LEAMING INDUSTRIES MTS-4A
BTSC STEREO GENERATOR

INSTRUCTION BOOK
IB 090941-01 C

LEAMING INDUSTRIES
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MTS-4A TABLE OF CONTENTS

1.0 QUICKSTART

This section is provided for those who want to skip directly to connecting the MTS-4A into their system. At the minimum, please see the Connection Diagrams in the Appendix at the rear of this manual, and read the remainder of this section (1.X).

1.1 Configure Video Modulator to accept BTSC Stereo in the format you wish to use. Refer to Section 3.3.

1.2 Loop baseband video through the MTS-4A on its way to the video modulator. Refer to Section 3.2.

1.3 Connect the output of the MTS-4A to your TV channel modulator (use either baseband multiplex or 4.5 MHz). Refer to Section 3.3.

1.4 Connect Program Audio to the MTS-4A. Refer to Section 3.1.

1.5 Connect AC Line Power.

1.6.1 If using Baseband Multiplex Stereo feed to audio modulator in video modulator, adjust Aural Carrier Deviation at video modulator. Refer to Section 4.1.

1.6.2 If using 4.5 MHz feed to video modulator, adjust CARRIER LEVEL output of MTS-4A. Refer to Section 4.2.

1.7 Adjust AUDIO LEVELS at MTS-4A. Refer to Section 4.4

2.0 INTRODUCTION TO THE MTS-4A

The Leaming MTS-4A provides a space-efficient means of generating high-quality TV audio in BTSC stereo format.

The MTS-4A generates the U.S. broadcast-standard BTSC format, including dbx companding. Left and Right baseband audio inputs are processed into a composite multiplex stereo signal. This signal is available from the MTS-4A both at baseband and on a 4.5 MHz carrier. Separate video sync input and 4.5 MHz audio carrier output loops are standard.

The MTS-4A has dual stereo inputs. The second input may be used for local ad insertion, or as an audio backup.

The MTS-4A includes automatic audio gain controls (AGC), which can significantly reduce the program level variations that often occur when the program source changes.

The MTS-4A displays stereo audio program levels with dual peak-reading 5-segment LED bargraphs.

In addition, for those who need a SAP generator, a SAP carrier input is provided on the MTS-4A. The Leaming SAP-1 or SAP-2 can be powered by the MTS-4A.

A Bessel-null calibration test tone is built-in to ensure a simple and accurate setup when the composite baseband interface is used.

A thorough complement of front-panel switches, level controls, and LED indicators facilitates use of the MTS-4A's features.

3.0 INSTALLATION

Refer to the CONNECTIONS drawings at the end of this book for illustrations of how the MTS-4A hooks to the other components in the system. Note that it is always necessary for the video to loop through the MTS-4A in order to phase-lock the stereo pilot to the horizontal sync of the video.

3.1 AUDIO INPUT

For signals from a balanced source, connect a shielded audio cable pair from the left channel of your stereo audio program source to the left channel of Input "A" ("A Audio In","LEFT") on the MTS-4A. Run an additional shielded cable pair from the right channel of your program source to the right "A" input ("A AUDIO IN","RIGHT"). Be sure that the + goes to the +, and the - goes to the -.

For signals from an unbalanced source, connect the high to the "+" and the shield to the "-". Also, tie the "-" to the "G" (Ground) terminal if the two chassis are not otherwise electrically grounded to each other.

NOTE: The screw-terminal strips located on the back panel of the MTS-4A may be removed (unplugged) for ease in wiring, and detachment also facilitates reading the pin identification on the rear label.

3.1.1 SECOND (B) AUDIO INPUT

"Input B" can be used for local ad insertion or backup audio. The B input is wired in the same procedure as that listed in Section 3.1, with the exception that it is wired into Input B (B Audio In) on the back of the MTS-4A, rather than Input A. See Section 4.3 for information regarding the selection of A/B inputs.

3.2 VIDEO SYNC IN CONNECTIONS

The MTS-4A's "VIDEO LOOP IN" must be connected to baseband video (unscrambled), to permit the stereo pilot within the MTS-4A to frequency-lock to it. The "VIDEO LOOP OUT" is to be connected as noted in 3.3.1, 3.3.2, or 3.3.3, depending on the format selected.

3.3 COMPOSITE BASEBAND OR 4.5 MHz FEED TO TV MODULATOR

TV channel modulators generally accept BTSC stereo in either of two common formats:

1) As a Composite (Multiplexed) Baseband "audio" or
2) On a 4.5 MHz subcarrier.

The MTS-4A provides both formats simultaneously. Either format produces satisfactory results. The selection of which format to use is dependent on what your TV modulator will accept, and which has been adopted as the preferred method in your system.

Refer to connection diagrams D2 through D4 (located at the rear of this manual)

3.3.1 BASEBAND STEREO MULTIPLEX TO TV MODULATOR

This method uses the audio modulator built into the video modulator; the 4.5 MHz modulator in the MTS-4A is not used. First, verify that your TV modulator is capable of accepting a baseband multiplex BTSC audio signal.

NOTE: All video modulators require configuration to accept a BTSC stereo multiplex signal, instead of mono audio. In most cases, this may be accomplished by re-positioning a few switches or jump-jacks in the modulator. Specifically, the 75 µS pre-emphasis, and any audio limiting, if present, must be removed. The modulator must have a wide "audio" bandwidth (flat through approx. 110 kHz). Contact your TV modulator manufacturer for configuration instructions.

Once your TV modulator has been properly configured to accept BTSC stereo as a baseband multiplex signal, refer to diagram D2 (at the rear of this manual) for an illustration of the external hookup:

Connect the "VIDEO SYNC IN" loop "OUT" on the MTS-4A to the "Video In" on your TV modulator.

Then connect a shielded audio cable from the "BTSC MULTIPLEX OUT" on the MTS-4A to the "Audio In" on the TV modulator.

NOTE: The BTSC MULTIPLEX OUTPUT of the MTS-4A is not balanced, When driving a balanced load, the + (Red) goes to the +, any one of the MTS-4A's G (Chassis Ground) terminals goes to - (Black), and another G (chassis ground) terminal goes to the shield (drain) wire.

For signals to an unbalanced load, connect the + (red, high) to the +, and the shield (and Black, if present) to "G" (Ground) terminals at both the MTS-4A and the video modulator.

NOTE: If you are using the 4.5 MHz (Audio Carrier) output of the MTS-4A, instead of the baseband multiplex output of the MTS-4A, there is no need to connect anything to the "Audio In" of the video modulator or the "BTSC MULTIPLEX OUT" on the MTS-4A.

3.3.2 4.5 MHz AUDIO CARRIER WITH VIDEO

If the TV modulator you are using accepts the 4.5 MHz audio carrier on the same cable as video, rather than on a separate cable from video, refer to diagram D3:

Connect a jumper cable from the "VIDEO SYNC OUT" of the MTS-4A to the "AUDIO CARRIER IN" of the MTS-4A.

Connect another cable from the "AUDIO CARRIER OUT" on the MTS-4A to the "Video plus 4.5 MHz Input" on your TV modulator.

NOTE: If you are using the BTSC MULTIPLEX OUT (baseband) of the MTS-4A, instead of the AUDIO CARRIER OUT (4.5 MHz) of the MTS-4A, there is no need to connect anything to the AUDIO CARRIER OUT of the MTS-4A.

3.3.3 4.5 MHz AUDIO CARRIER SEPARATE FROM VIDEO

If the TV modulator you are using requires separate video and 4.5 MHz inputs, refer to diagram D4:

Connect one cable from the "VIDEO SYNC OUT" connector on the MTS-4A to the "Video In" on the TV modulator.

Connect another cable from the "AUDIO CARRIER OUT" on the MTS-4A to the "Audio Carrier In" on the TV channel modulator. Then install a 75 ohm terminating resistor on the "AUDIO CARRIER IN" connector on the MTS-4A.

3.4 VIDEO SCRAMBLING

Because most video scramblers work at TV I.F. (45.75 & 41.25 MHz), the stereo connections are generally unaffected. However, if there is any possibility that the video is scrambled at baseband, loop the unscrambled video through the MTS-4A before the scrambler; the MTS-4A will not function properly if it is receiving sync-suppressed baseband video (i.e. the stereo pilot cannot sync to baseband-scrambled video).

4.0 OPERATION

4.1 SETTING THE AUDIO CARRIER DEVIATION

If you are using the 4.5 MHz Audio Carrier Output of the MTS-4A, its deviation has been calibrated at the factory; it is not field-adjustable. Skip to Section 4.2.

If you are using the composite baseband multiplex output of the MTS-4A, the aural carrier deviation must be accurately set at the TV channel modulator. (Otherwise, stereo channel separation will be less than optimum.)

The TEST position of the "TEST MONO STEREO" switch (located on the MTS-4A's front panel) activates a test tone, and shuts off the audio inputs, to facilitate setting the deviation of an external audio modulator.

The most convenient and accurate way of verifying correct deviation is to use the test tone and a spectrum analyzer to observe the first Bessel-null of the carrier.

As alternate methods, you may use either the meter or the peak modulation (±25 kHz) light on your TV modulator.

NOTE: If a video scrambler is being used in conjunction with the BTSC stereo generator, to avoid possible interaction with the calibration tone, the scrambler should be off or in the bypass mode while setting the audio deviation.

4.1.1 SPECTRUM ANALYZER & TEST TONE METHODS:

Move the "TEST MONO STEREO" switch to the "TEST" (left) position. Both the "A" & "B" input lights will extinguish. Using a spectrum analyzer, look at the audio carrier from your TV modulator. (For a clear picture, 20 kHz to 50 kHz resolution per division is suggested.) Using the front-panel deviation control on the TV modulator, null the carrier (to the first Bessel-null; see diagram 4-1).

To verify that the deviation is adjusted correctly, check the amplitude of the 15.734 kHz stereo pilot sidebands relative to the audio carrier. To do so, set the test switch to the "STEREO" (right) position and, at reduced audio input levels, look at the audio carrier and both sidebands using a spectrum analyzer (one sideband should be 15.734 kHz above the audio carrier and another sideband should be 15.734 kHz lower than the audio carrier). If the deviation is properly adjusted, the two sidebands should be approximately 16 dB down from the carrier (Refer to diagram 4-2). If they are not, after repeating the Bessel Null procedure, repair and calibration of the equipment is needed.

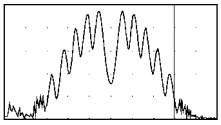


Figure 4-1A
Correct Bessel-null

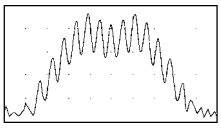


Figure 4-1B
Incorrect Bessel-null

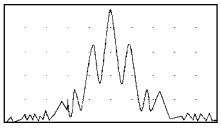


Figure 4-2
Main Audio Carrier with
Pilot Carrier Sidebands

Horizontal:

20 kHz/div

Vertical:

10 dB/div

(All Views)

4.1.2 SING THE METER OR PEAK FLASHER ON THE TV MODULATOR:

If you are using the meter on your TV modulator to set the deviation, move the "TEST MONO STEREO" switch to "TEST" (left position). Increase the Aural Carrier Deviation (not Level) until the "±25 kHz" or "100%" or "0 VU" light on the TV modulator comes on. Then, back it off until the light "just" goes off.

NOTE: If SAP or scrambling is being used, be sure that it is off or in the bypass mode while setting the deviation.

OPERATIONAL NOTE: The audio peak flasher on the TV modulator may flash during normal stereo operation, and more so if SAP is also present.

4.2 AUDIO CARRIER LEVEL ADJUSTMENT

When using the 4.5 MHz audio carrier output from the MTS-4A, the carrier level must be adjusted, generally both at the MTS-4A and at the TV modulator. In a typical case, such as when an MTS-4A feeds a Scientific Atlanta 6350, the audio carrier level is adjusted first at the MTS-4A while monitoring the TV channel output of the SA 6350 with a spectrum analyzer: Increase the carrier level at the MTS-4A until the output of the 6350 ceases to increase, indicating that the 6350 has achieved limiting. This is the optimum drive level to the 6350; less drive results in noisier audio, and more drive may splatter the audio into the video. Then adjust the Aural Carrier Level on the 6350 to set it at the desired output level, which is usually 15 dB below the (unmodulated) video carrier.

4.3 "A"/"B" AUDIO INPUTS

LEDS indicate which input is active, as selected remotely, or by the front-panel switch (which can enable or override the remote control). If power is applied, and

neither "A" nor "B" is illuminated, the MTS-4A's TEST/MONO/STEREO switch is in Test mode.

4.3.1 LOCAL & REMOTE AUDIO INPUT SELECTION:

Selection of "A" or "B" inputs may be accomplished either locally, or remotely. The "A" and "B" positions of the front panel switch will override remote A/B control.

By grounding a line connected to the A/B terminal on the rear panel of the MTS-4A, if the front-panel switch is in the center "REM" position, the "B" inputs will be selected.

The "REM" terminal is normally pulled to +5 volts by a resistor; any switch, relay, or appropriate logic device capable of sinking 0.5 mA and pulling the line to within a volt of ground may be used.

4.4 STEREO AUDIO LEVELS and AGC CONSIDERATIONS

The MTS-4A is furnished with two sets of level controls on the front panel: "A LEVEL" "LEFT" & "RIGHT" and "B LEVEL" "LEFT" & "RIGHT". Stereo audio program levels are monitored with dual peak-reading LED bargraph meters.

While listening to the audio program, with the audio AGC OFF, use a small flat-blade screwdriver thru the front-panel access holes to adjust the corresponding level controls so that both the left and the right meters read approximately 0 VU (regular flashes of the yellow LEDs on program peaks). The red +3 VU LEDs may flash briefly with very loud program peaks.

NOTE: It is recommended that the program be listened to while adjusting the audio level controls, to ascertain that the peak indicators are flashing only on material that is intended to be loud.

If desired, the audio AGC may be switched on after setting the audio levels. There should be no significant level change during normal program, but any over-modulation will be quickly reduced (within milliseconds); conversely, prolonged under-modulation will be gradually increased. The under-modulation correction is 1:2 dB; that is, if the 15-second time-averaged peak input level drops 10 dB, the peak output level will drop only 5 dB. The maximum under-modulation gain increase is limited to approximately 12 dB, in order to avoid increasing background noise excessively.

4.5 AUDIO AGC ON INDICATOR:

When the audio AGC is on, the AGC ON LED is illuminated whenever the incoming audio program level is within the normal range of the AGC, where the AGC can "silently" maintain good program dynamics.

The AGC ON LED may dim if the program level remains very low for approx. 15 seconds or more. If the AGC ON LED dims regularly, listen to the audio program to determine whether or not it is intended to be very quiet. If not, re-adjust the appropriate front-panel potentiometers so that the LED is usually illuminated.

If the incoming program level increases substantially from the initial setting, the yellow 0 VU LED may remain steadily illuminated, indicating that the audio AGC is maintaining a relatively constant peak output level. If the yellow 0 VU LED is on steadily, or for a significant time, the input level should be manually reduced somewhat with the appropriate front-panel potentiometers, in order to maintain optimum program dynamics.

In general, when the AGC is on, the ON LED should always be fully illuminated, unless there has been at least 15 seconds of near-silence (signal peak levels over 20 dB below the recent peak levels), in which case the ON LED will dim. At that time, the AGC will return to its standby gain setting, awaiting the arrival of program material, at which time it will automatically re-activate.

Whenever setting the audio levels, observe the VU indicators, and listen to and watch the program, to ensure that the adjustments you are making are appropriate. Unless you are compensating for a known problem elsewhere, mechanically position the Left and Right potentiometers identically to maintain normal channel balance.

4.6 STEREO / VIDEO SYNC LED

The STEREO LED, on the front panel beside the "TEST MONO STEREO" switch, will dim if the MTS-4A has lost video sync. The MTS-4A will continue to produce the BTSC signal, but the stereo image may shift slightly. If the Stereo LED dims, the cabling between the video source and the MTS-4A should be checked.

5.0 SPECIFICATIONS

Frequency Response Stereo:	(overall) 20 Hz to 14 kHz, ±1 dB
Distortion Stereo:	0.5% max. THD
Separation	>30 dB, 20 Hz to 10 kHz typ.; >26 dB, 20 Hz to 13.5 kHz
Signal-to-Noise Ratio	>65 dB, overall through receiver & expander
Pilot Protection	>50 dB at 15,734 Hz
Test Tone	2.5 V_{p-p} @ 10.4 kHz
Compressor, L-R	dbx licensed (BTSC Standard)
Nominal Input Level (APL)	0 dBm, adjustable ±10 dB
Peak Input Level	10 dB above nominal
Audio Input Impedance	100 k-ohms, balanced
Composite Stereo Baseband Output Level	0.1 Vp-p/kHz dev. into hi-z load (Source impedance = 75 ohms; min. load 600 ohms)
4.5 MHz Output Level	0.4 V p-p into 75-ohm loop, adjustable
4.5 MHz Freq. Tolerance	Locked to video at 286 F_H; if no video, may drop 1 kHz to 4.499 MHz.
4.5 MHz Harmonics	-50 dB re: .250 V p-p
Deviation, Peak	±25 kHz, mono ±50 kHz, stereo ±5 kHz, pilot >±100 kHz maximum
Controls (Front Panel)	AGC On/Off Input Levels, A & B, Left & Right A/B Input sw. w/ Remote position Test/Mono/Stereo switch 4.5 MHz Carrier Level

LED Indicators	Dual (L&R) Peak-reading 5-segment bargraphs, A/B Input AGC ON Stereo On
Connectors (Rear Panel)	Video (sync) Input Loop; 4.5 MHz Output Loop (Four F-type std.; BNC opt.) Audio Input A; Audio Input B; Composite Stereo Out, SAP carrier Input Remote A/B Select & Sync Output (Four detachable screw-terminal plugs)

Audio Input Connectors (Two)

PIN 1	R+
PIN 2	R-
PIN 3	G
PIN 4	L+
PIN 5	L-

BTSC Multiplex Output & SAP Carrier Input

PIN 1	SAP CXR
PIN 2	Ground-
PIN 3	BTSC MPX
PIN 4	Ground

Remote Control & Sync Output

PIN 1	A/B Input Select
PIN 2	Sync Output
PIN 3	Ground
PIN 4	18 V Output
PIN 5	Reserved

Size	1.6 inches H x 5.5 inches W x 18 inches D. Mounts on 1/3 of a PMU413 19-inch panel mount
Weight	5 lb.
Power	105-125 V, 50-60 Hz, 10 VA 210-250 VAC (factory config.)

6.0 AUDIO PERFORMANCE EVALUATION

When verifying performance specifications of the MTS-4A, be sure that none of its features interfere with the item being tested. Specifically, frequency response tests should be run with the AGC off, and at a level approximately 20 dB below 100% modulation. The reason is that the standard pre-emphasis will cause apparent frequency response errors, when running either with the AGC on, or at 100% modulation at high frequencies, due to AGC action and/or over-modulation limiting.

7.0 TROUBLESHOOTING

7.1 COMMON SETUP ERRORS

If the problem is low program level when listening in mono, but the stereo level seems OK, the phase of either the Left channel or the Right channel (but not both) needs to be reversed. Refer to sections 3.1, 4.3, and 4.4.

If the problem is somewhat excessive noise, and you are using the 4.5 MHz connection to the video modulator (not the baseband multiplex connection), the front-panel Audio Carrier Level control of the MTS-4A probably needs to be set higher. Refer to section 4.2.

If the program is overly sibilant ("hissy"; too much treble), and you are using the baseband multiplex connection to the video modulator (not the 4.5 MHz aural carrier), it is very likely that the TV modulator has not been configured to accept Baseband Multiplex Stereo. In addition, poor separation will be caused by this same error. Once the video modulator is properly configured, follow the setup instructions in section 4.1.

EXPLANATORY NOTES: The likely reason that the TV Channel Modulator may not have been configured to accept a BTSC Multiplex Stereo signal is that, when shipped from the factory, Channel Modulators are typically configured to accept Mono Program Audio, not Multiplex Stereo. Usually, it is simple to re-configure the modulator, for BTSC stereo, using its internal jumper-jacks or switches. (Refer to the Channel Modulator's instruction manual for instructions.)

Mono uses 75 microsecond pre-emphasis, and may have a 15 kHz audio low-pass filter. However, BTSC stereo requires its pre-emphasis to be in the stereo generator, not at the modulator. In addition, the modulator must have flat frequency response up to at least 50 kHz, and possibly up to 110 kHz (depending on whether SAP and PRO channels are in use).

7.2 TROUBLESHOOTING WITH A STEREO DECODER

First, determine that the MTS-4A alone is functioning normally. If you have access to a Leaming TSD (Television Stereo Decoder), or any other suitable stereo decoder, connect it directly to the output of the MTS-4A stereo generator. Follow the instructions that came with the stereo decoder.

7.2.1 USE YOUR EARS

Even if you are connecting audio-analyzer instrumentation to the stereo decoder, also listen to the stereo program from the audio outputs of the stereo decoder. Human ears can usually detect significant problems much more quickly than meters, and audible traits of the problem will generally reveal its cause.

Once the MTS-4A has been determined to be functioning normally, connect the MTS-4A back to the video modulator, and connect the stereo decoder to a monitor output of the cable system, through a set-top converter box if necessary. Repeat the performance tests. Re-read section 6.0 through 7.1.

If no professional stereo decoder is available, connect the channel to a known-good stereo TV.

Use appropriate attenuators in the line to keep from overloading the monitor's front-end.

7.3 TROUBLESHOOTING WITHOUT A STEREO DECODER

If no stereo decoder is available, but a spectrum analyzer or an oscilloscope is available, and an audio signal generator is also available, some troubleshooting is still possible.

7.3.1 TROUBLESHOOTING WITH A SPECTRUM ANALYZER

To help determine if the MTS-4A is at fault, check the 4.5 MHz output of the MTS-4A (even if you are not using it), directly at the back panel the MTS-4A, with a spectrum analyzer. Use the procedure in section 4 of this manual. If the sidebands appear as described (and illustrated if Figs. 4-1A and 4-2), the test tone and the stereo pilot of the MTS-4A are functioning correctly.

Next, while still observing the stereo pilot on the spectrum analyzer, apply audio to both Left and Right channels at 0 VU (100% modulation). The aural carrier should appear frequency-modulated, deviating ±25 kHz from the center frequency. Then turn down the audio on one channel (either

Left or Right) while leaving the other at 0 VU. Modulated Sidebands should appear, centered at approx. 32 kHz above and below the aural carrier.

Reconnect the MTS-4A into the video modulator and connect the spectrum analyzer to the channel output of the video modulator (or the cable system) and tune the spectrum analyzer to the aural carrier frequency of that TV channel. Repeat the tests from the preceding paragraph; the results should look identical, if the interface with the video modulator is correct, and if any video scrambling has been bypassed.

If these appear normal, the MTS-4A is generally functioning correctly. However, this simple test only indicates that the MTS-4A has an output which is modulated by the audio, and that the hookup to the video modulator is possibly correct. It cannot show that the internal calibration of the stereo generator is correct. For that, and to verify correct interface with the video modulator, a stereo decoder is essential.

7.3.2 TROUBLESHOOTING WITH AN OSCILLOSCOPE

If just an oscilloscope is available, it is still possible to check the basic normality of the composite baseband multiplex output of the MTS-4A.

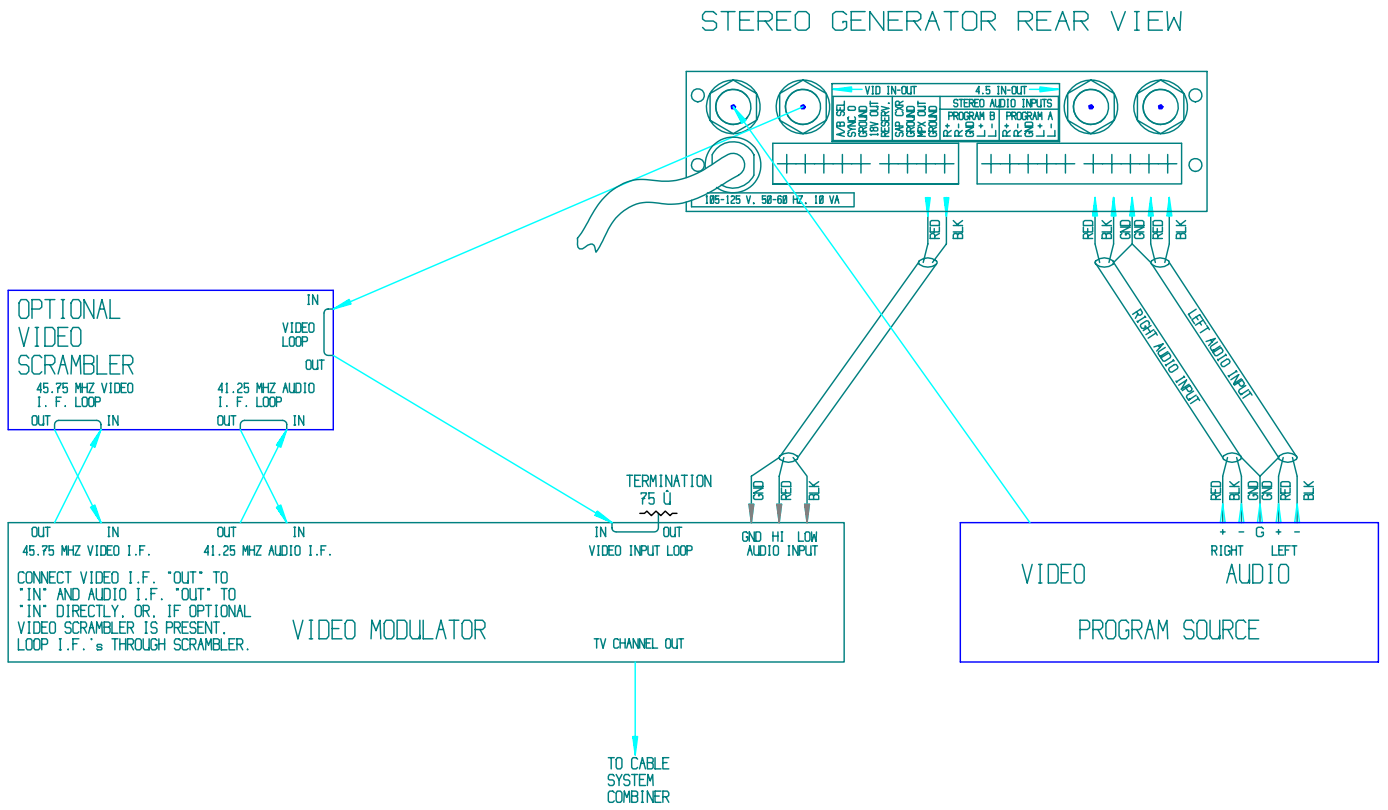
Place the "TEST MONO STEREO" switch in the "TEST" position. The output should be 10.4 kHz at 2.5 Vp-p. Next, with no audio input to the MTS-4A, move the "TEST MONO STEREO" switch to the "STEREO" position. The output should be the 15,734 Hz pilot at 0.5 Vp-p (ignore the noise peaks; read the "average" peak). The absolute values are not critical, but the 5:1 ratio is critical. If this ratio is correct, the test tone and the stereo pilot of the MTS-4A are functioning correctly.

NOTE: When in the stereo mode, the 15,734 Hz sine-wave-shape on the oscilloscope will appear slightly noisy. This is normal, caused by the difference-channel compander operating at very high gain in the absence of an audio signal.

Next, while still observing the stereo pilot on the oscilloscope, connect an audio signal generator to the Left and Right audio inputs of the MTS-4A. Set the signal generator to produce a 1000 Hz tone at approx. 1 volt RMS. Connect the oscilloscope to sync on the audio signal generator. Set the MTS-4A input level controls to cause an indication of 0 VU (100% modulation) on the MTS-4A's meters.

The baseband output should appear on the oscilloscope as a 2.5 Vp-p 1000 Hz sine wave with a 0.5 Vp-p 15,734 Hz sine wave riding on it. Then turn down the audio on one channel (either Left or Right) while leaving the

other at 0 VU. An envelope should appear on the oscilloscope similar to that above, but with an amplitude-modulated 31,468 Hz tone added (the Difference Channel Carrier). The phase and amplitude of the modulated envelope are difficult to describe, because of the effects of the dbx difference-channel companding, but if what you see resembles this, the MTS-4A does have a modulated output. For more meaningful evaluation, a stereo decoder is necessary.



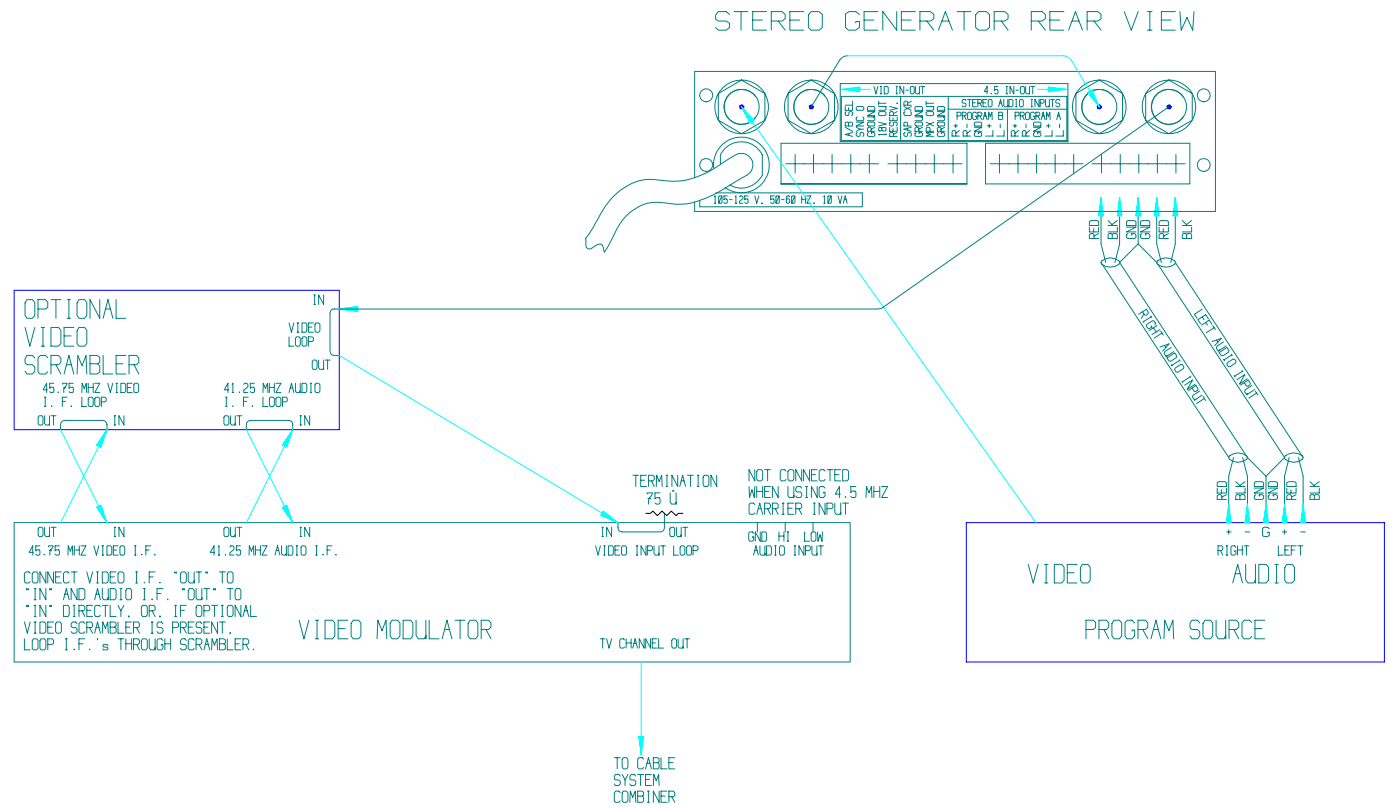
D2

STEREO @ BASEBAND (COMPOS. MPX.)
CONNECTIONS. MTS-4A TO VIDEO MOD.

LEAMING INDUSTRIES, INC.
15339 Barranca Parkway, Irvine, Calif. 92618 (949) 727-4144

BY: K.G.Rauch	DATE: 22 MAY 00	DWG.NO. ADTS4A2A	REV.
CKD: R.F.L.	DATE:	AD 030941-12	A

SYM	REVISION DESCRIPTION	REV CKD BY	DATE



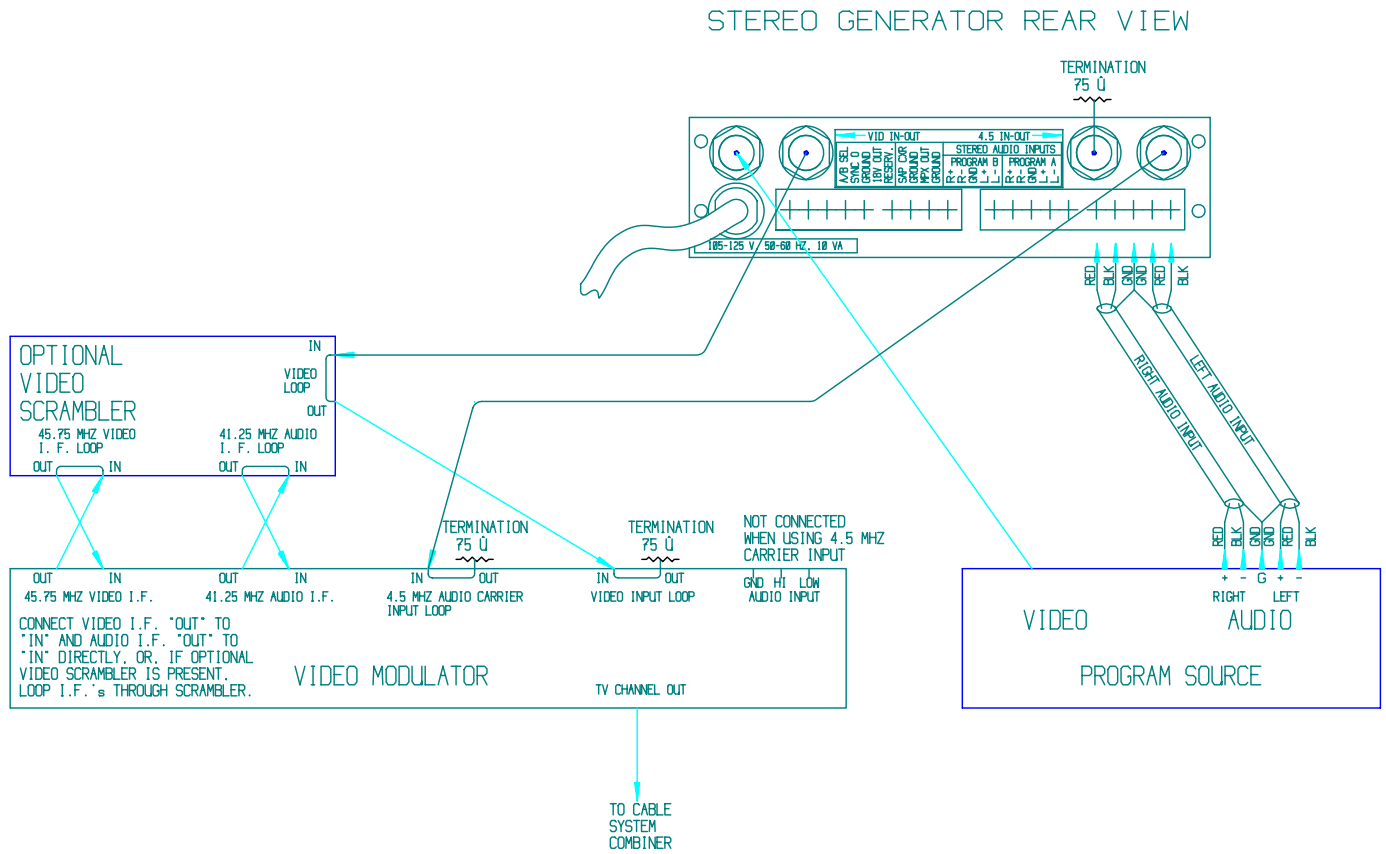
D3

STEREO @ 4.5 MHZ WITH VIDEO CONNECTIONS. MTS-4A TO VIDEO MOD.

LEAMING INDUSTRIES, INC.
15339 Barranca Parkway, Irvine, Calif. 92618 (949) 727-4144

BY: K.G.Rauch	DATE: 22 MAY 02	DWG.NO. ADTS4A3A	REV.
CKD: R.F.L.	DATE:	AD 030941-13	A

SYM	REVISION DESCRIPTION	REV CKD BY	DATE



D4

STEREO @ 4.5 MHZ SEPARATE FROM VID. CONNECTIONS. MTS-4A TO VIDEO MOD.

LEAMING INDUSTRIES, INC.
15339 Barranca Parkway, Irvine, Calif. 92618 (949) 727-4144

BY: K.G.Rauch	DATE: 22 MAY 00	DWG.NO. ADTS4A4A	REV.
CKD: R.F.L.	DATE:	AD 030941-14	A

SYM	REVISION DESCRIPTION	REV CKD BY	DATE