

MODULATION SCIENCES, INC.
MODEL CLD-2500 COMPOSITE LINE DRIVER/RECEIVER SYSTEM
OPERATING MANUAL



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1.0 INTRODUCTION

1.1 GENERAL

The Modulation Sciences CLD-2500 composite line driver system will transmit stereo composite baseband (including SCA channels) up to two miles over readily available cable without degrading signal quality. The system consists of a driver (CLD-2501), a receiver (CLD-2502), and up to 2500 feet of Belden No. 9463 or up to 4000 feet of Belden No. 9182. Cable runs up to 10,000 feet can be achieved by modifying the receiver.

One driver can handle two separate runs of different lengths, each with its own receiver. The driver can also stand alone as a composite distribution amplifier to drive four separate coaxial lines of up to 100 feet, provided that no substantial ground potential difference exists between the driver and the equipment to which it connects.

With the CLD-2500, you can:

move stereo generators, SCA generators, and composite processors from dangerous, inaccessible locations into the studio where they belong.

replace existing overly long coaxial lines to improve stereo separation and signal-to-noise ratio.

place STL transmitters and receivers near their antennas, eliminating the need for long runs of expensive semi-rigid foam coax.

distribute composite signal to testing and processing equipment within the studio or transmitter plant.

1.2 BACKGROUND

FM composite baseband is a complex signal, with a bandwidth greater than audio, yet requiring signal-to-noise figures considerably better than video. As a result, transmission over distances greater than six feet is difficult. Low capacitance cable like RG-62 extends the maximum transmission line length to about twelve feet, but this is

often inadequate.

Fiber optics, video distribution amplifiers, and new stereo generators with low output impedance have all been tried as composite line drivers, but none of these solutions have proved entirely satisfactory. With fiber optics, the drivers and receivers degrade signal quality. Video DA's offer fine high frequency response, but their low frequency roll-off causes poor separation, and they are usually too susceptible to 60 Hz hum and RF interference.

Although the low output impedance of some new stereo generators may extend the maximum coaxial transmission line length somewhat, output impedance is not the only limiting factor for a composite line driver. To drive a long line at high frequencies an amplifier must have both a high slew rate and sufficient output current to charge and discharge the capacitance of the entire length of cable. The longer the transmission line, the greater the output current required.

Ground loops present another problem in composite transmission. Ground potential differences between ends of an unbalanced coaxial line can produce substantial hum. For this reason, the CLD-2500 is balanced, and was designed to provide exceptional immunity to shield current related noise. A few stereo generators and exciters provide "floating" inputs or outputs, which does help somewhat, but not grounding the shield at one end can create severe RF interference problems, especially from AM broadcast energy. Here too, the longer the transmission line, the greater the problems.

1.3 OPERATION

The CLD-2500 features a high-current, balanced, impedance matched driver coupled to twinax line. At the receiver end, the cable is terminated and an active circuit translates the balanced twinax circuit to a coax drive suitable for the short run to the exciter. (For further details on the twinax cable, see section 3.1, CABLE SELECTION.) Isolated, single-ended test outputs are provided on the front panel of both the receiver and the driver.

In order to insure that the CLD-2500 system will never be the weak link in the air chain, it was designed to provide phase and frequency linearity sufficient to support stereo performance well in excess of that which can be achieved by the best existing equipment. Distortion and noise figures are likewise superior to those of even the

most advanced systems.

For more detailed, specific information, see sections 2.0, CHARACTERISTICS, and 5.0, PRINCIPLES OF OPERATION.

2.0 CHARACTERISTICS

2.1 CLD-2500 SYSTEM SPECIFICATIONS

SYSTEM CONFIGURATION: One CLD 2501 composite line driver with one or two CLD-2502 line receivers.
Driver also stands alone as composite distribution amplifier.

MAXIMUM LINE LENGTH: Belden No. 9463 (78 Ohm) - 2,500 feet
Belden No. 9182 (150 Ohm) - 4,000 feet
(Note 1)
With modified receiver - 10,000 feet

OVERALL SYSTEM GAIN: Adjustable from 0 to -20 dB

TEST CONDITIONS FOR ALL FOLLOWING SYSTEM SPECIFICATIONS:

INPUT LEVEL : 4 volts PP
GAIN : unity

TWO-TONE IM DISTORTION:

ANY 2 FREQUENCIES 50 HZ TO 53 KHZ,
1:1 @ 4 VOLTS PP TOTAL -70dB

ANY FREQUENCY 50 HZ TO 53 KHZ WITH
ANY FREQUENCY 53 KHZ TO 100 KHZ,
10:1 @ 4 VOLTS PP TOTAL -70 dB

BROADBAND NOISE (20 HZ TO 100 KHZ) 85 dB below 4 volts PP

60 HZ COMMON MODE REJECTION 95 dB nominal
70 dB at temp extremes

60 HZ SHIELD CURRENT NOISE REJECTION Shield current: 0.5 A
(WITH 500 FEET OF BELDEN NO. 9463) (Note 2)
Output noise: 66 dB
below 4 volts PP

Note 1: Termination resistors in both driver and receiver must be changed to use No. 9182 cable.

Note 2: This is an extreme figure. Normally shield currents of only a few milliamps would be expected, in which case output noise resulting from shield current would be virtually impossible to detect.

CABLE LENGTH (NO. 9463)	NONE	1,000 FEET (Note 1)	2,500 FEET (Note 1)
FREQUENCY RESPONSE (DC TO 53 KHZ)	+/- .01 dB	+/- .02 dB	+/- .03 dB
DIFFERENTIAL TIME DELAY RELATIVE TO 38 KHZ AT:			
1 KHZ	- 40 nS	+ 10 nS	+ 20 nS
10 KHZ	- 10 nS	+ 30 nS	+ 20 nS
19 KHZ	- 5 nS	+ 10 nS	- 15 nS
53 KHZ	+ 5 nS	+ 10 nS	- 40 nS
STEREO SEPARATION AT: 1 KHZ	> 60 dB	> 60 dB	55 dB
15 KHZ (Note 2)	> 60 dB	55 dB	45 dB

Note 1: All specifications relating to system with cable were measured with HF compensation control adjusted.

Note 2: Separation figures were calculated from measured amplitude and delay response, assuming an ideal stereo composite input signal.

2.2 CLD-2501 COMPOSITE LINE DRIVER SPECIFICATIONS

SIZE _____ 1-3/4" x 19" rack panel with
1-3/4" H x 12" W x 5-3/4" D rear housing

POWER _____ 95 to 130 volts AC, 10 watts max.
190 to 260 volt option available

TEMPERATURE RANGE 0 to 50 degrees C.

RF PROTECTION___ All inputs and outputs RF suppressed,
power supply RF suppressed and shielded
from main circuitry

GAIN _____ Unity to all outputs

POWER INDICATOR_ Green LED

CONNECTORS/___ INPUT: Floating BNC connector
LEVELS/ 1 to 10 volts PP
IMPEDANCES 15 kOhms

TEST OUTPUT: BNC connector
1 to 10 volts PP
200 Ohms

MAIN OUTPUTS: Two D3M (XLR type male)
1 to 10 volts PP (balanced)
Impedance matched to cable type:
No. 9463 (standard): 78 Ohm
No. 9182 (special order): 150 Ohm

2.3 CLD-2502 COMPOSITE LINE RECEIVER SPECIFICATIONS

SIZE _____ 1-3/4" x 19" rack panel with
1-3/4" H x 12" W x 5-3/4" D rear housing

POWER _____ 95 to 130 volts AC, 10 watts max.
190 to 260 volt option available

TEMPERATURE RANGE 0 to 50 degrees C.

RF PROTECTION__ All inputs and outputs RF suppressed,
power supply RF suppressed and shielded
from main circuitry

GAIN CONTROL___ 20-turn trim pot
Adjusts both main and test outputs from
0 to -20 dB

HF COMPENSATION_ 1-turn trim pot
Adjusts high frequency response for
cable length

POWER INDICATOR_ Green LED

CONNECTORS/___ INPUT: D3F (XLR type female)
LEVELS/_____ 1 to 10 volts PP (balanced)
IMPEDANCES_____ Impedance matched to cable type:
No. 9463 (standard): 78 Ohms
No. 9182 (special order): 150 Ohm

TEST OUTPUT: BNC connector
1 to 10 volts PP
1 kOhms

MAIN OUTPUT: BNC connector
1 to 10 volts PP
180 Ohms

3.0 INSTALLATION AND SETUP

3.1 CABLE SELECTION

Although twinax cable is not common in broadcasting, the type chosen is widely used in computer data communications. Readily available and reasonably priced, it consists of a balanced twisted pair surrounded by a shielded jacket. The description may make it sound like ordinary shielded audio cable, but its characteristic impedance is much more tightly controlled, it is better shielded, and it is relatively free of periodic discontinuities. Only twinax can provide the high degree of balance needed to reject induced magnetic interference as well as the shielding needed to reject electrical interference such as RF.

Only two types of cable are specified as suitable for use with the CLD-2500 system. The first, the standard type, is Belden No. 9463. UNLESS OTHERWISE SPECIFIED, ALL UNITS COME EQUIPPED WITH THE CORRECT IMPEDANCE MATCHING RESISTORS FOR THIS TYPE. With 9463, transmission lines of up to 2,500 feet may be driven. The second choice is Belden No. 9182, which is heavier, more expensive, and of higher impedance, but which can accommodate runs of up to 4,000 feet. Cable lengths greater than this require factory modification of the receiver. (Available on request)

Other manufacturers make similar cable, but since the operation of the system depends upon the loss versus frequency and impedance versus frequency curves of the particular type of cable employed (both of which curves may vary widely between two cable types of identical nominal impedance), NO OTHER TYPE OF CABLE SHOULD BE SUBSTITUTED, even if it is described as "interchangeable" with one of the specified types.

If you feel you must use a type of cable other than those specified, consult the factory.

3.2 CABLE WIRING

The twinax cable is handled very much like shielded audio cable. After the outer jacket is removed the braided shield and the drain wire should be combined together and the foil shield should be removed. The shield/drain wire

goes to pin 1 of the Switchcraft connector and the two inner conductors go to pins 2 and 3. The color code used is not important except that both ends of the cable should be wired to the same color code. In general the shell of the connector should not be tied to shield unless you have connectors installed in the middle of the cable run; if this is the case the shell may be tied to shield as long as the outside of the shell cannot come in contact with ground.

3.3 LEVEL AND HF COMP ADJUSTMENT

The input level to the Composite Line Driver should be as high as possible up to a maximum of 6 volts peak to peak. This generally means that the output level control on the signal source should be turned all the way up. The Driver unit has unity gain both to the test output on the front panel and to the twinax cable. The output level control on the Receiver unit should be used to reduce this level to match the input requirement of your exciter.

NOTE: If you are using less than 100 feet of cable, set the HF COMP pot to the fully counter-clockwise position and ignore the remainder of this section.

The HF COMP control is an adjustable high frequency equalizer used to compensate for losses in the cable. The easiest way to set it is to first observe the composite signal at the TEST jack on the Driver unit. Connect an oscilloscope to the TEST jack and drive the stereo generator with a sine wave on the Left channel only at 10 kHz. Adjust the stereo generator for the best possible signal (flattest baseline) at this point. Then take the oscilloscope to the Receiver unit and connect it to the test jack. Adjust the HF COMP control until the signal resembles as closely as possible the signal previously observed at the Driver unit.

WARNING:

Do not use a 10X probe on the scope when measuring separation. If the probe is not perfectly compensated the separation measurement may be seriously in error. Connect the composite signal directly to the scope input with a short length of coax cable.

If you have equipment capable of measuring frequency response out to 53 kHz with an accuracy of at least 0.05 dB, an alternate to the above method is to adjust the HF COMP control for the flattest frequency response out to 53 kHz. The Composite Line Driver system when properly equalized should have response within +/- 0.05 dB from DC to 53 kHz.

Frequency response beyond 53 kHz will be less flat, but more than adequate for SCA transmission. (Frequency response at 100 kHz = -1 dB, worst case)

Once you have adjusted the HF COMP control, any further adjustments necessary to optimize system performance should be made by observing the signal from your modulation monitor and adjusting the stereo generator in the normal fashion.

NOTE: See also Section 4.1, MONITORING PERFORMANCE.

4.0 MAINTENANCE

4.1 MONITORING PERFORMANCE

The single-ended test output on the front of each unit provides a convenient means of observing performance. The driver's test jack is driven by a separate differential amplifier which directly monitors the balanced output, while the receiver's test output is driven by the main output amplifier. If you wish to take measurements directly from the balanced line, you must use test equipment capable of operating in a full differential mode. Most dual trace oscilloscopes have this capability. (See your scope's owner's manual.) Do not attempt to make measurements directly on the balanced line with a meter or any other test instrument that will ground one side of the line.

4.2 FACTORY SERVICE

Each Composite Line Driver and Receiver is subjected to an extensive multi-stage test procedure, including a minimum 48-hour burn-in, before leaving the factory. Should any problems arise which cannot be corrected by simply replacing a defective op-amp (all of which are socketed for easy replacement), the unit should be returned to the factory for service, after first determining that the problem is not in some other piece of equipment. If you have any doubt as to the cause of any problem that may be associated with the CLD, the MSI engineering staff will be glad to respond to phone inquiries.

When returning your unit for service, in order to insure proper handling be sure to enclose a letter describing the nature of the malfunction, and of course your company name and shipping address. (See pages 30,31.)

In general, any failure due to defects in materials or workmanship during your first year of ownership should be covered by warranty. For full details, see "Modulation Sciences, Inc. Standard Warranty", SECTION 6.7.

4.3 FIELD REPAIR

As was mentioned above, MSI recommends that defective units be returned for factory service. If you must attempt field service, the following points should be kept in mind:

1. Some of the CLD's components are specially tested and/or matched to extremely tight tolerances. (See parts lists, SECTIONS 6.5 and 6.6 for details.) Replacing any of these components by an untested equivalent may result in severely degraded performance. It is especially important that matched components be replaced in groups rather than singly. MSI will be happy to supply sets of matched components for a nominal cost, should you require them.
2. When replacing components, care should be taken not to overheat traces in de-soldering. For ease of removal, we suggest cutting component leads flush with the top of the board before attempting de-soldering (from the bottom).
3. Replacing certain components in the CLD-2502 receiver may make it necessary to retrim either the HF COMP control (front panel) or the internal trim pot which nulls the receiver's common mode rejection ratio.
4. The above information, and any other material relating to servicing, is provided as a courtesy to those who feel that they must do their own repairs. MSI assumes no liability for damage or other problems arising from attempts to service units in the field. Any attempt at user servicing will void the warranty on that unit, although MSI will of course continue to provide non-warranty service at prevailing rates.

The following sections provide information on the CLD-2500's operation. We will be glad to respond to phone inquiries for additional information relating to particular problems that may arise.

5.0 PRINCIPLES OF OPERATION

5.1 GENERAL

The drive amplifiers are custom designed hybrid amplifiers which drive the twinax through precision impedance matching resistors. The CLD-2501 driver provides two independent outputs. Thus one driver can feed two cables, each driving a different exciter. Each cable may be any length up to 2,500 feet and still maintain performance equal to the best stereo generator. With factory modification of the CLD-2502 receiver equalizer, as much as 10,000 feet of cable may be used. Locating both system gain control and high frequency compensation in the receiver allows one driver to handle two dissimilar transmission lines.

The input to the driver is a floating BNC connector. A grounded, isolated BNC output is provided on the front panel for test purposes. A separate differential amplifier is used to drive this output so that the signal may be monitored after the balanced output amplifiers.

The connector chosen for the twinax is a standard XLR. It is well shielded, has controlled grounding, is readily available, and costs a small fraction of what RF type twinax connectors do. Also, assembly is relatively easy.

The receiver terminates the twinax, has an isolation amplifier, and provides a low impedance output on a grounded BNC connector. In addition, a grounded BNC connector on the front panel provides a separately isolated test output. The output level is adjustable by means of a 20 turn trim pot to provide a system gain of 0 to -20 dB.

5.2 CLD-2501 LINE DRIVER CIRCUIT DESCRIPTION

Input jack J4 floats, its shell isolated from ground by R4. RF bypassing is provided by capacitors C101 thru C103. Input amplifiers U1 and U3 drive output amplifiers U2 and U4. Precision 0.1% matched resistors set the gains to both phases of the balanced outputs, J1 and J2. Test output amplifier U5 monitors the main output thru resistors R19 and R20, providing an isolated, grounded output to the front test jack, J4. There are no trim pots, resistors selected on test, or any other form of trimming in the driver.

Output impedance matching resistors R11 thru R18 vary in value depending on which type of cable is used. For No. 9463, all 8 resistors are present, and each is 78.7 Ohms. For No. 9182, only one resistor is used in each output leg, and the value is 75.0 Ohms.

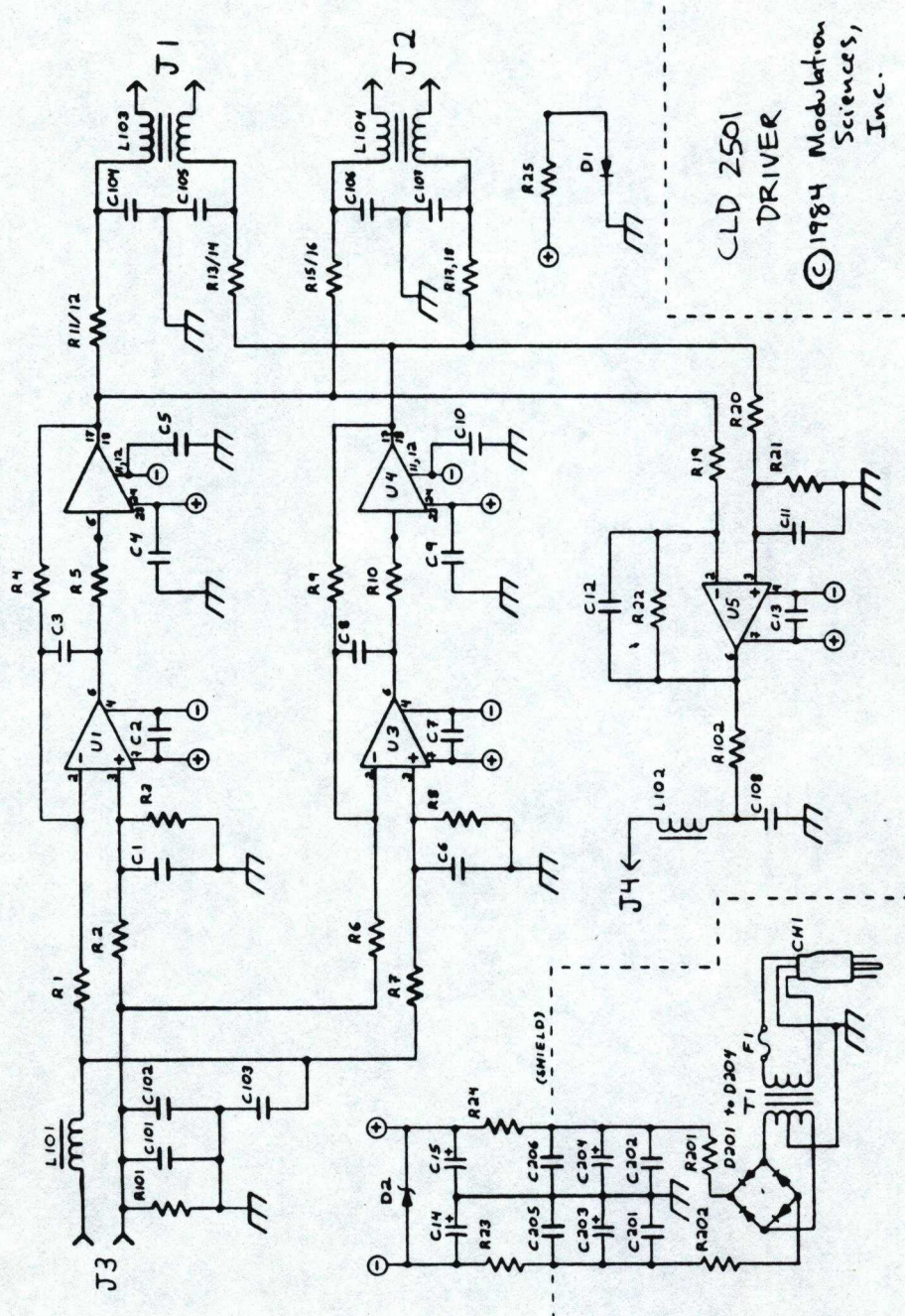
5.3 CLD-2502 LINE RECEIVER CIRCUIT DESCRIPTION

Input amplifier U1 changes the signal received thru input jack, J1, from balanced to unbalanced. Internal trim pot RV1 nulls the common mode gain of this differential input stage. Front panel 20-turn trim pot RV2 adjusts the overall gain. The network composed of R11, C5, R12, and front panel single-turn trim pot RV3 adjusts the high frequency response to compensate for cable losses. It is this portion of the circuit which must be replaced by a more sophisticated equalizer when lines longer than 2,500 feet are to be used.

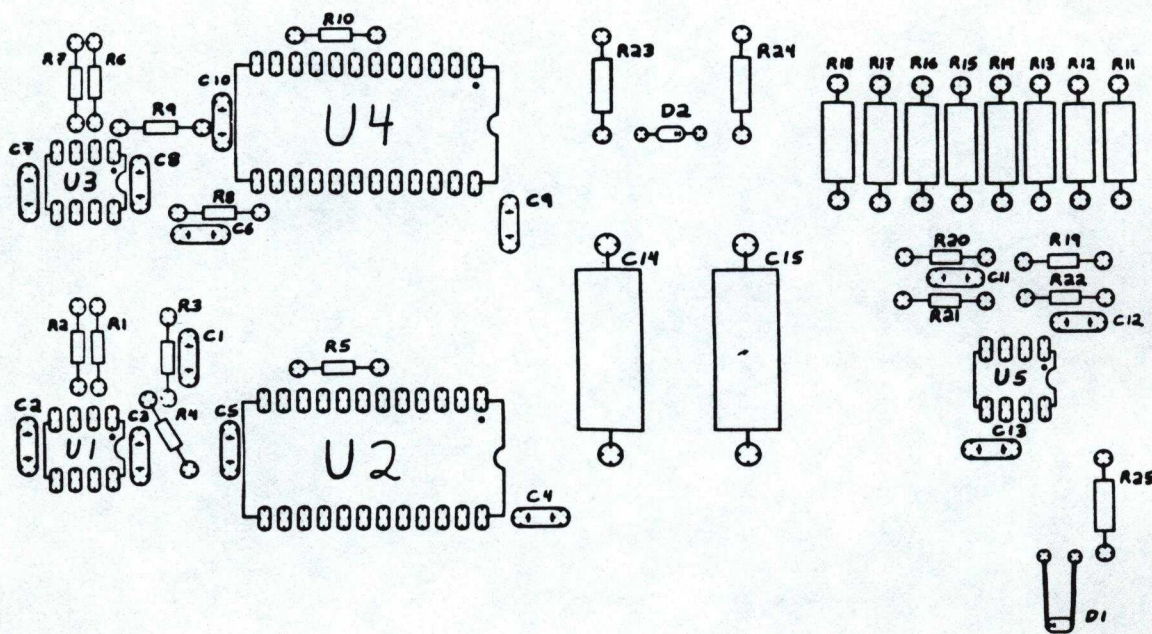
Output amplifier U2 drives main output J2 and test output J3, which are resistively isolated.

6.0 DIAGRAMS AND SUPPLEMENTARY INFORMATION

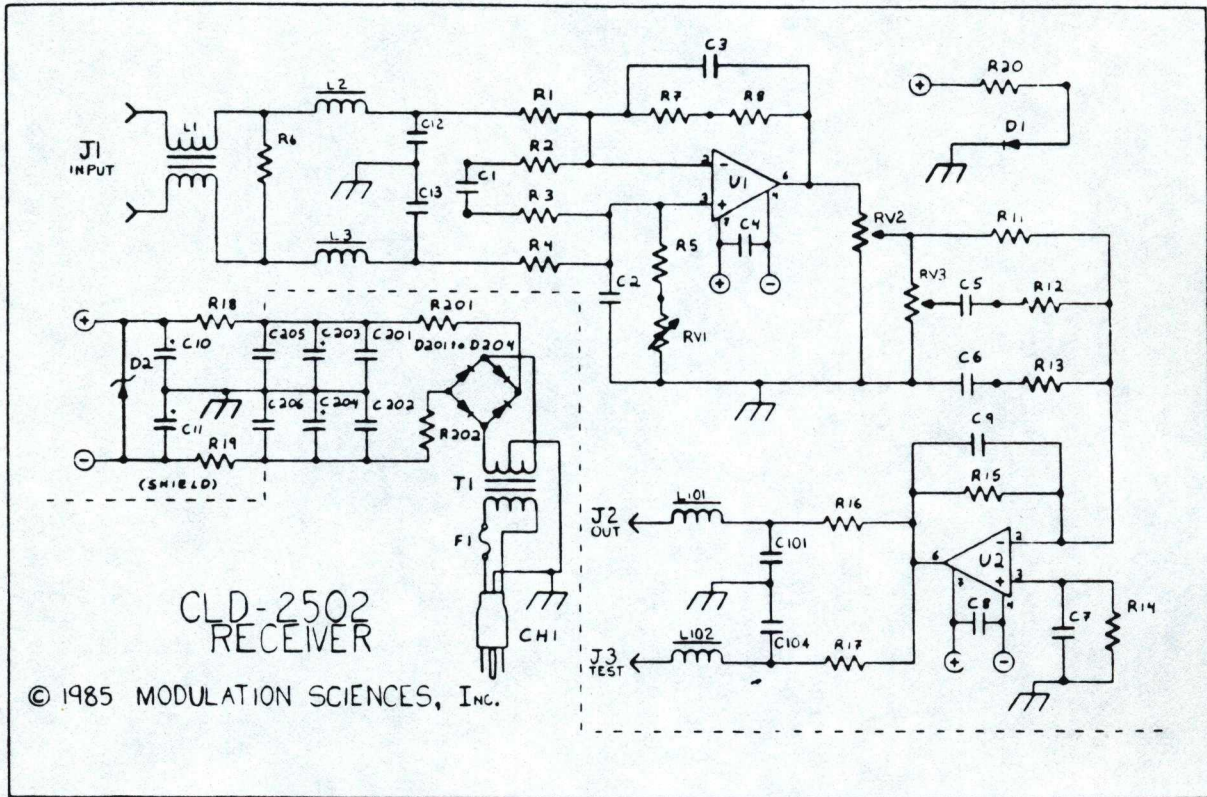
6.1 CLD-2501 SCHEMATIC



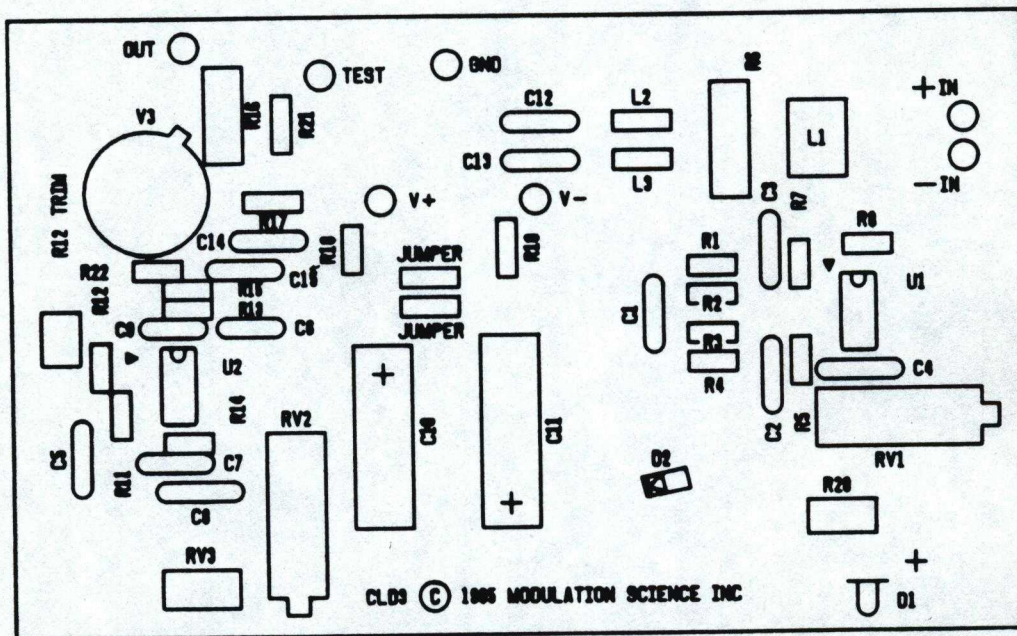
6.2 CLD-2501 PARTS LAYOUT



6.3 CLD-2502 SCHEMATIC



6.4 CLD-2502 PARTS LAYOUT



6.5 CLD-2501 PARTS LIST

PART	DESCRIPTION	MFR PART NO	MANUFACT
C 1	5 PF DISC	DD-050	CENTRALAB
C 2	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 3	5 PF DISC	DD-050	CENTRALAB
C 4	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 5	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 6	5 PF DISC	DD-050	CENTRALAB
C 7	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 8	5 PF DISC	DD-050	CENTRALAB
C 9	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 10	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 11	5 PF DISC	DD-050	CENTRALAB
C 12	5 PF DISC	DD-050	CENTRALAB
C 13	.01 UF 50 V 10% MC	CW20C103K	CENTRALAB
C 14	500 UF 50 V AE	39D507G050GL4	SPRAGUE
C 15	500 UF 50 V AE	39D507G050GL4	SPRAGUE
C 101	1 NF 10% DISC	CE102	CENTRALAB
C 102	.05 UF 50 V DISC	TCD-503Z	ARCO
C 103	120 PF DISC	10TST12	SPRAGUE
C 104	150 PF DISC	10TST15	SPRAGUE
C 105	150 PF DISC	10TST15	SPRAGUE
C 106	150 PF DISC	10TST15	SPRAGUE
C 107	150 PF DISC	10TST15	SPRAGUE
C 108	120 PF DISC	10TST12	SPRAGUE
C 201	.05 UF 50 V DISC	TCD-503Z	ARCO
C 202	.05 UF 50 V DISC	TCD-503Z	ARCO
C 203	1000 UF 25 V AE	1000/25/82000	SIEMENS
C 204	1000 UF 25 V AE	1000/25/82000	SIEMENS
C 205	1.5 NF FEED-THRU	357-001-X5U0-152M	TUSONIX
C 206	1.5 NF FEED-THRU	357-001-X5U0-152M	TUSONIX
CH 1	6 FOOT LINE CORD	17237B	BELDEN
D 1	GREEN LED	521-9175	DIALIGHT
D 2	33 VOLT ZENER DIODE	1N4752A	VARIOUS
D 201	RECTIFIER DIODE	1N4003	VARIOUS
D 202	RECTIFIER DIODE	1N4003	VARIOUS
D 203	RECTIFIER DIODE	1N4003	VARIOUS
D 204	RECTIFIER DIODE	1N4003	VARIOUS
F 1	.1 AMP SB FUSE	MDL 1/10	BUSSMAN
FH 1	FUSE HOLDER	HKP	BUSSMAN
H 1	CLD2501 HOUSING	CLD1-BX	MSI
J 1	3 PIN M PANEL MT XLR	D3M	SWITCHCRAF
J 2	3 PIN M PANEL MT XLR	D3M	SWITCHCRAF
J 3	LONG BUSHING BNC	KC79-46	KINGS
J 4	BNC CONNECTOR	31-221	AMPHENOL
J 5	3 PIN F CABLE MT XLR	A3F	SWITCHCRAF
L 101	FERRITE BEAD	743002121	FAIRRITEPR
L 102	FERRITE BEAD	2743002121	FAIRRITEPR

PART	DESCRIPTION	MFR PART NO	MANUFACT
L 103	FERRITE BEAD	28730024020	FAIRRITEPR
L 104	FERRITE BEAD	28730024020	FAIRRITEPR
PCB 1	PC BOARD	CLD-1	MSI
PCB 3	PC BOARD	GBU	MSI
R 1	22.1 K *	1/4 W 1 % MF	VARIOUS
R 2	22.1 K *	1/4 W 1 % MF	VARIOUS
R 3	22.1 K *	1/4 W 1 % MF	VARIOUS
R 4	22.1 K *	1/4 W 1 % MF	VARIOUS
R 5	100 OHM	1/4 W 5 % CF	VARIOUS
R 6	22.1 K *	1/4 W 1 % MF	VARIOUS
R 7	22.1 K *	1/4 W 1 % MF	VARIOUS
R 8	22.1 K *	1/4 W 1 % MF	VARIOUS
R 9	22.1 K *	1/4 W 1 % MF	VARIOUS
R 10	100 OHM	1/4 W 5 % CF	VARIOUS
R 11	78.7 OHM	1 W 1% MF	VARIOUS
R 12	78.7 OHM	1 W 1% MF	VARIOUS
R 13	78.7 OHM	1 W 1% MF	VARIOUS
R 14	78.7 OHM	1 W 1% MF	VARIOUS
R 15	78.7 OHM	1 W 1% MF	VARIOUS
R 16	78.7 OHM	1 W 1% MF	VARIOUS
R 17	78.7 OHM	1 W 1% MF	VARIOUS
R 18	78.7 OHM	1 W 1% MF	VARIOUS
R 19	10.0 K	1/4 W 1 % MF	VARIOUS
R 20	10.0 K	1/4 W 1 % MF	VARIOUS
R 21	4.99 K	1/4 W 1 % MF	VARIOUS
R 22	4.99 K	1/4 W 1 % MF	VARIOUS
R 23	10 OHM	EB 1/2 W 10% CC	ALLENBRAD
R 24	10 OHM	EB 1/2 W 10% CC	ALLENBRAD
R 25	2.2 K	EB 1/2 W 10% CC	ALLENBRAD
R 101	100 OHM	EB 1/2 W 10% CC	ALLENBRAD
R 102	200 OHM	1/4 W 5 % CF	VARIOUS
R 201	2.2 OHM	1/2 W 5 % CF	VARIOUS
R 202	2.2 OHM	1/2 W 5 % CF	VARIOUS
T 1	POWER TRANSFORMER	241-4-20	SIGNAL
TS 1	6 TERMINAL STRIP	854	HHSMITH
TS 2	6 TERMINAL STRIP	854	HHSMITH
U 1	FAST OP AMP	MA325CP	ANALOGSYS
U 2	HYBRID OP AMP	MM2	MSI
U 3	FAST OP AMP	MA325CP	ANALOGSYS
U 4	HYBRID OP AMP	MM2	MSI
U 5	FAST OP AMP	MA325CP	ANALOGSYS
US 1	8 PIN EDGE GRIP SS	C930802	TEXASINST
US 2	24 PIN EDGE GRIP SS	C932402	TEXASINST
US 3	8 PIN EDGE GRIP SS	C930802	TEXASINST
US 4	24 PIN EDGE GRIP SS	C932402	TEXASINST
US 5	8 PIN EDGE GRIP SS	C930802	TEXASINST

* SPECIALLY SELECTED OR TESTED PART

QTY	DESCRIPTION	PART NO	MANUFACT
4	4/40 X 3/8" HEX SPAC	1450B	KEYSTONE
4	4/40 X 1/2" HEX SPAC	1450C	KEYSTONE
1	NYLON FLAT WASHER	2678	HHSMITH
1	NYLON SHOULDER WASH	2668	HHSMITH
21	4/40 X 1/4" SEMS	NONE	VARIOUS
4	4/40 X 1/4" SEMS	NONE	VARIOUS
4	4/40 X 1/4" SEMS	NONE	VARIOUS
4	4/40 X 1/2" SEMS	NONE	VARIOUS
4	4/40 X 1/2" FH BL OX	NONE	VARIOUS
8	4/40 X 1/4" BH	NONE	VARIOUS
2	4/40 X 3/8" BH	NONE	VARIOUS
6	4/40 HEX NUT	NONE	VARIOUS
10	NO. 4 INT LOCK WASH	NONE	VARIOUS

EXPLANATION OF ABBREVIATIONS:

- AE: ALUMINUM ELECTROLYTIC
- BH: BINDING HEAD
- CC: CARBON COMPOSITION RESISTOR
- CF: CARBON FILM RESISTOR
- DT: DIP TANTALUM CAPACITOR
- LH: LEFT HAND
- LW: LOCK WASHER
- MF: METAL FILM RESISTOR
- MC: MONOLYTHIC CERAMIC
- PHIL: PHILLIPS HEAD
- RH: RIGHT HAND
- SB: SLOW BLOW
- SM: SILVER MICA
- SS: SOLDER SOCKET

NOTE: Information relating to specific part numbers and manufacturers is provided only as a courtesy, and is subject to change without notice. When ordering from MSI, specify component number(s).

6.6 CLD-2502 PARTS LIST

PART	DESCRIPTION	MFR PART NO	MANUFACT
C 1	5.6 NF 100 V 10% MC	CW15A562K	CENTRALAB
C 2	5 PF DISC	CMC050C	MALLORY
C 3	5 PF DISC	CMC050C	MALLORY
C 4	.1 UF 50 V 20% MC	C20C104M5UICA	MALLORY
C 5	100 PF 5% SM	DM15FD101J03	VARIOUS
C 6	5.6 NF 100 V 10% MC	CW15A562K	CENTRALAB
C 7	2.7 NF DISC	SM272K	MALLORY
C 8	.1 UF 50 V 20% MC	C20C104M5UICA	MALLORY
C 9	3.3 PF DISC	DD3R3	CENTRALAB
C 10	100 UF 25 V AE	TE 1211	SPRAGUE
C 11	100 UF 25 V AE	TE 1211	SPRAGUE
C 12	120 PF DISC	CCD 121	ARCO
C 13	120 PF DISC	CCD 121	ARCO
C 101	120 PF DISC	CCD 121	ARCO
C 102	56 PF 5 % COG DISC	CEC560J	MALLORY
C 201	.05 UF 50 V DISC	CZ20473M	CENTRALAB
C 202	.05 UF 50 V DISC	CZ20473M	CENTRALAB
C 203	1000 UF 25 V AE	39D108G025GL4	SPRAGUE
C 204	1000 UF 25 V AE	39D108G025GL4	SPRAGUE
C 205	1.5 NF FEED-THRU	357-001-X5U0-152M	TUSONIX
C 206	1.5 NF FEED-THRU	357-001-X5U0-152M	TUSONIX
CH 1	6 FOOT LINE CORD	17237B	BELDEN
D 1	GREEN LED	521-9175	DIALIGHT
D 2	33 VOLT ZENER DIODE	1N4752A	VARIOUS
D 201	RECTIFIER DIODE	1N4003	VARIOUS
D 202	RECTIFIER DIODE	1N4003	VARIOUS
D 203	RECTIFIER DIODE	1N4003	VARIOUS
D 204	RECTIFIER DIODE	1N4003	VARIOUS
F 1	.1 AMP SB FUSE	MDL 1/10	BUSSMAN
FH 1	FUSE HOLDER	HKP	BUSSMAN
H 1	CLD2502 HOUSING	CLD3-BX	MSI
J 1	3 PIN F PANEL MT XLR	D3F	SWITCHCRAF
J 2	BNC CONNECTOR	31-221	AMPHENOL
J 3	BNC CONNECTOR	31-221	AMPHENOL
J 4	3 PIN M CABLE MT XLR	A3M	SWITCHCRAF
L 1	FERRITE BEAD	28730024020	FAIRRITE
L 2	FERRITE BEAD	2743002111	FAIRRITE
L 3	FERRITE BEAD	2743002111	FAIRRITE
L 101	FERRITE BEAD	2743002111	FAIRRITE
L 102	FERRITE BEAD	2743002111	FAIRRITE
PCB 1	PC BOARD	CLD3	MSI
PCB 2	PC BOARD	UPS-6	MSI
PCB 3	PC BOARD	GBU	MSI
R 1	10.0 K *	RN55CF	MILITARY
R 2	2.7 K	1/4 W 5 % CF	VARIOUS
R 3	2.7 K	1/4 W 5 % CF	VARIOUS

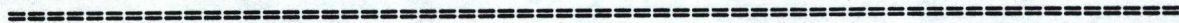
PART	DESCRIPTION	MFR PART NO	MANUFACT
R 4	10.0 K *	RN55CF	MILITARY
R 5	10.0 K *	RN55CF	MILITARY
R 6	78.7 OHM	RN65CF	MILITARY
R 7	10.0 K *	RN55CF	MILITARY
R 8	49.9 OHM	1/4 W 1 % MF	VARIOUS
R 11	10.0 K	RN55CF	MILITARY
R 12	28.7 K	1/4 W 1 % MF	VARIOUS
R 13	5.6 K	1/4 W 5 % CF	VARIOUS
R 14	5.6 K	1/4 W 5 % CF	VARIOUS
R 15	10.0 K	1/4 W 1 % MF	VARIOUS
R 16	180 OHM	1/4 W 5 % CF	VARIOUS
R 17	1 K	1/4 W 5 % CF	VARIOUS
R 18	27 OHM	EB 1/2 W 10% CC	ALLENBRAD
R 19	27 OHM	EB 1/2 W 10% CC	ALLENBRAD
R 20	2.2 K	EB 1/2 W 10% CC	ALLENBRAD
R 201	2.2 OHM	1/2 W 5 % CF	VARIOUS
R 202	2.2 OHM	1/2 W 5 % CF	VARIOUS
RV 1	100 OHM 20-T TRIMPOT	3006P1-101	BOURNS
RV 2	2K 20-T TRIMPOT	3006P1-202	BOURNS
RV 3	5K UPRIGHT TRIMPOT	3386W1-502	BOURNS
RVC 2	20-T TRIMPOT COVER	H-83-P	BOURNS
T 1	POWER TRANSFORMER	4-06-4-020	MAGNETCOIL
U 1	OP AMP	LM318N	NATIONAL
U 2	OP AMP	OP-17FJ	PRECMONOLI
US 1	8 PIN EDGE GRIP SS	C930802	TEXASINST
US 2	8 PIN MACHINE PIN SS	ICO-308-SGT	SAMTEC

* SPECIALLY SELECTED OR TESTED PART

QTY	DESCRIPTION	PART NO	MANUFACT
5	4/40 X 3/8" HEX SPAC	1450B	KEYSTONE
4	4/40 X 1/2" HEX SPAC	1450C	KEYSTONE
5	4/40 X 1/4" SEMS	NONE	VARIOUS
4	4/40 X 1/4" SEMS	NONE	VARIOUS
22	4/40 X 1/4" SEMS	NONE	VARIOUS
4	4/40 X 1/2" SEMS	NONE	VARIOUS
4	4/40 X 1/2" FH BL OX	NONE	VARIOUS
8	4/40 X 1/4" BH	NONE	VARIOUS
2	4/40 X 3/8" BH	NONE	VARIOUS
6	4/40 HEX NUT	NONE	VARIOUS
10	NO. 4 INT LOCK WASH	NONE	VARIOUS

EXPLANATION OF ABBREVIATIONS:

- AE: ALUMINUM ELECTROLYTIC
- BH: BINDING HEAD
- CC: CARBON COMPOSITION RESISTOR
- CF: CARBON FILM RESISTOR
- DT: DIP TANTALUM CAPACITOR
- LH: LEFT HAND
- LW: LOCK WASHER
- MF: METAL FILM RESISTOR
- MC: MONOLYTHIC CERAMIC
- PHIL: PHILLIPS HEAD
- RH: RIGHT HAND
- SB: SLOW BLOW
- SM: SILVER MICA
- SS: SOLDER SOCKET



NOTE: Information relating to specific part numbers and manufacturers is provided only as a courtesy, and is subject to change without notice. When ordering from MSI, specify component number(s).

6.7 MODULATION SCIENCES, INC. STANDARD WARRANTY

FOR A SUMMARY OF THIS TEXT AND INFORMATION ON OBTAINING WARRANTY SERVICE, PLEASE SEE PAGES FOLLOWING THIS WARRANTY.

SELLER warrants the products sold shall be free from defects in materials and workmanship under normal use and service for a period of one (1) year from the date of delivery when properly installed. SELLER's sole obligation under this warranty shall be limited to repair or replacement at SELLER's option of any such part or parts of the products which may prove defective under normal use and service within said one (1) year and which the SELLER's examination shall disclose to its satisfaction to have been defective. If BUYER wishes to have warranty services performed at the facilities of SELLER, BUYER shall obtain, in advance, permission to return product(s), and shall ship said product(s) properly packed and insured to the address specified. Service performed at the facilities of SELLER under this warranty shall include parts plus labor. Items returned under this warranty must be transportation prepaid unless otherwise agreed by SELLER. It is expressly agreed that SELLER's obligation to repair or replace defective parts is the sole and exclusive remedy of BUYER for breach of this warranty. UNDER NO CIRCUMSTANCES SHALL SELLER BE LIABLE FOR ANY OTHER DAMAGES, EITHER DIRECT OR CONSEQUENTIAL.

SELLER may, from time to time, make certain representations concerning the compliance of its products with the Rules and Regulations of particular governmental agencies. No such representation can be a basis of the bargain unless it is in writing, by an authorized representative of SELLER. Should this representation be found to be untrue, BUYER's sole remedy is the right of rescission, at BUYER's option. Under no circumstances shall SELLER be liable for any other damages, either direct or consequential.

THE WARRANTY TO REPAIR OR REPLACE DEFECTIVE PARTS AND THE REPRESENTATION OF COMPLIANCE WITH GOVERNMENTAL RULES AND REGULATIONS, WHEN GIVEN IN WRITING, ARE EXPRESSLY IN LIEU OF AND HEREBY IN DISCLAIMER OF ALL OTHER EXPRESS WARRANTIES, AND ARE IN LIEU OF AND IN DISCLAIMER AND EXCLUSION OF ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AS WELL AS ALL OTHER IMPLIED WARRANTIES, IN LAW OR EQUITY, AND OF ALL OBLIGATIONS OR LIABILITY ON SELLER'S PART. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION HEREOF.

SELLER neither assumes nor authorizes any person to assume for it any liability or obligation in connection with the sale of SELLER'S product except said repair or replace-

ment of the defective part and, when given, compliance with the applicable governmental agency Rules. SELLER'S liability does not include any labor charges for replacement of parts, adjustments, repairs or any other work done outside SELLER'S factory and SELLER'S LIABILITY DOES NOT INCLUDE ANY CONSEQUENTIAL OR RESULTING DAMAGE TO PERSON, PROPERTY, EQUIPMENT, GOODS, MERCHANDISE, PROFITS, GOODWILL OR REPUTATION ARISING OUT OF ANY DEFECT IN OR FAILURE OF SELLER'S PRODUCTS. SELLER'S obligation to repair or replace shall not apply to any product(s) which shall have been repaired or altered outside SELLER'S factory in any way, or which shall have been subject to negligence, misuse, unauthorized alteration or abuse.

SELLER'S warranty runs only to the FIRST END USER and does not extend, expressly or by implication, to any other person. No claim under this warranty will be allowed for materials damaged in transit. Expenses incurred in connection with claims for which SELLER is not liable hereunder will be charged to BUYER. SELLER shall not be responsible for any field repairs performed by BUYER unless such work is authorized in writing by SELLER.

Summary of:
MODULATION SCIENCES, INC. STANDARD WARRANTY
Effective April 1, 1982

NOTE: This is not the warranty. It is the summary of MSI's standard warranty and a description of how to obtain warranty service. The current, actual warranty is printed in its entirety on the preceding pages and supercedes warranty information which may be found elsewhere.

1. WHO RECEIVES WARRANTY PROTECTION?
Modulation Sciences' standard warranty protects the original end-user purchaser of record, but does not apply to subsequent owners.
2. WHAT DOES THE WARRANTY COVER?
Modulation Sciences agrees to repair or replace at its expense any unit which has a defect in materials or workmanship for a period of one (1) year after the date of sale to the original end-user purchaser. This warranty includes all parts, labor, calibration, and packing.
3. WHAT DOESN'T THE WARRANTY COVER?
MSI's warranty does not cover:
 1. Freight and insurance charges paid by the purchaser in returning the unit for repair.
 2. Defects which result from modifications or repairs to the unit not made by or authorized in writing by Modulation Sciences.
 3. Compensation for incidental or consequential damages resulting from any defect.
 4. Trivial or cosmetic defects which do not affect the unit's ability to function normally.

4. HOW IS THE WARRANTY PERIOD COMPUTED?

The warranty period begins on the date of delivery to the original end-user purchaser and is in effect for the next 365 days. The starting date is deemed to be the date on the invoice from Modulation Sciences, its agent, dealer, or distributor to the first end-user purchaser. Do not lose your invoice; it is your way to establish your warranty is still in force.

5. WHAT IF THE UNIT CANNOT BE REPAIRED OR IS TOO EXPENSIVE TO REPAIR?

If Modulation Sciences decides not to repair or replace a given unit, Modulation Sciences agrees to refund to the first end-user purchaser its full purchase price. Payment of that amount will end MSI's responsibilities and Modulation Sciences may keep the unit.

6. HOW IS WARRANTY SERVICE OBTAINED?

To claim your rights under this warranty:

1. Contact the dealer or distributor from whom this product was purchased. Describe the problem and ask if there is an easy solution.
2. If your dealer cannot help, contact Modulation Sciences' service department at the number given on page 1 of this manual and explain the problem. If the unit requires factory service, you will be given a return authorization number.
3. When you have your return authorization number, you may return the unit. Pack it carefully for shipment, preferably using the original shipping carton and packing materials. ASSUME THAT THE BOX WILL BE DROPPED SEVERAL TIMES DURING SHIPMENT. USE UPS OR SOME OTHER PRIVATE CARRIER YOU KNOW TO BE RELIABLE. DO NOT USE THE POSTAL SERVICE. The risk of loss is yours; Modulation Sciences will not be responsible for damage or loss until the package is received by Modulation Sciences. INSURE THE UNIT FOR ITS FULL REPLACEMENT VALUE. SHIP THE UNIT PREPAID TO THE ADDRESS SPECIFIED WHEN YOU RECEIVE YOUR RETURN AUTHORIZATION, AND BE SURE TO ENCLOSE A NOTE GIVING THE FOLLOWING INFORMATION:

1. Your company name and shipping address (not a P.O. Box)
2. Your return authorization number
3. A copy of your original invoice establishing the starting date of your warranty
4. As full a description as possible of the problem(s)

