TM 9-6625-2801-14&P

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL,

DIRECT SUPPORT, AND GENERAL SUPPORT

MAINTENANCE MANUAL (INCLUDING MAINTENANCE REPAIR PARTS LIST)

FOR

TEST SET, ELECTRICAL

TEKTRONIX TYPE 1502-1

NSN 6625-04-084-3855

TEKTRONIX, INC.

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1981

WARNING

DRY CLEANING SOLVENT

Dry cleaning solvent or mineral spirits paint thinner is flammable and should not be used near an open flame. Fire extinguishers should be provided when these materials are used. Use only in well-ventilated areas.

WARNING

Be extremely careful when working in the vicinity of batteries when the battery case is open. Do not use uninsulated tools. Do not wear rings or watches. Metal articles will, if allowed to contact connectors, cause severe arcing with possible injury to personnel and damage to the battery.

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DEPARTMENT OF THE ARMY
Washington, DC, *20 August 1981*

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TEST SET, ELECTRICAL

TEKTRONIX TYPE 1502-1*

REPORTING OF ERRORS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publication and Blank Forms) , or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Armament Materiel Readiness Command, ATTN: DRSAR-MAS , Rock Island, IL 61299. A reply will be furnished to you.

*NOTE
Throughout the text, this is referred to as a Time Domain Reflectometer or a TDR. This is in lieu of the authorized Federal nomenclature.

LIST OF ILLUSTRATIONS

LIST OF TABLES

This technical manual is an authentication of the manufacturers' commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

INSTRUCTIONS FOR REQUISITIONING PARTS

NOT IDENTIFIED BY NSN

When requisitioning parts not identified by National Stock Number, it is mandatory that the following information be furnished the supply officer.

1 - Manufacturer’s Federal Supply Code Number - 80009

2 - Manufacturer’s Part Number exactly as listed herein.

3 - Nomenclature exactly as listed herein, including dimensions, if necessary.

4 - Manufacturer’s Model Number. Tektronix Type 1502-1

5 - Manufacturerfs Serial Number (End Item)

6 - Any other information such as Type, Frame Number, and Electrical Characteristics, if applicable.

7 - If DD Form 1348 is used, fill in all blocks except 4, 5, 6, and Remarks field in accordance with AR 725-50.

Complete Form as Follows:

(a) In blocks 4, 5, and 6, list manufacturer's Federal Supply Code Number - 80009, followed by a colon and manufacturer’s Part Number for the repair part.

(b) Complete Remarks field as follows:

Noun: (nomenclature of repair part)
For: NSN: 6625-01-084-3855
Manufacturer: Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97005
Model: 1502-1
Serial: (of end item)

Any other pertinent information such as Frame Number, Type, Dimensions, etc.

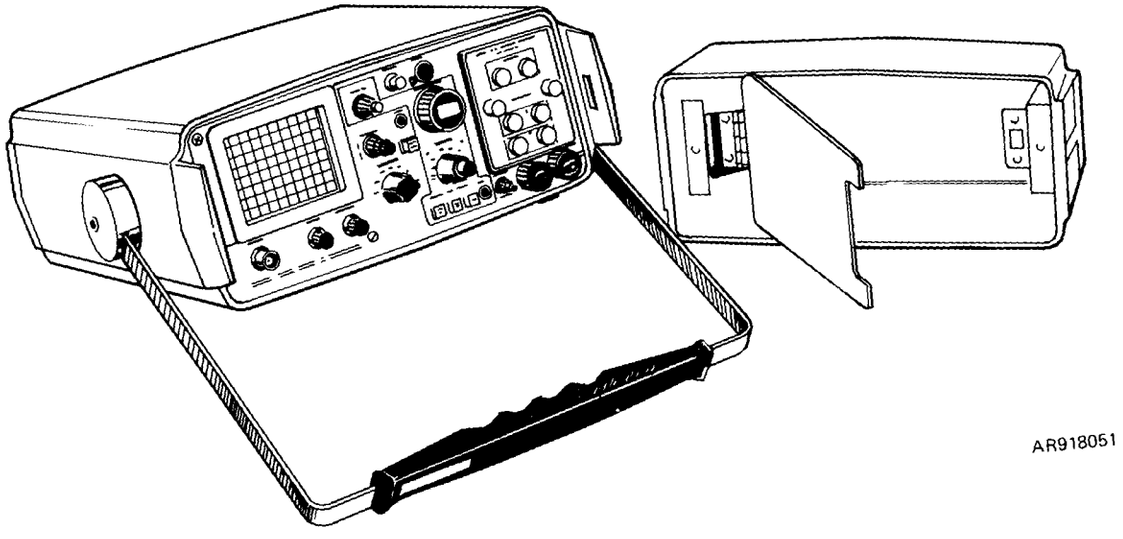


Figure 1-1. Time domain reflectometer, Tektronix1502-1, cover removed

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope.

a. Purpose. The purpose of this manual is to provide information and instruction for the direct support maintenance of the Time Domain Reflectometer, Tektronix 1502.1 (hereafter referred to as the TDR) including accessory equipment and external test cable assemblies (see figure 1-1),

b. Content Summary. This manual contains the following information:

(1) A description of the equipment.

(2) Corrective and preventive maintenance instructions.

(3) Checkout procedures.

(4) Repair instructions.

(5) Shipment and storage procedures.

(6) References to all related publications (appendix A).

(7) Maintenance allocation chart defining maintenance level responsibilities (appendix B).

(8) Maintenance repair parts list (appendix C).

1-2. Forms and Records. Refer to TM 38-750 for instructions on the use of appropriate forms, records and reports.

1-3. Calibration. Calibration procedures for the TDR are provided in Technical Bulletin TB 11-6625-2860-35.

1-4. Destruction of Material to Prevent Enemy Use. For information on destruction of materiel to prevent enemy use refer to TM 750-244-2.

1-5. Reporting Equipment Improvement Recommendations (EIR). EIR's will be prepared using SF 368, Quality Deficiency Report (QDR). Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System (TAMMS). EIR's should be mailed directly to Commander, U.S. Army Armament Materiel Readiness Command, Attention: DRSAR-MAO, Rock Island, IL 61299. A reply will be furnished directly to you.

Section II. DESCRIPTION AND DATA

1-6. Description.

a. General. The Tektronix 1502-1 is a portable Time Domain Reflectometer which uses radar principles to test cables and provides a visual display of cable faults. The test pulses are transmitted via the CABLE output jack. Reflections are received at the same jack and displayed on the cathode-ray tube (crt).

Calibrated distance controls allow an operator to examine up to 100 feet of cable with segments as small as 1 foot displayed horizontally across the 10-division crt screen. Low-loss cables as long as 2000 feet may be examined at 100 feet per division or 200 feet per division. The horizontal crt scale is calibrated directly in distance units from 0. 1 foot per division to 200 feet per division in a 1-2-5 sequence.

A 3-digit, direct reading dial indicates the distance to any cable discontinuity when the dial is used to horizontally position the discontinuity's reflection to a crt reference line.

b. Description.

(1) Main case. The TDR is a ruggedized portable instrument that can be used in the field as well as in the laboratory. The requirements for a Type II, Class 2, Style A instrument as specified in MIL-T-28800 were used as a guideline for the environmental specifications. The TDR has a ruggedized case that provides protection when the instrument is stored in exposed areas.

(2) Accessories. When the instrument is not being used, the accessories, including the Operators manual, may be packed in the front of the instrument. Table 1-1 indicates which accessories may be placed in the cover of the TDR.

Table 1-1. TDR Accessories Storage

Accessories Stored in Cover	
Accessories	Tektronix parts number
1 50Ω BNC Terminator	011-0123-00
1 Precision 50 Ω Cable	012-0482-00
1 Viewing Hood	016-0297-00
1 Operators Manual	070-1790-00
1 BNC Connector Female-to-Female	103-0028-00
2 Replacement Fuses (for front panel) For 115 Vac Operation or For 230 Vac Operation (Option 6)	159-0029-00 159-0054-00
1 Power Cord	161-0066-00
1 Filter, Mesh (crt)	378-0055-00

Accessories Not Stored in Cover	
Accessory	Tektronix part number
1 TDR Slide Rule	003-0700-00
1 TDR Application Note #1	062-1538-00
1 X-Y Output Module	016-0606-00
1 Instruction Manual	070-1792-00

1-7. Tabulated Data. The characteristics given in table 1-2 apply after the instrument has been calibrated and will perform to the requirements given in Chapter 5.

Table 1-2. Tabulated Data System

Characteristics	Performance
Termination	50 Ω within ±2%.
Pulse Amplitude Into 50 Ω Load	225 mV Nominal.
Vertical System	
Deflection Factor (7 steps, 1-2-5 sequence)	5 mρ /div to 500 mρ /div.
Accuracy	Within ±3%.
Gain (screwdriver control)	At least 3.5:1 from calibrated point.
Displayed Noise	±5 mρ or less, NOISE FILTER switch "Out".
Low Noise Operation	±2 mρ or less, NOISE FILTER switch "In".
Horizontal System	
Distance Controls	0 to 2000 feet total.

Table 1-2. Tabulated Data System - Continued

Horizontal System - Continued	
Characteristics	Performance
Distance Dial At X1 Multiplier Range	0 to 100 feet.
Accuracy	Within ±2%, ±0.5 foot.
At X1 Multiplier Range	0 to 1000 feet.
Accuracy	Within ±2 %, ±1 Digit.
FEET/DIV Control At X.1 Multiplier Range	To 20 feet/div
Scales (8 steps, 1-2-5 sequence)	0.1 foot/div to 20 feet/div.
Accuracy (All scale settings)	Within ±2%.
(With scale set at 20 ft/div)	Within ±1%
At X1 Multiplier Range	To 200 feet/div.
Scales (8 steps, 1-2-5 sequence)	1 foot/div to 200 feet/div.
Accuracy All scale settings	Within ±2%.
200 ft/div scale	Within ±1%.
Dielectric Scales SOLID PTFE	V_p / V_{air} = 0.70
SOLID POLY	V_p / V_{air} = 0.66
OTHER-VAR	V_p / V_{air} = 0.55 to 1
Accuracy	Within ±2%.
Recorders	
External Recorder Interface for X-Y Recorders Horizontal	0.1 V/div; (source impedance 10 K Ω).
Vertical	0.09 to 0.13 V/div adjustable (source) impedance 10 kΩ).
Pen Lift Mode 1 Source	V_s = 5 V Nominal with R_s = 10 k Ω.
Sink	≤ 10 mA (V out ≤ 0.5 V).
Mode 2 (inverted Mode 1) Source	V_s = 5 V Nominal with R_s = 10 k Ω.
Sink	≤ 0.5 mA (V out ≤0.6V).
Power System	
Line Voltage	117 Vac ±20%, 48 to 410 Hz; fused at 0.3 A. 234 Vac ±20%, 48 to 410 Hz; fused at 0.15 A.
Battery Pack (C size, 9 cell) Operation (+20°C to +25°C charge and dis-charge temperature)	At least 5 hours.
Full Charge Time	16 hours

Table 1-2. Tabulated Data - Continued

Power System - Continued			
Characteristics	Description		
Typical Charge Capacity			
Charge Temperature	Discharge Temperature		
	-15°C	+20°C to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

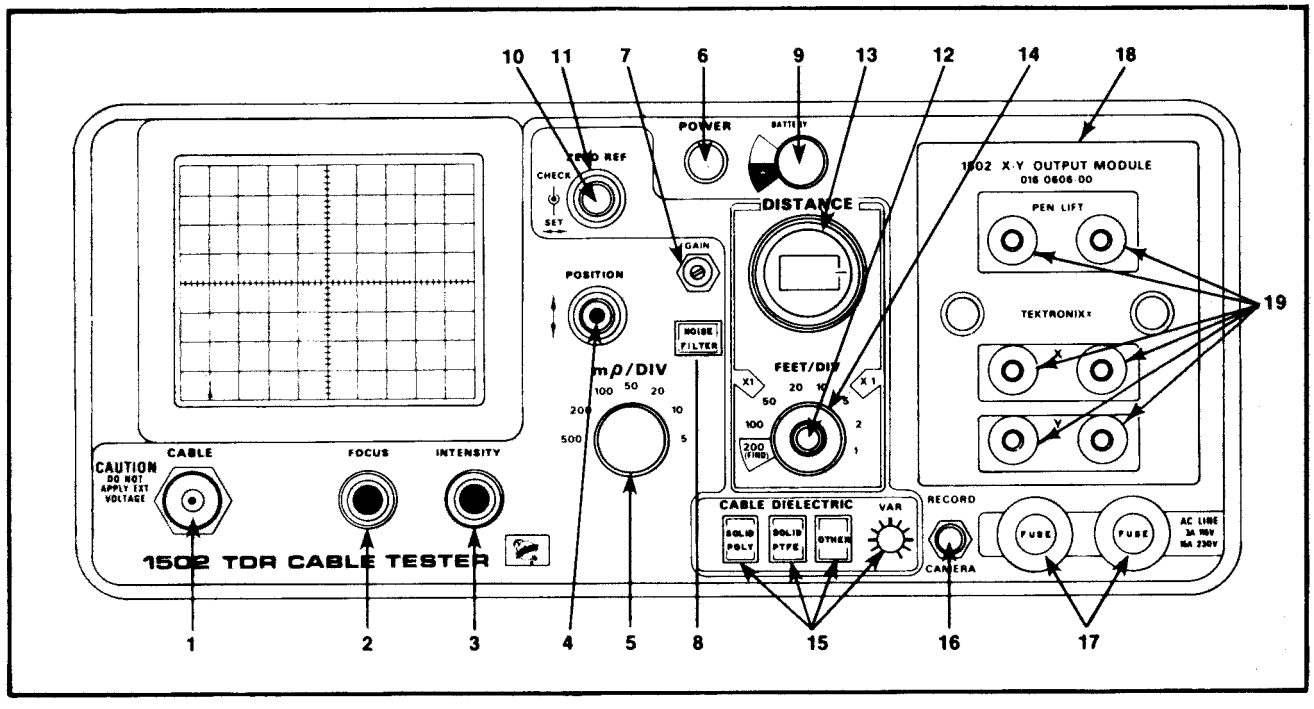
Physical Characteristics	
Characteristics	Description
Weight with panel cover and accessories	18 pounds
Without panel cover and accessories	16 pounds
Height	5.0 inches
Width with handle	12.4 inches
Without handle	11.8 inches
Depth including panel cover	16.5 inches
Handle extended	18.7 inches

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INDICATORS

2-1. Front Panel Controls and Indicators. A brief description of the purpose of each front panel connector, pushbutton, control, and screwdriver adjustment follows. A description of the controls of the plug-in module is also included. Refer to figure 2-1 for their location.



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Legend for fig. 2-1:

1. CABLE connector
2. FOCUS control
3. INTENSITY control
4. POSITION control
5. mρ/DIV switch
6. POWER switch
7. GAIN adjustment
8. NOISE FILTER switch
9. BATTERY meter
10. ZERO REF CHECK switch
11. ZERO REF SET control
12. multiplier switch
13. DISTANCE control
14. FEET/DIV switch
15. CABLE DIELECTRIC switches and control
16. RECORD/CAMERA switch
17. AC LINE fuses
18. X-Y OUTPUT MODULE
19. External chart recorder controls

Figure 2-1. TDR front panel controls and indicators

Table 2-1. TDR Front Panel Controls and Indicators

Figure 2-1 index no	Control or indicator	Function
1	CABLE	BNC Connector-delivers 110 ps risetime pulse to the test cable and receives the reflected return pulse.
2	FOCUS	Adjusts the focus of the crt electron beam.
3	INTENSITY	Controls the brightness of crt display.
4	POSITION/ FINE	Controls vertical position of the crt display. The outer control is a coarse adjustment and the inner control is a fine adjustment.
5	mρ /DIV	Selects the vertical deflection factor--5 mρ /div to 500 mρ /div (5-2-1 sequence).
6	POWER	Push-pull, off-on switch (pull for on) – does not affect the battery charging circuit.
7	GAIN	Screwdriver adjust to set the gain of the vertical amplifier.
8	NOISE FILTER	Reduces displayed noise. Display rate is reduced by a factor of 10.
9	BATTERY	Meter to indicate the relative charge of the power pack.
10	ZERO REF CHECK	Momentary contact Pushbutton. When pushed, checks the horizontal location of the incident pulse on the crt when the DISTANCE dial is being used.
11	ZERO REF SET	horizontal pulse position control for crt display. Sets the incident pulse edge to a vertical reference line of the crt when the DISTANCE dial is at 000 or the ZERO REF CHECK button is pushed.
12	MULTI-PLIER	Two-position switch (red control) for X.1 or X1 multiplier. Affects both the DISTANCE dial and the FEET/ DIV control.
13	DISTANCE	Inicates the distance from the TDR to the point on the cable where the display window begins. Two ranges: 100 feet at X.1 or 1000 feet at X1. Disabled when the FEET/DIV is at 200 (FIND).

Table 2-1. TDR Front Panel Controls and Indicators – Continued

Figure 2-1 index no	Control or indicator	Function
14	FEET/DIV	Selects the horizontal deflection factor: X1=1 - 200 ft/div. X.1=0.1 - 20 ft/div.
15	CABLE DIELECTRIC SOLID POLY SOLID PTFE OTHER VAR	Three pushbuttons and a screwdriver adjust. Selects the proper velocity of propagation. VAR from 0.55 to 1.0 when the OTHER pushbutton is pressed. Fully cw if for air dielectric. VAR control has reference marks every 30° to indicate relative propagation constants.
16	RECORD/CAMERA	Two-position lever switch; pushed up and then released, it initiates X-Y Recorder or a Chart Recorder; pushed down, it floods the crt - during retrace to display graticule for photography.
17	AC LINE FUSES	Protection fuses for line power and battery charging circuits (0.3 A fuses for 115 Vac; 0.15 A fuses for 230 Vac).
18	X-Y OUTPUT MODULE	The standard plug-in module for the TDR. Used to drive an external X-Y Chart Recorder.
19	X, Y, and PEN LIFT	Six front panel jacks used for driving an external X-Y recorder. X jacks are for horizontal drive. Y jacks are for vertical drive. PEN LIFT jacks are for pen control.

Section II. OPERATION

WARNING

Be extremely careful when working in the vicinity of batteries when the battery ease is open. Do not use uninsulated tools. Do not wear rings or watches. Metal articles will, if allowed to contact connectors, cause severe arcing with possible injury to personnel and damage to the battery.

2-2. Operating Power Selection.

CAUTION

When substituting a dc power supply or external battery for the battery pack, be sure the polarity is correct (see figure 2-2).

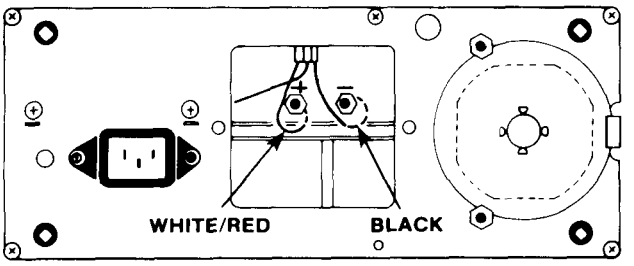

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Figure 2-2. Battery connector polarity

a. Battery Connections. A 12 Vdc power supply may be substituted for the TDR battery pack by removing the pack from the unit and connecting the power supply to the terminals inside the battery pack compartment.

The power pack can be stored at any temperature between -40°C and +50°C with the battery cells either fully or partially charged. The self-discharge rate of the cell increases with increased temperature. A fully charged battery will lose about 50% of its charge in 3 to 4 months if stored at +20°C to +25°C. Therefore, the battery pack should be completely recharged before using if it has been stored without power supplied to its charging circuit for more than a month.

When the TDR is wired for 230 Vac, be sure that the two front panel fuses are changed to 230 V, 0.15A slow-blow fuses and the proper plug is installed on the ac cable.

b. 230 Volt Operation. The battery charger is factory wired for 115 Vac or 230 Vac if Option 6 is ordered. The standard 115 Vac unit can be changed to 230 Vac operation by rewiring the line transformer. Figure 2-3 shows the proper wiring configuration for 230 V operation.

2-3. Turn-on Procedures.

NOTE

If crt displays no signal, check fault isolation paragraph 5-6.

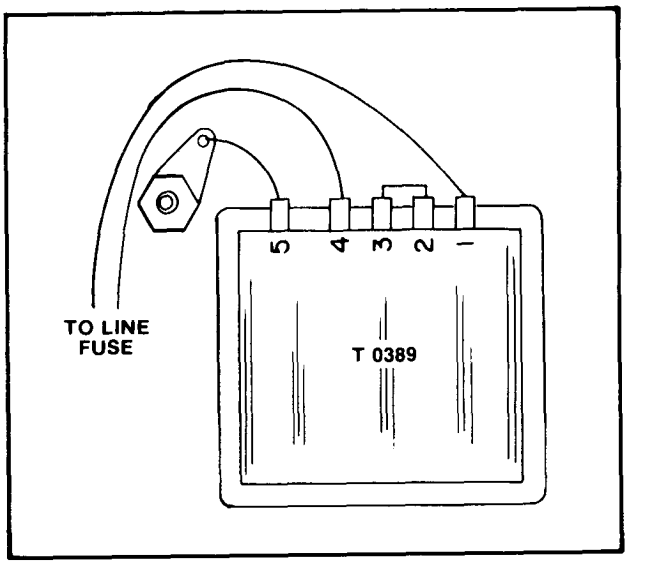

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Figure 2-3. 230 Vac transformer wiring

a. Preparation.

(1) To gain access to the front panel, pull the two side latches forward and remove cover. Using the handle of the TDR as a stand, position it to raise the unit to a convenient operating position (figure 1-1).

(2) The battery pack is fully charged in 16 hours when connected to an ac power source and the unit is switched off. The TDR may be operated while the battery pack is charging; however, the charging time will increase. The batteries will not overcharge if the charger is left on longer than 16 hours. Therefore, the TDR may remain connected to an ac source without damaging the batteries. Approximately once a month or every 15 -charge–discharge cycles, the batteries should be charged for approximately 24 hours.

Approximately 30 minutes of operating time can be expected from a 1-hour partial charge. To avoid reverse charging, the full 16 hour charge should be completed in preference to a partial charge whenever possible.

b. Control Settings (TDR).

(1) Set front panel controls as follows:

FOCUS	Midrange
INTENSITY	Full range
ZERO REF	Fully cw
POSITION	Midrange
mρ /DIV	500
DISTANCE	000
FEET/DIV	1
X1-x1	X1
CABLE DIELECTRIC	SOLID POLY
POWER	ON

(2) Adjust INTENSITY and FOCUS controls for a clear bright trace.

(3) Adjust POSITION controls to set trace 2 divisions below horizontal centerline.

(4) Attach precision 50 Ω cable (012-0482-00) to CABLE connector (stored in cover).

(5) Turn ZERO REF SET button ccw until incident pulse edge is located on a vertical reference line. The incident pulse edge is the initial rise of the step pulse. The vertical reference line may be any line you choose from center line to left side of crt graticule. An arrow in the second vertical line indicates a commonly used reference line.

NOTE

The reflected pulse from the open end of the 50 Ω cable should appear three horizontal divisions to right of reference line. Open end of cable is indicated by start of a second rise in trace (see figure 2-4).

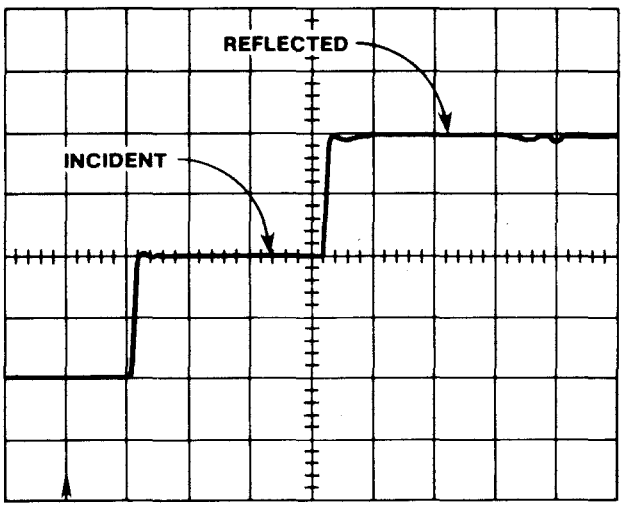

Figure 2-4. Incident and reflected pulses

(6) Turn ZERO REF SET button throughout its range to see that the incident pulse edge can be set on any vertical graticule line. Set incident pulse edge on vertical reference line.

(7) Set DISTANCE dial to 050 and check that top of step (open cable reflection) is displayed.

(8) Press ZERO REF CHECK button and check that incident pulse edge returns to vertical reference line of graticule. Reset DISTANCE dial to 000.

(9) Change mρ /DIV to 50 and adjust POSITION controls so top of incident pulse is on horizontal centerline.

(10) Press NOISE FILTER pushbutton and check for a reduction in displayed noise as well as a reduction in scan rate. Reset mρ /DIV to 500, and release (by depressing a second time) NOISE FILTER button.

(11) Press and hold CAMERA switch. Note crt display; entire crt should be flooded on retrace to illuminate graticule when taking photographs. Release CAMERA switch.

(12) Lift up and hold RECORD switch. Check that bright spot appears at left edge of crt.

(13) Release RECORD switch. Slow scan of spot will trace displayed waveform. When scan is complete TDR will automatically return to its normal mode of scanning.

c. Control Settings (Accessories).

NOTE

The X-Y OUTPUT MODULE is wired for either a positive or negative pen lift signal. Before using the X-Y OUTPUT MODULE , be sure that the pen lift circuit on the etched circuit board is properly connected. Figure 2-5 shows the proper connection for either a positive or negative pen lift signal.

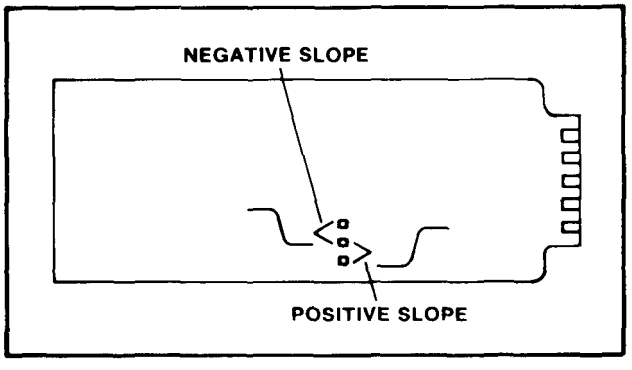

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Figure 2-5. X-Y output module strap

(1) If not already in place, install X-Y OUTPUT MODULE into its compartment on front panel of TDR.

(2) Connect X, Y, and PEN LIFT inputs of recorder to corresponding jacks of X-Y OUTPUT MODULE.

(3) Position and hold RECORD/CAMERA switch to RECORD to prepare for recording.

(4) To position stylus at desired position on paper, adjust STYLUS POSITION screw while RECORD/CAMERA switch is in the RECORD position.

(5) Release RECORD/CAMERA to precede with recording. Chart record circuits automatically shut off when recording is completed.

NOTE

In evaluating a graph, the distance between two dark horizontal lines corresponds to one vertical division of the crt display with respect to the mρ/DIV setting; the distance between two dark vertical lines corresponds to one horizontal division of the crt display with respect to the FEET/DIV setting.

d. Use of Accessories.

(1) Mesh Filter for the crt. A mesh filter is provided with the TDR which makes viewing of the crt easier when the unit is being used in the sunlight. This filter is placed over the crt by sliding it onto the slots of the crt bezel.

(2) Viewing Hood. The viewing hood provides shading for the crt and can be installed over the crt by sliding it down over the crt bezel sides. The mesh filter must be removed before the viewing hood will connect to the crt bezel.

(3) Using a Camera with the TDR. If a Camera Adapter (Tektronix Part Number 016-0327-00) is attached to the crt bezel of the TDR, a C–30A/31 camera can be used to take photographs of the crt display. To obtain graticule illumination, the RECORD/CAMERA switch must be pushed down and held while the photograph is being taken. After the trace is completed the entire crt is flooded to provide a light background to allow the dark graticule to appear in the photograph.

2-4. Cable Testing.

CAUTION

Do not connect live circuit cables to the input of the TDR. Voltages in excess of 5 volts can damage the sampling gate or tunnel diode.

Bleed cables before connecting them to the TDR to remove static charge from them. The 50 ohm termination and BNC adapter supplied may be used to bleed any cable charge.

When testing antennas, be sure that you are not close to transmitters that can be keyed at the antennas receiving frequency. Keying of transmitters in close proximity can cause damage to the TDR.

a. Connecting a Cable for Testing.

(1) Connect cables to be tested by the TDR to the BNC connector (CABLE) on the front panel. Use connector/adapter as required.

(2) Adjust FOCUS and INTENSITY controls for a sharp and bright display on the crt.

b. Locating a Discontinuity in a Cable.

The DISTANCE dial and the FEET/DIV control make it possible to evaluate cables as long as 2000 feet. The entire length can be displayed directly on the crt if desired. If a chart recorder is used, only that portion of the trace seen on the crt will be recorded on the graph. To check cables using the crt, proceed as follows:

(1) Set crt display window so it is longer than the cable under test by setting the FEET/DIV control and the X1/X.1 control, For example, if the cable is 150 feet long, set the FEET/DIV to 200 and the multiplier at X.1.

NOTE

Use the X.1 multiplier whenever possible to lessen the effects of jitter.

(2) Measure the distance between the incident pulse rise and the reflected pulse rise.

NOTE

The distance from the sampling bridge to the CABLE connector (2. 5 inches) should be taken into account when measuring cables less than 2 feet in length.

(3) To more accurately locate the discontinuity, set the FEET/DIV control to a lower setting. (The reflected pulse does not need to be in the display window). Push the ZERO REF CHECK button and adjust the ZERO REF SET control so that the incident pulse rise is set at a convenient vertical reference graticule line. The ZERO REF SET contol may have to be readjusted when changing the FEET/DIV control.

NOTE

Always set the incident and reflected pulse to the 10% points of their amplitude (see figure 2-6).

(4) Turn the DISTANCE dial clockwise until the reflected pulse is located on the reference graticule line. The reading on the DISTANCE dial times the multiplier gives the length from the CABLE connector to the end of the cable (or to the discontinuity).

NOTE

When checking cables longer than 1000 feet, adjust the DISTANCE dial until the reflected pulse reaches the right-hand

edge of the graticule, then add the graticule display distance to that on the DISTANCE dial for the total length. The reading of the DISTANCE dial, plus the number of divisions (from the reference line) across the graticule times the FEET/DIV setting gives the total length of the cable. Remember that in the 200 FEET/DIV setting the DISTANCE dial is inoperative.

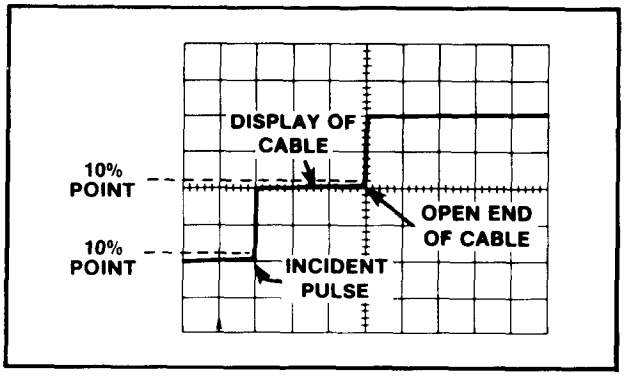


Figure 2-6. Crt display of pulse

(5) The CABLE DIELECTRIC pushbuttons allow the TDR to accurately locate discontinuities in cables of various relative propagation velocity constant (V_p). The SOLID POLY button is calibrated to check solid polyethylene dielectrics which have a V_p of 0.66. The SOLID PTFE button is calibrated to check solid polytetrafluoroethylene (Teflon) which has a V_p of 0.70. The OTHER button is variable from 0.55 to 1.00 and is controlled by the screwdriver adjustment control VAR. When this screwdriver control is turned to the fully clockwise position, it is calibrated for air dielectrics which have a V_p of 1.00. If all three of the CABLE DIELECTRIC buttons are released, a default condition leaves the instrument calibrated for air dielectrics (V_p) = 1.00).

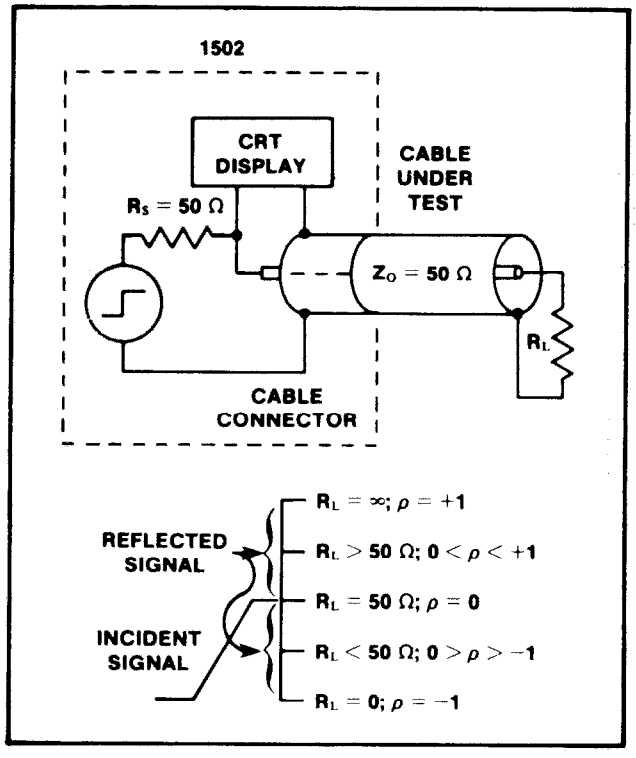
c. Evaluating a Discontinuity. The mρ /DIV control determines the vertical deflection that can be seen on the crt or recorded on a graph if a chart recorder is used. This control is calibrated to measure the ratio of the reflected signal amplitude to the incident signal amplitude in rho (ρ), which is called the voltage reflection coefficient. Rho (ρ) is the measurement of reflected signal amplitude and can be used to determine the impedance of a discontinuity. Note that no reflection is obtained from a cable that has no discontinuities if the cable is terminated with its characteristic impedance. If a cable has an open, i.e., a break (infinite impedance), the reflected step amplitude is +1 ρ; and if a cable has a short (zero impedance), the reflected step amplitude is -1 ρ.

(1) Figure 2-7 shows the two parts of a TDR display labeled to identify the incident and reflected voltage signals. When ρ =0, the transmission line is terminated by a resistance equal to its characteristic impedance (Z_0) which, in this case, is 50 Ω. When ρ equals +1, the transmission line load is a short. If the line is terminated by $R_L > 50$ Ω, ρ is positive and if the line is terminated by $R_L < 50$ Ω, ρ is negative.

(2) Figure 2-8 is a chart for converting reflected pulse amplitude to impedance. Rho is dependent on the characteristic impedance, Z_0, of the cable under test and the load (or the impedance of the discontinuity), R_L, on the cable. Therefore, a ρ can also be defined as:

$$\rho = \frac{R_L - Z_0}{R_L + Z_0}$$

d. Typical Cable Problems. A few of the cable problems that can be analyzed with the TDR include opens, shorts, pinholes in the cable shield, opens in the shield, kinks in the cable, mismatched connectors, and corroded connectors.



AR 918059

Figure 2-7. TDR display of R_L vs Z_0

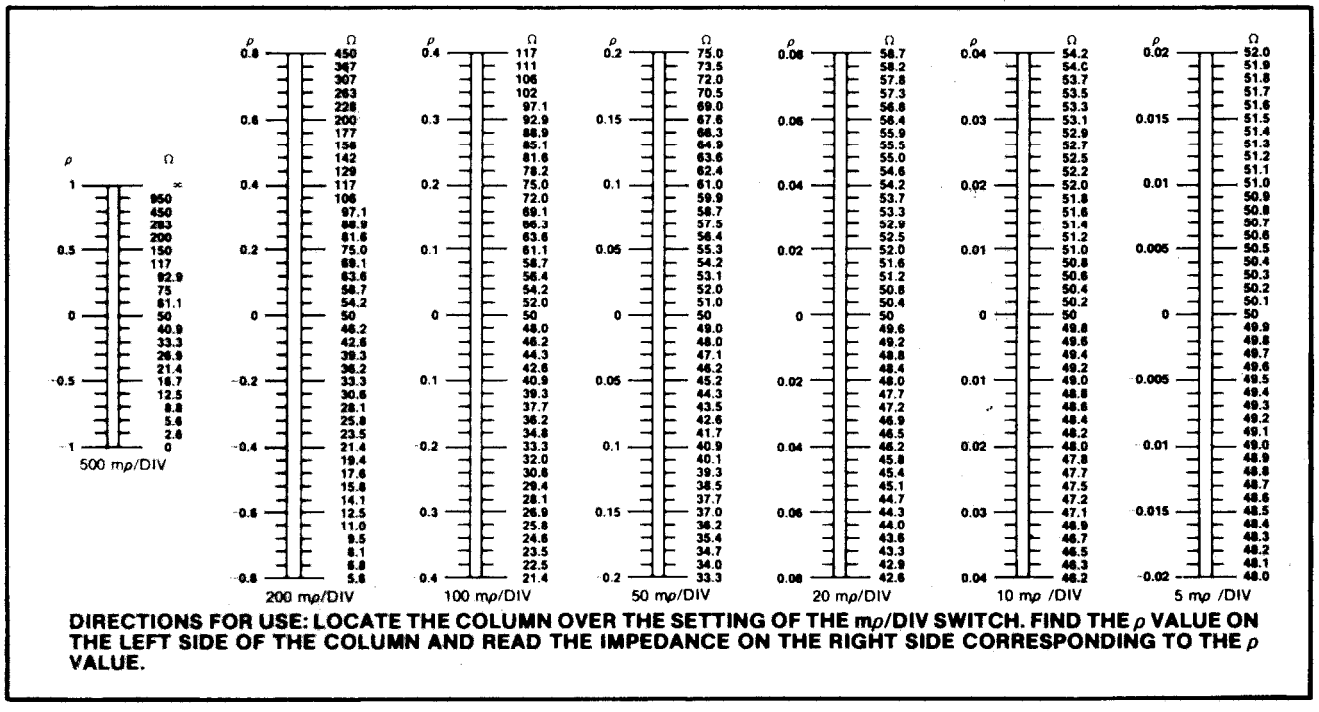


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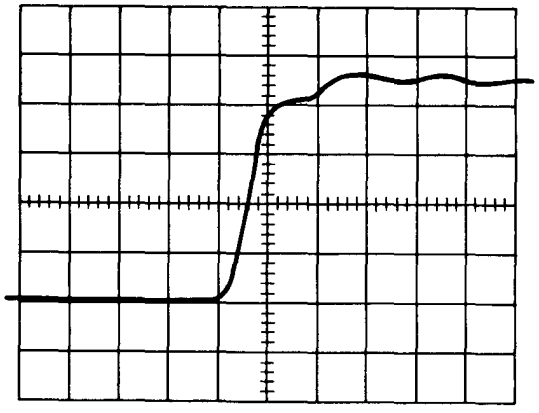
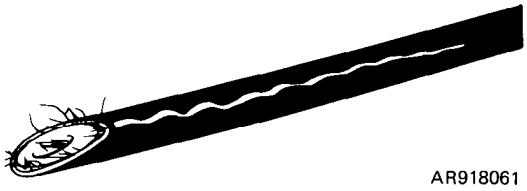
Figure 2-8. Impedance nomograph

Figures 2-9 through 2-12 show typical examples of these problems.





AR918061

Figure 2-9. Open cable

e. Checking Cables with Other than 50 Ohms Impedance.

(1) Cables with a characteristic impedance other than 50 Ω can be evaluated by adjusting the GAIN control (screwdriver adjust) to correct the reflected pulse for +1 ρ at the open end of a cable. When the GAIN is changed, the incident pulse will no longer be 1 ρ.

(2) To reset the GAIN for an impedance other than 50 Ω , either connect an impedance-matching adapter (50 to 75 Ω, 50 to 93 Ω, 50 to 125 Ω, etc.) to the CABLE connector and connect a short length of cable (with impedance the same as the adapter, i.e., 75 Ω, 125 Ω, etc.) to the adapter or connect the cable to be tested to the CABLE connector. With the mρ /DIV control set at 500, position the trace on the graticule so that the display of the cable appears in the display. Now

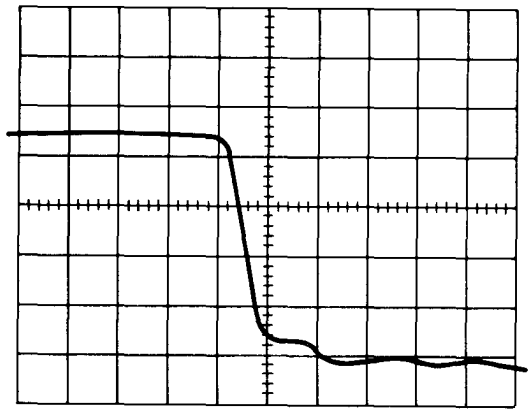


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Figure 2-10. Shorted cable

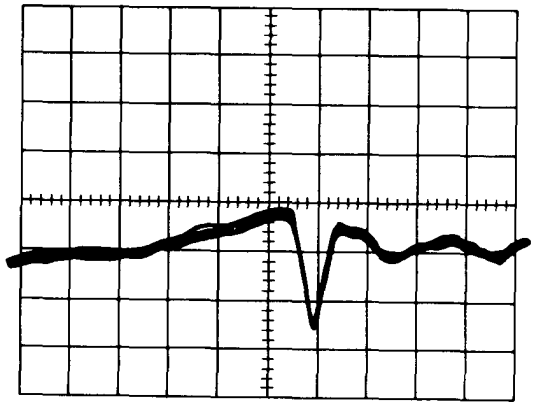

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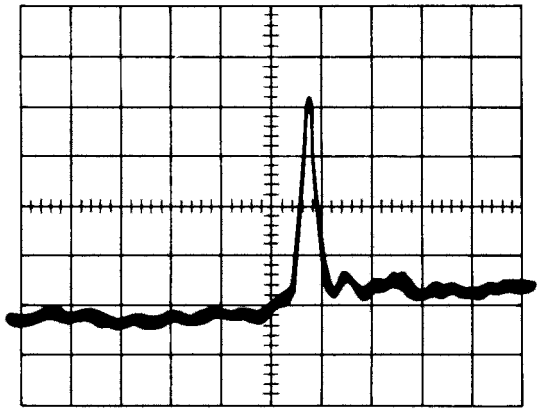
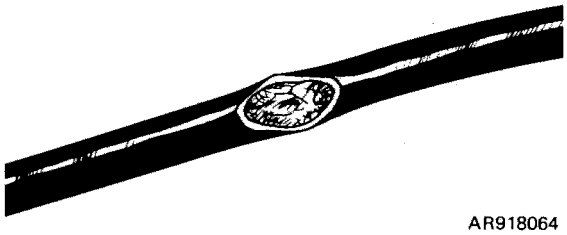
Figure 2-11. Crimped cable



adjust the GAIN control so that the open end display (reflected pulse) is set 2 divisions above the cable display (horizontal centerline). This sets the reflected pulse to +1 ρ : from the characteristic impedance.

NOTE

If an impedance adapter is not used, secondary reflections will re–appear as discontinuities beyond the open end of the cable.



AR918064

Figure 2-12. Frayed cable

CHAPTER 3

SERVICE AND PREVENTIVE MAINTENANCE

Section I. SERVICE UPON RECEIPT OF MATERIAL

3-1. Unpacking and Inspection. When the TDR is received, it will be packed in a corrugated cardboard carton. Inside packing and re-enforcement is also fabricated from corrugated cardboard. Gain access to the TDR by carefully cutting the sealing tape on top of the carton, open carton, remove the top packing, and withdraw TDR from carton, Carton should be stored for future use in reshipping. Visually inspect the TDR for damage. Release cover and inspect front panel and controls for damage. Open inside cover. Remove, unwrap and check for all items listed in table 1-1 and inspect all items for damage.

3-2. Checkout Procedures. Perform procedures given in paragraphs 2-3 a and b to ensure the equipment is in operational condition.

Section II. REPAIR PARTS , SPECIAL TOOLS AND EQUIPMENT

3–3. Repair Parts. Repair parts are listed in Appendix C of this manual.

Section III. LUBRICATION

3-4. General. This equipment does not require periodic lubrication.

Section IV. PREVENTIVE MAINTENANCE

WARNING

Dry cleaning solvent or mineral spirits paint thinner is flammable and should not be used near an open flame. Fire extinguishers should be provided when these materials are used. Use only in well ventilated areas.

3-5. General. Preventive maintenance consists of cleaning, visual inspection, etc. Preventive maintenance performed on a regular basis will help improve the reliability of the instrument. The severity of the environment to which the TDR is subjected determines the frequency of needed maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

3-6. Cleaning.

a. General. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulting blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

b. Interior. The TDR is constructed in a manner that protects the interior of the instrument from dust.

NOTE

When the cabinet is removed, the watertight integrity may be compromised. See the instructions (in this section) on removing and replacing the cabinet.

Therefore, the interior of the TDR should not require cleaning unless the unit has been left with the front cover removed and the plug–in compartment empty. The best way to clean the interior is to blow off the accumulated dust with low–pressure air. Remove any dirt that remains with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces on circuit boards.

CAUTION

Avoid the use of chemical cleaning agent which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xy–lene, acetone or similar solvents.

c. Exterior. The cabinet exterior can be washed with soap and water and rinsed with clear water. Loose dust accumulated on the front panel is best removed with a small brush or a soft cloth dampened with a mild detergent and water solution. Abrasive cleaners should not be used on the front panel.

d. CRT Implosion Shield. The face of the crt can be cleaned by using isopropyl alcohol applied and wiped very gently dry with lens paper (NSN 6640-00-559-1385).

3-7. Servicing battery. The battery pack should be inspected every two months. The entire battery pack should be replaced if venting or corrosion has occurred.

3-8. Water-tight Seals. The TDR is prepared to be operated in any weather (rain, snow, dust, etc.). To prevent moisture and dust from getting inside the instrument, special seals are used around the pushbuttons, crt, power switches, and rotary controls. Removal of any of the components on the front panel will require special resealing procedures to retain their water–tight integrity.

3-9. Calibration. To ensure accurate measurements, check the calibration every 120 days. Refer to Calibration Procedure Technical Bulletin for Time Domain Reflectometer, Tektronix Type 1502-1, TB 11-6625-2860-35 for calibration procedures.

CHAPTER 4

FUNCTIONAL ANALYSIS

4-1. Simplified Circuit Analysis. The TDR uses radar principles to check cable conditions. The pulser circuits transmit the pulses down the cable under test, and the sampler circuits sample the echos and provide the vertical signal for display on the crt.

a. Pulser. The pulser is basically a tunnel diode in a 50 ohm strip line (cavity). It contains all biasing and timing circuits required for operation of tunnel diode CR1703.

b. Sampling.

(1) Sequential equivalent-time sampling is used to develop a display (see figure 4-1). Two ramps are generated, a fast ramp and a slow ramp. The fast ramp is compared to the slow ramp or a fixed reference to generate trigger pulses for the sampler and the pulser respectively. These comparisons are made by the pulser and sampler comparators.

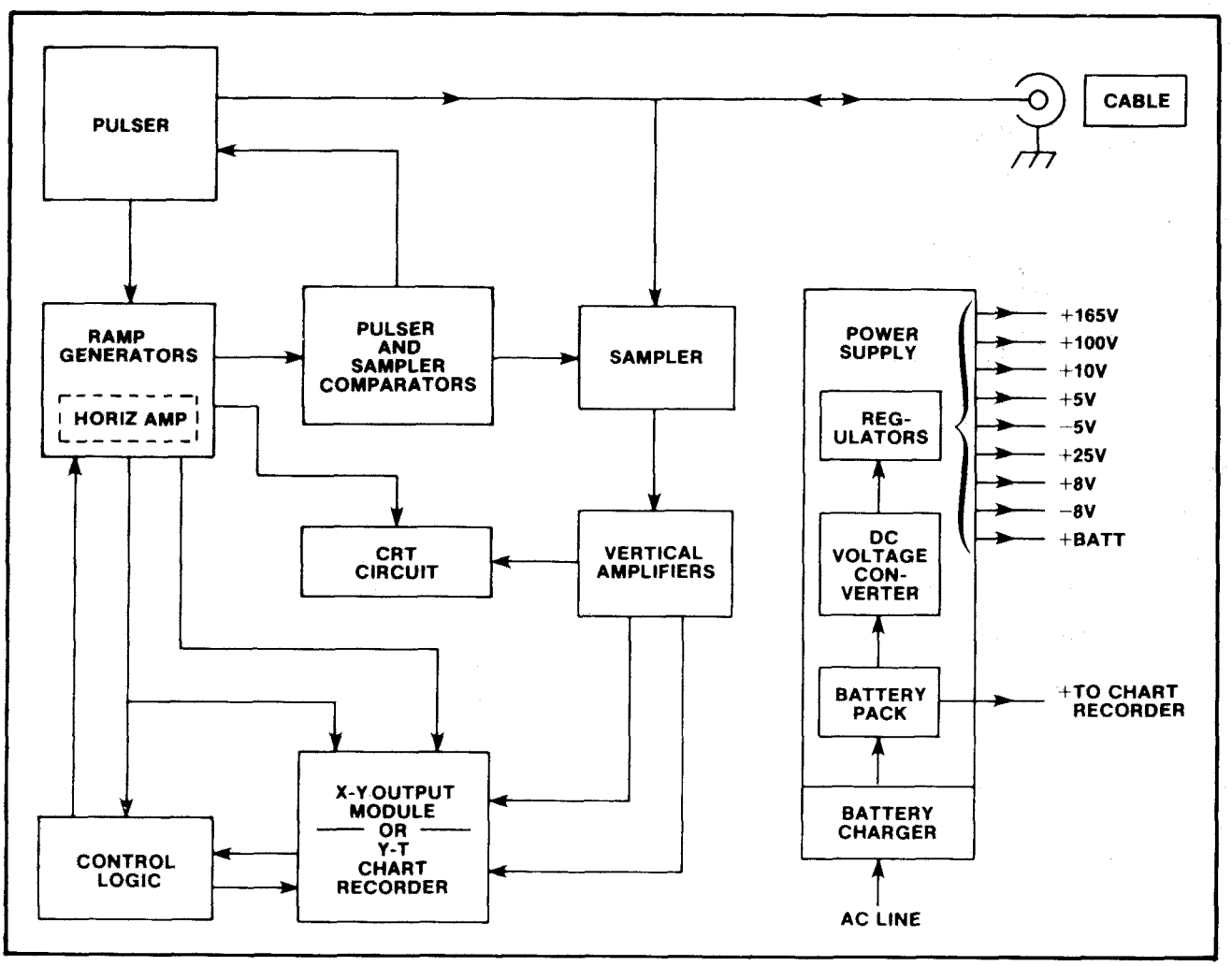


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Figure 4-1. Simplified block diagram

(2) A short time after the pulser transmits the step pulse into the cable under test, depending on the amplitude of the slow and fast ramps, a sampling trigger from the sampler comparator causes the sampler to sample–and–hold the voltage level appearing at that time. This voltage is taken at the point where the sampler is connected to the 50 ohm strip line. This voltage sample is amplified and sent through the vertical amplifiers to the crt.

(3) The slow ramp generator provides the horizontal sweep for the crt and, combined with the vertical sample, provides a display of the sampled value. Ensuing sampling triggers taken later during the next fast ramp time, cause additional samples to be displayed next to the first one, until a line of very short dashes is formed across the crt, appearing as a solid line (figure 4-2).

c. Chart Recorder.

(1) The amplified vertical and ramp signals are also sent to X–Y interface connectors. These signals, along with a pen lift control signal, provide the information for driving external X-Y recorders.

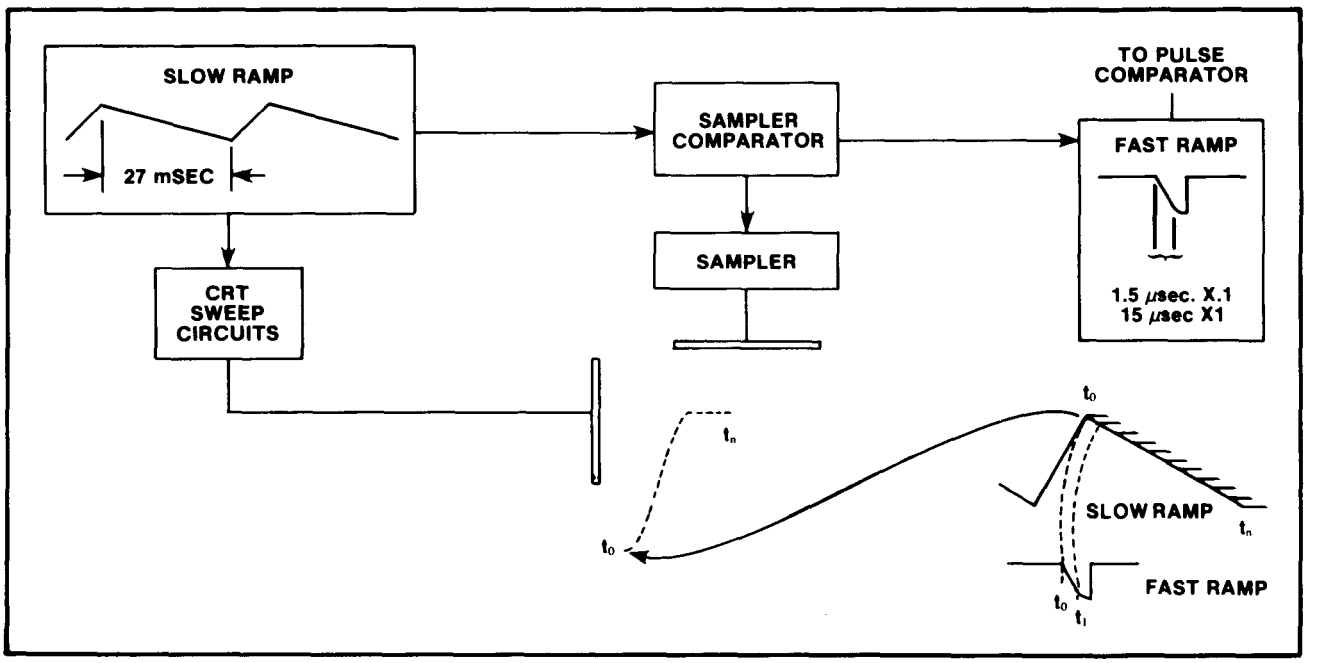

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Figure 4-2. Simplified sampling diagram

CHAPTER 5

PERFORMANCE CHECKS/ FAULT ISOLATION

Section I. GENERAL

5-1. Introduction. This chapter provides detailed performance checks for the TDR. Performance checks may be made without any test equipment. Performing the checks will also identify a fault present in the equipment.

Section II. PERFORMANCE CHECKS

5-2. Preparation for Performance Checks.

a. Ensure that a battery is installed in the TDR.

b. Connect TDR to ac power source.

c. Pull the POWER switch to turn the unit on. BATTERY meter will indicate the relative level of charge on the battery pack. If the battery pack is fully charged (charged for 16 hours), the BATTERY meter needle will be approximately at the top mark on the meter.

5– 3. Performance Checks.

a. Perform procedures given in paragraph 5-2 and then set front panel controls as follows:

INTENSITY	Fully cw
ZERO REF	Fully cw
POSITION	Midrange
mρ/DIV	500
DISTANCE	000
NOISE FILTER	Out
FEET/DIV	200
MULTIPLIER	X1
CABLE DIELECTRIC	
SOLID POLY	In
SOLID PTFE	Out
Other	Out
VAR	Fully cw

b. Preset the POSITION and GAIN controls so the trace is on screen and the amplitude is approximately 4 divisions. Adjust the FOCUS and INTENSITY controls for a clear, bright trace.

FEET/DIV	200
MULTIPLIER	X1
CABLE DIELECTRIC	
SOLID POLY	In
SOLID PTFE	Out
Other	Out
VAR	Fully cw

b. Preset the POSITION and GAIN controls so the trace is on screen and the amplitude is approximately 4 divisions. Adjust the FOCUS and INTENSITY controls for a clear, bright trace.

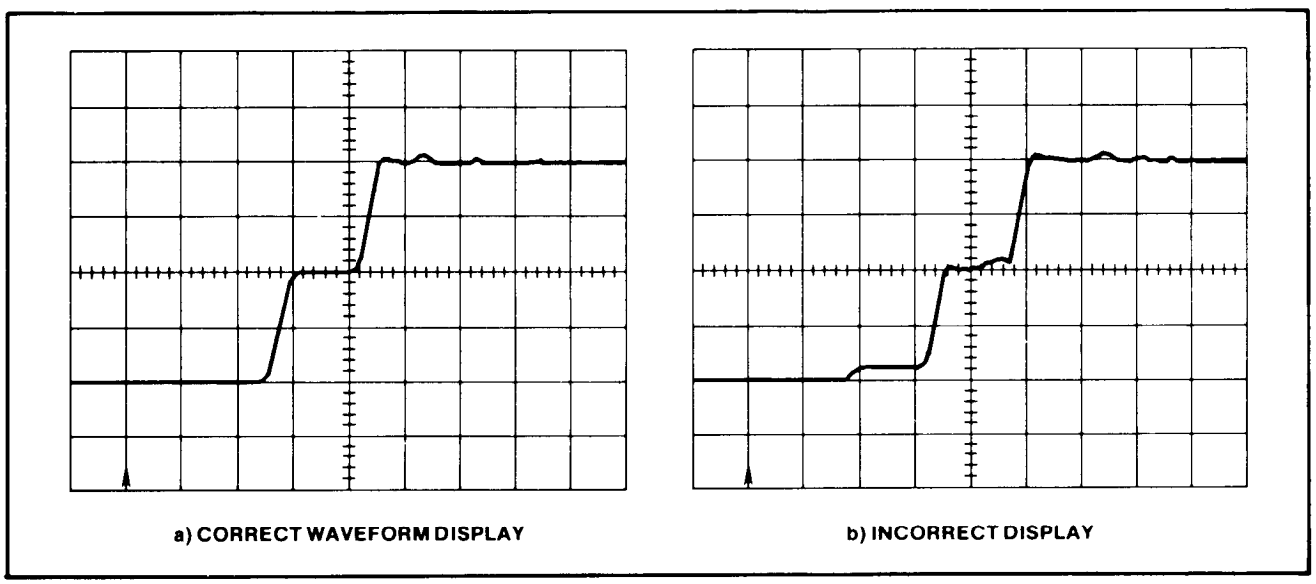
c. Adjust the GAIN control so that the total amplitude of the display is exactly 4 divisions. If incorrect, forward TDR to depot for repair.

d. Set FEET/DIV control to 2 and MULTIPLIER to X1.

e. Turn the ZERO REF SET control counterclockwise to locate the pulse at center screen. Check for correct waveform as shown in figure 5-1a. If the display is not correct, forward TDR to depot for repair.

f. Connect the precision 50 Ω terminator (Tektronix Part No. 011-0123-00) to the CABLE connector. Turn the GAIN control fully counterclockwise and note the

amplitude of the pulse. Turn the GAIN control fully clockwise. The amplitude should be 4 times greater than the amplitude with the GAIN control fully counterclockwise. (Adjust the POSITION control as necessary.)



AR 918073

Figure 5-1. Pulse display

g. Set the mρ/DIV control to 200, the FEET/DIV control to 20 and the MULTIPLIER control to X1.

h. Adjust the ZERO REF SET control so that the pulse is at the center of the screen. Adjust the GAIN control for exactly 5 divisions of amplitude.

i. Change the mρ/DIV control to 500 and remove the 50 Ω terminator. The amplitude of the pulse must be 4 divisions ±0.12 division (±0.6 minor division). If not, forward the TDR to depot for repair.

j. Set the FEET/DIV control to 1 and adjust the ZERO REF SET control so the leading edge of the incident pulse is set on the vertical centerline.

k. Change the MULTIPLIER control to X1. The leading edge of the incident pulse must be within 1 division of the vertical centerline. (If not, check the X1 Position calibration, para. 5-5k (5). If still incorrect, forward TDR to depot for repair.

l. Attach the 3 foot precision cable (Tektronix Part No. 012-0482-00) to the CABLE connector and change the FEET/DIV control to 5. Adjust the ZERO REF SET control to locate the incident pulse on the graticule reference line (as indicated by the arrow on the graticlde line). The reflected pulse should be 6.3 divisions to the right of the incident pulse.

m. Adjust the DISTANCE dial until the reflected pulse is located on the graticule reference line. The DISTANCE dial should read 031.5 ± 1 digit.

NOTE

When using the more sensitive ranges of the FEET/DIV control, the 0.3 foot between the CABLE connector and the sampler must be taken into consideration.

n. Push the ZERO REF CHECK button; the incident pulse should return to the graticule reference line. If the incident

pulse does not return to the graticule reference line, adjust the ZERO REF SET control so that the incident pulse is located on the graticule reference line. Release the ZERO REF CHECK control and check that the reflected pulse is located on the graticule reference line. Adjust the DISTANCE dial if necessary; it must remain 031.5±1 digit. (If incorrect, forward TDR to depot for repair). Return the DISTANCE dial to 000 when this step is completed.

NOTE

To more accurately check the DISTANCE dial, a known length of solid polyethylene (V_p=0.66) cable (1000 to 1600 feet) should be used.

o. Change the FEET/DIV control to 20, the MULTIPLIER control to X1, and the mρ/DIV control to 200. Adjust the ZERO REF SET control so that the reflected pulse is located exactly on the eighth graticule line from the left-hand edge of the graticule.

p. Adjust the DISTANCE dial to locate the reflected pulse on each graticule line. The DISTANCE dial should read as follows (if incorrect, forward TDR to depot for repair):

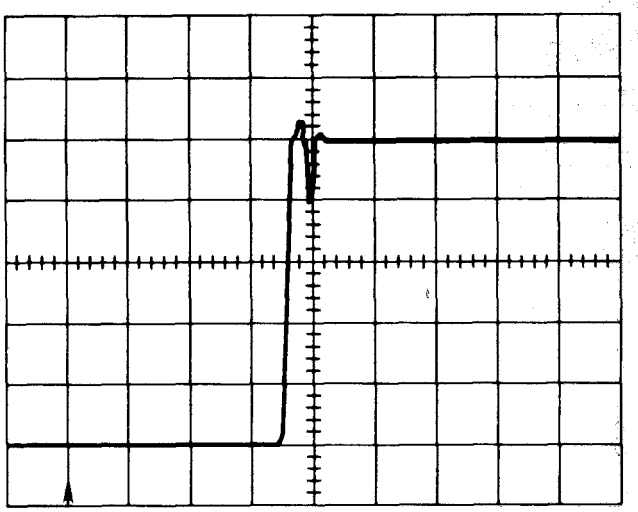
Graticule Line	Distance Dial Reading
8	000
7	020±1 digit
6	040±1
5	060±1.2
4	080±1.6
3	100±2
2	120±2.4
1	140±2.8
0	160±3.2

q. Return the DISTANCE dial to 000, change the MULTIPLIER control to X1 and repeat the above step.

r. Push the SOLID PTFE button (do not readjust the ZERO REF SET control) and adjust the DISTANCE dial so that the reflected pulse is located on the 0 graticule line (first vertical line at left edge of graticule). The DISTANCE dial should read between 167 and 173. Push in the OTHER button (VAR control must be fully cw) and locate the reflected pulse on the 0 graticule line with the DISTANCE dial. The DISTANCE dial should read between 240 and 250. (If incorrect, forward TDR to depot for repair). Return the DISTANCE dial to 000 when this step is completed.

s. Change the FEET/DIV control to 1, the MULTIPLIER control to X1, disconnect the 3 foot cable from the CABLE connector, and connect the precision 50 Ω terminator to the CABLE connector. Adjust the ZERO REF SET control to locate the pulse on the graticule center. Adjust the POSITION control to center the pulse on the graticule.

t. Check that the jitter is not greater than 0.1 division (200 ps) (see figure 5-2),



AR 918074

Figure 5-2. Jitter check

u. Change the MULTIPLIER control to X1 and adjust the ZERO REF SET control to locate the pulse on the graticule center. Check that the jitter is not greater than 0.2 division (40 ps). If not, forward TDR to depot for repair.

v. Change the mρ/DIV control to 50, and turn the POSITION control counterclockwise to display the top of the trace on the graticule, then adjust the ZERO

REF SET control to locate the pulse on the reference graticule line.

w. Set the DISTANCE control to 500 and adjust the POSITION controls to center the trace on the graticule, then return the DISTANCE dial to 000.

x. While viewing the trace, adjust the DISTANCE dial from 000 to 100. The trace must remain within ±1 division of the centerline (±5% peak for the first 10 feet of rise) (see figure 5-3).

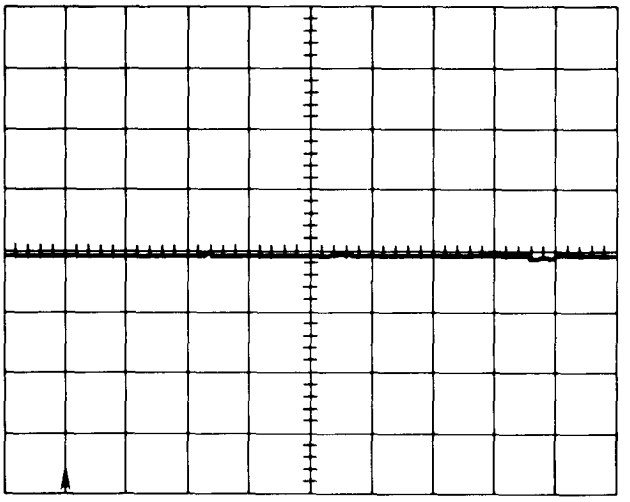


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Figure 5-3. Position check

y. Change the mρ /DIV control to 5, set the DISTANCE dial to 500, re-center the trace, then return the DISTANCE dial to 100.

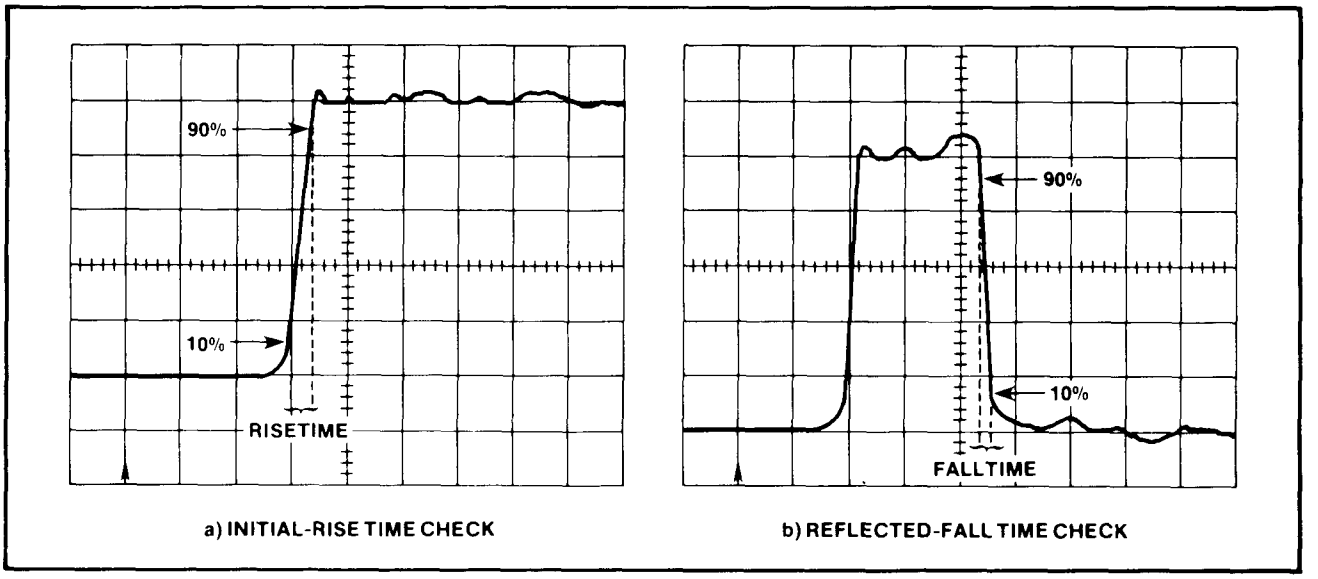
z. While viewing the trace, adjust the DISTANCE dial from 100 to 999. The trace must remain within ±1 division of the centerline (0. 5% peak beyond 10 feet).

aa. Return the DISTANCE dial to 100 and push the NOISE FILTER button. While viewing the trace, adjust the DISTANCE dial from 100 to 999. The trace must remain within ±0.4 division of the centerline (0.2% peak beyond 10 feet with noise filter). If there is a problem with aberrations or noise, forward TDR to depot for repair.

ab. Release the NOISE FILTER button, return the DISTANCE dial to 000, and set the mρ/DIV control to 200.

ac. Adjust the POSITION control so the entire incident pulse is displayed on the crt and check that the rise time is less than 0.55 division (100ps or 0.055 foot). See figure 5-4 for definition of rise time.

ad. Remove the 50 Ω terminator from the CABLE connector and connect a shorted terminator to the CABLE



AR 918076

Figure 5-4. Rise time and fall time

connector. Adjust the POSITION controls so the entire reflected pulse is on the crt. Check that the fall time is less than 0.7 division. Remove the shorted terminator from the CABLE connector.

ae. Push the RECORD/CAMERA switch to CAMERA and see that fogging oscillations fill the entire crt during retrace. (If fogging does not occur, return to depot.)

5-4. Detailed Performance Checks.

a. Introduction. This paragraph gives the detailed procedure recommended for verifying that a TDR performs according to specifications. The X-Y OUTPUT MODULE will be covered in this procedure.

b. Equipment Required. Digital multimeter, Fluke Model 8000A or equivalent. This will be referred to as DM 8000A or DM.

c. Preliminary Connections and Set-Up.

(1) Remove the battery pack from the rear of the TDR case. Remove the front cover of the TDR.

(2) Loosen the four screws at the rear of the case and set the unit face up, Push down on the handle to break the seal; then place it face down on a flat surface. Take hold of the sides of the case and pull free.

(3) Remove the EMI shields from the top and bottom of the unit. Place the battery pack in the rear of the TDR, taking care that the polarity is correct. Connect the ac power cord to the ac outlet, at the rear of the unit, and to a 115 Vac (230 Vac for Option 6) power source.

(4) Pull the POWER switch to turn the unit on and allow 20 minutes warm-up before proceeding with checks.

(5) Preset the front panel controls as follows:

INTENSITY	Fully cw
ZERO REF SET	Fully cw
POSITION	Midrange
mρ /DIV	500
NOISE FILTER	Out
GAIN	Fully cw
DISTANCE Dial	000
FEET/DIV	200 (FIND)
MULTIPLIER	X1
FOCUS	Adjust for a
CABLE DIELECTRIC	clear trace
SOLID POLY	In
SOLID PTFE	Out
Other	Out
VAR	Fully cw

(6) Set the DM 8000A RANGE/FUNCTION control of the digital multimeter to 200 DC VOLTS. Connect the test leads to the V-Ω common INPUT terminals.

d. Power Supply Checks. Power supply checks are not to be considered performance checks. The location of the test points are shown in figure 5-5. See table D-1 for location of board. Measure the supply voltages with the digital multimeter (Fluke 8000A).

e. Voltage Measurements.

(1) Connect the lead from the common terminal to TP 6332 (black test point) on the TDR power supply board.

(2) Connect the lead from the V-Ω terminal to TP 6256 (red test point).

(3) Adjust R6358 (HV ADJ) so the voltmeter reads +25 V (±0.25) V.

(4) Move the test lead from TP6256 to TP6411 (violet test point).

(5) Change the RANGE/FUNCTION switch to 20 Vdc.

(6) Adjust R6514 (+10 ADJ) so the voltmeter reads +10 V, ±0.1V.

(7) Move the test lead from TP6411 to TP6227 (green test point) and check that the voltmeter reads +5 V ±0.25V.

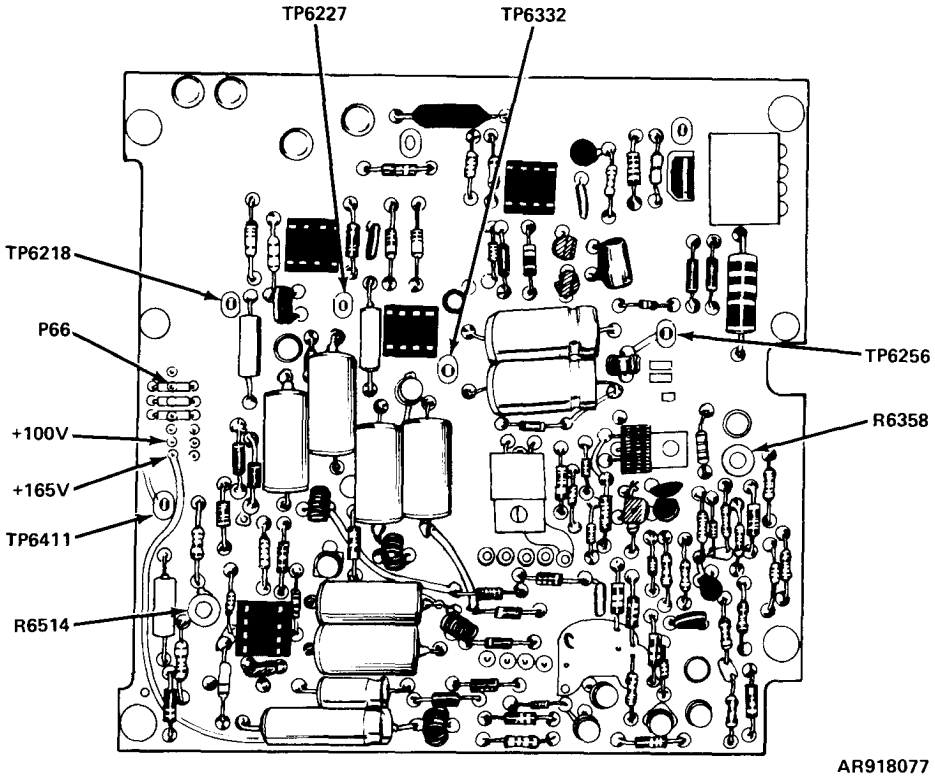


Figure 5-5. Power supply board test points and adjustments

(8) Move the test lead from TP6227 to TP6218 (orange test point) and check that the voltmeter reads -5 V ±0.25 V.

(9) Change the RANGE/FUNCTION switch to 200 Vdc.

(10) Move the test lead from TP6218 to connector P66 pin 6 (see figure 5-5) and check that the voltmeter reads +100V; tolerance +20 V, -5V.

(11) Move the test lead from P66 pin 6 to P66 pin 7 and check that the voltmeter reads +165 V; tolerance +25 V, –5V.

f. CRT Check.

(1) Attach the precision cable to the CABLE output.

(2) Check for a step pulse on the crt.

g. Trance Focus and Astigmatism.

(1) Set the FEET/DIV to 2 with the MULTIPLIER control to X1.

(2) Locate the trace with the ZERO REF SET at the center of the graticule.

(3) Set the front panel FOCUS control for the clearest possible trace.

(4) Remove the precision cable.

h. Trace Rotation.

(1) Set the mρ/DIV control to 200.

(2) Turn the ZERO REF SET fully clockwise and adjust the POSITION controls so that the trace is located on the horizontal centerline.

(3) Check that the trace aligns with the horizontal centerline.

i. Trace Geometry.

(1) Move the trace with the POSITION controls so that it is located 3 divisions below the horizontal centerline.

(2) Check that the trace aligns with the graticule line (has no bow).

(3) Move the trace with the POSITION controls so that it is located 3 divisions above the horizontal centerline.

(4) Check that the trace aligns with the graticule line (has no bow).

(5) Recheck the trace rotation and focus.

j. Vertical Checks.

(1) Pulse Strobe and Rise Time.

(a) Set the mρ /DIV control to 500.

(b) Use the ZERO REF SET and POSITION controls to locate the pulse at the graticule center.

(c) Check that the incident and reflected pulse both have equal amplitudes (see figure 5-6 for the correct display).

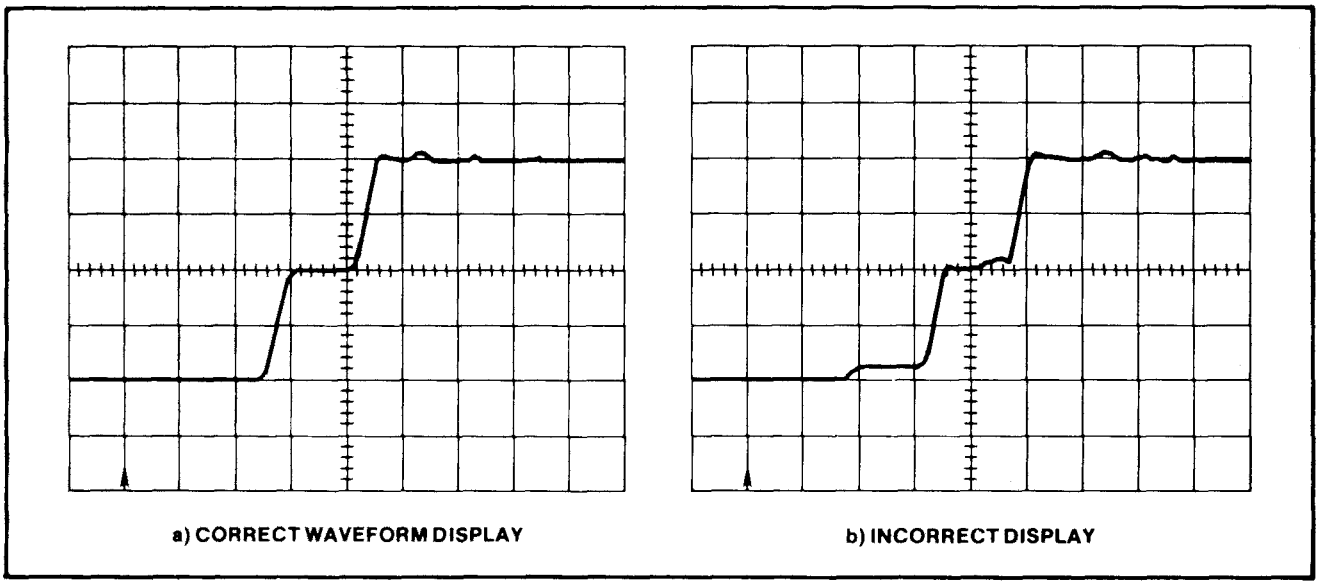


Figure 5-6. Pulse display AR918079

(2) Loop Gain.

(a) Set the FEET/DIV to 200, MULTIPLIER to X1, and mρ/DIV to 200.

(b) Connect the precision 500 terminator (Tektronix Part No. 011-0123-00) to the CABLE connector.

(c) Use the ZERO REF SET control to locate the pulse on the graticule. Use the POSITION controls as necessary to locate the entire pulse step on the graticule.

(d) Adjust the front-panel GAIN screw driver control for a pulse amplitude of 5 divisions. (Adjust the POSITION controls as necessary.)

(e) Check that the rise of the pulse occurs within 0.1 division horizontally and there is no spike at the top of the pulse. Figure 5-7 illustrates correct and incorrect displays.

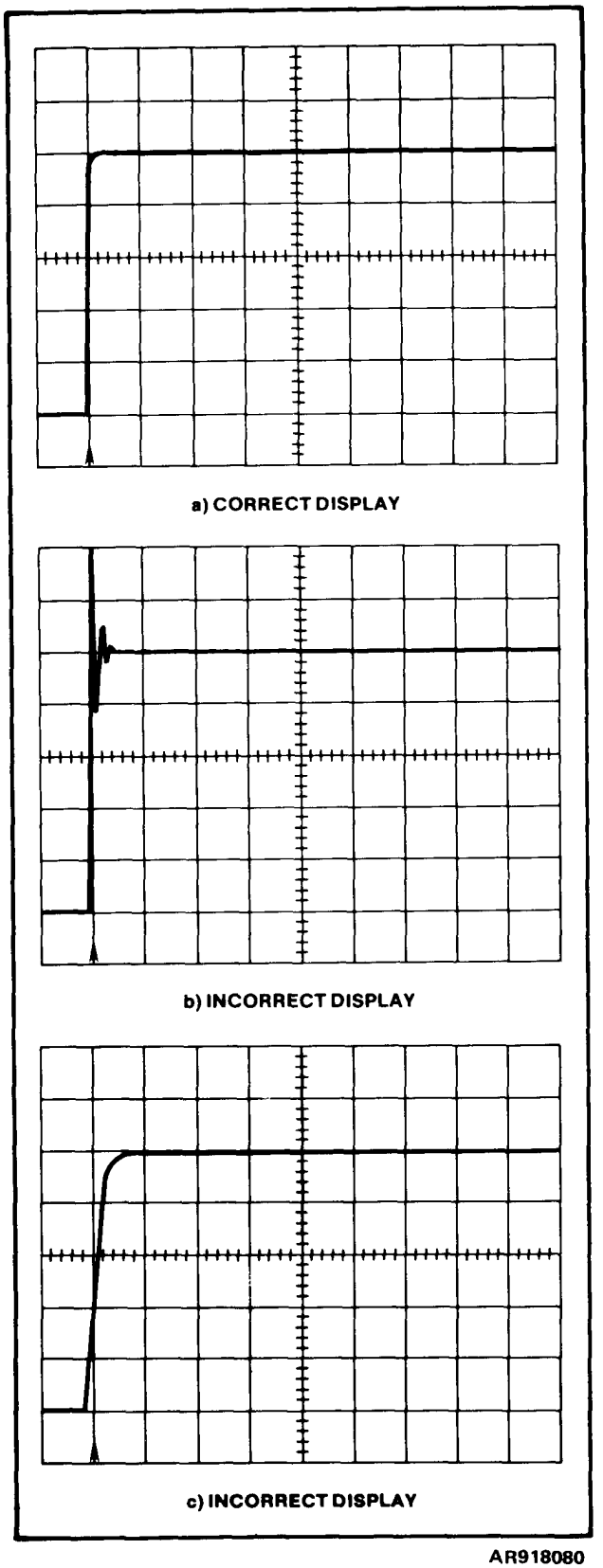


Figure 5-7. Loop gain adjustments

(3) Noise.

(a) Set the mρ/DIV to 5 and adjust the POSITION controls so the top of the trace is located on the horizontal centerline.

(b) Check that the peak-to-peak noise is not greater than 5 mρ (1 division).

(c) Push the NOISE FILTER button in and check that the peak-to-peak noise is less than 2 mρ (0.4 division).

(d) Change the FEET/DIV control to 20.

(e) Use the POSITION controls to set the bottom of the noise pulse at the horizontal centerline.

(f) Check that the peak-to-peak noise is less than 2 mρ.

(g) Release the NOISE FILTER button and check that the peak-to-peak noise is less than 5 mρ.

(4) DC Balance.

(a) Set the mρ/DIV to 100.

(b) Use the POSITION controls to locate the base of the pulse at the horizontal centerline.

(c) Remove the 50 Ω terminator and check that the trace shift is less than 1/2 division. Replace 50 Ω terminator.

(5) Vertical Attenuation.

(a) Remove the 50 Ω terminator, set the mρ/DIV to 500, and turn the DISTANCE dial completely clockwise.

(b) Set the DM RANGE/FUNCTION switch to 2 on the DC VOLTS scale.

(c) Connect the lead from the DM common terminal to the grounded terminal of C2137 (on the VERT AMP/SLOW RAMP board, figures 5-8 and 5-9).

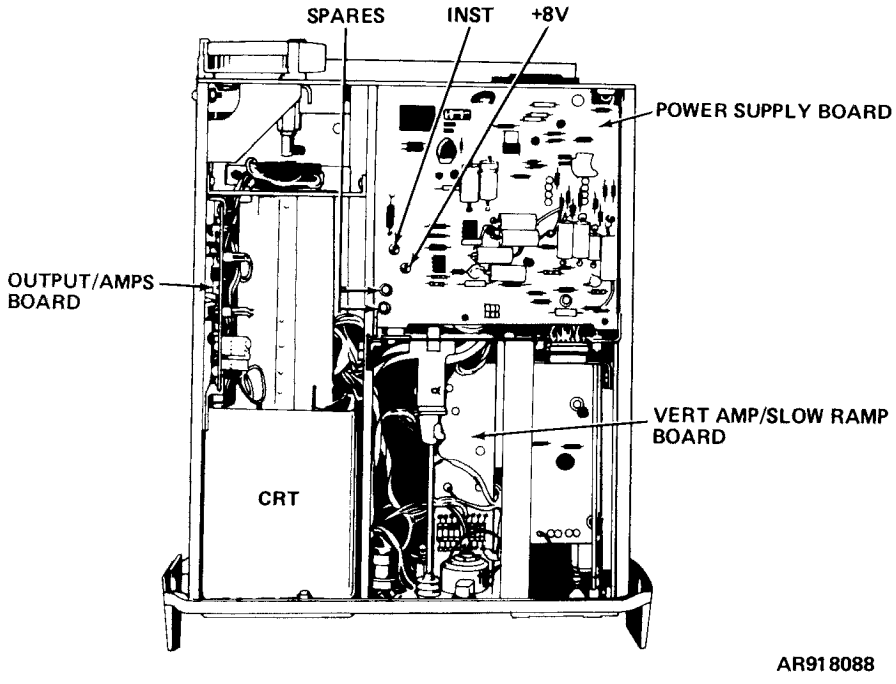


Figure 5-8. PC board location

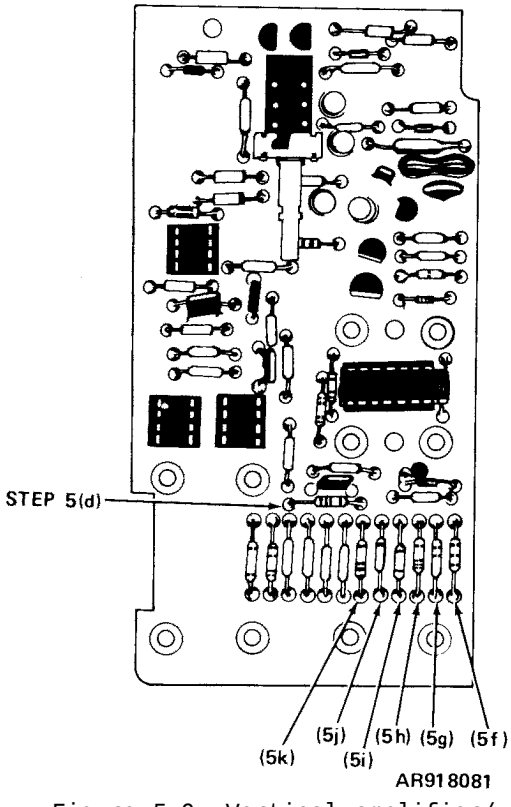


Figure 5-9. Vertical amplifier/ slow ramp board

(d) Connect the lead from the V-Ω terminal to the left end of R2229. See figure 5-9 for the proper connection points.

(e) Set the TDR POSITION controls so that the DM reads 1.000 ±0.008 volt.

(f) Move the test lead from R2229 to R2326 (see figure 5-9). The DM should read 0.400 ±0.008 volt.

(g) Move the test lead from R2326 to R2325 (see figure 5-9). The DM should read 0.199 ±0.004 volt.

(h) Move the test lead from R2325 to R2323 (see figure 5-9). The DM should read 0.991 ±0.002 volt.

(i) Move the test lead from R2323 to R2322 (see figure 5-9). The DM should read 0.405 ±0.0008 volt.

(j) Move the test lead from R2322 to R2321 (see figure 5-9). The DM should read 0.200 ±0.0004 volt.

(k) Move the test lead from R2321 to R2223 (see figure 5-9). The DM should read 0.0100 ±0.0002 volt.

(l) Remove the test leads from the TDR and turn the DISTANCE dial fully counterclockwise.

k. Horizontal Checks.

(1) DISTANCE dial.

(a) Set controls as follows:

mρ/DIV	500
FEET/DIV	1
MULTIPLIER	X1.

Attach the precision cable to the CABLE output.

(b) Set the front panel DISTANCE dial to exactly 031.5. Check that the leading edge of the reflected pulse is located on the graticule reference line within 0.1 division.

(c) Push the ZERO REF CHECK button; the incident pulse should return to the graticule reference line. If this check fails, adjust the ZERO REF SET button, while holding the ZERO REF CHECK button in, so the incident pulse is located on the graticule reference line.

(2) X1 MULTIPLIER Control.

(a) Set the DISTANCE dial to 000 and FEET/DIV to 5.

(b) Use the ZERO REF SET control to locate the leading edge of the incident pulse on the graticule reference line.

(c) Check that the leading edge of the reflected pulse is 6.3 divisions ±0.1 division away from the incident pulse.

(3) X1 Positioning.

(a) Set the FEET/DIV to 1 with the MULTIPLIER control X1.

(b) Remove the 3-foot cable from the TDR.

(c) Adjust the ZERO REF SET control so that the leading edge of the incident pulse is set on the vertical centerline.

(d) Check that the leading edge of the incident pulse is located within 1 division of the vertical centerline when the MULTIPLIER control is changed to X1.

l. Fogging Circuit Adjustments.

(1) Push the CAMERA/RECORD switch to CAMERA and see that bright (fogging) oscillations appear across the entire crt screen during retrace.

(2) Adjust the R3237 (FOG) located on the OUTPUT AMPS board, (figures 5-8 and 5-10) while holding the CAMERA/RECORD switch to CAMERA, until fogging vertically covers the entire crt screen during retrace.

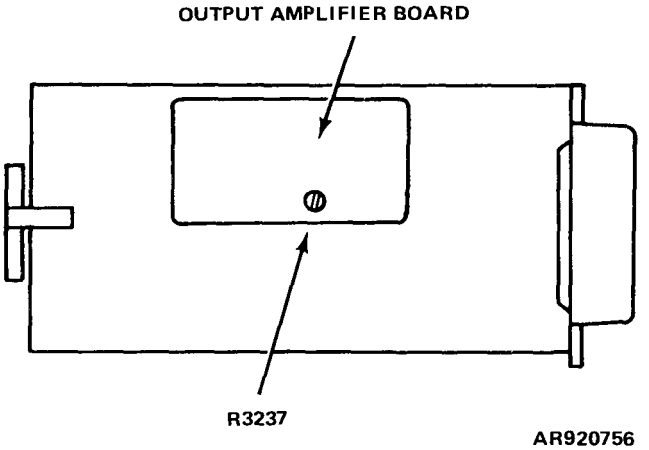


Figure 5-10. Output amplifier board fog adjustment

m. X-Y Output Module Checks.

(1) Pen Lift Signal.

(a) Set the Digital Multimeter RANGE/FUNCTION control to 20 on the DC VOLTS scale.

(b) Turn the TDR upright.

(c) Place the terminal connection link of the OUTPUT MODULE board on the negative slope terminals (see figure 2-5).

(d) Connect the lead from the DM V-Ω terminal to the X-Y OUTPUT MODULE PEN LIFT red terminal and the lead from the DM common terminal to the X-Y OUTPUT MODULE PEN LIFT black terminal.

(e) Check that the DM shows approximately +5 volts.

(f) Momentarily push the RECORD/CAMERA switch to RECORD, then release the switch. Check that the voltage goes to +0.5 volt or less and returns to approximately +5 volts at the end of the sweep.

(g) Move the terminal connection link to the positive slope terminals on the X-Y OUTPUT MODULE board.

(h) Check that the DM reads approximately -0.5 volt.

(i) Push the RECORD/CAMERA switch to RECORD and check that the DM reads +4 volt or greater, then returns to approximately 0.5 volt at the end of the sweep.

(2) Y Output.

(a) Move the test leads from the PEN LIFT terminals to the corresponding Y terminals of the X-Y OUTPUT MODULE.

(b) Set the TDR ZERO REF SET completely clockwise.

(c) Push the RECORD/CAMERA switch to RECORD and adjust the TDR POSITION controls so that the DM reads 0.0 volt.

(d) Turn the TDR ZERO REF SET completely counterclockwise and check that the DM reads approximately +0.04 volt. Release the RECORD switch.

(e) Move the test leads to the X terminals.

(f) Momentarily press the RECORD/CAMERA switch to RECORD, then release.

(g) Check that the voltage reads from 0 to 1 V (100 mV/div) as the dot moves across the screen.

Section III. FAULT ISOLATION

5-5. Introduction. Trouble shooting will be confined to power failure. A power failure indication would be no display on the crt or no indication on the battery meter. If the required corrective action does not restore power, forward TDR to depot for repair. Parts location drawings are referenced in the troubleshooting tables as required. Replacement parts are listed in Appendix C. Procedures for parts replacement are given in Chapter 6. Perform procedures given in paragraph 5-2 and perform troubleshooting given in table 5-1.

Table 5-1. TDR Troubleshooting Procedure

Para. ref.	Symptom	Corrective Action
7-4b	No CRT display	Check fuses
2-3a	No battery indication	Charge battery
	Battery does not charge	Replace battery

CHAPTER 6

MAINTENANCE INSTRUCTIONS

Section I. GENERAL

6-1. General. The TDR is maintained by direct support maintenance level personnel. The maintenance functions of the DS level personnel are shown in the Maintenante Allocation Chart (MAC) in Appendix B. The maintenance functions are to: (a) inspect; (b) test; (c) service; (d) install; (e) replace the equipment. Calibration of the TDR is performed by a separate calibration/repair facility in accordance with TB 11-6625-2860-35 for the TDR.

Section II. MAINTENANCE INSTRUCTIONS

6-2. Maintenance Efforts. Table 6-1 lists the various maintenance efforts required, the frequency of performance, and references to the actual procedures to be performed.

a. Battery pack replacement. See figure C-1 for location. Loosen the two thumbscrews and pull out the battery pack. Insert new battery pack and secure the two thumbscrews.

Table 6-1. Maintenance Efforts

Maintenance effort	Frequency of performance	Reference
Installation, replacement	On receipt of equipment	Para 3-1
Inspect and services:		
Preventive maintenance	As required	Paras 3-6, 3-7
Battery maintenance	Every 30 days	Para 3-7
Preparation for shipment and storage	As required	Chapter 9
Tests	Every 30 days or after repair and service	Para 5-3, 5-4
Repair	As required	Chapter 7

CHAPTER 7

REPAIR INSTRUCTIONS

Section I. GENERAL

7-1. Responsibilities. Repair at the direct support (DS) level consists of replacing damaged or malfunctioning components found during inspection and checkout. Removal of major assemblies is performed only to the extent necessary to accomplish the required repairs. Refer to the Maintenance Allocation Chart (MAC) in appendix B to determine the level of responsibility for maintenance functions. Items not identified in the MAC, such as accessory equipment, may be repaired by direct support maintenance personnel, if authorized by pertinent directives.

7-2. Depot Repaired Components. Items that cannot be repaired or disposed of at DS should be sent to depot for repair or disposition. Refer to the MAC.

Section II. REPAIR OF TDR

7-3. General. This section contains instructions for removal and replacement of assemblies and parts that need repair. Refer to appendix C for location of parts.

7-4. Repair and Replacement Instructions.

a. Fuses. All ac line fuses are located on the front panel. All dc fuses and spares are located on the power supply board inside the instrument. Remove the TDR from its case (See paragraph 5-4c). Remove the aluminum shield from the top of the unit. The fuses are upright plug-in types located near the center of the instrument (see figures 7-1 and C-1).

CAUTION

When the cabinet is removed high voltages may be present.

b. Replacing Case. To replace the ease on the TDR proceed as follows:

(1) Remove any termination and adapters from the cable connector.

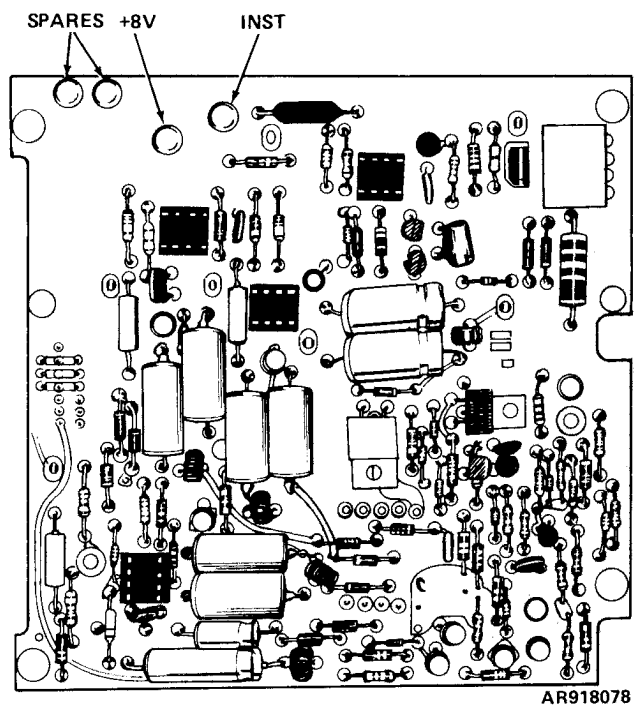


Figure 7-1. Power supply board DC fuse location

(2) Remove the battery pack and power cord from the back of the TDR.

(3) Place the EMI shields on the top and bottom of the TDR.

(4) Stand the TDR on its face.

(5) Slide the case over the back of the unit, until it has reached the sub-panel.

(6) Tighten the four screws on the back of the case until the case is aligned with the groove at the back of the sub–panel.

(7) Make sure the case is in the groove; then, using a torque screw-driver, tighten the four screws to 10 inch–pounds.

NOTE

If the screws are not tightened equally to the required torque, the watertight integrity of the case can be destroyed.

(8) Place the battery pack in its compartment and tighten the two screws (finger tight is sufficient).

(9) Place the power cord and the rest of the accessories in the front cover storage compartment and latch it closed.

(10) Place the front cover over the front cover panel and close the latches.

CHAPTER 8

FINAL INSPECTION

Section I. GENERAL

8-1. General. To ensure operational condition of the TDR after repair or replacement, a final inspection must be made. The inspection is to be made before the TDR is either returned to use or placed in stock. The inspection is a series of checks.

Section II. FINAL INSPECTION CHECKS

8-2. Final Inspection Checks. Table 8-1 lists final inspection checks for the TDR after it is repaired or replaced. References are provided for each check.

Table 8-1. TDR final inspection checks

Assembly repaired or replaced	Assembly reference designation	Checks	References
Assembled TDR (main case) and all accessories.		a. Inspect for visible damage. b. Check for completeness. c. Perform turn-on procedures.	Paragraph 1-5 b. Table 1-1. Paragraph 2-3.

CHAPTER 9

PREPARATION FOR SHIPMENT AND STORAGE

Section I. PREPARATION FOR TRAVEL (IN SHELTER)

9-1. General. Preparation for travel applies to the TDR when contained in the shelter. No special preparation is required, but the following general steps should be taken:

a. Place all accessory equipment and group test cables in the TDR cover.

b. Secure the cover in the closed position with the two side clamps.

Section II. SHIPMENT

9-2. Preparation of TDR.

a. Packing.

(1) Place TDR in corrugated containers in which it was shipped in accordance with Federal Specification PPP-B–636, style RSC (export), type CF, grade W5c, class WR.

(2) At the corners of each container, and to block the panel assembly above and below, re-use built-up corrugated blocking with double wall ac flute in accordance with Federal Specification PPP–F-320, type CR, grade DW200, class DOM.

(3) Apply adhesive per MIL-A-101 to flaps of containers and close the flaps.

(4) Apply 2-inch waterproof tape in accordance with Federal Specification PPP-T-76 over all corners and open seams.

(5) Mark container in accordance with MIL–STD-129.

b. Shipping Documents. Prepare shipping documents to accompany all freight in accordance with AR 725.50

Section III. STORAGE

9-3. Preparation.

a. Perform applicable checks listed in table 8-1 to ensure operational readiness of the equipment. These checks must be performed every 90 days while equipment is in administrative storage.

b. Select a storage area or site that best conforms to the following requirements:

(1) Level storage surface.

(2) Maximum protection against weather and pilferage.

(3) Adequate drainage.

(4) Access to permit inspection, maintenance, and removal from storage.

c. Place equipment on blocks or dunnage to prevent contact with the ground or a damp floor.

d. Mark or tag the equipment “administrative storage.” Equipment will not be operated while in the administrative storage category except at the 90–day intervals when checkout is performed to ensure operation condition (refer to TM 740-90-1).

9-4. Inspection and Maintenance.

a. Visually inspect the equipment at least once each month. For equipment stored outdoors, a visual inspection should be made immediately following hard rains, heavy snow storms, windstorms, and other adverse conditions.

b. Disassemble or unpack equipment only as necessary to determine the full extent of deterioration or damage found during visual inspection.

c. Perform preventive maintenance or repair immediately to correct any deterioration or damage.

d. Record each inspection, condition of the equipment at time of inspection, and corrective action taken. Attach this record to the equipment in such a manner as to be protected from the elements.

APPENDIX A

REFERENCES

A-1. Administrative Aids

Index of Administrative Publications	DA Pam 310-1
The Army Maintenance Management System	TM 38-750

A-2. Related Maintenance Technical Manuals

Materials Used for Cleaning, Preserving, Abrading and Cementing Ordnance Materiel and Related Materials Including Chemicals	TM 9-247
Painting Instructions for Field Use	TM 43-0139

A-3. Related Commercial Maintenance Manuals

Tektronix 1502-1 Time Domain Reflectometer, Instruction Manual-070-1792-00, September 1975

A-4. Related Calibration Manuals

Calibration Requirements for the Maintenance of Army Materiel	TB 43-180
Calibration Procedure for Time Domain Reflectometer Tektronix Type 1502-l	TB 11-6625-2860-35

A-5. Other Related Publications

Requisitioning, Receipt, and Issue System	AR 725-50
Administrative Storage	TM 740-90-1
Destruction to Prevent Enemy Use	TM 750-244-2
Marking for Shipment and Storage	MIL-STD-129
Tape, Pressure-Sensitive Adhesive Paper (for carton sealing)	PPP-T-76
Tape, Pressure-Sensitive Adhesive, Masking, Paper	UU-T-106
Adhesive, Water Resistant	MMM-A-260 (Replaces MIL-A-101)
Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes	
Plastic Film (Polyethylene Thin Gage)	L-P-378
Box, Fiberboard	PPP-B-636

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. General.

a. The maintenance allocation chart identifies the maintenance operations that must be performed. It assigns each of those operations to the lowest level of maintenance authorized to perform the complete task, or any part of the task, in terms of availability of time, tools, test and support equipment, skills and employment of the subsystem.

b. The Maintenance Allocation Chart (MAC) in section II designates overall responsibility for the performance of maintenance functions for the TDR.

c. Section III lists the special tools and test equipment required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions on explanatory notes for a particular maintenance function.

B-2. Maintenance Functions.

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition i.e., to clean (decontaminate), preserve, drain, paint or replenish fuel, lubricants, hydraulic fluids, or compressed air supplied.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services[1] or other maintenance actions [2] to restore serviceability to an item

[1]Services - inspect, test, service, adjust, align, calibrate, or replace.
[2]Action – welding, grinding, riveting, straightening, facing, remachining, or resurfacing.

by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), and item, or system.

j. Overhaul. The maintenance effort (services/actions) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publication. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new conditions in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipments/components.

B-3. Column Entries Used in the MAC.

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

b. Column 2, Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. (For detailed explanation of these functions , see para. B-2).

d. Column 4, Maintenance Category.

(1) Column 4 specifies, by the listing of a "work time" figure in the appropriate sub-column(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform the maintenance function, at the indicated level of maintenance.

(2) If the number or complexity of the tasks within the listed maintenance function vary at different maintenance levels, appropriate "work time" figures will be shown for each level. The number of man-hours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance levels are as follows:

C - Operator or crew.
O - Organization maintenance.
F - Direct support maintenance.
H - General support maintenance.
D - Depot maintenance.

e. Column 5, Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains a letter code in alphabet order which is keyed to the remarks contained in section IV.

B-4. Column Entries Used in Tool and Test Equipment Requirements (Section III).

a. Column 1, Tool or Test Equipment Reference Code. The tool and test equipment reference code correlates with a

maintenance function on the identified end item or component.

b. Column 2, Maintenance Category. The lowest level of maintenance authorized to use the tool or test equipment.

c. Column 3, Nomenclature. Name or identification of the tool or test equipment.

d. Column 4, National/NATO Stock Number. The National or NATO stock number of tool or test equipment.

e. Column 5, Tool Number. The manufacturer's part number.

B-5. Explanation of Columns to Section IV.

a. Reference Code. The code scheme recorded in column 1, section III.

b. Remarks. This column list information pertinent to the maintenance function being performed as indicated on the MAC, section II.

Section II. MAINTENANCE ALLOCATION CHART FOR TIME DOMAIN REFLECTOMETER TYPE 1502-1 (TDR)

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
1	Tektronix Time Domain Reflectometer Type 1502-1	Inspect Test Service Install Replace			.1 .5 .5 .2 .2				
1A1	Battery	Service Replace			.0				

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR TEKTRONIX TIME DOMAIN REFLECTOMETER TYPE 1502-1

TOOL OR TEST EQUIPMENT REF NUMBER	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	F	FLUKE 8000A DIGITAL MULTIMETER		
2	F	SHORTED BNC CONNECTOR		

APPENDIX C

MAINTENANCE REPAIR PARTS LIST

C-1. Introduction. This appendix lists authorized repair parts for performance of maintenance of the Time Domain Reflectometer Tektronix Type 1502-1.

C-2. Explanation of Columns. The following provides an explanation of columns found in the listings.

a. Figure. This column indicates the figure number of the illustration in which the item is shown.

b. Item. This column indicates the number used to identify each item called out in the illustration.

c. Part No. This column indicates the primary number used which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements, to identify an item or range of items.

NOTE

When a stock numbered item is requisitioned, the repair part received may have a different part number than the part being replaced.

d. Description. This column provides the item name and a minimum description to identify the item.

e. Manufacturer. This column provides the name of the manufacturer of a part where the manufacturer differs from the manufacturer of the Time Domain Reflectometer.

C–3. Abbreviations.

"	Inch
#	Number size
Actr	Actuator
Adptr	Adapter
Align	Alignment
Al	Aluminum
Assem	Assembled
Assy	Assembly
Atten	Attenuator
AWG	American wire gage
Bd	Board
Brkt	Bracket
Brs	Brass
Brz	Bronze
Bshg	Bushing
Cab	Cabinet
Cap	Capacitor
Cer	Ceramic
Chas	Chassis
Ckt	Circuit
Comp	Composition
Conn	Connector
Cov	Cover
Cplg	Coupling
Crt	Cathode ray tube
Cur	Current
Deg	Degree
Dia	Diameter
Dwr	Drawer
Elctrn	Electron
Elec	Electrical
Elctlt	Electrolytic
Elem	Element
EPL	Electrical parts list
Eqpt	Equipment
Fb	Fast blow
Ext	External
Fil	Fillister head
Flex	Flexible
Flh	Flat head
Flm	Film
Fltr	Filter
Fr	Frame or front
Fstnr	Fastener
Ft	Foot
Fxd	Fixed
Gskt	Gasket
Hd	Head
Hdl	Handle
Hex	Hexagon
Hex hd	Hexagonal head

Hex soc	Hexagonal socket
Hlcps	Helical compression
Hlext	Helical extension
Hv	High voltage
IC	Integrated circuit
ID	Inside diameter
Ident	Identification
Implr	Impeller
In	Inch
Incand	Incandescent
Insul	Insulator
Intl	Internal
LED	Light emitting diode
Lphldr	Lampholder
Mach	Machine
Mech	Mechanical
Met	Metal
Mtg	Mounting
Nip	Nipple
Non wir	Not wire wound
OBD	Order by description
OD	Outside diameter
Ovh	Oval head
PC	Printed circuit
PCB	Printed circuit board
Ph brz	Phosphor bronze
Pl	Plain or plate
Plstc	Plastic
PN	Part number
Pnh	Pan head
Pwr	Power
Qtz	Quartz
Rcpt	Receptacle
Res	Resistor
Rf	Radio Frequency
Rgd	Rigid
Rlf	Relief
Rtnr	Retainer
Sch	Socket head
Scope	Oscilloscope
Scr	Screw
SE	Single end
Sect	Section
Sel	Selected
Semicond	Semiconductor
Sens	Sensitive
Shld	Shield
Shldr	Shouldered
Skt	Socket
Sl	Slide
Slflkg	Self-locking
Slvg	Sleeving
Spr	Spring
Sq	Square
SST	Stainless steel
Stl	Steel
Sw	Switch
T	Tube
Term	Terminal
Thd	Thread
Thk	Thick
Tnsn	Tension
Tpg	Tapping
Trh	Truss head
V	Voltage
Var	Variable
W/	With
Wshr	Washer
WW	Wire wound
Xfmr	Transformer
Xstr	Transistor
Xtal	Crystal

TABLE C-1. REPLACEABLE ELECTRICAL PARTS

FIGURE	ITEM	FIGURE	DESCRIPTION
C-1	1	159-0029-00	*FUSE, CARTRIDGE:0.3A,3AG, SLO-BLOW
C-1	1	150-0029-00	*FUSE, CARTRIDGE:0.3A,3AG,SLO-BLOW
C-1	2	159-0128-00	*FUSE, CARTRIDGE:2A,125V, 5SEC
C-1	2	159-0128-00	*FUSE, CARTRIDGE:2A,125V, 5SEC
C-1	2	159-0128-00	*FUSE, CARTRIDGE:2A,125V, 5 SEC
C-1	2	159-0128-00	*FUSE, CARTRIDGE:2A,125V, 5 SEC
C-1	3	016-0595-00	BATTERY PACK

TABLE C-2. STANDARD ACCESSORIES

FIGURE	ITEM	PART NO.	DESCRIPTION
C-2	1	016-0297-00	VISOR, CRT:
C-2	2	103-0028-00	ADAPTER, CONN:BNC TO BNC
C-2	3	011-0123-00	TERM, COAXIAL:50 OHM, BNC
C-2	4	012-0482-00	CABLE ASSY, RF:50 OHM, 36 INCH LONG
C-2	5	161-0066-00	CABLE ASSY, PWR:3 WIRE, 98 INCH LONG
C-2	6	003-0700-01	RULE, SLIDE:TIME DOMAIN REFLECTOMETER
C-2	7	159-0029-00	FUSE, CARTRIDGE:0.3A,3AG,SLO-BLOW
		159-0054-00	FUSE, CARTRIDGE:0.15A,3AG,250V, SLO-BLOW
C-2	8	378-0055-00	FILTER, MESH:CRT

*STOCKED ITEM

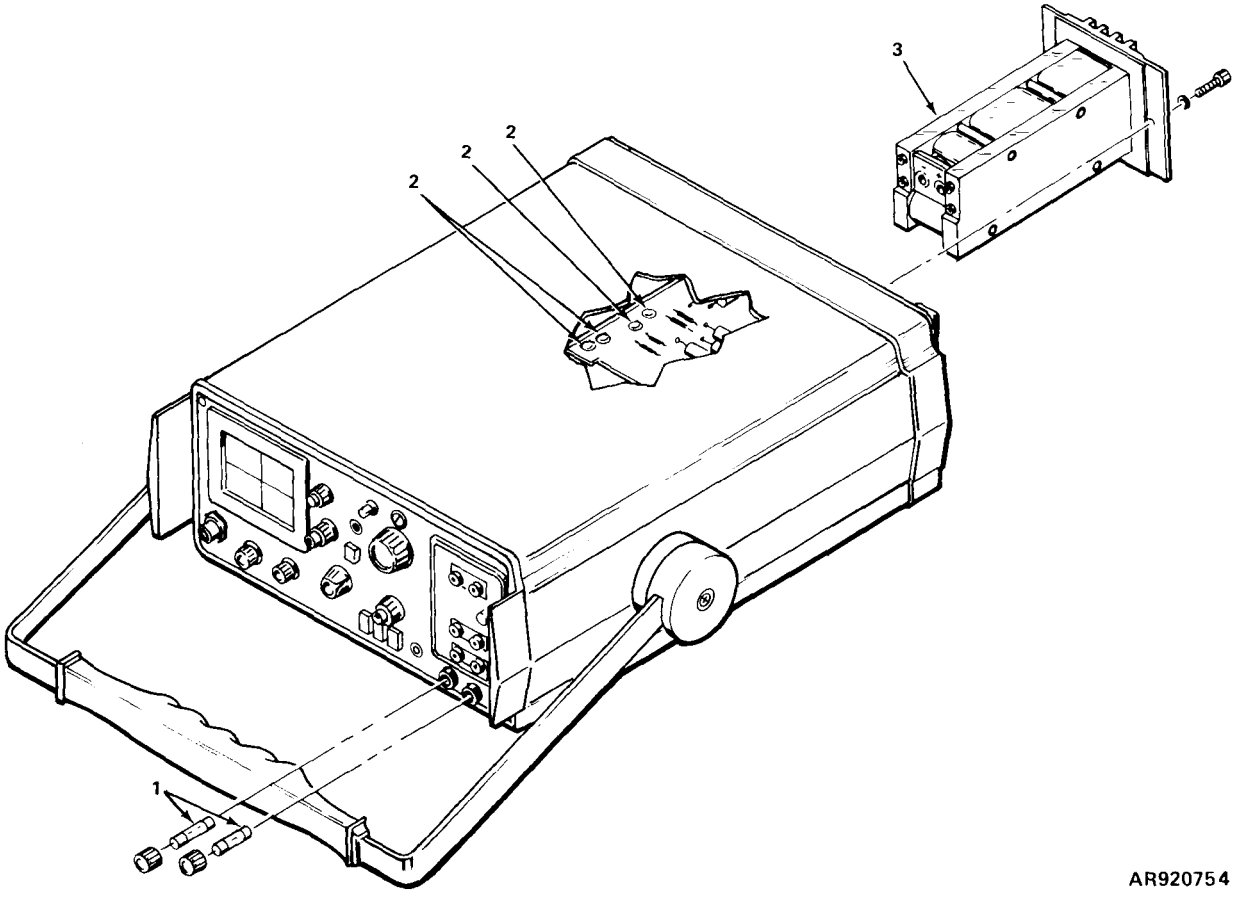


Figure C-1. Replaceable electrical parts

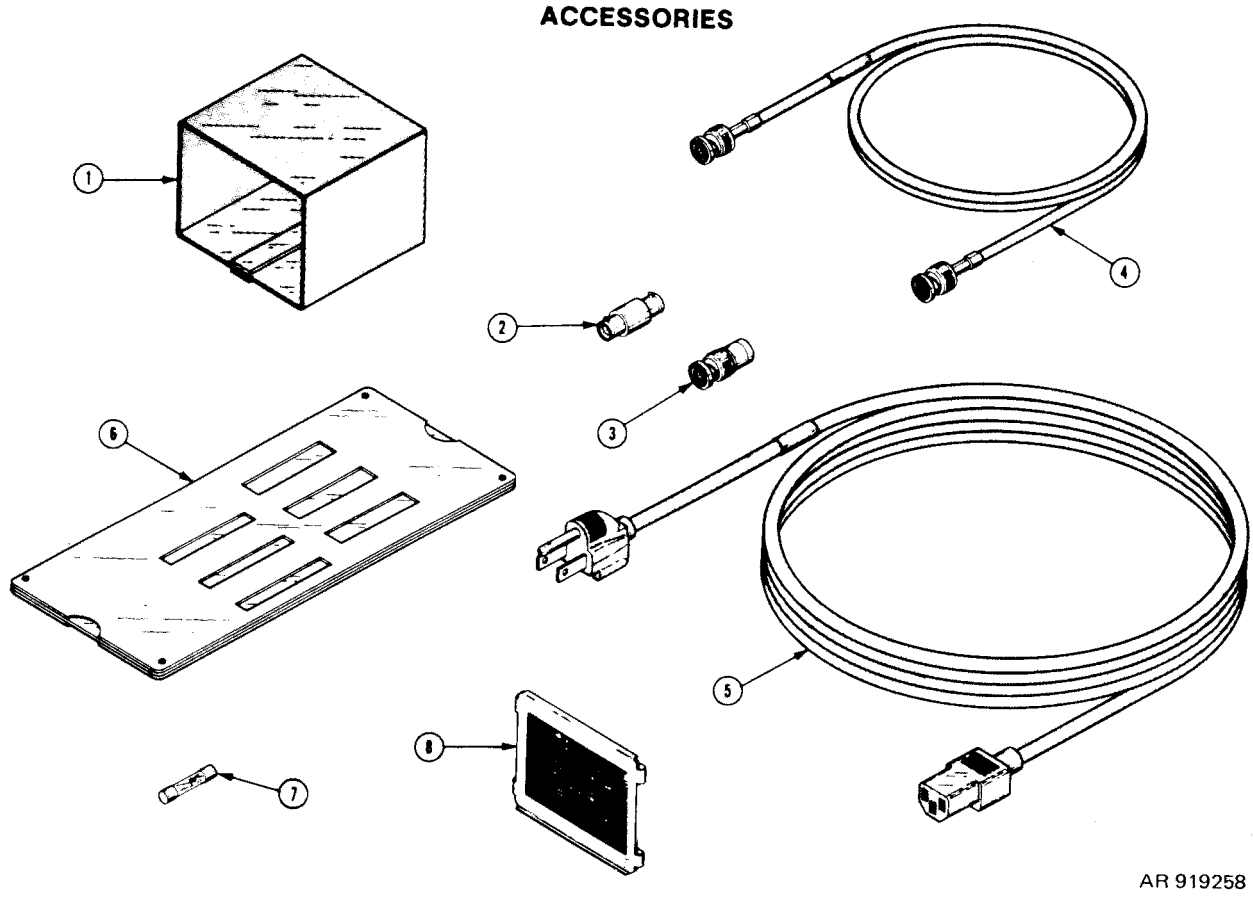


Figure C-2. Standard accessories

INDEX

INDEX - Continued

INDEX - Continued

INDEX - Continued

By Order of the Secretary of the Army:

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

Official:

ROBERT M. JOYCE
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3-10		3-2	
4-5		4-1	

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

Change illustration. Reason: Tube end shown assembled on wrong side of lever cam.

Figure 4-1, item 3 has the wrong NSN. Supply rejects orders for this item. The NSN shown here is not listed in the AMDF or the MCRL. Please give us the correct NSN and P/N.

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