EXHIBIT 2b

INSTRUCTION MANUAL 651176500 A

CAMS-60b

Channelized Agile Modulator

Stock No. 5995B

MADE IN USA

BLONDER TONGUE LABORATORIES, INC.
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The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert you to the presence of uninsulated "dangerous voltage" within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

CAUTION

RISK OF ELECTRIC SHOCK
DO NOT OPEN

The exclamation point within an equilateral triangle is intended to alert you to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product.

TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER FROM THIS UNIT. NO USER-SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

WARNING: TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS UNIT TO RAIN OR MOISTURE

NOTE TO CATV SYSTEM INSTALLER

This reminder is provided to call the CATV System Installers attention to Article 820-40 of the NEC that provides guidelines for proper grounding and, in particular, specifies that the cable ground shall be connected to the grounding system of the building, as close to the point of cable entry as practical.

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IMPORTANT SAFEGUARDS

1. **Read Instructions** - All the safety and operating instructions should be read before this product is operated.
2. **Retain Instructions** - The safety and operating instructions should be retained for future reference.
3. **Heed Warnings** - All warnings on the product and in the operating instructions should be adhered to.
4. **Follow Instructions** - All operating and use instructions should be followed.
5. **Cleaning** - Unplug this product from the wall outlet before cleaning. Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.
6. **Attachments** - Do not use attachments not recommended by Blonder Tongue as they may cause hazards.
7. **Water and Moisture** - Do not use this product near water - for example, near a bath tub, wash bowl, kitchen sink, or laundry tub, in a wet basement, or near a swimming pool, and the like. Refer to individual instruction manuals included with products designed for indoor use only. Do not expose these products to rain or moisture.
8. **Accessories** - Do not place this product on an unstable cart, stand, bracket, or table. The product may fall, causing serious injury to a child or adult, and serious damage to the product. Use only with a cart, stand, bracket, or table recommended by Blonder Tongue. Any mounting of the product should follow the instructions, and should use a mounting accessory recommended by Blonder Tongue.
9. 

   A product and cart combination should be moved with care. Quick stops, excessive force and uneven surfaces may cause the product and cart combination to overturn.
10. **Ventilation** - Slots and openings in the cabinet are provided for ventilation and to ensure reliable operation of the product and to protect it from overheating, and these openings must not be blocked or covered. The openings should never be blocked by placing the product on a bed, sofa, rug, or other similar surface. This product should never be placed near or over a radiator or heat register. This product should not be placed in a built-in installation such as a bookcase or rack unless proper ventilation is provided or the instructions are adhered to.
11. **Power Sources** - This product should be operated only from the type of power source indicated on the marking label. If you are not sure of the type of power supply to your home or business, consult your dealer or local power company. For products intended to operate from battery power, or other sources, refer to the operating instructions.
12. **Grounding or Polarization** - If this product is equipped with a 3-wire grounding-type plug, a plug having a third (grounding) pin, the plug will only fit into a grounding-type power outlet. This is a safety feature. If you are unable to insert the plug into the outlet, contact your electrician to replace your obsolete outlet. Do not defeat the safety purpose of the grounding-type plug.

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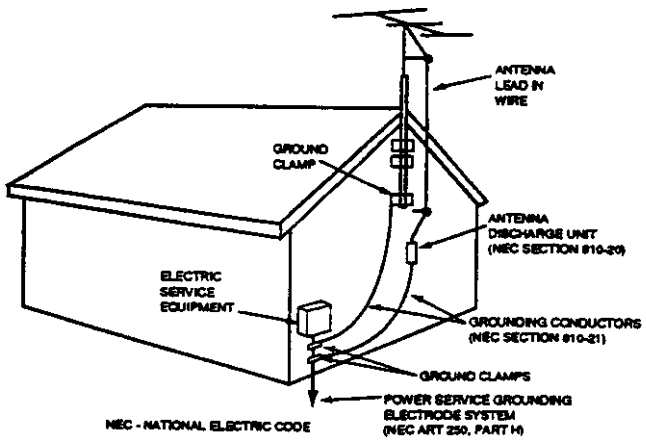
If this video product is equipped with a polarized alternating-current line plug (a plug having one blade wider than the other), the plug will fit into the power outlet only one way. This is a safety feature. If you are unable to insert the plug fully into the outlet, try reversing the plug. If the plug should still fail to fit, contact your electrician to replace your obsolete outlet. Do not defeat the safety purpose of the polarized plug.

13. **Power Cord Protection** - Power-supply cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, convenience receptacles, and the point where they exit from the unit.
14. **Lightning** - For added protection for this product during a lightning storm or when it is left unattended and unused for long periods of time, unplug it from the wall outlet and disconnect the antenna or cable system. This will prevent damage to the product due to lightning and power-line-surges.
15. **Power Lines** - An outside antenna system should not be located in the vicinity of overhead power lines or other electric light or power circuits, or where it can fall into such power lines or circuits. When installing an outside antenna system, extreme care should be taken to keep from touching such power lines or circuits as contact with them might be fatal.
16. **Overloading** - Do not overload wall outlets and extension cords as this can result in a risk of fire or electric shock.
17. **Object and Liquid Entry** - Never push objects of any kind into this product through openings as they may touch dangerous voltage points or short-out parts that could result in a fire or electric shock. Never spill liquid of any kind on the product.
18. **Servicing** - Do not attempt to service this product yourself as opening or removing covers may expose you to dangerous voltage or other hazards. Refer all servicing to qualified service personnel.
19. **Damage Requiring Service** - Unplug this product from the wall outlet and refer servicing to qualified service personnel under the following conditions:
    a. When the power-supply cord or plug is damaged.
    b. If liquid has been spilled, or objects have fallen into the product.
    c. If the product has been exposed to rain or water.
    d. If the product does not operate normally by following the operating instructions. Adjust only those controls that are covered by the operating instructions as an improper adjustment of other controls may result in damage and will often require extensive work by a qualified technician to restore the product to its normal operation.
    e. If the product has been dropped or the cabinet has been damaged.
    f. When the product exhibits a distinct change in performance-this indicates a need for service.
20. **Replacement Parts** - When replacement parts are required, be sure the service technician has used replacement parts specified by Blonder Tongue or have the same characteristics as the original part. Unauthorized substitutions may result in fire, electric shock or other hazards.
21. **Safety Check** - Upon completion of any service or repairs to this product ask the service technician to perform safety checks to determine that the product is in proper operating condition.
22. **Outdoor Antenna Grounding** - If an outside antenna or cable system is connected to the product, be sure the antenna or cable system is grounded so as to provide some protection against voltage surges and built-up static charges. Section 810 of the National Electrical Code, ANSI/NFPA No. 70, provides information with respect to proper grounding of the mast and supporting structure, grounding of the lead-in wire to an antenna discharge unit, size of grounding conductors, location of antenna-discharge unit, connection to grounding electrodes, and requirements for the grounding electrode.

See notes and diagram below.

EXAMPLE OF ANTENNA GROUNDING AS PER NATIONAL ELECTRICAL CODE INSTRUCTIONS



1. Drill a hole in wall (Careful! there are wires in that wall!) near set just large enough to permit entry of cable.
2. Punch cable through hole and form a rain drip loop close to where it enters house.
3. Put a small amount of caulking around cable where it enters house to keep out drafts.
4. Install static electricity discharge unit.
5. Connect antenna cable to set.

DESCRIPTION

The CAMS-60b is a professional quality, channelized agile, heterodyne audio/video modulator. The basic unit provides audio and video modulated RF carrier output on any single CATV, VHF or UHF channel in the frequency range of 50 to 750 MHz. Any standard audio/video source can be used, such as satellite receivers, television cameras, video tape recorders, or television demodulators. A low cost, removable, single channel output filter module is used to provide channelized configuration of the CAMS-60b. Customers can maintain an inventory of mainframes and a variety of output filter modules. Configuration of individual channels can be easily accomplished by combining the frequency agile mainframe with the appropriate output filter module.

The CAMS-60b accepts standard polarity (sync negative) video in the range of 0.7 to 2.0V p-p. A field selectable audio input allows for 600 ohm baseband or 4.5 MHz subcarrier modulated audio usage. The latter is available for stereo generators that deliver 4.5 MHz subcarrier output. Audio pre-emphasis is jumper selectable to properly accommodate either transmissions of stereo or monaural signals. True vestigial sideband selectivity and FCC group delay pre-distortion are maintained using a custom SAW filter. An external composite IF loop is provided which allows interfacing with Blonder Tongue's video all-call system. The heterodyne conversion process employs a crystal referenced PLL synthesized local oscillator with 12.5 KHz tuning increments. This guarantees very stable output frequency for the life of the modulator. The CAMS-60b meets FCC Docket 21006 aeronautical frequency offset requirements (±5 KHz video carrier accuracy). Surface mount technology is utilized to provide superior performance and extremely high reliability.

The CAMS-60b is housed in a single height, 1.75" high, rack mountable, aluminum chassis. The unit has a complete set of front panel accessible controls including: video modulation, audio modulation, visual to aural carrier ratio, and RF output level.

FEATURES

- Exceptional performance, CATV quality audio/video modulator
- PLL synthesized frequency control of 4.5 MHz aural carrier and RF Output
- Custom saw filter providing true VSB response with built-in FCC group delay pre-distortion
- Meets FCC Docket 21006 Aeronautical frequency offset requirements
- -60 dBc spurious response over the full output level range
- -120 dBc typical broadband noise for 110 channel system
- Fully compatible with BTSC encoded MTS stereo audio
- Jumper selectable audio pre-emphasis
- Accepts external 4.5 MHz input
- Field replaceable channelized output filter module
- -20 dB test point, front panel accessible
- Three year product warranty

OPTIONS

1. External IF In
2. Reference Lock
5. BTSC Stereo Encoder Module

SPECIFICATIONS *

RF

Frequency Range:	50 - 750 MHz, CATV, VHF and UHF channels
Output Level	
50 - 550 MHz:	+60 dBmV min.
550 - 750 MHz:	+58 dBmV min.
Output Level Adjust:	15 dB, continuously adjustable
Aural/Visual Carrier Ratio:	-9dB to -20dB, continuously adjustable
Visual Carrier Frequency Tolerance:	±10 KHz, Standard channels; ±5 KHz, FCC offset channels
Aural Carrier Frequency:	4.5 MHz above visual ±50 Hz
Channel VSB Selectivity:	
fv -1.25 MHz (channel edge):	25 dB typ., 15 dB min
fv -1.5 MHz (adj. aural carr.):	40 dB min
fv -2.42 MHz:	42 dB min
fv -3.58 MHz:	42 dB min
fv -6.0 MHz:	55 dB typ., 45 dB min
fv +6.0 MHz: (Adj. Visual Carr.):	55 dB typ., 45 dB min
Spurious Outputs:	-66 dBc typ., -60 dBc min
In Channel C/N Ratio:	68 dB in 4 MHz BW
Broadband Noise:	-120 dBc in 4 MHz BW
Output Impedance:	75 ohm
Output Return Loss:	18 dB

IF

Frequency:	45.75 MHz
Composite IF Loop:	Visual carrier, +35 dBmV; Aural carrier, +20 dBmV ±5 dBmV
Input/Output Return Loss:	16 dB

VIDEO

Input Level:	.7 V p-p for 87.5% modulation
Video Response:	±0.5 dB, 25 Hz to 4.2 MHz
P-P Video to RMS Hum Ratio:	65 dB
Video Signal-To-Noise Ratio:	64 dB, weighted
Differential Gain:	2%
Differential Phase:	1°
Group Delay Response:	Meets FCC group delay pre-distortion requirement for color transmission
Chrominance - Luminance Gain Inequality:	±5 IRE
Chrominance - Luminance Delay Inequality:	-170 ns
Tilt:	2%
Input Impedance:	75 ohm
Input Return Loss:	30 dB

AUDIO

Input Level:	-10 dBm to +10 dBm for 25 KHz peak deviation
Frequency Response	
30 Hz - 15 KHz:	±0.5 dB (w/pre-emphasis)
50 Hz - 50 KHz:	±0.1 dB (w/o pre-emphasis, external stereo input)
Pre-emphasis:	75 µs, jumper selectable
Audio Signal-To-Noise Ratio	
Mono, 25 KHz Dev.:	65 dB
Stereo, 50 KHz Dev.:	60 dB (external stereo input)
Total Harmonic Distortion	
30 Hz - 15 KHz @25 KHz Deviation:	1%
Input Impedance:	600 ohm, balanced
Overmodulation Indicator:	Mono, 25 KHz ±2 KHz Stereo, 55 KHz ±4 KHz
4.5 MHz Input Level:	+40 dBmV ±5 dB

GENERAL

Power Requirements:	105 - 130 VAC, 60 Hz, 14 W
Fuse:	.31 A, Type T
Temperature Range:	0° to +50° C
Dimensions (WxHxD)	19" x 1.75" x 14.25"

CONNECTORS

Audio Input:	8 position terminal block
Video Input:	"F" type, female
Composite IF In/Out:	"F" type, female
4.5 MHz In:	"F" type, female
RF Output:	"F" type, female
-20 dB RF Output:	"F" type, female

CONTROLS

Channel (Frequency) Selector:	DIP switches, 18 position, internal
Video Modulation:	Front panel control
Audio Modulation:	Front panel control
Mono/Stereo Modulation:	Front panel control (w/Option 5)
Aural Level (A/V ratio control):	Front panel control
RF Level:	Front panel control
Audio Input Switch:	2 position, rear panel, 600 ohm audio/4.5 MHz
Mono/Stereo Switch:	2 position, rear panel

INDICATORS

Video Over-Modulation:	LED, red
Audio Over-Modulation:	LED, red
Power:	LED, green
External IF In:	LED, green (w/Option 1)
Reference Lock:	LED, green (w/Option 2)
BTSC Stereo:	LED, red (w/Option 5)

ACCESSORIES

IF loop cable, 1 each

* Option specifications are included with the Option description

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UNPACKING AND HANDLING

UNPACKING. Each unit is shipped with all equipment assembled, wired, factory tested, and then packaged in an appropriate shipping container.

Ensure that all accessories are removed from the container and packing material before they are discarded. This includes the IF Jumper Cable which must be installed to make the unit operational.

MECHANICAL INSPECTION

Inspect the front and rear of the equipment for shipping damage. Make sure that the equipment is clean, and no wires, cables or connectors are broken, damaged or loose.

DAMAGE IN SHIPMENT

Should damage be discovered after unpacking the system, immediately file a claim with the carrier. A full report of the damage shall be made and a copy forwarded to Blonder Tongue Laboratories, Inc. The company will then advise what disposition is to be made of the equipment.

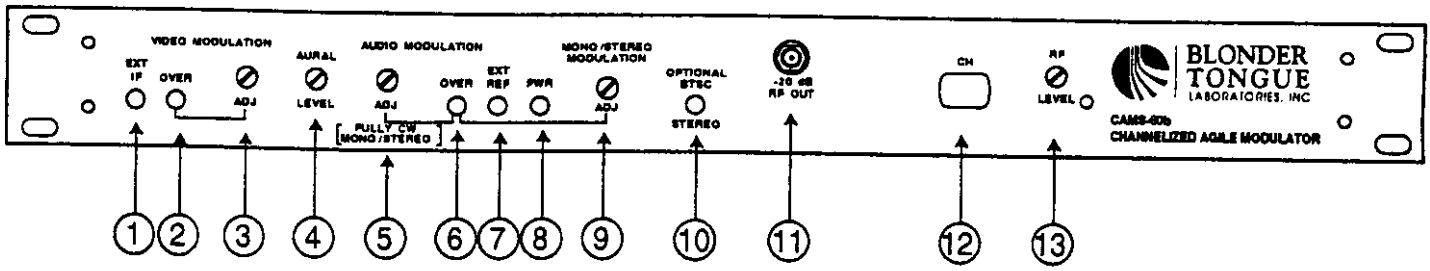
PRECAUTIONS

Adherence to the initial installation precautions outlined in the Table below will help prevent problems arising during initial installation and future maintenance of the unit.

PRECAUTION	REQUIREMENT
Avoid Heat Buildup.	Allow (1) EIA rack space (1-3/4") between Units in the equipment racks.
Ensure Easy Access to Rack Wiring.	Allow a minimum of 18" clearance behind equipment rack(s).
Faciliate Servicing and Maintenance.	Allow a minimum of 36" clearance in front of equipment rack(s).
Avoid Direct Heating or Air Conditioning.	If unavoidable, use deflector plates.
AC Power Source Outlets.	Locate equipment near enough to outlets to provide power for test equipment and power tools.
Rack Support.	Make certain rack supports are sufficiently rigid to support rack(s).
Building Leakage.	Beware of dripping water onto equipment from leaky roofs, waveguide roof entries, and cold water pipe condensations.

TABLE 1 Installation Precautions

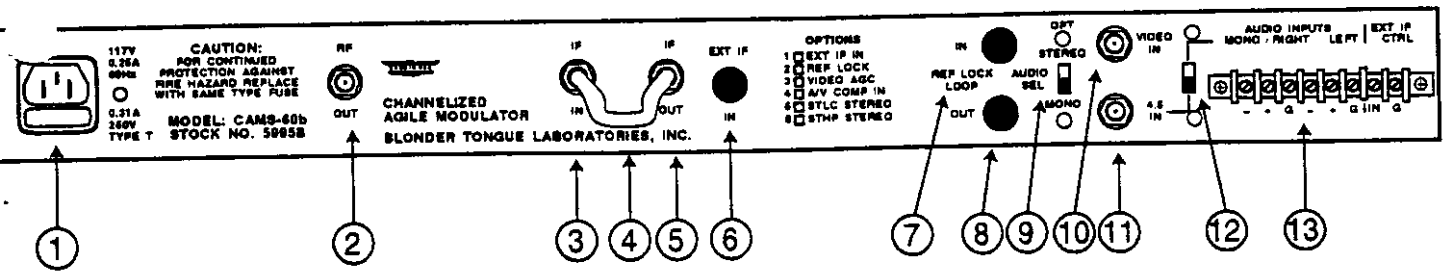
OPERATING CONTROLS



Front Panel Controls and Indicators

1. **EXTERNAL IF LED** - When the External IF option is present, the LED indicates that an external IF signal has been selected over the internally generated IF signal as the source for the IF out
2. **VIDEO OVERMODULATION LED** - Lights when the modulation exceeds 87.5%
3. **VIDEO LEVEL** - Adjusts the percentage of video modulation
4. **AURAL CARRIER** - Controls the amplitude of the aural carrier to change the aural/visual ratio
5. **AUDIO LEVEL** - Adjusts the aural carrier modulation. When stereo option is present, should be set fully CW
6. **AUDIO OVERMODULATION LED** - Lights when the aural carrier peak deviation is over 25 KHz in Mono mode and over 55 KHz when the Stereo option is present and the rear panel audio select switch is set to Stereo
7. **EXTERNAL REFERENCE LED** - When the External Reference option is present, the LED indicates that the internal visual carrier is phase locked to the external reference input
8. **POWER LED** - Indicates power is present and the fuse is good
9. **MONO/STEREO MODULATION** - Controls the modulation of the aural carrier when the Stereo option is present
10. **BTSC STEREO LED** - When the Stereo option and video input are present, the LED indicates the presence of the stereo pilot tone
11. **-20 dB RF OUT** - Test point output 20 dB below the RF output
12. **CHANNEL** - The channel number on the OFM-60 module is visible through this window
13. **RF LEVEL** - The Bridge-T pot simultaneously adjusts the amplitude of the aural and visual carriers to the final drive amplifier

OPERATING CONTROLS (Cont'd.)



Rear Panel Controls and Connections

1. **IEC POWER RECEPTACLE WITH FUSE** - The provided power cord is plugged into this receptacle. A slide-out drawer contains the AC fuse
2. **RF OUT** - The filtered RF signal is available for connection to a headend combiner
3. **IF IN** - The composite IF signal is looped to the PLL / Up-converter
4. **IF LOOP** - An F to F jumper cable is provided to loop the IF OUT to the IF IN
5. **IF OUT** - The combined SAW filtered and modulated IF signal appears at this port
6. **EXTERNAL IF IN** - For use with the External IF option

7 & 8. **REFERENCE LOCK LOOP** - For use with the Reference Lock option

9. **AUDIO SELECT** - Switches between the Mono and Stereo (when stereo option is present) mode of processing for the audio input
10. **VIDEO IN** - The modulator accepts standard negative sync video at a 0.7 to 2.5V pp level
11. **4.5 IN** - External 4.5 MHz modulated carrier input
12. **AUDIO INPUT SWITCH** - Selects between an external 4.5 MHz modulated aural carrier and the internally processed aural carrier
13. **AUDIO INPUTS/IF CONTROL** - Input connector for the Mono / Stereo audio signal and the External IF option control logic

PREPARATION FOR USE

After installing the unit make the following adjustments:

Output Level - Connect the IF Loop cable from the IF OUT to the IF IN connectors. Connect a suitable RF meter (Field Strength Meter or Spectrum Analyzer) to the RF OUT and tune to the visual carrier frequency. Adjust the RF LEVEL control to the desired visual carrier level.

Aural / Visual Carrier Ratio - Tune the level meter to the aural carrier frequency, then adjust the AURAL LEVEL control for the desired carrier ratio.

Video Level - With a nominal 1V pp video source connected, set the VIDEO MODULATION ADJ so that the VIDEO OVERMODULATION indicator just comes on. Verify with suitable test equipment or by using a TV, and checking picture contrast.

Audio Level - For monaural audio signals, connect the signal to the MONO / RIGHT terminals of the 8-pin terminal strip. Set the AUDIO INPUT switch to the UP position and the AUDIO SEL switch to the MONO position. Adjust the AUDIO MODULATION ADJ so that the AUDIO OVERMODULATION indicator flashes on the loudest peaks of the audio program. Monitor for a few minutes to assure the proper setting.

STEREO COMPATIBILITY OF THE CAMS-60b MODULATOR

The CAMS-60b is designed to accept either a standard monaural audio signal, a BTSC encoded baseband audio signal or a 4.5 MHz modulated subcarrier. It can also generate a BTSC encoded stereo signal when Option 5 is installed.

If a BTSC encoded baseband signal is used, the internal audio pre-emphasis circuit must be disabled. To do this, disconnect the unit from power and remove the unit cover. Locate the A/V modulator board (the board with the audio and video controls accessible through the front panel). Next, locate TH1 (behind Audio Level Adj pot) and put the shorting plug in the DISABLE position (Pins 2 and 3). This disables the audio pre-emphasis. Replace the unit cover. Connect the baseband stereo signal to the MONO / RIGHT terminals. Set the AUDIO INPUT switch to the UP position and the AUDIO SEL switch to STEREO. In the STEREO position the AUDIO OVERMODULATON indicator is set to come on when deviations exceed ±55 KHz (stereo peak deviation). Adjust the AUDIO MODULATION ADJ so the indicator just comes on. Monitor for a few minutes to assure proper setting.

If a 4.5 MHz modulated subcarrier is to be used, set the AUDIO INPUT switch to the 4.5 IN position. Neither the AUDIO MODULATION ADJ nor the AUDIO OVERMODULATION indicator are operational in this mode and no internal modifications to the modulator are required.

CHANGING THE OUTPUT FILTER MODULE

1. Unplug the modulator
2. Remove the unit cover
3. Remove the PLL module cover (located next to the RF Output).
4. Remove the two faceplate screws securing the Output Filter Module (OFM) to the faceplate
5. Note the connections of the two coax cables to the OFM before removing them
6. Remove the screw that secures the OFM L-mounting bracket to the chassis
7. Remove the OFM
8. Note the Channel Chart on the new OFM
9. Set the two sets of DIP switches, visible through the top of the PLL module, to the channel of the new OFM
10. Insert the new module, channel label up, and connect the two coax cables, OFM mounting hardware, PLL module cover and unit cover
11. Before reinstalling the unit in a rack, verify its operation by connecting the RF Out to an appropriate piece of test equipment. Use caution when connecting the modulator to test equipment because the output level may exceed +60 dBmV

CAMS-60b with STEREO OPTION

Description:

The CAMS-60b with the Stereo option (option 5) will convert the left and right channels from an audio source to the BTSC encoded stereo format used in television transmission. It can also be used for the transmission of standard monaural audio signals available from non-stereo sources.

Input Requirements

Audio Levels	
Stereo:	0.7 Vpp to 7 Vpp, typ (-10 dBm to +10 dBm)
Mono:	1 Vpp to 7 Vpp, typ
Video Level:	1 Vpp, typ

Connections:

Connect and make all adjustments for the video, IF loop thru and RF Out as described under Preparation For Use. The audio input signal may be balanced or unbalanced. If an unbalanced input is used, the unused terminal must be grounded via a short jumper to an adjacent ground terminal. Stereo input connections are made to the corresponding left and right terminals as indicated on the rear panel. A monaural input signal is connected to the right channel input with the left channel remaining either open or grounded.

Adjustments:

For stereo operation, the AUDIO SEL switch on the rear panel is set to the STEREO position and the AUDIO MODULATION ADJ is set fully CW. When the stereo option is present, the Audio modulation is controlled by the MONO/STEREO MODULATION ADJ. Internally, the programmable 75 µsec audio pre-emphasis must be set to the "Enable" position. This is the factory installed setting. If the shorting plug has been moved, it should be repositioned to connect pins 1 and 2 of TH1 on the A/V board.

The AUDIO OVERMODULATION indicator is configured to work in both the stereo and mono modes. When the AUDIO SEL switch is set to MONO, the LED will light when the deviation exceeds ±25 KHz. In the STEREO position the LED will light when the deviation exceeds ±55 KHz (±50 KHz program audio and ±5 KHz pilot tone). Adjust the MONO/STEREO MODULATION ADJ so that the overmod indicator flashes. Monitor for a few minutes to assure the proper setting.

For the BTSC STEREO indicator to light there must be an input video signal and the AUDIO SEL switch must be set to STEREO.

Specifications

Separation	
50 Hz - 10 KHz:	20 dB, typ
Frequency Response	
50 Hz - 10 KHz :	±1.5 dB, typ
Harmonic Distortion	
@1 KHz:	0.5 %, typ

FREQUENCY OFFSETS

The table on pages 10, 11 & 12 lists the switch settings for the standard cable TV and broadcast TV channel assignments. **0=UP=OFF** (as labeled on the switch). **The LO frequency is the sum weighting of the switches in the UP position.** The weighting of the specific switches are provided below:

Switch Bank 1				Switch Bank 2			
Switch#	**Weight**	**Switch#**	**Weight**	**Switch#**	**Weight**	**Switch#**	**Weight**
1	0.8 MHz	6	25.6 MHz	1	VCO BandSwitch	5	50 KHz
2	1.6 MHz	7	51.2 MHz	2	VCO BandSwitch	6	100 KHz
3	3.2 MHz	8	102.4 MHz	3	12.5 KHz	7	200 KHz
4	6.4 MHz	9	204.8 MHz	4	25.0 KHz	8	400 KHz
5	12.8 MHz	10	409.6 MHz				

To obtain a +12.5 KHz offset, move Switch Bank 2; Switch# 3 UP. If the switch is already in the UP position, move Switch Bank 2, Switch# 4 UP and move Switch Bank 2, Switch# 3 DOWN. (This add 25 KHz and subtracts 12.5 KHz.)

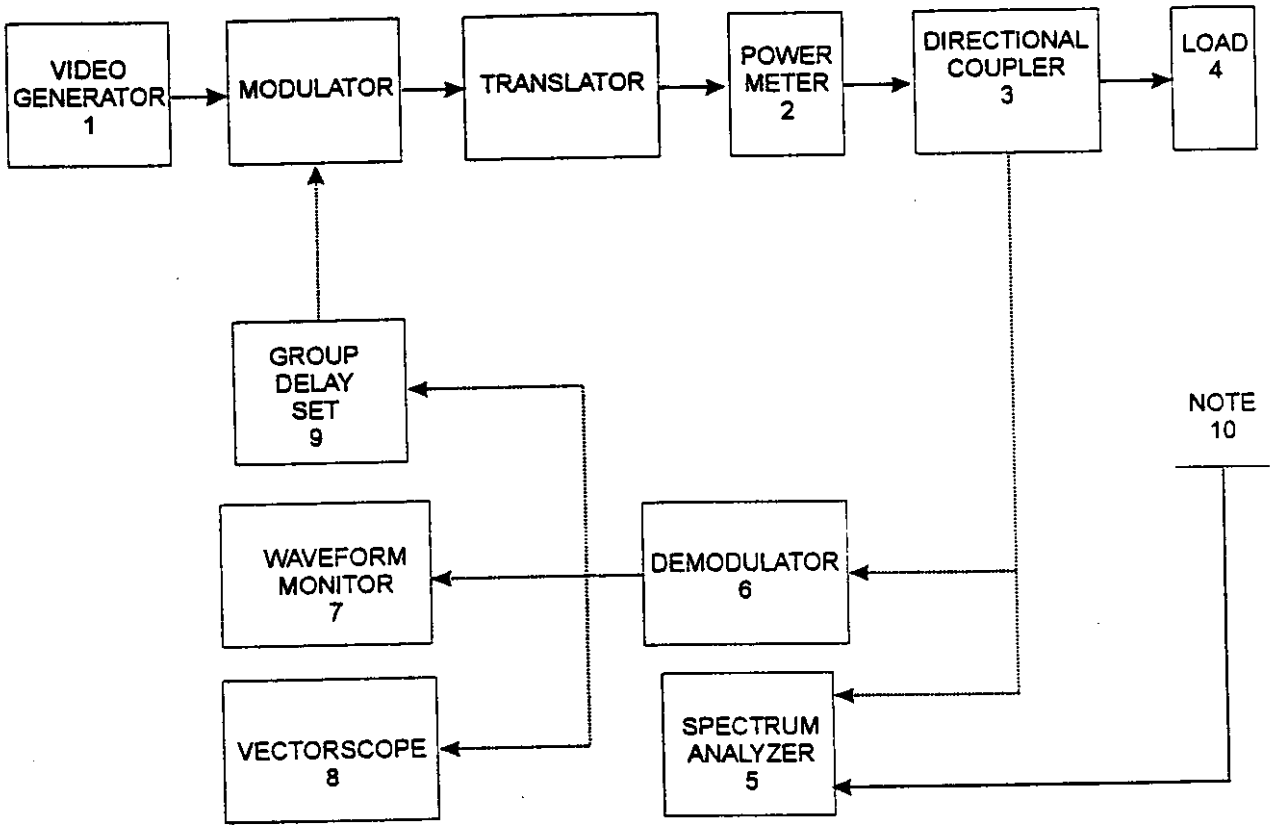
CHNL NO	VIDEO	LO	SWITCH ONE 1 = ON = DOWN 1	2	3	4	5	6	7	8	9	10	SWITCH TWO 1 = ON = DOWN 1	2	3	4	5	6	7	8
T7	7.0000	52.75	0	1	1	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0
T8	13.0000	58.75	0	1	1	0	1	1	0	1	1	1	0	0	1	1	0	0	0	1
T9	19.0000	64.75	1	1	1	1	0	1	0	1	1	1	0	0	1	1	0	0	0	0
T10	25.0000	70.75	1	1	1	0	0	1	0	1	1	1	0	0	1	1	0	0	0	1
T11	31.0000	76.75	0	0	0	0	0	1	0	1	1	1	0	0	1	1	1	1	0	0
2	55.2500	101.00	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	0	1
3	61.2500	107.00	0	1	0	1	1	1	1	0	1	1	0	0	1	1	1	1	0	0
4	67.2500	113.00	0	1	0	0	1	1	1	0	1	1	0	0	1	1	1	1	0	1
5	77.2500	123.00	0	1	1	0	0	1	1	0	1	1	0	0	1	1	1	1	0	0
6	83.2500	129.00	0	1	1	1	1	0	1	0	1	1	0	0	1	1	1	1	0	1
95	91.2500	137.00	0	0	1	0	1	0	1	0	1	1	0	0	1	1	1	1	0	1
96	97.2500	143.00	1	0	1	1	0	0	1	0	1	1	0	0	1	1	1	1	0	0
97	103.2500	149.00	1	0	1	0	0	0	1	0	1	1	0	0	1	1	1	1	0	1
98	109.2750	155.03	0	1	1	1	1	1	0	0	1	1	0	0	1	0	1	1	0	0
99	115.2750	161.03	0	1	1	0	1	1	0	0	1	1	0	0	1	0	1	1	0	1
14	121.2625	167.01	1	1	1	1	0	1	0	0	1	1	0	0	0	1	1	1	0	0
15	127.2625	173.01	1	1	1	0	0	1	0	0	1	1	0	0	0	1	1	1	0	1
16	133.2625	179.01	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	0
17	139.2500	185.00	0	0	0	1	1	0	0	0	1	1	0	0	1	1	1	1	0	1
18	145.2500	191.00	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	1	0	0
19	151.2500	197.00	1	0	0	1	0	0	0	0	1	1	0	0	1	1	1	1	0	1
20	157.2500	203.00	0	1	0	0	0	0	0	0	1	1	0	0	1	1	1	1	0	0
21	163.2500	209.00	0	1	0	1	1	1	1	1	0	1	0	0	1	1	1	1	0	1
22	169.2500	215.00	1	1	0	0	1	1	1	1	0	1	0	0	1	1	1	1	0	0
7	175.2500	221.00	1	1	0	1	0	1	1	1	0	1	0	0	1	1	1	1	0	1
8	181.2500	227.00	0	0	1	0	0	1	1	1	0	1	0	0	1	1	1	1	0	0
9	187.2500	233.00	0	0	1	1	1	0	1	1	0	1	0	0	1	1	1	1	0	1
10	193.2500	239.00	1	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	0	0
11	199.2500	245.00	1	0	1	1	0	0	1	1	0	1	0	1	1	1	1	1	0	1
12	205.2500	251.00	0	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0
13	211.2500	257.00	0	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0	1
23	217.2500	263.00	1	1	1	0	1	1	0	1	0	1	0	1	1	1	1	1	0	0
24	223.2625	269.01	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	0	1
25	229.2625	275.01	0	0	0	1	0	1	0	1	0	1	0	1	0	1	1	1	0	0
26	235.2625	281.01	0	0	0	0	0	1	0	1	0	1	0	1	0	1	1	1	0	1
27	241.2625	287.01	1	0	0	1	1	0	0	1	0	1	0	1	0	1	1	1	0	0
28	247.2625	293.01	1	0	0	0	1	0	0	1	0	1	0	1	0	1	1	1	0	1
29	253.2625	299.01	0	1	0	1	0	0	0	1	0	1	0	1	0	1	1	1	0	0
30	259.2625	305.01	0	1	0	0	0	0	0	1	0	1	0	1	0	1	1	1	0	1
31	265.2625	311.01	1	1	0	1	1	1	1	0	0	1	0	1	0	1	1	1	0	0
32	271.2625	317.01	1	1	0	0	1	1	1	0	0	1	0	1	0	1	1	1	0	1
33	277.2625	323.01	0	0	1	1	0	1	1	0	0	1	0	1	0	1	1	1	0	0
34	283.2625	329.01	0	0	1	0	0	1	1	0	0	1	0	1	0	1	1	1	0	1
35	289.2625	335.01	1	0	1	1	1	0	1	0	0	1	0	1	0	1	1	1	0	0
36	295.2625	341.01	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	1	0	1
37	301.2625	347.01	0	1	1	1	0	0	1	0	0	1	0	1	0	1	1	1	0	0
38	307.2625	353.01	0	1	1	0	0	0	1	0	0	1	0	1	0	1	1	1	0	1
39	313.2625	359.01	1	1	1	1	1	1	0	0	0	1	0	1	0	1	1	1	0	0
40	319.2625	365.01	1	1	1	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1
41	325.2625	371.01	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	0
42	331.2750	377.03	0	0	0	1	0	1	0	0	0	1	0	1	1	0	1	1	0	1
43	337.2625	383.01	1	0	0	0	0	1	0	0	0	1	0	1	0	1	1	1	0	0
44	343.2625	389.01	1	0	0	1	1	0	0	0	0	1	0	1	0	1	1	1	0	1
45	349.2625	395.01	0	1	0	0	1	0	0	0	0	1	0	1	0	1	1	1	0	0
46	355.2625	401.01	0	1	0	1	0	0	0	0	0	1	0	1	0	1	1	1	0	1
47	361.2625	407.01	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	0	0
48	367.2625	413.01	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	0	1

CHNL NO	VIDEO	LO	SWITCH ONE 1 = ON = DOWN 1	2	3	4	5	6	7	8	9	10	SWITCH TWO 1 = ON = DOWN 1	2	3	4	5	6	7	8
49	373.2625	419.01	0	0	1	0	1	1	1	1	1	0	0	1	0	1	1	1	0	0
50	379.2625	425.01	0	0	1	1	0	1	1	1	1	0	0	1	0	1	1	1	0	1
51	385.2625	431.01	1	0	1	0	0	1	1	1	1	0	0	1	0	1	1	1	0	0
52	391.2625	437.01	1	0	1	1	1	0	1	1	1	0	0	1	0	1	1	1	0	1
53	397.2625	443.01	0	1	1	0	1	0	1	1	1	0	0	1	0	1	1	1	0	0
54	403.2500	449.00	0	1	1	1	0	0	1	1	1	0	0	1	1	1	1	1	0	1
55	409.2500	455.00	1	1	1	0	0	0	1	1	1	0	0	1	1	1	1	1	0	0
56	415.2500	461.00	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	0	1
57	421.2500	467.00	0	0	0	1	1	1	0	1	1	0	0	1	1	1	1	1	0	0
58	427.2500	473.00	0	0	0	0	1	1	0	1	1	0	0	1	1	1	1	1	0	1
59	433.2500	479.00	1	0	0	1	0	1	0	1	1	0	0	1	1	1	1	1	0	0
60	439.2500	485.00	1	0	0	0	0	1	0	1	1	0	0	1	1	1	1	1	0	1
61	445.2500	491.00	0	1	0	1	1	0	0	1	1	0	0	1	1	1	1	1	0	0
62	451.2500	497.00	0	1	0	0	1	0	0	1	1	0	0	1	1	1	1	1	0	1
63	457.2500	503.00	1	1	0	1	0	0	0	1	1	0	0	1	1	1	1	1	0	0
64	463.2500	509.00	1	1	0	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1
65	469.2500	515.00	0	0	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	0
66	475.2500	521.00	0	0	1	0	1	1	1	0	1	0	1	1	1	1	1	1	0	1
67	481.2500	527.00	1	0	1	1	0	1	1	0	1	0	1	1	1	1	1	1	0	0
68	487.2500	533.00	1	0	1	0	0	1	1	0	1	0	1	1	1	1	1	1	0	1
69	493.2500	539.00	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1	0	0
70	499.2500	545.00	0	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1	0	1
71	505.2500	551.00	1	1	1	1	0	0	1	0	1	0	1	1	1	1	1	1	0	0
72	511.2500	557.00	1	1	1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	1
73	517.2500	563.00	0	0	0	0	0	0	1	0	1	0	1	1	1	1	1	1	0	0
74	523.2500	569.00	0	0	0	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1
75	529.2500	575.00	1	0	0	0	1	1	0	0	1	0	1	1	1	1	1	1	0	0
76	535.2500	581.00	1	0	0	1	0	1	0	0	1	0	1	1	1	1	1	1	0	1
77	541.2500	587.00	0	1	0	0	0	1	0	0	1	0	1	1	1	1	1	1	0	0
78	547.2500	593.00	0	1	0	1	1	0	0	0	1	0	1	1	1	1	1	1	0	1
79	553.2500	599.00	1	1	0	0	1	0	0	0	1	0	1	1	1	1	1	1	0	0
80	559.2500	605.00	1	1	0	1	0	0	0	0	1	0	1	1	1	1	1	1	0	1
81	565.2500	611.00	0	0	1	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0
82	571.2500	617.00	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1
83	577.2500	623.00	1	0	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0
84	583.2500	629.00	1	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	0	1
85	589.2500	635.00	0	1	1	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0
86	595.2500	641.00	0	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	0	1
87	601.2500	647.00	1	1	1	0	1	0	1	1	0	0	1	1	1	1	1	1	0	0
88	607.2500	653.00	1	1	1	1	0	0	1	1	0	0	1	1	1	1	1	1	0	1
89	613.2500	659.00	0	0	0	1	0	0	1	1	0	0	1	1	1	1	1	1	0	0
90	619.2500	665.00	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	1	0	1
91	625.2500	671.00	1	0	0	1	1	1	0	1	0	0	1	1	1	1	1	1	0	0
92	631.2500	677.00	1	0	0	0	1	1	0	1	0	0	1	1	1	1	1	1	0	1
93	637.2500	683.00	0	1	0	1	0	1	0	1	0	0	1	1	1	1	1	1	0	0
94	643.2500	689.00	0	1	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	1
100	649.2500	695.00	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0
101	655.2500	701.00	1	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	0	1
102	661.2500	707.00	0	0	1	1	0	0	0	1	0	0	1	1	1	1	1	1	0	0
103	667.2500	713.00	0	0	1	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1
104	673.2500	719.00	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0
105	679.2500	725.00	1	0	1	0	1	1	1	0	0	0	1	1	1	1	1	1	0	1
106	685.2500	731.00	0	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	0	0
107	691.2500	737.00	0	1	1	0	0	1	1	0	0	0	1	1	1	1	1	1	0	1
108	697.2500	743.00	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	0
109	703.2500	749.00	1	1	1	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1
110	709.2500	755.00	0	0	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	0

CHNL NO	VIDEO	LO	SWITCH ONE 1 = ON = DOWN 1	2	3	4	5	6	7	8	9	10	SWITCH TWO 1 = ON = DOWN 1	2	3	4	5	6	7	8
111	715.2500	761.00	0	0	0	1	0	0	1	0	0	0	1	1	1	1	1	1	0	1
112	721.2500	767.00	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	0	0
113	727.2500	773.00	1	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	0	1
114	733.2500	779.00	0	1	0	0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
115	739.2500	785.00	0	1	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	1
116	745.2500	791.00	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0
117	751.2500	797.00	1	1	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	1
			UHF																	
14	471.2500	517.00	1	0	0	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1
15	477.2500	523.00	0	1	0	0	1	1	1	0	1	0	1	1	1	1	1	1	0	0
16	483.2500	529.00	0	1	0	1	0	1	1	0	1	0	1	1	1	1	1	1	0	1
17	489.2500	535.00	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	1	0	0
18	495.2500	541.00	1	1	0	1	1	0	1	0	1	0	1	1	1	1	1	1	0	1
19	501.2500	547.00	0	0	1	0	1	0	1	0	1	0	1	1	1	1	1	1	0	0
20	507.2500	553.00	0	0	1	1	0	0	1	0	1	0	1	1	1	1	1	1	0	1
21	513.2500	559.00	1	0	1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	0
22	519.2500	565.00	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1
23	525.2500	571.00	0	1	1	0	1	1	0	0	1	0	1	1	1	1	1	1	0	0
24	531.2500	577.00	0	1	1	1	0	1	0	0	1	0	1	1	1	1	1	1	0	1
25	537.2500	583.00	1	1	1	0	0	1	0	0	1	0	1	1	1	1	1	1	0	0
26	543.2500	589.00	1	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	0	1
27	549.2500	595.00	0	0	0	1	1	0	0	0	1	0	1	1	1	1	1	1	0	0
28	555.2500	601.00	0	0	0	0	1	0	0	0	1	0	1	1	1	1	1	1	0	1
29	561.2500	607.00	1	0	0	1	0	0	0	0	1	0	1	1	1	1	1	1	0	0
30	567.2500	613.00	1	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	1
31	573.2500	619.00	0	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0
32	579.2500	625.00	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	1
33	585.2500	631.00	1	1	0	1	0	1	1	1	0	0	1	1	1	1	1	1	0	0
34	591.2500	637.00	1	1	0	0	0	1	1	1	0	0	1	1	1	1	1	1	0	1
35	597.2500	643.00	0	0	1	1	1	0	1	1	0	0	1	1	1	1	1	1	0	0
36	603.2500	649.00	0	0	1	0	1	0	1	1	0	0	1	1	1	1	1	1	0	1
37	609.2500	655.00	1	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	0	0
38	615.2500	661.00	1	0	1	0	0	0	1	1	0	0	1	1	1	1	1	1	0	1
39	621.2500	667.00	0	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	0	0
40	627.2500	673.00	0	1	1	0	1	1	0	1	0	0	1	1	1	1	1	1	0	1
41	633.2500	679.00	1	1	1	1	0	1	0	1	0	0	1	1	1	1	1	1	0	0
42	639.2500	685.00	1	1	1	0	0	1	0	1	0	0	1	1	1	1	1	1	0	1
43	645.2500	691.00	0	0	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0
44	651.2500	697.00	0	0	0	1	1	0	0	1	0	0	1	1	1	1	1	1	0	1
45	657.2500	703.00	1	0	0	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0
46	663.2500	709.00	1	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	0	1
47	669.2500	715.00	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	0
48	675.2500	721.00	0	1	0	1	1	1	1	0	0	0	1	1	1	1	1	1	0	1
49	681.2500	727.00	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	1	0	0
50	687.2500	733.00	1	1	0	1	0	1	1	0	0	0	1	1	1	1	1	1	0	1
51	693.2500	739.00	0	0	1	0	0	1	1	0	0	0	1	1	1	1	1	1	0	0
52	699.2500	745.00	0	0	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	1
53	705.2500	751.00	1	0	1	0	1	0	1	0	0	0	1	1	1	1	1	1	0	0
54	711.2500	757.00	1	0	1	1	0	0	1	0	0	0	1	1	1	1	1	1	0	1
55	717.2500	763.00	0	1	1	0	0	0	1	0	0	0	1	1	1	1	1	1	0	0
56	723.2500	769.00	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	1
57	729.2500	775.00	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
58	735.2500	781.00	1	1	1	1	0	1	0	0	0	0	1	1	1	1	1	1	0	1
59	741.2500	787.00	0	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0
60	747.2500	793.00	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	1
61	753.2500	799.00	1	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0

APPLICATION FOR FCC CERTIFICATION
BZ5MX10V
MODULATOR INPUT
10 WATT VHF TRANSLATOR

EXHIBIT 3a
VIDEO SET-UP #1

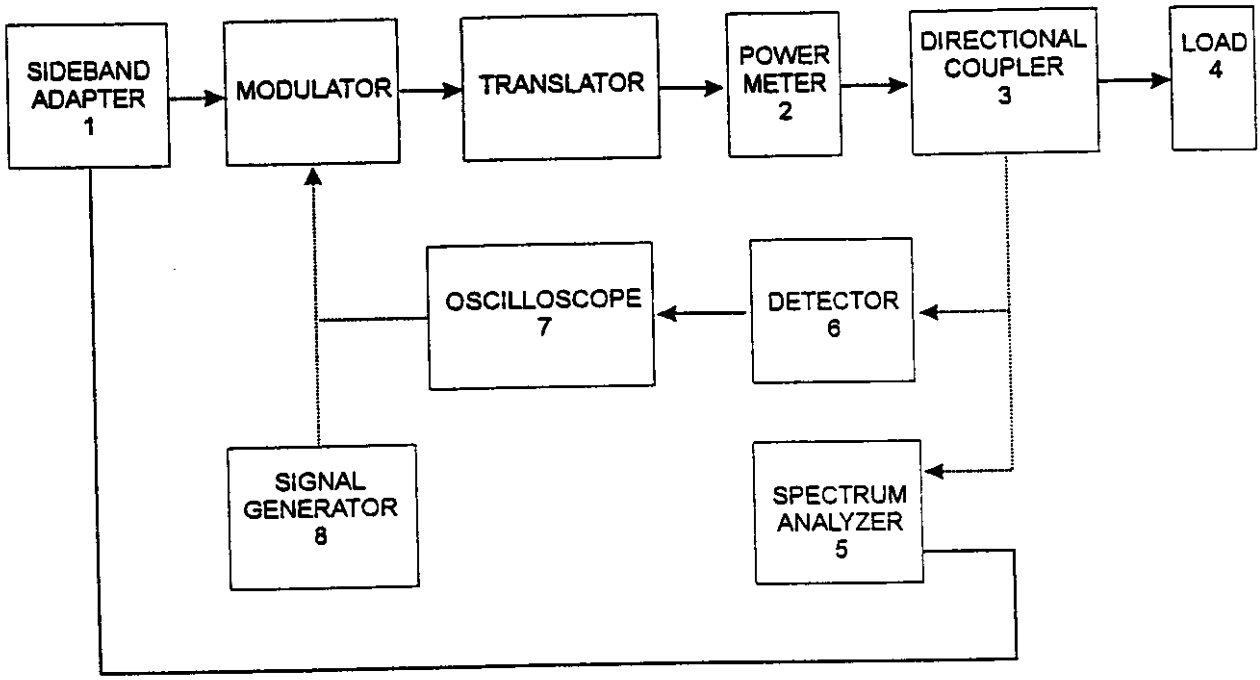


NOTES AND EQUIPMENT LIST

1. Video Generator - TEKTRONIX 1910 - Serial Number B010219
2. Power Meter - BIRD MODEL 43 - Serial Number 216291
3. Directional Coupler - CONNECTICUT MICROWAVE #250006
4. Load - DIELECTRIC 5750 - Serial Number 2354
5. Spectrum Analyzer - HEWLETT PACKARD 8591E - Serial Number 3325A01739
6. Demodulator - TEKTRONIX 1450-1 - Serial Number B020559
7. Waveform Monitor - TEKTRONIX 1780R - Serial Number B022663
8. Vectroscope - TEKTRONIX 1780R - Serial Number B022663
9. Group Delay Set - TEKTRONIX VM700A - Serial Number B040433
10. Dipole Antenna Cut to Frequency (For Field Strength Measurement Only)

APPLICATION FOR FCC CERTIFICATION
BZ5MX10V
MODULATOR INPUT
10 WATT VHF TRANSLATOR

EXHIBIT 3b
VIDEO SET-UP # 2



NOTES AND EQUIPMENT LIST

1. NTSC Sideband Adapter - TEKTRONIX 1405 - Serial Number B040665
2. Power Meter - BIRD MODEL 43 - Serial Number 216291
3. Directional Coupler - CONNECTICUT MICROWAVE #250006
4. Load - DIELECTRIC 5750 - Serial Number 2354
5. Spectrum Analyzer - HEWLETT PACKARD 8591E - Serial Number 3325A01739
6. Larcan-TTC Active Detector - Serial Number 002
7. Oscilloscope - TEKTRONIX 2465 - Serial Number B025622
8. Signal Generator - HEWLETT PACKARD 651A - Serial Number 434-00449

APPLICATION FOR FCC CERTIFICATION
BZ5MX10V
MODULATOR INPUT
10 WATT VHF TRANSLATOR

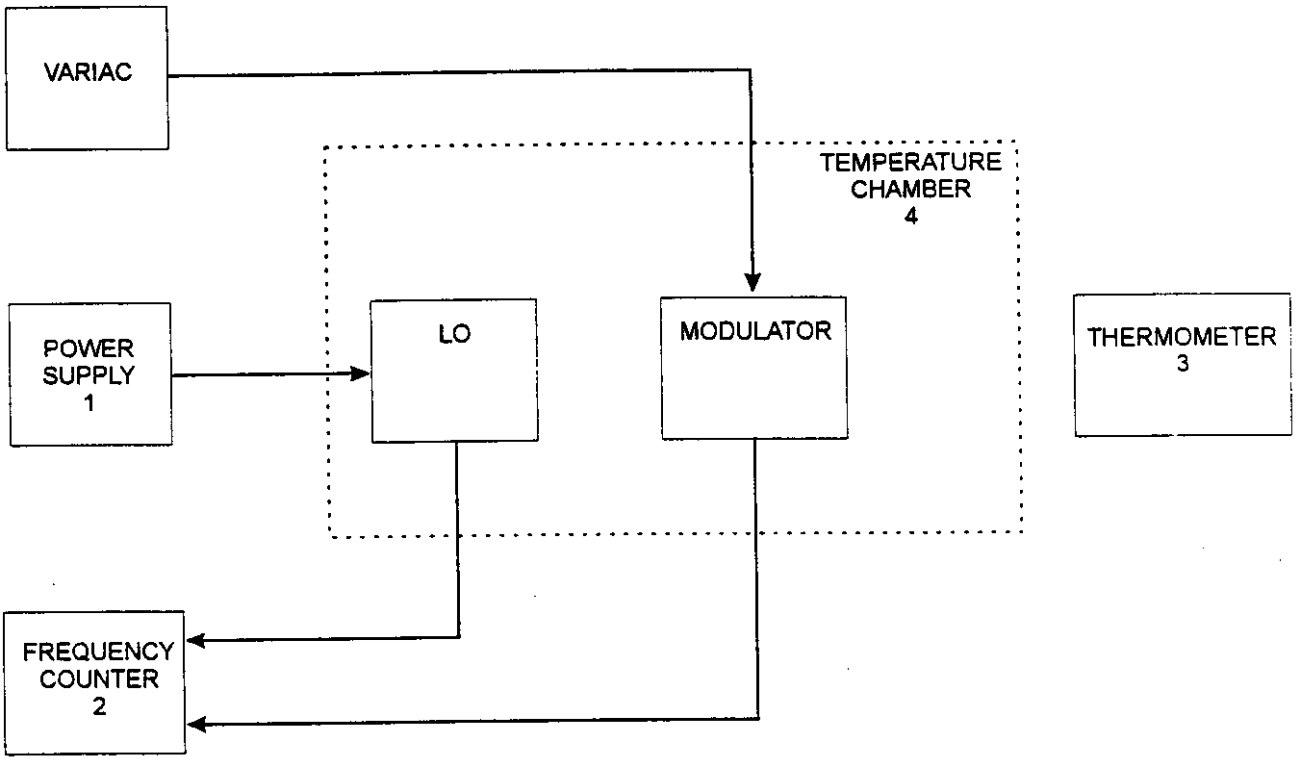
EXHIBIT 4a

FREQUENCY DRIFT VS. TEMPERATURE
CAMS-60b MODULATOR

DEGREES C	MEASURED LO FREQUENCY(Hz)	DEVIATION(Hz)	DEVIATION(%)
+50	181,250,647	379	0.000209
+40	181,250,449	181	0.000100
+30	181,250,205	-63	0.000035
+25	181,250,268	0	0.0000
+20	181,250,408	140	0.000077
+10	181,250,600	332	0.000183
0	181,250,673	405	0.000223
-10	181,250,605	337	0.000186
-20	181,250,228	-40	-0.000022
-30	181,249,700	-568	-0.000313

APPLICATION FOR FCC CERTIFICATION
BZ5MX10V
MODULATOR INPUT
10 WATT VHF TRANSLATOR

EXHIBIT 4b

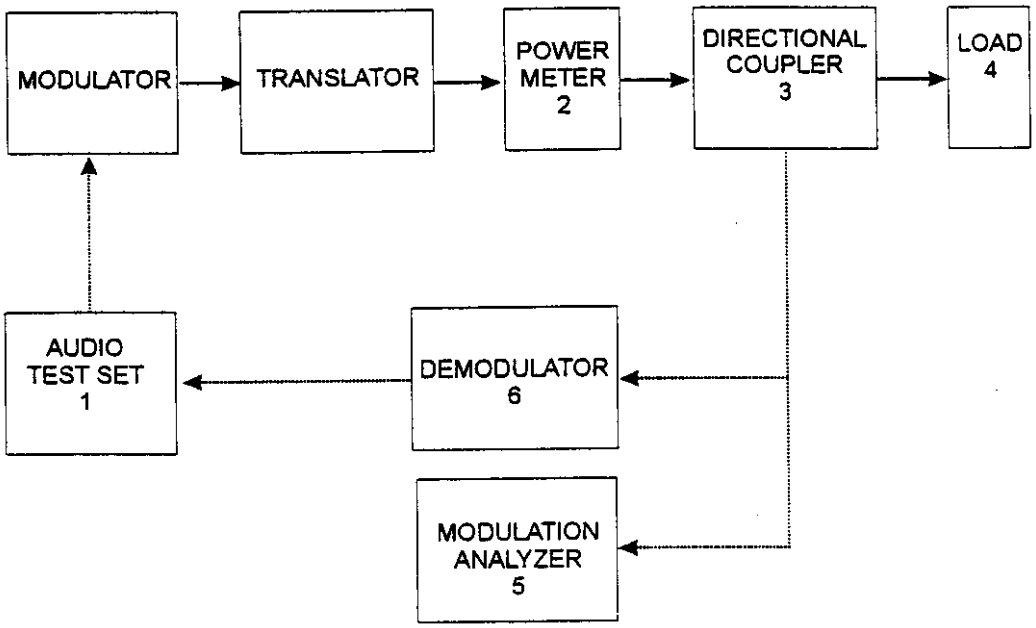


NOTES AND EQUIPMENT LIST

1. POWER SUPPLY - HP6012A - SERIAL NUMBER 2329A-02181
2. FREQUENCY COUNTER - HP5334B - SERIAL NUMBER 2937A05503
3. THERMOMETER - FLUKE 77/80T-150U
4. THERMOSTATICALLY CONTROLLED TEMPERATURE CHAMBER, ASSOCIATED

APPLICATION FOR FCC CERTIFICATION
BZ5MX10V
MODULATOR INPUT
10 WATT VHF TRANSLATOR

EXHIBIT 5
AURAL SET-UP



NOTES AND EQUIPMENT LIST

1. AUDIO TEST SET - HP339A - SERIAL NUMBER 1730A00691
2. POWER METER - BIRD MODEL 43 - SERIAL NUMBER 216291
3. DIRECTIONAL COUPLER - CONNECTICUT MICROWAVE - PART NUMBER 250006
4. LOAD - DIELECTRIC 5750 - SERIAL NUMBER 2354
5. MODULATION ANALYZER - HP8901A - SERIAL NUMBER 2911A05212
6. DEMODULATOR - TEKTRONIX 1450-1 - SERIAL NUMBER B020559

EXHIBIT 2a

PUBLICATION TSM 20-302

TECHNICAL MANUAL

10 WATT VHF AMPLIFIER

FOR MX10V SERIES

TV TRANSMITTER/TRANSLATOR

LARCAN INC.
228 AMBASSADOR DRIVE
MISSISSAUGA, ONTARIO
CANADA L5T 2J2

PHONE: (905) 564-9222
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Rev 0: November 26, 1998

MX10V series - 10 Watt VHF AMPLIFIER

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	GENERAL SERVICE INFORMATION	
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PUBLICATIONS LIST for MX10V series VHF Amplifier:

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NOTICES, ETC.:

THIS EQUIPMENT USES STATIC-SENSITIVE CMOS INTEGRATED CIRCUITS. Observe proper handling precautions (indicated in Maintenance Sections) at all times when working with this equipment.

TOXIC MATERIALS NOTICE... *IMPORTANT...*

Effective thermal management in certain semiconductor devices in this equipment is possible only through the use of Beryllium Oxide ceramic materials. This equipment contains devices made with Beryllium Oxide!

Beryllium and its compounds are a POISON if taken into the body in any manner.

To reduce your risk, remember: In case of accidental breakage of any kind of semiconductor device, DO NOT INHALE THE DUST, and AVOID GETTING DUST IN YOUR MOUTH; *it could contain Beryllium.* DO NOT LET BERYLLIUM DUST INTO YOUR BLOOD STREAM THROUGH CUTS OR OPEN WOUNDS !!

Seek and obtain IMMEDIATE medical attention if the dust enters your body in any manner.

Avoid cuts by wearing gloves while picking up the pieces. Wash your hands thoroughly after replacing devices. Dispose of defective devices only through approved toxic waste disposal facilities.

Remember too, after cleaning up an accidental breakage, avoid inhaling the dust while replacing or emptying vacuum cleaner filter bags, and wash your hands well after servicing the vacuum cleaner.

Although the following pages contain as much information about the TTS-10B transmitter or the TRS10B translator (they are both the same except for their exciters) as it is reasonably possible to provide, nevertheless we must state that these instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with its installation, operation, or maintenance. It is assumed that fully competent technical personnel will be responsible for the maintenance and repair of the equipment that is described in this manual. Should further information be desired, or should particular problems arise which are not covered sufficiently herein for the purchaser's purposes, or should replacement parts be required, the matter should be referred to us.

LARCAN INC.

228 Ambassador Drive,

Mississauga, Ontario, Canada L5T 2J2.

Telephone (905)564-9222, FAX (905)564-9244.

TRANSMITTER SAFETY PRECAUTIONS:

AC VOLTAGES USED FOR THE OPERATION OF THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE!

This instruction manual has been written for the general guidance and information of operation, maintenance and service personnel who are aware of, and are familiar with, the hazards of working with high powered electronic circuits.

This manual does not purport to detail all of the safety precautions which should be observed when servicing this or any other electronic equipment. Servicing by inadequately trained or inexperienced personnel may expose such personnel to serious risks which could result in personal injury or death, and/or damage to this equipment. All personnel concerned with the servicing of this equipment should be thoroughly familiar with standard first aid procedures for the treatment of electrical burns and shock.

The equipment has been designed to protect operating personnel from accidental contact with voltages dangerous to human life, either by means of distance (where it is necessary to deliberately reach to make contact with live terminals) or with shielding. It is therefore of prime importance that any protective covering devices be kept in place at all times.

While all practical safety precautions have been adopted to safeguard personnel from possible injury, in times of off-air emergency there is often a strong tendency to act without due regard for normal caution; for this reason, both supervisory and operating personnel are urged to **ENSURE THAT THE SAFETY RULES DETAILED BELOW ARE FOLLOWED AS AN ESTABLISHED ROUTINE** at all times.

1. *KILL THE AC POWER BEFORE IT KILLS YOU*

Under no circumstance should any person reach within the cabinets for the purpose of servicing or adjusting the equipment without first disconnecting the AC power, or without the immediate presence of another person capable of rendering aid. Use of the buddy system is encouraged for transmitter work.

2. *DO NOT TAMPER WITH INTERLOCKS OR SAFETY SHIELDS*

Under normal circumstances no safety shield should be removed.

3. *REMOVE PERSONAL JEWELRY WHEN WORKING ON THE EQUIPMENT*

The 48 volt power supply in this transmitter, although overload protected, is able to deliver currents capable of heating metallic tools or personal jewelry such as a watch band, bracelet, or ring. Accidental short circuits from such metallic objects can cause them to heat sufficiently to result in serious personal injury.

4. *KNOW FIRST AID, AND KEEP FIRST AID SUPPLIES AVAILABLE*

Illustrated first aid instructions for the treatment of electrical shock and burns should be displayed in a prominent location adjacent to the equipment. In rendering first aid, the timeliness and effectiveness of the treatment are vitally important to the recovery of the injured person.

Without exception, all personnel should thoroughly familiarize themselves with the procedures involved. One person, whose regular duties place him or her at the transmitter site often, should be delegated and given the complete responsibility and authority to ensure that first aid supplies are kept on site and maintained fresh and up to date.

Prominently display a list of emergency telephone numbers. This list should include the telephone numbers of the nearest ambulance, hospital, doctor, and fire department paramedics; and the public works (highways or county roads) department in case the former persons need access to the site during inclement weather.

HEALTH WARNINGS:

1. Non-metallic coverings of some coaxial cables used in this equipment are **FLAMMABLE** and may transmit fire when ignited. Other wire coverings are not capable of supporting combustion, but any non-metallic covering when heated sufficiently may emit dense smoke and acid gases which can be highly **TOXIC** and often **CORROSIVE.**

2. Be careful when replacing RF power transistors. Thermal transfer properties in these devices are achievable only by the use of Beryllium Oxide ceramics. We stated it earlier but we will emphatically repeat it again and again, ***Beryllium Oxide is a TOXIC substance.*** If the ceramic or other encapsulation is opened, crushed, broken or abraded, the Beryllium Oxide dust can be hazardous if taken into the body in any manner. Use caution in replacing these devices.

3. Solvents such as alcohols, ketones, aliphatic or aromatic hydrocarbons, halogenated hydrocarbons, etc. as found in glues, paints, paint thinners, paint removers, and/or cleaning fluids, may emit **TOXIC VAPOURS** and some may be **FLAMMABLE.** Read and understand the directions on their containers, and ensure that they are used only in well ventilated locations.

GENERAL SERVICE INFORMATION

1. Parts List Layout - EXPLAINED

Parts lists for manuals are computer-generated out of the LARCAN materials management database. They are presented in hierarchial or family tree order as far as is possible.

The computer is input with the parent parts list number, in this case the amplifier model 40D2168 which it designates as level 0. The computer first checks the parent list for major subassemblies, then each subassembly list for more subassemblies, etc., and arranges these lists in order of heirarchy beginning with level 0, then 1, then 2, etc., then prints each in the order in which they were found. In these booklets which together describe the PARTS of the amplifier, we have used the computer's electronic data output to allow us to more easily integrate the relevant parts list with the text.

The line of text immediately above the horizontal line on the first page of each list provides the number and name of the relevant assembly which the list represents.

An "R" followed by a dash and a number indicates revision status. This information is meaningful to our Renewal Parts and/or Customer Service people, and in order that these people can be most helpful, they should be advised of this revision number especially if renewal parts are needed.

2. Interpreting LARCAN Drawing Numbers

Engineering drawings at LARCAN are based on the concept that an assembly or subassembly is simply a GROUP of component parts, thus when a G appears on a list, it means an "assembly". Thus a circuit board loaded with parts may be referenced in this manual as "30C1055G1", while the drawing that shows how this assembly is put together will be "30C1055P1". Here, the P means PART, not PAGE (drawings in the LARCAN engineering department appear in "sheets" to avoid confusion between Parts and Pages), and sometimes several similar, but different, "parts" may be shown on the same drawing in order to save space. The circuit board drawing cited above is an example.

2. Interpreting LARCAN Drawing Numbers (continued).

There are two models of this particular circuit board which happens to be the output RF circuit board of the low band (Band I) power amplifier. The channel frequency range determines which particular group of this assembly is needed. NTSC channels 2 through 4 require a group 1, while channels 5 and 6 require the group 2 board assembly. These board assemblies differ in minor ways, but can be shown as a single illustration with the two "parts" defined by a note conveying essentially the meaning of "Part 1: as shown. Part 2: place copper strap jumpers for channels 5 and 6."

Other assemblies, such as in recent models of boards used for group delay correction in the exciter, may be shown as a number of separate assemblies (Parts 1, 2, 3, 4, or 5), on several sheets of a single drawing. The drawing "parts" all are assembled the same way, but vary in quantity and type of components.

For vendor components such as resistors and capacitors, often a generic drawing describing basic specifications, but having many "parts", will be used.

As an example, Drawing 3R152: Resistor, composition, ¼ watt. Drawing 3R152 describes a ¼ W resistor, but the drawing PART number calls for the value and tolerance of the resistor wanted. The first two digits after the "P" are the first two significant figures of the resistance, the third digit is the number of following zeroes in the resistance value, and a J is 5% tolerance, or K is 10% tolerance. Some example part numbers are: 47 Ω, ±10%, ¼W, is "3R152P470K"; and "3R152P243J" specifies 24 kΩ, ±5%, ¼W. For resistance values between 1 Ω and 10 Ω, a letter "R" will appear in the part number to indicate the decimal place; for instance a 5.6 Ω, ±5%, ¼W resistor will be designated as "3R152P5R6J".

Often the letter "R" appears on schematics or in parts lists where it specifies the decimal place when referring to resistances, such as "51R" or "75R" or "5R6", and sometimes the letter "k" will appear in the same context, such as "3k3". This practice is deplored by old-timers in our midst who attended North American tech schools and therefore learned about component values that are specified with the use of decimal notation, but schematics drawn this way are common in other parts of the world. In a parts list, moreover, an R followed by a dash and a number indicates a revision, but you will be able to recognize the difference from the layout framework of the list.

3. The LARCAN Assembly Prefix Numbering System

Because a transmitter is a complex device, a referencing system for unique identification of component parts reduces the chaotic situation that would otherwise result from the natural numbering system found in every parts list, in which the first capacitor is designated C1 and the first resistor is likewise designated R1, but when several assemblies using capacitors or resistors appear together, the entire question then becomes "*which* C1 or R1 are we talking about?"

The LARCAN prefixing system, and its "undocumented features" represent a beginning and evolving solution to some of these problems. It begins by assigning a distinct assembly prefix number to each subassembly.

Prefix 2 (the amplifier itself) has two unique subassemblies which are further prefixed 2A1 and 2A2, both of which could have a C1, an R1, etc. Identification of each component in full, is done by simply adding the prefix number to the component designator, thus 2A1C1, 2A2L3, etc.

Prefix designation is great for written communications such as letter or FAX, but when talking about it during a phone conversation, it is probably more natural to simply say "C1 in the preamp board" or "R7 in the output amplifier" than to go through the routine of looking up the prefix number.

4. List of Assembly Prefixes

1 -	Chassis, Cooling Fan and Terminal Blocks
2 -	RF Power Amplifier & Heatsink Assembly
2A1	RF Preamplifier
2A2	RF Amplifier
3 -	Power Supply (+48Vdc)
4 -	Control and AGC Circuit Board
5 -	RF Detector & Metering Circuit Board
6 -	RF Output Bandpass Filter
7 -	RF Output Directional Coupler
8 -	Control power supply (+12Vdc)
9 -	Pin Attenuator

5. Production Changes

From time to time, it may become necessary that changes be made in the equipment described in this manual. Such changes are usually made either to provide improved performance, or to accommodate component substitutions necessitated by vendor product availability. A revision letter or number may follow the model or group number marked on the nameplate, chassis, or circuit board; or on the parts list (where it is an "R" followed by a dash and a number). Whenever a revision letter or number appears, it should be quoted in any correspondence or communication regarding the equipment.

MX10V series - 10 Watt VHF AMPLIFIER

GENERAL DESCRIPTION

INTRODUCTION

This manual describes the LARCAN 10 watt VHF amplifier designed for NTSC channels 2 through 13. Models 40D2168G1 is for channels 7 through 13, 40D2168G2 for channels 2, 3, and 4, and model 40D2168G3 is for channels 5 and 6. These amplifiers are used in the LARCAN-TTC MX10V series transmitters and translators.

LARCAN all-solid-state 10 W VHF amplifier were designed to operate conservatively at 10 W peak sync visual RF power and 1 W average aural single carrier RF power, with superb performance, reliability and operating economy. This amplifier accepts an on-channel internally diplexed (in a 10:1 ratio vis to aur) composite driving signal of about 1mW peak visual RF, as input to its RF chain.

The 10 W amplifier and channel processor chassis' are designed to fit in a single 19" customer-provided cabinet rack, and require 7" (4RU) of vertical panel space for a complete transmitter or translator system. Alternatively, a 19" customer-provided tabletop cabinet could be substituted if the site requires it.

The RF amplifier heatsink has its own integral cooling fan, and other sub-assemblies are convection cooled. The simplicity of design, the deployment of all modular and other subassemblies, and the use of standard readily available components, also enhances serviceability.

Peak forward and reflected power are displayed on an analog percent power meter located on the front panel of the unit.

AMPLIFIER CHAIN

The internally diplexed composite RF output of the channel processor is fed to a conservatively designed broadband solid-state amplifier. This amplifier requires no tuning or adjustment. Simplicity of operation, reduced maintenance costs and increased reliability are a few of the major benefits derived from this amplifier.

The amplifier chain consists of two stages of amplification for low band and three stages for high band.

For amplifiers having somewhat more gain than usual, and especially for 10 watt output applications, the exciter driving the preamplifier may be padded down with an inline attenuator to avoid overdrive to the preamplifier, because exciters generally perform better at higher output levels.

The preamplifier uses high gain, broadband, integrated circuit amplifier(s) operating class A. This preamplifier has two stages in high band models, while a single stage suffices for low band.

The preamplifier uses the same circuit board that is an integral part of the "phase quadrature control" that is a required part of paralleled amplifier configurations. The 10 W transmitter uses a single RF chain, consequently quadrature phasing is not needed nor used, but some low cost components for it may remain in place on the board. Removal entails far greater overall expense than simply leaving them in place.

The PA stage consists of a pair of push-pull FETs in a single case, operating in class AB as a linear amplifier. This amplifier is capable of more than 50 watts RF output when driven by the preamplifier in the present system, but uses the identical dual FET device that is used in higher powered LARCAN transmitters.

The Sound/Aural signal of the transmitter is internally diplexed and corrected at IF with the visual/vision signal within the exciter, and is amplified in common with the visual/vision signal in the amplifier chain. Internal diplexing offers the distinct advantage of lower cost.

The amplifier output is fed through the bandpass filter and the directional coupler, which provides a small sample of forward and reflected output power for AGC and VSWR supervisory functions. The transmitter output then passes to the antenna system.

GENERAL DESCRIPTION

TRANSMITTER CONTROL

The control circuitry in this solid state transmitter is simple. Interlocking in the 10 W simply consists of jumpers (marked EXT1 and EXT2) but external patch panel link switches, or RF switching auxiliary contacts, can be connected if desired. This low power level generally needs no interlocking.

All control wiring of the transmitter passes through a control circuit board (prefix 4), and facilities are provided on this board for telemetry, status, and control connections to and from a remote control system.

The transmitter interlock wiring is also brought out on terminal block TB2. External interlocks 1 and 2 are all brought out on TB2 for connection as required. Interlock 1 is provided here only for consistency with other LARCAN transmitter designs in which this interlock is used with a fire alarm system to shut off blowers.

In the 10 W, the control is so simple (just a single contactor) that either interlock 1 or 2 can be used. The cooling fan for the PA heatsink is wired across the power supply output, therefore will operate whenever the supply is energized. A thermostat is provided in the PA heatsink to open the interlock chain should an unlikely overheating condition occur.

On site it is necessary to ensure that AC mains voltage within ±10% of nominal is available, especially in sites where the voltage can often be extremely variable, and/or failures are common. It is a good idea to log all voltage excursions in such sites over a period of time, and then specify a suitable voltage regulator.

It may be necessary to specify a regulator capable of wide input range if site voltage variations are extreme.

The amplifier's 48Vdc linear power supply (power-one™ type HD48-3-A) is rated for 3A and is designed for operation from AC power line voltage variation of +10%, -13%. The amplifier takes less than 240 VA.

The control's 12Vdc linear power supply is rated for 0.9A and is powered upon application of AC into the unit.

MX10V series - 10 Watt VHF AMPLIFIER

GENERAL DESCRIPTION

ELECTRICAL AND MECHANICAL SPECIFICATIONS

VISUAL-DOC/FCC (NTSC)

Power Output: ..... 10 W peak
Diplexing: ..... internal, 10:1 V to A
Frequency Range: ..... 54-216 MHz (channels 2 thru 13)
Output Impedance: ..... 50 Ω
Output Connector: ..... type N
Input Impedance : ..... 50 Ω
Output Regulation: ..... 3% (black-white picture)
Output Variation: ..... 2% (over 1 frame)
Amplitude/Frequency Response
-0.75 MHz to +4.75 MHz (Relative to Visual Carrier) ..... +0.5/-1.0 dB
Harmonic Radiation: ..... -60 dB
Intermodulation Distortion (3-Tone Method): ..... -52 dB

ELECTRICAL AND MECHANICAL SPECIFICATIONS

ELECTRICAL

AC Line Input: ..... 120 VAC
Power Consumption (amplifier alone):
Black Picture and aural on (typical): ..... 230 VA

ENVIRONMENTAL

Ambient Temperature: ..... 0° to +45°C
Humidity: ..... 0% to 90%
Altitude: ..... 7500 ft.

COOLING

Cooling air enters through front panel perforations from the room, and passes into the amplifier heatsink. The rear of this heatsink is fitted with a 4" fan that extracts the warmed air and exhausts it back into the room. Other parts of the amplifier are convection cooled.

DIMENSIONS

Amplifier and exciter/translator chassis are standard 19" rack width;
Amplifier depth is 19" including a 3" allowance for connectors.
Amplifier height is 5¼" (3U).

The MX10V series amplifier is marketed on the assumption that the customer prefers to provide the cabinet or enclosure for it.

SHIPPING WEIGHT

approx 28 lbs.

MX10V series - 10 Watt VHF AMPLIFIER

GENERAL DESCRIPTION

ABOUT THIS MANUAL

It will be observed that this manual consists of a collection of separate publications, each one of which describes its own module or section of the equipment. Parts lists, applicable alignment instructions, and illustrations which generally consist of assembly diagrams and schematics, are included in each of these booklets, which are identified by a "PUB" number and revision.

These mini-publications represent our attempt to assure quality of our documentation and at the same time maintain the material as current as possible. In the usual large manual or handbook, a change made to a single module might require a sentence or even several paragraphs be added, with the result that all text following the change will shift, consequently requiring renumbering of all pages and subsequent reprinting. These operations create an undesirable delay between the release of the revision to the equipment and the re-issue of its manual, despite our extensive use of computers. It is our hope that this republication delay will be reduced because revisions are nearly always done on one module at a time, and a few pages pertinent to one module are obviously simpler to revise and reprint than the many pages of a handbook.

Each section or module of the equipment is described in its own booklet. For each booklet, the format generally consists of a block diagram where applicable, then the relevant specifications, then the circuits are described, then test/alignment procedures are defined, and then the parts list is presented. Finally, the Figures (illustration drawings in 11" x 17" size) complete the booklet.

The Parts Lists in all booklets have been compiled by, and then extracted from, the LARCAN materials management computer system, and are current as of the date of issue of the booklet.

We have attempted to present our circuit descriptions in such a way that they would be meaningful to the competent technician whose main objective is to look after the equipment. We have therefore minimized the inclusion of material usually found in engineering textbooks, professional papers, and doctoral theses, because much of the information from such sources, although meaningful to the EE, can be too heavy and overdone for the beleaguered technician who is desperately trying to put a transmitter back on the air.

3-ring binders are used for LARCAN manuals as a courtesy to our customers because a 3-ring binder enables assembly drawings and/or equipment schematics to be temporarily extracted and used in a more convenient place when necessary. (Before their joining LARCAN, several of our staff technical people were previously broadcast station engineering technicians, whose custom was to temporarily tape their schematics to the transmitter cabinet doors for convenient reference when working inside the equipment).

Drawings whose numbers begin with 30C, 31C, 40D, 41D, 50E, or 51E may have been reduced in size or even split into several sheets to fit into the booklet's 11" x 17" format. Should any reduced drawings as presented in our manuals be found difficult to read, full size engineering blueprints are available at no charge by simply writing, calling or FAXing our Customer Service department and requesting the referenced drawing and revision wanted.

LARCAN INC.

228 Ambassador Drive,

Mississauga, Ontario, Canada L5T 2J2

Phone (905)-564-9222; FAX (905)-564-9244.

GENERAL DESCRIPTION

Notes:

VHF AMPLIFIER INSTALLATION

Contents:

Part	Topic	Page
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List of Figures:

Fig	Title	Drawing Reference
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2	Application Diagram: Transmitter Grounding Principles	
3	Application Diagram: Tower and Building Grounding	

Notes:

VHF AMPLIFIER INSTALLATION

IMPORTANT: If you haven't already done so, please take the time to read, study, and understand your Exciter manual, and all sections of this manual. You may find overlooked items that may be significant to your installation planning or to the actual work to be done.

1. GENERAL INFORMATION

The economics of manufacturing a transmitter dictates that much of the installation information in its manual must be non-specific to any particular site. Although most of the following material, which we are presenting as "technical interest" information, is pertinent to higher powered transmitters, some of it is generally applicable to low powered equipment as well. We hope that one or more of these suggestions contained herein will prove helpful to you and provide worthwhile challenge to your imagination and technical ability.

One of the keys to a successful installation is meticulous planning and adequate allowances for task times. Allow sufficient time to consider and plan all aspects of the installation, including the building, whether new or existing, then allow for realistic time spans for the building construction or renovation, equipment transportation and installation, and final commissioning. A low powered transmitter naturally will require a very short time span for these activities, while high powered equipment could require many months. Should you feel apprehensive about planning an installation, simply phone or FAX our Applications Engineering Manager who is available and able to guide you. Your consulting engineer is also a good source of information. Both these persons would be familiar with technical aspects of the proposed installation.

Applications Engineering support offered by LARCAN includes technical information, recommendations on vendor products when requested, and advice on project task considerations and time span estimation. This assistance is available upon request; simply ask your LARCAN representative.

Although general application information (Figures 2 and 3) was included in this manual, it is important that specific system layouts be prepared, and that locations of cabinets and RF equipment such as RF patching or switching equipment, are determined together with the routing of the transmission line, AC power (Mains) feeds and other wiring, grounding (earthing), and ventilation air ducting. Lightning protection should be considered early in the planning process, because a good building layout can offer significant benefit.

We mention "cabinets" throughout this document, although the TTS10B and TTS50B transmitters were designed as single chassis for rack mounting in a standard 19" cabinet to be supplied by the customer. This assumption was based on the anticipated market for the transmitter being for standby or unattended isolated site locations, and that cabinet rack space of about 10½" would be available for mounting the amplifier and exciter or translator. The cabinet ventilation openings should be fitted with air filters, to help the transmitter components remain clean. Alternatively, a tabletop style of cabinet can be used instead if required.

Due consideration must be given to ventilation, as proper cooling ensures the longest equipment lifetime. Basic cooling information is provided in following Part 5, but if a higher powered transmitter is also on site, we believe that the importance of the subject may warrant and justify the hire of an experienced air conditioning contractor.

Ensure that sufficient space is available both in front and rear of all cabinets and other equipment to permit easy access while equipment is being moved around, and to enhance accessibility for future maintenance. A minimum 90 to 100 cm (about 3 to 3½ ft) of clearance is recommended to allow access for a technician and test equipment, but you may need more clearance for other reasons or for the lifting devices sometimes used during installations. You may wish to consult local equipment rental agencies for dimensions of their available lifting apparatus; the required clearance is one of the "planning" items to be considered.

All cabinets should be level. An uneven floor surface can distort the sheet metal frames of many cabinets so that door latches will not operate properly.

2. GROUNDING/EARTHING

Please overlook our typically North American use of the word "grounding" throughout this text to describe a connection to earth, and the word "ground" which usually refers to a point of zero voltage, ie. the earth. We are certain, however, that the identical meanings of derivations of the word "ground" with those words pertinent to "earth" are universally understood by all broadcasters. That said, we shall proceed.

For safety, it is important that grounding conductors of adequate size be used to connect the transmitter (and other) cabinet(s) to the station "technical ground" point. The metal bulkhead plate through which all circuits and coax lines to and from the tower will pass, makes an excellent technical ground because it will be connected with one or two, 150 mm wide x 1.5 mm thick, copper straps to the tower ground system.

Figures 2 and 3 suggest one method, in which copper bar 75 or 100 mm wide and the same thickness as the floor tile is laid under transmitter and other cabinets for grounding. Each cabinet rack or tabletop cabinet is then connected with 1.5 mm copper strap or automotive starter cable to the copper ground bar. The copper bar in turn connects to the metal bulkhead plate. Alternatively, copper strap can be laid in a grounded overhead cable tray. Indoor grounding conductors must ultimately connect to the bulkhead plate.

Consult your electrical code book, or ask your electrical contractor about the minimum permissible ground conductor size, but for broadcast installations a low ground impedance is desirable, so generally the cross section of each cabinet ground should be the same or larger than the total of its AC wiring cross section.

All outdoor ground connections should be well bonded using an exothermic brazing process such as *Cadweld™* or equivalent. Special precautions should be taken to minimize corrosion where connections are made of dissimilar metals. Indoor connections can be brazed, silver soldered, or simply bolted together and then tin-lead soldered in the conventional manner. When indoors, don't forget that the steelwork, the ventilation system, and all other metallic objects in the building, should also be grounded.

It is mandatory that a good low impedance earth ground be provided for the tower, and it is good practice to employ this tower ground for all station ground connections. A system of buried radial conductors as shown in Figure 3, extending outwards from the tower base and from each guy anchor, with their far ends terminated in several ground rods spaced about twice their length apart and driven into the water table, is considered to be a good ground. The steel rebars and J-bolts in footings should also be bonded to this ground system. *Be careful of dissimilar metals, and don't braze anything to the tower legs!* Use stainless steel worm gear style hose clamps to clamp copper strap or copper wires to the tower members. A special conductive grease is available to avoid dissimilar metals corrosion, but frequent inspection is necessary.

More heroic measures become necessary if the tower footing is located on solid bare rock. These measures would include setting the grounding radials in poured concrete (which has surprisingly good conductivity), doping with conductivity-enhancing chemical salts such as magnesium sulphate (Epsom salts are supposed to be less environmentally harmful than others), and using special hollow ground rods that are intended to be driven into holes drilled in the rock, and which are said to bond chemically to the rock and provide excellent grounding, as long as they are kept filled with water or chemical solution. "ULTRA GROUND" rods are available through LARCAN or from our business affiliate LeBlanc & Royle Telcom Inc.

The building layout should place the tower, its wiring, transmission line, the AC panels and surge suppressor, and the telephone terminations, all near one another so that all ground connections are as short as possible; all indoor equipment should be grounded to the same "technical ground" which we suggest should be the bulkhead plate, which will become a good low impedance ground when connected with several 150 mm copper straps to the tower. This single technical ground will provide the basis for lightning protection of all equipment in the building. Both the power company and the telephone company should also use this same technical ground, otherwise a lightning hit to the tower could easily induce damaging transients that back up *through the equipment* and out the power or phone line to its own ground connections. Surge suppressors for coax lines and other tower circuits can mount (and ground) on the bulkhead plate.

VHF AMPLIFIER INSTALLATION

Many installations in large cities make use of existing tall buildings or specifically dedicated structures (such as the CN Tower in Toronto, Canada), and grounding for these installations could present a slight challenge.

Most tall structures are provided with wide copper straps running from top to base, and grounded at or under the building foundations. The structural steel is also grounded to the same point. The challenge occurs when the structure sustains a lightning hit, because an enormous voltage gradient will be present from top to bottom. Equipment grounding must be done *to one point only*, as explained in the next section.

Although most audio and video signals around the transmitter plant are of relatively high levels, it is well to be aware of another planning aspect that should be addressed anyway; this is the possibility of inadvertent creation of one or more "ground loops" of the kind that can induce hum into low level audio circuits.

The most common cause of the hum-inducing kind of "ground loop" is a result of code-approved electrical work in which all wiring is placed inside metallic conduit or raceway, and the conduit is attached to, and in contact with, the grounded structural steelwork of the building.

Here is what can happen: 1. The transmitter cabinets are grounded; 2. The electrical service panels are grounded; 3. The conduit or raceway additionally may be grounded through its fasteners to the structural steel; 4. The service panel is connected by the metallic path through a conduit or raceway to the transmitter cabinet. The result is one or more large area single turn loops that have AC induced in them due to the wiring in the conduit, but which can induce significant hum currents into low level audio wiring.

Suggested treatment for these AC ground loops, is simply to break each metallic loop by using a short length of non-metallic duct on the end of the metallic raceway, or use a short non-metallic section or a non-metallic coupling in the run of conduit. This non-metallic part should be located as near as possible to the cabinet. **IMPORTANT:** ***Non-metallic parts used for electrical work must not be able to burn, nor emit hazardous gases when subjected to flames.*** You will need to work out the exact ground loop treatment method with your electrical contractor, and probably with your local electrical inspector as well.

This grounding treatment is acceptable to most regulatory authorities in North America and perhaps elsewhere as well, *provided that the equipment in fact is grounded through the copper ground conductors, the bulkhead plate, and solid tower ground.* Note that this method does require installation of a separate dedicated grounding wire inside each conduit for the connection of the isolated ground contact of each receptacle, wherever receptacles are used. It is assumed that isolated ground receptacles are available, usually for use in computer rooms and in hospitals.

It may be necessary that you and your electrical contractor also become technical instructors, in order to reassure your electrical inspector that reduction of ground loops does not in fact contravene the applicable codes. At the very least you will probably need to prove that all your equipment is indeed grounded, despite the non-metallic connection of conduit or raceway.

Other, less severe, ground loops can result from the outer conductors of coax cables being grounded to the chassis of the equipment at both ends of the cable, and of course these components are also grounded through the cabinets in which they mount. LARCAN exciter video inputs use a differential connection and are not grounded, so do not contribute to a coaxial cable ground loop. The transmission line, however, is grounded at the tower, at the bulkhead, and at the transmitter.

Treatment of coax cable ground loops usually consists of coaxial cable dress in such a manner as to minimize the area presented by the loop. Lowering the line bridge between the building and tower will indeed reduce the loop area presented by the transmission line, but more importantly a lowered line bridge significantly reduces the energy induced on the center conductor due to a direct lightning hit to the tower. 100 to 130 cm (3-4 ft) above grade is the suggested maximum bridge height.

2. GROUNDING/EARTHING (continued).

The Canadian Broadcasting Corporation, through its Engineering Headquarters group, maintains its own standards for equipment design and installation and has published many of these for the information of its suppliers. The CBC specification *"Technical Power Distribution and Grounding Standards, ESS-124"* and CBC drawing 45753 which indicates the grounding practices followed in its installations, are highly recommended. Upon request, LARCAN can provide you with a copy of these CBC documents.

Although we try to avoid touting any particular vendor or product, we have no hesitation in also recommending two publications from the PolyPhaser Corp, phone 1-800-325-7170 or (702)-782-2511, FAX (702)-782-4476. In Canada, their rep is SINCLABS INC, tel (905)-841-0624, FAX (905)-727-0861.

One is *"The GROUNDS for Lightning and EMP Protection, Second Edition"* by Roger R. Block; this text published by PolyPhaser is well worth the small price asked. *"Lightning/EMP and Grounding Solutions"* is the current PolyPhaser catalog of grounding materials and lightning surge suppression devices. The catalog is free. Both of these publications are recommended reading for anyone planning a ground system.

3. LIGHTNING AND OTHER TRANSIENT PROTECTION - a tutorial:

A large proportion of the following information which is offered about lightning, was taken from a booklet entitled *"LIGHTNING PROTECTION for RADIO TRANSMITTER STATIONS"* published in 1985 by NAUTEL, which is a Canadian manufacturer of AM transmitting equipment; other information came from the PolyPhaser catalog and from their textbook *"The GROUNDS for Lightning & EMP Protection, Second Edition"* which we recommend highly as worth its modest purchase price for anyone planning a ground system.

We would like to thank the people at both NAUTEL and PolyPhaser, and we hereby gratefully acknowledge their contributions to the state of the art.

The real-world environment of transmitting equipment is one where periodic lightning storms may occur and cause antenna, tower, and power line strikes. The actual incidence varies widely with geographic location and is also affected by local topography, the height of the tower, and routing of the incoming power and telephone lines. Unless precautionary steps are taken, such strikes could cause transmitter damage, particularly to the final amplifiers and to the AC line rectifiers associated with them.

Our major area of concern is with the lightning strike caused by discharge of energy from an electrically charged cloud to ground.

Most electrical storms are localized, short in extent, and caused by localized air heating and convection. A less common but more troublesome type of storm is the frontal type caused by the meeting of warm-moist and cold-dry air masses, extending up to several hundred miles. The weather office people in the U.S. and Canada, and elsewhere, publish maps called "isokeraunic charts" which indicate the mean annual number of days having thunderstorms; these are shown as contours which in North America will vary from C = 1 for northern Canada, all the way to C = 100 for central Florida. (In equatorial regions worldwide, C is even higher. In some parts of Africa, C = 150, and in South America in the Amazon basin, C = 200). The average number of lightning strikes per square mile per year may be deduced from these contours by multiplying the C number by 0.37. For localized convection thunderstorms, the strike incidence is about 75% of the frontal storm incidence, perhaps due to more frequent cloud-to-cloud discharge occurrences.

A grounded (antenna) structure of "H" feet height is considered by some authorities to essentially cover an area of $9\pi H^2$ square feet (a radius approximately three times its height), and strike incidence within that area at a site where frontal storms predominate, will be approximately $C \times 0.375\ H^2 \times 10^{-6}$.

The foregoing leads us to speculate that a 500 foot tower in central Florida (or its equivalent in another region), in contour 100 and with frontal storms, will be struck an average of 9.4 times a year, and for the Canadian prairies in contour 20 with summertime convection storms, a 500 foot tower would receive an average of 1.4 hits per year. More important, the "lightning attractiveness" of the tower depends on the SQUARE of its height. If the tower is situated on top of a hill or mountain, "H" will be increased by the hill or mountain height, and becomes approximately equivalent to the antenna EHAAT. In practice, dimension "H" is slightly higher than the antenna elevation, because a metal lightning rod will be installed for protection of the topmost strobe or incandescent beacon, which is usually located above the antenna.

A lightning strike begins with a local ionization of the atmosphere called a "step leader" which jumps at a velocity about 150 ft per 1 µs increment, every 49-50 µs. It can be assumed that during each dormant 49 µs interval, this leader builds up its voltage to cause ionization for the next 150 ft, and then finds its next step, within an imaginary hemisphere of 150 ft radius.

Since it is postulated to be within a hemisphere, the step leader geometry can be such that a *horizontal* strike to a tower can occur anywhere higher than the 150 ft point above average terrain, so side mounted panel or STL microwave antennas can be just as vulnerable as top mounted slot or turnstile designs. Fortunately, the STL antenna is often flanked by metallic guy wires, thus has somewhat better protection, but guys that happen to be located in front of the panels of the main antenna are usually fiberglass to avoid distortion of the radiation pattern.

Imagine a large ball 300 ft in diameter, rolling around in all directions; wherever it touches a grounded object, can become a point of attachment for a lightning hit. (From this, we can infer that coaxial "grounding kits" will be required at least at the 150 ft point on the tower, at frequent intervals above that, and most definitely at both the base of the tower and the bulkhead plate in the building wall).

The return (main) stroke of a lightning strike is characterized by a rapid rise and nearly exponential decay of current, essentially from a high impedance source comprised of a long length of ionized air. Presumably, the inductance of this air path determines the rate of rise of the current, and the air path resistance determines the current peak value and its decay rate.

Obviously the current peak value will vary from strike to strike, and statistical probability based on empirical data indicates a median value (50% of all lightning strikes) of 18,000 to 20,000 amperes, while the pulse decay length to half its peak amplitude also has a probability distribution range from 10 µs to 100 µs, with a median value of 40 µs. There is also a 5% probability that the peak current can reach 80,000 amps, and a 1% probability that it can attain 120,000 amps. A once-in-a-lifetime monster peak current of 350,000 to 400,000 amperes is also statistically possible, maybe once every 10,000 hits. The current pulse median rise time to peak amplitude, is of the order of 5 µs.

The lightning strike consists of a discharge from a charged cloud into the semi-infinite reservoir which is called "ground" or "earth". Unfortunately, at the surface of our planet an ideal terminal connecting to the ideal ground (earth) is rarely if ever available; practical terminals will connect to it via a finite impedance having both resistance and inductance, ranging from a few ohms to a few hundred ohms.

This implies that if an impedance of, say, 10 ohms to the ideal ground is what you have, then an average lightning hit of 20,000 amps will deliver 200 kV across the 10 ohms, and it is obvious that this must be prevented from reaching the equipment. Considering the magnitudes of the lightning strike currents, it is mandatory that the best possible earth ground system available should be used, as we stated in the previous section on Earthing and Grounding, above.

If the tower ground is connected via other wiring (eg. grounding radials, and the power and phone lines) to remote grounds, a substantial part of the strike current can flow to these remote grounds, therefore the real connection to ideal ground becomes a *parallel combination of all possible ground paths.*

3. **LIGHTNING AND OTHER TRANSIENT PROTECTION - a tutorial:** (continued).

A single technical ground point for the equipment minimizes the bad effects of a lightning strike, because although the hit may raise this technical ground to 200 kV above the iron core of planet Earth, everything else on site connected to this same ground point is also raised equally to 200 kV, thus no damage is done. For installations in typical large city downtown locations, this is the only way of dealing with the enormous voltage gradients that can be developed over the height of a tall structure. When the transmitter is installed on the top floor of the tall building by itself and fed with microwave or other STL, there is no real problem.

When the studios and offices are located on a lower floor of the same building, and the standby plant is in a vault in the basement, during a lightning strike their technical grounds will be at a considerably lower voltage than that of the technical ground of the transmitter. In this situation you will need surge suppressors and plenty of isolating ferrite toroids to ensure the lightning goes down the ground strap and not down your signal and AC wiring. If coax video and twisted pair audio feeds seem less than desirable, you may wish to contemplate, evaluate, and use the complete isolation offered by fiber optics.

For discussion purposes, a median lightning strike can be considered to be a near-exponential **unidirectional** pulse of **20,000 amperes** peak amplitude, lasting **40 microseconds** to half-amplitude. For obvious reasons, it is impossible to exactly duplicate a lightning strike in the laboratory, so various working standards groups such as the IEEE in the electrical equipment industry have derived a repeatable, similar unidirectional pulse definition (ANSI C62.1) which implies that a "standard" fast power line transient (not necessarily lightning) has an 8 µs rise time, and a half amplitude time of 20 µs. This "8 x 20" definition appears frequently in MOV vendor information data sheets. There is also another common definition, based on a 10 µs rise and a half amplitude time of 1000 µs (10 x 1000), which is used by the MOV vendors as their standard to rate the energy dissipation of their devices.

The peak pulse current of 20,000 A can be used for estimating the size of surge suppressor required on the AC mains: Assume that the suppressor contains MOV devices that clamp the transient to less than 500 V above ground for a 115-0-115 V mains, therefore the energy dissipated will be the mathematical integral of a nearly exponential waveform which starts at time t = 0 and builds linearly to an instantaneous peak power of 10 Megawatts (20,000 amps x 500 volts) in the first 5 µs, decreasing in 40 µs exponentially to half amplitude, eventually decaying to zero. The answer is in Joules, which is the SI name for watts x seconds.

Vendors of MOV surge suppressor devices have published simplifying algorithms for this integral. They assume that a lightning hit has a two part waveform, and the answer is the sum of two equations of the form $K \times V \times I \times t$ where K is a constant corresponding to the evaluation of the integral of the part of the waveform being examined, V is the clamp voltage of the MOV, I is the peak current, and t is time in seconds. The first part of the wave has K = 0.5 so its energy is $0.5 \times 500 \times 20000 \times 5 \times 10^{-6} = 25$ J; while the second part K = 1.4 so its energy is $1.4 \times 500 \times 20000 \times 40 \times 10^{-6} = 560$ J. Adding the two, gives us 585 Joules. Multiple lightning current pulses during single hits are fairly common, so the energy number should be multiplied by another 5 or 6 when you decide on your surge suppressors.

For tall building installations, you may wish to multiply the energy number again, because the multiple ground paths available at grade level installations are not present here except for the building structural steel and copper strap ground, *and most probably the AC mains.* The mains therefore would carry a larger proportion of the strike current, and the suppressors should be appropriately chosen for higher peak current.

The entire basis of lightning protection is that the strike current should never be allowed to blast through the equipment, but paths should be provided for this current to go *around* it instead. These paths are provided through properly grounded (to your single technical ground) transient surge suppressors installed on all incoming wires, even if for aesthetic reasons they all arrive underground. These "incoming wires" include AC mains, other power circuits, and signal, telephone, and remote control circuits entering the building from the outside world, *and from the tower.*

VHF AMPLIFIER INSTALLATION

For any near or direct lightning hit, the tower wiring is "incoming" to the equipment in the building. You need the best possible ground at the tower to ensure that most of the current from the hit goes to ground at the tower, and much less goes to ground at the suppressors where the lines enter the building.

Series inductance should then be installed on the equipment side of each and every circuit (between the suppressor and the equipment) to provide enough isolating impedance that the transient is forced to choose the easier path through the suppressor, instead of through the equipment.

The minimum inductance needed can be calculated from the basic inductance expression V = L di/dt, where V = the suppressor clamping voltage, and di/dt = peak amps/risetime; when we rearrange this equation and plug in some numbers, L = 500V x 5µs/20,000A = 0.125 µH. Two or three ferrite toroids have been empirically proven to provide adequate inductance for lightning isolation when placed over each circuit, and in practice they limit the current to much lower values than 20,000 amps. The inductance of a toroid can be measured, or calculated from the vendor's data sheets.

Suitable ferrite toroids are offered by TDK, Fair-Rite, Siemens, and Ferroxcube. Typical TDK part numbers are H5C2-T52-72-10, which is 2" ID, and H5C2-T74-90-13.5, which is 2þ" ID. Equivalent ferrite toroids from other vendors could also be used if their sizes are adequate. TDK's H5C2 material has a high permeability μ_i of about 10,000, high saturation B_{sat} value of about 4000 gauss, and moderate Curie temperature of about 120°C. Other ferrites as used in switchmode power supply transformer applications should work as well, except that their µ values are usually much lower so more toroids would be required. The TDK toroids cited have AL values about 5000 to 6000 nH/N², suggesting about 5 to 6 µH each toroid.

Please note that we specified "each circuit", not "each wire". The operating current flow through each wire can easily saturate the magnetic path through the toroid. Place the toroid over the whole circuit instead, and the operating currents magnetic fields cancel each other, leaving the toroid to do its job. For low powered stations using typically RG-214 or semi-flexible Heliax™ or other ½" line, there are plenty of suitable ferrite toroids on the market. For higher powered installations, when toroids that are large enough to fit over larger transmission lines are not available, it is suggested that 1" lengths of steel pipe or steel electrical conduit, insulated from the line and from each other, are worth trying and may work almost as well. They should be provided with an air gap (a single cut with a hacksaw) to avoid saturation. You might want to measure the inductance and loss at, say, 2.5 MHz, of a single wire threaded through one of these gapped steel rings, and compare it with the measured inductance of a ferrite toroid.

Don't forget that ALL conductors and their sheathing or shielding extending up the tower are "incoming" for a lightning strike; they need suppressors and inductances. The outer conductor of every coaxial cable or transmission line, or the metallic sheath of mineral insulated or other multiconductor cable should be bonded (grounded) to the tower at frequent intervals to reduce probability of jacket puncture from the voltage gradients that could be developed between the cable and the tower, and these "outers and sheaths" definitely must be grounded to the tower base and to the building wall bulkhead plate. Rigid line is usually bonded to the tower with a metal strap or a line hanger placed every few flanges, mineral insulated cable sheathing is bonded with metallic fasteners, and plastic insulated cables must also have a metallic sheath.

Flexible line or sheathed jacketed cable is stripped of about 1" to 1½" of its jacket at frequent (60-80 ft) intervals, a ground strap is connected to the cable outer conductor, then a special polymer tape is used to reseal and waterproof the jacket. Grounding kits contain all the materials required.

Broadcast antennas are usually grounded to the tower, so create few problems. Other antennas, such as some designs used for two-way radio, may connect directly to the center conductors of their cables and are insulated from ground. In any event, the center conductor of any coax, or conductors inside sheathing, can have high voltage induced in them due to a direct hit on the tower. For coax lines up to 3þ" size, gas filled coaxial transient suppressors having good energy ratings and low VSWR are available from PolyPhaser, and for multiconductor cable there are also suitable suppressors offered. We don't intentionally wish to tout any particular vendor, but these products are highly recommended.

3. LIGHTNING AND OTHER TRANSIENT PROTECTION - a tutorial: (continued).

Coaxial line and other tower circuit surge suppressors should be mounted on and grounded to the bulkhead, which must be well grounded (that means low inductance as well) with at least two, 150 mm x 1.5 mm copper straps to the tower ground system. Any bends in these straps should be as gradual as possible.

Be sure that all ground path impedances are as low as possible, and try to arrange the suppressor locations and their grounding conductors so that personnel cannot come in contact with them during a thunderstorm. This includes placement of grounded security fencing around the tower base, the line bridge, the bulkhead, and the guy anchors. Heavy copper wire or strap connecting to multiple grounding rods around the foundation of the building, and including one or two of the tower ground radials, will help to equalize voltage distribution and the strike currents underground. All suppressors and equipment ground connections, however, should be made to the bulkhead plate which is bonded to the tower ground system.

Commercial "surge suppressors" designed to connect to AC mains and other lines, are available in various ratings of voltages, currents, surge currents, and Joules. Some of these may contain MOV devices and ferrite toroids integrated together, which may be worthwhile because the ferrite provides the necessary impedance between the suppressor and the equipment, and avoids the need for sourcing at least two large toroids that will fit over the four large conductors needed by the typical 3 phase AC power service entrance. Other designs use air core inductors to avoid possible saturation of ferrite material from successive unidirectional lightning hits. At least one other brand includes high powered active filter circuits. Be sure to devote some of your time to investigation of the various suppressors available to suit your applications (you will indeed have several applications on site) before your decision is made.

It is not a good idea to go without suppressors, or without isolating impedances between the suppressors and the equipment, because there would then not be a controlled path for the lightning energy to follow, thus it is possible that the next hit could find an easier path through the PA module circuit components, power supply rectifiers, or power transformer insulation, and these items can become quite expensive.

Generally, gas protector devices are useful on circuits having relatively low voltage but higher source impedance, as in telephone and signalling systems. With special gases, they can be effective on 50 Ω lines, especially where the transmitter's VSWR protection shuts off the RF momentarily during the arc. AC power line source impedances are much too low for gas filled protector devices to function properly, because once an arc begins there, the gas plasma remains ionized long enough that the next AC half cycle conducts, then the next, etc, resulting in extremely high current flow through the gas. Surge suppressors using MOVs work best for AC power circuits.

The tower itself must have sufficiently low ground impedance that a major portion of the lightning energy goes to ground at the tower base or guy anchors, and only a small amount then needs to be dissipated in the suppressors. Locating the line bridge between the tower and the building as low as possible (1 meter or 3 to 4 ft above grade is suggested) will result in lower induced energy into all suppressors, and at the same time, the extra line needed indoors to reach from the top of the transmitter cabinet or patch panel, down to the bulkhead plate, will add desirable isolating inductance.

Many types of protection devices are available at a wide range of prices, but even the most expensive protection is extremely economical when compared with potential costs of off-air loss of revenue, and/or the costs of rebuilding or replacement of the equipment being protected.

You may also wish to consult with your power utility company engineers; their extensive experience with lightning and grounding would certainly qualify them to be able to advise you about these same subjects, and a phone call or FAX to the PolyPhaser people might also prove worthwhile.

PolyPhaser numbers: Phone 1-800-325-7170 or (702)-782-2511; and their FAX is (702)-782-4476.

4. A FEW WORDS ABOUT POWER WIRING:

This transmitter requires a single phase power source. The transmitter power supply is a switcher type with autoranging AC input allowing it to operate in the ranges of 90 to 135 V or 180 to 270 V. Typical measured power consumption at black, amplifier only, is 200 VA at 49% PF for the TTS10B, and 285 VA at 49% PF for the TTS50B. The exciter, though, needs its primary taps set for appropriate line voltage, which must be within ±10% of nominal. Taps are at 100, 120, 130, 200, 210, 220, 230, 240, 250, and 260 V.

The standard design allows the transmitter to operate line-to-neutral from single phase 100 to 130 V. For operation in typical 50 Hz regions, where a 380 V or 416 V mains is available, the transmitter also would be connected to operate line-to-neutral. Line to neutral in 380 V 3 phase mains is 220 V, and in 416 V 3 phase mains, line to neutral is 240 V. Optionally (with added fuse 1F2) it can be operated line-to-line when used as a standby at a site where 208 V 3 phase power is available, or from single phase 115-0-115 V power.

All switcher power supplies use a large input filter capacitor, which is the reason for the poor power factor. "Power factor" is based on measurement of zero crossings of input voltage and input current, and 100 times the cosine of these zero crossings angular difference is the power factor in percent. As the switcher operates, the filter capacitor recharge current occurs in narrow high current peaks, so the current zero crossings obviously don't coincide with the voltage zero crossings. Furthermore, at startup, the capacitor has no stored charge and takes a large inrush current for the first few AC cycles to bring its stored charge up to a value enough for the supply to operate. Time delay fuses or circuit breakers are therefore necessary on the power line feeding the transmitter. Vendor specified voltage peak inrush current is about 55 amps.

For standard line-to-neutral operation, a fuse 1F1 is provided; for the TTS10B this fuse is 7 amps slow blow, and for the TTS50B the fuse is 12 amps slow blow. For the power source, we suggest that a slow trip breaker of 15 amps, rated for motor starting service, should be satisfactory. Even at lowest voltage the TTS50B transmitter and its exciter together should draw less than 5 amps, so a 15 amp breaker is adequate. For optional line-to-line operation, the transmitter is fitted with two fuses, 1F1 and 1F2.

A *sinusoidal output,* AC voltage regulator is recommended so that the exciter AC input remains within its ±10% limitation, especially at sites where line voltages fluctuate widely.

Regulators having variable transformers that work a buck-boost connection to the mains, provide sinusoidal outputs thus are the best regulators for the purpose. One small tradeoff is that some variable transformers are motor driven, thus may seem slow in correcting extremely wide variations in mains voltage. For most situations, most of the time, the mains voltage variation rate is slow enough that this is not of concern.

Motor driven regulator response speed is not usually critical, but there is one situation for this type of regulator that should be kept in mind: Many power failures are preceded by an abnormally low mains voltage with consequent highest output from the regulator, and upon restoration of power the output of the regulator will therefore be at its maximum for the length of time required for the regulator to respond.

To make matters worse, often the restored incoming mains voltage will be well above normal for several seconds. A power surge of extremely high voltage thus can be applied to the equipment.

There is a solution to this regulator response problem: The regulator should be specified to have *battery backup, a DC servo amplifier and DC motor* driving the variable transformer, and controller arrangements such that it will reset itself to its *LOWEST* output voltage *DURING* a power failure. The result will be that upon restoration, the output voltage will begin at its lowest value. This will avoid equipment overstress.

Setting of the regulator for tight regulation will cause it to correct often for small incoming voltage changes, which may result in increased brush wear in the variable transformer(s). Some regulators which have no brushes use special transformers in which two coils move in relation to each other. The original designs of these variable transformers came from General Electric and were called "Inductrol" regulators.

4. A FEW WORDS ABOUT POWER WIRING: (continued).

Another company's design of regulator made use of a large number of thyristor devices to switch taps on a transformer winding, and would require at least two AC cycles for its controller circuit to decide which tap needed to be switched, with the result that small spikes were inherently part of the regulated output.

The TTS10B or TTS50B and its exciter have good internal regulation for wide extremes (nominal ±10%) of incoming line voltage, but other on-site equipment may not be as forgiving of poor line regulation, and a voltage regulator is a desirable accessory. If the site mains voltage extremes are greater than 10% variation, a voltage regulator that has wide range input voltage specifications, should be considered mandatory.

5. VENTILATION/AIR CONDITIONING INFORMATION

At black level with full aural power, the maximum amount of heat is generated by the RF amplifier. This heat is removed by forced convection from the heatsink. A built-in blower pushes air through the heatsink, from which it is exhausted into the transmitter room. Care must be taken that the specified maximum transmitter ambient temperature of 45°C is not exceeded at any time.

The RF average power output delivered to the transmission line is almost 7 watts at black level with aural on, when the TTS10B transmitter is operating at its rated peak visual and 10% aural output. Subtracting this 7 W amount from the (200 VA x .49 PF) = 98 W of AC power input, gives us the heat generated by all stages in the transmitter; about 90 W total. Add the 100 W exciter power input to this, and the total is about 190 W for the transmitter on the air. Likewise, the TTS50B delivers average power of 35 watts RF to the line and takes about (285 VA x .49 PF) = 140 W of AC power input, which generates about 105 watts of heat, and with the exciter = 205 watts of heat when on the air. These equipment heat amounts do not include the heat dissipated by input and monitoring equipment, or other sources of heat in the room.

Due to the complexity of the entire discipline of "heating, ventilation and air conditioning" (HVAC), it is recommended for best results that the services of an experienced air conditioning contractor/engineer be engaged for the design and implementation of your building air conditioning or ventilation system. This is perhaps more important at shared sites using a single tower, such as for two-way radio, cell phone, telco, and/or other uses, such as in small communities where a studio installation may be in the same building.

For budgetary purposes, you may wish to perform this estimating exercise: Assuming a transmitter site only (no studio facilities), outdoor ambient temperature of 40°C, typically windowless concrete block walls, uninsulated precast concrete roof, and overall dimensions 16 ft x 20 ft x 11 ft, it would probably require about 2½ to 3 tons of refrigeration to keep the building habitable for an inside ambient of 20° to 25°C without equipment. This is equivalent to maybe 9 kW of heat, and equipment heat load adds to this, at a rate of 3413 BTU per hour for every kilowatt of heat, which works out to about 0.3 ton of refrigeration required to remove each kilowatt of heat. There are 12000 BTU per hour in a ton of refrigeration.

Transmitter heat is specified above, but the rack equipment and lighting loads are unspecified. Simply total the input power for this other equipment, since you can safely assume all its AC input gets converted into heat. Add the transmitter and exciter to this, add the result to the 9 kW for the building, multiply the total kW number by 0.3, round the result up to the next integral number, and that is your approximate tonnage.

Reference to mail order catalogs (Sears, etc) indicates approximately the price per **half-ton** for a 6000 BTU window mount air conditioner. We don't recommend window mount air conditioners because they are not designed for unattended continuous duty and they are difficult to service, but the catalog list price is a start. This price per half-ton must then be multiplied by two and then by your integral number of tons. The result of this math represents a continuously running system; multiply again by two for main-alternate.

The resulting total gives you an approximate equipment cost, less installation. Your air conditioning contractor should then be asked for an official estimate, including installation and warranty.

6. FIRE PROTECTION

Some persons may think that the following material is totally overdone for a low powered transmitter site; indeed, many such sites are in remote regions of the country and would probably sustain far more damage from forest fires than from fires originating in the equipment or elsewhere inside the building. Nevertheless, you may find something of technical interest in this part, even though some of it may not be relevant to you.

Transmitter interlock connections are on TB2-3 and TB2-4 on the back of the amplifier chassis. These connections form a series path for "External Interlock #1" which enables the transmitter's control circuit, including its blower. Because the air is simply exhausted to the room, in case of fire the current of air from the transmitter may fan the flames, so it is desirable that the blower be stopped. A fire alarm system should be able to be arranged to provide a set of normally closed dry contacts to connect into this interlocking circuit; it is recommended that this be done.

Other alarm system contacts may also be needed for various purposes separate from the transmitter. These extra alarm system contacts may be needed to shut down other air systems in the building, to close air dampers and fire doors, and to enable activation of automatic firefighting apparatus, if provided. One extra set of dry contacts should be made available for reporting of the fire through the remote control.

Building designers once thought that a fire alarm system needed only to trip the main AC breaker to the building, which would automatically stop all fans and blowers. As long as the fire is prevented from spreading by ensuring all blowers are stopped and air dampers closed, and fire doors are closed, there is no reason that AC cannot remain on, to keep lighting available for evacuation of personnel.

For installations where the transmitter is located on top of a tall building, the main AC should never be able to be tripped by a fire alarm, because doing this can also stop elevators full of people, sometimes between floors. Fire alarm systems for these situations should be engineered by specialists.

It is assumed that if an emergency alternator is installed at the station, it is located in either a separate building, a fire proof vault with its own separate ventilation, or in its own enclosure, and is fitted with its own fire protection systems, so the above air system considerations would not apply to it. Specific building codes may apply to it though, particularly regarding its fuel supply. It is well to check with your fire chief, fire marshall's office, and/or building inspector for applicable code requirements.

The transmitter plant, particularly those using higher powered transmitting equipment, represents too large an investment to neglect its fire protection, especially for unattended sites having difficult access. Investigation of available fire alarm and fire fighting systems should be carried out as early in the design process as possible, and well before final design commitment. Your local fire chief or fire marshall's office may be helpful sources of advice during planning of your installation.

Even if the site is normally unattended, it must be mandatory that any automatically activated fire fighting system can be disabled whenever personnel are working in the space protected by the system. Most systems for use with electrical apparatus, depend on the high pressure discharge of carbon dioxide, halogenated hydrocarbons such as Halon™, carbon tetrachloride, or other equally deadly extinguisher gases into a closed equipment room; this puts a fire out by displacing all oxygen. *Obviously, the design must be fail-safe, because when personnel are working in the room, they must never under any circumstances be exposed to a risk of system malfunction which could be fatal.* Check this out; it's important.

7. UNPACKING

Carefully inspect each package as it is received, for possible shipping damage. Claims for damaged equipment must be filed with the carrier within seven days of delivery or the claims will not be accepted.
Unless specific contractual arrangements for title, FOB location, etc. have been made, generally the delivery of the equipment to the carrier by LARCAN INC. constitutes transfer of title to the customer, and it is therefore customer responsibility to ensure that any such claims are promptly filed directly with the carrier.

Check the equipment received against the shipping list. Should there appear to be a shipping error or if replacement equipment must be ordered due to transportation damage, notify your LARCAN representative as soon as possible.

If construction or renovation work at the transmitter site is not complete by the time the equipment is received, repack all equipment items after their inspection and store them in a clean, safe, dry area to avoid harm to any of the equipment. Repacking for storage should be performed in such manner to prevent access by mice and other small animals which can damage wire coverings. Construction debris such as plaster dust, metal filings, and other abrasive contaminants entering the equipment can also cause damage.

When the construction work is complete, the area should be cleared of all dirt and debris, and vacuumed thoroughly before the equipment is installed. Plain concrete floors should be sealed or tiled to prevent surface dust from being drawn into the equipment.

When the installation work is complete, the area should again be cleared of all debris and vacuumed once more, before any of the equipment is initially turned on. Check for loose screws and connections, and tighten where necessary.

Finally, before powering up, be certain that all tools, surplus and scrap installation materials, stray hardware, stray "blobs" of solder, ends cut from wires, stripped wire insulation, and other trash, are completely removed from inside the cabinets.

8. TRANSMITTER EXTERNAL INTERLOCK CONNECTIONS:

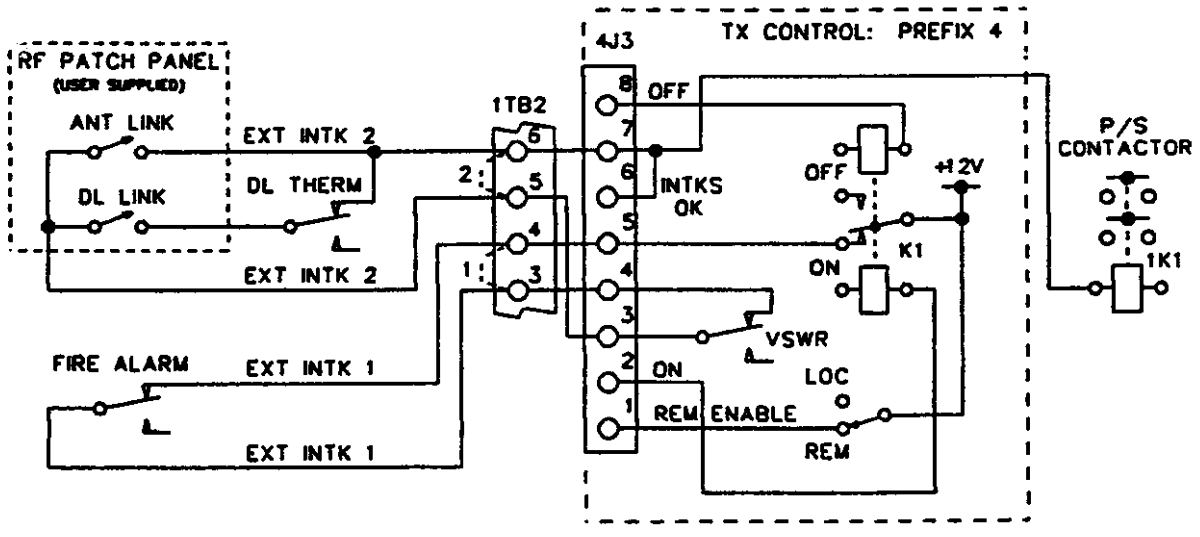

Figure 1: TTS10B and TTS50B Transmitter Interlock Connections.

We will be the first to admit that many people think "interlocking" is overdoing it for such low powered equipment, therefore we have shown dashed line jumpers 1 and 2 for you to use in lieu of interlocks. Just in case you DO need interlocks, such as when the amplifier is a driver for a high powered linear, know this: All interlocks are low energy, 12 VDC, and currents are in the order of about 250 milliamperes. Connections shown are functionally compatible with interlocks for other LARCAN transmitters, as follows.

Normally-closed contacts from the building fire alarm system should connect to "Ext Interlock 1" (1TB2-3,4) which will shut down the whole transmitter, including its blower. This fire alarm contact could connect in series with any patch panel and dummy load interlock wiring, or if wiring can be made easier, the patch panel and dummy load interlocks could connect for convenience to "Ext Interlock 2" (1TB2-5,6) as shown. Transmitter operation is identical from either; the only difference between these interlocks is in the status indications seen by both the observer of the transmitter control panel, and by the remote control system.

9. FIRST-TIME, ON-SITE TRANSMITTER START-UP PROCEDURE:

If you have not already done so, please take the time to read and understand the technical Sections of this manual, which contain information that you might want or need when you first start your newly installed transmitter. Read them again, just to be certain nothing was overlooked. The amplifier meter was calibrated to read 100% with the visual and aural present.

1. Connect the transmitter output to a 50 ohm dummy load or the antenna. The transmitter uses a 50 Ω type N connector for its output. An inline wattmeter with a selection of detector elements should be used for measurements.

2. Transmitters only: Connect a 1 V peak-to-peak video signal to the modulator video input jack. Connect an audio signal to the modulator audio input. Connect the RF output to the input of the amplifier.

   Translator only: Connect the input channel signal to the input of the channel processor, and its RF output to the input of the amplifier.

3. Connect the 115 VAC mains input. This AC circuit should be rated for 15 amperes, and should be supplied through a slow tripping breaker or time delay fuse. Generally, a breaker that is rated for across-the-line motor starting will be found to be satisfactory.

4. Depress the amplifier ON push button. The three LEDs marked EXT1, TEMP, and EXT2 should be lighted, and the amplifier power supply should be operating. Verify this by observing the blower, which is powered by the amplifier power supply and therefore should be running.

5. The amplifier is equipped with overpower and VSWR protections which have been factory set. To set the correct level on the channel processor/exciter, simply adjust the level control so that the output of the amplifier just reaches 100%.

6. For amplifiers equipped with AGC (later model with AGC ADJ level control), initially set the operation on manual by pushing the AGC switch such that the AGC switch LED is not lit. Adjust the channel processor/exciter level for a reading of 110%.

7. Switch to AGC operation (AGC switch lit) and adjust the AGC ADJ potentiometer on the amplifier front panel for a meter reading of 100%.

Notes:

VHF AMPLIFIER CHASSIS

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2	Wiring Diagram, Amplifier, AC Line to Neutral	30C1987 sht 1
3	'power-one' Power Supply Data	

1. Amplifier Chassis Assembly 40D2168G1 through 40D2168G3: Figure 1.

The Amplifier Chassis consists of a standard 19" rack mounted 5¼" 3U enclosure containing 2 linear power supplies, the amplifier heatsink assembly, the output directional coupler, the bandpass filter (in most models), a cooling fan, a control panel (meter and control board), an RF metering board, a line filter, and an AC relay. Its basic part number is 40D2168.

Three frequency ranges are required to cover the entire VHF television spectrum, thus there are three fundamental models of RF amplifier assemblies: for channels 2, 3, 4; channels 5, 6; and channels 7 - 13.

AC power input for the three Amplifier/ models is connected for system operation from one line to neutral, most commonly from 115 volts AC single phase.

40D2168G1	is the chassis for a 10 watt amplifier for operation on channels 7 through 13 (174-216 MHz), it has a 150 watt power supply, and its AC is connected line to neutral.
40D2168G2	is the chassis for a 10 watt Amplifier for operation on channels 2, 3, and 4 (54-72 MHz), it has a 150 watt power supply, and its AC is connected line to neutral.
40D2168G3	is the chassis for a 10 watt Amplifier for operation on channels 5 and 6 (76-88 MHz), it has a 150 watt power supply, and its AC is connected line to neutral.

Although we indicate NTSC frequency ranges, the amplifiers are capable of frequency coverage outside the ranges cited, for CCIR systems B, D, etc. transmitter applications in other regions worldwide.

Figure 1 is the fundamental assembly drawing of the chassis.

The heatsink cooling fan is a 48 volt DC "Muffin" model from Comair-Rotron; it is powered from the 48 volt amplifier power supply. As built, the cooling fan pulls warmed air from the heatsink so the cooling air enters through the perforations in the chassis front panel. This may be more convenient for a desktop cabinet arrangement, but for cabinet racks fitted with ventilation filtering, the fan can be mechanically reversed end for end, and remounted so that the fan forces air through the heatsink, from which the warmed air exhaust leaves the chassis through the front panel perforations.

A thermostat is mounted on the heatsink where operating temperature can be sampled. If this temperature should increase past the trip point of the thermostat,which is 60°C, its contacts will open and break the interlocking circuit of the transmitter or translator. The interlock circuit ultimately controls the power supply to the amplifier, and the power supply will therefore shut down and remain shut down until the heatsink cools and the contacts close again.

The chassis is wired according to one of the wiring diagram shown on Figures 2.

Chassis parts lists are provided on the last pages of this manual. The circled numbers on the assembly drawing correspond to the "symbol" item numbers on the parts list.

40D2168Gx means that the assembly can be any one of the 3 listed above, where "x" denotes the group.