

TEKTRONIX®

7A21N
DIRECT ACCESS UNIT
(SN B040000-up)

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
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070-1962-00

Serial Number _____

First Printing APR 1975



WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

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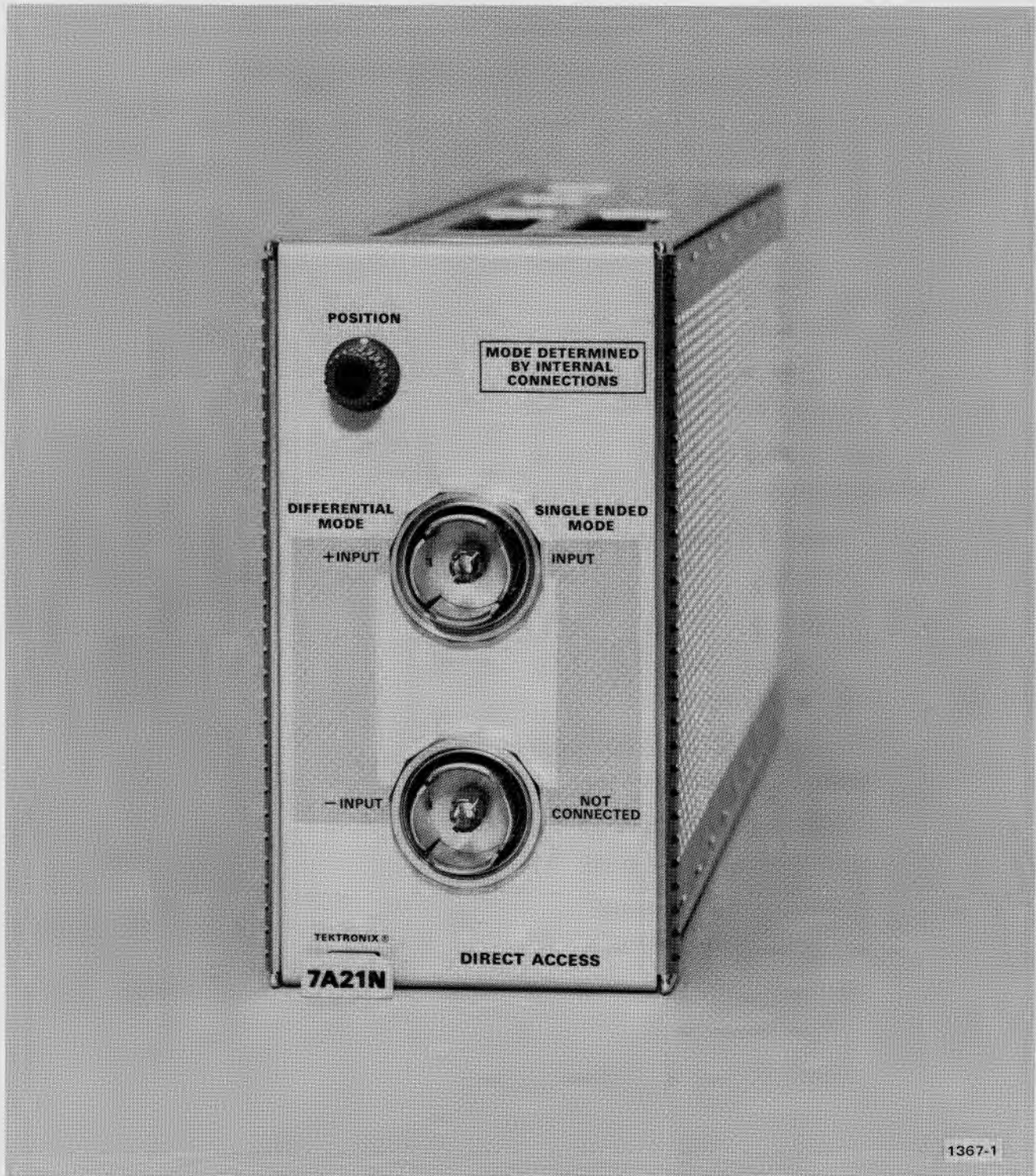
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TABLE OF CONTENTS

	Page
Specifications	1
Circuit Description	1
Maintenance	2
Calibration	3
Performance Check	3
Test Equipment	4
Installation Information	6
Installation	6
Removal	7
General Operating Instructions	8
Electrical Parts List	9
Diagram and Circuit Board Illustrations	1
7844 Installation Procedure	
R7844 Installation Procedure	
R7903 Installation Procedure	
7904 Installation Procedure	
R7912 Installation Procedure	
Mechanical Parts List	
Fig. 1 Exploded	
Fig. 2 Accessories and Repackaging	



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7A21N Features

The 7A21N Direct Access plug-in is designed for use with Tektronix 7800 and 7900-Series oscilloscopes. This unit provides AC coupling of high-frequency or fast-risetime signals directly to the crt vertical deflection plates. Two front-panel input connectors permit either single ended or differential operation (internally selected). Trace positioning is accomplished with a front-panel control.

7A21N (B040000—up)

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SPECIFICATION

The following electrical characteristics are valid for instruments calibrated at an ambient temperature between +20°C and +30°C after a 20 minute warm up period.

TABLE 1-1

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Deflection Factor		
Single Ended Mode	Less than four volts/division	
Differential Mode	Less than ten volts/division	
Bandwidth	20 kilohertz to one gigahertz	
Maximum Input Power (Each Input)	Six watts average; 200 volts dc	
Input Impedance (Each Input)	50 ohms, ac coupled	
Reflection Coefficient	0.1 peak-to-peak	Measured using a reflectometer with a system risetime of 75 ps.

CIRCUIT DESCRIPTION

The 7A21N circuitry is explained first as internally connected for the differential mode of operation, then as internally connected for the single-ended mode of operation. It should be noted that the entire signal line is designed to maintain a constant impedance of 50 Ω .

The signal connected to the -INPUT is ac coupled through C18 and inverted in L21. The signal is inverted to provide proper phasing with the -INPUT signal. After inversion, the signal is algebraically added to the +INPUT signal in the 50 Ω Bridge, U12. The characteristics of this bridge are such that each input is terminated into 50 Ω and the output of the bridge has a source impedance of 50 Ω .

The signal connected to the +INPUT is ac coupled through C5, then connected to U12 through the delay line, L6. The delay time of L6 is calculated so that the transit time from the +INPUT connector to U12 is the same as the transit time from the -INPUT connector to U12.

The output of the 50 Ω Bridge assembly, U12, is connected to the compensating network composed of R24, C24, R25, C25, R26, and L26. This network compen-

sates for the skin effect losses and line losses in U12 and the cables.

Power divider U30 splits the signal into two directions. The characteristics of the Power Divider are such that, when properly terminated, the impedance looking into any leg is 50 Ω .

The output of U30 at J31 is inverted at L56. Components R61, C61, R62, C62, R63, and L63 compensate for skin effect losses and line losses of the cables, the Inverter, and the Power Divider. The signal is then capacitively coupled to the crt deflection plate. The output of U30 at J30 is connected to the delay line L36. Delay time for L36 is calculated so that the transit times of the inverted and non-inverted signals are equal. R41, C41, R42, C42, R43, and L43 compensate for the skin effect losses and line losses of the cables, delay line and Power Divider. The non-inverted signal is connected to the crt Input Network where it is capacitively coupled to the crt vertical deflection plate. The 69 Ω resistors on the crt Input Network parallel the 182.5 Ω impedance of the deflection plates to form 50 Ω termination for the inverted and non-inverted signals.

7A21N (B040000—up)

Single ended circuitry is similar to differential circuitry except that the -INPUT is not used and the signal at the +INPUT bypasses 50 Ω Bridge U12 and the compensation network R24, C24, R25, C25, R26, and L26.

The vertical deflection plates are terminated into their characteristic impedance by the CRT Termination Assembly, U120. Positioning voltage is supplied from R96.

R98 sets the nominal position voltage. This control also has an effect on the crt trace focus.

The Load Board (located on U110) provides a storage space for the power line that was removed from the Oscilloscope Vertical Amplifier board. The +50 V and -15 V supplies in the power line are loaded so that the supplies stay in regulation during direct access operation. Proper bias is supplied from the Load Board to protect the oscilloscope Channel Switch.

MAINTENANCE

General

This portion of the manual contains information concerning preventive maintenance, corrective maintenance and troubleshooting the 7A21N.

Cleaning

To improve reliability and to avoid possible electrical problems, it is recommended that the 7A21N be cleaned at periodic intervals.

Loose dust may be removed with a soft cloth or a dry brush. Hardened dirt can be removed with a cotton-tipped swab or cloth, dampened with a mild detergent and water solution, then carefully rinsed and dried.

NOTE

Calibration of the 7A21N can be effected if the physical position of the components are moved.

Troubleshooting

If trouble is suspected, before moving or replacing any components, check that all cables and interconnections are properly made. Refer to the Operating Instructions portion of this manual for complete information. If trouble is still evident and if calibration does not correct the problem, then a component malfunction is the likely cause.

Since the 7A21N contains no active components, all that is usually required to locate the defective part is an ohmmeter. A reflectometer (such as the Tektronix 7L12 or 1501) can be used to pinpoint the problem area by checking for discontinuities in the 50 Ω signal path.

Before replacing any component first note the physical position of the component. Install the replacement part in the same position.

Corrective Maintenance

Standard Replacement Parts. All electrical and mechanical replacement parts for the 7A21N can be obtained through your local field office or representative. However, many of the electronic parts can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, rating, tolerance, and description.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the instrument types, instrument serial number, a description of the part (if electrical, include circuit number), and the Tektronix part number.

Soldering Techniques. Care should be taken when soldering to prevent damage due to excess heat. A small wattage soldering iron (15 to 50 watts) should be used. Apply heat directly to the junction to be soldered. Use only enough heat to form a good bond. Heat sink components when necessary.

CALIBRATION

Adjustment Procedure

Two methods of setting the 7A21N Vertical Voltage adjustment follow. If a focused trace was obtained prior to the installation procedure, use Method A. An alternative adjustment procedure is given as Method B.

Method A:

1. Position the trace to the center of the crt graticule area with the 7A21N POSITION control.
2. Adjust Vertical Voltage adjustment, R98 (located on left side of 7A21N) for a well-defined trace.

Method B:

1. Position the trace to the center of the crt graticule area with the 7A21N POSITION control.
2. Measure and record the DC voltage between pin 10 of the cathode ray tube and ground. Use a VOM set to the 50 V range, or higher, for this purpose.

NOTE

Pin 10 of the crt connects to the shield surrounding the Vertical Deflection plates. The easiest place to measure the voltage of this shield is on the multi-pin connector connecting pin 10 of the crt to the Z-Axis Amplifier board. Refer to the oscilloscope main-frame manual for the exact location.

3. Measure the DC voltage between each of the two Vertical deflection plates and ground. Average these two answers by the formula:

$$V_{\text{average}} = \frac{V_1 + V_2}{2}$$

4. Adjust the Vertical Voltage adjustment, R98 so that the voltage measured at pin 10 of the crt (step 2) and the V_{average} (calculated from step 3) are within 0.5 volt.

This completes the adjustment for the 7A21N.

PERFORMANCE CHECK

General

The performance of this instrument can be checked without making any internal adjustments by using the following procedure. This procedure checks the instrument against tolerances listed in the Specification section of this manual. If the instrument does not meet any or all of these specifications it is due to a malfunction. Refer to the Troubleshooting portion of this manual for possible causes and corrective techniques.

Test Equipment Required

General. The following test equipment and accessories, or its equivalent, is required for a complete check of the 7A21N. Specifications given for the test equipment are the minimum necessary for an accurate check. Therefore, the specifications of any test equipment used must meet or exceed the listed specifications. All test equipment is assumed to be correctly calibrated and operating within the listed specifications. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

Special Calibration Fixtures. Special Tektronix test fixtures are used in this procedure only where they facilitate the Performance Check. These special test fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Equipment Alternatives. All of the listed test equipment is required to completely check this instrument. The Performance Check procedure is based on the first item of equipment given as an example of applicable equipment. When other equipment is substituted, control settings or test setup may need to be altered slightly to meet the requirements of the substitute equipment. If the exact item of test equipment given as an example in the Test Equipment list is not available, first check the Specifications column carefully to see if any other equipment is available which might suffice. Then check the Usage column to see what this item of test equipment is used for. If used for a check which is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

TEST EQUIPMENT

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Calibration Oscilloscope	Tektronix 7900-Series 7A21N system bandwidth to 1 GHz.	Used throughout procedure to provide display.	a. Tektronix 7904 oscilloscope with 7A21N installed.
2. Time Base Plug-in Unit	Tektronix 7B-Series time base unit. 0.5 ns sweep rate required.	Used throughout procedure to provide sweep.	a. Tektronix 7B92 Time Base Unit.
3. Test Oscilloscope	Complete with time base unit and vertical unit. Must have vertical deflection factor of 5 V/div.	Used for deflection factor check.	a. Tektronix 7603 Oscilloscope with Tektronix 7A16A Vertical Unit and 7B50 Time Base Unit or equivalent.
4. Time Domain Reflectometer	System risetime, 75 ps; pulse amplitude, 200 mV; input, single ended; sensitivity, to 100 m ρ .	Used to check input reflections and transit time.	a. Tektronix 7S12 TDR/Sampler plug-in unit with S-52 Pulse Generator head and S-2 Sampling head. (This system to be used with the Test oscilloscope.)
5. Square-wave Generator	Frequency, to 75 kHz; output amplitude, 10 volts P-P into 50 Ω .	Used to check Deflection Factor.	a. Tektronix 106 Square Wave Generator.
6. Pulse Generator	Pulse risetime, 250 ps or less; pulse amplitude to 50 volts or greater.	Used to check risetime and aberrations.	a. Tektronix 109 Pulse Generator.
7. Delay Line and Trigger Pickoff	Delay time, approximately 75 ns; risetime, 175 ps or less.	Used to check risetime and aberrations.	a. Tektronix 7M11 Delay Line plug-in unit.
Cables and Accessories			
8. TEKTRONIX to GR adapter	Tektronix female to GR adapter.	Used for transit time check.	a. Tektronix Part Number 017-0093-00.
9. 20 ns Cable	Connectors, GR; impedance, 50 Ω ; time delay, 20 ns.	Used for risetime and aberration checks and other signal connections.	a. Tektronix Part Number 017-0504-00.
10. GR Cable (2 each)	Connectors, GR; impedance, 50 Ω ; length, 20-inch.	Used throughout procedures for signal connections.	a. Tektronix Part Number 017-0515-00.
11. BNC Cable	Connectors, BNC; impedance, 50 Ω ; length, 42-inch.	Used for external trigger in the risetime and aberration check.	a. Tektronix Part Number 012-0057-00.
12. SMA Male to GR Adapter	SMA (3 mm) to GR adapter.	Used for connections to Time-Domain Reflectometer pulse generator.	a. Tektronix Part Number 015-1007-00.

Preliminary Set Up

1. Connect the 7A21N internal connections for single-ended operation.

2. Install the 7A21N into the Calibration Oscilloscope and turn power on.

Check Reflection Coefficient

1. Connect the Time-Domain Reflectometer to the 7A21N +INPUT. Check that the reflections are 0.1 peak-to-peak or less (100 m μ peak-to-peak or less).

2. Change the 7A21N internal connections for differential operation.

3. Connect the Time-Domain Reflectometer to the 7A21N +INPUT: Check that the reflections are 0.1 peak-to-peak or less (100 m μ peak-to-peak or less).

4. Connect the Time-Domain Reflectometer to the 7A21N -INPUT. Check that the reflections are 0.1 peak-to-peak or less (100 m μ peak-to-peak).

Check +INPUT/-INPUT Transit Time

1. Remove the right side cover of the 7A21N. It is not necessary to plug the 7A21N into the Calibration Oscilloscope for this check.

2. Remove the cable connected to J29 (on U30). Connect the end of this cable to the Time-Domain Reflectometer sampling head by using the Tektronix to GR adapter and GR Cable.

3. Connect the Time-Domain Reflectometer pulse generator to the 7A21N +INPUT. Set the Reflectometer Time/Div to 50 ps.

4. Use the Time-Domain Reflectometer controls to obtain a full graticule display of the rising portion of the pulse. Adjust the controls so that the pulse starts at the lower left side of the graticule and intersects the graticule center lines, see Fig. 1.

5. Without moving any controls, move the pulse generator to the -INPUT.

6. Vertically position the trace so that the pulse (now negative going) starts at the graticule upper left side. Check that the trace intersects the horizontal graticule centerline within ± 25 ps of the vertical line, see Fig. 2.

7. Disconnect Time-Domain Reflectometer. Reconnect the cable to J29.

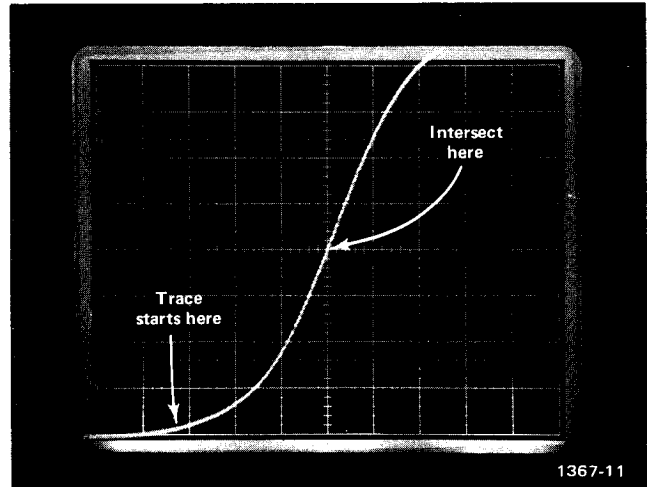


Fig. 1. +INPUT signal.

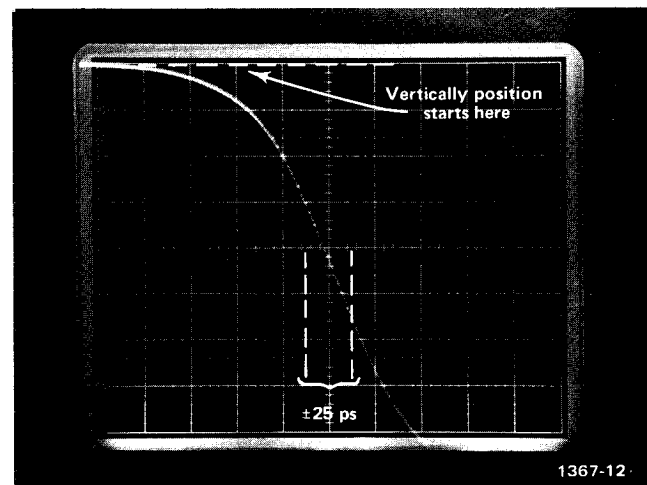


Fig. 2. -INPUT signal.

Alternate Procedure

Some reflectometers do not have a separate pulse generator output and sampling input. If this is the case, disconnect the cable connected to J29 and measure that the reflected pulses at the +INPUT and -INPUT is within 50 ps of one another.

7A21N (B040000—up)

Check Deflection Factor

1. Install the 7A21N into the Calibration Oscilloscope.
2. Set the Square Wave Generator frequency control to approximately 75 kHz. Use the test Oscilloscope to adjust the Square Wave Generator for an output of 10 volts peak-to-peak into 50 Ω .
3. Connect the Square Wave Generator to the 7A21N +INPUT. Terminate the -INPUT into 50 Ω . Check for a crt display of at least 1 division.
4. Connect the Square Wave Generator to the 7A21N -INPUT. Terminate the +INPUT into 50 Ω . Check for a crt display of at least 1 division.
5. Change the 7A21N internal connections for single-ended operation.
6. Connect the Square Wave Generator to the 7A21N +INPUT. Terminate the -INPUT into 50 Ω . Check for a crt display of at least 2.5 cm.

Check Risetime and Aberration

1. Connect the Pulse Generator to obtain a pulse duration of approximately 40 ns by connecting the 20 ns GR cable between the two charge line outputs.
2. Connect the Pulse Generator output to the Delay Line and Trigger Pickoff. Connect the Delay Line output to the 7A21N +INPUT. Connect the Trigger Pickoff to the external trigger input of the Time Base unit.
3. Adjust the Pulse Generator to obtain a six-division display. Set the triggering controls for a stable display.

4. Check that the risetime of the display is less than 465 ps².

5. Check that the aberrations are +4%, -6%, 8% peak-to-peak or less.

6. Change the 7A21N internal connections to obtain differential operation. Terminate the -INPUT into 50 Ω .

7. Connect the Pulse Generator to the 7A21N +INPUT and adjust for a 6 division display.

8. Check that the risetime of the display is less than 465 ps².

9. Check that the aberrations are 10% peak-to-peak or less.

10. Connect the Pulse Generator to the 7A21N -INPUT. Terminate the +INPUT into 50 Ω .

11. Check that the risetime of the display is less than 465 ps².

12. Check that the aberrations are 10% peak-to-peak or less.

²This value was calculated from the formula where: T_{rPG} is the risetime of the pulse generator; T_{rDL} is the risetime of the delay line; and $T_{r_{system}}$ is the risetime of the 7A21N/7904 system.

$$Tr = \sqrt{(Tr_{PG})^2 + (Tr_{DL})^2 + (Tr_{system})^2}$$

OR

$$Tr = \sqrt{250^2 + 175^2 + 350^2}$$

INSTALLATION INFORMATION

General

To effectively use the 7A21N, the operation and capabilities of the instrument must be known. This section gives installation procedures, and gives general information on operation and signal connections.

INSTALLATION

The 7A21N is designed to operate in the Left Vertical plug-in compartment of TEKTRONIX 7900-Series os-

cilloscope mainframes and the Left or Right, or both Vertical plug-in compartments of TEKTRONIX 7800-Series oscilloscopes mainframes. When shipped from the factory, this instrument has been calibrated to meet the tolerances listed in the Performance Requirement column in the Specification section.

To operate the 7A21N, the mainframe Vertical Amplifier board and the CRT Termination Assembly must first be replaced with the 7A21N Vertical Termination Board and the 7A21N CRT Termination Assembly. These assemblies

are provided as standard accessories and are stored on the left side of the 7A21N; see Fig. 3. Extension Cables and a Positioning Wire Assembly is also provided to connect the signal and the position control voltages to the crt deflection plates. Locations of board assemblies and cable connections are shown for each instrument in the Before and After illustrations, which are located in the foldout pages behind diagram 1.

Removal

To use other plug-in units in the Vertical compartments of the mainframe, it is necessary to remove the parts added for direct-access operation with the exception of the Positioning Wire assembly. The connector ends of this assembly are permanently installed and should not be removed. The multi-pin connector end of this assembly, however, should be disconnected and placed where it will not interfere with operation of the mainframe.

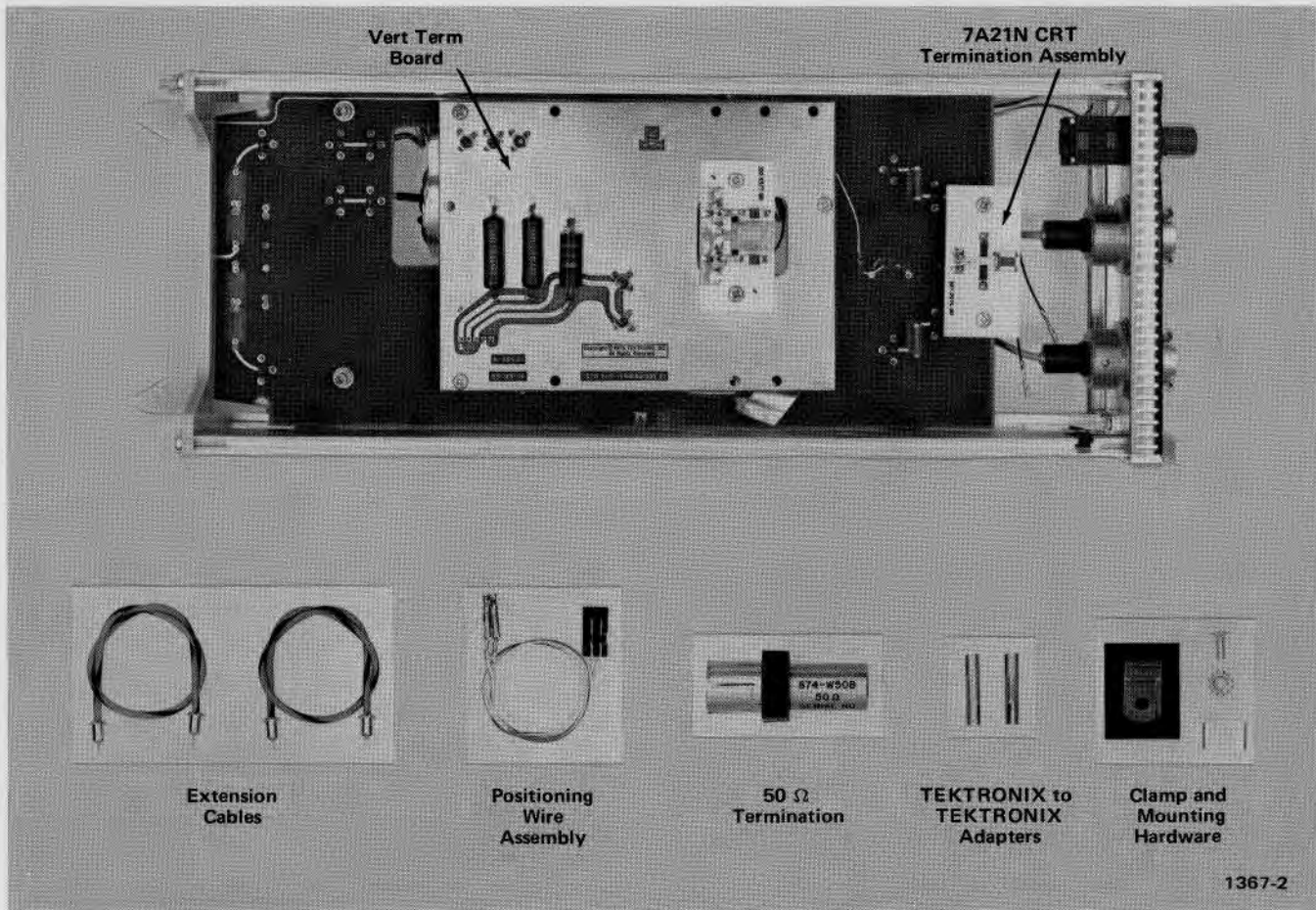


Fig. 3. Standard accessories supplied with 7A21N.

GENERAL OPERATING INSTRUCTIONS

The 7A21N can be connected (internally) for single-ended operation or differential operation. The illustrations shown in Fig. 4 show the internal cable connections used for the single ended and differential modes of operation.

When used in the differential mode and if only one input is used, the other input should be terminated into 50 Ω . It is always good practice to terminate the unused input. Use the 50 Ω Terminator supplied with the 7A21N.

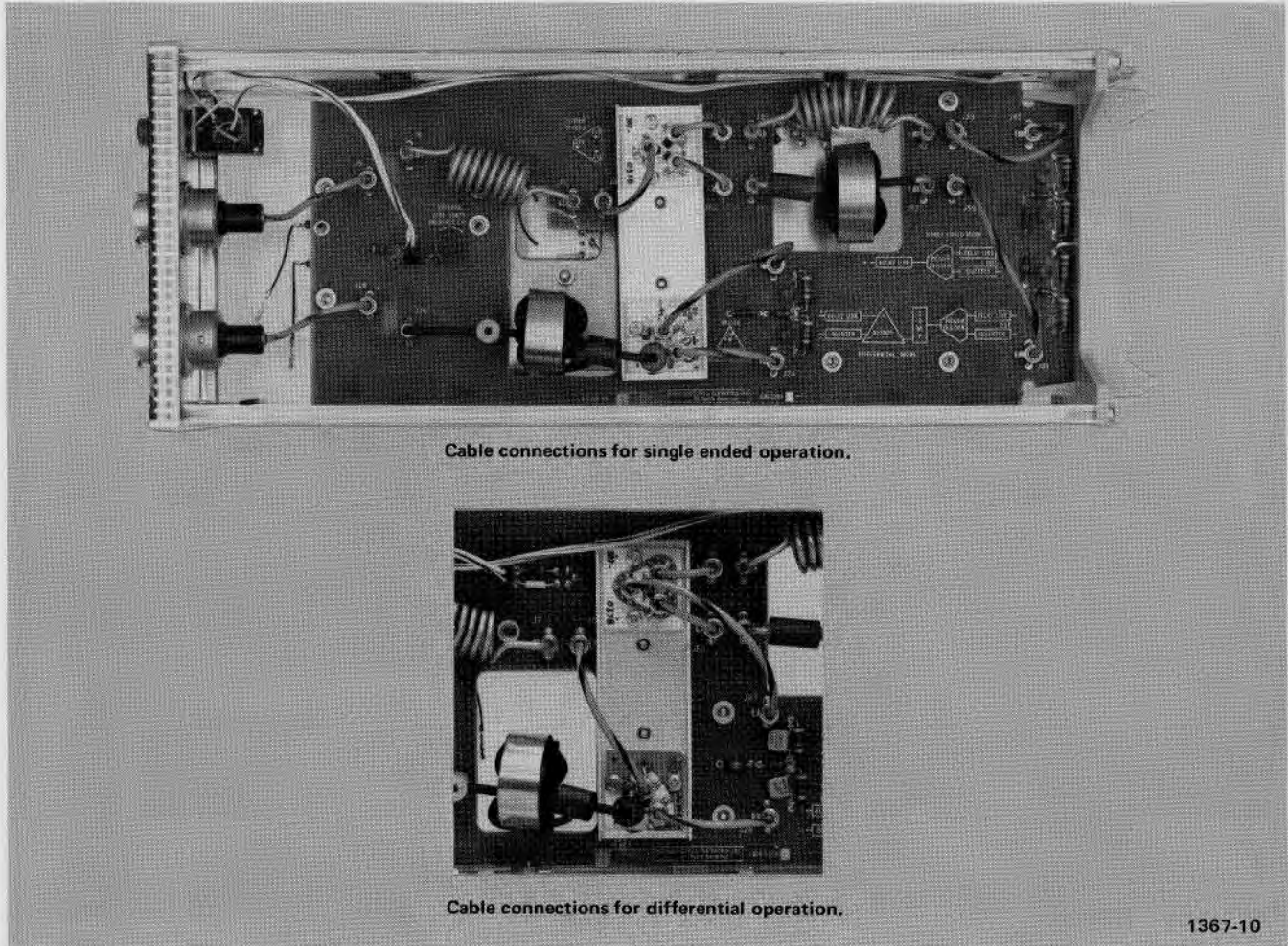


Fig. 4. Cable connections for single-ended and differential operation.