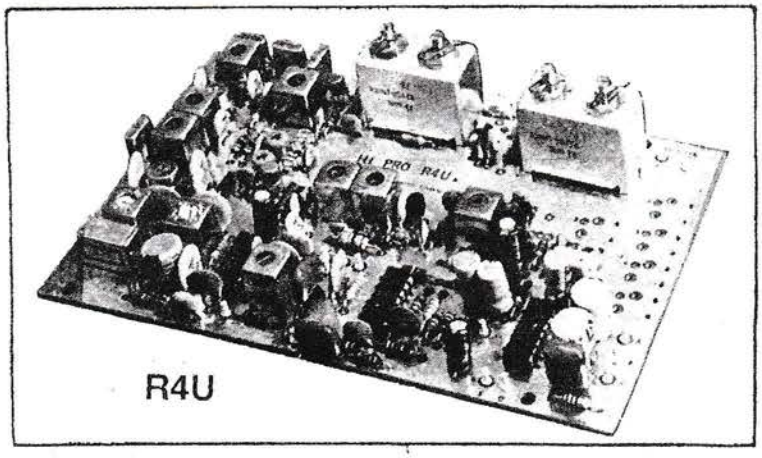
MELCO

MAGGIORE ELECTRONIC LAB.

Hi Pro

OPERATING AND MAINTENANCE MANUAL



R4U

Hi Pro Receiver

CONTENTS

1-1. DESCRIPTION. Maggiore Electronic Laboratory's Model R4U (Fig. 1-1) is a solid-state, completely self-contained receiver, designed to provide reliable and versatile FM (frequency modulation) communications in the frequency range of 400 to 512 MHz. The receiver can be supplied in a wide or a narrow band configuration as described in Performance Specifications Table 2-1. The construction is compact, lightweight, and rugged.

1-2. APPLICATION. The unit may be used with other FM transceivers provided: (1) transceivers are tuned to the same channel frequency, (2) transceivers are adjusted to the same modulation deviation, and (3) transceivers are operated in an FM system of the proper antenna polarization.

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

1-4. OPERATIONAL CHARACTERISTICS. Communication coverage in the operating frequency range of the receiver is a function of the following characteristics: (1) antenna height, (2) terrain, (3) receiver sensitivity, (4) condition of operating power source (batteries) and (5) transmitter power output. Communication is generally limited to the line-of-sight distance between the receiving and transmitting antennas. Maximum operating range can be obtained when both receiving and transmitting antennas do not have any large intervening objects between them. An improvment in distance can be realized when using high gain antennas.

2-1. RECEIVER SPECIFICATIONS. Table 2-1 lists the performance specifications for the model R4U.

2-2. CRYSTAL SPECIFICATIONS. Crystal specifications for the R4U are provided in Table 2-2.

2-3. TRANSISTOR AND DIODE COMPLEMENT. Table 2-3 lists the transistors and diodes used in the R4U. The type and function of each transistor and diode are listed for rapid identification.

Table 2-1. Performance Specifications

	GENERAL
Operating Frequency	Low - 400 to 444 MHz Hi - 442 to 470 MHz Extended - 465 to 512 MHz
Input Voltage	13.6 Vdc nominal, 11.5 V min., 15.0 V maximum.
Current Drain	Receive Standby (squelched): 75 mA nom. Receive (unsquelched): 175 mA @ 500 mw audio.
Operating Temperature Range*	-30° C to +60° C
Antenna Impedance	50 ohms-suitable for whip antennas.
Type of Modulation	FM voice.

*NOTE: Amateur equipment is furnished for a temperature range of -10° C - +60° C unless ordered for commercial specs.

Table 2-1. Performance Specifications (continued)

RECEIVER

Sensitivity	12 dB quieting: 0.20 nom. uV 20 dB quieting: 0.35 max. (0.3 nom.) uV 12 dB Sinad: 0.25 max. uV Threshold squelch: 0.2 uV max.
Circuit Type	Crystal-controlled, dual-conversion up to 6 channels.
Selectivity (EIA SINAD)	Narrow band: 110 dB min. at ±30 kHz (110 dB minimum @ ±20 kHz optional) Wide band: 90 dB min. at ±50 kHz (100 dB minimum @ ±40 kHz optional)
Modulation Acceptance Bandwidth	Narrow band: ±6 kHz min. Wide band: ±18 kHz min.
Spurious and Image Attenuation	90 dB min.
Oscillator Stability (see note page 2-1)	±0.0005% narrow band (±0.0002% opt.) ±0.001% wide band from -30° to +60° C (25° C reference)
Residual Hum and Noise	Better than 55 dB down from rated output with standard modulation 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	Speaker load (8 ohm): 2 watts nom.
Audio Distortion	Less than 8% at rated output.

Table 2-2. First Oscillator Crystal Specifications

Type	Minature plug-in
Holder	Similar to MIL Type HC-25/U
Holder Capacity	7 pf max.
Crystal Capacity	32 pf ±0.5 pf
Mode of Operation	3rd overtone, parallel resonance
Effective Resistance	35 ohms max.
Drive Level	1 mW
Operating Temperature Range	-30° C to +60° C
Frequency Tolerance	Calibration: +0.0015% of exact specified frequency at room temperature (25° C +3° C reference)

Table 2-2. Crystal Specifications (continued)

RECEIVER (continued)

Frequency Tolerance (continued)	Drift: Over temperature range (-30° C to +60° C) shall not exceed +0.0025% (25° C reference) narrow band, +0.005% wideband.
Crystal Frequency	Determined by formula: (also see note) Fx = Fc +10.7 MHz/9 where Fx = Crystal 3rd overtone frequency frequency in MHz and Fc = Channel frequency in MHz
Note: Use Fc +10.7 from 406 to 440 MHz Use Fc -10.7 from 440 to 512 MHz	

RECEIVER 2ND CONVERTER

Type	Minature solder-in
Holder	Similar to MIL Type HC-18/U
Frequency	Standard: 11,155 MHz Alternate: 10.245 MHz
Mode	Fundamental, parallel resonance
Load Capacity	32 pF +0.5 pF
Effective Resonance Resistance	25 ohms (max.)
Drive Level	1 mW max.
Operating Temperature Range	-30° C to +60° C
Frequency Tolerance	Calibration: +0.001% at 25° C Drift: +0.0015%, =30° C to +60° C
Crystal Frequency	Standard frequency used for all frequencies except alternate to be used when channel frequency is a harmonic of standard frequency.

(CRYSTAL FREQ x 9) + 10.7 = Fc

Table 2-3. Transistor and Diode Complement

CIRCUIT SYMBOL	TYPE	FUNCTION
	RECEIVER SECTION	
Q1	MRF901	RF Amplifier
Q2	MRF904	Firt Conversion
Q3	2N5179	Multiplier
Q4	2N5170	Multiplier
Q5	2N5170	Oscillator
IC-1	LM-3053/CA-3028B	Second IF Amplifier
IC-2	LM-3053/CA-3028A	Oscillator Limiter
IC-3	MC-1358 LM-3065	Discriminator
IC4	LM3046	Squelch Amplifier
IC5	LM-380	Audio Output
D1	10v	Regulator
D2	1N914	Metering Rectifier
D3	10v	Regulator
D4	10v	Regulator

3-4. SITE SELECTION. Due to the line-of-sight transmission and reception characteristics of the R4U, 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/ADJUSTMENTS. The antennas used with the R4U 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 unit used. 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 generally indicates that the antenna had not been pretuned to the correct frequency band. Full 1/4 wave vehicular antennas require "cutting to frequency" and instructions packed with such antennas should be followed carefully. When shortened whip antennas are used (less than 1/4 wave) the antenna should be checked for effective radiation. This can be done by using a simple field strength indicator.

4-1. INTRODUCTION. The R4U was specifically designed for repeater service and provides features necessary for this application. The features are:

1. Helical resonator tuned rf stages.
2. Rapid introduction to bandwidth determining stages.
3. High overload rejection.
4. Electrical stability with multiple voltage regulation.
5. Thermaly stable components used extensively.
6. Advanced squelch circuitry.
7. Expandable up to 6 channels.
8. Designated open collector COR control output.
9. Direct access to unprocessed audio.
10. Remote tone control capability.

4-2. RECEIVER WIRING EXPLANATION.

Pin Connections	Description
A	Main power supply for receiver.+13.6 volts filtered D.C.
B	Ground side of main power supply.-13.6 volts filtered D.C.
C	High level squelch controlled audio output. 8 ohms nominal. Up to 2 watts audio power.
D	Ground side of 10k volume control.
E	Wiper of 10k volume control.
F	Remote tone squelch control. ±5 volts will squelch audio & COR line.
G	Open collector COR control.Ungrounded with presence of signal. Where a positive voltage is required, a pull up resistor of approximately 22k can be used. Do not exceed 20 ma load on this output. Use a protection diode if an inductive load is used.
H	Wiper of 10k/50k squelch control.
I	Ground side of 10k/50k squelch control.

4-2. Pin Connections Description

J	High side of 10k/50k squelch control.
K	High side of 10k volume control.
L	Discriminator meter output. Meter movement, 50 ua.
M	Signal level output. Meter movement, 50 um.
N	Shield, 50 ohm unbalanced.
O	Center conductor, 50 ohm unbalanced.

4-3. GETTING IT TO WORK.

A. The squelch circuit. Care has been taken in the design to provide a very stable squelch circuit. Once the proper setting is made, the squelch control need not be continually readjusted. To adjust the squelch control, rotate this control completely counter clockwise. Then slowly rotate this control clockwise until the white noise present at 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 chop the audio during audio peaks.

B. Terminal "G" on receiver board is an open collector output controlled by the squelch circuit. When a signal is present, this terminal goes high and is capable of sinking up to 20 ma of current. This terminal is normally used as the input to our COR Board. It can also be used to activate an L.E.D., reed relay or any other low current device.

C. Terminal "F". The squelch can be controlled independently from the normal squelch with this terminal.

Mode A: With the receiver normally squelched (no audio) shorting terminal "F" will open squelch (audio will be present).

Mode B: With the receiver squelch off (audio will be present) if +5 volts D.C. is applied to terminal "F", the receiver will be squelched (no audio).

D. Squelch control pot 10k/50k: The higher the resistance of the squelch control pot, the finer the setting that can be made. The higher resistance pot will cause less upper limit squelch action.

E. Terminal "L". This output may be used for frequency monitoring. By placing a 50 ua meter in series with a 50k zero centering pot to ground, will allow monitoring of receiver input frequency. Direct low level audio may be sampled at this terminal before amplifier stages.

4-3. F. Terminal "M". This output may be used to monitor relative signal level input to the receiver. Since this is only a relative reading, a minimum signal of at least 1 uv is required to cause a deflection on a 50 ua meter.

5-1. INTRODUCTION. Rapid and efficient application of maintenance techniques requires complete and thorough understanding of the circuits used and the theory of operation. The subsequent paragraphs describe the theory of operation of the circuits used in the R4U receiver. For ease of understanding, the circuits are described in the order of signal flow. References are made to the block diagram (Fig. 5-1) and the schematic diagram.

5-2. RECEIVER CIRCUITS. The receiver is a double conversion, superheterodyne receiver capable of operating in the 400 to 512 MHz region.

RF energy enters the antenna terminals and is filtered by the helical resonator and is amplified by a single stage RF amplifier stage. The output of this amplifier stage is fed to another helical resonator and than to the mixer. The mixer receives its local oscillator injection from a crystal controlled oscillator which uses crystals in the 45 MHz range.

The output of the mixer is fed to a 10.7 MHz 1st IF amplifier through a 10.7 MHz filter. Up to eight poles of filtering helps to provide up to 105dB adjacent channel rejection. The output of the 10.7 MHz 1st IF stage is fed to a 455 MHz, 2nd IF limiter stage. This stage provides the necessary limiting required for FM reception and will start limiting at about 20uV. The output of the 455 MHz 2nd IF stage goes to a quadrature FM detector.

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 amplfiier that is capacitively coupled to the speaker. The squelch amplifier amplifies noise in the absence of a carrier and produces a D.C. voltage which operates a transistor switch to turn off the audio chip in the absence of a carrier. When a carrier is present, the squelch circuit sees no noise and turns the audio amplifier on so that the FM audio may be heard.

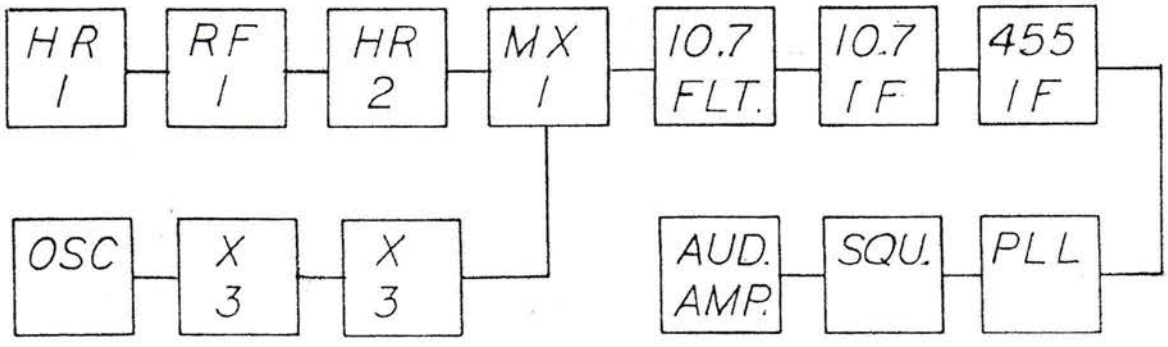


Figure 5-1

6-1. RECEIVER ALIGNMENT. Complete receiver alignment requires the use of the following test equipment:

1. Signal generator with 50-ohm output covering 455 KHz, 10.7 MHz, and the channel frequency.
2. Sweep generator.
3. VOM test meter.
4. Oscilloscope.
5. Frequency counter covering the channel frequency.
6. 12-VDC power source, negative ground.
7. Audio frequency wattmeter or Sinadder or equivalent.

PROCEDURE

ALIGNMENT: RF STAGES.

A. Connect the signal generator. Set receiver volume control to about mid range. Set the squelch control fully counter-clockwise. Connect the receiver to the 12-14 volt power source. Some background noise should be heard in the speaker.

B. Insert a receive 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, readjust L12 slightly off peak until it does. Then adjust L11 for a dip, indicating resonance. Move the test lead to the Q3 side of R31. Tune L10 for a peak reading, then adjust C47 for a dip. At this point, the receiver should be able to detect strong signals (1000 microvolts or so). Now adjust C46 for max. signal.

C. Connect the voltmeter to test point "M" and ground. (See assembly drawing) Fig. 1-1. Set the rf signal generator to the channel frequency. Adjust all of the rf coils for a maximum reading on the meter. Do not adjust the 10.7 or 455 if transformers. Compensate for the increase in gain due to alignment by decreasing the signal level from rf generator. The limiter voltage must be kept below the 3-4 volt range (limiting occurs). If this condition is not maintained, the rf system will not be properly aligned.

IF ALIGNMENT.

NOT RECOMMENDED UNLESS ABSOLUTELY NECESSARY AND COMPLETELY FAMILIAR WITH IF SWEEP ALIGNMENT PROCEDURES.

A. Connect oscilloscope to secondary of "L6", 455 KHz 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. See Fig. 6-1.

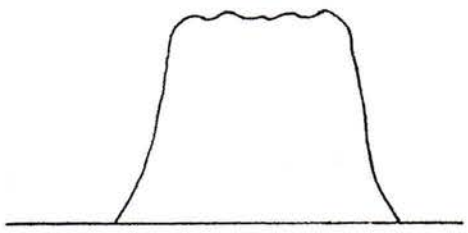


Figure 6-1

ALTERNATE IF ALIGNMENT.

Vary the generator frequency FM modulated by a 1000 Hz tone and 4 kHz deviation up and down until a maximum voltage is indicated at the first limiter test point. This will ensure the generator is centered in the bandpass of the crystal filter. Readjust all the if transformers, L1 through L6, for a maximum reading. Repeat this step several times until no increase to the limiter voltage can be made.

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 5.5 volts to 6.5 volts with no signal. It should also measure the voltage approximately with a signal centered in the receiver bandpass. Varying the signal frequency across the bandpass will cause the voltage to change about 1 volt each side of center.

E. Set the signal generator to the receive frequency. Turn the output level of the generator to the off position (below -130 dBm). Advance the squelch control clockwise until the audio cuts off. This point is generally found at one-half to three quarters of a full clockwise rotation. With the receiver muted or squelched, increase the output level of the generator to the point where the audio is switched on. The signal level at this point should be on the order of .3 microvolts or less.

   NOTE: Some generators develop enough rf leakage that a proper squelch setting may not be achieved without moving generator off frequency.

F. The receive crystal may be netted on frequency by adjusting the trimmer adjacent to the crystal.

   With A.C. voltmeter connected to pin "C" adjust helical resonator for minimum A.C. volts (lowest noise).

PARTS LIST	MAGGIORE ELECTRONIC LABS	CONTRACT NO.	FSCM NO.	PL	REVISION LTR DATE
LIST TITLE: Hi Pro R4U Receiver		AUTHENTICATION:		REV AUTH NO.	SHEET OF SHEETS

ITEM OR FIND NUMBER	QTY RQD	QTY RQD	QTY RQD	UNIT OF MEASURE	CODE IDENT	DRAWING OR DOCUMENT NUMBER	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION
C1						C1		27 PF DISC CERAMIC NPO
C2						C2		.001 MF DISC CERAMIC
C3						C3		47 PF DISC CERAMIC NPO
C4						C4		5 PF DISC CERAMIC NPO
C5						C5		47 PF DISC CERAMIC NPO
C6						C6		27 PF DISC CERAMIC NPO
C7						C7		.01 MF DISC CERAMIC
C8						C8		3.3 PF DISC CERAMIC NPO
C9						C9		3.3 PF DISC CERAMIC NPO
C10						C10		.02 MF DISC CERAMIC NPO
C11						C11		3.3 PF DISC CERAMIC NPO
C12						C12		.02 MF DISC CERAMIC
C13						C13		.02 MF DISC CERAMIC
C14						C14		.02 MF DISC CERAMIC
C15						C15		.02 MF DISC CERAMIC
C16						C16		.02 MF DISC CERAMIC
C17						C17		Deleted
C18						C18		68 PF DISC CERAMIC NPO
C19						C19		220 PF DISC CERAMIC
C20						C20		.05 MF DISC CERAMIC
C21						C21		.05 MF DISC CERAMIC
C22						C22		.05 MF DISC CERAMIC
C23						C23		220 PF DISC CERAMIC
C24						C24		.05 MF DISC CERAMIC
C25						C25		.005 MF DISC CERAMIC
C26						C26		.02 MF DISC CERAMIC
C27						C27		150 PF DISC CERAMIC
C28						C28		100 MF ELECTROLYTIC CAP.
C29						C29		47 MF ELECTROLYTIC CAP.
C30						C30		.02 MF DISC CERAMIC
C31						C31		.001 MF DISC CERAMIC
C32						C32		68 PF DISC CERAMIC NPO
C33						C33		.1 MF MYLAR CAP.
C34						C34		.05 MF MYLAR CAP.
C35						C35		.001 MF DISC CERAMIC

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C36						C36		.1 MF MYLAR CAP.
C37						C37		150 PE DISC CERAMIC
C38						C38		.005 MF DISC CERAMIC
C39						C39		47 MF ELECTROLYTIC CAP.
C40						C40		4.7 MF ELECTROLYTIC CAP.
C41						C41		10 MF ELECTROLYTIC CAP.
C42						C42		4.7 MF ELECTROLYTIC CAP.
C43						C43		100 MF ELECTROLYTIC CAP.
C44						C44		100 MF ELECTROLYTIC CAP.
C45						C45		.1 MF MYLAR CAP.
C46						C46		2-20 PF VAR. CAP.
C47						C47		2-20 PF VAR. CAP.
C48						C48		47 PF DISC CERAMIC NPO
C49						C49		47 PF DISC CERAMIC NPO
C50						C50		47 PF DISC CERAMIC NPO
C51						C51		12 PF DISC CERAMIC NPO
C52						C52		1 PF DISC CERAMIC NPO
C53						C53		.001 DISC CERAMIC NPO
C54						C54		5 PF DISC CERAMIC NPO
C55						C55		.001 DISC CERAMIC NPO
C56						C56		33 DISC CERAMIC NPO
C57						C57		.001 DISC CERAMIC
C58						C58		47 PF DISC CERAMIC NPO
C59						C59		.005 DISC CERAMIC
C60						C60		47 PF DISC CERAMIC NPO
C61						C61		Factory Option
C62						C62		18 PF DISC CERAMIC NPO
C63/ 68						C63/68		2-20 PF VAR. CAP.
C69						C69		22 MF ELECTROLYTIC
C70						C70		Factory Option
C71						C71		
C75						to C75		DELETED
C76						C76		.02 MF DISC CERAMIC
C77						C77		220 PF DISC CERAMIC

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								All resistors 1/4 watt unless noted.
R1						R1		4.7K
R2						R2		22K
R3						R3		330 OHM
R4						R4		5.6K
R5						R5		33K
R6						R6		1K
R7						R7		4.7K
R8						R8		18K
R9						R9		100 OHM
R10						R10		100 OHM
R11						R11		4.7K
R12						R12		100 OHM
R13						R13		56 OHM
R14						R14		1 K
R15						R15		2.2K
R16						R16		22K
R17						R17		100K
R18						R18		1K
R19						R19		4.7K
R20						R20		10K
R21						R21		8.2K
R22						R22		10K
R23						R23		4.7K
R24						R24		8.2K
R25						R25		100K
R26						R26		470K
R27						R27		100 OHM
R28						R28		10 OHM
R29						R29		10 OHM
R30						R30		1.2K
R31						R31		100 OHM
R32						R32		10K
R33						R33		150 OHM
R34						R34		100 OHM
R35						R35		1K

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R36						R36		47 OHM
R37						R37		82 OHM
R38						R38		1.2K
R39						R39		2.2K
R40						R40		1.2K
R41						R41		Factory Option
R42						R42		1K

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HR1						HR1	LOW 107-HI 147	HELICAL RESONATOR
HR2						HR2	LOW 107-HI 147	HELICAL RESONATOR
L1						L1		10.7 MHZ I.F. TRANSFORMER
L2						L2		10.7 MHZ I.F. TRANSFORMER
L3						L3		10.7 MHZ I.F. TRANSFORMER
L4						L4		10.7 MHZ I.F. TRANSFORMER
L5						L5		455 MHZ I.F. TRANSFORMER
L6						L6		455 MHZ I.F. TRANSFORMER
L7						L7		455 MHZ DISCRIMINATOR
L8						L8		OSC. OUTPUT COIL
L9						L9		OSC. OUTPUT COIL
L10						L10		OSC. MULT. COIL
L11						L11		OSC. MULT. COIL
L12						L12		OSC. COIL
Z1						Z1		.47 UH CHOKE
Z2						Z2		100 UH CHOKE
Z3						Z3		FERRITE CHOKE
Z4						Z4		100 UH CHOKE
Z5						Z5		10 UH CHOKE OR 455 KHz CERAMIC FILTER

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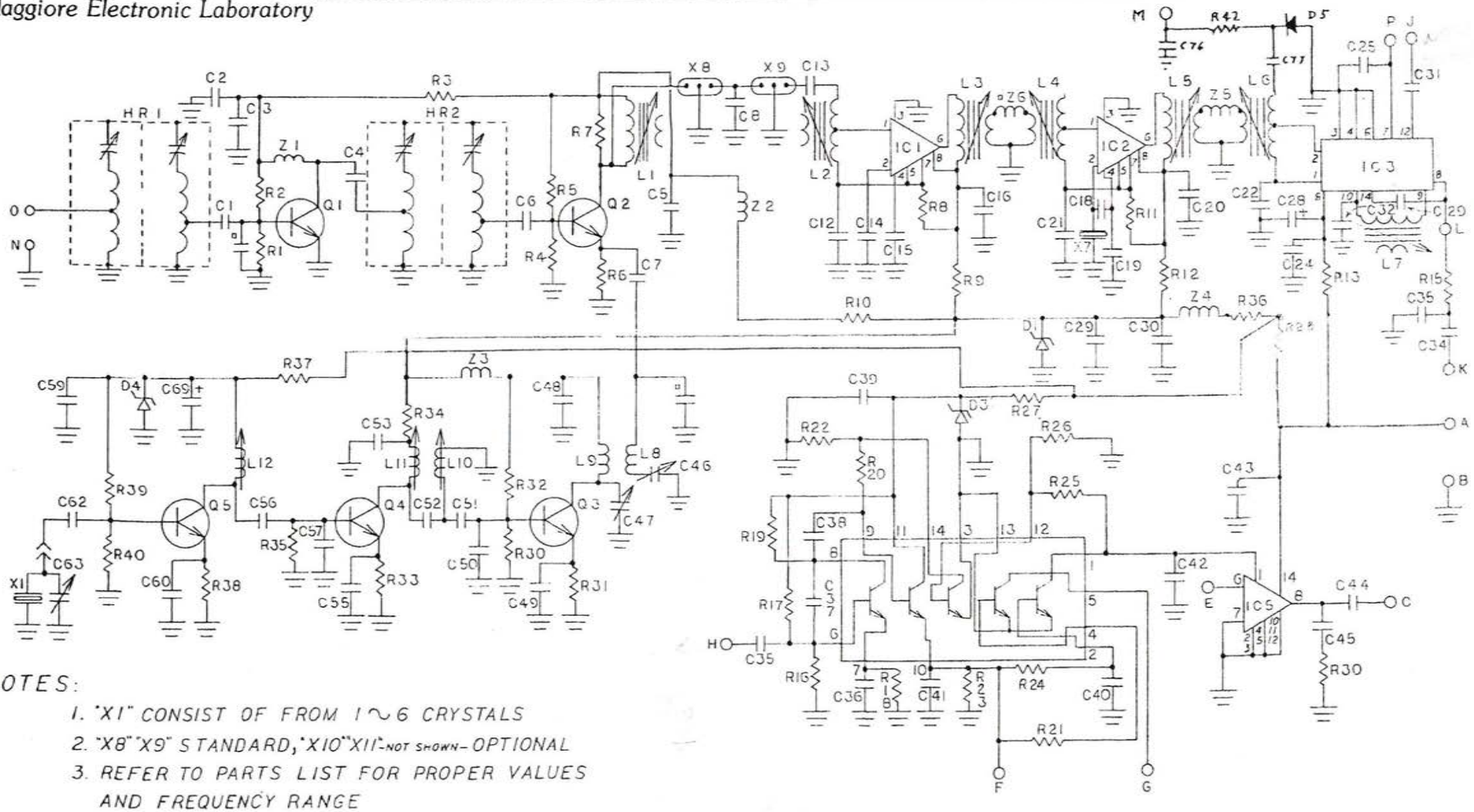
ITEM OR FIND NUMBER	QTY RQD	QTY RQD	QTY RQD	UNIT OF MEASURE	CODE IDENT	DRAWING OR DOCUMENT NUMBER	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION
D1						D1		10 VOLT ZENER
D2						D2		1N914
D3						D3		10 VOLT ZENER
D4						D4		10 VOLT ZENER
Q1						Q1		MRF 901
Q2						Q2		MRF 904
Q3						Q3		2N5179
Q4						Q4		2N5170
Q5						Q5		2N5170
IC1						IC1		CA3028B
IC2						IC2		CA3028B
IC3						IC3		CA3065
IC4						IC4		CA3046
IC5						IC5		LM380
X1/X6						X1/X6		Channel Crystals, First Osc.
X7						X7		Second Osc. Crystal
X8/X11						X8/X11		10.7 Mhz Crystal Filters

Maggiore Electronic Laboratory

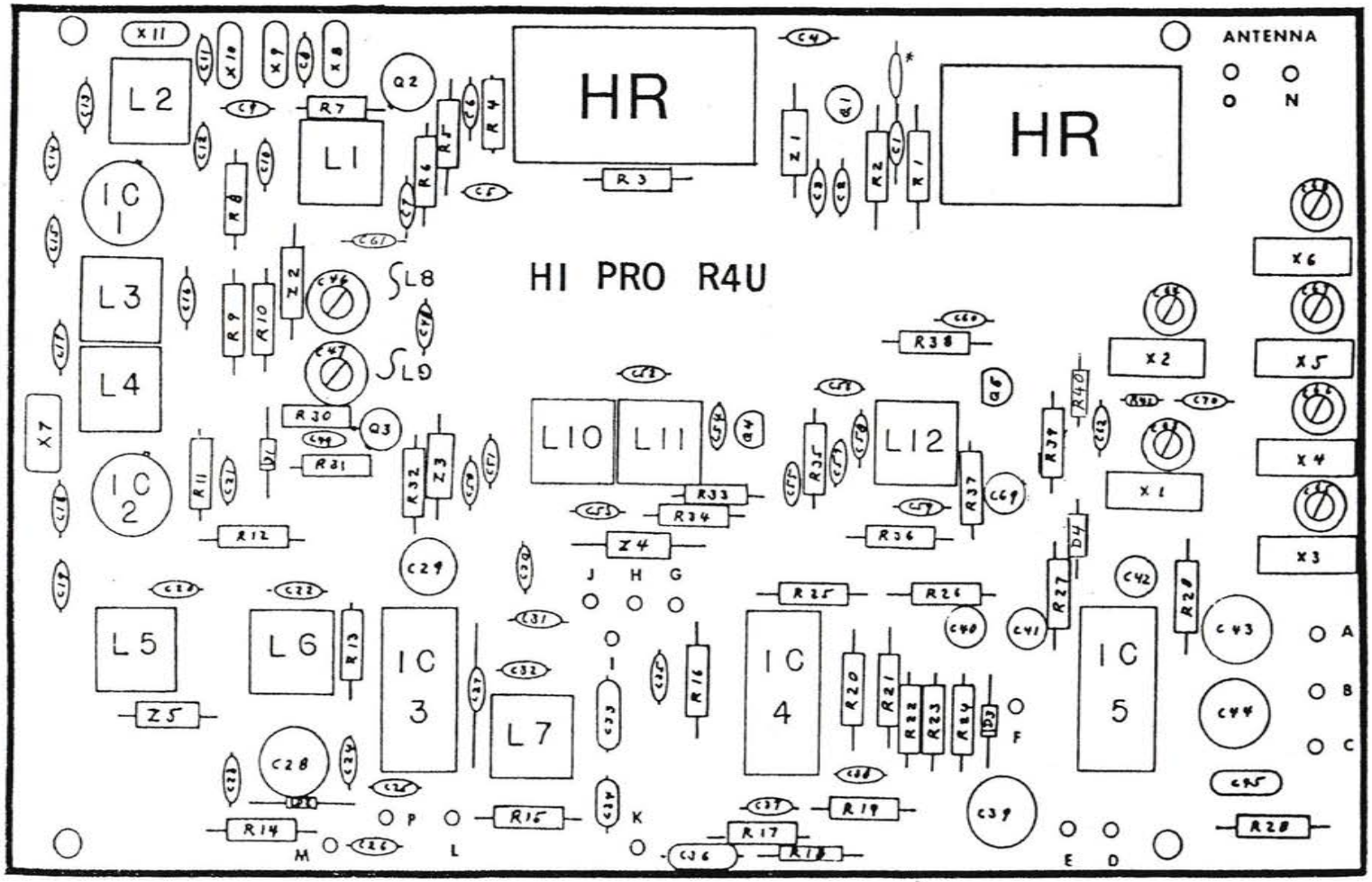


NOTES:

1. "X1" CONSIST OF FROM 1 ~ 6 CRYSTALS
2. "X8" "X9" STANDARD, "X10" "X11" -NOT SHOWN- OPTIONAL
3. REFER TO PARTS LIST FOR PROPER VALUES AND FREQUENCY RANGE
4. SCHEMATIC PROVIDED FOR REFERENCE ONLY
5. "▫" NOT USED ON ALL MODELS

HI PRO R4U UHF RECEIVER

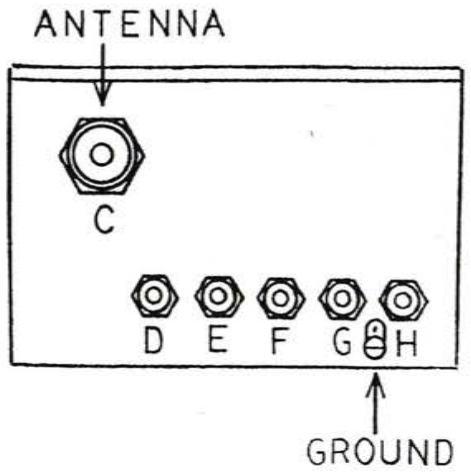
SIZE	CODE IDENT NO.	DRAWING NO.
	R4U	1-A-1282
SCALE X2		SHEET 1



COMPONENT AND PIN LAYOUT

HI PRO R4U

Figure 2



"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

SIZE	CODE IDENT NO.	DRAWING NO.
	RH-1	IB0783
SCALE	f. w.	SHEET 3

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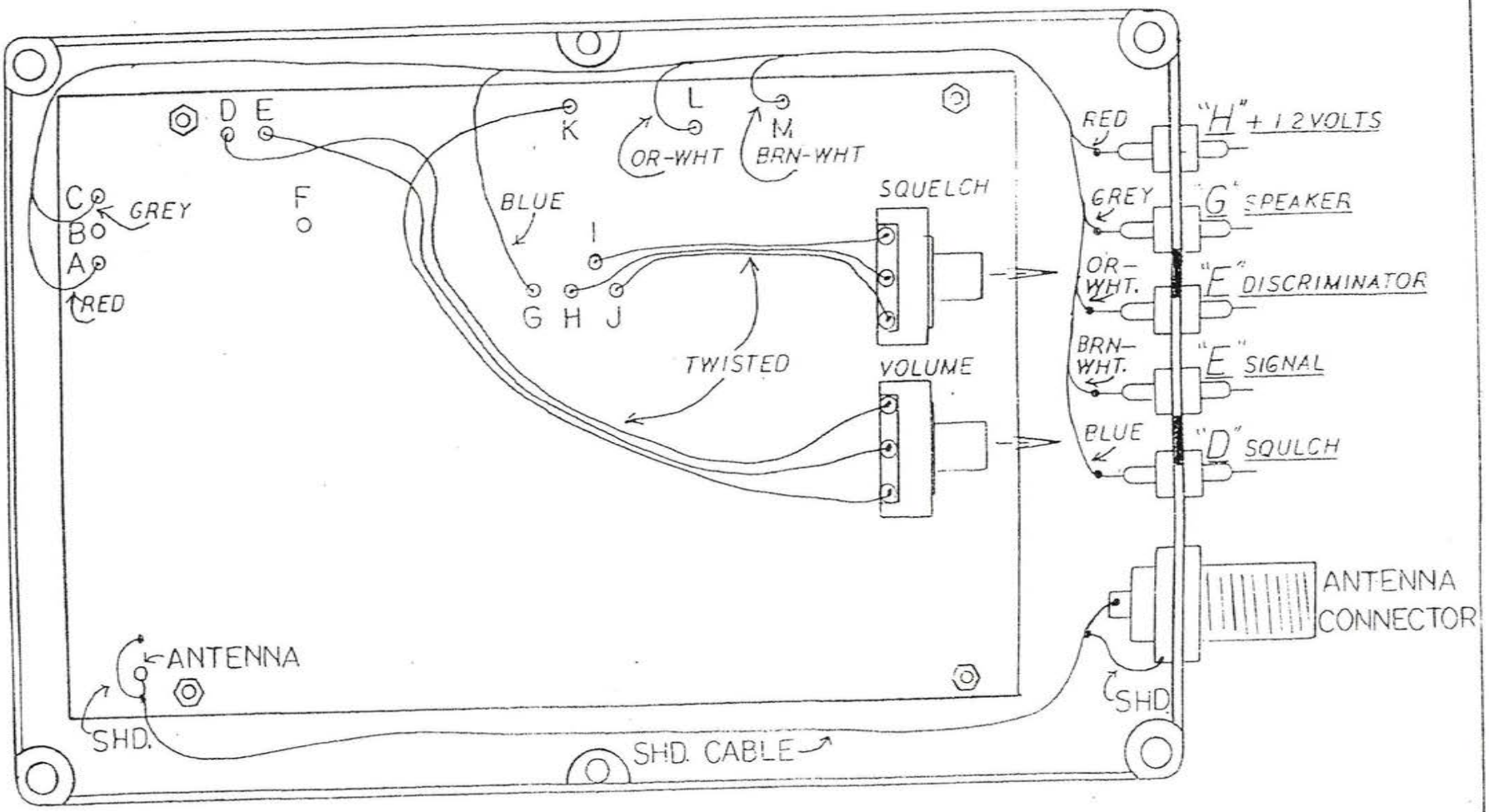

SIZE	CODE IDENT NO.	DRAWING NO.
	R 2404	RX HOUSING LAYOUT
SCALE	Full	SHEET