ELECTRICAL SERVICE ASSEMBLIES FOR LOW-LEVEL RADIO FREQUENCY INTERFERENCE (RFI) SUPPRESSION

DESCRIPTION AND PRINCIPLES OF OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section presents a general description of the various electrical service assemblies (ESA) housing low-level radio frequency components in 28 teletypewriter sets. It is to be used with other related sections to form a complete shielded electrical system for rfi suppression in the set.

1.02 Since the physical structure of the ESA differs for many installations, no attempt is made to give detailed description of each. The general characteristics and component elements are described with reference to schematic wiring diagrams in the associated wiring diagram package (refer to charts in Section 573-600-100TC).

1.03 The chart, Figure 1, indicates the quantity of major components required in each ESA, and the type of mounting employed. The abbreviations used in the chart are defined as follows:

CMD - Clutch Magnet Driver
IR - Isolation Relay
LLK - Low-Level Keyer
SMD - Selector Magnet Driver

1.04 The text is supported by photographs of typical ESA, Figures 2 through 10, and circuit cards, Figures 11 through 14. For

Electrical Service Assembly	Circuit Card Connectors						Type of Mounting	
	Power Supply							
	0.5A	1.0A	LLK	SMD	CMD	IR	Table	Rack
TP321225	1				1			X
TP321226	1			1				X
TP321228		1		4				X
TP321230	1				1		X	
TP321231	1			1			X	
TP323120	1				1		X	
TP323121	1		1	1			X	
TP323811	1		2	2		2		X
TP323812	1				2	3		X
TP323813	1		1	1			X	
TP323815	1		2	3		3		X
TP323820	1		1	1				X
TP324060	1			1				X
TP324061	2		1	1	1			X
TP325918	1		1	1	1			X
TP326471	1			1				X
TP326792	1		1		1		X	
TP332726	2		1	3	1			X
TP332727	1			4				X

Note: For appropriate wiring diagram package, refer to charts in Section 573-600-100TC

Figure 1 - Electrical Service Assembly Component Chart

detailed wiring refer to the wiring diagram package (WDP) listed in the charts of Section 573-600-100TC.

2. DESCRIPTION

2.01 The electrical service assemblies are metal shielded containers which vary in configuration for different applications. They are used as a housing for electronic components which serve to suppress radio frequency interference and provide low-level transmission of telegraph signals.

2.02 Electrical service assemblies differ from one another primarily because of the number of isolation relays and circuit board connectors which are provided for the associated keyers and drivers (Figure 1). Another difference is the mounting design; some are designed for rack mounting and others are designed for cabinet mounting.

2.03 Electrical service assemblies which house LLK and/or SMD circuit cards require double-shielded box construction. An inner aluminum box functions as an electrostatic shield and is electrically isolated from an outer box which serves as a magnetic shield. CMD circuit cards do not require a double box construction. Single box construction is adequate for the CMD and serves as a combined electrostatic-magnetic shield.

2.04 The inner box contains a mounting plate with printed circuit board connectors to accommodate a power supply printed circuit board assembly and the required number of CMD, SMD, and LLK circuit cards. A screw terminal strip is provided for connecting the signal line. The power supply rectifier filter capacitor is also located in the inner box.

2.05 The outer box contains the inner box, a power supply transformer, power line filter, and a screw terminal block for ac power connections. A power switch and fuse are located on one side of the outer box.

2.06 The power supply transformer and rectifier filter capacitor form an assembly capable of meeting the power supply requirements specified in 2.07 when used in conjunction with a power supply card.

2.07 Power Supply Technical Data

POWER SUPPLY	0.5 AMP	1.0 AMP
Input	100 to 130 volts ac, 45 to 66 hertz. Nominal Power: 55 watts at 115 volts ac for 25 watts output.	100 to 130 volts ac, 45 to 66 hertz. Nominal Power: 100 watts at 115 volts ac for 50 watts output.
Output	(a) +47 to +53 volts dc at 0.5 amp max (b) +6.6 to +7.8 volts dc at 0.018 amp max (c) -6.6 to -7.8 volts dc at 0.018 amp max	+47 to +53 volts dc at 1.0 amp max
Operating Temperature	$+40^{\circ}$ to $+110^{\circ}$ F with cooling fan in cabinet	$+40^{\circ}$ to $+110^{\circ}$ F with cooling fan in cabinet
Fusing	(a) ac — 0.8 amp slow-blowing (TP162360) (b) dc — 0.5 amp fast-blowing (TP131807)	ac — 2.0 amp slow-blowing (TP120166) dc — 1.0 amp fast-blowing (TP115358)

3. PRINCIPLES OF OPERATION

ESA USING 0.5 AMPERE POWER SUPPLY CARD (Figure 13)

3.01 Power supply transformer T1, diodes CR1, CR3, and power supply rectifier filter capacitor C8 form a full-wave rectifier to obtain a minimum of 58 volts unregulated dc.

3.02 Transistors Q1 and Q2 form a two-stage series voltage regulating element. Both transistors are always conducting, and the base-emitter drop of each transistor is approximately 0.7 volt. The voltage drop across R2 is negligible. (Resistor R2 is used in conjunction with capacitor C5 for rfi noise suppression.) In effect, then, the emitter of Q1 is clamped to the same potential as the reference diode combination CR7 and CR12, ie, the dc output of Q1 is nominally 47 volts. The difference between the Q1 dc output and the unregulated dc appears across the collector-emitter junction of Q1.

3.03 Transistor Q2 is a gain stage for Q1. Resistor R1 limits the current that divides between the CR7-CR12 reference diodes and the base of Q2. The base current of Q1 or the collector current of Q2 is equal to the base current of Q2 multiplied by the dc current gain (H_{FE}) of Q2.

3.04 Resistor R7 acts as a bleeder and assures that Q1 and Q2 will conduct even when no load is connected across the output terminals. Without R7 and no load connected, the output would rise to the same value as the unregulated dc. However, a minimum load of 0.150 ampere must also be applied to maintain the +53 volt regulation limit.

3.05 The +7 volt output is obtained by dropping the unregulated dc voltage through resistor R4 to supply the zener reference diode CR6 which is connected across the output.

3.06 Resistor R5 and zener diode CR5 provide a -7 volt output in a manner similar to that described in 3.05. However, a full-wave rectifier consisting of rectifier diodes CR2 and CR4 and capacitor C4 is required to obtain the negative unregulated potential with respect to the circuit common.

3.07 Capacitors C1, C2, and C3 suppress rfi noise transients which occur due to rectifier switching. Capacitors C6 and C7 and inductors L3 and L4 suppress zener diode noise.

3.08 The transformer shields and a low-pass filter consisting of L1, L2, C9, C10, C11, and C12 provide noise isolation between power line and power supply.

3.09 The electrical service assemblies are normally wired so that one 250 ohm (25 watt) resistor is connected across the collector-emitter of Q1 when each associated SMD or CMD is inserted in its connector to reduce power dissipation in Q1. (This is equivalent to paralleling Q1 with 250 ohms for each 0.150 ampere, approximately, of load current.)

3.10 Fuse F102 limits the output current to a total of 0.5 ampere.

ESA USING 1.0 AMPERE POWER SUPPLY CARD

3.11 Power supply transformer T1, diodes CR1, CR2, and power supply rectifier filter capacitor C5 form a full-wave rectifier to obtain a minimum of 58 volts unregulated dc.

3.12 Transistors Q1 and Q2 form a two-stage series voltage regulating element. Both transistors are always conducting, and the base-emitter drop of each transistor is approximately 0.7 volt. The voltage drop across R2 is negligible. (Resistor R2 is used in conjunction with capacitor C4 for rfi noise suppression.) In effect, then, the emitter of Q2 is clamped to the same potential as the reference diode combination CR3 and CR8, ie, the dc output of Q2 is nominally 47 volts. The difference between the Q2 dc output and the unregulated dc appears across the collector-emitter junction of Q2.

3.13 Transistor Q1 is a gain stage for Q2. Resistor R1 limits the current that divides between CR3-CR8 reference diodes and the base of Q1. The base current of Q2 or the collector current of Q1 is equal to the base current of Q1 multiplied by the dc current gain (H_{FE}) of Q1.

3.14 Resistor R4 acts as a bleeder and assures that Q1 and Q2 will conduct even when no load is connected across the output terminals. Without R4 and no load connected, the output would rise to the same value as the unregulated dc.

3.15 Capacitors C1, C2, and C3 suppress rfi noise transients which occur due to rectifier switching.

3.16 The transformer shields and a low-pass filter consisting of L1, L2, C6, C7, C8, and C9 provide noise isolation between power line and power supply.

3.17 Fuse F102 limits the output current to a total of 1.0 amperes.

4. SELECTOR MAGNET DRIVER (SMD) (Figure 11)

4.01 The TP323810 selector magnet driver is a 15-pin circuit card assembly designed to plug into an associated electrical service assembly as an integral part of its components. When used in conjunction with proper power supply and filter assemblies, it is intended for radio frequency interference suppression of receiving selector noise in systems requiring this suppression.

4.02 This selector magnet driver provides two inputs and makes possible reception from either one of two separate transmitters (single input operation) while the input line from the other transmitter is open. A spacing signal at either input will provide a spacing output.

4.03 In order to function properly, this selector magnet driver should be installed in a double-shielded enclosure and used in conjunction with the appropriate electrical service assemblies where extreme rfi suppression is required. It is not intended for general use.

TECHNICAL DATA

4.04 The input current to the TP323810 selector magnet driver (SMD) is a low-level +6 volt for a marking state, and a -6 volt for a spacing state.

4.05 The output current of the SMD is 60 milliamperes ±10% during the marking state. The output is zero during the spacing state.

4.06 The SMD assumes the marking state with positive input voltages not greater than 0.5 volt and the spacing state with negative voltages not greater than 0.5 volt. The marking and spacing switching levels are adjustable within 10% of each other. This requirement applies to either input.

4.07 Each input of the SMD has a minimum input resistance of 50,000 ohms.

4.08 The maximum input capacitance of either input is 2500 picofarads.

4.09 Overall receiving margins of properly adjusted 28 type selectors driven by this SMD (polar rectangular wave input) should exceed 70 points at either input.

4.10 The SMD provides a marking output when both inputs are open.

4.11 Both inputs cannot be in the marking condition simultaneously without producing a garbled output.

4.12 The SMD operates at bit rates up to 75 baud.

4.13 It operates in a free-air ambient temperature of 70°c (158°F). Storage temperature should not exceed 85°c (185°F).

4.14 The SMD operates from a power supply delivering 47 to 53 v dc.

4.15 The power consumption under any combination of power source, environmental, and component conditions is 8.5 watts maximum.

4.16 The TP323810 selector magnet driver, together with associated electrical service assembly and power supply, is intended for use with equipment requiring low-level rfi (polar — EMC) operation.

PRINCIPLES OF OPERATION

4.17 The following electrical theory requires reference to Figure 1, and the appropriate wiring diagram package.

4.18 The TP323810 selector magnet driver (SMD) is basically a direct coupled amplifier providing a current gain of approximately 80 db. The first two stages (Q1, Q6, or Q5, Q7) provide the necessary gain to drive a Schmitt trigger (Q8 and Q9). Q2, Q3, and Q4 comprise a power regulator stage which provides the power supply with a constant load.

4.19 In the marking state with a positive voltage with respect to common applied to each input (or a positive voltage on one input, the other open), Q1 and Q5 conduct, which in turn saturate Q6 and Q7. In this marking state the voltage drop from the emitter of Q6 to the collector of Q7 is less than the voltage drop from the CR15 anode to the Q8 emitter. Under this condition, the base-emitter junction of Q8 is reverse biased, thus turning Q8 off. With Q8 off, the Q9 base will conduct through R26 and thus energize the external selector magnet in the collector circuit. Transistor Q9 base current is sufficient to saturate the collector. In this condition, selector magnet current is determined primarily by the value of the limiting resistor R23 and the power regulator output voltage.

4.20 In the spacing state, with a negative voltage on input 1, input 2, or both inputs, the respective input transistor or transistors (Q1, Q5) are off. In this condition Q6-Q7 collector current is cut off and the base of Q8 conducts. Transistor Q8 base current is sufficient to saturate the collector. The Q8 emitter-collector saturation voltage is less than the forward drop across CR13 thus reverse biasing the base emitter junction of Q9. With this junction reverse biased, Q9 collector current is cut off and the selector magnet is de-energized.

4.21 Because of the difference in magnitude of Q8 and Q9 load currents, the drop across R21 will be greater in the marking state than in spacing. This means that the input voltage to the third stage (Q6 VCE + Q7 VCE) necessary to change the state of Q8 will be different depending on the previous state. Specifically, a larger combined Q6 and Q7 collector-emitter voltage is required to turn on Q8 than to turn off Q8. This hysteresis, peculiar to Schmitt triggers, enables positive driver input signals to energize the selector coil and negative going input signals to de-energize the coil.

4.22 Resistors R4, R16, and potentiometers R3 and R15 serve to bias Q1 and Q5 and set the center of the switching interval. Emitter resistors R7 and R18 assist in gain stabilization. Resistors R6, R8 and R19, R20 form voltage dividers to bias CR2, 3, 4 and CR10, 11, 12. These diodes exhibit temperature characteristics such that together with R7 and R18, effective temperature compensation is obtained to stabilize the switching level of the SMD. Diode CR5 establishes a voltage reference for the first stages to insure switching level stability.

4.23 When low resistance transmitters (about 100 ohms) are used to key the driver, R1 and R13 have no significant effect on the operation of the circuit. However, when the line resistance is high (open line), R1 and R13 apply sufficient bias to drive Q1 and Q5 into conduction. This operation will maintain the terminal equipment in the idle state when input lines are open, or allow single line operation by simulating a marking signal on the other input.

4.24 In the power regulator, CR8 and the base-emitter junction of Q4 establish a voltage reference for R11 which determines the current drain of the unit. Diode CR6, CR7 and the base-emitter junction of Q3 serve to clamp the Q4 collector at a low voltage so as to minimize power dissipation in Q4. As the power requirement of the circuitry following the regulator decreases, the output voltage of the regulator will begin to rise. This rise corresponds to a decrease in Q4 collector-base voltage. The effect is to increase the forward bias on the base-emitter junction of Q3 and cause increased collector conduction. This collector current increases the conduction of Q2 whereby Q2 and R10 absorb the excess power. Q2 functions as a variable resistance so as to maintain a constant resistance across the output of the regulator regardless of the state of the driver circuitry. As a consequence of this, the power supply sees a constant load, regardless of driver state.

4.25 Capacitors C4 and C5 provide negative feedback to reduce transient generation in the driver. Capacitors C3 and C7 and C8 are radio frequency bypass capacitors to eliminate any parasitic oscillations that may occur as a result of switching.

5. LOW-LEVEL KEYER (LLK) (TP303142 Figure 12, and TP323130)

5.01 The low-level keyers (LLK) are circuit card assemblies approximately 2-1/4 by 4-1/2 inches. They are designed to plug into a 15-pin connector that is wired into the electrical service assembly where it becomes an integral component for the suppression of radio frequency interference (rfi).

5.02 The TP303142 LLK, when used in conjunction with the TP321268 filter card assembly, is intended for use with the TP323644 and TP323645 signal generator (one contact) assemblies. This LLK is adaptable to various types of 28 type equipment when used with the applicable ESA and is designed to operate from one set of contacts. Two signal generator outputs (filter card outputs), however, may be paralleled to drive one signal line from either of two signal generators.

5.03 The TP323130 LLK is for use in photoelectric systems (such as 28/32 keyboard) requiring a low-level interface and extreme rfi suppression. It is used in conjunction with a TP333069 CMD.

5.04 Each keyer is designed to operate into a high resistance load such as the TP323810 SMD.

5.05 An external power source, mounted in the associated electrical service assembly, is required to operate the keyers.

TECHNICAL DATA

5.06 All low-level keyer features for the TP303142 and TP323130 given in the following paragraphs assume the use of the TP321268 filter card assembly.

5.07 Maximum unloaded power consumption of each keyer is less than 50 milliwatts.

5.08 The output of the TP303142 keyer is +6.0 volts ±1.0 corresponding to the marking state and -6.0 volts ±1.0 corresponding to the spacing state. The output of the TP323130 keyer is also +6.0 volts ±1.0 for marking and -6.0 volts ±1.0 for spacing.

5.09 The marking and spacing output voltages should be balanced to within 10 percent of each other.

5.10 The TP303142 keyer operates from the spacing contacts (mark contact open, space contact closed) of the TP323645 or TP323644 signal generator assembly.

5.11 The outputs from two TP321268 filter card assemblies may be paralleled for parallel operation of either of two transmitters.

5.12 The nominal output impedance is 100 ohms.

5.13 The keyers operate at bit rates up to 75 baud.

5.14 Maximum short circuit output current is 60 milliamperes.

5.15 The TP303142 and TP323130 keyers operate into a load resistance of 5000 ohms minimum.

5.16 The keyers and TP321268 filter card assembly operate in a maximum free-air ambient temperature of 70°C (158°F). Storage temperature should not exceed 85°C (185°F).

5.17 The TP303142 keyer operates from a power source delivering ±7.2 volts dc ±0.6 v. The TP323130 keyer also operates from a power source delivering ±7.2 volts dc ±0.6 v. Maximum unloaded power consumption is less than 50 milliwatts.

5.18 The mark and space symmetry at zero volt (output waveform) is adjustable by means of the signal generator position adjustment for the TP303142 keyer. It may be adjusted within 10 percent of each other by the 5 megohm potentiometer on the keyer card for the TP323130 keyer.

5.19 The keyer is intended for use on signal lines less than 1000 feet in length. However, operation is possible with line lengths up to 5000 feet.

PRINCIPLES OF OPERATION

A. TP303142 Keyer

5.20 All circuit references in the following paragraphs are made with respect to the schematic wiring diagrams in the wiring diagram package applicable to the set.

5.21 The TP303142 low-level keyer is a neutral to polar converter which, by means of passive and active filtering, shapes the output waveform.

5.22 In the marking state the signal generator contact is open and Q1 conducts to a level established by resistors R1, R2, and R11. Transistor Q1 conducts sufficient current to saturate the collector of Q2 which rises to slightly less than the positive supply voltage. With Q2 conducting, Q4 and Q6 also conduct. Transistor Q4 base current (equal to the total output load current divided by the product of Q4 and Q6 gains) is small and consequently the voltage drops across R6, R10, and R7 are insignificant. Transistor Q6 base current (equal to total output load current divided by the gain of Q6) is also small resulting in an insignificant voltage drop across R8. Thus, the output voltage is the power supply voltage minus the sum of Q2 voltage with collector-emitter saturated, Q4 base-emitter voltage and Q6 base-emitter voltage. The drop across R9 for normal output loads is insignificant.

5.23 In the spacing state the signal generator contact is closed. In this state R1 is shunted by the series combination of R13, R14, and R15 thus reducing Q1 base voltage below the emitter voltage established by the voltage divider R3, R11. With the emitter being at a higher potential than the base, Q1 is turned off. With Q1 off, Q2 is off and its collector voltage approaches the negative supply voltage. In this state Q3 and Q5 conduct. For the same reasons as in the marking state, the output voltage is primarily a function Q3 base-emitter voltage and Q5 base-emitter voltage. Diode CR1 is added to compensate the unsymmetrical properties associated with the second stage.

5.24 During transitions, the nonsymmetric low-pass contact filter prefilters the input to the keyer. In addition, common mode effects due to the unbalanced strap capacitance of the contact assembly, are reduced. Capacitors C1 and C6 limit the high frequency response of stages 1 and 2 thus providing additional shaping.

5.25 Stage 3 (Q4 and Q3) is a low-pass active filter. By means of C2 charging and discharging through the feedback network, consisting of R6, R10, R7, and C2, the rise and fall times are lengthened to produce an acceptable spectrum (from rfi standpoint). Capacitors

C3, C4, and C5 provide additional shaping by bypassing undesirable frequency components generated in Q3, Q4, Q5, and Q6. C7 is a radio frequency bypass capacitor to decouple the power supply.

B. TP323130 Keyer

5.26 All references in the following paragraphs are made with respect to the schematic wiring diagrams in the wiring diagram section or the wiring diagram package applicable to the set.

5.27 The TP323130 keyer takes a 250 ua (min) photocell signal from the distributor and by means of passive and active filtering, shapes the output.

5.28 In the marking state (photocell illuminated), Q5 is turned off causing the bases of Q1 and Q2 to go positive through the passive shaping network made up of R2, C1 and R4. With the bases of Q1 and Q2 positive, Q1 will turn on turning Q4 off and Q2 will turn off turning Q3 on. Capacitor C2, resistor R6, R9, and capacitor C3 further shape the wave by providing feedback and phase shift thereby controlling the rate at which the active filter Q1, Q2, Q3, Q4 will switch.

5.29 In the spacing state (photocell dark), Q5 is turned on providing a negative signal to the bases of Q1 and Q2. The switching occurs as in 5.28 except, transistors that are off turn on and those that are on turn off.

5.30 During the transition from on to off and off to on, one of the output transistors of the active filter is always conducting. This will provide a smooth transition from plus volts through 0 volts to minus volts and back again. The rate of switching being controlled by the feedback and phase shift of C2, R6, R9 and C3.

5.31 Diode CR1 compensates for the nonsymmetry of the first stage. Resistors R10 and R5 and capacitors C6 and C7 provide for the proper output impedance and some additional shaping.

6. POWER SUPPLY CARD (Figure 13)

6.01 Two power supply circuit cards are employed in the ESA used with 28 type equipment; one a 0.5 ampere, and the other a 1.0 ampere. The 0.5 ampere and 1.0 ampere circuit cards, when installed in a shielded electrical service assembly (ESA) containing the proper transformer and filter assembly, are intended as radio frequency interference suppression power sources in systems requiring low-level rfi.

6.02 The required power supply should be plugged into the 15-pin TP148458 connector in the ESA that has a TP198650 polarizing key between pins M and N for the 0.5 ampere power supply and between pins K and L for the 1.0 ampere power supply. Refer to the chart, Figure 1, for information regarding the applicable power supply card to be used with the particular set and to the wiring diagram package for the applicable wiring diagrams. See Figure 13 for a typical card.

6.03 The transformer and filter circuits for both power supplies are located in part of their associated electrical service assemblies. The power transistor and heat sink for the 1.0 ampere power supply is also part of the electrical service assembly. The power transistor and heat sink for the 0.5 ampere power supply are included as part of the TP321290 circuit card assembly.

6.04 The amperage rating and quantity of power supply circuit cards to be used (one per electrical service assembly) will depend upon the equipment used. Each power supply circuit card assembly is a part of some ESA. Each ESA is part of equipment used in low-level operation.

TECHNICAL DATA

6.05 In the following paragraphs, the technical data refers to the complete power supply, including transformer and filter components in the associated electrical service assembly.

A. One-Half Ampere Power Supply

6.06 The following technical data applies to 0.5 ampere power supplies when installed in an electrical service assembly that accommodates from one to three selector magnet drivers (SMD) or clutch magnet drivers (CMD).

(a) Input: 100 v ac to 130 v ac, 45 to 66 hertz

(b) Output

(1) +47 v dc to +53 v dc at 0.5 ampere maximum

(2) +6.6 v dc to +7.8 v dc at 0.018 ampere maximum

(3) -6.6 v dc to -7.8 v dc at 0.018 ampere maximum

(c) Fusing

(1) ac: 0.8 ampere, slow-blowing (TP162360)

(2) dc: 0.5 ampere, fast-blowing (TP131807)

(d) Operating Ambient Temperature: +40°F to +120°F with cooling fan in Automatic Send-Receive Set (ASR)

B. One Ampere Power Supply

6.07 The following technical data applies to the 1.0 ampere power supply installed in an electrical service assembly that accommodates from one to six selector magnet drivers (SMD) or clutch magnet drivers (CMD).

(a) Input: 100 v ac to 130 v ac, 45 to 66 hertz (cps)

(b) Output: +47 v dc to +53 v dc at 1.0 amperes maximum

(c) Fusing

(1) ac: 2 ampere slow-blowing

(2) dc: 1.5 ampere fast-blowing

(d) Operating Ambient Temperature: +40°F to +120°F with cooling fan in a multiple page printer monitor cabinet (LBAC).

PRINCIPLES OF OPERATION

6.08 The following paragraphs explain the general operation of each power supply circuit card assembly when it is installed in an electrical service assembly (ESA). The transformer, filter, and the 1.0 ampere power transistor with heat sink are included as part of the ESA. For more detailed information, refer to the wiring diagram package of the specific set that is used.

A. One-Half Ampere Power Supply

6.09 Transformer T1, capacitor C8, filter components L1, L2, C9, C10, C11, and C12 are all located in the electrical service assembly, not on the circuit card assembly. (Refer to Figure 13 and wiring diagram package.)

6.10 Transformer T1, diodes CR1, CR3, and capacitor C8 form a full-wave rectifier to obtain a minimum 58 volts unregulated dc.

6.11 Transistors Q1 and Q2 form a two stage series voltage regulating element. Both transistors are always conducting with the base-emitter drop of each transistor at approximately 0.7 volt. The drop across R2 (used in conjunction with C5 for noise suppression) is negligible. In effect, the emitter of Q1 (dc output) is clamped to the same potential as the reference diode combination CR7-CR12 (nominally 47 v). The difference between the dc output and unregulated dc appears across the collector-emitter junction of Q1.

6.12 Resistor R1 limits the current that divides between the CR7-CR12 reference diodes and the base of Q2, which is a gain stage for Q1. The base current of Q1 (Q2 collector current) is the base current of Q2 multiplied by the dc current gain (H_{FE}) of Q2.

6.13 Resistor R7 across the output acts as a bleeder and also assures that Q1 and Q2 will conduct even when no load is connected across the output terminals. Without R6, the output would rise to the same value as the unregulated dc with no load connected.

6.14 The +7 volt output is obtained by dropping the unregulated dc voltage through resistor R4 to supply the zener reference diode CR6, which appears across the output.

6.15 R5 and CR5 provide -7 volts in a similar manner; however, a full-wave rectifier consisting of rectifier diodes CR2, CR4, and capacitor C4 is required to obtain the negative unregulated potential with respect to circuit common.

6.16 Capacitors C1, C2, and C3 are used to suppress noise transients which occur due to rectifier switching. Capacitors C6 and C7 and inductors L3, L4 suppress zener diode noise.

6.17 A low-pass filter consisting of L1, L2, C9, C10, C11, C12, and transformer shielding are used to obtain noise isolation between power line and power supply.

B. One Ampere Power Supply

6.18 Transformer T1, capacitor C101 and low-pass filter components L1, L2, C102, C103, C104, C105, transformer shielding, and power transistor with heat sink Q2 (Q1 of ESA) are located in and are parts of the associated electrical service assembly. (Refer to Figure 13 and wiring diagram package.)

6.19 Transformer T1, diodes CR1, CR2, and capacitor C101 form a full-wave rectifier to obtain a minimum 58 volts unregulated dc.

6.20 Transistors Q1 and Q2 form a two-stage series voltage regulating element. Both transistors are always conducting with the base-emitter drop of each transistor at approximately 0.7 volt. The drop across R2 (used in conjunction with C4 for noise suppression) is negligible. In effect, the emitter of Q2 (dc output) is clamped to the same potential as the reference diode combination CR3-CR8 (nominally 47 v). The difference between the dc output and unregulated dc appears across the collector emitter junction of Q2.

6.21 Resistor R1 limits the current that divides between the CR3-CR8 reference diodes and the base of Q1, which is a gain stage for Q2. The base current of Q2 (Q1 collector-emitter current) is the base current of Q1 multiplied by the dc current gain (H_{FE}) of Q1.

6.22 Resistor R4 across the output acts as a bleeder and also assures that Q1 and Q2 will conduct even when no load is connected across the output terminals. Without R4, the output would rise to the same value as the unregulated dc with no load connected.

6.23 Capacitors C1, C2, and C3 are used to supress noise transients which occur due to rectifier switching.

6.24 A low-pass filter (in ESA), consisting of L1, L2, C102, C103, C104, C105, and transformer shielding, is used to obtain noise isolation between power line and power supply.

6.25 Fuse F102 limits current output to a total of 1.0 amperes.

7. CLUTCH MAGNET DRIVER (CMD)

7.01 The following paragraphs describe the TP321991 and the TP333069 clutch magnet driver circuit cards and outline the electrical theory when installed (plugged) into a shielded electrical service assembly containing the proper power supply and filter assemblies.

7.02 The clutch magnet driver (CMD) is a solid state, direct coupled amplifier built as a plug-in circuit card assembly approximately 2-1/2 by 4-1/4 inches (Figure 14). It requires an external power source. All connections are made through a 15-pin circuit card connector.

7.03 The CMD output drive a 28 type transmitting clutch upon receipt of a low-level input pulse. It is to be used with the proper associated equipment and is not for general use.

7.04 These clutch magnet drivers (CMD) are adaptable to various 28 type equipment sets through the use of associated modification kits. Each CMD (one or more) is part of, or associated with, some electrical service assembly (ESA). The number of CMDs used depends on the number of clutch magnets used in the set.

TECHNICAL DATA (TP321991 OR TP333069 CMD)

7.05 The clutch magnet drivers (CMD) receive low-level signals (+6 volt clutch coil energized, -6 volt coil de-energized, nominal) and operate a 28 type clutch.

7.06 The TP321991 CMD is designed for use with 256M or 252M coils, depending on the type of transmitting equipment used. The TP333069 CMD is for use with 278M magnet coils. 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

278M Coil (single coil for photoelectric distributor clutch) 36 to 56 ma

(Use two TP323354 cores for LXD coils)

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

(a) Minimum sync pulse duration = 20 ms.

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

(c) Minimum sync 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.

7.08 Under the conditions of 7.07 (c), start pulse delay should be between 15 and 35 ms. (Delay is measured from zero volt of the positive going input synchronous pulse signal to the beginning of the start pulse at the signal generator contacts. If the TP321268 filter card assembly and TP303142 keyer are used, a nominal 6 ms must be added to the delay to account for delay in the keyer.)

7.09 The TP321991 or TP333069 clutch magnet driver assumes the energized state with positive input voltages not greater than +0.5 volt and the de-energized state with negative voltages not greater than -0.5 volt.

7.10 The energized and de-energized switching levels as defined in 7.09 are adjustable to within 10 percent of each other.

7.11 The TP321991 or TP333069 clutch magnet driver should have a minimum input resistance of 50,000 ohms.

7.12 The maximum input capacitance is 2500 picofarads.

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

7.14 The clutch magnet driver operates in a free air ambient temperature range of 0^{o}c to 65^{o}c (150^{o}F). Storage temperature should not exceed 85^{o}c (185^{o}F).

7.15 The TP321991 or TP333069 clutch magnet driver operates from a power supply delivering +47 to +53 v dc.

7.16 Power consumption under any combination of power source, environmental, and component conditions is 13 watts maximum.

7.17 The TP321991 or TP333069 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.

7.18 The TP321991 or TP333069 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) MIL STD. 188B

ELECTRICAL THEORY (TP321991 AND TP333069 CMD)

7.19 All circuit references in the following paragraphs are made with respect to Figure 14, the circuit board assembly drawing, and schematic wiring diagram of the respective clutch magnet driver (CMD). Refer to wiring diagram package and/or Section 573-600-400TC.

7.20 The driver is basically a direct coupled amplifier providing a current gain of approximately 80 db (60 db on TP333069 CMD). 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.

7.21 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 in a condition 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.

7.22 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.

7.23 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.

7.24 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.

7.25 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.

7.26 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.

7.27 In the power regulator, CR1 and the base-emitter junction of Q5 establish a voltage reference for R1 and R2 which determines the current drain of the unit. As the driver demands less power from the regulator, such as being 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.

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

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

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

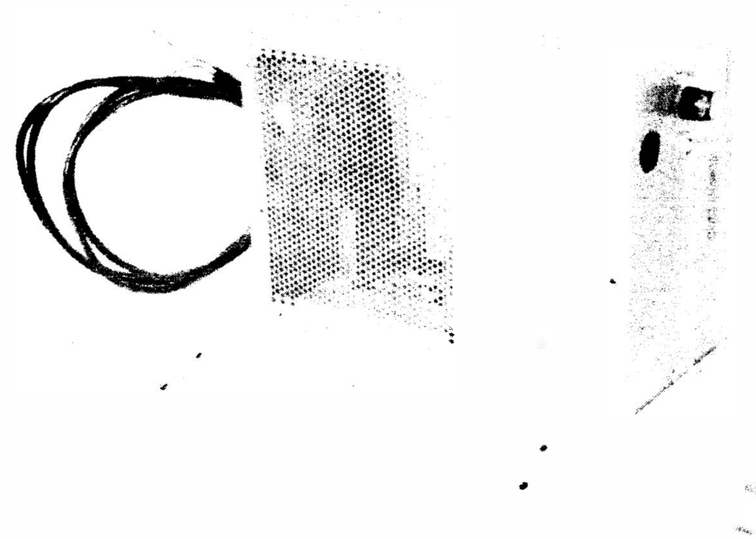


Figure 2 - ESA for Rack Mounting — Single Box Construction

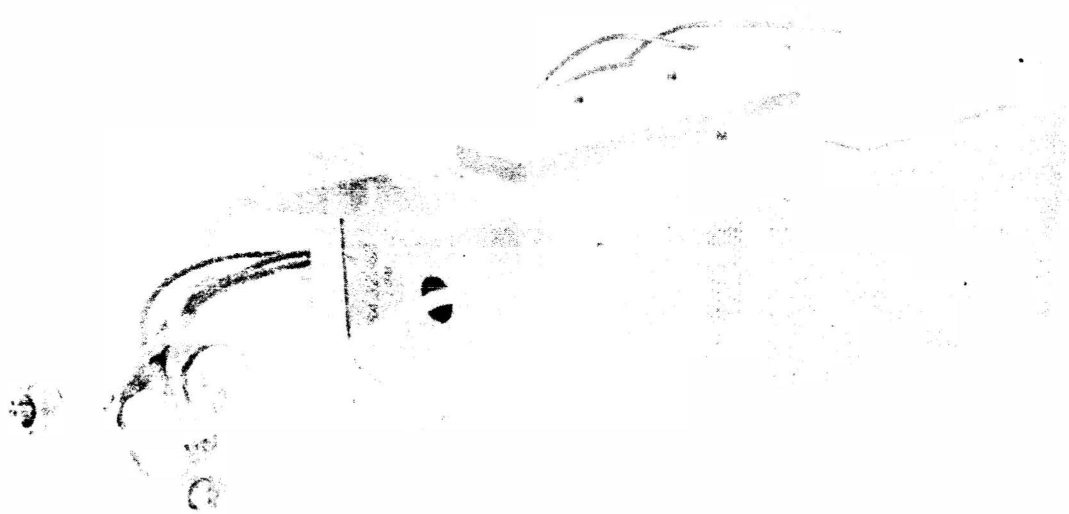


Figure 3 - ESA for Rack Mounting — Double Box Construction

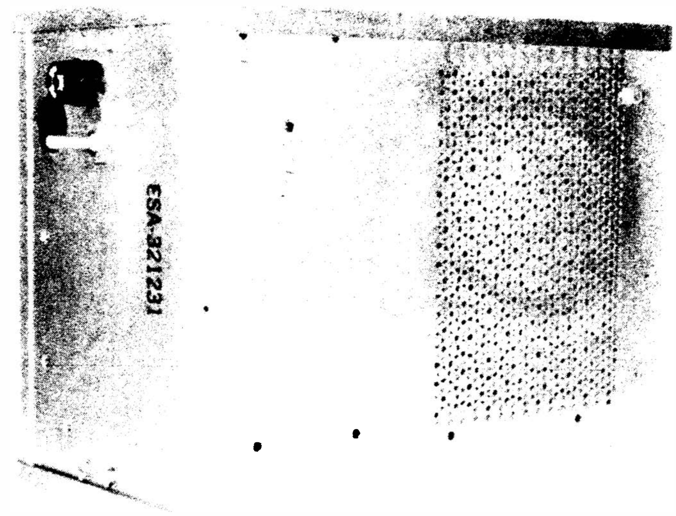


Figure 4 - ESA for Table Mounting — Double Box Construction

Figure 5 - ESA for Rack Mounting — Single Box Construction with Isolation Relays

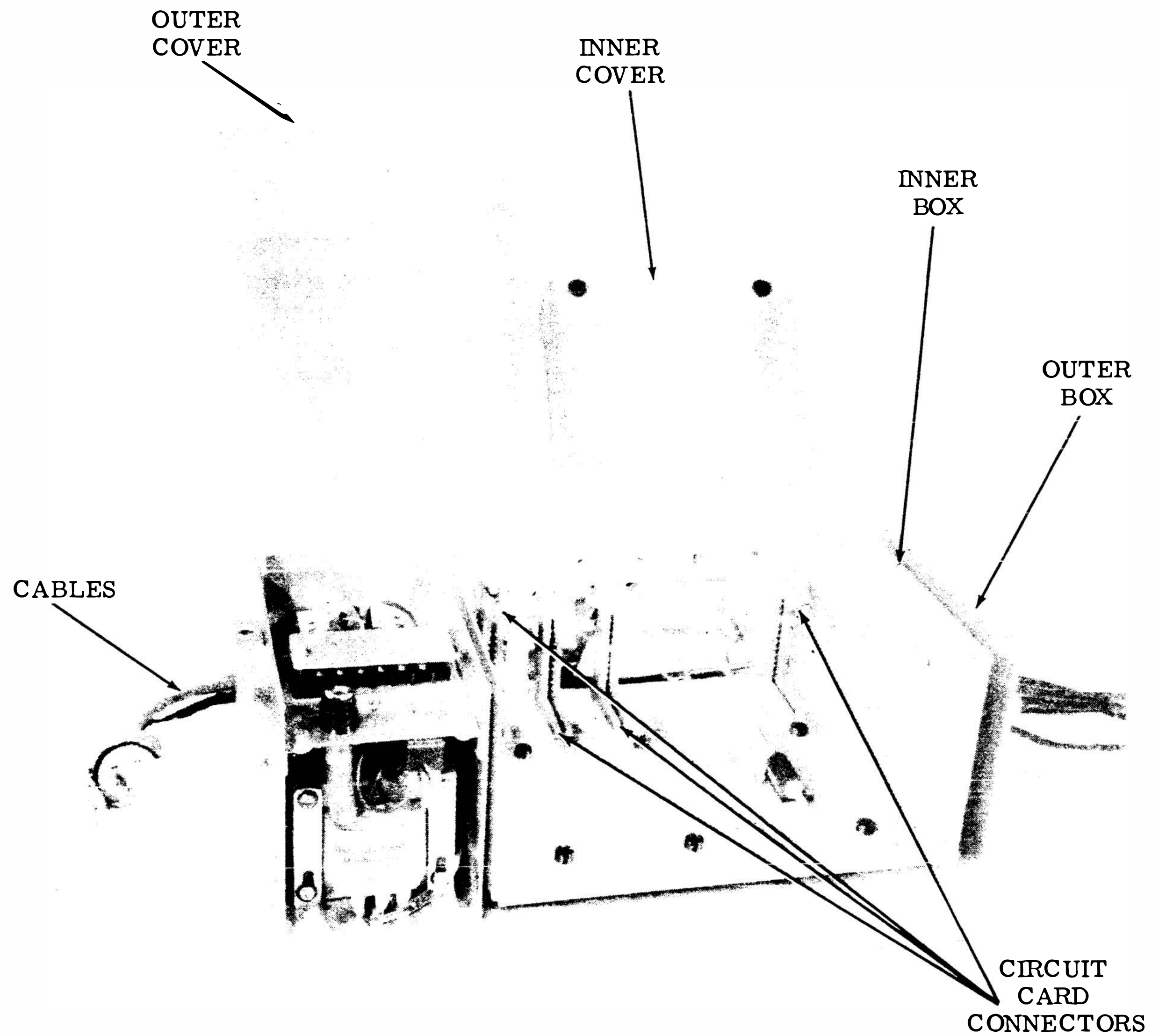


Figure 6 - ESA Showing Circuit Card Connectors

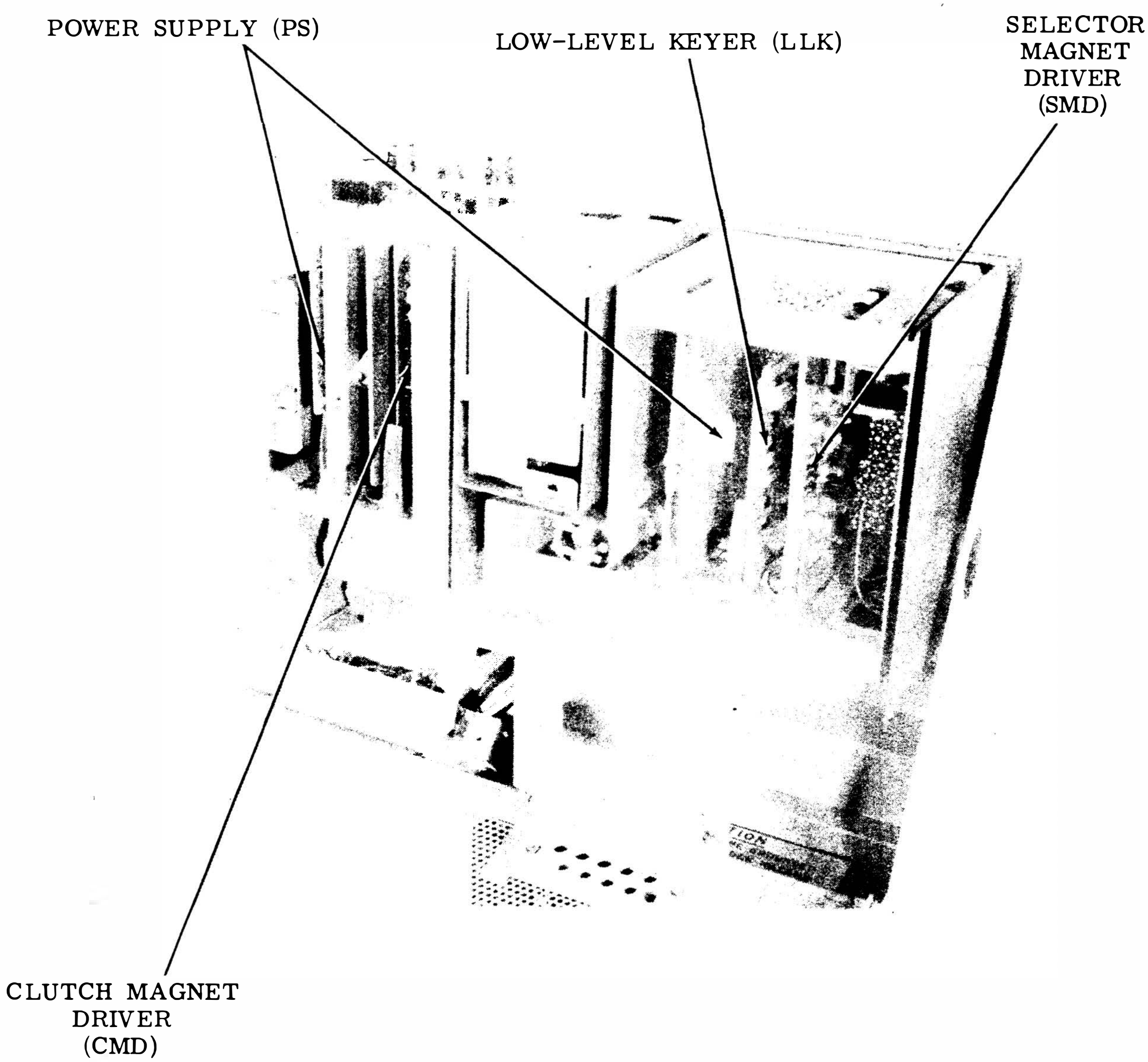
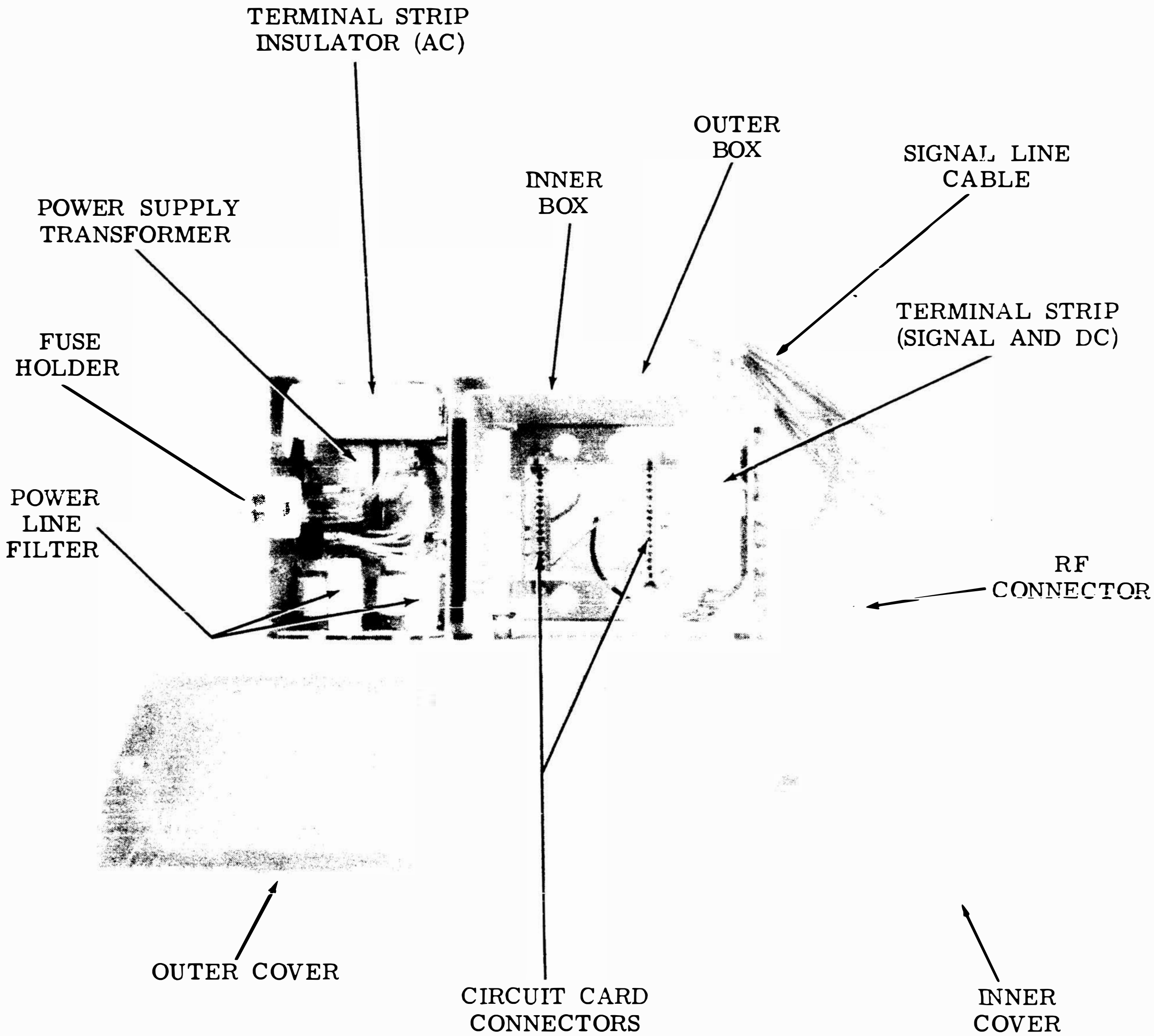


Figure 7 - ESA Showing Typical Circuit Cards



(Top View)

Figure 8 - Typical Parts of an ESA — Double Box Construction

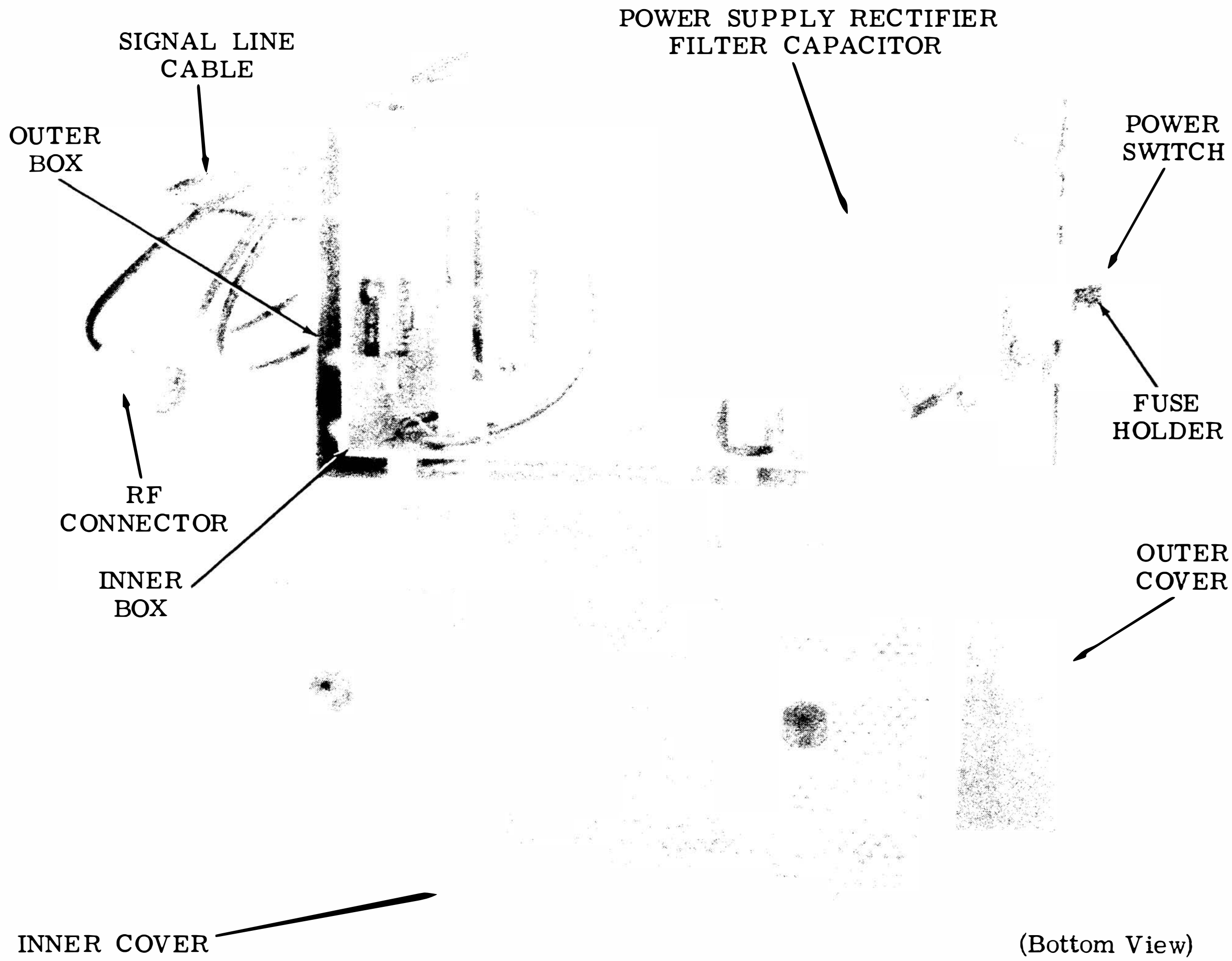


Figure 9 - Typical Parts of an ESA — Double Box Construction

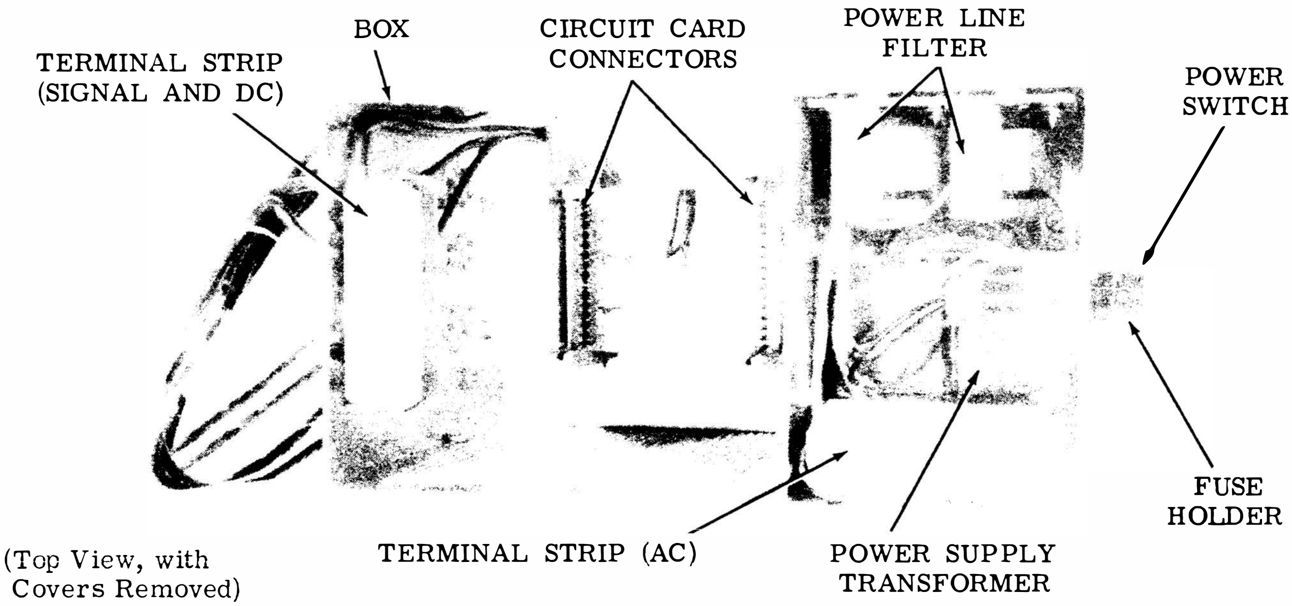


Figure 10 - Typical Parts of an ESA — Single Box Construction

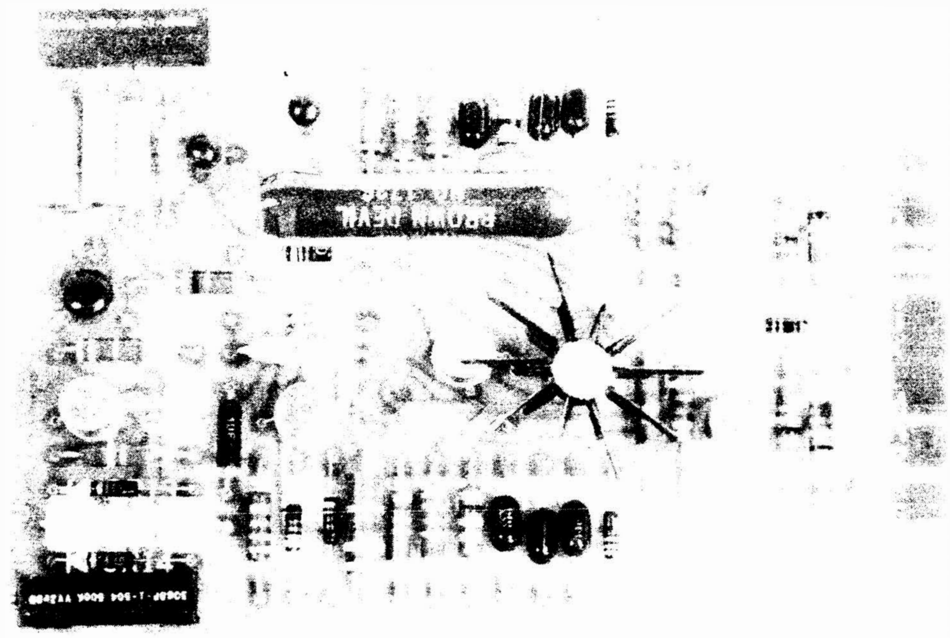


Figure 11 - Selector Magnet Driver (SMD) TP323810

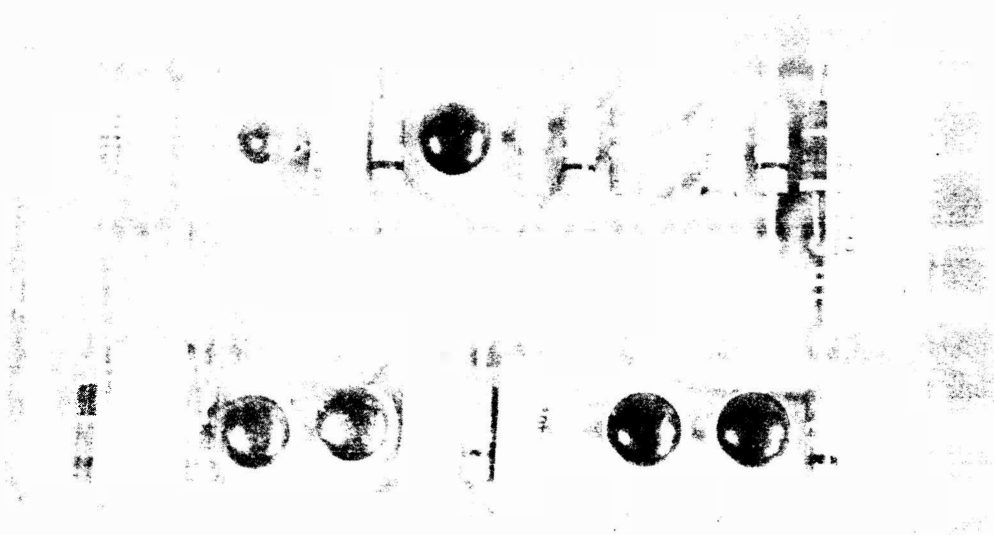


Figure 12 - Low-Level Keyer TP303142

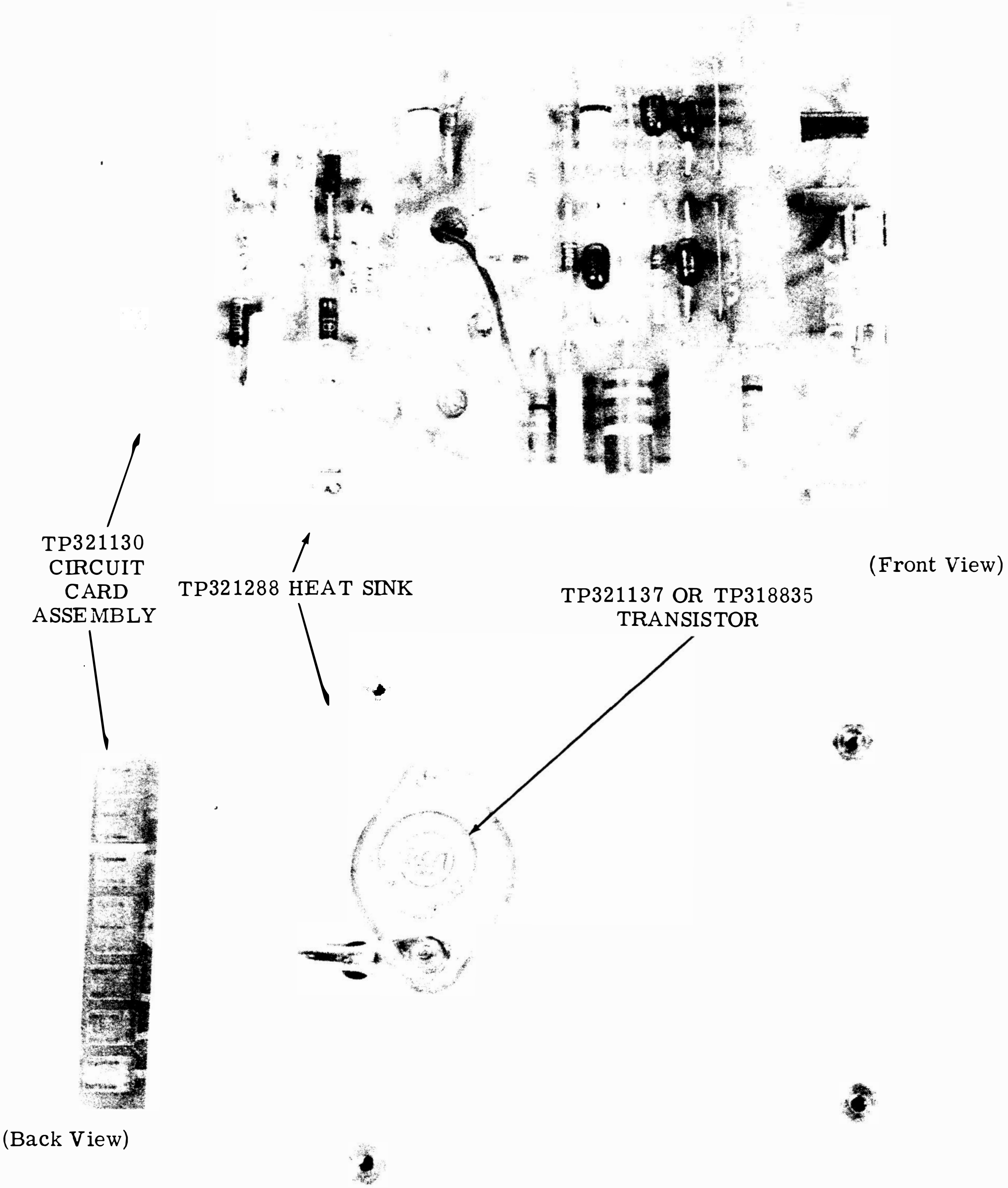


Figure 13 - One-Half Ampere Power Supply (TP321290)

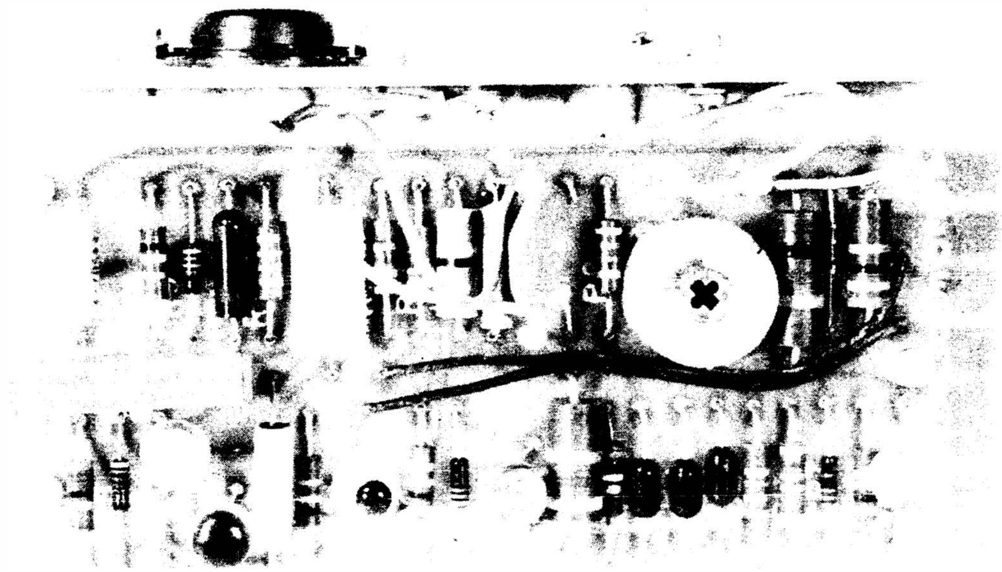


Figure 14 - Clutch Magnet Driver (CMD) TP321991 for Low-Level Operation