray, through J4, so the information can be displayed on that tray's LCD Display. The board will generate a Red Blinking Status LED if it detects an alarm, fault, prompting the operator to look at the LCD display on the driver tray to see what fault has occurred.

The +5 VDC inputs to this board are routed through J4 and J5. The +5 VDC inputs are diode Or connected so that either the +5VDC from the (A8) power supply or the +5VDC from the (A9) power supply will operate the board. The +5VDC is split with one output connected to U1 a voltage regulator IC, which provides +5V and +5V_ANALOG as outputs. The +5 VDC is filtered before being connected to the rest of the board. The other +5 VDC output is connected to the regulator IC U2 that supplies +3.3 V to the microcontroller and programmable logic array.

8.5.1.3 (A5) 4 Way Splitter Board (1304714)

The 4 way splitter board takes the RF Input at J1 (≈11Watts ATSC) on the board and splits it into four equal outputs (≈4.75Watts ATSC) that connect to the inputs of the four amplifier pallets at J1.

8.5.1.4 (A1-A4) Amplifier Pallets (1306040)

There are four Amplifier Pallets mounted on the Amplifier Heatsink Assembly. Each the pallet has approximately +18dB of gain for the VHF frequency range of 54 to 88 MHz. The pallets operate Class AB and generate 300 Watts ATSC with an input of 4.75 Watts ATSC.

8.5.1.5 (A6) 4 Way Combiner Board (1304767)

The 4 way combiner board takes the four RF Inputs at J4, J5, J6 & J7 (≈300Watts ATSC) on the board and combines them to a single output (≈1200Watts) at J1 that connects to J2 the 7/16" (1.1cm) Din RF output jack of the tray.

8.5.1.6 (A8 & A9) 2300W Amplifier Tray Power Supplies

The 230VAC, needed to operate the tray, connects through the AC power cord at J3, the power entry module located on the rear panel of the tray. In the four pallet amplifier tray, there are two On/Off 20A/250VAC circuit breakers that are mounted on the back panel of the tray on either side of J3 the AC input jack. The AC lines are connected to a terminal block TB1. With the circuit breakers switched On, the AC is distributed to the two (A8 and A9) DC power supplies. TB1 has three varistors (VR1-VR3) connected across the AC input lines for surge and over voltage protection. The AC input from TB1 also connects to through 2 amp fuses to the two fans (A11 & A12) mounted in the tray. Both fans will run immediately when AC is applied to the tray.

The +5VDC for the operation of the amplifier control board in the tray is generated by the (A8 & A9) power supplies at J1-9 on each power supply. The +5VDC from the (A8) power supply connects to J4-8 and the +5VDC from the (A9) power supply connects to J5-8 on the control board. The +5VDC is produced when AC is connected to the tray and the CB1 and/or the CB2 circuit breakers are turned On. Either or both power supplies provides the +5VDC for use by the control board.

The +48VDC needed by the amplifier modules on the heat sink assembly is generated by the (A8 & A9) power supplies. The power supplies will operate when AC is connected to the tray, the CB1 circuit breaker for the (A8) power supply and the CB2 circuit breaker for the (A9) power supply, are turned On and a Low is provided on the Inhibit Line that connects to J1-6 on the power supplies from the control board. The CB1 circuit breaker supplies the AC to the (A8) power supply which provides the +48VDC to the (A1) and (A2) BLF574 amplifier pallets. The CB2 circuit breaker supplies the AC to the (A9) power supply which provides the +48VDC to the (A3) and (A4) BLF574 amplifier pallets.