INSTRUCTION SUPPLEMENT

FOR THE

WJ-8718/FSK

DEMODULATOR OPTION

WATKINS-JOHNSON

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WARNING

This equipment employs dangerous voltages which are dangerous and may be fatal if contacted. Exercise extreme caution in working with the equipment with any of the protective covers removed.

PROPRIETARY STATEMENT

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1.1 GENERAL

The WJ-8718 Frequency Shift Keying (FSK) Demodulator option is a single plug-in card for the WJ-8718 HF Receiver. It demodulates two-tone FSK signals with frequency shifts between 50 Hz and 2000 Hz. Switchable on-board active filtering utilizes the demodulator for maximum keying speeds of 60, 75, 150 and 300 baud. Demodulation is accomplished for keying speeds between 10 baud and 300 baud.

The circuitry compensates automatically for signal drift. Long periods of all mark or all space transmission do not affect the demodulator. Output levels compatible with EIA RS-232, MIL STD 188C and TTL/MOS 5 volt logic are selected via on-board plug-in jumper wires.

The FSK Demodulator is operated manually by the WJ-8718 HF Receiver Front panel or controlled remotely by receivers with remote BFO control capability. Tuning is enhanced by the front panel FSK tuning meter.

Table 1-1. WJ-8718/FSK Table of Specifications

Shift	Less than 50 Hz to greater than 2 kHz
Keying Speed	Less than 10 baud to greater than 300 baud
Output	Bipolar, EIA RS-232 or MIL STD 188C compatible; unipolar 0/4.8V TTL/CMOS compatible. Outputs jumper selectable.
Sensitivity	Operates with WJ-8718 antenna input of less than 0.1 μV with a 300 Hz band width.

1.2 INSTALLATION

For WJ-8718 receivers which have been wired for the FSK option, installation consists of plugging the FSK Demodulator board into the A4-XA11 socket. However, the FSK board will not function in a non-FSK WJ-8718 Receiver. An existing non-FSK receiver may be modified to use the FSK board as follows:

1. Install the FSK Demodulator Type 794241 into the unused A4XA11 socket.
2. Prepare a 4" length of #30 insulated wire by stripping 1" of insulation from each end. Wire wrap one end on pin A4XA10-57 and the other end on pin A4XA11-57.
3. Mount a BNC-type panel connector on a convenienct location on the receiver rear panel. Run an insulated wire from A4XA11-19 to the center pin of the connector.

4. Run an insulated wire from A4XA11-11 to the front panel Line Audio Level switch as shown in **Figure 1-1.** Run a short piece of insulated wire from the Line Audio Level Switch to the Signal Strength Switch as shown in **Figure 1-1.** Solder all wires to the pins shown in **Figure 1-1.**

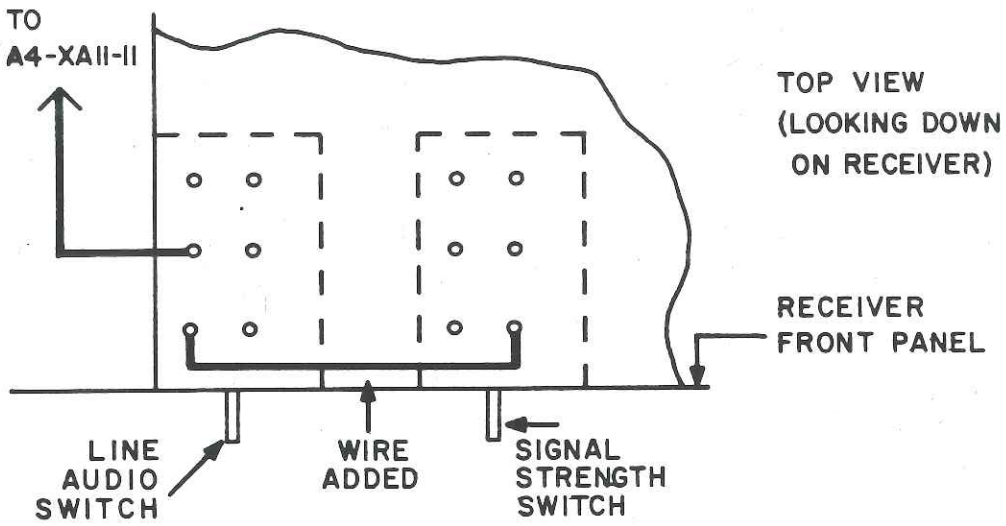


Figure 1-1. FSK Meter Modification

5. With both switches in the out position, the meter functions as an FSK tuning indicator. Correct tuning is indicated by a center scale meter reading.

1.3 OPERATION

1.3.1 OPERATIONAL SETUP PROCEDURE

1. Set the receiver for FAST AGC and CW mode.
2. Set the BFO for zero offset.
3. "Zero Beat" the signal.
   a. Tune the desired signal with the RF frequency control in 10 Hz increments while monitoring the audio output.
   b. When the FSK signal is tuned for "zero beat", both the mark and space frequencies will produce the same beat note "pitch" (frequency). The audio will sound somewhat like a steady tone.

If the signal is not tuned correctly, a high and low tone will be heard. Zero beating will produce the lowest over-all pitch.

NOTE

The lowest over-all pitch is indicated by the tuning meter needle at center scale.

c. For narrow shift FSK signals, it may be necessary to "rock" the tuning back-and-forth slightly to determine the zero beat.

4. Select an IF bandwidth proper for the signal.

a. The bandwidth is wide enough to pass the mark and space tones without distortion.

b. The bandwidth in hertz must be at least equal to the sum of the shift in hertz and the keying speed in band.

Example 1: 850 Hz shift +50 band = 900
A 1 kHz bandwidth is a good choice in this case

Example 2: 170 Hz shift +75 band = 245
A 300 Hz bandwidth is the best choice

Example 3: 1000 Hz shift +100 band =1100
In this case, the 3.2 kHz bandwidth is the best choice

3.2 kHz is the widest bandwidth that will be required for this demodulator.

c. If the signal drifts excessively in frequency, add to the bandwidth requirement the amount of the maximum expected drift in hertz for example: An 850 Hz shift signal drifts about 300 Hz while keying at 50 band. 850 + 50 + 300 = 1200 so that the 3.2 kHz filter is the correct choice.

5. Set the BFO to -5.0 kHz offset.

a. Verify that FSK Tuning Meter indicates center-scale. Rock the Main Tuning dial as necessary to obtain a center-scale indication.

b. Utilizing a negative BFO setting produces an audio spectrum which has the same frequency relationship of mark and space tones as the original RF signal.

c. Setting the BFO to +5.0 kHz inverts the demodulated data and the audio spectrum.

6. The signal should demodulate properly without further attention. The Line Audio Level Control may be adjusted from minimum to maximum without affecting FSK demodulation.

1.3.2 BAUD RATE FILTER SETTING

To optimize the demodulator for use with various keying speeds, the baud filter can be set for maximum data rates of 60, 75, 150 and 300 baud. If the highest baud rate of interest is 100 baud, than the 150 baud setting is appropriate. If the highest baud rate of interest is 75 baud (100 wpm TTY), then the 75 baud setting is correct. The baud rate setting must equal or exceed the highest baud rate of interest. The optimum choice is the setting which is just sufficient to meet this critereon.

Six miniature switches on the demodulator board control the baud rate filter. Opening or closing these switches varies the filter characteristics. The following table shows the switch settings for the various maximum baud rates. Other switch patterns yield poor performance and are not recommended.

	S1	S2	S3	S4	S5	S6	
300	x	x	x	x	x	x	
150	.	.	.	x	x	x	
75	x	x	x	.	.	.	
60	.	.	.	.	.	.	
	S1	S2	S3	S4	S5	S6	(on new card)

x = Switch Closed (On)

. = Switch Open (Off)

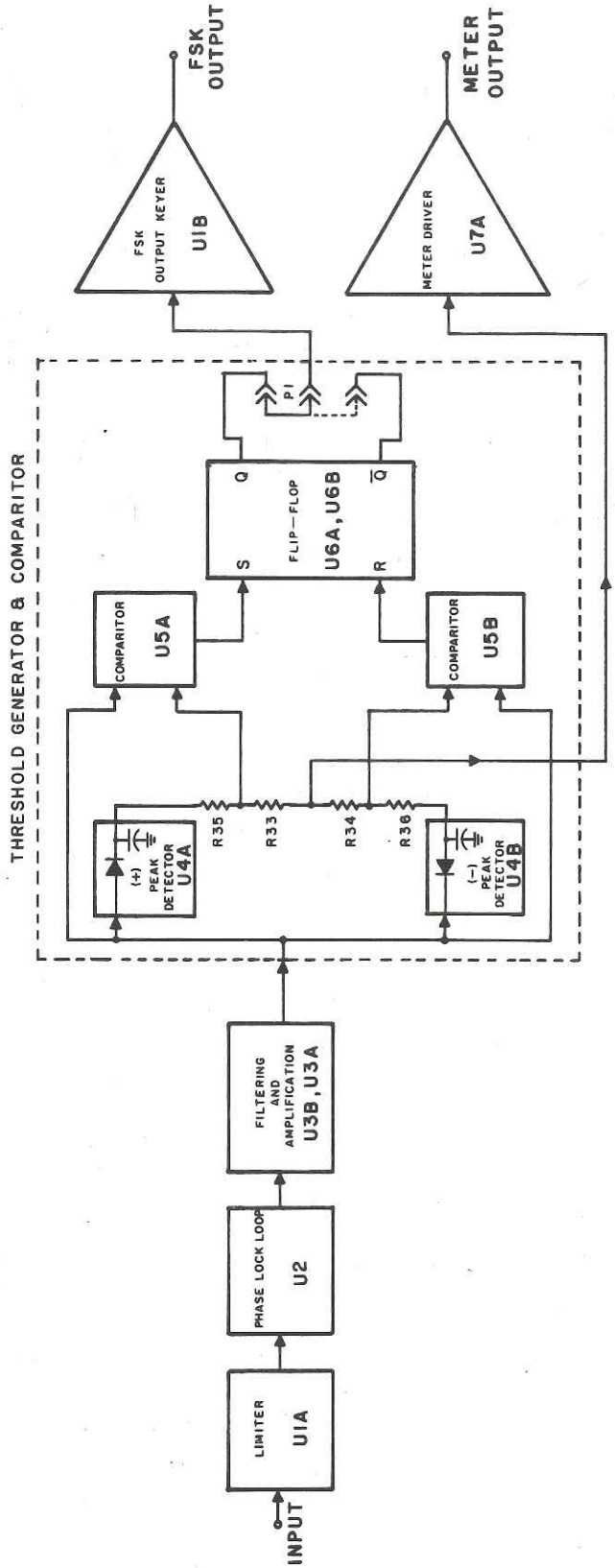


Figure 1-2. FSK Simplified Block Diagram

1.4 CIRCUIT DESCRIPTION

1.4.1 GENERAL

The FSK Demodulator Option board receives an FSK input signal from pin# 57 of the FM/CW/SSB Demodulator, A4A9. The demodulated bipolar (RS-232/MIL-188C compatible) or unipolar (TTL Logic Compatible) output at A4A11-19 is routed to rear panel jack J____. The tuning meter control voltage, A4A11-11, is routed to the Upper Panel Control, A10A1, which is modified to include an FSK tuning mode for the front panel meter.

1.4.2 DETAILED CIRCUIT DESCRIPTION

Refer to **Figure 1-1.** FSK Demodulator Simplified Block Diagram and **Figure 1-3,** FSK Demodulator Schematic as an aid in understanding the operation of the FSK Demodulator Option board.

1.4.2.1 Input Limiter U1A and Phase Lock Loop U2

The audio signal is coupled via C15 and R1 to the inverting input of limiter UIA. A signal of approximately 1.2V peak-to-peak amplitude, established by CR1 and CR2 at the output of UIA, is applied to the input of phase locked look U2.

Phase locked look U2 has an internal voltage controlled oscillator (VCO). The free running frequency of the VCO (no input condition) is established by C3, R5 and R6. When an audio-signal from U1A is applied to pin# 2 of the U2, the VCO will "lock up" at the audio input frequency. The VCO control voltage, which varies linerly with the VCO frequency with the VCO frequency (and therefore with frequency shifts at the input of U2), is applied to the input of amplifier V3B.

1.4.2.2 Amplifier U3B and Active LP Filter U3A

U3B filters residual VCO frequency components, amplifies the signal by 4.5 and provides a DC level shift. The output of U3B, established by R27 and R28 to vary symetrically around Ø V d.c., is applied to an active low-pass filter network consisting of U3A, R9 thru R17, C5, and C6 and C7. The bandpass roll off characteristic of the low-pass Butterworth Filter at the input of U3A is determined by the setting of baud rate switch S1. The roll-off frequency is approximately equal to 0.5X the keying speed in baud referred to in **Table 1-1.** U3A also provides a voltage gain of 2.

1.4.2.3 Peak Detectors U4A and U4B, Summer (R33 thru 36)

The output of U3A is sinusoidal with an amplitude determined by the magnitude of frequency shift detected by the phase locked loop. This signal is applied to positive peak detector U4A and negative peak detector U4B which determine the peak-to-peak signal swing.

In addition to compensating for frequency drift of the FSK signal, U4A, U4B and the voltage divider (summer) between their outputs establish threshold references for U5A and U5B. Meter driver U7A also receives its input from the previously mentioned voltage divider.

1.4.2.4 Comparators U5A and U5B, Set-Reset Flip Flop U6

Comparators U5A and U5B compare the signal from U3A with their respective threshold levels from U4A and U4B. This provides a hysteresis characteristic which minimizes the effects of noise present on the input FSK signal. When the signal amplitude exceeds the threshold level at the junction of R33 and R35, U5A changes state. Likewise when signal level drops to the threshold level at the R34 and R36 junction, U5B will change state. The hysteresis created by this action always represents the same percentage of the signal swing.

The outputs of U5A and U5B are converted to logic levels by CR7, CR8, and CR9, and CR10 and flip-flop U6A and B. The polarity of the data is determined by the position of P1 which selects either the Q (U6A) or $\overline{Q}$ (U6B) output of the latch.

1.4.2.5 Output Keyer U1B and Meter Driver U7A

Output keyer U1B operates in either of two modes which are selected by the position of P2. With P2 in "+/-" position the output will be unipolar pulses at approx. 4.8 V (TTL). With P2 in "+/-" position the output will bipolar pulses of approx. ±5.5 V (RS232 or MIL-STD 188-C). C14 aids in reducing switching transients. CR12 is a protective diode which keeps the output of U1B from swinging negative on power up when connected for TTL output levels.

Meter driver U7A receives its input from the previously mentioned voltage divider. The dc offset of the meter driver is determined by R23. Zener diode VR1 protects the front panel meter circuitry by limiting the output voltage swing of U7A.

1.5 MAINTENANCE

1.5.1 GENERAL

The WJ-8718 HF Receiver and WJ-8718/FSK Demodulator option have been designed to operate for extended periods of time with minimum routine maintenance. Inspection and perforamnce tests should be conducted at regular intervals consistent with the facility's normal scheduling and after troubleshooting. No routine adjustments are required. Troubleshooting procedures can be most effectively carried out if the technician is thoroughly familiar with the operating instruction and circuit descriptions in both the manual for the WJ-8718 HF Receiver and this supplement.

1.5.2 INSPECTION FOR DAMAGE OR WEAR

Many existing or potential troubles can be detected by visual inspection. For this reason, a complete visual inspection should be performed on a regular basis and whenever the unit is inoperative. Any component showing signs of deterioration and its associated circuitry should be checked to verify proper operation. Any apparent damage due to overheating may be the result of other less apparent troubles in a circuit. As a result, the cause of overheating should be determined and corrected prior to replacing any damaged components. Inspect mechanical parts as pin connectors, contracts, printed wiring board guides and contacts and chassis wiring for excessive wear, looseness, misalignment, corrosion or other deterioration.

1.5.3 REPAIR

1.5.3.1 General

As a result of the high density component packaging of the WJ-8718/FSK Demodulator Option and associated WJ -8718 HF Receiver, repair of a specific trouble or fault is limited to component, circuit board, or assembly replacement. The options available are to either make the repair locally or to return the faulty component, circuit board, or assembly to the factory for replacement while in other cases, only complete circuit boards can be removed. Since component and assembly replacement are obvious upon inspection and the level of maintenance and repair capability vary, the following procedures are presented in general terms.

1.5.3.2 Component Removal

When removing components from a printed circuit board for inspection, testing, or replacement, be careful not to damage the tracks. Use a soldering iron with a power rating of 40 watts, or less, in conjunction with either a solder sipper or wicking procedure. If using a wicking procedure, be sure to use non-corrosive soldering flux. If possible, use a heat sink to prevent component damage.

1.5.3.3 Component Installation

When installing components on a printed circuit board after inspection, testing or as a replacement part, be sure lead connection holes are clear and free of excess solder prior to installing the components. Also be sure that component leads do not catch on any track edges and cause tracks to be lifted from the board or cause any track damage. The soldering technique used should involve the same size soldering iron as in component removal, along with only enough heat and solder (60/40 rosin core) required to achieve good solder joints. If possible, use a heat sink to prevent component damage.

1.5.3.4 Post Installation Procedures

After any components, circuit boards or assemblies have been installed in the demodulator or associated receiver, perform any necessary alignment procedures and appropriate performance tests to verify proper operation and unit integrity.

1.5.4 FSK OPTION ALIGNMENT PROCEDURE

The following alignment/adjustment procedures should not be performed on a routine basis. They should be performed strictly as an integral part of troubleshooting (if required) and as a part of post repair procedures (if necessary) to bring repaired/replaced components on-line. The procedures should be performed by skilled technicians, familiar with the unit.

1. On the receiver rear panel, connect the 1 MHz REF output, J1, to the RF input, A2J1.

2. Tune the receiver to 15.00000 MHz. Select CW detection mode, FAST AGC, and 1.0 kHz IF Bandwidth.

3. Place the front panel meter in FSK Tuning Mode (both switches out).

4. Set the BFO offset to -5.0 kHz.

5. Adjust the bias of the tuning meter driver circuit.

   a. Connect a jumper wire between A4A11-TP1 and ground.

   b. Adjust A4A11R23 for a center-scale indication on the tuning meter.

   c. Remove the jumper wire.

6. Adjust A4A11R6 for a center-scale indication on the tuning meter.

7. Set the BFO offset to 0.0 kHz. Adjust A4A11R27 for a center-scale indication on the tuning meter.

8. Repeat steps 6 and 7 as necessary to obtain a center-scale indication on the tuning meter for both 0.0 kHz and -5.0 kHz BFO offsets.

9. This completes the FSK Option alignment procedure.

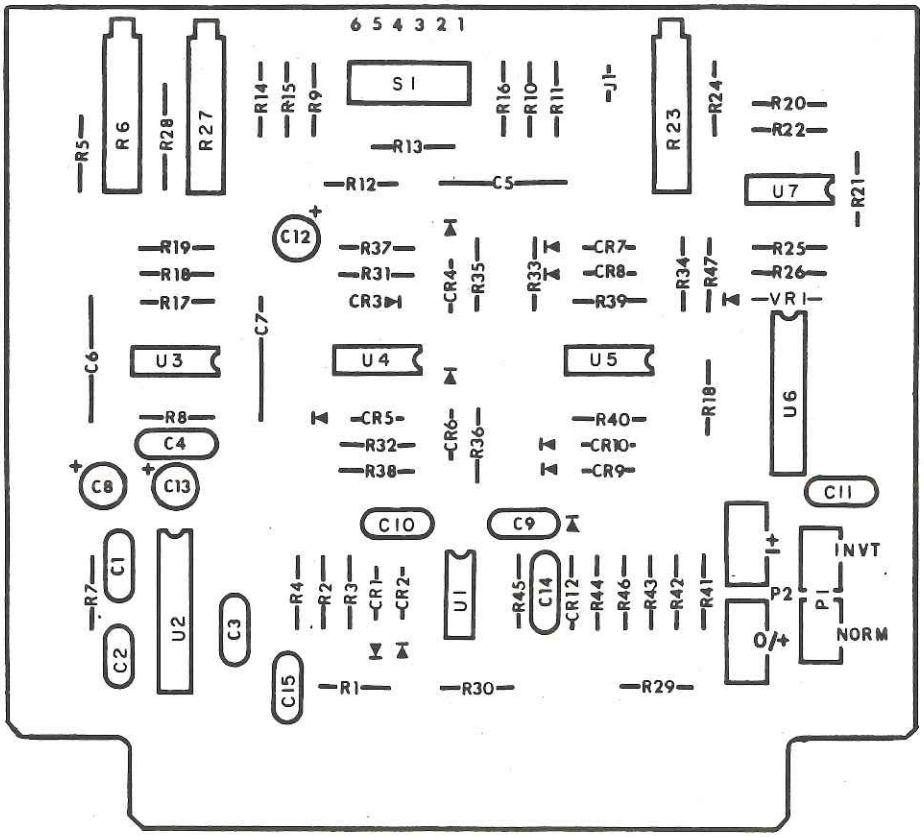


Figure 1-3. FSK Demodulator Parts Location

TYPE NUMBER 794241-1 REVISION B SCHEMATIC 470383

TITLE - FSK DEMODULATOR PRINTED WIRING ASSY

REF DESIG	DESCRIPTION	QTY/ EQPT	PART NUMBER	CODE IDENT
CR1	DIODE HI COND HS SW 75PRV SILICON	10	1N4449	80131
CR2	S/A CR1			
CR3	S/A CR1			
CR4	S/A CR1			
CR5	S/A CR1			
CR6	S/A CR1			
CR7	S/A CR1			
CR8	S/A CR1			
CR9	S/A CR1			
CR10	S/A CR1			
CR11	DIODE ZENER 10V SILICON	1	1N758A	80131
CR12	DIODE GENERAL PURPOSE 80PRV	1	1N198A	80131
C1	CAP/CER/DISC .1UF 20PCT 100V	3	8131M100-651-104M	72982
C2	CAP/CER/DISC 1000PF GMV 500V	1	B-GP1000PFP	91418
C3	CAP/CER/DISC .01 UF 5 PCT 100 V NPO	1	8131-100-C0G0-103J	72982
C4	CAP/CER/DISC 470PF 20PCT 1000V	1	BHD470-20PCT	91418

TYPE NUMBER 794241-1 REVISION B SCHEMATIC 470383

TITLE - FSK DEMODULATOR PRINTED WIRING ASSY

REF DESIG	DESCRIPTION	QTY/ EQPT	PART NUMBER	CODE IDENT
C5	CAP/PCLYCRBNT .1UF 2PCT 100V	3	MPCW-104-1-2	04099
C6	S/A C5			
C7	S/A C5			
C8	CAP/ELEC/TANT 3.3UF 20PCT 35V	1	196D335X0035JE3	56289
C9	CAP/CER/DISC 0.47UF 20PCT 100V	2	8131M100-651-474M	72982
C10	S/A C9			
C11	S/A C1			
C12	CAP/ELEC/TANT 47UF 20PCT 20V	2	1S6D476X0020PE4	56289
C13	S/A C12			
C14	CAP/CER/DISC 5000PF 20PCT 100V	1	C0238101E502M	56289
C15	S/A C1			
J1	JACK/TIP PC BRCWN RT ANGLE	1	TJ202BR	49956
P1	CONN/PLUG 2 PIN JUMPER .040RND X .181LG PINS ON .200 CTR BLACK	2	021-4802-0	98291
P2	S/A P1			
R1	RES/FIXED/COMPO 10K 5PCT .25W	7	RCR07G103JS	81349
R2	S/A R1			

TYPE NUMBER 794241-1 REVISION B SCHEMATIC 470383

TITLE - FSK DEMODULATOR PRINTED WIRING ASSY

REF DESIG	DESCRIPTION	QTY/ EQPT	PART NUMBER	CODE IDENT
R3	S/A R1			
R4	S/A R1			
R5	RES/FIXED/FILM 1.0K 1PCT 0.10W	1	RN55C1C01F	81349
R6	RES/VAR/FILM 5K 10PCT 0.75W	1	89PR5K	73138
R7	RES/FIXED/COMPO 22K 5PCT .25W	5	RCR07G223JS	81349
R8	RES/FIXED/COMPO 100K 5PCT .25W	5	RCR07G104JS	81349
R9	RES/FIXED/COMPO 43K 5PCT .25W	2	RCR07G433JS	81349
R10	RES/FIXED/COMPO 15K 5PCT .25W	2	RCR07G153JS	81349
R11	RES/FIXED/COMPO 13K 5PCT .25W	3	RCR07G133JS	81349
R12	S/A R11			
R13	S/A R11			
R14	RES/FIXED/COMPO 39K 5PCT .25W	2	RCR07G393JS	81349
R15	RES/FIXED/COMPO 12K 5PCT .25W	1	RCR07G123JS	81349
R16	RES/FIXED/COMPO 3.9K 5PCT .25W	2	RCR07G392JS	81349
R17	S/A R16			

TYPE NUMBER 794241-1 REVISION B SCHEMATIC 470383

TITLE - FSK DEMODULATOR PRINTED WIRING ASSY

REF DESIG	DESCRIPTION	QTY/ EQPT	PART NUMBER	CODE IDENT
R18	RES/FIXED/FILM 309K 1PCT .25W	2	CC3093F	01121
R19	S/A R18			
R20	RES/FIXED/COMPO 4.7K 5PCT .25W	1	RCR07G472JS	81349
R21	RES/FIXED/COMPO 51K 5PCT .25W	1	RCR07G513JS	81349
R22	RES/FIXED/COMPO 4.3K 5PCT .25W	1	RCR07G432JS	81349
R23	RES/VAR/FILM 50K 10PCT 0.75W	2	89PR50K	73138
R24	S/A R14			
R25	RES/FIXED/COMPO 68K 5PCT .25W	1	RCR07G683JS	81349
R26	S/A R1			
R27	S/A R23			
R28	RES/FIXED/FILM 210K 1PCT .25W	1	RN60D2103F	81349
R29	RES/FIXED/COMPO 10 OHMS 5PCT .25W	2	RCR07G100JS	81349
R30	S/A R29			
R31	RES/FIXED/COMPO 470K 5PCT .25W	2	RCR07G474JS	81349
R32	S/A R31			

TYPE NUMBER 794241-1 REVISION B SCHEMATIC 470383

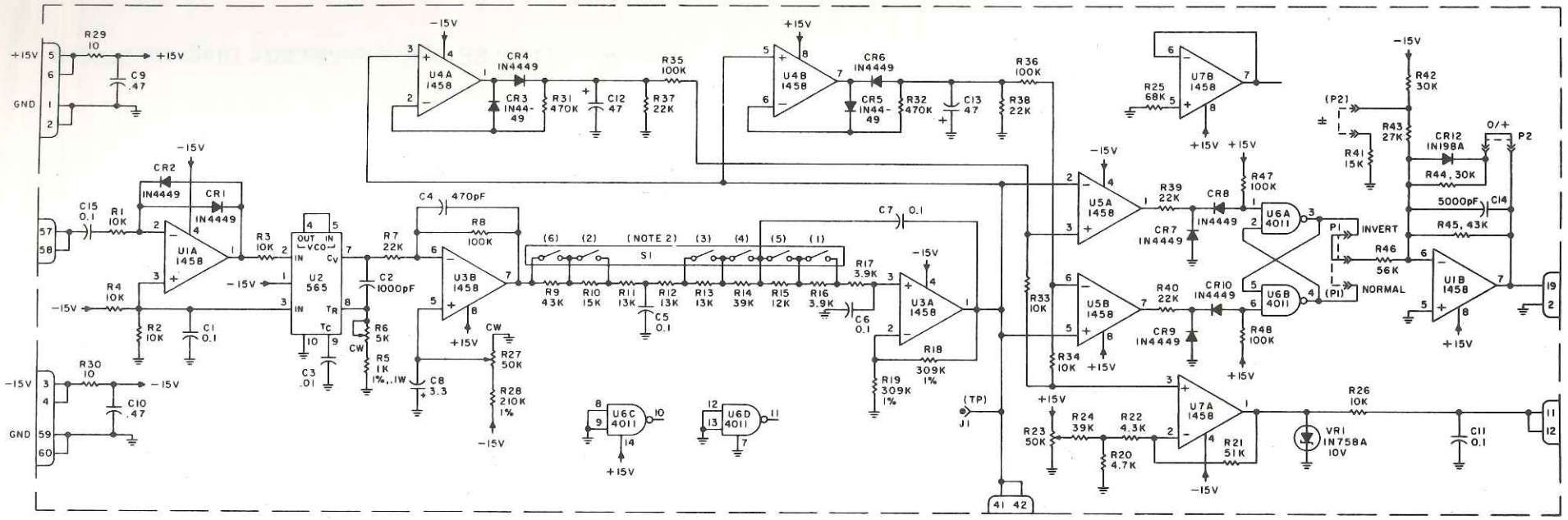
TITLE - FSK DEMODULATOR PRINTED WIRING ASSY

REF DESIG	DESCRIPTION	QTY/ EQPT	PART NUMBER	CODE IDENT
R33	S/A R1			
R34	S/A R1			
R35	S/A R8			
R36	S/A R8			
R37	S/A R7			
R38	S/A R7			
R39	S/A R7			
R40	S/A R7			
R41	S/A R10			
R42	RES/FIXED/COMPO 30K 5PCT .25W	2	RCR07G303JS	81349
R43	RES/FIXED/COMPO 27K 5PCT .25W	1	RCR07G273JS	81349
R44	S/A R42			
R45	S/A R9			
R46	RES/FIXED/COMPO 56K 5PCT .25W	1	RCR07G563JS	81349
R47	S/A R8			
R48	S/A R8			
S1	SWITCH/TOGGLE ROCKER 6 SPST SIDE ACTUATED (PIANO)	1	76PSB06	80173
U1	I C DUAL OPERATIONAL AMPLIFIER	5	MC1458N	18324

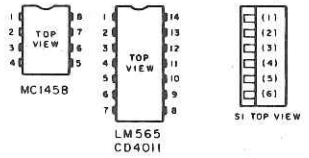
TYPE NUMBER 794241-1 REVISION B SCHEMATIC 470383

TITLE - FSK DEMODULATOR PRINTED WIRING ASSY

REF DESIG	DESCRIPTION	QTY/ EQPT	PART NUMBER	CODE IDENT
U2	INTEGRATED CKT VCO AND PHASE COMPARATO	1	NE565N	18324
U3	S/A U1			
U4	S/A U1			
U5	S/A U1			
U6	I C CMOS QUAD 2-INPUT NAND GATE	1	CD4011AE	02735
U7	S/A U1			



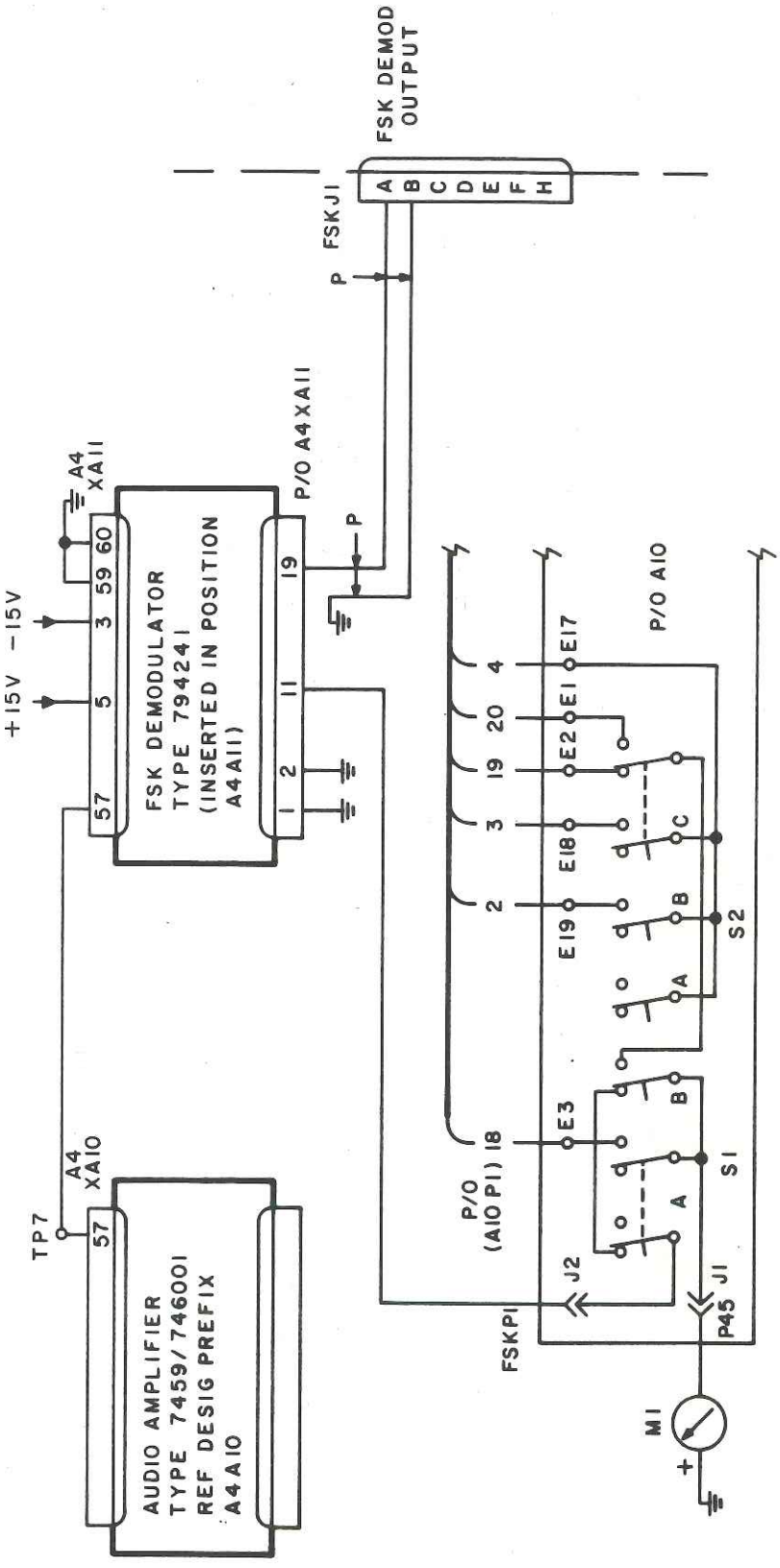
NOTES
1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS IN OHMS, ±5%, 1/4W.
   b) CAPACITANCE IS IN μF.
2. FOR BAUD RATE SELECT, SEE TABLE.



BAUD	(1)	(2)	(3)	(4)	(5)	(6)
300	X	X	X	X	X	X
150				X	X	X
75	X	X	X			
60						

X = SWITCH CLOSED

FIGURE 1-4. TYPE 794241-1 FSK DEMODULATOR SCHEMATIC DIAGRAM 470383



Type WJ-8718/FSK Option Schematic Diagram 370622