8. OPERATIONAL DESCRIPTION - MODEL Axcera-HU5000AD

8.1 General Description

The HU5000AD is a complete 5000-watt UHF solid-state, digital transmitter. It operates at a nominal visual output power of 5000 watts average.

8.2 Technical Specifications

Type of Emission 6M00K1D

Frequency Range..... 470 MHz to 608 MHz & 614 MHz to 806 MHz

Output Power ..... 5000 watts average

8.3 Performance Specifications

Operating Frequency Range..... 470 MHz to 608 MHz & 614 MHz to 806 MHz

RF output - Nominal:
Power ..... 5000 watts average
Impedance ..... 50 ohms
Connector ..... 3-1/8" EIA

Regulation of Output..... 3%
Signal-to-Noise Ratio (SNR) ..... 27 dB or better
Carrier Frequency Stability ..... ±1000 Hz

Out of Band:
Compliant with FCC Mask
(Measured in 30 KHz RBW, relative to total average power
Channel Edge ± 500 KHz ..... -47 dB or better
6 MHz Channel Edge ..... -110 dB or better

Data Interface:
Input Rate..... 19.39 Mbps, 6 MHz Channel
Input Interface..... SMPTE 310M

<u>Electrical Requirements</u>

Power Line Voltage ..... 230 volts, 50/60 Hz
Power Consumption ..... 28,000 watts

<u>Environmental</u>

Maximum Altitude ..... 8,500 feet
Operational Temperature Range..... 0°C to +45°C

Mechanical

Dimensions:

Width..... 47 inches
Depth ..... 50 inches
Height..... 79 inches

8.4. System Overview

Each Innovator™ HX Series UHF transmitter system consists of an Exciter/Driver System Control Cabinet and one or more RF Power Amplifier (PA) Cabinets each of which has a maximum power output of 5 kW DTV.

The Exciter/Driver System Control Cabinet contains a computer with a touch screen, keyboard and mouse and a UPS power supply. Also part of the exciter/driver cabinet are an HX Series Driver/Amplifier Assembly and an Axciter Modulator. An external Dual Peak Detector Board generates a forward and a reflected power sample for metering purposes in the driver/amplifier assembly. A Serial Loop-Thru board is part of the cabinet assembly and provides system serial interface connection to both the Axciter and the Driver/Amplifier Assembly. A relay is also part of the cabinet assembly and is used to switch the pre-filer and post-filter samples to the Axciter Modulator for use by the Adaptive Digital Equalization.

NOTE: Refer to the separate Axciter Modulator Instruction Manual for more detailed information on the Axciter Modulator Tray and the Upconverter and Downconverter Modules mounted in the exciter/driver chassis assembly

The HU5000AD is made up of the assemblies listed in Table 8-1.

Table 8-1. HU5000AD Major Trays and Assemblies

MAJOR ASSEMBLY DESIGNATOR	TRAY / ASSEMBLY NAME
A1	Axciter Modulator
A2	UHF Exciter Assembly
A3	RF Amplifier Cabinet

8.4.1 Axciter – External Digital Modulator

The Axciter modulator is an ATSC compliant 8 VSB modulator that is used externally with the Innovator HX Driver chassis assembly. The Axciter modulator accepts a SMPTE-310 MPEG data stream input and outputs a 6 MHz wide IF output centered at 44 MHz. All of the functions of the Axciter modulator are controlled from the front panel pushbuttons.

8.4.2 Exciter Tray

The HX Exciter with Axciter accepts the SMPTE-310 encoded digital video and performs all processing necessary to create an ATSC compatible RF output. The exciter is equipped with a high-speed digital signal processing system that monitors not only the incoming digital video signal but also the amplified RF signal before it is filtered and after

it is filtered. The Axciter monitors the output of the RF amplifier cabinet or combiner, which is the pre filter sample (non-linear distortion), and the after filter sample (linear distortion), from the output of the DTV Filter. The Axciter automatically computes pre-correction information that is used to produce the highest quality over-the-air 8VSB signal output possible. This system is called Adaptive Digital Equalization.

The Exciter consists of the Axciter Modulator, the Axciter Upconverter module and the Axciter Downconverter module mounted in the Driver/Amplifier Assembly, the (Driver/Amplifier Assembly and the Dual Peak Detector Board.

The output of the Exciter Tray (driver) drives the input to the RF Amplifier Cabinet.

8.4.2.1 Axciter Upconverter – Used with Axciter Modulator (Exciter)

The 44 MHz IF input, -6 dBm in level, to the upconverter module assembly is applied through the backplane board from the modulated IF input jack located on the rear of the HX or LX exciter/driver chassis assembly. The 44 MHz IF input to the upconverter/downconverter tray connects through J5, the IF input jack located on the rear panel. The signal connects to the First Conversion board and is converted to a second IF of 1044 MHz by an image rejection mixer located on the First Conversion board. A filter selects the appropriate conversion product, which is then amplified to a level of approximately –8 dBm. The 1 GHz LO frequency is generated externally by the Axciter modulator and is applied to a high pass and low pass filter designed to eliminate any other interfering signals that might be coupled into the 1 GHz LO. The LO is applied to an ALC circuit that maintains the LO level to each mixer of +13 dBm over a wide range of 1 GHz LO input levels. The LO sample is also sent to the Downconverter board inside the tray or to the external Downconverter module for its use.

This second IF signal is then applied to a second mixer mounted on the Final Conversion board that converts it back to a broadcast channel (2-69) by an LO that operates in 1.0 MHz steps between 1.1-1.9 GHz depending on the channel selected. The LO frequency equals the Channel center frequency plus 1044 MHz. (As an example CH: 14: Center Frequency is 473.00 MHz therefore LO2 is 473 + 1044, which equals 1517.00 MHz.)

The output of the mixer is applied to a 900 MHz Low pass filter to remove unwanted conversion products. The resulting signal is amplified and wired to a Pin diode attenuator and then connected to the output of the Upconverter/Downconverter Tray or the output of the Upconverter Module. This pin diode attenuator adjusts the gain of the tray or module and is controlled by an Automatic Gain Control circuit, which maintains a constant power out of the upconverter, and also the transmitter, that connects to the power amplifier module.

The Axciter upconverter module has no need for periodic alignment.

8.4.2.2 Axciter Downconverter – Used with Axciter Modulator (Exciter)

A sample of the transmitter's RF output is applied to the downconverter board, mounted on the downconverter module, at a nominal input level of –6 dBm. The signal is attenuated by a 10 dB pad, and then converted to an IF of 1044 MHz by mixer U1. A sample of the upconversion LO from the L-Band PLL Board mounted in the upconverter module assembly is sent through the exciter's backplane board, or directly to the board in the stand alone tray. On the downconverter board, the LO is amplified and then filtered to remove any spurious energy before being applied to U1.

A filter selects the appropriate conversion product, with the resulting signal being applied to the mixer U9, which converts the signal to a second IF of 44 MHz. A 1 GHz LO frequency that is generated externally, and either sent through the exciter's backplane board to the downconverter module or connected from the 1st conversion board in the stand-alone tray. The 1 GHz LO is applied to a high pass and low pass filter designed to eliminate any other interfering signals that might be coupled into the 1 GHz LO. This 44 MHz second IF signal is then applied to a low pass filter to remove any out of band energy, amplified and connected to a frequency response correction circuit intended to compensate for any linear distortions in the downconversion path. Adjustments R50-R52 and C78-C80 are used to control the frequency response of the downconverter. The resulting signal is sent to a pin diode attenuator, which allows the operator to adjust thegain of the downconversion path. The signal is then amplified again to a level of +4 dBm average and applied to a cascaded high pass low pass filter, which removes any out of band energy that would be aliased in the demodulation process.

8.4.2.3 Control & Monitoring / Power Supply Module (Exciter)

The Control & Monitoring/Power Supply Assembly is made up of a Control Board, a Power Protection Board and a Switch Board. The Assembly also contains a switching power supply that provides ±12 VDC to the rest of the modules in the chassis and +32 VDC to the Power Amplifier module.

The Assembly provides all transmitter control and monitoring functions. The Front panel LCD allows monitoring of system parameters, including forward and reflected power, transistor currents, module temperatures and power supply voltages.

8.4.2.4 Power Amplifier Module (Exciter)

The (Power Amplifier Module Assembly is made up of an Amplifier Control Board, a Coupler Board Assembly, 1-Watt UHF Module Assembly and a RF Module Pallet Assembly, 250 Watts.

The Power Amplifier Module contains Broadband LDMOS amplifiers that cover the UHF band. The RF output of the Axciter Upconverter is passed through the attenuator, (+6 to +10.8 dBm), and enters the module at J24. The DTV RF connects to J3 on the 1-Watt UHF Amplifier Module that contains a 1 Watt UHF Amplifier Board. The module has approximately 17 dB of gain. The RF output of the module (+27 dBm) at J4 connects to the RF input jack on the RF module pallet (Philips) that is made from the RF module pallet w/o transistors. The RF module pallet (Philips) has approximately 12 dB of gain. The amplified RF output (+39 dBm) is cabled to J1 on the Coupler Board Assembly that supplies a forward power sample to the Amplifier Control Board.

AGC Voltage, control and monitoring lines from the Amplifier Control Board are routed through the floating blind-mate connector to the Control & Monitoring/Power Supply module.

8.4.3 RF Amplifier Cabinet Assembly

The RF Amplifier cabinets are typically made up of a eight RF amplifier assemblies, using seven 2 way splitters, an 8 way combiner, a Top Power Supply Assembly #1, a Bottom

Power Supply Assembly #2, two Transformers, two SCR Controllers, a 480 or 208 VAC Power Distribution Panel that also distributes the 110 VAC.

The RF input, (+27 dBm, 500 mW), from the Exciter or the two way or three way splitter connects to the Amplifier Cabinet at the 2-Way Splitter in an eight amplifier assembly cabinet. Each output of the 2 Way Splitter is split by another 2 Way Splitter, creating four outputs. Each of these outputs is split again by another 2-Way Splitter creating eight total outputs, each (+18 dBm, 63 mW) that connect to the eight Power Amplifier Assemblies. Each PA Assembly has approximately +40.5 dB of gain and generates a RF output of (+58.5 dBm, 700 W). These eight RF outputs are combined in an 8 Way Combiner to produce an RF Output of (+67.2 dBm, 5.2 kW) DTV.

8.5 Control and Status

8.5.1 External Axciter Digital Modulator Tray

Please refer to the Axciter Operating Manual for status indicators and controls

8.5.2 Exciter Tray

Table 8-2. Controller/Power Supply Display

DISPLAY	FUNCTION
LCD	A 4 x 20 display providing a four-line readout of the internal functions, external inputs, and status. See Chapter 3, Controller/Power Supply Display Screens, for a listing of displays.

Table 8-3. Controller/Power Supply Status Indicators

LED	FUNCTION
OPERATE (green)	When lit it indicates that the transmitter is in the Operate Mode. If transmitter is Muted the Operate LED will stay lit, the transmitter will remain in Operate, until the input signal is returned.
FAULT (red or green)	Red indicates that a problem has occurred in the transmitter. The transmitter will be Muted or placed in Standby until the problem is corrected.
DC OK (red or green)	Green indicates that the switchable fuse protected DC outputs that connect to the modules in the transmitter are OK.

Table 8-4. Controller/Power Supply Control Adjustments

POTENTIOMETERS	DESCRIPTION
DISPLAY CONTRAST	Adjusts the contrast of the display for desired viewing of screen.

Table 8-5. Power Amplifier Status Indicators

LED	FUNCTION
ENABLED (Green)	When lit Green, it indicates that the PA is in the Operate Mode. If a Mute occurs, the PA will remain Enabled, until the input signal is returned.
DC OK (Green)	When lit Green, it indicates that the fuse protected DC inputs to the PA module are OK.
TEMP (Green)	When lit Green, it indicates that the temperature of the heatsink assembly in the module is below 78°C.
MOD OK (Green)	When lit Green, it indicates that the PA Module is operating and has no faults.
MOD OK (Red)	If the Module OK LED is Red and blinking a fault is present. **1 Blink** indicates Amplifier Current Fault. **2 Blinks** indicate Temperature Fault. **3 Blinks** indicate +32V Power Supply Over Voltage Fault. **4 Blinks** indicate +32V Power Supply Under Voltage Fault. **5 Blinks** indicate Reflected Power Fault. **6 Blinks** indicate +12V or –12V Power Supply Fault.

Table 8-6. Power Amplifier Control Adjustments

POTENTIOMETERS	DESCRIPTION
AVERAGE CAL	Adjusts the gain of the Average Power monitoring circuit
FORWARD CAL	Adjusts the gain of the Forward Power monitoring circuit
REFLECTED CAL	Adjusts the gain of the Reflected Power monitoring circuit

Table 8-7. Power Amplifier Sample

DISPLAY	FUNCTION
FORWARD SAMPLE	RF sample of the amplified DTV RF signal being sent out the module on J25. (~ - 10 dBm)

8.6 Remote Interface Connections

8.6.1 Remote Interface Connections (Axciter Digital Moduator)

Please refer to the Axciter Operating Manual for all Remote Interface Connections.

8.6.2 Remote Interface Connections (Exciter)

Port	Type	Function	Impedance
J1	**IEC**	**AC Input**	**N/A**
TB02	Term	NOT USED Base Band Audio Input	600O
J3	BNC	NOT USED Composite Audio Input	75O
J4	BNC	NOT USED SAP/PRO Audio Input	50O
J5	BNC	NOT USED CW IF Input	50O
J6	BNC	NOT USED Modulated IF Input (From Axciter)	50O
J7	BNC	NOT USED Video Input (Isolated)	75O
J8	BNC	NOT USED Visual IF Loop-Thru Output	50O
J9	BNC	NOT USED Modulator Aural IF Output	50O
J10	**BNC**	**External 10 MHz Reference Input (From Axciter)**	**50O**
J11	BNC	NOT USED System 10 MHz Reference Output	50O
J12	BNC	NOT USED MPEG Input to DM8	50O
J13	**BNC**	**Downconverter IF Output (To Axciter)**	**50O**
J14	BNC	NOT USED RF Spare 2	50O
J15	**BNC**	**Digital IF Input (From Axciter)**	**50O**
J17	BNC	NOT USED Video Loop-Thru (Isolated)	75O
J18	BNC	NOT USED Visual IF Loop-Thru Input	50O
J19	BNC	NOT USED Aural IF Loop-Thru Input	50O
J23	**BNC**	**Upconverter RF Output (Jumpered to J24)**	**50O**
J24	**SMA**	**Power Amplifier RF Input (Jumpered to J23)**	**50O**
J25	**SMA**	**Power Amplifier RF Output**	**50O**
J35	BNC	NOT USED Power Amplifier Aural RF Input	50O
J36	N	NOT USED Power Amplifier Aural RF Output	50O
J32	**RJ-45**	**SCADA (Input/Loop-Thru)**	**CAT5**
J33	RJ-45	SCADA (Input/Loop-Thru)	CAT5
J34	**RJ-45**	**System RS-485 Serial**	**CAT5**
J40	**BNC**	**1 GHz Input (From Axciter)**	**50O**
J41	**SMA**	**Downconverter RF Input (From Relay)**	**50O**
TB30	**Termination**	**Remote Control & Monitoring**	**N/A**
TB31	**Termination**	**Remote Control & Monitoring**	**N/A**

8.7 AC Input

8.7.1 External Axciter Digital Modulator

The AC input to the Axciter Modulator Tray is 117 VAC or 230 VAC (factory selectable). The AC input is applied to the internal switching power supply.

8.7.2 Exciter Tray

The AC input to the Exciter Tray is 117 VAC or 230 VAC (factory selectable). The AC input is applied to the tray through Jack J1. MOV's are provided to protect the Tray from transients or surges, which may occur on the AC Input Lines.

8.7.3 RF Amplifier Cabinet

The AC input to the RF Amplifier Cabinet is 208, 240 or 480 VAC. The AC input is applied to the RF Amplifier Cabinet at a terminal block. MOV's are provided within the AC Distribution Panel to protect the RF Cabinet and its components from transients or surges, which may occur on the AC Input Lines.

8.8 System Operation

When the transmitter is in operate, as set by the menu screen on the touch screen, the following occurs. The +32 VDC stage of the Power Supply in the Control & Monitoring Module is enabled, the operate indicator on the front panel is lit and the DC OK on the front panel should also be green. The enable and DC OK indicators on the PA Module will also be green.

When the transmitter is in standby, the +32 VDC stage of the Power Supply in the Control & Monitoring Module is disabled, the operate indicator on the front panel will be extinguished and the DC OK on the front panel should remain green. The enable indicator on the PA Module is also extinguished.

8.8.1 Principles of Operation

Operating Modes

This transmitter is either operating or in standby mode. The sections below discuss the characteristics of each of these modes.

Operate Mode

Operate mode is the normal mode for the transmitter when it is providing RF power output.

Entering Operate Mode

Entering the operate mode can be initiated a few different ways by the transmitter control board. A list of the actions that cause the operate mode to be entered is given below:

- A low on the Remote Transmitter Operate line.
- User selects "OPR" using switches and menus of the front panel.
- Receipt of an “Operate CMD” over the serial interface.

There are several fault or interlock conditions that may exist in the transmitter that will prevent the transmitter from entering the operate mode. These conditions are:

- Power Amplifier heat sink temperature greater than 78°C.
- Power Amplifier Interlock is high indicating that the amplifier is not installed.

Standby Mode

The standby mode in the transmitter indicates that the output amplifier of the transmitter is disabled.

Entering Standby Mode

Similar to the operate mode, the standby mode is entered using various means. These are:

- A low on the Remote Transmitter Stand-By line.
- Depressing the “STB” key on selected front panel menus.
- Receipt of a “Standby CMD” over the serial interface.

RF System Interlock

A RF System Interlock signal is provided through TB30-5. When this signal circuit is completed to ground such as through a wire between TB30-5 and TB30-15, the transmitter is allowed to operate. If this circuit is opened, the transmitter switches to a Mute condition. This circuit may be completed through coax relay contacts and/or reject load contact closures to assure the RF output system is available to receive the transmitter's output RF signal.