INSTRUCTION MANUAL

TYPE P6023 PROBE

Tektronix, Inc.
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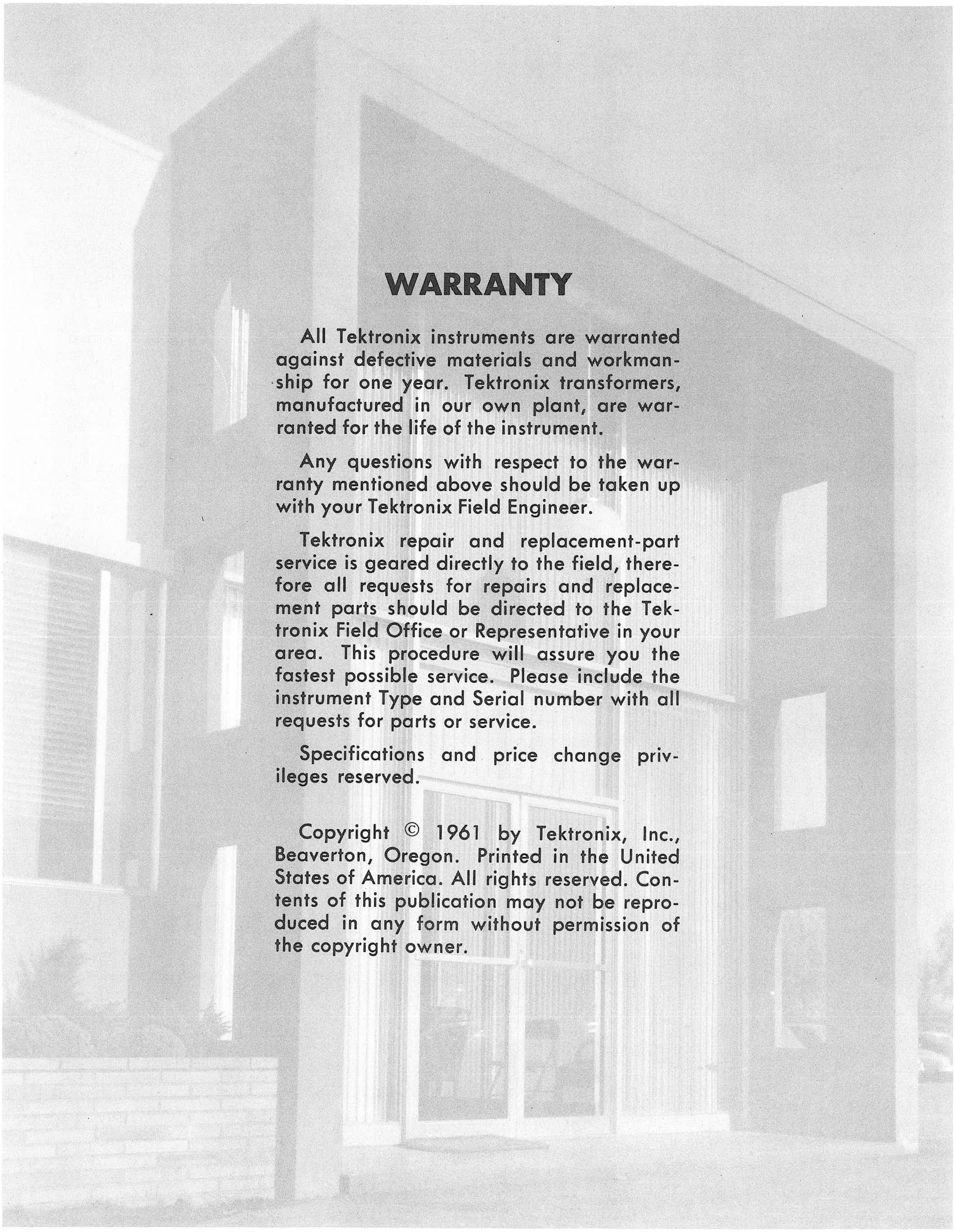
070-294



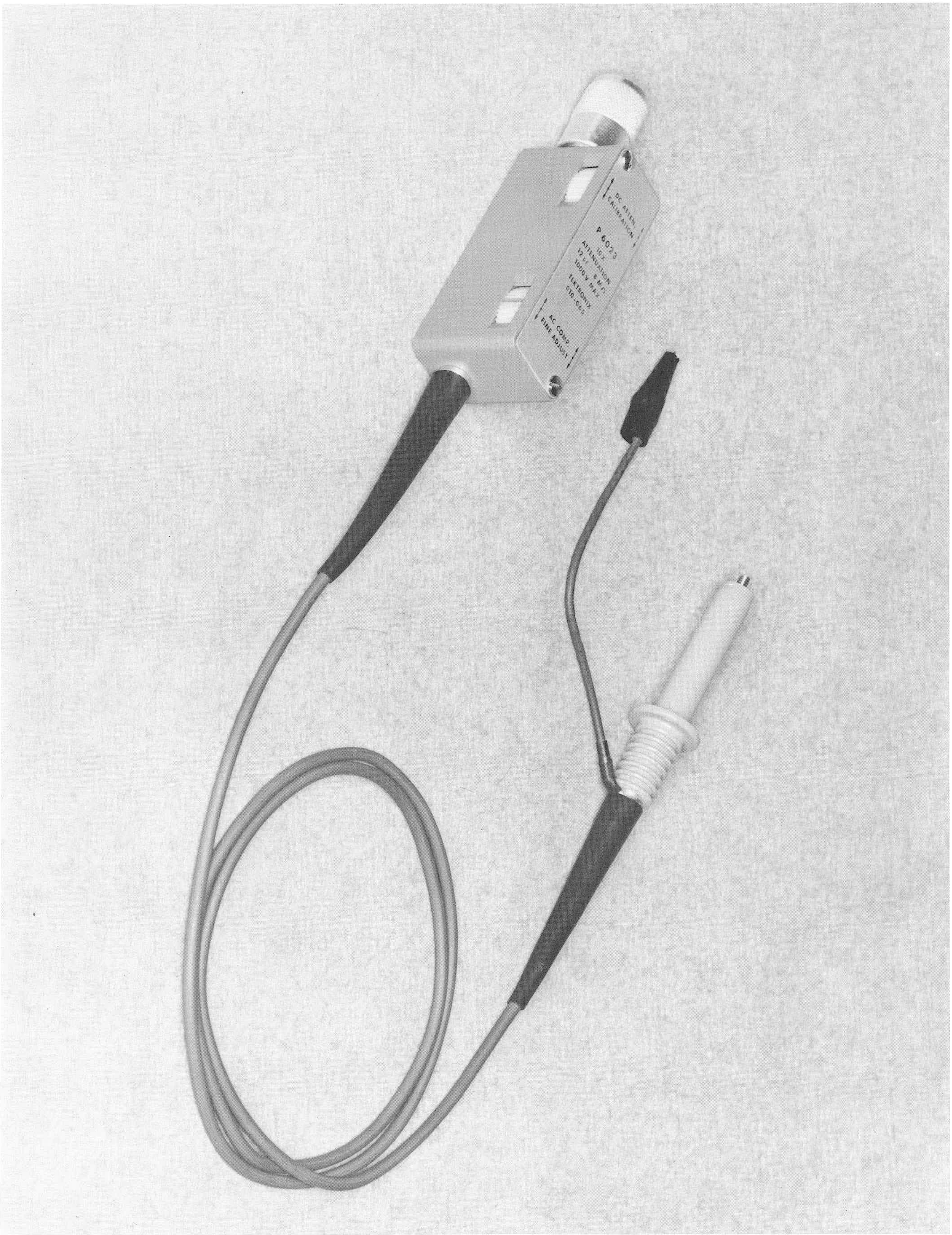
WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.


DC ATTEN.
CALIBRATION
P 6023
10X
ATTENUATION
12 pF 8 MΩ
1000V MAX.
TEKTRONIX
010-065
AC COMP.
FINE ADJUST

P6023 Probe

TYPE P6023 LOW-CAPACITANCE PROBE

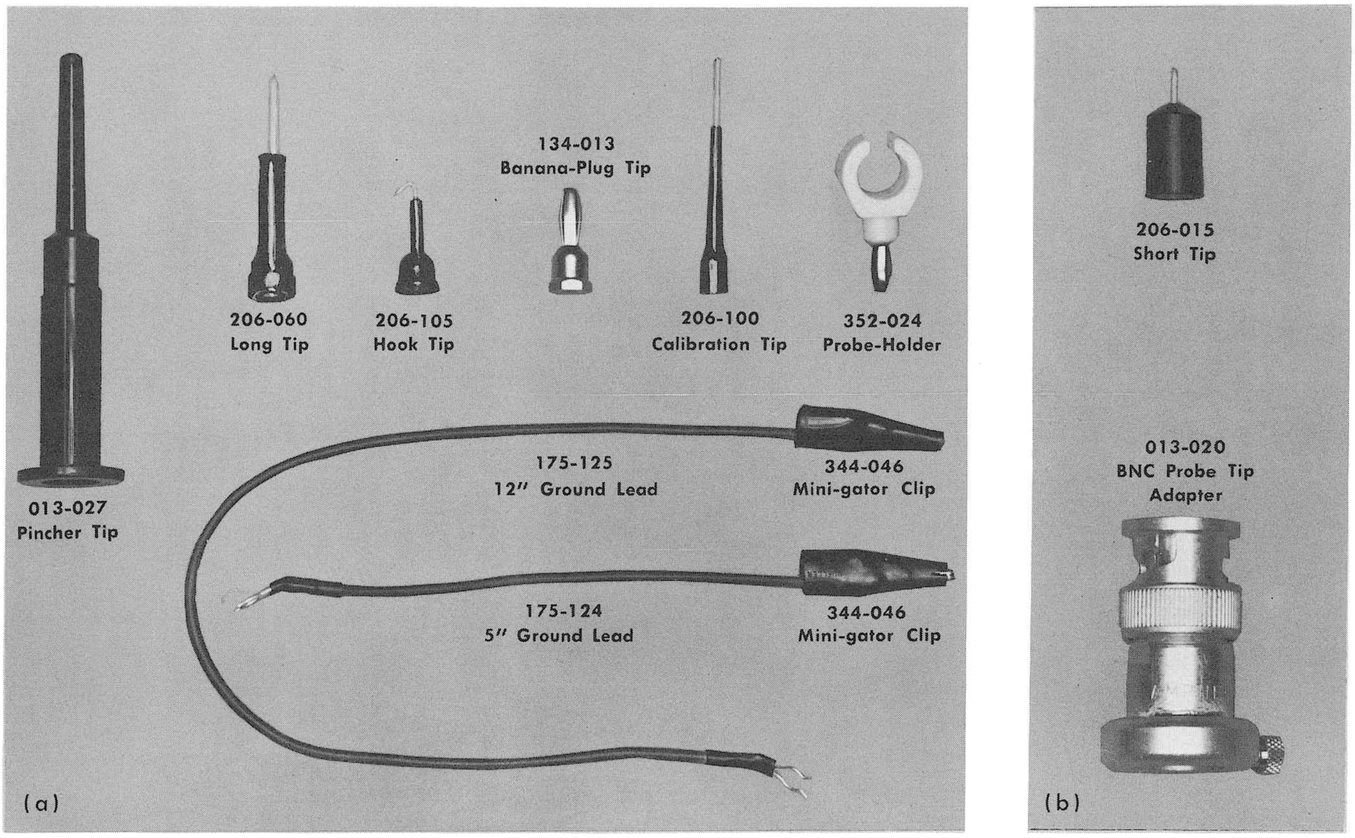


Fig. 1. (a) Accessories furnished with the probe, and (b) additional accessories available but not furnished.

Purpose

The Type P6023 Probe is a low-capacitance, adjustable-attenuation-ratio probe. Attenuation ratio is nominally X10 and is adjustable over a ±2.5% range (X9.75 to X10.25). Designed for use with Tektronix differential-input amplifiers, the probe offsets the one-percent-tolerance resistors used in amplifier attenuators. With the use of two such probes the attenuation-factor differences of the attenuators can be eliminated and thus increase the common-mode rejection ratio of the system.

The Type P6023 Probe is especially useful with the Type Z Differential Comparator Plug-In Unit. When used with this unit during differential comparator operation, the probe can be accurately adjusted so that voltages can be read directly from the COMPARISON VOLTAGE Helidial and multiplied by the nominal attenuation factor without having to take into account the attenuation factor tolerances generally encountered with other probes. During differential preamplifier operation when using two of these probes, the differential capabilities of the Z Unit are increased and accurate rejection ratio computations can be made.

Variable shunt resistance and capacitances in the Compensator Box permit the probe to be compensated for correct attenuation ratio at dc and to provide uniform frequency-response characteristics. The cable used in conjunction with the probe is a Tektronix coaxial cable which has a resistive center conductor.* The resistance value of the conductor is chosen for optimum transient response. Resilient bend-relief boots protect the cable where it joins the probe body and the Compensator Box.

The maximum voltage that can be applied to the probe is 1000 volts DC or peak-to-peak value. However, when applying voltage in the range of 900 to 1000 volts to the probe, it should be applied intermittently. Continuous application causes R1 (7.2-meg resistor located in the probe body) to heat up which, in turn, will produce some voltage-measurement error. Exceeding this rating either in peak-to-peak ac volts or dc volts, can cause a short circuit through the probe body to ground. The short circuit could result in damage to the components inside the probe body and the device under test.

CHARACTERISTICS

Attenuation Ratio—9.75:1 to 10.25:1

Input Capacitance, Input Resistance, Risetime and Frequency Response—Refer to Table I.

Voltage Rating—1000 volts DC or peak-to-peak value.

Cable Length—42 inches only.

Cable Connector—UHF.

Net weight—Complete probe (including ground lead) weighs 15 ounces.

*Patent No. 2,883,619.

Table I

	Input Capacitance	Input Resistance	Risetime	Frequency Response (3 db down)
P6023 Probe Alone	Approx. 12 pf.	10.5 meg to 12 meg	9 nsec	dc to 44 mc
P6023 Probe with Type CA Plug-In Unit and 540-Series Oscilloscope or equivalent	Approx. 12 pf.	7.8 meg to 8.2 meg	16 nsec	dc to 21 mc
P6023 Probe with Type D, G, or Z Plug-In Unit and 540-Series Oscilloscope or equivalent	Approx. 12 pf. (Input capacitance remains the same over the 20-pf to 47-pf input capacitance of Tektronix plug-ins or oscilloscopes)	7.8 meg to 8.2 meg	Probe does not noticeably affect the risetime or the bandpass of these instruments.	
P6023 Probe with Type 503 Oscilloscope				
P6023 Probe with Type 63 Module and 560-Series Oscilloscope				

Accessories Furnished with Probe (see Fig. 1a):

1-Pincer Tip (013-027).

1-Long Tip (206-105); supplied until replaced by 206-060.

1-Hook Tip (206-023).

1-Banana-Plug Tip (134-013).

1-Calibration Tip (206-100); used with Z Units to reach the ATTEN. TEST PT connector.

1-Probe Holder (352-024).

1-5" Ground Lead (175-124); shipped attached to probe.

1-12" Ground Lead (175-125).

2-Mini-gater clip (344-046).

Additional Available Accessories Not Furnished (see Fig. 1b):

Short Tip (206-015).

BNC Probe Tip Adaptor (013-020)—Allows connection of the Type P6023 Probe tip to a female BNC connector. This adaptor provides very low grounding inductance and slips over the Short Tip (which thus becomes the center conductor for the adaptor). The grounding screw in the adaptor aligns with a hole near the probe nose to ground and holds the adaptor body.

ADJUSTMENT PROCEDURES

General Information

Two adjustment procedures are provided in this Instruction Manual. The first procedure describes how one or two probes are adjusted when used with a modified Z Unit. When properly adjusted, the probes aid in obtaining maximum common-mode rejection and accurate voltage measurements. The information before the procedure describes resolution accuracy, the difference between modified and unmodified Z Units, and how to modify an unmodified unit.

The second procedure tells how two probes are adjusted for optimum common-mode rejection ratio when they are used with differential amplifiers such as those listed in Table I (which includes the Z Unit).

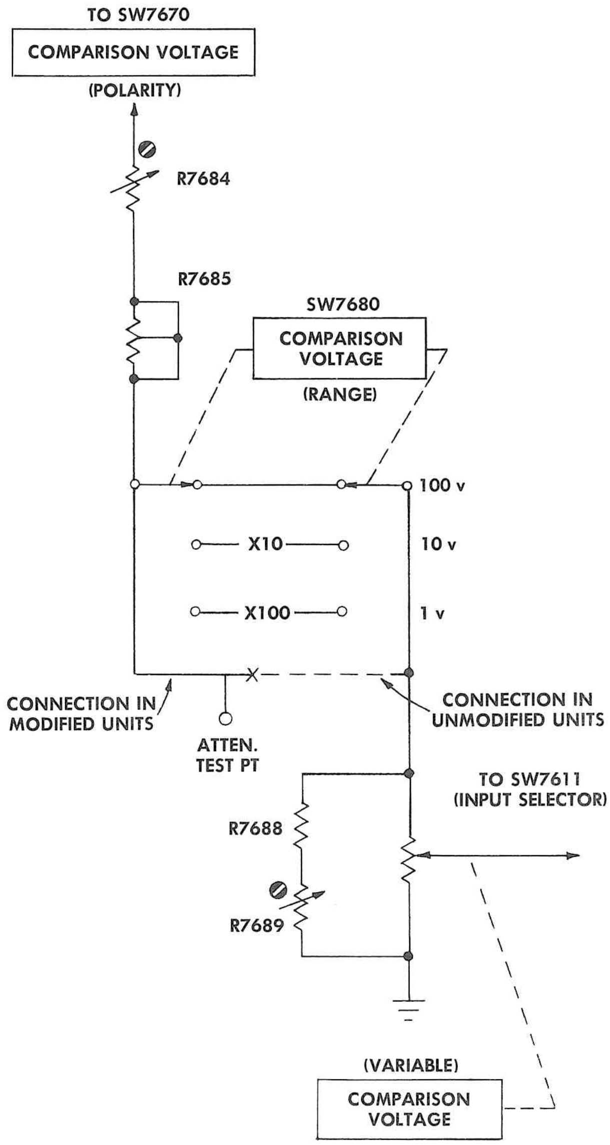


Fig. 2. Portion of the Type Z Plug-In Unit schematic diagram showing modified and unmodified connections leading from the ATTEN. TEST PT connector.

Probe Adjustment Procedure with a Z Unit

The comparison voltage available at the ATTEN. TEST PT connector in the Z Unit is the potential used in setting the nominal attenuation factor of the probe and Z-Unit input-attenuator combination. However, to set the probe attenuation adjustment accurately, the resolution accuracy of the Z Unit depends on these main factors: differential balance, vertical resolution and COMPARISON VOLTAGE Helidial setting.

Differential balance can be checked quickly by following the instructions given on page 2-1 in the Type Z Unit Instruction Manual.

Vertical resolution is the accuracy with which the trace can be returned to the null or zero reference point. This results in a percent accuracy for each attenuation factor. Refer to the graph on page 11.

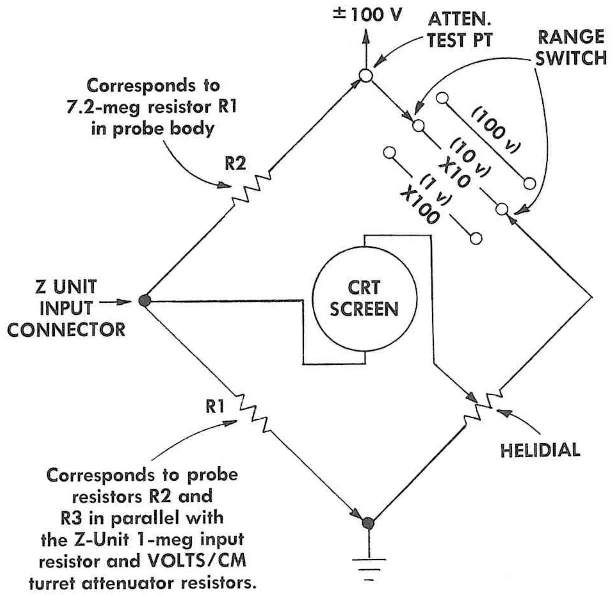


Fig. 3. Simplified diagram of the bridge circuit when modified for use with the Type P6023 Probe. This change does not alter the applications described on page 2-6 in the Z Unit Instruction Manual.

The advantage of modifying the unit can be seen clearly by referring to the graph on page 8. Additional comparisons can be made by comparing the bridge circuit of Fig. 3 in this manual with Fig. 2-5 in the Z Unit Instruction Manual.

In the unmodified circuit the ATTEN. TEST PT voltage drops from 100 volts to 10 volts and 1 volt respectively as the COMPARISON VOLTAGE Range switch is set from 100 V to 10 V and 1 V. This, in turn, decreases the available potential applied to the probe. As a result, the Helidial resolution accuracy cannot be improved and as the attenuation factor is increased, Helidial resolution accuracy decreases.

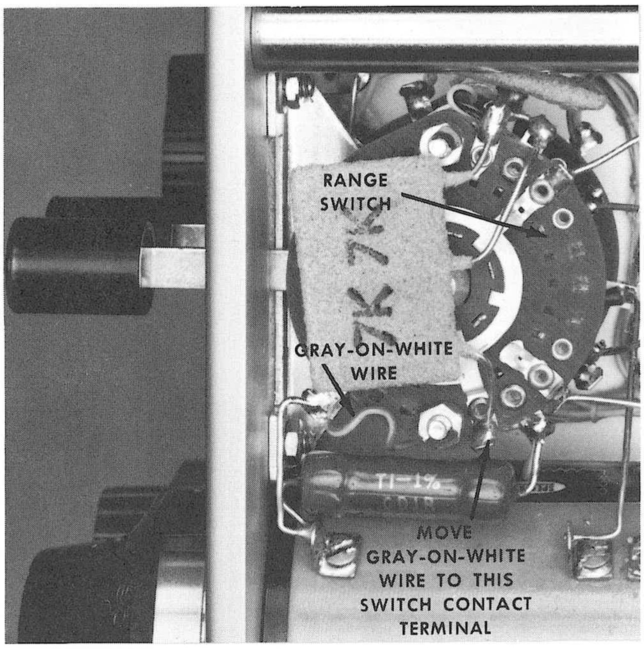


Fig. 4. Right side view, front portion, of the Z Unit showing how to modify your unit.

In the modified circuit the ATTEN. TEST PT connector connects directly to the 100-volt comparison voltage source.

This allows the 100-volts to be applied to the probe independent of the Range switch setting. Now the Helidial can be set to higher readings for improved resolution accuracy.

If your Z Unit is not modified, we suggest that you make the modification before using the probe. The circuit change can be made easily by moving only one wire. To make the change, cut the gray-on-white wire where it connects on the Range switch (SW7680) terminal shown in Fig. 4 and move the wire to the next switch terminal. When soldering the connection, do not let the solder flow beyond the rivet to to the switch contact area.

The following adjustment procedure applies to probes used with a modified Z Unit. Steps 1 through 13 describe how one probe is adjusted for accurate dc and ac attenuation when it is connected to the A input connector. After the probe is adjusted, a second probe connected to the other input connector is differentially adjusted to match the input attenuation factor of the A channel. Accurate common-mode signal-rejection ratio calculations can be made using this method.

NOTE

When starting the procedure, it is assumed that all the preliminary operational adjustments pertaining to the Z Unit as given on page 2-1 of the Z-Unit Instruction manual have been made.

1. Connect the Type P6023 Probe to the A input connector on the Z Unit. Set the A VOLTS/CM switch to the setting you intend to use with the probe.

2. Set the AC-DC switch to DC and Input Selector switch to A-Vc.

3. Place the COMPARISON VOLTAGE Polarity switch to 0.

4. Set the comparison voltage range and helidial to 10/N where N is the attenuation factor of the VOLTS/CM setting. 10/N is the voltage applied to the grid, which is offset by the comparison voltage.

5. Attach the calibration tip to the probe.

6. Set the oscilloscope triggering controls to obtain a free-running sweep. Ground the probe tip and position the trace within the viewing area of the graticule. Note the position of the trace for reference.

7. Place the probe tip through a vent hole in the left side panel of the oscilloscope and connect the probe tip to the ATTEN. TEST PT connector.

8. Set the COMPARISON VOLTAGE Polarity switch to + and adjust the probe DC ATTEN. CALIBRATION control to return the trace to the positition noted in step 6. To check for exact null or dc balance, set the Polarity switch to 0. If the trace shifts, adjust the DC ATTEN. CALIBRATION control until there is no trace shift as the Polarity switch is operated. (Adjust the DC ATTEN. CALIBRATION control when the Polarity switch is set to the + position so results of the adjustment can be seen.) Disconnect the probe from the ATTEN. TEST PT. Remove the calibration tip and in its place connect the probe tip you intend to use with the probe.

9. Rotate the probe AC COMP. FINE ADJUST to mid-range as indicated by the knob index marking.

10. Connect the probe tip to a square-wave signal source whose output amplitude is about 100 volts peak-to-peak. The waveform originating from the generator should have a risetime of 1 microsecond or faster and negligible overshoot. Use the oscilloscope calibrator or a similiar source; for example, a Tektronix Type 105 Square-Wave Generator with output unterminated.

11. Use the COMPARISON VOLTAGE Polarity, Range and Helidial controls to position the top of the positive-going square-wave within the graticule viewing area. For negative-going square waves such as that obtained from Type 105, the top of the waveform is at the zero level.

12. Set the oscilloscope triggering controls for triggered-sweep operation and set the sweep rate to display several cycles of the waveform. Adjust the AC COARSE COMP. adjustment to obtain good square-wave response (see Fig. 5c). This adjustment does not have to be made with extreme accuracy.

13. Adjust the AC COMP. FINE ADJUST control for optimum square-wave response.

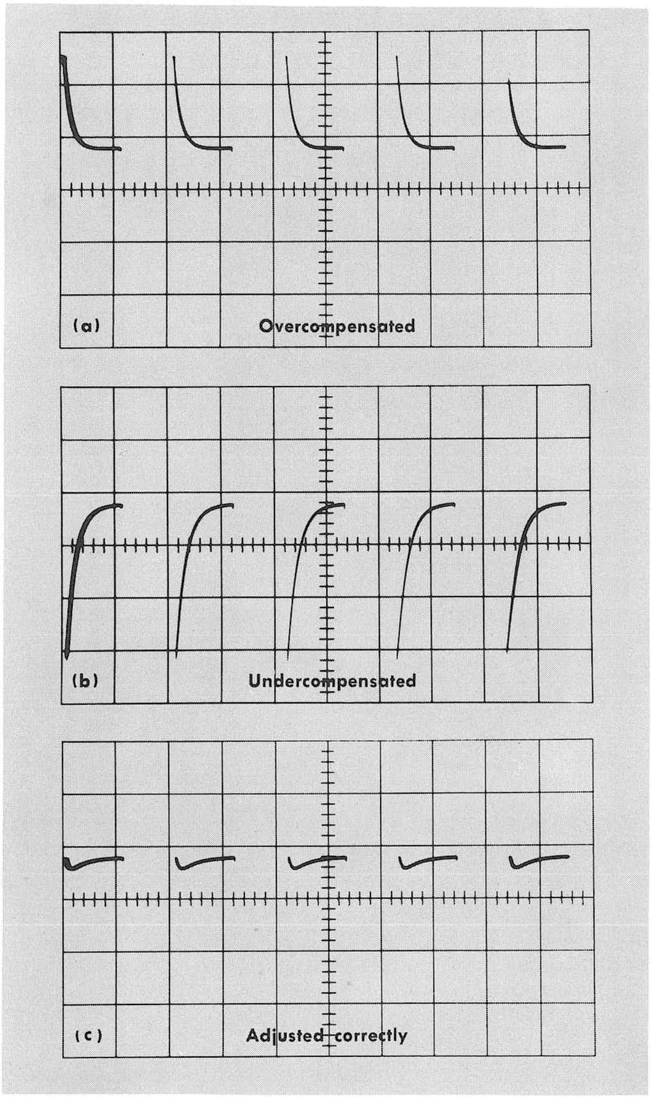


Fig. 5. Compensating the ac-attenuation to match the dc-attenuation ratio when the probe is connected to the A input connector on the Z Unit. Signal applied to the probe originates from the oscilloscope calibrator and is 100 volts peak-to-peak in amplitude. Vertical sensitivity is 0.5 volts/cm.

NOTE

The remaining steps describe how to differentially adjust a second probe which is connected to the B input connector so that the B channel attenuation matches the attenuation factor of the A channel.

14. Connect the Compensator Box of a second probe to the B input connector on the Z Unit. Set the B VOLTS/CM switch to the same setting as the A VOLTS/CM switch.

15. Set the B Channel AC-DC switch to DC and the Input Selector switch to A-B DIFF.

16. Connect the tips of both probes to a square-wave common-signal source. Use a signal which is close to the maximum signal-handling capabilities of the Z Unit and yet does not exceed the rating of the probe (1000 volts peak-to-peak).

17. If a common-mode signal appears on the screen, adjust the **B input probe** controls in this order—DC ATTEN. CALIBRATION, AC COARSE COMP. and AC COMP. FINE ADJUST—for maximum common-mode signal rejection characterized by minimum signal amplitude (see Fig. 6c).

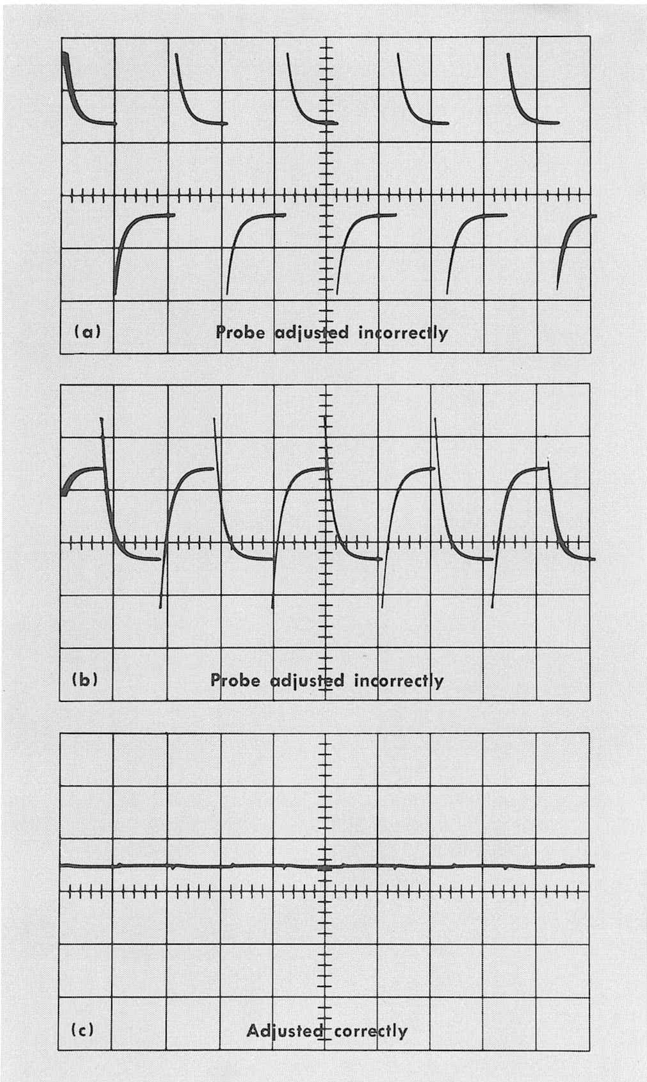


Fig. 6. Matching the B input probe to the A input probe by adjusting for minimum common-signal amplitude. For this illustration the VOLTS/CM switches on the Z Unit were set to .05 and both probe tips were connected to a 100-volt peak-to-peak oscilloscope calibrator signal source.

Probe Adjustment Procedure with a Differential Amplifier

In the following procedure two probes are adjusted so that maximum common-mode rejection ratio can be obtained when the probes are used with differential amplifiers such as those listed in Table I. If the probes are used with a Z Unit and you are performing this procedure instead of the first one, the same common-mode rejection can be obtained but ratio calculations cannot be made as accurately. (Calculation errors can be off as much as ±4.5%.)

NOTE

If your amplifier has a Differential Amplifier adjustment, check the adjustment to obtain best common-mode signal rejection before starting the procedure.

1. Connect the Compensator Boxes of two Type P6023 Probes to the input connectors of a different amplifier.

2. Set the differential amplifier volts/cm switches to the positions you intend to use for your particular application.

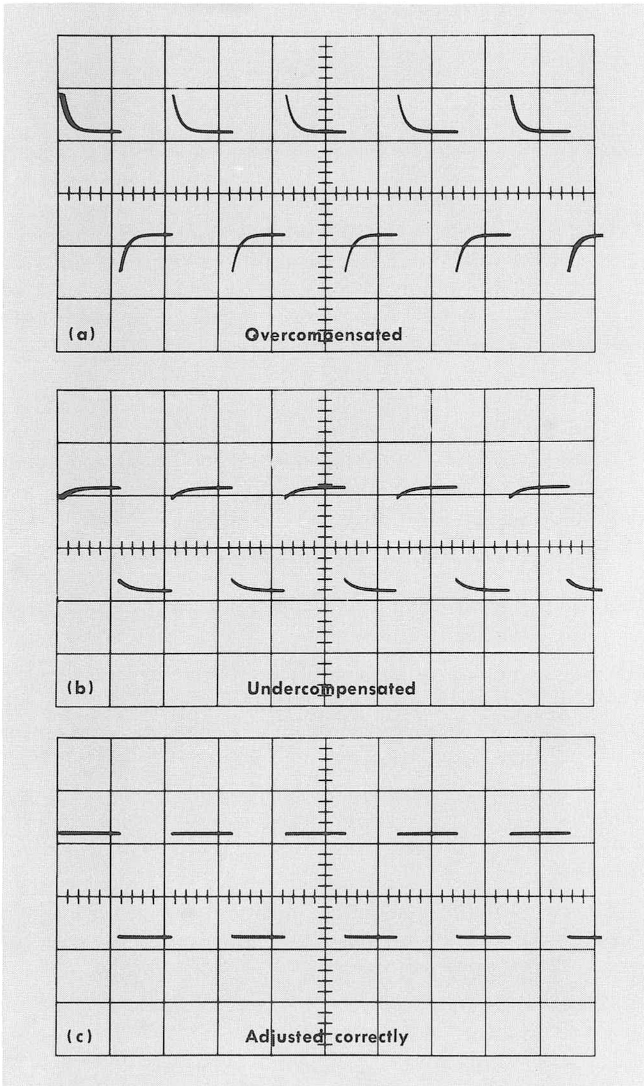


Fig. 7. Compensating the ac-attenuation to match the dc-attenuation ratio when the probe is connected to the A input connector on a differential amplifier. Oscilloscope calibrator is the signal source.

3. Set the oscilloscope Input Selector switch to A only and the AC-DC switches to DC.
4. Set the AC COMP. FINE ADJUST control of the A input probe to midrange.
5. Connect the A input probe tip to the CAL. OUT connector on the oscilloscope. Set the calibrator control for an output amplitude 2 times the vertical deflection factor of the amplifier and probe combined so that a display 2 centimeters in amplitude is obtained. Set the oscilloscope sweep rate and triggering controls to display several cycles of the waveform.
6. Adjust the A input probe AC COARSE COMP. control for an undistorted square-wave shape (see Fig. 7c). This adjustment does not have to be made with extreme accuracy for this step.
7. Adjust the A input probe DC ATTEN. CALIBRATION control in conjunction with the AC COARSE COMP. control so the square-wave amplitude is exactly 2 centimeters in amplitude while still retaining the best square-wave response.
8. Set the oscilloscope Input Selector switch to B only. Follow steps 4 through 7 and adjust the **B-channel probe.**
9. Set the amplifier Input Selector switch to the A-B differential position.
10. Connect the probe tips to a square-wave common-signal source. Use a signal which is close to the maximum signal-handling capabilities of the differential amplifer for the attenuator position you intend to use and yet does not exceed the rating of the probe (1000 volts peak-to-peak).
11. If a common-mode signal appears on the screen, adjust the **B-channel probe** controls in this order—DC ATTEN. CALIBRATION, AC COARSE COMP. and AC COMP. FINE ADJUST—for maximum signal rejection characterized by minimum signal amplitude (see Fig. 8c).

PRACTICAL OPERATING HINTS

Here are a few hints that will help you obtain proper performance from your probe.

1. Check the compensation of the probe before using it, especially when the probe is transferred from one channel to the other or from one amplifier to another. For precise measurements frequent calibration checks are recommended.

2. To obtain accurate measurements when using the probe with the Z Unit, recalibrate the probe each time a different VOLTS/CM switch setting is used. Follow the first procedure.

3. During differential amplifier operation when other attenuation factors of the amplifier attenuators are used, readjust the probe for optimum common-mode rejection ratio.

4. When optimum accuracy is desired, allow the probe body to reach ambient temperature before recalibrating it.

5. During differential operation when fast-rise pulses containing very-high frequency components are applied, lead length is important. Using a pincher tip on one probe and a short tip on the other probe will cause a time delay difference between channels. This will cause fast-rise positive and negative spikes to appear on the display.

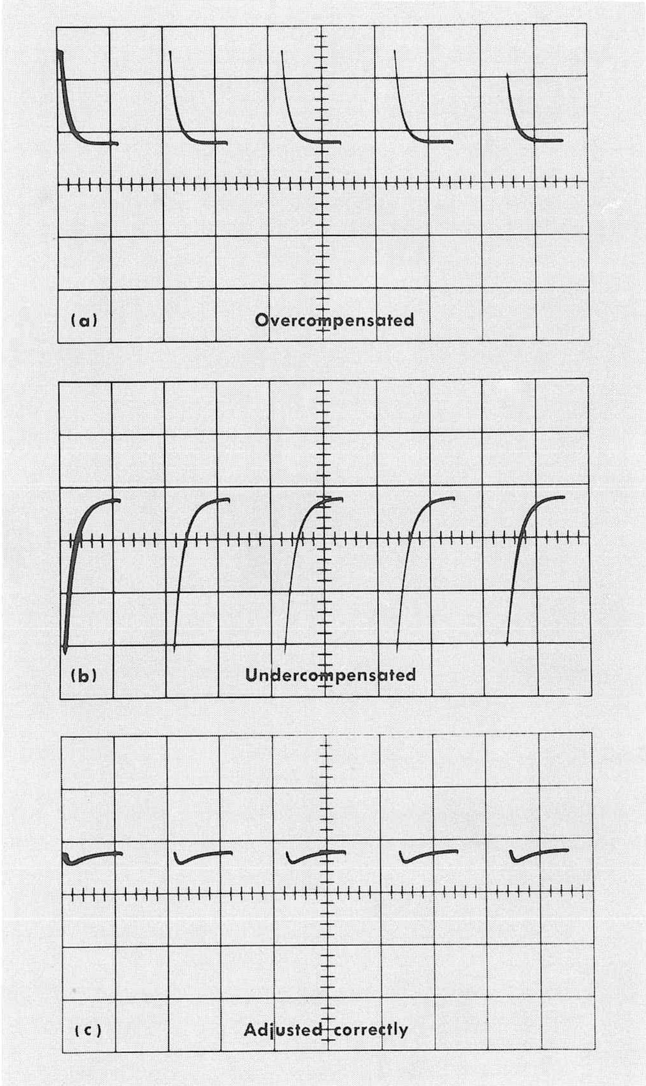


Fig. 8. Matching the B input probe to the A input probe by adjusting for minimum common-signal amplitude. Signal source is the oscilloscope calibrator.

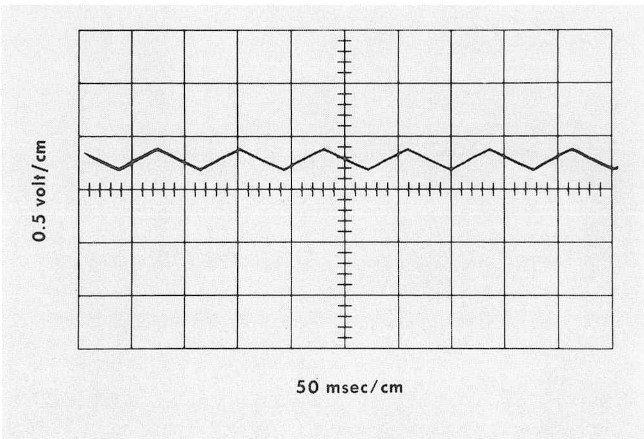


Fig. 9. Waveform caused by slight differences in Z-Unit ac-coupling input time constants.

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6. When a Type P6023 Probe and a conventional probe are used together during ac-coupled preamplifier operation, the differences in input-circuit time constants will introduce low-frequency response measurement errors. With the Type P6023 Probe connected to the amplifier, the time constant of the input circuit is 0.357 second and low-frequency response is 0.447 cps at —3 db; with a conventional probe connected to the amplifier, the time constant is 1 second and the low-frequency response is 0.159 cps at —3 db.

When two P6023 Probes are used with the Z-Unit, consider the ±2% maximum tolerances of the Z-Unit ac-coupling input time constants. These tolerances produce a waveform similar to that shown in Fig. 9. This waveform was obtained by applying a 100-volt amplitude, 14 cps, signal from the Type 105 Square-Wave Generator through the probes to both Z-Unit inputs. The Z-Unit MODE switch was set to A-B DIFF. The input time constants, of the Z-Unit **cannot** be corrected by adjusting the probes but some correction can be obtained by referring to the information given in the last paragraph on page 2-3 of the Z-Unit Instruction Manual.

MAINTENANCE

Preventive Maintenance

Regular inspection of the cable and coax-connector setscrews will prevent possible mechanical damage due to twisting. These setscrews are 0.050" hex screws and if they should work loose, they should be tightened so the probe connectors are held firmly in place.

In addition, check the 0.035" hex setscrew in the nose of the probe. If this screw becomes loose, intermittent contact troubles may result. Retighten the screw but do not use too much force or the lead from R1 may be sheared. The screw should be tightened just enough to make a good electrical contact between the lead of R1 and the threaded probe nose.

REPAIRING THE PROBE

Probe Body

To disassemble the probe body, proceed as follows:

1. Loosen the 0.035" hex setscrew located in the nose of the probe and the 0.050" hex setscrew in the probe base.

2. Slide the probe body forward and off R1-CI.

3. Note the physical location of the components. R1 and C1 are a special assembly. The outer sleeve of C1 is adjusted at the factory in such a way that it compensates for the environmental characteristics of R1. This results in a linear-frequency characteristic of the assembly and once the adjustment is made, no further adjustment is necessary. To maintain the adjustment setting, the lead from the outer sleeve of C1 is soldered to the lead of R1. The assembly is then soldered to the center conductor of the probe cable. The center conductor is a fine, resistive wire which is brought through a hole in the center of a ceramic insulator. In the hole area the ceramic is silvered and tinned for instant soldering.

4. If you need to replace the R1-C1 assembly, apply the tip of the soldering iron to the tinned area of the ceramic insulator. When the solder melts, slide the lead of R1 out until it is free of the insulator.

5. When installing the replacement nose assembly, note that the rear lead has a crimp 1/8 inch from the end. Push the rear lead into the cup until the crimp hits the cup and stops further progress. The assembly is now positioned properly, and may be soldered in this position.

6. Install the probe body.

7. Cut off the excess lead length from R1 that protrudes beyond the probe nose.

Compensator Box

A. Replacing the Coax Connector

1. Remove the cover plate (see item 6, Fig. 10).
2. Loosen the 0.050" hex setscrew holding the coax connector.
3. Apply the soldering iron to the tip of the connector and slide the connector out of the Compensator Box.

B. Replacing Components in the Compensator Box

By removing the cover plate(s) from the Compensator Box, any of the internal components can be replaced easily. 0.035" hex setscrews hold the knobs on the control shafts. Always mount the replacement part in the same location as the part which was removed. When remounting the AC COMP. FINE ADJUST knob, set the knob so that the index mark indicates the midrange position of the control. Tighten the knob setscrew.

Probe Cable

As mentioned earlier, the cable contains fine, resistive wire which requires careful handling. The cable is an assembly (see item 3, Fig. 11) and its length is 42" (+0", —1/4"). The length of the cable is kept to a close tolerance to maintain a close match between probes. To remove the probe cable proceed as follows:

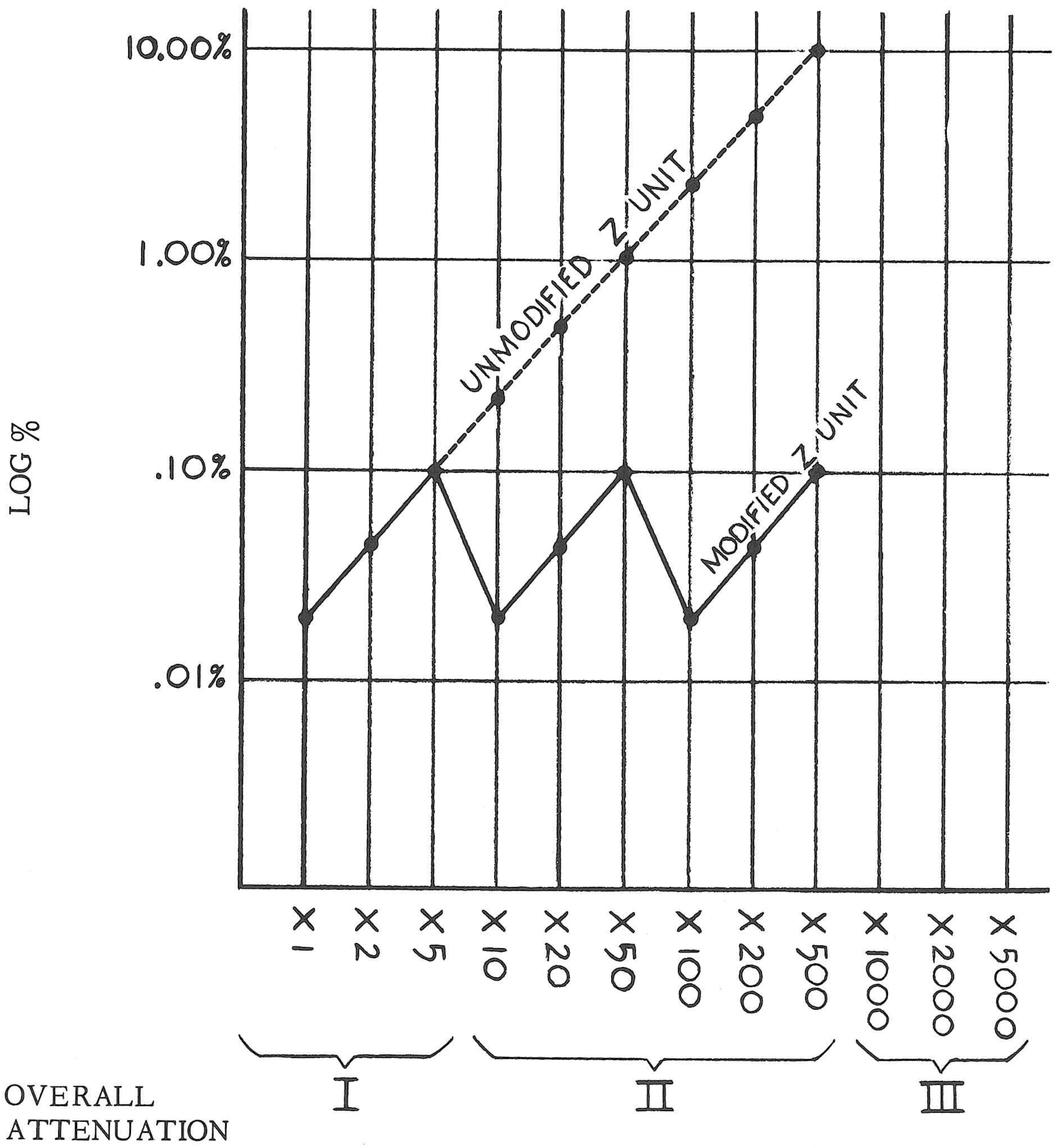
1. Remove the probe body and the R1-C1 assembly as outlined in steps 1 through 4 under the title "Probe Body". Take care and do not change the position of R1 with respect to C1.

2. Remove the Compensator Box cover plate (see item 6, Fig. 11).

3. Loosen the 0.050" hex setscrew which holds the cable in the Compensator Box.

4. Unsolder the selected resistor where it connects to C2 (see item 7, Fig. 11) and remove the cable. Install the replacement cable assembly. Use the information given in step 5 of the "Probe Body" instructions.

Resolution accuracy of the Helidial only for a modified and a unmodified Z unit.



I Using a X1 probe with the Type Z Unit it is possible to measure the attenuation factors in the X2 and X5 positions of the attenuator switch with the accuracy shown in the graph above. To measure these attenuation factors use the procedure given below.

1. Select the attenuation position (X2 or X5) you want to measure.

2. Switch the COMPARISON VOLTAGE switch to 100 V and to 0 polarity.

3. Attach the X1 probe to the Type Z Unit and apply the ATTEN. TEST PT voltage to the probe.

4. Note the position of the trace and change the polarity to the + position.

5. With the helidial, return the trace to the exact position noted in step 4.

6. Divide the helidial reading by 100 to find the attenuation.

II and III the attenuation factors shown as II and III in the graph above are the product of the 10X attenuation of the P6023 and the attenuator setting of the Type Z Unit.

Note: The factors covered by III are not normally used since voltages permitted by the rating of the Type P6023 probe do not produce usable amounts of deflection.

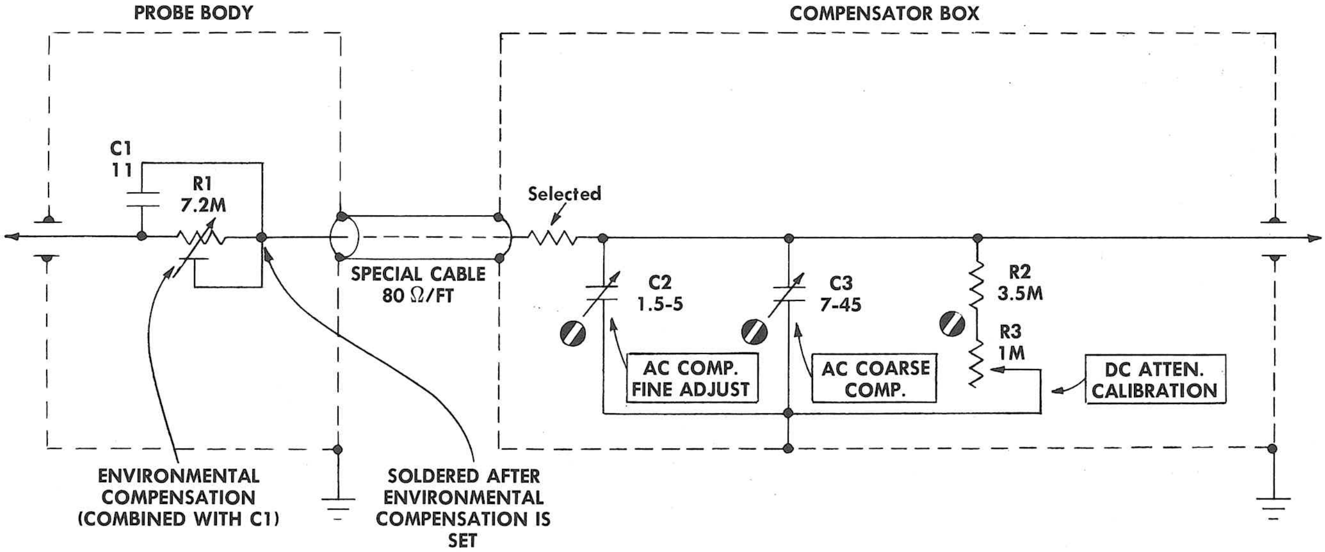


Fig. 10 Schematic diagram of the Type P6023 Probe.

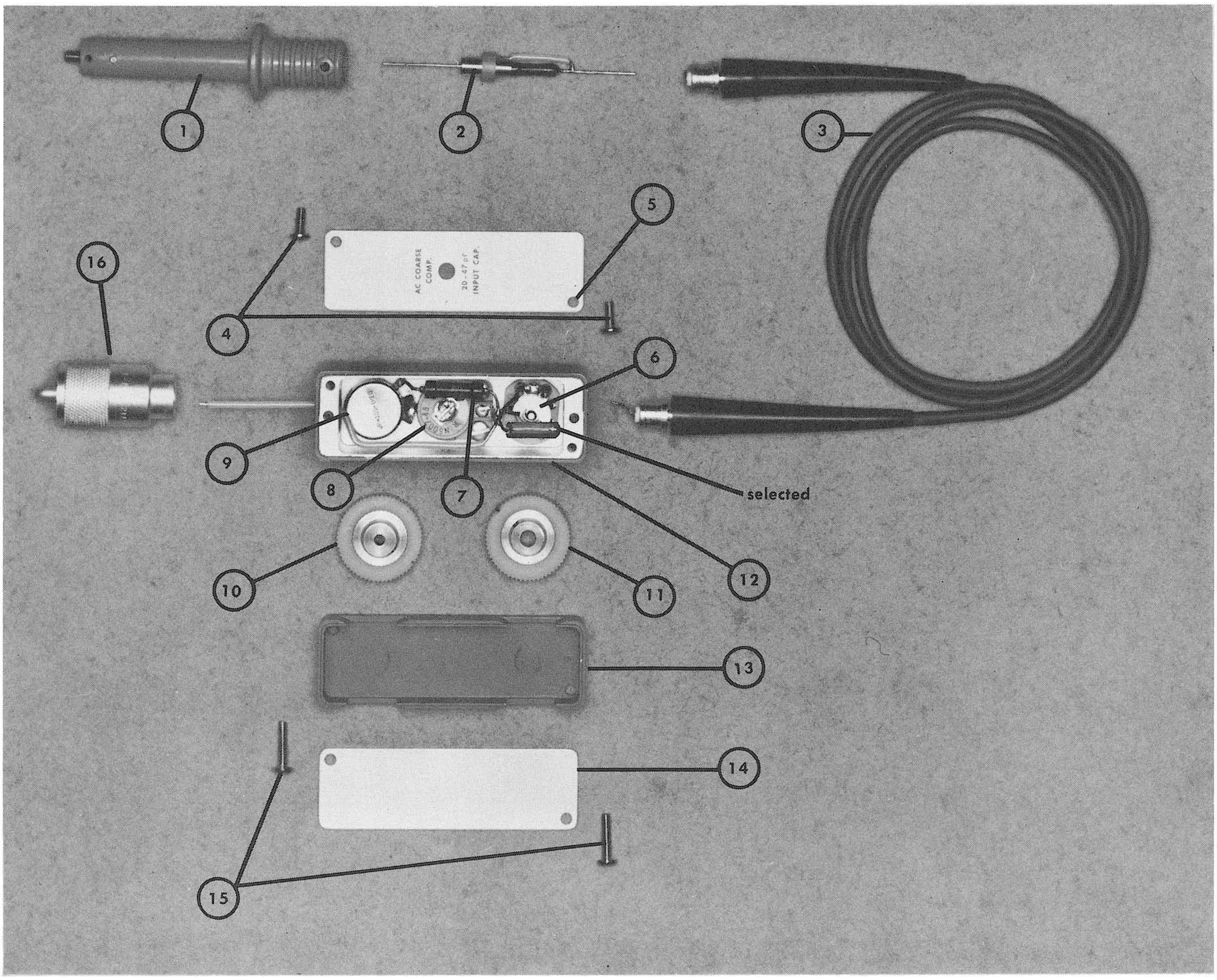
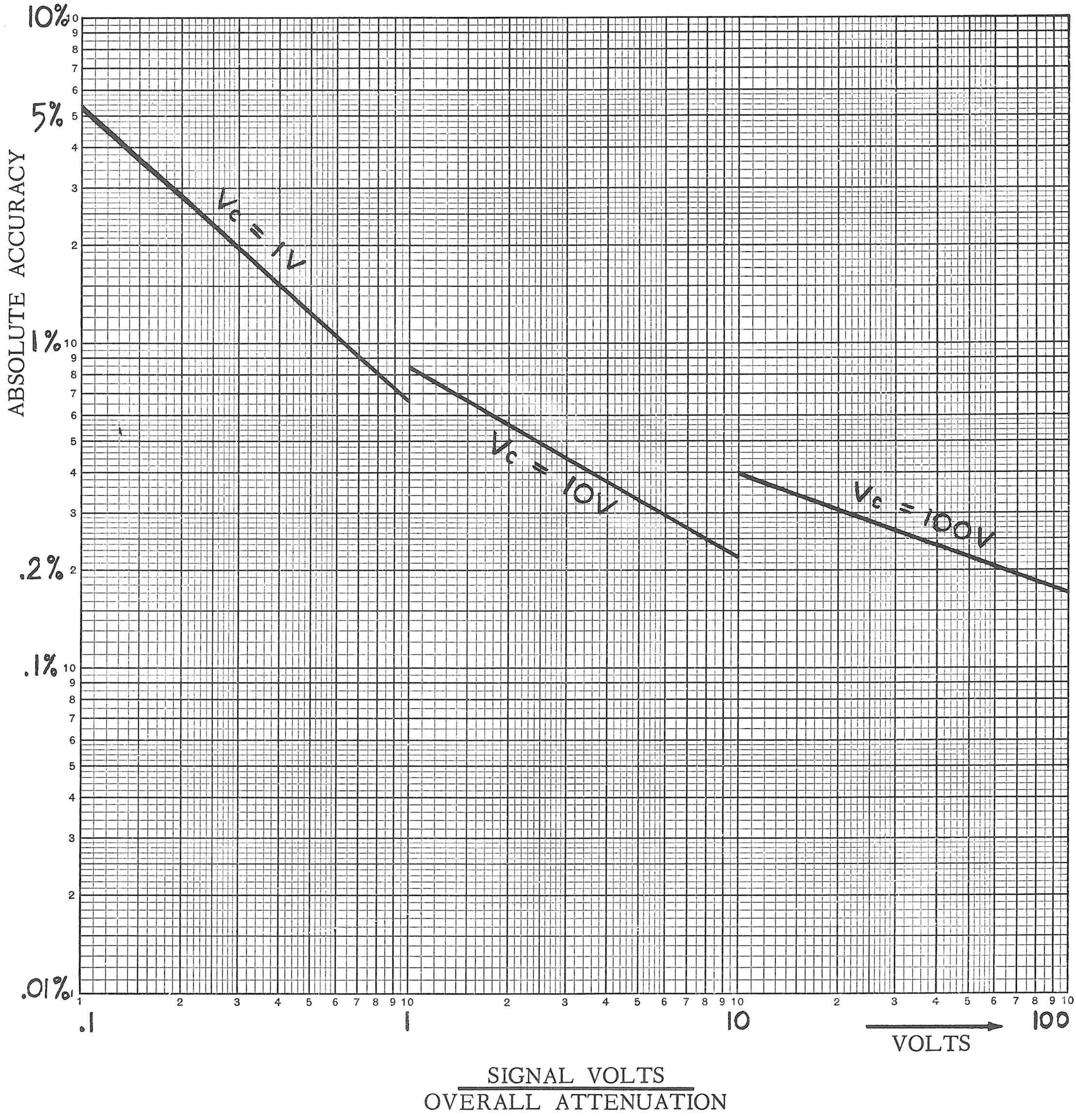


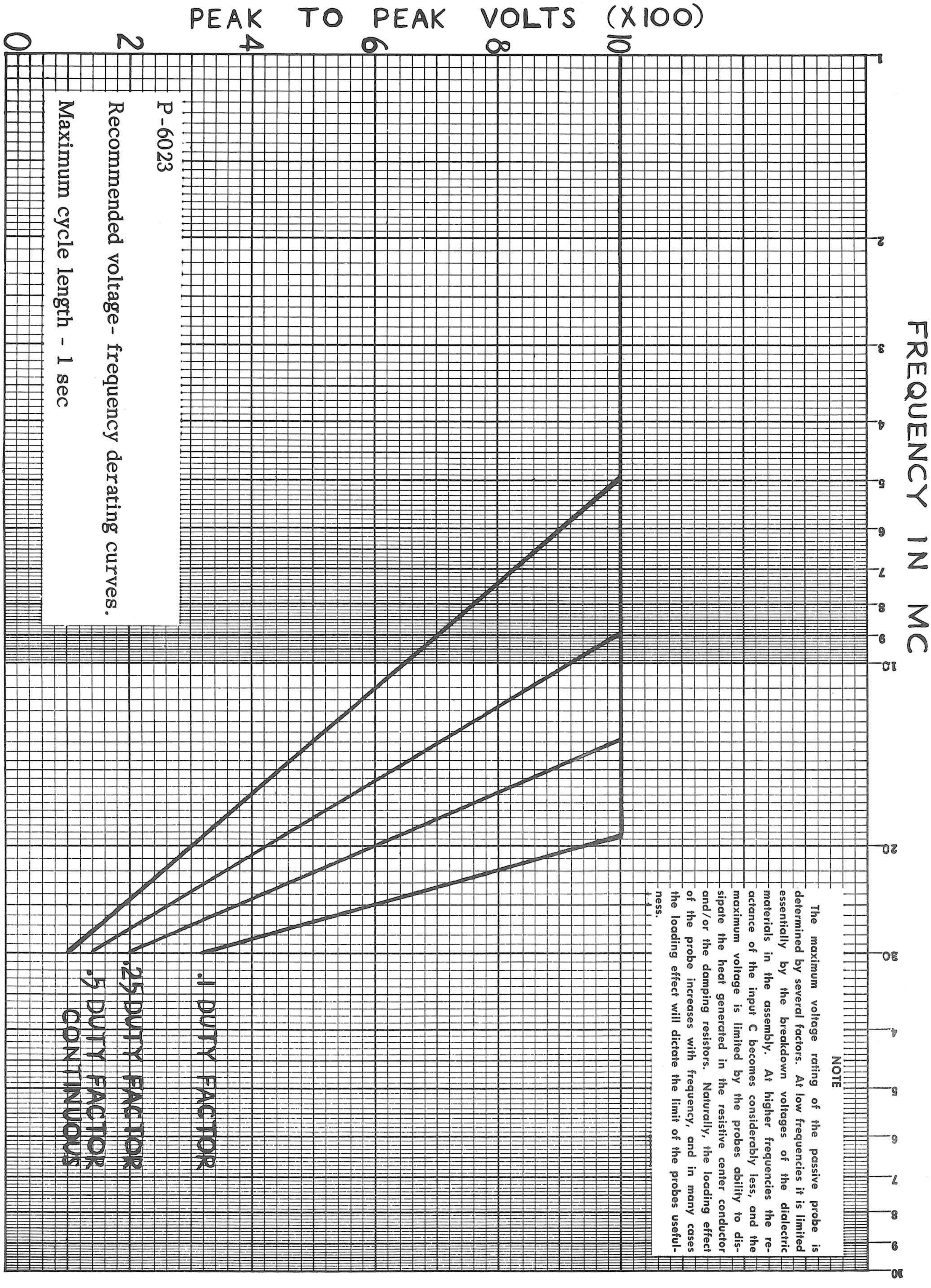
Fig. 11 Exploded view of the Type P6023 Probe with item numbers.

PARTS LIST

Item No.	Circuit Symbol	Description	Tektronix Part Number
1		Probe body	204-054
2	C1, R1	Nose components (special assy.)	206-076
3		Cable assy.	175-190
4		Screw, 4-40 x 1/4" long, RH Phillips	211-010
5		Cover, Compensator Box	200-287
6	C2	Capacitor, 1.5-5 $\mu\mu$f, air, variable	281-056
7	R2	Resistor, 3.5 M, 1/2 w, fixed, prec., 1%	309-086
8	C3	Capacitor, 7-45 $\mu\mu$f, Cer., variable	281-012
9	R3	Resistor, 1 meg, variable	311-252
10		Knob, DC ATTEN. CALIBRATION	366-128
11		Knob, AC COMP. FINE ADJUST	366-127
12		Compensator Box	202-075
13		Dial box, Compensator	202-076
14		Dial cover, Compensator Box	200-286
15		Screw, 4-40 x 5/8" long, RH Phillips	211-016
16		Coax connector, male, single contact	131-058
Selected		Nominally 47 ohm 1/2 w Comp	302-470

ABSOLUTE ACCURACY OF MODIFIED Z UNIT




PEAK TO PEAK VOLTS (X100)
0
2
4
6
8
10
FREQUENCY IN MC
1
2
3
4
5
6
7
8
9
10
20
30
4
5
6
7
8
9
10
P-6023
Recommended voltage- frequency derating curves.
Maximum cycle length - 1 sec
.1 DUTY FACTOR
.25 DUTY FACTOR
.5 DUTY FACTOR
CONTINUOUS
NOTE
The maximum voltage rating of the passive probe is determined by several factors. At low frequencies it is limited essentially by the breakdown voltages of the dielectric materials in the assembly. At higher frequencies the reactance of the input C becomes considerably less, and the maximum voltage is limited by the probes ability to dissipate the heat generated in the resistive center conductor and/or the damping resistors. Naturally, the loading effect of the probe increases with frequency, and in many cases the loading effect will dictate the limit of the probes usefulness.

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.