MOTOROLA INC.
Communications
Sector

MULTIPLE PL DECODER MODULE

MODEL TRN5329A

1. FUNCTIONS

This multi-PL decoder module is used with base and repeater stations to provide multiple PL receive operation. It is also used with non-wire line repeater stations to select the PL tone transmitted with repeated messages. Depending on the PL tone received, a switched ground signal will appear at one of the outputs of this module which is used to:

- (with base stations) unsquelch the receiver, or

- (with non-wire line repeater stations) unsquelch the receiver and enable an associated PL oscillator in the multi-PL encoder module.

This module is installed with a modified tone PL encoder-decoder module, that provides this module with Delayed Keyed A+. The modifications to the tone PL encoder-decoder module are as given in Table 1.

Table 1.
Tone PL Encoder-Decoder Module Modifications

Factory Option No.	Tone PL Module	Components Removed
C158AB/AE	TRN5074A	C51 and 52
C261AC/AH	TRN5074A	R19
C262AE	TRN5073A	C51, C52, R19, Z1, and Z2
C263AB	TRN5074A	C51, C52, R19, and Z1

2. DESCRIPTION

This module is fully transistorized and occupies the single-tone decoder module position in the RF-Control Chassis. All components and circuitry are mounted on a sturdy card with interconnecting pins to mate with the backplane interconnect board of the RF-Control Chassis.

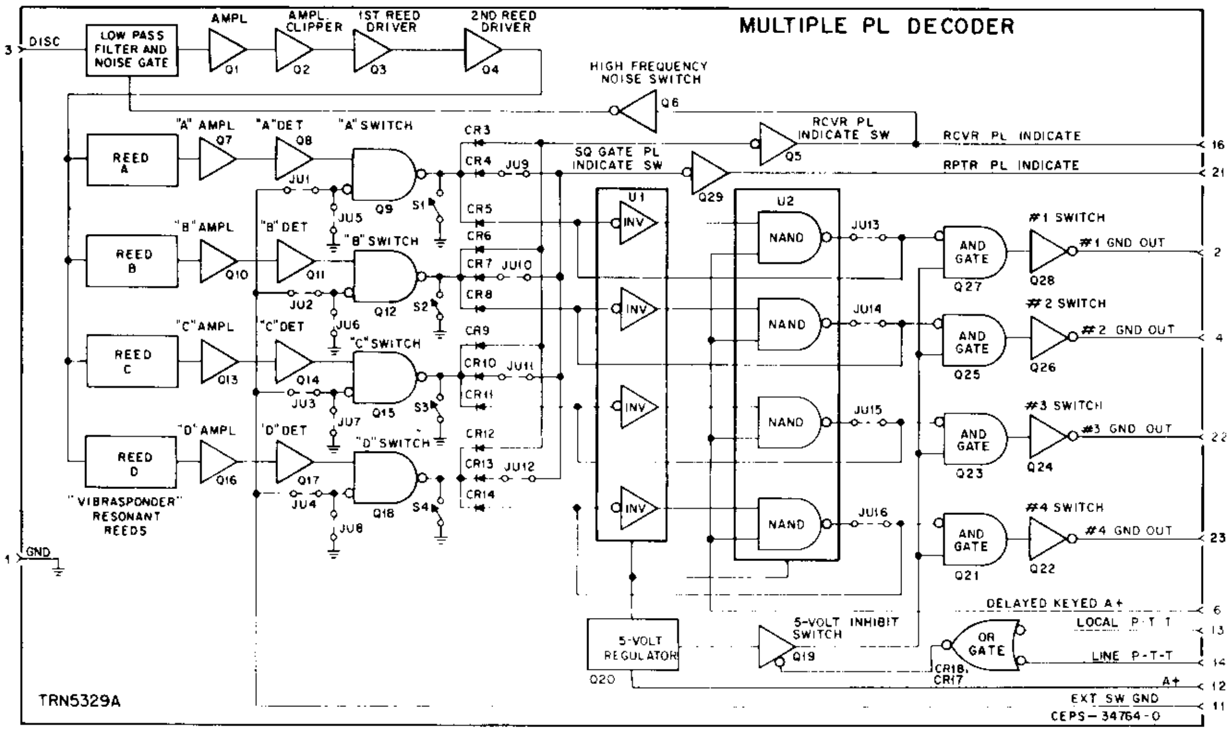

Figure 1. Functional Diagram

3. CIRCUIT DESCRIPTIONS

3.1 INTRODUCTION

This module responds only to specific continuous low-frequency tones from a transmitter in the same *Private-Line* system. Four Vibrasponder resonant reeds are used as tone detectors by the decoder. These reeds detect tones within an accuracy of less than one Hertz (0.15%). A switched ground from an open collector output stage is provided for each of the four detected tone inputs by the decoder.

3.2 PL TONE PRESENT

When PL tones are present on the input signal to the decoder, the PL filter will pass the low frequency PL tones and attenuates voice and noise frequencies above 300 Hz. The noise switch shorts out high frequency noise frequencies. The tone from the PL filter is amplified by the PL amplifier and is limited to a fixed level by the amplifier/clipper. The tone is applied to the Vibrasponder resonant reed which vibrates when the tone is the same frequency as the reed's resonant frequency. When the reed is vibrating, the device acts as a transformer and couples the tone from primary to secondary. The tone is amplified in the next stage and applied to a detector. When a tone is present, the detector develops a dc output which activates the detector output switch. When the detector output switch is activated, its ground output is applied to three circuits:

- Receive PL indicate switch which, in turn, drives the high frequency noise switch (shorts input high frequency noise and voice signals to ground) and provides an output "high" on the PL indicate line to the station's receiver (unsquelches the receiver).

- Squelch gate PL indicate switch which, in turn, provides an output "high" on the PL indicate line to a repeater station's squelch gate module (keys the station's transmitter).

- Through inverter and latch circuits to an applicable output switch which, in turn, is activated (provides an associated ground level output in response to the particular PL tone detected).

3.3 PL TONE NOT PRESENT

When no PL tone is present, or when a PL tone of an incorrect frequency is present, the Vibrasponder resonant reed does not operate. Therefore, the output of all detector switches is high which inhibits the squelch gate through pin 21.

When no PL tone is detected, switch Q6 is off. This allows high frequency noise to bypass the PL filter which prevents random low frequency noise from activating the Vibrasponder resonant reeds.

3.4 INPUT CIRCUITS

The receiver discriminator output signal is applied to the multi-PL decoder input at pin 3. When no carrier is received this signal consists of noise only. Whhen voice or voice/PL tone frequencies are received, the noise is reduced and the voice/PL tone frequencies are routed through the low pass PL filter and noise gate circuits. The low pass PL filter, which consists of L2, C2, C3, and C4, sharply attenuates all signals above 300 Hz. Therefore, voice and noise frequencies above 300 Hz are effectively blocked while PL tones are passed.

High pass filter C1, R1 and R7, provides a shunt for high frequnecy noise around the PL filter when no tones are detected. The high frequency noise desensitizes the amplifier/clipper and prevents low frequency noise from triggering the decoder. When a PL tone is detected, noise switch Q6 shorts all high frequency signals to ground.

3.5 AMPLIFIER/CLIPPER

The noise and PPL tones are ampified and coupled to amplifier/clipper Q2 by Q1. Diode CR1 and Q2 (base emitter junction) limit both the positive and negative signal swing to a maximum amplitude. The output of Q2 provides a constant drive to compensate for the tone amplitude deviation between transmitters. Q2 also reduces the sensitivity of the Vibrasponder resonant reeds to noise. Drivers Q3 and Q4 operate as emitter followers to provide current drive to the low impedance Vibrasponder resonant reed assembly.

3.6 VIBRASPONDER RESONANT REEDS

The Vibrasponder resonant reeds are the frequency detecting devices of the decoder. When the input tone from the Vibrasponder resonant reed driver is the same frequency as a reed's resonant frequency, the reed vibrates. At resonance, the reed acts as a high Q transformer coupling energy from the primary to the seconary winding. At all other frequencies, the reed will not vibrate and no energy is coupled to the secondary winding. The reed is a precision built device consisting of a tuned cantilever reed of special steel mounted on a rugged base with a coil and permanent magnets. The entire assembly is spring-mounted and hermetically sealed in a metal housing to insure long life at peak performance under all types of conditions. Its design eliminates the need for servicing throughout its useful life. The plug-in unit is easily removed and replaced. The reed is sensitive to within 1 Hz of its resonant frequency. Specific tones in the 82.5 to 210 Hz range are used.

3.7 TONE DETECTORS

The following description applies to the signal flow through Vibrasponder resonant reed "A" and associated circuits. Vibrasponder resonant reed circuits "B," "C," and "D" operate in an identical manner.

When a PL tone is detected by a Vibrasonder resonant reed, a resonant sinusoidal waveform appears at its output. This signal is amplified by Q7. (Negative feedback through C11 maintains the sinusoidal voltage.) The output of Q7 is detected by Q8.

Detector Q8 is normally turned off by +13.4 volts on the base and +12.3 volts on the emitter. Therefore, when a tone is detected, Q8 turns on each time the tone signal waveform goes negative more than 1.3 volts (the amount of Q8 reverse bias). Each time Q8 turns on, C13 is charged by the +12.3 volts on the emitter. When Q8 turns off, C13 discharges through R25 and the base of Q9 turning on Q9. When Q9 turns on, it applies a ground to the base of Q5 and Q29, turning them on. When Q5 and Q29 are turned on, they apply a positive level to the receiver and squelch gate respectively. The positive level from Q5 also turns on Q6 which shunts high frequency noise from the PL filter to ground.

3.8 DECODER OUTPUT

When a tone is detected, the low output of Q9 is applied to inverter U1-5. This low is inverted and applied to NAND gate U2-2. When delayed keyed A+ is applied to U2-3, a low level is generated and fed back to U1-5, causing a latch condition and applying a continuous low to the base of Q27. This low turns on Q27 and Q28 producing a low (ground level) output #1 signal at pin 2.

When transmission has been completed, and the PL tone has dropped, the collector of detector output switch Q9 goes high. This high reverse biases all three isolation diodes, causing the three associated circuits to reverse their operation as previously described. Delayed Keyed A+ remains on for approximately 180 milliseconds. The voltage delay keeps the NAND gate on, feeding back the output to the input of inverter U1, thereby keeping a high applied to pin 1 of U2. This state continues until Delayed Keyed A+ drops, causing the NAND gate to return to its normal state.

4. MAINTENANCE

4.1 RECOMMENDED TEST EQUIPMENT

- Motorola S1318A, S1319A, S1320A, or S1321A RF Signal Generator. This solid-state unit provides receiver rf carrier signals.

- Motorola SLN6221A PL Tone Generator and Vibrasender resonant reeds on the same frequency as the Vibrasponder resonant reeds of the decoder. An audio signal generator may be used if it is accurately set to the decoder frequency. However, to obtain the accuracy necessary, the frequency should be adjusted while the signal is measured on a frequency counter.

- Tektronix/Telequipment Model D61 Oscilloscope for tone signal measurement. Some measurements may be taken with a high impedance ac voltmeter.

- Motorola solid state multimeter for dc voltage measurements.

4.2 PERFORMANCE TESTS

A 0.25 microvolt rf carrier signal modulated ±0.5 kHz with PL tone should unsquelch the receiver. This can be checked as follows:

Step 1. Connect the rf signal generator to the receiver rf input receptacle. Set the signal generator output to the receiver carrier frequency, then set the output to minimum.

Step 2. Modulate the signal generator output ±0.5 kHz with a PL tone of the frequency stamped on one of the Vibrasponder resonant reeds. The tone can be generated with a Motorola SLN6221A PL Tone Generator and a Vibrasponder resonant reed. A Vibrasender resonant reed from the PL encoder may be used if it is the proper frequency.

Step 3. Also modulate the signal generator with an audio tone in the 300 to 3000 Hz range at ±3.3 kHz deviation.

Step 4. Increase the output of the signal generator until the receiver unsquelches and the audio tone is heard on the speaker. No more than 0.25 microvolt should be required to unsquelch the receiver.

4.3 TROUBLESHOOTING

If the PL decoder does not operate, or operates improperly, the following hints may be helpful in locating the malfunction.

4.3.1 Testing the Vibrasponder Resonant Reeds

One of the first tests should be a check of the Vibrasponder resonant reeds. Inject 340 millivolts rms of PL tone at the proper frequency directly to the primary of each reed. Use an oscilloscope or ac voltmeter to check the output across the secondary of the reeds. Approximatley 75 millivolts rms should be measured. If the reeds are good, continue with other decoder tests.

4.3.2 Decoder Testing

Step 1. To test the decoder, inject a 1000 microvolt carrier signal into the receiver. Adjust PL modulation for 60 millivolts rms tone signal at the input to the decoder. If the PL tone is injected directly onto the decoder for testing, an rf carrier signal should be injected into the receiver to quiet the receiver noise. Otherwise, noise and PL tone will both be present and will produce erroneous readings.

Step 2. With 60 millivolts PL tone input, measure signal and dc voltages at various points in the decoder to isolate the trouble. Typical values for a normally operating decoder are given on the schematic diagram. Some waveforms are not sinusoidal and should be measured with an oscilloscope. Most ac voltmeters are calibrated to read accurately only for sinusoidal signals.

Step 3. If under normal operating conditions, the PL tones are heard with the speaker audio, the high pass filter on the decoder board should be checked.

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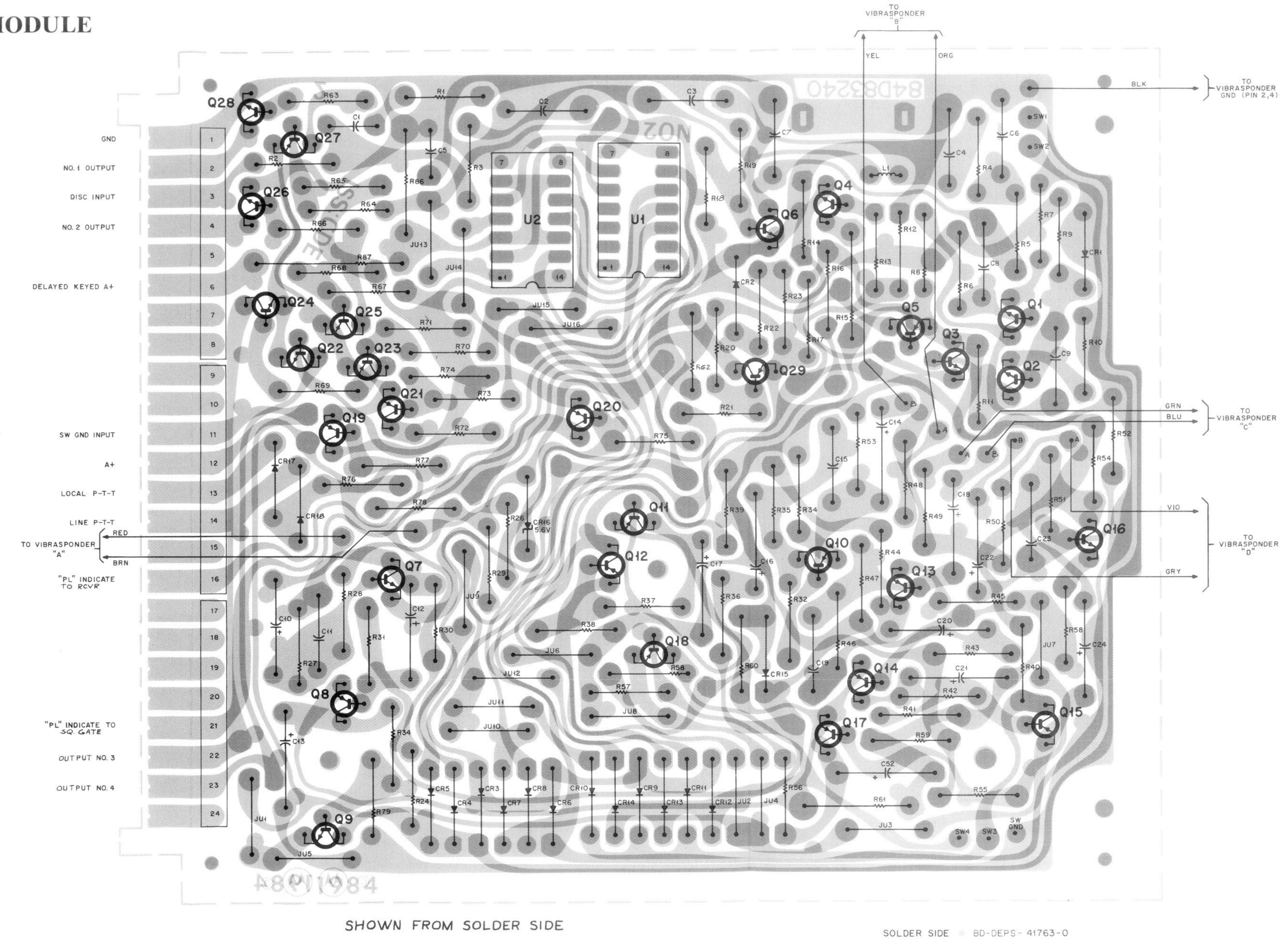
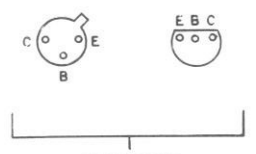


SHOWN FROM SOLDER SIDE

Circuit Board Detail & Parts List
Motorola No. ***PEPS-34703-A***
(Sheet 1 of 2)
11/1/85-UP

SOLDER SIDE BD-DEPS-41763-O
COMPONENT SIDE BD-DEPS-41764-O
OL-DEPS-41762-O



TRANSISTOR DETAILS

parts list

TRN5329A Multi-PL Decoder Module PL-7968-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF ±10%; 50 V: unless otherwise stated
C1	21-859178	270 pF ±5%; 300 V
C2	8-82905G32	0.22
C3	8-82905G08	.033
C4	8-82905G30	0.1
C5	21-82187B26	.003; 100 V
C6	8-82905G04	.068
C7	8-82905G01	.01
C8,9	8-82427B01	.068
C10	23-865137	4.7 ±20%; 25 V
C11	8-82905G02	.022
C12	23-865137	2.7 ±20%; 25 V
C13	23-82783B08	1 ±20%; 35 V
C14	23-865137	4.7 ±20%; 25 V
C15	8-82905G02	.022
C16	23-865137	4.7 ±20%; 25 V
C17	23-82783B08	1 ±20%; 35 V
C18	23-865137	4.7 ±20%; 25 V
C19	8-82905G02	.022
C20	23-865137	4.7 ±20%; 25 V
C21	23-82783B08	1 ±20%; 35 V
C22	23-865137	4.7 ±20%; 25 V
C23	8-82905G02	.022
C24	23-865137	4.7 ±20; 25 V
C25	23-82783B08	1 ±20%; 35 V
C26	23-11019A20	10 ±20%; 50 V
		semiconductor device, diode: (see note)
CR1 thru 4	48-82392B03	silicon
CR5	48-82178A04	germanium
CR6,7	48-82392B03	silicon
CR8	48-82178A04	germanium
CR9,10	48-82392B03	silicon
CR11	48-82178A04	germanium
CR12,13	48-82392B03	silicon
CR14	48-82178A04	germanium
CR15	48-822392B03	silicon
CR16	48-82256C12	Zener; 5.6 V
CR17,18	48-82392B03	silicon
		reactor; a-f choke:
L1	24-84003A03	6 H
		transistor: (see note)
Q1 thru 4	48-869570	NPN; type M9570
Q5	48-869571	PNP; type M9571
Q6,7	48-869570	NPN; type M9570
Q8	48-869571	PNP; type M9571
Q9	48-869567	NPN; type M9567
Q10	48-869570	NPN; type M9570
Q11	48-869571	PNP; type M9571
Q12	48-869567	NPN; type M9567
Q13	48-869570	NPN; type M9570
Q14	48-869571	PNP; type M9571
Q15	48-869567	NPN; type M9567
Q16	48-869570	NPN; type M9570
Q17	48-869571	PNP; type M9571
Q18,19	48-869567	NPN; type M9567
Q20	48-869491	NPN; type M9491
Q21	48-869571	PNP; type M9571
Q22	48-869570	NPN; type M9570
Q23	48-869571	PNP; type M9571
Q24	48-869570	NPN; type M9570
Q25	48-869571	PNP; type M9571
Q26	48-869570	NPN; type M9570
Q27	48-869571	PNP; type M9571
Q28	48-869570	NPN; type M9570
Q29	48-869571	PNP; type-M9571
		resistor, fixed ±5%; 1/4 W: unless otherwise stated
R1	6-11009C73	10k
R2	6-11009C57	2.2k
R3	6-11009C69	6.8k
R4,5	6-11009C73	10k
R6	6-11009C89	47k
R7	6-11009C41	470
R8,9	6-11009C81	22k
R10	6-11009C41	470
R11	6-11009C81	22k
R12	6-11009C73	10k
R13	6-11009C25	100
R14	6-11009C49	1k
R15	6-125C33	220; 1/2 W
R16	6-11009C97	100k
R17	6-11009C89	47k
R18	6-11009C73	10k
R19	6-11009C57	2.2k
R20	6-11009C89	47k
R21	6-11009C97	100k
R22	6-11009C13	33
R23	6-11009C57	2.2k
R24,25	6-11009C73	10k
R26	6-11009C67	5.6k
R27	6-11009C93	68k
R28	6-11009C83	27k
R29	6-11009C13	33
R30	6-11009C49	1k
R31	6-11009C83	27k
R32	6-11009C93	68k
R33	6-11009C83	27k
R34	6-11009C13	33
R35	6-11009C49	1k
R36	6-11009C83	27k
R37 thru 42	6-11009C73	10k
R43	6-11009C83	27k
R44	6-11009C49	1k
R45	6-11009C13	33
R46	6-11009C93	68k
R47	6-11009C83	27k
R48,49,50	6-11009C67	5.6k
R51	6-11009C93	68k
R52	6-11009C83	27k
R53	6-11009C13	33
R54	6-11009C49	1k
R55	6-11009C83	27k
R56,57,58	6-11009C73	10k
R59	6-11009C57	2.2k
R60	6-11009C25	100
R61	6-125C49	1k; 1/2 W
R62	6-11009C73	10k
R63,64	6-11009C49	1k
R65	6-11009C73	10k
R66,67	6-11009C49	1k
R68	6-11009C73	10k
R69,70	6-11009C49	1k
R71	6-11009C73	10k
R72,73	6-11009C49	1k
R74	6-11009C73	10k
R75	6-11009C47	820
R76	6-11009C61	3.3k
R77	6-11009C49	1k
R78	6-11009C61	3.3k
R79	6-11009C73	10k
R80	6-126C31	180 ±10%; 1 W
R81	6-125A73	82; 1/2 W
		switch, slide:
S1 thru S4	40-83204B01	dpdt
		integrated circuit: (see note)
U1	51-84805E02	hex inverter
U2	51-84805E20	quad NAND gate
		non-referenced items
	9-84906E01	SOCKET; 2 used
	7-84785F01	BRACKET, reed retaining
	75-82333B18	PAD
	1-80757D86	PANEL ASSEMBLY: includes; ref. items S1 thru S4, and:
	64-83137L04	PANEL, screened
	1-80759B43	BRACKET & SOCKET ASSEMBLY, includes:
	7-84784F01	BRACKET, reed socket, mounting
	64-84782F02	PANEL, screened
	9-83035A02	SOCKET, reed; 4 used
	43-84783F01	BUSHING, spacer (threaded) 3 used
	3-135084	SCREW, tapping; 4-40 x 5/16"; 3 used
	3-84256M01	SCREW, tapping; 2 used
	4-51143	WASHER, insulator; 3/8"; 3 used
	5-84220B01	GROMMET; 2 used
	9-83497F01	RECEPTACLE, 8 contact; 3 used (PCB Edge Connector)

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

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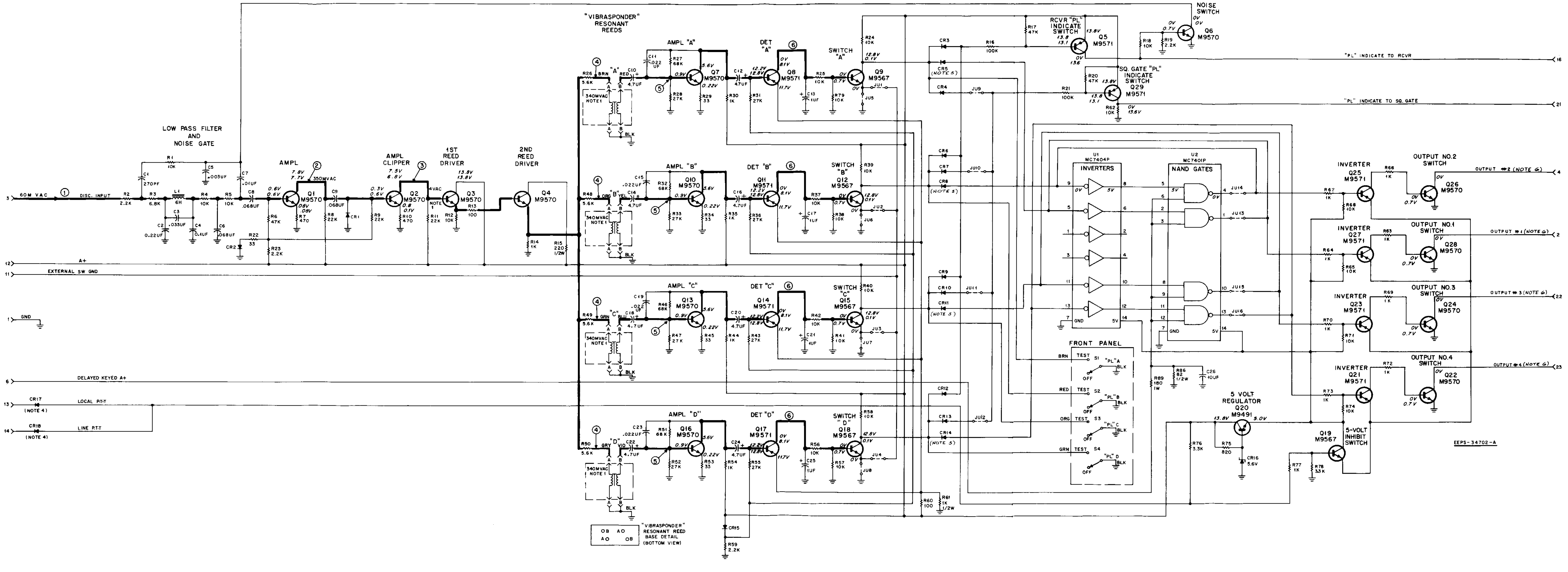

NOTES:

1. Due to square wave characteristic some meters respond differently. Voltage should be measured with an oscilloscope.
2. AC voltage readings are RMS values with 60 millivolts PL tone input. Use high impedance (10 megohm) ac voltmeter. Measurement made with respect to chassis ground.
3. DC voltage readings taken with high impedance (11 megohm) dc voltmeter. Top value is measured without PL tone. Bottom value is measured with 60 millivolts PL tone input. Measurement made with respect to chassis ground.
4. Diodes CR17 and CR18 provide local PTT and Line PTT priority over repeat operation. removal of both diodes inhibits local and line PTT priority.
5. Diodes CR5, 8, 11 and 14 are always connected except for when the diodes are removed, the decoder does not influence PL encoder output.
6. Collector valtage to Q22, 24,2 6 and 28 must not exceed +30 volts.

Jumper Table

Jumper (JU)	Function
1 2 3 4	Permits external switched ground to enable detector switches. Normally OUT.
5 6 7 8	Provides internal ground to enable detector switches. Normally IN.
9 10 11 12	Routes PL indicate (Xmit key) to sq. gate for non wireline applications. Normally all IN. Example, to cause messages accompanied by codes A and B to be repeated but not messages accompanied by codes C and D. Jumpers 9 and 10 must be IN and jumpers 11 and 12 must be OUT.
13 14 15 16	Causes circuit to latch until delayed keyed A+ is lost so that there is time to transmit a reverse burst PL tone before the transmitter unkeys. Normally IN for repeaters.

Schematic Diagram
Motorola No. PEPS-34703-A
(Sheet 2 of 2)
11/1/85- UP