# 8. OPERATIONAL DESCRIPTION - MODEL UBS-Axcera-CU0TD-5

## 8.1 General Description

The CU0TD-5 is a complete 200-watt UHF solid-state, digital television transmitter. It operates at a nominal output power of 200 watts average (Tray output).

## 8.2 Technical Specifications

Type of Emission ........................................ 6M00K1D

Frequency Range ........................................ 470 MHz to 806 MHz

Output Power ........................................ 200 watts average

## 8.3 Performance Specifications

Operating Frequency Range ........................................ 470 MHz to 806 MHz

RF output - Nominal:
- Power ........................................ 200 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

<u>Electrical Requirements</u>

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

<u>Environmental</u>

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 CU0TD-5 is made up of the trays/assemblies listed in Table 8-1.

*Table 8-1. CU0TD-5 Major Trays and Assemblies*

| MAJOR ASSEMBLY DESIGNATOR | TRAY/ASSEMBLY NAME |
|---|---|
| A1 | Digital Transmitter (Driver) |

### 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 up to 200 Watts.

### 8.4.2.1 (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 CU0TD-1, CU0TD-2, CU0TD-3, CU0TD-4 and CU0TD-5 transmitters. The board accepts an 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 (1312827)**

The (A6) Amplifier Assembly (1312827) is made up of (A6-A1) the 1 Watt Amplifier Board (1310282), (A6-A2) the BL881 Single Stage Amplifier Board (1311041), and (A6-A3) the Dual 888A Pallet Assembly (1310138). The entire amplifier assembly has approximately 36 dB of gain.

**8.4.2.3 (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.

**8.4.2.4 (A6-A2) BL881 Single Stage Amplifier Board (1311041)**

This board consists of a single stage amplifier operating at +48 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.

**8.4.2.5 (A6-A3) Dual 888A 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 +48 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 250 Watts average power DVB, 300 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.

**8.4.2.6 (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 +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. The +48VDC power supply outputs connect to the (A8) Control Board, which then supplies the switched +48VDC to the (A6) Amplifier Assembly.

### 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/ | A **Green** LED indicates that the system is functioning normally. A flashing **Red** LED indicates a fault is occurring at this time. An |

| | |
|---|---|
| Amber) | **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 CU0TD-3, 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.*

### 8.4.10 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 |
| 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 |

| Signal Name | Pin Designations | Signal Type | Description |
|---|---|---|---|
| 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.