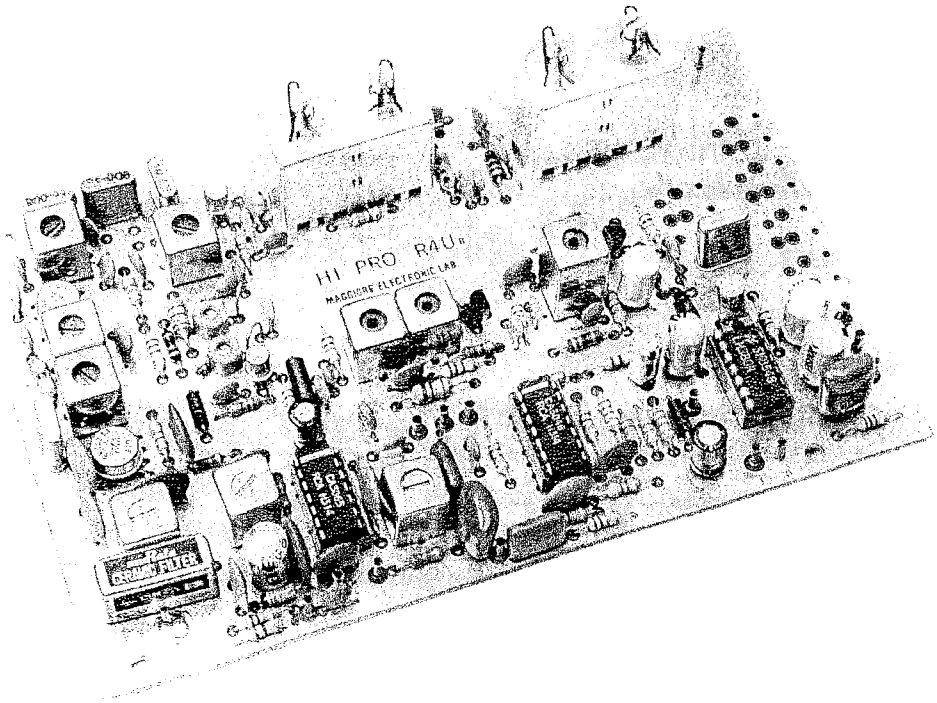
MAGGIORE ELECTRONIC LABORATORY

Hi Pro

OPERATING AND MAINTENANCE MANUAL



Hi Pro R4U RECEIVER

CONTENTS

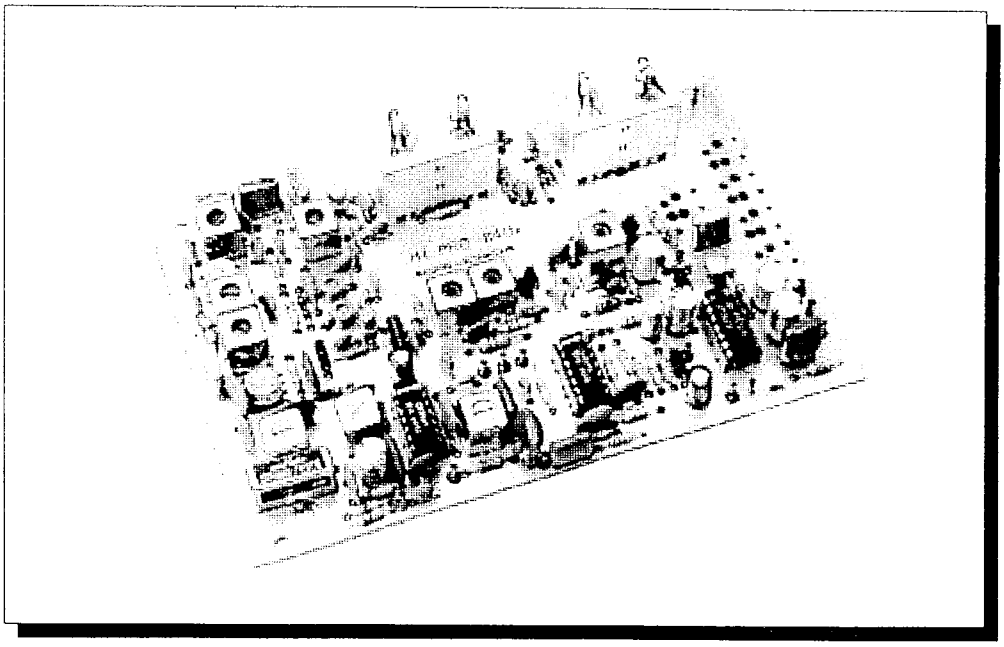
1-1. DESCRIPTION. Maggiore Electronic Laboratory's model R4U receiver is a solid-state complete self-contained unit designed to provide reliable and versatile FM communications in the UHF frequency range. The receiver is narrow passband.The construction is compact, lightweight, rugged and extensively shielded for severe repeater service.

1-2. APPLICATION. The unit may be used with any FM transmitters if:

(1) transmitters are tuned to the same frequency.
(2) transmitters are adjusted to the same deviation.
(3) transmitter antennas are similarly polarized.

1-3. PHYSICAL DESCRIPTION. The dimensions of the receiver are 6 3/16" long x 3 7/8" wide x 1 3/8" deep.

1-4. OPERATIONAL CHARACTERISTICS. Communication coverage in the operating frequency range of the receiver is a function of the following: antenna gain and height, terrain, receiver sensitivity, and transmitter output. Communication is generally limited to the line-of sight distance between the two antennas. Maximum range can be obtained only when both antennas are free from obstacles between them.



R4U
U H F RECEIVER

2-1. **RECEIVER SPECIFICATIONS.** Table 2-1 lists the performance specifications for the R4V.

TABLE 2-1. PERFORMANCE SPECIFICATIONS

OPERATING FREQUENCY	UHF 430 To 512 MHz. * See note below.
INPUT VOLTAGE	13.8 VDC Nominal, 11 VDC Min., 15 VDC Max.
CURRENT DRAIN	Receive standby, (squelched) 75 Ma.
OPERATING TEMPERATURE	-20°C to +60°C.
ANTENNA IMPEDANCE	50 Ohms nominal.
TYPE OF MODULATION	FM voice.
SENSITIVITY	12db Sinad: 0.25 uV typical. Squelch sensitivity: 0.15 uV.
CIRCUIT TYPE	Crystal-controlled, double conversion, multi channel.
SELECTIVITY (EIA)	Standard: 110 db min. +/- 30 KHz. Optional: 110 db min. +/- 20 KHz.
MODULATION ACCEPTANCE	Standard: +/- 6.8 KHz. Optional: +/- 5.9 KHz.
SPURIOUS & IMAGE REJECTION	90 db min.
OSCILLATOR STABILITY	Temperature compensated +/- 0.0005% (with proper crystal)
RESIDUAL HUM & NOISE	Better than 55 db down from rated output with standard signal input.
AUDIO FREQUENCY RESPONSE	Within +2 to -3 db of 6 db/octave de-emphasis characteristic from 300-3000 Hz. 1000 Hz reference.
AUDIO OUTPUT POWER	2 WATTS MAX. (8 ohm load).
AUDIO DISTORTION	Less than 8% at 1 watt output.

** Not All Frequencies Listed Are Available In the U.S.A.*

2-2. FIRST AND SECOND CONVERTER CRYSTAL SPECIFICATIONS. All of the crystal specifications for the R4Ureceiver are listed in tables 2-2 and 2-3.

TABLE 2-2. FIRST CONVERTER CRYSTAL SPECIFICATIONS

TYPE	Miniature plug-in.
HOLDER	Similar to MIL type HC-25/U.
HOLDER CAPACITY	7 pf max.
CRYSTAL CAPACITY	32 pf +/- 0.5 pf.
EFFECTIVE RESISTANCE	35 ohms max.
MODE OF OPERATION	3rd overtone, parallel resonance.
DRIVE LEVEL	1 mW.
OPERATING TEMPERATURE	-20°C to +60°C.
FREQUENCY TOLERANCE	Drift: Over temperature range shall not exceed 0.0025% (25°C reference).
CRYSTAL FREQUENCY	Determined by formula: Fx = Fc -10.7 MHz / 9 (200-250 MHz / 4) Where Fx = Crystal, 3rd overtone in MHz and Fc = Channel frequency in MHz

Note: Fc +10.7 from 406 to 440 MHz.

Not All Frequencies Listed Are Available In The U.S.A.

TABLE 2-3 SECOND CONVERTER CRYSTAL SPECIFICATIONS

HOLDER	HC-18, Wire leads.
FREQUENCY	Standard: 10.245 MHz. Alternate: 11.155 MHz.

2-3. TRANSISTOR, IC AND DIODE COMPLIMENT. Table 2-4. lists the transistors, IC's and used in the type and function of each transistor, IC and diode are listed for rapid identification. Devices may vary from model run to model run, but will not change the overall performance of the receiver or the specifications. Refer to figure #9 in the back section of this manual for component locations.

TABLE 2-4. TRANSISTOR AND DIODE COMPLEMENT

CIRCUIT SYMBOL	TYPE	FUNCTION
Q1	MRF901 OR EQUIV.	RF AMPLIFIER
Q2	2N5179 OR EQUIV.	FIRST CONVERTER
Q3	2N5179 OR EQUIV.	MULTIPLIER
Q4	2N5770 OR EQUIV.	MULTIPLIER
Q5	2N5770 OR EQUIV.	OSCILLATOR
IC-1	CA3028 OR LM3053	IF AMPLIFIER
IC-2	CA3028 OR LM3053	OSCILLATOR, LIMITER
IC-3	LM3065 OR MC1358	FM DETECTOR
IC-4	LM3046	SQUELCH AMPLIFIER
IC-5	LM-380	AUDIO OUTPUT AMP.
D-1, 2, 3	10 VOLT ZENER	VOLTAGE REGULATOR
D-4	1N4281 OR EQUIV.	METER RECTIFIER

3-1. **UNPACKING.** The equipment may be shipped in either export or domestic packing cases. In either event, carefully unpack and check the contents. Do not discard packaging material. The unit has been thoroughly tested and inspected before leaving the factory. Should any damage be apparent upon receipt of shipment, immediately report the damage to your deliverer. Do Not Attempt to Place Damaged Equipment In Service.

3-2. **PRELIMINARY PROCEDURES.** The receiver is normally furnished completely aligned and tested and a crystal may be installed if ordered with receiver. A general pre-installation checkout should be done at this time, to bench check the receiver before placing it in operation. Extensive system troubleshooting can be avoided if the receiver is bench checked prior to installation to uncover any invisible damage or misalignment incurred in shipping. If crystals were not included with the receiver, then you must install them and align the receiver as outlined in the receiver alignment instructions. Refer to the crystal specifications in this manual for the correct crystal for this receiver. Do Not Attempt To Use Other Types Of Crystals Especially If This Unit Is to Be Used In A Repeater Configuration. A wrong crystal can cause erratic operation, unwanted off frequency signals being received and severe desense.

3-3. **PRELIMINARY-INSTALLATION NOTES.** Before installing, plan the installation ahead of time, then install, keeping in mind that all controls provide easy access for the operator and service personnel. The following procedures should be used as a basic guide in planning the installation; it will vary with the types and amount of accessories you use.

a. Select the location where the receiver will be installed. Carefully avoid locations where the equipment will be subjected to heat, cold, grease or oil. Any adverse conditions will shorten the life of the receiver and impair peak operation.

b. Determine the location and proper source of power which the receiver will be operating from. Locate the receiver close to the power source, avoiding lengthy power cables which will produce a drop in voltage.

c. For fixed installation, determine the antenna site and the receiver in close proximity to the antenna to avoid excessive RF coaxial cable length losses.

3-4. **SITE SELECTION.** Due to the line-of-sight transmission and reception of this equipment it is necessary to select a location where the antenna will be free from obstructions blocking line-of-sight transmission. It is desirable to elevate the antenna as high as practicable, to further increase the effective transmission range of the equipment.

3-5. **ANTENNAS AND ADJUSTMENTS.** Antennas used with this receiver are of two basic types; i.e., the single-frequency, pretuned, nonfield adjustable types and the field adjustable types. The field adjustable types are generally tunable over a limited range of about 3 to 4 MHz and it is essential to select the antennas to match the operating frequencies of the receiver. When the antenna is of the base station or vehicular type employing a length of coaxial cable for a feedline, it is desirable to check the VSWR on the line using a thruline type VSWR bridge. A VSWR in excess of 2:1 (1.2:1 in repeater service) generally indicates that the antenna had not been pretuned to the correct frequency. Full 1/4 wave antennas require "cutting to frequency" and instructions packed with such antennas should be followed carefully. Dual band or multi-band antennas should never be used in repeater service.

4-1. INTRODUCTION. The R4V receiver was specifically designed for use in a repeater system or severe RF environment and provides features necessary for these applications. These features are as follows:

1. High Q Helical Resonator RF stages.
2. Rapid introduction to bandwidth determining stages.
3. High overload immunity.
4. Electrical and mechanical stability with multiple voltage regulation.
5. Thermal stability. Thermal compensating components used extensively.
6. Advance squelch circuitry.
7. On board multiple channel operation.
8. Designated open collector COS output with selectable active low or active high logic.
9. Direct access to discriminator audio before and after filtering.
10. Remote controlled squelch capability.
11. Excellent on board RF shielding.
12. Constructed to commercial quality standards for long term service and dependability.

4-2. RECEIVER WIRING EXPLANATION.

PIN CONNECTIONS	DESCRIPTION
A	+13.8 VDC Filtered main supply.
B	-13.8 VDC Ground.
C	Audio output, up to 2 watts squelch controlled.
D	Ground side of 10K volume control.
E	Wiper of 10K volume control.
F	Remote control of squelch. Applying +5 volts to this point will squelch audio and COS control output.
G	Open collector COS output. Active high or active low, depending on logic control jumper. "T to R" active high, "T to S" active low. This is an open collector output and requires a pull up resistor of 10K if a voltage swing is required. If a relay is used be sure to put a protection diode across relay coil.
H	Wiper of a 10K squelch control.
I	Ground side of the 10K squelch control.
J	High side of 10K squelch control.
K	High side of 10K volume control.
L	Discriminator meter output. 50uA movement.
M	Signal level output, 50 uA movement.
N	Shield, 50 ohms unbalanced.
O	Center conductor, 50 ohms unbalanced.

4-3. GETTING IT TO WORK.

A. Care has been taken in the design of the squelch circuit to provide a very stable operation. Once the proper setting is made, the squelch control need not be readjusted. To adjust the squelch control, rotate the control until the audio is present, then slowly rotate this control in the opposite direction until the audio the audio output drops. This is the critical setting of the squelch control, and a slight increase in the same direction is all that will be needed for the proper squelch setting. This setting will give the best overall squelch action for weak signals. Too tight a setting will cause the squelch to limit the signal that can be received.

B. Terminal "G" on the receiver board is an open collector output controlled by the squelch circuit. When a signal is present, this terminal will change state (*). This output is capable of handling up to 40mA of current. This output is normally used as the input to our COR board. It can also be used to control an LED a relay, or any other device. The output state is controlled by the jumpers "T-R" and "T-S".

C. Terminal "F". The output from terminal "G" can be controlled remotely by applying voltage to terminal "F". There are two modes. They are:

MODE A: With the receiver normally squelched, grounding terminal "F" will open squelch.

MODE B: With the receiver squelched off (audio is present) if at least +5 volts is applied to terminal "F", the receiver will be squelched. (no audio).

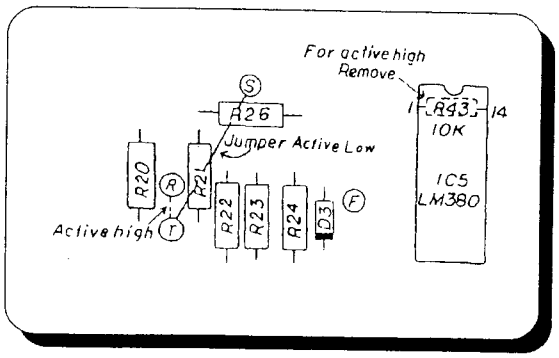
D. Squelch control. A squelch control pot of 10 to 20K ohms is recommended.

E. Terminal "L". This output may be used for frequency monitoring. By placing a 10 volt DC meter to this terminal and ground, will allow monitoring of the receiver input frequency. Direct low level audio may be sampled at this terminal before the amplifier stages and filter as long as a decoupling cap is used.

F. Terminal "M" is for monitoring the relative strength of the signal input to the receiver. Since this is only a relative reading, a minimum signal of 0.3 uV is required to cause a deflection on a 50 uA meter.

4-4. CHANGING LOGIC OUTPUT OF RECEIVER.

When changing the logic of terminal "G" (COS output) from an active low to an active high, the jumper connected from "T" to "S" must be changed to "T" to "R". A 10K resistor connected across pin "1" and pin "14" of the LM380 audio amplifier must be removed or audio distortion will occur.



5-1. INTRODUCTION. Rapid and efficient application of maintenance techniques requires a complete understanding of the theory of operation. The subsequent paragraphs describe the theory of the circuits used in this receiver. For ease of understanding, the circuits are described in the order of signal flow.

5-2. RECEIVER CIRCUITS. The receiver is a double conversion, superheterodine receiver capable of operating in the 440 to 512 MHz range.

RF energy enters the antenna terminals and is filtered by two helical RF cavities and then amplified by a high gain low noise RF amplifier. The output of this amplifier stage is fed to two more helical cavities and then to the first mixer. The mixer receives its local oscillator injection from a crystal controlled oscillator which uses crystals in the 45 to 55 MHz range. The output of the mixer is fed to a 10.7 MHz 1st IF amplifier through a series of narrow band crystal filters. These filters provide substantial adjacent channel rejection. The output of the 10.7 MHz filter is fed to the 1st 10.7 Mhz amplifier IF stage which is folowed by a 455 KHz, 2nd IF limiter and mixer stage. This stage provides the necessary limiting required for FM reception and will start limiting at about 20uV. The output of the 455 KHz 2nd stage goes to a quadrature FM detector with a high level of AM rejection, to help eliminate ignition, atmospheric and AM generated noise.

Audio output from the quadrature detector is fed to an audio stage and to a squelch amplifier. The audio stage consists of an LM380 audio amplifier that is capacitively coupled to the speaker. The squelch amplifier amplifies noise in the absence of a carrier and produces a DC voltage which operates a transistor switch to turn off the LM380 audio amplifier. When a carrier is present, the squelch circuit sees no noise and the DC switch turns the audio amplifier on so that the received audio may be heard.

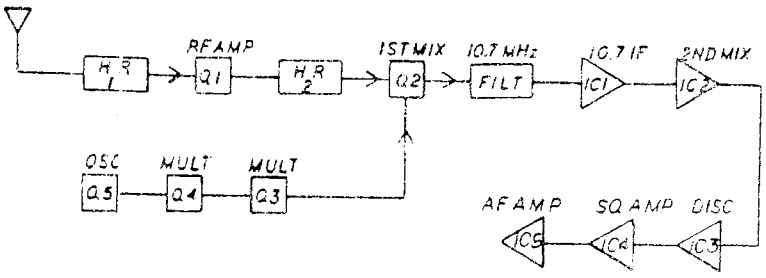


FIGURE. 5 1

6-1. RECEIVER ALIGNMENT.

Receiver alignment requires the use of the following test equipment:

1. Signal generator with a 50 ohm output covering the VHF, 10.7 MHz and the 455 KHz range.
2. Sweep generator.
3. VOM test meter.
4. Oscilloscope.
5. Frequency counter covering the channel frequency.
6. 13.8 VDC power supply, negative ground.
7. Audio frequency wattmeter or Sinadder.

6-2. PROCEDURE.

Alignment of RF and oscillator stages.

A. Connect the signal generator to the receiver input. Set receiver squelch control open. Set receiver volume to an audible level being sure the receiver has been connected to the proper power source and speaker.

B. Insert a receiver crystal into the appropriate crystal socket. The oscillator is tuned first by connecting the voltmeter across the emitter resistor of Q4 (the negative lead to ground, the positive lead to the top of R33). Adjust the oscillator coil, L12 for a maximum voltage reading. Remove and re-apply power to the receiver to make sure the oscillator will start each time. If the oscillator does not start each time, adjust L12 slightly off peak until it does. At this point, the receiver may be able to detect a very strong signal from the signal generator. If not, rock the crystal netting cap., to pull the crystal on frequency. Now tune L10 for a peak reading.

C. Connect the voltmeter to the signal level output terminal "M" and ground. Set the RF generator to the channel frequency. Adjust all of the RF coils for maximum reading on the meter. Do not adjust the 10.7 MHz or the 455 KHz IF transformers. Compensate for the increase in gain due to alignment by decreasing the signal level from the RF generator. The limiter voltage must be kept below 3 volts (where limiting occurs). If this condition is not maintained, the RF system will not be properly aligned.

6-3. IF ALIGNMENT.

NOT RECOMMENDED UNLESS ABSOLUTELY NECESSARY.

A. Connect the oscilloscope to the secondary of "L6", the 455 KHz IF transformer.

B. Couple sweep generator, set at 10.7 MHz and a sweep width of approximately 15 KHz to high side of "R6" through a 47 pF capacitor.

C. Adjust "L1, L2, L3, L4, L5 and L6" for best passband.

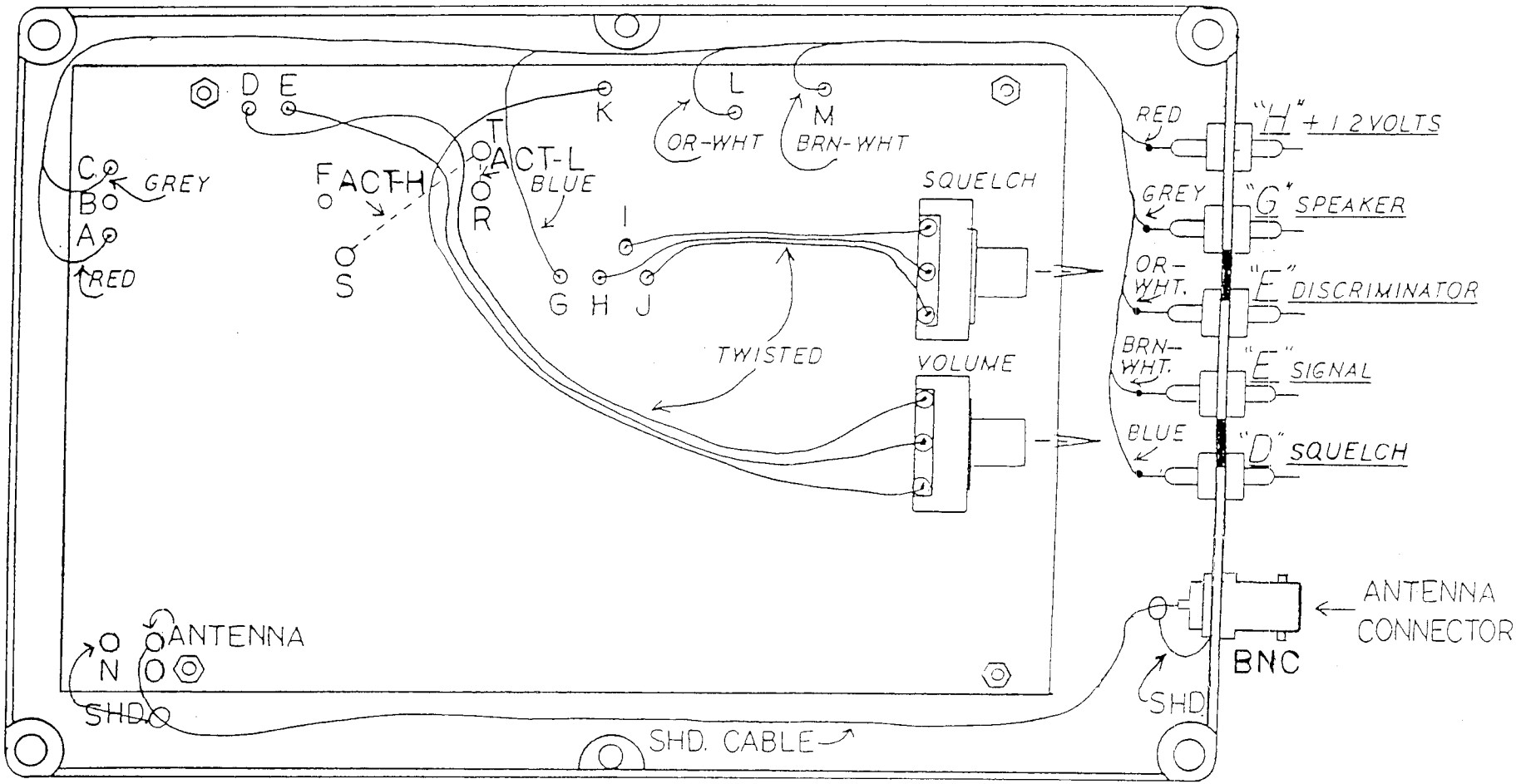
D. The discriminator transformer may be adjusted by several methods. the most accurate is to connect an oscilloscope to the discriminator test point or squelch output, and adjust "L7" for noise spikes symmetrically above and below the baseline (no signal). Acceptable results can be obtained by adjusting "L7" for peak noise on a signal free channel. This will correspond to minimum audio distortion. The voltage at the discriminator test point should be between 5.5 and 6.5 volts with no signal. You should also measure the voltage with a signal centered in the receiver passband. Varying the signal frequency across the bandpass will cause the voltage to change about 1 volt each side of center.

Hi Pro R4U Receiver Parts List 430 to 512 MHz

C01	.001 uF DC	C02	.001 uF NPO	C03	47 pF DC NPO
C04	2.2 pF DC NPO	C05	47 pF DC NPO	C06	5 pF DC NPO
C07	.01 uF DC	C08	5 pF DC NPO	C09	3.3 pF DC NPO
C10	.02 uF DC	C11	2.2 pF DC NPO	C12	.02 uF DC
C13	5pF DC NPO	C14	.02 uF DC	C15	.02 uF DC
C16	.02 uF DC	C17	Deleted	C18	47 pF DC NPO
C19	470 pF DC	C20	.1 uF DC	C21	.1 uF DC
C22	.1 uF DC	C23	220 pF DC	C24	.1 uF DC
C25	.005 uF DC	C26	.02 uF DC	C27	150 pF DC NPO
C28	100 uF Elec.	C29	47 uF Elec.	C30	.02 uF DC
C31	.001 uF DC	C32	62 pF DC NPO	C33	.1 uF Mylar
C34	1 uF Elec.	C35	.001 uF DC	C36	.1 uF DC
C37	150 uF DC	C38	.005 uF DC	C39	47 pF DC
C40	4.7 uF Elec.	C41	10 uF Elec.	C42	4.7 uF Elec.
C43	100 uF Elec.	C44	100 uF Elec.	C45	.1 uF Mylar.
C46	2-20 pF Var. Cap.	C47	2-20 pF Var. Cap.	C48	47 pF DC NPO
C49	47 pF DC NPO	C50	33 pF DC NPO	C51	1.2 pF DC NPO
C52	1 pF DC NPO	C53	.001 uF DC	C54	5 pF DC NPO
C55	.001 uF DC	C56	47 pF DC NPO	C57	47 pF DC NPO
C58	30 pF DC NPO	C59	.005 uF DC	C60	62 pF DC NPO
C61	.01 uF DC	C62	Deleted	C63-68	4-20 pF Var. Cap.
C69	22 uF Elec.				

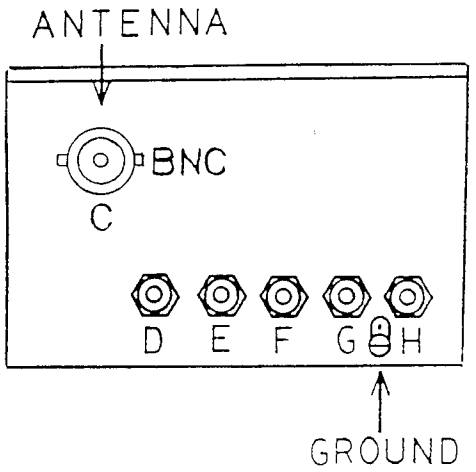
R01	4.7 K	R02	22 K	R03	330 Ohms
R04	5.6 K	R05	33 K	R06	4.7K
R07	10 K 1/8 W	R08	4.7 K	R09	100 Ohms
R10	100 Ohms	R11	4.7 K	R12	100 Ohms
R13	56 Ohms	R14	10 K	R15	2.4K
R16	22 K	R17	100 K	R18	1 K
R19	4.7 K	R20	10 K	R21	8.2K
R22	10 K	R23	4.7 K	R24	8.2 K
R25	470 K	R26	100 K	R27	33 Ohms
R28	10 Ohms	R29	10 Ohms	R30	100 K
R31	680 Ohms	R32	10 K	R33	150 Ohms
R34	100 Ohms	R35	1 K	R36	47 Ohms
R37	82 Ohms	R38	680 Ohms	R39	10 K
R40	10 K	R41	10 K	R42-R46	Deleted
R47	10 Ohms				

L01	10.7 MHz IF Transf,	L02	10.7 MHz IF Transf.	L03	10.7 MHz IF Transf.
L04	10.7 MHz IF Transf.	L05	455 KHz IF Trasnf.	L06	455 KHz IF Transf.
L07	455 KHz IF Transf.	L08	Osc. Mult. Coil	L09	Osc. Mult. Coil.
L10	Osc. Mult. Coil	L11	Osc. Mult. Coil	L12	Osc. Coil
CF1	Optional Filter	X8/X11	10.7 MHz Crystal Filters	X1/X6	Channel Crystals
X7	10.245 MHz 2nd Osc.	HR1	1st Helical Resonato	HR2	2nd Second Helical Res.
Z1	100 uH Choke	Z2	10 ohm resistor	Z3	Ferrite Choke
Z04	100 uH Choke	Z5	10 uH Choke	D01	10 Volt Zener
D02	1N4381 Diode	D03	10 Volt Zener	D04	10 Volt Zener
Q01	MRF901 Or Equiv.	Q02	MRF901 Or Equiv.	Q03	2N5179
Q04	2N5170 Or Equiv.	Q05	2N5170 Or Equiv.	IC1	CA3028/CA3054
IC2	CA3028/CA3054	IC3	CA3065/LM1358	IC4	CA3046
IC5	LM380				



SIZE	CODE IDENT NO.	DRAWING NO. R4U
	R 2404	RX HOUSING LAYOUT
SCALE		SHEET

Maggiore Electronic Laboratory

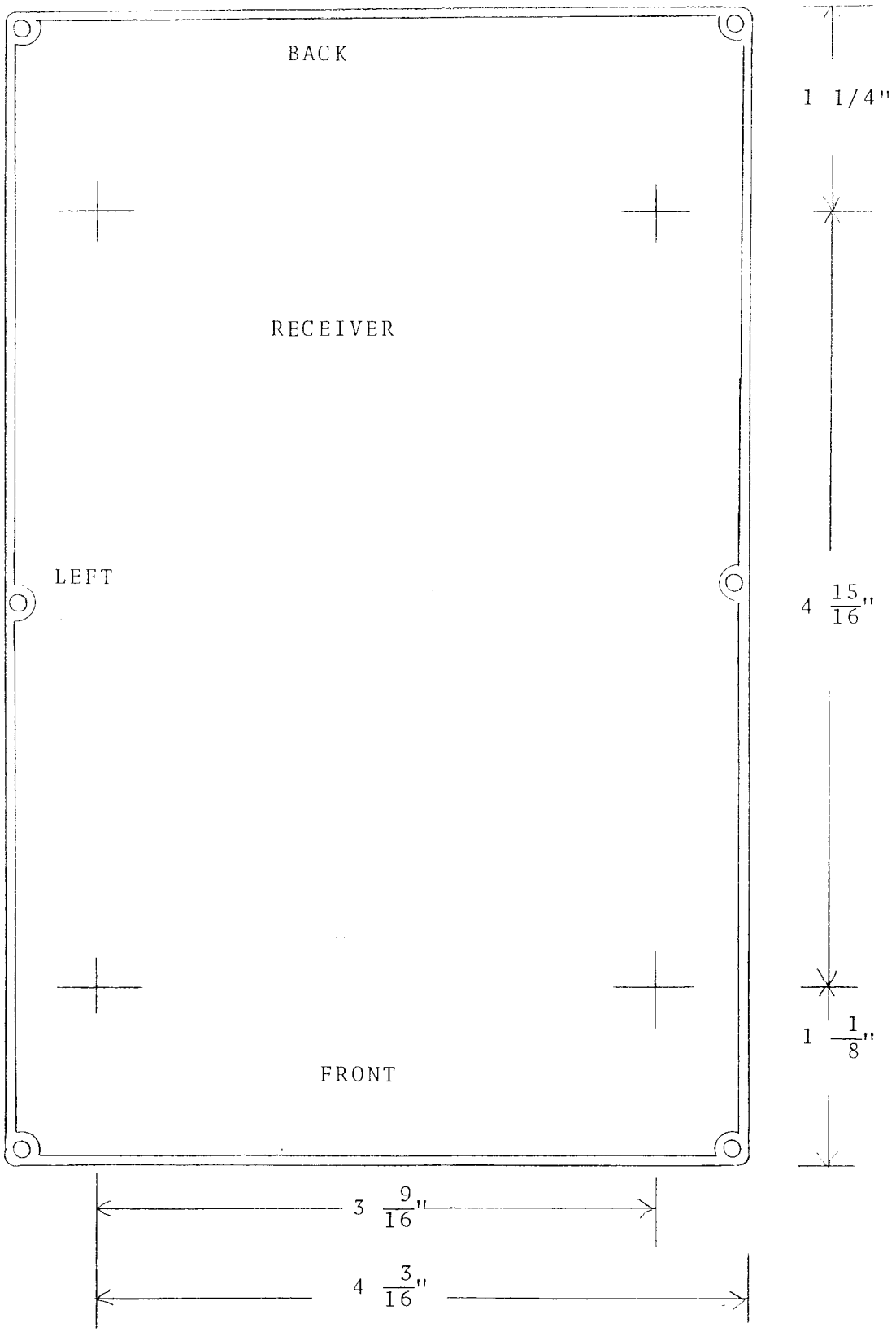


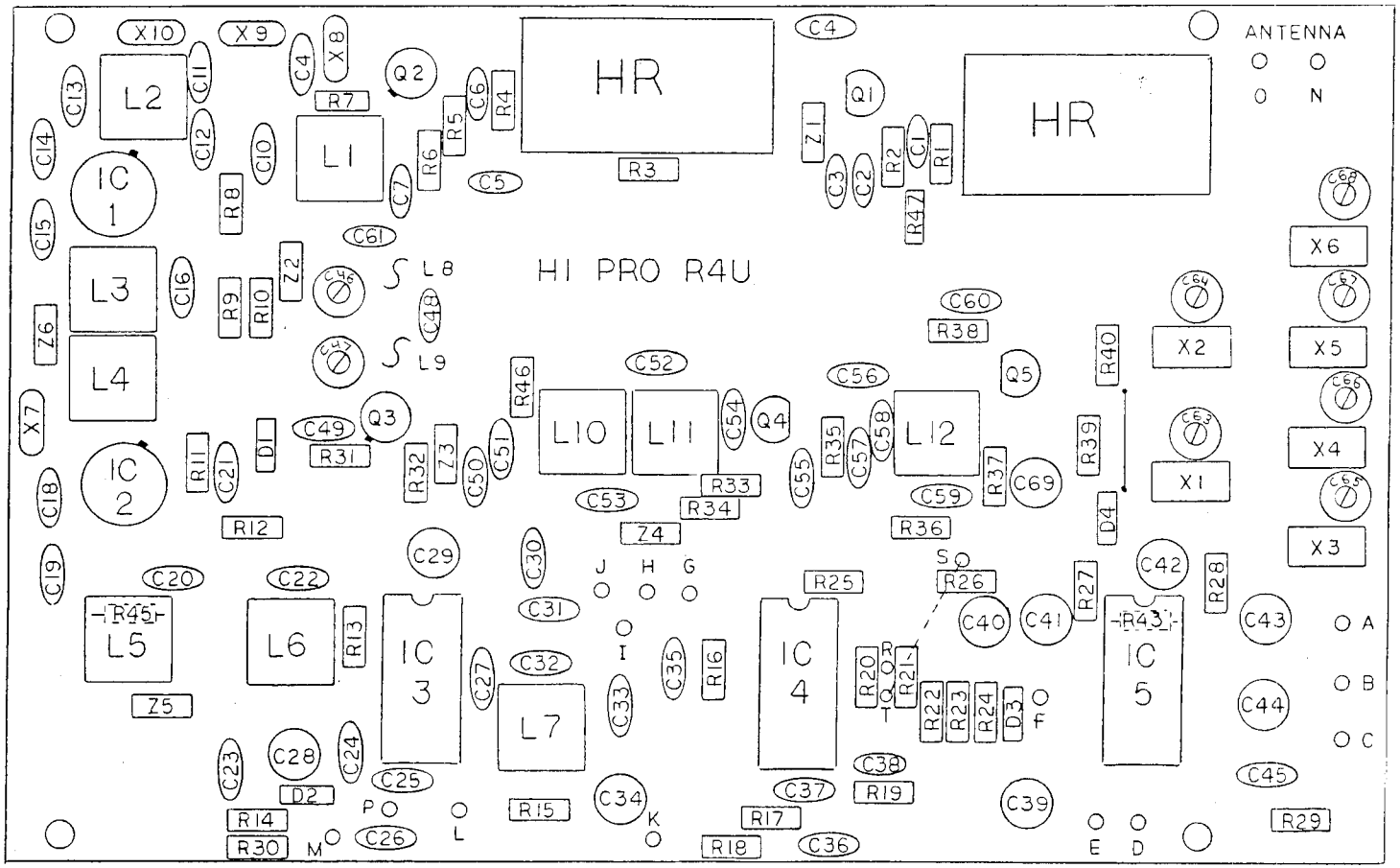
"C" Antenna Connector, 50 Ohm Impedance
"D" C.O.R. Out
"E" Receiver Signal Level Output
"F" Receiver Discriminator Output
"G" Receiver High Level Output, 8 Ohm
"H" + 13.8 V.D.C. Regulated

HI PRO RECEIVER HOUSING

R4U	CODE IDENT NO. RH-1	DRAWING NO. IB0783
SCALE		SHEET

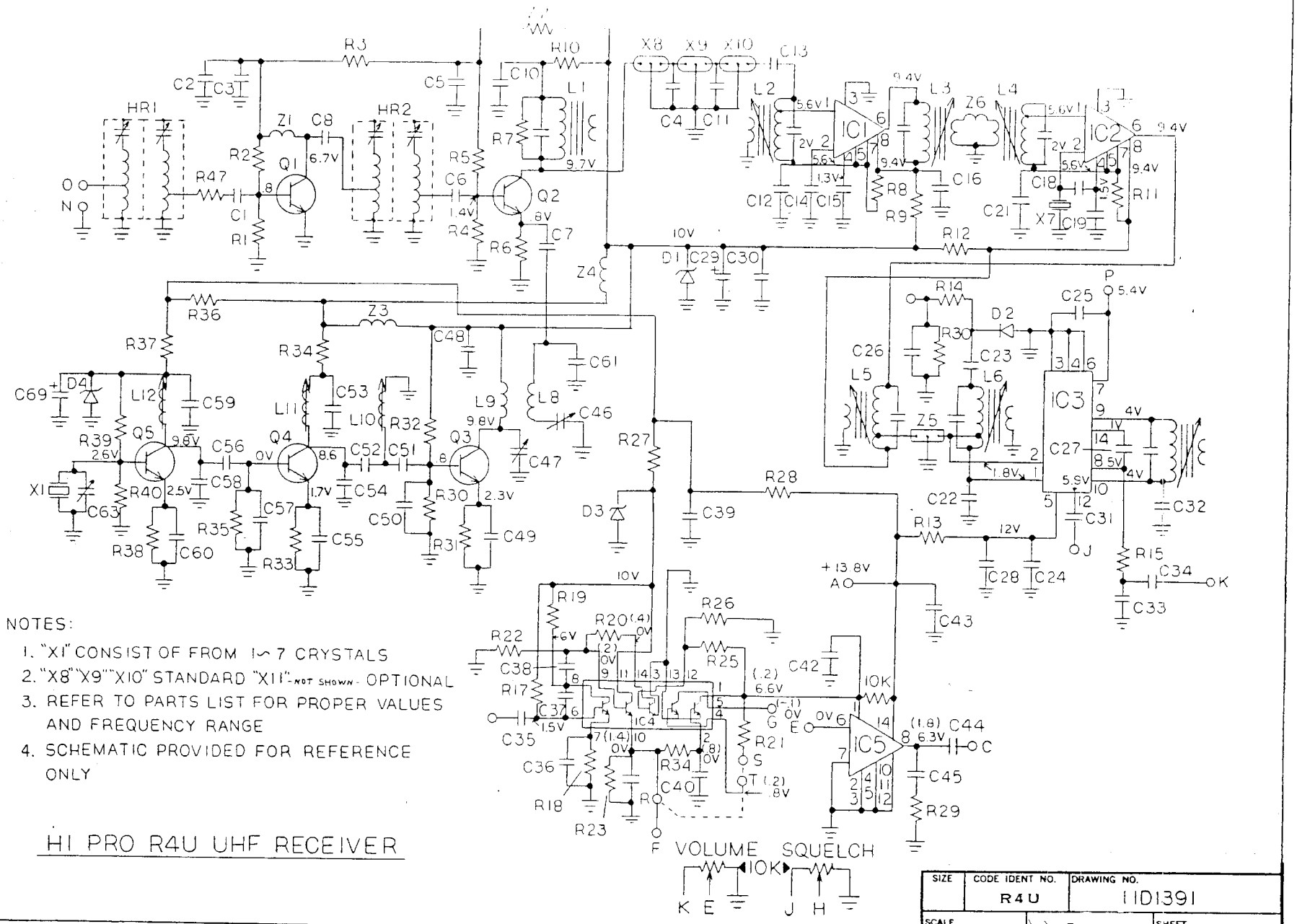
LEFT SIDE AND FRONT OF BOX IS MOUNTED ABOUT ONE INCH FROM EDGE OF CHASSIS.





COMPONENT AND PIN LAYOUT

SIZE	CODE IDENT NO.	DRAWING NO.
	R4U	IIC1391
SCALE		11/91 SHEET



NOTES:

1. "X1" CONSIST OF FROM 1~7 CRYSTALS
2. "X8" "X9" "X10" STANDARD "X11" - NOT SHOWN - OPTIONAL
3. REFER TO PARTS LIST FOR PROPER VALUES AND FREQUENCY RANGE
4. SCHEMATIC PROVIDED FOR REFERENCE ONLY

HI PRO R4U UHF RECEIVER

SIZE	CODE IDENT NO.	DRAWING NO.
	R4U	11D1391
SCALE	N.O.S.	SHEET

BISHOP GRAPHICS INC. REORDER NO. 1852