

**TM 9-6920-483-34-2**

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**TECHNICAL MANUAL**

**DS AND GS MAINTENANCE MANUAL  
FAULT ISOLATION INSTRUCTIONS  
FOR IR TRANSMITTING SET M89**

**DRAGON MEDIUM  
ANTITANK/ASSAULT WEAPON SYSTEM**

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**HEADQUARTERS, DEPARTMENT OF THE ARMY**

**JULY 1982**



## **SAFETY SUMMARY**

The following are general safety precautions that personnel must understand and apply during operation and maintenance.

### **KEEP AWAY FROM LIVE CIRCUITS**

Operating personnel must observe safety regulations at all times. Do not replace components or make adjustments inside the equipment with high voltage present. Under certain conditions, dangerous potentials may exist when the power control is in the OFF position. To avoid injury, remove power and discharge and ground a circuit before touching it.

### **DO NOT SERVICE OR ADJUST ALONE**

Under no circumstances should any person reach into the enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

### **RESUSCITATION**

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

### **WARNING**

Personnel must wear safety goggles when destroying the I R lamp assembly to prevent eye damage or loss of sight.

The lamp bulb in the I R source is pressurized to about 215 psi. Safety goggles shall be worn and a protective shield for the body (such as plexiglass panel) shall be used whenever disassembly beyond the filter retainers (i.e., within the housing) is necessary. If lamp bulb is to be handled, light gloves shall be worn. Failed bulbs shall be disposed of by enclosing them within a thick plastic bag before breaking with a tool with a flat surface such as a shovel. Disposal techniques similar to those for cathode ray tubes are recommended.



Technical Manual )  
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 No. 9-6920-483 -34-2 )

HEADQUARTERS,  
 DEPARTMENT OF THE ARMY  
 Washington, D. C., 27 July 1982

**DS AND GS MAINTENANCE MANUAL:  
 FAULT ISOLATION INSTRUCTIONS FOR IR TRANSMITTING SET M89  
 (DRAGON MEDIUM ANTITANK/ASSAULT WEAPON SYSTEM)**

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\*This manual supersedes TM 9-6920-483-34-2, 31 January 1977, including all changes.



**CHAPTER 1**  
**INTRODUCTION**

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**1-1. PURPOSE AND SCOPE.**

This manual contains fault isolation instructions for, the direct support and general support maintenance of the M89 infrared transmitting set.

**1-2. TROUBLESHOOTING PROCEDURES.**

Troubleshooting and testing of the training equipment and subassemblies will be accomplished by the procedures contained in chapter 2, and the schematics in TM 9-6920-483-34-1.

**1-3. FORMS, RECORDS, AND REPORTS.**

All personnel and organizations responsible for operating and/or maintaining this equipment are also responsible for the preparation and disposition of appropriate forms, records, and reports.

**1-4. SECURITY RESPONSIBILITIES.**

a. The security classification of the DRAGON Weapon System Equipment is UNCLASSIFIED. Portions of data relative to the DRAGON system are classified.

b. The importance of security of classified material cannot be overemphasized. Security is an individual as well as a Command responsibility.

c. Safeguarding of classified material will be accomplished in accordance with current directives.

**1-5. REPORTS OF EQUIPMENT MANUAL IMPROVEMENTS.**

Reports of errors, omissions, and recommendations for improving this publication by the individual user are encouraged. U.S. Marine Corps reports should be submitted on Form NAVMC 10772 in accordance with MCO 5600.4 1 \_\_\_\_\_. All other should be submitted on DA Form 2028, Recommended Changes to Publications, and forwarded directly to: Commander, U.S. Army Missile Command, ATTN: DRSMI-SNPM, Redstone Arsenal, Alabama 35898.





**CHAPTER 2**  
**FAULT ISOLATION**

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**2-1. GENERAL.**

*a.* This procedure is designed to be used by an electronics technician when the target source fails to perform correctly.

*b.* We strongly recommend that you start at the beginning of the procedure and work through, and not skip or omit anything unless instructed, because the procedure is designed to work effectively only in this sequence.

**2-2. TEST SEQUENCE.**

Test sequences referenced in the procedure are:

“Troubleshooting The Power Supply Modulator” Instructions . . . . .	begin on page 2-10
Lamp - “Failure to Modulate” - Instructions . . . . .	begin on page 2-27
“Troubleshooting the PCA Card” Instructions . . . . .	begin on page 2-30
Output Power Calibration Instructions . . . . .	begin on page 2-46

**2-3. SPECIAL EQUIPMENT.**

Two pieces of special equipment required to perform these tests are:

- Tektronix type 422 oscilloscope -or- equivalent (with a compensated probe)
- Fluke digital multimeter, type 853A-03 -or- equivalent

Additional piece of equipment required to perform PSM Output Power Calibration

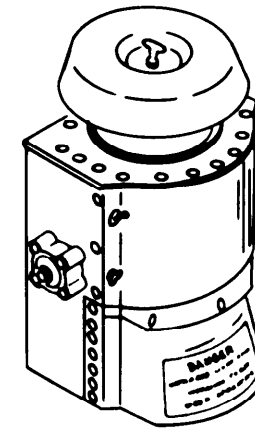
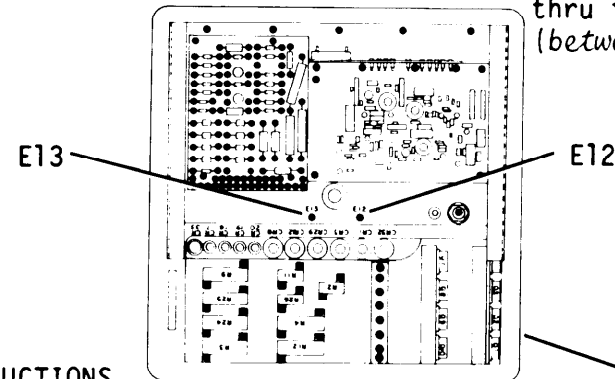
- Variable power supply 24 Vdc to 30 Vdc @ 30 Amps.

**2-4. REPAIR PARTS.**

Refer to TM 9-6920480-24P-1 for repair parts.

**TO perform repairs on the TARGET SOURCE (TS)  
& the POWER SUPPLY MODULATOR (PSM)  
YOU need to understand each unit's purpose  
& the functions it provides.**

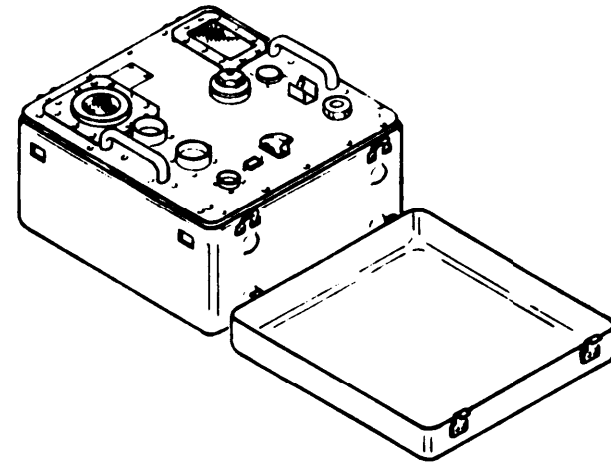
The TARGET SOURCE  
houses/cool's the Xenon lamp  
& provides optical filtering for the radiated light  
has a high voltage power supply to light the lamp  
thru the third electrode.  
(between cathode & anode)



**GENERAL INSTRUCTIONS**

- **BEFORE ANY ELECTRICAL TESTING**  
test all cables for continuity between appropriate pins  
for shorts between adjacent pins
- **IF ANY TEST FAILS TO FIND FAULTY COMPONENT**  
look for circuit wiring "OPENS"  
look for circuit wiring **ERRORS**  
look for circuit wiring "SHORTS"
- **A FAILURE NOT UNCOVERED BY INSTRUCTIONS (during testing)**  
is cause to continue the test series (if possible)  
as the failure is likely located by a later test
- **VOLTAGE READINGS ARE TO GROUND**
- **ALWAYS USE E12 & E13 FOR GROUND CONNECTION**  
(chassis anodize may insulate "chassis ground")
- **TO OBSERVE WAVE-FORMS**  
use Tektronix 422 oscilloscope or equivalent  
use a compensated probe  
(do NOT use coaxial cable/distort wave-forms)
- **FOR DC VOLTAGE MEASUREMENT & CONTINUITY CHECKS**  
use Fluke Digital Multimeter or equivalent
- **ALL RESISTANCE VALUES ARE IN OHMS**

The POWER SUPPLY MODULATOR



provides cooling for itself  
provides the lamp  
with regulated/modulated power and its monitoring  
& with controlled boost voltage for starting

has a DC-to-DC converter  
has a modulation and power control card  
has current and voltage control & switching for lamp starting  
arc stabilizing  
& normal operation.

GENERAL STRATEGY

FIRST isolate the problem to the TARGET SOURCE(TS)  
or POWER SUPPLY MODULATOR(PSM)

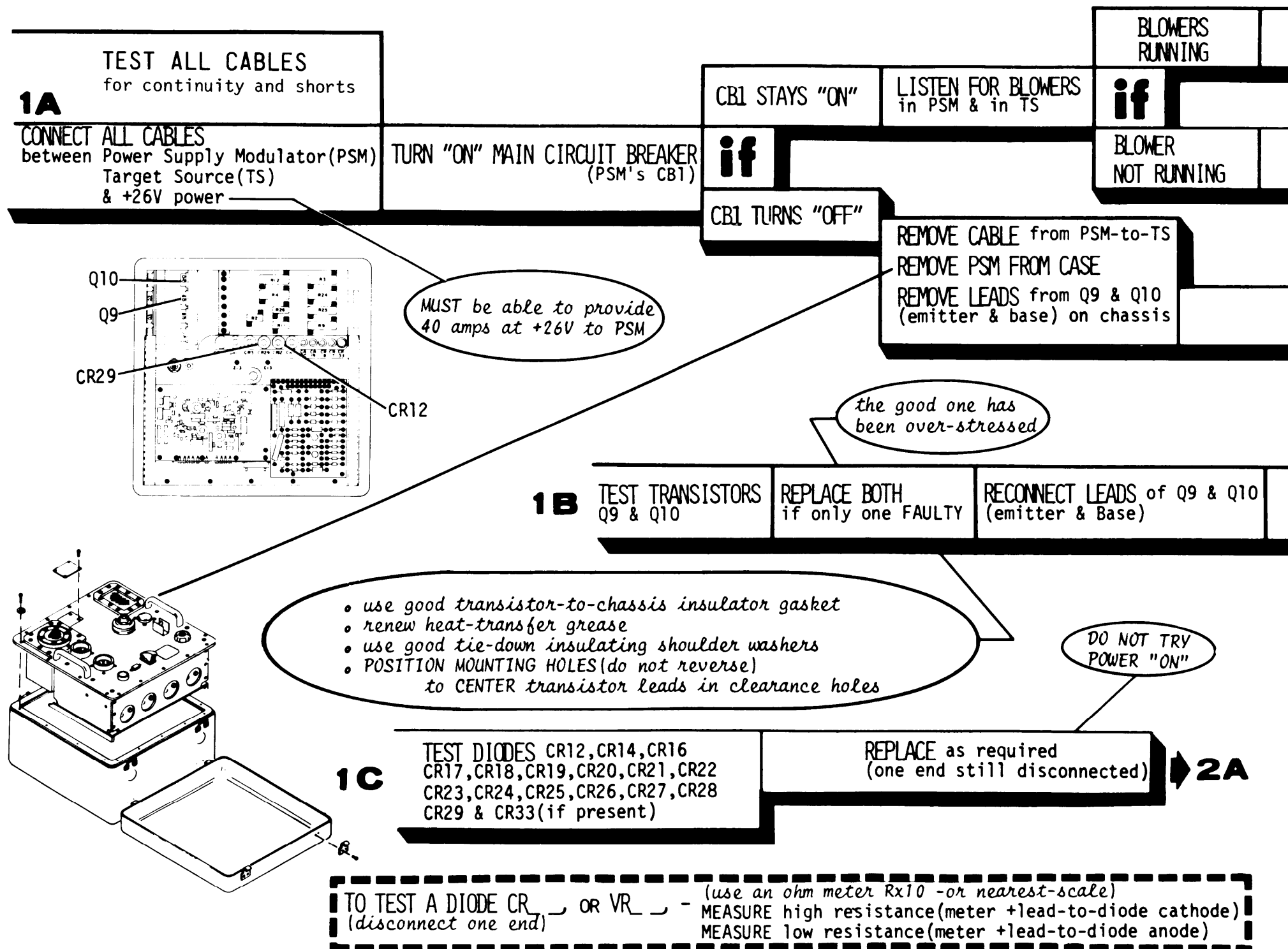
IF BOTH ARE FAULTY - repair the PSM first.

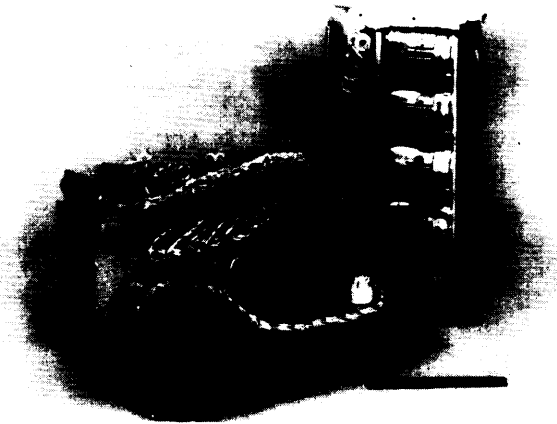
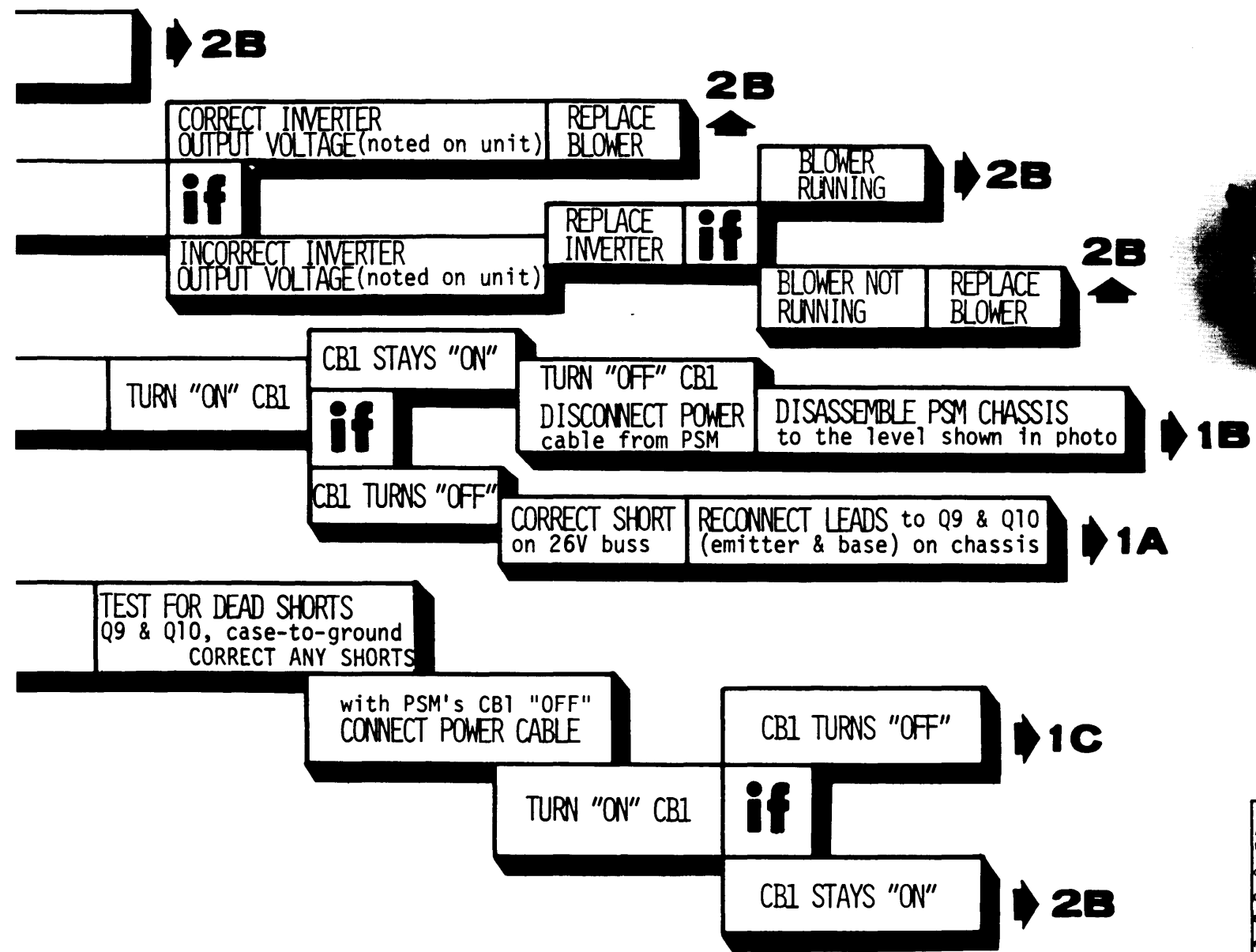
SECOND determine those basic functions not operating normally.

THIRD isolate the failed component  
by checking the operation of all minor circuit functions  
contributing to the faulty basic function.



26V power cable leads

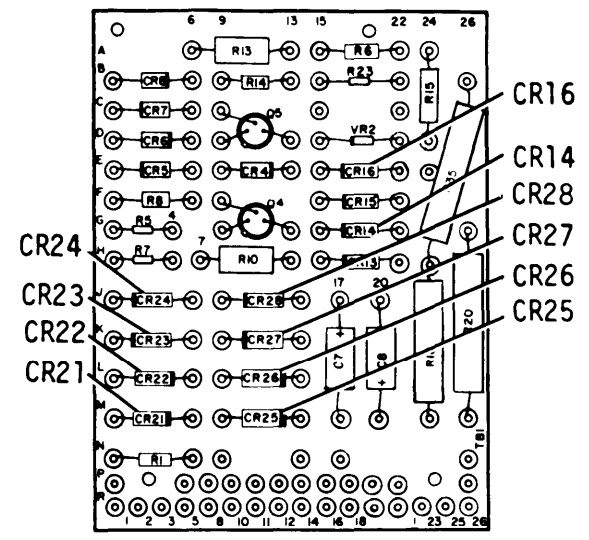




TO TEST A TRANSISTOR Q<sub>x</sub> - (use an ohm meter Rx10 -or nearest-scale) compare resistance readings to a new part (±20% variation between parts is normal)

- (base-to-emitter/both directions)
- (base-to-collector/both directions)
- (collector-to-emitter/both directions)

*(used power transistors may have less resistance, collector-to-emitter)*



**WARNING**

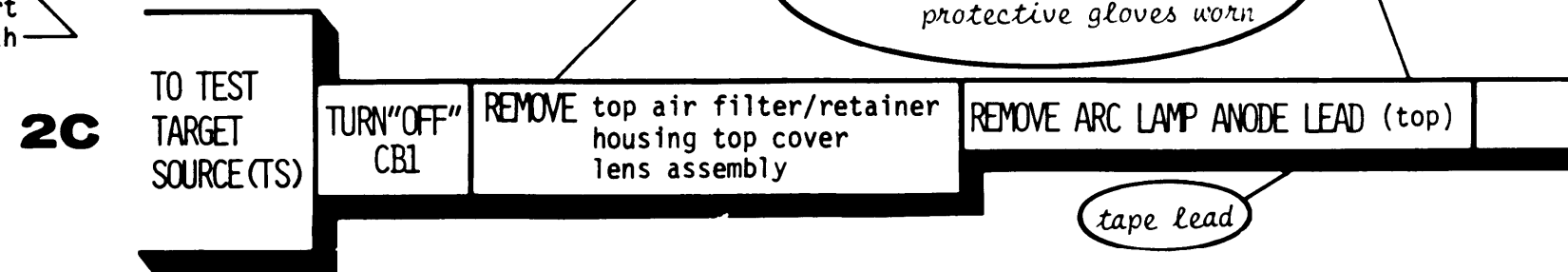
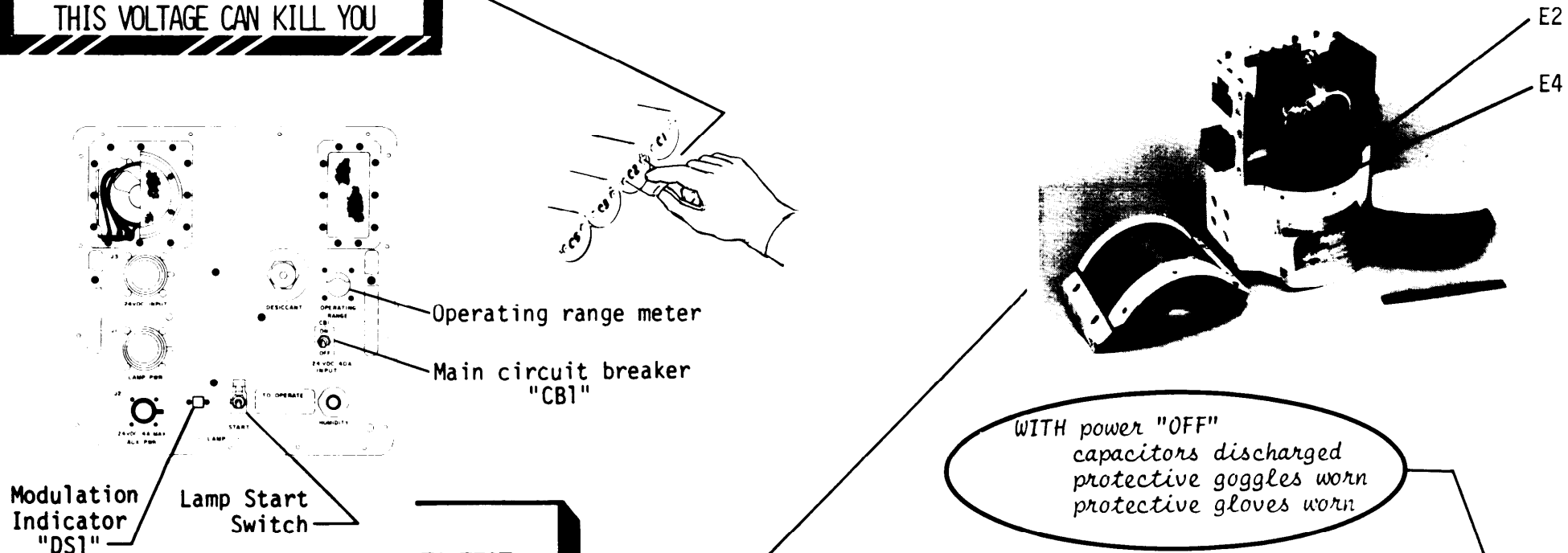
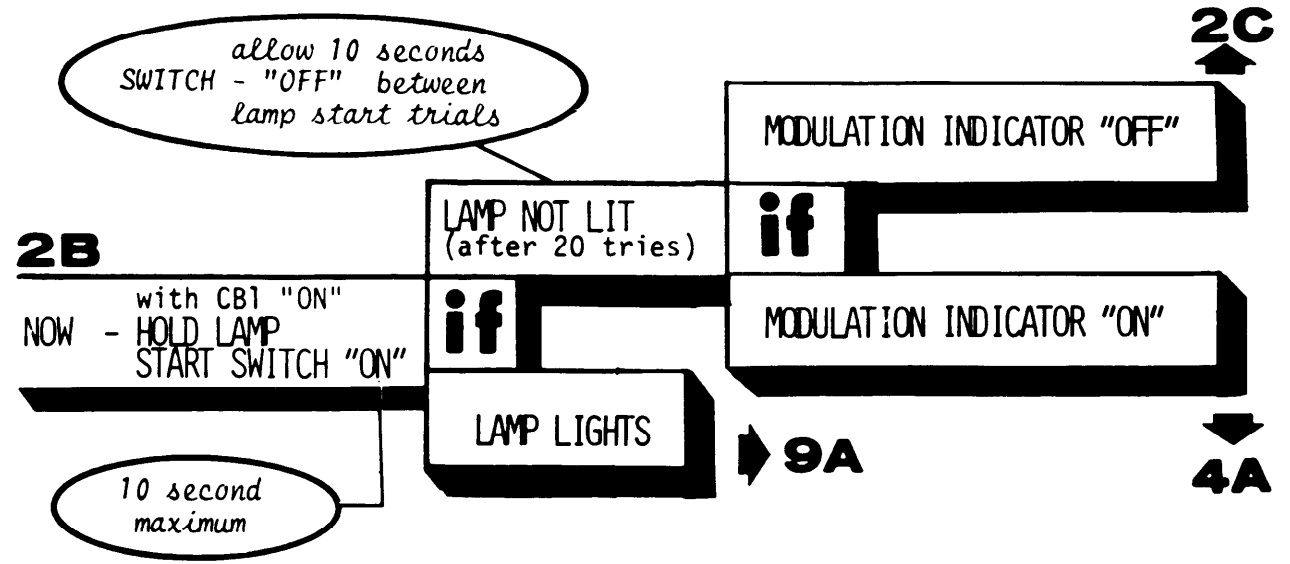
DO NOT LOOK AT LAMP DIRECTLY  
(WITHOUT PROTECTIVE GOGGLES)

LEAVE LENS GUARD IN PLACE  
BELOW SURROUNDING TEMPERATURES  
OF 86°F/30°C

ALWAYS WEAR PROTECTIVE GOGGLES  
NEAR TARGET SOURCE - IF LENS  
GUARD IS NOT IN PLACE

NEVER TOUCH LAMP BULB ANODE  
LEAD - UNLESS ALL POWER IS "OFF"  
-- AND CAPACITORS C1 C2 C3 C5  
ARE FIRST DISCHARGED THROUGH AN  
APPROX. 100 OHM/2 WATT RESISTOR

**THIS VOLTAGE CAN KILL YOU**



**2A**

WITH ONE END OF ALL DIODES  
STILL DISCONNECTED

TEST FOR SHORTS-TO-GROUND from +side of C7,C9,C12  
from -side of C8,C10  
from J2-B(front panel) to ground

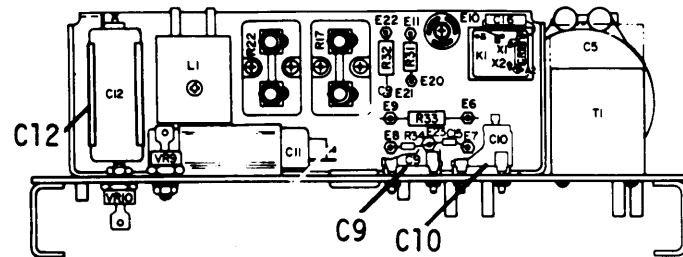
REPAIR shorts to ground

DO NOT TRY POWER "ON"

RECONNECT ALL DIODE WIRES

REMOVE LEADS from Q9 & Q10 (emitter & base)

▶ **1B**



CHECK CABLE CONNECTOR WIP2 AT TS

prepare to SAFELY OBSERVE voltages and high voltage sparking in the Target Source

TURN "ON" CBI

USE WIP2 CABLE AT TS for checking voltages  
on High Voltage Power Supply  
MONITOR VOLTAGE (with voltmeter)  
Pin 4 to Pin 8 +400±80V  
Pin 3 to Pin 8 +26±2V  
WHILE HOLDING LAMP START SWITCH "ON"

**if**

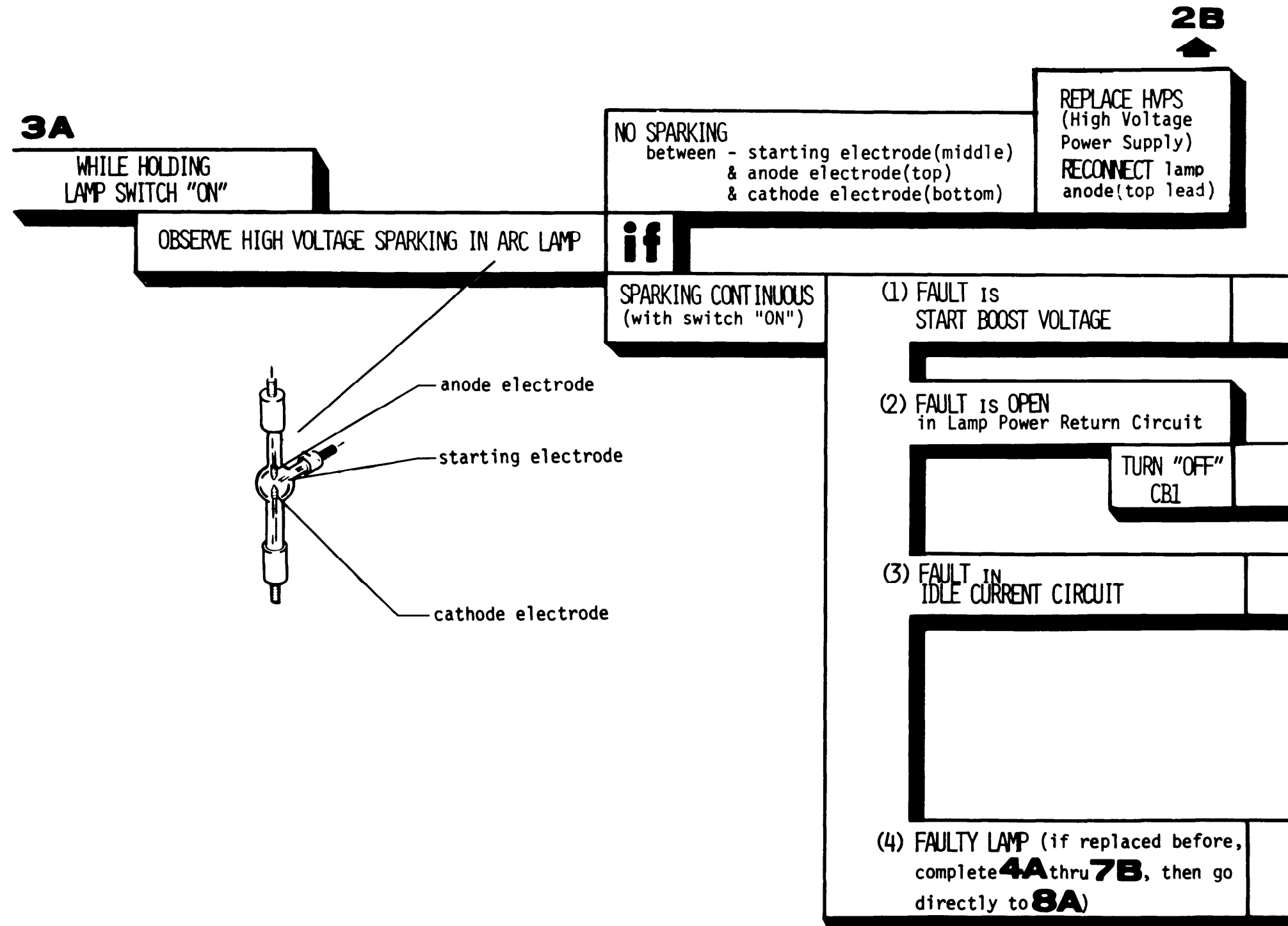
EITHER BOTH INCORRECT

TROUBLESHOOT PSM

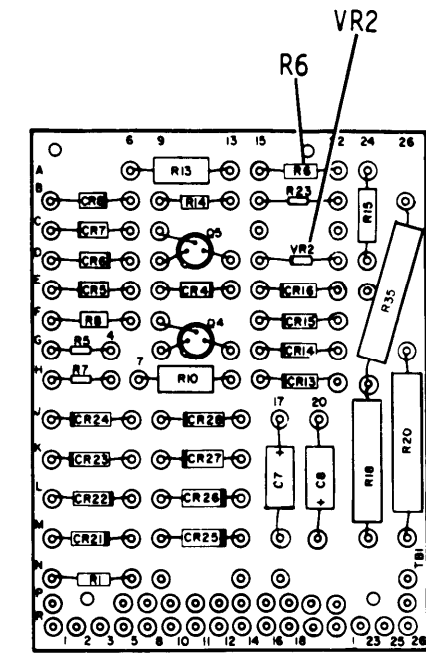
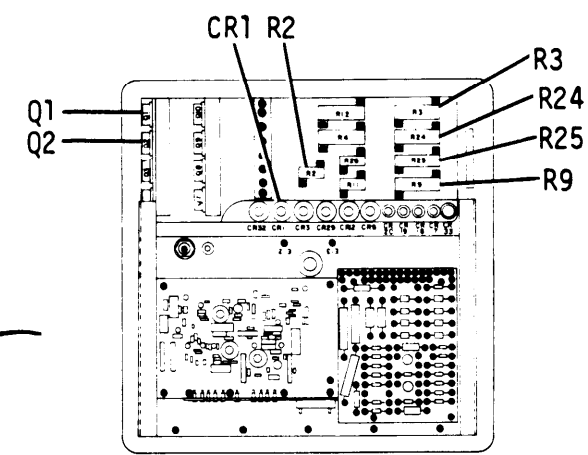
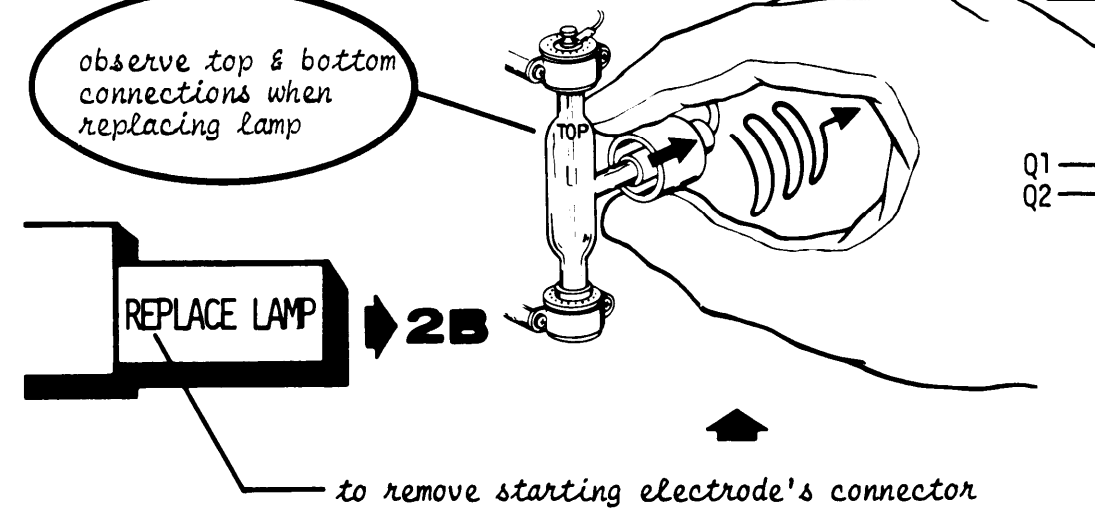
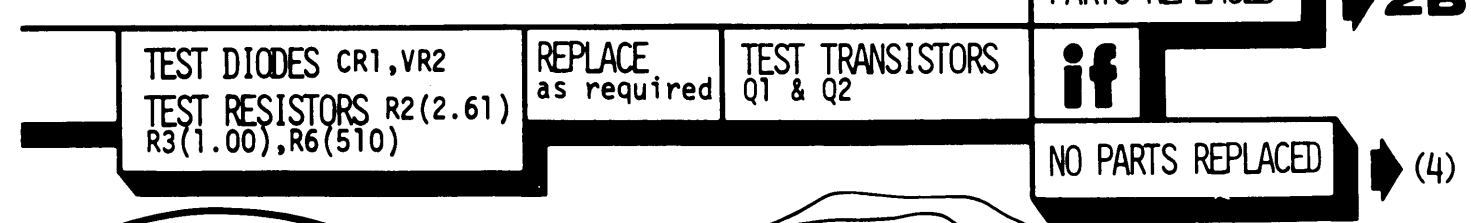
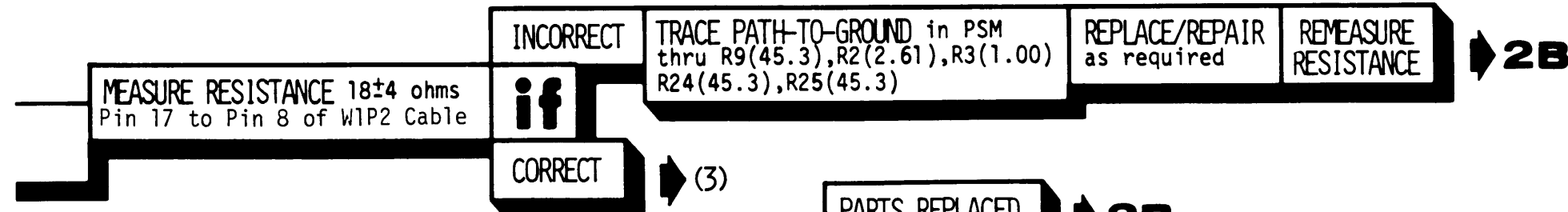
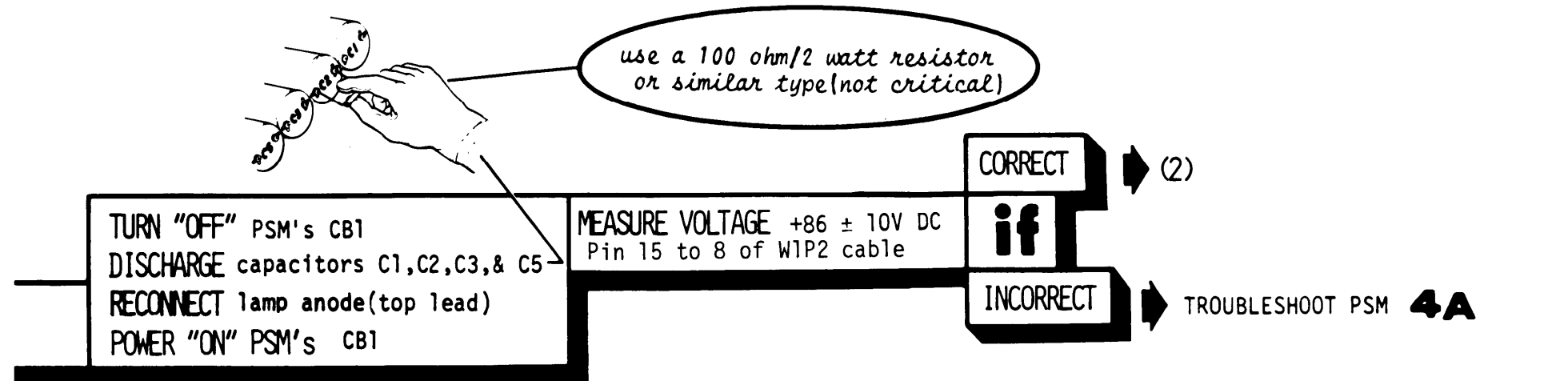
BOTH VOLTAGES CORRECT

▶ **3A**

▲ **4A**



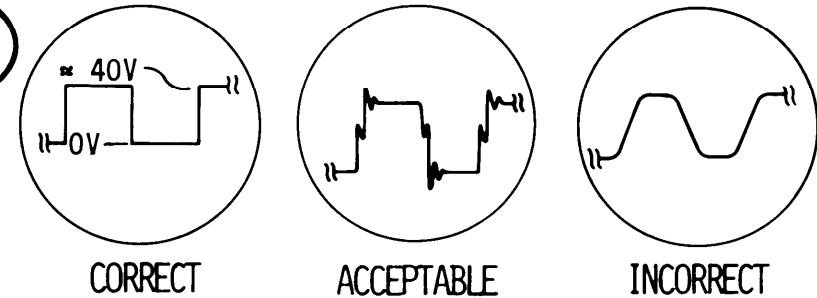




**TROUBLESHOOTING THE PSM**

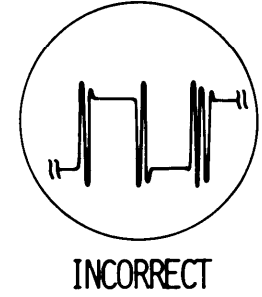
**4A** TEST DC-TO-DC CONVERTER OPERATION  
 FIRST - DISCONNECT CABLES  
 from J1 to Target Source  
 from P1 on PCA Card  
 OBSERVE WAVE-FORMS  
 on case of Q9 & Q10

using  
 Tektronix type 422  
 scope or equivalent  
 with compensated probe

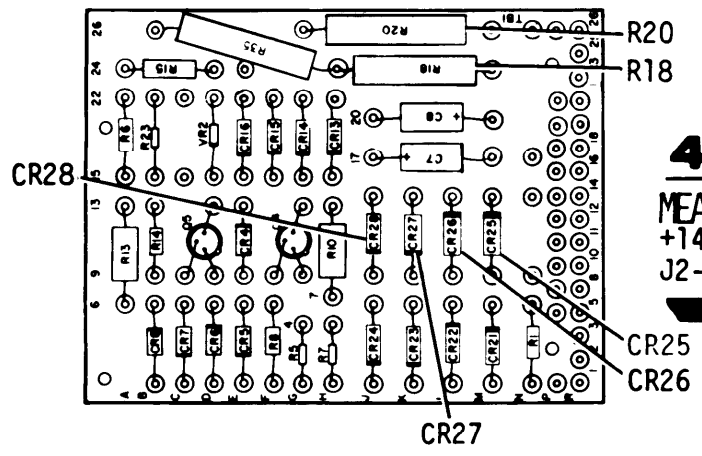
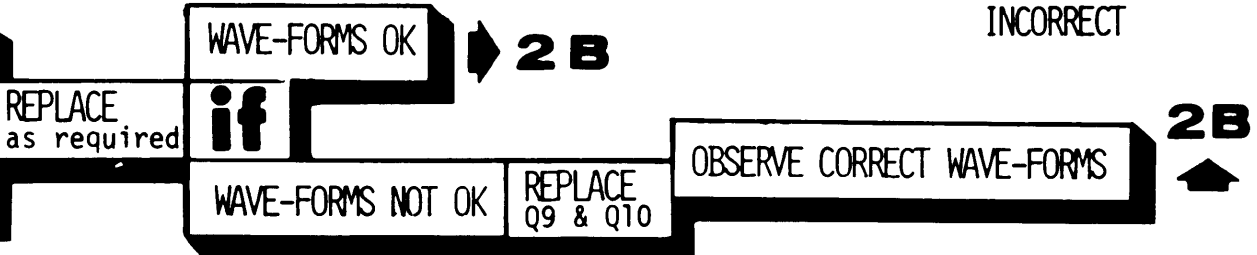


TO TEST A DIODE CR\_ OR VR\_ - (use an ohm meter Rx10 -or nearest- scale)  
 (disconnect one end) MEASURE high resistance(meter +lead-to-diode cathode)  
 MEASURE low resistance(meter +lead-to-diode anode)

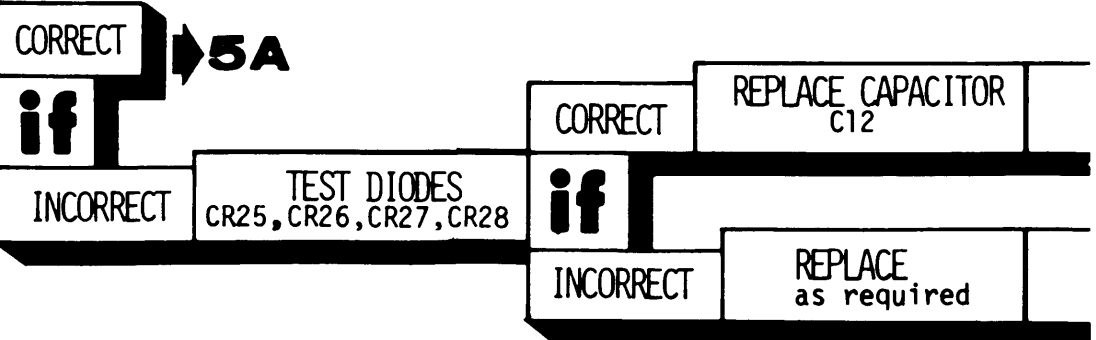
TO TEST A RESISTOR R\_( ), - MEASURE specified( ) resistance  
 (disconnect one end) (using an ohm meter)

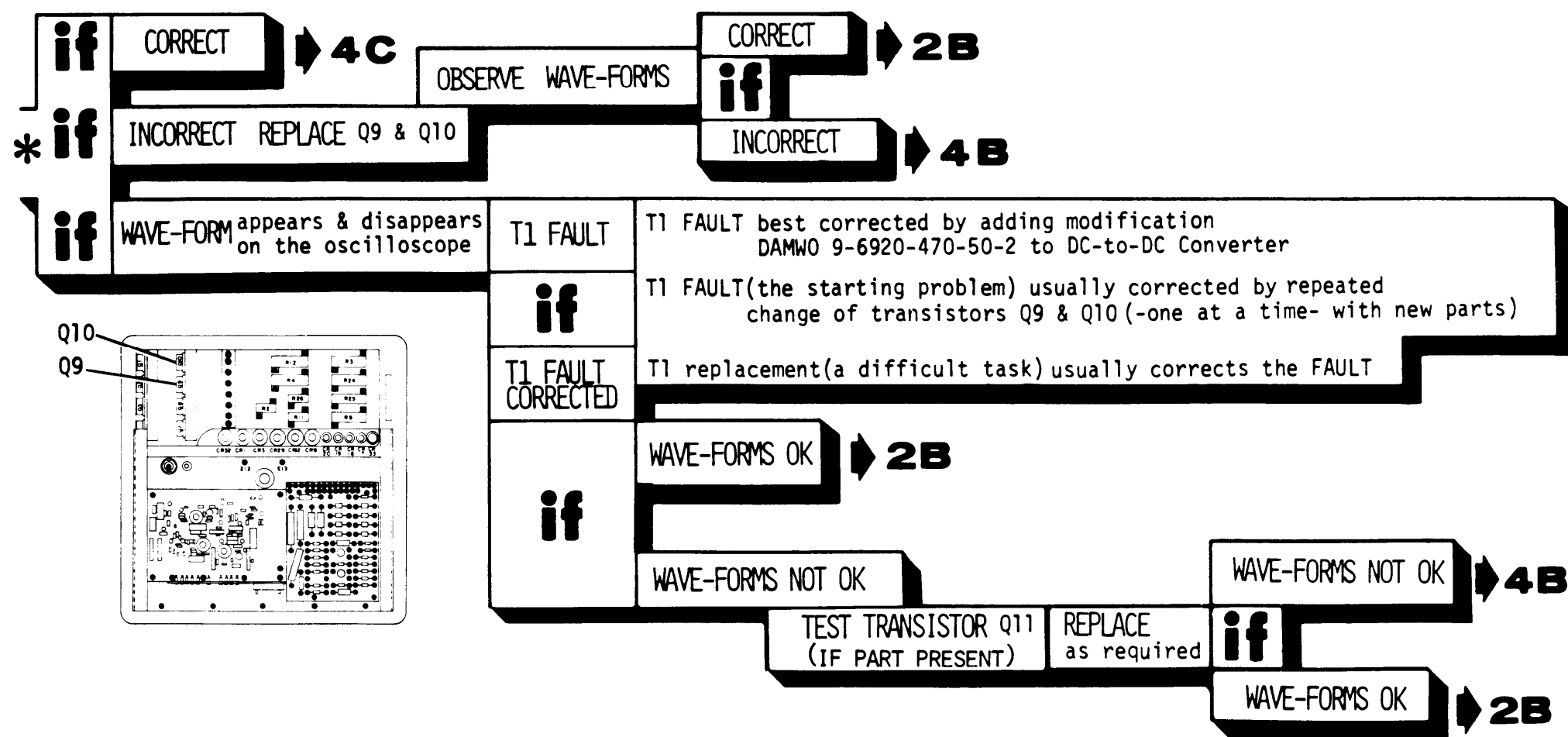


**4B** TEST DIODE CR33  
 (if part present)  
 TEST RESISTORS R18(2),  
 R19(510),R20(200),R21(75)  
 R35(2) if part present



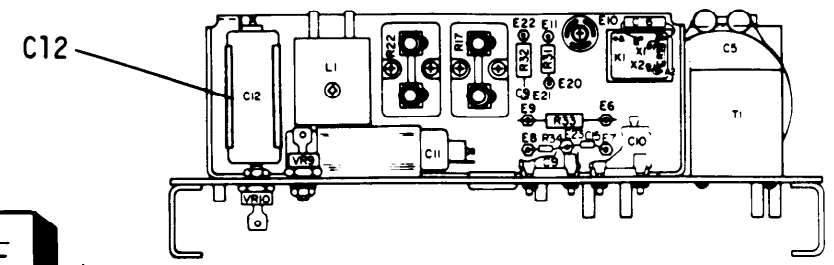
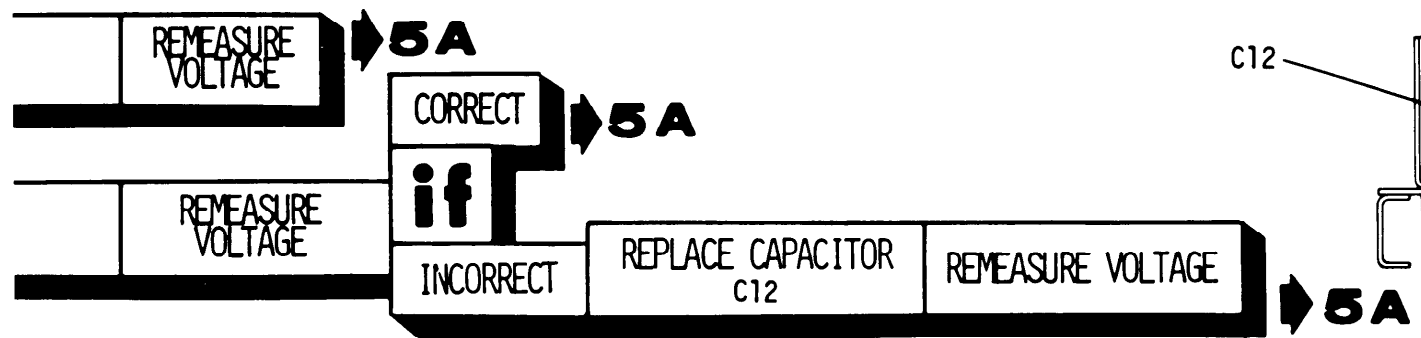
**4C** MEASURE VOLTAGE  
 +145±45V,  
 J2-M to ground

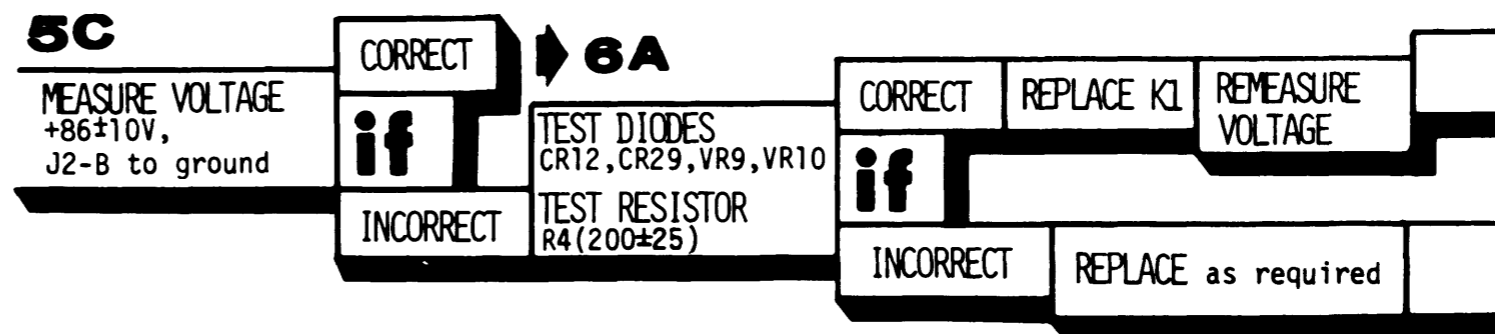
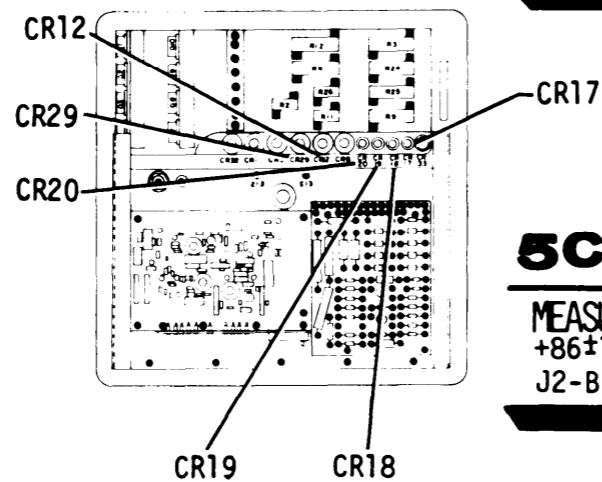
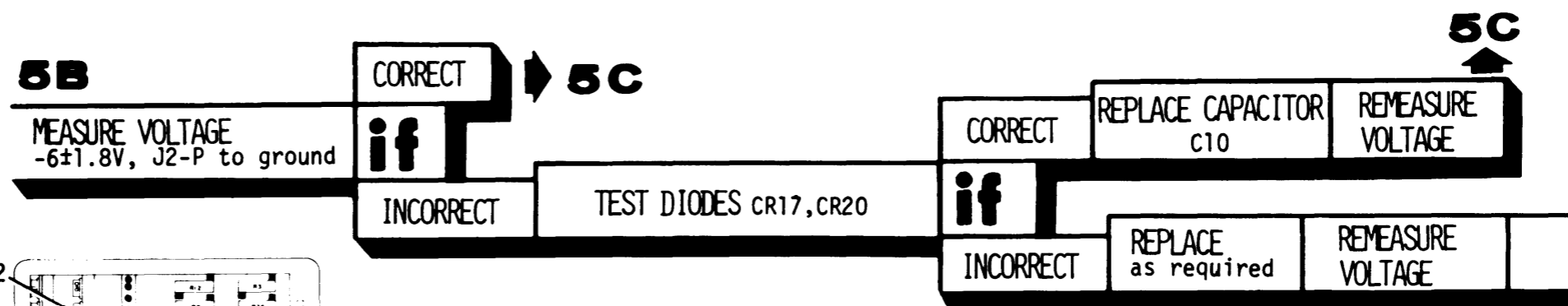
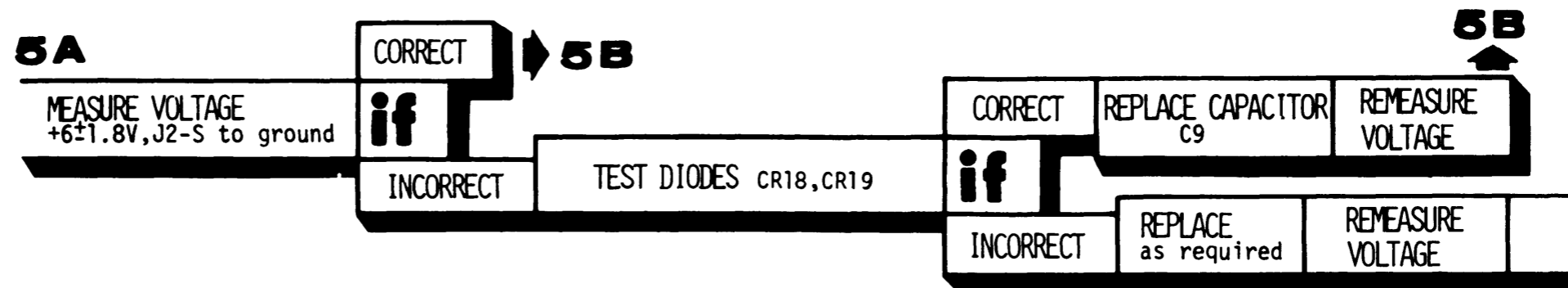


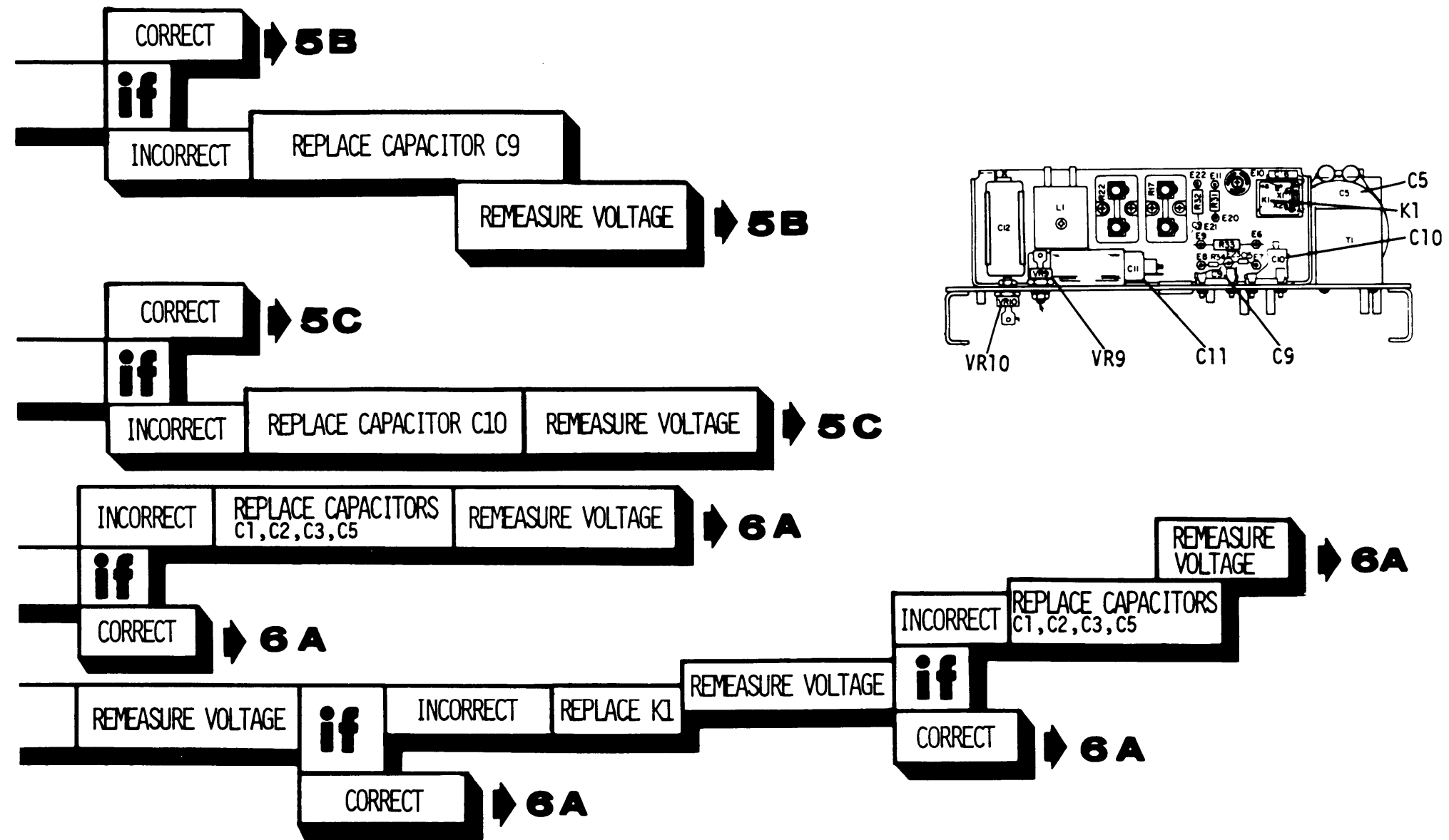


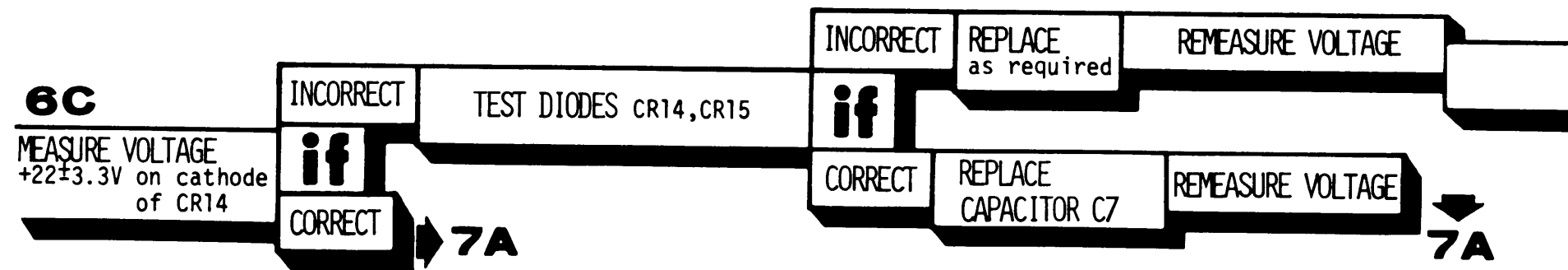
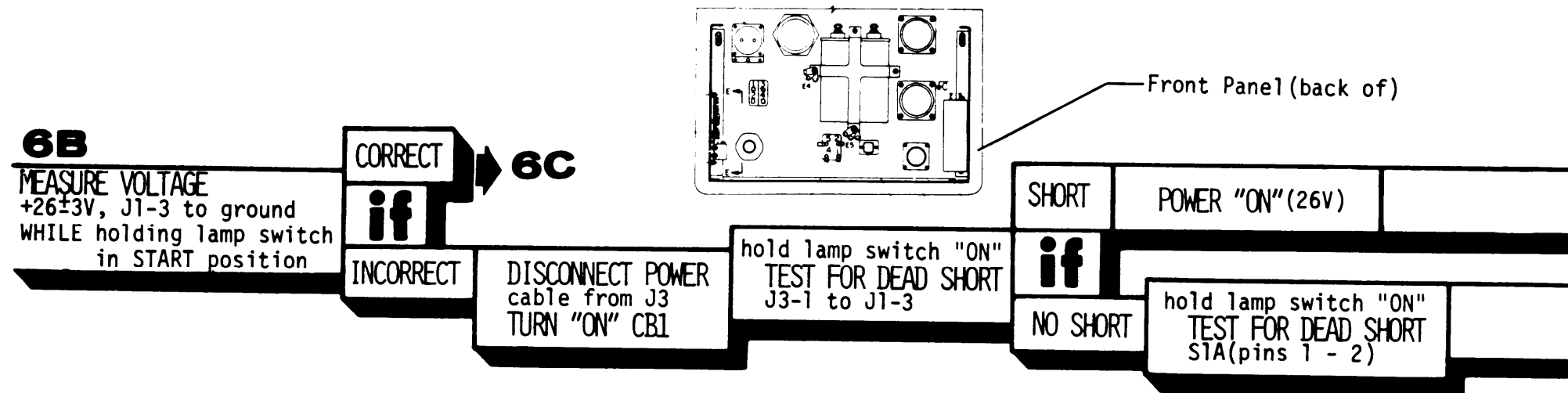
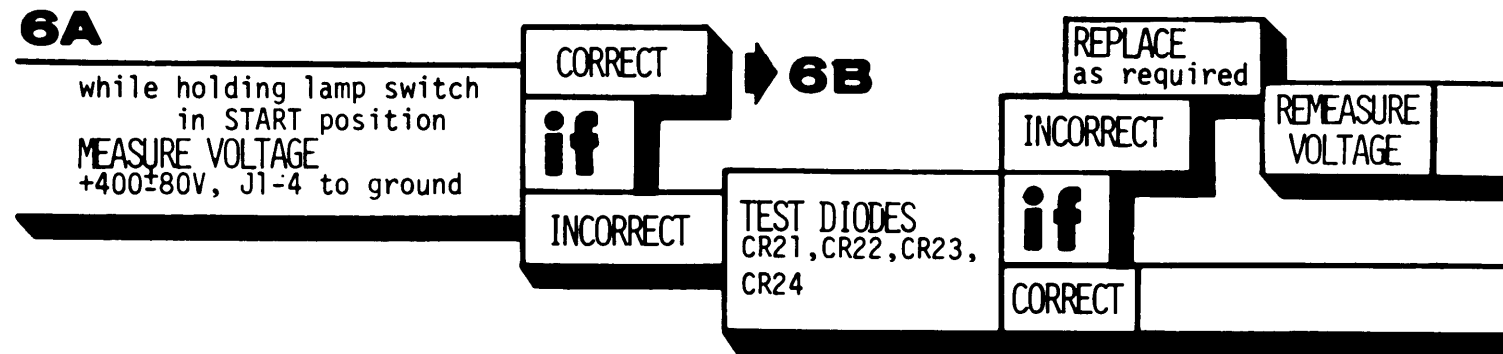
T1 FAULTY - if voltage measurements at steps 4C, 5A, 5B, 6A, 6C, 7A and 9B remain incorrect after testing (and replacing) the called out components, T1 is faulty. Replace T1 and remeasure the voltages.

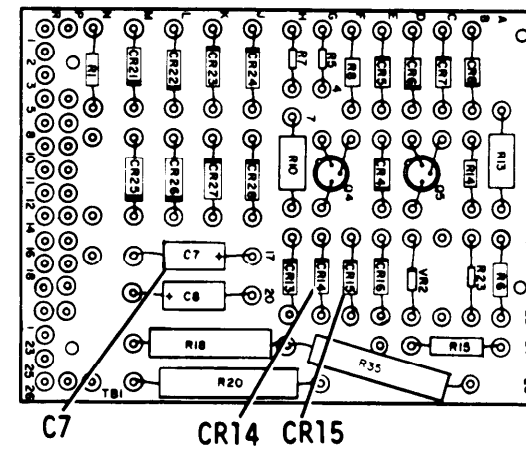
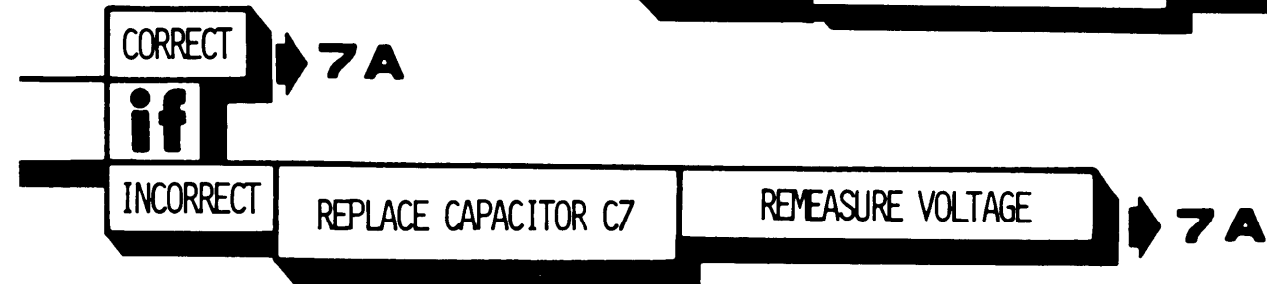
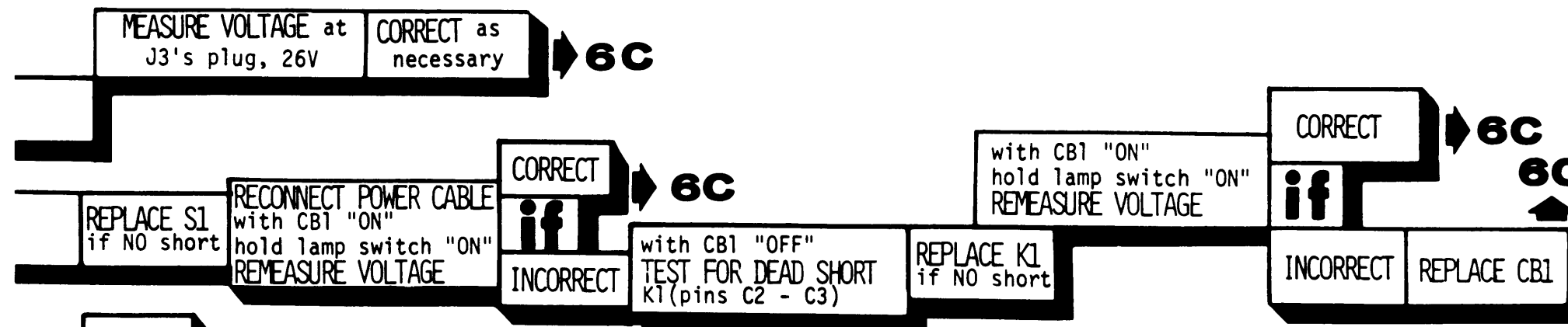
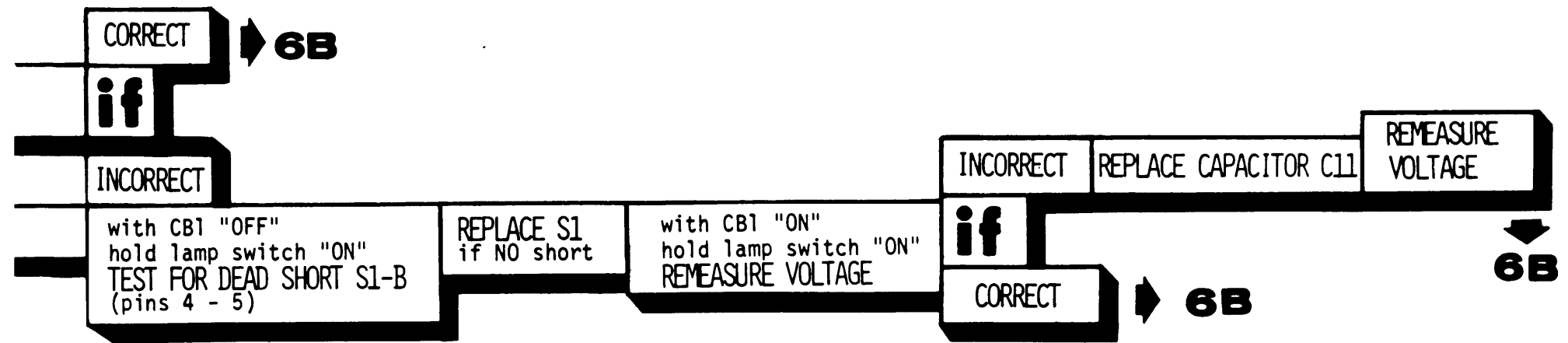
TO TEST A CAPACITOR C<sub>12</sub> - SUBSTITUTE a new part (disconnect one end) & REMEASURE required voltage

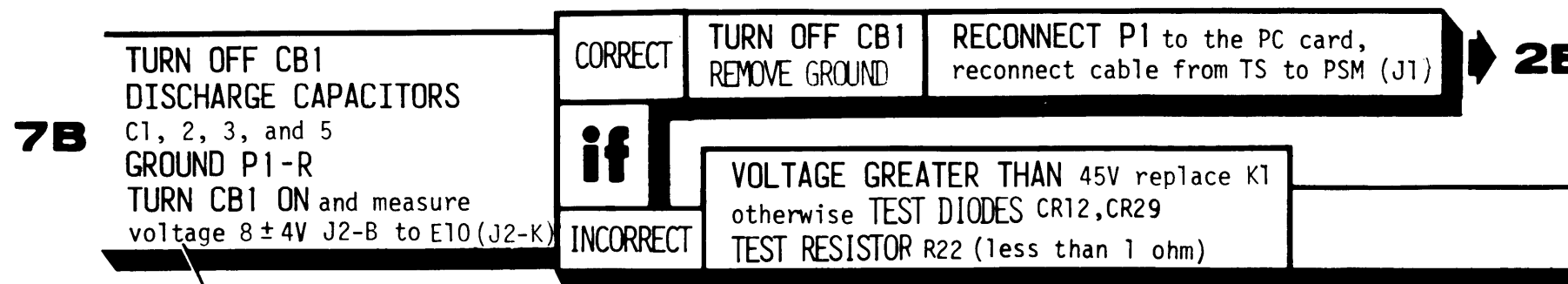
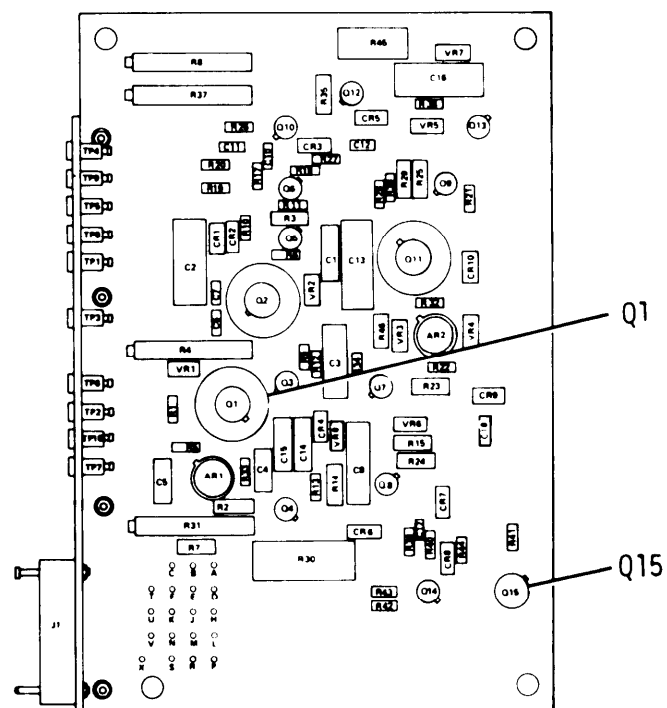
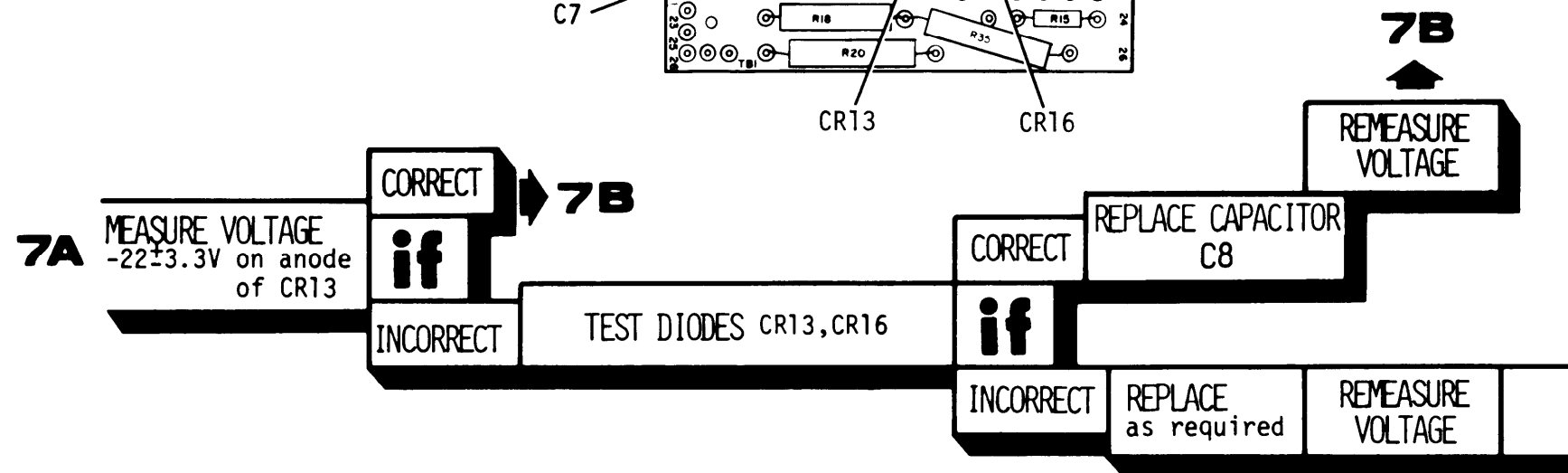
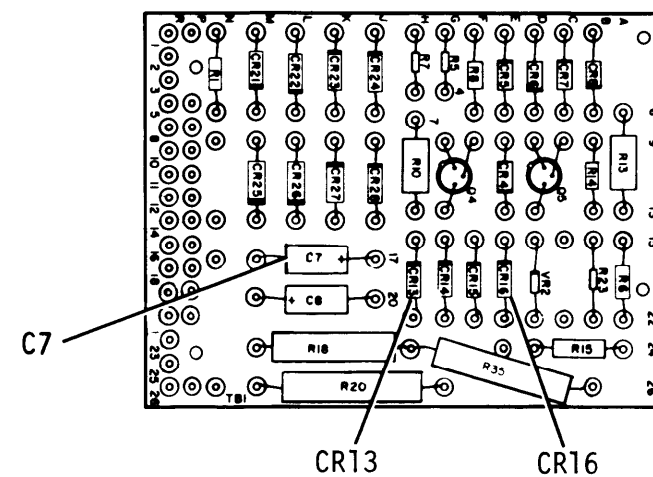




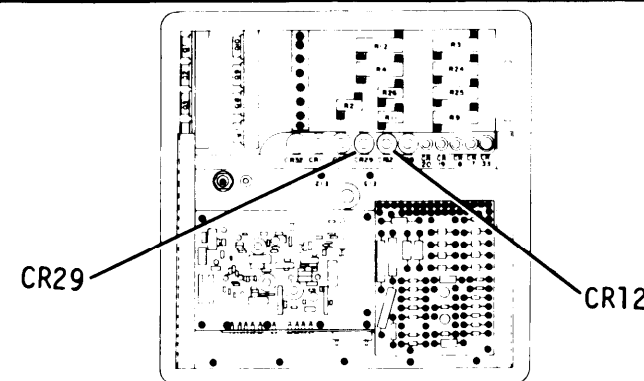




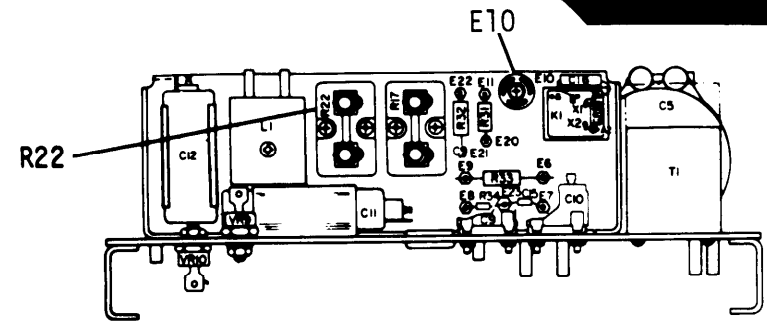
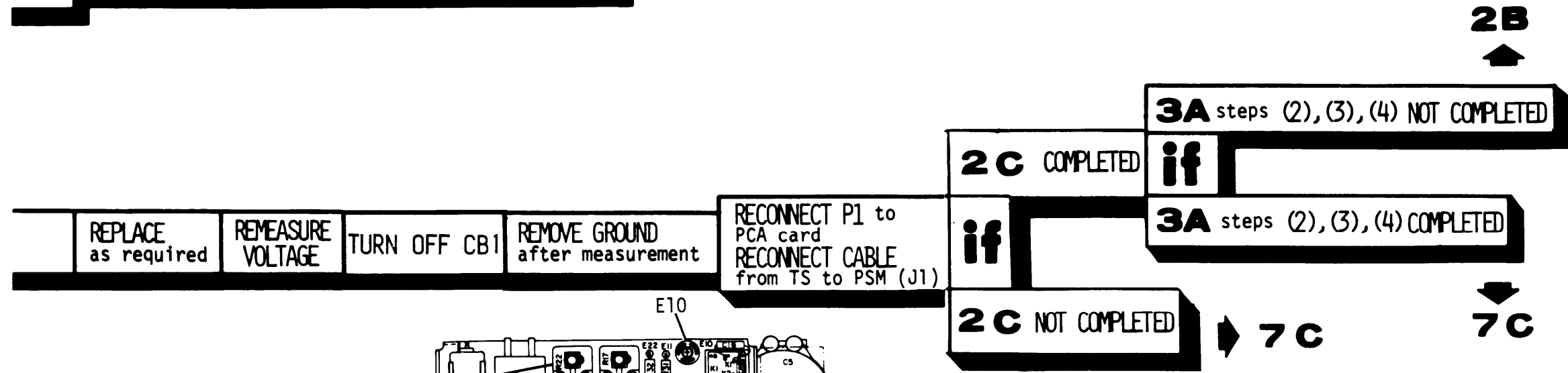
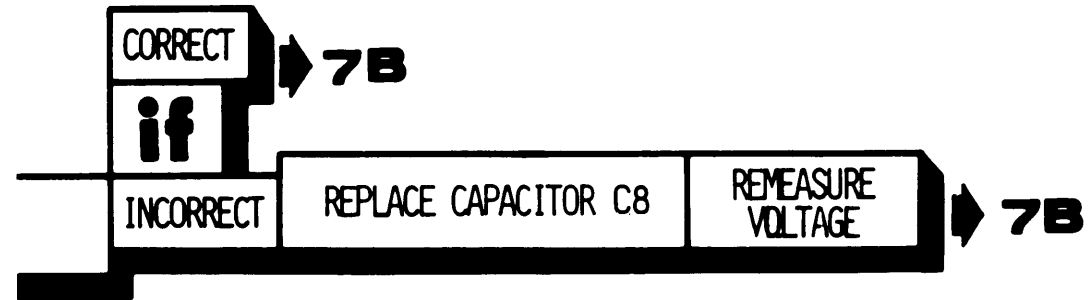
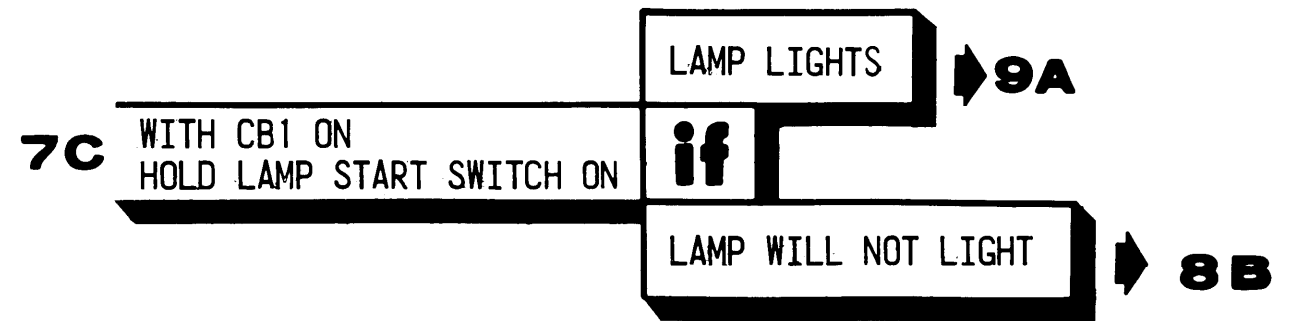


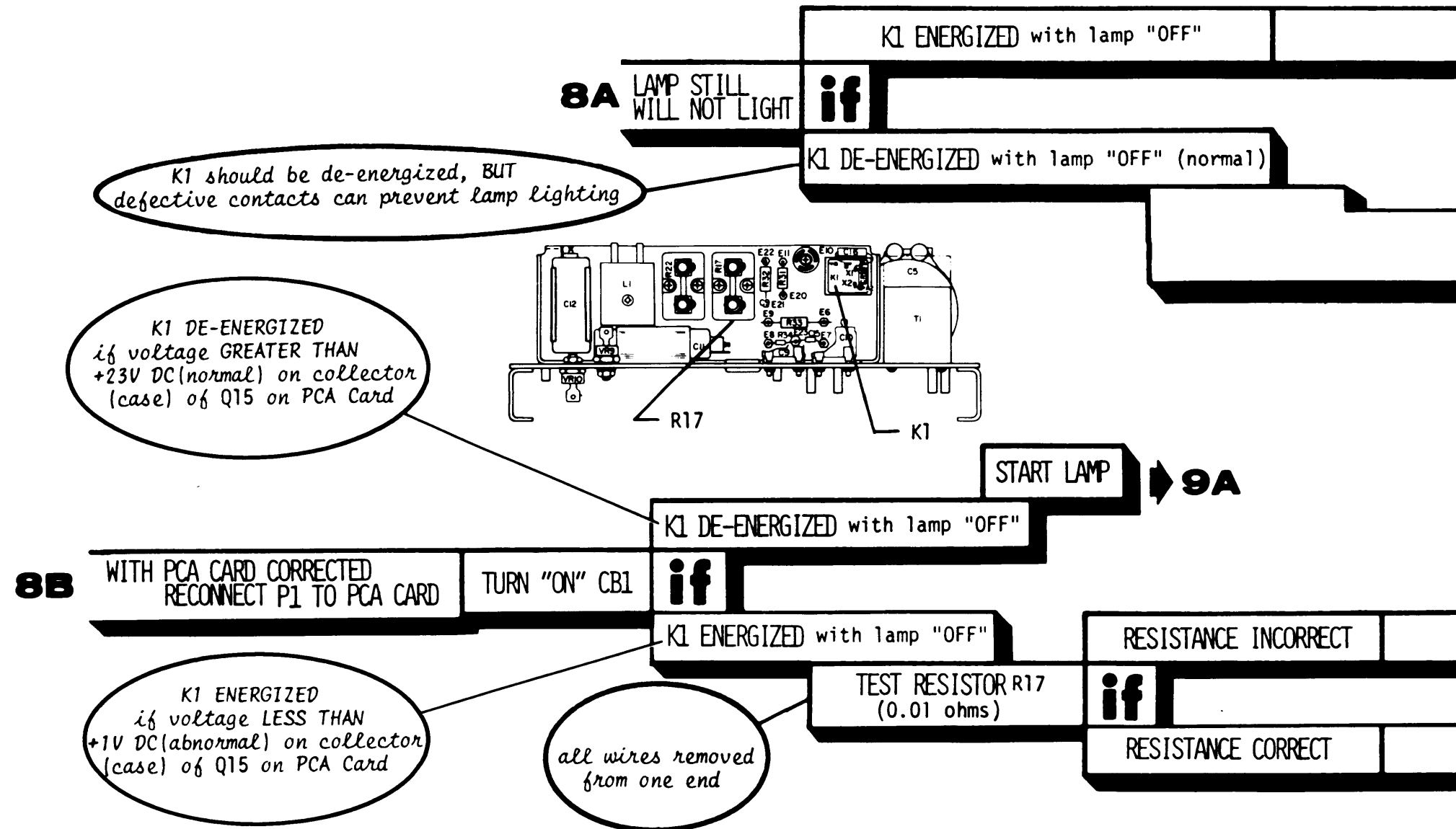


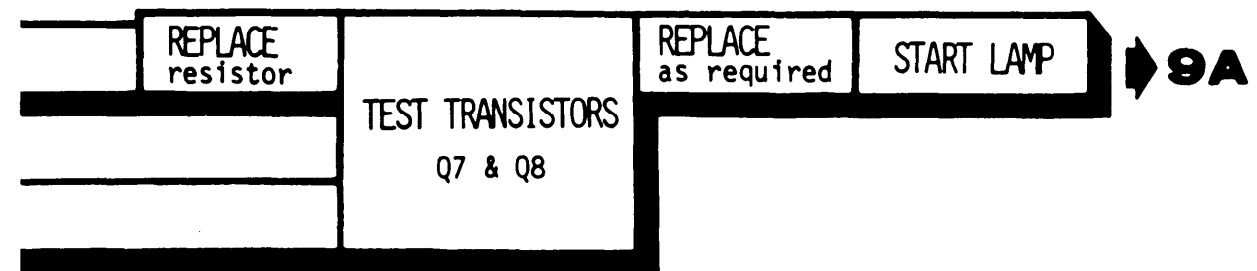
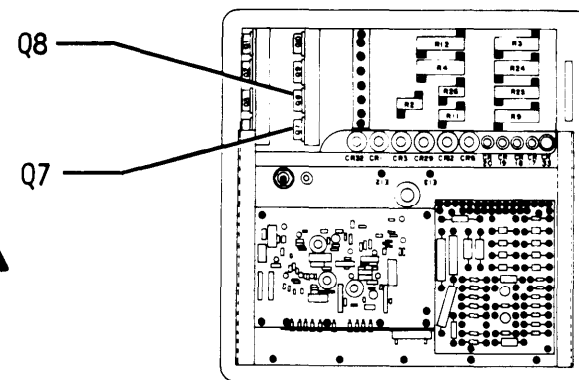
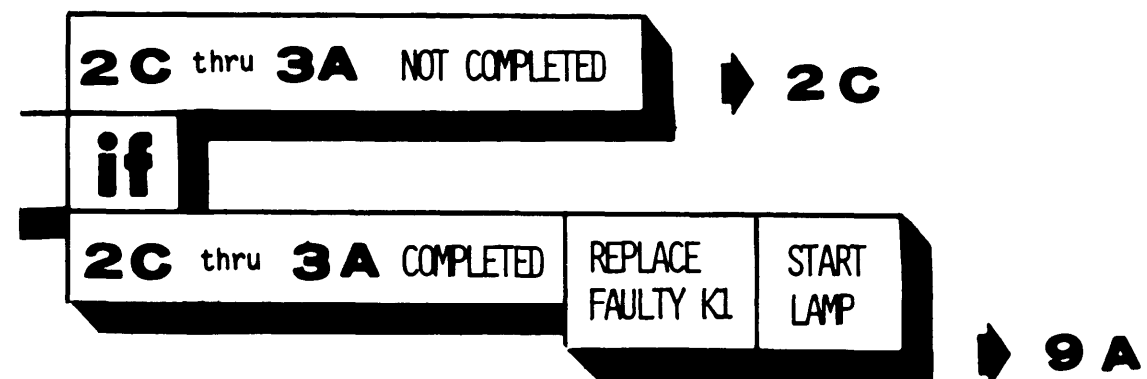
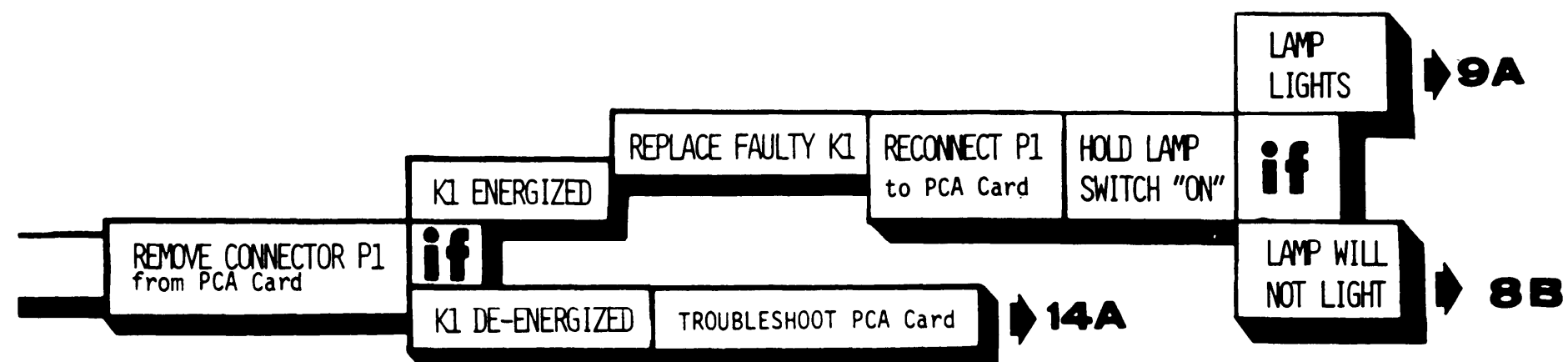
NOTE Voltage will continue to increase to ≈60V because of a no load condition. Take reading immediately after turning CB1 on.

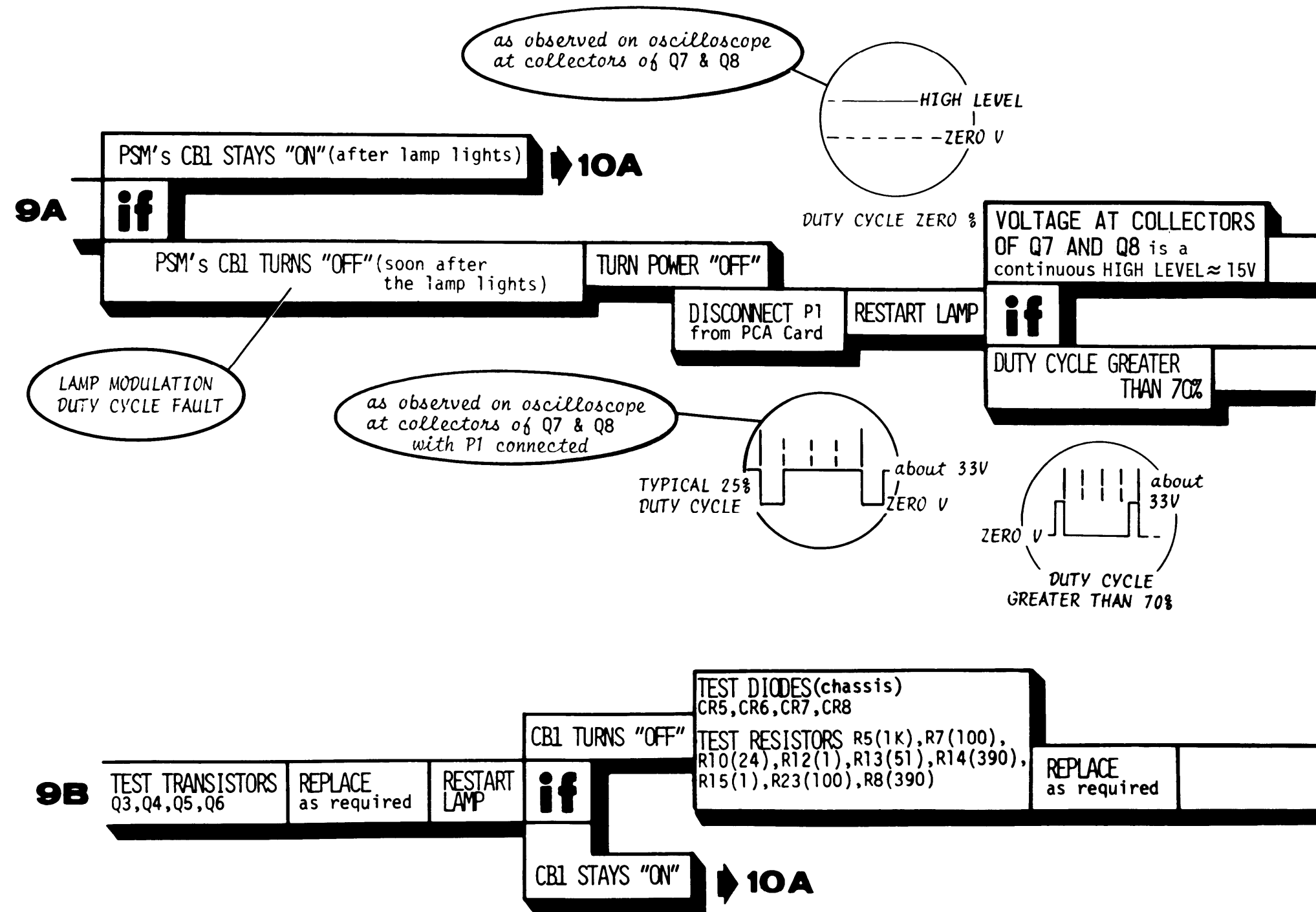


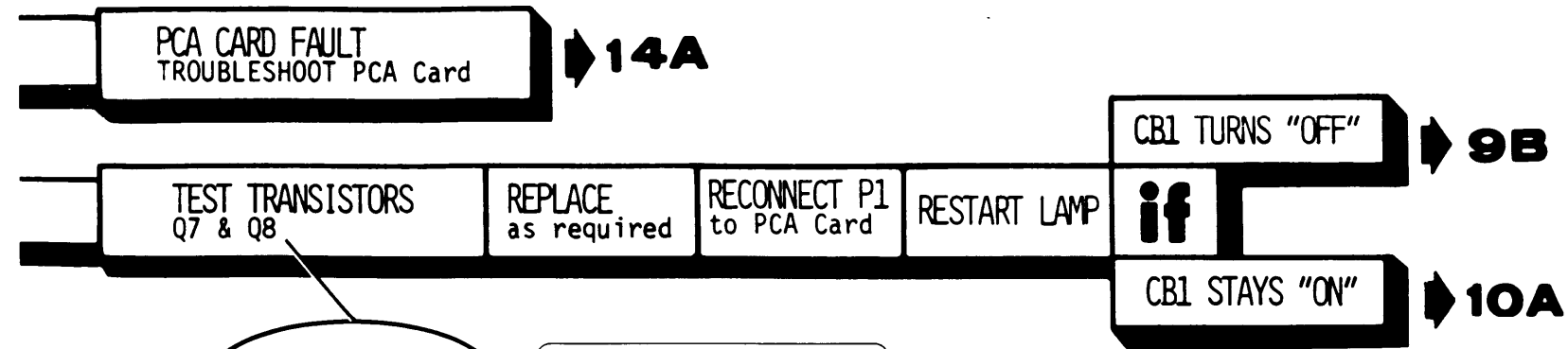




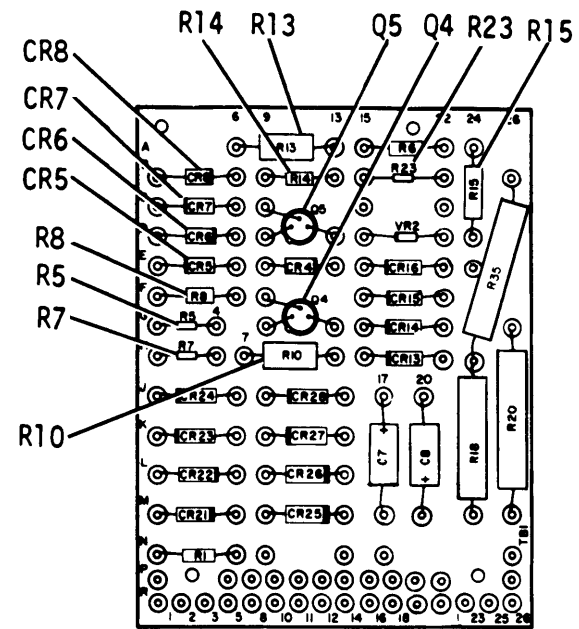
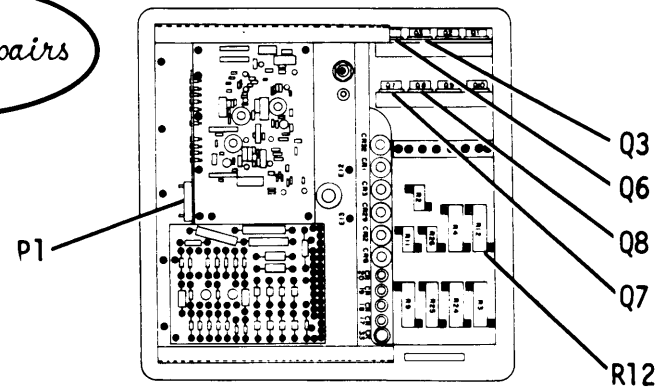


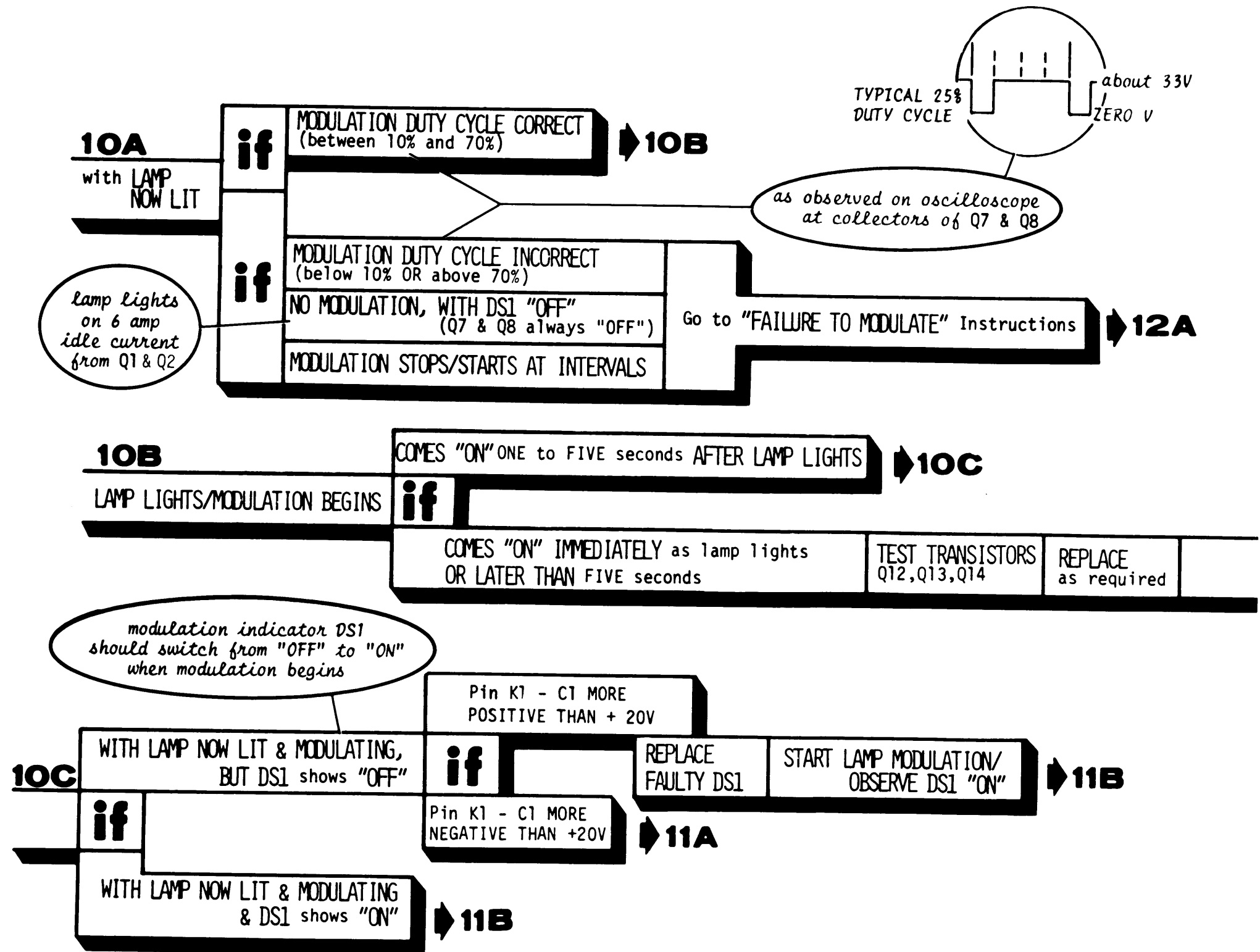


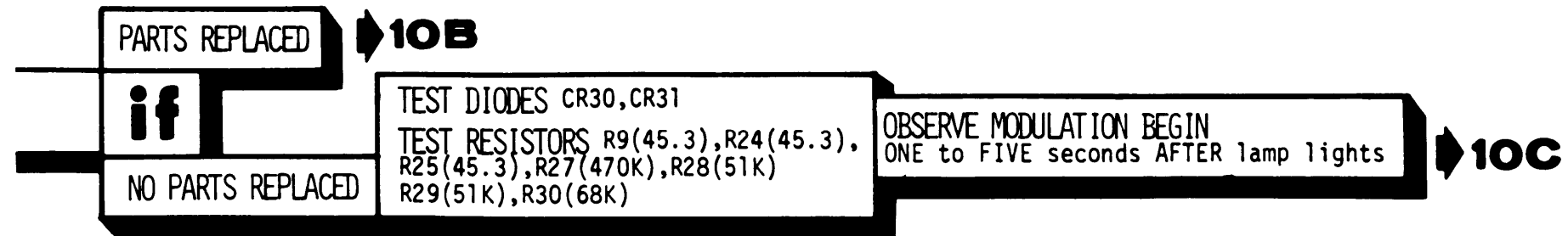
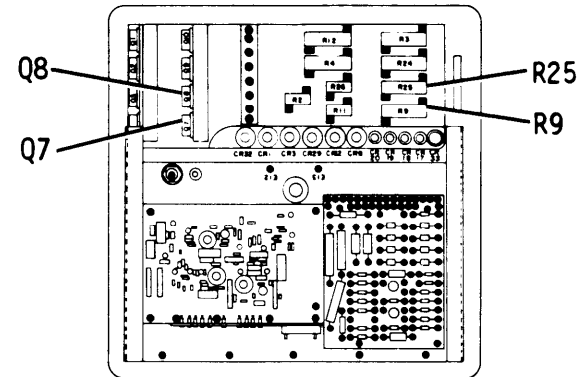
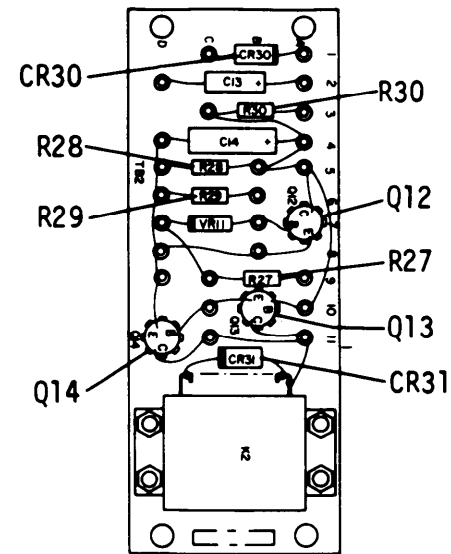


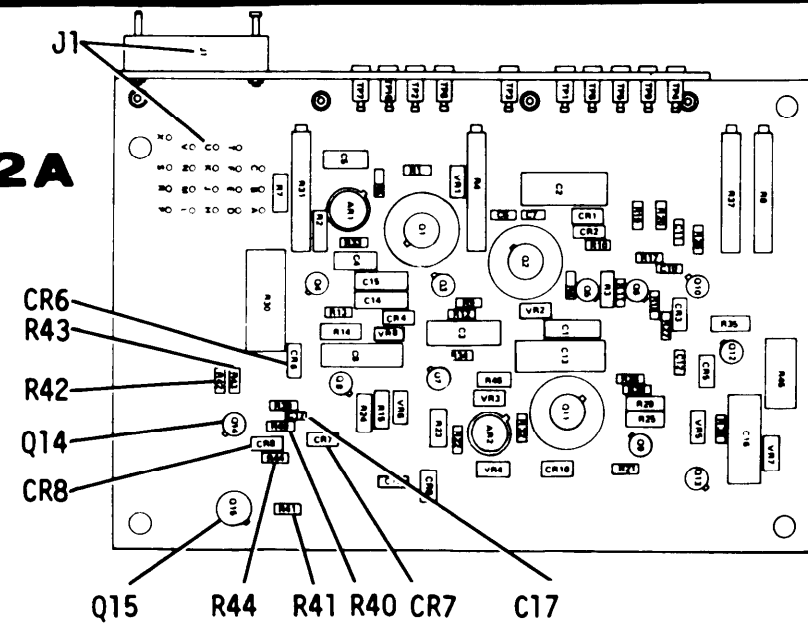
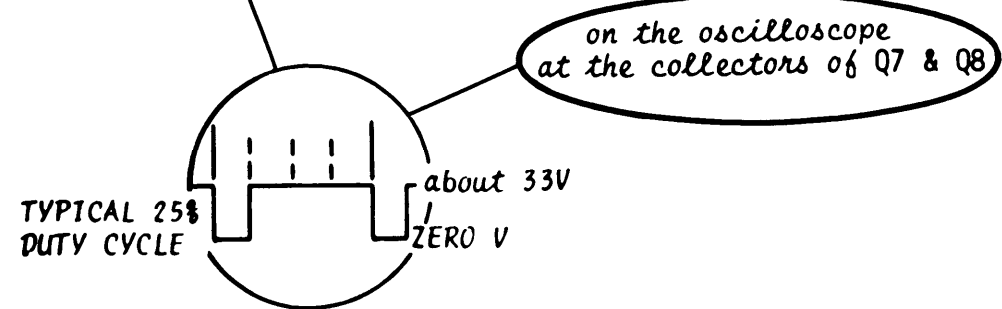
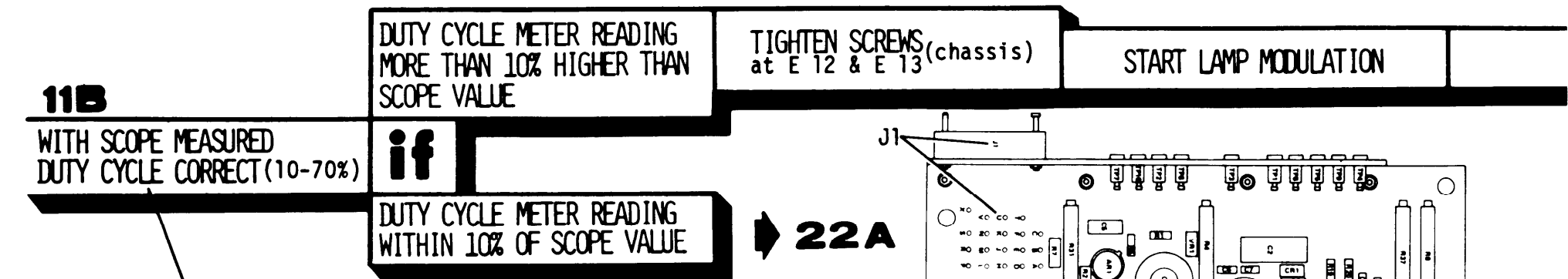
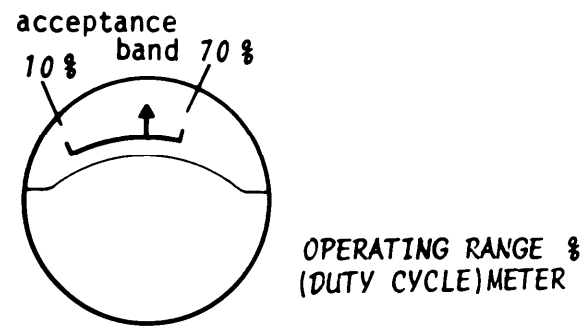
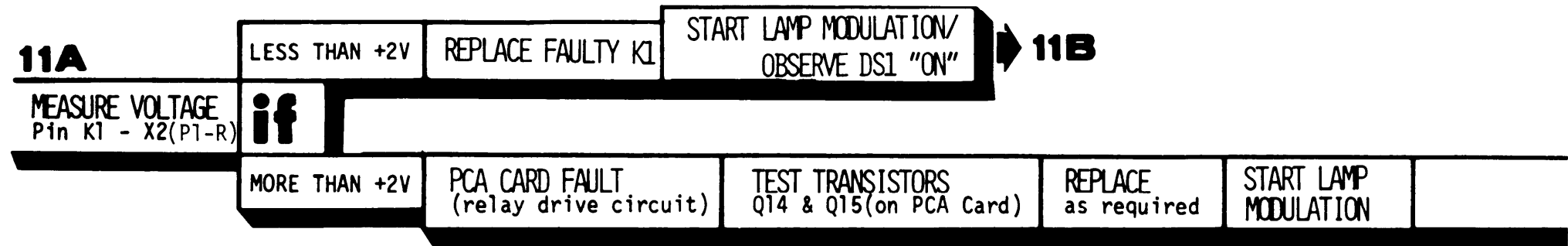


Replace in pairs

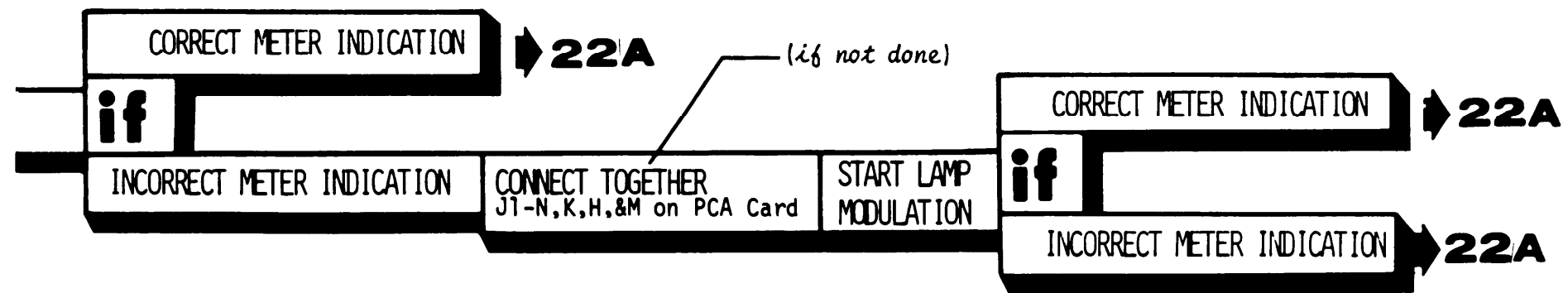
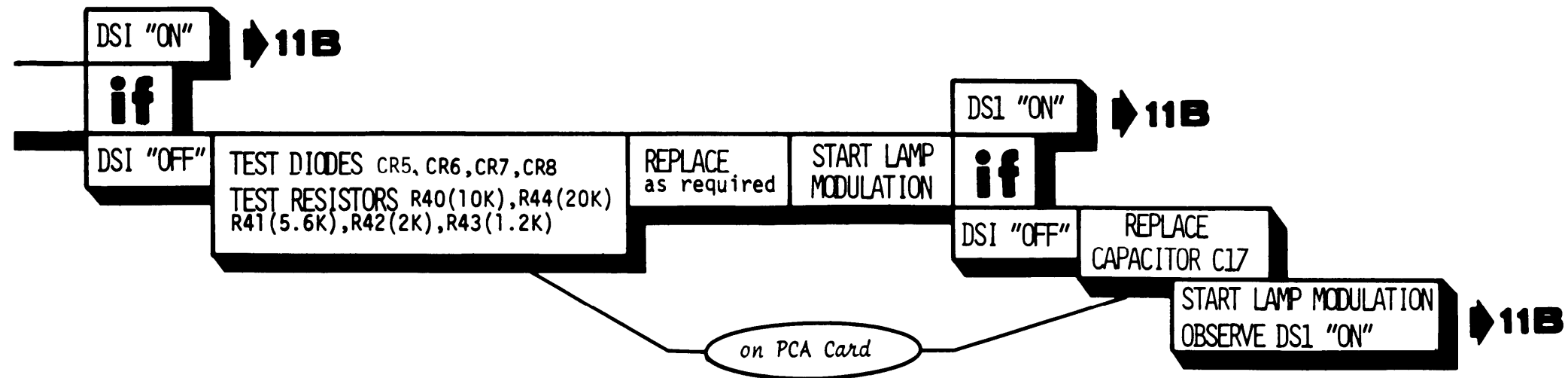












*Duty Cycle circuitry requires depot repair  
Unit may be used with meter reading incorrectly -as long as-  
scope-measured duty cycle is between 10% - 70%*

**12A**

DISCONNECT LEADS (base & emitter) of transistors Q7 & Q8 from chassis terminals

TO TEST A TRANSISTOR Q<sub>7</sub> - compare resistance readings to a new part  
 (±20% variation between parts is normal)  
 (base-to-emitter/both directions)  
 (base-to-collector/both directions)  
 (collector-to-emitter/both directions)  
 (used power transistors may have less resistance, collector-to-emitter)

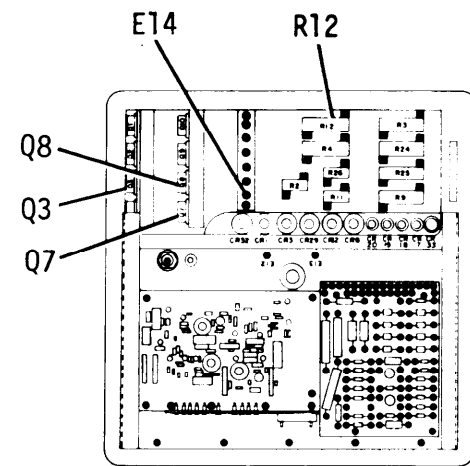
TEST TRANSISTORS Q7 & Q8

REPLACE as required DISCONNECT P1 from PCA Card

GROUND ANODE of CR5 on chassis TURN "ON" CB1

MEASURE VOLTAGE -6V±3V at E 14 (R12 - R15 junction)

DO NOT reconnect leads of Q7 & Q8 at this time

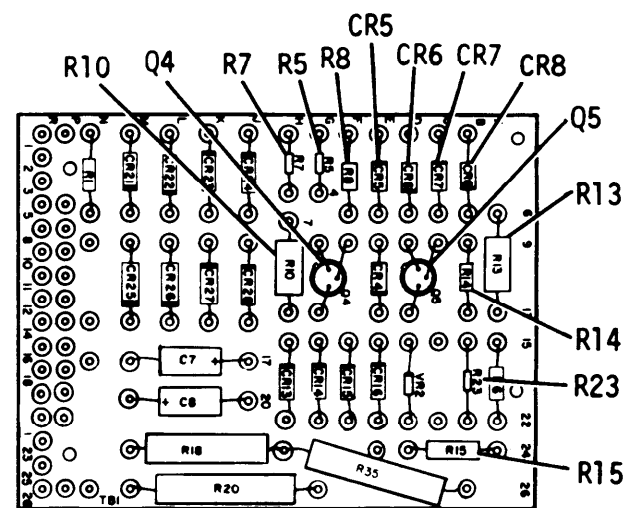


**12B**

REMOVE CR5 GROUND

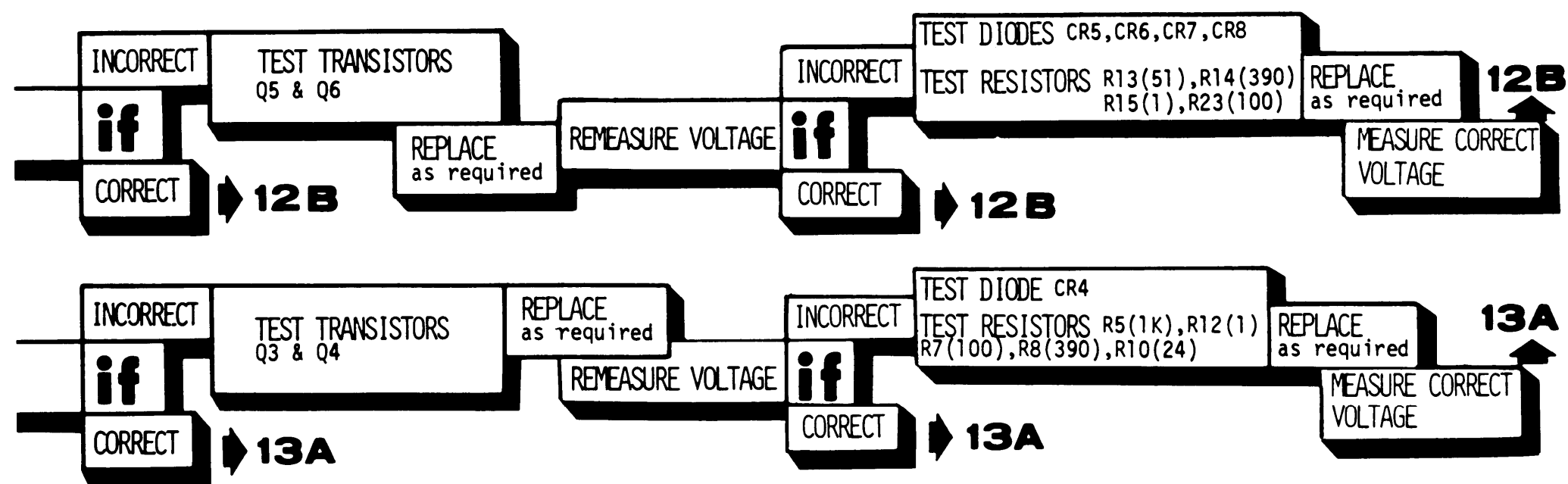
CONNECT CR5 ANODE to J2-S

MEASURE VOLTAGE +6±3V at E 14 (R12 - R15 junction)

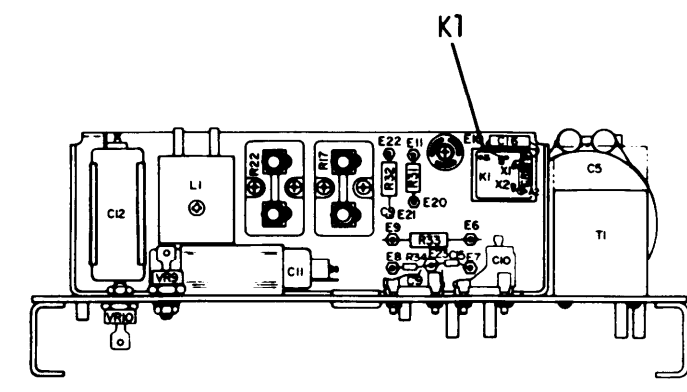
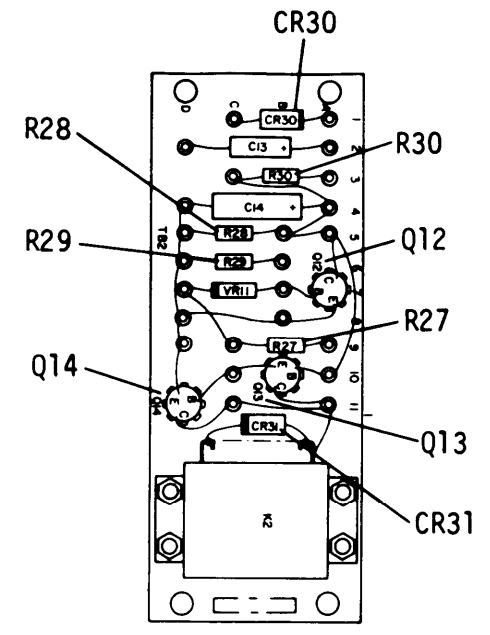
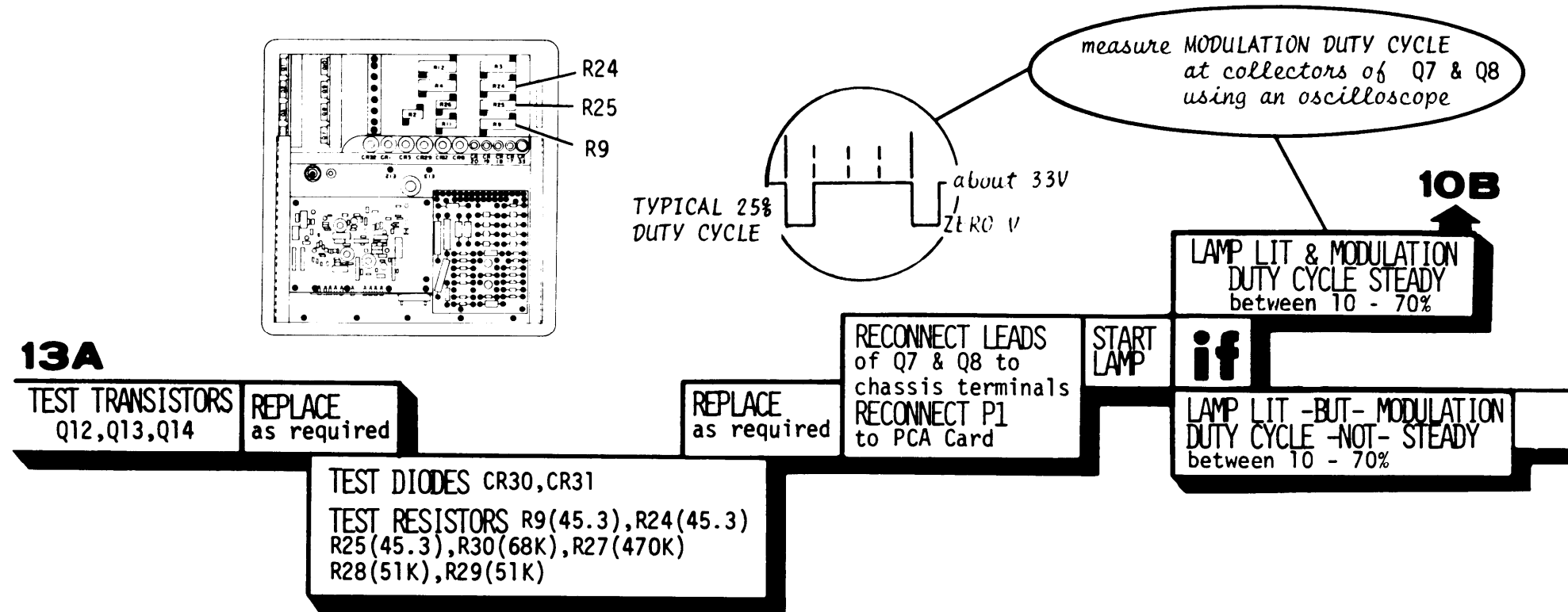


**LAMP – "FAILURE TO MODULATE" – INSTRUCTIONS**

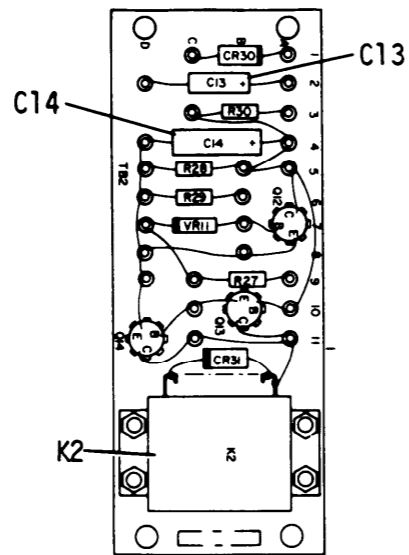
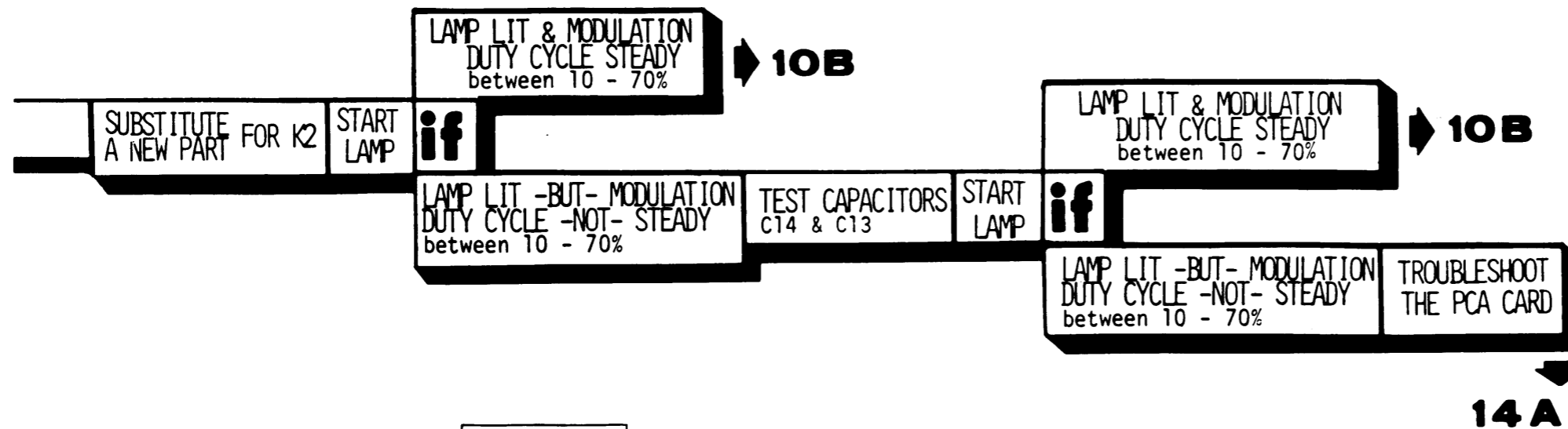
TO TEST A RESISTOR R(), - MEASURE specified() resistance  
 (disconnect one end) (using an ohm meter)



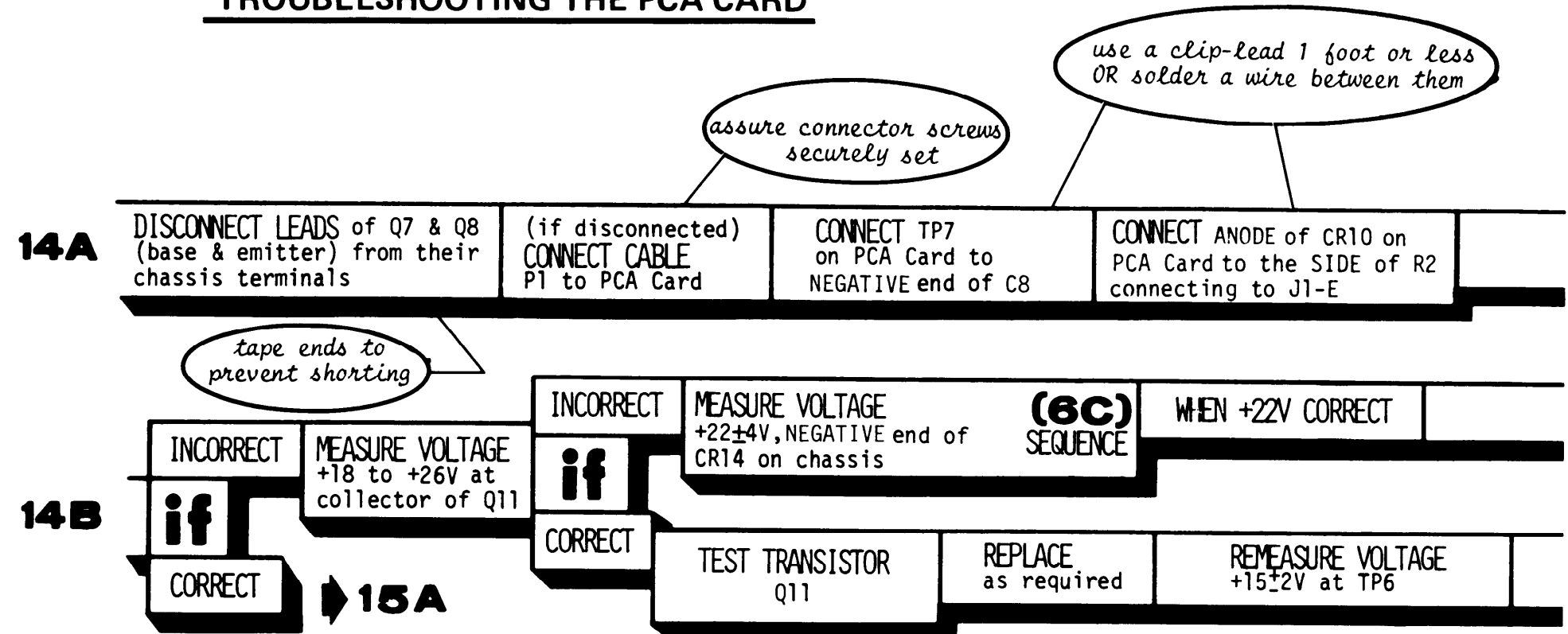
TO TEST A DIODE CR OR VR - (use an ohm meter Rx10 -or nearest- scale)  
 (disconnect one end) - MEASURE high resistance(meter +lead-to-diode cathode)  
 MEASURE low resistance(meter +lead-to-diode anode)



TO TEST A CAPACITOR C\_ - SUBSTITUTE a new part  
 (disconnect one end) & REMEASURE required voltage  
 OR repeat prior test

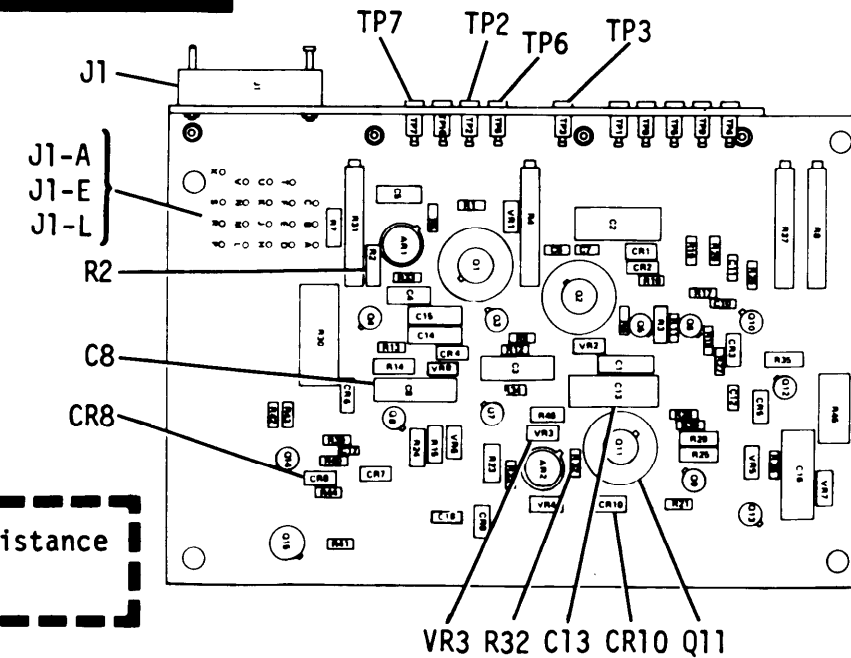


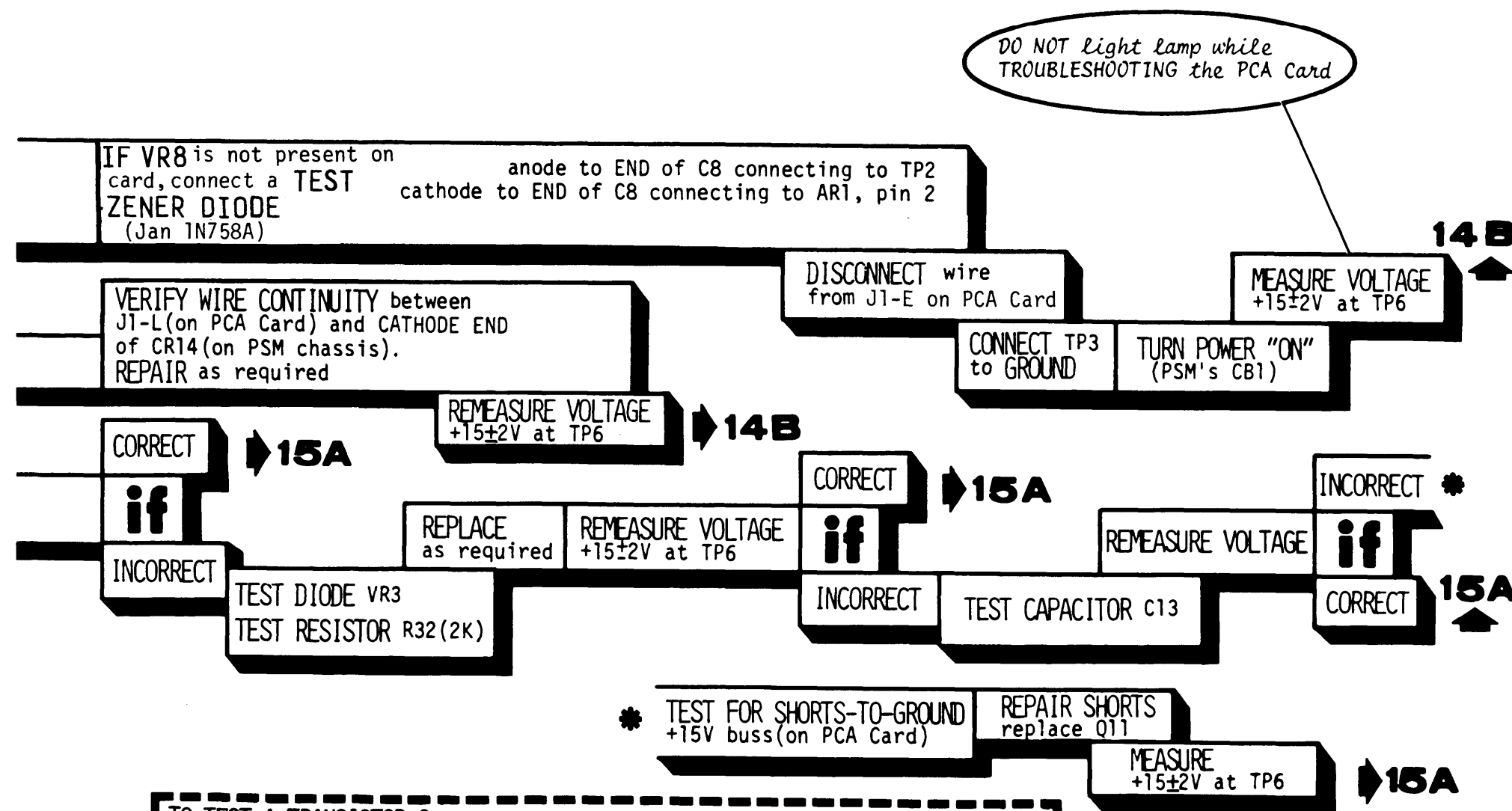
### TROUBLESHOOTING THE PCA CARD



TO TEST A CAPACITOR C\_ ( ) - SUBSTITUTE a new part (disconnect one end) & REMEASURE required voltage

TO TEST A RESISTOR R\_ ( ), - MEASURE specified ( ) resistance (disconnect one end) (using an ohm meter)





TO TEST A TRANSISTOR Q<sub>x</sub> - compare resistance readings to a new part (±20% variation between parts is normal)

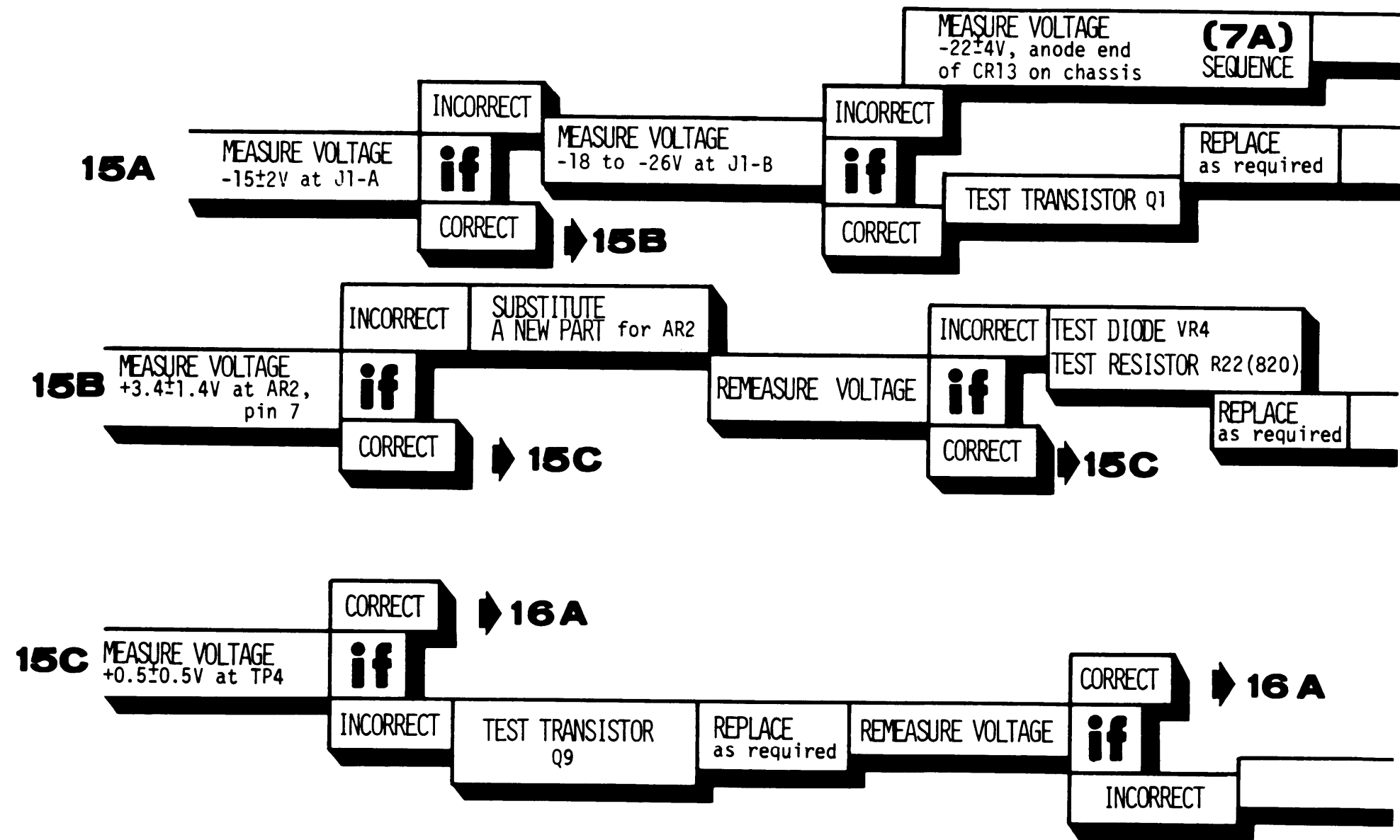
- (base-to-emitter/both directions)
- (base-to-collector/both directions)
- (collector-to-emitter/both directions)

(used power transistors may have less resistance, collector-to-emitter)

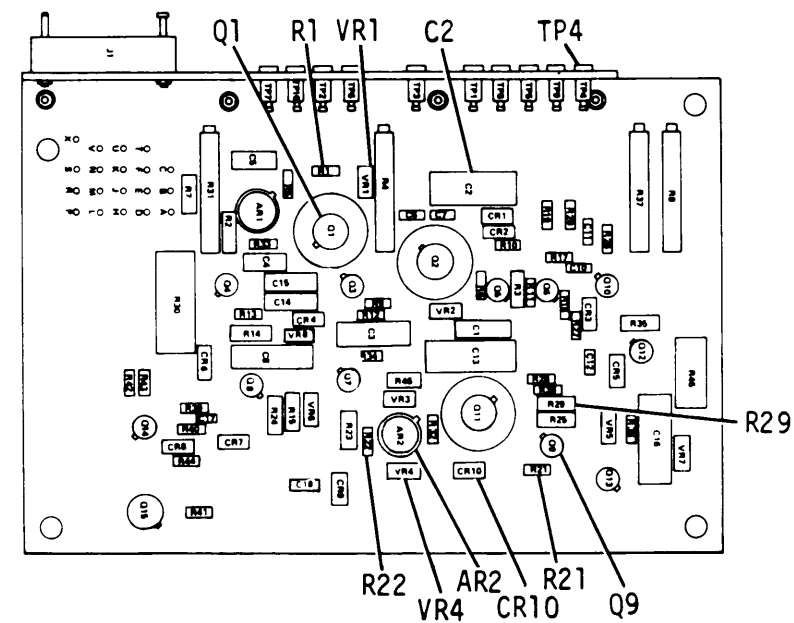
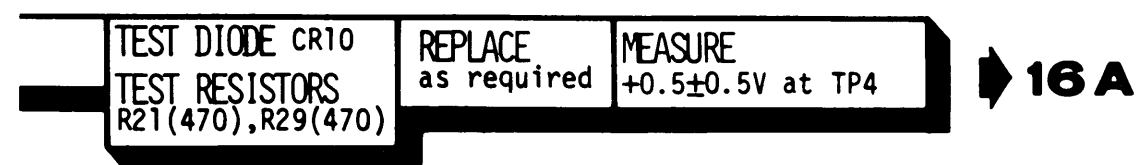
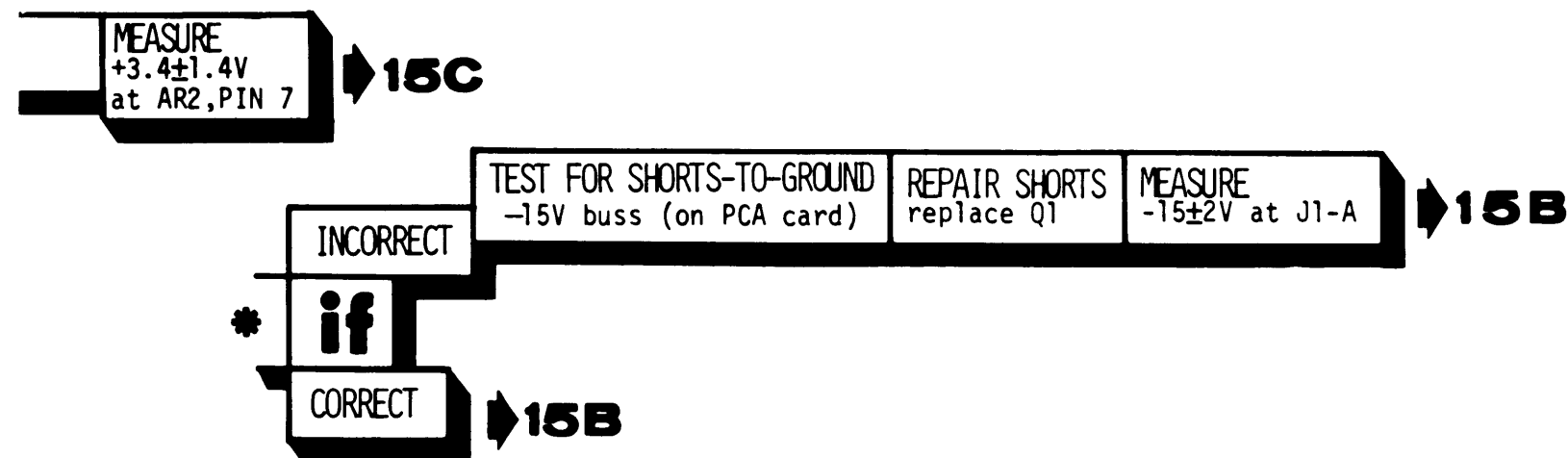
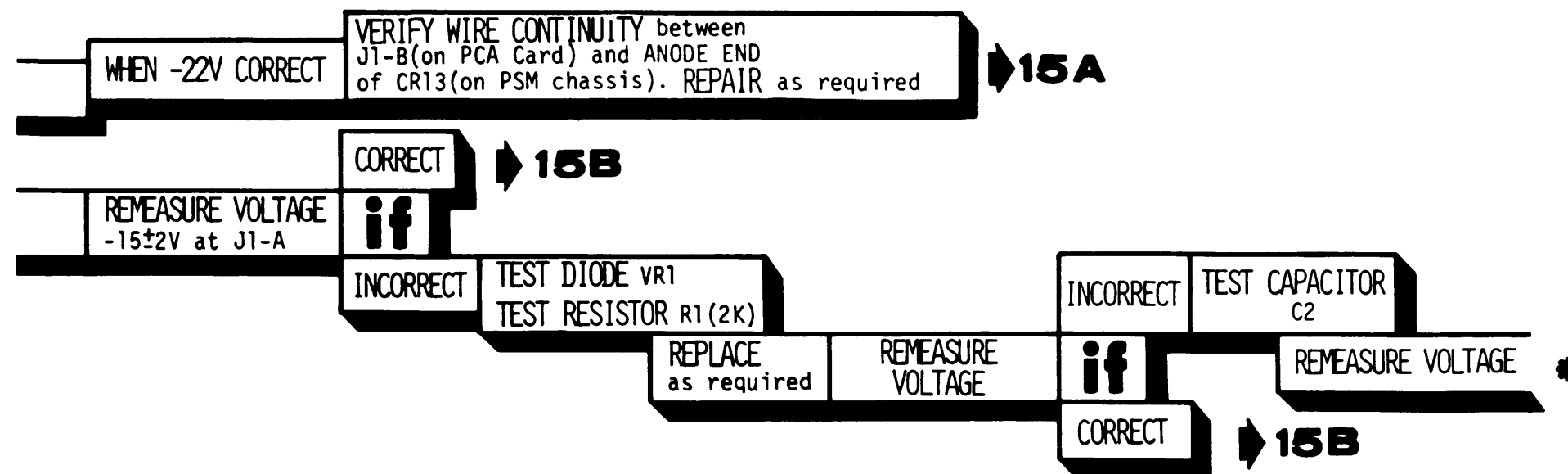
TO TEST A DIODE CR<sub>x</sub> OR VR<sub>x</sub> - (use an ohm meter Rx10 -or nearest-scale)

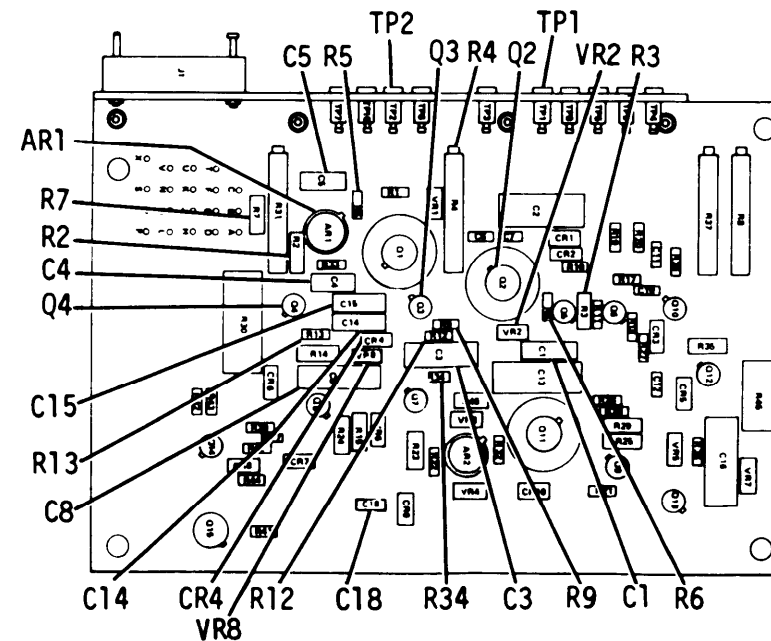
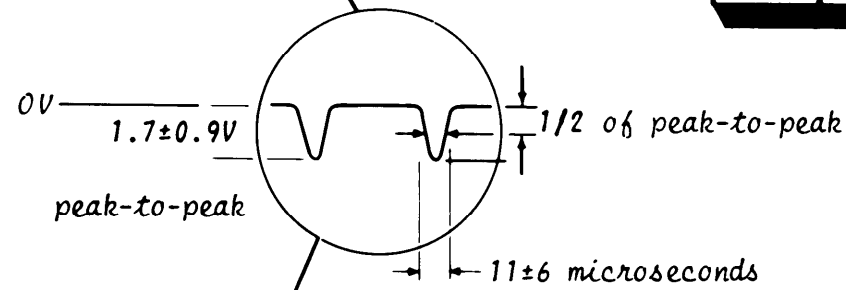
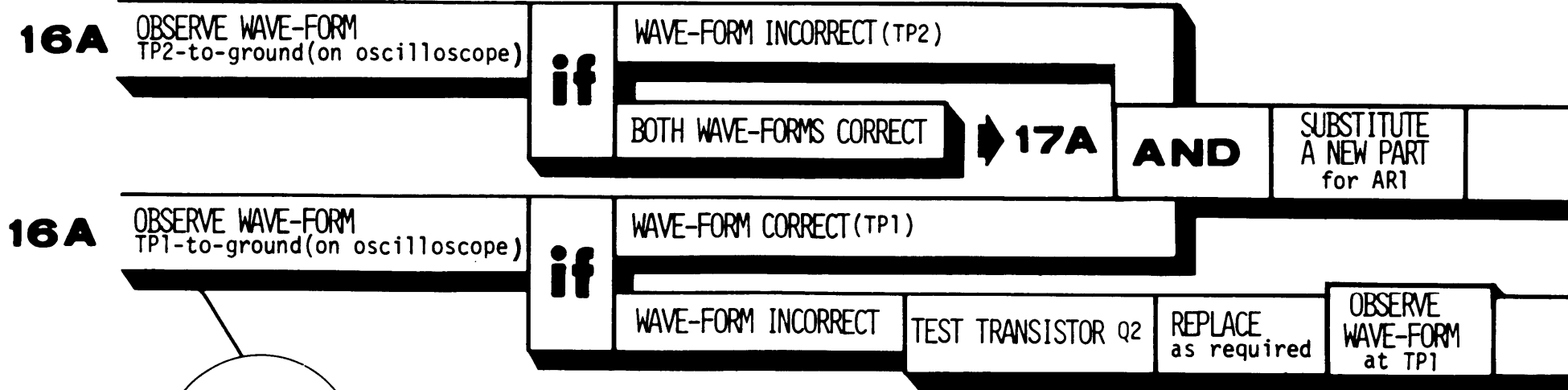
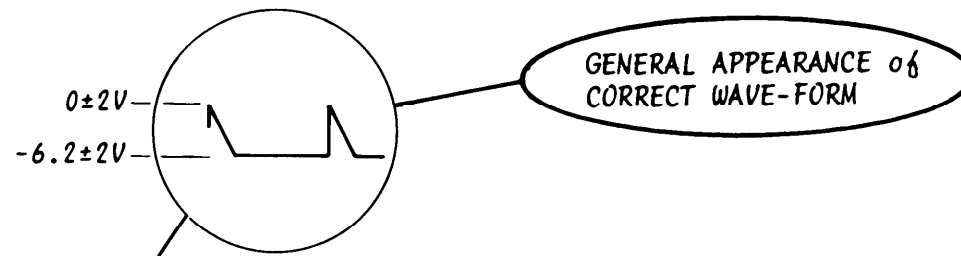
- MEASURE high resistance (meter +lead-to-diode cathode)
- MEASURE low resistance (meter +lead-to-diode anode)

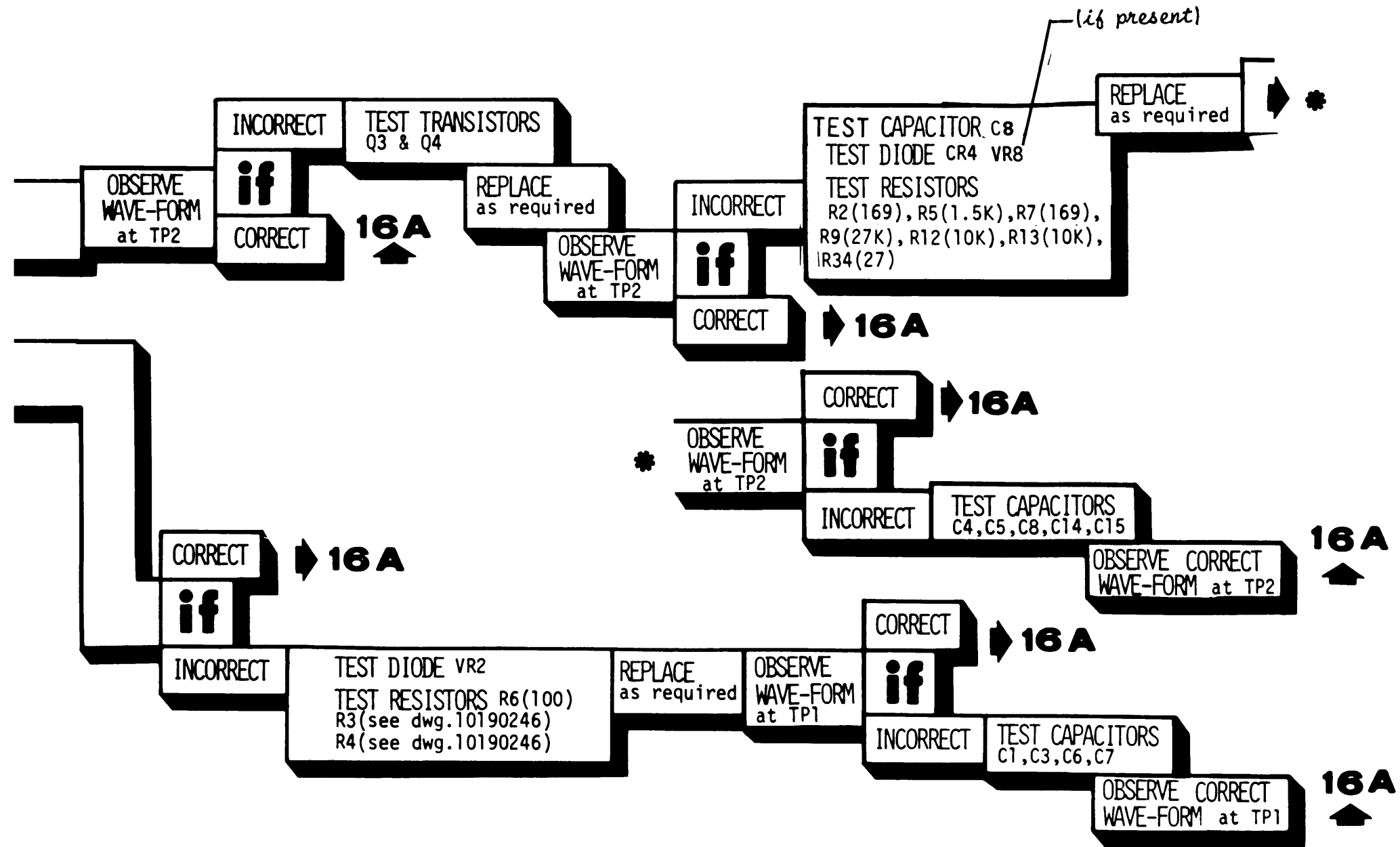
(disconnect one end)







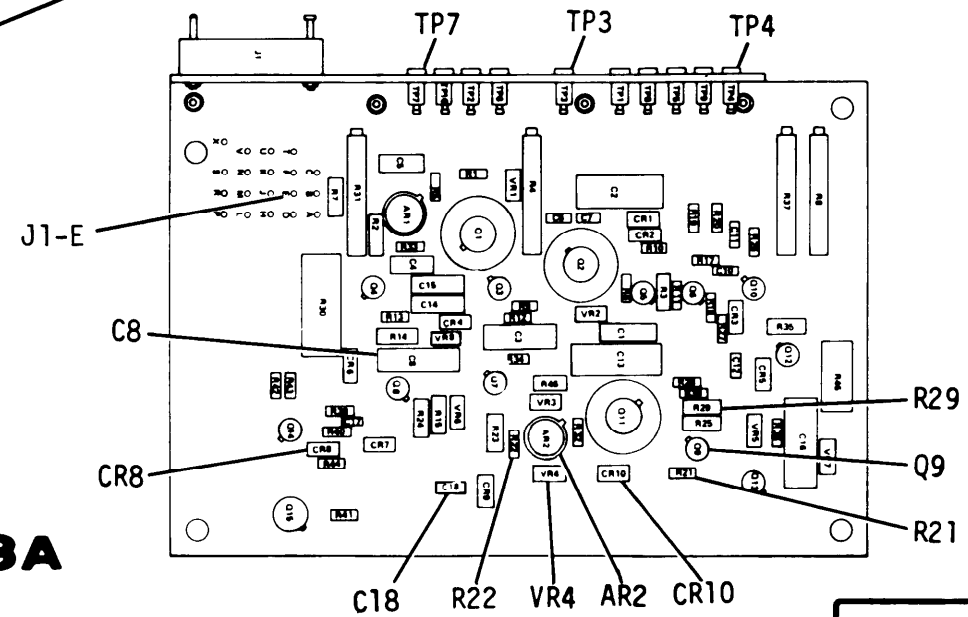




**17A**

REMOVE JUMPER WIRES at C8 & CR10	REMOVE TEST ZENER DIODE at C8 if installed in step 14A.	REMOVE GROUND at TP3	CONNECT OSCILLOSCOPE CALIBRATOR OUTPUT ( $2 \pm 0.2V$ peak-to-peak of $1 \pm 0.2$ KHz square-wave, to TP7 thru a 6.8 MFD (or larger) capacitor	RECONNECT WIRES to J1-E on PCA CARD
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*amplitude of square-wave will normally decrease after this*

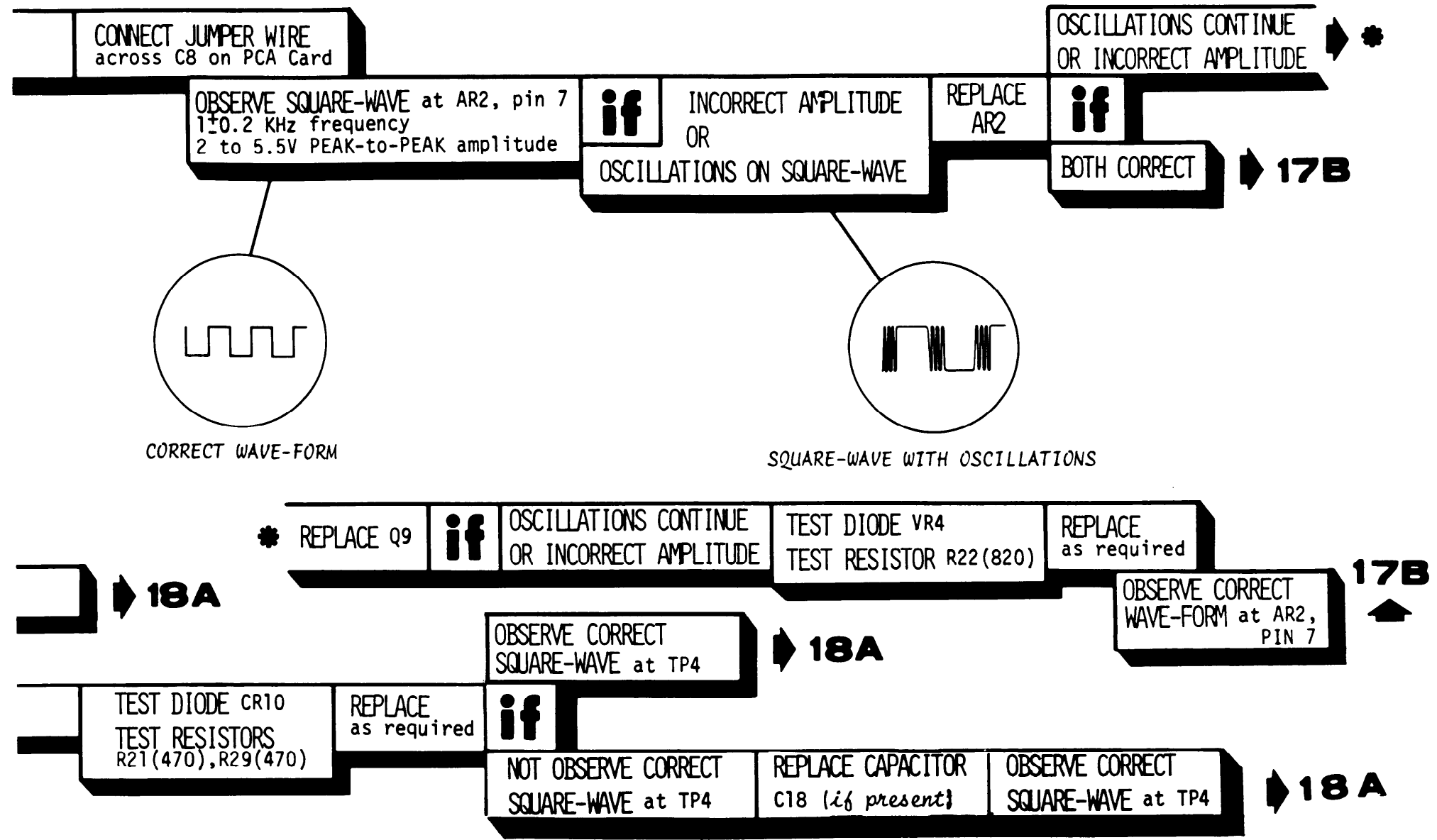


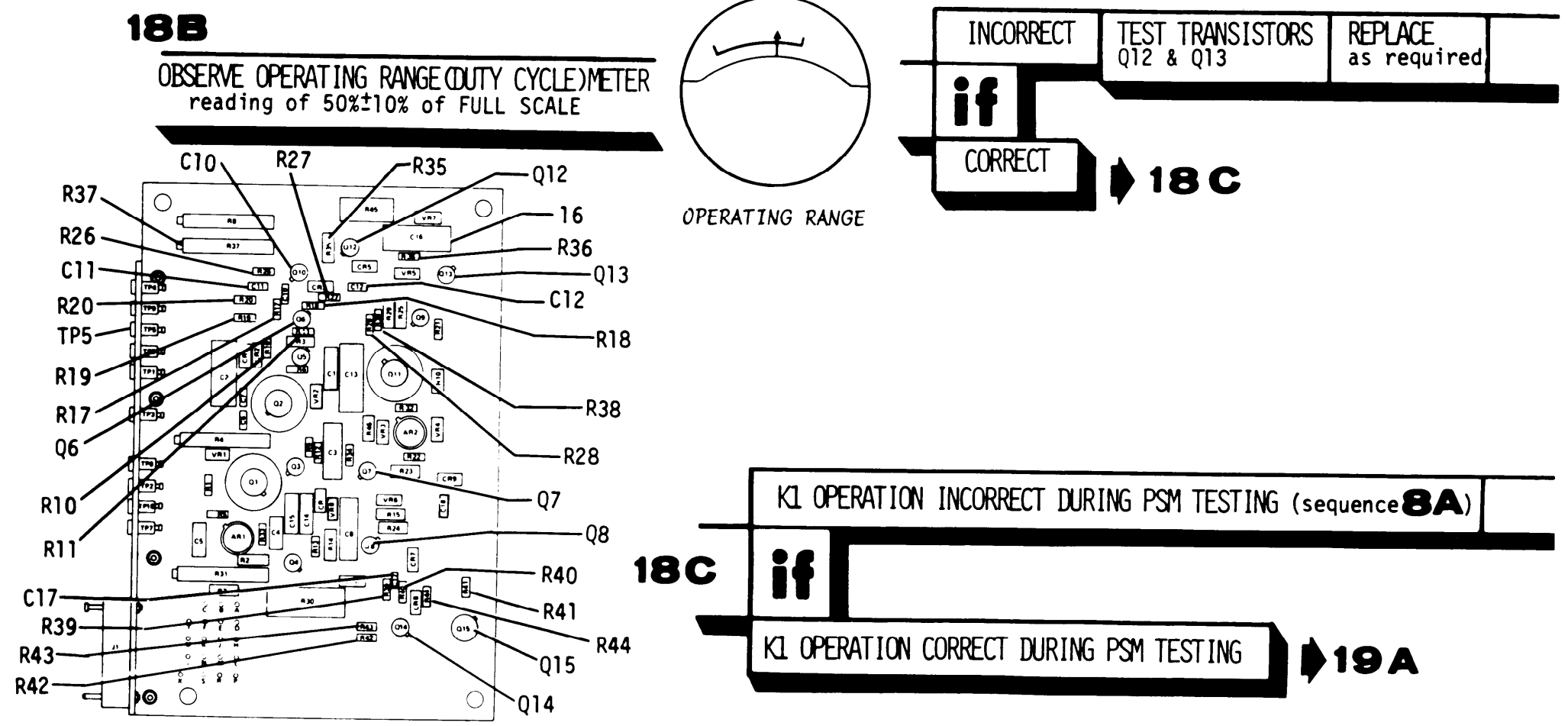
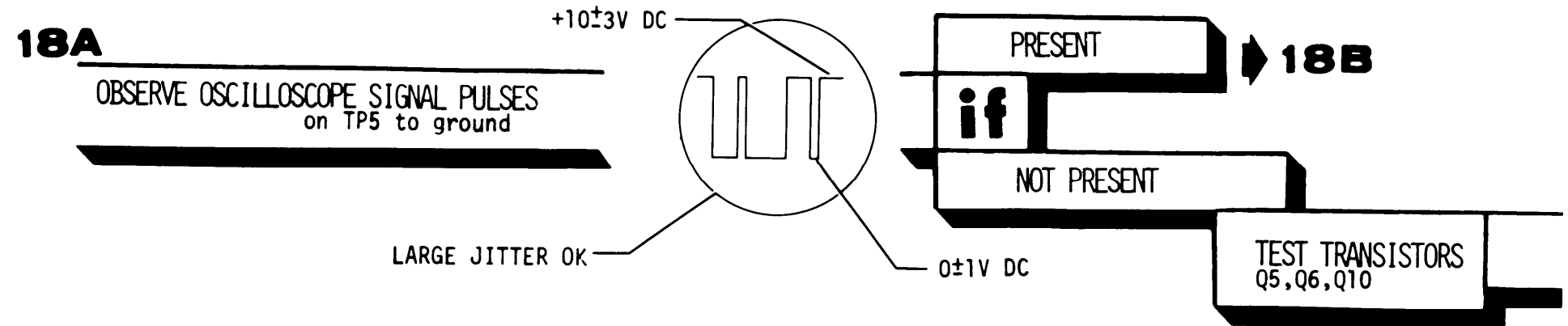
**17B**

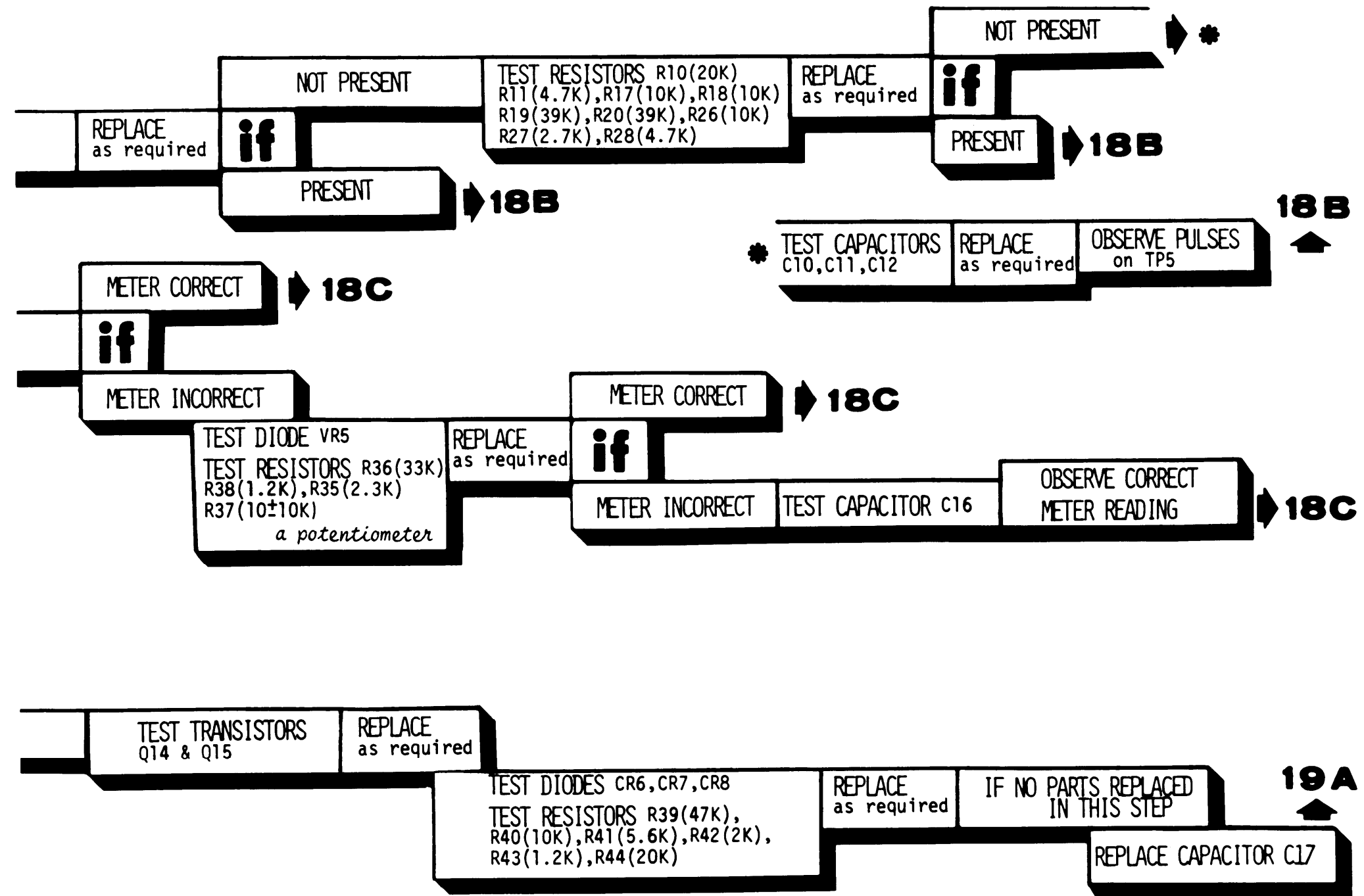
OBSERVE SQUARE-WAVE at TP4  
 $1 \pm 0.2$  KHz frequency  
 $14.3 \pm 3V$  PEAK-to-PEAK amplitude

CORRECT	if	TEST TRANSISTOR Q9	REPLACE as required	OBSERVE SQUARE-WAVE	CORRECT
INCORRECT					if

➔ **18A**

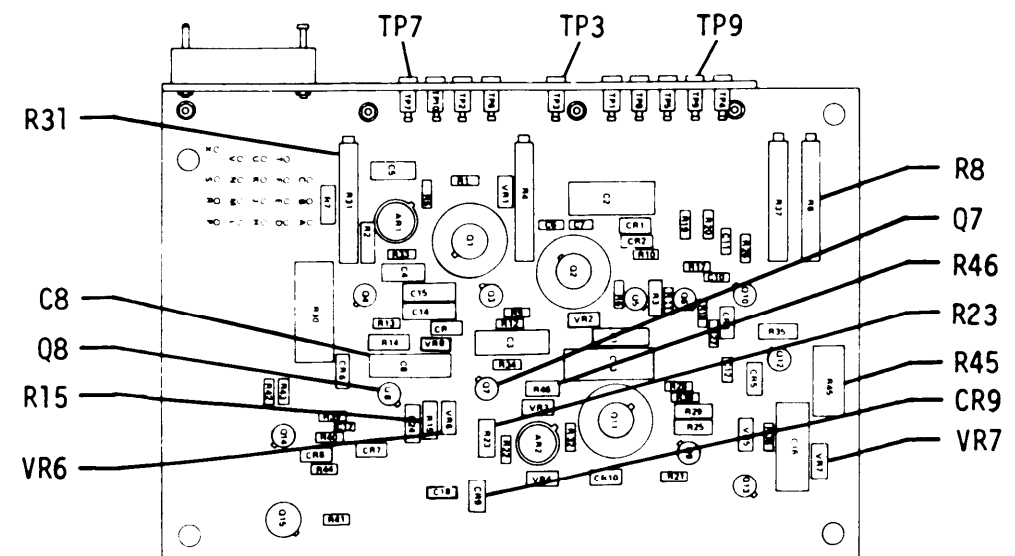




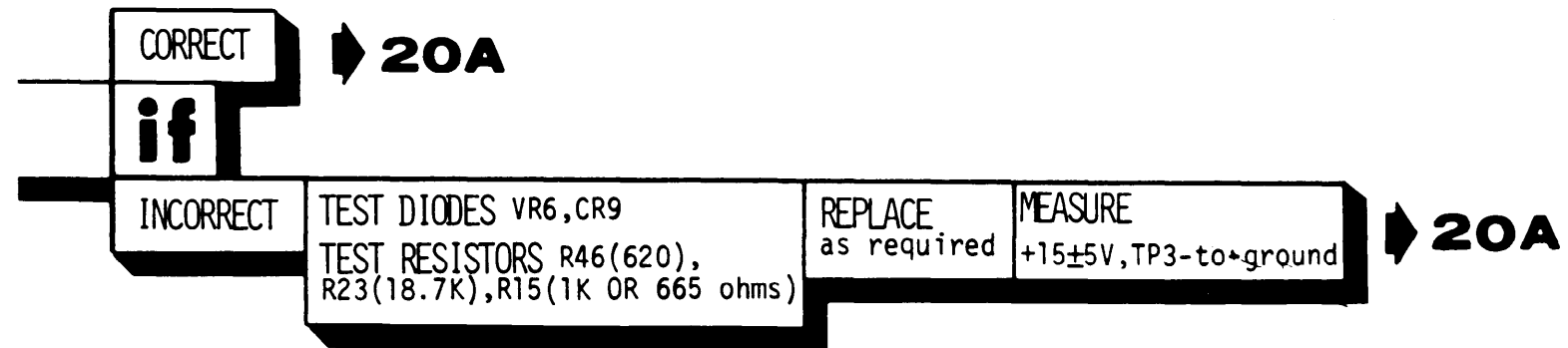
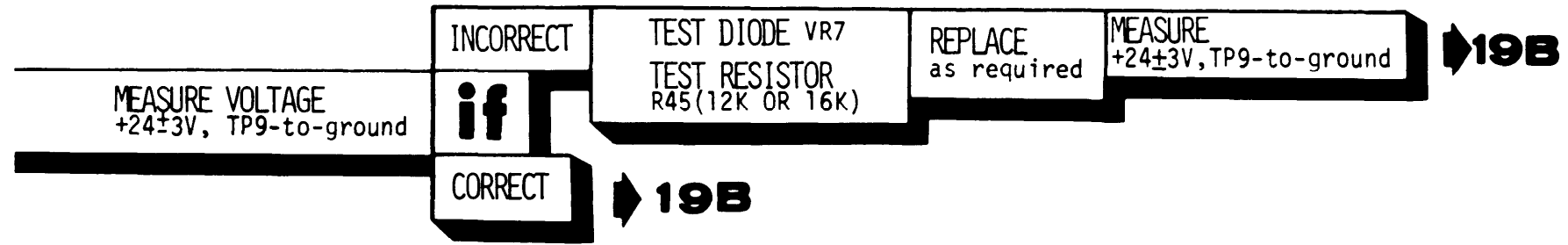


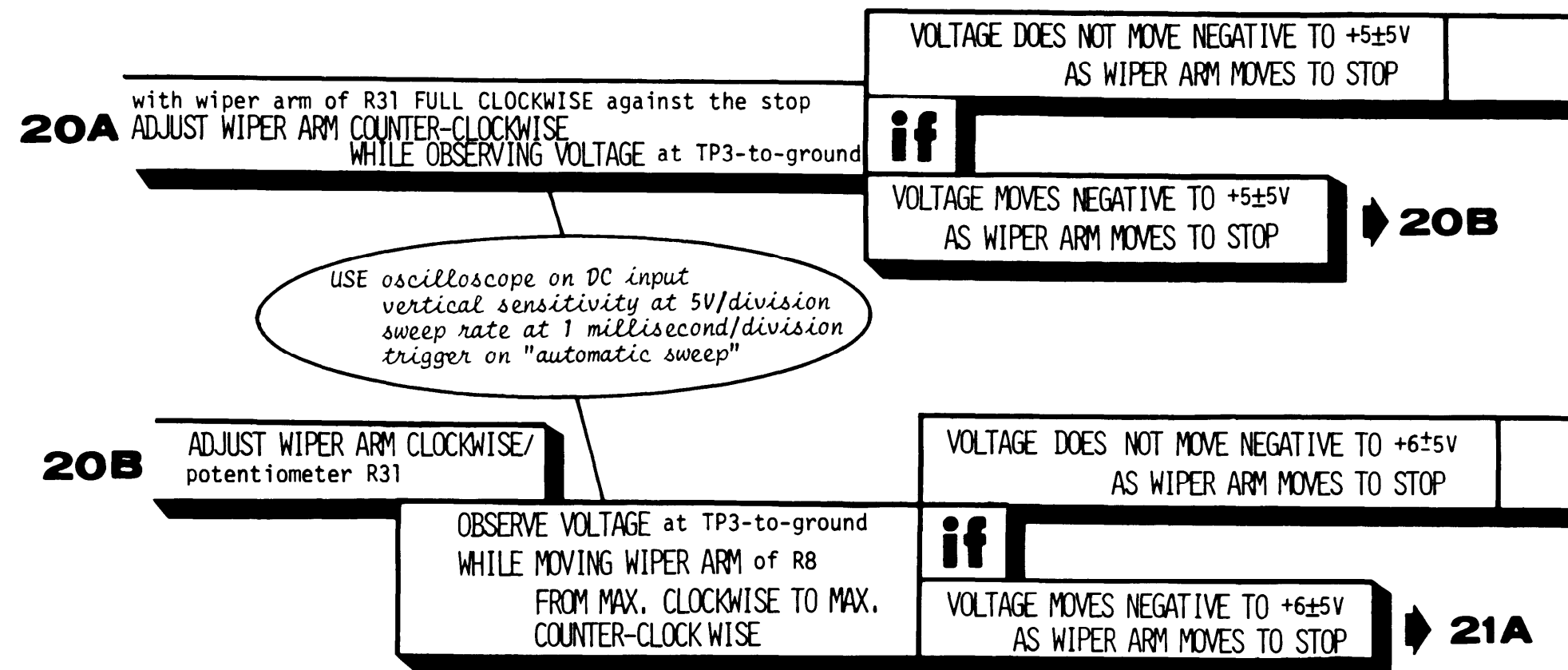
<b>19A</b>	REMOVE SQUARE-WAVE SIGNAL from TP7	REMOVE JUMPER WIRE from across C8	ADJUST WIPER ARM MAX. CLOCKWISE/ potentiometer R31
			ADJUST WIPER ARM MAX. CLOCKWISE/ potentiometer R8

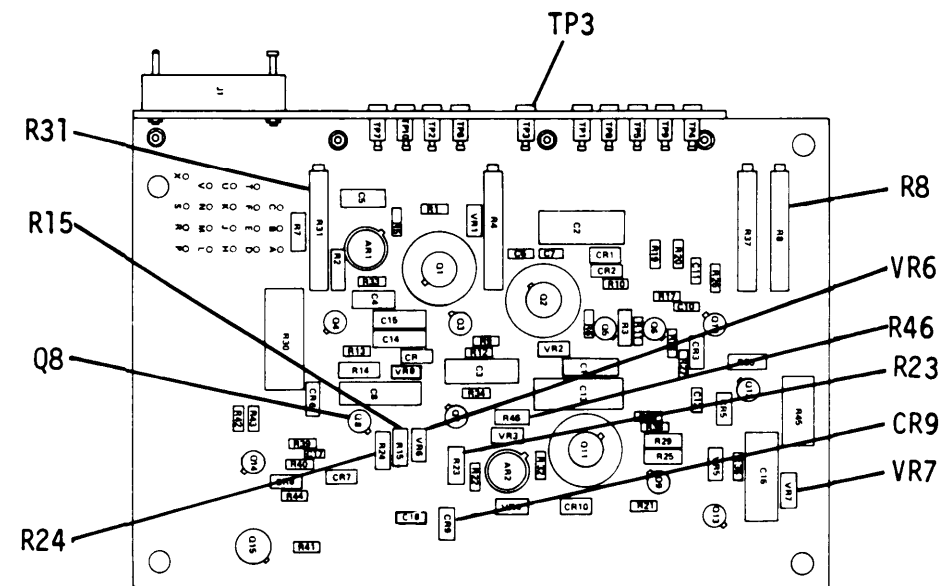
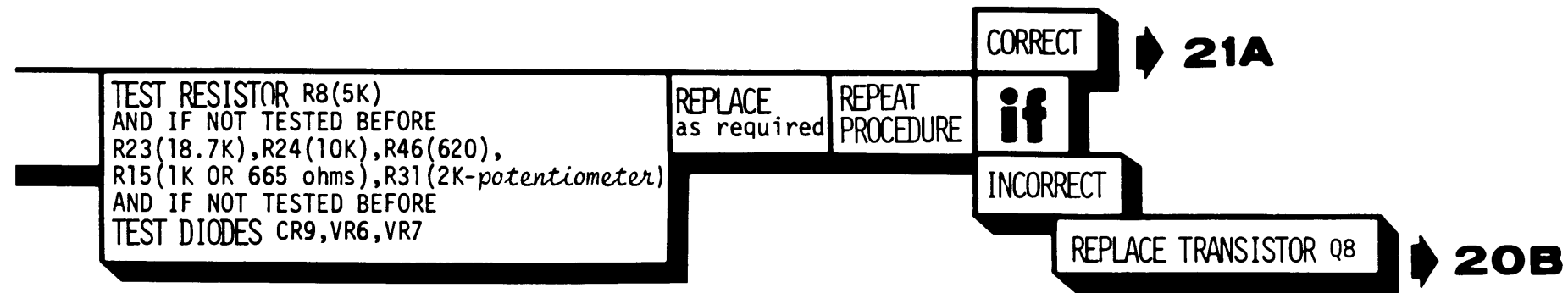
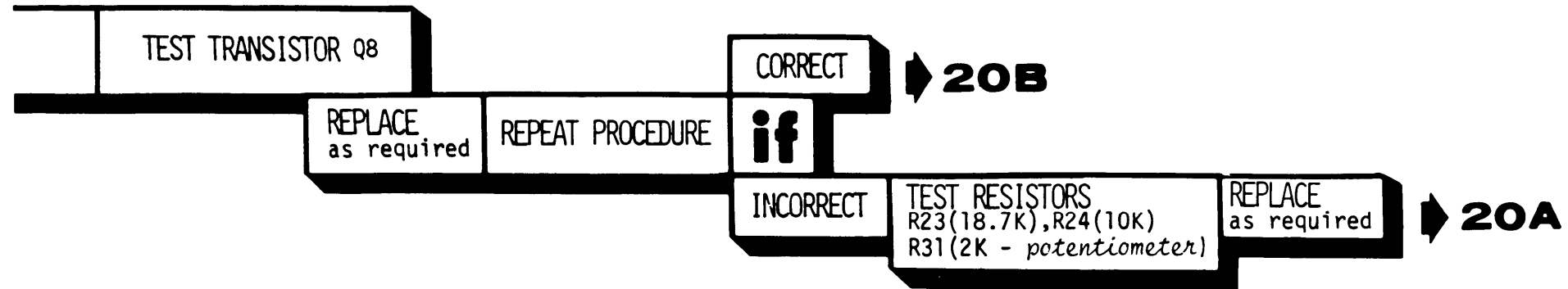
<b>19B</b>	MEASURE VOLTAGE +15±5V, TP3-to-ground	CORRECT	➔ <b>20A</b>		
		if			
		INCORRECT	TEST TRANSISTORS Q7 & Q8	REPLACE as required	REMEASURE VOLTAGE

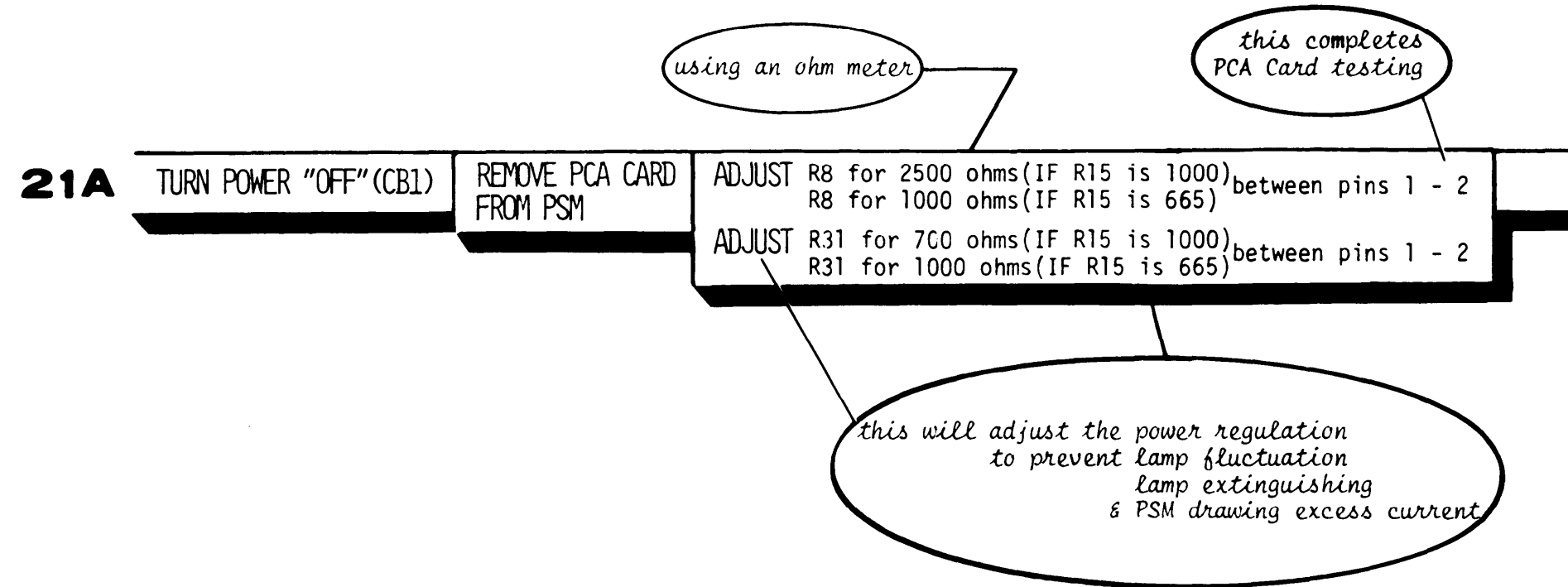






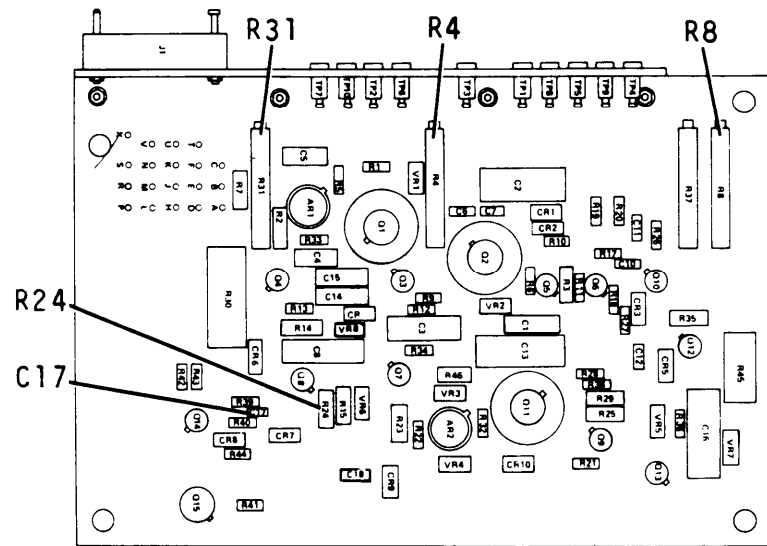




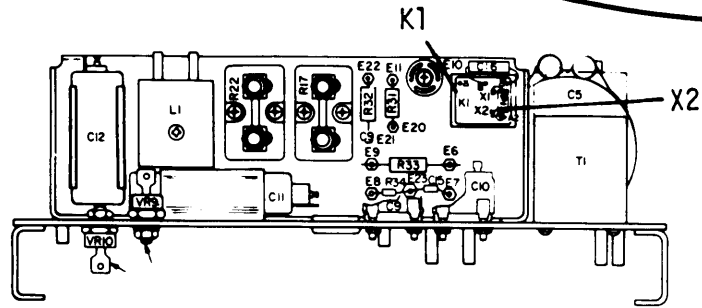


REINSTALL PCA CARD IN PSM  
RECONNECT P1  
RECONNECT LEADS of Q7 & Q8  
to PSM's chassis terminals

8B

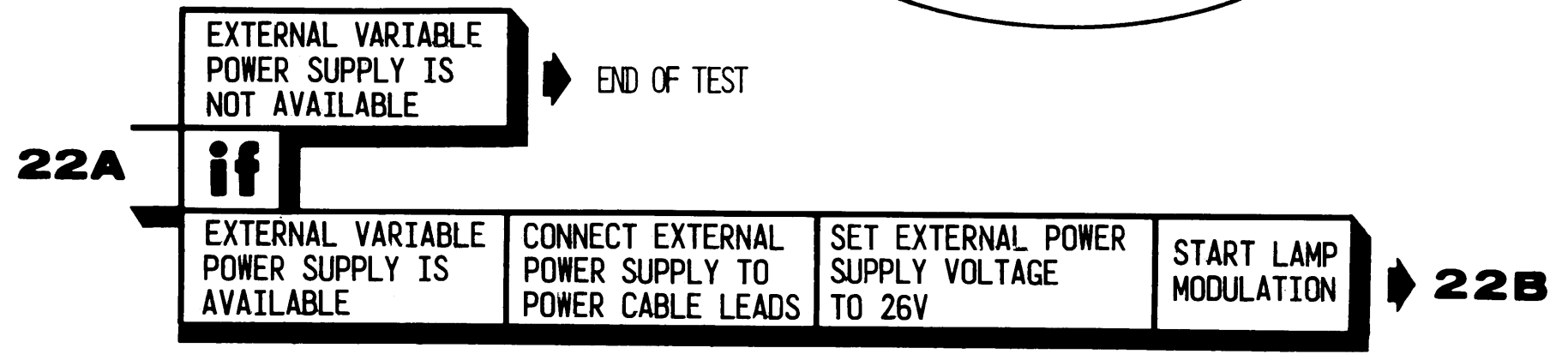


BEFORE installing chassis in case  
• check all wire connections  
• P1 connector on PCA Card  
• wires on E12 & E13



### OUTPUT POWER CALIBRATION

*This calibration will adjust the PSM for optimum performance of the TARGET SOURCE LAMP.*

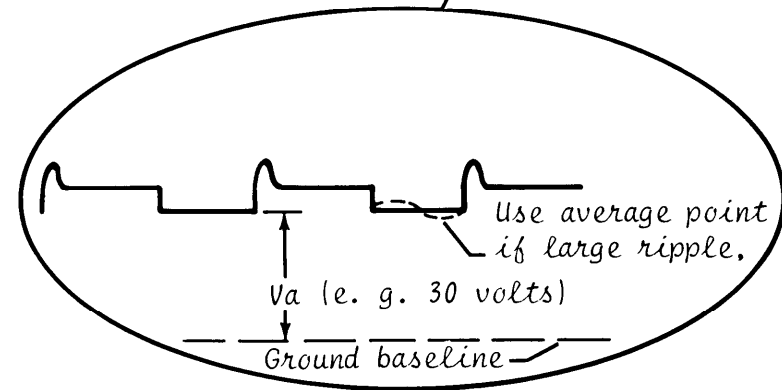


**22B**

ADJUST EXTERNAL  
POWER SUPPLY  
VOLTAGE TO 24V

USING OSCILLOSCOPE,  
OBSERVE LAMP ANODE  
VOLTAGE (J2-J TO J2-L)  
and RECORD THE VOLTAGE  
as  $V_a$ .

MEASURE LAMP CURRENT AVERAGE  
VOLTAGE  $V_i$  (J2-B TO J2-A).  
CALCULATE TOTAL CURRENT  $A_t$ ,  
by multiplying the voltage ( $V_i$ )  
by 300. RECORD  $A_t$ .



MEASURE IDLE CURRENT AVERAGE  
VOLTAGE  $v_i$  (J2-G TO J2-L).  
CALCULATE IDLE CURRENT  $A_i$ , by multiplying  
the voltage ( $V_i$ ) by 0.383 RECORD  $A_i$ .

➡ **23A**

**TYPICAL CALIBRATION VALUES**

- $V_a = 30v$
- $V_i = 0.040v$
- $V_i = 5V$
- $A_t = 12 \text{ amps}$
- $A_i = 1.92 \text{ amps}$

**23A**

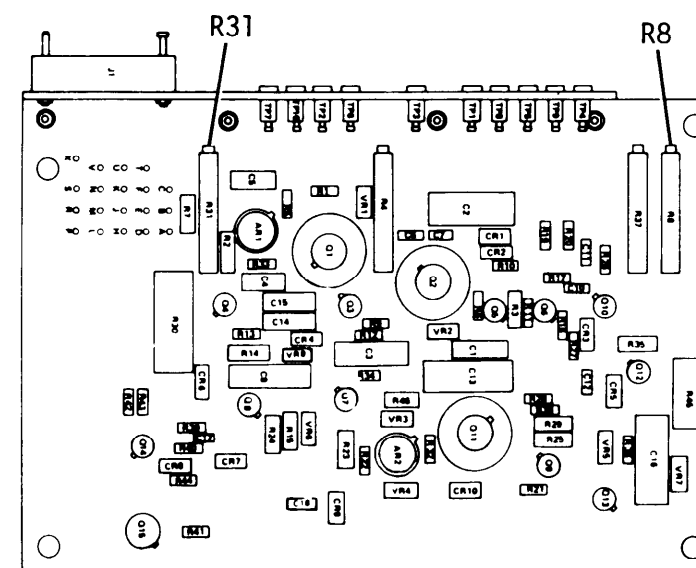
**CALCULATE LAMP POWER OUTPUT** by multiplying the **LAMP ANODE VOLTAGE** ( $V_a$ ) by the **TOTAL CURRENT** ( $A_t$ ) less the **IDLE CURRENT**  $A_i$   
 i.e. **LAMP POWER OUTPUT**  $=V_a(A_t - A_i)$

**LAMP POWER OUTPUT**  
 $300 \pm 30$  watts

INCORRECT

**if**

CORRECT



**MEASURE IDLE CURRENT AVERAGE VOLTAGE**  $V_i$  (J2-G TO J2-L)  
**CALCULATE IDLE CURRENT**  $A_i$  by multiplying the voltage ( $V_i$ ) by 0.383. **RECORD**  $A_i$ .

**CALCULATE LAMP POWER OUTPUT** by multiplying the **LAMP ANODE VOLTAGE** ( $V_a$ ) by the **TOTAL CURRENT** ( $A_t$ ) less the **IDLE CURRENT**  $A_i$ .  
 i.e. **LAMP POWER OUTPUT**  $=V_a(A_t - A_i)$



MONITOR AMPERES METER ON EXTERNAL POWER SUPPLY and ADJUST R8 (on PCA) for 1/2 AMP less if LAMP POWER OUTPUT is too high or 1/2 AMP more if LAMP POWER OUTPUT is too low.	REPEAT PROCEDURE (22B)	▶ 22B
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ADJUST EXTERNAL POWER SUPPLY VOLTAGE TO 30V	OBSERVE LAMP ANODE VOLTAGE (J2-J TO GND) AND RECORD THE VOLTAGE AS $V_a$	MEASURE LAMP CURRENT AVERAGE VOLTAGE $V_i$ (J2-B TO J2-A). CALCULATE TOTAL CURRENT $A_t$ , by multiplying the voltage ( $V_i$ ) by 300. RECORD $A_t$	▶ *
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*Adjustment of R31 affects the adjustment of R8 and vice versa. THEREFORE, the entire Calibration procedure must be rechecked.*

LAMP POWER OUTPUT 300 + 30 WATTS	CORRECT	END OF TEST	if	INCORRECT MONITOR AMPERES METER ON EXTERNAL POWER SUPPLY and ADJUST R31 (on PCA) for 1/2 AMP less if LAMP POWER OUTPUT is too high or 1/2 AMP more if LAMP POWER OUTPUT is too low	REPEAT PROCEDURE (22B)	▶ 22B
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**By Order of the Secretary of the Army:**

**E. C. MEYER**  
*General, United States Army*  
*Chief of Staff*

**Official:**

**ROBERT M. JOYCE**  
*Brigadier General, United States Army*  
*The Adjutant General*

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