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Skokie, Illinois, U. S. A.

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DESCRIPTION, SERVICING, AND ADJUSTMENTS FOR 321991 CLUTCH MAGNET DRIVER (CMD) WHEN INSTALLED IN AN ELECTRICAL SERVICE ASSEMBLY EQUIPPED FOR LOW LEVEL RFI (POLAR-EMC) OPERATION

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1. DESCRIPTION

1.01 The 321991 clutch magnet driver (CMD) circuit card assembly (Figure 1), when installed (plugged) in a shielded electrical service assembly (ESA) containing the proper power supply and filter assemblies, is intended for radio frequency interference (rfi) suppression of transmitter clutch operation in systems requiring low level rfi (Polar-EMC) kits. The complete CMD assembly, including heat sink, is mounted on a single 4-1/4 by 2-1/2 inch plug-in card (Figure 2).

1.02 The CMD unit is a voltage device functioning as a solid-state, direct-coupled amplifier, that is placed across the transmitter output to provide a low level interface for the 28 type transmitting clutch (synchronous pulsed transmission). These units should be used with the proper associated equipment (kits).

1.03 One CMD assembly is plugged into each 15-pin 148458 connector (in an ESA) that has a 198650 polarizing key located to accommodate the card slot between pins F and H (Figure 3).

1.04 The 321991 clutch magnet driver (CMD) is adaptable to various types of 28 equipment through the use of special modification kits that are applicable in either field or factory installation. Each CMD (one or more) is part of, or associated with, some electrical service assembly (ESA) and each ESA (one or more) is a part of some modification kit. The quantity of CMDs and associated low level equipment will depend upon which modification kit is used. For wiring diagrams and additional information, refer to Specification 50505S covering the associated electrical service assemblies.

2. TECHNICAL DATA

2.01 The 321991 clutch magnet driver (CMD) receives signals from a low level polar line keyer (low level +6 clutch coil energized, -6 clutch coil de-energized, nominal) and operates a 28 clutch.

2.02 The CMD is designed for use with 256M or 252M coils, depending on the type of transmitting equipment used. The output current during the energized state for the CMD is:

252M Coil	(Single coil for LK/LAKs)	- 107 to 132 ma
256M Coils	(Two coils in series for LXDs)	- 124 to 156 ma

(Use (2) 323354 cores for LXD coils)

2.03 Operation is considered satisfactory when the incoming synchronous pulse complies with the following requirements:

(a) Minimum synchronous pulse duration = 20 ms

(b) Maximum synchronous pulse duration = 40 ms or 2 bit lengths whichever is longer

(c) Minimum synchronous pulse period = 110 percent of transmitted character length

Note: When operating an LK or LAK at the maximum pulsing rate (minimum period), the machine may not respond to each synchronous pulse when in the REPEAT mode.

2.04 Under the conditions of Paragraph 2.02(c), start pulse delay should be between 15 and 35 ms. (Delay is measured from zero volts of the positive going input synchronous pulse signal to the beginning of the start pulse at the signal generator contacts. If the 321268 filter card assembly and 303142 polar line keyer are used, a nominal 6 ms must be added to the delay to account for delay in the keyer.)

2.05 The 321991 clutch magnet driver assumes the energized state with positive input voltages not greater than +0.5 volts and the de-energized state with negative voltages not greater then -0.5 volts.

2.06 The energized and de-energized switching levels as defined in Paragraph 2.05 are adjustable to within 10% of each other.

2.07 The 321991 clutch magnet driver should have a minimum input resistance of 50,000 ohms.

2.08 The maximum input capacitance should be 2500 picofarads.

2.09 The CMD provides a spacing (de-energized) output when the input line is open.

2.10 The CMD operates in a free air ambient temperature range of 0°C - 65°C (150°F). Storage temperature shall not exceed 85°C (185°F).

2.11 The 321991 clutch magnet driver operates from a power supply delivering +47 to +53 v dc and -6 v dc.

2.12 Power consumption under any combination of power source, environmental, and components conditions shall not be over 13 watts maximum.

2.13 The 321991 CMD is intended for use on clock lines less than 1000 feet in length. However, operation is possible with line lengths up to 5000 feet.

2.14 The 321991 CMD when used with associated power supplies is intended for use with interfaces conforming to the following requirements:

(a) Fed. Std. 222 Section 3102 b
(b) NSA 65-1 Section 3.4.3 b

3. PRINCIPLES OF OPERATION

3.01 All circuit references in the following paragraphs are made with respect to the 320045 circuit board assembly drawing and schematic wiring diagram of the 321991 clutch magnet driver (CMD). Refer to Figures 2, 3 and 4.

3.02 The driver is basically a direct coupled amplifier providing a current gain of approximately 80 db. The first two stages (Q1 and Q2) provide the necessary gain to drive a Schmitt Trigger (Q3 and Q4). Q5 and CR2 comprise a power regulator stage which provides the power supply with a constant load.

3.03 In the marking state, with a positive voltage with respect to common applied to the input side of the Q1 base resistor R5, Q1 conducts, which in turn saturates Q2. In this condition the sum of the voltage drops around the loop R14, Q2 collector-emitter and Q3 base-emitter is such as to reverse bias the base-emitter junction of Q3 and thus cut off Q3 collector current. The Q4 base current increases the voltage drop across R15 in order to satisfy loop conditions established by the power regulator voltage, R14, CR8 and Q4 base-emitter voltage. The Q4 base current is sufficient to saturate the collector. In this condition, load current is determined primarily by the load resistance, R17, and the power regulator output voltage.

3.04 In the spacing state, with a negative input voltage, Q1 is cut off with reverse base-emitter bias established by the reverse transient protection diode CR3. With Q1 off, Q2 does not conduct. Consequently, to satisfy loop conditions established by R13, Q3 base-emitter, R14, and the regulator voltage, Q3 conducts to raise the voltage across R13. Base current is sufficient to saturate the Q3 collector. The Q3 collector-emitter voltage is less than CR8 voltage, which in turn reverse biases the base-emitter junction of Q4. With the latter junction reverse biased, the Q4 collector is cut off.

3.05 The collector circuit at Q2 has been interrupted and brought out to the connector contacts at the bottom of the card. This circuit must be completed externally or Q3 cannot be turned off and the magnet coils are held de-energized. The circuit thus affords a degree of local magnet control.

3.06 Because of the difference in magnitude of Q3 and Q4 load currents, the drop across R14 will be greater in the marking state than in spacing state. This means that input voltage to the third state (Q2 VCE) necessary to change the state of Q3 will be different depending on the previous state. Specifically, a larger Q2 collector-emitter voltage is required to turn on Q3 than to turn off Q3. This hysteresis, peculiar to Schmitt Triggers, enables positive driver input signals to energize the load coil and negative going input signals to de-energize the load coil.

3.07 Resistor R6 and potentiometer R7 serve to bias Q1 and set the center of the switching interval. Emitter resistor R8 assists in gain stabilization. R11 and R9 form a voltage divider to bias CR4, CR5, and CR6. These diodes exhibit temperature characteristics such that together with R8, effective temperature compensation is obtained to stabilize the switching level of the driver. CR7 establishes a voltage reference for the first stage to insure switching level stability.

3.08 When a low resistance transmitter (about 100 ohms) is used to key the driver, R4 has little significance on the operation of the circuit.

However, when the input resistance is extremely high, R4 applies sufficient bias to Q1 to cut off. This operation will maintain the terminal equipment in the idle state when the input line is open circuited.

3.09 In the power regulator, CR1 and the base-emitter junction of Q5 establish a voltage reference for R1 and R2 which determine the current drain of the unit. As the driver demands less power from the regulator, as in the de-energized state, the excess current (excess over energized current) is shunted through zener diode CR2. This operation maintains a relatively constant load for the external power supply. R2 is adjusted to set minimum CR2 current for voltage regulation.

3.10 Coil L1 and capacitor C1 serve to reduce noise generated by zener diode CR2.

3.11 Capacitors C3 and C6 provide negative feedback to reduce transient generation in the driver. C5 and C7 are radio frequency by-pass capacitors to eliminate any parasitic oscillations that may occur during high speed switching.

3.12 Diode CR9, C4 and R16 form a transient limiting network to protect Q4 from excessive reverse transient present when switching inductive loads.

4. SERVICING

Note: Installation instructions are included in the specifications for the modification kit and electrical service assembly to be used. The 321991 clutch magnet driver (CMD) is a circuit card assembly that needs only to be plugged into a properly keyed (polarizing key between pins F and H) 15-pin receptacle which is wired into an appropriate electrical service assembly (ESA).

4.01 It is recommended that any damaged 321991 clutch magnet driver (CMD) unit be replaced in the field and maintained in a repair center. The repair center should have equipment capable of simulating normal operating conditions.

4.02 It is also recommended that the CMD be radio frequency interference (rfi) suppression tested after servicing and prior to final installation. Failures from this standpoint are not necessarily recognized by monitoring a typical communications operation.

4.03 If disassembly is necessary the heat sink may be separated from the circuit card by removing the four mounting screws, three insulated spacers, and one aluminum spacer.

(a) To remove the circuit card from the heat sink, unsolder the base and emitter leads from the transistor and the cathode lead from the zener diode. To remove the Q5 collector lead, remove the nut, screw, and washers.

(b) Transistor Q5 and diode CR2 can be removed from the heat sink by removing their respective mounting screws.

4.04 To reassemble, reverse the disassembly procedure, being careful to replace washers and spacers in their proper positions. The case of transistor Q5 is electrically insulated from the heat sink. The metal spacer must be placed between the circuit card and the heat sink in the area adjacent to the .1 mfd ceramic disc capacitor to assure electrical connection between the card and heat sink.

4.05 The following information may be used as a guide for troubleshooting:

	Symptom	Probable Cause
(a)	Switching levels out of tolerance	(1) Improper adjustment of R7 (2) Q1 low gain (3) CR7 defective or out of tolerance
(b)	Circuit always marking	(1) Q3 open (2) Q1, Q2, or Q4 collector-emitter shorted
(c)	Circuit always spacing	(1) Q1, Q2, or Q4 open (2) Q3 collector-emitter shorted (3) CR8 open
(d)	Output current too high	(1) CR2 open (2) R17 out of tolerance
(e)	Output current too low	(1) R2 improperly adjusted or defective (2) R17 out of tolerance
(f)	Transient suppressor network ineffective	(1) CR9 open (2) R16 open (3) C4 open

5. ADJUSTMENTS

Note: No mechanical adjustments are required on the 321991 clutch magnet driver.

5.01 The following instruments are required for making 321991 clutch magnet driver (CMD) electrical adjustments (refer to schematic wiring diagram of Figure 4 and to Figures 1, 2, and 3 for location of circuit elements):

(a) Milliameter (to measure 15 ma) with accuracy of ±10 percent

(b) +6 volt ±20 percent dc source (required power less than 6 milliwatts)

(c) LXD with series connected 256M clutch coils

5.02 Terminate the output of the driver with an LXD clutch assembly utilizing two 256M coils in series (pins A or B and K, L, or M).

5.03 Place a milliameter in series (connect positive terminal of meter to test point T4) with the zener regulator diode CR2 (mounted on the heat sink).

5.04 With normal power applied to the circuit (+47 to +53 v dc and -6 v dc), and a +6 volt input to pin N or P, adjust R2 for 15 ma of zener current. Secure the wiper of R2, by applying an appropriate cement, to prevent accidental rotation. Remove the +6 volt input.

5.05 Short the input to common (pins N or P to K, L, or M) and adjust R7 until the clutch magnet changes state. Note the position of the potentiometer.

5.06 Rotate R7 back until the clutch magnet returns to its initial state.

5.07 Set the potentiometer midway between the two positions obtained in Paragraphs 5.05 and 5.06.

5.08 Secure the adjustment by applying an appropriate cement to the potentiometer adjustment screw.

5.09 Remove power and solder the zener diode lead to the cathode pin nearest the component side of the card.

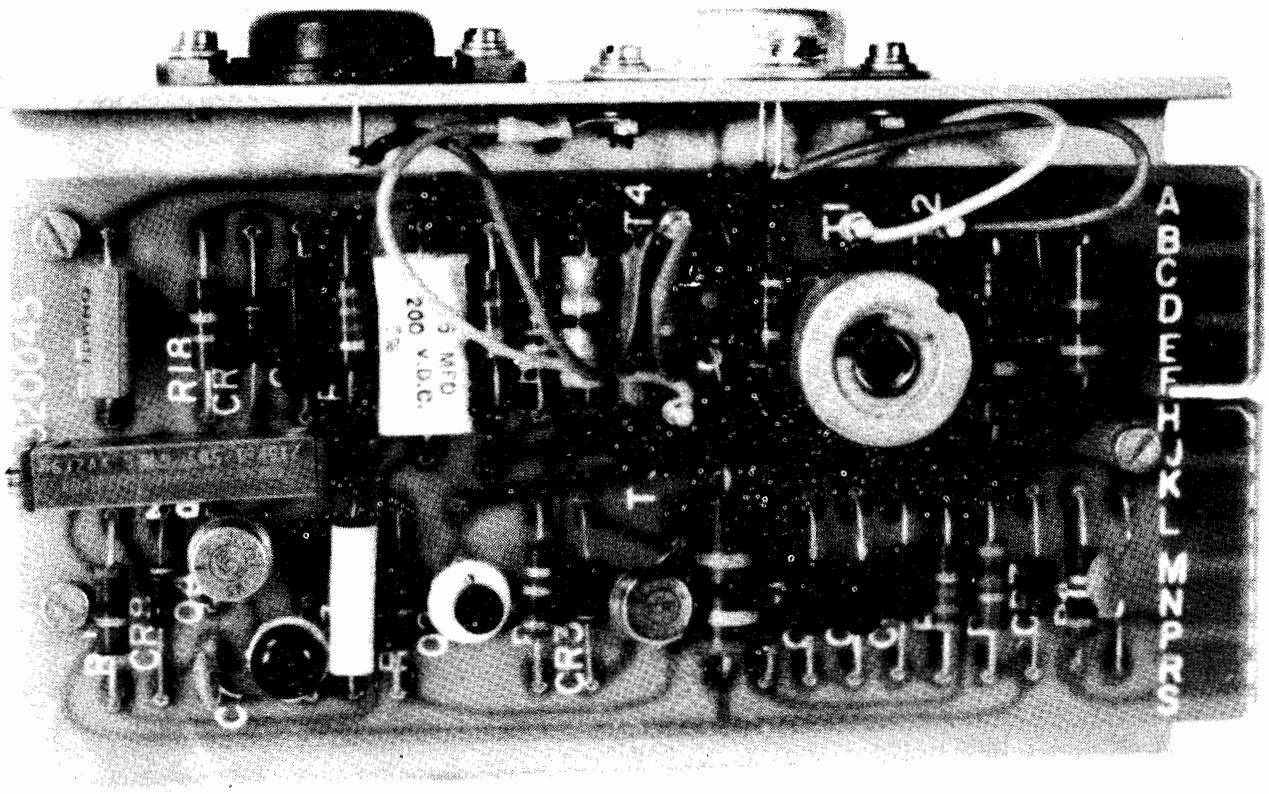


Figure 1 - Clutch Magnet Driver (CMD) 321991
for Low Level Operation

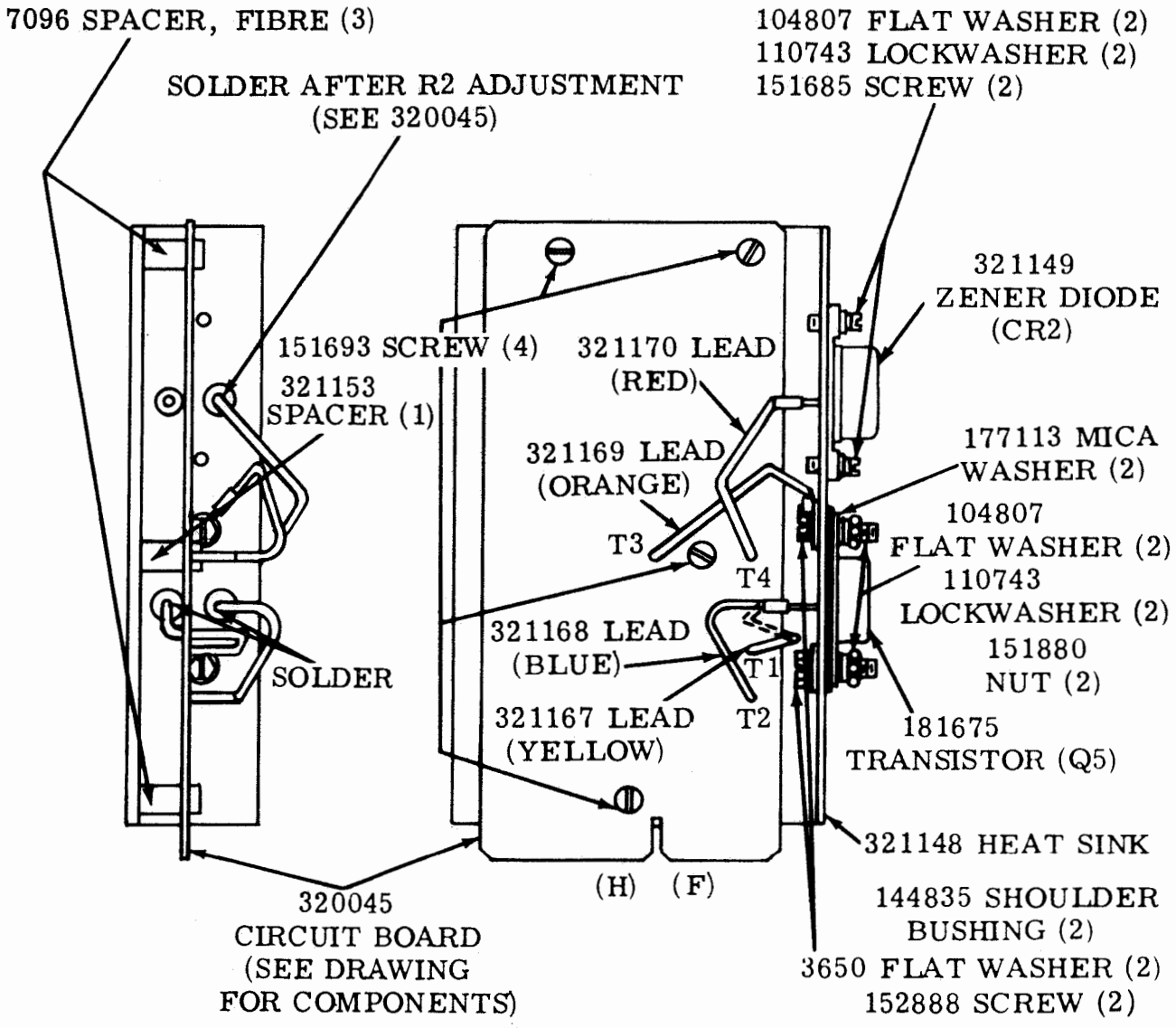
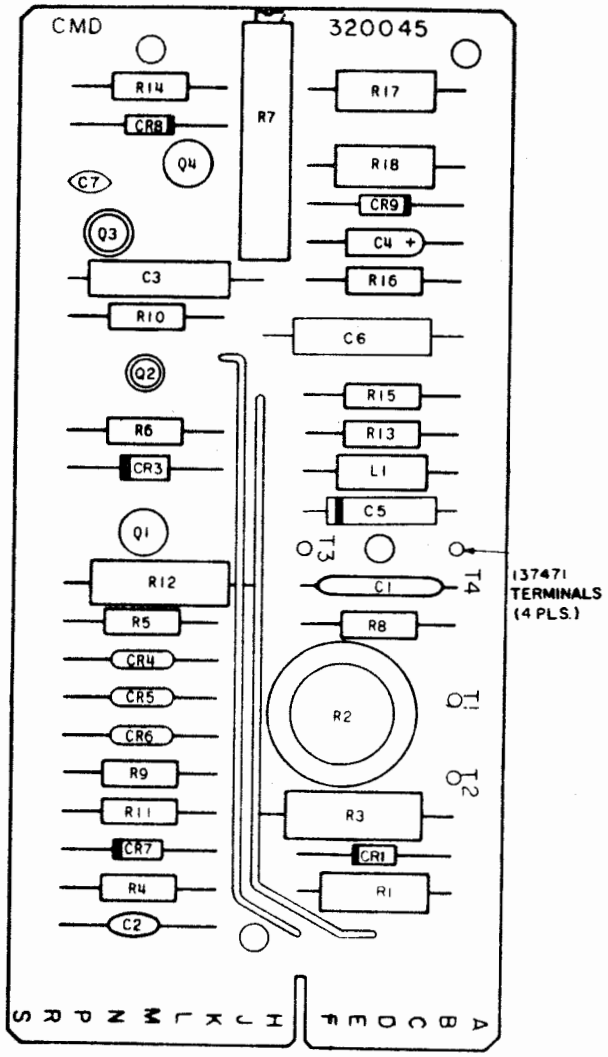


Figure 2 - 321991 Clutch Magnet Driver (CMD) Components and Hardware



ASSEMBLY, CIRUIT CARD (CMD)

REF. DESIG.	TELETYPE PART NO.	TOTAL QTY.	NAME AND DESCRIPTION	LOCATING FUNCTION
R1	321263	1	RESISTOR, 13 OHM, 1W, 5%	REG. CURRENT LIMITER
R2	321164	1	POTENTIOMETER, 50 OHM, 2.5W	REG. CURRENT ADJ.
R3	321155	1	RESISTOR, 2K, 2W, 5%	CR1 CURRENT LIMITER
R4	118720	1	RESISTOR, 100K, 1/2 W, 5%	Q1 OPEN LINE BIAS
R5	118720	1	RESISTOR, 100K, 1/2W, 5%	INPUT RESISTOR
R6	129854	1	RESISTOR, 10K, 1/2W	Q1 BIAS
R7	321160	1	POTENTIOMETER, 5M	Q1 BIAS
R8	118146	1	RESISTOR, 4.7K, 1/2W, 5%	Q1 EMITTER RES.
R9	129850	1	RESISTOR, 680 OHM, 1/2W, 5%	VOLTAGE DIVIDER
R10	321258	1	RESISTOR, 20K, 1/2W, 5%	Q1 LOAD RES.
R11	137604	1	RESISTOR, 620 OHM, 1/2W, 5%	VOLTAGE DIVIDER
R12	321292	1	RESISTOR, 1.3K, 2W, 5%	CR7 CURRENT LIMITER
R13	139143	1	RESISTOR, 43K, 1/2W, 5%	Q2 LOAD RES.
R14	321259	1	RESISTOR, 15 OHM, 1/2W, 5%	Q3 EMITTER RES.
R15	165178	1	RESISTOR, 3.6K, 1 W, 5%	Q3 LOAD RES.
R16	137442	1	RESISTOR, 1.5K, 1/2W, 5%	C4 BLEEDER RES.
R17	321151	1	RESISTOR, 110 OHM, 3W, 1%	COIL CURRENT LIMITER
R18	321258	1	RESISTOR, 20K, 1/2W, 5%	CR8 BIAS RES.
C1	321158	1	CAPACITOR, .1 MFD.	R.F. BY-PASS CAP.
C2	321157	1	CAPACITOR, 500 PFD.	R.F. BY-PASS CAP.
C3	171829	1	CAPACITOR, .15 MFD.	Q3 FEEDBACK CAP.
C4	321264	1	CAPACITOR, 50V, 2.7 MFD.	TRANSIENT SUPP.
C5	178860	1	CAPACITOR, 100V, .022 MFD.	R.F. BY-PASS
C6	171587	1	CAPACITOR, 200V, .25 MFD.	Q4 FEEDBACK CAP.
C7	321157	1	CAPACITOR, 500 PFD.	R.F. BY-PASS CAP.
L1	321159	1	CHOKE, 390μH	R.F. CHOKE
CR1	321161	1	DIODE, 1N748A, 3.9V ± 5%	REG. VOLT. REF.
CR3	321154	1	DIODE, 1N457A	Q1 BASE PROT.
CR4	178844	1	VARISTOR, 100-A	TEMP. COMP.
CR5	178844	1	VARISTOR, 100-A	TEMP. COMP.
CR6	178844	1	VARISTOR, 100-A	TEMP. COMP.
CR7	181667	1	DIODE, 1N750A, 4.7V ± 5%	TEMP. COMP. REF.
CR8	177611	1	DIODE, 1N682	Q4 EMITTER DIODE
CR9	321154	1	DIODE, 1N457A	TRANSIENT SUPP.
Q1	321166	1	TRANSISTOR, 2N1893	D.C. AMP.
Q2	324144	1	TRANSISTOR, 2N4121	D.C. AMP.
Q3	321165	1	TRANSISTOR, 2N3638A	D.C. AMP.
Q4	321261	1	TRANSISTOR, 2N4036	D.C. AMP.
	324147	1	PAD, TRANSISTOR	
	144495	3	PAD, TRANSISTOR	
	321299	1	CIRCUIT BOARD, ETCHED	
	321171	2	LEAD (BK)	
T1-T4	137471	4	LUG, TERMINAL	

Figure 3 - 320045 Circuit Card Assembly for
321991 Clutch Magnet Driver (CMD)

NO.	NOTES
1.	ALL RESISTORS 1/2 WATT, ALL RESISTANCE VALUES IN OHMS AND ALL CAPACITANCE VALUES IN MFD. UNLESS OTHERWISE SPECIFIED.
2.	Q5 (181675) AND CR2 (321149) ARE MOUNTED TO 321148 HEAT SINK. SEE CMD ASSEMBLY 321991.
3.	R2 IS ADJUSTED FOR 15 MA IN CR2 WITH INPUT MARKING (*6) AND OUTPUT CONNECTED TO A 150 OHM RESISTOR (5W)
4.	R7 IS ADJUSTED FOR SYMMETRICAL SWITCHING ABOUT ZERO.
5.	PINS A,B — 140 MA TO COILS PINS R,S — -6V DC PINS C,D — +47 TO 53V DC POWER PINS E,F,H,J — CONTROL CONTACT PROVISION PINS N,P — MS 1888 SIGNAL INPUT PINS K,L,M — COMMON (ALL INPUTS AND OUTPUTS REFERRED TO COMMON)

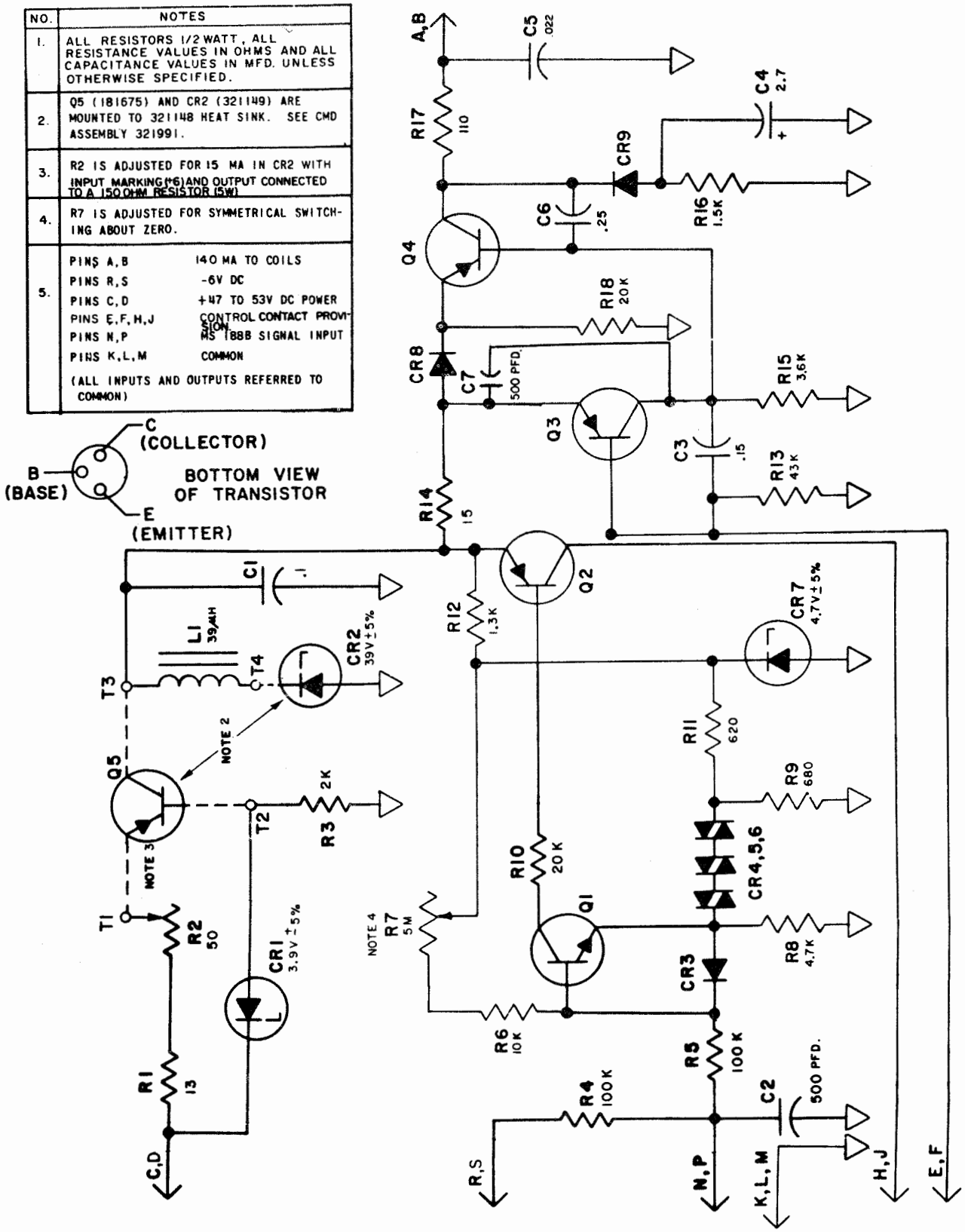


Figure 4 - Schematic Wiring Diagram for 321991 Clutch Magnet Driver