8. OPERATIONAL DESCRIPTION - MODEL Axcera-LLV20AT

8.1 General Description

The LLV20AT is a complete 20-watt VHF low-band solid-state, internally diplexed television transmitter. It operates at a nominal visual output power of 20 watts peak sync and an average aural output power of 2 watts, at an A/V ratio of 10 dB, 10% sound.

8.2 Technical Specifications

Type of Emissions:
- Visual 5M75C3F
- Aural 250KF3E

Frequency Range..... 54 MHz to 88 MHz (any 6-MHz channel)

Output Power
- Visual ..... 20 watts peak sync
- Aural ..... 2 watts average

Maximum Power Rating
- Visual ..... 20 watts peak visual
- Aural ..... 2 watts average aural

Power Consumption ..... 300 watts

8.3 Performance Specifications

Visual Performance

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

RF output - Nominal:
- Power ..... 20 watts peak sync
- Impedance ..... 50 ohms
- Connector ..... Type N

Visual Sideband Response:
- -1.25 MHz and below ..... -20B
- -0.75 to -0.5 MHz..... +0.5, -2.0dB
- -0.5 MHz to +3.58 MHz..... ±0.5 dB
- 3.58 MHz to 4.18 MHz..... +0.5, -1.0 dB

Variation of Frequency Response with Brightness..... ±0.5 dB
Differential Phase ..... ±3°
Incidental Phase Modulation..... ±3°
Differential Gain 5%
Low Frequency Linearity..... 5%
Intermodulation Products ..... -52 dB (red field)
Output Variation (Over 1 Frame) 2%
Regulation of Output..... 3%

Signal-to-Noise Ratio ..... 55 dB
2t K-Factor 2%
Harmonic Radiation ..... -60 dB
Spurious (>3 MHz from channel edge) ..... -50 dB
Carrier Frequency Stability ..... ±1000 Hz

Aural Performance

Frequency Deviation Capability (Transmitters) ..... ±75 kHz
Distortion 0.5%
FM Noise ..... -60 dB
AM Noise ..... -55 dB
Visual to Aural Separation ..... 4.5 MHz, ±100 Hz

Composite Audio Input (Multi-channel sound - Transmitters)
- Input Level ..... 1V peak, nominal
- Input Impedance ..... 75 ohms, unbalanced

Frequency Range:
- ±0.1 dB Response ..... 50 Hz to 50 kHz
- ±0.5 dB Response ..... 30 Hz to 120 kHz

Monaural Audio Input (Transmitters):
- Input Level ..... 0 to +10 dBm
- Input Impedance ..... 600 ohms, balanced
- Frequency Range (±0.5 dB resp.) ..... 30 Hz to 15 kHz
- Pre-emphasis ..... 75 uS

Subcarrier Audio Input (Transmitters):
- Input Level ..... 1V peak, nominal
- Input Impedance ..... 75 ohms, unbalanced
- Frequency Range (±0.5 dB resp.) ..... 20 kHz to 120 kHz

Electrical Requirements

Power Line Voltage ..... 117/230 volts, 50/60 Hz
Power Consumption ..... 300 watts

Environmental

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

Mechanical

Dimensions:
- Width ..... 19 inches
- Depth ..... 23 inches
- Height ..... 8.75 inches
- Weight ..... 45 lbs

8.4. System Overview

The LLV20AT is made up of the trays listed in Table 8-1.

Table 8-1. LLV20AT Major Trays and Assemblies

ASSEMBLY DESIGNATOR	TRAY / ASSEMBLY NAME
	Exciter Driver Chassis Assembly, LX Series
A11	Backplane Board, Axciter
A2	Modulator Module
A3	IF Processor Module
A5	VHF/UHF Upconverter Module
A4	Control/Power Supply Module
A6	Power Amplifier Module

8.4.1 Transmitter Tray

8.4.1.1 Modulator Module

The (A2) Modulator Assembly contains the Modulator Board (1304704). The modulator is broadcast quality and provides front panel access to control and monitoring points. The video level is controlled through a sync tip clamp and sync and white clipping circuitry. The IF oscillator is oven controlled and locked to a 10 MHz reference for stability. The IF signal is fed through a SAW filter for precise sideband shaping. The Modulator operates using either the baseband audio and video inputs or the 4.5-MHz composite input to produce a diplexed, modulated, and on-channel frequency visual + aural RF output that is cabled to the IF Processing Module.

8.4.1.2 IF Processor Module

The (A3) IF Processor Assembly contains the IF Processor Board (1304687). 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.

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 (A5) VHF/UHF Upconverter Module Assembly contains (A1) a Downconverter Board Assembly (1303834), (A3) a First Conversion Board (1303838), (A2) a L-Band PLL Board (1303846) and (A4) an Upconverter Control Board (1304760).

A 44 MHz IF input @ 0 dBm level connects to the upconverter through the backplane board and 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 CH9: Center Frequency is 189.00 MHz and LO1 is 1000.00 MHz therefore, LO2 is 189 + 1000 + 44, which equals 1233.00 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 screens allow 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 Power Amplifier Module Assembly 1307156 contains (A2) a VHF LB Driver Assembly (11153-1107), (A3) a VHF LB Amplifier Board (1172-1101), (A4) a Coupler Board Assembly (1141-1002), (A5) an Amplifier Control Board (1303682) and (A6) a Temperature Sensor IC.

The RF from the Upconverter Module Assembly connects from the Upconverter RF Output BNC Jack J23, through a cable, to the PA RF Input BNC Jack J24, located on the rear of the exciter/amplifier chassis assembly.

The Power Amplifier of the Transmitter/Exciter Driver is used to amplify the RF output of the Upconverter module. A cable, located on the rear chassis, connects the RF output from the Upconverter at J23 to J24 the RF input to the PA Assembly. 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 are used to calibrate the following:

Table 1: Power Amplifier Calibration Adjustments in Analog Systems

R201 Reflected Power Cal
R202 Visual / Forward Power Cal
R203 Aural Power Cal
R204 Visual Offset Zero
R205 Aural Null

In analog systems, the Aural power of an Exciter Driver Power Amplifier and the Aural power of any external amplifier will not be reported by the system Control Monitoring module. Additionally the Visual power of these amplifiers, is reported as Forward Power just like in digital systems. In analog systems, aural and visual power will only be reported for the final system RF output.

If the Control Monitoring module is monitoring a 5-50 Watt Translator, system power is measured in the Power Amplifier module. The wired connections are transferred through the power supply connector to the backplane board on a five position header. All four positions of control board switch SW1 must be set on to route these lines as the system's RF power signals. In systems of output power greater than 50 Watts, system power is monitored by an external module that is connected to TB31 and control board SW1 switches must be set off.

The Forward Power of the Transmitter/Exciter Driver Power Amplifier module is routed to the Upconverter module as AGC #1. A system over-drive condition is detected when this value rises above 0.9 VDC. When an over-drive condition is detected, the Upconverter module reduces its RF output level. For values less than 0.9 VDC, the Upconverter uses this voltage for automatic gain.

8.5 Control and Status

8.5.1 Transmitter Tray

Table 8-2. Modulator Front Panel Switch

SWITCH	FUNCTION
MAN/AUTO CLAMP SW1	When Manual Clamp is selected, the video level is set by the Manual Bias Pot R67 located on the board. (**NOTE**: The pot is factory set and needs no adjustment by the customer). When Auto Clamp is selected, the video level control circuit will automatically increase or decrease the video to maintain the desired video level.

Table 8-3. Modulator Front Panel Status Indicators

LED	FUNCTION
AUR UNLOCK DS5 (Red)	When lit it indicates that the 4.5 MHz VCO and the 10 MHz reference are not PLL locked.
VIS UNLOCK DS6 (Red)	When lit it indicates that the 45.75 MHz VCXO and the 10 MHz reference signal are not PLL locked.
AUD DEV DS4 (Red)	When lit it indicates the deviation level is more than ±80kHz
VIDEO LOSS DS1 (Red)	When lit it indicates the Video Input to the transmitter is lost.
OVER MOD DS3 (Red)	When lit it indicates the Video input level is too high.
ALT IF DS7 (Green)	When lit it indicates that external or alternate 4.5MHZ is present.
10 MHz PRES DS2 (Green)	When lit it indicates that a 10MHz reference is present to the transmitter.

Table 8-4. Modulator Front Panel Control Adjustments

POTENTIOMETERS	DESCRIPTION
Video Gain (R42)	Adjusts the level of the output video.
Visual Level (R214)	Adjusts the Visual IF level that combines with the Aural IF.
Aural Level (R243)	Adjusts the Aural IF level that combines with the Visual IF.
MONO (R110)	Adjusts the deviation level of the balanced audio input.
STEREO (R132)	Adjusts the deviation level of the composite audio input.
SAP/PRO (R150)	Adjusts the deviation level of the subcarrier audio input.

Table 8-5. Modulator Front Panel Sample

SMA CONNECTOR	DESCRIPTION
MOD IF SAMPLE (J10)	Sample of the combined Aural IF and Visual IF signals.

Table 8-6. 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. When Auto ALC is selected, the IF level control circuit will automatically increase the IF output until the desired output power is attained.

Table 8-7. 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 8-8. IF Processor Front Panel Control Adjustments

POTENTIOMETERS	DESCRIPTION
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.

Table 8-9. IF Processor Front Panel Sample

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

Table 8-10. 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. 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 8-11. 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 8-12. 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 8-13. 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 8-14. 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 8-15. 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 8-16. Controller/Power Supply Control Adjustments

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

Table 8-17. 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 8-18. Power Amplifier Control Adjustments

POTENTIOMETERS	DESCRIPTION
FWD CAL	Adjusts the gain of the Forward Power monitoring circuit
RFL CAL	Adjusts the gain of the Reflected Power monitoring circuit

Table 8-19. Power Amplifier Sample

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

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 Transmitter Tray

The AC input to the Transmitter 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.

8.8 System Operation

When the transmitter is in operate, as set by the menu screen located on the Control & Monitoring Module in the exciter/driver assembly. The IF Processor will be enabled, the mute indicator on the front panel will be extinguished. 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 IF Processor will be disabled, the mute indicator on the front panel will be red. 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.
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.

The transmitter can be controlled by the presence of a modulated input signal. If the input signal to the transmitter is lost, the transmitter will automatically cutback and the input fault indicator on the IF Processor module will light. When the video input signal returns, the transmitter will automatically return to full power and the input fault indicator will be 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. To provide RF power to the output, the transmitter will not be in mute. Mute is a special case of the operate mode where the +32 VDC section of the power supply is enabled but there is no RF output power from the transmitter. This condition is the result of a fault condition that causes the firmware to hold the IF Processor module in a mute state.

Operate Mode with Mute Condition

The transmitter will remain in the operate mode but will be placed in mute when the following fault conditions exists in the transmitter.

- Upconverter is unlocked
- Upconverter module is not present
- IF Processor module is not present
- Modulator (if present) is in Aural/Visual Mute

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.
- Transmitter is Muted due to conditions listed above.
- 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.

Operating Frequency

The LX Series 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 it can be set to a custom frequency using software set-up menus. 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 have frequency dependency, 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.