# 8. OPERATIONAL DESCRIPTION - MODEL Axcera-LHV66ATD

## 8.1 General Description

The LHV66ATD is a complete 66-watt High-band VHF solid-state, digital transmitter. It operates at a nominal output power of 66 watts average.

## 8.2 Technical Specifications

Type of Emission ..... 6M00K1D

Frequency Range ..... 174 MHz to 216 MHz (any 6-MHz channel)

Output Power ..... 66 watts average

## 8.3 Performance Specifications

Operating Frequency Range ..... 174 MHz to 216 MHz

RF output - Nominal:
Power ..... 66 watts average
Impedance ..... 50 ohms
Connector ..... "N"

Regulation of Output ..... 3%
Signal-to-Noise Ratio (SNR) ..... 33 dB typical

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, Serial Differential ECL & TTL

<u>Electrical Requirements</u>

Power Line Voltage ..... 110-260 volts, 50/60 Hz
Power Consumption ..... 725 watts

<u>Environmental</u>

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

Mechanical

Dimensions:

Width ..... 22 inches
Depth ..... 34 inches
Height ..... 55 inches
Weight..... 250 lbs

## 8.4. System Overview

The LHV66ATD is made up of the trays listed in Table 8-1.

*Table 8-1. LHV66ATD Major Trays and Assemblies*

| MAJOR ASSEMBLY DESIGNATOR | TRAY/ASSEMBLY NAME |
|---|---|
| A1 | VHF HB Exciter Assembly |

### 8.4.1 Exciter Tray

#### 8.4.1.1 DM8 - Digital Modulator Module

The DM8 modulator is an ATSC compliant 8 VSB modulator that slides into the left most slot in the Innovator LX Driver chassis assembly. The DM8 modulator accepts a SMPTE-310 MPEG data stream input and outputs a 6 MHz wide IF output centered at 44 MHz with a pilot carrier at 46.69 MHz. The DM8 modulator provides linear and nonlinear correction capability for the transmission path as well as internal test sources that are used during initial transmitter installation. All of the functions of the DM8 modulator are controlled from the LX Controller LCD display and pushbuttons.

#### 8.4.1.2 IF Processor Module

The IF Processor Assembly contains the IF Processor Board (1301977). The IF Processor provides pre-correction to ensure broadcast quality output signal. The pre-correction consists of amplitude linearity correction, Incidental Carrier Phase Modulation (ICPM) correction and frequency response correction.

The IF Processor module is configured either for an analog or digital system. Pin 13C of the IF Processor module is grounded in analog systems and left not connected in digital systems. An IF Processor Interlock signal is used to report the presence of the IF Processor module to the Control Monitoring board. If the IF Processor interlock signal is not present, the Transmitter/Exciter Driver RF output is Muted (turned off). If an analog IF Processor module is installed and the Modulation Present signal is not true, the Transmitter / Exciter Driver output is Muted (turned off).

The Control & Monitoring/Power Supply module uses the IF Processor module for System output power control. Through the front panel display or a remote interface, an operator can set the transmitter's RF output power. The range of RF power adjustment is between 0% (full off) and 105% (full power plus). A front panel IF Processor module potentiometer sets the upper limit of RF power at 120%. The system's Control Monitoring board compares the RF Power Monitoring module RF power level with the desired level and uses the IF Power Control PWM line to correct for errors.

In digital systems, a digital level control (DLC) voltage is generated on the IF Processor module and sent to the digital modulator. RF power control is implemented by changing the DLC voltage provided to the digital modulator. The 'RF High' potentiometer sets the upper adjusted range of RF control circuit output to 120%.

The IF Processor module provides a reference ALC voltage to the system's Upconverter. When the ALC voltage decreases, the Upconverter automatically lowers the system output power through the AGC circuits.

The IF Processor module has a front panel switch to select Auto or Manual ALC. When Manual ALC is selected, the reference ALC voltage is set by a front panel potentiometer. In this condition, the RF power level control circuit is removed from use. When the ALC select switch is changed to Auto, the RF power level control circuit will start at low power and increase the RF output until the desired output power is attained.

The IF Processor module Modulation Present signal is monitored. If the modulation level is too low or non-existent, a Modulation Present fault is reported to the Control Monitoring board. When the controller detects this fault, it can be set to Automatically Mute the transmitter or in Manual mode the transmitter will continue to operate at 25% output.

The IF Processor module Input Signal level is monitored. If the signal level is too low or non-existent, an Input fault is reported on the Control Monitoring board. When the IF Processor board detects an Input Signal fault it automatically Mutes the transmitter. The system controller does not Mute on an IF Processor Input fault.

#### 8.4.1.3 VHF/UHF Upconverter Module

The VHF/UHF Upconverter Module Assembly contains (A1) a Downconverter Board Assembly (1303834), (A3) a First Conversion Board, LX Series (1303838), (A2) a L-Band PLL Board, LX Series (1303846) and (A4) an Upconverter Control Board (1304760).

A 0 dBm 44 MHz IF input to the upconverter through the backplane board is applied to a mixer mounted on the first conversion board. Also applied to the mixer is a nominal 1 GHz LO1. The mixer converts it to a nominal frequency centered at 1044 MHz. A filter selects the appropriate conversion product, which is then amplified to a level of approximately –4 dBm. The frequency of the first conversion LO1 can be shifted by ± 10 kHz to generate channel offsets of 10kHz. For +offsets the frequency is 999.99 MHz and for –offsets the frequency is 1000.01 MHz.

This signal is applied to a second mixer mounted on the downconverter board that converts it back to a broadcast channel (2-69) by an LO2 that operates in 100kHz steps between 1.1-1.9 GHz depending on the channel selected. The LO2 frequency equals the Channel center frequency plus the LO1 frequency plus 44 MHz. (As an example CH14+: Center Frequency is 473.01 MHz and LO1 is 999.99 MHz therefore LO2 is 473.01 + 999.99 + 44, 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 applied to a Pin diode attenuator before it is connected to the output of the upconverter. This pin diode attenuator adjusts the gain of the 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.

#### 8.4.1.4 Control & Monitoring / Power Supply Module

The (A4) Control & Monitoring/Power Supply Assembly is made up of a Control Board (1302021), a Power Protection Board (1302837) and a Switch Board (1527-1406). 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.

#### 8.4.1.5 Power Amplifier Module

The (A6) Power Amplifier Module Assembly is made up of a VHF HB Coupler Board Assembly (1142-1002), an Amplifier Control Board (1308260), a 25 Watt VHF Driver Assembly (1305820) and a 400W VHF Amplifier Assembly (1301322).

The Power Amplifier Module contains Broadband LDMOS amplifiers that cover the VHF High Band with no tuning required. They amplify the RF to the output power of the transmitter.

The Power Amplifier is used to amplify the RF output of the Upconverter module. A jumper cable, located on the rear chassis, connects the RF output from the Upconverter at J23 to J24 the RF input to the PA Assembly.

The Power Amplifier module contains an amplifier control and monitoring board. This board monitors the RF output power, RF reflected power, the current draw of amplifier sections, the supply voltage, and the temperature of the PA heat sink. The Control and monitoring lines to the Power Amplifier module are routed through the floating blind-mate connector of the Control & Monitoring/Power Supply module.

The RF power detector circuit outputs vary with operating frequency. These circuits must be calibrated at their intended operating frequency. Front panel adjustment potentiometers, R201 for Reflected Power and R202 for Forward Power, are used for calibration.

The Aural power of the Power Amplifier assembly is not reported by the system Control Monitoring module. Additionally the Visual power of the amplifier is reported as Forward Power.

The Forward Power of the Power Amplifier module is routed to the Upconverter module as AGC #1. A system over-drive condition is detected when this value rises above 1.6 VDC on the Axciter's Upconverter Screen. When an over-drive condition is detected, the Upconverter module reduces its RF output level. For values less than 1.6 VDC, the Upconverter uses this voltage for automatic gain.

## 8.5 Control and Status

### 8.5.1 Exciter Tray

Table 8-2. Digital Modulator Front Panel Status Indicators

| LED | FUNCTION |
|---|---|
| MPEG (Green) | Indicates the presence of a valid MPEG stream at the J1-2B input jack. |
| PLL A (Green) | Indicates that the DM8 symbol clock is locked to the frequency of the 10 MHz reference. |
| PLL B (Green) | Indicates that the pilot frequency is locked to the incoming 10 MHz reference. |

Table 8-3. Digital Modulator Front Panel Alignment Port

| PORT | DESCRIPTION |
|---|---|
| RS-232 | Serial port used for the initial DM8 modulator alignment. |

Table 8-4. Digital Modulator Front Panel Sample

| SAMPLE | DESCRIPTION |
|---|---|
| IF Sample | Provides a sample of the IF output from the modulator at approximately a –20 dBm level. |

Table 8-5. IF Processor Front Panel Status Indicators

| LED | FUNCTION |
|---|---|
| INPUT FAULT (Red) | When lit it indicates that there is a loss of the IF Input signal to the IF Processor. Transmitter can be set to Mute on an IF Input Fault. |
| ALC Fault (Red) | When lit it indicates that the required gain to produce the desired output power level has exceeded the operational range of the ALC circuit. The LED will also be lit when ALC is in Manual. |
| MUTE (Red) | When lit it indicates that the IF input signal is cut back but the enable to the Power Supply is present and the +32 VDC remains on. |

Table 8-6. IF Processor Front Panel Control Adjustments

| POTENTIOMETERS | DESCRIPTION |
|---|---|
| FREQUENCY RESPONSE EQUALIZER | These three variable resistors, R103, R106 & R274, adjust the depth of gain for the three stages of frequency response correction. |
| ALC GAIN | Adjusts the gain of the transmitter when the transmitter is in the Auto ALC position. |
| MAN GAIN | Adjusts the gain of the transmitter when the transmitter is in the Manual ALC position. |
| LINEARITY CORRECTION | These three variable resistors adjust the threshold cut in for the three stages of linearity pre-correction. R211 and R216, the top two pots, are adjusted to correct for in phase amplitude distortions. R 231, the bottom pot, is adjusted to correct for quadrature phase distortions. |

Table 8-7. IF Processor Front Panel Switch

| SWITCH | FUNCTION |
|---|---|
| MAN/AUTO ALC | When Manual ALC is selected, the reference ALC voltage is set by the ALC Gain front panel potentiometer.<br><br>When Auto ALC is selected, the IF level control circuit will automatically increase the IF output until the desired output power is attained. |

Table 8-8. IF Processor Front Panel Sample

| SMA CONNECTOR | DESCRIPTION |
|---|---|
| IF SAMPLE | Sample of the pre-corrected IF output of the IF Processor |

Table 8-9. VHF/UHF Upconverter Front Panel Status Indicator

| LED | FUNCTION |
|---|---|
| PLL 1 Fault (Red) | When lit it indicates that the 1 GHz PLL is unlocked |
| PLL 2 Fault (Red) | When lit it indicates that the 1.1 –1.9 GHz PLL is unlocked |
| AGC Fault (Red) | When lit it indicates that the AGC is out of range. |
| AGC Override (Red) | When lit it indicates that the AGC is cutting back due to too much drive to the driver module. |
| Man Gain (Amber) | When lit it indicates that the AGC is bypassed in Manual. |

Table 8-10. VHF/UHF Upconverter Front Panel Control Adjustments

| POTENTIOMETERS | DESCRIPTION |
|---|---|
| MAN GAIN ADJ | Adjusts the gain of the upconverter and transmitter when in the Manual AGC position. |
| AGC ADJ | Adjusts the gain of the upconverter and transmitter when in the Auto AGC position. |
| AGC CUTBACK ADJ (AGC OVERRIDE) | Adjusts the point at which the transmitter will cut back in power, due to too much drive, when the Transmitter is in Auto AGC. |

Table 8-11. VHF/UHF Upconverter Front Panel Switch

| SWITCH | FUNCTION |
|---|---|
| MAN/AUTO AGC | When Manual AGC is selected, the reference AGC voltage is set by the AGC Manual Gain front panel potentiometer.<br><br>When Auto AGC is selected, the RF power level control circuit will automatically increase the RF output until the desired output power is attained. |

Table 8-12. VHF/UHF Upconverter Front Panel Samples

| SMA CONNECTOR | DESCRIPTION |
|---|---|
| LO1 SAMPLE | Sample of the 1 GHz nominal LO1 signal in the Upconverter as generated on the L-Band PLL Board. |
| LO2 SAMPLE | Sample of the 1.1-1.9 GHz LO2 signal in the Upconverter as generated on the First Conversion Board. |
| RF SAMPLE | Sample of the On Channel RF Output of the Upconverter |

Table 8-13. 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 8-14. 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 8-15. Controller/Power Supply Control Adjustments

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

Table 8-16. 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. The meaning of the blinking LED is as follows.<br><br>1 Blink indicates Amplifier Current Fault.<br>2 Blinks indicate Temperature Fault.<br>3 Blinks indicate +32V Power Supply Over Voltage Fault. |

| | |
|---|---|
| | 4 Blinks indicate +32V Power Supply Under Voltage Fault.<br>5 Blinks indicate Reflected Power Fault.<br>6 Blinks indicate +12V or –12V Power Supply Fault |
| MOD OK (Amber) | A blinking Amber Mod OK LED indicates the power output of the amplifier module is below 65%. (**NOTE**: Only in Amplifier Code Versions 3.7A or later & System Controller Code Versions 3.9C or later.) |

Table 8-17. Power Amplifier Control Adjustments

| POTENTIOMETERS | DESCRIPTION |
|---|---|
| RFL CAL | Adjusts the gain of the Reflected Power monitoring circuit |
| FORWARD CAL | Adjusts the gain of the Forward Power monitoring circuit |
| AURAL CAL | (NOT USED) Adjusts the gain of the Aural Power monitoring circuit |
| AURAL NULL | (NOT USED) Adjusts the offset of the Forward Power monitoring circuit based on the Aural signal level.. |

Table 8-18. Power Amplifier Sample

| DISPLAY | FUNCTION |
|---|---|
| FWD SAMPLE | RF sample of the amplified signal being sent out the module on J25. |

The driver/power amplifier RF output jack is at an "N" connector J25, PA RF Output. The RF output of the driver/amplifier chassis assembly is connected to the input of the (A6) circulator and then to the (A7) pre-filter coupler assembly.

The pre-filter coupler supplies a forward, pre-filter power sample at J3, Non-Linear Distortion, which is cabled to J1 on (K2) the Axciter relay mounted on the left side toward the rear of the cabinet. The output of the pre-filter coupler connects to the (A10) low pass filter and then to J1, the RF input jack, on (A8) the DTV band-pass filter. The low pass and band-pass filtered output connects to the (A9) coupler and then to (A11) the post-filter coupler assembly.

The post-filter coupler supplies a forward sample, Linear Distortion, which is cabled to J2 on the (K2) Axciter relay.

The RF output of the post-filter coupler assembly at the J2 "N" connector, connects to the antenna of the system

## 8.6 Remote Interface Connections

### 8.6.1 Remote Interface Connections

| Port | Type | Function | Ohm |
|---|---|---|---|
| J1 | IEC | AC Input | N/A |
| TB02 | Term | Base Band Audio Input | 600 |
| J3 | BNC | Composite Audio Input | 75 |
| J4 | BNC | SAP / PRO Audio Input | 50 |
| J5 | BNC | CW IF Input | 50 |
| J6 | BNC | Modulated IF Input | 50 |
| J7 | BNC | Video Input (Isolated) | 75 |
| J8 | BNC | Visual IF Loop-Thru Output | 50 |
| J9 | BNC | Aural IF Loop-Thru Output | 50 |
| J10 | BNC | 10 MHz Reference Input | 50 |
| J11 | BNC | 10 MHz Reference Output | 50 |
| | | | |
| J17 | BNC | Video Loop-Thru (Isolated) | 75 |
| J18 | BNC | Visual IF Loop-Thru Input | 50 |
| J19 | BNC | Aural IF Loop-Thru Input | 50 |
| | | | |
| J23 | BNC | Upconverter RF Output | 50 |
| J24 | BNC | Power Amplifier RF Input | 50 |
| J25 | N | Power Amplifier RF Output | 50 |
| | | | |
| TB30 | Term | Remote Control & Monitoring | |
| TB31 | Term | Remote Control & Monitoring | |
| J32 | RJ-45 | SCADA (Input / Loop-Thru) | CAT5 |
| J33 | RJ-45 | SCADA (Input / Loop-Thru) | CAT5 |
| J34 | RJ-45 | System RS-485 Serial | CAT5 |

## 8.7 AC Input

### 8.7.1 Exciter Tray

The AC input to the Exciter Tray is 117 VAC or 230 VAC. 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.

## 8.8 System Operation

When the transmitter is in operate, as set by the menu screen located on the Control & Monitoring Module. 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 is green. The enable and DC OK indicators on the PA Module will also be turned to 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 and indicator on the PA Module is also extinguished.

If the transmitter does not switch to Operate when the operate menu is switched to Operate, check that all faults are cleared and that the remote control terminal block stand-by signal is not active.

### 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's 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 reject load contact closures to assure the RF output system is available to receive the transmitter's output RF signal. This feature is implemented in transmitter software version 1.4 and above.

**Operating Frequency**

The transmitter controller is designed to operate on VHF frequencies. The exact output frequency of the transmitter can be set to one of the standard VHF frequencies, or to a custom frequency using the software channel set-up menu on the Controller Module. Since RF performance of the transmitter requires different hardware for different frequency bands, not all frequency configurations are valid for a specific transmitter. The Power detectors in the transmitter are frequency dependent, therefore detectors of power amplifiers are calibrated at their frequency of use. The detectors for System RF monitoring are also calibrated at the desired frequency of use.