

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND

GENERAL SUPPORT MAINTENANCE MANUAL

**DIGITAL
VOLTMETER
AN/GSM-64A**

W A R N I N G

Be careful when working on the 115/230-volt ac line connections, 250-volt internal circuitry and high voltage input to the instrument. Serious injury or death may result from contact with these terminals.

DO NOT TAKE CHANCES!

TECHNICAL MANUAL }
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HEADQUARTERS
 DEPARTMENT OF THE ARMY
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Operator's, Organizational, Direct Support, and
 General Support Maintenance Manual
 DIGITAL VOLTMETER AN/GSM-64A

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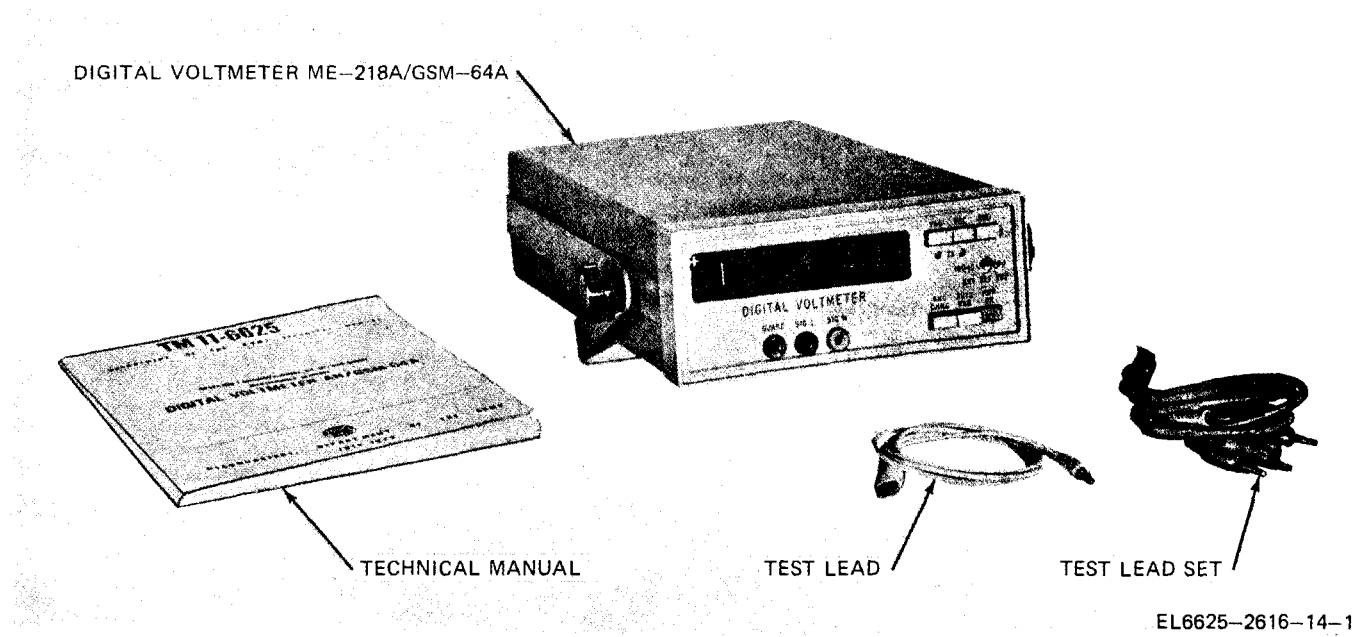


Figure 1-1. Digital Voltmeteter AN/GSM-64A.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual describes Digital Voltmeter AN/GSM-64A and covers its installation and operation, operator, organizational, and general support maintenance. It includes operation under usual conditions, cleaning, and inspection of the equipment, replacement of parts available to the operator and organizational repairman, and instructions appropriate to general support for troubleshooting, testing, calibration, and repairing the equipment.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO'S) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records

in accordance with instructions given in TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army) /NAVSUP PUB 378 (Navy) /AFR 71-4 (Air Force)/ and MCO P4030.29 (Marine Corps).

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 (Army) /NAVSUP PUB 459 (Navy)/AFM 75-34 (Air Force)/ and MCO P4610.19 (Marine Corps).

d. Reporting of Equipment Publication Improvements. The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commander US Army Electronics Command, ATTN: AMSEL-MA-C, Fort Monmouth, N.J. 07703.

Section II. DESCRIPTION AND DATA

1-4. Purpose and Use

a. Digital Voltmeter AN/GSM-64A (fig. 1-1) is a five-digit digital voltmeter used to measure dc voltages in three ranges from ± 0.0001 volt to ± 1000.0 volts, and dc voltage ratio (with ± 1 volt to ± 10 volts reference input) in three ranges from 000,000 to ± 11999.9 percent or (with ± 10 volts to ± 100 volts reference input) in three ranges from 00.0000 to ± 1199.99 percent.

b. Although not part of the basic equipment, AN/GSM-64A will internally accept AC/DC conversion, data output, and remote control ac-

cessories. The instrument will also accept rack-mounting adapters for mounting in a standard 19-inch mounting rack.

1-5. Technical Characteristics

Dc voltage measurements:

Ranges -----	00.0000 to ± 11.9999 volts
-----	000.000 to ± 119.999 volts
-----	0000.00 to ± 1000.0 volts
Ranging -----	Automatic or manual
Polarity -----	Automatic
Accuracy -----	$\pm 0.01\%$ of reading or ± 1 digit
Resolution -----	± 1 digit
Input impedance _	Greater than 10 megohms

Temperature coefficient	± 0.0007% of reading per degree C.
Normal-mode-rejection	Greater than 60 db at 60 Hz
Common-mode-rejection	Greater than 120 db at 60 Hz, and greater than 140 db at dc with 1,000 ohms unbalance in either lead

Dc voltage ratio measurements:

Ranges:	±1 volt to ±10 volts reference input
-----	000.000 to ± 119.999%
-----	0000.00 to ±119.999%.
-----	00000.0 to ± 11999.9%
	±10 volts to ±100 volts reference input
.....	00.0000 to ± 11.9999%
.....	000.000 to ± 119.000%
.....	0000.00 to *1199.99%

Ranging	Automatic or manual
Polarity	Automatic
Accuracy	± 0.005% of reading or ± 1 digit
Reference input impedance	Greater than 50K ohms
Signal input impedance	Greater than 10 megohms
Temperature coefficient	±0.0007% of reading per degree C.
Balancing time	Less than 2 seconds
Isolation - chassis ground to signal low	Greater than ±200 volts de
Input power	Selectable - 115/230 vac (± 10), 50-60 Hz, single phase
Power consumption	Less than 20 watts
Dimensions	8½ in. wide × 3½ in. high × 15 in. deep
Weight	Less than 15 lbs

1-6. Items Comprising an Operable Equipment

Federal stock No.	Description	Unit of measurement	Qty in each unit	Qty furn eqpmt	Fig. No.
6625-165-5779	Voltmeter, Digital AN/GSM-64A	each	1	1	1-1
	Technical Manual TM 11-6625-1626-14	each	1	1	1-1
	Lead, test: 34-65; 03626	each	1	1	1-1
	Lead test: 34-66; 03626	each	1	1	1-1
6625-450-0964	Voltmeter, Digital ME-218A/GSM-64A	each	1	1	1-1

1-7. Description of Equipment

- a. The AN/GSM-64A Digital Voltmeter is a solid-state digital measuring instrument with 5 full digits and a sixth digit which provides a 20 percent over-range capability, except in the 1, 000-volt range. Polarity of signal input is displayed automatically and range changing may be either automatic, or manually controlled as selected by front-panel switches.
- b. In operation, the unknown input voltage applied to the instrument is buffered and used to charge a capacitor during a specific time interval. An internal reference is then applied to discharge the capacitor. Measuring the time interval required to discharge the capacitor indicates the unknown input which is visually displayed in neon glow tubes at the front of the instrument.

c. The voltmeter is portable, weighing less than 15 pounds. A carrying handle is provided which also serves as a tilt-stand for the unit. By removal of the top and bottom covers of the instrument, internal calibration and adjustment controls are easily reached and clearly labeled. Power application and function and range selection are accomplished by activation of pushbutton switches on the front panel. Signal input binding posts, located on the front and rear of the instrument, will accept standard test leads or leads equipped with banana plugs. A power-selection switch is located on the rear of the instrument for rapid conversion to either 115-volt or 230-volt power sources. The powerline cord is permanently attached to the rear of the unit and terminates in a three-pin polarized plug. The powerline fuse is externally located in an extractor post on the rear of the instrument.

CHAPTER 2

INSTALLATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

2-1. Unpacking

a. Packaging Data. When packed for shipment, the AN/GSM-64A is placed in a carton, wrapped and sealed in scrim foil, and packed in a shipping box. A typical shipping container and its contents are shown in figure 2-1. The test lead and test lead set are each packed in a cardboard box and placed on top of the carton containing the instrument. The technical manual is placed in a waterproof wrapper and is also packed on top of the carton containing the instrument. The outside dimensions of the shipping box are 20 3/8 by 11 3/4 by 9 3/4 inches. The volume of the box is 1.35 cubic feet, and the shipping weight is 18 pounds.

b. Removing Contents.

- (1) Cut tape on top of outer carton and fold back flaps.
- (2) Remove technical manual and boxes containing test lead and test lead set.
- (3) Remove inner carton and remove scrim foil from around carton.
- (4) Cut tape on top of carton and fold back flaps.
- (5) Remove cushioned top and instrument from carton.
- (6) Remove desiccant bag from carton.

NOTE

Do not dispose of original packing materials. Retain for use in repacking equipment for storage or shipment.

2-2. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6 (para 1-3).

b. See that the equipment is complete as listed

on the packing slip. If a packing slip is not available, check the equipment against the maintenance allocation chart (app B). Report all discrepancies in accordance with TM 38-750. Shortage of a minor assembly or part that does not affect proper functioning of the equipment should not prevent use of the equipment.

c. If the equipment has been used or reconditioned, see whether it has been changed by a modification work order (MWO). If the equipment has been modified, the MWO number will appear on the rear panel near the nomenclature plate. If modified, see that any operational instruction changes resulting from the modification have been entered in the equipment manual.

NOTE

Current MWO's applicable to the equipment are listed in DA Pam 310-7.

2-3. Installation of Equipment

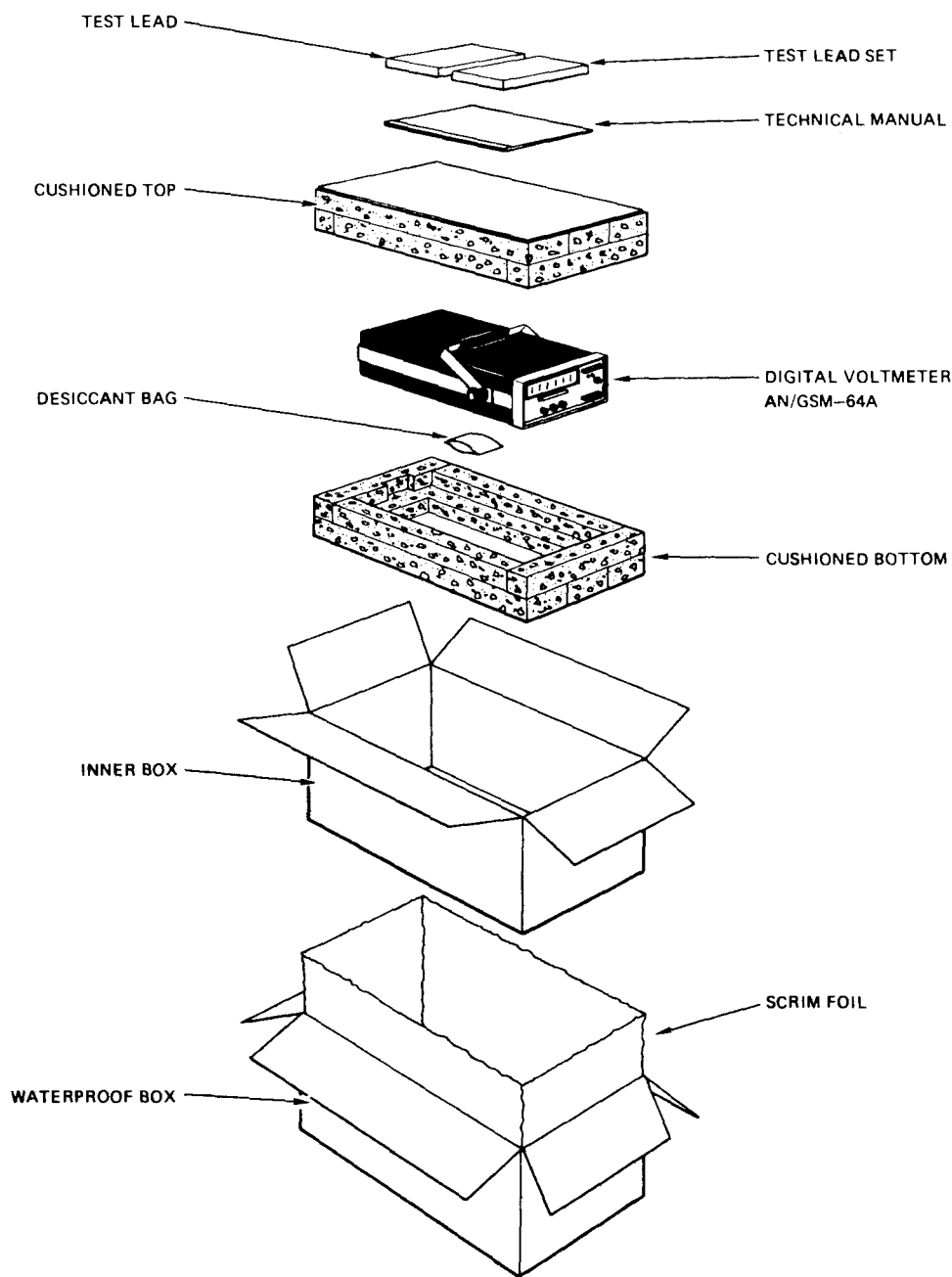
The digital voltmeter is portable and self-contained, and requires no installation other than tilt-stand adjustment, power connection to a suitable ac power source, and assurance that the readout will properly "zero" (para 2-5).

a. Tilt-Stand. The carrying-handle of the instrument also serves as a tilt-stand for the unit.

(1) Slightly loosen (turn counterclockwise) the two knobs attaching the handle to the frame of the instrument.

(2) Raise the front of the instrument and pull the front of the handle forward and then press downward and underneath the unit until the front of the handle (now the base of the stand) is in such a position to provide the desired angle to the instrument for easy observation of the digital readout.

(3) Tighten the two knobs attaching the stand to the frame.



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Figure 2-1. Packaging of Digital Voltmeter AN/GSM-64A.

NOTE

Always loosen the knobs before repositioning the handle. Never force the handle to a new position while the knobs are tight.

b. Fuse. The instrument is shipped with a 0.25 ampere slow-blow fuse inserted in the fuse

holder on the rear of the unit. The fuse is suitable for either 115-volt or 230-volt operation.

c. Power-Selection Switch. Be sure that the power-selection switch on the rear of the instrument is in the proper position: 115 showing for 115-volt operation, or 230 showing for 230-volt operation.

Section II. INITIAL ADJUSTMENT OF EQUIPMENT

2-4. Extent of Initial Adjustments

Before using Digital Voltmeter AN/GSM-64A for routine operation, perform the procedure outlined in paragraph 2-5. These procedures should always be performed prior to equipment use after extensive shipment, a long period of storage, or a drastic change in temperature environment.

2-5. Zeroing the Readout

CAUTION

Be sure to follow instruction set forth in paragraph 2-3c before connecting power cord to ac outlet. Failure to do so may cause the fuse to blow and damage to the transformer.

- a.* Plug the power cord connector into the selected ac outlet.
- b.* Depress PWR ON pushbutton switch. Allow 30 minutes for instrument warmup.
- c.* Plug connector of test lead set (P/N 34-65) into SIG H and SIG L input jacks.

NOTE

A small polarity tab sticks out from

the connector nearest the SIG L plug; i.e., the tab sticks out to the left of the operator when the connector is properly installed.

d. Insert blue plug adjacent to connector into GUARD input jack.

e. Connect the three clips of the test lead set together. They are covered with red, black, and blue protective boots.

f. Be sure that the VDC and AUTO RNG pushbutton switches are in the "in" position.

g. The instrument readout should display 00.0000. If it does not, adjust the ZA potentiometer by inserting a small screwdriver in the opening directly underneath the VDC pushbutton switch and turning the adjustment screw until the readout transfers from 00.0000 to +00.0001; observe the angle of the screwdriver blade. Back off the adjustment until the readout transfers from 00.0000 to -00.0001; observe the angle of the screwdriver blade. Now place the adjustment halfway between these two settings. The AN/GSM-64A is now ready to make measurements accurately, conveniently, and quickly.

CHAPTER 3

OPERATION

Section I. OPERATOR'S CONTROLS, INDICATORS, AND INPUT JACKS

3-1. General

This section lists, illustrates and describes the various controls, indicators, and input jacks provided for the operation of the digital voltmeter. These items are listed, with their functions in paragraph 3-3. Operating instructions are described in section II of this chapter.

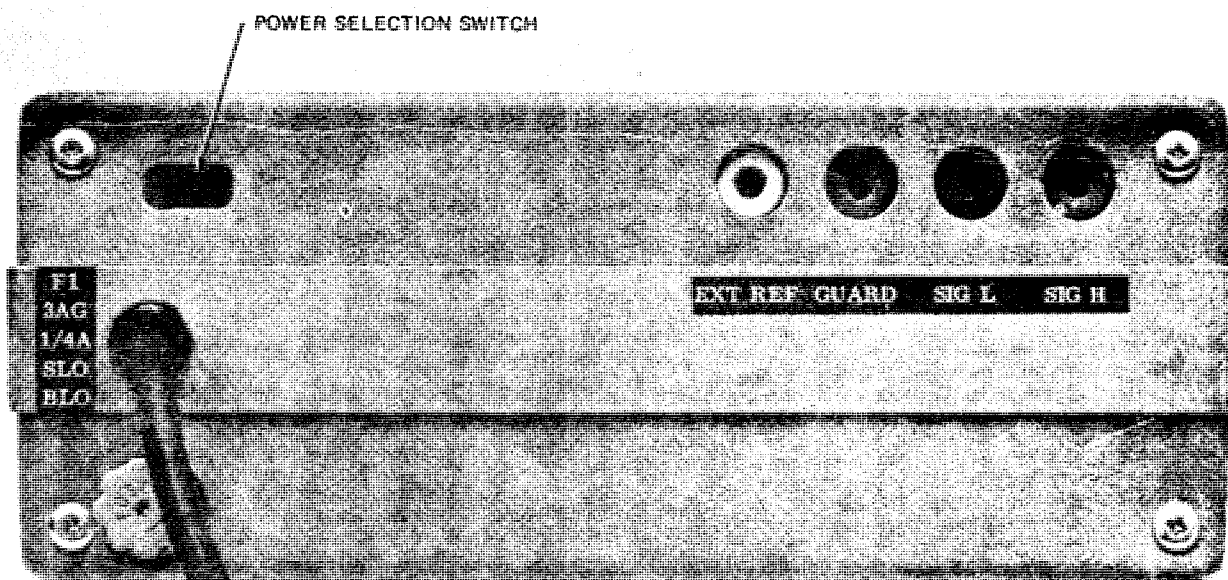
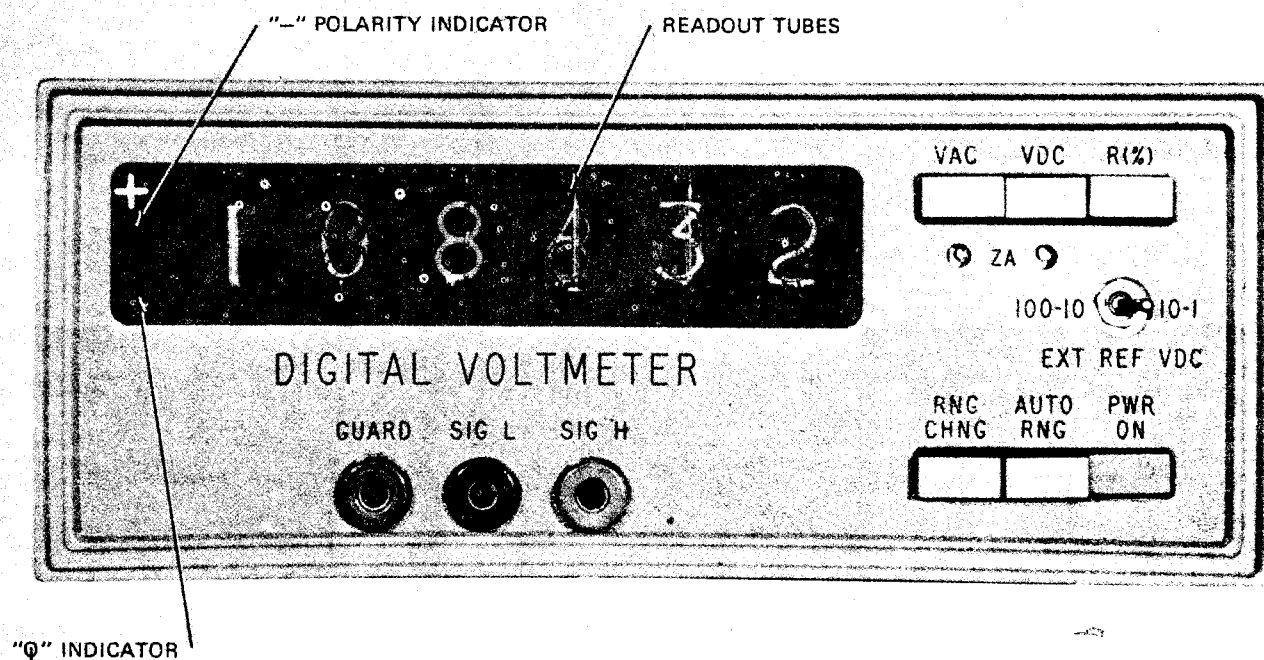
3-2. Damage from Improper Settings

If a 230-volt power source is to be used, be sure

that the power-selection switch on the rear of the instrument is in the 230 position. If this precaution is not observed, the fuse will blow and the power transformer may be damaged.

3-3. Operating Controls, Indicators, and Input Jacks
 (fig. 3-1)

<i>Control, indicator, or input jack</i>	<i>Function</i>
Polarity indicators	Incandescent bulbs behind mask indicate polarity of dc voltage applied to SIG H terminal with respect to SIG L terminal in vdc and ratio modes.
Readout tubes	Gas discharge display tubes which provide the readout in decimal form. There are six plug-in tubes, each containing the numerals 0 through 9 and a decimal point.
VAC pushbutton switch	Places the instrument in the ac voltage measurement mode if an AC/DC Converter accessory is installed (para 1-4b).
VDC pushbutton switch	Places the instrument in the dc voltage measurement mode.
R(%) pushbutton switch	Places the instrument in the ratio measurement mode. The reading displayed is the ratio of the input voltage to the reference voltage in percent.
ZA potentiometers	Permits adjusting the readout to 00.0000 when input leads are shorted together.
EXT REF VDC toggle switch ...	Selects external reference range of instrument.
PWR ON pushbutton switch ---	Applies vac line power to the instrument.
AUTO RNG pushbutton switch ..	Selects automatic ranging mode of operation.
RNG CHNG Pushbutton switch ..	Changes range of instrument if AUTO RNG switch is in the "out" position.
SIG H input jack	Front and rear jacks connect to instrument signal input.
SIG L input jack	Front and rear jacks connect to instrument signal common.
GUARD input jack	Front and rear jacks connect to inner guard shield,
EXT REF input jack	Connection for external reference voltage input.
Overload indicator	Incandescent bulb behind mask flashes Q symbol when input voltage exceeds full scale capability of range selected if in manual range, or overall instrument capability if in AUTO RNG mode.
Power-selection slide-switch	Permits operation from either 115 vac or 230 vac input power source.



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Figure 3-1. Front and rear views of AN/GSM-64A.

Section II. OPERATION UNDER USUAL CONDITIONS

3-4. Starting Procedure

Make sure that the instructions contained in paragraphs 2-4 and 2-5 have been followed before this procedure is started.

a. *Preliminary.* Set the front panel controls as follows:

Control	Position
PWR ON pushbutton switch	Out
VAC pushbutton switch	Out
VDC pushbutton switch	In
AUTO RNG pushbutton switch	Out
RNG CHNG pushbutton switch	Out
R(%) Pushbutton switch	Out
EXT REF VDC toggle switch	Any

b. *Starting.*

(1) Plug power cord connector into selected ac outlet.

(2) Depress PWR ON pushbutton switch. Allow 30 minutes for instrument warmup.

3-5. Measurement of DC Voltage

a. Be sure that the VDC pushbutton switch is in the "in" position.

b. Depress AUTO RNG pushbutton switch.

c. Plug connector of test lead set (P/N 34-65) into SIG H and SIG L input jacks.

NOTE

A small polarity tab sticks out from the connector nearest the SIG L plug; i.e., the tab sticks out to the left of the operator when the connector is properly installed.

d. Insert blue plug adjacent to connector into GUARD input jack.

e. Connect blue-covered and black-covered clips of test lead set together.

WARNING

If high voltages are to be measured, use extreme caution. Serious injury or death may result from contact with terminals connected to high voltage sources.

CAUTION

See figure 3-2 for maximum voltages which may be applied to the input jacks of the instrument without causing damage.

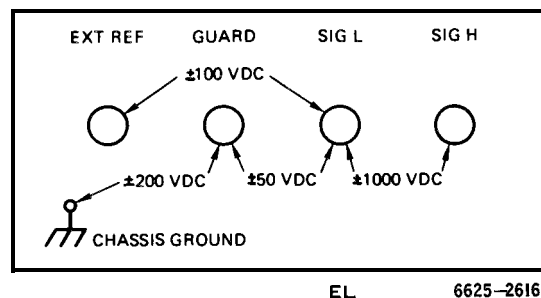


Figure 3-2. Maximum voltage which may be applied to inputs of AN/GSM-64A without causing damage.

f. Connect black-covered clip of test lead set to dc common of voltage source and red-covered clip to voltage source.

g. The voltmeter will select the proper range automatically, displaying the voltage, decimal point and polarity of the input to the SIG H jack with respect to the input of the SIG L jack.

h. To select a voltage range manually, depress AUTO RNG pushbutton switch, bringing it to the "out" position. Note position of decimal point. Depress RNG CHNG pushbutton switch as required to reach desired range.

3-6. Measuring DC Voltage Ratio

a. Depress the R(%) pushbutton switch.

b. Insert yellow plug of test lead (P/N 34-66) into EXT REF input jack of instrument.

c. Place EXT REF VDC toggle switch in proper position as determined by external reference voltage to be applied; the switch must be in the 10-1 position for an input of from ± 1 volt to ± 10 volts and must be in the 100-10 position for an input of from ± 10 volts to ± 100 volts.

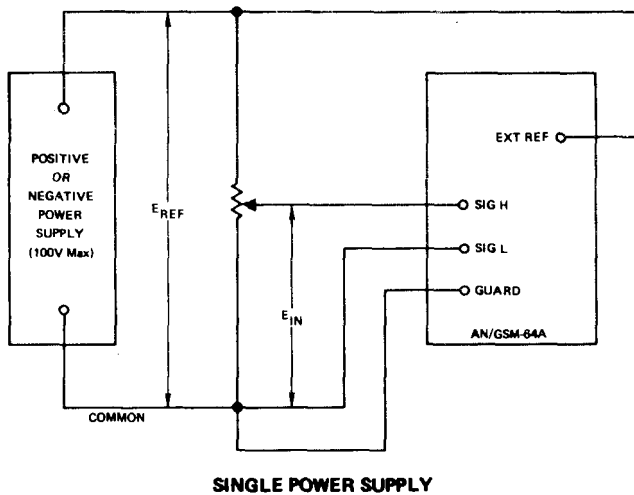
d. Connect test lead set to voltmeter and to input voltage source as described in paragraph 3-5c through f.

CAUTION

Do not apply more than ± 100 volts between the EXT REF input jack and SIG L input jack (fig. 3-2).

NOTE

The AN/GSM-64A makes a three-terminal measurement in the ratio mode. Therefore, a common connection between the input source and the reference source is required. See figure 3-3



for typical ratio application connections. The common connection must be identified and connected to signal low of the AN/GSM-64A.

e. Connect yellow-covered clip of test lead to external reference voltage source.

f. The readout of the instrument will display the ratio of the input voltage to the external reference voltage in percent. The polarity displayed will be the polarity of the input voltage.

3-7. Stopping Procedure

To stop the digital voltmeter, depress PWR ON pushbutton switch, bringing it to the "out" position. Disconnect test leads and remove power cord from ac power source.

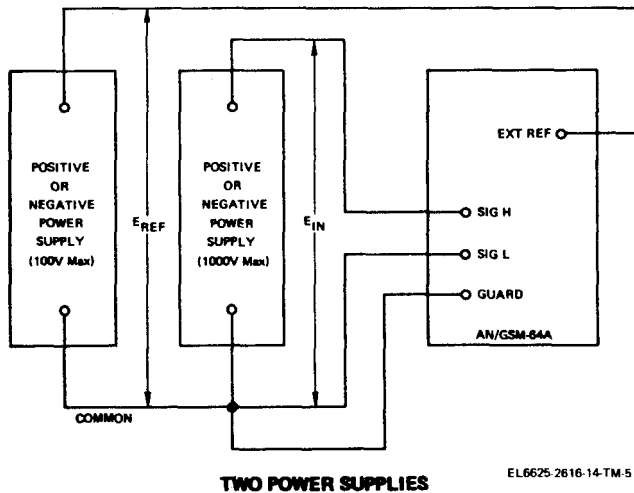


Figure 3-3. Connections for typical ratio applications.

CHAPTER 4

OPERATOR AND ORGANIZATIONAL MAINTENANCE

4-1. Scope of Operator and Organizational Maintenance

The maintenance duties assigned to the operator and organizational repairman of Digital Voltmeter AN/GSM-64A are listed below with a reference to the paragraphs covering the specific maintenance functions. These procedures do not require special tools or test equipment.

- a. Operator's daily preventive maintenance checks and services (para 4-4).
- b. Operator's weekly preventive maintenance checks and services (para 4-5).
- c. Operator's monthly preventive maintenance checks and services (para 4-6).
- d. Operator's quarterly preventive maintenance checks and services (para 4-7).
- e. Cleaning (para 4-8).
- f. Touchup painting (para 4-9).
- g. Troubleshooting (para 4-10).
- h. Organizational repairs (para 4-12).

4-2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. *Systemtic Care.* The procedures given in paragraphs 4-3 through 4-7 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. *Preventive Maintenance Checks and Services.* The preventive maintenance checks and services charts (para 4-4 through 4-7) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and what the normal conditions are. If a defect cannot be remedied by the operator, higher category of maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

4-3. Preventive Maintenance Checks and Service Periods

Preventive maintenance checks and services are required daily, weekly, and quarterly.

a. Paragraph 4-4 specifies checks and services that must be accomplished daily and under the special conditions listed below.

- (1) When the equipment is initially installed.
- (2) When the equipment is reinstalled after removal for any reason.
- (3) At least once each week, if the equipment is maintained in a standby condition.

b. Paragraphs 4-5 through 4-7 specify additional checks and services that must be performed on a weekly, monthly, and quarterly basis, respectively.

4-4. Operator's Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness	Check to see that the equipment is complete	Para 1-6, fig 1-1.
2	Controls	Check the mechanical action of each switch for smooth non-binding operation. Also check for proper operation of the pushbutton switch detents and interlocks.	
3	Preliminary	Check front panel switch for preliminary setup	Para 3-4a.

Sequence	Item	Procedure	References
4	Preliminary	Check power-selection switch position -----	Para 2-3c.
5	Preliminary	Plug test lead set into front panel input jacks and short leads together.	Para 2-5c, d, and e.
6	Preliminary	Plug power cord into selected ac outlet.	
7	PWR ON switch.	Depress the PWR ON pushbutton switch. Observe the readout illuminate (six digits, a decimal point, and a polarity sign).	
8	AUTO RNG switch	Depress the AUTO RNG pushbutton switch. Observe that the decimal is located in the readout as follows: XX. XXXX. The digits displayed should be all zeros; however, if the instrument has not been completely warmed up (approximately 30 minutes), or if it has not been adjusted for zero (para 2-5), the last digit may display a 1 or a 2.	
9	RNG CHNG switch	Depress the AUTO RNG switch to bring it to the "out" position. Depress the RNG CHNG switch several times. Observe that the decimal moves each time the RNG CHNG switch is depressed and that its locations are as follows: XX.XXXX, XXX.XXX, and XXXX.XX.	
10	R(%) switch	Depress the R(%) switch and place the EXT REF VDC switch in the 10-1 position. The reading should be + or - 120000. Depress the RNG CHNG switch several times. Observe that the decimal moves each time the RNG CHNG switch is depressed and that its locations are as follows: 120.000, 1200.00, and 12000.0. Place the EXT REF VDC switch in the 100-10 position. Observe that depressing the RNG CHNG switch several times will move the decimal to the following locations: 12.0000, 120.000, and 1200.00.	

4-5. Operator's Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Power cord	Check the outer covering (jacket) of the power cord for cuts, cracks, or abrasions. Check connector for bent contacts, cracked insulation, or evidence of arcing.	
2	Input cables	Check the outer covering (jacket) of the input cables for cuts, cracks, or abrasions. Check the insulation of the conductors in the cables for damage. Check the jaws of the alligator clips for good gripping action. Check the banana plugs for corroded or deformed contacts which would prevent good electrical contact with mating jacks. Warning: A damaged input cable is a safety hazard and should be replaced or repaired immediately.	
3	Exterior surfaces	Clean the exterior surfaces including the front panel and readout window.	Para 4-8a,
4	Metal surfaces	Examine exposed metal surfaces for corrosion. Touch up paint as required.	Para 4-9.

4-6. Operator's Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Interior of instrument	Clean interior of chassis	Para 4-8c, (para 4-8b for access).
2	Transformer terminals	Inspect terminals on power transformer for evidence of dirt or corrosion.	Para 4-8b for access.
3	Input jack terminals	Inspect input jack terminals for evidence of loose connections, dirt, or corrosion.	Para 4-8b for access.
4	Switch terminals	Inspect switch terminals for evidence of dirt or corrosion ..	Para 4-8b for access.
5	C o m p o n e n t s	Inspect internal components (resistors, diodes, capacitors, etc.) for cracks, blistering, broken leads, dirt or corrosion.	Para 4-8b for access.

4-7. Organizational Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Publications	Check to see that all publications are complete, serviceable, DA Pam 310-4. and current.	
2	Modifications	Check DA Pam 310-7 to determine if new applicable MWO's TM 38-750 and DA Pam 310-7. have been published. All URGENT MWO'S must be applied immediately. All NORMAL MWO's must be scheduled.	
3	Spare parts	Check all spare parts (operator and organizational) for App B. general conditions and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisition,	

4-8. Cleaning

a. Exterior Cleaning. The exterior surfaces should be clean and free of dust, dirt, and grease,

(1) Remove dust and loose dirt with a clean, sof cloth.

(2) Remove dust and dirt from the input jacks with a soft brush.

(3) Remove grease and ground-in dirt from the case with a soft cloth dampened with a mild solution of detergent or soap and lukewarm water.

CAUTION

Care should be taken in cleaning the readout window. An adhesive is used to bond the window to the front panel and too much pressure may separate the window from the panel.

(4) Clean the front panel, readout window, and pushbuttons with a soft cloth dampened with a mind solution of detergent or soap and lukewarm water.

b. Access to Components. Perform the following steps to gain access to internal components for inspection and cleaning.

(1) *Cover removal.*

(a) Turn fuse holder cap counterclockwise and remove it from the body of the fuse holder.

(b) Remove the two screws attaching bottom cover to chassis and remove bottom cover.

(c) Remove the two screws attaching the top cover to chassis and remove top cover.

(2) *Shield removal.*

(a) Remove the four screws attaching the bottom shield and remove shield.

(b) Remove the four screws attaching the top shield and remove top shield.

(3) *Signal conditioning assembly mounting.*

(a) Remove the six screws attaching the signal conditioning assembly to the chassis (fig. 4-1).

(b) Place the signal conditioning assembly upright in the mounting slots provided (fig. 4-1).

c. Interior Cleaning. The interior of the instrument should be clear and free of dust and dirt. Remove "any accumulated dust or dirt with low-pressure clean, dry air. Reassemble the instrument in reverse order of disassembly.

4-9. Touchup Painting

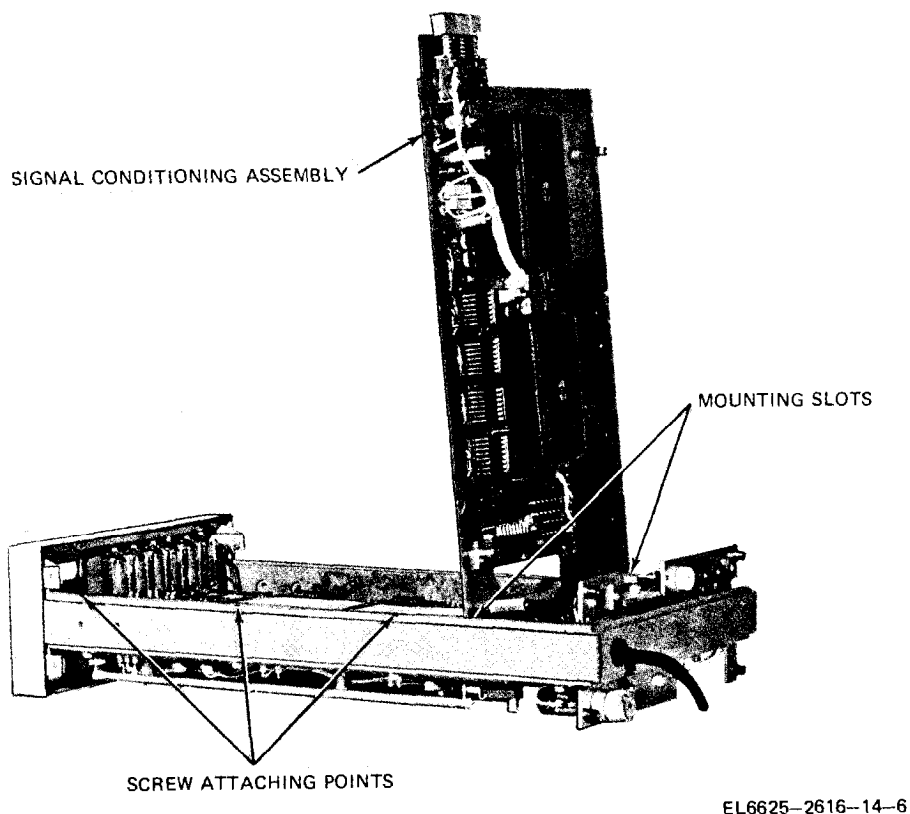
CAUTION

Do not use steel wool for rust removal. Minute particles of steel wool may enter the chassis of the instrument and cause harmful arcing, electrical shorting, or grounding of circuitry.

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB 746-10.

4-10. General Troubleshooting Information

Operator and organizational troubleshooting this equipment is based upon the operational check contained in the daily preventive maintenance checks and services chart. To troubleshoot the equipment, perform all functions in the chart (para 4-4) and proceed through the items until an abnormal condition or result is observed. When an abnormal condition is observed, note the item number and turn to the corresponding number in the troubleshooting chart (para 4-11). Perform the checks and corrective actions indicated in the troubleshooting chart. If the cor-



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Figure 4-1. Signal conditioning assembly mounting.

rective measures indicated do not result in correction of the trouble, or if the corresponding number does not appear in the troubleshooting chart, higher level maintenance is required. Para-

graph 4-12 (referenced in the chart) contains additional information and step-by-step instructions for effecting repair of the equipment during the troubleshooting procedures.

4-11. Organizational Troubleshooting Chart

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
1	Readout tubes and incandescent lamps do not light when PWR ON switch is depressed.	<p>a. Improper ac line cord connection.</p> <p>b. Defective ac line fuse.</p> <p>c. Power-selection switch in 230 position with 115 volts ac applied.</p>	<p>a. Check ac line cord and connector plug,</p> <p>b. Check ac line fuse (para 4-12a). <i>Note.</i> Defective line fuse may indicate some other trouble. If fuse replacement continues to result in blown fuse, higher level of maintenance is required.</p> <p>c. Check position of power-selection switch.</p>
2	A single readout tube does not light.	Defective readout tube	Replace readout tube (para 4-12b).
3	Readout will not come to all zeros with input leads shorted together.	<p>a. Insufficient warmup time</p> <p>b. Zero adjustment (ZA) required . . .</p>	<p>a. Allow 30 minutes for complete warmup.</p> <p>b. Zero the readout (para 2-5).</p>

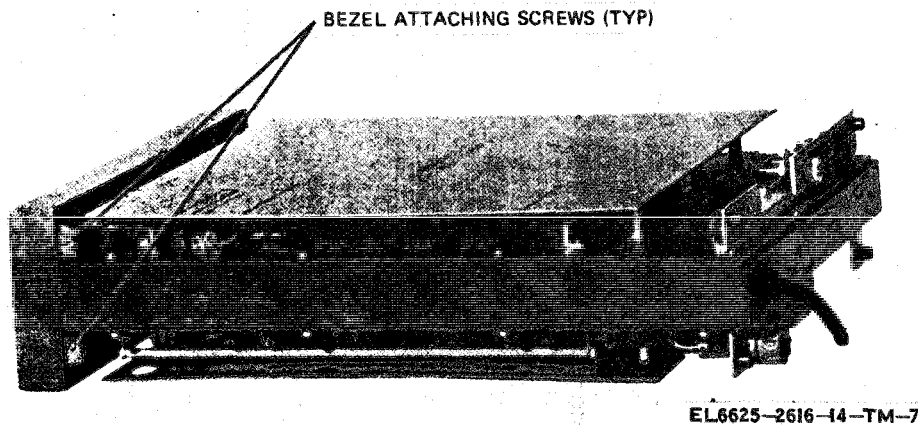


Figure 4-2. Bezel removal.

4-12. Organizational Repair

a. Replacement of Fuse.

(1) Turn the fuse holder cap counterclockwise and remove it from the body of the fuse holder.

(2) Remove the defective fuse from the fuse holder cap.

(3) Insert a new fuse in the fuse holder cap.

NOTE

Be sure the fuse is a "slow-blow" type with a 0.25 ampere rating.

(4) Replace fuse holder cap in the fuse holder body and turn it clockwise to tighten.

b. Replacement of Readout Tube.

(1) Remove top and bottom covers (para 4-8b(1)).

(2) Remove bezel and front panel by removing the four screws attaching bezel to chassis (fig. 4-2).

(3) With a rocking motion, carefully pull the faulty tube from its socket.

(4) Install new tube, using care to properly align pins into tube socket.

(5) Replace bezel with front panel and replace top and bottom covers.

CHAPTER 5

FUNCTIONING

5-1. Introduction

The electrics of the AN/GSM-64A Digital Voltmeter may be divided into two basic sections: a signal conditioning section and a digitizing section. The signal conditioning section processes dc voltage inputs into a normalized dc analog signal. The digitizing section accepts the normalized dc analog signal from the signal conditioning section and converts it to a visual digital display.

5-2. Signal Conditioning Section-General

a. The signal conditioning circuits are contained on the signal conditioning circuit board assembly. These circuits provide-

- (1) Accurate attenuation of large input voltages.
- (2) Filtering of the input signal.
- (3) Over-voltage protection for solid-state components.
- (4) A low source impedance to the digitizing section.

b. Three pushbutton switches on this circuit board allow the instrument to operate as a dc voltmeter, a radiometer, or as an ac voltmeter when an ac converter has been installed.

c. The volts dc mode has three ranges: 10 volts, 100 volts, and 1,000 volts full scale. Any range may be selected by depressing the range change pushbutton or the instrument may be operated in the auto-range mode. In the auto-range mode, the range attenuator is set to the proper range by logic circuits which actuate the range relays.

5-3. Signal Conditioning Section Circuit Description

(fig. 5-1 and 9-3)

a. Signal high is connected to the attenuator input, pin 4. Range selection provides the proper voltage level into pin 8 of the buffer-amplifier. Signal filtering is provided by C1 and C2. A volt-

age protective circuit prevents damage to U5. This circuit is formed by diodes CR3, CR4, CR5, CR6, and transistors Q1 and Q2 with associated bias resistors. Voltage is limited at just over 12 volts.

b. U5 is connected to form an extremely high input impedance, low output impedance device which feeds the digitizing circuits on the main circuit board.

5-4. Digitizing Section-General

The digitizing section functions to accept the normalized dc analog signal and process it so that it may be displayed digitally with the proper decimal and polarity signs. The digitizing circuits are located on the main circuit board. In this chapter, paragraphs 5-5 and 5-6 describe the overall operation of the digitizing section and paragraphs 5-7 through 5-12 describe other main elements of the digitizing circuitry.

5-5. Digitizing Section Principle of Operation

The ac line frequency is used to trigger the basic timing for the digitizing circuits. A number of ac line pulses are processed, initiating the start of a flip-flop. This flip-flop is used to gate on a 500 KHz oscillator which drives a frequency counter. At the 100,000 count the flip-flop is reset, thus generating a 200-millisecond wide pulse. This 200-millisecond period is used to allow an integrating capacitor to charge from the signal conditioning circuits. At the end of the 200-millisecond period, the frequency counter is reset and the charged integrating capacitor is switched to a constant current reference supply which allows a controlled discharge to occur. The frequency counter proceeds to count pulses from the 500 KHz oscillator until the capacitor has discharged to its precharged condition, at which time a null detector circuit ends the cycle. The frequency counter displays the voltage reading in terms of pulses counted during the discharge period. When the 500 KHz oscillator stops, the ac line pulses again trigger the flip-flop and the cycle is repeated.

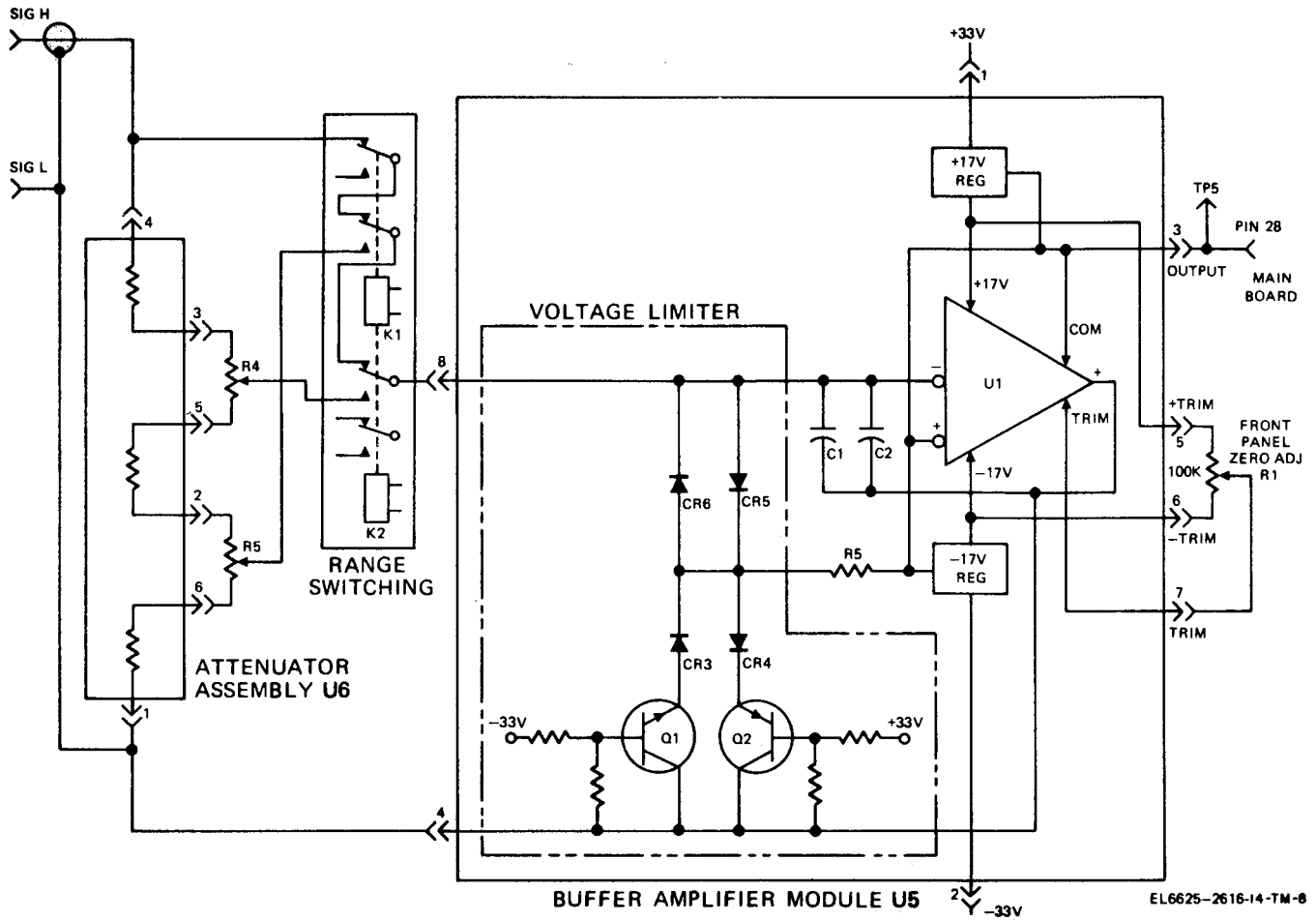


Figure 5-1. Signal conditioning circuits, simplified schematic diagram.



5 - 3

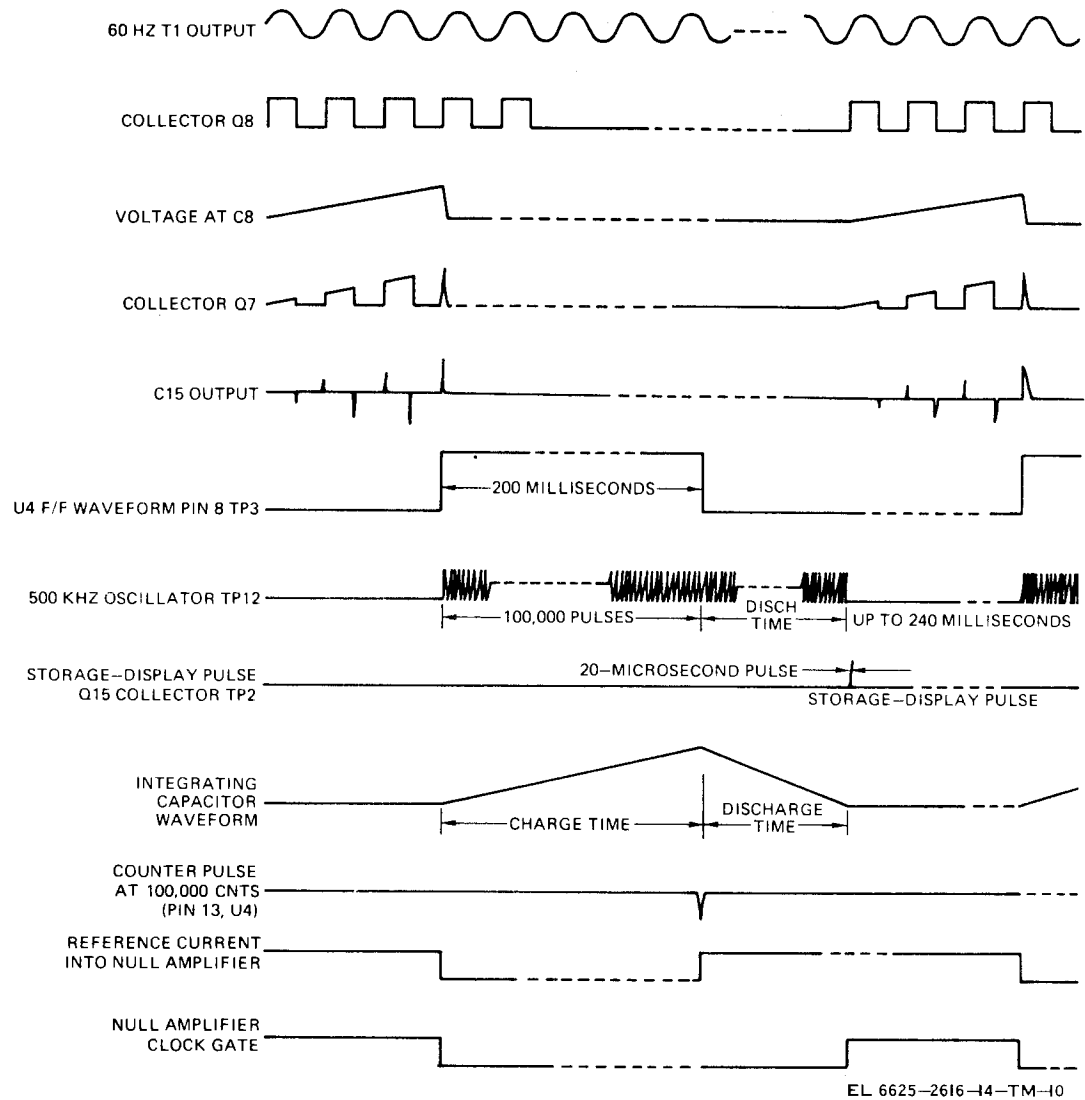
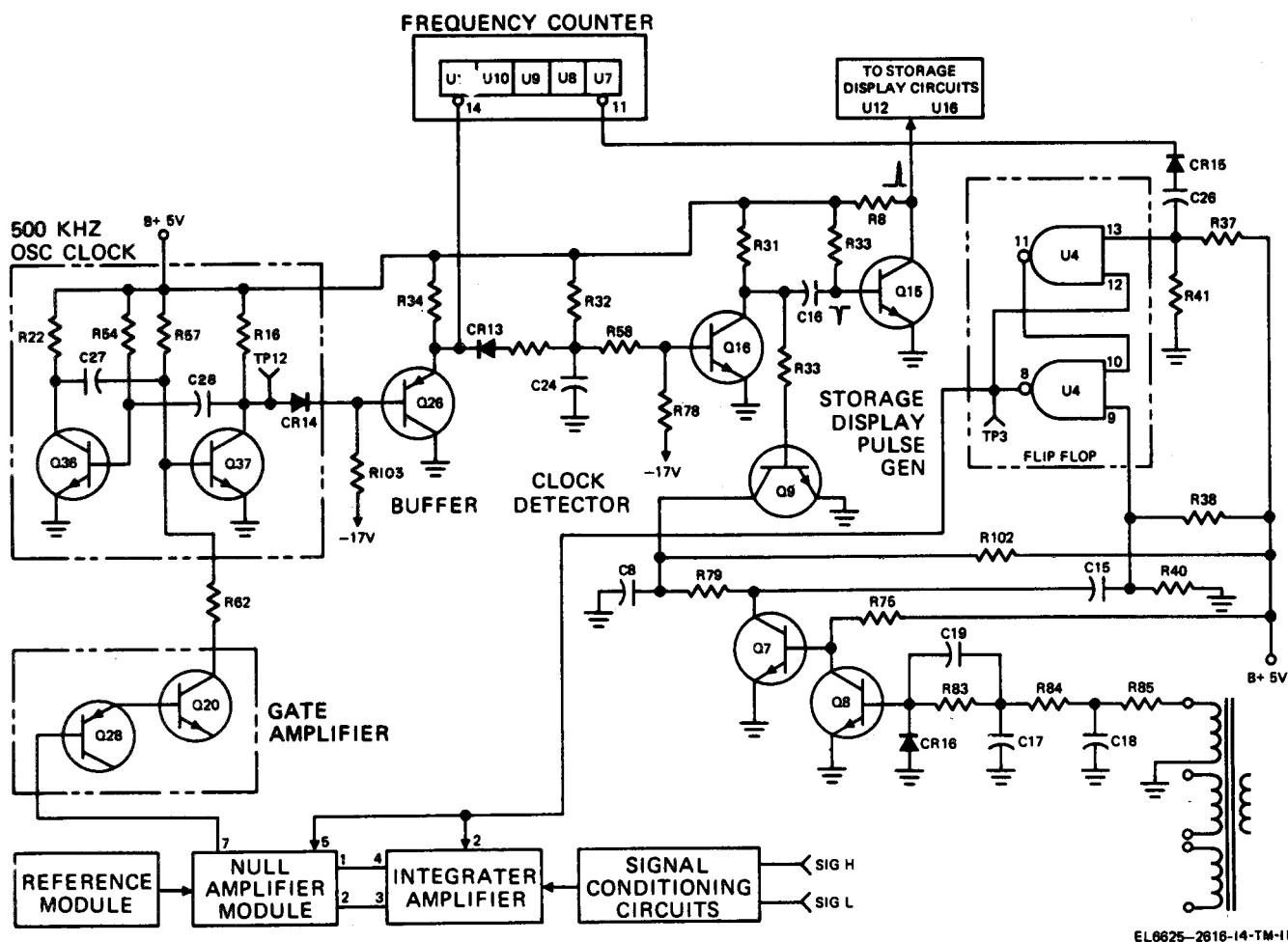


Figure 5-3. Digitizing waveforms.



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Figure 5-4. Timing circuits, simplified schematic diagram.

5-6. Digitizing Section Circuit Description

(fig. 5-2, 5-3, 5-4, and 9-4)

Basic timing for the digitizing circuits is produced as described in the following paragraphs.

a. A 60 Hz output from transformer T1 (pin 2, secondary 3) feeds R83, R84, R85 and associated capacitors C17, C18, and C19 into diode CR16 and transistor Q8. This results in a square-waveform output at the collector of Q8 and the base of Q7. Normally Q7 feeds its square-wave output into differentiating capacitor C15 which forms the sharp pulses that trigger flip-flop U4. The change in state of U4 appears at pin 8 and feeds pin 2 of the integrating amplifier and pin 5 of the null amplifier. At the instant U4 changes state, switching circuits in the null amplifier turn on a 500 KHz oscillator Q36, Q37 through gate amplifiers Q20, Q28, and R62. Circuits in the integrating amplifier switch on an integrating capacitor, C1 (physically located in the null amplifier). C1 begins charging to the signal input level.

b. The 500 KHz oscillator drives buffer transistor Q26 which feeds the frequency counter (U11, U10, U9, U8, and U7) and Q16. Q16 detects the presence of an oscillator frequency and turns on Q9 through R76. This causes Q9 to shunt C8, discharging it and removing the collector voltage from Q7 thereby ending further triggering of U4.

c. The clock frequency oscillator continues to drive the frequency counters until a count of 100,000 is reached (and a time period of 200 milliseconds). At the 100,000th count, the counters are zeroed and the output of U7, pin 11, resets flip-flop U4.

d. As U4 resets, its changed output level at pin 8 is coupled to both the integrating amplifier (pin 2) and the null amplifier (pin 5). Switching transistors in the integrating amplifier disconnect the integrating capacitor charging circuit. Switching circuits in the null amplifier connect the constant current reference source (reference assembly) allowing a controlled discharge of the integrating capacitor to take place.

e. The integrating capacitor continues to discharge until it reaches its precharged condition at which time the null amplifier senses the capacitor level and switches off the clock frequency through transistors Q20 and Q28. The discharge time of the integrating capacitor will vary from

0 to 240 milliseconds, depending on input signal levels.

f. The termination of clock frequency pulses is sensed by Q16 and its associated circuitry, CR13, C24, R4, R32, R58, and R31. This circuit produces a DC level shift at the collector of Q16 and to the base of Q9. The presence of clock pulses forces Q16 into a nonconducting state which turns Q9 on hard, discharging C8 as described earlier. When clock pulses cease, the collector voltage of Q16 drops and is coupled as a short negative pulse through Q16 into Q15. The pulse is fed to pins 4 and 13 of U12 through U16, storing the output of the frequency counter. The readout now displays the number of clock pulses counted during the discharge period of the integrating capacitor.

g. The absence of clock pulses allows C8 to slowly charge, building up trigger pulses at C15 which again fire flip-flop U4, repeating the digitizing cycle and provides a 200-millisecond delay between digitizing cycles.

5-7. Integrator Amplifier

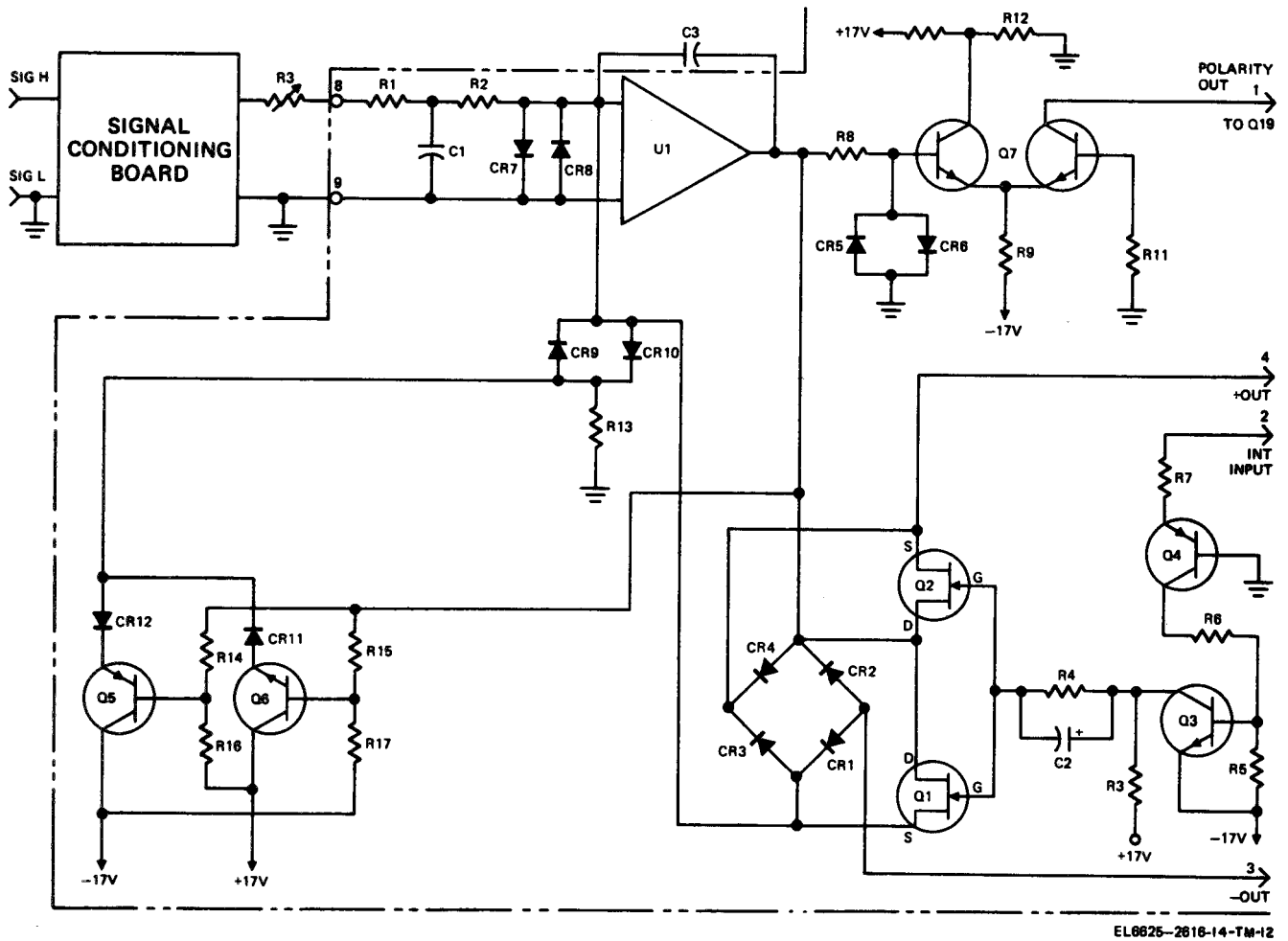
(fig. 5-5)

The output of the signal conditioning circuit board appears at pin 8 of the integrator amplifier. R1, C1, and R2 provide further filtering of the input signal. CR7 and CR8 limit the input to U1. U1 and C3 form a feedback integrating circuit. CR9, CR10, R13, and the circuit formed by Q5, Q6, CR11, CR12, and associated resistors prevent large saturating voltages from building up across U1. U1 feeds R8 and the polarity indicating circuits, described separately. U1 also feeds diode bridge CR1, CR2, CR3, and CR4, placed in a feedback loop around U1. The bridge provides a single polarity output (regardless of input polarity) to charge the integrating capacitor which is connected externally to the output pins 3 and 4. The bridge is allowed to charge the integrating capacitor by switching transistors Q1 and Q2 when Q3 and Q4 are pulsed by the integrating pulse at pin 2.

5-8. Null Amplifier

(fig. 5-6)

a. The diode bridge output from the integrator amplifier (U25) feeds pins 1 and 2 of the null amplifier (U26). The integrating capacitor is connected across the input pins which also feed the gate inputs of field effect transistor (FET) Q1. Q1 is connected as a differential amplifier and uses



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Figure 5-5. Integrator amplifier, simplified schematic diagram.

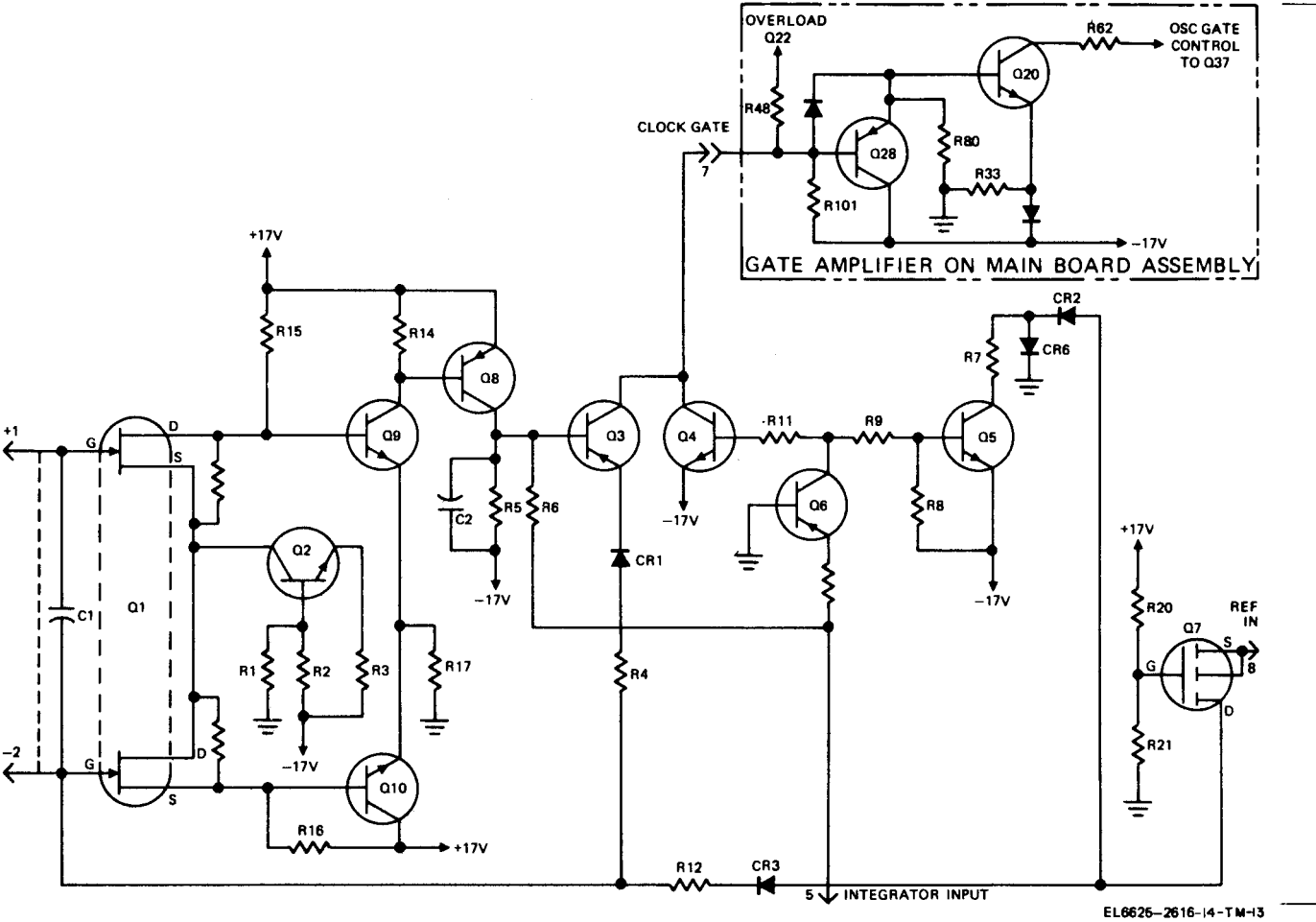


Figure 5-6. Null amplifier, simplified schematic diagram.

Q2 as a common source load. Q9 and Q10 provide symmetrical loading for Q1 with Q8 providing an unbalanced output. When the input integration pulse appears at pin 5, Q6 is turned on, actuating Q4 and the clock gate amplifier externally connected via pin 7. This allows the clock frequency to start. Q6 also turns on Q5 simultaneously with Q4. Q5 functions to provide a path for the reference current coming from the drain of constant current, source Q7 during integration time.

b. At the end of the integration period, Q6, Q4, and Q5 switch off. Q3 senses the charge on C1 (through amplifiers Q1, Q8, and Q9) and keeps the clock gate on. The reference discharge current flows from the drain of Q7 through CR3, C12, and (C1, discharging C1. When Q1 senses that C1 has discharged, Q3 is turned on, permitting the current from Q7 to flow into pin 7 and control the clock gate amplifier Q28 and Q20 which stops the 500 KHz oscillator.

5-9. Reference Supply

(fig. 5-7)

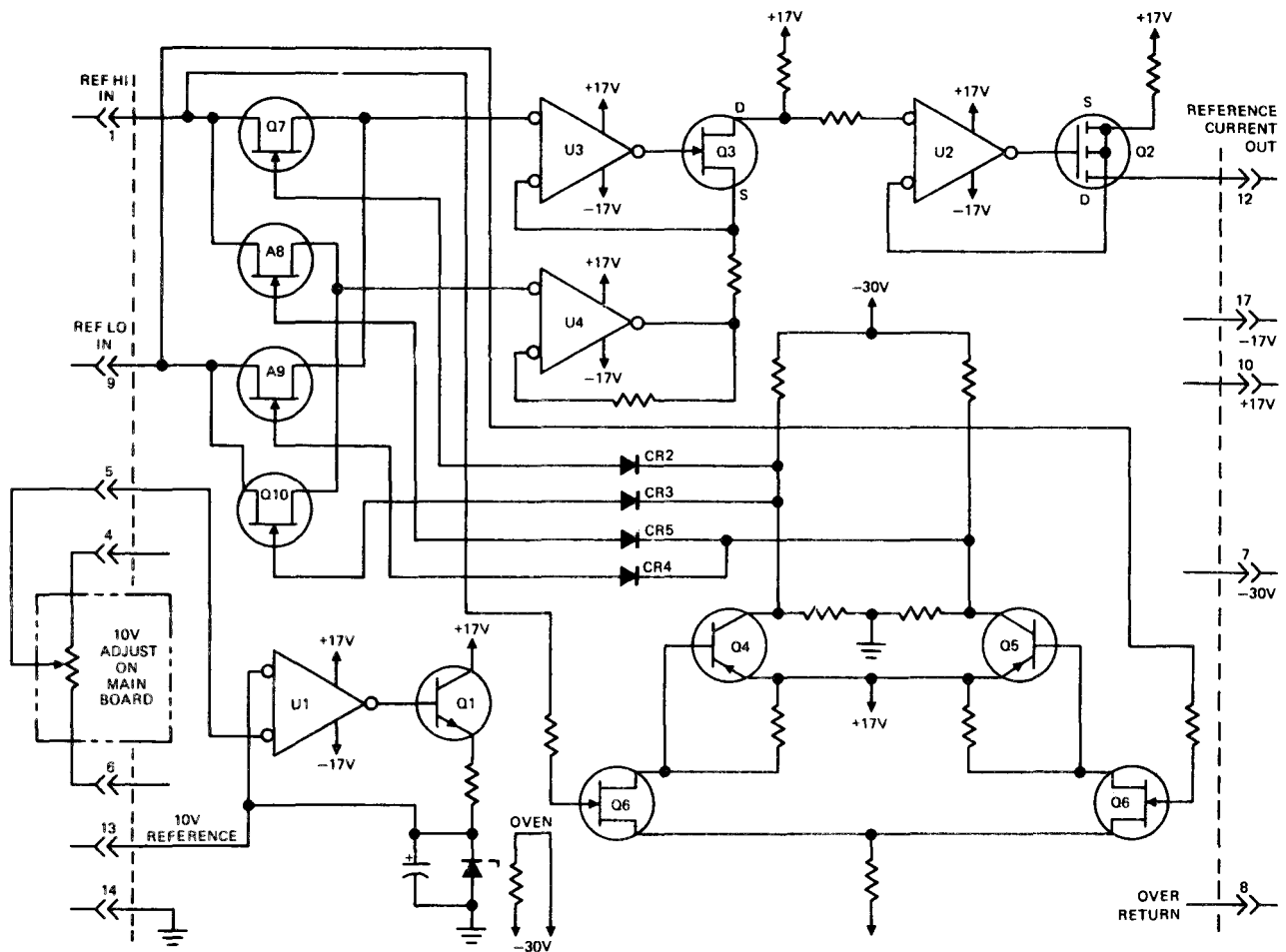
a. The reference supply (U24) incorporates circuitry to provide the following functions:

(1) Produce an accurate +10 volts which is used as a reference for all the other regulated supplies.

(2) Product an accurate reference current which is used to discharge the integrating capacitor.

(3) Electronically switch external reference voltages of either polarity to a unipolar controlled reference discharge current.

b. Operational amplifier U1, transistor Q1, Zener CR1, and associated circuitry produce the accurate + 10-volt reference at pin 13. Amplifier U2 and transistor Q2 produce the accurate reference current which appears at pin 12.



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Figure 5-7. Reference supply, simplified schematic diagram.

c. Reference input pin 1 is switched externally by the front panel ratio switch to either the internal +10-volt reference or in the ratio mode to external bipolar voltages.

d. Q7, Q8, Q9, and Q10 act as polarity reversing switches which are controlled by Q4, Q5, and Q6, connected in a differential amplifier configuration. Differential outputs at Q4 and Q5 collectors, gate CR2, CR3, CR4, and CR5, switching the proper transistor pairs, Q7-Q9 or Q8-Q10. The outputs of Q7 and Q9 are fed to U3. The outputs of Q8 and Q10 are fed to U4. U4 feeds the differential input of U3, resulting in a unipolar output at pin 6 of U3 for an input of either polarity at pin of the reference supply. Q3 acts as a buffer for U3 and drives the reference current generator U2-Q2.

5-10. Polarity Indicating Circuit

a. The polarity indicating circuit begins at the output of U1, in the integrator amplifier (fig. 5-5). U1 feeds the integrating capacitor diode bridge circuit CR1, CR2, CR3, and CR4, the polarity indicating circuit input, R8, CR5, CR6, and Q7. R8, CR5, and CR6 protect differential amplifier Q7 from excessive signal out of U1. The output of Q7 appears on pin 1 of the integrator amplifier and is connected to the base of Q19. The state of Q19 determines which polarity lamp will light. The output of Q19 and timing signals from the digitizing circuits gate two sections of U23. U23 then controls a flip-flop (two sections

of U2, pins 8, 9, 10, and 11, 12, 13) which drive buffers (U3, pins 1, 2, 3, and Q11, Q12) capable of illuminating the proper polarity lamp.

b. The polarity signal at the collector of Q19 (fig. 5-8) is fed to pins 1 and 2 of buffer U2. Buffer output (pin 3) feeds a gate signal to pin 5 of U23. Pin 4 of U23 is held on continuously by U3 (pins 11, 12, and 13) which is used in conjunction with an ac converter. Pin 2 is gated by the 200-millisecond pulse from the output of the input integrating flip-flop (U4, pin 8) which also gates on by pin 11 of U7. The timing insures an optimum sampling of signal polarity.

5-11. Auto and Manual Range-General (fig. 5-9)

a. The range selecting circuits of the AN/GSM-64A may be operated by a front panel pushbutton or, set to automatically selected the proper range by depressing the auto-range pushbutton. In the manual mode, the range circuits are actuated by a pulse generated when the range change pushbutton is depressed, Range changes step from the highest range to the midrange, to low range and then to the highest range again. In the automatic mode, an up-range signal causes the automatic circuitry to select the highest range. A down-range signal will cause the circuitry to select the next lower range.

b. The auto-ranging circuitry is actuated by the presence of an up- or down-range signal. An up-range signal is generated when the fre-

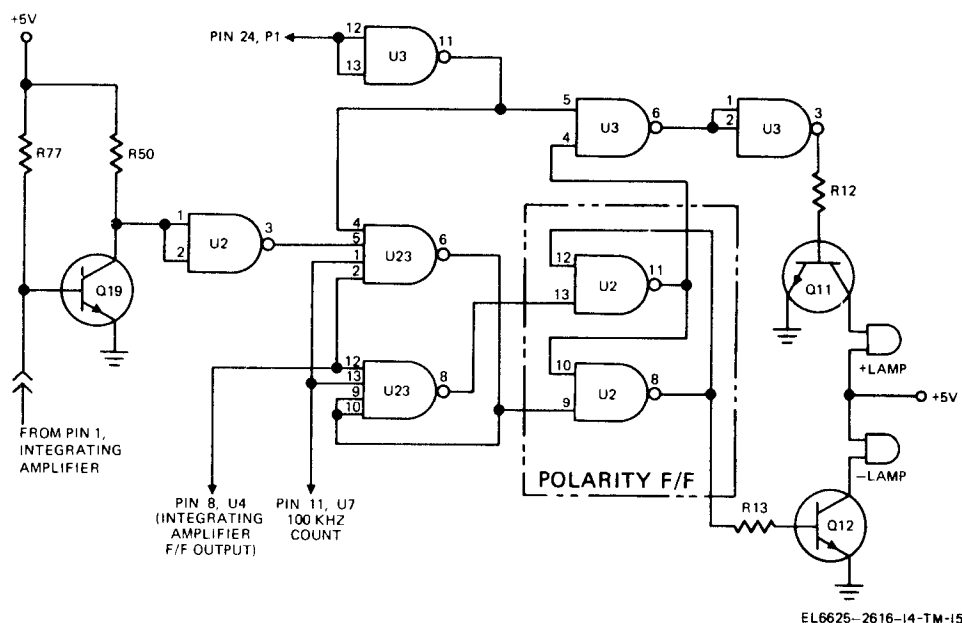


Figure 5-8. Polarity circuits, simplified schematic diagram.

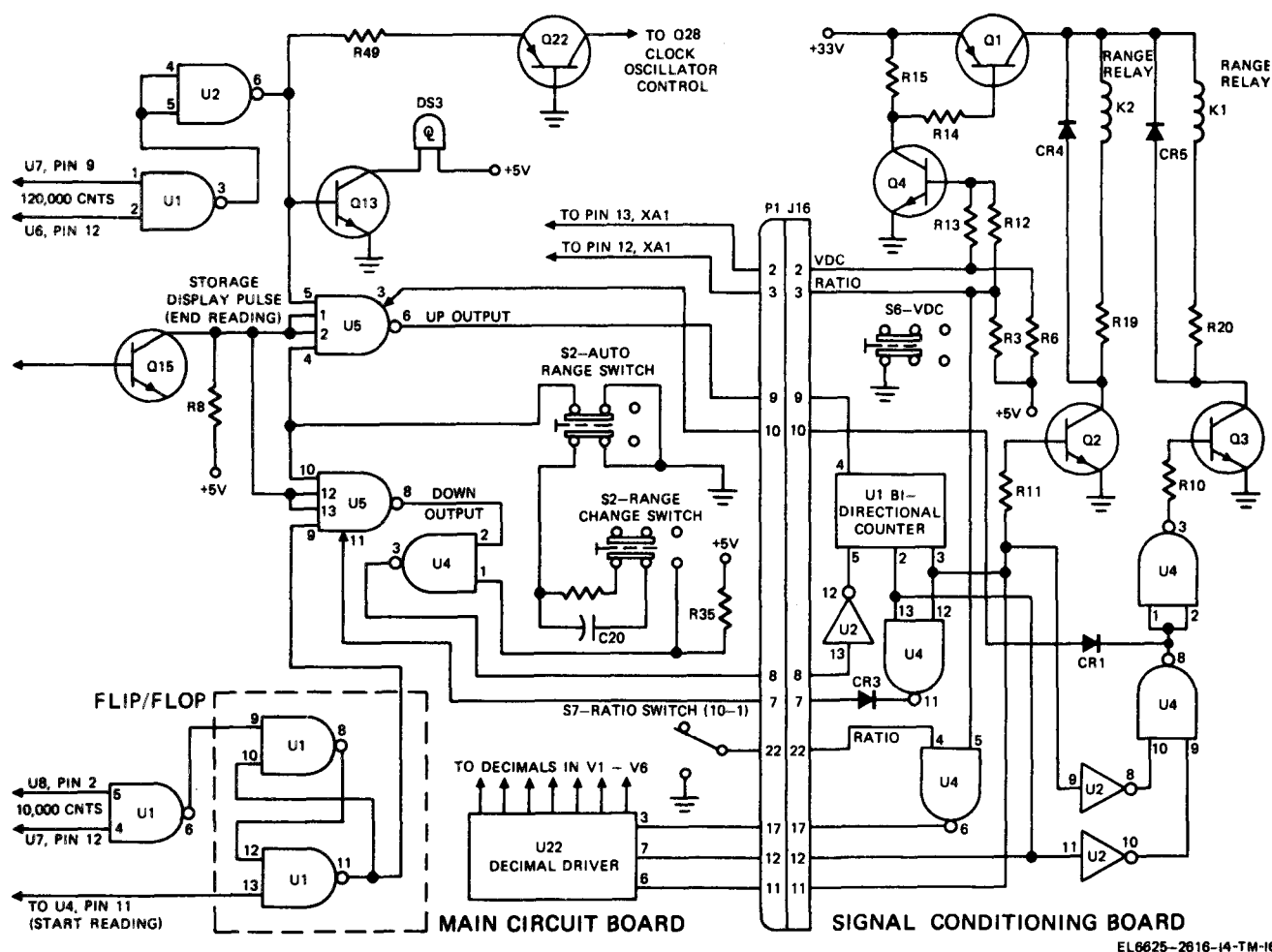


Figure 5-9. Auto/manual range circuitry, simplified schematic diagram.

quency counter counts 120,000 counts prior to the storage display pulse which occurs at the end of a reading. A down-signal is generated similarly when the counter counts 10,000 or less pulses before the storage display pulse occurs.

5-12. Auto and Manual Range-Circuit Description

a. U1 (pins 1, 2, and 3) detects the presence of 120,000 counts and drives buffer U2 (pins 4, 5, and 6). Pin 6 drives the following circuits.

- (1) Q13 which lights the overload lamp.
- (2) Q22 which shuts off the clock oscillator.
- (3) Pin 5 of U5.

b. U5 will produce an up-range signal at pin 6, when—

- (1) Pin 5 is turned on by a count of 120,000.

(2) Pins 1 and 2 are triggered by the storage display pulse (end of reading).

(3) Pin 4 is on through the auto-range switch, S2.

(4) Pin 3 is on from the bidirectional counter, U1 (on the signal conditioning board).

c. To generate a down-pulse at U5, pin 8, the following conditions must occur:

(1) Pin 10 must be on through the auto-range switch, S2.

(2) Pins 12 and 13 must be pulsed by the storage display pulse.

(3) Pin 9 must be held on by flip-flop U1, pin 11 when the above occurs.

(4) Pin 11 is held on by bidirectional counter, U1.

d. Flip-flop U1 is set by U4, pin 11, at the

beginning of each reading and remains on until a count of 10,000 occurs. If the 10,000 count occurs earlier than the storage display pulse, flip-flop U1 resets and prevents U5, pin 8, from down-pulsing.

e. The up-down outputs of U5 are fed to bi-directional counter U1 on the signal conditioning board via pins 8 and 9 of J16. Counter U1 outputs are decoded and feed range relay driver transistors Q2 and Q3 which actuate relays K1, K2, or neither. Counter outputs are also fed to pins 11 and 12 of J16 from which decimal driver U22 (located on the main circuit board) decodes the range information and illuminates the proper decimal readout.

f. In the ratio mode, U22 receives a third input at pin 3 from gate U4 (pins 4, 5, and 6) located on the signal conditioning board. U4 is actuated by front panel ratio switch, S8. The third input produces a decimal shift to correspond to the percentage reading required in the ratio mode.

g. Relay driver transistors Q2 and Q3 are powered through collector supply transistors Q1 and Q4. In the ac mode (if an ac converter has been installed), Q4 does not receive base bias through R12 or R13, which cuts off Q1 and prevents K1 and K2 from operating.

5-13. Integrated Circuit Logic Diagrams

The logic diagrams in figures 5-10 through 5-18 are provided to assist the repairman in understanding the internal circuitry of the integrated circuits and thereby their effect upon overall functioning of the AN/GSM-64A.

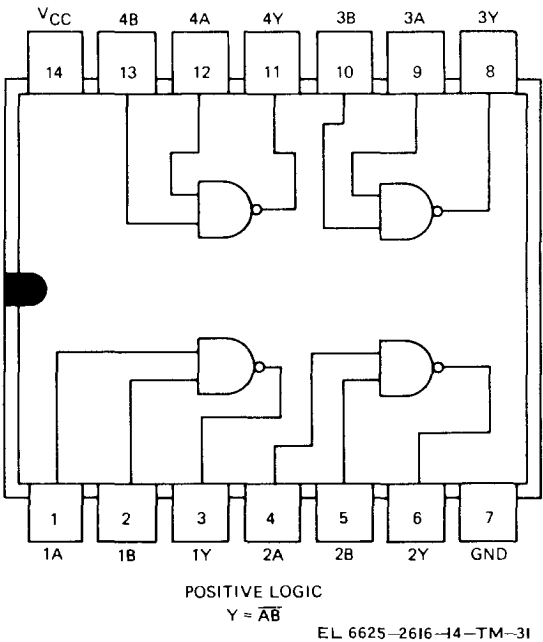


Figure 5-10. Types N7400A and MC846 P quadruple 2-input positive nand gate logic diagram.

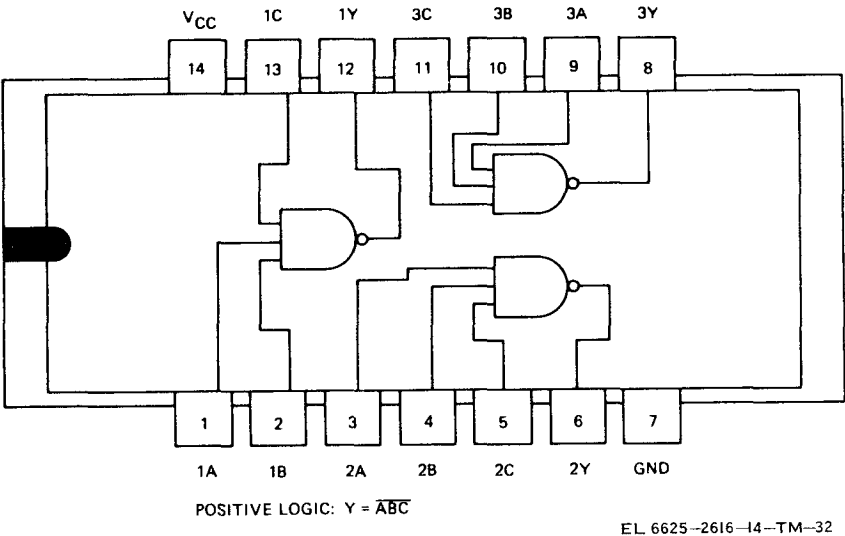


Figure 5-11. Type N7410A triple 3-input positive nand gate logic diagram.

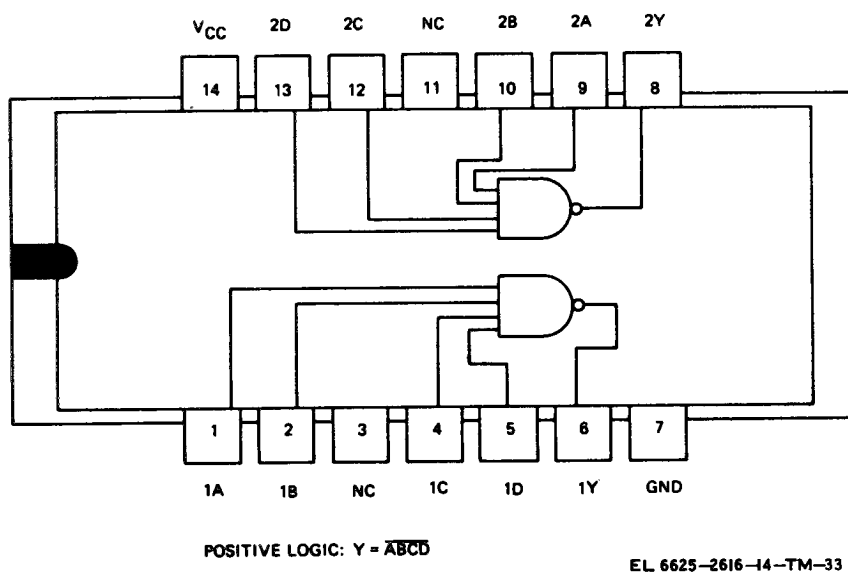


Figure 5-12. Type N7420A dual 4-input positive nand gate logic diagram.

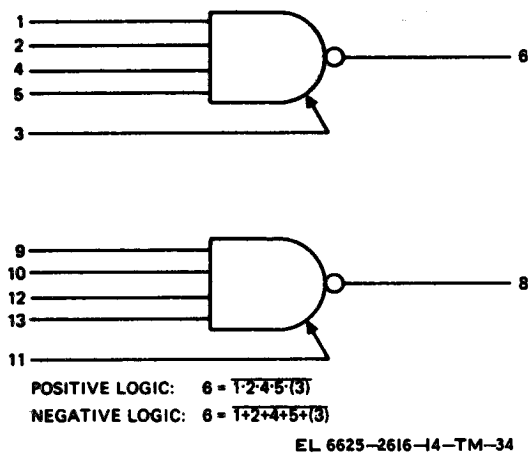


Figure 5-13. Type MC830P expandable dual 4-input nand gate logic diagram.

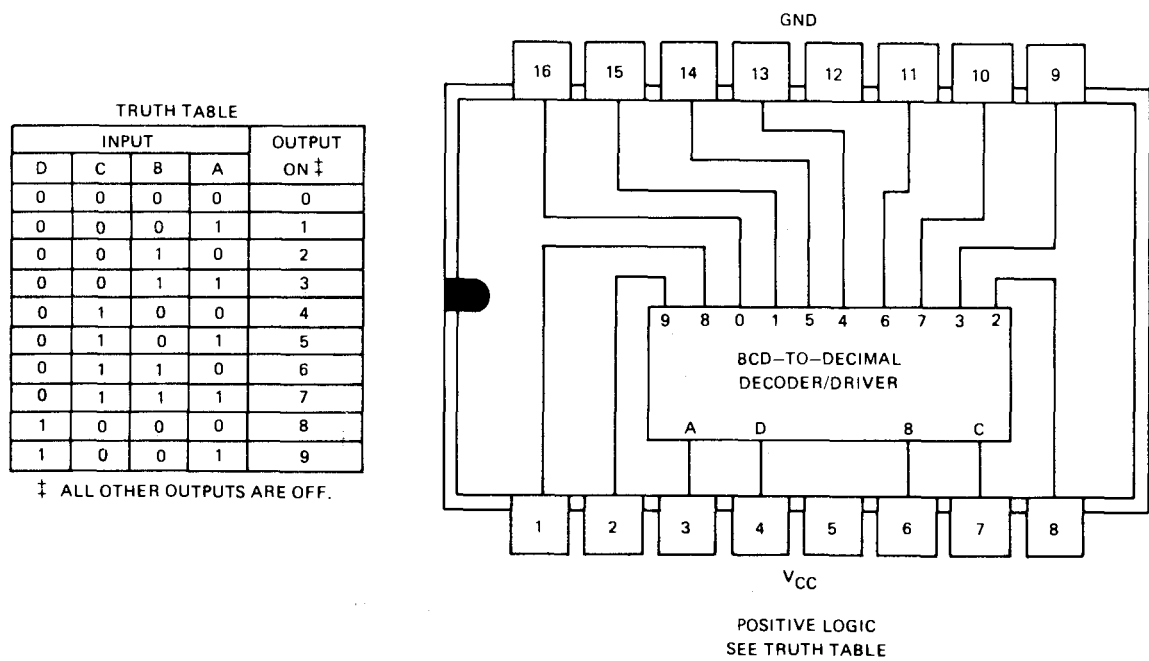
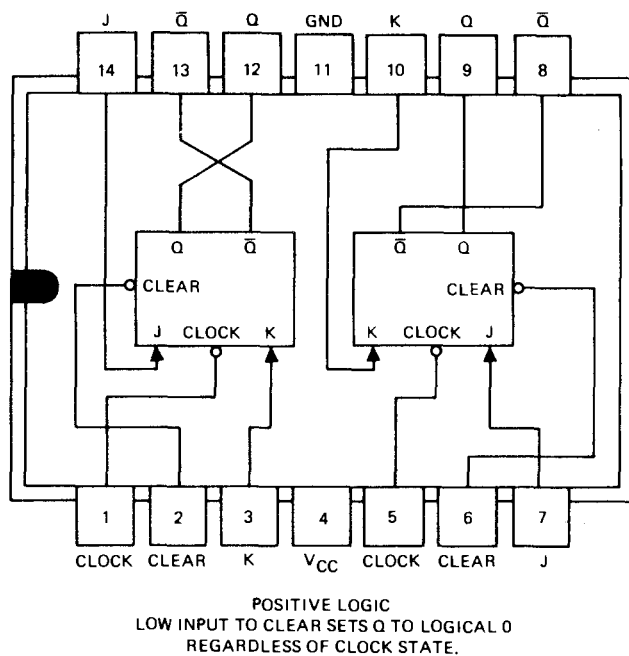


Figure 5-14. Type N7441B bcd-to-decimal decoder/driver logic diagram.



TRUTH TABLE (EACH FLIP-FLOP)		
t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	\bar{Q}_n

- NOTES:
1. t_n = BIT TIME BEFORE CLOCK PULSE.
 2. t_{n+1} = BIT TIME AFTER CLOCK PULSE.

Figure 5-15. Type N7473A dual j-k master-slave flip-flop logic diagram.

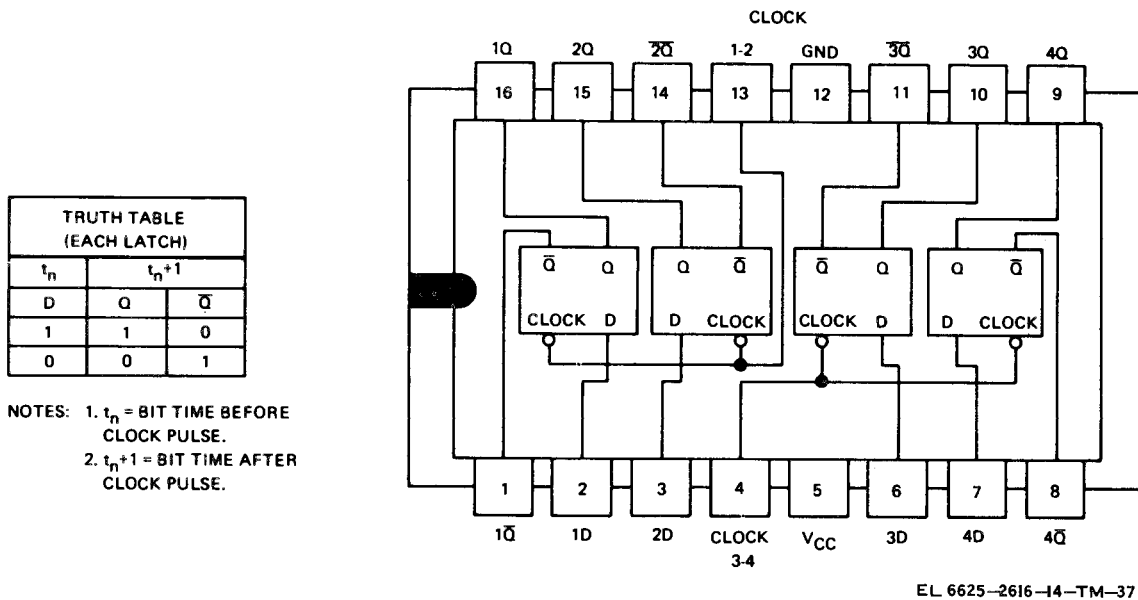


Figure 5-16. Type N7475B quadruple bistable latch logic diagram.

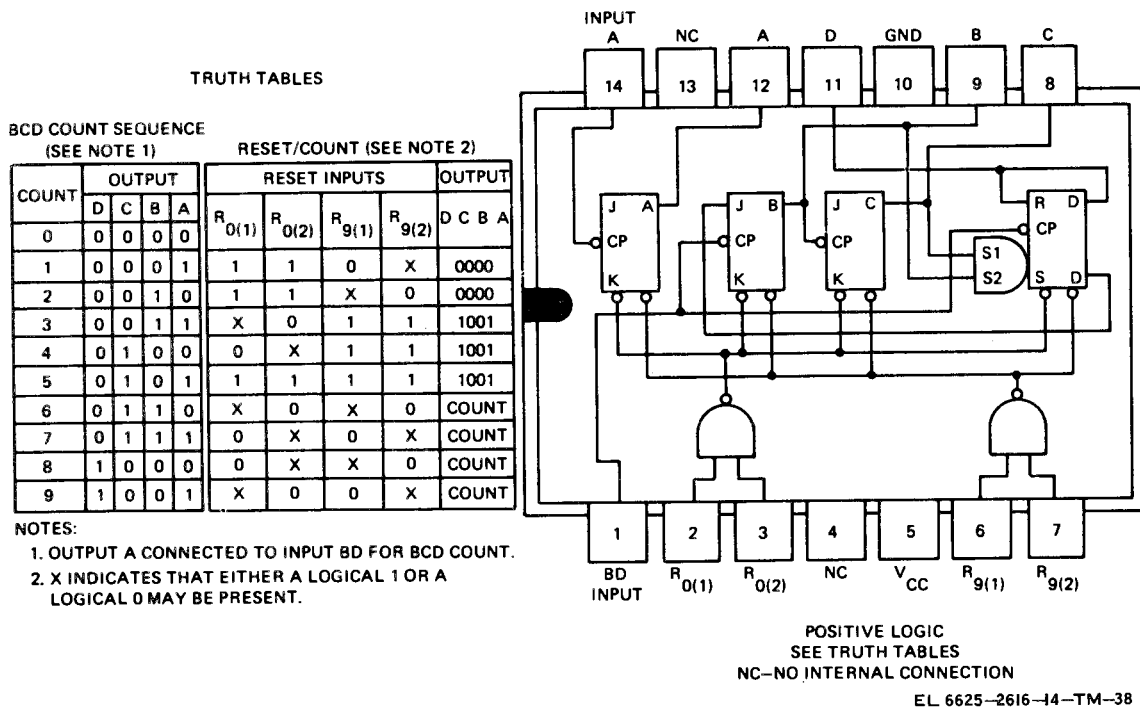
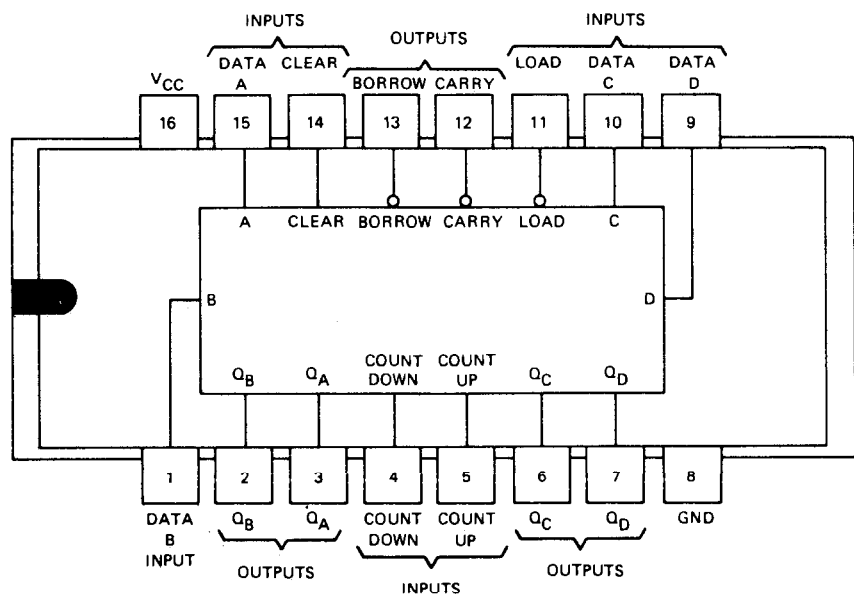


Figure 5-17. Type N7490A decade counter logic diagram.



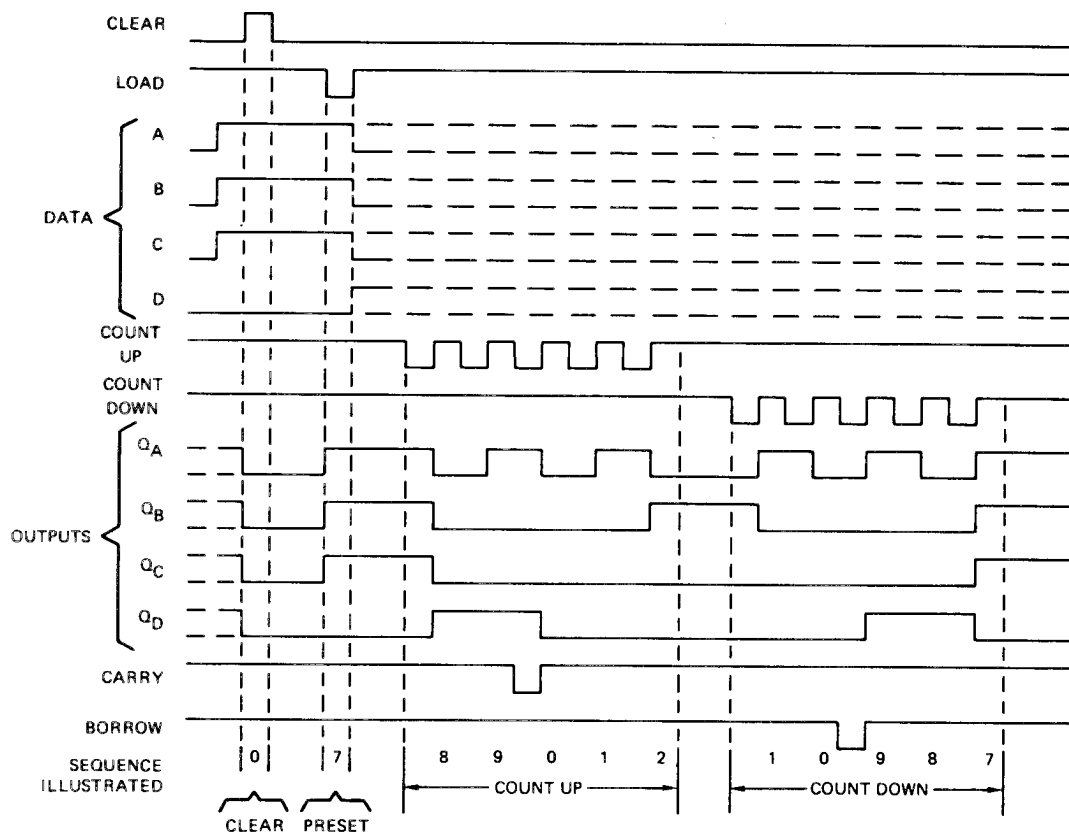
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Figure 5-18(1). Type 74192B synchronous 4-bit up/down counters logic diagram (part 1 of 2).

TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

ILLUSTRATED BELOW IS THE FOLLOWING SEQUENCE:

1. CLEAR OUTPUTS TO ZERO.
2. LOAD (PRESET) TO BCD SEVEN.
3. COUNT UP TO EIGHT, NINE, CARRY, ZERO, ONE, AND TWO.
4. COUNT DOWN TO ONE, ZERO, BORROW, NINE, EIGHT, AND SEVEN.



- NOTES: A. CLEAR OVERRIDES LOAD, DATA, AND COUNT INPUTS
 B. WHEN COUNTING UP, COUNT-DOWN INPUT MUST BE HIGH; WHEN COUNTING DOWN, COUNT-UP INPUT MUST BE HIGH.

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Figure 5-18②. Type 74192B synchronous 4-bit up/down counters logic diagram (part 2 of 2).

CHAPTER 6

GENERAL SUPPORT TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

WARNING

Voltages as high as 200 volts exist at various points in the digital voltmeter. Use caution when servicing the unit with the power on. However, with the power off, the line cord disconnected, and no voltage applied to the input terminals, the maximum voltage retained on the filter capacitors is only 50 volts. Under these conditions, the instrument is quite safe to work on.

6-1. General Instructions

Troubleshooting includes all techniques which may be used to isolate a defective part or assembly which is causing a malfunction of some type in the equipment. This section will deal with general procedures and techniques which may be used in troubleshooting the AN/GSM-64A Digital Voltmeter. Section II will provide troubleshooting data relating to the instrument.

6-2. Organization of the Troubleshooting Process

The troubleshooting process can be broken down into a three-step sequence. The steps in the sequence are as follows:

a. Definition of Problem. Determine in complete detail what the symptoms of the problem are and under what conditions they may be reproduced or demonstrated. This involves conducting performance tests on the equipment and noting deviations from expected performance. Since some problems are intermittent it may be necessary to repeat the tests until the malfunction appears or to conduct the tests during some adverse environmental stresses such as shock, vibration, or temperature changes.

b. Localization of Problem. Determine the circuits that are likely to contain the fault. From an analysis of the symptoms of the problem noted above, it can be deduced that the defect lies in some specific circuit location or locations. An example of this process in the automotive

field would be: if your car is overheating, *the* problem is most likely in your cooling system.

c. Isolation of the Defective Component or Assembly. Determine which part or assembly in the suspected circuit is at fault. Any one of the troubleshooting techniques listed below may identify the defective component or assembly; however, it is seldom possible to know which technique will work on some specific problem. It may be necessary to try all of them.

6-3. Troubleshooting Techniques

The troubleshooting techniques listed here are in the order in which they are usually employed by experienced personnel to locate a defective component or assembly.

a. Visual Inspection. The purpose of visual inspection is to locate faults without further testing or measuring of the circuits. If a good instrument of the same type is available, compare the faulty AN/GSM-64A to an AN/GSM-64A in good working order. The symptoms noted in the performance tests should provide clues about where to look and what to look for. Good lighting is, of course, essential and sometimes a magnifying glass is helpful. Look for the following defects.

(1) Broken wires or wires with faulty insulation.

(2) Overheated resistors.

(3) Integrated circuit not oriented in socket properly. The index mark on the end of the integrated circuit must be toward the index

mark on the printed circuit board at one end of the socket.

(4) Integrated circuit with bent lead not mating with socket on all contacts. It may be necessary to unplug the integrated circuit to see this.

(5) Integrated circuit not plugged into right socket.

(6) Fractured diodes.

(7) Broken readout tubes; a crack in the glass will cause a failure eventually. Look closely at the base and tip for flaws.

(8) Readout tube with bent leads or with internal pieces loose. It may be necessary to remove the tube to see this.

(9) Foreign objects, such as nuts, screws, pieces of wire, solder, etc. may cause intermittent shorts.

(10) Dirt or grime will degrade insulation resistance causing problems, especially in high impedance circuits.

(11) Cold solder joints. Look for holes in solder joint, crystalline appearance of solder or improper wetting of solder to parts joined.

(12) Hairline cracks in printed circuit lines or bridges between circuits.

(13) Charred or discolored printed circuit board, indicating an overheating component,

(14) Faulty pin and socket connection. A 0.040-inch diameter pin is used on the plug-in modules, on the connector between the two boards, and on the switches. Use the shank of a new #60 drill to check the individual sockets for good contact gripping action. Check the pins and sockets for wear, or for foreign matter adhering to the mating parts and interfering with the electrical contact between them.

b. Substitution.

(1) Many components and assemblies in the AN/GSM-64A plug into the printed circuit board and, in fact, the entire top board plugs into the bottom board. The repairman should make use of this feature to the fullest extent possible. There are three options available:

(a) Interchange like numbered integrated circuits or readout tubes within the voltmeter. If the symptoms change, replace the suspect part.

(b) Interchange like numbered integrated circuits, readout tubes or modules between the faulty instrument and a properly operating one.

(c) Replace integrated circuits, readout tubes, or modules from spares stock.

(2) Substitution may also be employed with resistors, capacitors, diodes, and transistors, but this involves soldering and should be avoided. If possible, use voltage and resistance tests first to pinpoint a defective part which is soldered in.

c. Signal Tracing. Most circuits have an input vs output relationship which can be measured. Sometimes a volt-ohmmeter (VOM) can be used and sometimes an oscilloscope. However, sometimes neither will work because of circuit loading or induced oscillation, or because the signal characteristic of interest cannot be detected. Whenever applicable, this is a very powerful troubleshooting technique. Compare measurements taken on an operating instrument with the measurements on the faulty one.

d. Resistance Measurements. Open or shorted semiconductors can be quickly detected by using the $R \times 1K$ range of a VOM. The use of other scales should be avoided because of excessive voltage or current which may damage a good semiconductor.

e. Mechanical Stress. When electrical connections are suspected, it is useful to apply mechanical stress to the area to see if the performance of the instrument is effected by the stress. This can be accomplished by operating the instrument and simultaneously pushing, twisting, prying, etc. the suspected component or assembly. The repairman should use caution while doing this so as not to injure himself or damage the instrument.

f. Heating or Cooling. If the fault is intermittent or occurs during temperature extremes, it can sometimes be located by the use of a heat gun or an aerosol can of carbon dioxide (CO₂) or Freon to heat or cool a suspected component or assembly while observing the performance of the instrument. Care should be taken to not exceed the operating temperature rating of the instrument (122° F.) during this procedure.

g. Cleaning. Sometimes when all else fails, this approach may fix the problem. Cleaning the suspected area with detergent and water and then drying the instrument in an oven set at low temperature won't damage the instrument and may solve the problem. Even though the area looks clean, it may not be with resultant poor insulation resistance.

h. Jumpering. Whenever an electrical connection is suspected of being faulty, it is usually possible to parallel the connection with a jumper

wire or clip lead, If this fixes the problem then, of course the connection must be repaired.

Section II. TROUBLESHOOTING DIGITAL VOLTMETER AN/GSM-64A

6-4. General

The foregoing has provided the organization and general techniques of the troubleshooting process. The following paragraphs provide detailed troubleshooting information which, coupled with a thorough understanding of the functioning data described in chapter 5, should enable the repairman to isolate the cause of the trouble and, with reference to chapter 7, to effect repair.

6-5. Equipment Required

- a. DC voltage standard, John Fluke Model 332A (FSN 6625-239-8924), or equivalent.
- b. Oscilloscope, AN/USM-281.
- c. Multimeter, IS-189
- d. Variac, Superior Electric Co. Type 3PN.

6-6. Initial Preparation

- a. Disassemble the instrument only so far as is required to perform the specified checks or tests (para 7-2a).

- b. Connect the unit to a 115 vac power source as required.

- c. Connect the test equipment as specified for each particular test (para 6-8 through 6-15).

6-7. Localizing Troubles

a. General. In the troubleshooting chart (*d* below) procedures are given for localizing troubles to a circuit or a specific component. Parts locations and test points are shown in figures 6-1 and 6-2. Integrated circuits are not called out on the figures since their reference designations are etched on the printed circuit board,

b. Resistor and Capacitor Color Code Diagrams. Color code diagrams for resistors and capacitors (fig. 9-1 and 9-2) provide pertinent resistance, capacitance, voltage rating, and tolerance information.

- c. *Use of Chart.* When an abnormal symptom has been observed in the instrument, look for a description of this symptom in the *Trouble symp-*

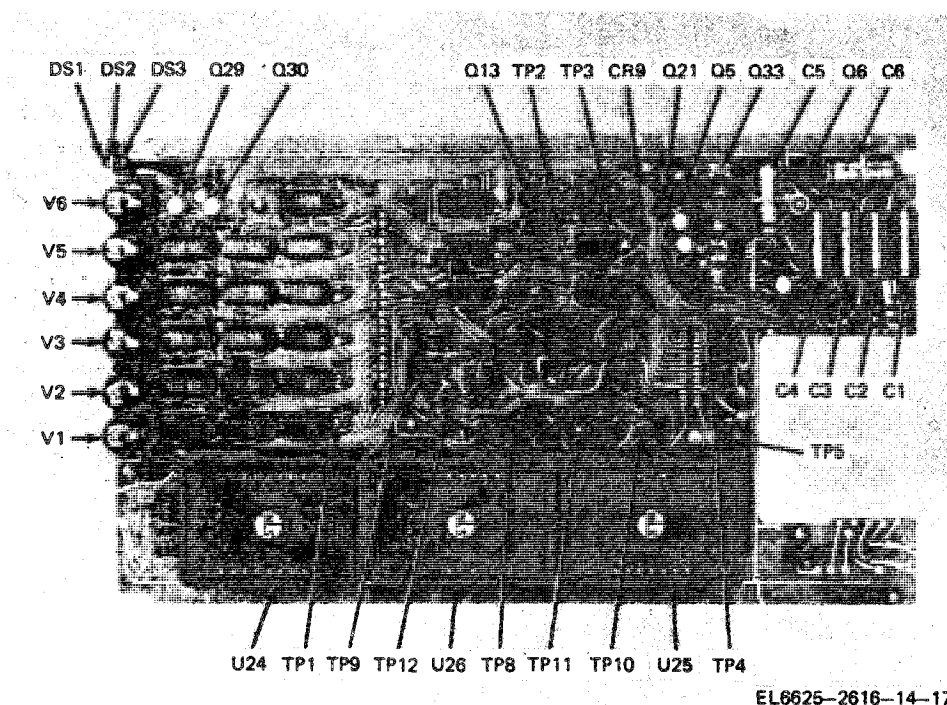


Figure 6-1. Main board assembly.

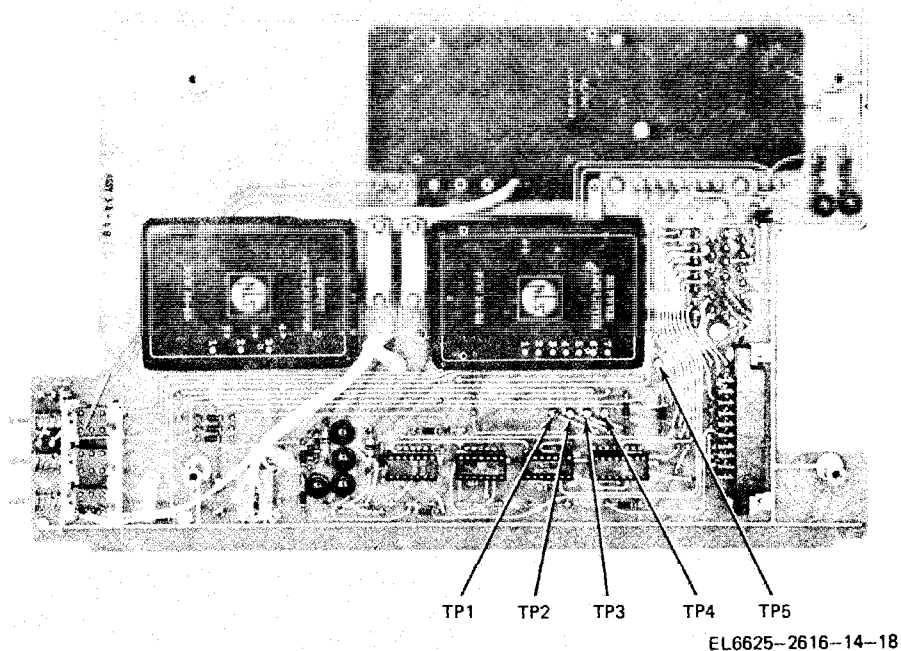


Figure 6-2. Signal conditioning assembly.

tom column and perform the corrective measures shown in the *Checks and corrective measures* column. If no operational symptoms are known, begin with sequence No. 4 in the operator's daily

preventive maintenance checks and services chart (para 4-4) and proceed until a trouble symptom appears.

d. Troubleshooting Chart.

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
1	No display	a. No power from ac line b. Defective power cord c. Blown fuse d. No high voltage	a. Check power source. b. Check cord with ohmmeter. Replace if defective. c. Replace fuse. If fuse blows again, check power transformer, rectifier filter capacitors (C1 through C6), and 115/230-volt switch. d. Defective transformer winding or defective rectifier CR9.
2	Display incorrect in one decade: double numbers, incorrect numbers, missing numbers, etc.	a. Defective readout tube b. Defective decoder driver integrated circuit. c. Defective quad latch integrated circuit. d. Defective decade counter integrated circuit.	a. Replace readout tube V1, V2, V3, V4, V5, or V6, depending upon which decade effected. b. Replace U17, U18, U19, U20, or U21 on main board assembly, depending upon which decade effected. c. Replace U12, U13, U14, U15, or U16 on main board assembly, depending upon which decade effected. d. Replace U7, U8, U9, U10 or U11 on main board assembly, depending upon which decade effected.

<i>Item No.</i>	<i>Trouble symptom</i>	<i>Probable trouble</i>	<i>Checks and corrective measures</i>
3	Digital display correct but decimal improperly positioned.	Defective decimal driver integrated circuit.	Replace U22 on main board assembly.
4	Auto range selection faulty . .	Defective integrated circuit	Replace U1, U2, U3, or U4 on signal conditioning assembly or U1, U2, U4, or U5 on main board assembly until faulty integrated circuit is located.
5	Polarity indication faulty	a. Input leads reversed b. Defective lamp bulb c. Defective integrated circuit d. Defective integrator amplifier module.	a. Check polarization of input cable. b. Measure resistance of DS1 and DS2 with power off; 20 ohms to 40 ohms is normal. Replace defective bulb. c. Replace U2, U3, or U23 on main board assembly until faulty integrated circuit is located. d. Replace integrator amplifier module.
6	Meter reads correctly in one polarity of vdc but not in the other.	Defective integrator amplifier module.	Replace integrator amplifier module.
7	Meter reads correctly in one polarity of external reference but not in the other.	Defective reference supply module . .	Replace reference supply module.
8	Display incorrect in over-range decade.	a. Defective readout tube b. Defective readout driver c. Defective integrated circuit	a. Replace V6. b. Check Q29 and Q30 on main board assembly. Replace if necessary. c. Replace U6 on main board assembly.
9	Meter reads incorrectly in 100-10 external reference mode.	a. Defective reference supply module. b. Defective EXT REF VDC switch.	a. Replace reference supply module. b. Replace switch.
10	Meter will not display 000000 .	a. Bottom shield left off b. Defective null amplifier module . .	a. Install shield. b. Replace null amplifier module.
11	No Q display although meter locks up at 120000 in manual range mode and up-ranges at 120000 in auto-range mode.	a. Defective lamp bulb b. Defective driver	a. Measure resistance of DS3 with power off; 20 ohms to 40 ohms is normal. Replace if necessary. b. Check Q13 and replace if necessary.
12	Multinumeral illuminate (presenting a blurring effect) in all readout tubes.	+5-volt supply low	a. Check for short from +5 volts to ground. b. Check transformer, rectifier filter capacitors (C1 through C4), and 5-volt regulators (Q5, Q6, Q21, and Q38).

6-8. Power Supply Tests

a. General. The regulated voltages developed by the power supplies are critical to the proper performance of every circuit in the AN/GSM-64A. It is, therefore desirable, whenever a malfunction occurs, to determine that the voltages developed in the power supplies are correct. A quick check of the voltages at the test points provided on the printed circuit boards will verify that this is, or is not, the source of the malfunction. Since this is so simple to do and since the power supplies are so important, it is good practice to do this test first before anything else.

b. Test Condition.

(1) Instrument connected to a 115 vac power source through a variac.

(2) PWR ON pushbutton in (no warmup required).

(3) VDC pushbutton in.

c. Test Procedure. Connect the leads of the multimeter (VOM) between instrument SIG L and the test points set forth in the chart below. The chart provides nominal voltage of each power supply and the acceptable limits. During the testing of each supply, vary the

variac output from 103.5 vac to 126.5 vac. There should be no obvious change in any power supply voltage.

Test point No.	Nominal voltage	Acceptable limits
4 -----	+5v -----	+4.75v to +5.25v
11 -----	+17v -----	+16.5v to 18.5v
9 -----	+33v -----	+30.5 to 33.5v
10 -----	-17v -----	-16.5v to -18.5v
8 -----	-33v -----	-30.5v to -33.5v

6-9. Input Attenuator, Range Relays, and Buffer Amplifier Test

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (allow 5 minutes warmup time).

(3) VDC pushbutton in.

b. Test Procedure.

(1) Connect the voltage standard output to instrument SIG H.

(2) Connect the voltage standard common to instrument SIG L.

(3) Connect the leads of the multimeter between the voltage standard output and TP5 on the signal conditioning assembly.

(4) Set the voltage standard output to +10.0000 volts.

(5) The multimeter should not show any visible deflection.

6-10. 10-Volt Reference Check

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (no warmup time required).

(3) VDC pushbutton in.

b. Test Procedure.

(1) Connect the voltage standard common to instrument SIG L.

(2) Connect the leads of the multimeter between the voltage standard output and TP5 on the main board assembly.

(3) Set the voltage standard to +10.0000 volts.

(4) The multimeter should not show any visible deflection.

6-11. Clock Frequency Test

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (no warmup required).

(3) VDC pushbutton in.

b. Test Procedure.

(1) Connect the oscilloscope common to instrument SIG L.

(2) Connect the oscilloscope 10:1 probe to TP12 on the main board assembly.

(3) The oscilloscope should indicate a gated clock frequency of approximately 500 KHz and from 3- to 4-volt amplitude.

6-12. Input Integration Time Pulse Width Test

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (no warmup required).

(3) VDC pushbutton in.

b. Test Procedure.

(1) Connect the oscilloscope common to instrument SIG L.

(2) Connect the oscilloscope 10:1 probe to TP3 on the main board assembly.

(3) The oscilloscope should indicate 200-millisecond pulses at 3- to 5-volt amplitude.

NOTE

The presence of a 200-millisecond pulse confirms that the counters are operating properly. The trailing edge of the 200-millisecond pulse is formed by the end of the one hundred thousandth count which terminates the pulse.

6-13. Readout Storage/Range Change Enable Pulse Width Test

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (no warmup required).

(3) VDC pushbutton in.

b. Test Procedure.

(1) Connect the oscilloscope common to instrument SIG L.

(2) Connect the oscilloscope external trigger to TP3 on the main board assembly.

(3) Connect the oscilloscope 10:1 probe to TP2 on the main board assembly.

(4) The oscilloscope should indicate a 20-microsecond pulse at 3- to 5-volt amplitude from 0 to 240 milliseconds after the trailing edge (negative going) of the pulse at TP3. Delay between pulses is proportional to the input being measured by the instrument. The pulse at TP2 is generated when the clock pulses at TP12 cease.

6-14. Range Counter State Test

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (no warmup required). VDC pushbutton in.

b. Test Procedure.

(1) Connect the oscilloscope common to instrument SIG L.

(2) Connect the oscilloscope 10:1 probe to TP3 or TP4 on the signal conditioning assembly,

(3) Actuate RNG CHNG pushbutton to place instrument in the ranges shown in the chart below,

NOTE

“0” state corresponds to a voltage less than + 0.4v and “1” state corresponds to a voltage greater than +2.4v.

(4) The oscilloscope should indicate the levels shown in the chart.

VDC range	TP3 state	TP4 state
10 -	0	1
100 -	1	0
1000 -	0	0

6-15. Range Change Pulse Width Test

a. Test Conditions.

(1) Instrument connected to 115 vac or 230 vac power source.

(2) PWR ON pushbutton in (no warmup required).

(3) VDC pushbutton in.

b. Test Procedure,

(1) Connect the oscilloscope common to instrument SIG L.

(2) Connect the voltage standard common to instrument SIG L.

(3) Connect the voltage standard output to instrument SIG H.

(4) Connect the oscilloscope external trigger to TP2 on the main board assembly.

(5) Set the voltage standard output to +5.0000 volts.

(6) Connect the oscilloscope 10:1 probe to TP2 on the signal conditioning board.

(7) The oscilloscope should indicate a 20-microsecond pulse at 3- to 5-volt amplitude coincident with the external trigger pulse whenever a range change is required by the input to the instrument, If the input is increased from 5 volts to 50 volts, the pulse will appear at TP2 on the signal conditioning board. If the input is decreased from 50 volts to 5 volts, the pulse will appear at TP1.

CHAPTER 7

REPAIRS AND ADJUSTMENTS

Section I. REPAIRS

7-1. General Parts Replacement Techniques

When replacing parts in Digital Voltmeter AN/GSM-64A, follow the precautions given below.

a. Do not disturb the settings of potentiometers R1 through R7.

b. Before a part is unsoldered, note the position of the leads. If the part to be replaced has a number of connections, such as a transformer, tag each lead.

c. Be careful not to damage other leads by pulling or pushing them out of the way to reach other parts or connections.

d. Do not allow drops of solder, loose screws, nuts, or washers to fall into the equipment; they may cause short circuits and damage to the instrument.

e. Use care when soldering joints; an incorrectly soldered joint is a potential source of trouble and is extremely difficult to find.

f. When a part is replaced, position it exactly as the original part. Pay particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may effect the accuracy of the instrument.

7-2. Replacement of Parts in Digital Voltmeter AN/GSM-64A

a. Disassembly. The following steps are provided to enable the repairman to disassemble the instrument in the easiest manner down to the point where further disassembly, if required, is obvious. It is not necessary to follow all of these steps to effect certain repairs or replacements. The following paragraphs of this chapter, pertaining to repair or replacement of parts or adjustment procedures, will refer to steps in this paragraph which are required to be taken prior to proceeding with repair, replacement or adjustment.

ment. Reassembly in reverse order of disassembly as required.

NOTE

Although not necessary, it may prove more convenient to remove the handle while performing maintenance on the instrument. To do so, turn knobs counterclockwise until they can be removed from the chassis frame, and remove handle.

(1) Remove power cord from power outlet.

(2) Turn fuse holder cap counterclockwise and remove it from the body of the fuse holder.

(3) Remove top and bottom covers by removing two screws in each at rear of instrument and moving covers away and back toward rear of instrument.

(4) Remove top and bottom shields by removing four screws attaching each to standoffs on the circuit board.

(5) Remove six screws attaching signal conditioning assembly to chassis frame and place assembly upright in the slots provided (fig. 4-1).

(6) Remove bezel and front panel by removing the four screws attaching bezel to chassis (fig. 4-2).

(7) Remove polarity and overload lamp bulb bracket by removing screw at side of instrument (fig. 7-1) and screw on bottom of instrument (fig. 7-2).

(8) Pull front plate away from chassis by removing two screws on each side of plate and by removing nut attaching EXT REF VDC toggle switch to front plate.

b. Integrated Circuit Replacement.

(1) Remove power cord from power outlet, top cover, and top shield (a(1), a(3), and a(4) above).

(2) Place signal conditioning assembly in upright position (a(5) above).

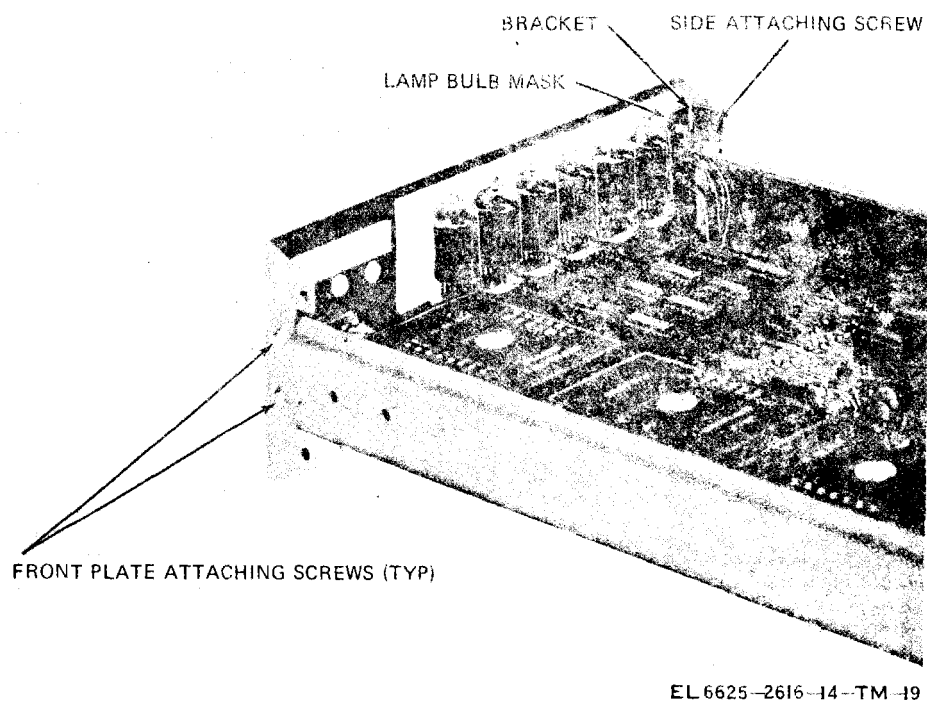


Figure 7-1. Lamp bulb bracket and front plate removal.

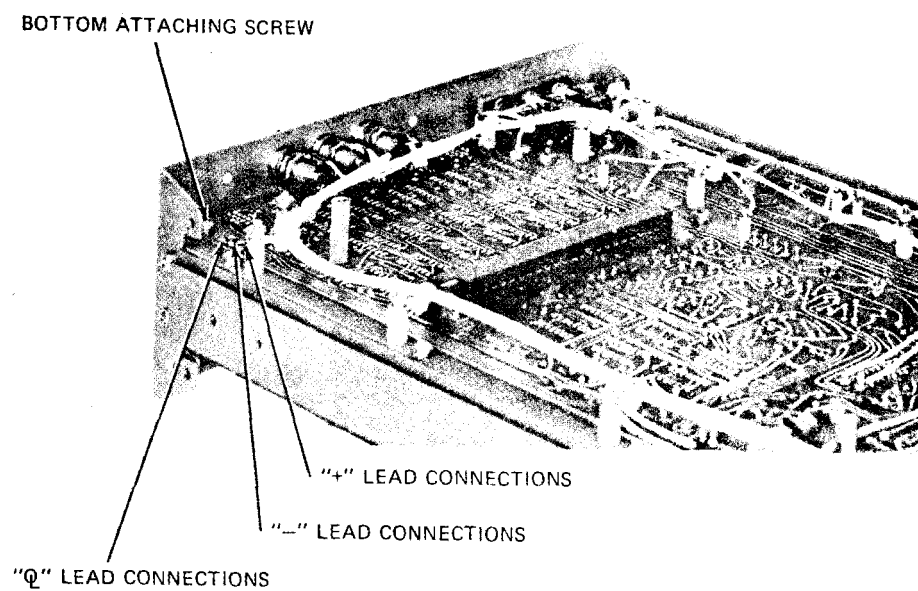


Figure 7-2. Lampbulb bracket removal and lamp bulb leads.

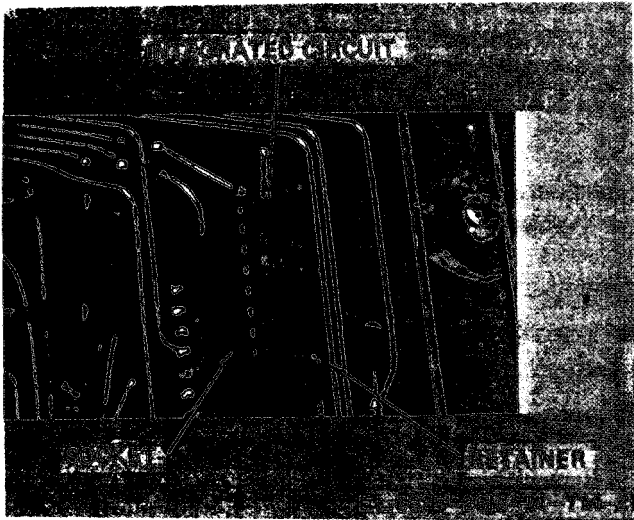


Figure 7-3. Integrated circuit package.

(3) The integrated circuit package consists of three parts: the integrated circuit, the retainer, and the socket (fig. 7-3).

(4) Carefully grasp the faulty or suspected integrated circuit at each end (use a standard pair of pliers or thumb and forefinger) and gently pull straight upward and away from the socket.

CAUTION

Do not use a twisting or rocking motion as this will most likely bend the leads.

(5) Remove the retainer and place it on the new integrated circuit.

(6) Carefully insert the new integrated circuit into the socket. Be sure the leads are properly aligned and that the index mark on the end of the integrated circuit is toward the index mark on the printed circuit board at one end of the socket.

c. Buffer Amplifier and Input Attenuator Replacement.

(1) Remove power cord from power outlet, top cover, and top shield (a(1), a(3), and a(4) above).

(2) Place signal conditioning assembly in upright position (a(5) above) and place the instrument on its side.

(3) Remove the four screws and washers attaching these modules to the signal conditioning printed circuit board.

(4) While holding the printed circuit board steady, carefully press evenly against the four

screws extending from the module through the circuit board until the end of the screws are flush with the bottom of the circuit board.

(5) Grasp the module and carefully pull it away from the circuit board.

(6) Carefully insert the new module into position making sure that the leads are properly aligned. Note that the decal on the module can be read when facing the front of the instrument.

(7) Replace washers and nuts. Tighten nuts evenly in a rotating manner until they are snug.

d. Integrator Amplifier, Null Amplifier, and Reference Supply Replacement.

(1) Remove power cord from power outlet, fuse holder, top and bottom covers, top and bottom shields (a(1) through a(4) above).

(2) Perform the steps set forth in c(2) through c(7) above, noting however, that these three modules are attached to the main printed circuit board.

e. Signal Conditioning Board Removal.

(1) Remove power cord from power outlet, top cover, and top shield (a(1), a(3), and a(4) above).

(2) Place signal conditioning board in upright position (a(5) above).

(3) Remove the two nuts and washers attaching the main board ribbon cable connector to the signal conditioning board (fig. 7-4).

(4) Carefully pull the cable connector away from the underside of the signal conditioning board.

(5) Place the signal conditioning board flat, in its normal operating position.

(6) Remove clamp attaching nut (fig. 7-4) and remove clamp.

(7) Remove solder lug attaching nuts (fig. 7-4) and remove solder lugs. Tag one of these lugs for identification.

(8) Remove signal conditioning board.

f. Readout Tube Replacement.

(1) Remove power cord from power outlet, fuse holder, and top and bottom covers (a(1) through a(3) above).

(2) Remove bezel and front panel (a(6) above).

(3) With a rocking motion, carefully pull the faulty tube from its socket.

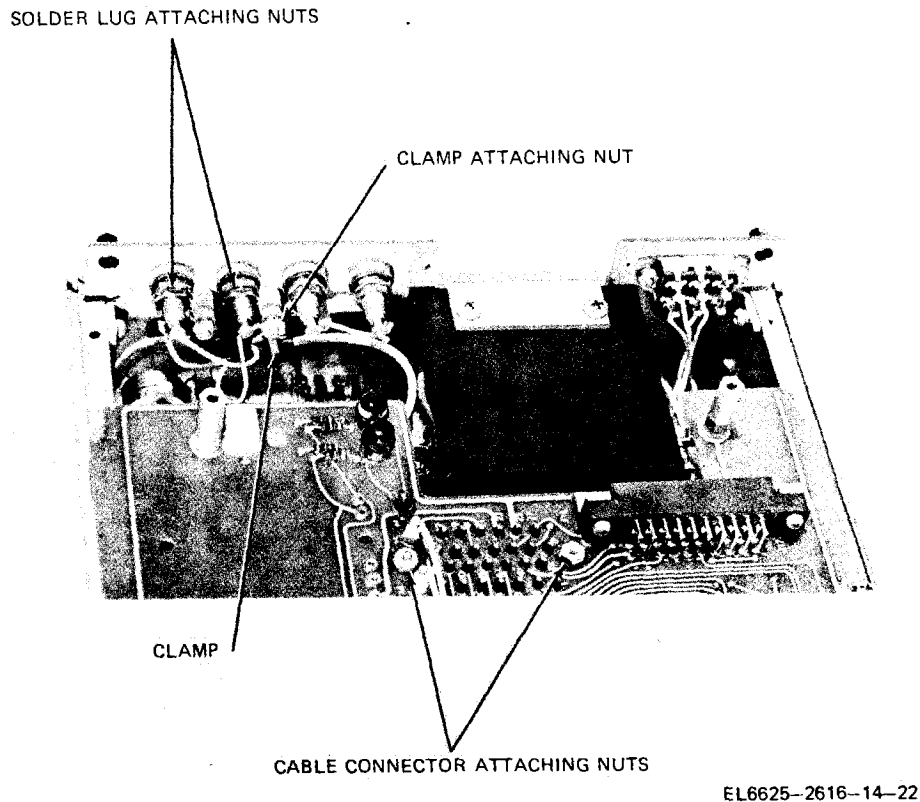


Figure 7-4 Signal conditioning board removal.

(4) Install new tube with the numerals facing forward using care to properly align pin into tube socket.

g. Lamp Bulb Replacement.

(1) Remove power cord from power outlet, fuse holder, top and, bottom covers, and top and bottom shields (a(1) through a(4) above),

(2) Remove bezel and front panel (a(6) above).

(3) Remove polarity and overload lamp bulb bracket (a(7) above).

(4) Pull lamp bulb bracket away from front plate and remove lamp bulb mask (fig. 7-1). Note that the mask is installed so that "+" polarity indicator is at the top.

(5) Remove retaining ring holding faulty bulb to bracket.

(6) Remove faulty bulb from opening in bracket.

(7) Unsolder leads of faulty bulb at points indicated in figure 7-2.

(8) Solder new leads into place, taking care to ensure a firm and clean solder connection.

h. Pushbutton Switch Replacement. The pushbutton switches require special attention in removal and replacement. The switch assemblies and power switch near the rear of the unit are plug-in components and are attached to the printed circuit boards by spot bonding with silicon rubber, Type SR per MIL-I-46058, Insulating Compound, Electrical (For Coating Printed Circuit Assemblies) ; manufacturer is Dow Corning Corporation, South Saginaw Road, Midland, MI 48640; manufacturer's designation is 3144 RTV. The material is available in three-ounce, self-dispensing, collapsible tubes.

(1) Function switch assembly replacement.

(a) Remove power cord from power outlet, fuse holder, and top and bottom covers (a(1) through a(3) above).

(b) Remove top shield (a(4) above).

(c) Remove bezel and front panel (a(6) above).

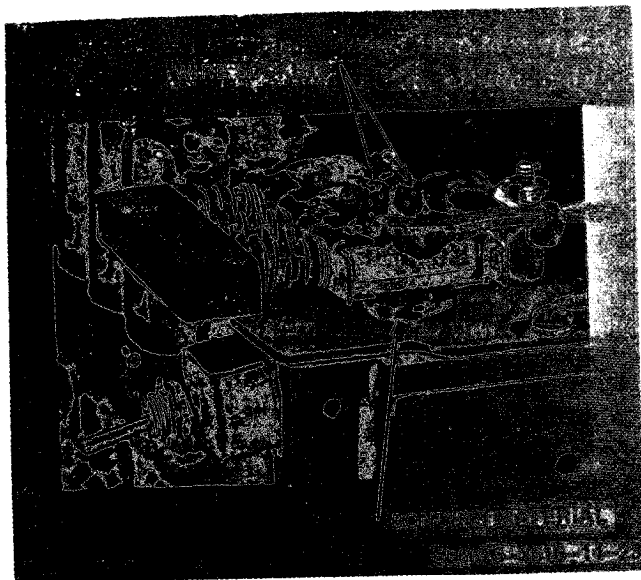


Figure 7-5. Function switch assembly replacement.

(d) Pull front plate away from chassis (a(8) above).

(e) With a sharp knife, cut silicon rubber away from switch pins and wire sockets on top of switch assembly (fig. 7-5).

(f) Remove wire sockets from switch pins.

(g) Carefully cut away the silicon rubber bonding the switch assembly to the circuit board (fig. 7-5). The bonding material is located on both sides and in the middle of the switch assembly. Due to switch assembly pins inserted into sockets in the circuit board, it is difficult to cut all of the silicon rubber away. After most of the material is cut free, use a screwdriver to carefully and evenly pry the switch assembly away from the circuit board, cutting the bonding material as required.

(h) Trim all bonding material neatly back to the surface level of the plug-in sockets on the circuit board. Clean any bits of the material from the sockets or around the switch mounting area with isopropyl alcohol.

(i) Squeeze a moderate amount of 3144-RTV silicon rubber on plug-in side of new switch assembly. Do not allow bonding material to get on the tip of the switch pins or to enter the sockets. Evenly press switch assembly against circuit board until pins contact the bottom of the sockets. Observe that the bonding material is in contact with the surface of the circuit board.

(j) Allow 24 hours drying time before operating the instrument.

(2) Power and range switch replacement.

(a) Remove power cord from power outlet, fuse holder, and top and bottom covers (a(1) through a(3) above).

(b) Remove bottom shield (a(4) above).

(c) Remove bezel and front panel (a(6) above) and turn the instrument so that it rests on the top shield.

(d) Pull front plate away from chassis (a(8) above).

(e) Insure that the PWR ON pushbutton is in the "out" position (fig. 7-6).

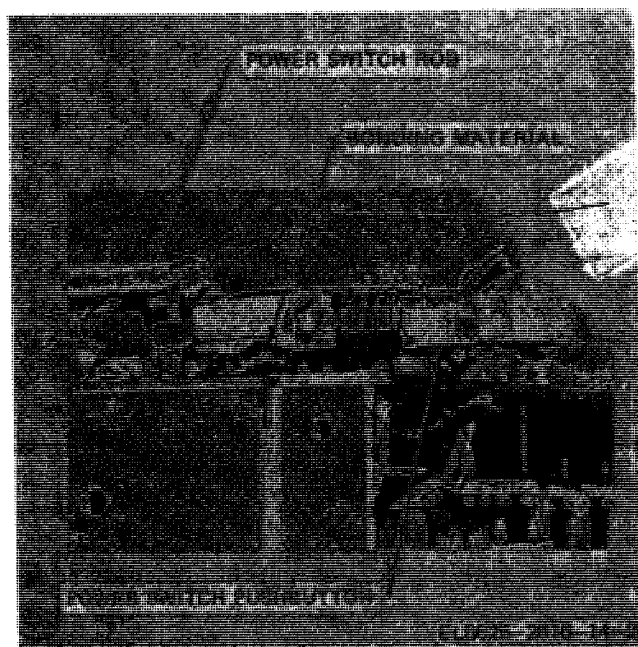


Figure 7-6. Power and range switch assembly replacement.

(f) Carefully move the power switch rod (fig. 7-6) rearward and then lift the front of the rod upward away from the coupler on the front switch. Move the rod forward and away from the rear power switch.

(g) Remove bonding material, remove switch assembly, and install new switch ((1)(g) through (1)(j) above).

(3) *Rear Power Switch Replacement.* Refer to figure 7-7 and perform the steps set forth in (2)(a) through (2)(g) above.

i. Replacement of Minor Components.

(1) The minor components of the AN/GSiM-64A (capacitors, resistors, etc.) are mounted on

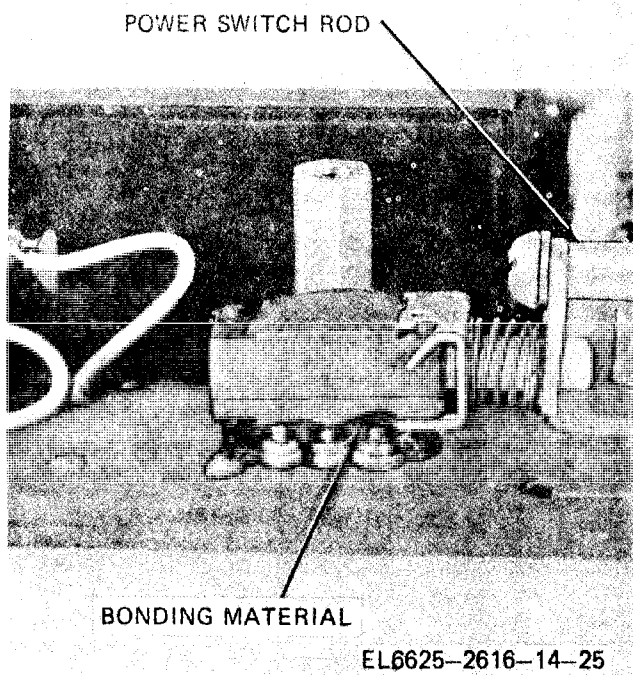


Figure 7-7. Rear power switch replacement.

the printed circuit boards by soldering. They are then coated and bonded to the circuit board to protect them and the printed circuitry from humidity and moisture. This bonding, or post coating, also serves to protect the components under conditions of vibration or shock.

(2) The coating and bonding agent used is a translucent, room temperature-curing silicon rubber. Type SR per MIL-I-46058, Insulating Compound, Electrical (For Coating Printed Cir-

cuit Boards); manufacturer is Dow Corning Corporation, South Saginaw Road, Midland, MI 48640; manufacturer's designation is 3140RTV. The material is available in three-ounce, self-dispensing, collapsible tubes.

(3) To replace a defective component soldered and bonded to the circuit board, perform the following steps.

(a) With a sharp knife, cut away as much of the bonding material as possible from the defective part and its solder pads. Use care not to damage the printed circuitry or the solder pads.

(b) Apply additional solder to the component leads and to the solder pads on each side of the board. This application of solder destroys the bonding material and re-tins the solder pads.

(c) Heat solder on component leads and pads and remove with a solder sucker. Inspect leads and pad area to make sure leads are loose.

(d) Components may still be attached to the circuit board by small amounts of bonding material; Carefully manipulate the component and cut away the material until the defective component is free from the circuit board.

(e) Inspect the immediate area from where the component was removed for loose flaps or bits of the bonding material; if found, trim the flaps and clean the area with isopropyl alcohol.

(f) Solder new component in place, insuring a firm and clean solder connection.

(g) Apply a moderate amount of 3140-RTV silicon rubber to the repaired area and over the new component.

(h) Allow 24 hours drying time before operating the instrument.

Section II. ADJUSTMENTS

7-3. General

An adjustment (or calibration) cycle of 6 months is sufficient for areas of normal operating conditions. The calibration of any instrument changes slightly with age, use, and operating conditions. Also, problems which may not be apparent during normal use will show up during a calibration check.

7-4. Test Equipment required

DC voltage standard, John Fluke Model 332A (FSN 6625 -239-8924), or equivalent).

7-5. Calibration Procedure

a. Initial Preparation.

(1) Remove fuse and top and bottom covers (para 7-2a(2) and (3)).

(2) Replace fuse.

(3) Plug power cord into ac outlet, ensuring that the power selection switch is set to proper voltage.

(4) Depress PWR ON pushbutton switch. Allow 30 minutes for instrument warmup.

(5) Be sure that the VDC and AUTO RNG pushbutton switches are in the "in" position.

(6) It will be noted that the top shield displays the sequence numbers of calibration and the reference designation of each adjustment potentiometer (fig. 7-8).

b. Zeroing the Readout.

(1) Plug connector of test lead set into SIG H and SIG L input jacks.

NOTE

A small polarity tab sticks out from the connector nearest the SIG L plug; i.e., the tab sticks out to the left of the operator when the connector is properly installed.

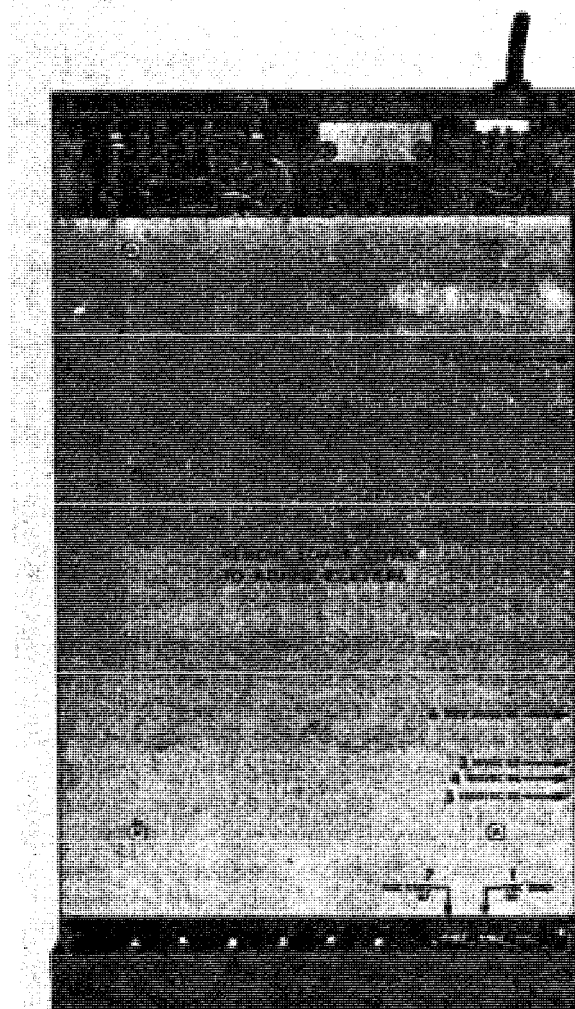
(2) Insert blue plug adjacent to connector into GUARD input jack.

(3) Connect the three clips of the test lead set together. They are covered with red, black, and blue protective boots.

(4) The instrument readout should display 00.0000. If it does not, adjust the ZA potentiometer by inserting a small screwdriver in the opening directly underneath the VDC pushbutton switch and turning the adjustment screw until the readout transfers from 00.0000 to +00.0001; observe the angle of the screwdriver blade. Back off the adjustment until the readout transfers from 00.0000 to - 00.0001; observe the angle of the screwdriver blade. Now place the adjustment half-way between these two settings.

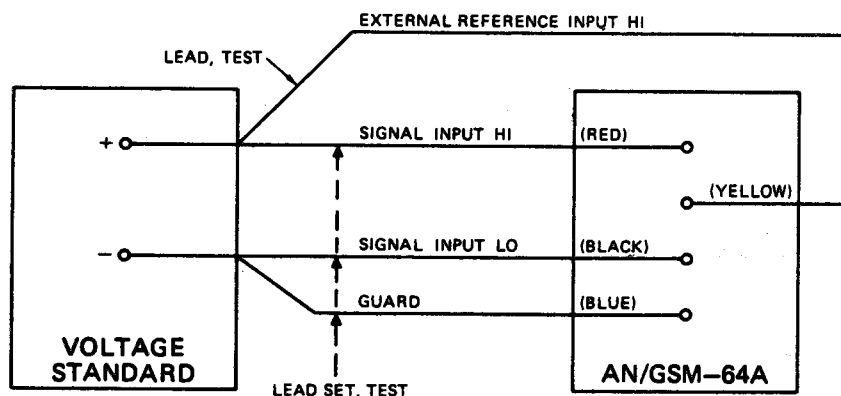
c. Ratio Adjustment-10-Volt Reference.

(1) Connect the instrument as shown in figure 7-9.



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Figure 7-8. Calibration adjustment points.



CAUTION

WITH THE INSTRUMENT CONNECTED AS SHOWN ABOVE, NEVER APPLY MORE THAN 100 VDC FROM THE VOLTAGE STANDARD OR DAMAGE MAY RESULT.

EL 6625-2616-14-TM-27

Figure 7-9. Connections for reference adjustment.

- (2) Press R% pushbutton switch.
- (3) Place the EXT REF VDC selection switch in the 10-1 position.

CAUTION

With the instrument connected as shown in figure 7-9, never apply more than 100 vdc from the voltage standard or damage may result.

- (4) Set voltage standard to +10.00000 volts.
- (5) The numerical value displayed in the readout should be equal to +100.000. If not, adjust R3 until the readout displays the correct value.

d. Range Adjustments.

- (1) Connect the instrument as shown in figure 7-10.
- (2) Press the VDC pushbutton switch.
- (3) Set the voltage standard to +10.00000 volts.
- (4) The numerical value displayed in the readout should be equal to +10.0000. If it is not, adjust R2 until the readout displays the correct value.

WARNING

Use extreme caution in performing the following steps as dangerously high voltages will be employed.

- (5) Set the voltage standard to +100.0000 volts.

- (6) The numerical value displayed in the readout should be equal to +100.000. If it is not, adjust R4 until the readout displays the correct value.

- (7) Set the voltage standard to +1000.000 volts.

- (8) The numerical value displayed in the readout should be equal to +1000.00. If it is not, adjust R5 until the readout displays the correct value.

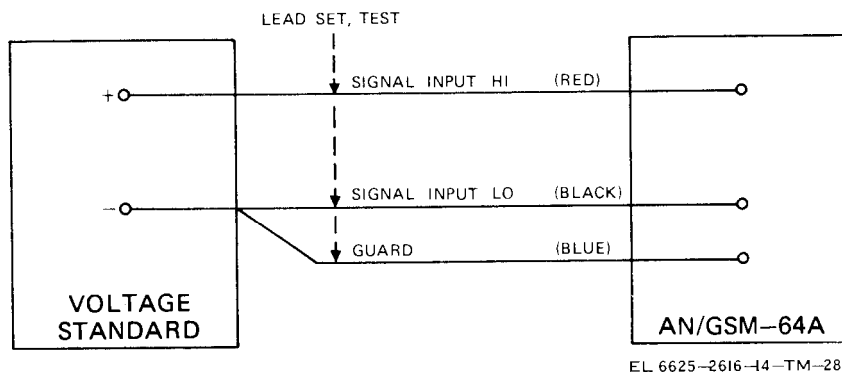
e. Ratio Adjustment-100-Volt Reference.

- (1) Connect the instrument as shown in figure 7-8.
- (2) Press R% pushbutton switch.
- (3) Place the EXT REF VDC selection switch in the 100-10 position.

CAUTION

With the instrument connected as shown in figure 7-8, never apply more than 100 vdc from the voltage standard or damage may result.

- (4) Set the voltage standard to +100.00-0 volts.
- (5) The numerical value displayed in the readout should be equal to +100.000. If it is not, adjust R6 until the readout displays the correct value.



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Figure 7-10. Connections for vdc adjustments.

CHAPTER 8

GENERAL SUPPORT TESTING PROCEDURES

8-1. General

a. Testing procedures are prepared for use by electronics field maintenance shops and service organizations responsible for general support maintenance to determine the acceptability of repaired electronic equipment. These procedures set forth specific requirements that repaired equipment must meet before it is returned to the using organization.

b. Comply with the instructions preceding each chart before proceeding to the chart. Perform each step in sequence; do not vary the sequence. For each step, perform all the actions required in the *Control settings* column; then, perform each specific procedure and verify it against its performance standard.

8-2. Test Equipment and Materials Required

a. Test Equipment. DC voltage standard, John Fluke Model 332A (FSN 6625-239-8924), or equivalent.

b. Materials. The only materials required are a 1K ohm, 1/2-watt resistor and either a 1.5-volt flashlight cell or a 1.3-volt mercury cell.

8-3. Modification Work Orders

The performance standards listed in the tests (para 8-5 through 8-7) are based on the assumption that all modifications have been performed. A current listing of modification work orders will be found in DA Pam 310-7.

8-4. Physical Tests

a. Test Equipment and Materials. None required.

b. Test Connection and Conditions.

(1) No connections necessary.

(2) Turn fuse holder cap counterclockwise and remove it from the body of the fuse holder.

(3) Remove top and bottom covers by removing two screws in each at rear of instrument and moving covers away and back toward rear of instrument.

(4) Remove top and bottom shields by removing four screws attaching each to standoffs on the circuit board.

(5) Remove six screws attaching signal conditioning assembly to chassis frame and place assembly upright in the slots provided (fig. 8-1).

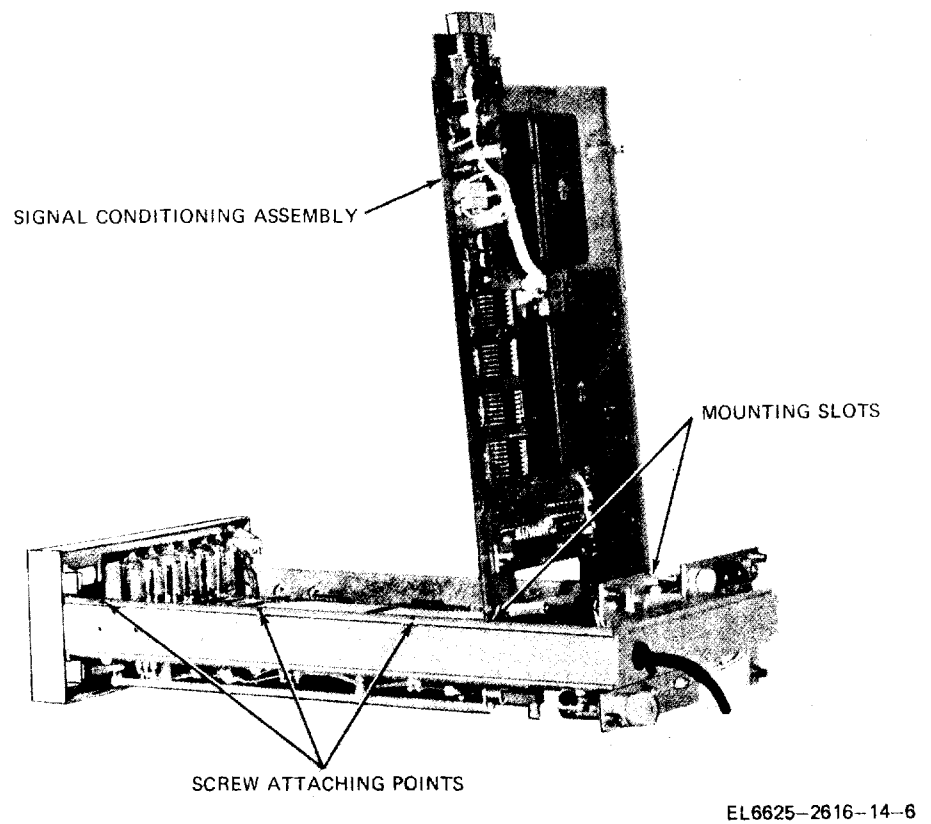


Figure 8-1. Signal conditioning assembly mounting.

c. Procedure.

Step No.	Test equipment	Control settings	Equipment under test	Test procedure	Performance standard
1	None		Controls may be in any position	<p>a. Inspect case and chassis for damage, missing parts, and condition of paint.</p> <p>b. Inspect all controls and mechanical assemblies for loose or missing screws, bolts, and nuts.</p> <p>c. Inspect all connectors, sockets, and fuseholders for looseness, damage, or missing parts.</p>	<p>a. No damage evident or parts missing. External surfaces intended to be painted will not show bare metal. Panel lettering will be legible.</p> <p>b. Screws, bolts, and nuts will be tight. None missing.</p> <p>c. No looseness or damage evident. No missing parts.</p>
2	None		Controls may be in any position	Operate all switches	Switches will operate properly.
3	None		Controls may be in any position	Resassemble instrument	None.

8-5. DC Volts Performance Test

a. Test Equipment. DC voltage standard, John Fluke Model 332A (FSN 6625-239-8924), or equivalent.

b. Initial Preparation.

(1) Plug power cord into ac outlet, insuring that the power selection switch is set to proper voltage.

(2) Depress PWR ON pushbutton switch. Allow 30 minutes for instrument warmup.

(3) Be sure that the VDC and AUTO RNG pushbutton switches are in the "in" position.

(4) Plug connector of test lead set into SIG H and SIG L input jacks.

NOTE

A small polarity tab sticks out from the connector nearest the SIG L plug; i.e., the tab sticks out to the left of the operator when the connector is properly installed.

(5) Insert blue plug adjacent to connector into GUARD input jack.

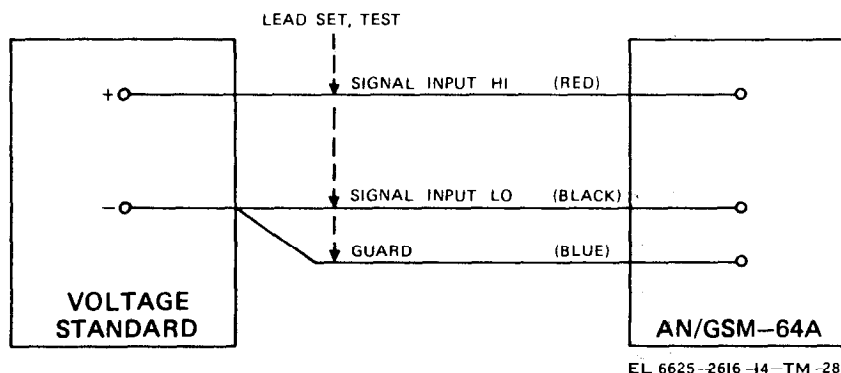
(6) Connect the three clips of the test lead set together. They are covered with red, black, and blue protective boots.

(7) The instrument readout should display 00.0000. If it does not, adjust the ZA potentiometer by inserting a small screwdriver into the opening directly underneath the VDC pushbutton switch and turning the adjustment until the readout transfers from 00.0000 to +00.0001; observe the angle of the screwdriver blade. Back off the adjustment until the readout transfers from 00.0000 to -00.0001; observe the angle of the screwdriver blade. Now place the adjustment halfway between these two settings.

c. Test Connection and Conditions.

(1) Connect the equipment as shown in figure 8-2.

(2) All reference to switch settings refer to the AN/GSM-64A.



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Figure 8-2. Connections for DC volts test.

d. Procedure.

Step No.	Test equipment	Control settings	Equipment under test	Test procedure	Performance standard
1	Voltage standard -----	PWR ON pushbutton – in. VDC pushbutton – in. AUTO RNG pushbutton – in.		<p>a. Set voltage standard to +10.00000 volts.</p> <p>Warning: Use extreme caution. High voltage!</p> <p>b. Set voltage standard to +100.0000 volts.</p> <p>c. Set voltage standard to +1000.000 volts.</p>	<p>a. AN/GSM-64A must indicate +10.0000 (± 0.0010) volts.</p> <p>b. AN/GSM-64A must indicate +100.000 (± 0.010) volts.</p> <p>c. AN/GSM-64A must indicate +1000.00 (± 0.10) volts.</p>

8-6. DC Volts Ratio Performance Test

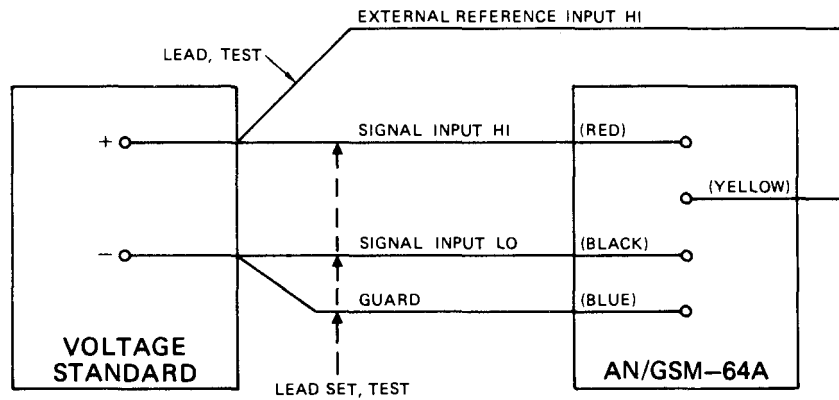
a. Test Equipment. DC voltage standard, John Fluke Model 332A (FSN 6625-239-8924), or equivalent.

b. Initial Preparation. Be sure that all of the steps set forth in paragraph 8-5b have been performed.

c. Test Connections and Conditions.

(1) Connect the equipment as shown in figure 8-3.

(2) All reference to switch settings refer to the AN/GSM-64A.



CAUTION

WITH THE INSTRUMENT CONNECTED AS SHOWN ABOVE, NEVER APPLY MORE THAN 100 VDC FROM THE VOLTAGE STANDARD OR DAMAGE MAY RESULT.

EL 6625-2616-14-TM-27

Figure 8-3. Connections for DC volts ratio test.

d. Procedure.

Step No.	Test equipment	Control settings	Equipment under test	Test procedure	Performance standard
1	Voltage standard		PWR ON pushbutton – in	a. Set voltage standard to +10.00000 volts.	a. AN/GSM-64A must indicate +100.000 (±5 digits).
			R% pushbutton – in.	Caution: Do not apply more than 100 vdc.	
			AUTO RNG pushbutton – in.	Warning: Use extreme caution. High voltage!	
			EXT REF VDC switch in 10–1 position.	b. Set voltage standard to +100.0000 volts.	b. AN/GSM-64A must indicate +100.000 (±5 digits).
			Same as above except, EXT REF VDC switch in 100–10 position.		

8-7. Isolation Test

a. Test Equipment. DC voltage standard, John Fluke Model 332A (FSN 6625-239-8924), or equivalent.

b. Materials. 1K ohm, 1/2-watt resistor and either a 1.5-volt flashlight cell or a 1.3-volt mercury cell.

c. Test Connections and Conditions.

(1) Connect the equipment as shown in figure 8-4.

(2) All reference to switch settings refer to the AN/GSM-64A.

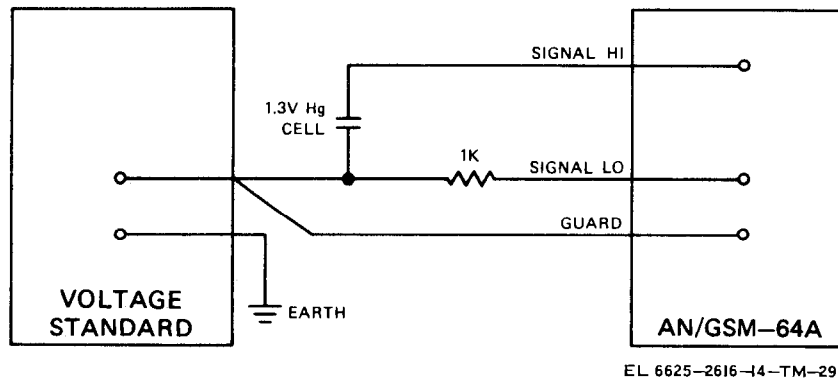


Figure 8-4. Connections for isolation test No. 1.

d. Procedure

Step No.	Test equipment	Control settings	Equipment under test	Test procedure	Performance standard
1	Voltage standard		PWR ON pushbutton - in. VDC pushbutton - in. AUTO RNG pushbutton - in.	<p>a. Set voltage standard to 0.000000 volts.</p> <p>Warning: Use extreme caution. High voltage!</p> <p>b. Set voltage standard to 200.0000 volts.</p>	<p>a. Note the reading of the AN/GSM-64A.</p> <p>b. Note the reading of the AN/GSM-64A.</p> <p>c. There should be no difference between the reading obtained in a or b above.</p>
2	Same as step 1		Same as step 1	<p>a. Connect the equipment as shown in figure 8-5.</p> <p>b. Same as step 1</p>	<p>a. None.</p> <p>b. Same as step 1.</p>

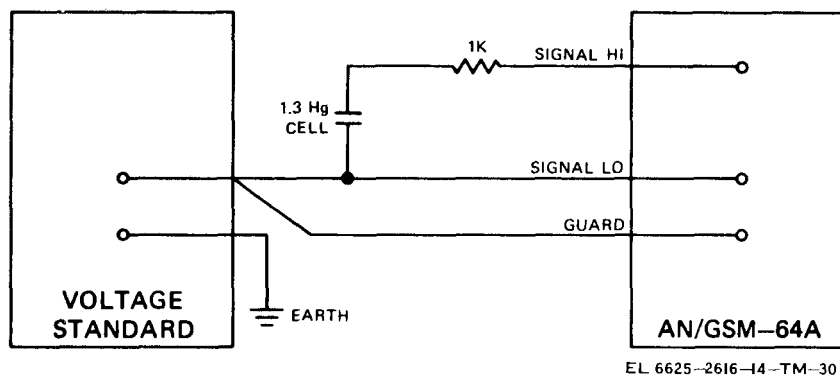


Figure 8-5. Connections for isolation test No. 2.

CHAPTER 9

SHIPMENT AND LIMITED STORAGE, AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

9-1. Disassembly of Equipment

Prepare the AN/GSM-64A for shipment and storage as follows:

- a. Disconnect the power cord from the power source.
- b. Roll the power cord into a neat roll and secure it with a small piece of twine.
- c. Disconnect the test lead set and test lead from any voltage sources and from the AN/GSM-64A.
- d. Roll the leads into neat rolls and secure them with a small piece of twine.

9-2. Repacking for Shipment or Limited Storage

a. *Material Requirements.* The materials listed in the chart below are required for packaging Digital Voltmeter AN/GSM-64A. If the original packaging material is available, only the tape is required. For stock numbers of materials, refer to SB 38-100.

<i>Material</i>	<i>Quantity</i>
Barrier material, waterproof	24 sq ft.
Tape, cloth-backing	15 ft.
Fiberboard, corrugated	24 sq ft.
Tape, gummed paper	15 ft.
Cushioning material	18 sq ft.

b. *Packaging.* Package the digital voltmeter as follows :

- (1) Seal the AN/GSM-64A in the barrier material.
- (2) Cushion the AN/GSM-64A on all sides, except the top, with pads of cushioning material.
- (3) Seal the test lead set, test lead, and the technical manual in the barrier material and package them in a small flat wrap of corrugated material. Secure the wrap with gummed tape.
- (4) Place the package on top of the digital voltmeter.
- (5) Cushion the top of the package with a pad of cushioning material.
- (6) Place the cushioned unit within a wrap of corrugated fiberboard, or, preferably, the original corrugated shipping box. Secure the wrap or box with the cloth-backing tape.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

9-3. Authority for Demolition

The demolition procedures given in paragraph 9-4 should be used to prevent the enemy from using or salvaging the equipment. Demolition of the equipment will be accomplished only upon the order of the commander.

9-4. Methods of Destruction

a. *Smash.* Use sledges, axes, hammers, crow-bars, and any other heavy tool available to smash the interior portion of the AN/GSM-64A.

- (1) Use the heaviest tool on hand to smash the connectors, controls, and indicator lights.

- (2) Remove the top cover and smash as many of the exposed parts as possible.

b. *Cut.* Use axes, handaxes, machetes, or similar tools to cut cabling and wiring. Use a heavy axe or machete to cut the power cord. Cut the power cord and cables in a number of places.

WARNING

Be extremely careful with explosives and incendiary devices. Use these items only when the need is urgent.

c. *Burn.* Burn the technical manuals first. Burn as much of the equipment as is flammable; use

gasoline, oil, flamethrowers, and similar materials. Pour gasoline on the cut cables and internal wiring and ignite it. Use incendiary grenades to complete the destruction of the AN/GSM-64A.

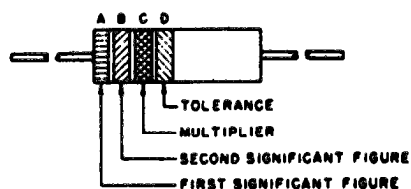
d. Explode. Use explosives to complete demolition, or to cause maximum damage before burning when time does not permit complete demolition by other means. Powder charges, fragmen-

tation grenades, or incendiary grenades may be used. Incendiary grenades usually are most effective if destruction of small parts and wiring is desired.

e. Dispose. Bury or scatter destroyed parts, or throw them into nearby waterways. This is particularly important if a number of parts have not been completely destroyed.

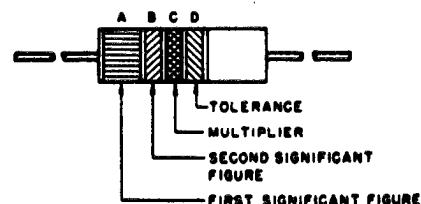
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A—Equal Width Band
Signifies Composition-Type

WIREWOUND-TYPE RESISTORS

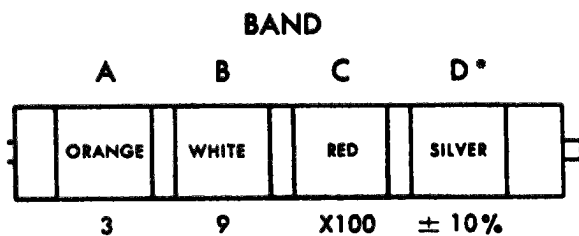


BAND A—Double Width Signifies
Wire-wound Resistor

COLOR CODE TABLE

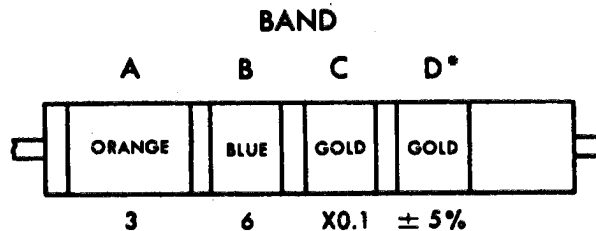
BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 Ohms

RESISTANCE TOLERANCE ± 10 percent



3.6 Ohms

± 5 percent

STD-R2

*If Band D is omitted, the resistor tolerance is ± 20%, and the resistor is not Mil-Std.

Figure 9-1. Color code marking for MIL-STD resistors.

Figure 9-2. Color code marking for MIL-STD capacitors.
(Located in back of manual)

Figure 9-3. Signal conditioning assembly schematic diagram.
(Located in back of manual)

Figure 9-4. Main board assembly, schematic diagram.
(Located in back of manual)

APPENDIX A

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals, (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	U.S. Army Equipment Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies, and Equipment Used by the Army.
TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 11-6625-444-45P	Field (Fourth Echelon) and Depot Maintenance Repair Parts and Special Tool Lists: Digital Voltmeter AN/GSM-64.
TM 38-750	The Army Maintenance Management System (TAMMS).

APPENDIX B

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

B-1. General

This appendix provides a summary of the maintenance operations covered in the equipment literature. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

B-2. Maintenance Functions

Maintenance functions will be limited to and defined as follows:

- a. Inspect.* To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.
- b. Test.* To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc. This is accomplished with external test equipment and does not include operation of the equipment and operator type tests using internal meters or indicating devices.
- c. Service.* To clean, to preserve, to charge, and to add fuel, lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately, they may be so listed.
- d. Adjust.* To rectify to the extent necessary to bring into proper operating range.
- e. Align.* To adjust two or more components or assemblies of an electrical or mechanical system so that their functions are properly synchronized. This does not include setting the frequency control knob of radio receivers or transmitters to the desired frequency.
- f. Calibrate.* To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.
- g. Install.* To set up for use in an operational environment such as an encampment, site, or vehicle.
- h. Replace.* To replace unserviceable items with serviceable like item.
- i. Repair.* To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes, but is not limited to welding, grinding, riveting, straightening, and replacement of parts other than the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.
- j. Overhaul.* Normally, the highest degree of maintenance performed by the Army in order to minimize time work in process is consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by maintenance standards in technical publications for each item of equipment. Overhaul normally does not return an item to like new, zero mileage, or zero hour condition.
- k. Rebuild.* The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance category. Rebuild reduces to zero the hours or miles the equipment, or component thereof, has been in use.
- l. Symbols.* The uppercase letter placed in the appropriate column indicates the lowest level at

which that particular maintenance function is to be performed.

B-3. Explanation of Format

a. *Column 1, Group Number.* Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. *Column 2, Functional Group.* Column 2 lists the noun names of components, assemblies, subassemblies, and modules on which maintenance is authorized.

c. *Column 3, Maintenance Functions.* Column 3 lists the maintenance category at which performance of the specific maintenance function is authorized. Authorization to perform a function at any category also includes authorization to perform that function at higher categories. The codes used represent the various maintenance categories as follows:

Code	Maintenance category
C	Operator/crew
O	Organizational maintenance
F	Direct support maintenance
H	General support maintenance
D	Depot maintenance

d. *Column 4, Tools and Test Equipment.* Column 4 specifies, by code, those tools and test equipments required to perform the designated function. The numbers appearing in this column refer to specific tools and test equipment which are identified in table I.

e. *Column. 5, Remarks.* Self-explanatory.

B-4. Explanation of Format of Table I (Tool and Test Equipment Requirements)

The columns in table I, are as follows:

a. *Tools and Equipment.* The numbers in this column coincide with the numbers used in the tools and equipment column of the applicable tool for the maintenance function.

b. *Maintenance Category.* The codes in this column indicate the maintenance category normally allocated the facility.

c. *Nomenclature.* This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

d. *Federal Stock Number.* This column lists the Federal stock number of the specific tool or test equipment.

e. *Tool Number.* Not used.

SECTION II.

MAINTENANCE ALLOCATION CHART

SECTION II. MAINTENANCE ALLOCATION CHART														
GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS										TOOLS AND EQUIPMENT	REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL			REBUILD
	VOLTMETER, DIGITAL AN/GSM-64A	0	H	0		H				H	D		10 8,9	
	AMPLIFIER TRIGGER PULSE ASSEMBLY								H				6	
	BOARD ASSEMBLIES								H	H			6	
	INDICATOR DIGITAL ASSEMBLY									H			1 thru 7,10	
	ZENER SUPPLY ASSEMBLY								H	H			6	
	CABLE ASSEMBLIES									H			6	

TABLE I.

TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOLS AND EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL STOCK NUMBER	TOOL NUMBER
1	H	AUTOTRANSFORMER, VARIABLE CN-16/U	5950-688-5722	
2	H	DEKAVDER ELECTRO SCIENTIFIC INDUSTRIES MODEL RV 622		
3	H	DUMMY AMPLIFIER: NONLINEAR SYSTEMS PART # 3017-024		
4	H	MULTIMETER TS-352B/U		
5	H	OSCILLOSCOPE AN/USM-281A	6625-228-2201	
6	H	TOOL KIT, ELECTRONIC EQUIPMENT TK-100/G	5180-605-0079	
7	H	VOLTMETER, ELECTRONIC ME-30E/U	6625-643-1670	
8	H	VOLTAGE STANDARD: JOHN FLUKE MODEL 332A9		
9	H	SWITCH: SHALLCROSS MFG. CO. PART NO. 12628		
10	O	TOOLS AND TEST EQUIPMENT NORMALLY SUPPLIED TO THE REPAIRMAN USER BECAUSE OF HIS ASSIGNED MISSION		

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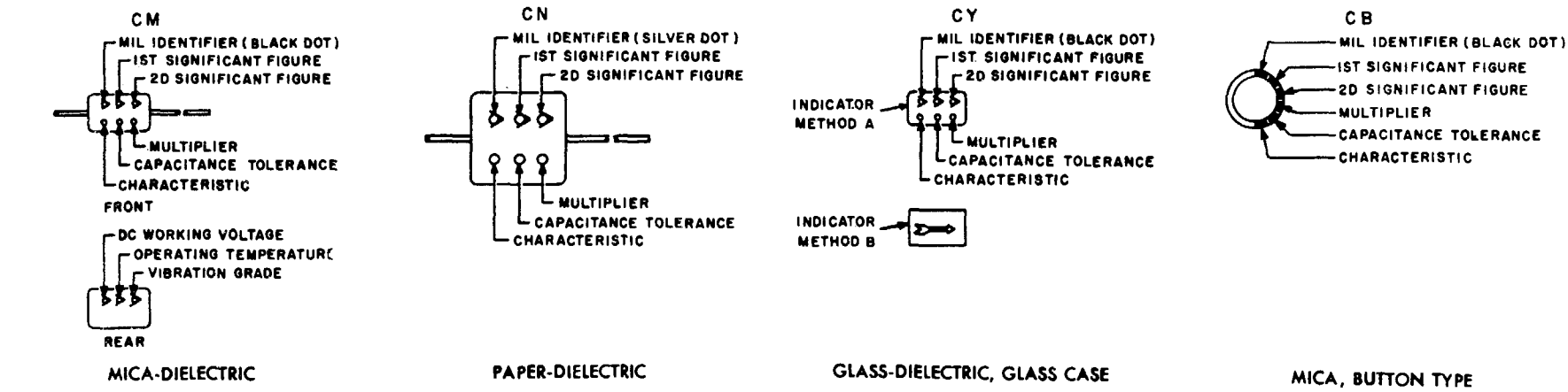
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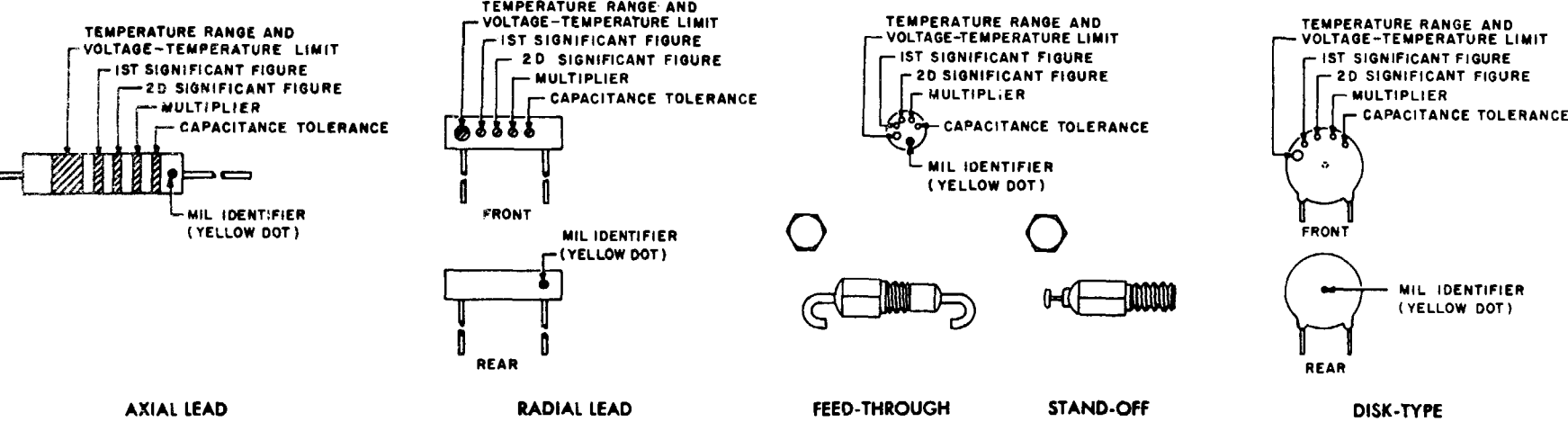
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COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

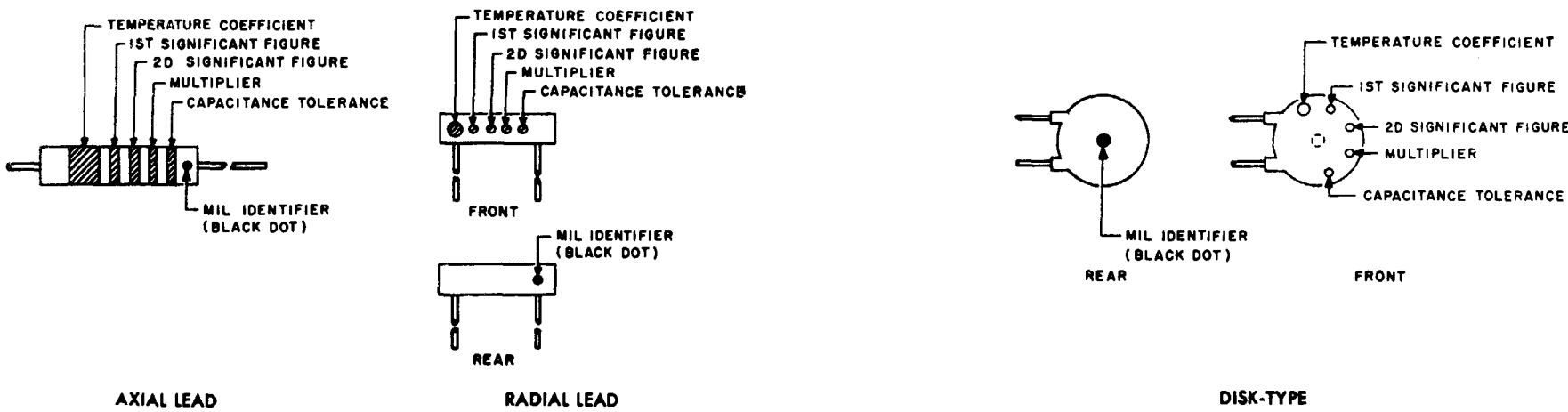
GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



GROUP III Capacitors, Fixed, Ceramic-Dielectric (Temperature Compensating) Style CC



COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER ¹	CAPACITANCE TOLERANCE				CHARACTERISTIC ²				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
BLACK	CM, CY, CB	0	0	1			± 20%	± 20%		A				–55° to +70°C	10–55 cps
BROWN		1	1	10					B	E		B			
RED		2	2	100	± 2%		± 2%	± 2%	C		C			–55° to +85°C	
ORANGE		3	3	1,000		± 30%			D			D	300		
YELLOW		4	4	10,000					E					–55° to +125°C	10–2,000 cps
GREEN		5	5		± 5%				F				500		
BLUE		6	6											–55° to +150°C	
PURPLE (VIOLET)		7	7												
GREY		8	8												
WHITE		9	9												
GOLD				0.1			± 5%	± 5%							
SILVER	CN				± 10%	± 10%	± 10%	± 10%							

TABLE II – For use with Group II, General Purpose, Style CK

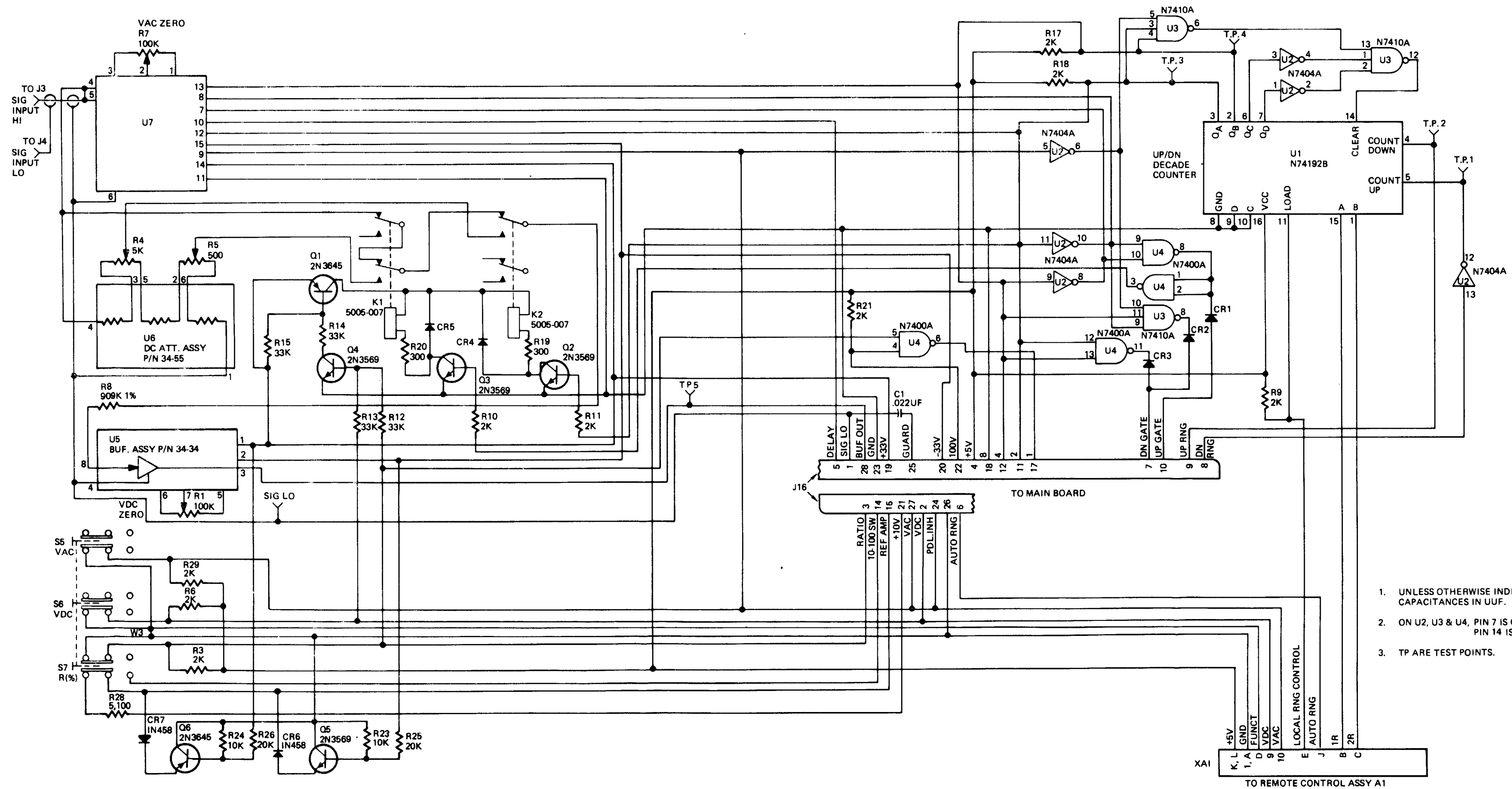
COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS ³	1st SIG FIG	2nd SIG FIG	MULTIPLIER ¹	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AY	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT ⁴	1st SIG FIG	2nd SIG FIG	MULTIPLIER ¹	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	–30	1	1	10	± 1%		
RED	–80	2	2	100	± 2%	± 0.25uuf	
ORANGE	–150	3	3	1,000			
YELLOW	–220	4	4				
GREEN	–330	5	5		± 5%	± 0.5uuf	
BLUE	–470	6	6				
PURPLE (VIOLET)	–750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL-C-5, MIL-C-91, MIL-C-11272, and MIL-C-10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL-C-11015.
4. Temperature coefficient in parts per million per degree centigrade.

Figure 9-2. Color code marking for MIL-STD capacitors.



- NOTES
1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES IN UUF.
 2. ON U2, U3 & U4, PIN 7 IS CONNECTED TO GND. PIN 14 IS CONNECTED TO $V_{CC}(+5V)$.
 3. TP ARE TEST POINTS.

Figure 9-3. Signal conditioning assembly, schematic diagram.

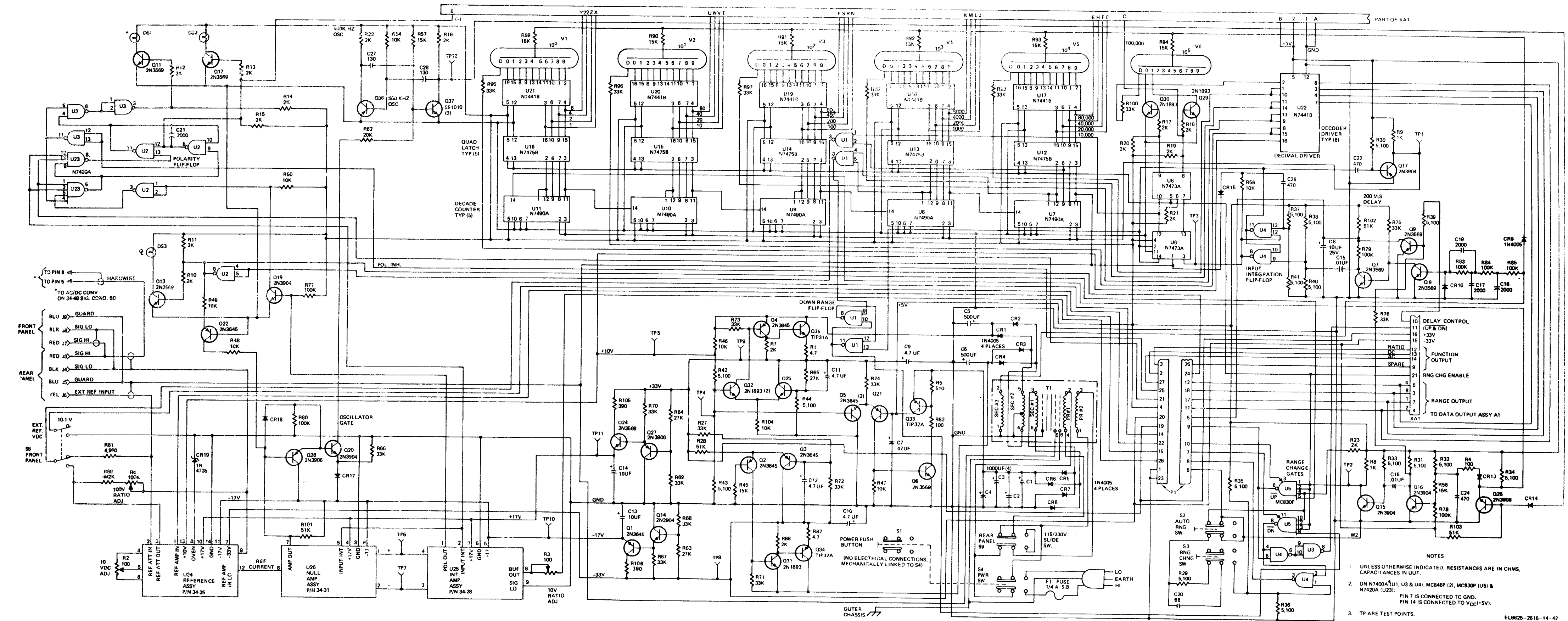


Figure 9-4. Main board assembly, schematic diagram.

- NOTES
1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES IN UUF.
 2. ON N7400A (U1, U3 & U4), MC846P (U2), MC830P (U5) & N7420A (U23), PIN 7 IS CONNECTED TO GND. PIN 14 IS CONNECTED TO VCC(+5V).
 3. TP ARE TEST POINTS.

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