March 23, 1987

INSTRUCTION MANUAL

RF LINK DEVICES

FM TRANSMITTER UNIT
FM RECEIVER UNIT

RDL SERIES

138-174MHz

Repco®
REPCO, INCORPORATED
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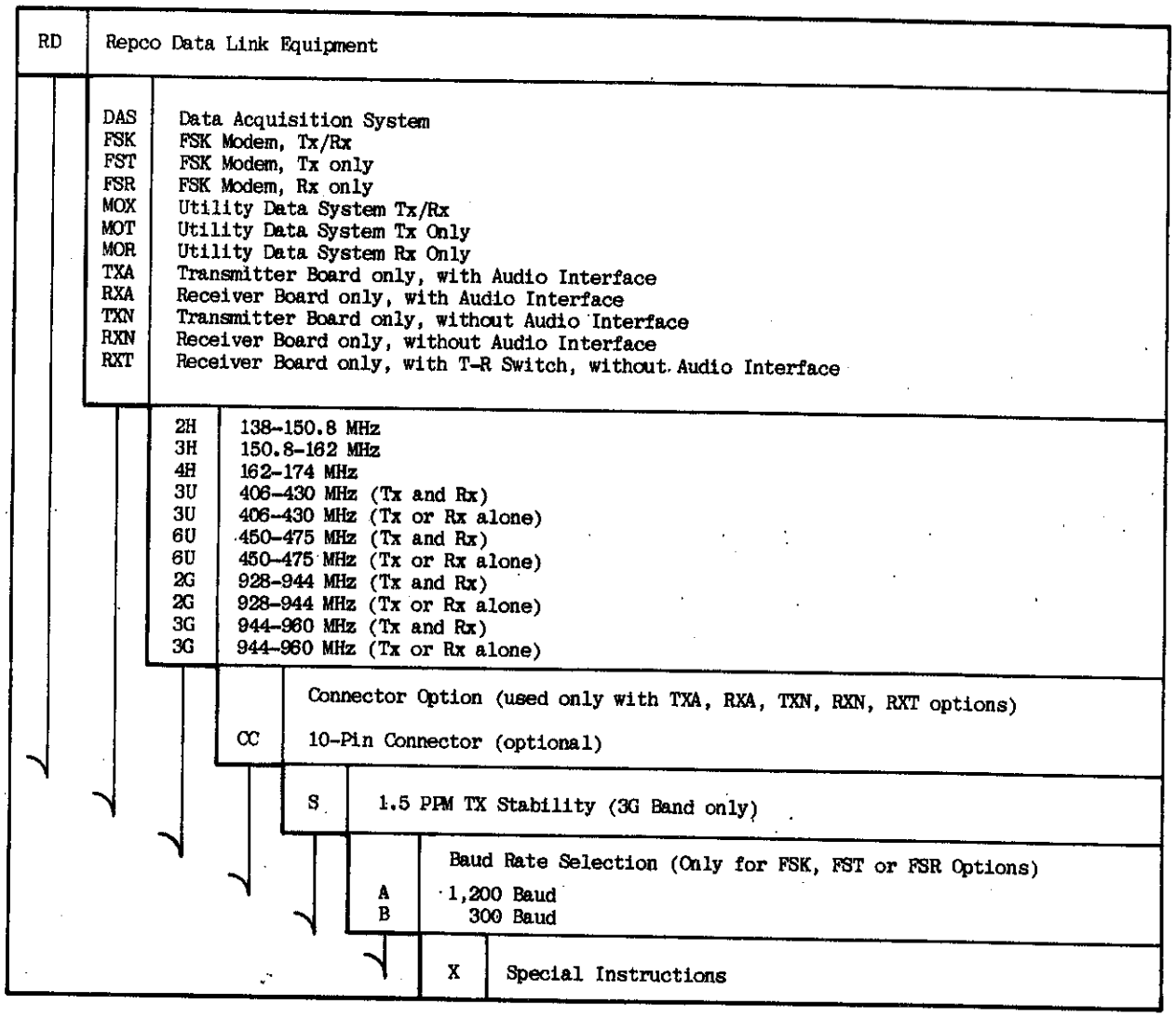
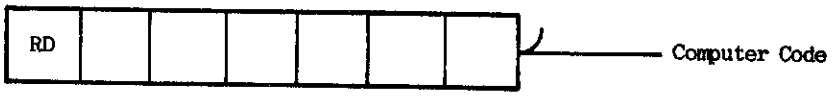
Orlando, Florida 32804-4806
(305) 843-8484
Telex: 441117REPCO UI

CREATING PRODUCTS THAT COMMUNICATE...QUALITY

42-30-031

RADIO CATALOG NUMBER AND OPTION IDENTIFICATION





CONTENTS

TRANSMITTER SPECIFICATIONS

Frequency Ranges:	138-150.8 MHz 150.8-162 MHz 162-174 MHz
Number of Channels:	One (crystal controlled)
RF Power Output:	1.0 - 2.0 Watts (adjustable)
Dimensions	
Length (w/ conn.):	5.62"
Length (w/o conn.):	5.10"
Width:	2.10"
Height:	1.03" max.
Operating Temperature:	-30° to +60°C
Frequency Stability:	±5 ppm
Emission Type:	16F3, 16F9, 15F2
Power Supply Volts:	+12.5 VDC ±10%
Power Supply Current:	550 mA max. at 2.0 Watts; 400 mA max. at 1.0 Watt; 0.1 mA max. with Tx unkeyed
Duty Cycle (w/o Degradation):	Continuous (-30°C to +60°C)
Modulation Deviation:	±5 kHz with 2.0 Volts P-P at data input (J1-1)
Frequency Response:	Flat within ±2.0 dB from 50 Hz to 10 kHz (referenced at 1.0 kHz)
Harmonic Distortion:	5% maximum
FM Hum and Noise:	-50 dB maximum
Spurious and Harmonic Output:	-50 dBc maximum
Carrier Attack Time:	5 mS max. (>90% power and frequency within 1 kHz)
Antenna VSWR Alarm:	Alarm for VSWR > 25:1 at 2.0 Watts

RECEIVER SPECIFICATIONS

Frequency Ranges:	138-150.8 MHz 150.8-162 MHz 162-174 MHz
Number of Channels:	One (crystal controlled)
Dimensions	
Length (w/ conn.):	5.62"
Length (w/o conn.):	5.10"
Width:	2.10"
Height:	1.03" max.
Operating Temperature:	-30° to +60°C
Power Supply Volts:	+12.5 VDC ±10%
Power Supply Current:	20 mA max. (receive) 15 mA max. (standby)
Frequency Stability:	±10 ppm
Sensitivity:	
10 dB S+N/N,	0.25 uV max. (300 Hz baseband bandwidth)
20 dB Quieting,	1.5 uV max. (6.5 kHz baseband bandwidth)
Signal Present Indicator,	.20 uV (switching time <50 mS at threshold)
Intermodulation:	-18 dBm typ. 3rd order intercept
I.F. Selectivity:	6 dB (bandwidth = ±7.5 kHz minimum) 60 dB (bandwidth = ±25 kHz maximum)
Harmonic Distortion:	5% max. (±3 kHz dev. at 1 kHz audio)
Frequency Response:	±2 dB from 50 Hz to 4.5 kHz
Discriminator Output:	1.4V P-P into 600 ohm load (±5kHz deviation)
T/R Switch Loss (Option):	1.0 dB maximum

Specifications Subject To Change Without Notice

Transmitter Unit

The RDL series transmitter is designed to provide reliable wireless transmission of data from remote or unattended locations. It provides 1.0 to 2.0 watts of R.F. power in the 138-174 MHz frequency range operating from a 12.5 volt DC source. A crystal oscillator is used in conjunction with a varactor diode to produce direct FM. Connection to the transmitter unit may be made via hard wiring installed by the user (plated through holes are provided) or through the use of the optional 10 pin connector (721-050-02). The antenna is connected via coaxial cable and an accessory connector (21-15-038) to J2, an SMB type coaxial connector. Should the antenna become disconnected, VSWR sensing circuitry provides the means to activate an external alarm system. Also available to the user is an external line that will supply a regulated 8 volts when the transmitter is keyed. When installed in a system employing suitable modulation limiting and filtering along with proper R.F. cabling and mounting techniques, transmitter performance complies with FCC parts 21 and 90.

The transmitter frequency is determined by a crystal (Y1) located in the base circuit of the oscillator. Q1 is a crystal controlled oscillator with its collector circuit tuned to three times the crystal frequency. A variable inductor in series with the crystal is used for adjusting the frequency of each transmit channel. A varactor diode, CR1, in series with the crystal and Q1, is used for frequency modulating the oscillator, hence the transmitter. Q1 is a tripler, and Q2 a doubler, increasing the multiplication factor to 6. Q3 amplifies the FM signal to a level adequate for driving the final stage amplifier, Q4 to the rated wattage. Two test points, TP1 (R11) and TP2 (R15) are provided in the emitter circuit of the multiplier and amplifier stages, and are used for observing the peak emitter voltage while tuning. A low pass filter in the collector circuit of the final amplifier (Q4) provides matching to the antenna, and assists in the suppression of spurious radiation.

When a transistor to transistor logic (TTL) level voltage (+2.5V to +5.0V) is applied to the key line (J1-8) the base of Q6 goes high causing it to conduct. This in turn pulls the base of Q5 low allowing it to conduct, supplying voltage to the transmitter circuits. U1 serves as a voltage regulator to supply the crystal controlled oscillator with a regulated 8 volts. The doubler and amplifier stages are powered by the switched 12.3 volts while the final stage is supplied directly from the battery. For the user's convenience a regulated 8 volts (20 milliamp max.) is supplied to pin of J1 when the transmitter is keyed.

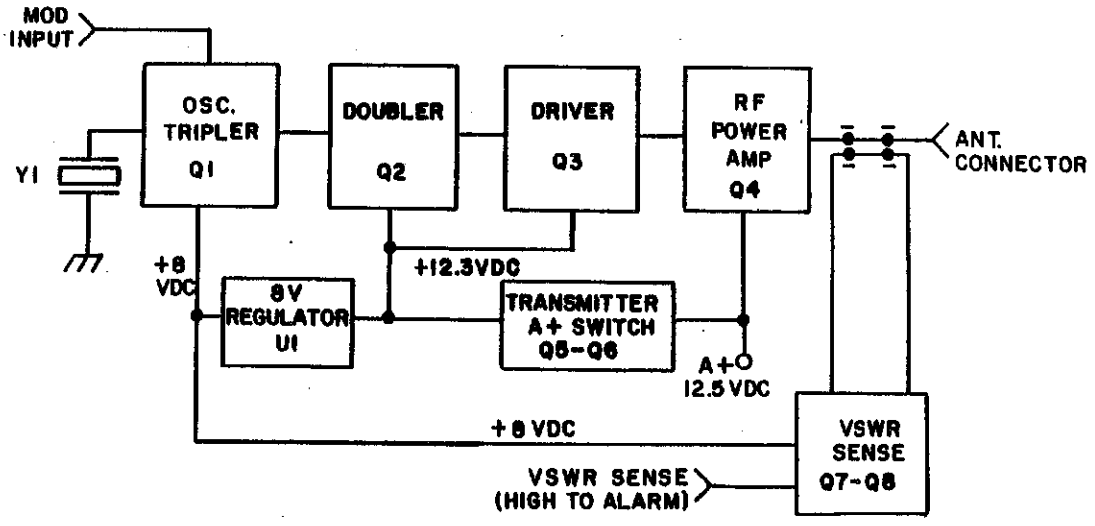


Fig. 1

The data input to the transmitter enters at J1-1 and develops across the deviation control, R1. The bias of CR1 varies at the rate of the modulated input as does the capacitance. This causes the frequency of the oscillator to vary at the modulated input rate to produce the desired frequency modulation. The small frequency shift of the oscillator is also multiplied by six to produce the ±5 kHz of deviation. Variable resistor R1 adjusts the level of the modulated input applied to the varactor diode and consequently the deviation of the transmitter. The standard deviation is ±5 kHz and the transmitter should be adjusted so that the peaks of the modulating signal do not cause the deviation to exceed that figure (no limiting action is provided by the transmitter circuitry).

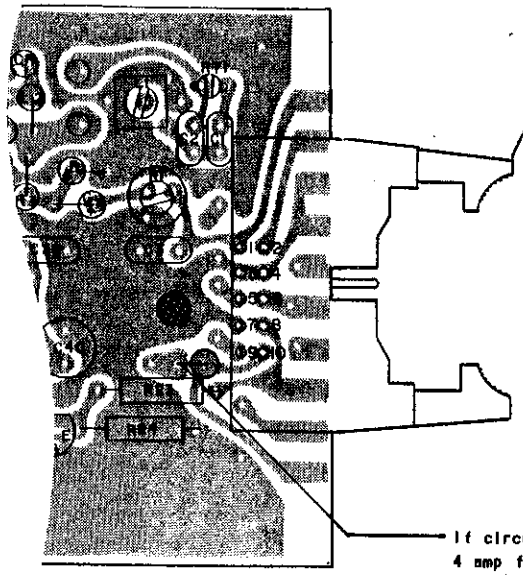
Should the antenna become disconnected, the VSWR alert circuitry provides a means of preventing damage to the transmitter. With the transmitter keyed and the antenna disconnected there is an increase in the voltage level present at W1, a printed transmission line located on the p.c. board. This increase induces a voltage in W2, an adjacent printed transmission line. The base of Q8 goes high causing it to conduct and pull down the base of Q7. Through R31, Q7 supplies pin 6 of J1 with a logic level voltage suitable to activate an external alarm.

Transmitter Pin Functions

Pin No.	Function
1	Data Input (2VPP into 7K resistive load)
2	Not Used
3	Ground
4	Ground
5	Not Used
6	VSWR Sense (high to alarm)
7	Ground
8	Keyline (high to transmit, TTL level* compatible)
9	Regulated +8.0 VDC Out (20 mA max.)
10	+12.5 VDC In

*TTL Levels: High = +2.5V to 5.0V
Low = 0V to 0.5V

CIRCUITRY SHOWN IS FARSIDE



If circuit protection is required, install a 4 amp fuse (part number 51-15-006) as shown and cut the trace on the bottom of the p.c. board.

Fig. 2

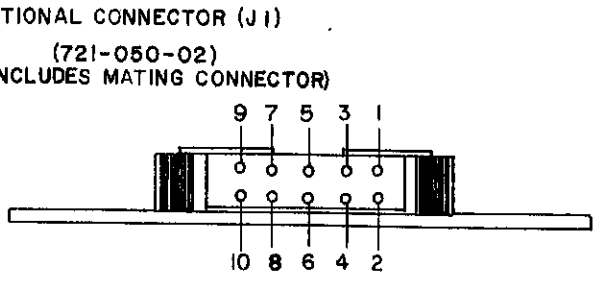


Fig. 3

Transmitter Alignment Procedure

Recommended Test Equipment

1. Regulated Power Supply (12.5 VDC/1 amp)
2. DC Oscilloscope
3. RF Wattmeter
4. Audio Signal Generator
5. DC Voltmeter
6. 30 dB Thru-line RF Attenuator
7. Communications Monitor
8. RG58/U Cable Assembly - 2 foot maximum (SMB to BNC)

Transmitter Tune-up

1. Connect the test equipment to the transmitter as shown in Figure 4.
2. Set R16 (transmitter power) fully clockwise.
3. Key the transmitter and verify that 8.0 ±.4 volts is present at TP3 (R8). Unkey the transmitter after this and all other steps.
4. Connect the oscilloscope to TP1 (R11), key the transmitter, and tune L3, L4, and L5 for maximum (nominal voltage 1.1 volt DC).
5. Transfer the oscilloscope to TP2 (R15), key the transmitter, and adjust L6 and L7 for maximum (nominal voltage 0.75 volts DC).
6. Adjust C29 for maximum current, and C34 and C29 for maximum power output.
7. Adjust R16 (Tx power output) for the rated output power (may be varied between 1.0 and 2.0 watts). Readjust C34 for maximum power output and R16 for rated power output.

Frequency Adjustment

1. Using a non-metallic tuning tool, set the unit on frequency by adjusting L1.

Deviation Adjustment

1. Connect the audio signal generator to pin 1 of J1.
2. Adjust the frequency of the audio signal generator to 1 kHz and the output level to 2V P-P (700 mV RMS) as measured on the oscilloscope.
3. Key the transmitter and verify that R1 (transmitter deviation control) can be adjusted for ±5 kHz of deviation.

Antenna VSWR Alarm Check

1. Remove the test equipment from the antenna jack (J2) and momentarily key the transmitter. A TTL level voltage (+2.5V to +5.0V) should be present at pin 6 of J1.

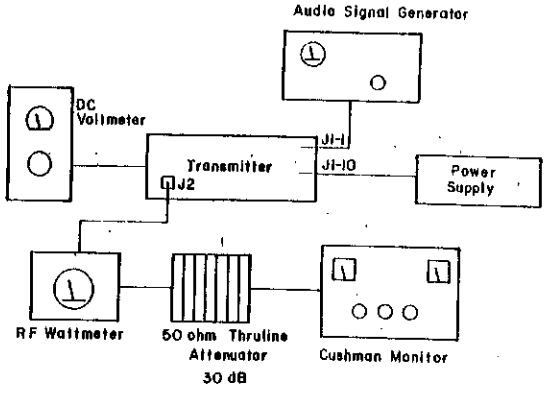


Fig. 4

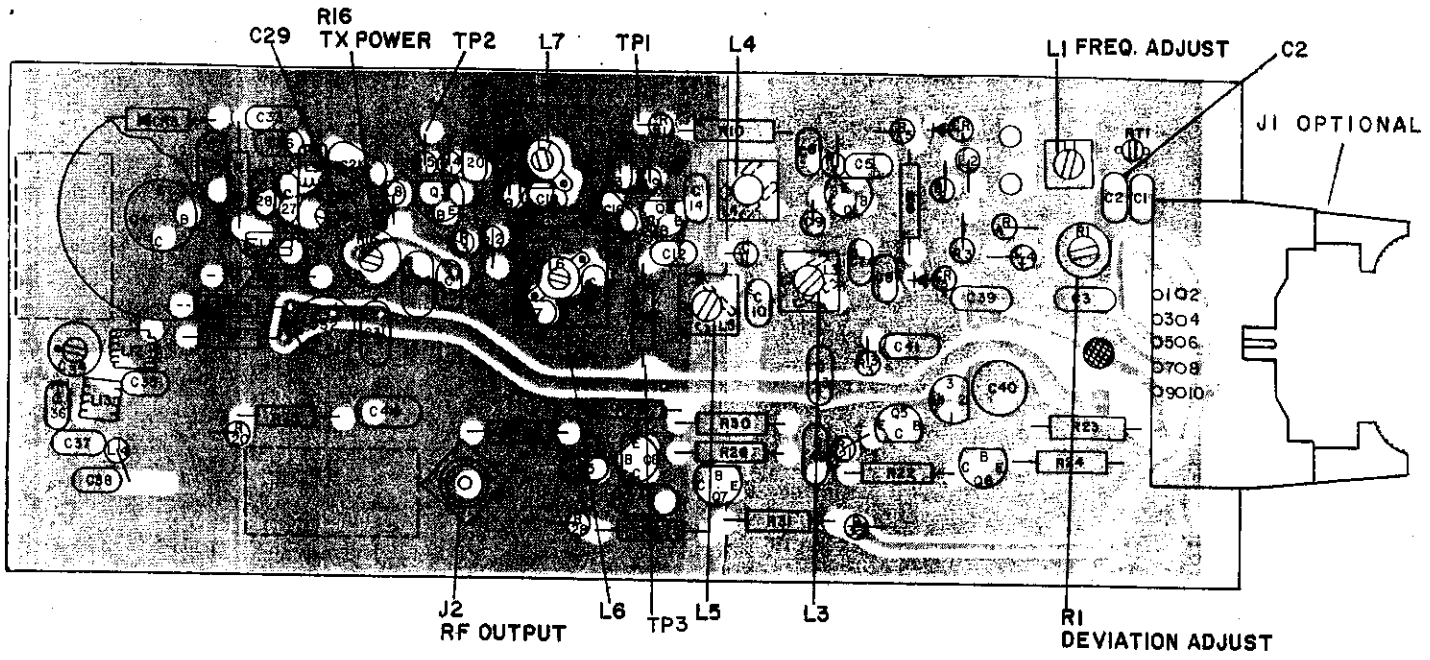


Fig. 5

Transmitter Test Voltages

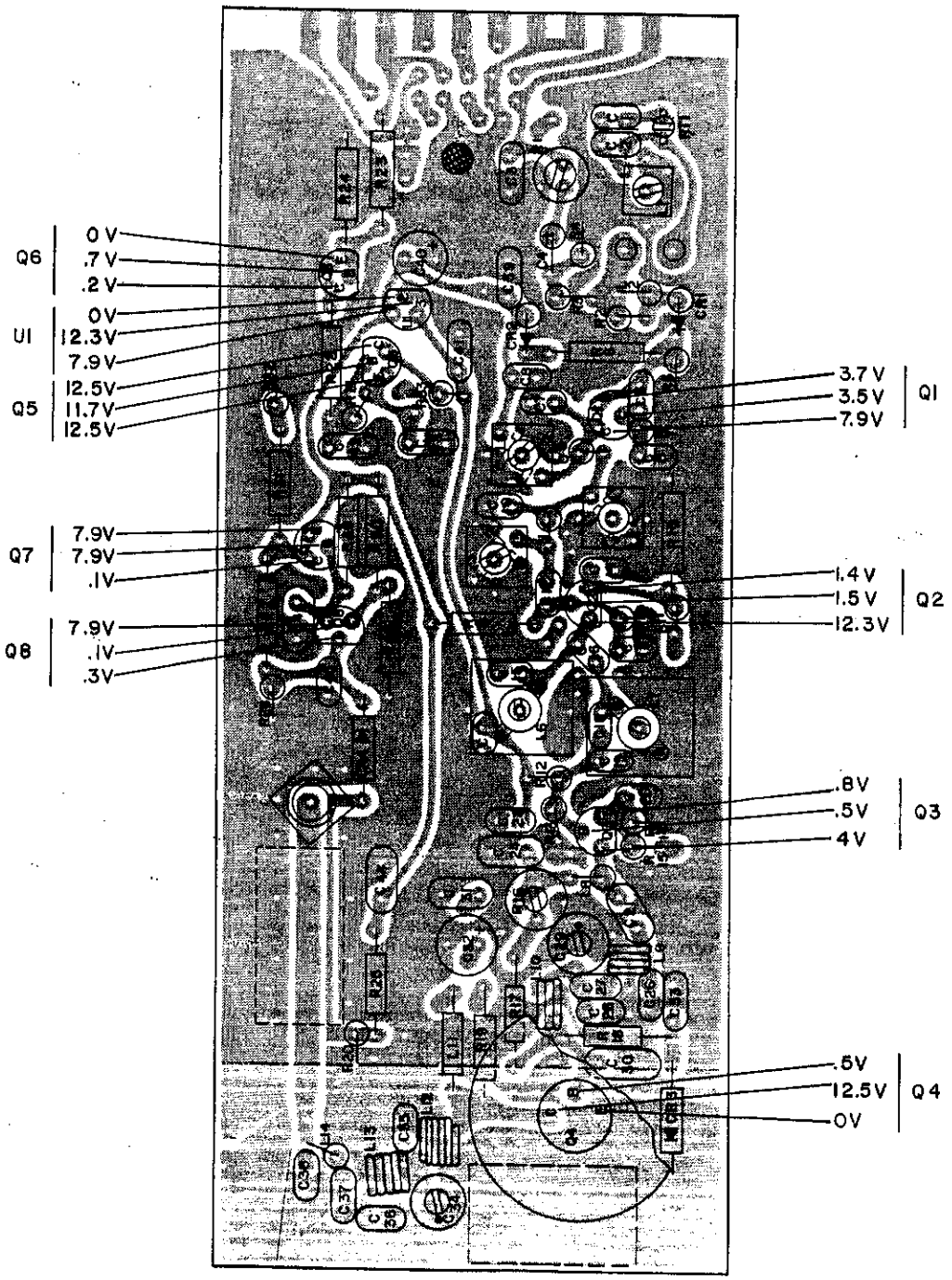


Fig. 6

See schematic at rear of manual for voltage measurement conditions.

Note : Components Shown are Farside

TRANSMITTER PC BOARD ASSEMBLY

138-150.8 MHz (a)	**721-235-01**
used with Honcho System (b)	**721-235-03**
150.8-162 MHz (c)	**721-053-01**
used with Honcho System (d)	**721-053-03**
162-174 MHz (e)	**721-054-01**
used with Honcho System (f)	**721-054-02**

Ref. Des.	Description	Part #
	CAPACITORS	
C1	Capacitor, Cer., 5 pF	15-01-214
C2	Capacitor, Cer., 20 pF	15-01-307
C3	Capacitor, Cer., 270 pF	15-01-166
C4	Cap., Tant., 3.3 uF 10V	15-03-009
C5	Capacitor, Cer., 180 pF(c,d)	15-01-157
C5	Capacitor, Cer., 120 pF(e,f)	15-01-091
C6	Capacitor, Cer., 150 pF(c,d)	15-01-105
C6	Capacitor, Cer., 120 pF(e,f)	15-01-091
C7	Capacitor, Cer., 22 pF(a,b)	15-01-195
C7	Capacitor, Cer., 18 pF(c,d)	15-01-057
C7	Capacitor, Cer., 15 pF(e,f)	15-01-276
C8	Capacitor, Cer., .001 uF	15-01-112
C9	Capacitor, Cer., 1.5 pF	15-01-052
C10	Capacitor, Cer., 18 pF(c,d)	15-01-057
C10	Capacitor, Cer., 15 pF(e,f)	15-01-276
C10	Capacitor, Cer., 22 pF(a,b)	15-01-195
C11	Capacitor, Cer., 1.5 pF	15-01-052
C12	Capacitor, Cer., 27 pF(c-f)	15-01-215
C12	Capacitor, Cer., 36 pF(a,b)	15-01-068
C13	Capacitor, Cer., 47 pF(d,c)	15-01-197
C13	Capacitor, Cer., 33 pF(e,f)	15-01-067
C14	Capacitor, Cer., 470 pF	15-01-040
C15	Capacitor, Cer., 10 pF(c-f)	15-01-203
C15	Capacitor, Cer., 15 pF(a,b)	15-01-276
C16	Capacitor, Cer., .56 pF(c,d)	15-01-093
C16	Capacitor, Cer., .82 pF(e,f)	15-01-098
C17	Capacitor, Cer., .001 uF	15-01-112
C18	Capacitor, Cer., 15 pF(c-f)	15-01-276
C18	Capacitor, Cer., 22 pF (a,b)	15-01-195
C19	Capacitor, Cer., 39 pF(c,d)	15-01-204
C19	Capacitor, Cer., 27 pF(e,f)	15-01-215
C20	Capacitor, Cer., 270 pF	15-01-106
C21	Capacitor, Cer., 18 pF(c,d)	15-01-173
C21	Capacitor, Cer., 22 pF(e,f)	15-01-160
C22	Not Used	
C23	Capacitor, Cer., .001 uF	15-01-112
C24	Capacitor, Cer., 270 pF	15-01-166
C25	Not Used	
C26	Capacitor, Cer., 27 pF(c,d)	15-01-215
C26	Capacitor, Cer., 22 pF(e,f)	15-01-195
C27	Capacitor, Cer., 12 pF	15-01-240
C28	Capacitor, Cer., 18 pF(c,d)	15-01-057
C28	Capacitor, Cer., 6.8 pF(e,f)	15-01-072
C28	Capacitor, Cer., 27 pF(a,b)	15-01-148
C29	Capacitor, Var., 6-22 pF	15-08-017
C30	Cap., Mica, 120 pF 100 V	15-04-013
C31	Capacitor, Cer., 270 pF	15-01-166
C32	Cap., Tant., 6.8 uF 16V	15-03-051
C33	Capacitor, Cer., 270 pF	15-01-166
C34	Capacitor, Var., 6-22 pF	15-08-017
C35	Capacitor, Cer., 39 pF(c,d)	15-01-204
C35	Capacitor, Cer., 43 pF(e,f)	15-01-062
C35	Capacitor, Cer., 47 pF(a,b)	15-01-197
C36	Capacitor, Cer., 47 pF(c,d)	15-01-197
C36	Capacitor, Cer., 43 pF(e,f)	15-01-062
C37	Capacitor, Cer., 18 pF(c,d)	15-01-173
C37	Capacitor, Cer., 22 pF(e,f)	15-01-160
C38	Capacitor, Cer., 8 pF	15-01-194
C39	Capacitor, Cer., 270 uF	15-01-166
C40	Cap., Tant., 6.8 uF 16V	15-03-051
C41	Capacitor, Cer., 270 uF	15-01-166
C42	Capacitor, Cer., 270 uF	15-01-166
C43	Capacitor, Cer., 270 uF	15-01-166
C44	Capacitor, Cer., 270 uF	15-01-166
C45	Capacitor, Cer., .001 uF	15-01-112
C46	Capacitor, Cer., 270 uF	15-01-166
	DIODES	
CR1	Diode, Varicap 19-21 pF	48-13-014
CR2	Diode, Signal	48-05-011
CR3	Diode, Signal	48-06-001
CR4	Diode, Signal	48-05-011
	CONNECTORS	
J1	Connector, 10 pin(optional)	721-050-02
J2*	Connector, 50 ohm SMB	521-151-01
	INDUCTORS	
L1	Inductor, Variable	719-011-14
L2	Choke, 1.8 uH(a,b)	18-01-082
L2	Choke, 1.5 uH(c,d)	18-01-067
L2	Choke, 1.2 uH(e,f)	18-01-093
L3	Coil, Variable 7 1/2 T	18-09-807
L4	Coil, Variable 7 1/2 T	18-09-807
L5	Coil, Variable 7 1/2 T	18-09-807
L6	Coil, Variable 3 1/2 T	18-09-603
L7	Coil, Variable 3 1/2 T	18-09-603
L8	Choke, .1 uH	18-01-032
L9	Coil, 3 1/2 T	530-036-40
L10	Coil, 2 1/2 T	530-036-37
L11	Choke, .27 uH	18-01-045
L12	Coil, 5 1/2 T(c,d)	530-036-44
L12	Coil, 4 1/2 T(e,f)	530-036-45
L13	Coil, 4 1/2 T	530-036-45
L14	Choke, .10 uH	18-01-032
	TRANSISTORS	
Q1	Transistor, Silicon NPN	48-01-069
Q2	Transistor, Silicon NPN	48-01-080
Q3	Transistor, Silicon NPN	48-01-080
Q4	Transistor, Silicon NPN	48-01-064
Q5	Transistor, Silicon PNP	48-12-007
Q6	Transistor, Silicon NPN	48-12-006
Q7	Transistor, Silicon PNP	48-12-007
Q8	Transistor, Silicon NPN	48-12-006
	RESISTORS	
R1	Resistor, Variable, 10K	47-08-020
R2	Resistor, 1.5K, 1/4W	47-13-152
R3	Resistor, 10K, 1/4W	47-13-103
R4	Resistor, 27K, 1/4W	47-13-273
R5	Resistor, 6.8K, 1/4W	47-13-682
R6	Resistor, 4.7K, 1/4W	47-13-472
R7	Resistor, 470 ohm, 1/4W	47-13-471
R8	Resistor, 6.8K, 1/4W	47-13-682
R9	Resistor, 1.8K, 1/4W	47-13-182
R10	Resistor, 100 ohm, 1/4W	47-13-101
R11	Resistor, 10K, 1/4W	47-13-103
R12	Resistor, 5.6K, 1/4W	47-13-562
R13	Resistor, 470 ohm, 1/4W	47-13-471
R14	Resistor, 22 ohm, 1/4W	47-13-220
R15	Resistor, 10K, 1/4W	47-13-103
R16	Resistor, Variable, 1K	47-08-034
R17	Resistor, 820 ohm, 1/4W	47-13-821
R18	Resistor, 10 ohm, 1/4W	47-13-100
R19	Resistor, 560 ohm, 1/4W	47-13-561
R20	Resistor, 150 ohm, 1/4W	47-13-151
R21	Resistor, 10K, 1/4W	47-13-103
R22	Resistor, 820 ohm, 1/4W	47-13-821

*The accessory mating connector for J2 has part number 21-15-038

R23	Resistor, 10K, 1/4W	47-13-103
R24	Resistor, 22K, 1/4W	47-13-223
R25	Resistor, 2.7K, 1/4W	47-13-272
R26	Resistor, 10K, 1/4W	47-13-103
R27	Resistor, 1 meg, 1/4W	47-13-105
R28	Resistor, 68K, 1/4W	47-13-683
R29	Resistor, 100 ohm, 1/4W	47-13-101
R30	Resistor, 47K, 1/4W	47-13-473
R31	Resistor, 6.2K, 1/4W	47-13-622
R32	Resistor, 4.7K, 1/4W	47-13-472
R33	Resistor, 2.7 ohm, 1/4W	RC07GF2R7J
	INTEGRATED CIRCUIT	
U1	Integrated Circuit Voltage Regulator	31-30-042
	THERMISTOR	
RT1	Thermistor, 100 ohm	47-04-013
	CRYSTAL	
Y1	(see selection information below)	23-XX-XXX
	MISCELLANEOUS	
2	Crystal Sockets	21-05-017
3	Can, Coil	25-10-006
4	Can, Coil	25-10-007
6	Heatsink	21-26-010
7	Label, Catalog Number	521-136-01
8	Label, Serial/Freq.	521-136-02
9	Crystal Retainer	519-684-01

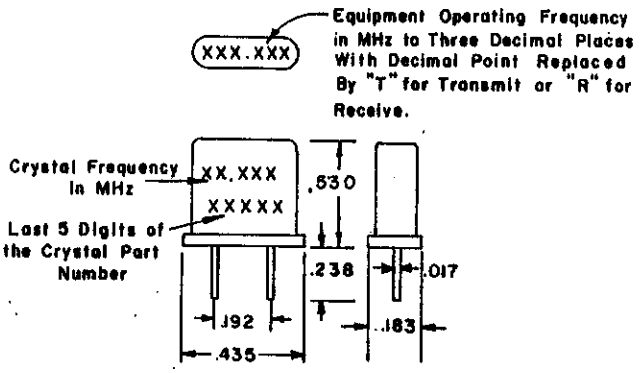


Fig. 7

Transmitter Crystal Specifications

The equipment specifications involving frequency stability are assured only if crystals are supplied by the manufacturer or furnished by manufacturer's approved suppliers.

TRANSMITTER CRYSTAL 138-174 MHz

Part Number: 23-10-015 ▷

Case Type: HC-18/U except pin length of .238" and case height of .53"

Freq. Range: 25.133333 to 29.000000 MHz (Calculated as follows)

Crystal Frequency = $\frac{\text{Operating Frequency*}}{6}$

*(to six decimal places)

Load Capacitance: 43 pF

Drive Level: 0.5 milliwatt maximum

Motional Capacitance: .018 pF ±10%

Equivalent Series Resistance: 18 ohms maximum (without load capacitor)

Frequency Tolerance at +25°C: ±.001%

Frequency Stability: ±5ppm maximum shift from -30°C to +60°C (with compensation)

NOTE: Color dot on crystal case determines temperature compensating requirements.

Tx crystal 23-10-015 is preferred but can be replaced with Tx crystal 23-09-015 if necessary (23-09-015 has a case height of .53" and a pin length of .125").

Temperature Compensating Capacitors

Crystal Color Dot	Compensating Cap., (C2)	Part Number
Black (138-150.8 MHz)	Cap., 20 pF N750	15-01-309
Black (150.8-174 MHz)	Cap., 20 pF N470	15-01-308
Green	Cap., 20 pF N330	15-01-307
Violet	Cap., 20 pF N220	15-01-310

The capacitors listed in the above table are used at C2 in the crystal circuit of the transmitter oscillator. Each transmit crystal has a dot (black, green or violet) that determines which temperature compensating capacitor should be used. Boards shipped from the factory without crystals are equipped with green coded temperature compensating capacitors (15-01-307).

▷ Tx crystal 23-10-015 is preferred but can be replaced with Tx crystal 23-09-015 if necessary (23-09-015 has a case height of .53" and a pin length of .125").

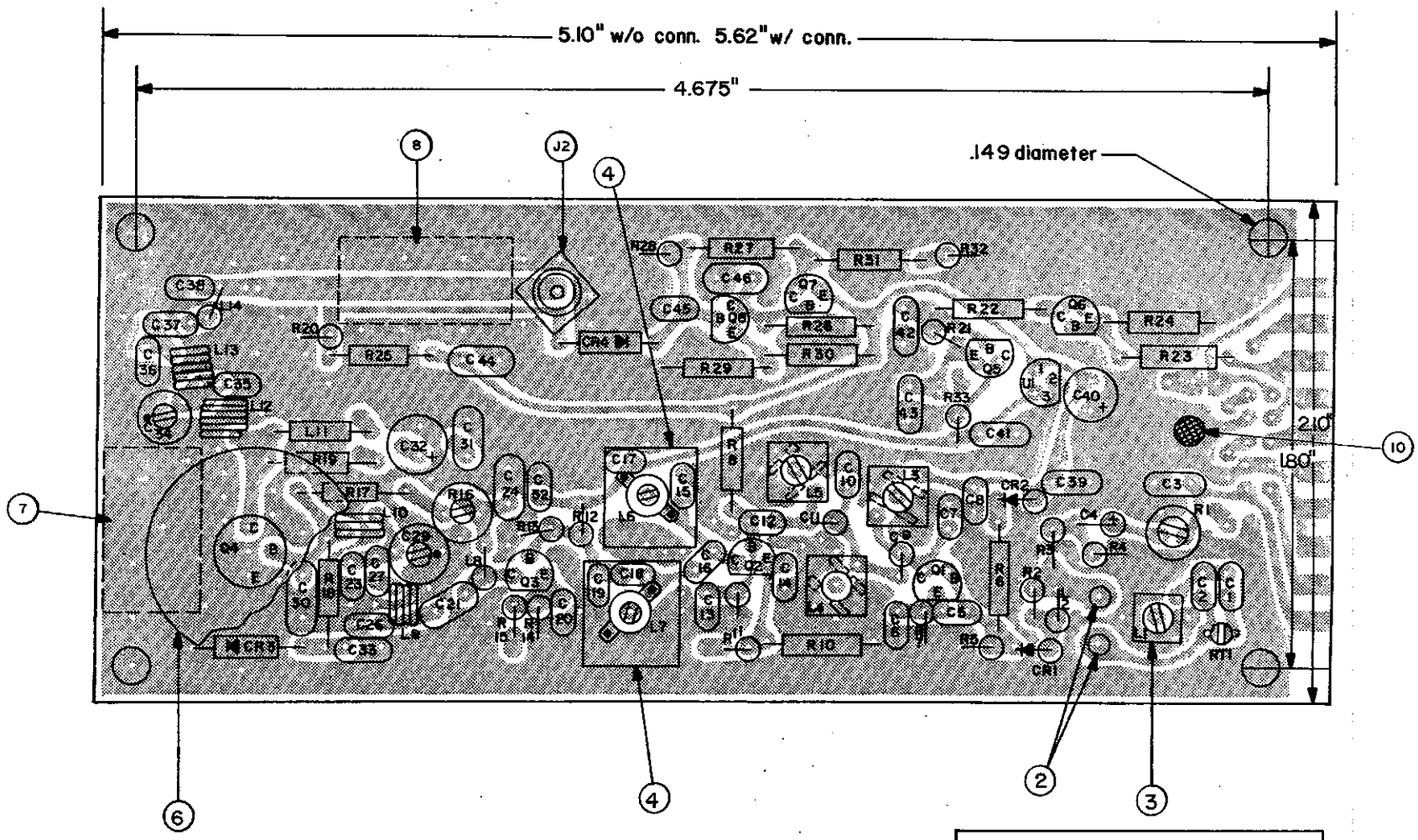


Fig.8

NOTE: COMPONENTS ARE SHOWN FARSIDE

P.C. BOARD ASSEMBLY
TRANSMITTER UNIT

138-150.8MHz (721-235-XX)
150.8-162MHz (721-053-XX)
162-174MHz (721-054-XX)

RECEIVER SQUELCH MODIFICATION

For applications requiring receiver squelch operation, install a diode (IN277, part #48-06-001) between the base of Q9 and the collector of Q8 with the band oriented toward Q8.

Receiver Unit

The RDL 150 telemetry receiver is a single p.c. board unit designed to handle coded R.F. intelligence. Because the receiver is intended primarily for use in decoding digital transmissions, there is no audio processing circuitry. Figure 9 is a simplified block schematic, and shows the process of converting an RF signal at the input to recovered information at the output. The receiver is available in two basic configurations. One model comes without transmit/receive switching circuitry, while the other is equipped with the transmit/receive switching option. Those so equipped are designed to interface with a transmitter unit and an external transmit/receive switch. The modulated output from the transmitter is coupled to the receiver through an additional coaxial connector (J2, part number 21-15-039)* positioned on the receiver p.c. board. Connection to the receiver unit may be made via hard wiring installed by the user (plated through holes are provided) or through the use of the optional 10 pin connector (part number 721-050-02). A board-mounted coaxial connector (J1, part number 21-15-039)* is used to connect the unit to the antenna.

Most of the active devices in the receiver are connected in a series parallel configuration across the power source, resulting in a very low quiescent current, (typically 15 mA). The supply voltage (12.5 VDC) flows through switching transistor Q7 and is regulated by Q6 to 9.5 V. Variable resistor R45 is used to adjust this voltage. The receiver may be muted by applying a logic level voltage (2.5 to 5.0 V) to pin 1 of J3. This causes switching transistor Q5 to conduct which in turn pulls down the base of NPN transistor Q7. Q7 stops conducting, removing supply voltage from the receiver.

The received signal from the antenna is fed to the input stage of the receiver, RF amplifier Q1, through a two pole bandpass filter comprised of resonators L4 and L5. C4 and C5 provide impedance matching from the antenna to the input of the filter while C7 and C8 provide matching to the RF amplifier from the output of the filter. Q1 is a common emitter RF amplifier. The amplified RF signal at the collector of Q1 is coupled to the gate of mixer (JFET) transistor, Q2, through a two pole filter comprised of L6, and L7. Q4 is a crystal controlled oscillator, with its collector tuned to three times the crystal frequency. (A third overtone crystal is used with this oscillator.) The receiver frequency is determined by a crystal (Y2) located in the base circuit of the

*The accessory mating connector for J1 & J2 has part number 21-15-038.

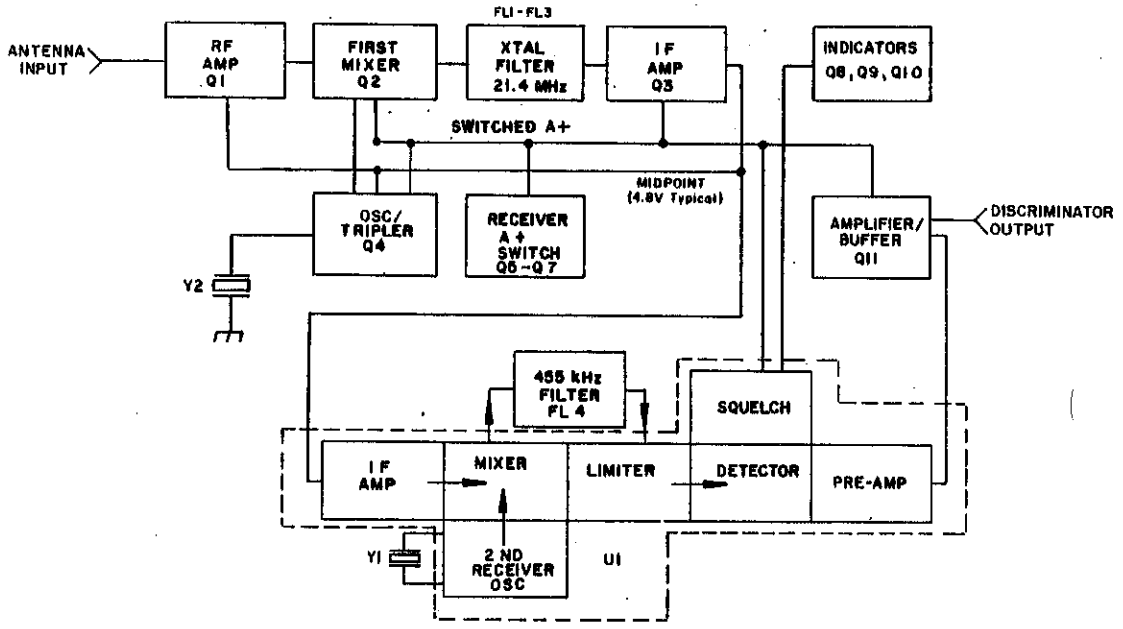


Fig. 9

oscillator. A variable capacitor (C28) in series with the crystal is used to set the receive channel on frequency. The output of the oscillator ($3F_X$) is capacitively coupled to the source of the mixer, Q2. The difference frequency of 21.4 MHz, (the first I.F.), is selected by three series two pole crystal filters, (FL1, FL2, and FL3), and amplified by the I.F. amplifier Q3. The output of Q3 is taken from its collector, and fed to a multipurpose integrated circuit U1.

U1 operates as an I.F. amplifier, oscillator, mixer, limiter, detector, amplifier, and in addition has an operational amplifier noise amplifier (pins 10 and 11) and a Schmitt trigger circuit that is used to activate the signal present alert. The crystal Y1, in the circuit of pins 1 and 2, sets the frequency of the second oscillator to 20.945 MHz, and the second I.F. of 455 kHz is filtered by ceramic filter FL4. Inductor L15 tunes the detector to 455 kHz, and the detector output is taken from pin 9, and developed across the discriminator output level control, R30. Q11 serves as an amplifier/buffer, supplying pin 5 of J3 with the final amplified discriminator output.

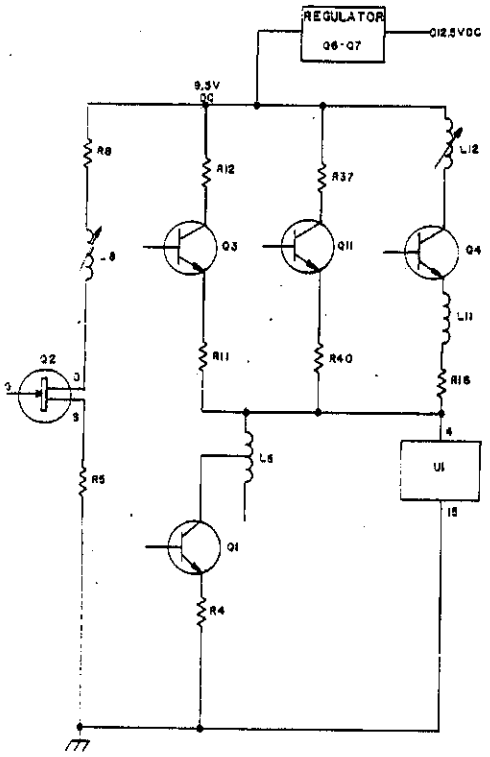


Fig. 10

The signal present indicator control (R18) is part of a voltage divider network and controls the DC voltage to the Schmitt trigger input at pin 12. The output of pin 13 is used to activate the signal present light (DS1) and external indicator (J3-6) through switching transistors Q8, Q9, and Q10. With no signal present, pin 13 supplies the base of Q9 with sufficient voltage to cause it to conduct, thus shutting off Q8 and Q10. Upon receipt of a signal, pin 13 goes to ground and Q9 quits conducting. This switches on both Q8 and Q10 by supplying voltage to their bases. Q10 causes pin J3-6 to sink to ground (the user may wish to utilize this function to provide an external indicator, etc.) while Q8 allows the signal present light (DS1) to illuminate.

When the receiver is equipped with the T/R switching option, L2, L3 and C3 form a quarter wave section at the RF input to the receiver (see Figure 11). If the transmit mode is desired, switched voltage (3 to 5 volts at 20 mA typical) is applied to the antenna circuit through J3-2 and R1. Pin diodes CR1 and CR2 are forward biased, and CR2 shorts the receiver input and one end of the quarter wave section. Looking at the receiver, the antenna sees an infinitely high impedance, and looking at the transmitter it sees a relatively low impedance (in the order of 50 ohms) through conducting pir diode CR1. Thus, the transmitter is "connected" to the antenna. To return to the receive mode, the T/R switch voltage is removed from J3-2 and thus from pin diodes CR1 and CR2. The antenna now sees an extremely high impedance looking at the transmitter, and approximately 50 ohms looking at the receiver. Signals at the antenna are consequently routed to the receiver.

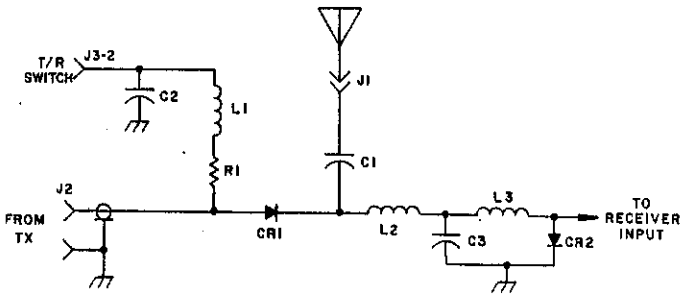


Fig. 11

As indicated by the dotted lines shown on the receiver schematic, several variations of the basic signal present circuitry are possible. These additional components (R46, R47, R48) may be installed by the user in predrilled positions on the p.c. board (refer to figure 18). The functions of these components are as follows:

R47 (47K) adds hysteresis to the signal present indicator circuitry. i.e. The rated indicator threshold is .20 uV. When R47 is added, .20 uV is still required to activate the indicator, however, it will remain activated even if the signal strength falls slightly below the initial .20 uV threshold level.

R48 (22K) is used to bypass Q9 and thus invert the function of Q10 and the external signal present indicator (J3-6). Instead of sinking to ground when a signal is received, J3-6 is now grounded when no signal is present.

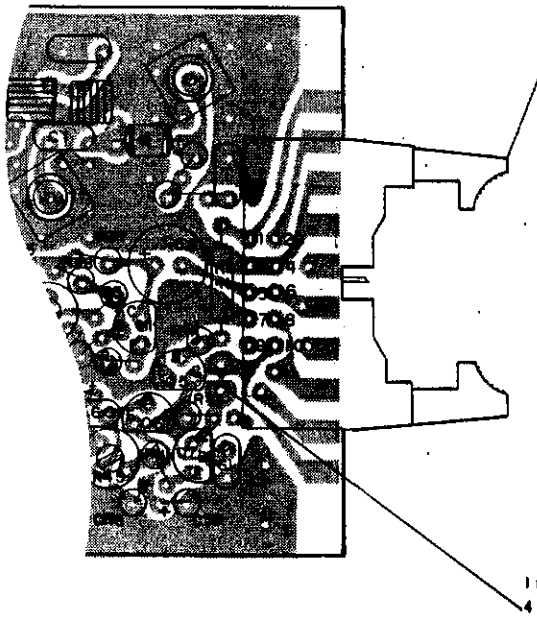
R46 (10K) serves as a pull-up resistor at the collector of Q10. When there is no received signal present, pin J3-6 is supplied with current through R46. A received signal will cause Q10 to go to ground and remove the voltage from pin J3-6. NOTE: R48 may be used in conjunction with R46 to invert the output at pin J3-6 according to the presence or absence of a signal.

Receiver Pin Functions

Pin No.	Function
1	Receiver Mute (high to mute, TTL level* compatible)
2	T/R Switch (+3 to +5 volts at 20 mA typ. for Tx)
3	Ground
4	Ground
5	Discriminator Output
6	Signal Present (sinks to ground when signal received)
7	Ground
8	Not Used
9	+9.5 V Test Point
10	+12.5 VDC In

*TTL Levels: High = +2.5V to +5.0V
Low = 0V to +0.5V

CIRCUITRY SHOWN IS FARSIDE



OPTIONAL CONNECTOR (J3)
(721-050-02)
(INCLUDES MATING CONNECTOR)

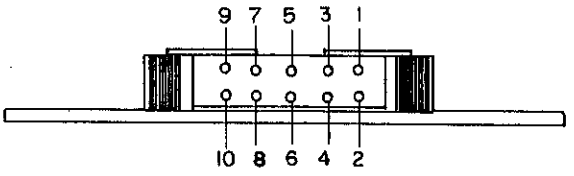


Fig. 13

If circuit protection is required, install a 4 amp fuse (part number 51-15-006) as shown and cut the trace on the bottom of the p.c. board.

Fig. 12

Receiver Alignment Procedure

Recommended Test Equipment

1. Regulated Power Supply (12.5 VDC/1 amp.)
2. FM Signal Generator
3. DC Voltmeter
4. Distortion Analyzer
5. 21.4 MHz Crystal Oscillator
6. DC Oscilloscope
7. RG58/U Cable Assembly - 2 foot maximum (SMB to BNC)
8. 600 ohm load

Receiver Tune-Up

1. Connect the test equipment to the receiver as shown in Figure 14. The DC voltmeter is connected to TP2 (C62) initially.

2. Adjust R45 for 9.5 ±.1 volts.

3. Connect the oscilloscope to TP1 (R7) and tune L12, L13 and L14 for maximum voltage.

4. Adjust R30 (Disc. Output) for approximately 50 mV RMS and tune L15 for maximum noise on the distortion analyzer.

5. Set the FM signal generator (unmodulated) to the channel frequency, adjust the RF output level so that the receiver quiets (signal present indicator light illuminates), then reduce the signal by 10 dB.

6. Loosely couple the 21.4 MHz test oscillator near the IF amplifier (U1) and adjust C28 for zero beat.

7. Set the FM signal generator to 3 kHz deviation with a 1 kHz tone. Tune L4, L5, L6, L7, L8 and L9 for best 12 dB SINAD.

8. Set the FM signal generator to 1 mV. Adjust R30 for 50 mV RMS and L15 for maximum noise on the distortion analyzer.

9. Adjust R30 (discriminator output) for the rated output of 850 mV P-P (approx. 300 mV RMS).

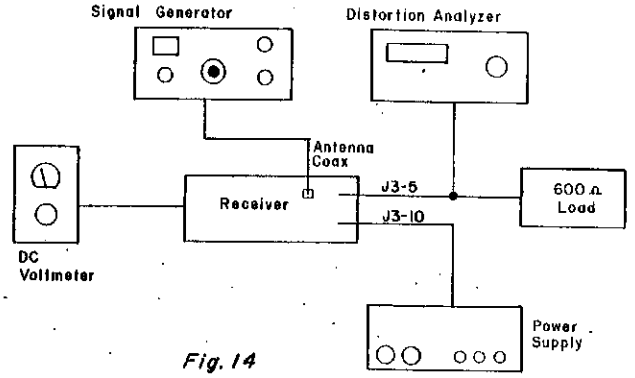


Fig. 14

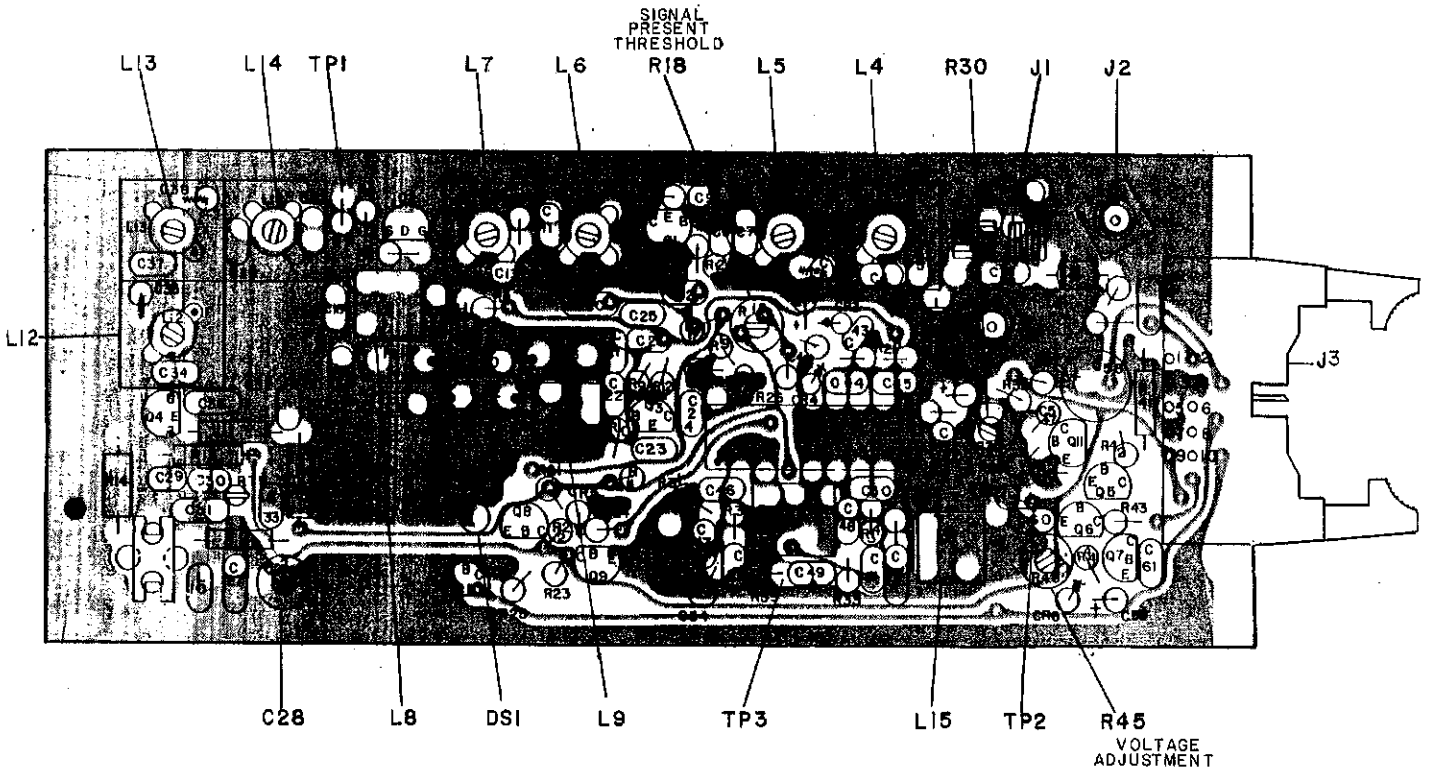


Fig. 15

10. Tune L8 and L9 and then retune L8 for minimum distortion. Distortion should be less than 5%.

11. Check the 20 dB quieting by reducing the unmodulated output of the signal generator to zero microvolts and then increase the output level until the noise output drops by 20 dB. At that level sensitivity should be 1.5 uV (-103 dBm) or less.

12. Set the signal generator output to zero and turn R18 (signal present indicator control) fully clockwise. The signal present indicator light (DS1) should be off. Rotate R18 counterclockwise until DS1 illuminates and then clockwise until it just turns off. Increase the signal generator level until DS1 illuminates. The level required should be no greater than .20 uV (-121 dBm).

13. Apply a TTL level voltage to J3-1. The receiver should mute until the voltage is removed.

14. On units equipped with the T/R switch option activate the T/R switch by applying voltage (3 to 5 volts) to J3-2. Receiver quieting sensitivity should degrade by at least 10 dB.

Receiver Test Voltages

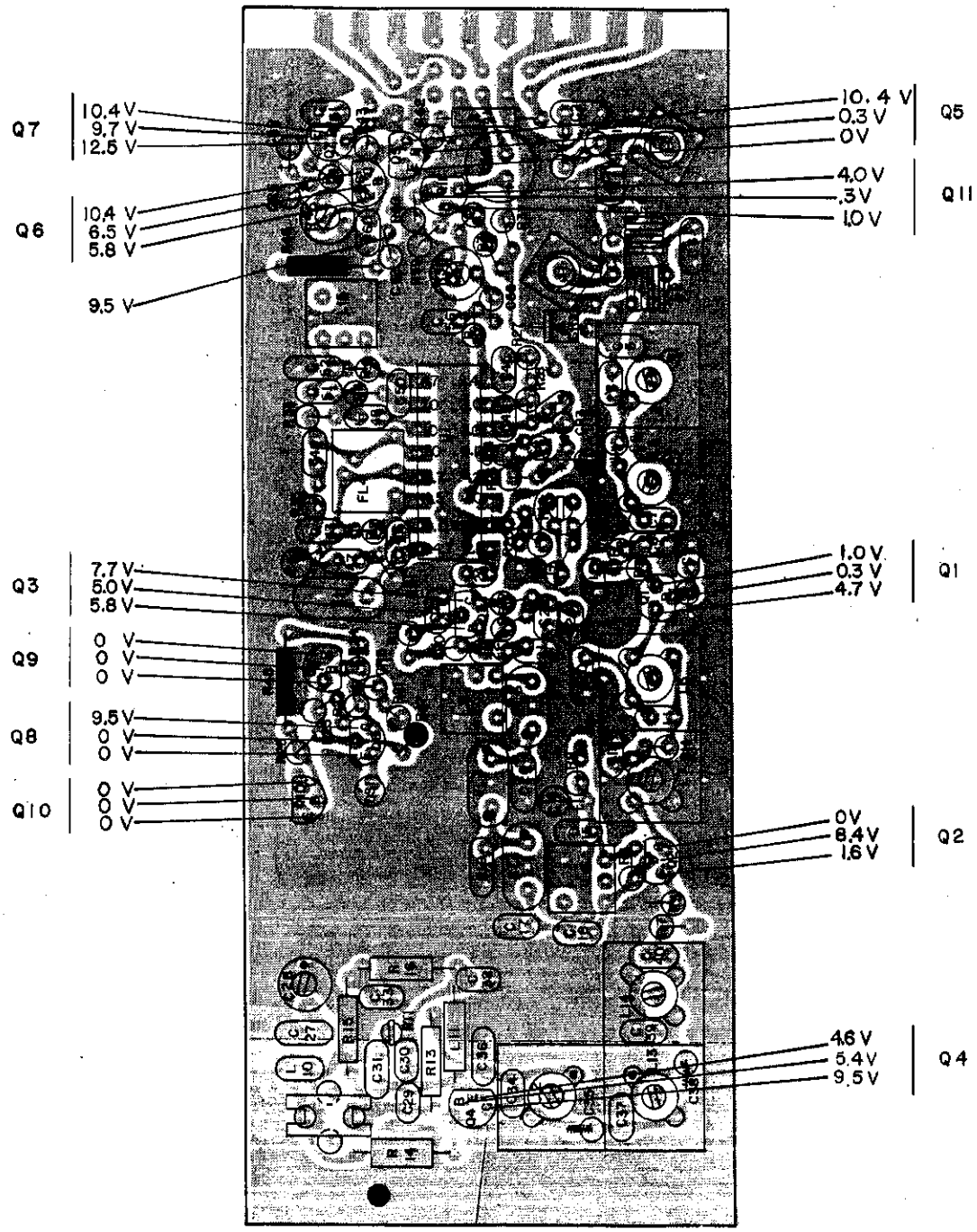


Fig. 16

Note: Components Shown are Farside

See page 21 for voltage measurement conditions

RECEIVER P.C. BOARD ASSEMBLY

138-150.8 MHz	
with trans./rec. switching (a)	721-236-01
without trans./rec. switching(b)	721-236-02
used with DAS (c)	721-236-04
150.8-162 MHz	
with trans./rec. switching (d)	721-055-01
without trans./rec. switching(e)	721-055-02
used with DAS (f)	721-055-04
used with Honcho Remote (g)	721-055-05
162-174 MHz	
with trans./rec. switching (h)	721-056-01
without trans./rec. switching(i)	721-056-02
used with DAS (j)	721-056-03
used with Honcho Remote (k)	721-056-04

Ref. Des.	Description	Part No.
	CAPACITORS	
C1	Capacitor, Cer., 270 pF	15-01-166
C2	Capacitor, Cer., 270 pF (a,c,d, f,g,h,i,k)	15-01-166
C3	Capacitor, Cer., 18 pF (a,c)	15-01-173
C3	Capacitor, Cer., 10 pF (d,f,g, h,j,k)	15-01-163
C4	Capacitor, Cer., 10 pF (a-c)	15-01-046
C4	Capacitor, Cer., 8 pF (d-k)	15-01-194
C5	Capacitor, Cer., 39 pF (a-c)	15-01-110
C5	Capacitor, Cer., 33 pF (d-k)	15-01-067
C6	Capacitor, Cer., .47 pF (a-c)	15-01-029
C6	Capacitor, Cer., .56 pF (d-k)	15-01-082
C7	Capacitor, Cer., 10 pF (a-c)	15-01-046
C7	Capacitor, Cer., 8 pF (d-k)	15-01-194
C8	Capacitor, Cer., 27 pF (a-c)	15-01-148
C8	Capacitor, Cer., 18 pF (d-k)	15-01-057
C9	Capacitor, Cer., .001 uF	15-01-112
C10	Capacitor, Cer., 270 pF	15-01-166
C11	Capacitor, Cer., 6.8 pF (a-c)	15-01-072
C11	Capacitor, Cer., 5.6 pF (d-g)	15-01-071
C11	Capacitor, Cer., 5 pF (h-k)	15-01-214
C12	Capacitor, Cer., .001 uF	15-01-112
C13	Capacitor, Cer., 6.8 pF (a-c)	15-01-072
C13	Capacitor, Cer., 5.6 pF (d-g)	15-01-071
C13	Capacitor, Cer., 5 pF (h-k)	15-01-214
C14	Capacitor, Cer., .33 pF (a-c)	15-01-031
C14	Capacitor, Cer., .56 pF (d-k)	15-01-082
C15	Capacitor, Cer., .001 uF	15-01-112
C16	Capacitor, Tant., 6.8 uF	15-03-051
C17	Capacitor, Cer., 12 pF	15-01-240
C18	Capacitor, Cer., 100 pF	15-01-026
C19	Capacitor, Cer., 6.8 pF	15-01-186
C20	Capacitor, Cer., 6.8 pF	15-01-186
C21	Capacitor, Cer., 2.7 pF	15-01-196
C22	Capacitor, Cer., 27 pF	15-01-189
C23	Capacitor, Cer., .001 uF	15-01-112
C24	Capacitor, Cer., 27 pF	15-01-189
C25	Capacitor, Cer., .001 uF	15-01-112
C26	Capacitor, Cer., .1 uF	15-01-073
C27	Capacitor, Cer., 4.7 pF (d-g)	15-01-187
C27	Capacitor, Cer., 2.7 pF (h-k)	15-01-170
C28	Capacitor, Var., 4.5-15 pF	15-08-005
C29	Capacitor, Cer., 43 pF	15-01-062
C30	Capacitor, Cer., 56 pF	15-01-064
C31	Capacitor, Cer., 39 pF	15-01-185
C32	Capacitor, Cer., .001 uF	15-01-112
C33	Capacitor, Cer., .001 uF	15-01-112
C34	Capacitor, Cer., 10 pF (a-c)	15-01-046
C34	Capacitor, Cer., 8 pF (d-g)	15-01-194
C34	Capacitor, Cer., 6.8 pF (h-k)	15-01-072
C35	Capacitor, Cer., .68 pF	15-01-032
C36	Capacitor, Cer., 270 pF	15-01-166
C37	Capacitor, Cer., 10 pF (a-c)	15-01-046
C37	Capacitor, Cer., 8 pF (d-g)	15-01-194
C37	Capacitor, Cer., 6.8 pF (h-k)	15-01-072
C38	Capacitor, Cer., .68 pF	15-01-032
C39	Capacitor, Cer., 10 pF (a-c)	15-01-046
C39	Capacitor, Cer., 8 pF (d-g)	15-01-194
C39	Capaciotr, Cer., 6.8 pF (h-k)	15-01-072
C40	Capacitor, Cer., .01 uF	15-01-086
C41	Capacitor, Tant., 1 uF	15-03-016
C42	Capacitor, Tant., 1 uF	15-03-016
C43	Capacitor, Cer., .001 uF	15-01-112
C44	Capacitor, Cer., 100 pF	15-01-026
C45	Capacitor, Cer., 680 pF	15-01-181
C46	Capacitor, Cer., 39 pF	15-01-204
C47	Capacitor, Cer., 150 pF	15-01-105
C48	Capacitor, Cer., .1 uF	15-01-073
C49	Capacitor, Cer., 27 pF	15-01-189
C50	Capacitor, Cer., 10 pF	15-01-203
C51	Capacitor, Cer., .1 uF	15-01-073
C52	Capacitor, Cer., 270 pF	15-01-166
C53	Capacitor, Cer., .001 uF	15-01-112
C54	Capacitor, Tant., 10 uF	15-03-008
C55	Capacitor, Tant., 3.3 uF (a,b,d,e,g,h,i,k)	15-03-009
C56	Capacitor, Cer., .01 uF	15-01-131
C57	Capacitor, Tant., 10 uF (a,b,d,e,g)	15-03-008
C58	Capacitor, Tant., 47 uF (a,b,d,e,g)	15-03-048
C59	Capacitor, Tant., 10 uF	15-03-008
C60	Capacitor, Cer., .018 uF	15-01-150
C61	Capacitor, Cer., 270 pF	15-01-106
C62	Capacitor, Tant., 10 uF	15-03-008
	DIODES	
CR1	Diode, Switching (a,c,d,f,g, h,j,k)	48-05-021
CR2	Diode, Switching (a,c,d,f,g, h,j,k)	48-05-023
CR3	Diode, Signal	48-05-011
CR4	Diode, Signal	48-05-011
CR5	Diode, Signal	48-05-011
CR6	Diode, Zener 5.8V	48-11-013
DS1	LED	39-06-004
	FILTERS	
FL1	Filter, 21.4 MHz I.F.	27-03-022
FL2	6 pole set, Crystal Filter	
FL3		
FL4	Filter, 455 kHz I.F.	27-03-025
	CONNECTORS	
J1*	Connector, Coax (50 ohm, SMB)	21-15-039
J2*	Connector, Coax (50 ohm, SMB) (a,c,d,f,g,h,j,k)	21-15-039
J3	Connector, 10 pin (optional)	721-050-02
	INDUCTORS	
L1	Choke, 1 uH (a,c,d,f,g,h,j,k)	18-01-004
L2	Coil, 5 1/2 T(a,c,d,f,g,h,j,k)	530-036-44
L3	Coil, 5 1/2 T(a,c,d,f,g,h,j,k)	530-036-44
L4	Coil, Variable 5 1/2 T	18-09-502
L5	Coil, Variable 5 1/2 T	18-09-502
L6	Coil, Variable 5 1/2 T Tapped 3 5/8	18-09-519
L7	Coil, Variable 5 1/2 T Tapped 3 5/8	18-09-519
L8	Transformer, 21.4 MHz I.F.	56-06-008

*The accessory mating connector for J1 & J2 has part number 21-15-038

L9	Transformer, 21.4 MHz I.F.	56-06-008
L10	Toroid, 1.8 uH (a-c)	18-01-082
L10	Toroid, 1.2 uH (d-k)	18-02-008
L11	Choke, .33 uH	18-01-070
L12	Coil, Variable 5 1/2 T	18-09-502
L13	Coil, Variable 5 1/2 T	18-09-502
L14	Coil, Variable 5 1/2 T Tapped 4 7/8	18-09-520
L15	Transformer, 455 kHz I.F.	56-06-002
	TRANSISTORS	
Q1	Transistor, Silicon NPN	48-01-069
Q2	Transistor, N-Channel JFET	48-14-006
Q3	Transistor, Silicon NPN	48-01-095
Q4	Transistor, Silicon NPN	48-01-069
Q5	Transistor, Silicon NPN	48-01-053
Q6	Transistor, Silicon NPN	48-01-053
Q7	Transistor, Silicon NPN	48-12-006
Q8	Transistor, Silicon NPN	48-01-053
Q9	Transistor, Silicon NPN	48-01-053
Q10	Transistor, Silicon NPN	48-01-053
Q11	Transistor, Silicon NPN	48-01-053
	RESISTORS	
R1	Resistor, 150 ohm (a,c,d,f,g, h,j,k)	47-13-151
R2	Resistor, 3.3 K	47-13-332
R3	Resistor, 12 K	47-13-123
R4	Resistor, 240 ohm	47-13-241
R5	Resistor, 470 ohm	47-13-471
R6	Resistor, 3.3 K	47-13-332
R7	Resistor, 10 K	47-13-103
R8	Resistor, 330 ohm	47-13-331
R9	Resistor, 33 K	47-13-333
R10	Resistor, 10 K	47-13-103
R11	Resistor, 470 ohm	47-13-471
R12	Resistor, 2.7 K	47-13-272
R13	Resistor, 27 K	47-13-273
R14	Resistor, 2.7 K	47-13-272
R15	Resistor, 10 K	47-13-103
R16	Resistor, 150 ohm	47-13-151
R17	Resistor, 22 K	47-13-223
R18	Resistor, Var., 10 K	47-08-020
R19	Resistor, 6.2 K	47-13-622
R20	Resistor, 5.1 K	47-13-512
R21	Resistor, 3.6 K	47-13-362
R22	Resistor, 1.5 K	47-13-152
R23	Resistor, 10 K	47-13-103
R24	Resistor, 10 K	47-13-103
R25	Resistor, 4.7 K	47-13-472
R26	Resistor, 100 K	47-13-104
R27	Resistor, 12 K	47-13-123
R28	Resistor, 56 K	47-13-563
R29	Resistor, 1.5 K	47-13-152
R30	Resistor, Var., 25 K	47-08-007
R31	Resistor, 18 K	47-13-183
R32	Resistor, 1.5 K	47-13-152
R33	Resistor, 1.5 K	47-13-152
R34	Resistor, 47 K	47-13-473
R35	Resistor, 10 K	47-13-103
R36	Resistor, 47 K	47-13-473
R37	Resistor, 2.7 K	47-13-272
R38	Resistor, 39 K	47-13-393
R39	Resistor, 4.7 K	47-13-472
R40	Resistor, 150 ohm	47-13-151
R41	Resistor, 10 K	47-13-103
R42	Resistor, 10 K	47-13-103
R43	Resistor, 4.7 K	47-13-472
R44	Resistor, 22 ohm	47-13-220
R45	Resistor, Var., 50 K	47-08-039
	THERMISTOR	
RT1	Thermistor, 50 ohm	47-04-007
RT2	Thermistor, 3 K	47-04-016
	INTEGRATED CIRCUITS	
U1	Integrated Circuit Mix-Lim.-Det.	31-30-037
	CRYSTALS	
Y1	Crystal, 20.945 MHz	23-09-024
Y2	(See selection information below)	23-XX-XXX
	MISCELLANEOUS	
2	Crystal Sockets	21-05-017
3	Coil Can Assembly	25-10-007
5	Label, Serial/Frequency	521-136-02
6	Label, Catalog Number	521-136-01
7	Sleeving	60-16-820
12	Cable Tie	28-01-004
13	Paint, White (a-g)	
13	Paint, Red (h-k)	
14	Nylon Spacer (2 required)	31-01-016

Receiver Crystal Specifications

The equipment specifications involving frequency stability are assured only if crystals are supplied by the manufacturer or furnished by manufacturer's approved suppliers.

RECEIVER CRYSTAL 138-174 MHz

Part Number: 23-10-016 [1]

Case Type: HC-18/U except pin length of .238" and case height of .53"

Freq. Range: 38.866667 to 50.866666 MHz

$$\text{Crystal Freq} = \frac{\text{Operating Frequency}^* - 21.4}{3}$$

*(to six decimal places)

[1] Receive crystal 23-10-016 is preferred but can be replaced with receive crystal 23-09-016 if necessary (23-09-016 has a case height of .53" and a pin length of .125").

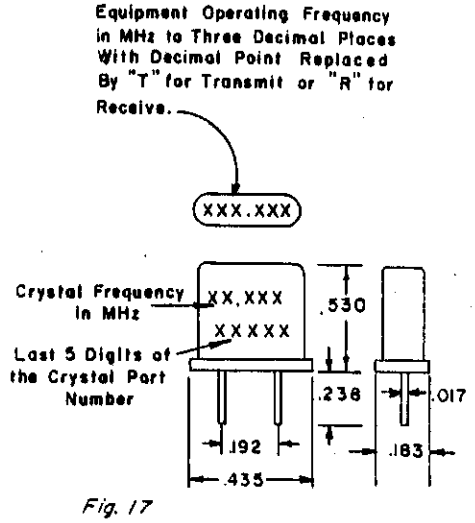
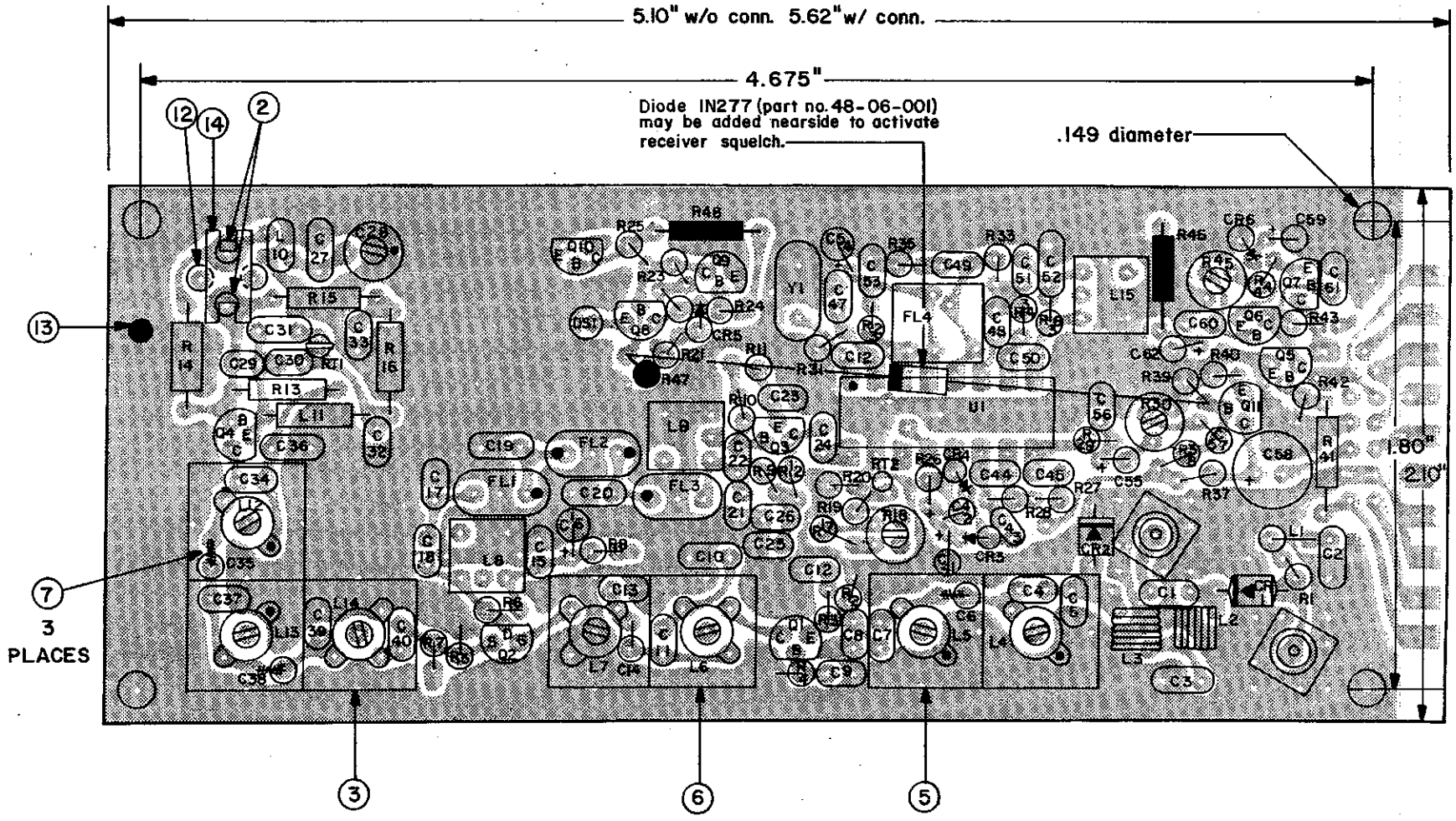


Fig. 17

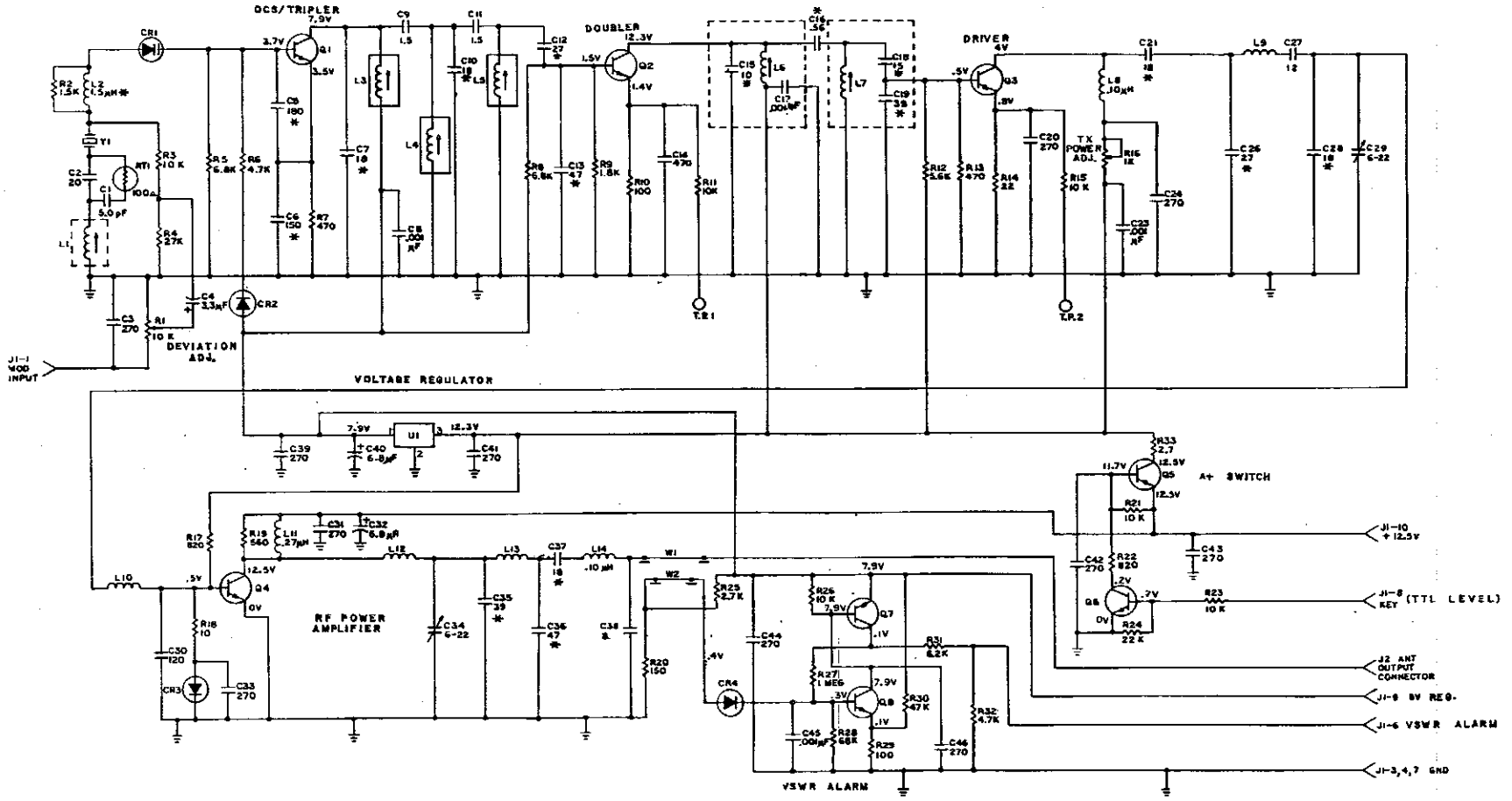


NOTES

1. Components shown are farside.
2. R46, R47 and R48 are user installed, see page 12 for details.
3. C55 is replaced with a bus wire when used in the Data Aquisition system.

Fig. 18

P.C. BOARD ASSEMBLY RECEIVER UNIT	
138-150.8 MHz	(721-236-XX)
150.8-162 MHz	(721-055-XX)
162-174 MHz	(721-056-XX)



DC VOLTAGE MEASUREMENT CONDITIONS (12.5 VDC @ J1-10)

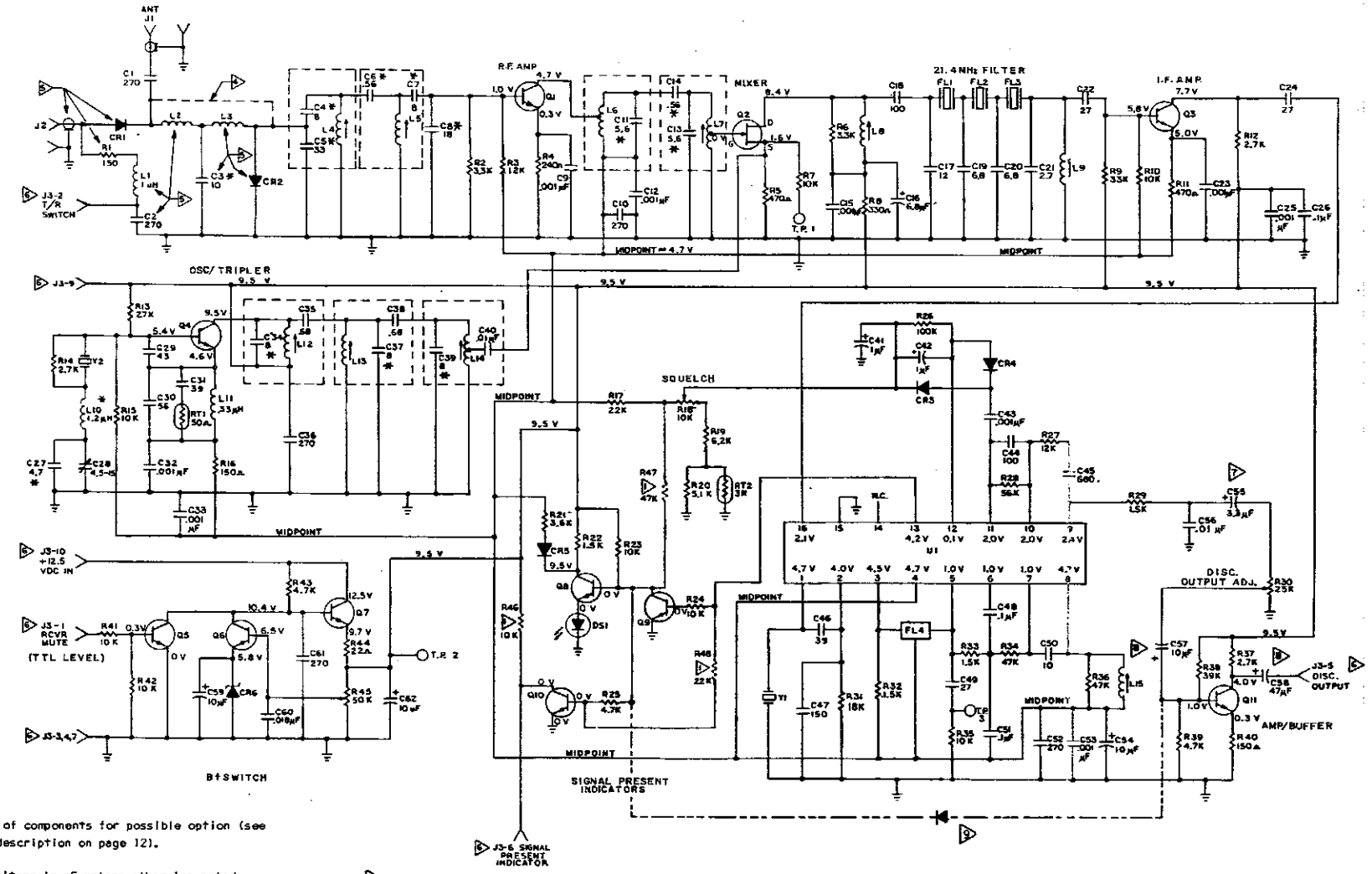
R1 adjusted to a minimum (0kHz DEV)
R16 adjusted to 2W rated output
Voltage level at J1-8 was 2.5V min
Voltmeter = High impedance (100M ohm input z)

NOTES:

1. All capacitors in pF unless otherwise noted.
2. All resistors in ohms and are 1/4W unless otherwise noted.
3. —●—●— This symbol indicates printed transmission line, and is part of circuit board.

* Component values shown are for 150.8-162 MHz, see parts list for 138-150.8 MHz and 162-174 MHz component values.

RDL 150
TRANSMITTER SCHEMATIC



NOTES:

1. Location of components for possible option (see circuit description on page 12).
2. All capacitors in pF unless otherwise noted.
3. All resistors are 1/4 watt unless otherwise noted. All resistors in ohms unless otherwise noted.
4. Connection for receiver only configuration.
5. Delete these components for "receive only" configuration.
6. J3 is an optional connector.
7. Not used in Data Acquisition System.
8. Part values differ when used in the Data Acquisition System (see parts list).
9. Diode IN277 (part #48-06-001) may be added to activate receiver squelch operation.

DC VOLTAGE MEASUREMENT CONDITIONS

J1 = 0.5V applied (TTL - LO)
NO RF Signal
R18 fully CW
R30 fully CCW
R45 adjusted for 9.5V @ J3-9
HT_z voltmeter (10M ohm input z)

* Component values shown are for 150.8-162 MHz, see parts list for 138-150.8 MHz and 162-174 MHz component values.

RDL 150
RECEIVER SCHEMATIC