Feb '71 ID0100

INSTRUCTION MANUAL

Type 1435 Programmable Decade Resistor

A

GENERAL RADIO

Contents

WARRANTY

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

Type 1435 Programmable Decade Resistor

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Concord, Massachusetts, U.S.A. 01742
Form 1435-0100 A
February, 1971
ID-0100

Specifications

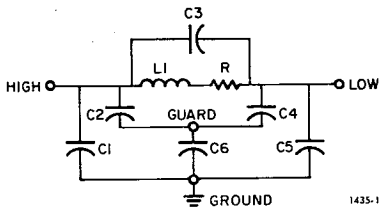
Range: 1,111,100 Ω total resistance; 10 Ω smallest step. Each decade can be individually controlled: manually by in-line-readout dials or remotely by external 1-2-4-8 BCD signals at standard DTL or TTL levels (logic 0 ≈ ground, logic 1 ≅ + 3.5 V) or closures to ground applied to rear-panel etched-board (36 pins.) *Switching speed,* <4 ms per change. *Switches* are mercury-wetted reed relays for low, stable, and repeatable zero resistance and are used for both manual and remote control.

Accuracy: The resistance difference between that at any setting and that at the zero setting is equal to the indicated value ±(0.02% + 0.9 mΩ) for all decades except 10Ω/step which is ±(0.05% + 0.9 mΩ); at low currents and at dc or low-frequency ac.

Zero Resistance: 700 mΩ total, typical.

Temperature Coefficient: +(10 ppm + 3 mΩ)/°C.

Frequency Characteristics: At high-resistance values, frequency characteristics depend mainly on capacitances and on the type of connections used (2- or 3-terminal, grounded or guarded). At low resistance values, they depend mainly on the inductance. Calculations based on values shown should give approximate series-resistance error.



Parameter	Decade Resistance R = 100 kΩ	R = 1 MΩ
C1	34 pF	40 pF
C2	193 pF	252 pF
C3	32 pF	24 pF
C4	101 pF	52 pF
C5	25 pF	18 pF
C6	1760 pF	1760 pF
L1	21 μH	21 μH

Maximum Power: 0.125 W per step (1.25 W max) without accuracy change; 0.25 W per step (2.5 W max) without damage.

Terminals: Five (HIGH, LOW, GROUND, 2 GUARDS) nickel-plated brass binding posts with standard ¾-in. spacing in parallel with 14-pin Amphenol Type 57 connector, all on rear panel.

Supplied: Power cord, Amphenol Type 225 connector to mate with programming input, Amphonel Type 57 connector to mate with resistance terminals.

Power: 100 to 125 or 200 to 250 V, 50 to 60 Hz, 7 W.

Mechanical: Bench or rack mount. *Dimensions* (w x h x d): Bench, 19.75 x 4.22 x 12.88 in. (500 x 107 x 327 mm); rack, 19 x 3.47 x 10.8 in. (485 x 88 x 274 mm). *Weight:* Bench, 18 lb (8.5 kg) net, 23 lb (10.5 kg) shipping; rack, 13 lb (6 kg) net, 18 lb (8.5 kg) shipping.

Catalog Number	Description
	1435 Programmable Decade Resistor
1435-9700	Bench Model
1435-9701	Rack Model

Introduction—Section 1

1.1 PURPOSE.

The Type 1435 Programmable Decade Resistor, with a range from 10 Ω to 1.11 MΩ, that consists of five precision resistance decades that can be controlled either manually or automatically, or in mixture of the two modes. Its principal use is in the automatic control of gain, load, time constant, and other parameters of dc and audio-frequency circuits.

1.2 DESCRIPTION.

Four wire-wound resistors are used in each of five decades that offer steps of 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, and 100 kΩ. The 10 Ω/step decade is Ayrton-Perry wound, to reduce inductance. Each decade is controlled by a front-panel knob and dial with 12 detented positions: 0 through X (or 10) and R (remote). Each decade is mounted on a plug-in board. Any or all of the decades can be remotely controlled, with the others set manually. An additional front-panel control serves as on-off switch, with a third (REMOTE) position to transfer total control of all decades to external control signals. This transfer itself is also externally programmable.

Two logic lines are provided, one to short-circuit and one to open the output terminals, during the interval when the decade settings are being changed..

1.3 CONTROLS, CONNECTOR, INDICATORS.

The controls, connectors, and indicators located on the front and rear panels of the 1435 are described in Tables 1-1 and 1-2.

1.4 ACCESSORIES SUPPLIED.

The accessories supplied with the Decade Resistor are listed in Table 1-3.

1.5 PATCH CORDS AND ADAPTORS.

Methods of connection of the many available patch cords and adaptors to GR938 jacks are shown in Figure 1-3.

Table 1-2 (Cont)

REAR-PANEL CONTROLS, CONNECTORS AND INDICATORS

Fig. 1-2 Ref.	Name	Description	Function
5	100 V-125 V 200 V-250 V 50-60 Hz	Two-position, screw-driver-operated line switch	Selects line-voltage range: 100-125 V or 200-250 V, 50-60 Hz
6	————	Three-pin male power connector	For connection to power line. Accepts 4200-9622, 3-wire power cord (supplied).
7	1/8 A	Extraction-post fuseholder	Holds 1/8-A Slo-Blo line fuse.
8	EXTERNALLY PROGRAMMABLE INPUT	36-pin board-edge connector: mates with connector Set 1435-1100	Provides connections for programming input signals.

Table 1-3

ACCESSORIES SUPPLIED

Quantity	Item	GR Part Number
1	Power cord, 3-wire, 7-foot	4200-9622
1	Connector Set (36-terminal)	1435-1100 (refer to paragraph 2.3).

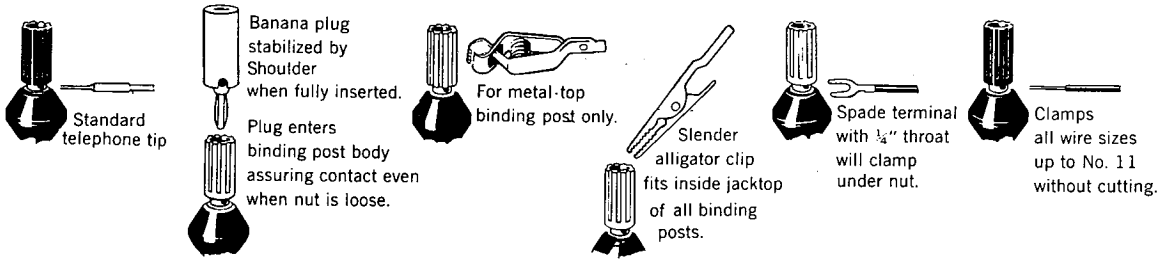


Figure 1-3. Methods of connection to the measurement terminals.

Installation—Section 2

2.1 POWER.

Power requirements for the 1435 are 100 to 125 V or 200 to 250 V, 50 to 60 Hz, 7 W. A slide switch, S2, on the rear panel, selects the proper line-voltage range. Use a screwdriver or similar tool to set the slot to the desired range. A 1/8-A, Slo-Blo line fuse protects the instrument for either voltage.

Connection to the power line is made by means of a 3-wire, 7-foot power cord (supplied) that attaches to the rear-panel power connector, J1. The long pin connects directly to the frame of the 1435. The Type SVT cord is made of plastic-covered #18 conductor and is rated at 7A, 230 V. Plug and connector bodies are molded integrally with the cord, and the hammerhead design permits stacking. The connectors, designed for 125-V operation, conform to the Standard for Grounding Type Attachment Plug Caps and Receptacles, ANS1 C73.11-1963.

2.2 DIMENSIONS.

The dimensions of both the bench and the relay-rack models of the 1435 are given in Figure 2-1.

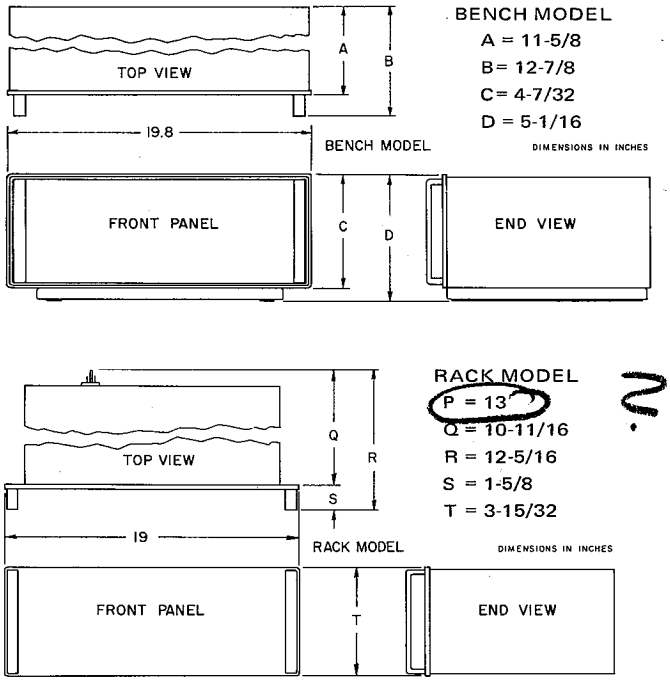


Figure 2-1. Dimensions of bench and relay-rack models.

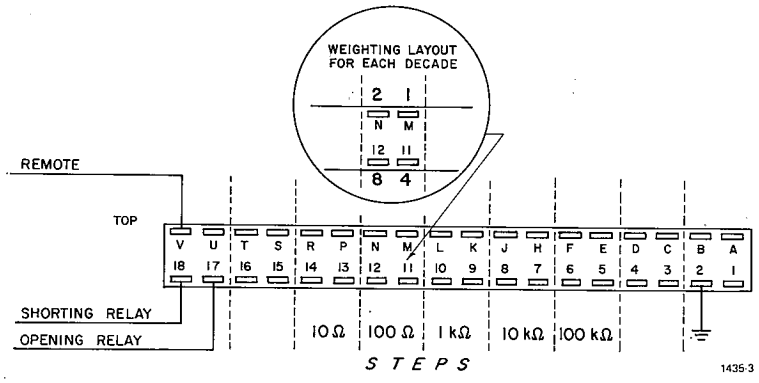


Figure 2-2. Pin connection on J8 to program operation.

2.3 REMOTE PROGRAMMING CONNECTIONS. (Figures 2-2/2-3.)

Input signals for remote programming are applied at the EXTERNALLY PROGRAMMABLE INPUT plug (J8) on the rear panel. The connections are shown in Figure 2-2. The positions of the 1-2-4-8 weightings for all decades are identical and are shown in the diagram.

A 36-contact, multiple-socket Connector Set, P/N 4230-1018, (Figure 2-3) is supplied for making connections to J8. The assembly procedure for the socket is as follows:

a. Feed the cable carrying the remote-control signals through the small elongated hole in the connector case.

b. Orient the contacts on the connector so that contact 1 engages pin 1 on plug J8 (see Figure 2-2). The etched-board is recessed at that end to accommodate the spacer and ensure correct polarization.

c. Connect the cable leads to the proper contacts on the connector.

d. When all connections have been made, place the cable on the open strain-relief clamping link, as shown in Figure 2-3. Allow approximately 1.5 in. between the front edge of the contacts and the link, as shown.

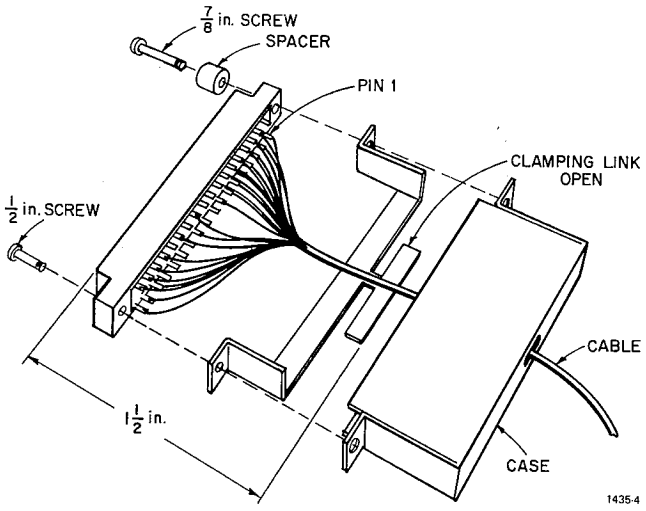


Figure 2-3. Remote programming connector plug assembly.

e. Squeeze the ends of the clamping link around the cable and flatten the link so that it will slide into the connector case.

f. Note the location of pin 1 and slide the strain-relief link and the connector (with leads attached) into the connector case.

g. Slip the spacer (supplied) over the longer of the two screws. Pass the screw through the clearance hole in the flange nearest pin 1, through the hole in the clamp, and thread it into the tapped hole in the flange of the case (see Figure 2-3). The spacer prevents incorrect polarization of the socket. Tighten the screw.

h. Use the shorter screw to lock together the opposite ends of the connector, clamp and case.

The connector will now slide readily onto the board-edge connector, J8.

The control circuits are fully buffered and ready to use; refer to para. 3.2.

2.4 MOUNTING.

The 1435 can be ordered enclosed in a cabinet for bench use (P/N 1435-9700). If ordered for relay-rack mounting (P/N 1435-9701), it is shipped with Rackable Cabinet Assembly P/N 4174-3240 and Hardware Set P/N 4174-2007.

2.5 BENCH MODELS.

2.5.1 Removing the Cabinet.

To remove a bench-model instrument from its cabinet: Remove the four panel screws (A, Figure 2-4), two on each side of the front panel. These are No. 10-32, 9/16-in. screws, with Nylon washers. To loosen them, insert a Phillips-head screwdriver through the holes in the handles, as shown in the figure. Then pull the instrument forward, out of the cabinet, lifting it slightly at the end of the track to clear the stops.

2.5.2 Conversion for Rack Use.

To convert a bench model for relay-rack use, order from GR one Rackable Cabinet Assembly, P/N 4174-3240 and

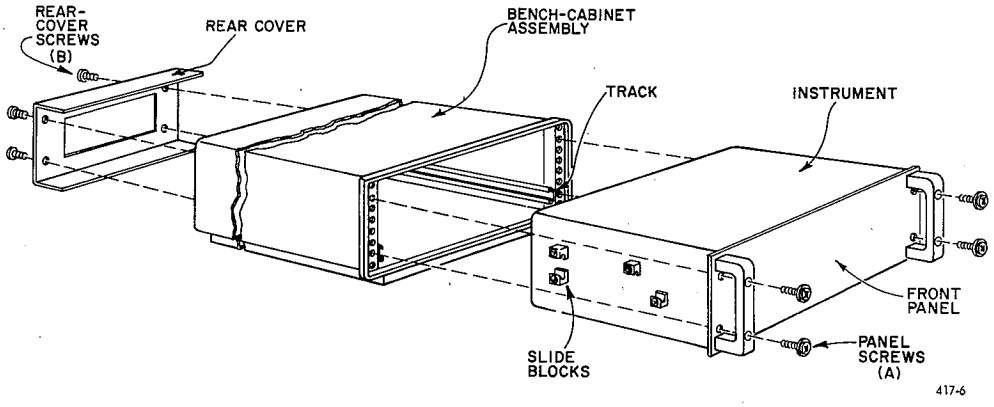


Figure 2-4. Bench-cabinet assembly.

one Hardware Set, P/N 4174-2007 (Table 2-1), then proceed as follows:

a. Disconnect all cables from the rear of the instrument, remove the four panel screws (A, Figure 2-4), and pull the instrument forward, out of the cabinet.

b. From the rear, remove the four screws (B) holding the rear cover to the bench cabinet and remove the cover.

c. Proceed with the relay-rack installation, as given in para. 2.6.

2.6 RELAY-RACK MODELS.

2.6.1 Installation.

Relay-rack models of the 1435 are supplied with Rackable Cabinet Assembly P/N 4174-3240 and Hardware Set P/N 4174-2007 (Table 2-1)..

To install a rack-model instrument in an EIA standard RS-310 19-in. relay rack with universal mounting hole spacing, proceed as follows:

a. From the rear, remove the rear-cover screws (B) holding the rear cover and remove the cover.

b. Release the four panel screws from the shipping nuts, (A, Figure 2-5) slide the instrument forward, out of the rack cabinet, until it stops. Raise the front edge slightly to release the stops. The instrument can then be completely removed from the rack cabinet.

c. If the rack contains a rear support rail, attach the brackets (D) to the rack cabinet, using the rear support screws (E). Insert the screws through the set of slots in the bracket, then drive them into the closest set of self-tap holes in the rear side wall of the cabinet that aligns slotted holes in the brackets with holes in the rear rail of the relay rack.

d. Insert the rack cabinet in the rack and secure it to the front rails of the rack with four front-support screws (C).

e. Secure the brackets to the rear rails, using rear-bracket screws (C).

f. Place the rear edge of the instrument in the rack cabinet, so that the rear slide blocks (F) engage the track. Slide the instrument into the cabinet, making sure that the front slide blocks (G) also engage the tracks. Lift the front slightly to clear the stops. Lock the instrument in the cabinet with the four panel screws (A) with nylon washers. (Tighten these screws by inserting a Phillips-head screwdriver through the holes in the handles).

g. Remount the rear cover and lock it in place using the rear-cover screws (B).

Table 2-1

HARDWARE SET SUPPLIED WITH RACK MODEL

(P/N 4174-2007)

Fig. 2-5 Ref.	Quantity	Description
D	2	Brackets, L-shaped
C	8	Screws, thread-forming, 10-32, 1/2 in.
E	4	Screws, thread-forming, 8-32, 3/16 in.

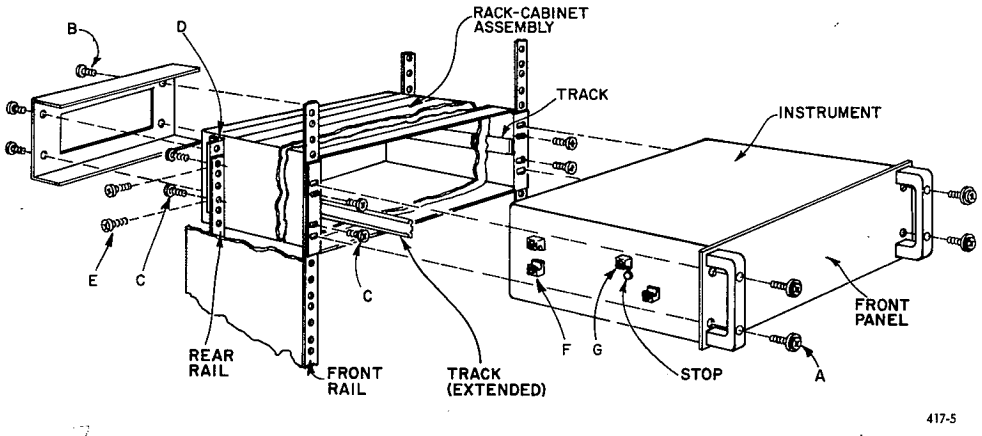


Figure 2-5. Method of mounting the relay-rack model.

h. Connect power, signal and control leads to the rear panel, leaving sufficient slack to permit the instrument to be operative when drawn out into the service position.

By removing the four panel screws (A), one can slide the instrument forward, out of the rack cabinet on the extendable tracks (see Figure 2-5). The tracks will support the instrument, fully extended for easy access to the interior.

2.6.2 Converting to Bench Mounting.

To convert a relay-rack model for bench use:

a. Order, from GR, a Bench-Cabinet Assembly (P/N 4172-4015).

b. Disconnect any cables from the instrument, remove the front-panel screws (A), and withdraw the instrument from the rack cabinet.

c. Remove the rear-cover screws and rear cover from the rack cabinet. Place the cover on the rear of the bench cabinet and secure it to the rear brackets with the cover screws (B).

d. Insert the instrument into the bench cabinet, straddling the tracks with the slide blocks. Secure the instrument with the four front-panel screws.

NOTE

The 1435 will not operate inverted, or standing on its side, because of the mercury wetted reed switches used.

Operation–Section 3

NOTE
The 1435 will not operate inverted or standing on edge, because of the mercury wetted-reed switches used.

3.1 MANUAL OPERATION.

For manual operation, set the front-panel ON/OFF switch to ON. Adjust the five dials to give the desired resistance between the H and L terminals on the rear panel. Use of the front-panel decimal-point marking gives the readout in kΩ.

3.2 REMOTE OPERATION.

3.2.1 Decades.

The 1435 uses negative true logic on all inputs; i.e., logic zeros or closures to ground are used to perform the desired function. The input levels are fully DTL and TTL compatible. Levels should be:

0 ———— 0.0 to +0.4 V
1 ———— +3.5 to +5.0 V

Example: It is desired to set remotely 107.38 kΩ.
a. Apply line power.
b. Put 1435 into remote-operation mode by one of three ways:
1. Set all dials to be used to R position.
2. Set ON/OFF switch to REMOTE.
3. Apply logic 0 to pin V of J8.
c. Apply the input signals at J8 as shown in Table 3-1.

NOTE
When no signal is applied at an input terminal, that terminal is at logic 1.

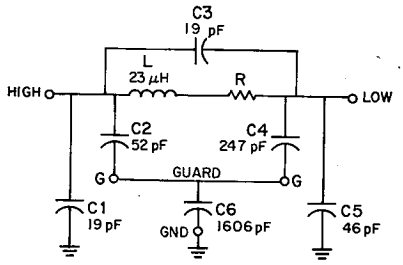
3.2.2 Output Terminals.

When it is desirable to short-circuit or open the H and L terminals, e.g., during the interval when the resistance is being changed, the same logic applies as in para. 3.2.1. A logic 0 applied to pin 17 opens the opening relay (closed when no signal is applied); a logic 0 applied to pin 18 closes the shorting relay (open when no signal is applied).

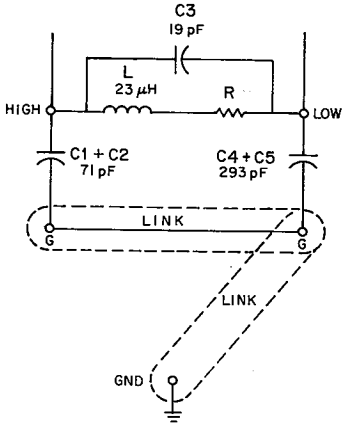
Table 3-1

EXAMPLE OF REMOTE OPERATION

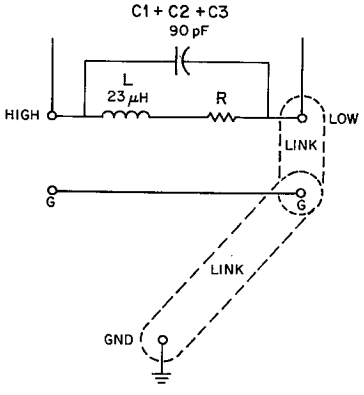
	100kΩ/step	10kΩ/step	1kΩ/step	100Ω/stepx	10Ω/step
INPUT PIN	E F 5 6	H J 7 8	K L 9 10	M N 11 12	P R 13 14
WEIGHTING	1 2 4 8	1 2 4 8	1 2 4 8	1 2 4 8	1 2 4 8
INPUT SIGNAL	0 1 1 1	1 1 1 1	0 0 0 1	0 0 1 1	1 1 1 0
RESULTING RESISTANCE BETWEEN H AND L TERMINALS kΩ	1 x 100k	0 x 10k	7 x 1k	3 x 100	8 x 10
	1	0	7	3	8



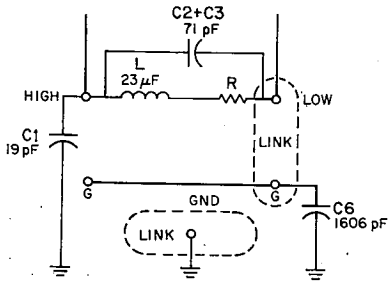
a. Terminal capacitances.



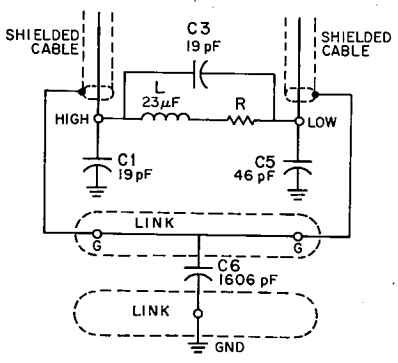
b. 2-terminal, ungrounded.



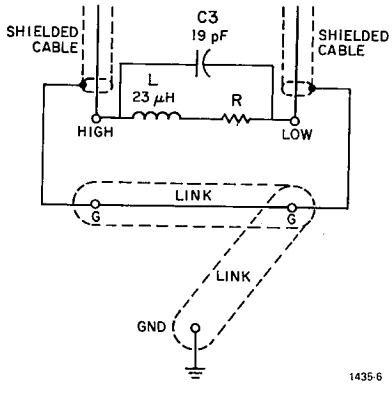
c. 2-terminal, grounded.



d. 2-terminal, minimum capacitance from HIGH to ground.



e. 3-terminal, shield ungrounded — eliminates C2, C4, and cable capacitances.



f. 3-terminal, shield grounded — eliminates C1, C2, C4, C5 and cable capacitances.

Figure 3-1. Effects on terminal capacitances with various connecting-link configurations. Capacitance values are approximate.

3.3 USE OF CONNECTING LINKS.

The approximate terminal capacitances in the 1435 are shown in Figure 3-1, a. Two connecting links are attached to the GUARD and ground binding posts on the rear panel. With the proper positioning of these links, various terminal capacitances can be eliminated or greatly reduced. The various configurations and resulting capacitance effects are given in Figure 3-1, b through f.

3.4 THERMAL EMF OF REED SWITCHES.

A small emf is generated by all reed switches because of the difference between the ambient temperature at the leads and that of the reeds themselves when power is applied to the coils. This is on the order of 10 μV per reed for the type used in the 1435. The effects of several reeds are usually noncumulative.

Theory–Section 4

4.1 GENERAL.

Each decade of the 1435 contains four precision resistors, four reed relays, and the necessary logic to permit operation in either the remote or manual mode. One plug-in board is used per decade, with all boards identical except for the value of the precision resistors. The logic circuitry and reed coils obtain power from a single 5-V regulated supply on the mother board.

4.2 BLOCK DIAGRAM DESCRIPTION.

The operation of the 1435 is best described by referring to the complete block diagram, Figure 4-1.

The first information sensed is whether remote or manual operation is required. The 1-2-4-8 BCD signals for a resistor decade, received at the rear-panel input connector, J8, are obeyed only if: at least one of the three remote-command locations has been activated, the front-panel decade dial for that decade has been turned to the R position, or the power switch has been turned to the REMOTE position, or a logic 0 has been applied to pin V on the rear panel.

The presence of an R on each decade dial offers the flexibility of setting some of the decades for remote operation, while retaining manual control over the others.

Circuit operation is the same for manual or remote mode (or a combination of the two). Remote operation requires four BCD lines per decade, and the output of the front panel decade switches is also four BCD lines (same 1-2-4-8 code).

The signals on the lines are inverted and applied directly to the coils of miniature mercury-wetted reed relays, which shunt the four precision resistors of each decade (also given a 1-2-4-8 weighting). If, for example, in remote operation, the 4 line of the 10 Ω/step decade receives a logic 0 (or is grounded), the relay coil is de-energized, the reed shunting the 40-Ω resistor opens, and 40 Ω appears at the decade output terminals.

Also shown on the block diagram are two additional relays: one shorts the resistor output terminals and one opens them. Applying a logic 0 to pin 17 of the rear panel connector opens the opening relay; applying a logic 0 to pin 18 closes the shorting relay. Therefore, if the shorting and opening feature is not needed in a particular application, no signals need be applied to pins 17 and 18 for proper 1435 operation. The shorting and opening relay coils have been buffered to appear like a DTL load of one, the same as all other inputs on the rear panel.

4.3 CIRCUIT DESCRIPTION.

The schematic of one decade is shown in Figure 5-6. All decades are identical except for the value of the four precision resistors, R14-R17.

The logic state of pin 8 (IC3) determines whether the decade in question will respond to remote or manual commands. A logic 1 on pin 8 puts a 1 on pins 5 and 9 (IC2) and pins 5 and 9 (IC1). Also, because of the inversion at pins 5 and 6 (IC3), a logic 0 is placed on pins 2 and 12 (IC2) and pins 2 and 12 (IC1). These zeros on one input of the dual-input gates cause the outputs to remain at logic 1 regardless of which logic state is present at the other inputs. These other inputs, pins 1 and 13 (IC2) and pins 1 and 13 (IC1) are the four manual lines from the front-panel rotary switches. However, a zero on any of the four rear-panel remote lines will cause the output at the corresponding gate

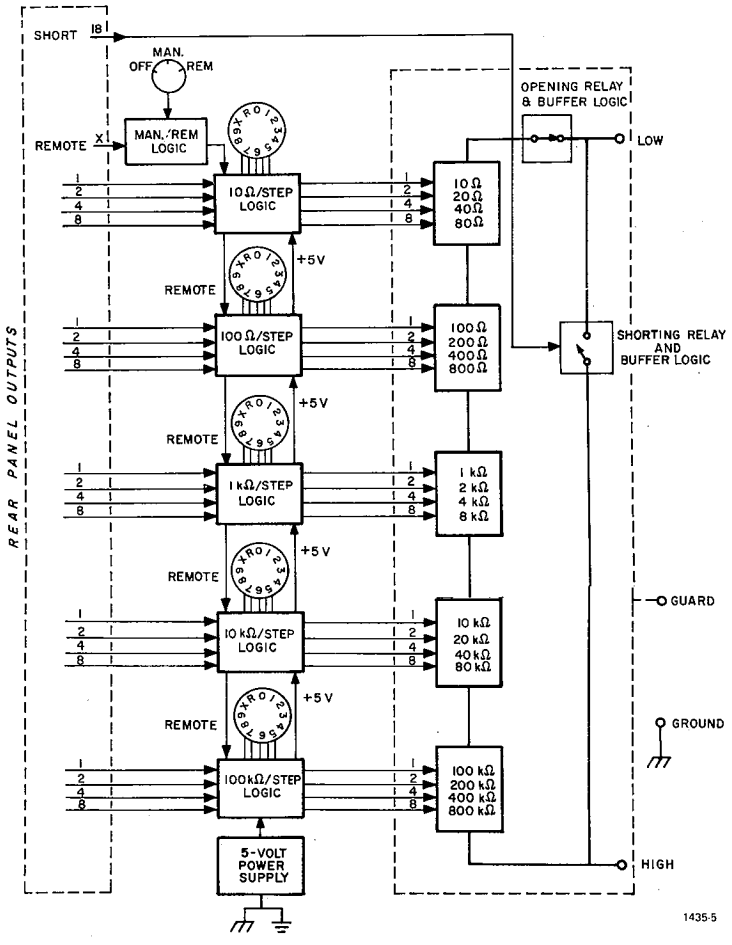


Figure 4-1. Block diagram.

to go high, removing the drive from the relay coil. The reed opens and the selected value of resistance appears at the resistance output terminals.

Thus, a logic 1 on pin 8 (IC3) puts that decade in remote operation. Similar reasoning shows that a logic 0 on pin 8 puts that decade in manual operation.

A logic 1 may appear at pin 8 in any of three ways, which correspond to the three methods of putting the 1435 into remote operation. They are:

1. When a decade dial is turned to the R position, pin 9 (IC3) is grounded and a 1 appears at pin 8 (IC3). This puts only the decade in question in remote operation.
2. Pin 12 (M-IC1) can be grounded by turning the power switch to its third position, REMOTE. This puts a 1 on pin 11 (M-IC1), a zero on both pin 8 (M-IC1) and pin 10 (IC3) of ***all*** decades, a 1 appears at pin 8 (IC3) of all decades, and the entire 1435 is placed in remote operation.
3. The same function just described can itself be remotely controlled by grounding pin V on the rear panel. This puts a zero on pin 13 (M-IC1), a 1 on pin 11 (MIC1), a zero on pin 8 (M-IC-1), and once again, a zero on pin 10 (IC3) of every decade. Thus, pin 8 (IC3) of all decades is high and only remote commands are obeyed.

A filter network is placed on all input lines, including the shorting and opening lines. The filter consists of a ~~150Ω~~ 51Ω series resistor, a .001-μF capacitor to ground, and a 100-kΩ pull-up resistor. The filter is effective in removing noise spikes arising from capacitive coupling between pairs of input lines, when they are run in a common cable.

4.4 PRECISION RESISTANCE DECADES.

Four high-quality wire-wound resistors of low-temperature-coefficient Evanohm* wire are used in each decade. All are straight wound except the 10Ω/step decade which is Ayrton-Perry wound to reduce inductance. Due to discontinuities that may exist when the settings are changed (manually or remotely), two logic lines are provided to short or open the decade-output terminals during the switching interval.

Epoxy coatings are used to counter stray leakage paths that could be caused by humidity effects.

*Registered trademark of the Wilbur B. Driver Co.

Service and Maintenance—Section 5

NOTE

The 1435 will not operate inverted or standing on edge, because of the mercury wetted-reed switches used.

5.1 GR FIELD SERVICE.

The two-year warranty attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see last page of manual), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial, ID, and type numbers of the instrument.

5.2 INSTRUMENT RETURN.

Before returning an instrument to General Radio for service, please contact our Service Department or nearest District Office requesting a "Returned Material" number. Use of this number will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.3 MINIMUM PERFORMANCE STANDARDS.

Direct-reading, resistance-measuring instruments that are accurate enough for measuring 1435 performance specifications are not commercially available. It is suggested that the following National Bureau of Standards publications be referred to for information on apparatus and procedures necessary for such measurements.

- Methods, apparatus, and procedures for the comparison of precision standard resistors. F. Wenner, J. Research, NBS 25, 229, (1940).
- Precision resistors and their measurement, J. L. Thomas, NBS Circular 470, 32 p (1948).
- Calibration procedures for dc resistance apparatus, P.B. Brooks, NBS Mono 39, (1962).

5.4 OPERATIONAL CHECK.

5.4.1 General.

The functional performance of the decade box, quite apart from considerations of accuracy, can be checked with

an ohmmeter placed across the output terminals. A properly operating decade box should respond within the accuracy of the ohmmeter.

Manual. To check response to manipulation of the front-panel dials, proceed as follows:

a. Arrange the output terminals as in Figure 3-1 (b), apply power to the instrument, and connect the ohmmeter to the HIGH and LOW terminals.

b. Set all decades to 0 and, starting with the rightmost (10 Ω-per-step) decade, increase the setting in unit steps to X. Proceed in this fashion sequentially through the progressively larger decades, observing that the meter reading corresponds to front-panel dial indications of the 1435.

Programmable. To check response to the exercise of the rear-panel programmable plug, proceed as follows:

a. Apply power to the instrument and place all the decade dials in the R position.

b. Place the mode switch in the MANUAL position.

c. Arrange the output terminals as in Figure 3-1 (b) and connect the ohmmeter to the HIGH and LOW terminals. The meter reading should be 0 Ω.

d. Refer to Figure 2-2 for selection of the appropriate pins for the BCD line selection and short them sequentially to pin 2 of connector J8. Follow the sequence 8,4,2,1, starting with the largest-value decade and progressively working through to the smallest-value decade. Observe that the ohmmeter reading corresponds to the value of the activated line in each decade.

NOTE

Overall performance of the entire decade array, as opposed to individual decades, must be done manually (refer to above para.).

e. Place all the decades in the 0 position and connect pin V to pin 2.

NOTE

If a clip lead is used, insulate the bottom jaw at the pin-V end, so that pin 18 is not shorted.

f. Repeat the above procedures but limit the check to the 8 line and look for the results in each decade to repeat.

g. Reset the mode switch to REMOTE and move the jumper from pin V to pin 2.

h. Repeat step f.

i. Connect pin E to pin 2 and observe a reading of 100 kΩ on the meter.

j. Add another jumper, shorting pin 17 to pin 2; the value observed in step i should change to open circuit. Remove this jumper and look for the previous resistance value to reappear on the meter.

k. Add a jumper between pins 18 and 2 and observe that the reading of step i changes to short circuit. Remove all jumpers.

Malfunction. In the event that the appropriate meter reading cannot be achieved in any of the above procedures, refer to para. 5.5 for trouble-analysis information.

5.5 TROUBLE ANALYSIS.

5.5.1 General.

Isolation to a defective plug-in decade board, or to a detail part otherwise attached to the instrument, can best be accomplished in conjunction with the Manual Operational Check (para. 5.4).

Use the full schematic diagram, Figure 5-6, to find the affected circuit. Then use Figure 5-1 to find the general physical location of the circuitry. Finally, use of Figures 5-2 to 5-5 will give the location of the defective detail part. Remove the instrument from its cabinet (refer to para. 2.5).

5.5.2 Functional Failure.

If the instrument cannot meet the functional checks called for in para. 5.4, a point-to-point resistance check, working back from the output connectors, should reveal the failed part.

5.5.3 Accuracy Failure.

In the event that the instrument fails to meet the accuracy checks of para. 5.3 (for those properly equipped to perform such checks) we recommend that the out-of-tolerance decade be isolated, by a process of elimination measurement, and that decade board only be returned to General Radio for repairs.

NOTE

If the malfunctioning decade board occurs anywhere in the chain, the remainder of the decade box can still be used, if the input and output pins of the associated connector on the mother board are shorted together (Figure 5-6).

5.5.4 Intermittent Failure.

Intermittent malfunction could be caused by a failure in the instrument power supply. Plug the 1435 power cord into a metered Variac® autotransformer (such as GR WM10MT3A) set for 115 or 230 V, as appropriate, and look for +5 V dc at any convenient point on the 5-V dc bus-line on the motherboard (Figure 5-3) with the 1806 electronic voltmeter. If an out-of-tolerance level is observed, try to bring it back in by adjustment of M-R10 (Figure 5-1). If this does not improve performance, a point-to-point check through the power-supply regulator and other circuitry is recommended.

5.6 REPAIRS.

5.6.1 Electrical Parts.

General. Any electrical detail part can be replaced on the

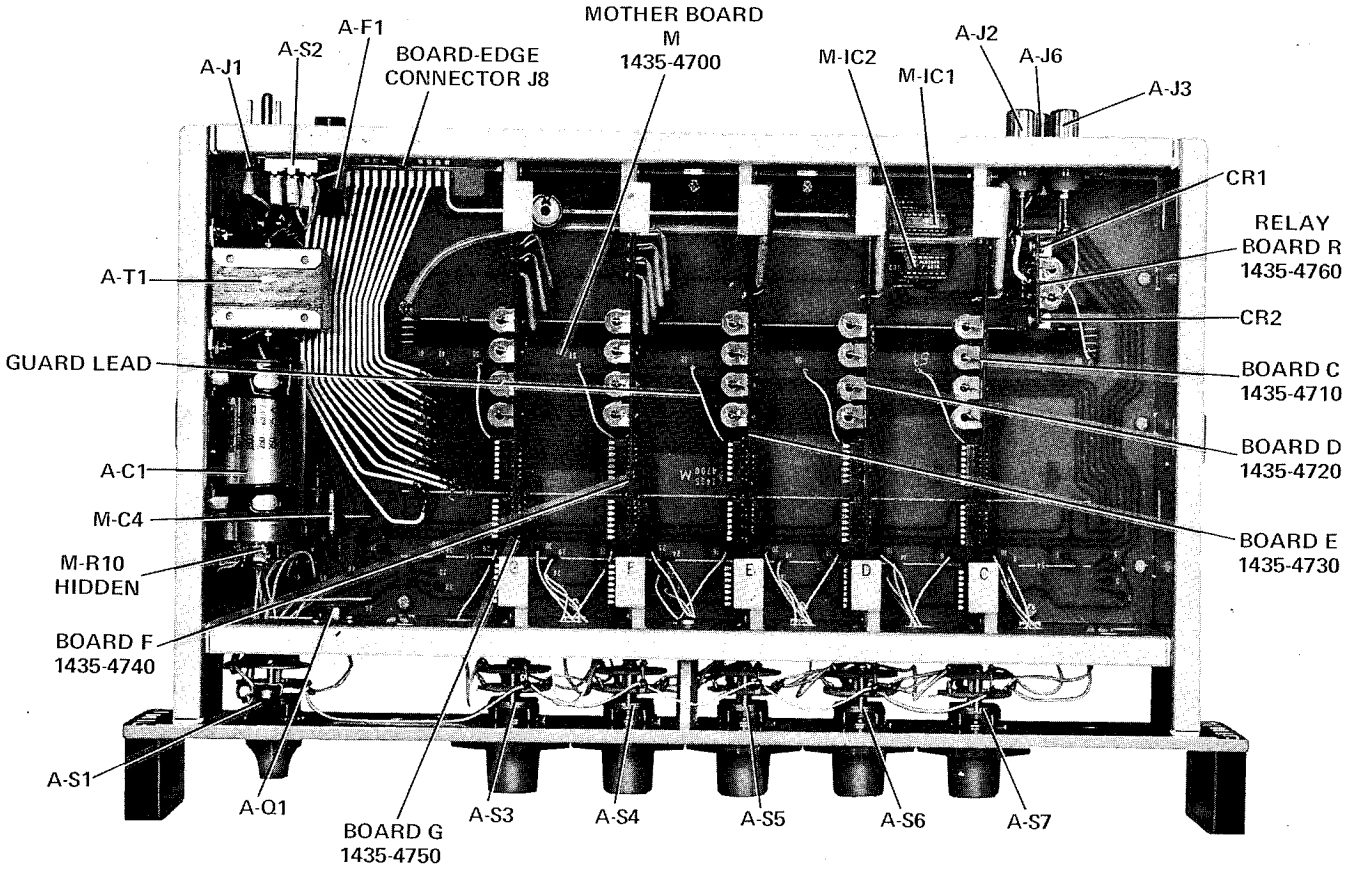


Figure 5-1. Top interior view.

1435. Semi-conductor manufacturer's recommended procedures should be followed in working with such devices to avoid damage from soldering temperatures.

Etched Boards. To remove a plug-in etched board unplug the guard lead, lift the white Teflon tab at each end, then pull the board straight up out of the connector on the mother board. The tab with the engraved letter designation should always face the front of the instrument. The relative positions of the plug-in boards are shown in Figure 5-1. Board positions are marked on the top of the mother board in the center of the plug-in board position.

To reinstall a board, line it up carefully in the connector elements on the mother board and press gently until it is seated and the tip of the handle element is in position for final closure. Press down on the white tabs to jack the board into place.

CAUTION

If a board binds, don't attempt to force it into place or the mother board may be damaged.

Reed Relays. In replacing a switch element in one of the reed-relay switches, observe that the mercury-pool end is installed so that it will be nearest the connector end of the etched board, with the leaf portion uppermost.

Decade etched boards are covered with a protective coating* at the relay end and require the use of a few drops of toluol as a solvent to permit removal of anything in the coated area. Apply it sparingly; it should operate in 5 minutes.

NOTE

Reed relays may disintegrate during removal. Clear any debris with a 1/8-in. Allen wrench or similar probe.

5.6.2 Knob Removal.

If it should be necessary to remove the knob on a front-panel control, either to replace one that has been damaged or to replace the associated control, proceed as follows:

a. Grasp the knob firmly with the fingers, close in to the indicator dial and pull the knob straight away from the panel.

CAUTION

Do not pull on the dial to remove a dial/knob assembly. Always remove the knob first. To avoid damage to the knob and other parts of the control, do not pry the knob loose with a screwdriver or similar flat tool, and do not attempt to twist the knob from the dial.

*Dow-Corning 630.

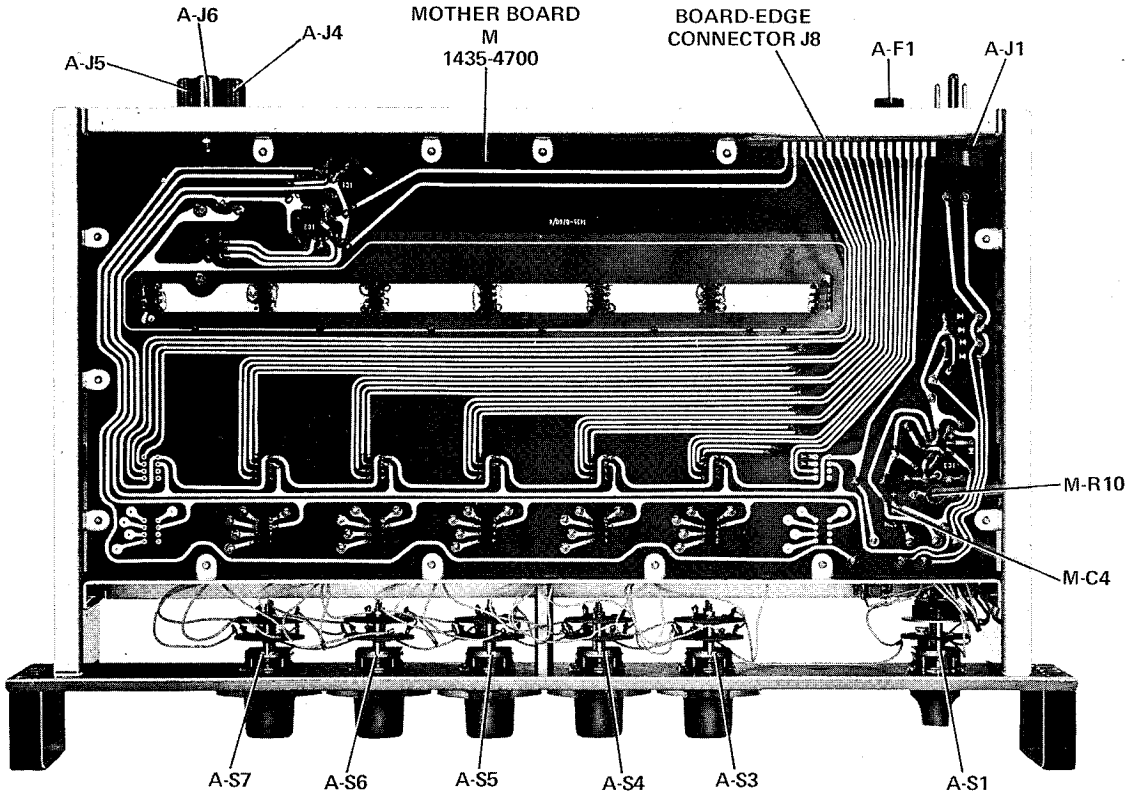


Figure 5-2. Bottom interior view.

b. Observe the position of the setscrew in the bushing, with respect to any panel markings (or at the full ccw position of a continuous control).

c. Release the setscrew and pull the bushing off the shaft. Use a No. 10 Allen wrench for the bushings.

d. Remove and retain the black nylon thrust washer, behind the dial/knob assembly.

NOTE

To separate the bushing from the knob, if for any reason they should be combined off the instrument, drive a machine tap a turn or two into the bushing for a sufficient grip for easy separation.

5.6.3 Knob Installation.

To install a knob assembly on the control shaft:

a. Place the black nylon thrust washer over the control shaft.

b. Mount the bushing on the shaft, using a small slotted piece of wrapping paper as a shim for adequate panel clearance.

c. Orient the setscrew on the bushing with respect to the panel-marking index and lock the setscrew with the appropriate key wrench.

NOTE

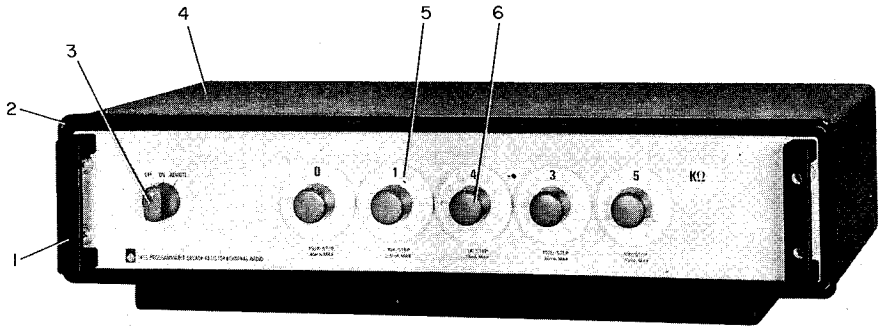
Make sure that the end of the shaft does not protrude through the bushing or the knob won't bottom properly.

d. Place the knob on the bushing with the retention spring opposite the setscrew.

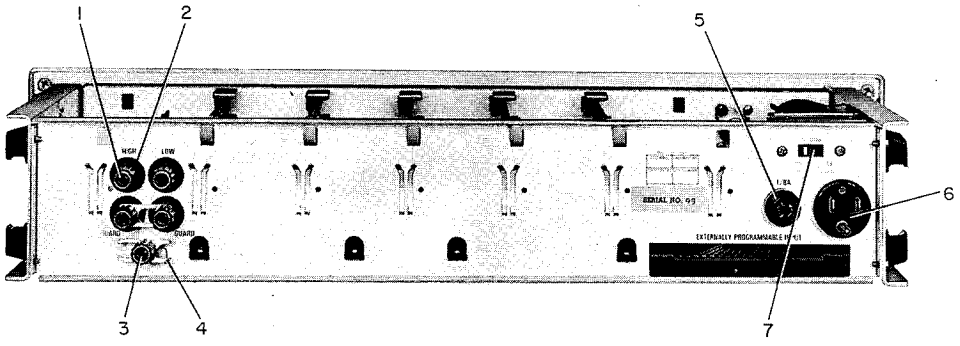
e. Push the knob in until it bottoms and pull it slightly to check that the retention spring is seated in the groove in the bushing.

NOTE

If the retention spring in the knob comes loose, reinstall it in the interior notch that has the thin slit in the side wall. It will not mount in the other notch.



Front panel view.



Rear panel view.

MECHANICAL PARTS LIST

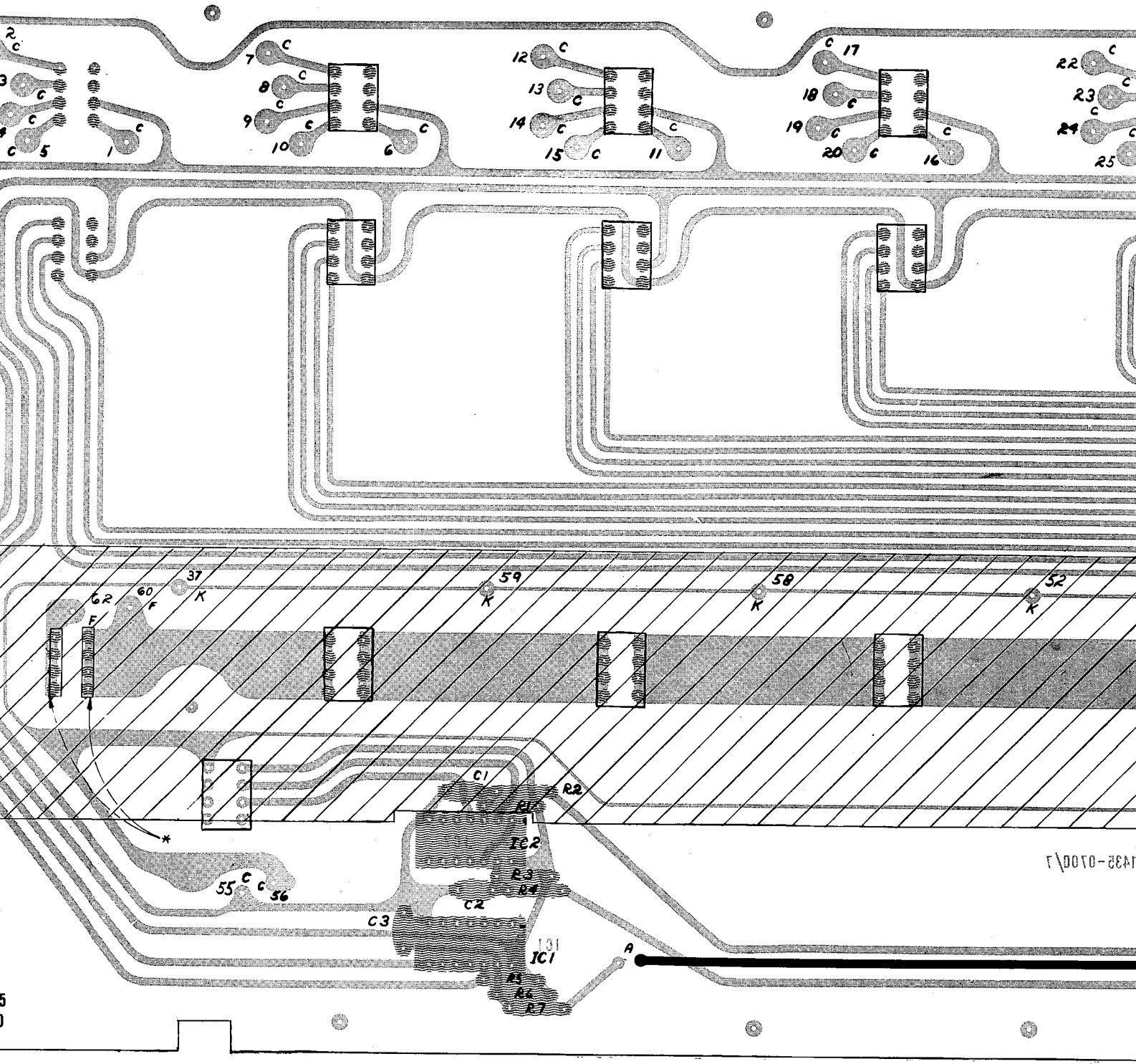
Qnt	Fig Ref	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
FRONT PANEL						
2	1.	Handle	5360-2007	24655	5360-2007	
1	2.	Cabinet gasket	5331-2156	24655	5331-2156	
1	3.	Knob asm., OFF/ON/REMOTE, including retainer 5220-5402	5500-5321	24655	5500-5321	
1	4.	Bench cabinet asm. comp:	4172-4015	24655	4172-4015	
		Bench cabinet asm.	4172-2042	24655	4172-2042	
		Base asm.	4171-1021	24655	4171-1021	
		Foot	4171-7010	24655	4171-7010	
5	5.	Dial asm., Decade Steps	1435-1200	24655	1435-1200	
5	6.	Knob asm., Decade Steps, including retainer 5220-5402	5520-5320	24655	5520-5320	
REAR PANEL						
4	1.	Binding post, J2, LOW; J3, HIGH; J4, GUARD; J5, GUARD	0938-3000	24655	0938-3000	5940-075-9617
4	2.	Insulator	0938-7130	24655	0938-7130	
1	3.	Binding post, J6	0938-3016	24655	0938-3016	
2	4.	Shorting link	5080-4800	24655	5080-4800	5940-927-7452
1	5.	Fuse mounting device	5650-0100	71400	HKP-H	5920-284-7144
1	6.	Power plug, J-1	4240-0600	24655	4240-0600	5935-816-0254
1	7.	Slide switch, S1, LINE VOLTAGE SELECTOR	7910-0832	82389	11A-1118	

ELECTRICAL PARTS LIST – CHASSIS

(Mother Board Below)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
A-C1	Electrolytic, 1500, 750, 750 µF	4450-0700	90201	203828S10C10X2	5910-918-4057
CONNECTORS					
A-J1	Power plug	4240-0600	24655	4240-0600	5935-816-0254
A-J2 thru A-J5	Binding post	0938-3000	24655	0938-3000	5940-9617
A-J6	Binding post	0938-3016	24655	0938-3016	
LAMPS					
A-D51	Pilot light	5600-0309	71744	#330	6240-990-2164
FUSE					
A-F1	Slo-blo	5330-0450	71400	MDL, 0.125 Amp	5920-284-9455
SOCKETS					
	Transistor, power	7540-3440	22753	PTS-4	
SWITCHES					
A-S1	Rotary wafer	7890-5334	24655	7890-5334	
A-S2	Slide	7910-0832	82389	11A-1118	
A-S3 thru A-S7	Rotary wafer	7890-5335	24655	7890-5335	
A-S8	Rotary wafer	7890-5334	24655	7890-5334	
TRANSFORMERS					
A-T1	Power	0745-4650	24655	0745-4650	
TRANSISTORS					
A-Q1	Type 40250	8210-1095	79089	40250	

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C1 thru C3	Ceramic, 0.001 µF +80-20%	4404-2109	72982	831, 0.001 µF +50-20%	5910-075-9607
C4	Tantalum, 68 µF ±20%	4450-5615	80183	150D686X0015R2	
C5	Ceramic, 0.1 µF +80-20%	4431-4109	80183	20C202, 0.1 µF +80-20%	
C6	Electrolytic, 5 µF +150-10%	4450-3900	37942	204059S9C10X3	5910-926-2454
C7	Ceramic, 0.01 µF +80-20%	4401-3100	80131	CC61, 0.01 µF +80-20%	5910-974-5697
DIODES					
CR1	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR2 thru CR5	Type 1N3253	79089	79089	1N3253	5961-811-8372
INTEGRATED CIRCUITS					
IC1	Digital	5431-9462	96214	SN15846N	
IC2	Digital	5431-9362	96214	SN15836N	
IC3	Linear	5432-1002	04713	MC1460G	
JACKS					
	Signal jack	4260-0850	22526	47330	
RESISTORS					
R1	Comp., 10 Ω ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R2	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R3	Comp., 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R4	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R5	Comp., 5.6 kΩ ±5%	6099-2565	75042	BTS, 5.6 kΩ 5%	5905-691-0195
R6	Comp., 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R7	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R8	Wire wound, 1 Ω ±5%	6760-9105	75042	BWH, 1 Ω 5%	
R9	Film, 1.61 kΩ ±1%	6450-1161	75042	CEC, 1.61 kΩ 1%	
R10	Wire wound, 5 kΩ ±10%	6056-0142	11236	115, 5 kΩ 10%	
R11	Film, 2.74 kΩ ±1%	6450-1274	75042	CEC, 2.74 kΩ 1%	
R12	Comp., 10 Ω ±5%	6099-0105	75042	BTS, 10 Ω 5%	5905-809-8596



NOTE: *Orientation:* Viewed from parts side. *Part number:* Refer to caption. *Symbolism:* Wavy-line area = part; black ckt pattern (if any) = parts side, gray = other side. *Pins:* Separate dot (●) = collector, half dot (◖) or 1 = I-C pin 1.

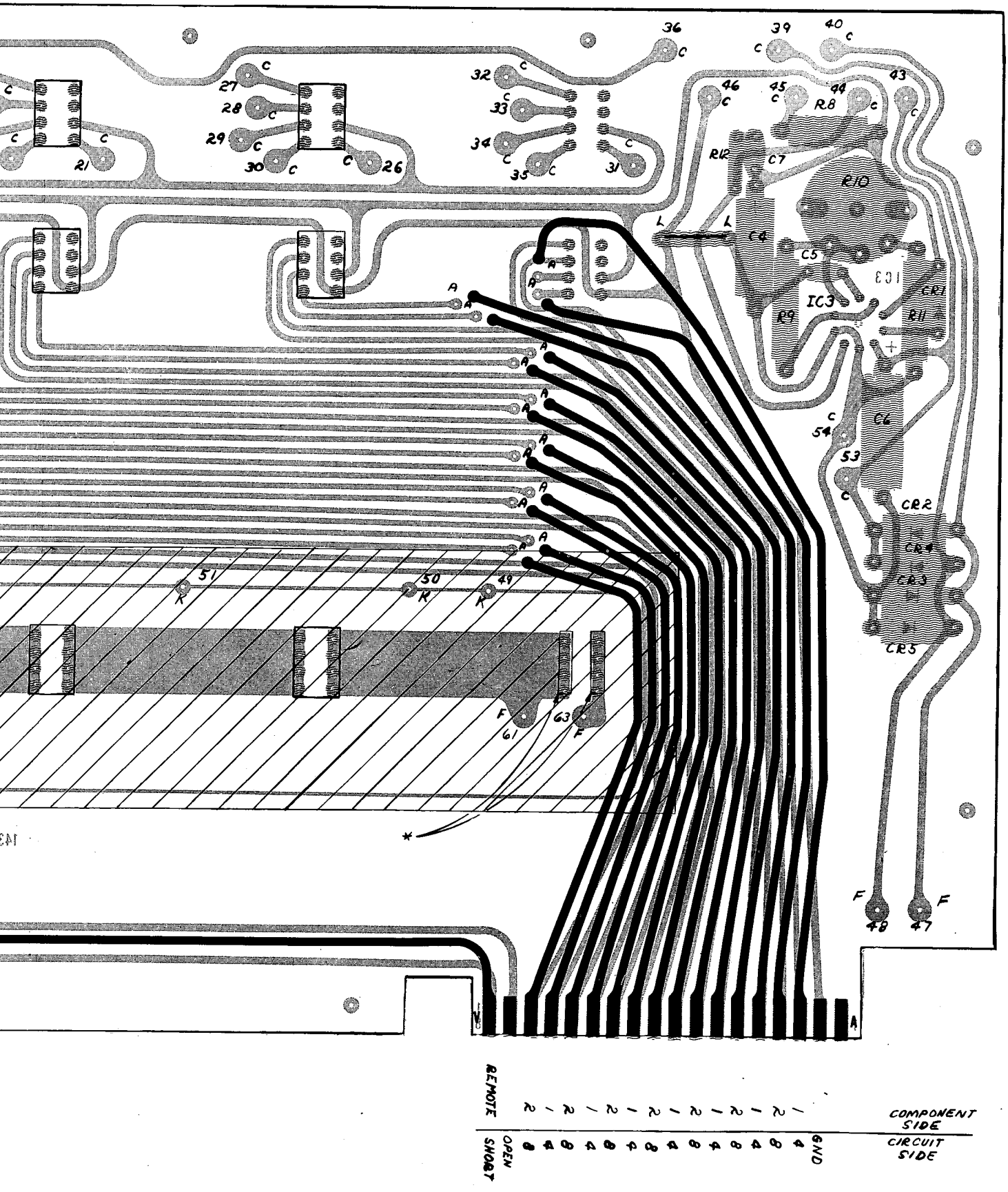


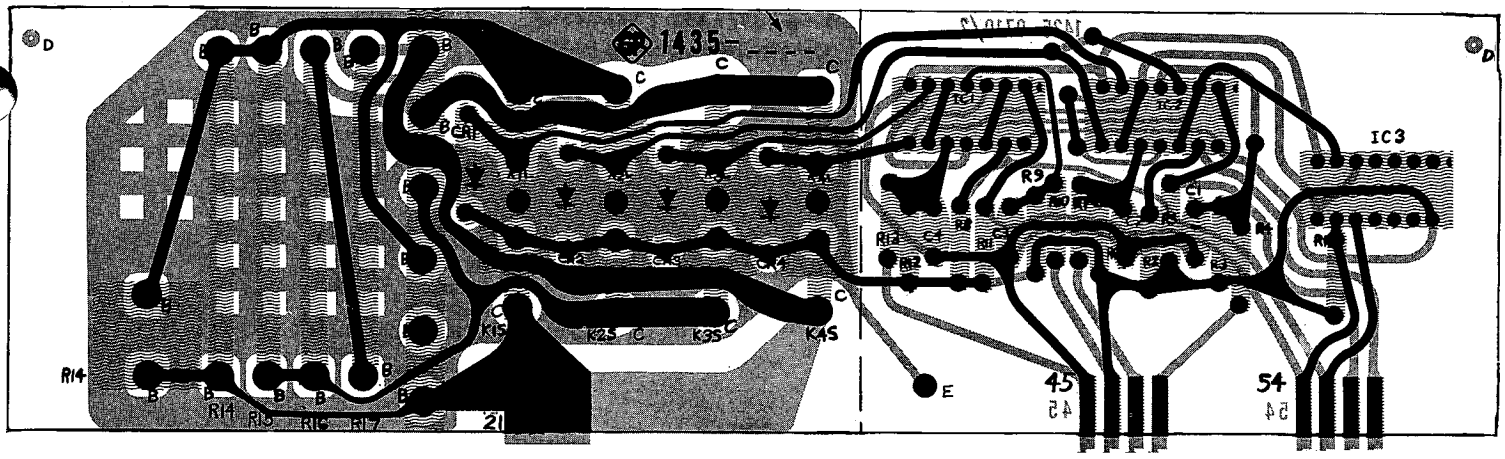
Figure 5-3. Etched circuit diagram — mother board and power supply regulator — (P/N 1435-4700).

ELECTRICAL PARTS LIST DECADE BOARD

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C1 thru C4	Ceramic, 0.001 μF ±20%	4404-2109	72982	831, 0.001 μF 20%	5910-075-9607
DIODES					
CR1 thru CR4	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
INTEGRATED CIRCUITS					
IC1 thru IC3	Digital	5431-9462	96214	SN15846N	
RELAYS					
K1L thru K4L	Coil	6090-1129	24655	6090-1129	
K1S thru K4S	Switch, reed	6090-1164	95348	WR126	
RESISTORS					
R1 and R2	Comp., 5.6 kΩ ±5%	6099-2565	75042	BTS, 5.6 kΩ 5%	5905-691-0195
R3	Comp., 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R4	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R5	Comp., 5.6 kΩ ±5%	6099-2565	75042	BTS, 5.6 kΩ 5%	5905-691-0195
R6	Comp., 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R7	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R8	Comp., 5.6 kΩ ±5%	6099-2565	75042	BTS, 5.6 kΩ 5%	5905-691-0195
R9	Comp., 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R10	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R11	Comp., 5.6 kΩ ±5%	6099-2565	75042	BTS, 5.6 kΩ 5%	5905-691-0195
R12	Comp., 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R13	Comp., 51 Ω ±5%	6099-0515	75042	BTS, 51 Ω 5%	
R14 thru R17	Wire wound, for board 1435-4710	6990-5223	24655	6990-5223	
R14 thru R17	Wire wound, for board 1435-4720	6990-5222	24655	6990-5222	
R14 thru R17	Wire wound, for board 1435-4030	6990-5221	24655	6990-5221	
R14	Wire wound, 80 kΩ ±0.02%, for board 1435-4740	6983-5042	24655	6983-5042	
R15	Wire wound, 40 kΩ ±0.02%, for board 1435-4740	6983-5041	24655	6983-5041	
R16	Wire wound, 20 kΩ ±0.02%, for board 1435-4040	6983-5040	24655	6983-5040	
R17	Wire wound, 10 kΩ ±0.02%, for board 1435-4040	6983-5039	24655	6983-5039	
R14	Wire wound, 800 kΩ ±0.02%, for board 1435-4050	6991-2006	24655	6991-2006	
R15	Wire wound, 400 kΩ ±0.02%, for board 1435-4050	6983-6013	24655	6983-6013	
R16	Wire wound, 200 kΩ ±0.015%, for board 1435-4050	6983-6003	24655	6983-6003	
R17	Wire wound, 100 kΩ ±0.02%, for board 1435-4050	6983-6012	24655	6983-6012	

ELECTRICAL PARTS LIST – RELAY BOARD

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
DIODES					
CR1 and CR2	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
RELAYS					
K1L and K2L	Switch, reed	6090-1164	95348	WR126	
K1S and K2S	Coil	6090-1129	24655	6090-1129	



Handle Designation	Decade Position	Part Number
C	10 Ω/step	1435-4710
D	100 Ω/step	1435-4720
E	1 kΩ/step	1435-4730
F	10 kΩ/step	1435-4740
G	100 kΩ/step	1435-4750

Figure 5-4. Etched circuit diagram — typical decade board.

NOTE: *Orientation:* Viewed from parts side. *Part number:* Refer to caption. *Symbolism:* Wavy-line area = part; gray ckt pattern (if any) = parts side, black = other side. *Pins:* Separate dot (●) = collector, half dot (◖) or 1 = I-C pin 1.

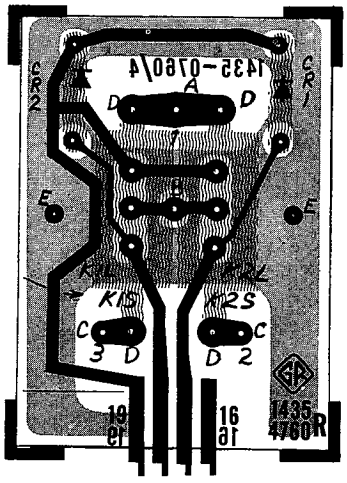
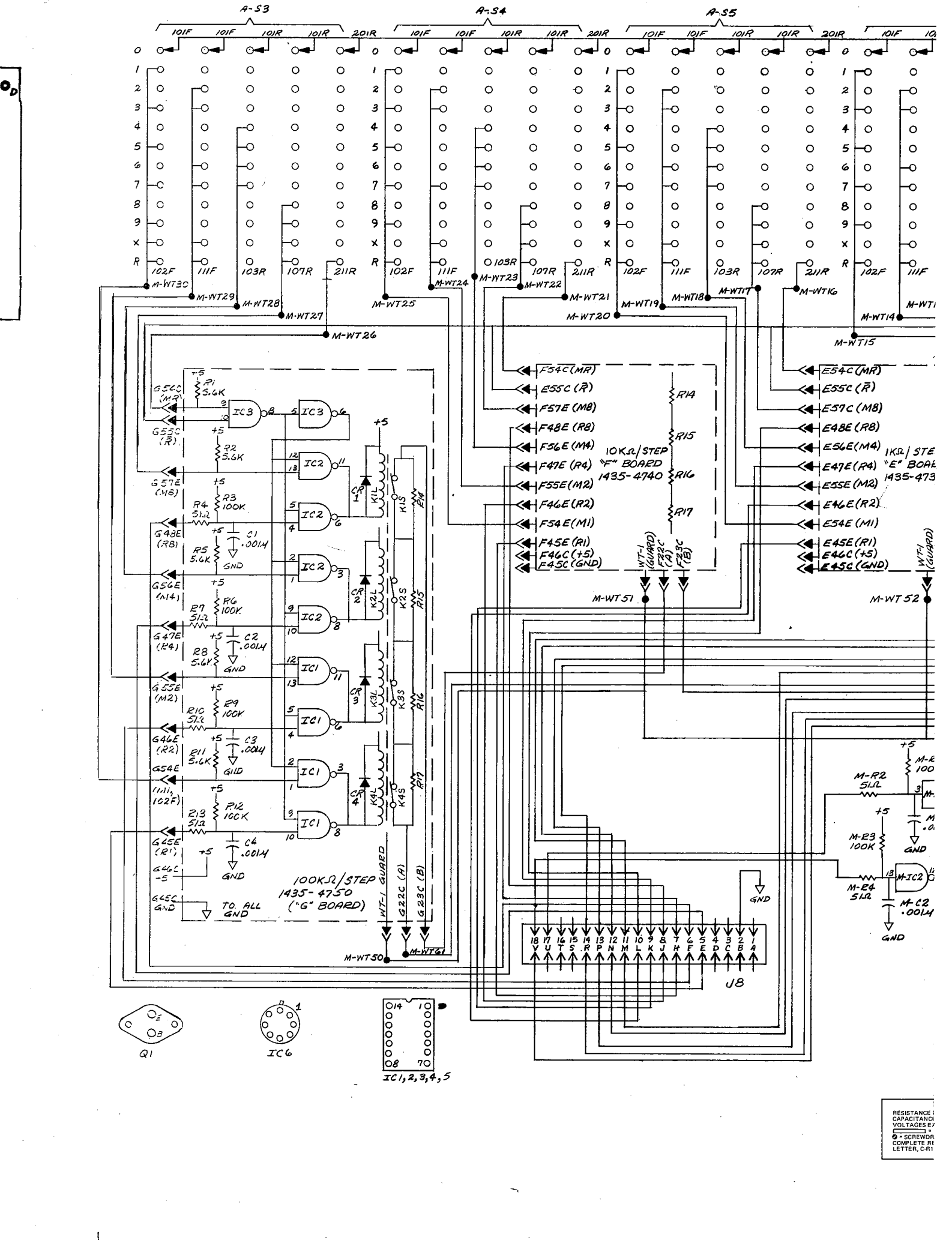
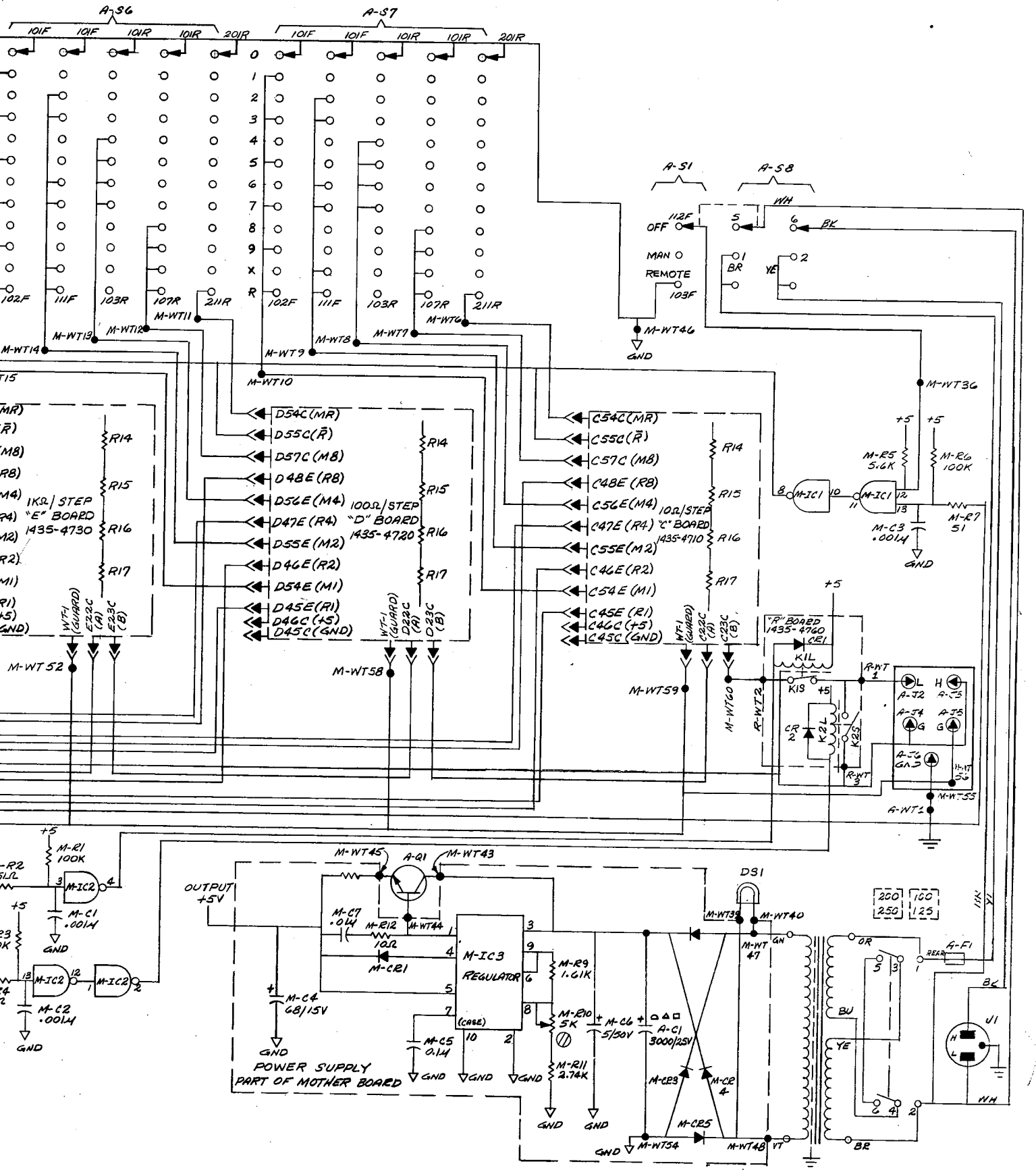


Figure 5-5. Etched-circuit diagram — Open and Short Relay Board (P/N 1435-4760).


A-53
A-54
A-55
101F
101R
201R
111F
103R
107R
211R
102F
M-WT30
M-WT29
M-WT28
M-WT27
M-WT26
M-WT25
M-WT24
M-WT23
M-WT22
M-WT21
M-WT20
M-WT19
M-WT18
M-WT17
M-WT16
M-WT15
M-WT14
F54C(MR)
F55C(R)
F57E(M8)
F48E(R8)
F56E(M4)
F47E(R4)
F55E(M2)
F46E(R2)
F54E(M1)
F45E(R1)
F46C(+5)
F45C(GND)
10KΩ/STEP
"F" BOARD
1435-4740
R14
R15
R16
R17
E54C(MR)
E55C(R)
E57C(M8)
E48E(R8)
E56E(M4)
E47E(R4)
E55E(M2)
E46E(R2)
E54E(M1)
E45E(R1)
E46C(+5)
E45C(GND)
1KΩ/STE
"E" BOAR
1435-473
WT-1 (GUARD)
F22C (A)
F23C (B)
M-WT51
M-WT52
G54C (MR)
G55C (R)
G57E (M8)
G48E (R8)
G56E (M4)
G47E (R4)
G55E (M2)
G46E (R2)
G54E (R1)
11.11, 102F)
G45E (R1)
G46C -5
G45C GND
R1 5.6K
R2 5.6K
R3 100K
R4 51Ω
R5 5.6K
R6 100K
R7 51Ω
R8 5.6K
R9 100K
R10 51Ω
R11 5.6K
R12 100K
R13 51Ω
C1 .001μ
C2 .001μ
C3 .001μ
C4 .001μ
GND
+5
IC3
IC2
IC1
CR1
CR2
CR3
CR4
K1L
K2L
K3L
K4L
K1S
K2S
K3S
K4S
R14
R15
R16
R17
100KΩ/STEP
1435-4750
("G" BOARD)
TO ALL GND
WT-1 GUARD
G22C (A)
G23C (B)
M-WT50
M-WT61
M-R2 51Ω
M-R3 100K
M-R4 51Ω
M-C2 .001μ
M-IC2
J8
Q1
IC6
IC1,2,3,4,5



RESISTANCE IS IN OHMS, K = 10^3, M = 10^6
CAPACITANCE IS IN FARADS, μ = 10^{-6}, p = 10^{-12}
VOLTAGES EXPLAINED IN INSTRUCTION BOOK SERVICE NOTES
▭ = PANEL CONTROL ▭▭▭ = REAR CONTROL
⊘ = SCREWDRIVER CONTROL WT = WIRE TIE TP = TEST POINT
COMPLETE REFERENCE DESIGNATION INCLUDES SUBASSEMBLY LETTER, C-R1, B-R1, ETC.

4 0 4 F ROTARY SWITCH NUMBERING
WAFER SURFACE: FRONT, REAR
CONTACTS: FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY IS 01.
SECTION: SECTION NEAREST PANEL IS 1.
ROTORS SHOWN CCW.

CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

Figure 5-6. Schematic diagram — complete.