INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

FUNCTIONAL TEST UNIT

Caution: It is recommended that the user of this equipment become thoroughly acquainted with the information in this instruction leaflet before energizing these functional test units. Failure to observe this precaution may result in damage to the equipment.

APPLICATION

The functional test package is a rack-mounted unit providing a means to exercise analog, digital and timing circuits. It facilitates commissioning, trouble shooting, and periodic checks of a relaying system. It provides 3 phase ac voltage and single phase ac current test quantities derived from a single phase, 115V ac station supply.

These instructions cover the six (6) basic types listed in Table I.

TABLE I

Type	Application
FTU	STU & STU-12 Systems, with TCF, or TA-3 tone channel equipment. And also can be applied for SKAU, SKBU and non-pilot system.
FTAU	SKAU Systems with TC Carrier.
FTBU	SKBU Systems with TCF or TC carrier.
FTNU	Non-pilot Systems.
FTRU	STU-91, STU-92, STU-93, or STU-94 Direct transfer trip relaying system Receiver Panel with TCF, or TA-3 tone channel equipment.
FTTU	Direct transfer trip relaying system Transmitter Panel with TCF, or TA-3 tone channel equipment.

It provides a means of disconnecting a transmission line relaying system from the devices it controls and to substitute indicating lights for those devices to assure that proper outputs are obtained during testing. The system is entirely secure and cannot produce a misoperation of a breaker due to the interlocking that has been included. During testing the CT's are shorted and disconnected and the PT's are disconnected.

Refer to separate system schematics and instruction leaflets for the external connections of functional test units and the descriptions of operation of the system functional test.

CONSTRUCTION

Functional test units for systems test application are mounted on a standard 19-inch wide panel with edge slots for mounting on a standard relay rack. The types FTU, FTAU, FTBU, and FTNU are 10½ inches high (6 rack units). The type FTRU is 7 inches (4 rack units), and the type FTTU is 5-¼ inches (3 R.U.) high. All switches, indicating lights, milliammeters, and the test-reset pushbutton are accessible from the front of the panel.

A. FTU – The test package as shown on Fig. 1 and Fig. 2 contains all the necessary features to provide for all the functions provided by FTAU, FTBU, or FTNU units. The FTU can substitute for any of these by simply leaving unused terminals open.

The unit consists of a phase splitter, one current transformer, one power supply, four telephone relays, two W-2 switches (RST & TCO), several indicating circuits and switches (TK, OSS, 85CO, Test-Reset) and two dual range milliammeters, as shown on Fig. 3.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-850A
*Denotes change from superseded issue.

EFFECTIVE FEBRUARY 1975

B. FTAU– Construction is similar to the FTU except it contains one milliammeter and trip outputs are reduced to those required by SKAU systems as shown on Fig. 4. All other features remain.

C. FTBU– Construction is similar to the FTU but contains no phase splitter, no out-of-step simulation switch, only one milliammeter, trip outputs are reduced to those required by SKBU system as shown on Fig. 5.

D. FTNU– Construction is similar to the FTU but contains no TK or 85CO switches, and contains no milliammeters, trip outputs are reduced to those required by non-pilot system as shown on Fig. 6.

E. FTRU– The functional test package for direct transfer trip relaying systems is a 2 part unit, receiver and transmitter panel. FTRU is the receiver terminal panel shown on Fig. 7 and consists of three W-2 switches (TCO-Test output, TCS-Trip Channel simulate, ACS-abnormal channel simulate), two sets of power supply, eight indicating lights, two on-off switches and two dual range milliammeters. It is mounted on a four rack unit panel.

F. FTTU – The type FTTU is the transmitter panel test unit for direct transfer trip relaying systems shown on Fig. 8. Consists of one W-2 switch (TCT-trip channel test), one pushbutton SW, two on-off switches and two indicating lights. It is mounted on a 3 R.U. panel.

OPERATION

Functional test units operate by means of several independent circuits that provide simulation of faults or fault situations. Following is a list of parts and functions contained in the various FTU styles.

A. Power Supply

The dc supply is taken from a station battery and brought down to 20 volts by means of a zener diode and a series resistor. Protection from external surges is accomplished with a 200 volt output zener. For FTRU, two sets of supplies are used in order to provide for +20 volts with respect to negative and -20 volts with respect to positive required by receiver terminal panel test.

B. Phase Splitter

The phase splitter consists of a tapped autotransformer, and a resistor. Its function is to provide 3ϕ, 60 Hz., voltage out of a single phase, 115V ac supply for the system tests. Figure 9 illustrates this circuit.

C. Current Transformer

The current transformer is a high current device able to provide ac current requirements for the system tests. It consists of a primary winding and a tapped secondary winding. The transformer is factory set on the lowest current tap.

D. Telephone Relays

Telephone TCOX and RSTX relays are used in critical contact applications for certain selected circuits. A telephone relay XR contact controls the dc power supply to the SRU terminals. By means of the time delay it introduces it avoids incorrect indications during TCO, or RST switching. In the circuit, XR-1 relay is used as a slave that delays release of XR after RST is moved to an "operate" (Rev. or For.) position. Other XR contacts are inserted in the trip output circuits to automatically interrupt the SRU thyristor output currents when RST switch is moved back to NORMAL position or when the test reset pushbutton is pushed.

E. Milliammeters

Some styles have one or two milliammeter (CLI-1 and CLI-2) for carrier level indication. CLI-2 is for 3-terminal lines. Meters are 0-3 mA scale a tap allows accommodation of 300 mA input and readings should be multiplied by 100 when used.

F. TCO Switch (FTU, FTAU, FTBU, FTNU)

This type W-2 switch for test cut-out isolates the SRU outputs from the power circuit breaker devices and connects these outputs to the blue lamps instead. It also performs other switching necessary to prepare the relay system for test. The operating handle is removable in the test position only. This same operating handle is used to operate the RST switch.

G. RST Switch (FTU, FTAU, FTBU, FTNU)

The relay system test switch is also a type W-2.

This switch disconnects relays from CT's & PT's shorts the CT's (make before break) and applies test voltage and current to the relaying system. Current is reversed in the "REV" position to restrain "forward-set" directional relays. The handle is removable only in the "NORMAL" position.

H. TCT Switch (Trip Channel Test – FTTU)

This type W-2 switch is used in the transmitter test panel (FTTU). It connects test voltage to channel 1, channel 2 or both. It disables the transmitter output to the line equipment (for Lenkurt and TA-3) or disconnects the power supply to the transmitter (for TCF).

I. TCO (Test cutout – FTRU)

The test cut-out switch (W-2) for FTRU application disables all trip outputs, BFI, etc. It also connects test dc voltage to the test power supply units and sets up simulated low signal and noise testing circuits.

J. TCS (FTRU)

This four-position W-2 switch provides for trip channel simulation. The handle is spring return to "normal" position.

K. ACS (FTRU)

This abnormal channel simulation switch provides for CH. 1 and CH. 2 low signal or noise test. The handle is spring return to "normal" position.

L. BPS Switch (FTU, FTAU, FTBU, FTNU)

The by-pass toggle switch is a three position, ϕ-bypass, normal and SIU test switch. It serves two purposes:

1. SIU Test – Provides for bypassing of other current circuits when testing SIU, to avoid the possibility of thermal damage and excessive test source requirements.
2. ϕ-BPS- bypass phase relays during ground relay calibration to avoid difficulties in adjusting calibration voltage and current caused by induced voltages from phase relay compensators.

M. FT-1 Switch (FTU, FTAU, FTBU, FTNU)

A type FT-1 Flexitest switch is provided to enable relay test personnel to measure current and potential seen by the relay system. In addition, it enables one to isolate the relay system from the current and potential transformers and apply controlled currents and potentials to the relay system for calibration checks. A meter seal may be applied to discourage removal of the switch cover by unauthorized personnel.

For SRGU, and SRTU applications and additional FT-1 switch is required for the polarizing circuits. This switch is provided on a separate 2-rack unit panel.

N. OSS Switch

The OSS switch provides for out-of step simulation tests. It is spring-return-to-normal from both "Block" and "Trip" positions.

O. Other Switches

85CO permits the operator to disable the pilot trip portion of the relay system, TK permits the operator to key the pilot channel transmitter for checkback test TR pushbutton, for test reset. The TK switch is spring-return-to-normal from both test positions. TR is also spring return.

P. Indicating Lights (FTU, FTAU, FTBU, FTNU)

A white lamp "DC PWR" indicates that dc power is applied to the relay system. A red lamp "OFF NORMAL" indicates that one or more of the 85CO, BPS, or TCO switches are in an off normal position. Blue lamps sense all SRU outputs that offset the power circuit breaker during test.

In addition, the blue lamps are useful in determining that the outputs have ceased before restoring the system to service.

Q. Indicating Lights (FTRU)

Channel 1 and channel 2 have separate lights for dc power on (white), test power on (red, when TCO switch is on TEST position), and STU-91 or STU-92 etc. outputs (blue).

R. Indicating Lights (FTTU)

Channel 1 and channel 2 have separate white power on light.

INSTALLATION

Functional test units should be mounted on

switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the unit by means of the slotted holes on the front panel. Utilize varicon terminal #1 for grounding the unit. In case where more than one varicon is used, each #1 terminal of each varicon connector should be grounded.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data, and component nameplate data, and component style number given in the electrical parts list.

Receiving Acceptance

Acceptance test consist of two parts:

1. Visual check to make sure there are no loose connections, broken resistors, or broken resistor wires.
2. An electrical check to make certain that polarities are correct and that test quantities are available as required.

Recommended Procedure

a. Check resistor settings (factory setting is for 250VDC) to agree with rated voltage as shown by table in Internal Schematic.

b. Check Indicating Lights to be rated:
   1. 120V dc for 125 and 250V dc units (Note that there is a series resistor).
   2. 60 Volts dc for 48V dc units.

c. Polarity Test
   1. Place a 4000-ohm resistor across terminal J2-21 and terminal block 13.
   2. Apply rated DC voltage to terminal blocks 14 and 13 (14 is positive).
   3. Place TCO switch in test position.
   4. Measure 20 ±3 volts DC across terminals J2-21 and terminal block #13 (J2-21 is positive).
   5. Place RST switch in "F" position and measure 20 volts dc across terminals J2-22 and terminal block #13.
   6. Return all switches to normal position.

d. Phase Splitter
   1. Apply 120 volts, 60 Hz. to terminals 31 and 32.
   2. Place RST switch in "F" position.
   3. Read 120 ± 5% volts across terminal J2-18 and terminal 31, and between J2-18 terminal 32.
   4. Read 4 ± .2 volts between terminals J2-8 and 31.

e. Low Angle Testing

When testing low angle (45° maximum torque angle) distance relays, a 2 ohm external reactor should be connected in series with the test current circuit (Terminal 2 of the FTU).

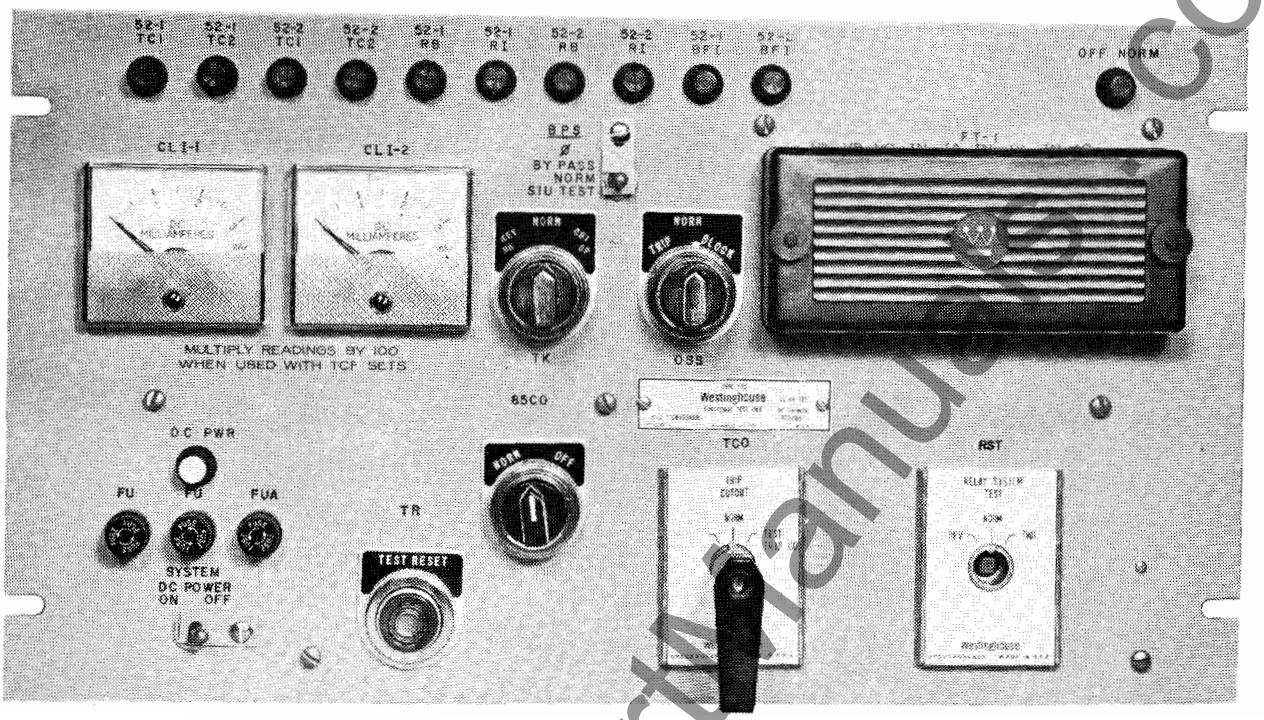


Fig. 1 Functional Test Unit – Front View

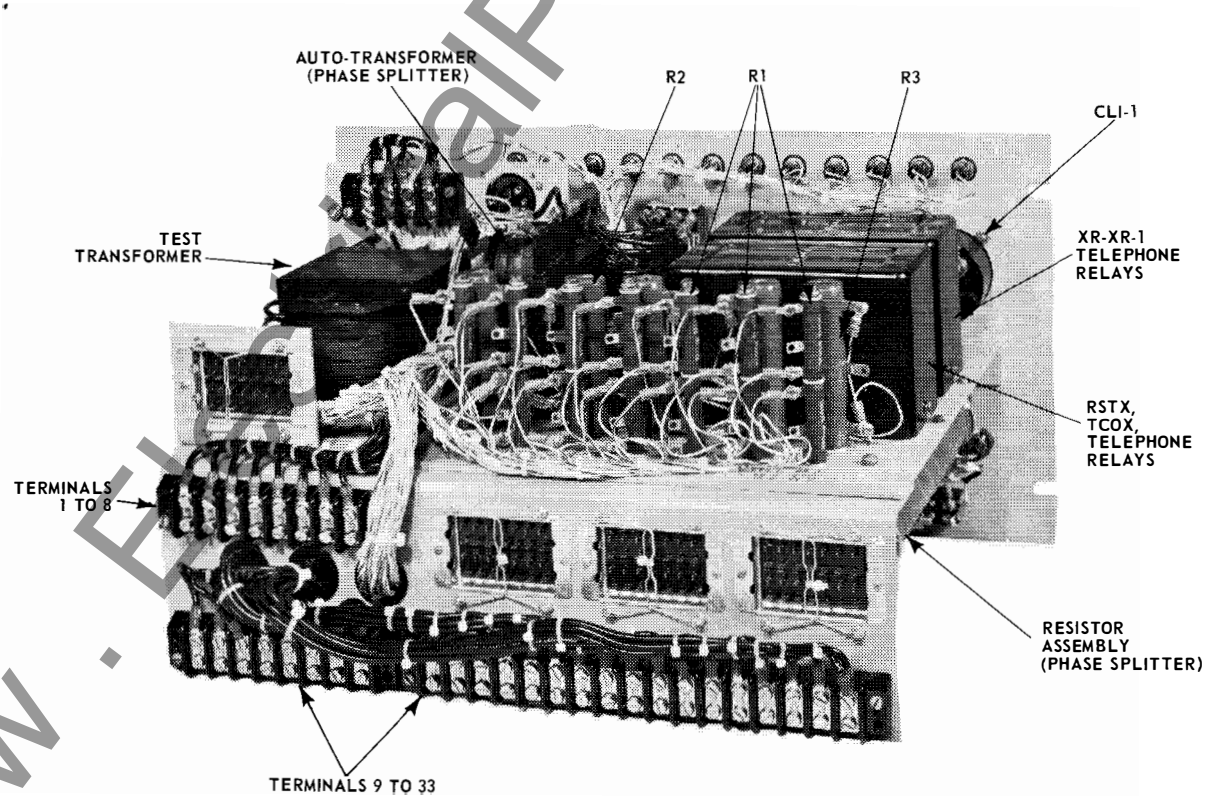
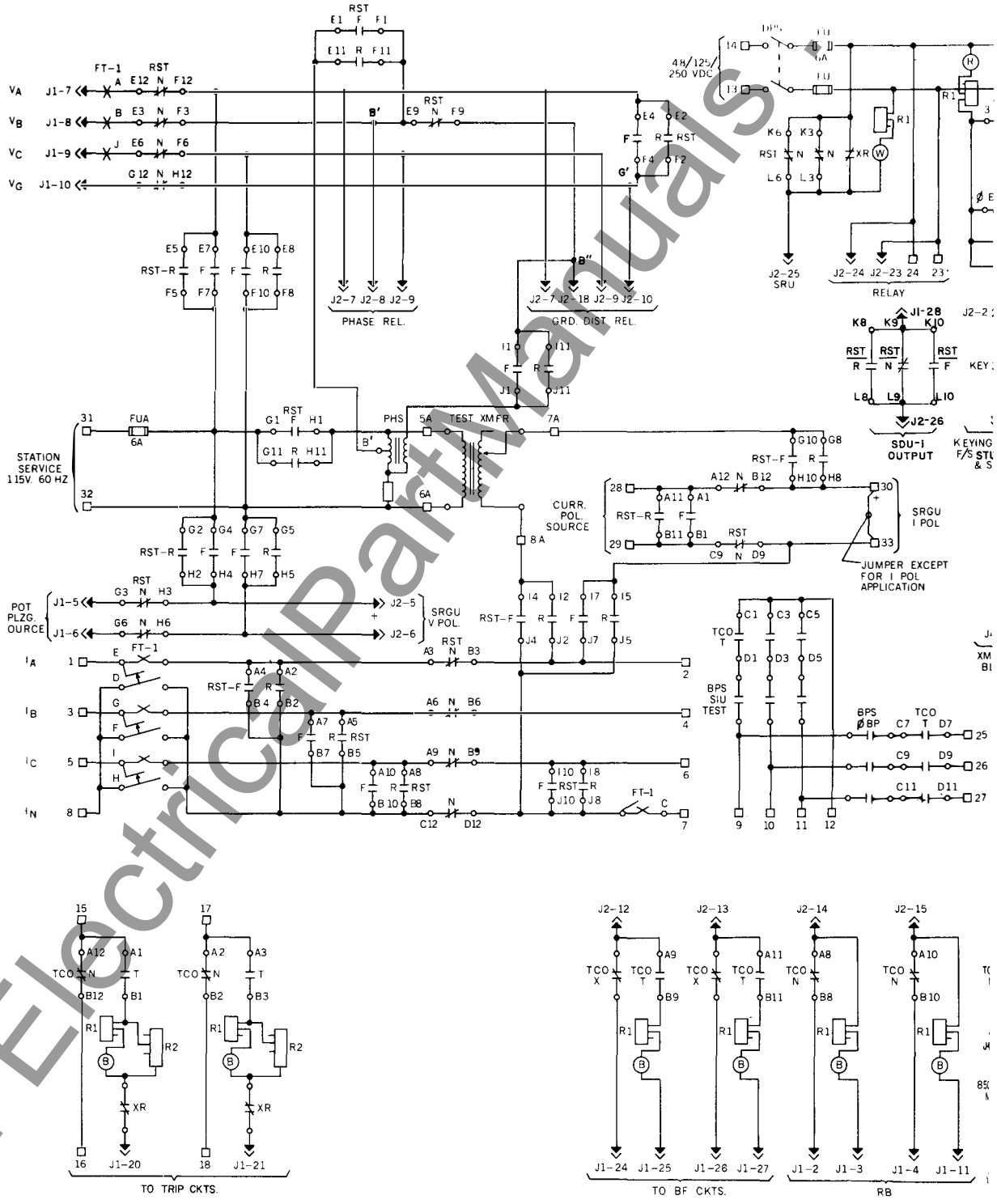
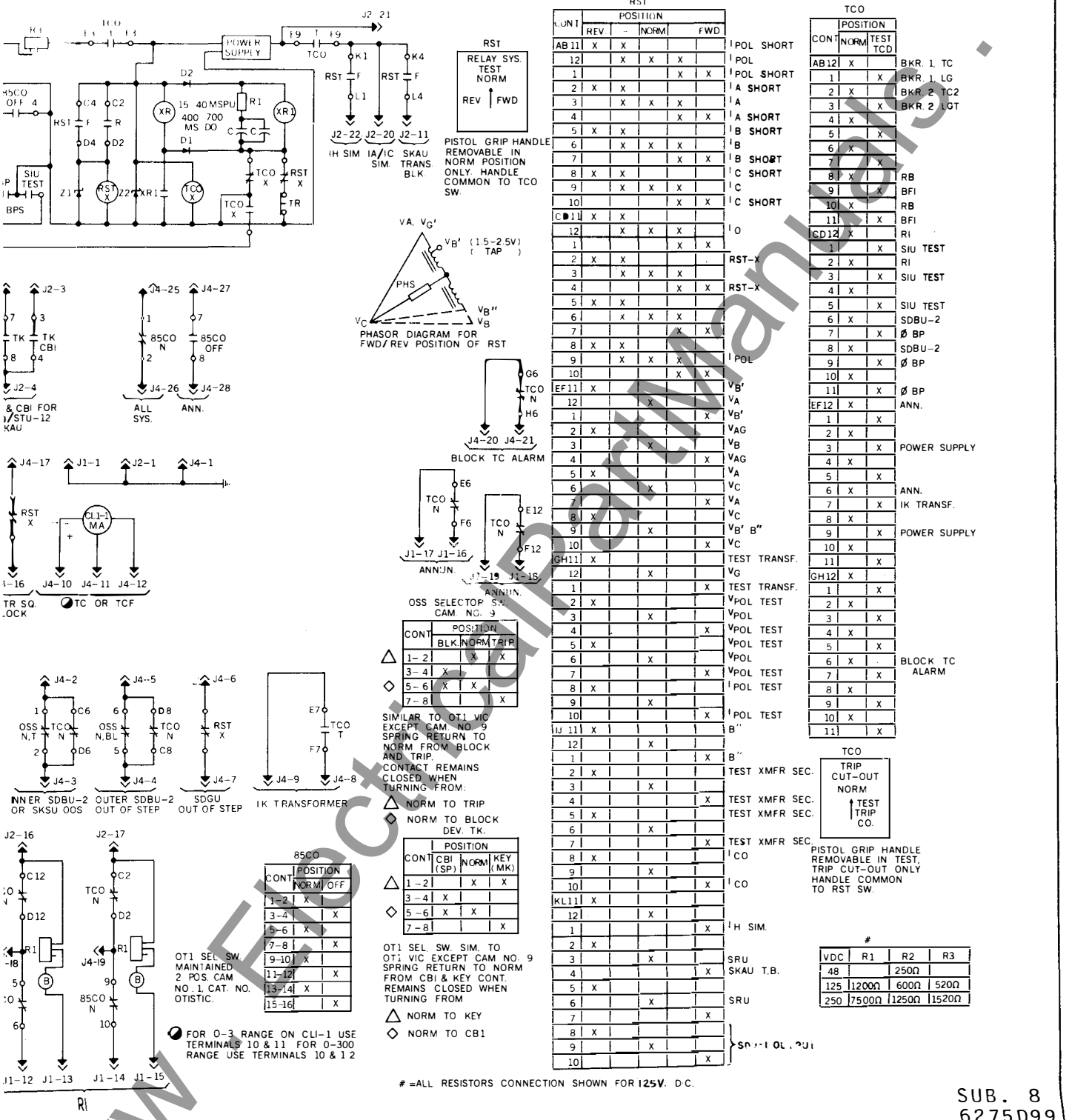


Fig. 2 Functional Test Unit – Rear View



* Fig. 4 FTA



SUB. 8
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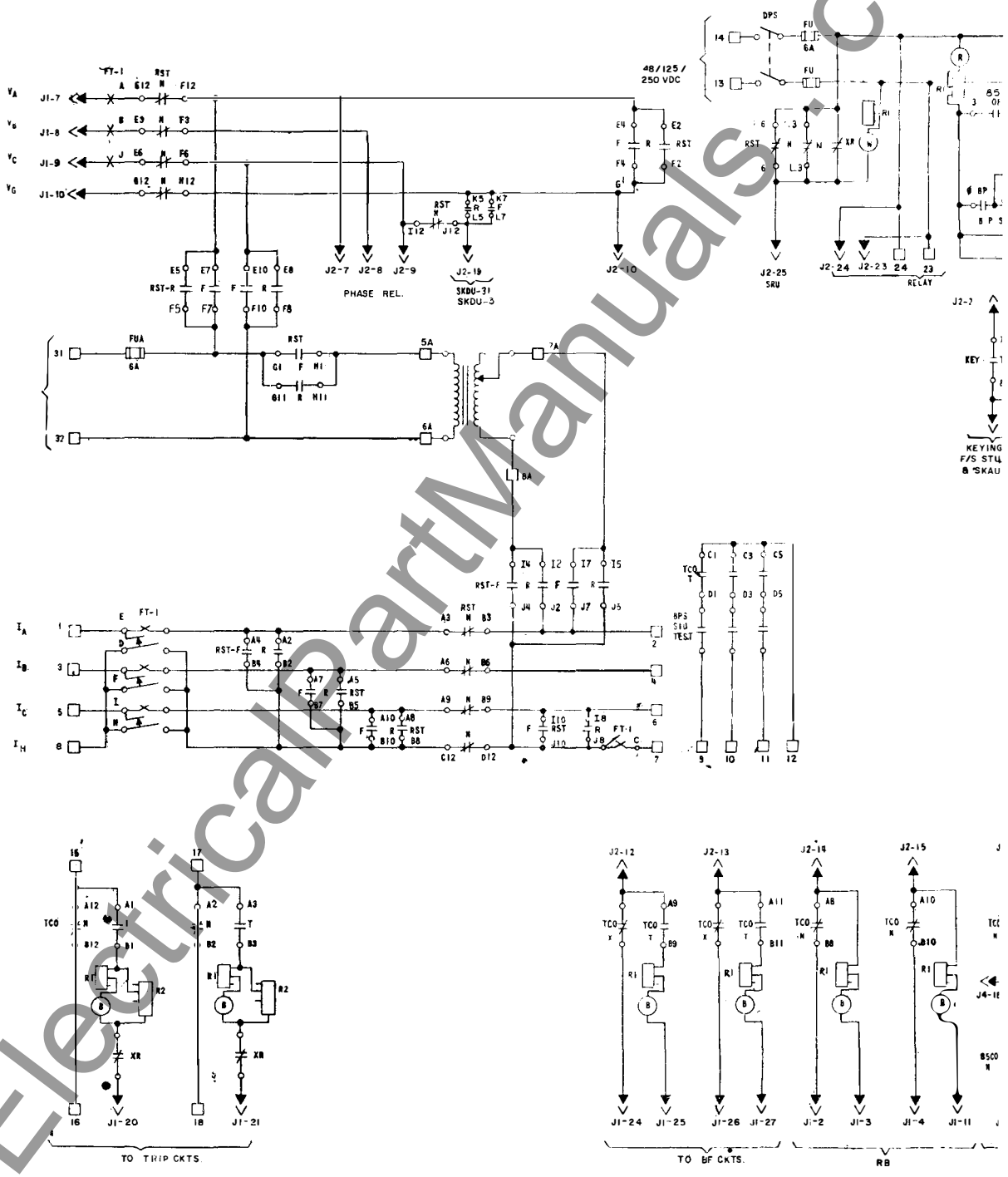
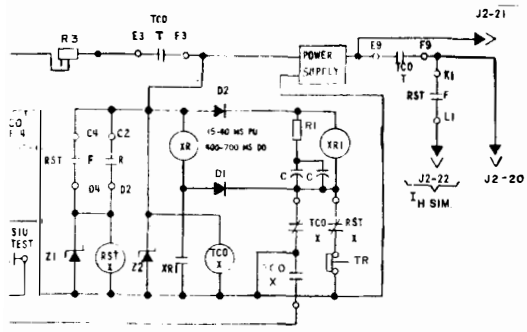
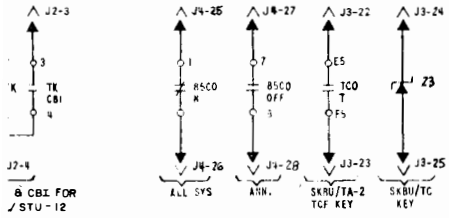
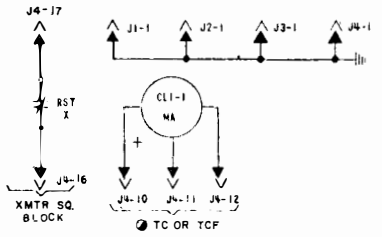
Internal Schematic

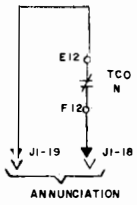


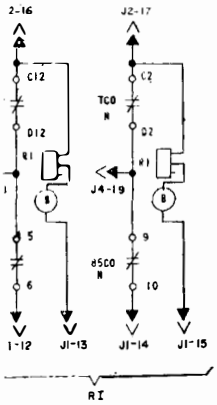
* Fig. 5 FTBU I



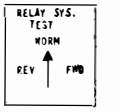








◐ FOR 0-3 RANGE ON CLI-1 USE TERMINALS 10 & 11 FOR 0-300 RANGE USE TERMINALS 10 & 12

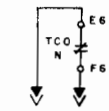


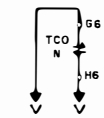
PISTOL GRIP HANDLE REMOVABLE IN NORM POSITION ONLY. HANDLE COMMON TO TCO SW.

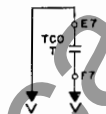
RST

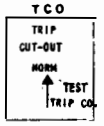
CONT.	POSITION REV.	–	NORM	–	FWD	
AB11	X	X				
12		X	X	X		
1				X	X	
2	X	X				I_A SHORT
3		X	X	X		I_A
4				X	X	I_A SHORT
5	X	X				I_B SHORT
6		X	X	X		I_B
7				X	X	I_B SHORT
8	X	X				I_C SHORT
9		X	X	X		I_C
10				X	X	I_C SHORT
CD11	X	X				
12		X	X	X		I_D
1				X	X	
2	X	X				RST-X
3		X	X	X		
4				X	X	RST-X
5	X	X				
6		X	X	X		
7				X	X	
8	X	X				
9		X	X	X		I_{POL}
10				X	X	
FF11						
12			X			V_A
1					X	
2	X					
3			X			V_B
4					X	
5	X					V_A
6			X			V_C
7					X	V_A
8	X					V_C
9				X		
10					X	V_C
CH11	X					TEST TRANSF.
12				X		V_B
1					X	TEST TRANSF.
2	X					
3			X			
4					X	
5	X					
6			X			
7					X	
8	X					
9			X			
10					X	
KL11	X					
12			X			3KBU-31
1					X	
2	X					TEST XMFR SEC.
3			X			
4					X	TEST XMFR SEC.
5	X					TEST XMFR SEC.
6			X			
7					X	TEST XMFR SEC.
8	X					$I_{CO, SKAU-31}$
9			X			
10					X	$I_{CO, SKAU-31}$
KL11	X					
12			X			$I_{H SIM.}$
1					X	
2	X					
3			X			SRU
4					X	
5	X					
6			X			SRU
7					X	
8	X					
9			X			
10					X	

CONT.	POSITION NORM	TEST TCO	
AB12	X		3KR 1, TC
1		X	3KR. 1, LGT
2	X		3KR. 2, TC
3		X	3KR. 2, LGT
4	X		
5		X	
6	X		
7		X	
8	X		RB
9		X	BFI
10	X		RB
11		X	BFI
CD12	X		RI
1		X	STU TEST
2	X		RI
4		X	STU TEST
4	X		TK SUPV.
5		X	STU TEST
6	X		SDBU-2
7		X	
8	X		SDBU-2
9		X	
10	X		
11		X	
EE12	X		ANN.
1		X	
2	X		
3		X	POWER SUPPLY
4	X		
5		X	XMFR KEY SKBU
6	X		ANN.
7		X	ANN
8	X		
9		X	POWER SUPPLY
10	X		
11		X	
GH12	X		
1		X	
2	X		
3		X	
4	X		
5		X	
6	X		BLOCK TC ALARM
7		X	
8	X		
9		X	
10	X		
11		X	









PISTOL GRIP HANDLE REMOVABLE IN TEST, TRIP CUT-OUT ONLY HANDLE COMMON TO RST SW.

DEV TK

CONT.	POSITION CBI (SP)	NORM	KEY (MK)
1-2		X	X
3-4	X		
5-6	X	X	
7-8			X

OTI SEL SW. SIM. TO OTIVIC EXCEPT CAM NO. 9 SPRING RETURN TO NORM. FROM CBI & KEY CONT REMAINS CLOSED WHEN TURNING FROM

△ NORM TO KEY
◇ NORM TO CBI

VDC	R1	R2	R3
48		250 Ω	
125	1200 Ω	680 Ω	520 Ω
250	7500 Ω	1250 Ω	1520 Ω

: ALL RESISTORS CONNECTION SHOWN FOR 125 V.D.C.

85CO

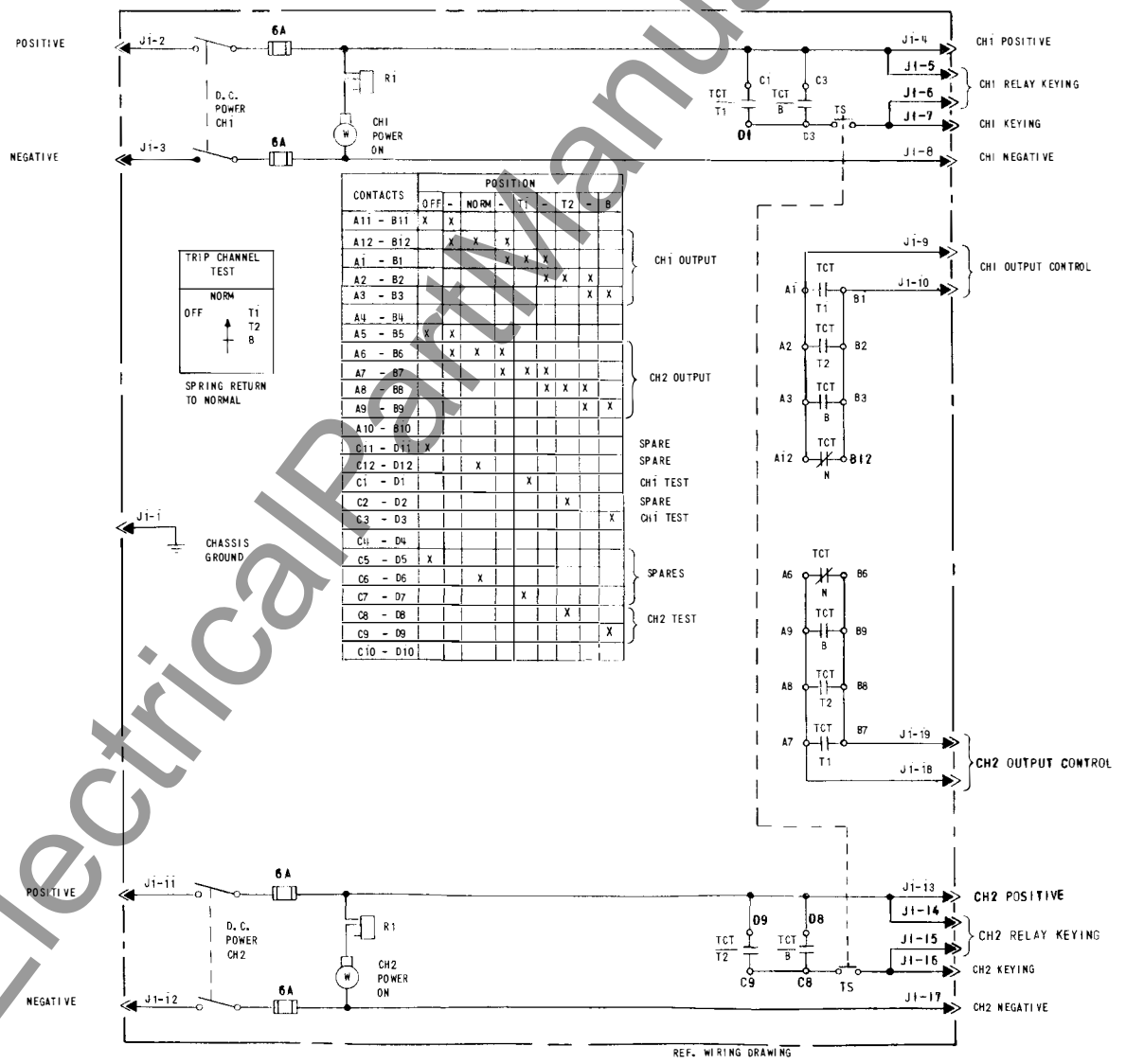
CONT.	POSITION NORM	OFF
1-2	X	
3-4		X
5-6	X	
7-8		X
9-10	X	
11-12		X
13-14	X	
15-16		X

OTI SEL SW MAINTAINED 2 POS., CAM NO 1, CAT NO OTISTIC

SUB. 8
6275D97

VARICON POINT LEGEND

J1	
1	CHASSIS GROUND
2	POSITIVE
3	NEGATIVE
4	CH1 POSITIVE
5	CH1 RELAY KEYING
6	
7	CH1 KEYING
8	CH1 NEGATIVE
9	CH1 OUTPUT CONTROL
10	
11	POSITIVE
12	NEGATIVE
13	CH2 POSITIVE
14	CH2 RELAY KEYING
15	
16	CH2 KEYING
17	CH2 NEGATIVE
18	CH2 OUTPUT CONTROL
19	
20	SPARES
21	
22	
23	
24	
25	
26	
27	
28	



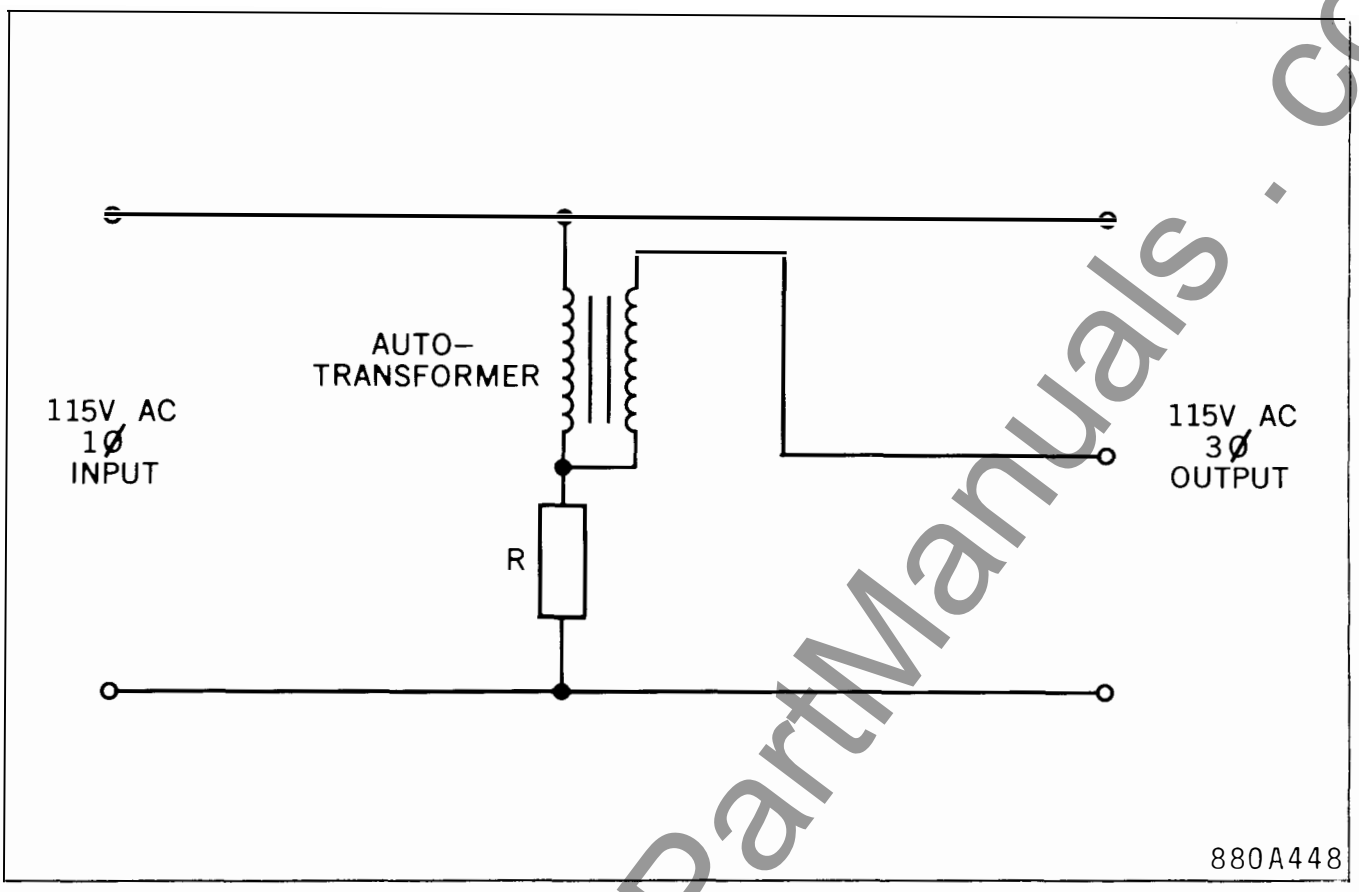


Fig. 9 Phase Splitter Ckt.

Fig. 8 FTTU Internal Schematic

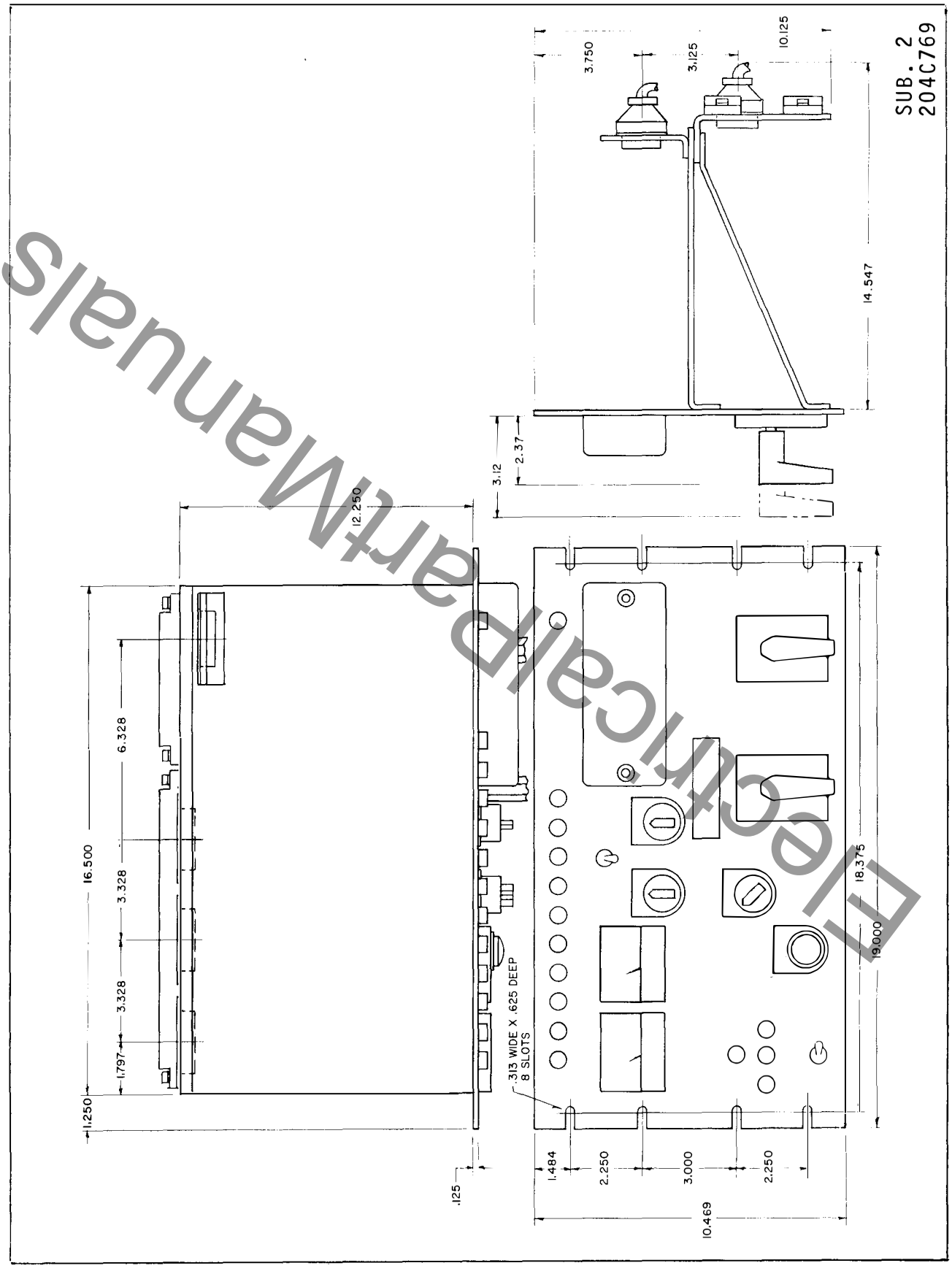


Fig. 10 Case Outline – FTU, FTAU, FTBU, FTNU

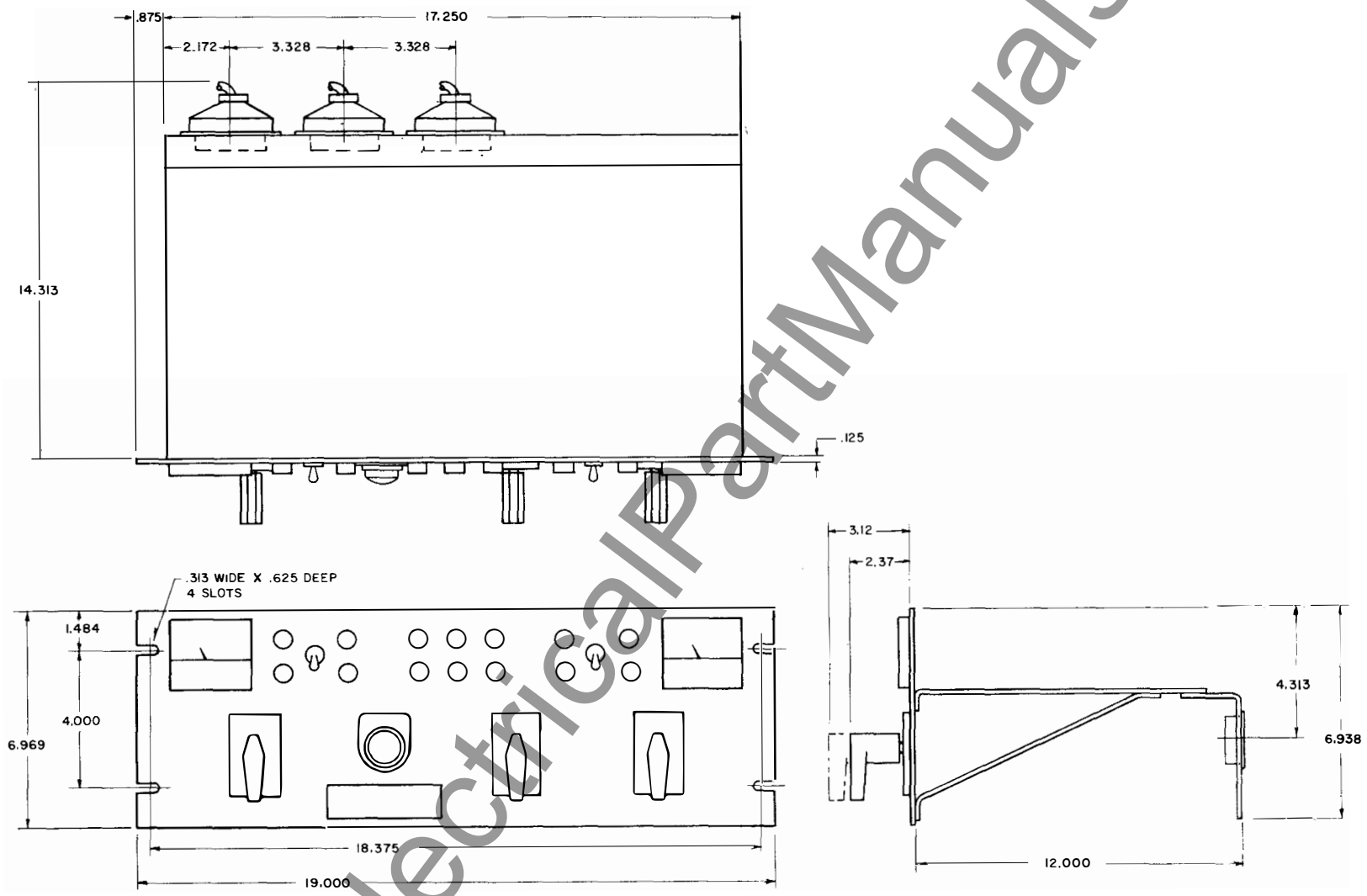


Fig. 11 Case Outline – FTRU

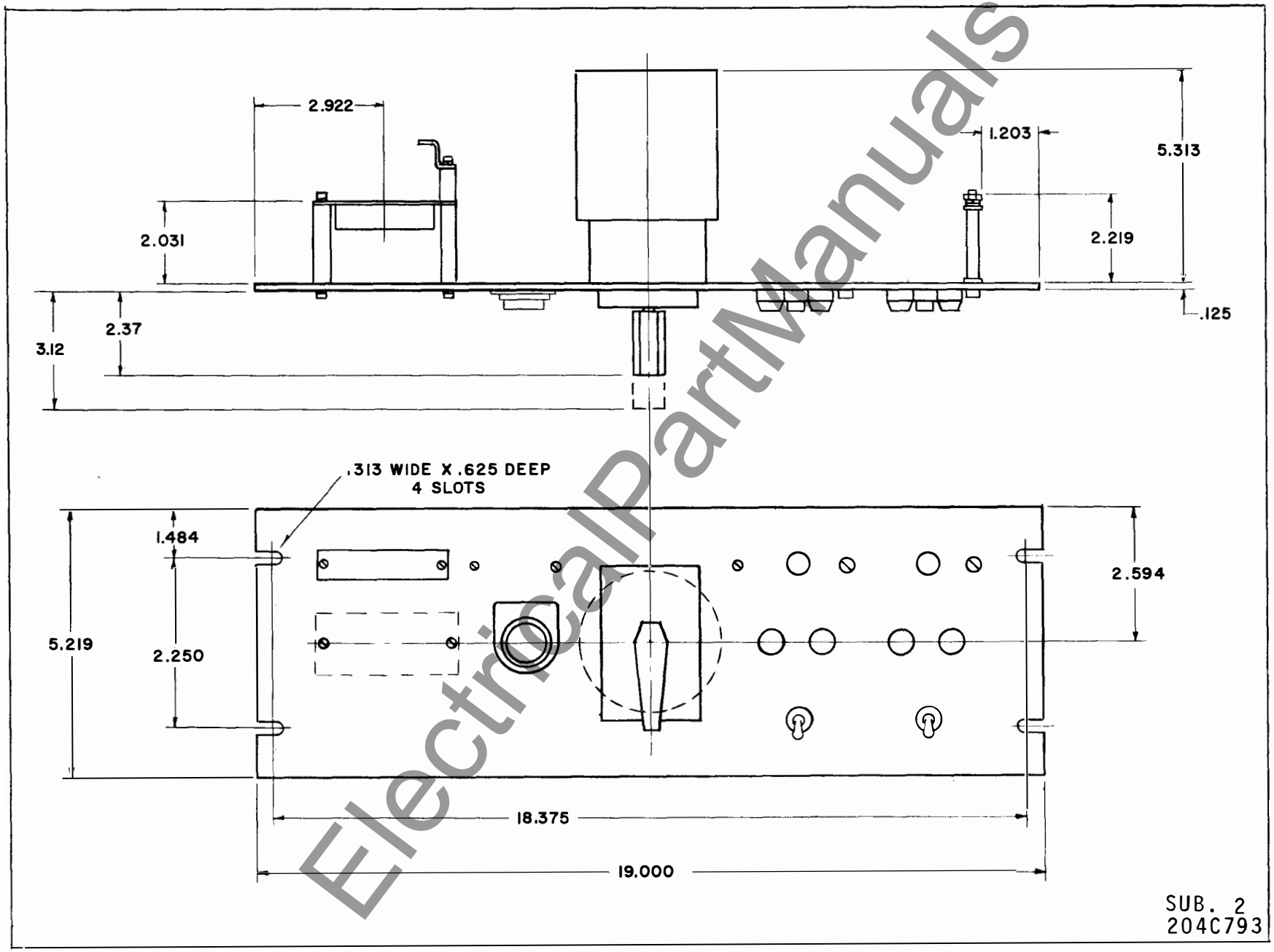
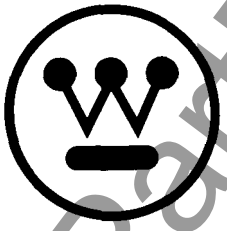


Fig. 12 Case Outline – FTTU



WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

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