ITS *information transmission systems*
CORPORATION

TECHNICAL MANUAL
EXHIBIT II

(PRELIMINARY)

ITS-5523

DIGITAL TRANSMITTER

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ITS-5523
DIGITAL TRANSMITTER

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A. This section contains information on troubleshooting, problem analysis and repair procedures for the ITS-5523.

SYSTEM DESCRIPTION

The ITS-5523 Digital Transmitter is designed to operate in conjunction with a QAM digital IF modulator. The Modulator used with this model is a Comstream CM720M. The ITS-5523 incorporates Automatic Level Control (ALC) and Automatic Gain Control (AGC), which serve to maintain a constant output power level.

Combining the latest in GaAsFET amplifier technology and space saving design, the ITS-5523 delivers an output power of 5 watts (average).

The unit's circuitry is enclosed in a tray assembly designed for mounting in a standard 19" equipment rack. The unit comes complete with slide rail mounting hardware to allow the tray to move in and out of the rack for ease of service. The outside dimensions of the tray assembly are 19" x 21" x 8.75" (W x D x H).

The ITS-5523 is factory calibrated for a front panel power meter reading of 100%, which represents the rated output power of the unit (unless otherwise specified).

THEORY OF OPERATION

The 64 QAM digital IF signal, derived from the digital IF modulator, is applied to the rear of the tray (J2). The input signal is fed to the IF Amplifier Board (1521-1101), which provides impedance matching and amplification of the IF input signal. The output of the Impedance Matching Board is fed to a SAW Filter Board (1600-1209), which attenuates any spurious signals outside the channel bandwidth. The output of the SAW Filter Board is connected to the IF Delay Board (1165-1018), which contains two sections of delay equalization to compensate for Group Delay created by external filters.

The IF Delay Board output is fed to the Response Corrector Board (1034-1205). On this board are three adjustable notch filters which correct for nonlinearities in the IF response. The output signal (J5) is connected to the input of the ALC/AGC Board (1022-1102).

The signal enters the board on J1, and after a 2 dB pad, a IF band-pass filter, and a second 2 dB pad, is adjusted in level by PIN Diode Attenuator/ALC circuitry. This circuitry takes a peak-detected sample of the IF signal and generates an ALC voltage, which biases the PIN Diode Attenuator. The ALC circuitry senses any change in the IF level and automatically adjust the loss of the PIN attenuator to compensate, thereby maintaining a constant IF output level regardless of minor changes in the input signal.

Next, the IF signal is fed to a loop through at J2 to a series of two boards. The first, the Linearity Corrector Board (1034-1201) pre-distorts the IF signal to compensate for compression in later stages of the system. The second board, the IF Phase Corrector Board (1227-1250) corrects for any phase error, which may be introduced by the amplifiers later in the system. The phase and linearity corrected signal reenters the ALC\AGC Board at J3 and after an IF filter identical to that used on the main input of the board (J1), is applied to a Wilkinson Splitter. The main output of the splitter is fed to an AGC pin diode attenuator circuit. The AGC pin diode attenuator, which functions in the same manner as the ALC pin attenuator diode attenuator uses a DC level generated externally by a peak-detected sample of the output to adjust the loss of the attenuator. The AGC circuitry maintains a constant level regardless of minor changes in the IF signal.

The AGC circuit can be bypassed by switch S2. When the AGC is disabled, the loss through the AGC PIN attenuator is adjusted by the Manual Gain potentiometer R101, which directly controls the output in a manual fashion. The AGC/AGC output (J4) is fed to the input of the Response Corrector Board (1034-1205), with form and function identical to the response corrector above. The Response Corrector Board output (J4) is connected to the IF input of the Upconverter Module (1519-1125).

THEORY OF OPERATION - Continued

A L.O. (local oscillator) signal is generated on the UHF Generator Board. This Board is comprised internally of a voltage controlled crystal oscillator circuit and a x8 multiplier consisting of three x2 broadband doublers (2^3 = x8) which produces the local oscillator signal (L.O.) signal.. The oscillator circuit is a modified Colpitts design and the crystal is mounted in an oven set at 60° C and operates at 1/24 of the local oscillator frequency. The output of the UHF Generator Board is applied to a x3 Multiplier and then to the input of a mixer which is located on the Upconverter Board. The voltage controlled crystal oscillator circuit within the UHF Generator Board is controlled by the VHF PLL Board, which locks the L.O. signal to a precise external 10 MHz reference, which is applied to the rear of the tray at jack J6. A sample of the L.O. signal is available at the front panel jack J3. A 50 kHz reference sample is available at jack J5.

The PLL circuit on the VHF PLL Board divides a sample of the channel VCXO frequency and compares it to the reference frequency (50 KHz) also generated by the VHF PLL Board. The difference between the phase of the reference frequency and the divided down VCXO frequency sample causes the PLL IC to create an error output voltage called Automatic Frequency Control (AFC) voltage, which is used to bias a variable capacitor in the channel VCXO.

The Upconverter Board generates a RF signal from the difference between the L.O. signal and the IF signal (LO - IF). The output of the Upconverter Board is sent through a Four Stage Cavity Filter w/Trap (2000-1240, which attenuates any undesired signals that may have been generated by the Upconverter Board during the mixing process.

The output from the Four Stage Cavity Filter (2000-1240) is sent to the Three Stage Amplifier Module (1516-1108), which consist of three cascaded GaAs FET amplifiers (FLL101ME driving a FLL351ME driving a FLL200IB-3) with an averall gain of 36 dB. The output of the Three Stage Amplifier (J2) is connected to the input of the 50W Amplifier (1512-1107).

The signal enters the input the 50-Watt Amplifier Module at J1 and amplified by GaAs FET Q101 (FLL2008-3). Then the signal is split four ways by three Wilkinson in phase couplers and amplified by GaAs FET amplifiers Q201, Q301, Q401, and Q501 (all FLL2008-3's). The signal is then combined by three Wilkinson in phase couplers and fed to the output of the module at jack J2. The output is fed to a Circulator Kit (A50), then to the RF output jack at the rear of the tray (J10).

Two 20 dB micro-strip couplers located within the 50-Watt amplifier Module provide a forward and reflected sample of the final output signal. Both samples are sent to the Dual peak Detector Board (1512-1147), which detects each sample and provides a forward and reflective metering voltage, which drives the transmitter's front panel.

The DC biasing of each FET is controlled and filtered by the corresponding daughter boards (D1, D2, D3, D4, and D5), Which are soldered directly to the motherboard. The DC bias drain to source currents are set by adjusting the negative gate to source voltages which are adjusted by potentiometers on the daughter boards.

THEORY OF OPERATION - Continued

The Six Section Bias Board (1519-1136) supplies the two amplifier modules with both +10 VDC (operating voltage) and -5 VDC (bias voltage).

The Transmitter Control Board (1555-1214) provides the capability to control and monitor the operating status of the transmitter. The board is designed to protect the transmitter in the event of the following faults: over temperature, loss or reduction in output power and loss of the -5 VDC GaAsFET bias voltage. The Transmitter Control Board also provides the capability to remotely control and monitor the booster status by providing external remote connections via the Connector Assembly Board (1519-1109) jacks J16 and J17 at the rear of the tray.

The transmitter may be configured to be powered by either a 115 VAC/60 Hz or 230V AC/50 Hz source. The AC source enters the tray at jack J1. The AC source passes through a line filter and is distributed to a terminal block (TB1). Varistors VR1, VR2, VR3 and VR4 provide transient and over voltage protection to the transmitter. The rear panel circuit breaker applies AC voltage to the input of the toroid transformer.

The toroid transformer provides (2) 15 VAC secondary windings. The first winding is sent to a full wave bridge rectifier which supplies a positive 18 VDC to several positive voltage regulators located on the DC Power Supply Board. The second winding is applied to the +12 VDC Power Supply Board (1512-1119) which powers the 12 VDC cooling fan. The second winding is also applied to a full wave bridge rectifier circuit on the DC Power Supply Board whose output is sent to several negative voltage regulators. Two +12 VDC switching supplies (SPL250-1012) rated at 21 amperes are used to supply the GaAs FET Amplifier Modules with power.

THEORY OF OPERATION - Continued

AC Voltage Source

The transmitter may be configured to be powered by either a 115 VAC/60Hz or 230 VAC/50Hz by the following procedures.

230 VAC to 115 VAC Operation

Locate the 10 position terminal block (TB1) within the transmitter. Referring to Interconnect drawing 1555-8102, remove the jumper between positions 2A and 3A. Remove the jumper between positions 4A and 5A. remove VR1 (250V), VR2 (275V), and VR4 (275V) from terminal block TB1. Connect a jumper between positions 3A and 4A. Connect another jumper between positions 5A and 6A. Move the jumper wire from the 230 VAC terminal of the + 12VDC switching power supplies (A9 and A19) to the 115VAC terminal. Install VR3 (150V) across positions 1A and 6A. Install VR4 (150V) across positions 1A and 3A.

115 VAC to 230 VAC Operation

Locate the 10 position terminal block (TB1) within the transmitter. Referring to Interconnect drawing 1555-8102, remove the jumper between position 3A and 4A. Remove the jumper between positions 5A and 6A. remove VR1 (130V), VR2 (150V), VR3 (150V), and VR4 (150V) from terminal block TB1. Connect a jumper between position 2A and 3A. connect another jumper between positions 4A and 5A. Move the jumper wire from the 115 VAC terminal of the +12 VDC switching power supplies (A9 and A19) to the 230 VAC terminal. Install VR1 (250V) across positions 8A and 10A. Install VR2 (275V) across positions 3A and 6A. Install VR3 (275) across positions 1A and 3A.

ITS-5523 DIGITAL TRANSMITTER TRAY (11555-1102)

SPECIFICATIONS

Technical Specifications

Type of Emissions.. 6M00D7W
Frequency Range ....2150 to 2162 and 2500 to 2686 MHz (any 6 MHz channel)
Output Power Rating .... 5 to 10 watts total average
DC voltage and total current of final amplifier stage .... 10 volts DC at 24 amps
(Class A - Not RF power dependent)

Performance Specifications

Operating Frequency Range..2150 to 2162 and 2500 to 2686 MHz
RF output - Nominal:
Power.. 5 to 10 watts average (adjustable)
Impedance ....50 ohms
Connector..Type N

Input: (Digital QAM) ....44 MHz

Out-of-Band Power..-38 dB max (at channel edge)
-60 dB max (0.5 MHz above channel edge and 1.0 MHz below channel edge)
Harmonic Products..-60 dB max

Electrical Requirements

Power Line Voltage ....117 VAC, ±10%, 60 Hz or
220 VAC ±10%, 50 Hz
Power Consumption..175 watts

Environmental

Maximum Altitude.. 12,000 feet (3,660m)

Ambient Temperature ....0° to 50°C

Mechanical

Dimensions: (WxDxH) .... 19" x 21" x 8.75" (48.3cm x 53.3cm x 22.24cm)

Weight:.. 30 lbs. (13.6 kgs)

FRONT PANEL METER, CONTROLS, AND LED INDICATORS

The ITS-5523 front panel provides operating controllability, metering capability and status indication. These features provide an effective means to determine the over-all operating status of the transmitter at a glance.

Controls

ON/OFF (Rear Panel)	Provides control of AC to the tray as well as circuit protection.
OPERATE (DS2)	Places transmitter into the Operate mode.
STANDBY (DS1)	Places transmitter into the Standby mode.

A front panel meter is provided to monitor two levels. A rotary switch, located next to the meter, is used to select the following metered parameters:

% FWD. PWR. (0-100%)	Indicates percentage of output power (top scale).
% REFL. PWR. (0-100%)	Indicates percentage of reflective power (top scale).

Status Indicators

Operating status indicators are provided for front panel viewing. From left to right they are:

PLL LOCKED (DS6)-GREEN	Illumination indicates that the UHF generator is locked.
PLL REFERENCE PRESENT (DS4)-GREEN	Illumination indicates that an internal or external reference is present.
THERMAL INTERLOCK (DS3)-GREEN	Illumination indicates that an over temperature fault is not present in the amplifier
OUTPUT FAULT (DS7)-RED	Illumination indicates that a fault condition exist.
OPERATE (DS2)	Illumination indicates the transmitter is enabled.
STANDBY (DS3)	Illumination indicates that the transmitter is disabled.

FRONT PANEL METER, CONTROLS, AND LED INDICATORS - Continued

One front panel label is provided for channel indication.

CHANNEL	Indicates the operating channel.

Two front panel sample ports provide for monitoring specific RF levels:

CHANNEL OSCILLATOR	Provides a sample from the channel oscillator. Nominal sample level is - 3 dBm.

PRINTED CIRCUIT BOARD LED INDICATORS AND DESCRIPTIONS

There are both red and green LED indicators located within the transmitter. The green LEDs, when lit, show that the function indicated is operating correctly. The red LEDs, when lit, show a malfunction of the function indicated.

PRINTED CIRCUIT BOARD/LED	DESCRIPTION
ALC/AGC BOARD:	
(DS2)-RED	Illumination indicates that there is no IF signal present.
(DS3)-RED	Illumination indicates that the ALC is out of range.
(DS5)-RED	Illumination indicates that the IF signal is muted.
(DS4)-RED	Illumination indicates that the AGC is out of range.
±12 VDC POWER SUPPLY BOARD:	
(DS1)-GREEN	Illumination indicates that U1 is supplying +12VDC to J3.
(DS2)-GREEN	Illumination indicates that U2 is supplying +12VDC to J5.
(DS3)-GREEN	Illumination indicates that U3 is supplying +12VDC to J4.
(DS4)-GREEN	Illumination indicates that U4 is supplying +12VDC to J6.
(DS5)-GREEN	Illuminatoion indicates that U5 is supplying +12VDC to J10.
(DS6)-GREEN	Illumination indicates that U6 is supplying -12VDC to J7.
(DS7)-GREEN	Illumination Indicates that U7 is supplying -5VDC to J8.
6 SECTION BIAS PROTECTION BOARD:	
(DS1)-GREEN	Illumination indicates that the Driver Amplifier and correction amplifier are functioning properly.
(DS2 DS6)-GREEN	Illumination indicates that the Output Amplifier is functioning properly.

SYSTEM ALIGNMENT PROCEDURE

Connect a suitable load to the output of the Upconverter/Amplifier tray. Turn the circuit breaker (CB1) located on the back of the tray to the on position. Place the Upconverter/Amplifier in standby by pressing the standby switch on the front panel. The amber front panel indicator will light indicating that the Upconverter/amplifier is in standby.

Connect the output of the CM720M Modulator tray (J5) to the IF Input of the Upconverter/Amplifier tray (J2).

Make the connections and switch settings on each of the boards indicated below as follows.

IF Delay Equilizer Board (A3)	Jumper from J1 to J2 (out of circuit)
Response Corrector Board (A5)	S1 and S2 to out
ALC/AGC Board (A6)	S1 and S2 to Manual
Linearity Corrector Board (A33)	S1 to disable
Phase Corrector Board (A34)	J9 and J10 to disable
Response corrector Board (A32)	S1 and S2 to out

Place the Upconverter/Amplifier into operate by pressing the operate switch on the front panel. The green front panel indicator will illuminate indicating that the Upconverter/Amplifier is in the operate mode.

IF Amplifier Board (A1) 1521-1101

The IF Amplifier Board consist of a transformer coupled input for impedance matching to 50 Ω or 75 Ω signals and a two stage amplifier providing about +24 dB of gain. Place W1 and W2 on pins 1 and 2 of J10 and J11 (50Ω). Place jumpers W7 and W8 on pins 1 and 2 of J 12 and J13 (attenuator out). The output of this board is approximately +6 dBm.

ALC/AGC Board (A6) 1022-1102

Disconnect J2. With SW1 and SW2 in the Manual position, adjust Manual ALC gain potentiometer R17 for about - 8 dBm at J2. Measure and record the voltage at TP3. Switch S1 to the ALC position. Reconnect J2 and adjust ALC Gain potentiometer for the recorded voltage at TP3.

Using an appropriate directional coupler, connect a power meter to the RF output of the tray (J10). Adjust Manual AGC potentiometer R101 for the rated output power (4 watts average) of the unit.

Dual Peak Detector Board (A22) 1522-1147

With the front panel selector switch in the Forward Power position, adjust Metering Adjust potentiometer R101 for 100% on the front panel meter.

SYSTEM ALIGNMENT PROCEDURE - Continued

ALC/AGC Board (A6) 1022-1102

Adjust Inner Loop potentiometer R63 for 0.8 volts at TP7. Place switch SW2 into the AGC position. Adjust AGC potentiometer R96 for 100% on the front panel meter.

Phase Corrector Board (A34) 1227-1250

The Phase Corrector Board corrects for phase non-linearities of the amplifier stages later in the system. This board has been factory aligned and should not be adjusted without the proper equipment.

Response Corrector Board (A32) 1034-1205

Switch S1 and S2 into the in position.

Connect a sweep signal to the input of the Upconverter/Amplifier tray (J2). Monitor the output of the Upconverter/Amplifier with a spectrum analyzer. Adjust C6, C7, and C8 for the frequency of the correction notch being applied to response of the transmitter. R13, R15, and R17 are used to adjust the depth and width of the correction notch. Adjust C6 and R13, C7 with R15, and C8 with R17 as needed to flatten the response.

IF Delay Equalizer Board (A3) 1165-1018

The IF Delay Equalizer Board contains two sections of delay equalization that compensates for the group delay created by external band pass filters (waveguide) and should not be adjusted without the proper test set-up and equipment.

The IF enters the board at J1 and is applied to first section of the IF Delay Equalizer Board. The delay equalizer is adjusted by removing W1 on J5 and tuning L1 for a notch at center frequency. Replace W1 and adjust C8 for the best response. The output of the first section at J2 connects to the input of the second section at J3. The second section of the group delay equalizer circuit is adjusted by removing W2 on J6 and tuning L2 for a notch at center frequency. Replace W2 and adjust C10 for the best response.

VHF Generator Control Board (A14) 1519-1112

1. Disconnect the PLL reference frequency by removing the plug at J5 and/or J6.

2. Connect a digital voltmeter between TP4 (+) and ground (-). Adjust the manual bias potentiometer (R87) for a reading of -3 VDC at TP4.

3. Connect a frequency counter to J11 to measure the VHF frequency (if frequency adjustments are necessary, follow the above procedure for the UHF Generator board).

4. Set PLL programming per required channel frequency (See programming chart on following page).

5. Connect an oscilloscope between pin 28 of U2 or TP9 (+) and ground (-).

6. Reconnect the plugs at J5 and/or J6 and minimize the spike amplitude that will be observed on the oscilloscope using the phase detector balance potentiometer R70.

SYSTEM ALIGNMENT PROCEDURE – Continued

UHF Generator Board (A15-A1) 1512-1101

1. Connect the main output from the channel oscillator section of the UHF Generator Board (J1) to a spectrum analyzer, tuned to the crystal frequency and peak the tuning capacitors C6 and C11 for maximum output. Tune L3 and L2 for maximum output. The output level should be +5 dBm ±2 dB.

While monitoring with a DVM, maximize each of the following test point voltages by tuning the broadband multipliers in sequence.

2. Monitor TP1: Tune C32 for maximum (Typical 0.6 VDC).
   Monitor TP2: Tune C34 and C38 for maximum (Typical 1.2 VDC).
   Monitor TP3: Tune C40 and C44 for maximum (Typical 2.0 VDC).
   Monitor TP4: Tune C46 for maximum.
   Monitor TP4: Re-peak C38, C40, C44 and C46 (Typical 3.5 VDC).

3. Connect a spectrum analyzer, tuned to 8 times the crystal frequency, to the UHF Generator output (J3). Monitor the output while peaking the tuning capacitors for maximum output.

4. The output level at J2 should be +15 dBm ±2 dB.

x3 Multiplier (A16) 1003-1004

1. While monitoring the x3 output (24 times the crystal frequency) with a spectrum analyzer, peak the four tuning capacitor for maximum output. Typical output is about +3 dBm ±2 dB.

The output of the x3 Multiplier is fed to the input of the Upconverter Board.

MMDS PROGRAMMING CHART FOR VHF GENERATOR CONTROL BOARD (1555-1214)

CHANNEL NUMBER	VISUAL CARRIER (MHz)	L.0. = (F_V+45.75 MHz)	OSCILLATOR FREQUENCY = (L.O./24 MHz)	(S1)	(1 = HIGH) (0 = LOW) (S2)	(S3)	(S4)
A1	2501.25	2547.00	106.125	1101	1000	1100	1111
A2	2513.25	2559.00	106.625	1111	1000	1100	1101
A3	2525.25	2571.00	107.125	1100	0100	1100	1110
A4	2537.25	2583.00	107.625	1110	0100	1100	1100
B1	2507.25	2553.00	106.375	1011	1000	1100	1011
B2	2519.25	2565.00	106.875	1000	0100	1100	1001
B3	2531.25	2577.00	107.375	1010	0100	1100	1010
B4	2543.25	2589.00	107.875	1001	0100	1100	1000
C1	2549.25	2595.00	108.125	0101	0100	1100	1111
C2	2561.25	2607.00	108.625	0111	0100	1100	1101
C3	2573.25	2619.00	109.125	0100	1100	1100	1110
C4	2585.25	2631.00	109.625	0110	1100	1100	1100
D1	2555.25	2601.00	108.375	0011	0100	1100	1011
D2	2567.25	2613.00	108.875	0000	1100	1100	1001
D3	2579.25	2625.00	109.375	0010	1100	1100	1010
D4	2591.25	2637.00	109.875	0001	1100	1100	1000
E1	2597.25	2643.00	110.125	1001	1100	1100	1111
E2	2609.25	2655.00	110.625	1011	1100	1100	1101
E3	2621.25	2667.00	111.125	1000	0010	1100	1110
E4	2633.25	2679.00	111.625	1010	0010	1100	1100
F1	2603.25	2649.00	110.375	1101	1100	1100	1011
F2	2615.25	2661.00	110.875	1111	1100	1100	1001
F3	2627.25	2673.00	111.375	1100	0010	1100	1010
F4	2639.25	2685.00	111.875	1110	0010	1100	1000
G1	2645.25	2691.00	112.125	0001	0010	1100	1111
G2	2657.25	2703.00	112.625	0011	0010	1100	1101
G3	2669.25	2715.00	113.125	0000	1010	1100	1110
G4	2681.25	2727.00	113.625	0010	1010	1100	1100
H1	2651.25	2697.00	112.375	0101	0010	1100	1011
H2	2663.25	2709.00	112.875	0111	0010	1100	1001
H3	2675.25	2721.00	113.375	0100	1010	1100	1010

NOTE: ON SWITCHES S1, S2, S3 AND S4. THE HIGH (1) AND LOW (0) SETTINGS ARE READ AS MARKED ON THE CIRCUIT BOARD.

MDS PROGRAMMING CHART FOR VHF GENERATOR CONTROL BOARD (1555-1214)

CHANNEL NUMBER	VISUAL CARRIER (MHz)	L.0. = (F_V+44.75 MHz)	OSCILLATOR FREQUENCY = (L.O./24 MHz)	(S1)	(1 = HIGH) (0 = LOW) (S2)	(S3)	(S4)
MDS1	2151.25	2196.00	87.875	1100	1001	0100	1000
MDS2	2157.25	2203.00	88.125	0010	1001	0100	1111

SYSTEM ALIGNMENT PROCEDURE – Continued

Upconverter Board (A4) 1519-1125

This board does not contain any RF tuning adjustments. The Upconverter Module produces an RF output at J2 by mixing two input signals (L.O. and I.F.) which are applied to J1 and J4 respectively.

The L.O. signal (+3 dBm) enters the module at J1 and is split into (2) separate and equal signals by a Wilkinson splitter. One output from the splitter is amplified to provide a buffered output sample (0 dBm) at J3. The second output from the splitter is also amplified and applied to the input of a mixer.

The IF signal enters the module at J4 and is applied to the input of a mixer. The output of the mixer produces a difference signal (L.O - IF) which is then amplified and sent to the to the RF output jack J2 (+4 dBm). The RF output from the board is sent a four section cavity filter.

Biasing for the amplifier stages is accomplished by the setting of potentiometers.
The board receives DC power (-5 VDC and +12 VDC) from an external source. +5VDC is produced on the board by applying +12 VDC to the input of + 5VDC regulator.

Four Section w/Trap Cavity Filter (A15) 2000-1240

This filter has been factory swept for a 6 MHz bandwidth and should not be tuned without proper equipment. The filter has a typical loss of approximately 3 dB. The output of the filter is sent to a three stage amplifier module.

Three Stage Amplifier Module (A10-A1) 1516-1108

This amplifier does not contain any RF tuning adjustments. The module contains three cascaded broadband GaAsFET amplifier stages (FLL101ME driving a FLL351ME driving a FLL2001-3) providing a nominal gain of 36 dB. The operating current for each device (Q101, Q201, Q301) is controlled by a pot mounted on a bias board within the module and can be set by measuring the voltage drop across the across the .05 ohm resister (R1) on the Seven Section Bias Protection Board (A20) for Q301, and the voltage drops across R14, and R15 (0.22Ω) on the Drain Daughter Board (1516-1114) for Q101 and Q201 respectfully.

1. With no RF signal applied and with the transmitter off, unsolder the drain leads located near the ferrite beads of Q201 and Q301 on the drain Daughter Board (1516-1120). Connect a digital voltmeter across R14 on the drain Daughter Board. Apply AC power to the transmitter and place the transmitter into the Operate mode.

2. Adjust the bias control (R103) for a reading of .04V across R14 on the drain Daughter Board (1516-1120). This voltage represents a bias current of .18 amps on Q101.

3. Place the transmitter into the standby mode and then turn the transmitter off. Unsolder the drain lead of Q101 and resolder the drain lead of Q201. Apply AC power to the transmitter and place the transmitter into the Operate mode. Adjust the bias control (R203) for a reading of .16V across R15 on the drain Daughter Board. This voltage represents a bias current of .720 amps on Q201.

4. Place the transmitter into the standby mode and then turn the transmitter off. Resolder the drain leads of Q101 and Q301. Apply AC power to the transmitter and place the transmitter into the Operate mode. Adjust the bias control potentiometer R303 for a reading of .24V across R1 on the Seven Section Bias Protection Board. This represents a bias current of 4.8 amps on Q301.

The output of this amplifier is fed to the 50 Watt Amplifier Module (A10-A1).

SYSTEM ALIGNMENT PROCEDURE – Continued

50 Watt Amplifier Module (A10-A3) 1512-1107

This Amplifier module does not contain any RF tuning adjustments. The module contains two cascaded broadband GaAs FET amplifier stages (FLL200-3 driving four parallel FLL200-3 's) providing a nominal gain of 18 dB. The operating current for each device (Q101, Q201, Q301, Q401,and Q501) is controlled by a pot mounted on a bias board within the module, next to each corresponding FET, and can be set by measuring the voltage drop across the .05 Ω resistors (R3, R4, R5, R6, and R43) on the bias protection board. See chart below.

GaAs FET Transistor	Potentiometer Adjustment	Bias Protection Board Resistor	Voltage Across Bias Protection Resistor	Drain Current Calculated
Q101	R902	R3	.24	4.8
Q201	R802	R4	.24	4.8
Q301	R902	R5	.24	4.8
Q401	R802	R6	.24	4.8
Q501	R902	R43	.24	4.8

The output of this amplifier is sent through a circulator (A50), then to the RF input jack (J10) at the rear of the tray.

The voltages needed to operate the amplifier modules are provided by the +12V/21 amp switching supplies (A9 and A10) and the ±12VDC Power Supply Board (A28) which produces the -5VDC bias voltage.

The -5VDC supply is non-adjustable with a regulated output. To prevent damage to the GaAs FET amplifiers, the +12VDC Supplies will not turn on until the -5VDC bias supply is operating.

The +12VDC/21 amp switching, regulated power supplies do not require any adjustment.

Six Section Bias Protection Board (A20) 1555-1213

This board does not contain any RF tuning adjustments. Indicator DS1 will illuminate if the amplifier circuits are operating correctly with normal biasing and operating voltages.

REAR PANEL CONNECTIONS

The rear panel of the ITS-5523 provides quick and easy access to all of the external connections necessary to interface the transmitter to the outside world.

	CONNECTOR NUMBER	CONNECTOR TYPE	
AC	J1 .	IEC .	Provides AC input to the transmitter
IF INPUT . . .	J2 .	BNC .	Provides an external IF input from the MMDS Receiver tray (50 Ω impedance)
L.O. OUTPUT . . .	J6 .	BNC .	Provides an L.O. output to a Modulator.
EXT. 10 MHz REF. INPUT .	J7 .	BNC .	Provides an external input to precisely phase lock the L.O. to an external reference (50 Ω impedance)
CONTROL . . .	J12 .	37 Pos. Female "D"	Provides access to remote control functions of the booster.
REMOTE . . .	J16 and J17.	RJ45	Provides access to remote status and metering functions of the booster.
RF OUTPUT . . .	J8 .	"N" .	Provides the RF output from the tray. (50 Ω impedance)

REMOTE CONTROL INTERFACE

All remote/control functions are accessed through a 37 position "D" connector (J12) and two RJ45 connectors (J16 and J17) located on the rear panel of the Upconverter/Amplifier.

	CONNECTION
Control:	
REMOTE OPERATE	J16
REMOTE STANDBY	J16
EXTERNAL OPERATE COMMAND	J12
Metering:	
FWD POWER	J16
REFL POWER	J16
ALC INPUT	J12
Status:	
REMOTE OPERATE	J16
TRANSMITTER INTERLOCK	J12
TRANSMITTER FAULT	J16
OVERTEMP	J16

ITS-5523
DIGITAL TRANSMITTER

DRAWING LIST
UPCONVERTER/AMPLIFIER TRAY

The UPCONVERTER/AMPLIFIER TRAY consist of the following boards/modules:

x3 Multiplier Assembly 1003-1004

UHF Generator Board 1512-1101
Schematic 1512-3101

50 Watt Output Amplifier Module 1512-1107
Schematic 1512-3107

+12 VDC Power Supply Board 1512-1119
Schematic 1512-3119

Dual Peak Detector Board 1512-1147
Schematic 1512-3147

Three Stage 10W Amplifier Module 1516-1108
Schematic 1516-3108

±12VDC Power Supply Board 1516-1145
Schematic 1516-3145

Six Section Bias Protection Board 1519-1136
Schematic 1519-3136

VHF Generator Control Board 1555-1112
Schematic 1555-3112

Transmitter Control Board 1555-1102
Schematic 1555-3102

ALC/AGC Board 1022-1102
Schematic 1022-3102

IF Input Equalizer Board 1555-1219
Schematic 1555-3219

Linearity Equalizer Board 1034-1201
Schematic 1034-3201

Visual Response Corrector Board 1034-1205
Schematic 1034-3205

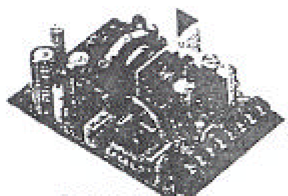
IF Delay Equalizer Board (45.75 MHz) 1165-1018
Schematic 1165-3018

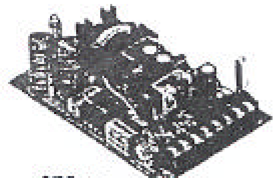
ITS-5523
DIGITAL TRANSMITTER

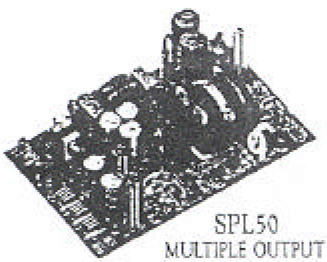
DRAWING LIST
UPCONVERTER/AMPLIFIER TRAY

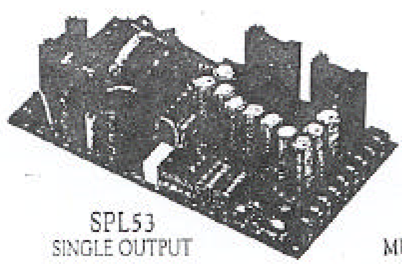
SPL SERIES
PROVEN TECHNOLOGY SWITCHERS

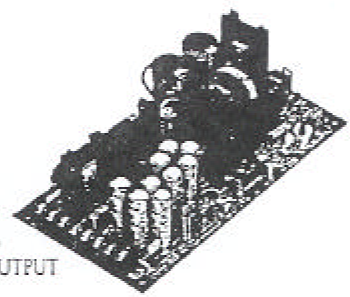
- Over 1,000,000 SPL Series Units Shipped
- Cost Effective Proven Technology
- Worldwide AC Input: 90-132/180-264 VAC
- 2 Year Warranty
- Designed For Convection Cooled Applications. For Applications With Moving Air Please Refer To The SWA Section Starting On Page 49.

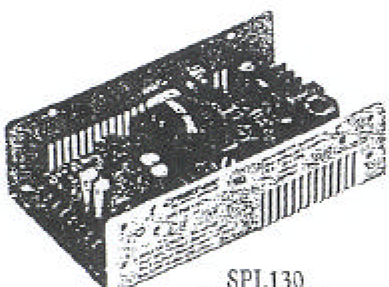

SPL40
SINGLE OUTPUT

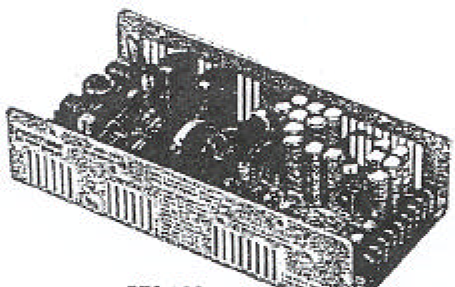

SPL40
MULTIPLE OUTPUT

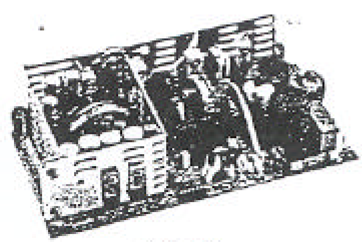

SPL50
MULTIPLE OUTPUT

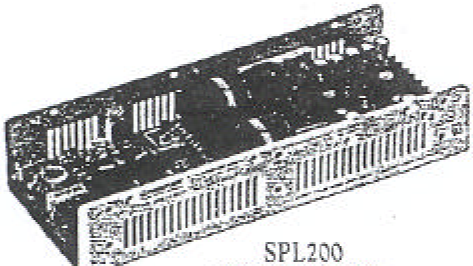

SPL53
SINGLE OUTPUT

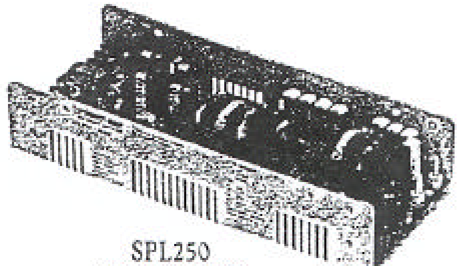

SPL53
MULTIPLE OUTPUT


SPL130
SINGLE OUTPUT


SPL130
MULTIPLE OUTPUT


SPL175
MULTIPLE OUTPUT


SPL200
MULTIPLE OUTPUT


SPL250
SINGLE OUTPUT

GENERAL SPECIFICATIONS

AC Input:
Standard dual range: 90-132 VAC or 180-264 VAC, user selectable. 47-63 Hz, single phase. Consult factory for 400 Hz operation.

DC Outputs:
See Voltage/Current Rating Charts. pages 43-46.

Output Power:
See Voltage/Current Rating Charts. pages 43-46.

Brown-Out Protection:
Regulation is maintained down to 90/180 VAC, at full load, with no compromise in performance.

Hold-Up Time:
20 msec minimum at full rated load and nominal AC input voltage. Hold-up time increases to 40 msec at 50% load.

Power-Fail Warning Signal:
Single Output Models: Provided on SPL250 models only. TTL compatible signal goes low 10 msec minimum before the output voltage drops 5%, at a 100% load condition.

Multiple Output Models: Provided on models with a "P" suffix. Signal goes low 5 msec minimum before +5V main output drops 5%, at a 100% load condition.

Warning time increases at reduced load levels.

Efficiency:
Measured at full rated output power and nominal AC input voltage. 70% ±5% depending on how the load is distributed among the outputs.

Regulation Characteristics:
See Voltage/Current Rating Charts for individual model ratings.
Measurement method (unless otherwise noted):
Line: Measured over a 90-132 VAC or 180-264 VAC line change.
Load: Measured by varying the load current from 60% to either 20% or 100% of full rated.

Cross Regulation:
Multiple Output Models: Where indicated, cross regulation specifies the maximum voltage change on an auxiliary output when the +5V main output load current is varied from 75% of full rated to either 50% or 100% of full rated. NOTE: The effect of load and cross regulation are generally not cumulative, and may actually act to cancel each other in an operating system environment.

Minimum Load:
Single Output Models: 5% of full rated output current.
Multiple Output Models: Minimum load required on the +5V main output for full load capability on auxiliary outputs:

SPL40, SPL50:	1A	SPL175:	3A
SPL53:	2A	SPL200:	6A
SPL130:	5A	SPL400:	10A

Remote Sensing:
Single Output Models: Provided on SPL53, SPL130, and SPL250 series models.
Multiple Output Models: Provided on the +5V main output of SPL130, SPL200, and SPL400 series models.

Output Noise and Ripple:
0.3% RMS, 1% PK-PK maximum.

Output Overshoot:
No overshoot on turn-on or turn-off.

Transient Response:
Recovery Time: 500 μsec typical for a 50-100% load change and recovery to within 1% of initial voltage set point.
Maximum Excursion: 3% from initial voltage set point.
Multiple Output Models: Above applies to +5V main output only.

Output Overload Protection:
Fully protected against output overload and short circuit.
Automatic recovery upon removal of overload condition.

Overvoltage Protection:
Set at 6.2V ±0.6V.
Single Output Models: Provided on all 5V models.
Multiple Output Models: Provided on +5V main output.

Reverse Voltage Protection:
Inherently protected from damage due to application of reverse polarity voltage across DC output terminals.

Input Protection:
AC input line fuse provided. Internally located.

Inrush Current:
Internally limited by thermistor. Cold start, peak current at 230 VAC input. SPL40 through SPL53: 9A maximum.
SPL130 through SPL250: 17A maximum.
SPL400: 65A maximum.

Temperature Rating:
Operating: 0°C to +50°C at full rated output power. Consult factory for operating information between +50°C to +70°C.
Storage: −55°C to +85°C.

Temperature Coefficient:
±0.03%/°C typical, ±0.05%/°C maximum over entire operating temperature range of 0°C to +70°C.

Cooling:
Convection cooling is adequate where non-restricted air flow is available. When operating in a confined area, forced air cooling is recommended.

Vibration:
Per MIL-STD-810D, Method 514.3, Category 1, Procedure I.

Shock:
Per MIL-STD-810D, Method 516.3, Procedure III.

OPTIONS

Overvoltage Protection:
Available on all single output models.

Input/Output Connectors:
Quick-disconnect terminals are available for all models except SPL50 and SPL175. Amp or Molex wafer style connectors (.312 centers) are available for SPL40 and SPL53 series models.

Safety Covers:
Available for SPL130, SPL200, SPL250 and SPL400 series models.

USER-SPECIFIED OUTPUTS

Output voltage and current ratings can be factory modified to meet user specified requirements. Upon request, any 12V output can be factory modified to 15V. Also, all models offering ±12V complimentary outputs can be modified to ±15V.
NOTE: Existing Safety Agency Certifications can be extended to modified standard models within certain limitations.

SPL SERIES
GENERAL SPECIFICATIONS AND SINGLE OUTPUT MODELS

SAFETY SPECIFICATIONS

A[illegible]dels exceed the following safety standards:

L[illegible]ge Current:
Line to Ground (max.): 0.75 mA
Safety Spacings:
8.0 mm minimum between primary and secondary circuitry.
4.0 mm minimum between primary and grounded circuitry.
Dielectric Withstand Voltage (min.):
Input to Ground ________ 3750 VRMS
Input to Outputs ________ 3750 VRMS
Outputs to Ground ________ 700 VDC

UL RECOGNIZED: UL File Number E55974
CSA CERTIFIED: CSA File Number LR38879
TÜV LICENSE NUMBERS Tested and certified by TÜV to VDE 0806 and IEC 380.

SPL40: R30059	SPL130: R30062	SPL250: R50174
SPL50: R50006	SPL175: R50177	SPL400: R50177
SPL53: R30060	SPL200: R30063	

EMI SPECIFICATIONS

All International Series models are equipped with internal line filtering which allows compliance to the conducted emission limits of FCC Docket 20780 Part 15 Class A, and VDE 0871/6.78 Class A.

AGENCY LIMITS – CLASS A

FREQUENCY RANGE	VDE 0871 LEVEL A	FCC 20780 PART 15	SPL SERIES DESIGN STANDARDS
150KHz-450KHz	66dBμV	NOT SPECIFIED BY FCC	<63dBμV
450KHz-30MHz	60dBμV	CONSULT FACTORY	<57dBμV

Models may be brought into compliance with Class B limits by the addition of an optional single stage line filter. Please consult Power-One for more information.

Mechanical Dimensions On Pages 47 and 48.

VOLTAGE	CONVECTION COOLED POWER (WATTS) CONTINUOUS	PEAK	MODEL	CURRENT	LINE REGULATION	LOAD REGULATION	CONFIGURATION
	40	N/A	SPL40-1005	8A	±0.3%	±1%	BOARD ONLY 5.75" x 3.93" x 1.68 (146.05mm) x (99.822mm) x (42.672mm)
	80	N/A	SPL53-1005	16A	±0.3%	±1%	BOARD ONLY 8.25" x 4.25" x 2.10" (209.55mm) x (107.95mm) x (53.34mm)
	140	N/A	SPL130-1005	26A	±0.3%	±1%	U-CHANNEL CHASSIS 8.90" x 5.00" x 2.45" (226.06mm) x (127mm) x (62.23mm)
	250	N/A	SPL250-1005	50A	±0.3%	±1%	U-CHANNEL CHASSIS 12.00" x 4.94" x 2.45" (304.8mm) x (125.476mm) x (62.23mm)
12-15V* ADJUSTABLE	40	N/A	SPL40-1012	3.3A/2.7A	±0.3%	±1%	BOARD ONLY 5.75" x 3.93" x 1.68 (146.05mm) x (99.822mm) x (42.672mm)
	80	N/A	SPL53-1012	6.7A/5.3A	±0.3%	±1%	BOARD ONLY 8.25" x 4.25" x 2.10" (209.55mm) x (107.95mm) x (53.34mm)
	130	N/A	SPL130-1012	11A/9A	±0.3%	±1%	U-CHANNEL CHASSIS 8.90" x 5.00" x 2.45" (226.06mm) x (127mm) x (62.23mm)
	250	N/A	SPL250-1012	21A/17A	±0.3%	±1%	U-CHANNEL CHASSIS 12.00" x 4.94" x 2.45" (304.8mm) x (125.476mm) x (62.23mm)
24-28V* ADJUSTABLE	40	N/A	SPL40-1024	1.6A/1.4A	±0.3%	±1%	BOARD ONLY 5.75" x 3.93" x 1.68 (146.05mm) x (99.822mm) x (42.672mm)
	80	N/A	SPL53-1024	3.3A/2.8A	±0.3%	±1%	BOARD ONLY 8.25" x 4.25" x 2.10" (209.55mm) x (107.95mm) x (53.34mm)
	140	N/A	SPL130-1024	5.5A/4.5A	±0.3%	±1%	U-CHANNEL CHASSIS 8.90" x 5.00" x 2.45" (226.06mm) x (127mm) x (62.23mm)
	250	N/A	SPL250-1024	10A/7A	±0.3%	±1%	U-CHANNEL CHASSIS 12.00" x 4.94" x 2.45" (304.8mm) x (125.476mm) x (62.23mm)

*Models With Adjustable Voltages Have Current Ratings Expressed A[illegible]ent At Lowest Voltage/Current At Highest Voltage.

MAINTENANCE AND TROUBLESHOOTING

Problem Analysis

In most cases, the performance of a GaAsFET transistor is closely tied to the DC operation of the system. Any degradation in signal quality, gain or power is usually related to a corresponding change in a DC parameter somewhere in the system. An exception may be a defective RF input or output connection, which can result in poor performance of the amplifier with all DC parameters appearing normal.

The first step of analysis is therefore to carefully measure all DC parameters and compare these to the numbers indicated on the schematics, block diagrams, and factory test data sheet. Each GaAsFET operates with – .5V of bias on the gate and about +10.2V maximum volts on the drain. The static current of a GaAsFET is determined by measuring across associated .05 ohm resistor, located on the bias protection board and using Ohm's Law.

If all DC parameters are normal, an RF intermittency should be suspected. Follow the RF path from input to output and apply a small physical force on all connectors while observing the output power. If an intermittency is detected, a simple re-soldering can be attempted.

While following these procedures, it is important to maintain terminations on all amplifier circuits to avoid VSWR damage. Before a fan fails, it normally begins to exhibit noisy operation. Always check for free fan blade movement and procure a replacement fan if fan-bearing noise is evident.

Repair Procedures

Repair of this transmitter normally involves module level replacement. ITS Corporation maintains an adequate stock of replacement modules. If you have determined that a particular subassembly is defective and that it cannot be easily repaired at your facility, please contact the ITS Customer Services Department. An effort will be made to provide a module on an exchange basis. It is often possible to ship replacement modules counter-to-counter or one-day UPS/Federal Express to expedite delivery.

On some occasions it is necessary to perform component level repairs. In many cases failures can be a result of poor connections somewhere in the system. Poor connections can generally be repaired with a suitable, small, grounded soldering iron. A spare parts kit of standard components is available for this booster. Please contact the ITS Marketing Department for the price and availability of the spare parts kit. Individual components can also be ordered from the Customer Services or Marketing departments of ITS. The fuses are standard and generally available at local parts distributors. The parts list provides complete manufacturer's information and part number for all standard electrical components. These components can often be obtained from local distributors. An effort has been made to select standard (off-the-shelf) components whenever possible in the product design. Replacement of the GaAsFET transistors in the field is not recommended unless performed by an experienced technician. It is important to realize that each GaAs FET operates at a specific bias voltage that must be preset before the main power supply is switched on. Failure to provide the proper bias voltage will result in rapid GaAsFET destruction. Please refer to the ITS Warranty and Material Return Authorization procedures for additional information concerning repair parts.

Periodic Procedures

This transmitter is designed with components that require no periodic maintenance except for cleaning and record keeping.

The amount of cleaning necessary depends greatly on the conditions in the translator room. While the electronics have been designed to function well even if covered with dust, heavy buildups of dirt and insects will impede the effectiveness of the cooling and lead to shutdown or premature failure.

When it is apparent that the front panel is becoming dust covered, the top cover should be opened and the accumulated foreign material removed. A small, soft brush used in conjunction with a plastic wand-like attachment on a small vacuum cleaner is an excellent way to remove dirt. Alcohol and other cleaning agents should not be used unless you are certain that the solvents will not damage components or markings. Water based cleaners can be used if only a small amount of moisture is used. The fans or heat sinks should be carefully cleaned.

Occasionally check that all RF connections are secure, but be careful not to over-tighten.

Data should be recorded for all meter readings on a regular basis. It is suggested that data be recorded once each month and that it be retained in a rugged folder or envelope for the life of the equipment. A sample format of a log sheet is included at the end of this section. Photocopies of this sheet may be used for if desired.