

**TECHNICAL MANUAL**

**DIRECT SUPPORT AND GENERAL SUPPORT  
MAINTENANCE MANUAL**

**TEST SET, CONTROL PANEL,  
FOCAL PLANE SHUTTER**

**LS-78A**

**(NSN 6760-00-878-0592)**



**5**

**SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK**

**1**

**DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL**

**2**

**IF POSSIBLE, TURN OFF THE ELECTRICAL POWER**

**3**

**IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH OR LIFT THE PERSON TO SAFETY USING A DRY WOODEN POLE OR A DRY ROPE OR SOME OTHER INSULATING MATERIAL**

**4**

**SEND FOR HELP AS SOON AS POSSIBLE**

**5**

**AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION**

## **WARNINGS**

### **HIGH VOLTAGE IS USED IN THIS EQUIPMENT**

DEATH ON CONTACT may result if safety precautions are not observed DON'T TAKE CHANCES. Be careful not to come in contact with high voltage or power connections in this equipment. Turn off the power before making any connections or doing any work inside the equipment ALL operations must conform to TB 385-4, Safety Precautions for Maintenance of Electrical Electronic Equipment (8 Aug 79).

### **USE EARTH GROUND, AVOID SHOCK**

Avoid shock, ground the shutter test set. Before connecting the equipment to a power source, the protective ground terminals must be connected to the equipment grounding (safety) conductor (green) of the power cable. Ensure that the ac line power plug is connected to a circuit that has a protective earth (safety) ground Improperly grounded equipment can result in hazardous voltages between equipments Ensure that all devices connected to the shutter test set are connected to earth ground.

### **RESPECT CHEMICAL PRECAUTIONS**

Respect the precautions pertaining to the various chemicals used in the procedures described in this technical manual.

### **USE TWO-MAN LIFT**

Avoid personal injury. The shutter test set is heavy (78 lbs.) and bulky. Use a two-man lift.

### **OBEY TWO-MAN SAFETY RULE**

Do not service, repair, or adjust the equipment alone. Always have another person available to give first aid in case of an accident.

**DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL:  
 TEST SET, CONTROL PANEL, FOCAL PLANE SHUTTER  
 LS-78A  
 (NSN 6760-00-878-0592)**

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**  
 You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ Fort Monmouth, NJ 07703. In any case a reply will be furnished direct to you.

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**CHAPTER 1  
INTRODUCTION**

**1-1. Scope**

a. This manual contains direct support (DS) and general support (GS) maintenance for Test Set, Control Panel, Focal Plane Shutter LS-78A (shutter test set). It includes instructions appropriate to direct support and general support maintenance for trouble shooting, testing, aligning and repairing the equipment, and replacing maintenance parts. It also lists tools, materials, and test equipment for direct support and general support maintenance.

b. The complete technical manual for this equipment includes TM 11-6760-238-12.

**NOTE**

For applicable forms and records, refer to TM 11-6760-238-12

**1-2. Indexes of Publications**

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

**1-3. Reporting Equipment Improvement Recommendations (EIR)**

EIR can and must be submitted by anyone who is aware

of an unsatisfactory condition with the equipment design or use. It is not necessary to show a new design or list a better way to perform a procedure, just simply tell why the design is unfavorable or why a procedure is difficult. EIR may be submitted on SF 368 (Quality Deficiency Report) Mail directly to: Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ Fort Monmouth, NJ 07703 A reply will be furnished to you.

**1-4. Calibration**

Special calibration procedures are not required for the shutter test set.

**1-5. Shutter Test Set Component List**

The shutter test set major components and their reference designations are listed in table 1 - 1.

*Table 1-1. Shutter Test Set Major Components List*

Item	Reference designation
Relay assy test board and components assembly	A1
Control panel test board and components assy	A4
Shutter assy test board and components assy	A8
Bndge assy	A10

## CHAPTER 2 PRINCIPLES OF OPERATIONS

### 2-1. Shutter Test Block Diagram Analysis

(fig.\* FO-1)

a. Control, power, and signal voltages, from the relay assembly under test and present at the relay assembly connector J1, are applied to relay assembly test board and components assembly A1. Control signals from assembly A1 are applied to the A, B, C and D lamp assembly A2. When set to the RELAY TEST position, +28-volt dc power is applied to the relay assembly test board and components assembly A1.

b. Primary +28 volts dc and 115 volts ac, 400 Hz power are applied through power connector J2, fuses F1 and F2 to POWER switch S1. 115-volt ac power from switch S1 is applied to power transformer T1 and control panel test board and components assembly A4. Positive 28 volts dc power from switch S1, is applied to the DC POWER lamp and also throughout the test panel as needed. Power transformer T1 supplies ac power to the AC POWER lamp, throughout the test panel as needed, and also panel illuminating 5 volts ac power to the externally connected aircraft camera control system (ACCS) master control under test.

c. Control panel test board and components assembly A4 accepts control and signal voltages from the ACCS master control under test through CONTROL PANEL connector J6. In addition, it produced output control signals required to illuminate various lamps located within indicator lamp assemblies A6 and A7. Output signals from assembly A4 also control operation of the 900 indicator lamp assembly A5, and indicator lamp assembly A7, as well as provide 115 volts 400 Hz power, converter E V/H (+28 volts dc and ready indicate +28 volts dc power through CONTROL PANEL connector J6 to the ACCS master control. When OPERATE switch S2 is depressed, operate fail +28 volts dc is applied through CONTROL PANEL connector J6 to the ACCS master control under test.

d. Various dc voltages, E V/H to system analog voltage and E input voltage are applied through CONTROL PANEL connector J6 to CONTROL PANEL TEST switch S4. Selected output voltage from CONTROL PANEL TEST switch S4 is then applied through MASTER switch S3 to VOLTMETER + and - binding posts J14 and J15, respectively for monitoring purposes.

e. Control, power, and signal voltages in the shutter assembly under test, present at SHUTTER

MECHANISM connector J3 and connector J4, are applied to SHUTTER ASSY TEST switch S7. Control, power, and signal voltages selected by the SHUTTER ASSY TEST switch S7 are processed by shutter assembly test board and components assembly A8 for controlling operation of the following lamps: Forward, center, and aft lamps, DS3 through DS5, SENSOR CAL lamp DS2; 1/3000 lamp DS1; and OPER, DATA, RECY, and ELECT FLASH indicator lamp assembly A9.

f. Bridge assembly photosensitive transistor output signals are processed by the FWD, CTR, and AFT variable resistor controls R1, R2, and R3 and applied through FOCAL PLANE SHUTTER switch S8 to shutter assembly test board and components assembly A8. Here, the signals are amplified and then applied through SHUTTER ASSY TEST switch S7 to SCOPE + B, SCOPE + A, COUNTER START and COUNTER STOP binding posts J12, J10, J8 and J9 respectively.

g. When depressed, SHUTTER TRIP switch S5 applies +28 volts dc power to SHUTTER connector J5 and also to the shutter assembly test board and components assembly A8.

h. When depressed, SLIT WIDTH switch S6 applies +28 volts dc and ground to SHUTTER MECHANISM connector J3 and connector J4.

i. Shutter assembly variable resistors are connected through SHUTTER MECHANISM connector J3 and connector J4 to RC BRIDGE + and - binding posts J16, J17 to permit resistance readings with an externally connected bridge.

### 2-2. Shutter Test Set Circuit Analysis

The shutter test set tests all cycling functions and shutter speeds of Camera, Still Picture KA-76A. It also isolates malfunctions and provides calibration capabilities for Control, Master, Aircraft Camera LA-405A. The shutter test set consists of: (a) Relay assembly test board and component assembly A1; (b) Control panel test board and components assembly A4; (c) Shutter assembly test board and components assembly A8; (d) Bridge assembly A10; (e) Indicator lamps DS1 through DS5, indicator lamp assemblies A2, A3, A5, A6, A7, and A9, and (f) Associated switches and controls.

#### NOTE

Only major subassemblies of the shutter test set such as: Shutter assembly test board and components assembly A8, control panel test.

board and components assembly A4, and relay assembly test board and components assembly A1 are discussed in a stage-by-stage manner. Remaining circuitry contained within the test set is not sufficiently complex to warrant detailed theoretical discussion. The overall test set schematic diagram is figure\* FO-5 and individual simplified schematic diagrams serve as aids to support the following test. The overall test set wiring diagram is figure\* FO-7 sheets 1 and 2.

a. *Relay Assembly Test Board and Components Assembly A1 (fig\* FO-2)*

(1) Relay assembly test board and components assembly A1 consists of a lamp driver transistor Q1, to six-deck rotary selector RELAY ASSY switch S1, diodes CR1 through CR31, and resistors R1 and R2. This assembly, working in conjunction with indicator lamp assembly A2 and MASTER switch S3, processes + 28 volts dc primary power and ground control signals to provide lamp indications dependent upon operational status.

(2) When a ground signal is *not* applied to pin H of RELAY ASSY connector and/or the RELAY ASSY switch S1 is *not* in position 2 (switch marking), +28 volts dc power is applied through resistors R1 and R2 to the base lead of transistor Q1 and also directly to the emitter lead of the transistor. In this operational condition transistor Q1 is held in a cutoff state and the D lamp is unable to light. When a ground signal is present at pin H, transistor Q1 conducts and the D lamp lights. Zener diode CR31 protects transistor Q1 from a current overload and subsequent breakdown. Whenever MASTER switch S3 is set to the LAMP TEST position, lamp test 28 volts dc and lamp test ground are applied to the relay assembly test board and components assembly, A1 and the A, B, C and D lamps, A2DS1 through A2DS4 light.

b. *Control Panel Test Board and Components Assembly A4 (fig. 2-1)* Control panel test board and components assembly A4 consists of one four-input AND gate, one three-input AND gate, two lamp driver transistors Q1 and Q2, two control relays K1 and K2, diodes CR1 through CR22, and resistors R1 and R2. The two control relays govern application of 28 volts dc and 115 volts, 400 Hz ac power to the ACCS master control under test. The two lamp driver transistors Q1 and Q2 control operation of the 900 and AUTO indicate mg lamps respectively. The diodes are used as steering devices to control indicating lamp operation or as relay protective devices. The assembly processes control panel mode ground, mount position ground, and various control voltages to provide lamp indications thus denoting operational status of the ACCS master control. Since the four-input AND gate and three-in-put AND gate and associated transistor circuits are similar, only

the four-input AND gate and lamp driver transistor Q1 circuitry is discussed.

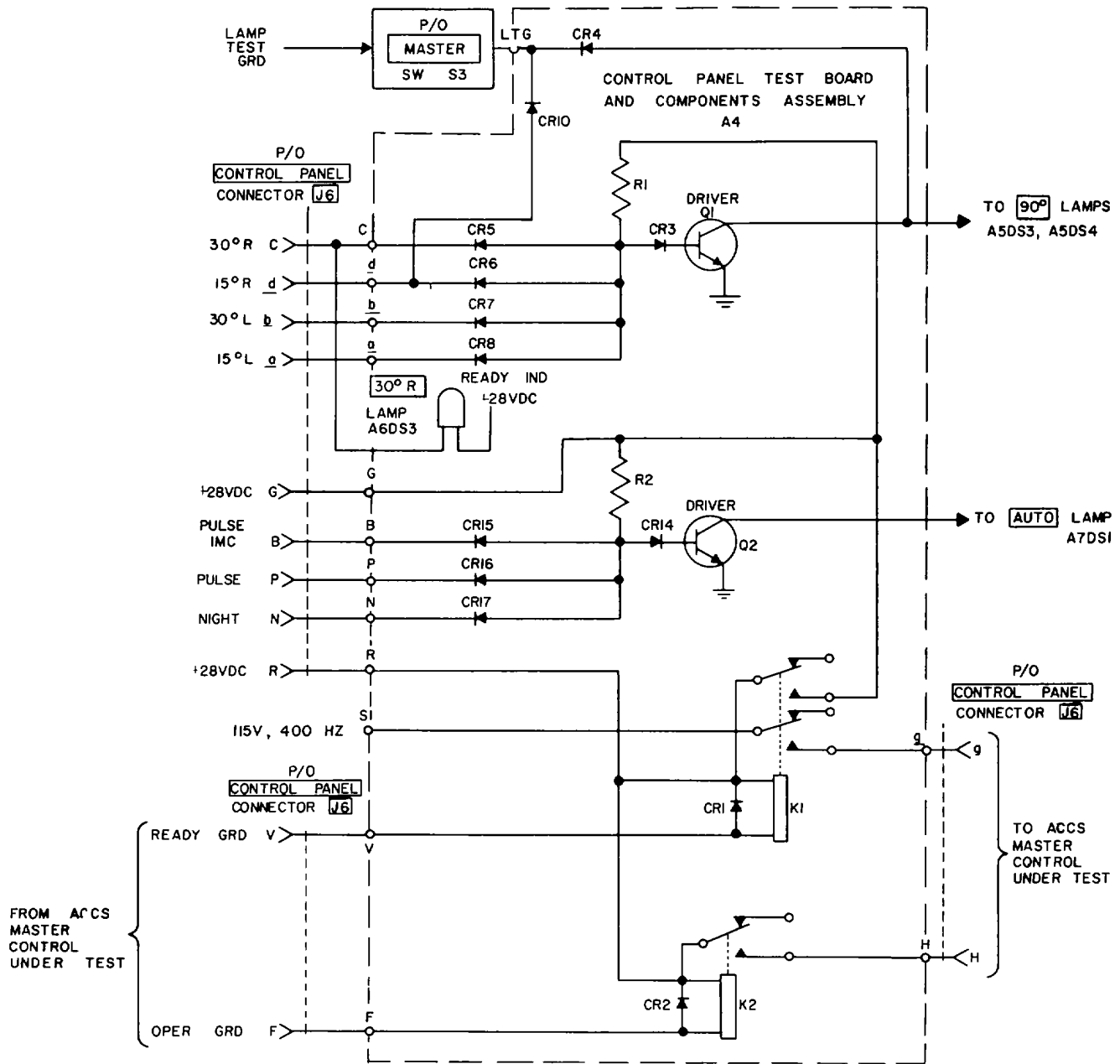
(1) *Mount position four-input AND gate circuit.* The mount position four-input AND gate circuit is comprised of diodes CR3 through CR12, lamp assembly A6, lamp driver transistor Q1, resistor R1 and part of lamp assembly A5 and control relay K1. When MASTER switch S3 is operated to the CONTROL PANEL position, externally connected ACCS master control MOUNT switch is in the 900 position, +28 volts dc power is applied through terminal R, contacts of energized control relay K1, resistor R1, and diode CR3 to the base of transistor Q1. Application of this positive voltage places driver transistor Q1 in a current conducting state thereby lighting the 900 lamps A5DS3 and A5DS4. When the ACCS master control MOUNT switch is placed in the 300 R position, a ground signal is applied through pin C of CONTROL PANEL connector J6 to 300 R lamp A6DS3 and also through terminal C of assembly A4 to diode CR5. In this operational state, the 300 R lamp is lit and diode CR5 conduction applies an effective ground signal to the junction of resistor R1 and diode CR3. This action effectively reverse-biases transistor Q1 to cutoff, thereby causing the 900 lamps DS3 and DS4 to go out. Application of 150 R, 300 L and 150 L ground signals cause the respective lamps to light and in each instance the 900 lamps go out. When MASTER switch S3 is set to the LAMP TEST position, a lamp test ground is applied through diodes CR4 and CR9 through CR12 to the 900 lamps DS3, DS4 and all lamps in assembly A6 thus causing the lamps to light.

(2) *Control relays K1 and K2.* Control relays K1 and K2 and associated diodes CR1 and CR2 process 115-volt, 400 Hz, ac power and 28volt dc power to produce a + 28volt dc E V/H converter output signal, 115-volt, 400 Hz, ac power; and +28-volt dc ready indicate signal to the ACCS master control under test. These relays are energized when MASTER switch S3 is set to the LAMP TEST position.

c. *Shutter Assembly Test Board and Components Assembly A8 (fig\* FO-3).* Shutter assembly test board and components assembly A8 primarily consists of a power supply regulator circuit, two operational amplifiers and associated lamp drivers, two control relays, and two lamp driver transistor stages. This assembly processes +28-volt dc power, bridge assembly photo-transistor signals and various other signals and control voltages to develop various dc voltages, output signals, and indicating lamp control signals.

(1) *Voltage regulator circuit.* The voltage regulator circuitry consists of transistor Q1, zener diodes CR1, CR2 and CR3, capacitors C1, C2 and resistors R1, R2, and R3. Primary + 28 volts dc input power is applied through pin B of connector XA8 to the network consisting of resistor R1, capacitor C1 and zener.





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Figure 2-1. Control panel test board and components assembly A4, simplified schematic diagram.

diode CR1. Zener diode CR1 functions to regulate the input + 28-volt dc power to a + 2(0volt dc level which is applied to the base of series regulator transistor Q1 Resistor R1 serves as a zener diode current limiting resistor while capacitor C1 functions as a filter capacitor. Series regulator transistor Q1 produces regulated + 20-volt dc output which is applied to filter capacitor C2 and zener diode networks comprised of resistors R2, R3 and diodes CR2, CR3 Resistors R2 and R3 serve as diode current limiting resistors while zener diodes CR2 and

CR3 produce + 13-volt dc and + 6.8-volt dc regulated outputs respectively. Regulated + 6.8-volt dc output power is applied through variable resistor R6 to voltage divider networks consisting of resistors R7, R8, R10 and R11. Adjustment of variable resistor R6 determines the magnitude of positive voltage applied to the voltage divider networks.

(2) -6.2 V dc power supply. The -6.2-volt dc power supply circuitry consists of rectifiers CR4 and CR5, capacitors C3 and C4, resistors R4 and R5, and

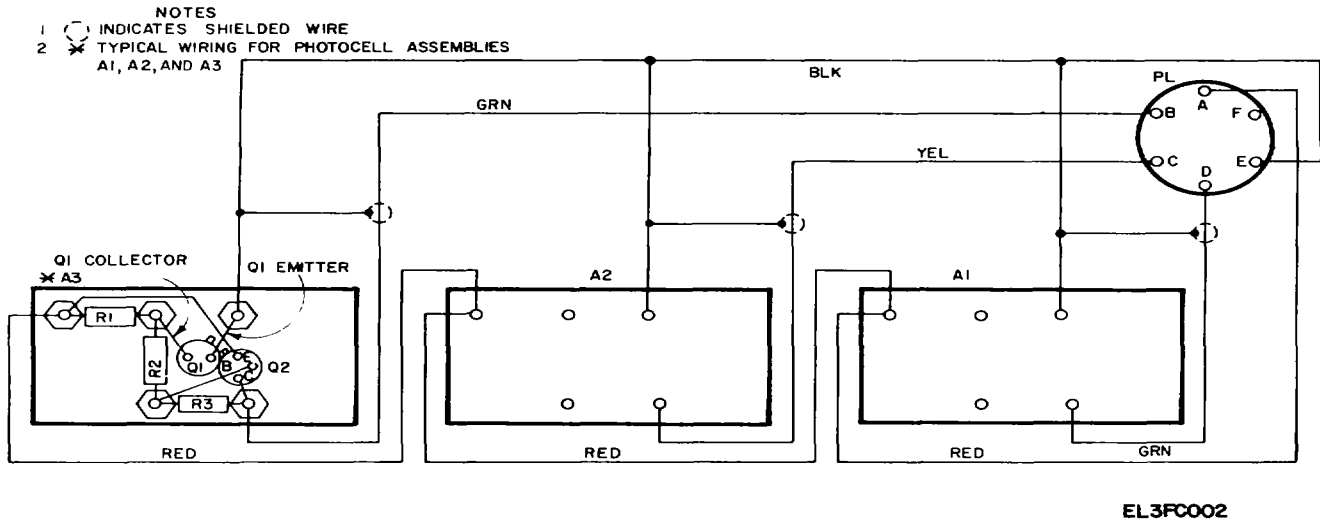


Figure 2-2. Bridge Assembly A10, schematic diagram.

zener diode CR6. Diode rectifiers CR4 and CR5 process ac voltage from transformer T1 through pins U and of connector XA8 to produce full wave pulsating negative dc output voltage which is filtered and smooth, by the filter comprised of capacitors C3, C4, and resistor R4. The filtered output voltage is regulated by zener diode CR6 to a - 6.2-volt dc output and then a piled to terminal 4 of operational amplifiers A1 and A2.

(3) *Operational amplifiers and associated lamp drivers* (The operational amplifiers A1 and A2 and lamp driver transistors Q2 and Q3 and associated circuitry. When the externally connected SENSOR switch S9 is placed in its CALIBRATED position, phototransistor signal energy is coupled through pin of connector XA8 to the non-inverting input terminal 2 of operation amplifier A1. In addition, phototransistor signal energy is applied through pin K of connect XA8 to the inverting input terminal 3 of operation amplifier A2. When SENSOR switch S9 is in the OPERATE position, ground is applied to input terminal 2 of operational amplifier A1. Operational amplifier A1 and A2 output signals are applied through diodes CR7 and CR8 to load resistor R12. When the operational amplifier output signal is of positive polarity, this signal is applied through the diodes and base load resistor R14 to the base of driver transistor Q2 thus causing transistor conduction. With Q2 conducting, an effective ground is applied through resist R16 to the base of driver transistor Q3 thus cutting off the transistor thereby keeping SENSOR CAL lamp DS2 from lighting. When operational amplifier A2 output signal is of negative polarity (when light is impinged upon

selected light sensitive transistor) diode CR8 is reverse-biased and ground is applied through resistors R12 and R14 to the base of driver transistor Q2. The action cuts off transistor current conduction, applies positive voltage to the base of transistor Q3 thereby causing transistor Q3 current conduction. Transistor Q3 current conduction lights SENSOR CAL lamp DS2.

(4) *DATA and ELECT FLASH lamp driver transistors Q4 and Q5* DATA and ELECT FLASH lamp driver transistor stages consist of driver transistors Q4 and Q5 capacitors C5, C6 and associated diodes and resistors. Since both circuits are identical, only the DATA lamp circuitry is discussed.

(a) When the shutter mechanism data request switch is actuated, + 28-volt dc power is applied through pin E of SHUTTER MECHANISM connector J3, diode CR20 and resistor R17, charging capacitor C5, and continues through resistor R19 to the base of lamp driver transistor Q4. This action places the transistor in a current conducting state thus flashing DATA lamp A9DS1. The shutter mechanism's DATA pulse however, is not of sufficient length for the DATA lamp to become illuminated. After the data pulse is removed, current stored in capacitor C5 discharges through resistor R19 and the base of transistor Q4 thus holding the DATA Lamp on for a time interval longer than the duration of the data pulse.

(b) When MASTER switch S3 is set to the LAMP TEST position, a lamp test ground signal is ap-

plied through diode CR24 to the DATA lamp thus lighting the lamp

(5) *Control relays K1 and K2.* Control relays K1, K2 and diodes CR16 and CR17 in conjunction with lay K1 and diode CR1 (located on the chassis), function, to control application of the + 28-volt dc pulse power to the shutter mechanism assembly for tripping the shutter curtain mechanism. When depressed, SHUTTER TRIP switch S5 applies + 28 volts dc to pin D of SHUTTER connector J5, through pins A2 and A3 relay K2 to pin X1 of relay K1 causing it to energize. When relay K1 is energized +28 volts dc is applied pins C and L of SHUTTER MECHANISM connect J3.

d. *Bridge Assembly A10* (fig 2-2) Bridge assembly

A10 consists of three phototransistor and amplifier assemblies A1 through A3 mounted in a column. Two razor blades, positioned in close proximity to each phototransistor assembly, establish the aperture (0.0115 + 0.001 inch) which admits light onto the phototransistor. Bridge assembly photosensitive transistor output signals are processed by the FWD, CTR, and AFT variable resistor controls R1, R2 and R3 and applied through FOCAL PLANE SHUTTER switch S8 to shutter assembly test board and components assembly A8. Here, the signals are amplified and then applied through SHUTTER ASSY TEST switch S7 to SCOPE + B, SCOPE + A, COUNTER START and COUNTER STOP binding posts J12, J10, J8 and J9 respectively.

## CHAPTER 3 DIRECT SUPPORT MAINTENANCE

### Section I. DIRECT SUPPORT TROUBLESHOOTING

#### WARNING

When troubleshooting or making repairs on Test Set, Control Panel, Focal Plane Shutter LS-78A, be extremely careful. Use insulated test probes when making the required voltage measurements. Always disconnect the power cord from the test panel before touching any of the internal parts. Ground all points of high potential to ensure any residual voltages are removed. Make certain that you are not grounded when making measurements or adjustments inside the test set. Do not deviate from recommended procedural steps.

#### 3-1. General Instructions

a. Troubleshooting at the direct support maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The maintenance procedures are not complete in themselves but supplement the procedures outlined in Operator's and Organizational Maintenance Manual (TM 11-6760-238-12).

b. Troubleshooting may be performed while the test panel is operating or if necessary, after the equipment (or parts of it) has been removed from service. When trouble occurs, certain observations and measurements can be made that will help to determine the source of trouble. Usually, when troubleshooting is performed while the shutter test set is operating, it is done at the organizational level (TM 11-6760-238-12).

#### 3-2. Organization of Direct Support Troubleshooting Procedures

a. *General.* Three steps are used in troubleshooting equipment. They are. *Sectionalization, localization, and isolation.* Sectionalization means tracing the fault to the major unit. Refer to TM 11-6760-238-12 for sectionalization procedures. Localization means tracing the fault to the defective section or stage within an assembly or subassembly. Isolation means tracing the fault to the defective part. Some faults can often be isolated by sight, touch, or hearing. The majority of faults, however, must be isolated by detailed electrical, mechanical, and electronic checks.

b. *Sectionalization Checks.* Sectionalization of

troubles is started with the troubleshooting procedures provided in Operator's and Organizational Maintenance Manual, TM 11-6760-238-12.

c. *Localization Checks.* After the trouble has been sectionalized, perform operational check (para 3-5) of the shutter test set. The operation check serves as a check of the localization technique. In addition, assemblies or subassemblies, in some cases parts, can be localized within the shutter test set by the methods listed (1) through (3) below.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits or components. All visual signs should be analyzed to help locate the fault to a particular subchassis, stage, or part. Mechanical faults are most often localized through visual inspection.

(2) *Pluck-out parts.* Defective pluck-out parts will be the cause of many troubles. Remove and test all pluck-out parts suspected of being faulty. Replace each defective part with an identical part known to be good.

(3) *Troubleshooting table.* The malfunctions listed in the troubleshooting table (para 3-6) will aid localizing trouble to a component part, subassembly, or assembly.

d. *Isolation Checks.* Isolation checks for individual assemblies and subassemblies will not be performed at the direct support maintenance level. Defective parts can be isolated by the methods listed in (1) through (2) below.

(1) *Voltage and resistance measurements.* This equipment is transistorized. Observe all cautions given to prevent transistor damage. Make voltage and resistance measurements in this equipment only as specified in table 3-2. Use resistor and capacitor color codes (FO-8) to find value of components.

(2) *Intermittent troubles.* In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made evident by tapping or jarring the front panel. Check the wiring and connections to the assemblies and subassemblies of the shutter test set.

#### 3-3. Test Equipment and Tools Required

Table 3-1 below lists the tools and test equipment required for troubleshooting and repair of the test panel

at direct support maintenance level. Refer to figure\* FO-5 sheets 1 through 5 for a complete schematic diagram of the shutter test set Figure\* FO-7 sheet through 4 comprise the wiring diagram for shut test set.

Table 3-1. Test Equipment and Tools

Tool and test equipment	Used to
Voltmeter, ME-202B/U	Perform voltage measurements.
Multimeter, AN/USM-223	Performs continuity and assistance checks
Tool Kit, Photographic Repair TK-77/GF	Perform repairs and alignment.
Tool Kit, Photographic Repair TK-77/GF	Perform repairs and alignment.

**3-4. Expendable Supplies and Material**

Refer to appendix B for the list of expendable supplies and materials.

**3-5. Operational Check**

- a. With power off and the shutter test set separated from its case (para 3-8a) for access to its internal parts, examine the shutter test set for visual signs of damage
- b. Check for broken, burned or damaged wires and insulation.
- c. Examine the external connectors to ensure there are no bent or misaligned pins.
- d. Ensure that all switches index properly and do not bind.
- e. Check the fuses to ensure they are in good operating condition.
- f. Set all control switches to the off, neutral, or maximum counterclockwise positions.
- g. Connect test equipment as shown in figure 3-1 and perform the steps of the following general operational check (table 3-2) in the order given to check the shutter test set electrically.

**CAUTION**

Observe polarity when connecting the ME-202B/U voltmeter cables to shutter test set. All voltages displayed on the voltmeter will be positive readings.

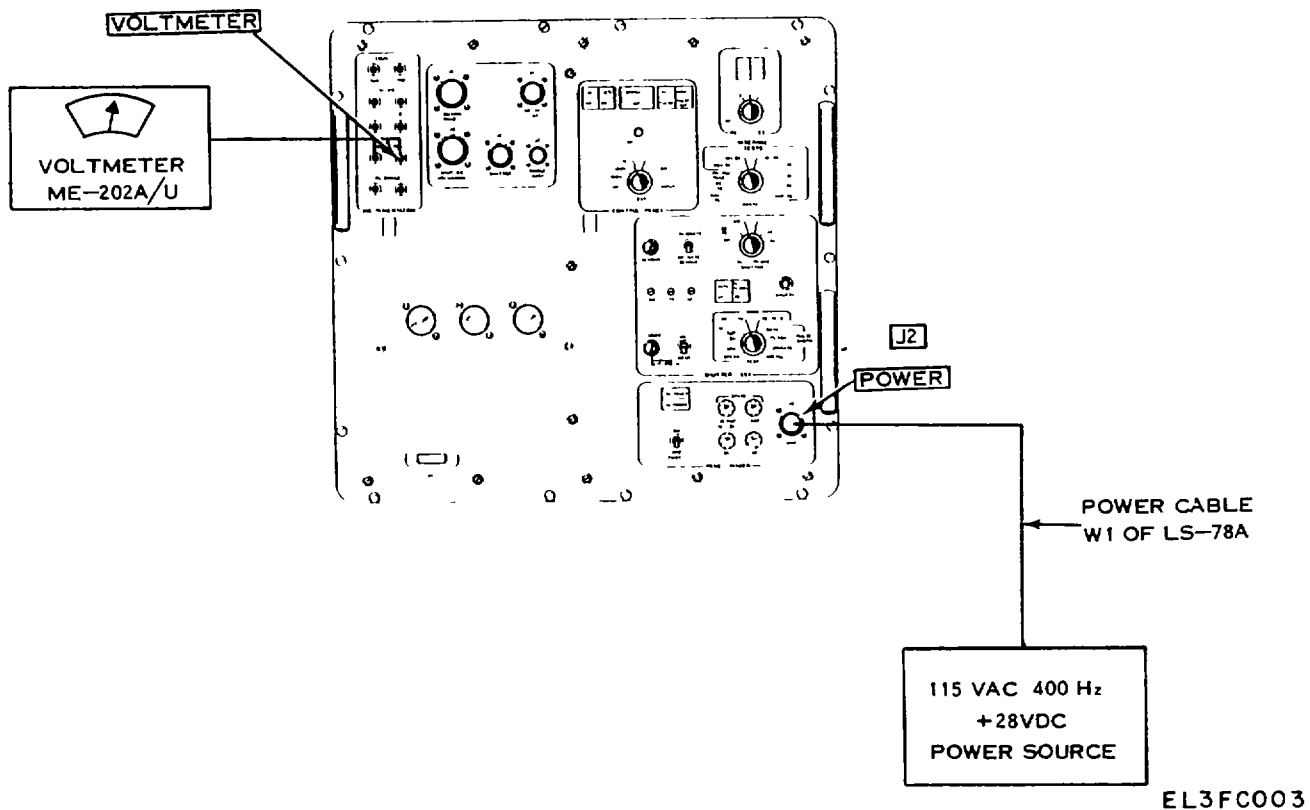


Figure 3-1. Operational check, test setup.

Table 3-2. Operational Check

Step	Action to be taken	Position of shutter test set switches	Required indication
1	Connect voltmeter to VOLT-METER + and - binding posts for steps 1 through 8.	POWER switch ON	AC POWER and DC POWER lamps light
2	NOTE Disconnect grounding bar on voltmeter	MASTER switch INTERNAL TESTS + 28VDC	VTVM should indicate + 24 to
3		MASTER switch INTERNAL TESTS + 19VDC	VTVM should indicate + 19 +
4		MASTER switch INTERNAL TESTS + 13VDC	VTVM should indicate +13 +0 65 vdc
5		MASTER switch INTERNAL TESTS +6 8VDC	VTVM should indicate +6 8 + 1 35 vdc
6		MASTER switch INTERNAL TESTS + 4 2VDC	VTVM should indicate + 4 2 + 0 20 vdc
7		MASTER switch INTERNAL TESTS - 6.2VDC	VTVM should indicate +62 + 0 30 vdc
8		MASTER switch: INTERNAL TESTS LAMP TEST	Panel lamps light
9		MASTER switch SHUTTER TEST	All lamps go out except DC and AC POWER indicators
10		FOCAL PLANE SHUTTER switch SELF TEST	SENSOR CAL lamp lights
11		FOCAL PLANE SHUTTER switch OFF	SENSOR CAL lamp goes out
12		POWER switch OFF	All lamps go out
	<b>NOTE</b> Ensure that all test panel switches are set in the OFF position or extreme counter clockwise position		
13	Mount shutter holding fixture to test panel and connect test cable W2 between shutter holding fixture connector J1 and SHUTTER MECHANISM connector J3 on the test panel	a. POWER switch ON  b. Push in crank handle. c. Release crank handle.  d. POWER switch OFF	a. AC and DC Power lamps light  b. CRANK ENGAGED lamp lights c. CRANK ENGAGED lamp goes out  d. AC and DC POWER lamps go out.
		<b>NOTE</b> Ensure MASTER switch is in SHUTTER TEST position.	
14	Mount bridge assembly on shutter holding fixture and connect pendent connector to BRIDGE ASSY connector J5 on test panel.	a. SENSOR switch CALIBRATE, FOCAL PLANE SHUTTER switch FWD b. Rotate FWD control clockwise until required indication is obtained	SENSOR CAL lamp lights
15		a. FOCAL PLANE SHUTTER switch CTR b. Rotate CTR control clockwise until required indication is obtained	SENSOR CAL lamp lights
16		a. FOCAL PLANE SHUTTER switch AFT b. Rotate AFT control clockwise until required indication is obtained.	SENSOR CAL lamp lights
17		a. FOCAL PLANE SHUTTER switch ALL b. Rotate FWD, CTR and AFT controls counterclock wise	SENSOR CAL lamp goes out after last control is turned counter-clockwise
		<b>NOTE</b> Ensure that all test panel switches are set in the OFF position or extreme counterclockwise position	
18	Turn POWER switch to the OFF position and remove bridge assembly and shutter holding fixture from test panel <b>NOTE</b> Set POWER switch to the OFF position before making each of the following connections		All lamps out

Table 3-2. Operational Check-Continued

Step	Position of shutter test set switches	Required indication
19	MASTER switch: INTERNAL TESTS + 28VDC, POWER switch ON	OPER lamp lights
20		OPER lamp goes out
21	MASTER switch INTERNAL TESTS + 19VDC, POWER switch ON.	RECY lamp lights
22		RECY lamp goes out
23	MASTER switch INTERNAL TEST + 28VDC, POWER switch ON	DATA lamp lights
24		DATA lamp goes out
25	MASTER switch INTERNAL TEST + 28VDC; POWER switch: ON	ELECT FLASH lamp lights
26		ELECT FLASH lamp goes out
27	MASTER switch- CONTROL PANEL, POWER switch ON	90° and AUTO lamps light
28		90° and AUTO lamps go out
29	MASTER switch RELAY TEST, RELAY ASSY switch position 2, POWER switch ON	D lamp lights
30	Set all test panel switches to OFF or extreme counter- clockwise position	D lamp goes out.

**3-6. Direct Support Troubleshooting Procedures**

a. Direct support troubleshooting procedures (table 3-3) supplements the equipment performance checklist in TM 11-6760-238-12. If the symptoms are not known, perform the preoperational test (TM 11-6760-238-12) and observe any malfunction. Table 3-3 lists the malfunctions, test or inspection, and corrective action. Refer to figure\* FO-4 for location of parts.

b. Troubleshooting Table. Steps referenced in the malfunction column refer to the operational check (para 3-5).

**NOTE**

Perform the operation given in TM 11-6760-238-12 before using this chart unless the trouble has already been localized

Table 3-3. Direct Support Troubleshooting

SYMPTOM	PROBABLE TROUBLE	CORRECTIVE ACTION
1. DC POWER LAMPS DS1, DS2 DO NOT LIGHT (step 1)		
	a. Defective DC POWER lamps DS1 and/or DS2, or indicator lamp assembly A3	Replace lamps or modicator lamp assembly (para 3-8t)
	b. Defective 10 ampere DC fuse FI, or fuseholder	Replace fuse or fuseholder (para 3-8p)
	c. Defective POWER switch S1	Replace POWER switch (para 3-8h)
2. AC POWER LAMPS DS3, DS4 DO NOT LIGHT (step 1)		
	a. Defective AC POWER lamps DS3 and/or DS4 or indicator lamp assembly A3	Replace lamps or indicator lamp assembly A3 (para 3-8t).

Table 3-3. Direct Support Troubleshooting-Continued

SYMPTOM	PROBABLE TROUBLE	CORRECTIVE ACTION
	b. Defective 1 ampere AC fuse F2 or fuseholder	Replace fuse or fuseholder (para 3-8p)
	c. Defective POWER switch S1	Replace POWER switch (para 3-8h).
3. NO + 28 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 2), DC POWER LAMPS ON	a. Defective MASTER switch S3	Refer to higher category of maintenance
	b. Broken lead to VOLTMETER binding post J14 or J15	Check for broken lead; repair or replace
4. NO + 19 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 3), DC POWER LAMPS ON	a. Defective MASTER switch S3	Refer to higher category of maintenance
	b. Broken lead to VOLTMETER binding post J14 or J15	Check for broken lead, repair or replace
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and component assembly A8 (para 3-8b)
5. NO + 13 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 4), DC POWER LAMPS ON	a. Defective MASTER switch S3	Refer to higher category of maintenance
	b. Broken lead to voltmeter binding post J14 or J15	Check for broken lead, repair or replace
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b).
6. NO + 6.8 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 5), DC POWER LAMPS ON	a. Defective MASTER switch S3	Refer to higher category of maintenance
	b. Broken lead to VOLTMETER binding post J14 or J15	Check for broken lead, repair or replace
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b).
7. NO + 4.2 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 6), DC POWER LAMPS ON	a. Defective MASTER switch S3	Refer to higher category of maintenance.
	b. Broken lead to VOLTMETER binding post J14 or J15	Check for broken lead, repair or replace
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8(para 3-8b)
8. NO + 6 2 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 7), AC POWER LAMPS ON.	a. Defective MASTER switch S3	Refer to higher category of maintenance
	b. Broken lead to VOLTMETER binding post J14 or J15	
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b)
9. WITH EXCEPTION OF AC POWER, DC POWER AND FWD, CENTER AND AFT LAMPS (DS3, DS4, DS5), PANEL LAMPS DO NOT LIGHT (step 8)	a. Defective MASTER switch S3	Refer to higher category of maintenance
	b. Broken lead to MASTER switch	Check for broken lead, repair or replace
10. SENSOR CAL LAMP DS2 DOES NOT LIGHT (step 10 and 14), AC POWER AND DC POWER LAMPS ON	a. Defective SENSOR CAL lamp DS2	Replace lamp or lampholder socket (para 3-8n)
	b. Defective FOCAL PLANE SHUTTER switch S8	Refer to higher category of maintenance
	c. Defective FWD control R1	Replace FWD control R1 (para 3-8r)
	d. Defective SENSOR switch S9	Replace SENSOR switch (para 3-8h)
	e. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b).
	f. Defective bridge assembly A10	Replace bridge assembly A10



Table 3-3. Direct Support Troubleshooting-Continued

SYMPTOM	PROBABLE TROUBLE	CORRECTIVE ACTION
11. CRANK ENGAGED LAMP DOES NOT LIGHT (step 13), AC POWER AND DC POWER LAMPS ON	a. Defective shutter holding fixture	Refer to higher category of maintenance.
12. SENSOR CAL LAMP DS2 DOES NOT LIGHT (step 15), AC POWER AND DC POWER LAMPS ON	a. Defective SENSOR CAL lamp DS2	Replace lamp or lampholder socket (para 3-8n)
	b. Defective FOCAL PLANE SHUTTER switch S8	Refer to higher category of maintenance
	c. Defective CTR control R2	Replace CTR control (para 3-8r)
	d. Defective SENSOR switch S9	Replace SENSOR switch (para 3-8h).
	e. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b).
	f. Defective bridge assembly A10	Replace bridge assembly
13. SENSOR CAL LAMP DS2 DOES NOT LIGHT (step 16), AC POWER AND DC POWER LAMPS ON.	a. Defective SENSOR CAL lamp DS2	Replace lamp or lampholder socket (para 3-8n)
	b. Defective FOCAL PLANE SHUTTER switch S8	Refer to higher category of maintenance
	c. Defective AFT control R3	Replace AFT control (para 3-8r).
	d. Defective SENSOR switch S9	Replace SENSOR switch (para 3-8h).
	e. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b)
	f. Defective bridge assembly A 10	Replace bridge assembly A 10
14. OPER LAMP A9DS4 DOES NOT LIGHT (step 19), DC POWER LAMPS ON	a. Defective OPER lamp A9DS4 or indicator lamp assembly A9	Replace lamp or indicator lamp assembly A9 (para 3-8t).
	b. Defective MASTER switch S3	Refer to higher category of maintenance
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b)
15. RECY LAMP A9DS3 DOES NOT LIGHT(step 21); DC POWER LAMP ON	a. Defective RECY lamp A9DS3 or indicator lamp assembly A9	Replace lamp or indicator assembly (para 3-8t)
	b. Defective MASTER switch S3	Refer to higher category of maintenance
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b).
16. DATA LAMP A9DS1 DOES NOT LIGHT (step 23); DC POWER LAMPS ON.	a. Defective DATA lamp A9DS1 or indicator lamp assembly A9.	Replace lamp or umdicator assembly A9 (para 3-8t)
	b. Defective MASTER switch S3.	Refer to higher category of maintenance
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b)
17. ELECT FLASH LAMP A9DS2 DOES NOT LIGHT (step 25); DC POWER LAMPS ON	a. Defective ELECT FLASH lamp A9DS2 or indicator lamp assembly A9	Replace lamp or indicator assembly A9 (para 3-8t)
	b. Defective MASTER switch S3	Refer to higher category of maintenance.
	c. Defective shutter assembly test board and components assembly A8	Replace shutter assembly test board and components assembly A8 (para 3-8b)
18. 90° LAMPS A5DS3 AND A5DS4 DO NOT LIGHT (step 27); DC POWER LAMPS ON	a. Defective 900 lamp A5DS3 and A5DS4 or indicator lamp assembly A5.	Replace lamps or indicator assembly A5 (para 3-8t)
	b. Defective MASTER switch S3	Refer to higher category of maintenance

Table 3-3. Direct Support Troubleshooting-Continued

SYMPTOM	PROBABLE TROUBLE	CORRECTIVE ACTION
		c. Defective control panel test board and components assembly A4 Replace control panel test board and components assembly A4 (para 3-8d)
19. AUTO LAMP A7DS1 DOES NOT LIGHT (step 27), DC POWER LAMPS ON		a. Defective AUTO lamp A7DS1 or indicator lamp assembly A7 Replace lamp or indicator assembly A7 (para 3-8t)
		b. Defective MASTER switch S3 Refer to higher category of maintenance
		c. Defective control panel test board and components assembly A4 Replace control panel test board and components assembly A4 (para 3-8d)
20. D LAMP A2DS3 DOES NOT LIGHT (step 29), DC POWER LAMPS ON		a. Defective D lamp A2DS3 or indicator lamp assembly A2 Replace lamp or indicator assembly A2 (para 3-8t)
		b. Defective MASTER switch S3 Refer to higher category of maintenance.
		c. Defective relay assembly test board and components assembly A1. Replace relay assembly test board and components assembly A1 (para 3-8f).

**Section II. DIRECT SUPPORT REPAIR PROCEDURES AND ADJUSTMENTS**

**WARNING**

When making repairs or adjustments, be extremely careful of the ac line voltage. Always disconnect the power source from the equipment making repairs.

**3-7. General Parts Replacement Techniques**

All of the parts and assemblies in the shutter test set can easily be reached without any special procedures.

**NOTE**

Before any part is removed, note the position of the part and its leads. Wire replacement parts in essentially the same position to avoid undesired coupling and shorting together of wires. If necessary, use tags.

**3-8. Direct Support Disassembly/Assembly Procedures (FO-4)**

**NOTE**

Localizing trouble in the shutter test set (para 3-2) can simplify repairs by limiting the work to the defective area. Repair or replace the defective assembly, subassembly or part; then assemble the shutter test set. Disassembly of the test set should be limited to major subassemblies and/or major components.

- a. *Removal of test Panel.* Remove 14 screws (1) from test panel (2) and move test panel away from cat (3)
- b. *Removal of Shutter Assembly Test Board.* Remove two screws (4) from shutter assembly test board (5) and carefully remove shutter assembly test board from test panel (2).
- c. *Replacement of Shutter Assembly Test Board.*

Replace shutter assembly test board (5) in position on test panel (2) and secure with hardware removed in step b above.

d. *Removal of Control Panel Test Board.*

(1) Unsolder and tag all wires attached to the control panel test board (9).

(2) Remove four screws (6), lockwashers (7), flatwashers (8), and remove control panel test board (9) and two spacer assemblies (22) from test panel (2)

e. *Replacement of control panel test board.*

(1) Place lockwasher (7), and flatwasher (8) on screw (6) and insert in control panel test board. Place spacer (22) on screw (6) and mount on test panel (2) Repeat this procedure for the rest of the hardware.

(2) Replace and solder all wires removed in step d(1) above.

f. *Removal of Relay Assembly Test Board.*

(1) Unsolder and tag all wires attached to the relay assembly test board (14).

(2) Loosen two setscrews (p/o 13) and remove RELAY ASSY switch knob (13).

(3) Remove nut, lockwasher and flatwasher (p/o 14) from the front of test panel (2) and remove relay assembly test board (14) from test panel (2).

g. *Replacement of Relay Assembly Test Board.*

(1) Mount relay assembly test board (14) in test panel (2) and secure with hardware removed in step f(3) above.

(2) Replace RELAY ASSY switch knob (13) removed in step f(2) above and tighten the set screws.

(3) Replace and solder all wires removed in step f(1) above.

**NOTE**

Removal and replacement instructions listed

in steps h and h below will be used for removing and replacing SLIT WIDTH switch S6 (16) and SENSOR switch S9 (17).

h. *removal of POWER Switch S1.*

(1) Unsolder and tag all wires from rear of POWER switch S1 (15).

(2) Remove nut, lockwasher and keywasher (p/o 15) from front of test panel (2) and remove POWER switch S1 (15) from rear of test panel.

**NOTE**

Remove second nut (p/o 15) from POWER switch S1 if necessary.

i. *Replacement of POWER Switch S1.*

(1) Position POWER switch S1 (15) in test panel (2) and secure with hardware removed in step h above.

(2) Replace and solder wires to rear of POWER switch S1.

j. *Removal of OPERATE Switch S2 or SHUTTER TRIP Switch S5.*

(1) Unsolder and tag all wires from rear of OPERATE switch S2 (18) or SHUTTER TRIP switch S5 (18)

(2) Remove nut and lockwasher (p/o 18) from rear of test panel (2) and remove switch (S2 or S5) from front of test panel (2).

k. *Replacement of OPERATE Switch S2 or SHUTTER TRIP Switch S5.*

(1) Position switch (S2 or S5) (18) through front test panel (2) and secure with hardware removed step j (2) above.

(2) Replace and solder all wires removed in step j(1) above.

1. *Removal of VOLTMETER + or VOLTMETER Binding Post J14 or J5.*

(1) Remove rear nut (p/o 19) and solder lug (21) (with wires attached) from rear of binding post J14 J15 (19).

(2) Remove second nut, flatwasher and insulating washer (p/o 19) from rear of binding post (19) and move binding post J14 or J15 from front of test panel (2).

(3) Remove second insulating washer (p/o 19) from binding post J14 or J15.

m. *Replacement of VOLTMETER + or VOLTMETER - Binding Posts J14 or J15.*

(1) Place insulating washer removed in step l(3) above on binding post J14 or J15 (19) and insert through front of test panel (2).

(2) Place second insulating washer on binding post J14 or J15 and secure with hardware removed step 1(2) above.

(3) Position solder lug (21) on binding post and secure with nut removed in step 1(1) above.

**NOTE**

Removal and replacement procedures listed in steps l and m above will be

used to remove and replace all other binding posts.

n. *Removal of Lamp Socket Holder XDS1 or DS2.*

(1) Unsolder and tag all wires from rear of lamp socket holder XDS1XDS2 (29).

(2) Turn lens (p/o 29) counterclockwise and pull out of lamp socket holder (29).

(3) Remove nut and lockwasher (p/o 29) from front of test panel (2) and remove lamp holder socket (29) from rear of test panel

(4) Remove second nut (p/o 29) from lamp socket holder (29)

o. *Replacement of Lamp Socket Holder XDS1/ XDS2.*

(1) Replace second nut (p/o 29) on lamp socket (29).

(2) Position lamp socket holder XDS1XDS2 (29 in test panel (2) and secure with hardware removed in step n(3) above

(3) Replace lens (p/o 29) in lamp socket holder (29).

(4) Replace and solder wires removed in step n(1) to rear of lamp socket holder (29).

p. *Removal of DC/AC Fuseholder XF1 or XF2.*

(1) Unsolder and tag all wires from rear of fuseholder XF1 or XF2 (30).

(2) Remove cap (p/o 30) and fuse (31 or 32) from fuseholder XF1 or XF2 (30).

(3) Remove nut and lockwasher (p/o 30) from rear of fuseholder XF1 or XF2 (30) and remove fuseholder from front of test panel (2).

q. *Replacement of DC/AC Fuseholder XF1 or XF2.*

(1) Position fuseholder XF1 or XF2 (30) in test panel (2) and secure in place with hardware removed in step p(3) above.

(2) Replace and solder all wires removed in step p(1) above to rear of fuseholder (30).

(3) Replace fuse (31 or 32) in fuseholder (30) and replace cap (p/o 30).

r. *Removal of FWD, CTR, or AFT Control Assembly.*

(1) Unsolder and tag all wires from rear of control assembly (27).

(2) Loosen two setscrews (p/o 26) and remove control knob (26) from control assembly (27).

(3) Remove nut and lockwasher (p/o 27) from front of test panel (2) and remove control assembly (27) from rear of test panel.

s. *Replacement of FVWD, CTR, or AFT Control Assembly.*

(1) Position control assembly (27) in test panel (2) and secure with hardware removed m step r(3) above.

(2) Replace and solder all wires removed in step r(1) above to rear of control assembly (27).

(3) Replace control knob (26) on control assembly

(27) and tighten setscrews (p/o 26).

t. *Removal of Indicator Lamp Assembly (fig. 3-2)*

**NOTE**

Removal and replacement instructions given in step t and u below will be used for indicator lamp assemblies A2 (A3), A3 (24), A5 (10), A6 (11) A7 (12), and A9 (25)

**NOTE**

Indicator lamp assemblies (11) and (12) have a plate and spacer assembly (22) that clips in. This assembly should be removed and kept for reassembly purposes if either of these subassemblies (11) or (12) are to be replaced.

(1) Unsolder and tag all wires connected to the indicator lamp assembly.

(2) Insert fingernails in cutouts in lens and pull lens away from indicator body.

(3) Rotate lens 90 degrees counterclockwise, push in slightly to remove tension on index key, and pull complete bulb assembly to stop of indicator body.

(4) Using screwdriver, loosen two screws on inside of indicator body by rotating counter clockwise until tabs are loose and free mounting support

(5) Slide mounting support from test panel (2) direction of arrow.

(6) **Remove indicator body from test panel (2).**

a. *Replacement of Indicator Lamp Assembly (fig*

3-2)

(1) Position indicator body in test panel (2).

(2) Slide mounting support over indicator body and secure by tightening the two screws loosened in step t(4) above

(3) Push bulb assembly into indicator body and rotate lens 90 degrees clockwise to secure lens to indicator body.

v. *Replacement of test panel.* Position test panel (2) in case (3) and secure with hardware removed in step a above.

**3-9. DS3, DS4 or DS5 Light Source Focus Adjustment**

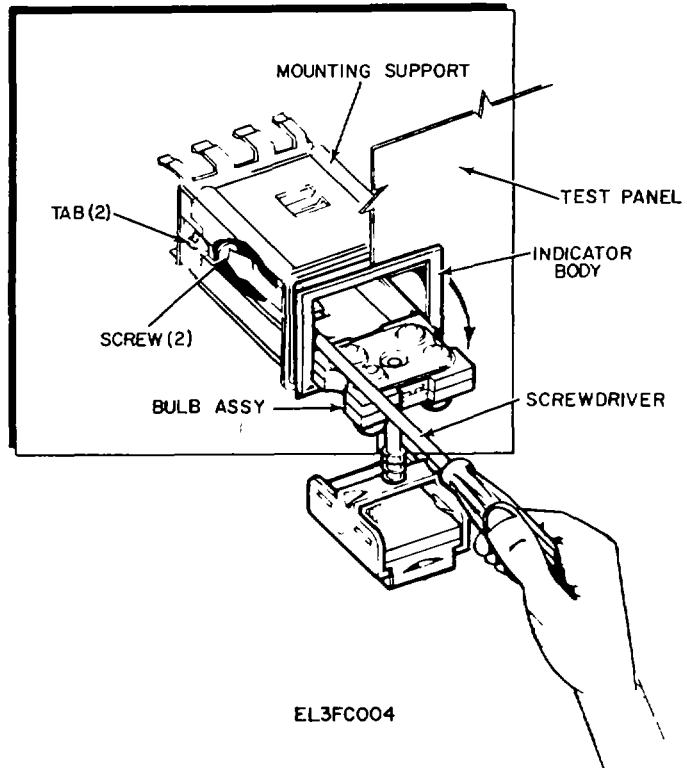
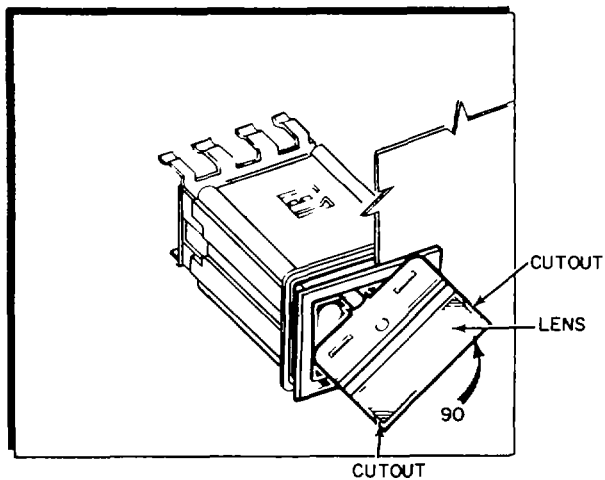
(fig. 3-)

The focusing adjustment procedure for each of the three light sources on the test panel is as follows:

a. Connect power cable W1 of LS-78A between POWER connector J2 on test panel and power source.

b. Loosen the two hex-nut setscrews mounting the lens barrel in position, (refer to paragraph 3-11a).

c. Carefully begin to tighten one of the setscrews while manipulating the lens barrel in and out until it is felt that the screw is engaged in one of the threads on the lens barrel. The lens barrel may now be screwed in or out into final adjustment.



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Figure 3-2. Replacement of indicator lamp assembly.

d. Place a sheet or paper approximately 6 inches above and perpendicular to the beam of light emanating from the lens barrel, and focus the beam of light on the sheet by adjusting the lens barrel. Care should be exercised not to focus the filament of the lamp by mistake. Correct adjustment is obtained when a sharp point of light is obtained on the sheet. Incorrect focus is evident by the presence of the shadow of the filament of the lamp along with rings of light. If the light can be adjusted to a sharp spot of light on the sheet, focus is correct.

e. Tighten the two setscrews and liquid stake (para 3-12).

**3-10. Cleaning of Mechanical Parts, Electrical Contacts, and Lenses**

**WARNING**

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame; the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary, use gloves which the solvent

cannot penetrate. If the solvent is taken internally, consult a physician immediately.

a. *Mechanical Parts and Electrical Contacts.*

(1) To remove grease or dirt from mechanical parts or electrical contacts, wipe the area to be cleaned with a cloth moistened with cleaning compound.

(2) Wipe them dry with a clean lint-free cloth. Do not allow lint or foreign matter to remain between surfaces of any parts.

b. *Lenses.*

(1) To remove dust, lint, or other foreign matter from lenses, use a soft bristled brush to loosen and remove foreign matter from the lenses. Use a small syringe to blow loose particles from the lens area.

**CAUTION**

Do not use lens tissue containing silicone. Avoid excessive use of lens cleaner.

(2) Moisten a wad of lens tissue with lens cleaner and wipe the outer surfaces of the lens with a gentle circular motion from edge to center. Change the surface of the lens tissue that touches the glass with each stroke to avoid reusing any part of the tissue. Use as many tissues as necessary.

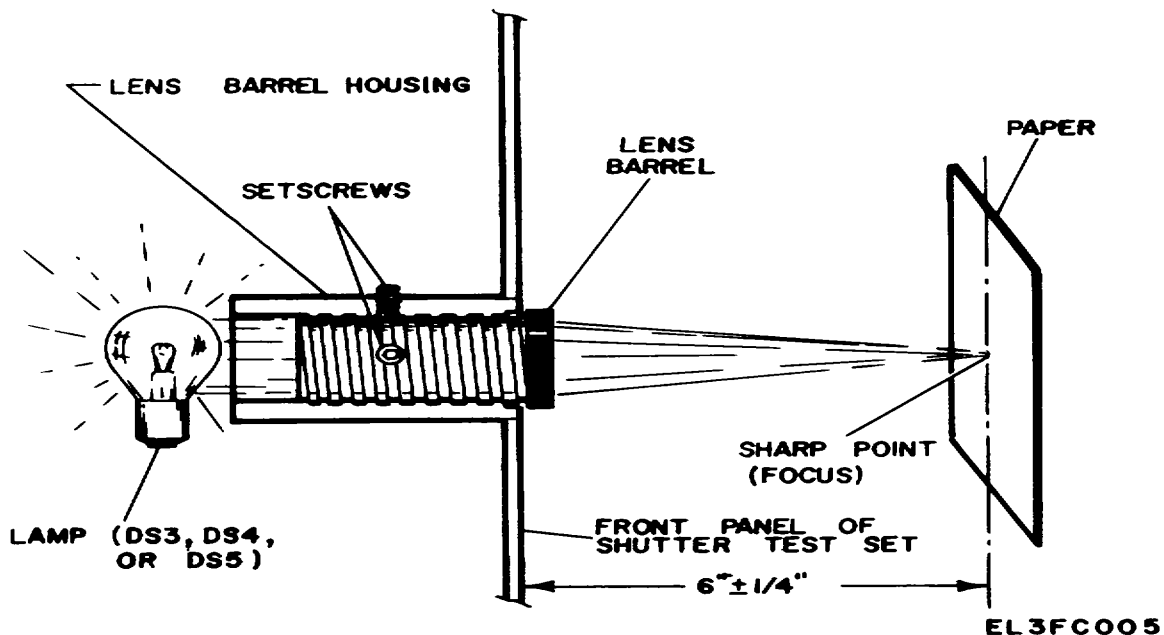


Figure 3-3. Light source focus adjustment.

### 3-11. Direct Support Repair Procedures

#### WARNING

Acetone is toxic and flammable, use only in small quantities in a well ventilated area. Do not breathe vapors or allow liquid to contact the skin. Do not use in the presence of open flame or sparks.

a. To remove or loosen liquid staked parts, carefully scrape away any visible staking compound first, then attempt to loosen part. If necessary, apply heat to the screw using a soldering iron; heat only the staked part. If heat fails, apply small quantities of acetone, Federal Specification O-A-51, directly to the area with small brush. Remove acetone as soon as possible. To apply liquid staking, refer to paragraph 3-12.

b. Use a pencil type soldering iron with a 25-watt maximum capacity. This equipment is transistorized. If the iron must be used with ac, use an isolating transformer between the iron and the line. Do *not* use a soldering gun near the transistorized assemblies; damaging voltages may be induced in the circuit

components.

### 3-12. Liquid Staking

Liquid staking (Glyptal 1201 F) is a paste that is applied to machine screws, adjustments, nuts, and other fasteners to lock them in place.

a. *Grade.* Liquid staking grade 4 (Glyptal 1201 F, manufactured by General Electric Co., Schenectady, New York) is the only grade used in the shutter test set.

b. *Application* Before it hardens, liquid staking can be applied as follows.

(1) Using a brush, apply liquid staking to the screw threads. Remove excess liquid staking.

(2) If the screw is placed in a blind hole, reverse the rotation occasionally to allow trapped air to escape.

(3) If necessary to thin liquid staking, use Glyptal 1500 Thinner (manufactured by General Electric Co., Schenectady, New York).

(4) Approximately 12 hours curing time is required. Heat, not exceeding 2120 F for three to five hours, may be used to accelerate curing.

**CHAPTER 4  
GENERAL SUPPORT MAINTENANCE**

**Section I. GENERAL SUPPORT TROUBLESHOOTING**

**WARNING**

When troubleshooting or making repairs on Test Set, Control Panel, Focal Plane Shutter LS-78A, be extremely careful. Use insulated test probes when making the required voltage measurements. Always disconnect the power cord from the test panel before touching any of the internal parts. Ground all points of high potential to ensure any residual voltages are removed. Make certain that you are not grounded when making measurements or adjustments inside the test set. Do not deviate from recommended procedural steps.

**4-1. Tools and Test Equipment Required for General Support Troubleshooting**

In addition to the tools and test equipment listed in paragraph 3-3, the following items should be available

- a. Oscilloscope ANIUSM-281C

- b. Bridge, Impedance, General Radio Type 1650A ANfURM-190.

**4-2. Organization of General Support Troubleshooting Procedures**

General support troubleshooting procedures include all troubleshooting performed at lower levels in addition to the information contained in this chapter. Troubleshooting table 4-1 lists possible malfunctions that cannot be remedied with the maintenance facilities allocated to lower levels. Unless the trouble has been specifically localized or isolated, perform applicable troubleshooting procedures given in TM 11-6760-238-12.

**4-3. General Support Troubleshooting Procedures**

Steps referenced in the malfunction column refer to the operational check (para 3-5)

**NOTE**

Refer to the schematic diagram (fig.\* FO-5) and wiring diagram (fig.\* FO-7) when troubleshooting the equipment.

*Table 4-1. General Support Troubleshooting*

SYMPTOM	PROBABLE TROUBLE	CORRECTIVE ACTION
1. NO + 28 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 2), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
2. NO + 19 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 3), DC POWER LAMPS ON.	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
3. NO + 13 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 4), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
4. NO + 6 8 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 5), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
5. NO + 4 2 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 6), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
6. NO + 6 2 VDC MEASURED AT VOLTMETER BINDING POSTS J14 AND J15 (step 7), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and a)

Table 4-1. General Support Troubleshooting - Continued

SYMPTOM	PROBABLE TROUBLE	CORRECTIVE ACTION
7. WITH EXCEPTION OF THE AC POWER, DC POWER, AND FWD, CENTER AND AFT LAMPS (DS3, DS4, DS5), PANEL LAMPS DO NOT LIGHT (step 8)	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
8. SENSOR CAL LAMP DS2 DOES NOT LIGHT(step 9), AC POWER AND DC POWER LAMPS ON	a. Defective LOCAL PLANE SHUTTER switch S8 b. Defective phototransistor assembly A10A3	Replace FOCAL PLANE SHUTTER switch (para 4-6 h and i) Replace phototransistor assembly (para 4-7a and h)
9. SENSOR CAL LAMP DS2 DOES NOT LIGHT (step 10), AC POWER AND DC POWER LAMPS ON	a. Defective FOCAL PLANE SHUTTER switch S8 b. Defective phototransistor assembly A10A2	Replace FOCAL PLANE SHUTTER switch (para 4-6h and I) Replace phototransistor assembly (para 4-7a and b)
10. SENSOR CAL LAMP DS2 DOES NOT LIGHT (step 11), AC POWER AND DC POWER LAMPS ON	a. Defective FOCAL PLANE SHUTTER switch S8 b. Defective phototransistor assembly A10A1	Replace FOCAL PLANE SHUTTER switch (para 4-6 h and I) Replace phototransistor assembly (para 4-7 a and b)
11. OPER LAMP A9DS4 DOES NOT LIGHT (step 19), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
12. RECY LAMP A9DS3 DOES NOT LIGHT (step 21), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
13. DATA LAMP A9DS1 DOES NOT LIGHT (step 23), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4- 6 h and i)
14. ELECT FLASH LAMP A9DS2 DOES NOT LIGHT (step 25), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
15. 90° LAMPS A5DS3 AND A5DS4 DO NOT LIGHT (step 27), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
16. AUTO LAMP A7DS1 DOES NOT LIGHT (step 27), DC POWER LAMPS ON	Defective MASTER switch S3	Replace MASTER switch (para 4-6 h and i)
17. D LAMP A2DS3 DOES NOT LIGHT (step 29), DC POWER LAMPS ON	Defective MASTER switch S3)t	Replace MASTER switch (para 4-6 h and i)

**4-4. Signal Substitution**

Signal substitution procedures quickly enable localization of a trouble. An oscilloscope, rc bridge, and voltmeter may be used in performing signal substitution procedures. Below are general notes on signal substitution and signal tracing.

- a. Test jumper cables are used to apply either + 28 volt dc power or ground to particular points throughout the test panel.
- b. A multimeter (Multimeter ANIUSM-223 or

equivalent) is used to measure voltages.

**NOTE**

When connecting the test jumper cables, it may be necessary to partially remove the fungicide coating to ensure proper electrical contact. Use acetone (Federal Specification O-A-51) to remove the fungicide from the printed circuit board.

- c. After trouble is traced to a circuit, disconnect the test equipment and perform voltage and resistance measurements to localize the defective part.



**Section II. GENERAL SUPPORT REPAIR PROCEDURES**

**4-5. General**

**WARNING**

Before beginning any work with these chemicals, be sure to check with the local Safety Office or Preventive Medicine Activity. They can inform you of any special precautions (handling, storage, accidental contact with, etc.) to take to avoid any health hazards.

Most of the assemblies, subassemblies, and parts in the shutter test set can be reached easily and replaced without the use of special tools. When replacing part the general techniques and precautions in paragraph 3-11 and 3-12 apply.

a. *Epoxy Coating.* After any maintenance has been performed that requires removal of the surface coating on test board and components assemblies, the exposed areas must be recoated for fungus and moisture protection using the following procedure.

**WARNING**

Xylol is toxic and flammable, use it only in small quantities in a well ventilated area. Do not breathe vapors or allow liquid to contact the skin. Do not use in the presence of open flame or sparks.

(1) *Part A (Resin).* Measure 100 parts by weight of Araldite 571 CX (manufactured by Ciba Co., Fair Lawn, NJ) with 29 parts by weight of Beetle 216-8 (manufactured by American Cyanamid Co.) and stir well. Mix 27 parts by weight of Diacetone Alcohol (Federal Specification O-D-306) and stir well. Store in separate container.

(2) *Parts B (Hardener).* Measure 100 parts by weight of Araldite 820 (manufactured by Ciba Co., Fair Lawn, NJ) with 37.5 parts by weight of Xylol (Federal Specification TT-X-916) and stir well. Mix 20 parts by weight of Butyl Alcohol (Federal Specification TT-B-846) and stir well. Store in separate container.

b. *To Prepare Epoxy for Immediate Use.* To prepare the epoxy for immediate use, mix two parts "A" (Resin) with one part "B" (hardener) in a quantity that can be used in eight hours. Mix thoroughly. Brush the mixture onto the areas to be coated, making sure to avoid areas that require mechanical movement such as control adjustments and wafer switch contacts.

(1) The epoxy mixture will dry to the touch in approximately 1 hour when applied in a film of 0.005 to 0.010 inch thickness. Total curing time requires 24 hours at room temperature. Curing time can be shortened by heating in a circulating oven at 1500 F for hours.

(2) If necessary to spray Epoxy coating, thin with Xylol (Federal Specification TT-X-916).

(3) Mask over terminals on both sides of printed circuit boards before applying Epoxy coating

(steps (1) through (3) above).

**WARNING**

When making repairs or adjustments, be extremely careful of the ac line voltage. Always disconnect the power source from the equipment when making repairs.

**4-6. General Support Disassembly/Assembly Procedures (FO-6)**

**NOTE**

General support maintenance includes all repair operations covered in lower level manuals and lower level portions of this manual as well as those covered in this chapter.

a. *Removal of Test Panel Assembly.* Refer to paragraph 3-8a for removal of test panel assembly.

b. *Removal of SHUTTER MECHANISM Connector J3.*

**NOTE**

The following instructions will apply for the removal and replacement of RELAY ASSY connector J1, SHUTTER connector J5, CONTROL PANEL connector J6 and BRIDGE ASSY connector J7.

(1) Unsolder and tag all wires attached to SHUTTER MECHANISM connector J3( ).

(2) Remove four screws (1), four flatwashers (2), four nuts (3), and remove SHUTTER MECHANISM connector J3 (4) from rear of test panel (10).

c. *Replacement of SHUTTER MECHANISM Connector J3.*

(1) Position SHUTTER MECHANISM connector J3 (4) in test panel (10) and secure with hardware removed in step b(2) above.

(2) Replace and solder all wires removed in step b(1) above.

d. *Removal of POWER Connector J2.*

(1) Remove two top screws (20), two flatwashers (2), two nuts (3), and remove component assembly (19) away from test panel (10).

(2) Unsolder and tag all wires attached to POWER connector J2 (5).

(3) Remove bottom two screws (1), flatwashers (2), nuts (3), and remove POWER connector J5 (5) from test panel (10).

e. *Replacement of POWER Connector J2.*

(1) Position POWER connector J2 (5) in test panel (10) and secure with hardware removed in step d(3) above.

(2) Replace and solder all wires removed in step d(2) above.

(3) Position component assembly (19) on POWER

connector J2 (5) and secure with hardware remove step d(1) above.

f. *Removal of Connector J4.*

(1) Unsolder and tag all wires attached to connector J4 (11).

**NOTE**

Observe location of guide pins on connector J4.

(2) Remove two nuts (13) and remove connector J4 (11) and shell (12) from test panel (10).

g. *Replacement of connector J4.*

(1) Ensure that guide pins are in the correct position and position connector J4 (11) and shell (12) in place on the test panel (10) and secure with hardware removed in step f(2) above.

(2) Replace and solder all wires removed in step f(1)

**NOTE**

For removal and replacement of FOCAL PLANE SHUTTER Switch S8 (16), MASTER Switch S3 (17) or CONTROL PANEL TEST Switch S4 (18), refer to the instructions given in steps h and i below

h. *Removal of SHUTTER ASSY TEST Switch S7*

(1) Unsolder and tag all wires attached to switch S7 (15).

(2) Loosen two set screws (p/o 14) and remove knob (14) from shaft of switch S7 (15).

(3) Remove nut (15), lockwasher (15), and flatwasher (15) from front of test panel (10) and remove switch assembly (15) from rear of test panel.

i. *Replacement of SHUTTER ASSY TEST Switch S7.*

(1) Position switch assembly (15) in test panel (10) and secure with hardware removed in step h(3) above.

(2) Replace knob (14) on shaft of switch assembly S7 (15) and tighten the two set screws.

(3) Replace and solder all wires removed in step (1) above

j. *Removal of Transformer T1.*

(1) Unsolder and tag all wires attached to transformer T1 (23).

(2) Remove two nuts (22) and two screws (21) and remove transformer T1 (23) from chassis and nut assembly (43)

k. *Replacement of Transformer T1.*

(1) Position transformer T1 (23) on chassis and nut assembly (43) and secure with hardware remove in step (2) above.

(2) Replace and solder all wires removed in step J(1) above

l. *Removal of Lamp Assemblies.*

**NOTE**

Removal and replacement instructions in step l and m will apply to LEFT (FWD)

DS3, CENTER (CTR) DS4 and RIGHT (AFT) DS5 lamp assemblies

(1) Remove lamp (26) from lampholder assembly (27).

(2) Unsolder and tag wires attached to lampholder assembly (27).

(3) Remove two screws (24) and two flatwashers (25) and remove lampholder assembly (27) from support (30).

m. *Replacement of Lamp Assemblies.*

(1) Position lampholders assembly (27) on support (30) and secure with hardware removed in step 1(3) above.

(2) Replace and solder all wires removed in step 1(2) above.

(3) Replace lamp (26) in lampholder assembly (27).

**NOTE**

Focus adjustment (para 3-9) should be performed after replacement of lampholder assembly.

n. *Removal of Support.*

**CAUTION**

Coated lens are installed in the lamp assemblies support Avoid handling lens when removing or replacing support.

(1) Remove two screws (31) and two flatwashers (32) from each lampholder assembly (27) and move the lampholder assemblies away from the support (30).

(2) Remove six screws (31) and six lockwashers (32) from the support (30) and remove support from lens housing.

o. *Replacement of Support.*

(1) Position support (30) on lens housing and secure with hardware removed in step n(2) above

(2) Position lampholder assemblies (27) on support (30) and secure with hardware removed in step n(1) above

**NOTE**

Focus adjustment (para 3-9) should be performed after replacement of support.

p. *Removal of Connector XA8.*

(1) Refer to paragraph 3-8b and remove shutter assembly test board A8 from connector XA8 (37).

(2) Remove two screws (33) from spacer assembly (34) and move spacer assembly and connector XA8 (37) away from chassis and nut assembly (43).

(3) Unsolder and tag all wires attached to connector XA8 (37).

(4) Remove two screws (35) and two nuts (36) from connector XA8 (37) and remove connector XA8 from spacer assembly (34)

g. *Replacement of Connector XA8.*

(1) Position connector XA8 (37) in place on spacer assembly (34) and secure with hardware removed in step p(4) above.

(2) Replace and solder all wires removed in step p(3) above.

(3) Position spacer assembly (34) and connector XA8 (37) in place on chassis and nut assembly (43) and secure with hardware removed in step (2) above.

(4) Replace and secure shutter assembly test board removed in step p(1) above.

r. *Removal of Chassis and Nut Assembly.*

(1) Refer to paragraph 3-8b and remove shutter assembly test board A8 from connector XA8 (37).

(2) Remove two screws (33) from plate and spacer assembly (34) and move support and spacer assembly (34) and connector XA8 (37) to one side.

(3) Remove four screws (38) and four nuts (42) from top and bottom of test panel (10).

(4) Remove three screws (38) and three lockwashers (40) from front of test panel (10) and remove chassis and nut assembly (43) away from test panel.

(5) Remove three screws (38) and three lockwashers (39) from chassis and nut assembly (43) and remove the three spacers (41) from chassis and nut assembly.

s. *Replacement of Chassis and Nut Assembly.*

(1) Replace and secure the three spacers (41) removed in step r(5) above to chassis and nut assembly (43).

(2) Position chassis and nut assembly (43) on test panel and secure with hardware removed in step r(3) and (4) above

(3) Position plate and spacer assembly (34) and connector XA8 (37) on chassis and nut assembly (43) and secure with hardware removed in step r(2) above.

(4) Replace and secure shutter assembly test board removed in step r(1) above.

t. *Removal of Handle(s).* Remove two screws (47) and remove handle (48) from test panel (10).

u. *Replacement of Handle(s)* Position handle (48) on test panel (10) and secure with hardware removed in step t above.

v. *Removal of Block(s).* Remove two screws (49) and two lockwashers (50) from rear of test panel (10) and remove block(s) (51) from test panel (10).

w. *Replacement of Block(s).* Position block(s) (51) test panel (10) and secure with hardware removed step v above.

x. *Removal of Relay K1.*

(1) Unsolder and tag all wires attached to relay K1 (46).

(2) Remove three nuts (44) and three washers (45) from relay K1 (46) and remove relay from chassis and nut assembly (43)

y. *Replacement of Relay K1.*

(1) Position relay K1 (46) on chassis and nut assembly (43) and secure with hardware removed in step x(2) above.

(2) Replace and solder wires removed in step x(1) above.

z. *Replacement of Test Panel Assembly.* Position test panel ((2) Fig. 3-2) and secure to case (3) with 14 screws (1).

**4-7. Disassembly and Reassembly of Bridge**

**Assembly A10** (fig. 4-1)

a. *Disassembly Procedures.*

(1) Remove four screws (1) and remove cover (2) from support fastener (13).

(2) Unsolder and tag all wires attached to phototransistor A1, A2 or A3 (3)

(3) Remove three screws (1), three nuts (7), and three solder lugs (4) (tag solder lugs) from plate (5).

(4) Remove nut (7), washer (10), cable clamp (9), and screw (8) from support fastener (13) and set cable to one side.

(5) Remove five screws (8) from underside of plate (6) and remove plate from support fastener (13).

(6) Remove SIX screws (17), six washers (18), six washers (6) and remove phototransistor assemblies (3) from plate (5) and set them to one side.

(7) Remove two screws (14), two lockwashers (15) and remove razor blade (16) from plate (5). Repeat this step for removal of the other razor blades.

(8) Remove two screws (11) and two washers (12) and remove support and fastener assembly (13).

b. *Reassembly Procedures.*

(1) Position support and fastener assembly (13) in place and secure with hardware removed in step a(8) above.

(2) Position razor blade(s) (16) on bottom of plate (5) and secure with hardware removed in step a(7) above.

**NOTE**

Perform adjustment procedure of paragraph 4- 11 before proceeding.

(3) Position phototransistor assemblies (3) on plate (5) and secure with hardware removed in step a(6) above.

(4) Position plate (5) on bridge assembly (13) and secure with hardware removed in step a(5) above.

(5) Position cable on support fastener (13) and secure with hardware removed in step a(4) above.

(6) Secure solder lugs (4) to plate (5) with hardware removed in step a(3) above.

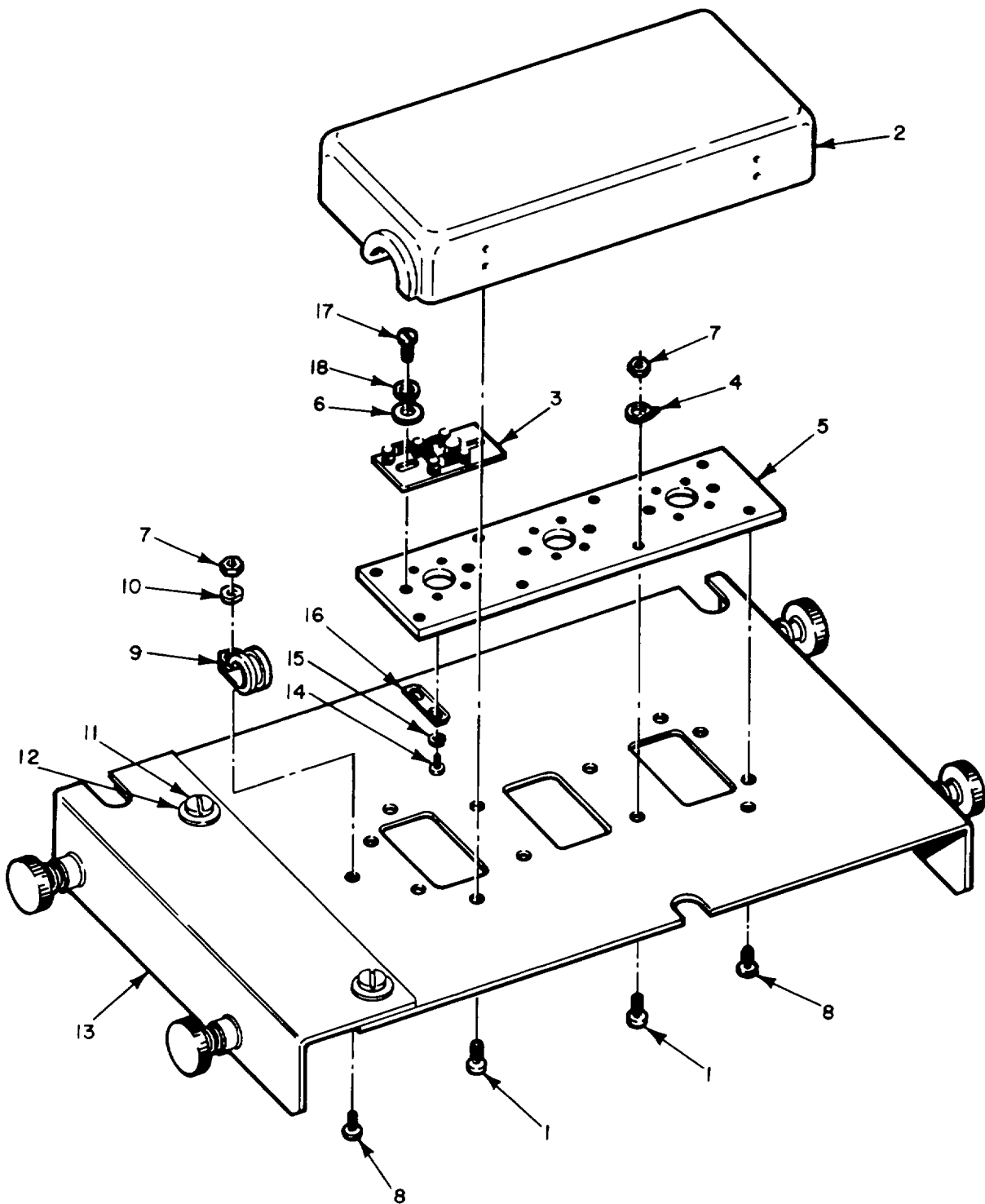
(7) Replace and solder all wires removed in step a(2) above

(8) Replace cover (2) and secure with hardware removed in step a(1) above.

**4-8. Disassembly/Reassembly of Shutter Holding Fixture**

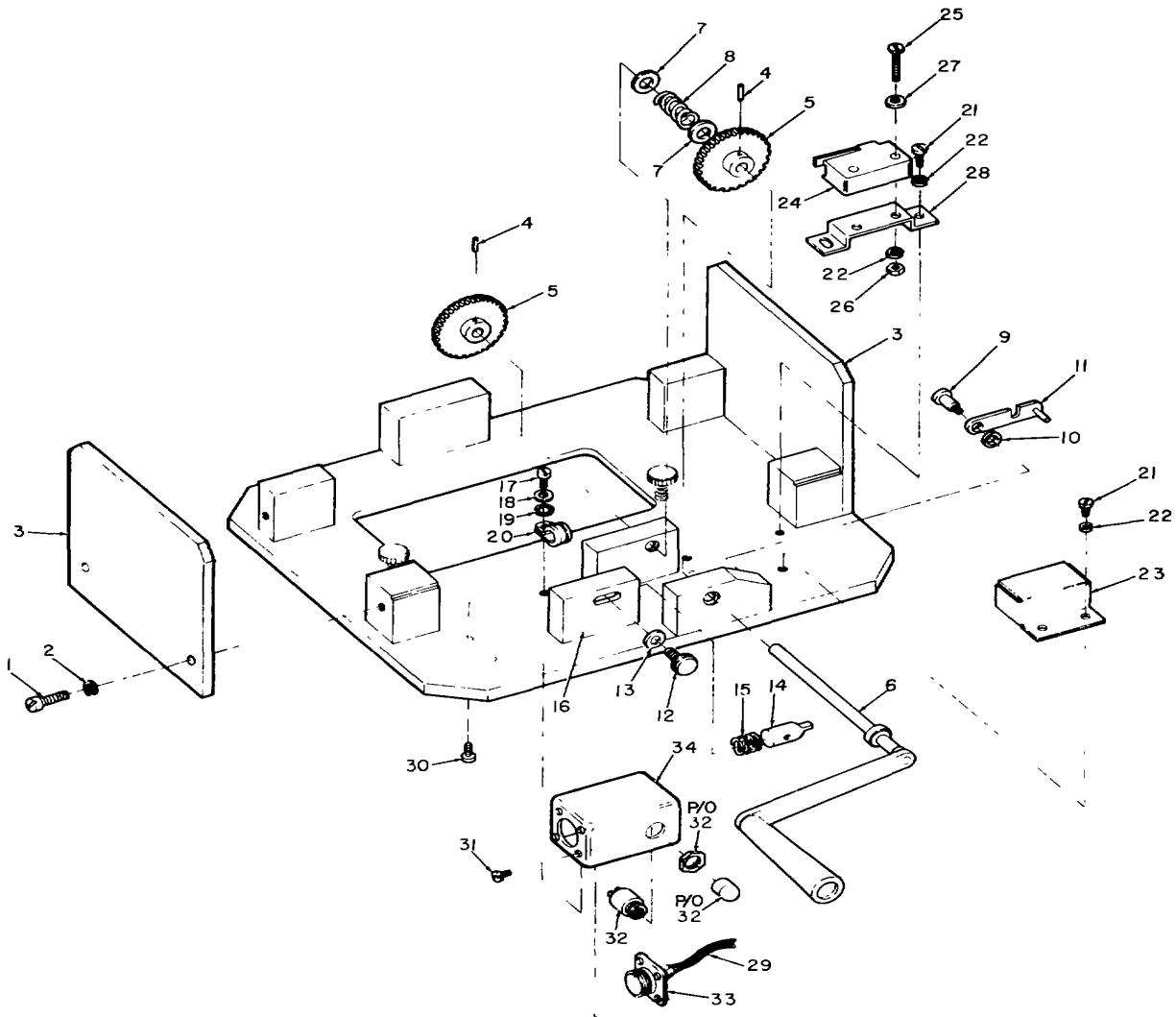
(fig 4-2)

a. *Disassembly Procedures.*



EL3FC006

Figure 4-1. Bridge assembly A10, exploded view.



EL3FC007

- |    |   |    |                            |    |   |
|----|---|----|----------------------------|----|---|
| 1  | Screw (4) (1A4H13, 1A4H15)                | 13 | Washer (1A4H56)            | 24 | Switch assy (three screws supplied with switch) (1A4A2) |
| 2  | Washer (4) (1A4H14, 1A4H16)               | 14 | Lock pin (1A4MP15)         | 25 | Screw (2) (1A4H8)                                       |
| 3  | Plate and fastener assy(2) (1A4A4, 1A4A5) | 15 | Spring (1A4MP19)           | 26 | Nut (2) (1A4H9)   |
| 4  | Taper pin (2) (1A4H3)                     | 16 | Block (1A4MP14)            | 27 | Washer (2) (1A4H11)                                     |
| 5  | Gear (2) (1A4MP16, 1A4MP17)               | 17 | Screw (1A4H50)             | 28 | Bracket (1A4MP5)  |
| 6  | Crank Assy (1) (1A4A7)                    | 18 | Washer (1A4H50)            | 29 | Electrical wire (AR)                                    |
| 7  | Washer (2) (1A4H54, 1A4H55)               | 19 | Washer (1A4H51)            | 30 | Screw (2) (1A4H12)                                      |
| 8  | Spring (1A4MP18)                          | 20 | Clamp (1A4H48)             | 31 | Screw (4) (1A4H7)                                       |
| 9  | Shoulder screw (1A4H25)                   | 21 | Screw (4) (1A4H3, 1A4H10)  | 32 | Light (DS1)   |
| 10 | Spacer (2) (1A4H26)                       | 22 | Washer (6) (1A4H4, 1A4H10) | 33 | Connector and nut assy (1A4A1)                          |
| 11 | Latch and pin assy (1A4A6)                | 23 | Shield (1A4MP6)            | 34 | Case and nut assy (1A4A3)                               |
| 12 | Thumb screw (1A4H52)                      |    |                            |    |   |

Figure 4-2. Shutter holding fixture, exploded view.

(1) Remove two screws (1) and two lockwashers and remove plate and fastener assembly (3) from holding fixture. Repeat this step for the other side if necessary.

(2) Remove two taper pins (4) and remove (5) gear at rear location from crank handle (6)

(3) Remove crank handle (6) and washer (7), spring (8), washer (7), gear (5) and remove crank handle (6) from holding fixture.

(4) Remove shoulder screw (9) latch and pin assembly (11), and spacer (10) from holding fixture.

(5) Depress lockpin (14) and remove thumbscrew (12) and washer (13) from lockpin (14) and carefully move lockpin (14) and spring (15) from block (16).

(6) Remove screw (17), washer (18), washer (19) and clamp (20) from holding fixture.

(7) Remove four screws (21), four washers (22) and remove shield (23) from holding fixture.

(8) Remove and tag wires attached to switch assembly (24).

(9) Remove two screws (25), two nuts (26), two washers (22), two washers (27), and remove switch assembly (24) from bracket (28).

(10) Remove two screws (30) and remove case and nut assembly (34) from holding fixture.

(11) Remove nut (p/o 32), lamp (p/o 32), four screws (31) and remove electrical connector (33) and light assembly (32) from case and nut assembly (34).

(12) Unsolder and tag wires attached to light assembly (32).

b. *Reassembly Procedures.*

(1) Replace and solder wires removed in step a(12) above to light assembly (32).

(2) Position electrical connector (33) and light assembly (32) in case and nut assembly (34) and secure with hardware removed in step a(11) above.

(3) Position case and nut assembly (34) on holding fixture and secure with hardware removed in step a(10) above.

(4) Position switch assembly (24) on bracket (28) and secure with hardware removed in step a(9) above.

(5) Replace and solder wires removed in step a(8) above to switch assembly (24).

(6) Place shield (23) over switch assembly (24) and secure with hardware removed in step a (7) above.

(7) Replace clamp (20) and secure with hardware removed in step a(6) above.

(8) Insert spring (15) and lockpin (14) in block (12). Depress lockpin (14) and secure in place with washer (13) and thumbscrew (12)

(9) Position latch and pin assembly (11) and spacer (10) on shoulder screw (9) and secure to holding fixture.

(10) Insert crank handle (6) in holding fixture and replace gear (5), washer (7), spring (8), washer (7), and slide crank handle through rear block and place second gear (5) on crank handle (6) and replace taper pins (4).

(11) Position plate and fastener assembly (3) on holding fixture and secure with hardware removed in step a(1) above.

**Section III. ADJUSTMENTS**

**4-9. General**

This section contains detailed instructions for alignment and adjustments required after general support repairs have been performed on the equipment. When ever lower level repairs have been performed on the equipment by general support personnel, or when the extent of repairs performed by lower levels and the condition of the equipment is uncertain, perform lower level alignment procedures as applicable Lower level alignment procedures are contained in paragraph 3-9 of this manual.

**4-10. Variable Resistor A8R6 Adjustment**

(fig. 4-3)

To properly adjust variable resistor A8R6 (10), proceed as follows:

- a. Connect test equipment as shown in figure 3-1.
- b. Set MASTER switch on test panel to INTERN. TESTS + 4.2VDC.

**CAUTION**

Adjust voltmeter controls to monitor +5 volts dc.

- c. Operate test panel POWER switch to ON

position.

d. Adjust variable resistor A8R6 on shutter assembly test board and components assembly A8 until voltmeter reads + 4.2 + 0.1 volts dc.

**4-11. Bridge Assembly A10 Razor Blade Adjustment**

(fig 4-4)

To properly adjust the six razor blades located on the bridge assembly A10, proceed as follows:

- a. Carefully loosen but do not remove the ten mounting screws which secure five selected razor blades.

**NOTE**

The two mounting screws of either the extreme left or right end razor blade must not be loosened. The selected blade will serve as the reference blade for proper adjustment of the remaining blades.

- b. Hold a 0 015 inch thickness gauge perpendicular to the edge of the reference blade and position the ad-

adjacent blade until it is resting snugly against the thickness gauge. Secure the blade in position by tightening its two mounting screws

c. Repeat step b (above) for remaining parts of razor blades. Make certain the center-to-center of the razor blade slits is adjusted to be 2.125 inches.

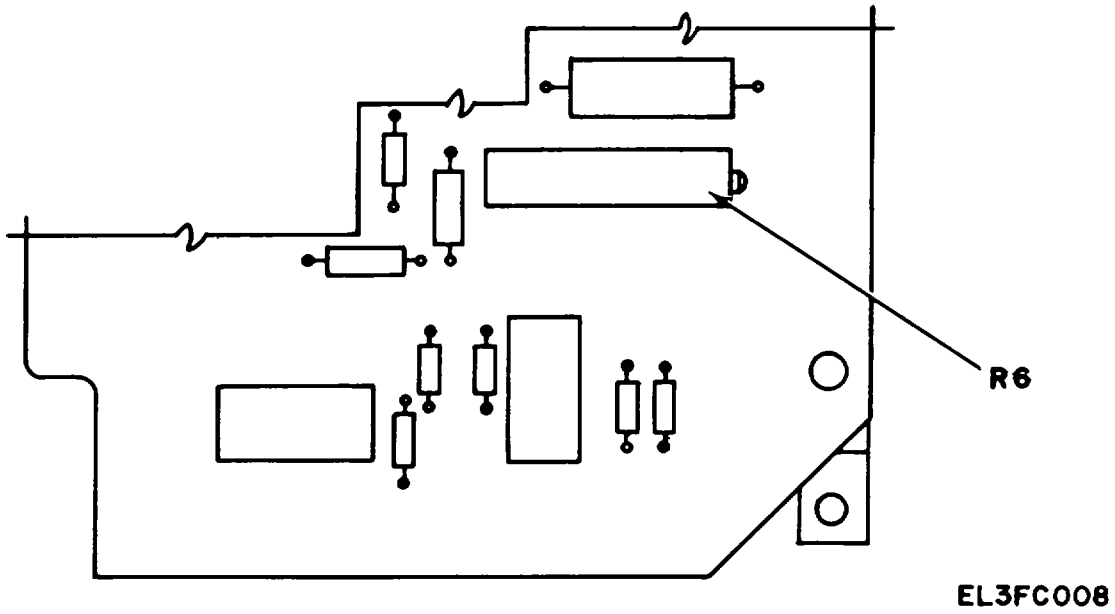


Figure 4-3. Variable resistor R6 adjustment.

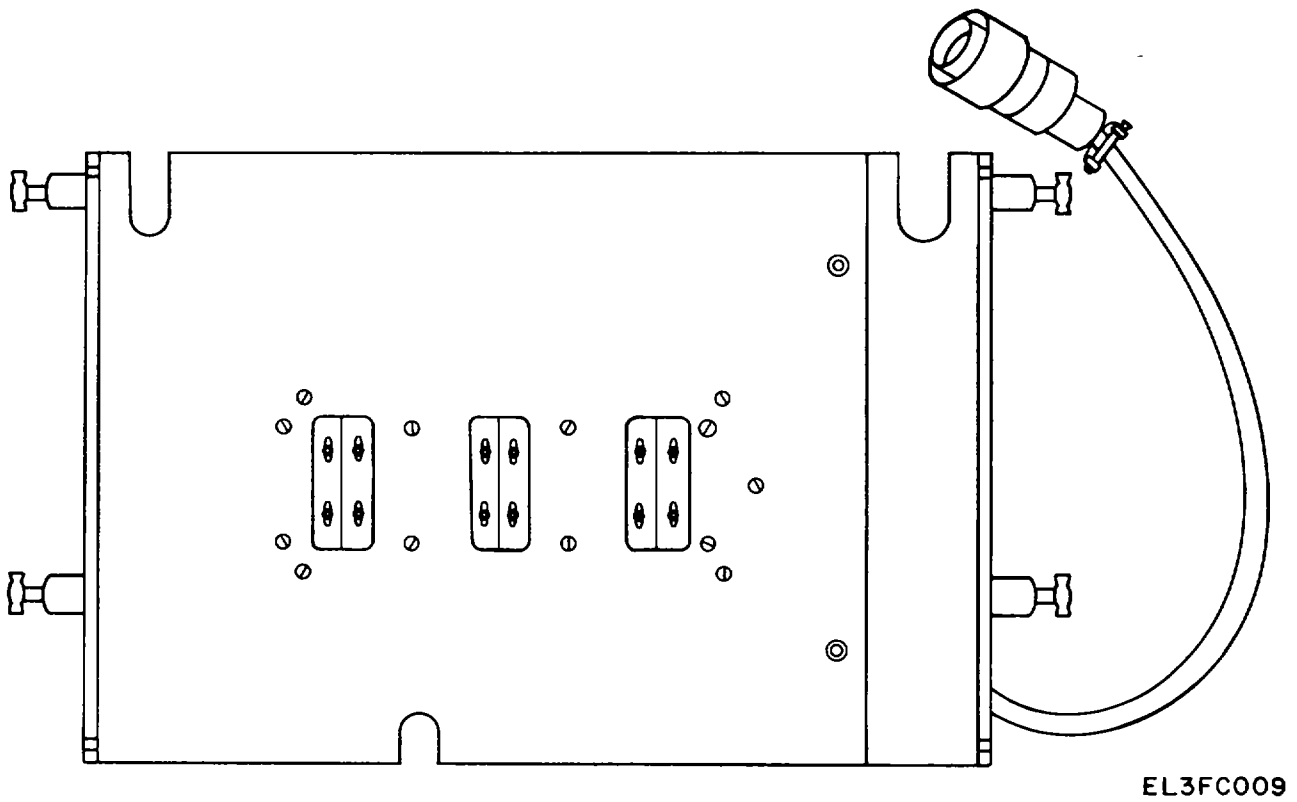


Figure 4-4. Razor blade adjustment.

## APPENDIX A REFERENCES

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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	US Army Equipment Index of Modification Work Orders.
TB 385-4	Safety Precautions for Maintenance of Electrical Electronic Equipment.
TM 11-1510-204-20-2-1	Organizational Maintenance Manual for Signal Electronic Equipment Configurations, Army Model OV-1D Aircraft (NSN 1510-00-869-3654)
TM 11-1510-204-34-2-1	Direct Support and General Support Maintenance Manual: Signal Electronic Equipment Configuration, Army Model OV-1D Aircraft (NSN 1510-00-869-3654)
TM 11-6625-203-12	Operator and Organizational Maintenance Manual Multimeter AN/URM-105, and ANIURM 105C (Including Multimeter <i>ME-77/U</i> and <i>ME-77C/U</i> ).
TM 11-6625-537-14-1	Operator's, Organizational, Direct Support and General Support Maintenance Manual: Electronic Voltmeter <i>ME-202A/U</i> (NSN 6625-00-709-0288) and <i>ME-202B/U</i> (NSN 6625-00-972-4046)
TM 11-6625-654-14	Operator's Organizational Direct Support and General Support Maintenance Manual. Multimeter ANIUSM-223.
TM 11-6225-2658-14	Operator's, Organizational Direct Support and General Support Maintenance Manual for Oscilloscope AN/USM-281C (NSN 6625-00-106-9622)
TM 11-6720-236-12	Operator's and Organizational Maintenance Manual. Camera, Still Picture KA-76A (NSN 6720-00-087-3151) and Lens Cones, Camera, Aerial Reconnaissance LA-370A (NSN 6760-00-007-3736), LA-371A (NSN 6760-00-087-3740), and LA-372A (NSN 6760-00-087-3737)
TM 11-6720-236-35	Direct Support, General Support, and Depot Maintenance Manual (Including Repair Parts and Special Tool Lists): Camera, Still Picture KA-76A and Lens Cones, Camera, Aerial Reconnaissance LA-370A, LA-371A, and LA-372A
TM 11-6720-245-20	Organizational Maintenance Manual Including Repair Parts and Special Tools Last: Photographic Surveillance System, Airborne KS-104A (6720-890-7623) and Photographic Surveillance System, Airborne KS-104B (6720-406-4653).
TM 11-6720-245-34	Direct Support and General Support Maintenance Manual Including Repair Parts and Special Tools List for Photographic Surveillance System, Airborne KS-104A (NSN 6720-00-890-7623) and KS-104B (NSN 6720-00-406-4653)
TM 11-6720-250-12	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools List). Photographic Surveillance System, Airborne KS-113A (NSN 6720-00-406-4656).
TM 11-6720-250-35	Direct Support, General Support, and Depot Maintenance Manual: Photographic Surveillance System, Airborne KS-113A (NSN 6720-00-406-4656)
TM 11-6760-220-12	Operator and Organizational Maintenance Manual: Test System, Photographic Surveillance System, LS-34A and LS-45A, Analyzer, Still Picture Camera LS-44A, Tool Kit, Still Picture Camera Maintenance LS-48A, Test Set, Converter, Altitude-Ground Speed Ratio LS-50A, Test Set, Scanner Alignment LS-51A and Test Set, Vacuum Regulator Assembly LA-185A as used for Testing Camera, Still Picture KA-30A and Photographic Surveillance Systems, Airborne KS-59(#) and KS-61A
TM 11-6760-238-12	Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tool Lists for Test Set, Control Panel, Focal Plane Shutter LS-78A (FSN 6760-878-0592).



TM 11-6760-242-15	Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual' Timer, Digital Electronic LA-387A (NSN 6645-00-877-8380)
TM 11-6760-245-12	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools Lists): Analyzer Set, Photographic Surveillance System LS-89 (NSN 6760-00-462-3041).
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 55-1510-213-10	Operator's Manual: OV-1D/RV-D Aircraft.

**APPENDIX B  
EXPENDABLE SUPPLIES AND MATERIALS LIST**

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**Section I. INTRODUCTION**

**B-1. Scope**

This appendix lists expendable supplies and materials you will need to operate and maintain the LS-78A. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items)

**B-2. Explanation of Columns**

a. *Column 1-Item Number.* This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e g., "Use cleaning compound, item 5, app "B").

b. *Column 2-Level.* This column identifies the lowest level of maintenance that requires the listed item.

C-Operator/Crew

O-Organizational Maintenance

F-Direct Support Maintenance

H-General Support Maintenance

c. *Column 3-National Stock Number.* This is the National Stock Number assigned to the item; use it to request or requisition the item.

d. *Column 4-Description.* Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Federal Supply Code for Manufacturer (FSCM) in parenthesis, if applicable.

e. *Column 5-Unit of Measure (U/M)* Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e g , ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

\* U.S. GOVERNMENT PRINTING OFFICE: 1980-603-128:41

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J. C. PENNINGTON

*Major General, United States Army*

*The Adjutant General*

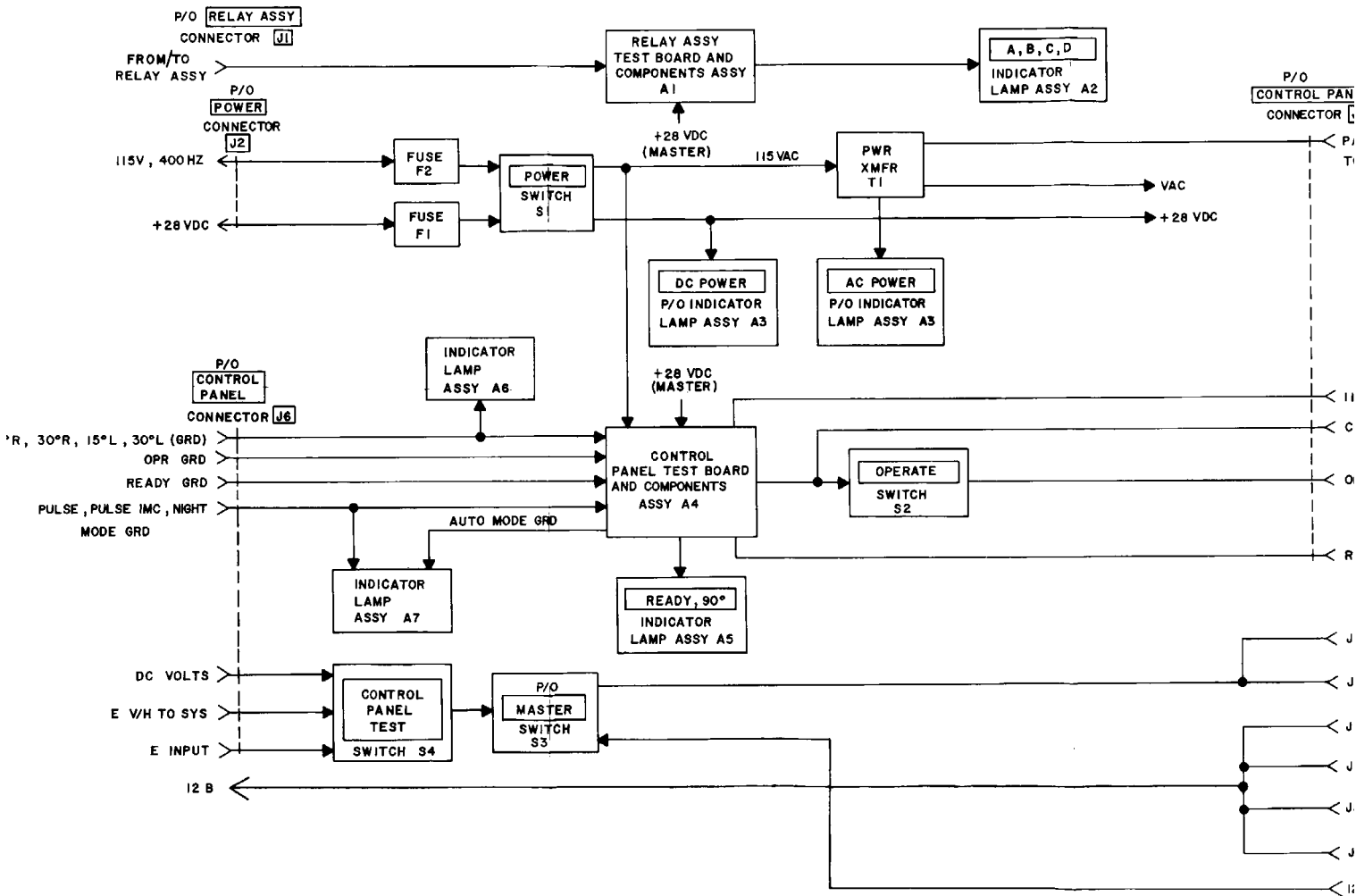
E. C. MEYER

*General, United States Army*

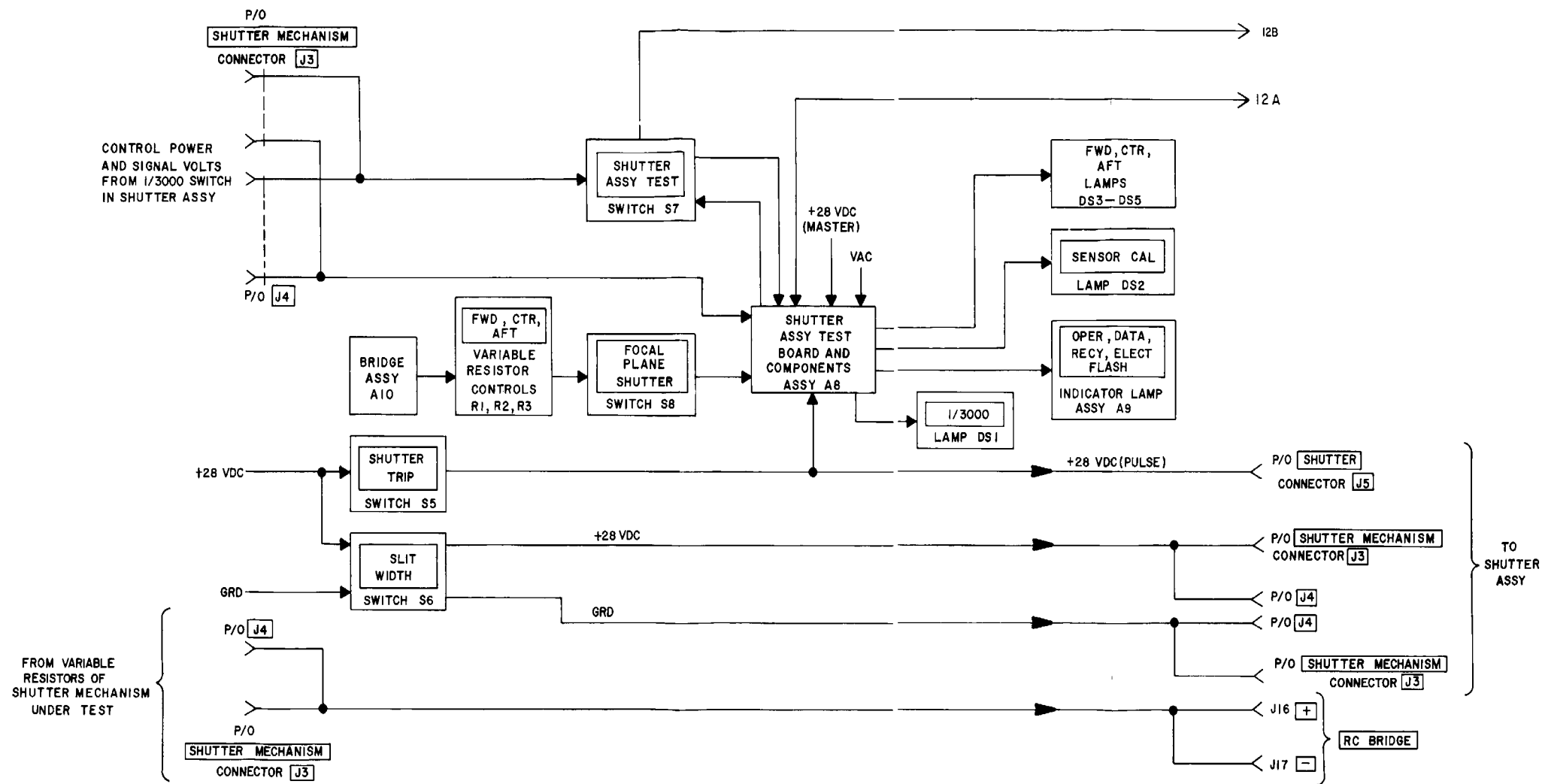
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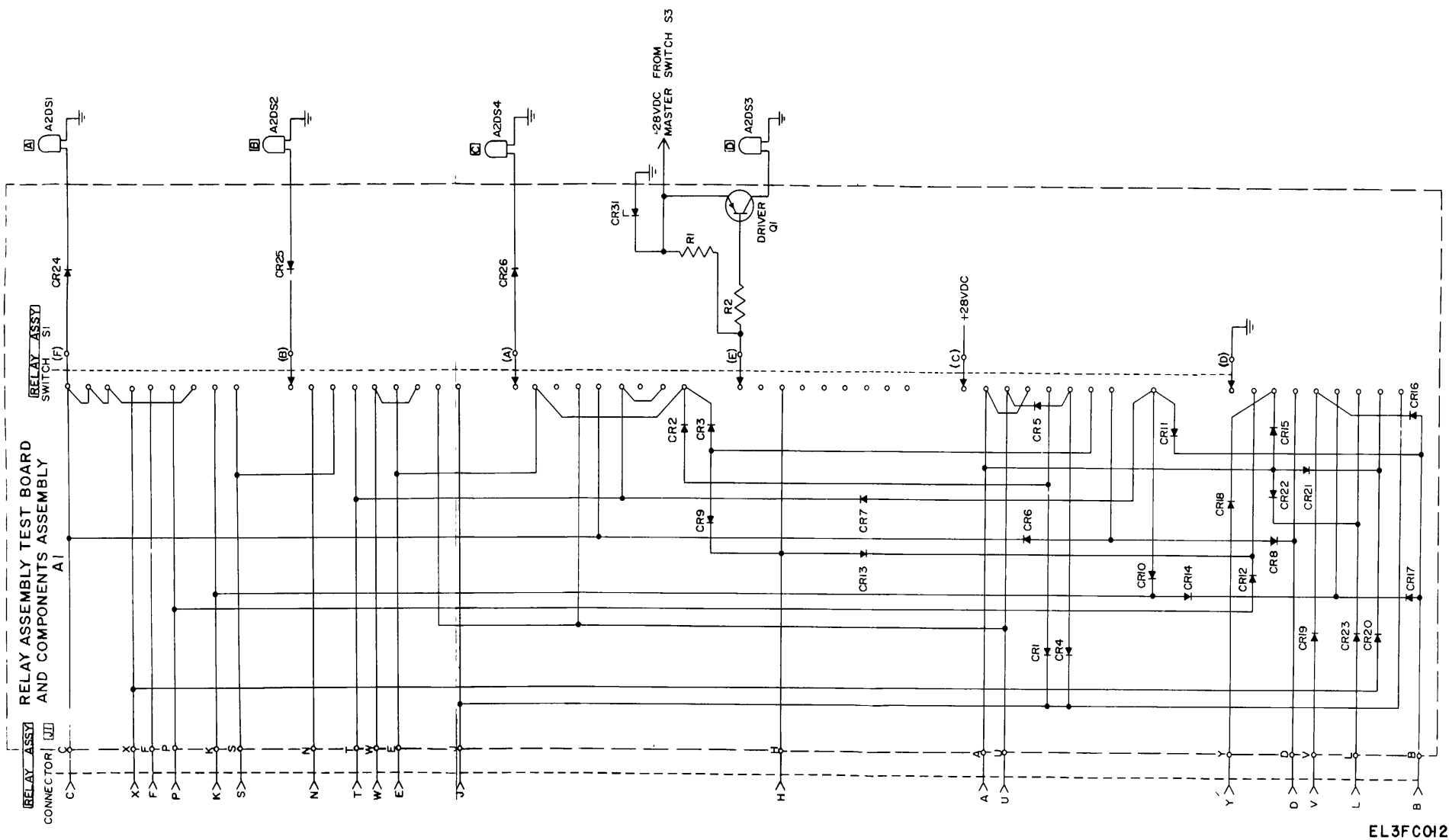


FO-1. Test set, block diagram analysis (sheet 1 of 2).

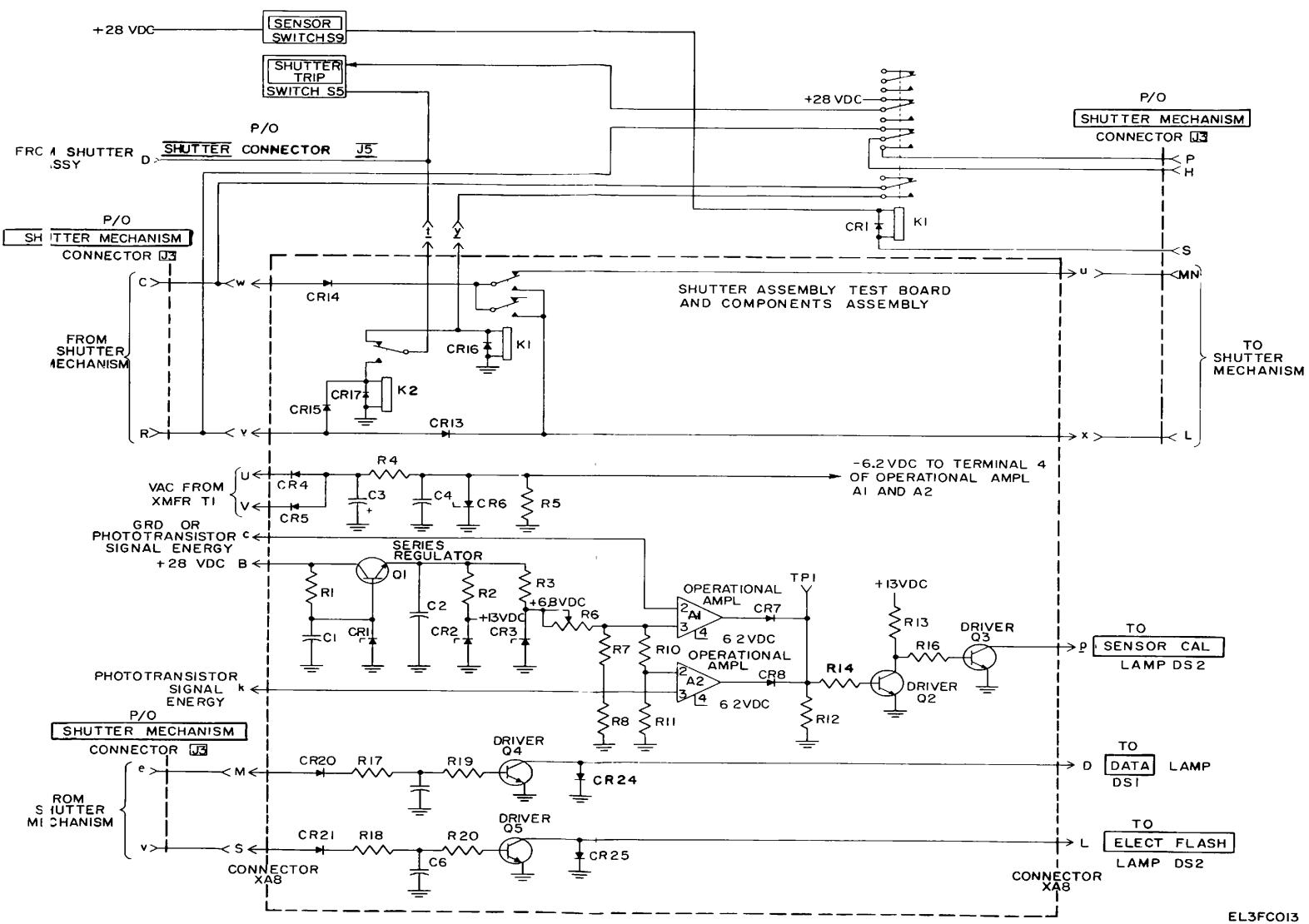


2 OF 2 EL3FC011

FO-1. Test set, block diagram analysis (sheet 2 of 2).

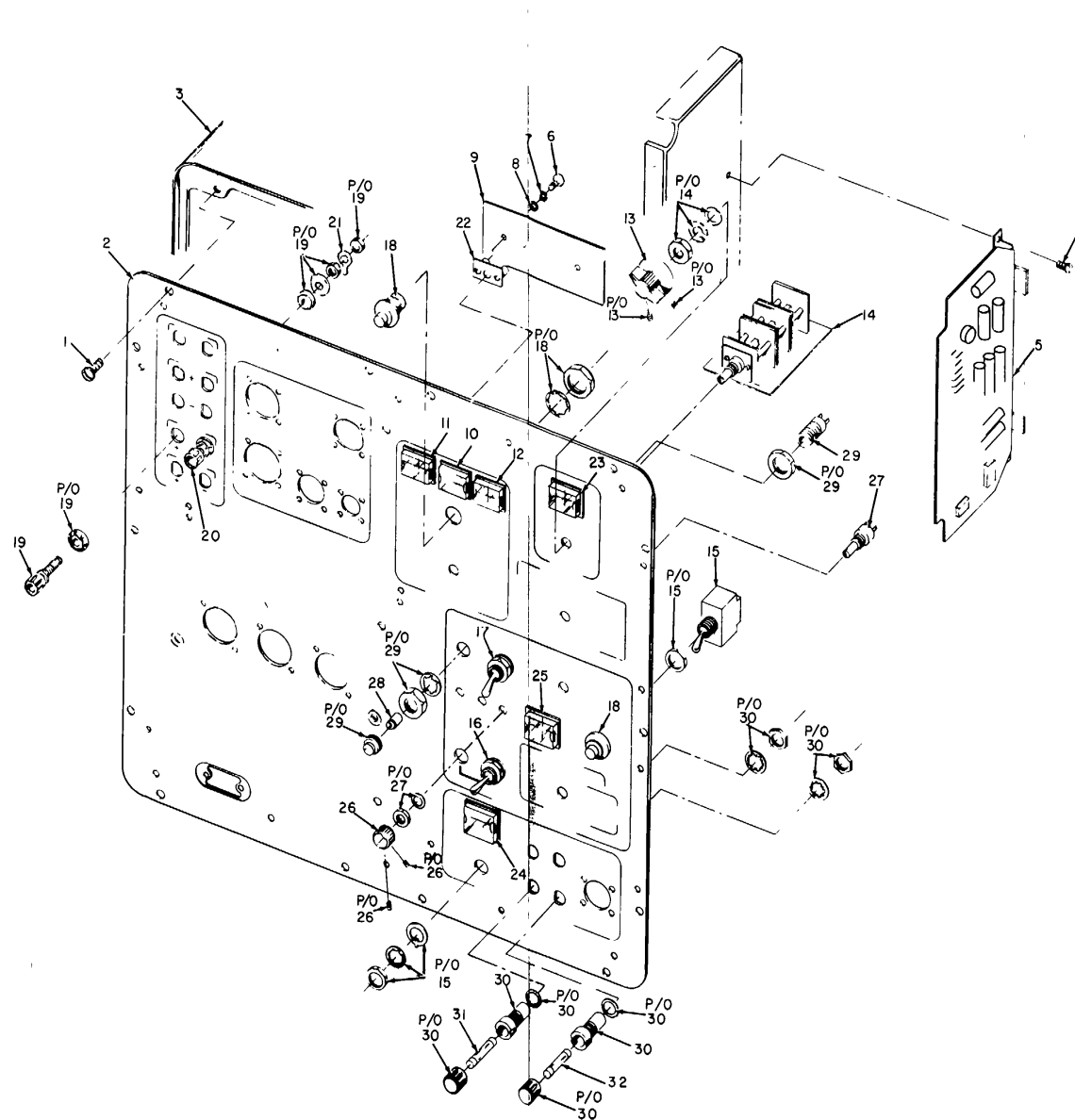


FO-2. Relay assembly test board and components assembly A1, schematic diagram.



EL3FC013

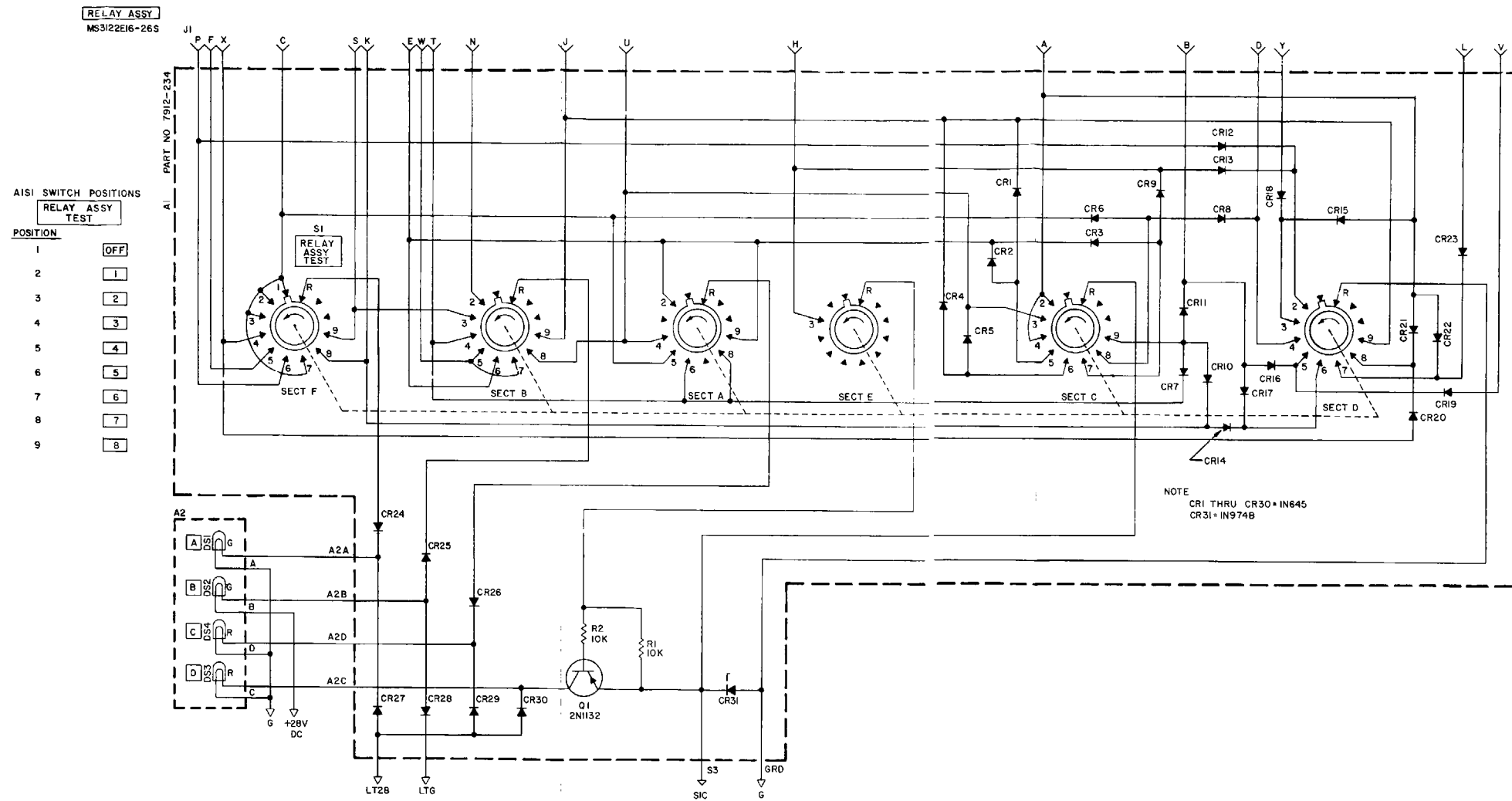
FO-3. Shutter assembly test board and components assembly A8, schematic diagram.



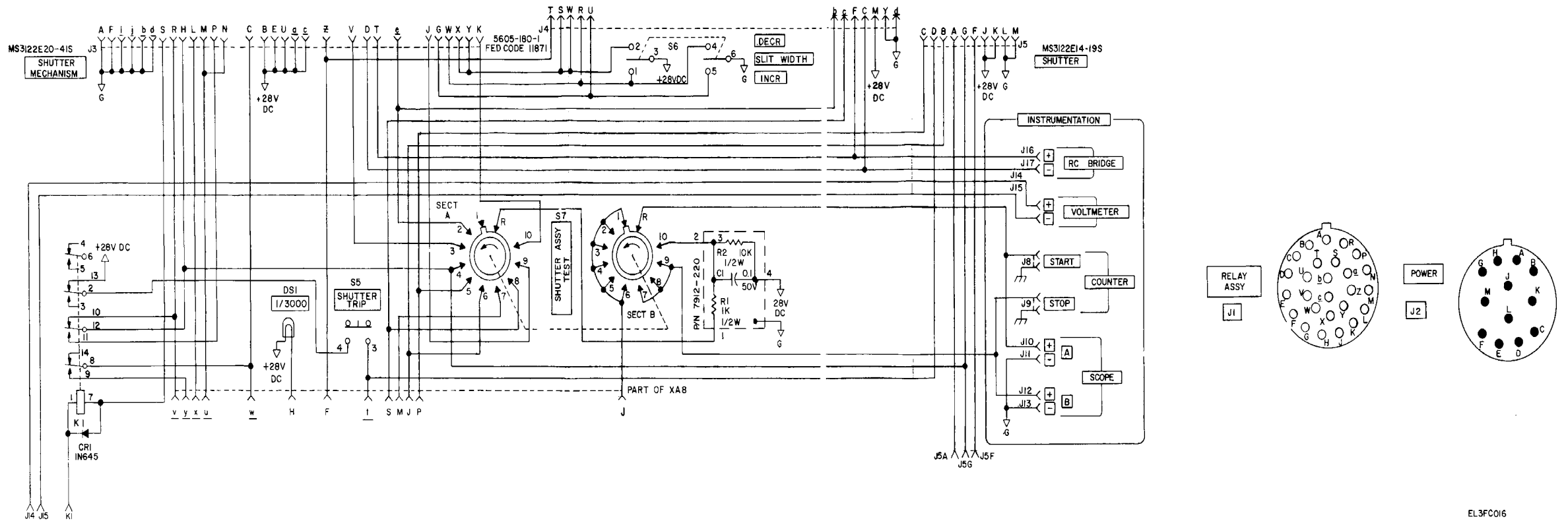
- 1 Screw (14) (1H2)
- 2 Test panel (1A7)
- 3 P/O combination case (p/o 1MP4)
- 4 Screw (2) (1A7H1)
- 5 Shutter assembly test board and components assembly (A8)
- 6 Screw (4) (1A7H27)
- 7 Lockwasher (4) (1A7H6)
- 8 Washer (4) (1A7H26)
- 9 Control panel test board and components assembly (A4)
- 10 Indicator lamp assembly (A5)
- 11 Indicator lamp assembly (A6)
- 12 Indicator lamp assembly (A7)
- 13 RELAY ASSY switch A1S1 knob (includes two setscrews) (1A7MP23)
- 14 Relay assembly test board and components assembly (A1) (includes nut, lockwasher and stop washer)
- 15 POWER switch S1 (mounting hardware supplied with switch)
- 16 SLIT WIDTH switch S9 (mounting hardware supplied with switch)
- 17 SENSOR switch S9 (mounting hardware supplied with switch)
- 18 OPERATE switch S2, SHUTTER TRIP switch S5 (mounting hardware supplied with switch)
- 19 VOLTMETER + binding post J14 (mounting hardware supplied with binding posts)
- 20 VOLTMETER - binding post J15 (mounting hardware supplied with binding posts)
- 21 Lug (8) (1A7E1-1A7E8)
- 22 Plate and spacer assembly (1A7A10, 1A7A11)
- 23 Indicator lamp assembly (A2)
- 24 Indicator lamp assembly (A3)
- 25 Indicator lamp assembly (A9)
- 26 FWD, AFT, CTR control knob (includes two setscrews (3) 1A7MP20-1A7MP22)
- 27 FWD, AFT, CTR control R1-R3 (mounting hardware supplied with control)
- 28 SENSOR CAL lamp DS 2, 1/3000 lamp DS1 (2)
- 29 SENSOR CAL lampholder socket XDS2, 1/3000 lampholder socket
- 30 Fuseholder (4) (mounting hardware supplied with fuseholder)
- 31 DS fuse F1 and spare F3
- 32 AC fuse F2 and spare F4

FO-4. Shutter test set, exploded view for direct support.

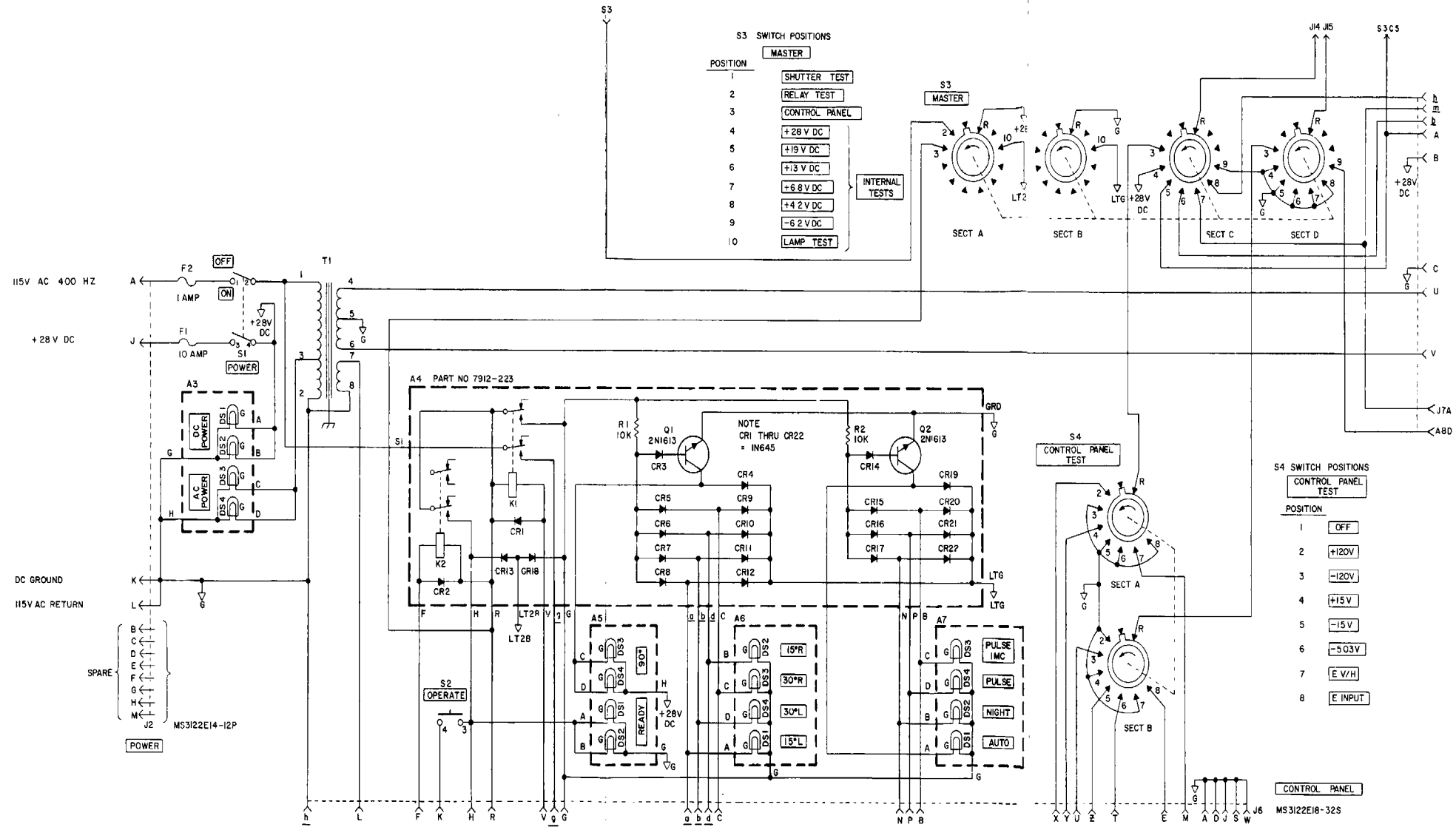




FO-5. Shutter test set, overall schematic diagram (sheet 1 of 5).

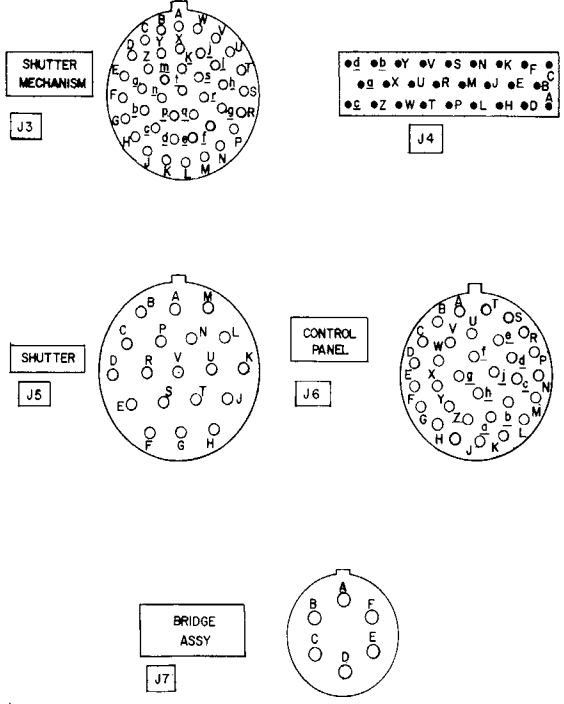
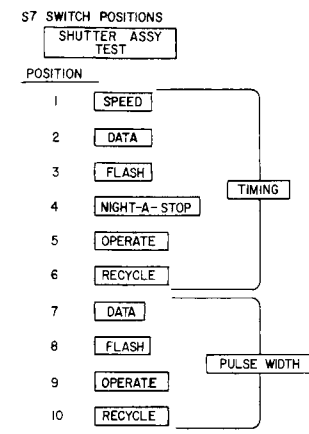
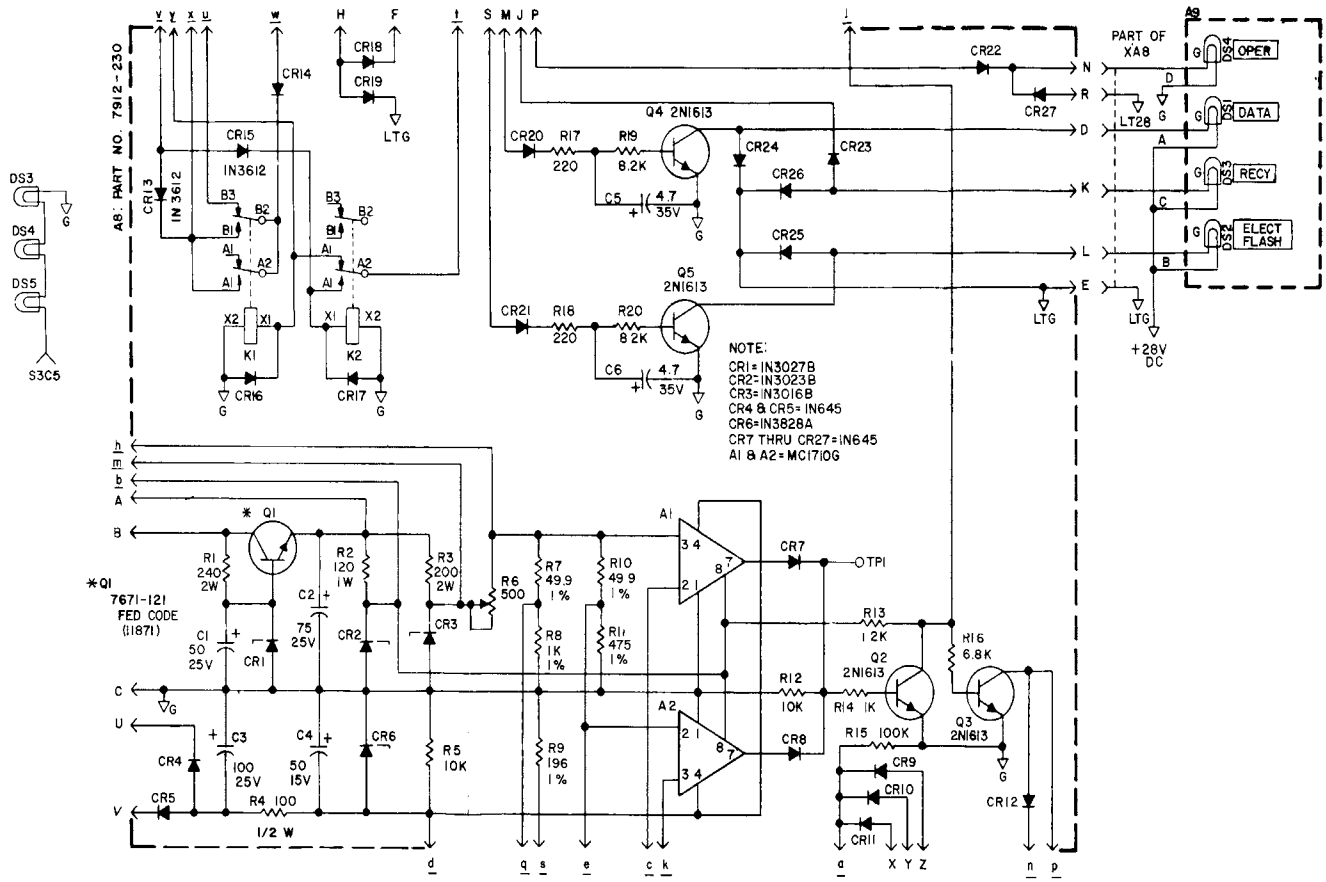


FO-5. Shutter test set, overall schematic diagram (sheet 2 of 5).



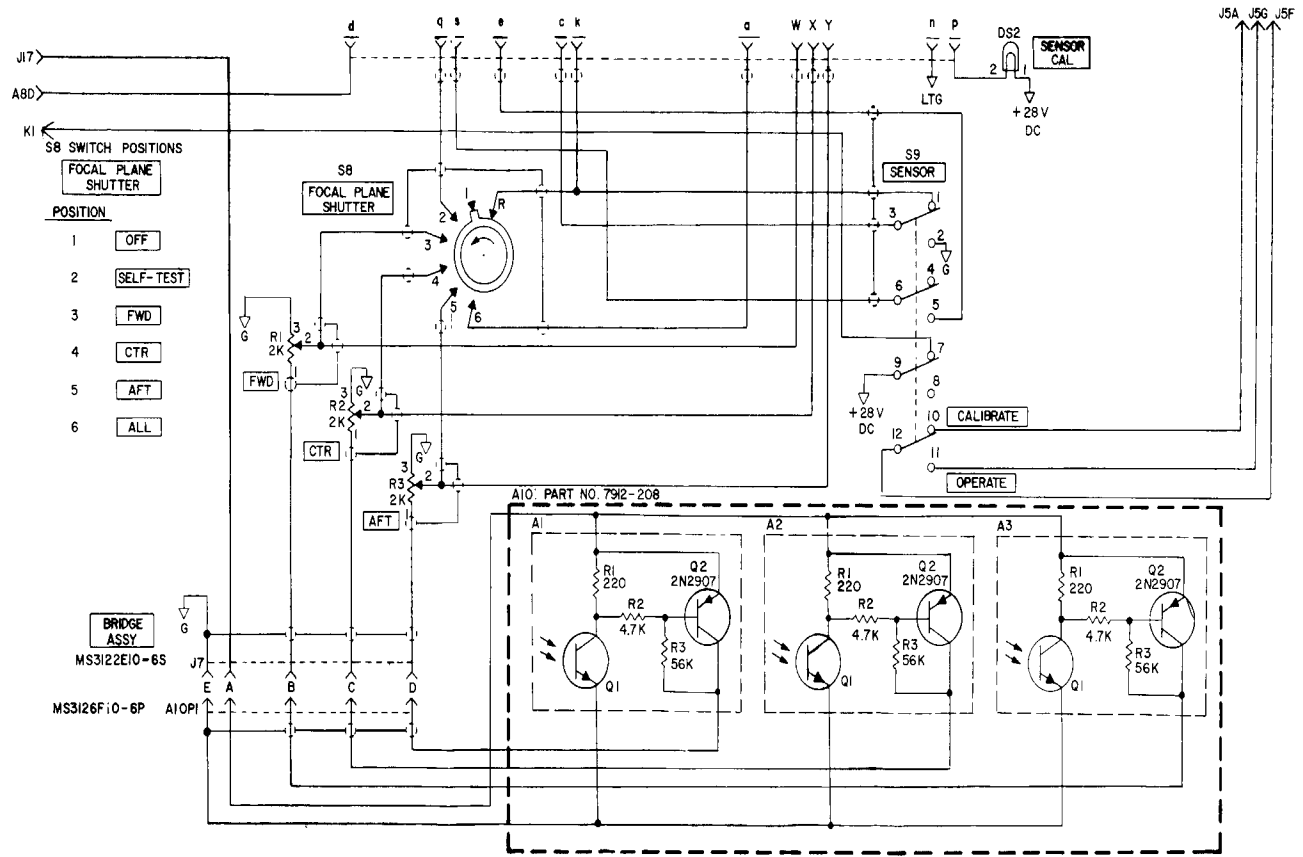
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FO-5. Shutter test set, overall schematic diagram (sheet 3 of 5).



EL 3FC018

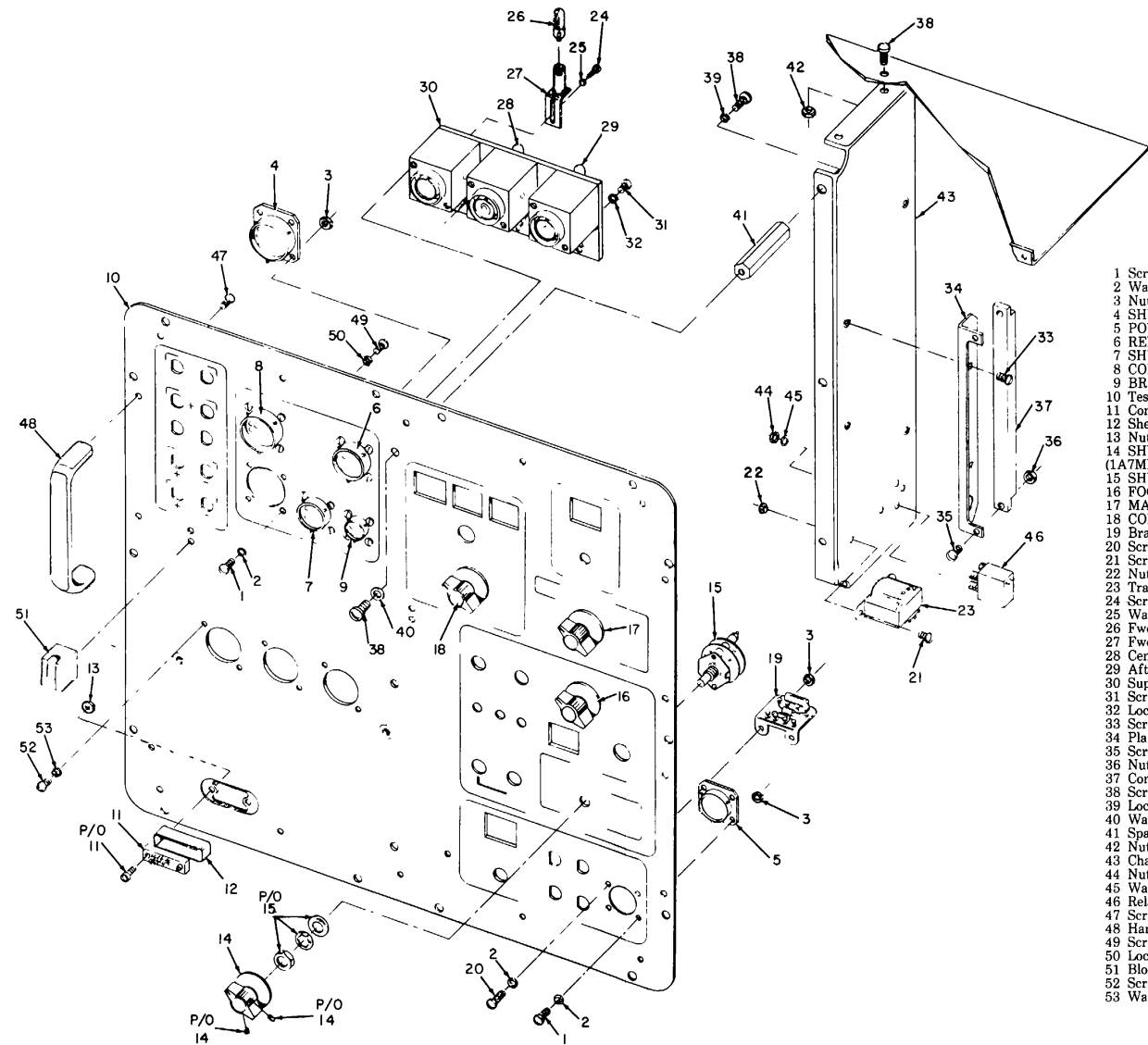
FO-5. Shutter test set, overall schematic diagram (sheet 4 of 5).



- NOTES:**
- PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.
  - INDICATES EQUIPMENT MARKING.
  - ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE INDICATED.
  - ALL RESISTOR VALUES ARE IN OHMS AND ARE 1/4 WATT UNLESS OTHERWISE INDICATED.
  - DENOTES CHASSIS GROUND.
  - DENOTES SHIELDED CABLE.
  - DENOTES POWER GROUND.
  - ARBITRARY NUMBERS ASSIGNED TO CERTAIN SUBASSEMBLIES.

EL3FC019

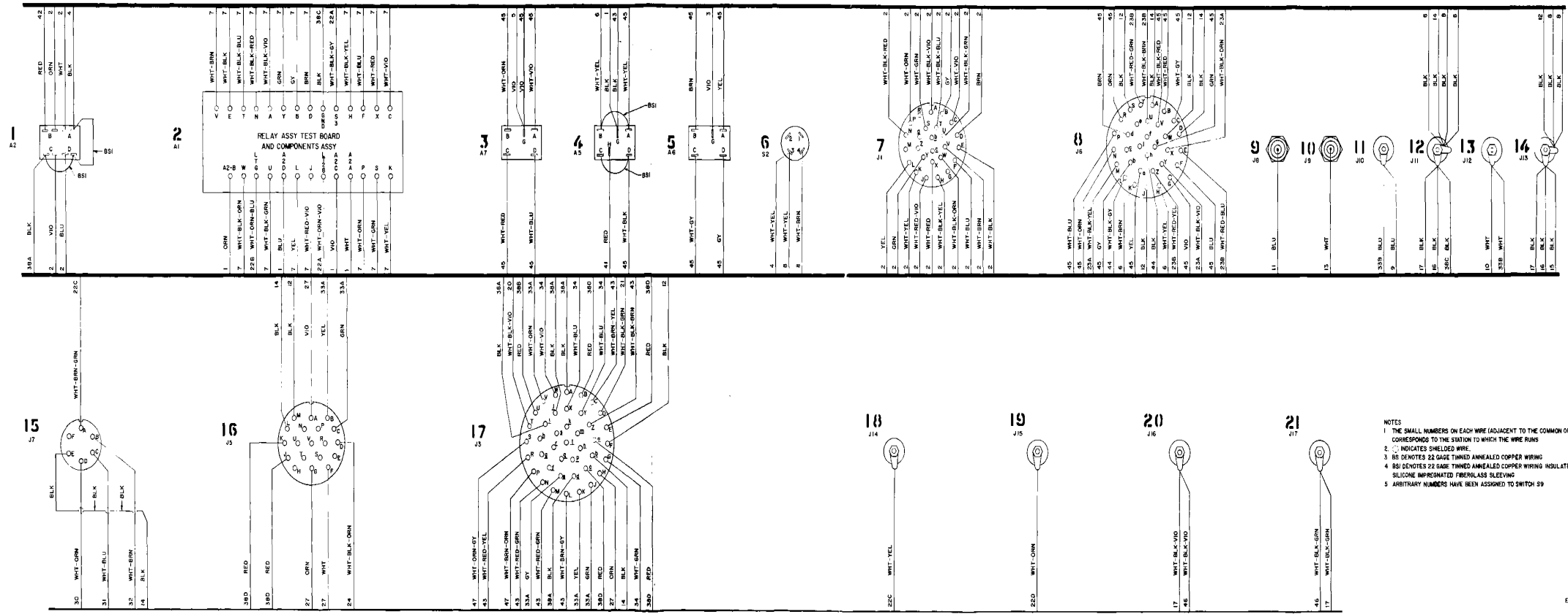
FO-5. Shutter test set, overall schematic diagram (sheet 5 of 5).



- 1 Screw (4)(1A74H47)
- 2 Washer (4)(1A74H46)
- 3 Nut (4)(1A74H48)
- 4 SHUTTER MECHANISM connector J3
- 5 POWER connector J2
- 6 RELAY ASSY connector J1
- 7 SHUTTER connector J5
- 8 CONTROL PANEL connector J6
- 9 BRIDGE ASSY connector J7
- 10 Test panel (1A7)
- 11 Connector J4 (mounting hardware supplied with connector)
- 12 Shell (1A7MP28)
- 13 Nut (2)(P/O 11)
- 14 SHUTTER ASSY TEST, FOCAL PLANE SHUTTER, MASTER or CONTROL PANEL TEST switch knob (4) (includes two setscrews) (1A7MP24-1A7MP27)
- 15 SHUTTER ASSY TEST switch S7 (mounting hardware supplied with switch)
- 16 FOCAL PLANE SHUTTER switch S8 (mounting hardware supplied with switch)
- 17 MASTER switch S3 (mounting hardware supplied with switch)
- 18 CONTROL PANEL TEST switch S4
- 19 Bracket and component assembly (1A7A12)
- 20 Screw (2)(91A7H20)
- 21 Screw (2)(1A7H22)
- 22 Nut (2)(1A7H24)
- 23 Transformer T1
- 24 Screw (6)(1A7H28)
- 25 Washer (6)(1A7H29)
- 26 Fwd lamp DS3
- 27 Fwd lamp holder XDS3
- 28 Center lamp DS4 and lampholder XDS4
- 29 Aft lamp DS5 and lampholder XDS5
- 30 Support (1A7MP5)
- 31 Screw (6)(1A7H5)
- 32 Lockwasher (6)(1A7H6)
- 33 Screw (2)(1A7H4)
- 34 Plate and spacer assy (1A7MP4)
- 35 Screw (2)(1A7H49)
- 36 Nut (2)(1A7H50)
- 37 Connector XA8
- 38 Screw (10)(1A7H17)
- 39 Lockwasher (3)(1A7H30)
- 40 Washer (3)
- 41 Spacer (3)(1A7MP1-1A7MP3)
- 42 Nut (4)(1A7H3)
- 43 Chassis and nut assy (1A7A16)
- 44 Nut (3)
- 45 Washer (3)
- 46 Relay K1
- 47 Screw (6)(1A7H31)
- 48 Handle (3)(1A7MP17-1A7MP19)
- 49 Screw (4)(1A7H5)
- 50 Lockwasher (4)(1A7H30)
- 51 Block (2)(1A7MP14, 1A7MP15)
- 52 Screw (6)(1A7H14)
- 53 Washer (6)(1A7H13)

EL3FC020

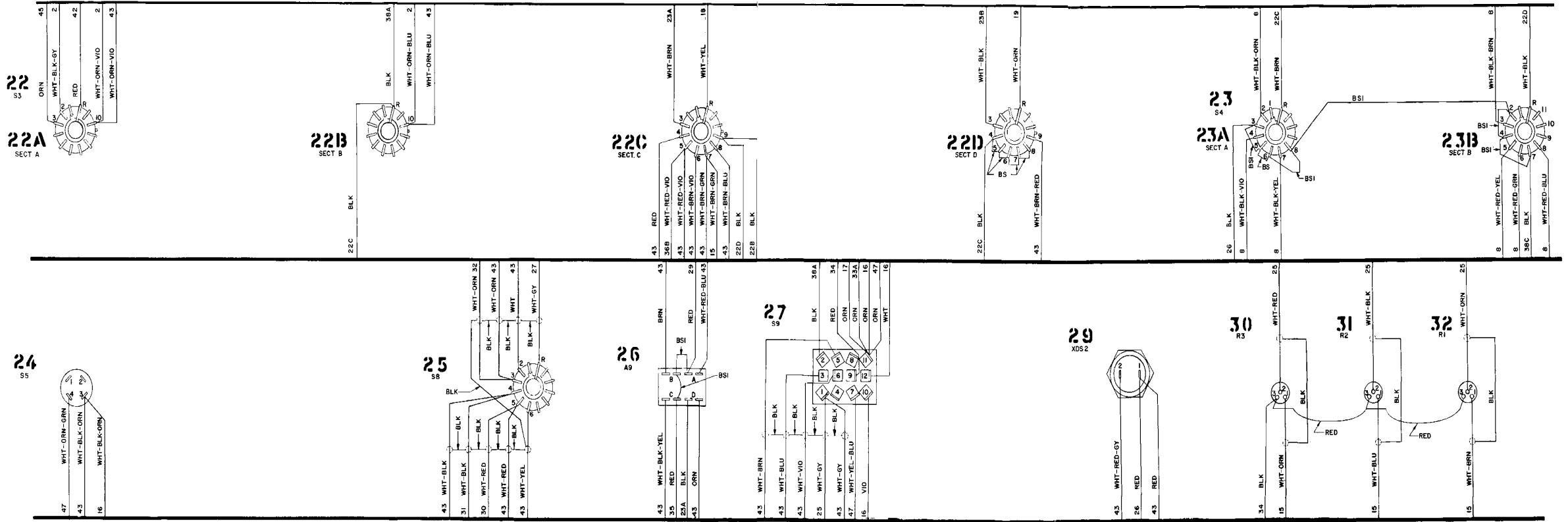
FO-6. Shutter test set, exploded view for general support.



- NOTES  
 1 THE SMALL NUMBERS ON EACH WIRE (ADJACENT TO THE COMMON OR BASE LINE) CORRESPONDS TO THE STATION TO WHICH THE WIRE RUNS  
 2 ○ INDICATES SHELDED WIRE  
 3 BS DENOTES 22 GAUGE TINED ANNEALED COPPER WIRING  
 4 BS DENOTES 22 GAUGE TINED ANNEALED COPPER WIRING INSULATED WITH SILICONE IMPREGNATED FIBERGLASS SLEEVING  
 5 ARBITRARY NUMBERS HAVE BEEN ASSIGNED TO SWITCH 39

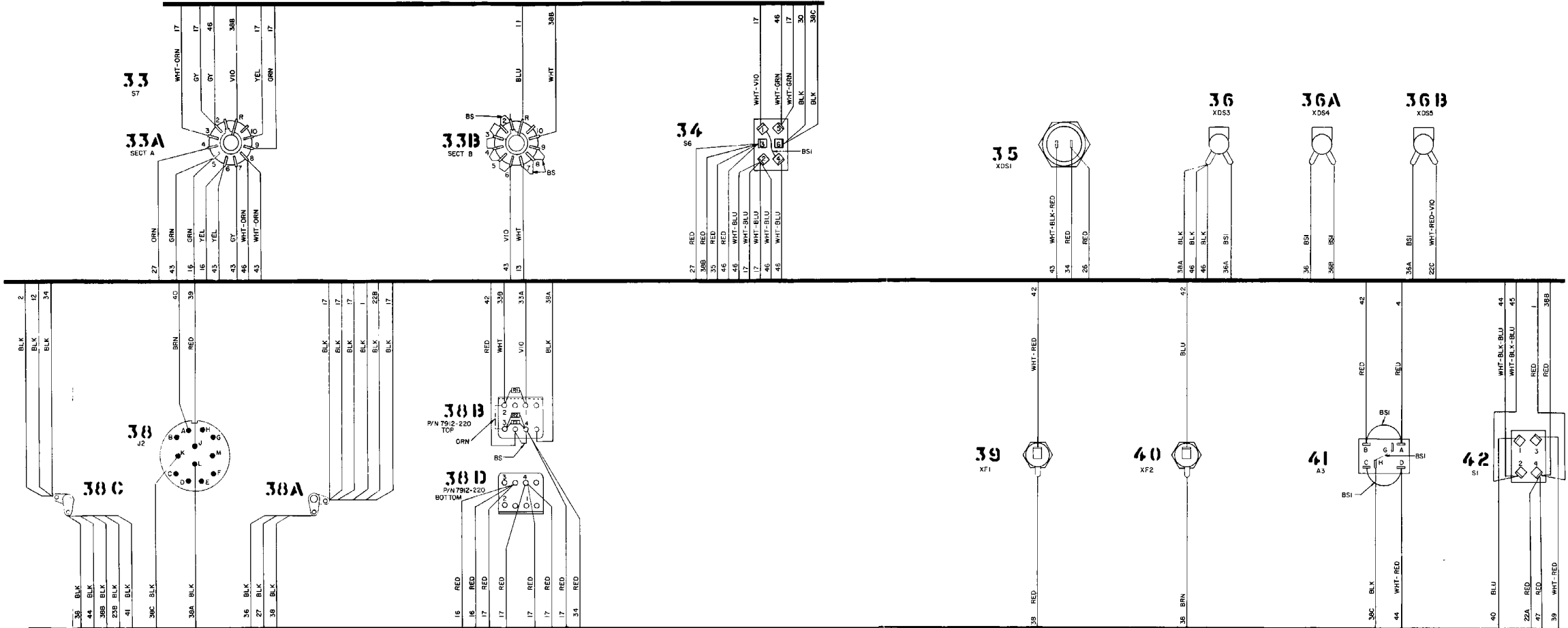
61.2FC02

FO-7. Shutter test set wiring diagram (sheet 1 of 4).



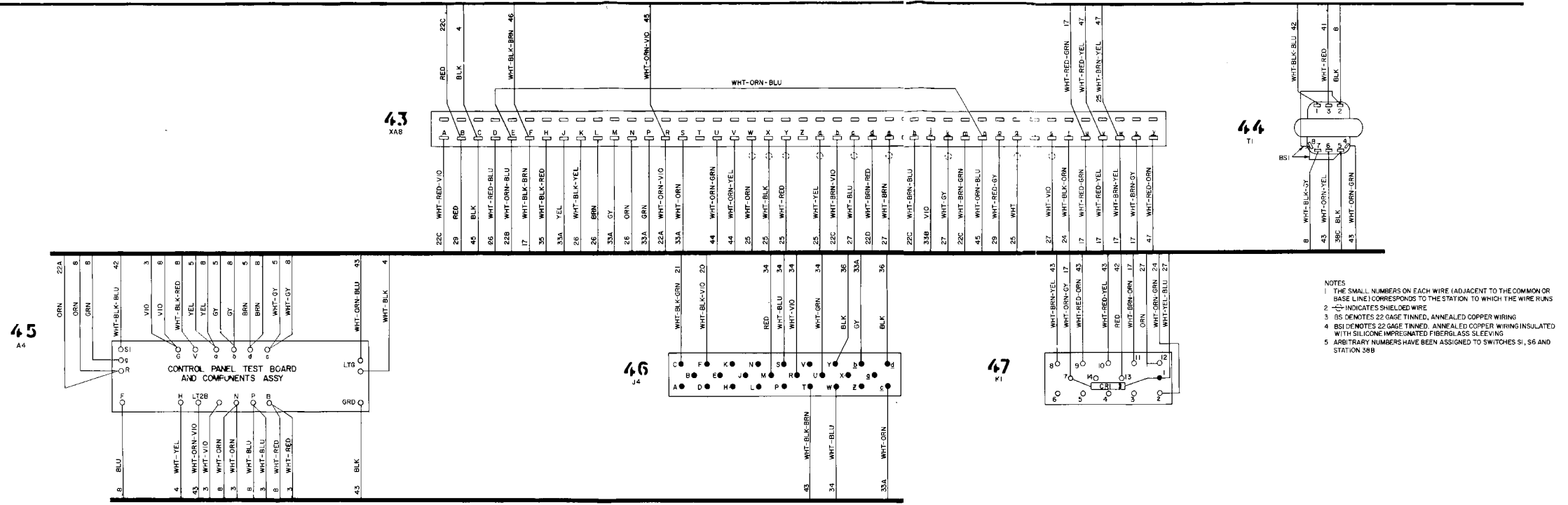
FO-7. Shutter test set wiring diagram (sheet 2 of 4).





E13FC023

FO-7. Shutter test set wiring diagram (sheet 3 of 4).



FO-7. Shutter test set wiring diagram (sheet 4 of 4).

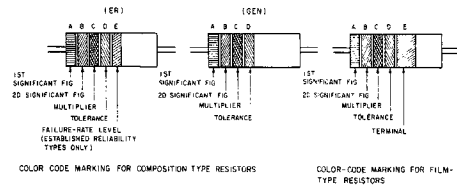


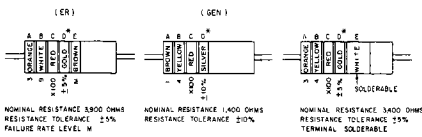
TABLE I  
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS

BAND A		BAND B		BAND C		BAND D		BAND E	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL
BLACK	0	BLACK	0	BLACK	10	BROWN	±10%	BROWN	100
BROWN	1	BROWN	1	BROWN	100	RED	±5%	RED	1000
RED	2	RED	2	RED	1000	ORANGE	±20%	ORANGE	10000
ORANGE	3	ORANGE	3	ORANGE	10000	YELLOW	±20%	YELLOW	100000
YELLOW	4	YELLOW	4	YELLOW	100000	GREEN	±5%	GREEN	1000000
GREEN	5	GREEN	5	GREEN	1000000	BLUE	±10%	BLUE	10000000
BLUE	6	BLUE	6	BLUE	10000000	RED	±2% (NOT APPLICABLE TO ESTABLISHED RELIABILITY)	RED	100000000
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7	SILVER	0.01	WHITE	±5%	WHITE	1000000000
GRAY	8	GRAY	8	GOLD	0.1				
WHITE	9	WHITE	9						

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH)  
 BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE  
 BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE)  
 BAND D — THE RESISTANCE TOLERANCE  
 BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE-RATE LEVEL (PERCENT FAILURE PER 1000 HOURS ON FILM RESISTORS AND HOURS SHALL BE 0.01% FAILURE 1/2 TIMES THE WIDTH OF OTHER BANDS AND INDICATES TYPE OF TERMINALS)  
 RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS (THESE ARE NOT COLOR CODED)  
 SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED FOR EXAMPLE  
 2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED. IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3300 OHMS  
RESISTANCE TOLERANCE ±5%  
FAILURE RATE LEVEL M

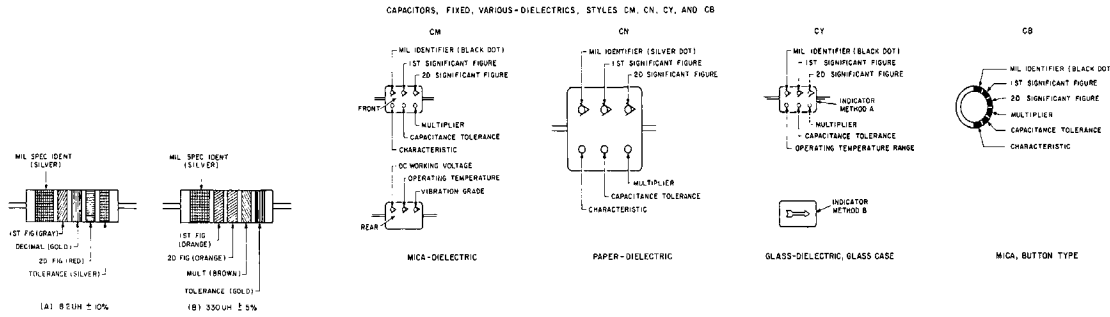
NOMINAL RESISTANCE 1400 OHMS  
RESISTANCE TOLERANCE ±20%  
TERMINAL SOLDERABLE

NOMINAL RESISTANCE 3400 OHMS  
RESISTANCE TOLERANCE ±5%  
TERMINAL SOLDERABLE

COMPOSITION-TYPE RESISTORS  
FILM-TYPE RESISTORS

\* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD

A COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS  
B COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS

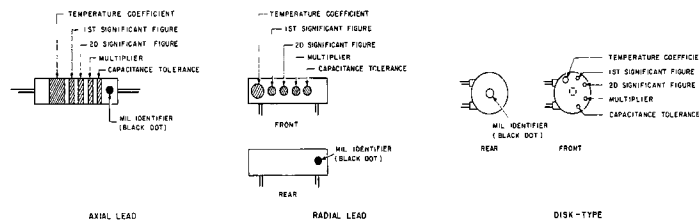


COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES AT A AN EXAMPLE OF THE CODING FOR AN R.F. CHOKE IS GIVEN AT B. THE COLOR BANDS FOR A 350UH INDUCTOR ARE ILLUSTRATED

TABLE 2  
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	2
YELLOW	4	10000	
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE		20	
SILVER		10	
GOLD		DECIMAL POINT	

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL



AXIAL LEAD  
RADIAL LEAD  
DISK-TYPE

C COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB

COLOR	MIL ID	1ST SIG FIG	2D SIG FIG	MULTIPLIER	CAPACITANCE TOLERANCE				CHARACTERISTIC	TEMPERATURE RANGE	VIBRATION GRADE
					CM	CN	CY	CB			
BLACK	00	0	0	1							
BROWN	01	1	1	10	±20%	±20%			B Z B		
RED	02	2	2	100	±2%	±2%	±2%	C			-55° to +85°C
ORANGE	03	3	3	1000	±30%				D D D	300	-55° to +85°C
YELLOW	04	4	4	10000					E		-55° to +85°C
GREEN	05	5	5		±5%				F	300	-55° to +100°C
BLUE	06	6	6								
PURPLE (VIOLET)	07	7	7								
GRAY	08	8	8								
WHITE	09	9	9								
GOLD				0.1			±5%	±5%			
SILVER	CN			0.01	±10%	±10%	±10%	±10%			

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC

COLOR	TEMPERATURE COEFFICIENT	1ST SIG FIG	2D SIG FIG	MULTIPLIER	CAPACITANCE TOLERANCE		MIL CAPACITANCE
					OVER 0.1UF	10.0UF OR LESS	
BLACK	0	0	0	1			±2.0 UUF CC
BROWN	-30	1	1	10	±1%		
RED	-80	2	2	100	±2%		±0.25 UUF
ORANGE	-100	3	3	1000			
YELLOW	-200	4	4				
GREEN	-350	5	5		±5%		±0.5 UUF
BLUE	-470	6	6				
PURPLE (VIOLET)	-750	7	7				
GRAY		8	8	0.01*			
WHITE		9	9	0.1*	±10%		
GOLD	+100			0.1			±1.0 UUF
SILVER				0.01			

- THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF
- LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS MIL-C-5, MIL-C-250, MIL-C-1872B, AND MIL-C-1090C RESPECTIVELY
- LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11013D
- TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE
- OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE

ESC FM 913 73

FO-8. Color code markings for inductors, resistors, and capacitors.

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