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# **RDL Series RF Links**

**FM Transmitters & Receivers**

**406-430 MHz**

**450-475 MHz**

**CREATING PRODUCTS THAT COMMUNICATE...QUALITY**

A series of five thick, parallel horizontal black lines at the bottom of the page.

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### Transmitter Specifications

Frequency Range:	406-430 MHz 450-475 MHz	Current Drain @ 12.5 VDC:	950 mA max. at 4W 550 mA max. at 2W 400 mA max. at 1W 0.1 mA max. with Tx unkeyed
Number of Channels:	One (crystal controlled)		
RF Power Output:	4.0 Watts or 1.0 - 2.0 Watts (adjustable)	Duty Cycle (w/o Degradation):	100% (2 & 4 Watt models) 25% (4 Watt model)
Dimensions		Modulation Deviation:	±5 kHz with 2.0 Volts P-P at data input (J1-1)
Length (w/ conn.):	5.62"	Frequency Response:	Flat within ±2.0 dB from 50 Hz to 10 kHz (referenced at 1.0 kHz)
Length (w/o conn.):	5.10"		
Width:	2.10"		
Height:	1.03" max.		
Operating Temperature:	-40° to +60°C (406-430 MHz) -30° to +60°C (450-475 MHz)	Harmonic Distortion:	5% maximum
		FM Hum and Noise:	-50 dB maximum
Frequency Stability:	±5 ppm (-30° to +60°C) ±10 ppm (-40° to +60°C, 406-430 MHz only)	Spurious and Harmonic Output:	-50 dBc maximum
		Carrier Attack Time:	5 mS max. (>90% power and frequency within 1 kHz)
Emission Type:	16F3, 16F9, 15F2	Antenna VSWR Alarm:	High for VSWR > 25:1 at rated power output
Voltage Requirement:	+12.5 VDC ±10%		

### Receiver Specifications

Frequency Range:	406-430 MHz 450-475 MHz	Signal Present Indicator Threshold:	.20 uV (switching time <50 mS at threshold)
Number of Channels:	One (crystal controlled)	Intermodulation:	-18 dBm typ. 3rd order intercept
Dimensions		I.F. Selectivity:	6 dB (bandwidth = ±7.5 kHz minimum) 60 dB (bandwidth = ±25 kHz maximum)
Length (w/ conn.):	5.62"		
Length (w/o conn.):	5.10"		
Width:	2.10"		
Height:	1.03" max.		
Operating Temperature:	-30° to +60°C	Harmonic Distortion:	5% max. (±3 kHz dev. at 1 kHz audio)
Voltage Requirement:	+12.5 VDC ±10%	Frequency Response:	±2 dB from 50 Hz to 4.5 kHz
Current Drain @ 12.5 VDC:	18 mA max. (receive) 13 mA max. (standby)	Discriminator Output:	1.4V P-P into 600 ohm load (±5kHz deviation)
Frequency Stability:	±10 ppm	T/R Switch Loss (Option):	1.0 dB maximum
Sensitivity:			
10 dB S+N/N:	0.25 uV max. (300 Hz baseband bandwidth)		
20 dB Quieting:	1.5 uV max. (6.5 kHz base band bandwidth)		

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. The various transmitter models provide a range of UHF frequencies, power output levels, and duty cycles from which to choose (refer to page 7 for a complete listing). All units operate 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 to adjust the transmit frequency. A varactor diode, CR1, in series with the crystal and Q1, is used for frequency modulating the oscillator, hence the transmitter. Q2 is a tripler, and Q3 a doubler, increasing the multiplication factor to 18. Two test points, R9 (TP1) and R13 (TP2) are provided in the emitter circuit of the multiplier stages, and are used for observing the peak emitter voltage while tuning. Multiple tuned circuits between the oscillator and multipliers enhance the suppression of the crystal and multiplier products. Q4 is the driver stage, and amplifies the FM signal to a level adequate for driving the final stage amplifier, Q5, to over the rated wattage. A low pass filter in the collector circuit of the final amplifier (Q5) 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 Q9 goes high causing it to conduct. This in turn pulls the base of Q8 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 tripler, doubler, and driver stages are powered by the switched 12.2 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 9 of J1 when the transmitter is keyed.

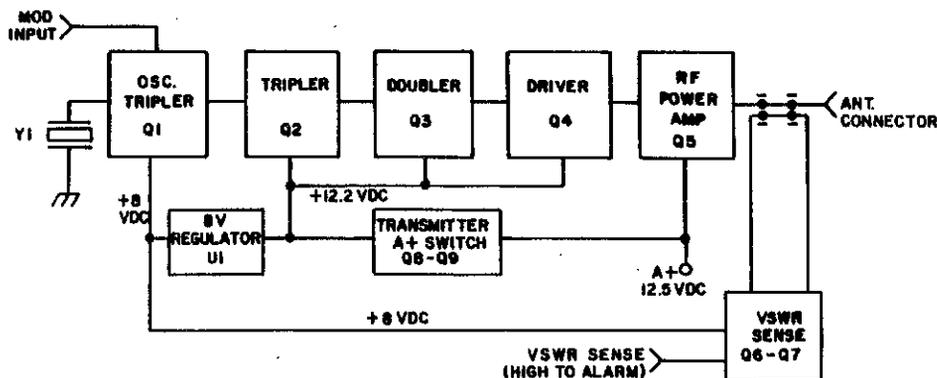


Fig. 1

The data input to the transmitter enters at J1-1 and develops across the deviation control, R21. 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 eighteen to produce the  $\pm 5$  kHz of deviation. Variable resistor R21 adjusts the level of the modulated input applied to the varactor diode and consequently the deviation of the transmitter. The standard deviation is  $\pm 5$  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 Q7 goes high causing it to conduct and pull down the base of Q6. Through R23, Q6 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

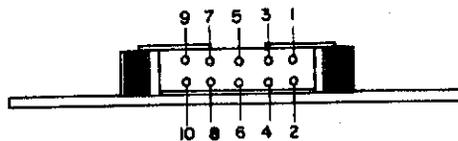
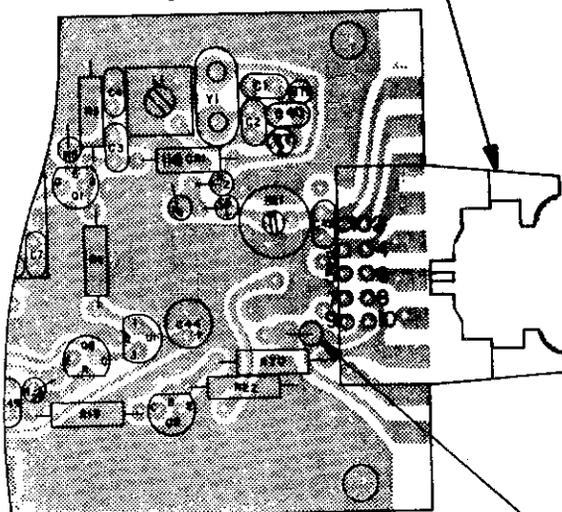


Fig. 2

Optional Connector (J1)  
(721-050-02) (Includes Mating Connector)

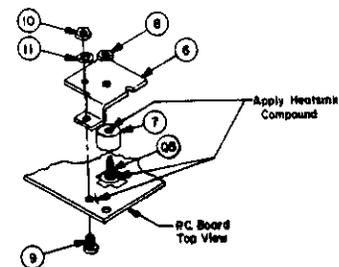


Circuitry Shown is Farside

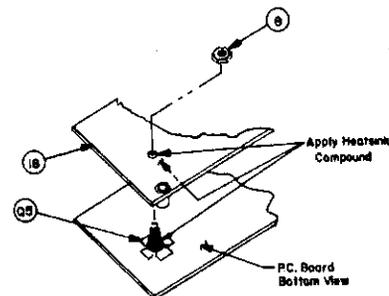
If circuit protection is required, install a 4 amp fuse (part number 51-15-006) as shown and cut trace on the p.c. board.

Fig. 3

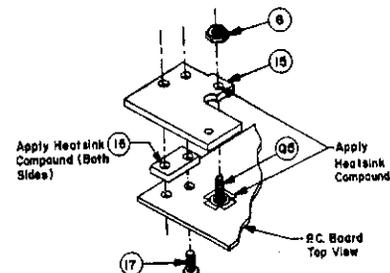
### Heatsink Configurations



2W 100% duty, 4W 25% Duty  
721-044-01 (-04), 721-060-U01, 721-242-01 (-02)



4W 100% Duty  
721-044-03



4W 100% Duty-Chassis Mount  
721-044-05 (-06)

NOTE: Refer to parts list (p. 8) for component descriptions.

## 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 R27 (transmitter power) fully clockwise.
3. Key the transmitter and verify that 8.0  $\pm$  0.4 volts is present at TP3 (R4). Unkey the transmitter after this and all other steps.
4. Connect the oscilloscope to TP1 (R9), key the transmitter, and tune L2 and L3 for maximum (nominal voltage 1.0 volt DC).
5. Transfer the oscilloscope to TP2 (R13), key the transmitter, and adjust L4 and L5 for maximum (nominal voltage 1.75 volts DC).
6. Tune C26 and L6 for maximum current, and C30 and C34 for maximum power output.
7. Readjust L6, C26, C30, and C34 for maximum power output, and adjust R27 (Tx power output) for the rated output power.

### 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 R21 (transmitter deviation control) can be adjusted for  $\pm$ 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.

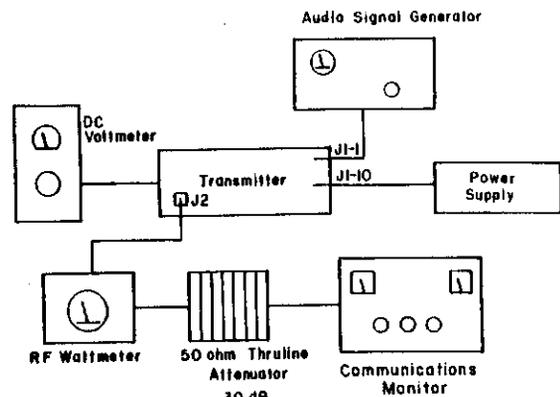


Fig. 4

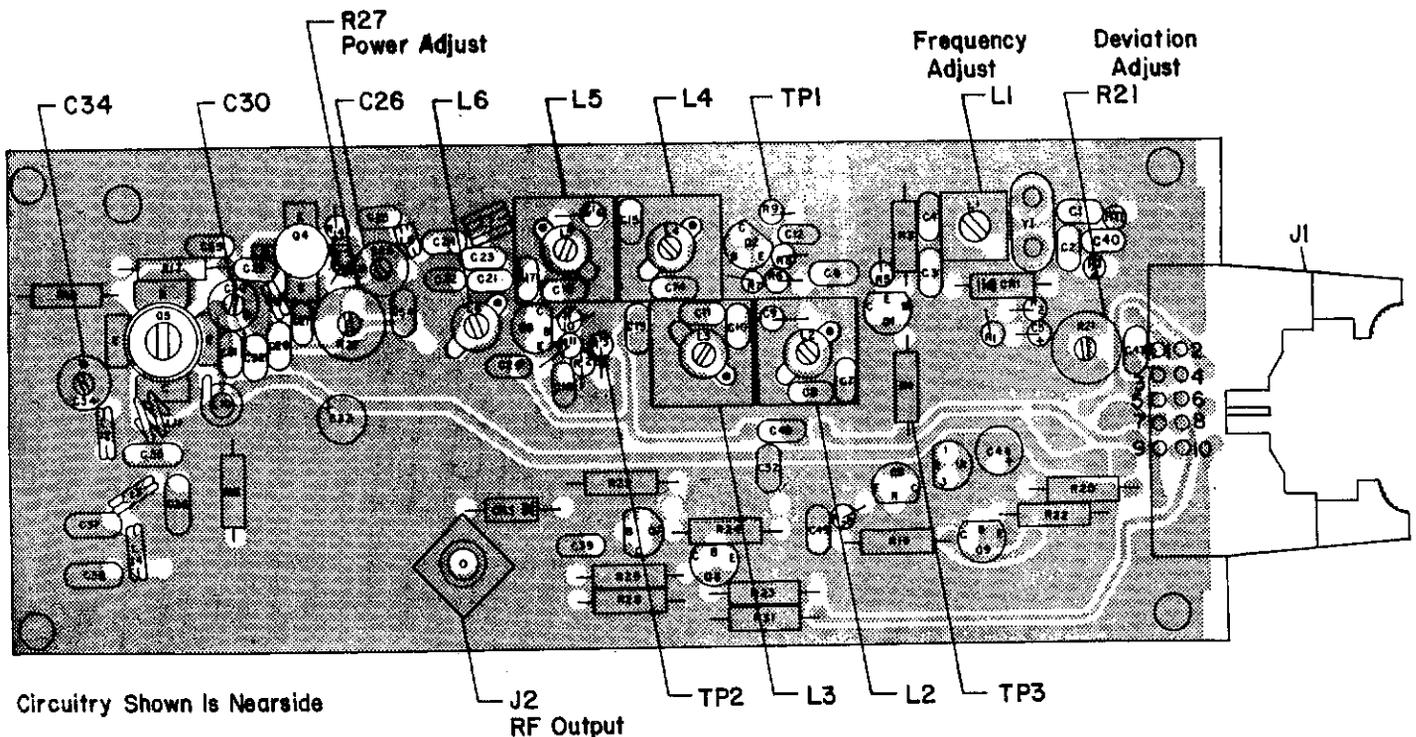
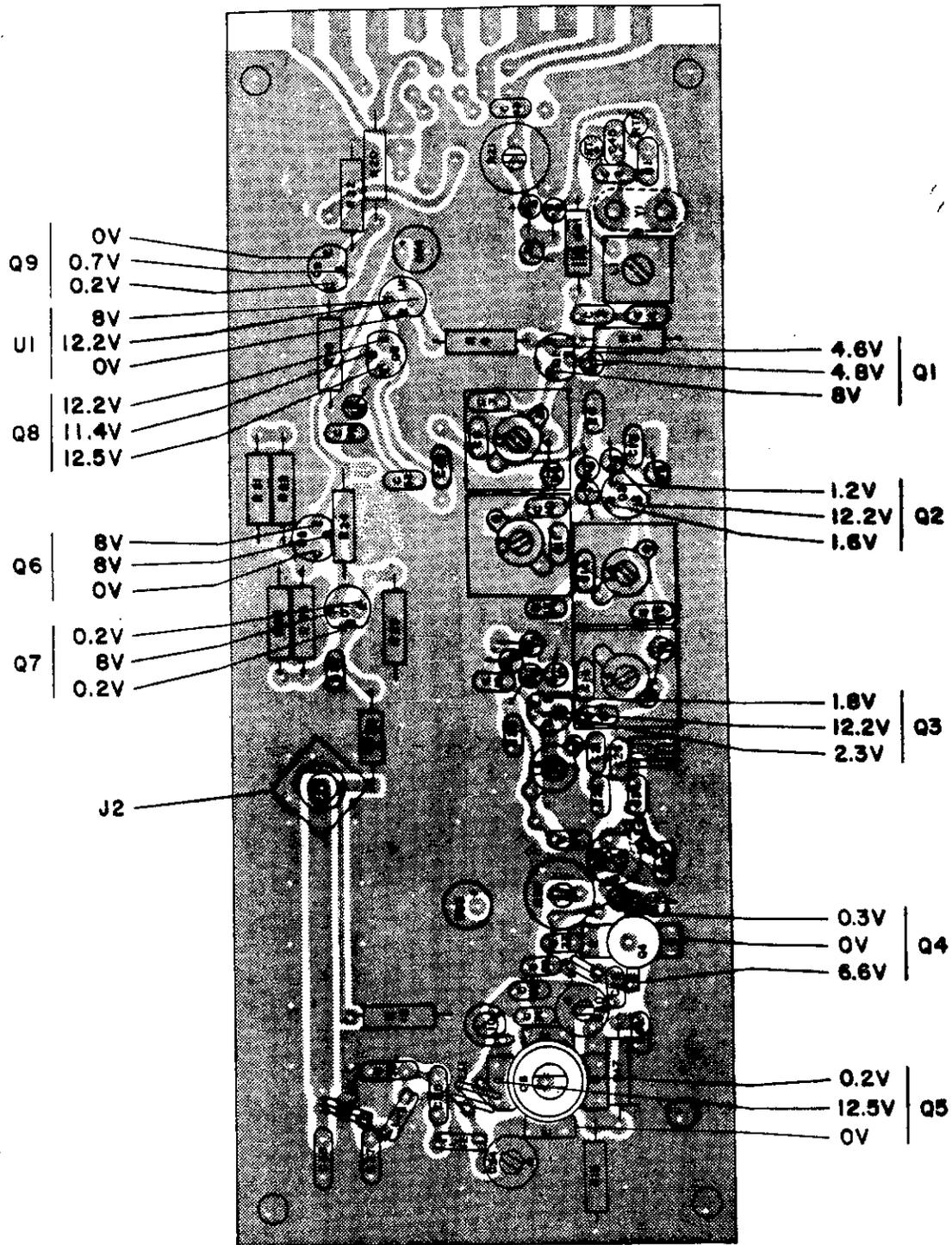


Fig. 5

### Transmitter Test Voltages



Note: Components shown are farside  
See page 20 for voltage measurement conditions.

Fig. 6

450-475 MHz Transmitter Assembly	721-044-XX
2 Watt, 10% duty cycle (a)	-01
4 Watt, 100% duty cycle (b)	-03
4 Watt, 25% duty cycle (c)	-04
2 Watt, 100% duty cycle * (d)	-05
4 Watt, 100% duty cycle * (e)	-06
450-475 MHz Transmitter Assembly	740-060UXX
Used with RMS 2000 Security System (f)	-01
406-430 MHz Transmitter Assembly	721-242-XX
2 Watt, 100% duty cycle (g)	-01
4 Watt, 25% duty cycle (h)	-03
* Chassis-Mount Heatsink	

Ref. Des.	Description	Part No.
<u>CAPACITORS</u>		
C1	Capacitor, Cer., 5.0pF (a-f)	15-01-214
C1	Capacitor, Cer., 5.6pF (g,h)	15-01-205
C2	Capacitor, Cer., (See following page for selection information)	15-01-XXX
C3	Capacitor, Cer., 100pF (a-f)	15-01-028
C3	Capacitor, Cer., 270pF (g,h)	15-01-106
C4	Capacitor, Cer., 82pF	15-01-027
C5	Capacitor, Tant, 3.3uF 10V	15-03-009
C6	Capacitor, Cer., 47pF	15-01-197
C7	Capacitor, Cer., 33pF (a-f)	15-01-067
C7	Capacitor, Cer., 43pF (g,h)	15-01-062
C8	Capacitor, Cer., .01uF	15-01-131
C9	Capacitor, Cer., 1.8pF (a-f)	15-01-030
C9	Capacitor, Cer., 1.5pF (g,h)	15-01-052
C10	Capacitor, Cer., 47pF (a-f)	15-01-197
C10	Capacitor, Cer., 62pF (g,h)	15-01-312
C11	Capacitor, Cer., 100pF	15-01-026
C12	Capacitor, Cer., 47pF	15-01-197
C13	Capacitor, Cer., .001uF	15-01-112
C14	Capacitor, Cer., 250pF	15-01-024
C15	Capacitor, Cer., 1.2pF (a-f)	15-01-115
C15	Capacitor, Cer., 2.7pF (g,h)	15-01-196
C16	Capacitor, Cer., 1.0pF	15-01-050
C17	Capacitor, Cer., 5.6pF (a-f)	15-01-071
C17	Capacitor, Cer., 6.8pF (g,h)	15-01-072
C18	Capacitor, Cer., 5.6pF (a-f)	15-01-071
C18	Capacitor, Cer., 6.8pF (g,h)	15-01-072
C19	Capacitor, Cer., 150pF	15-01-105
C20	Capacitor, Cer., 47pF	15-01-197
C21	Capacitor, Cer., 2.7pF (a-f)	15-01-196
C21	Capacitor, Cer., 5.0pF (g,h)	15-01-038
C22	Capacitor, Cer., 6.8pF (a-f)	15-01-072
C22	Capacitor, Cer., 10pF (g,h)	15-01-203
C23	Capacitor, Cer., 3.9pF (a,d,f)	15-01-198
C23	Capacitor, Cer., 6.8pF (b,c,e)	15-01-072
C23	Capacitor, Cer., 2.2pF (g,h)	15-01-152
C24	Capacitor, Cer., 3.9pF (a,d,f)	15-01-198
C24	Capacitor, Cer., 6.8pF (b,c,e)	15-01-072
C24	Capacitor, Cer., 2.2pF (g,h)	15-01-152
C25	Capacitor, Cer., 15pF (a-f)	15-01-276
C25	Capacitor, Cer., 20pF (g,h)	15-01-151
C26	Capacitor, Var., 4.5-15pF (a,d,f,g,h)	15-08-005
C26	Capacitor, Var., 5-25pF (b,c,e)	15-08-021
C27	Capacitor, Cer., 100pF (a-f)	15-01-026
C27	Capacitor, Cer., 150pF (g,h)	15-01-105
C28	Capacitor, Cer., .001uF	15-01-112
C29	Capacitor, Cer., 15pF	15-01-276
C30	Capacitor, Var., 5-25pF	15-08-021

C31	Capacitor, Cer., 47pF	15-01-197
C32	Capacitor, Cer., .001uF	15-01-112
C33	Capacitor, Tant, 6.8uF 25V	15-03-068
C34	Capacitor, Var., 4.5-15pF (a,d,f,g)	15-08-005
C34	Capacitor, Var., 5-25pF (b,c,e,h)	15-08-021
C35	Capacitor, Cer., 47pF	15-01-165
C36	Capacitor, Cer., 5.6pF (a,d,f,g,h)	15-01-188
C36	Capacitor, Cer., 6.8pF (b,c,e)	15-01-186
C37	Capacitor, Cer., 10pF (a,d,f,g,h)	15-01-163
C37	Capacitor, Cer., 12pF (b,c,e)	15-01-164
C38	Capacitor, Cer., 2.2pF (a,d,f,g,h)	15-01-174
C38	Capacitor, Cer., 6.8pF (b,c,e)	15-01-186
C39	Capacitor, Cer., .001uF	15-01-112
C40	Capacitor, Cer., 5.6pF (a,c,d,e)	15-01-071
C43	Capacitor, Cer., 47pF	15-01-197
C44	Capacitor, Tant, 6.8uF 16V	15-03-051
C48	Capacitor, Cer., 47pF (a-f)	15-01-197
C48	Capacitor, Cer., .1uF (g,h)	15-01-073
C49	Capacitor, Cer., 47pF	15-01-197
C52	Capacitor, Cer., 47pF	15-01-197
C54	Capacitor, Cer., .001uF	15-01-112
C55	Capacitor, Cer., 270pF	15-01-106
C56	Capacitor, Cer., 3.3pF (b,c,e)	15-01-158

CONNECTORS

J1	10 Pin Connector (Optional)	721-050-02
J1*	10 Pin Connector Header (b)	21-14-184
J2**	Coax Connector 50 ohm (SMB)	521-151-01
	*Mating Connector	21-14-107
	**Accessory Mating Connector	21-15-038

DIODES

CR1	Diode, Varicap	48-13-015
CR3	Diode, Signal	48-05-011

INDUCTORS

L1	Inductor, Variable	719-011-14
L2	Coil, Variable, 4 1/2 T	18-09-604
L3	Coil, Variable, 4 1/2 T	18-09-604
L4	Coil, Variable, 3 1/2 T	18-09-603
L5	Coil, Variable, 3 1/2 T	18-09-603
L6	Coil, Variable, 1 1/2 T	18-09-517
L7	Coil, 3 1/2 T (a,d,f,g)	530-036-40
L7	Coil, 3 T (b,c,e)	517-110-35
L8	Coil, 2 1/2 T	530-036-41
L9	Coil, 1 1/2 T	530-036-39
L10	Coil, 4 3/4 T	517-110-31
L11	Coil, 2 T (a,d,f,g)	517-110-69
L11	Coil, 2 T (b,c,e)	517-110-07
L11	Coil, 3 T (h)	517-110-25
L12	Coil, 1 1/2 T (a,d,f,g)	530-036-39
L12	Coil, 4 3/4 T (b,c,e)	517-110-31
L12	Coil, 3 T (h)	517-110-18
L13	Coil, 1 1/2 T	530-036-39
L14	Coil, 1 1/2 T (a,d,g)	530-036-39
L14	Coil, 2 T (b,c,e)	517-110-38

TRANSISTORS

Q1	Trans., Silicon NPN	48-01-069
Q2	Trans., Silicon NPN	48-01-081
Q3	Trans., Silicon NPN	48-01-080
Q4	Trans., Silicon NPN	521-247-01

Q5	Trans., Silicon NPN (a,d,f,g)	521-048-01
Q5	Trans., Silicon NPN (b,c,e,h)	521-048-02
Q6	Trans., Silicon PNP	48-12-007
Q7	Trans., Silicon NPN	48-12-006
Q8	Trans., Silicon PNP	48-12-007
Q9	Trans., Silicon NPN	48-12-006

**RESISTORS**

R1	Res., 27K	47-13-273
R2	Res., 10K	47-13-103
R3	Res., 12K	47-13-123
R4	Res., 5.6K	47-13-562
R5	Res., 820 ohm	47-13-821
R6	Res., 6.8K	RC07GF682J
R7	Res., 1.8K	RC07GF182J
R8	Res., 150 ohm	47-13-151
R9	Res., 10K	47-13-103
R10	Res., 820 ohm	RC07GF821J
R11	Res., 4.7K	47-13-472
R12	Res., 100 ohm	RC07GF101J
R13	Res., 10K	47-13-103
R14	Res., 220 ohm	47-13-221
R15	Res., 3.3K	47-13-332
R16	Res., 56 ohm	47-13-560
R17	Res., 1.5K	47-13-152
R18	Res., 75 ohm	47-13-750
R19	Res., 820 ohm	47-13-821
R20	Res., 10K	47-13-103
R21	Res., 10K Variable	47-13-223
R22	Res., 22K	47-13-622
R23	Res., 6.2K	47-13-103
R24	Res., 10K	47-13-105
R25	Res., 1 meg	47-13-683
R26	Res., 68K	47-08-034
R27	Res., 1K Var. (a,d,f,g,h)	47-13-103
R27	Res., 100 ohm, Var. (b,c,e)	47-08-205
R28	Res., 10K	47-13-101
R29	Res., 100 ohm	47-13-472
R31	Res., 4.7K	47-08-020

**THERMISTOR**

RT1	Thermistor, 100 ohm (a-f)	47-04-013
RT1	Thermistor, 50 ohm (g,h)	47-04-007
RT2	Thermistor, 100 ohm (a-f)	47-04-013

**INTEGRATED CIRCUIT**

UI	Integrated Circuit Voltage Regulator 8V	31-30-042
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**CRYSTAL**

Y1	(See selection information below)	23-XX-XXX
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**MISCELLANEOUS**

3	Crystal Sockets	21-05-017
4	Can, Coil	25-10-012
5	Can, Coil	25-10-007
6	Heatsink Bracket (a,c,f,g,h)	521-119-02
7	Heatsink Spacer (a,c,f,g,h)	521-106-02
8	Nut, 8-32 (a,c,f,g,h)	90-10-004
9	Screw, 4-40 x 5/16 (a,c,f,g,h)	80-31-023
10	Nut, 4-40 (a,c,f,g,h)	90-10-007
11	Lock Washer, #4 (a,c,f,g,h)	91-13-002
12	Label, Catalog Number	521-136-01
13	Label, Serial/Freq.	521-136-02
14	Retainer, Crystal	519-684-01
15	Heatsink (d,e)	540-132-01
16	Heatsink Spacer (d,e)	540-133-01
17	Screw, 4-40 x 3/8 (d,e)	80-31-024
18	Heatsink (b)	721-318-01
19	Connector Spacer (b)	31-01-015
20	Connector Header, 10 Pin* (b)	21-14-184
	*Mating Connector Strip	21-14-107

**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** 406-430 MHz  
450-475 MHz  
Part Number: 23-10-015  
Case Type and Markings: Same as Rx crystal, refer to page 17.  
Freq. Range: 22.555555 to 26.388888 MHz (Calculated as follows)  
Crystal Frequency = Operating Frequency\*

$$18$$

\*(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.

**Temperature Compensating Capacitors (C2)**

Crystal Color Dot	Compensating Cap., (C2)	Part Number
<b>406-430 MHz</b> Black Green Violet	Cap., 47pF N470	15-01-315
	Cap., 47pF N220	15-01-314
	Cap., 47pF NPO	15-01-197
<b>450-475 MHz</b> Black, Green, Violet	Cap., 36pF N470	15-01-235

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 identifies the appropriate temperature compensating capacitor. Boards shipped from the factory without crystals are equipped with green coded temperature compensating capacitors (15-01-235).

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



## Receiver Unit

The RDL 400 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 13 mA). The supply voltage (12.5 VDC) flows through switching transistor Q13 and is regulated by Q12 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 Q11 to conduct which in turn pulls down the base of NPN transistor Q13. Q13 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 helical resonators L3 and L4. C1 provides impedance matching from the antenna to the input of the filter and C5 provides 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 base of mixer transistor, Q2, through a two pole helical filter comprised of L6 and L7. Q4 is a crystal con-

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

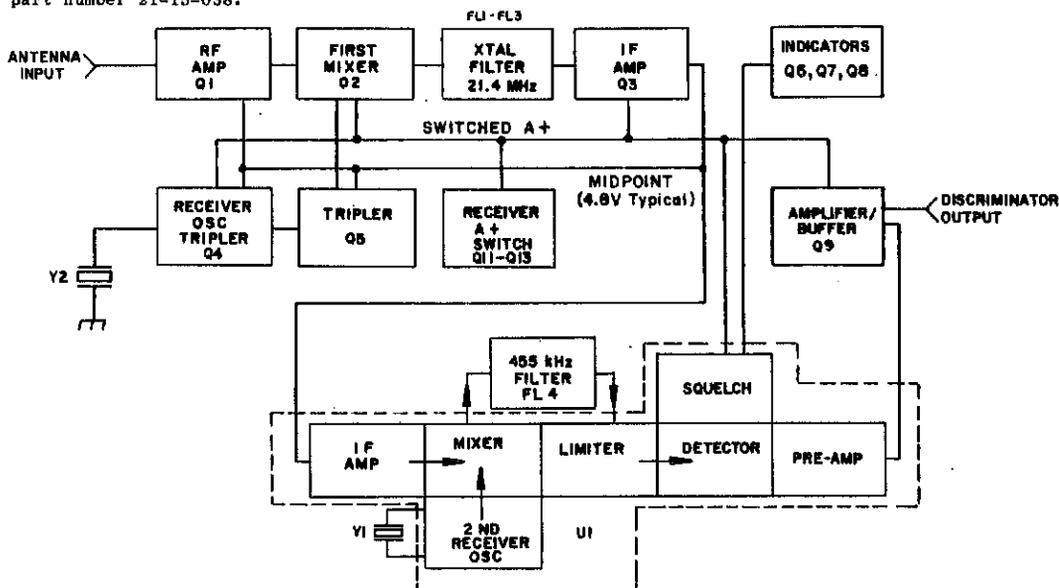


Fig. 9

trolled 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 oscillator. A variable capacitor (C43) in series with the crystal is used to set the receive channel on frequency. The output of the oscillator ( $3F_x$ ) is fed to a tripler, Q5, and the resulting output signal ( $9F_x$ ) is capacitively coupled to the emitter 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 multi-purpose integrated circuit U1.

U1 operates as an I.F. amplifier, oscillator, mixer, limiter, detector, amplifier, and in addition has 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 L10 tunes the detector to 455 kHz, and the detector output is taken from pin 9, and develops across the discriminator output level control (R22). Q9 serves as an amplifier/buffer, supplying pin 5 of J3 with the final amplified discriminator output.

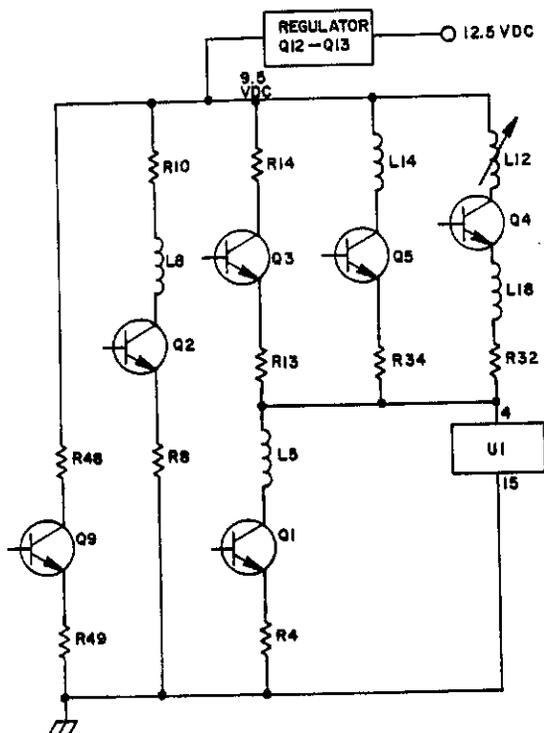


Fig. 10

When the receiver is equipped with the T/R switching option, L1, L2 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 pin 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.

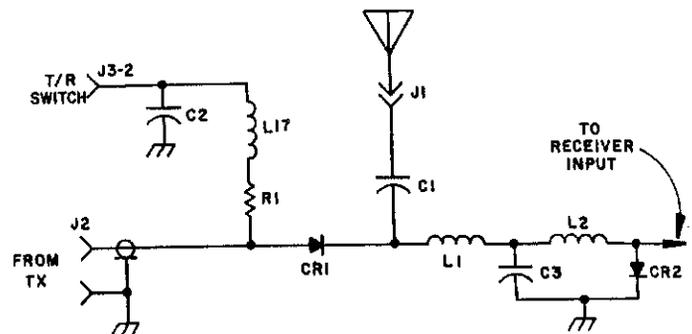


Fig. 11

The signal present indicator control (R16) 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 Q6, Q7, and Q8. With no signal present, pin 13 supplies the base of Q8 with sufficient voltage to cause it to conduct, thus shutting off Q6 and Q7. Upon receipt of a signal, pin 13 goes to ground and Q8 quits conducting. This switches on both Q6 and Q7 by supplying voltage to their bases. Q6 causes pin J3-6 to sink to ground (the user may wish to utilize this function to provide an external indicator, etc.) while Q7 allows the signal present light (DS1) to illuminate.

As indicated by the dotted lines shown on the receiver schematic, several variations of the basic signal present circuitry are possible. These additional components (R50, R52, R53) or jumpers 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:

R50 adds hysteresis to the signal present indicator circuitry. i.e. The rated indicator threshold is .20 uV. When R50 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.

R52 is used to bypass Q8 and thus invert the function of Q6 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.

R53 serves as a pull-up resistor at the collector of Q6. When there is no received signal present, pin J3-6 is supplied with current through R53. A received signal will cause Q6 to go to ground and remove the volt-

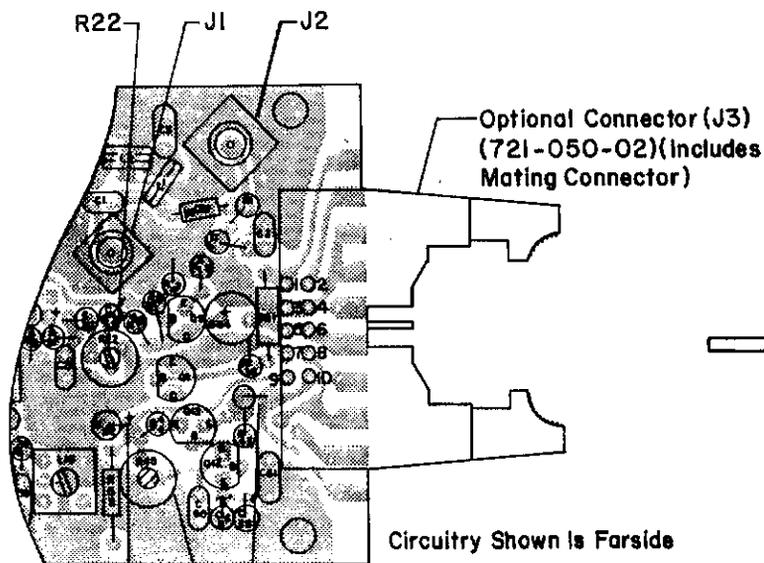
age from pin J3-6. NOTE: R52 may be used in conjunction with R53 to invert the output at pin J3-6 according to the presence or absence of a signal.

Squelch Option - Installing a jumper at position E1 on the receiver board activates the receiver squelch function. In the absence of a received signal of the correct frequency, the discriminator output will be shut off.

### 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)(inverted for Sec. Sys.)
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



TP3 R45

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

Fig. 12

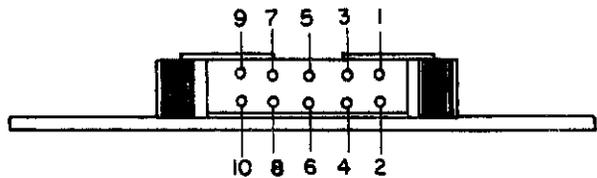


Fig. 13

## 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

6. 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.
7. Loosely couple the 21.4 MHz test oscillator near the IF amplifier (U1) and adjust C43 for zero beat.
8. Set the FM signal generator to 3 kHz deviation with a 1 kHz tone. Tune L3, L4, L6, L7, L8 and L9 for best 12 dB SINAD.

### Receiver Tune-up

1. Connect the test equipment to the receiver as shown in Figure 13. The DC voltmeter is connected to TP3 (C62) initially.
2. Adjust R45 for  $9.5 \pm 1$  volts.
3. Connect the oscilloscope to TP1 (R35) and tune L12 and L13 for maximum voltage. 5.7 volts  $\pm 0.5$  volts is typical.
4. Transfer the oscilloscope to TP2 (R7) and tune L15 and L16 for maximum. 0.6 volts is typical.
5. Adjust R22 (Disc. Output) for approximately 50 mV RMS and tune L10 for maximum noise on the distortion analyzer.

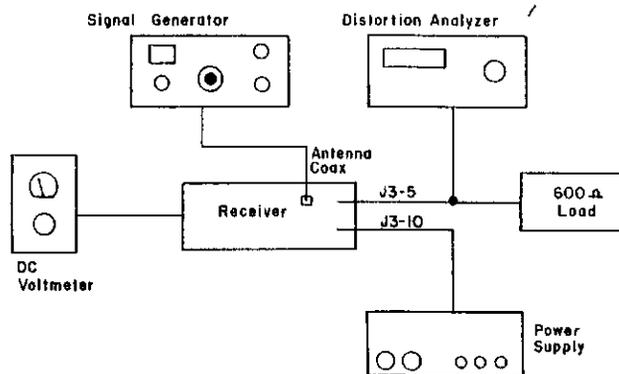


Fig. 14

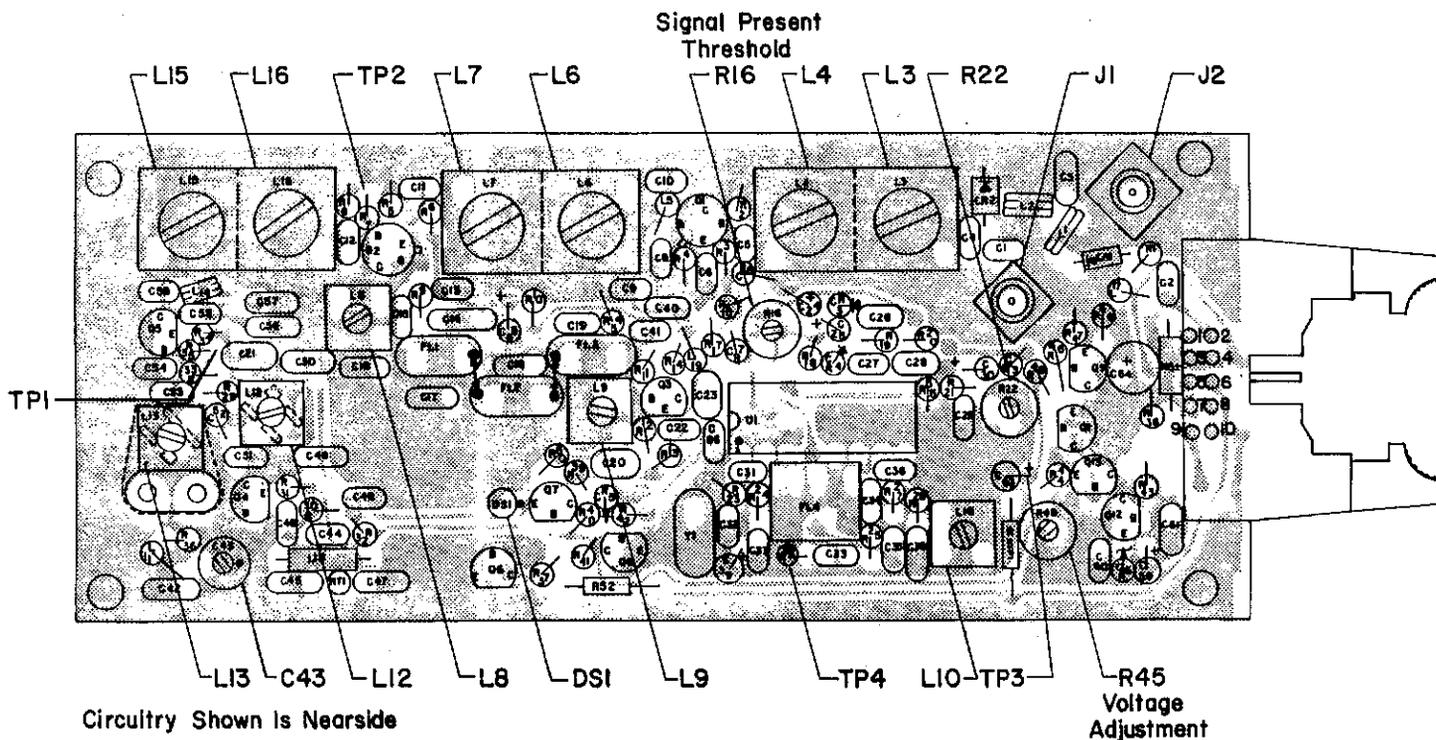
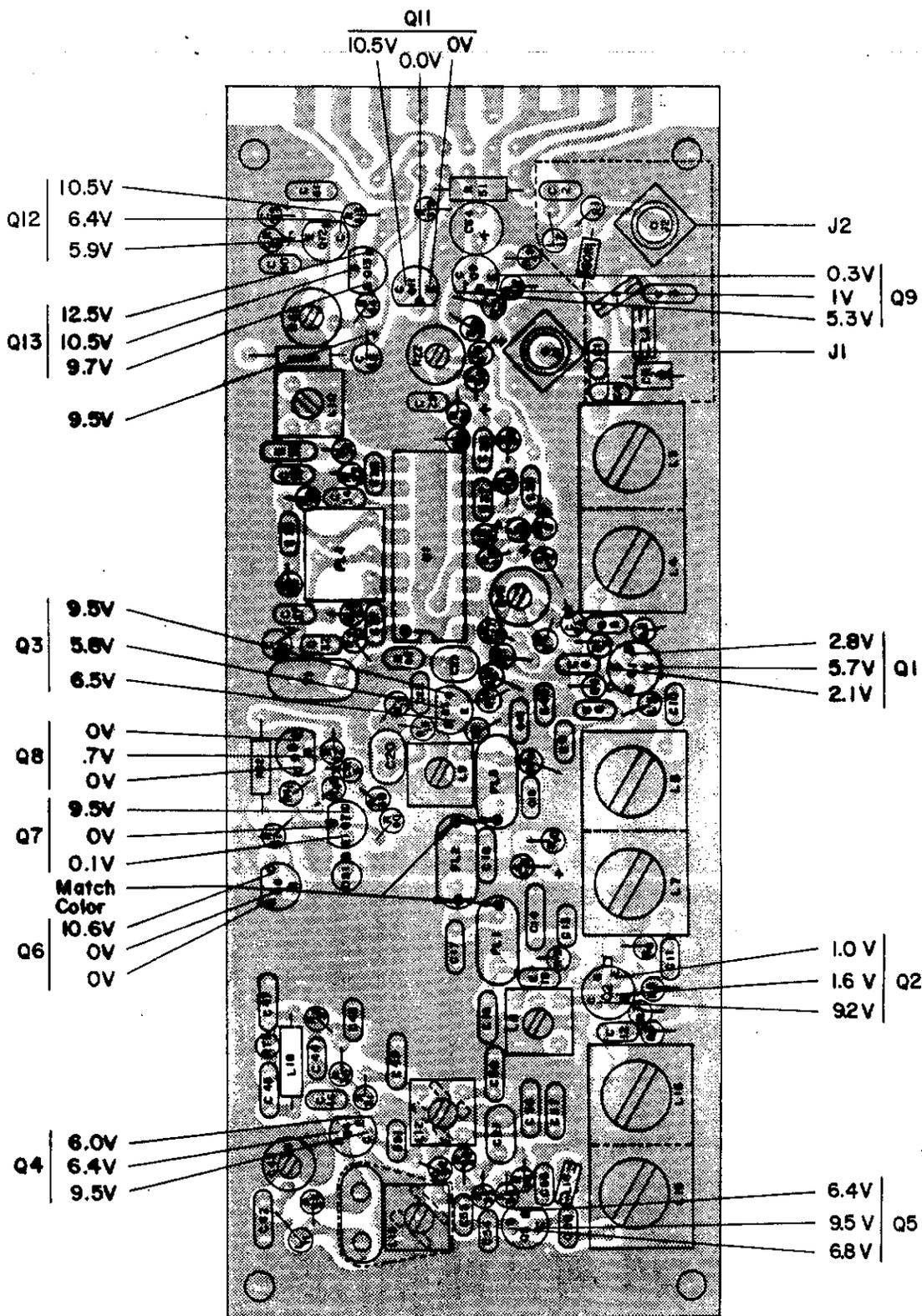


Fig. 15

9. Set the FM signal generator to 1 mV. Adjust R22 for 50 mVRMS and L10 for maximum noise on the distortion analyzer.
10. Adjust R22 (discriminator output) for the rated output of 850 mV P-P (approx. 300 mV RMS).
11. Tune L8 and L9 and then retune L8 for minimum distortion. Distortion should be less than 5%.
12. 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.
13. Set the signal generator output to zero and turn R16 (signal present indicator control) fully clockwise. The signal present indicator light (DS1) should be off. Rotate R16 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).
14. Apply a TTL level voltage to J3-1. The receiver should mute until the voltage is removed.
15. 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.
16. Apply a drop of Loctite 222 mild strength adhesive/sealant or equivalent to L3, L4, L6, L7, L15, and L16 after tuning is completed. The adhesive should be added at a point where the slug and can contact (avoid allowing adhesive to seep down into the threaded portion of helical can).

### Receiver Test Voltages



Note: Components shown are farside  
See page 19 for voltage measurement conditions.

Fig. 16

UHF Receiver Assembly		721-241-XX			
406-430 MHz with T/R switch (a)			-01		
406-430 MHz w/o T/R switch (b)			-02		
450-475 MHz with T/R switch (c)			-04		
450-475 MHz w/o T/R switch (d)			-05		
Ref. Des.	Description	Part #			
<u>CAPACITORS</u>					
C1	Cap., Cer., 47pF	15-01-197			
C2	Cap., Cer., 47pF (a,c)	15-01-197			
C3	Cap., Cer., 2.2pF (a,c)	15-01-174			
C4	Cap., Cer., 47pF (a,c)	15-01-197			
C5	Cap., Cer., 47pF	15-01-197			
C6	Cap., Cer., 47pF	15-01-197			
C8	Cap., Cer., 47pF	15-01-197			
C9	Cap., Cer., .001uF	15-01-112			
C10	Cap., Cer., 18pF	15-01-274			
C11	Cap., Cer., 250pF	15-01-024			
C12	Cap., Cer., .001uF	15-01-112			
C13	Cap., Cer., .001uF	15-01-112			
C14	Cap., Cer., .47uF	15-01-076			
C15	Cap., Cer., 47pF	15-01-197			
C16	Cap., Cer., 18pF	15-01-057			
C17	Cap., Cer., 6.8pF	15-01-186			
C18	Cap., Cer., 6.8pF	15-01-186			
C19	Cap., Cer., 15pF	15-01-019			
C20	Cap., Cer., .001uF	15-35-016			
C21	Cap., Cer., 68pF	15-01-169			
C22	Cap., Cer., .01uF	15-01-031			
C23	Cap., Cer., 27pF	15-35-016			
C24	Cap., Tant, 1uF 25V	15-03-016			
C25	Cap., Tant, 1uF 25V	15-03-016			
C26	Cap., Cer., .001uF	15-01-112			
C27	Cap., Cer., 180uF	15-01-157			
C28	Cap., Cer., 680pF	15-01-181			
C29	Cap., Cer., .01uF	15-01-131			
C30	Cap., Tant, 3.3uF 10V	15-03-009			
C31	Cap., Cer., 39pF	15-01-204			
C32	Cap., Cer., 150pF	15-01-105			
C33	Cap., Tant, 27pF	15-01-189			
C34	Cap., Cer., .1uF	15-01-073			
C35	Cap., Cer., .1uF	15-01-073			
C36	Cap., Cer., 39pF	15-01-023			
C37	Cap., Cer., .1uF	15-01-073			
C38	Cap., Cer., 68pF	15-01-169			
C39	Cap., Tant., 10uF 10V	15-03-008			
C40	Cap., Cer., .1uF	15-01-073			
C41	Cap., Cer., .001uF	15-01-112			
C42	Cap., Cer., 6.8pF	15-01-186			
C43	Cap., Var., 4.5-15pF	15-08-005			
C44	Cap., Cer., 43pF	15-01-062			
C45	Cap., Cer., 39pF	15-01-185			
C46	Cap., Cer., 43pF	15-01-062			
C47	Cap., Cer., 270pF	15-01-166			
C48	Cap., Cer., .1uF	15-01-073			
C49	Cap., Cer., 270pF	15-01-166			
C50	Cap., Cer., 68pF	15-01-169			
C51	Cap., Cer., 8pF	15-01-194			
C52	Cap., Cer., .56pF	15-01-082			
C53	Cap., Cer., 12pF	15-01-240			
C54	Cap., Cer., 56pF	15-01-209			
C55	Cap., Cer., 47pF	15-01-197			
C56	Cap., Cer., 270pF	15-01-166			
C57	Cap., Cer., 68pF	15-01-169			
C58	Cap., Cer., 3.9pF	15-01-198			
C59	Cap., Tant., 10uF 10V	15-03-008			
C60	Cap., Cer., .018uF	15-01-150			
C61	Cap., Cer., 270pF	15-01-166			
C62	Cap., Tant., 10uF 10V	15-03-008			
C63	Cap., Tant., 10uF 10V	15-03-008			
C64	Cap., Tant., 47uF 10V	15-03-048			
C65	Cap., Tant., 10uF 10V	15-03-008			
C66	Cap., Cer., 9.1pF	15-01-078			
<u>DIODES</u>					
CR1	Diode, Switching (a,c)	48-05-021			
CR2	Diode, Switching (a,c)	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			
CR7	Diode, Signal	48-05-011			
CR8	Diode, Signal	48-05-011			
DS1	LED	39-06-004			
<u>FILTERS</u>					
FL1	Filter, 21.4 MHz I.F.				
FL2	6 pole set, Crystal Filter	27-03-022			
FL3					
FL4	Filter, 455 kHz I.F.	27-03-025			
<u>CONNECTORS</u>					
J1	Connector, Coax 50 ohm SMB	21-15-039			
J2	Connector, Coax 50 ohm SMB (a,c)	21-15-039			
J3	10 Pin Connector (optional)	721-050-02			
<u>INDUCTORS</u>					
L1	Coil, 1 1/2 T (a,c)	530-036-39			
L2	Coil, 2 1/2 T (a,c)	530-036-37			
L3	Resonator, Helical	521-089-01			
L4	Resonator, Helical	521-089-01			
L5	Choke, .05 uH	18-01-060			
L6	Resonator, Helical	521-089-01			
L7	Resonator, Helical	521-089-01			
L8	Transformer, 21.4 MHz	56-06-008			
L9	Transformer, 21.4 MHz	56-06-008			
L10	Transformer, 455 kHz	56-06-002			
L11	Coil, Molded RF, 1.0 uH	18-01-065			
L12	Coil, Variable, 4 1/2 T	18-09-804			
L13	Coil, Variable, 4 1/2 T	18-09-804			
L14	Coil, 2 1/2 T	530-036-39			
L15	Resonator, Helical	521-089-01			
L16	Resonator, Helical	521-089-01			
L17	Choke, 0.33 uH (a,c)	18-01-059			
L18	Choke, 0.33 uH	18-01-070			
L19	Coil, Molded RF, 4.7 uH	18-01-036			
<u>TRANSISTORS</u>					
Q1	Transistor, Silicon NPN	48-01-062			
Q2	Transistor, Silicon NPN	48-01-062			
Q3	Transistor, Silicon NPN	48-01-095			
Q4	Transistor, Silicon NPN	48-01-069			
Q5	Transistor, Silicon NPN	48-01-069			
Q6	Transistor, Silicon NPN	48-01-053			
Q7	Transistor, Silicon NPN	48-01-053			
Q8	Transistor, Silicon NPN	48-01-053			
Q9	Transistor, Silicon NPN	48-01-053			
Q10	Not Used				
Q11	Transistor, Silicon NPN	48-01-053			
Q12	Transistor, Silicon NPN	48-01-053			
Q13	Transistor, Silicon NPN	48-12-006			
<u>RESISTORS</u>					
R1	Resistor, 150 ohm (a,c)	47-13-151			
R2	Resistor, 10K	RC07GF103J			
R3	Resistor, 8.2K	47-13-822			

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

R4	Resistor, 820 ohm	47-13-821	R43	Resistor, 4.7K	47-13-472
R5	Resistor, 3.9K	47-13-392	R44	Resistor, 22 ohm	47-13-220
R6	Resistor, 18K	RC07GF183J	R45	Resistor, Variable 50K	47-08-039
R7	Resistor, 10K	47-13-103	R46	Resistor, 39K	47-13-393
R8	Resistor, 1.2K	RC07GF122J	R47	Resistor, 10K	47-13-103
R9	Resistor, 3.9K	47-13-392	R48	Resistor, 1.5K	47-13-152
R10	Resistor, 270 ohm	47-13-271	R49	Resistor, 100 ohm	47-13-101
R11	Resistor, 39K	RC07GF393J	R51	Resistor, 10K	47-13-103
R12	Resistor, 10K	RC07GF103J	R54	Resistor, 1.8K	47-13-182
R13	Resistor, 100 ohm	47-13-101	R55	Resistor, 8.2K	47-13-822
R14	Resistor, 1.5K	47-13-152	<u>THERMISTOR</u>		
R15	Resistor, 33K	47-13-333	RT1	Thermistor, 160 ohm	47-04-018
R16	Resistor, Variable, 10K	47-08-020	<u>INTEGRATED CIRCUITS</u>		
R17	Resistor, 2.7K	47-13-272	U1	Integrated Circuit Mix-Lim.-Det.	31-30-037
R18	Resistor, 100K	47-13-104	<u>CRYSTALS</u>		
R19	Resistor, 68K	47-13-683	Y1	Crystal, 21.855 MHz (a,b)	23-09-029
R20	Resistor, 10K	47-13-103	Y1	Crystal, 20.945 MHz (c,d)	23-09-024
R21	Resistor, 1.5K	47-13-152	Y2	(See selection information below)	23-XX-XXX
R22	Resistor, Variable, 25K	47-08-007	<u>MISCELLANEOUS</u>		
R23	Resistor, 18K	47-13-183	2	Crystal Sockets	21-05-017
R24	Resistor, 1.5K	47-13-152	3	Can Assy, Helical Resonator	721-027-01
R25	Resistor, 1.5K	47-13-152	4	Screw, Helical Resonator (a,b)	521-063-01
R26	Resistor, 10K	47-13-103	4	Screw, Helical Resonator (c,d)	521-087-01
R27	Resistor, 47K	47-13-473	6	Crystal Retainer	519-684-01
R28	Resistor, 9.1K	RC07GF912J	7	Label, Catalog No.	521-136-01
R29	Resistor, 10K	RC07GF103J	8	Label, Serial/Freq.	521-136-02
R30	Resistor, 10K	47-13-103			
R31	Resistor, 27K	47-13-273			
R32	Resistor, 180 ohm	47-13-181			
R33	Resistor, 4.7K	47-13-472			
R34	Resistor, 180 ohm	47-13-181			
R35	Resistor, 10K	47-13-103			
R36	Resistor, 2.7K	47-13-272			
R37	Resistor, 4.7K	47-13-472			
R38	Resistor, 10K	47-13-103			
R39	Resistor, 2.7K	47-13-272			
R40	Resistor, 1.5K	47-13-152			
R41	Resistor, 10K	47-13-103			
R42	Resistor, 10K	47-13-103			

### 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 406-430 MHz

450-475 MHz

Part Number: 23-10-016

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

Freq. Range: 47.488888 to 50.400000 MHz

406-430 MHz

Crystal Freq =  $\frac{\text{Operating Frequency} * + 21.4}{9}$

450-475 MHz

Crystal Freq =  $\frac{\text{Operating Frequency} * - 21.4}{9}$

\*(to six decimal places)

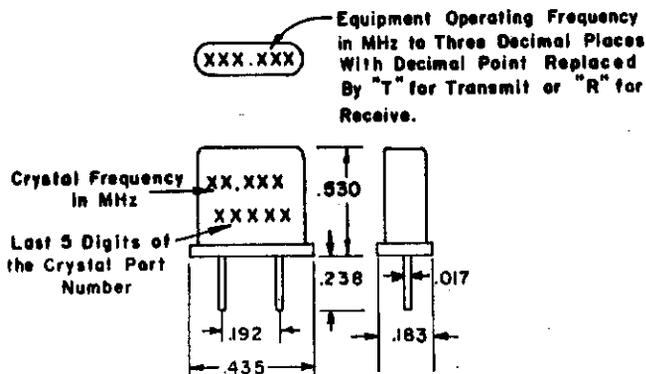
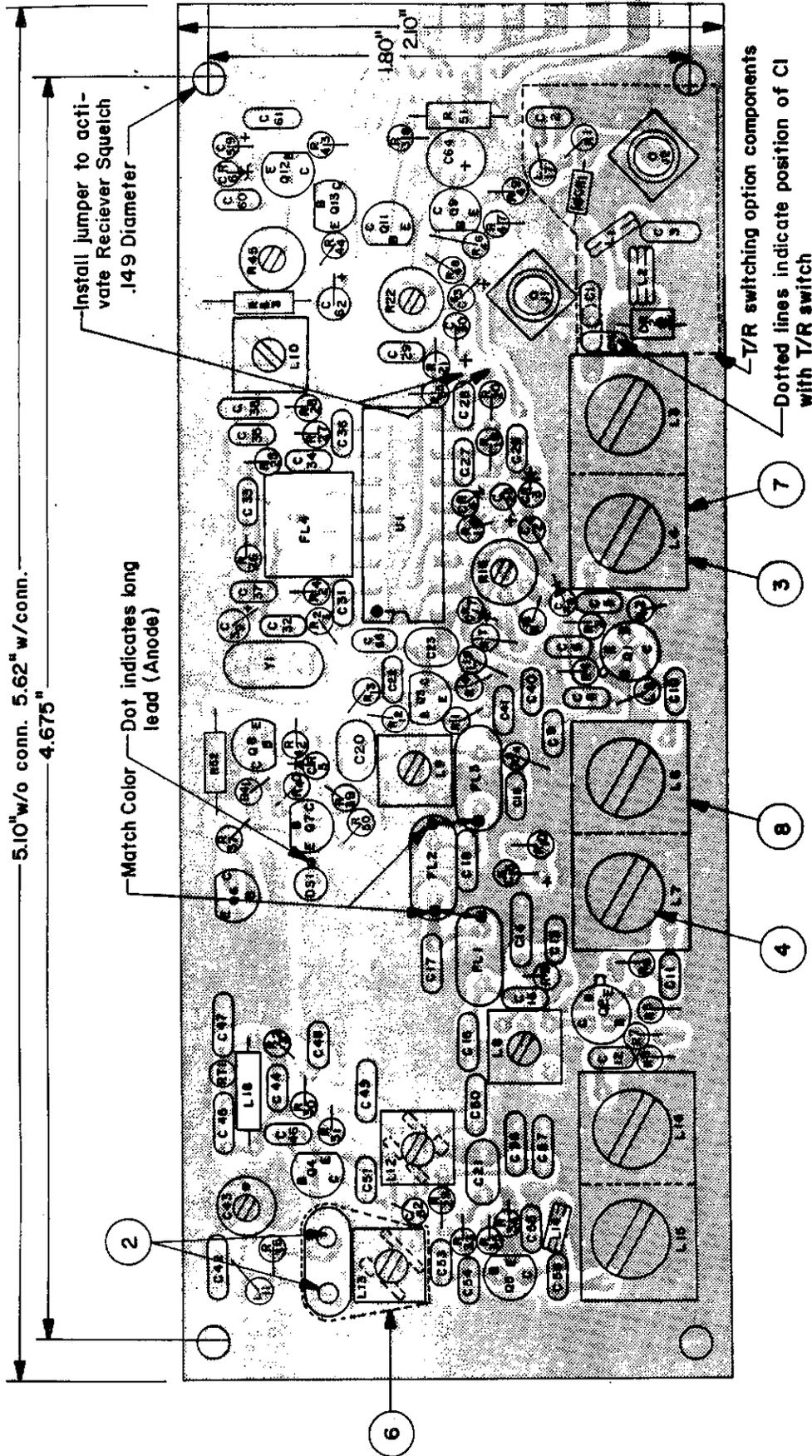


Fig. 17

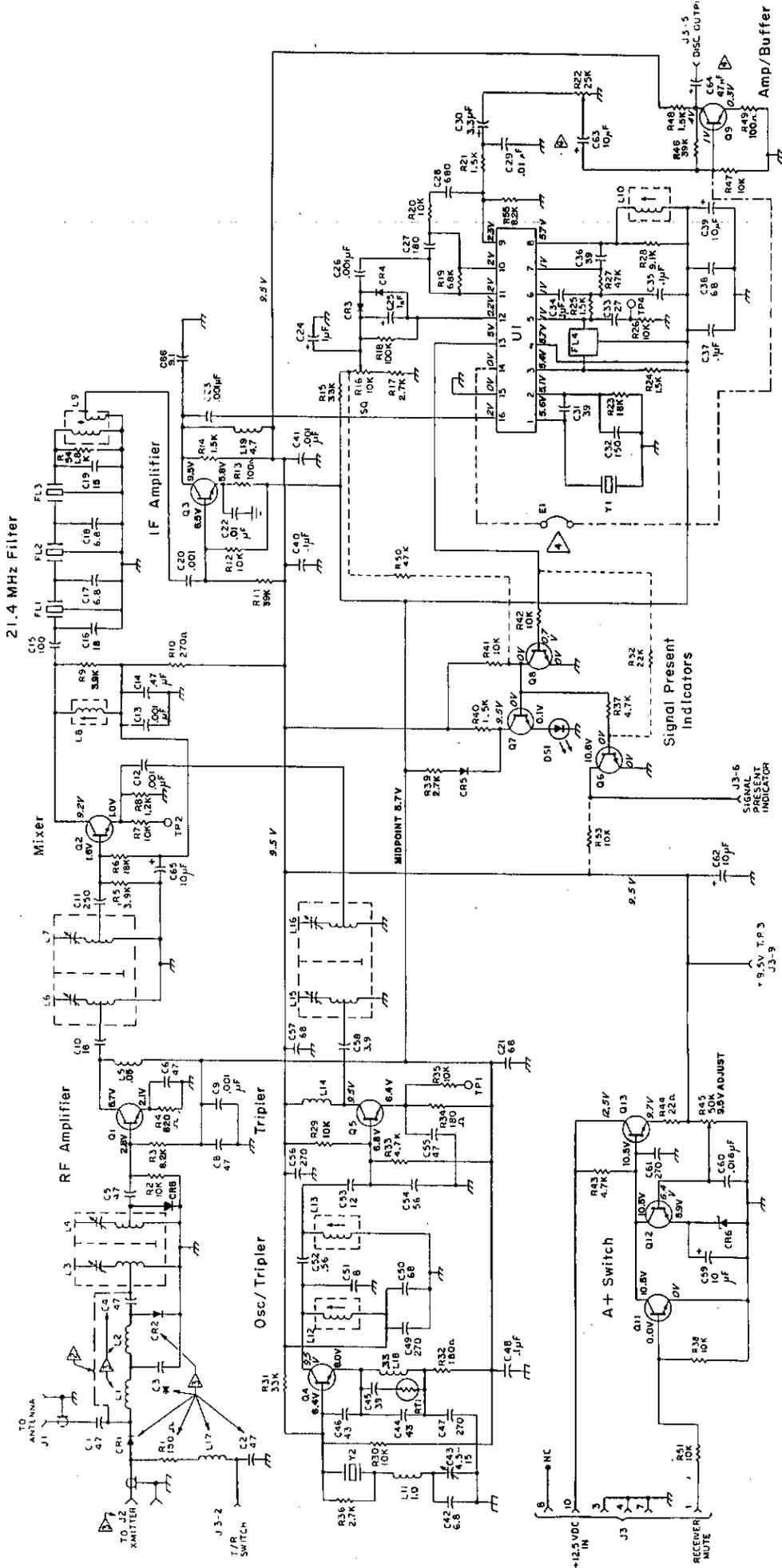
▷ Receive crystal 23-10-016 is preferred but can be replaced with receive crystal 23-09-016 if necessary (23-09-016 has a case height of .53" and a pin length of .125").



P.C. BOARD ASSEMBLY  
RECEIVER UNIT  
721-241-XX

Fig. 18

- NOTES:
1. Components shown are farside.
  2. R50, R52, R53 and squelch option jumper are user installed - Refer to page 12 for details.



Receiver Schematic

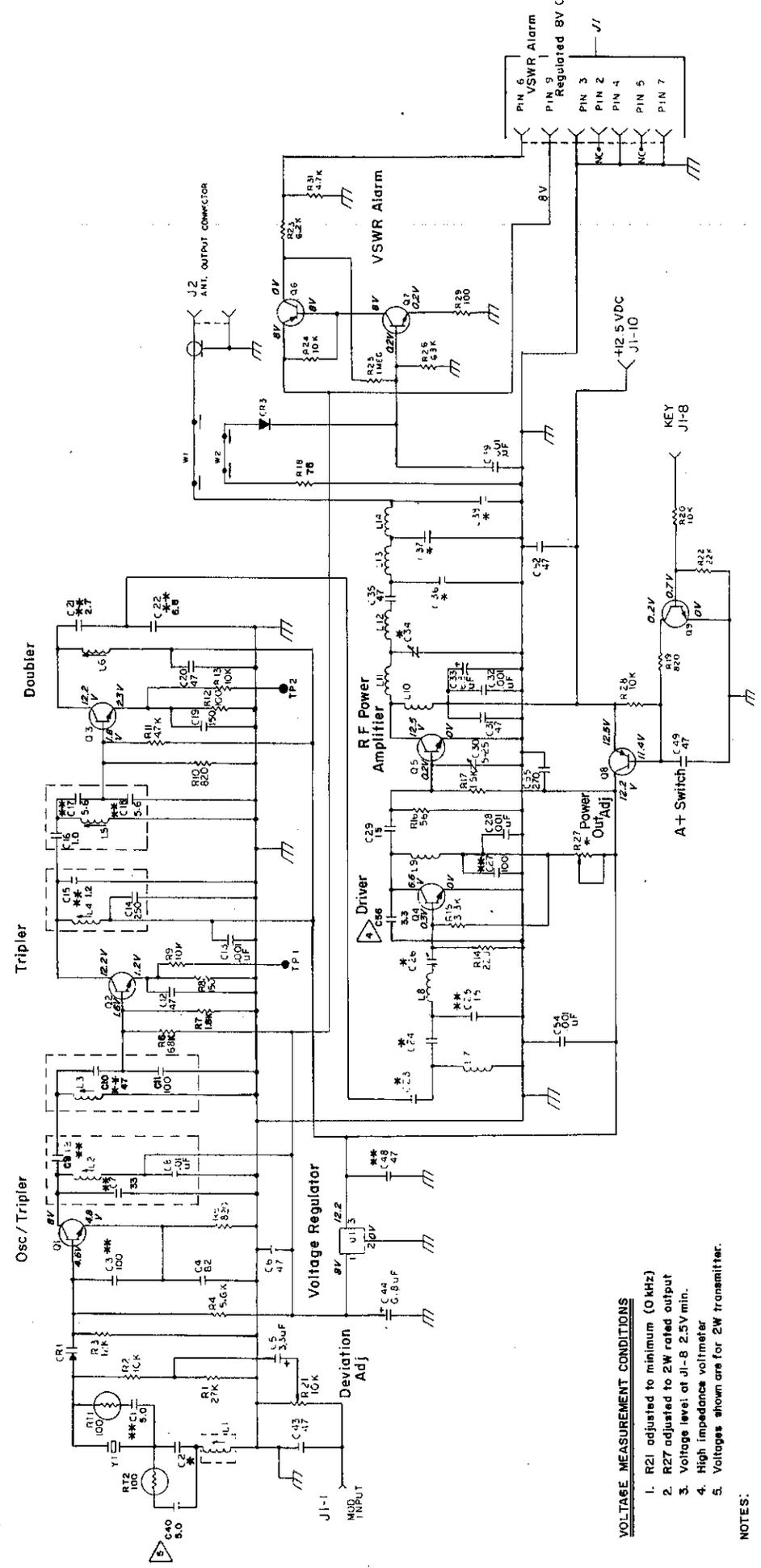
VOLTAGE MEASUREMENT CONDITIONS

1. No RF input
2. R16 fully clockwise
3. R22 fully counterclockwise
4. R45 adjusted to 9.5V at J3-9
5. High impedance voltmeter
6. Mute switch off.

NOTES:

1. Unless otherwise specified, all capacitor values are in picofarads; inductance values in microhenries.
2. Connection for "Receiver Only" option.
3. Delete these components for "Receiver Only" option-02.
4. Jumper used for receiver squelch option.

Transmitter Schematic



VOLTAGE MEASUREMENT CONDITIONS

1. R21 adjusted to minimum (0 MHz)
2. R27 adjusted to 2W rated output
3. Voltage level at J1-8 2.5V min.
4. High impedance voltmeter
5. Voltages shown are for 2W transmitter.

NOTES:

1. Unless otherwise noted all capacitor values are in picofarads.
  2. Unless otherwise noted all resistor values are in ohms.
  3. This symbol indicates printed transmission line, and is part of circuit board.
  4. C56 used on 4 watt models only.
  5. C40 and RT2 not used on 406-430 MHz models.
- \* Refer to parts list for appropriate value.  
 \*\* Values shown are for 450-475 MHz models only.