8. OPERATIONAL DESCRIPTION - MODEL Axcera-LL100ATC

8.1 General Description

The LL100ATC is a complete 100-watt solid-state, DVB-H transmitter. It operates at a nominal output power of 100 watts (average).

8.2 Technical Specifications

Type of Emission 5M00W7D

Frequency Range..... 1670 MHz to 1675 MHz

Output Power Rating ..... 100 watts average

8.3 Performance Specifications

Operating Frequency Range ..... 1670 MHz to 1675 MHz

RF output - Nominal:
- Power ..... 100 watts average
- Impedance ..... 50 ohms
- Connector ..... 7/8" EIA

Standard ..... DVB-H
Modulation..... QPSK, 16 QAM, 64 QAM
IFFT Length 2K, 4K, 8K
Protection Interval ..... 1/4, 1/8, 1/16 & 1/32
Code Rate ..... 1/2, 2/3, 3/4, 5/6, & 7/8
Frequency Stability ..... 1×10^{-6}
- w/Precise Frequency Option..... 1×10^{-10}

Regulation of RF Output Power..... 3%
Shoulder Attenuation ..... -35 dB or better
Phase Noise ..... <-85 dBc/Hz @ 100 Hz
Inputs ..... Serial data inputs (ASI), Parallel Data Input (SPI), High Priority, LVDS

<u>Electrical Requirements</u>

Power Line Voltage ..... 230 volts, 50/60 Hz
Power Consumption ..... 1300 watts

<u>Environmental</u>

Maximum Altitude ..... 8,500 feet
Operational Temperature Range ..... -5°C to +50°C

Mechanical

Dimensions:

Width .....22 inches
Depth .....34 inches
Height.....55 inches
Weight.....390 lbs

8.4. System Overview

The LL100ATC (1304845) is made up of the trays listed in Table 8-1.

Table 8-1. LL100ATC Major Trays and Assemblies

MAJOR ASSEMBLY DESIGNATOR	TRAY/ASSEMBLY NAME	DRAWING NUMBER
A1	DVB-T Modulator	Model PT-5780
A2	Driver Assembly	1305021
A3	External Amplifier Assembly	1305863

8.4.1 DVB-T Modulator Tray/Driver Tray/External Amplifier Tray

The LL100ATC is a complete DVB-H transmitter capable of operating at an output power of 100 watts (average). Functionally, the LL100ATC is comprised of a modulator (Pro-Television, Model 5780) and driver/amplifier tray. The 36 MHz IF signal from the modulator is applied to the input of the driver/amplifier which provides spectral shaping of the IF signal in accordance with Occupied Bandwidth requirements of the Rules and Regulations. The modulator receives a serial bit stream, consisting of multiplexed MPEG-2 transport streams, translates the signal to a Quadrature Amplitude Modulated (QAM) format, converts the digital information to analog, and modulates the signal to IF (36 MHz). The modulator tray's IF output is routed to the driver/amplifier tray for IF signal processing, upconversion to the 1670-1675 MHz band, and final amplification. The driver/amplifier tray utilizes ALC circuitry for automatic level control of the output signal to maintain a constant power level. Both modulator and driver/amplifier trays are 19-inch rack mount assemblies and can be supplied with or without a cabinet. Both trays are supplied complete with cables and cabinet slides.

The output of the DVB-T Modulator Tray is connected to the Driver Tray (driver), which drives the input to the External Amplifier Tray.

8.4.1.1 Metering Module (Driver)

This assembly has circuitry that is used to measure the average power of up to four RF inputs. Each RF input is split on the Metering Board (1304922), with some of the signal being applied to an average power detector, and the rest of the signal sent to the front panel sample to allow the operator to monitor the RF signal with his own test equipment. The output of each detector is sent to the transmitter's system control via the Backplane that the assembly plugs into.

8.4.1.2 L.O. / Upconverter Module (Driver)

This assembly converts either one or two separate 36 MHz IF signals to either one or two RF outputs at a frequency of 1670-1675 MHz. It contains an Upconverter Control board (1304780), an LO Generator board (1304940) and either one or two Upconverter boards (1304929).

The description below is for one half of the upconverter. The IF and upconverter paths can be duplicated to provide two outputs when needed. The second IF path is always present, but not used in single output upconverters. A second Upconverter board is added for dual output transmitters.

An IF Signal centered at 36 MHz at a level of 0 dBm average is applied to the Upconverter Control board. A sample is applied to a peak detector, which checks for the presence of an IF input. If the input is not present, an alarm is generated and displayed on the module's front panel, and is also noted by the microcontroller on the Upconverter control board. The IF signal is then applied to a pin diode attenuator, which is used to hold the output level of the transmitter constant.

The signal then is applied to the Upconverter board, and converted to RF via a double balanced mixer. The resulting RF output signal is filtered, then amplified, and is sent back to the Upconverter Control board, which routes it to the back of the tray. There is also a second output -20dB from the main output that is sent to the front panel as a sample.

The local oscillator consists of a Crystal oscillator running at 1/15 of the final LO frequency of 1708.5 MHz. The oscillator drives a X5 multiplier, is filtered, and then is sent to a final X3 multiplier circuit. A sample of the output signal is applied to a PLL circuit, which locks the LO signal to a 10 MHz reference generated by the Upconverter Control Board. An alarm generated if the PLL unlocks is sent to a microcontroller on the Upconverter Control Board. There are two outputs that are sent to the two upconverter control boards, and a third output used as a front panel LO sample.

The LO generator board also contains all the front panel alarms and controls. In addition to the Input Fault indicator mentioned above, there is also an indicator that shows the status of the Overdrive detection circuit, and another indicator that shows the status of the AGC circuit.

The AGC circuit is located on the upconverter control board, and attempts to adjust the gain of the IF pin attenuator to hold a constant output power. The circuit also looks at the output power of the driver, and will limit how far the pin attenuator can adjust if the output power of the driver gets to high. When it does so, the Overdrive indicator switches from green to Red. The status of the AGC circuit is controlled by a front panel switch, which can bypass the AGC and operated the pin attenuator with a fixed bias instead of with the AGC circuit. The indicator is normally green when the AGC circuit is enabled, and switches to Amber if the AGC switch is in manual.

8.4.1.3 Control & Monitoring / Power Supply Module (Driver)

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.

8.4.1.4 Power Amplifier Module (Driver)

The driver assembly consists of an amplifier control board (1304774) and a two stage Driver board (1304865). The assembly amplifies the output from the upconverter assembly to a power level of 1-5W average power.

The amplifier has two stages of gain, both of them LDMOS transistors operating from a +28V supply. The amplifier control board monitors the assembly's output and reflected power, temperature, and the current drawn from the two devices.

A sample of the output signal is routed to the front panel for monitoring purposes. There are also two controls on the front panel used to calibrate the metering of the forward and reflected power of the driver assembly.

8.4.1.5 Power Amplifier Module (External Power Amplifier Assembly)

The 100W amplifier assembly consists of an amplifier control board (1304774) , a driver board, phase/gain board (1305026) and a Quad Stage board (1304607). The assembly amplifies the output from the upconverter assembly to a power level of 1-5W average power.

The amplifier has two stages of gain, both of them LDMOS transistors operating from a +28V supply. The output stage consists of four LDMOS devices operating in parallel, combined with quadrate hybrids. The amplifier control board monitors the assembly's output and reflected power, temperature, and the current drawn from the driver, and each pair of output devices.

A sample of the output signal is routed to the front panel for monitoring purposes. There are also two controls on the front panel used to calibrate the metering of the forward and reflected power of the driver assembly.

8.4.1.6 Power Supply Module (External Power Amplifier Assembly)

The Power Supply Module Assembly is made up of a +28V/2000W Switching Power Supply and a ±12V/40W Switching Power Supply.

The power supply module provides the +28 VDC and the +12 VDC and -12 VDC to the power amplifier module assembly.

8.5 Control and Status

8.5.1 Driver Tray

Table 8-2. Metering Front Panel Samples

SMA CONNECTOR	DESCRIPTION
A FWD PWR	Sample of A Output Power
A REFL PWR	Sample of A Reflected Power
B FWD PWR	Sample of B Forward Power
B REFL PWR	Sample of B Reflected Power

Table 8-3. LO/Upconverter Front Panel Control Adjustments

POTENTIOMETERS	DESCRIPTION
MAN GAIN ADJ	Adjusts the gain of the upconverter and transmitter when in the Manual AGC position.
MAN/AUTO SWITCH	Controls AGC function. Switched to left bypasses AGC

Table 8-4. LO/Upconverter Front Panel Status Indicator

LED	FUNCTION
Input Fault (Red or Green)	Red when no IF input
Overdrive (Red or Green)	Red when driver output power is being limited
AGC (Amber or green)	Amber when AGC bypassed

Table 8-5. LO/Upconverter Front Panel Samples

SMA CONNECTOR	DESCRIPTION
LO SAMPLE	Sample of the LO Frequency.
RF SAMPLE	Sample of the On Channel RF Output of the Upconverter

Table 8-16. Controller/Power Supply Control Adjustments

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

Table 8-6. 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 8-7. 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 8-8. Power Amplifier Control Adjustments

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

Table 8-9. 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.

Table 8-10. Power Amplifier Sample

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

8.5.2 External Power Amplifier Tray

Table 8-11. Power Amplifier Control Adjustments (External Power Amplifier Assembly)

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

Table 8-12. Power Amplifier Status Indicators (External Power Amplifier Assembly)

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.

Table 8-13. Power Amplifier Sample (External Power Amplifier Assembly)

SMA CONNECTOR	FUNCTION
FWD 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 (Driver)

Port	Type	Function	Ohm
J12	IEC	AC Input	N/A
J1	SMA	RF Output A (from Upconverter)	50
J2	SMA	RF Output B (from Upconverter) – N/A	50
J3	SMA	Forward A Sample	50
J4	SMA	Reflected A Sample	50
J5	SMA	Forward B Sample – N/A	50
J6	SMA	Reflected B Sample – N/A	50
J7	BNC	RF Input A (to Power Amplifier A)	50
J8	N	RF Output A (from Power Amplifier A)	50
J10	BNC	10 MHz Reference Input	50
J11	BNC	10 MHz Reference Output	50
J17	BNC	RF Input B (to Power Amplifier B) – N/A	50
J18	BNC	RF Output B (from Power Ampl B) – N/A	50
J21	BNC	IF Input A	75
J22	BNC	IF Input B – N/A	75
TB30	Term	Remote Control & Monitoring	
J35	RJ-45	SCADA (Input / Loop-Thru)	CAT5
J36	RJ-45	SCADA (Input / Loop-Thru)	CAT5
J37	RJ-45	System RS-485 Serial	CAT5

8.6.2 Remote Interface Connections (External Power Amplifier Assembly)

Port	Type	Function	Ohm
J220	Circular-3	AC Input #1	N/A
J221	Circular-3	AC Input #2	N/A
J201	N	Power Amplifier RF Input A	50
J203	7-16	Power Amplifier RF Output A	50
J205	7-16	System RF Output – N/A	50
J200	N	Power Amplifier RF Input B – N/A	50
J202	7-16	Power Amplifier RF Output B – N/A	50
J232	RJ-45	System RS-485 Serial Input	CAT5
J233	RJ-45	System RS-485 Serial Output	CAT5

8.7 AC Input

8.7.1 Driver Tray

The AC input to the Driver 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.

8.7.2 Power Amplifier Tray

The AC input to the Power Amplifier Tray is 230 VAC. The AC input is applied to the tray through Jacks J220 and J221. 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 +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.

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 input signal. If the input signal to the transmitter is lost, the transmitter will automatically cutback and the input fault indicator will light. When the 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 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

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 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.