

AM 503S
CURRENT PROBE
SYSTEM

**User
Manual**

*Please check for CHANGE INFORMATION
at the rear of this manual.*

First Printing MAR 1992

Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., PO. Box 500, Beaverton, OR 97077

Printed in U.S.A.

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In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

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Standard warranty for: **AM503A, AM503S, A6302, A6303**



This manual describes how to operate the AM 503S Current Probe System with emphasis on the AM 503A Current Probe Amplifier, A6302 Current Probe, and A6303 Current Probe. To obtain operating and servicing information for the TM 502A Power Module, refer to the TM 502A Instruction Manual. To obtain servicing information for the AM 503A, A6302, and A6303, including a replaceable parts list, refer to the AM 503S Service Manual (Tektronix part number 070-8174-00).

Conventions

This manual uses the following conventions:

- AM 503S refers to a combination of a TM 502A Power Module, an AM 503A Current Probe Amplifier, and an A6302 or A6303 Current Probe.
- TM 502A refers to a TM 502A Power Module. Power module refers to any Tektronix TM 500- or TM 5000-Series power module.
- AM 503A refers to the AM 503A Current Probe Amplifier.

- A6302 refers to the A6302 Current Probe and A6303 refers to the A6303 Current Probe.
- Items in bold capital letters, such as **DC LEVEL**, represent a button, knob, indicator, or connector on the AM 503A front panel.
- Items in bold, such as **50**, represent values displayed on the AM 503A front panel.

Notes appear throughout the manual. They provide information that helps you get the best performance from your product.

NOTE

Read note statements for helpful information.

Organization

This manual is divided into four sections and three appendices.

- Section 1, *General Information*, describes the components included with the AM 503S, describes how to install and power up the system, and provides general safety guidelines.
- Section 2, *Control Summary*, briefly describes the functions of the AM 503A front panel controls.
- Section 3, *Operation*, tells how to operate the AM 503S system and highlights specific operating considerations.
- Section 4, *Applications*, shows some typical applications of the AM 503S.
- Appendix A, *Specifications*, lists major specifications of the AM 503S Current Probe System.
- Appendix B, *Glossary of Terms*, defines key technical terms used in this manual.
- Appendix C, *Troubleshooting Guide*, lists possible solutions to some of the most-common measurement problems.



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General Information

The Tektronix AM 503S Current Probe System consists of an AM 503A Current Probe Amplifier, an A6302 Current Probe (the A6303 Current Probe may be ordered separately or as an option), and a TM 502A Power Module.

The AM 503S lets you use one probe to simultaneously measure AC and DC current. The AM 503A amplifier converts the sensed current into a proportional voltage signal that you can measure directly with an oscilloscope or similar measuring device.

You can select the probe that best matches your application. Each probe uses a moveable slide to clamp around the conductor under test. Section 3, *Operation* and Section 4, *Applications* provide information to help you choose the correct probe for your application.

The AM 503S provides better linearity than other current measurement systems because of a current feedback process used with the probe. DC measurement capability and high bandwidth allow the AM 503S to accurately represent square waves and fast-rise signals. The high sensitivity of the AM 503A maximizes measurement precision.

Features

The AM 503A Current Probe Amplifier includes these features:

- simultaneous DC and AC current measurements
- high sensitivity
- one-button autobalancing and probe degaussing

Applications

The AM 503S Current Probe System can be used in a wide variety of DC and AC measurement applications.

- motor start-up circuits
- power supplies and inverters
- automotive signals
- inductance measurements

Some typical applications of the AM 503S are presented in Section 4, *Applications*.

AM 503S System Components

The standard AM 503S Current Probe System includes the following items (shown in Figure 1-1):

- AM 503A Current Probe Amplifier
- A6302 Current Probe (for optional probes, see the options list)
- TM 502A Power Module
- Toolbox
- AC Power cord
- BNC Output cable
- 50 Ω Termination
- User Manual and Quick Reference card

In addition to the AM 503S system, you need an oscilloscope to display the AM 503S measurements. The oscilloscope bandwidth should be approximately four times the bandwidth of your current probe and should be capable of displaying a vertical scale factor of 10 mV/div.

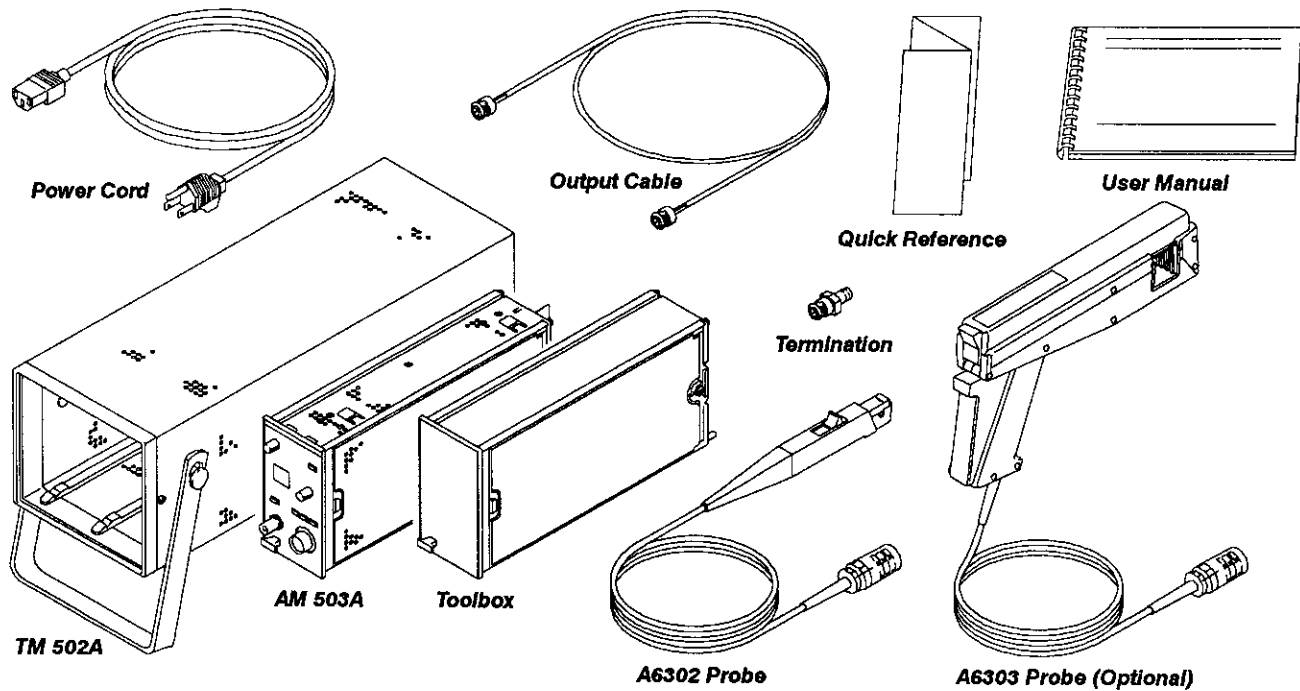


Figure 1-1: Components of the AM 503S

AM 503A Current Probe Amplifier

The AM 503A is a single-width instrument that plugs into any Tektronix TM 500- or TM 5000-series power module. The AM 503A amplifies the current sensed by the probe and converts the current to a proportional voltage that is displayed on an oscilloscope or other similar measuring device.

Current Probes

The probes available for use with the AM 503S system are the A6302 and the A6303. These probes cover a wide range of applications (for information about maximum operating limits, see Appendix A, *Specifications*). A standard AM 503S system includes the A6302 Probe; you may add or substitute the A6303 Probe (see the Options list in this section for alternative system configurations). The A6302 and A6303 probes may also be ordered separately. You can significantly extend the AC dynamic range of the A6302 Probe by using the CT-4 High-Current Transformer. The CT-4 can be ordered from your Tektronix sales representative. For more information about using the CT-4 with the AM 503S system, see Section 3, *Operation*.

TM 502A Power Module

The TM 502A Power Module is a lightweight, portable power supply that operates on either 110 or 220 VAC, 50 or 60 Hz, and accepts up to two single-width TM 500 instruments, such as the AM 503A or TVC 501 Time-to-Voltage Converter.

Power Cord

The power cord supplies power to the TM 502A Power Module. Several options of the power cord are available (see the power cord options list).

Output Cable

The output cable, a 50 Ω BNC cable, connects the output of the AM 503A to your oscilloscope or measuring device.

50 Ω Termination

Because the output impedance of the AM 503A is 50 Ω , the input impedance of your oscilloscope must be 50 Ω . If the input impedance of your oscilloscope is 1 M Ω , attach the 50 Ω feed-through termination to the oscilloscope input.

Toolbox

The AM 503S system includes a toolbox for storing probes, cables, accessories, and small tools. The toolbox can be plugged into the TM 502A next to the AM 503A Amplifier.

User Manual and Quick Reference Card

This user manual explains how to use the AM 503S current measurement system. The quick reference card provides an annotated front panel illustration, lists several important operating guidelines, and lists the essential steps for making a current measurement. Service information for the A6302 and A6303 Current Probes and the AM 503A Current Probe Amplifier is provided in the *AM 503S Service Manual*. Operating and servicing instructions for the TM 502A are in the *TM 502A Instruction Manual*.

Options

You can order the following options for the AM 503S Current Probe System:

Option 01: Add the A6303 Probe.

Option 03: Substitute the A6303 Probe for the A6302 Probe.

Power Cord Options

You can order the following power cord options for the AM 503S Current Probe System:

Option A1: Universal European, 220 V

Option A2: United Kingdom, 240 V

Option A3: Australia, 240 V

Option A4: North America, 240 V

Option A5: Switzerland, 220 V

Optional Accessories

You can order the following optional accessories for the AM 503S Current Probe System:

- AM 503S Service Manual (Tektronix part number 070-8174-00)
- Current Loop (Tektronix part number 015-0601-50)

The AM 503S Service Manual provides information for testing, calibrating, and troubleshooting your AM 503S system.

The current loop is used for checking the performance characteristics of the AM 503S. Refer to the AM 503S Service Manual for more information about these accessories.

Initial Inspection

After carefully unpacking your AM 503S Current Probe System, verify that you have all of the items for your system configuration as described in this manual. If any item is missing, consult your Tektronix representative for assistance.

Safety Summary

Observe the safety precautions described in this summary when operating the AM 503S Current Probe System. Specific warnings and cautions appear throughout the manual but may not appear in this summary.

Symbols and Terms

These two terms appear in manuals:

- **CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property.
- **WARNING** statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- **CAUTION** indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- **DANGER** indicates a personal injury hazard immediately accessible as one reads the marking.

This symbol appears in manuals:



Static-Sensitive Devices

These symbols appear on equipment:



DANGER
High Voltage



Protective
ground (earth)
terminal



ATTENTION
Refer to
manual

Specific Precautions

Observe all of these precautions to ensure your personal safety and to prevent damage to your equipment.

Power Source — This product is designed to operate from a power source that will not apply more than 250 V_{RMS} between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product — This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting equipment to the product input or output terminals. The protective ground conductor in the power cord is essential for safe operation.

Danger Arising from Loss of Ground — Upon loss of the protective ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electrical shock.

Use the Proper Power Cord — Use only the power cord and connector specified for your product and use only a power cord that is in good condition. Any changes to the cord or power connector should be performed by qualified service personnel only.

Use the Proper Fuse — To avoid fire hazard, use only the fuse of correct type, voltage rating, and current rating as specified in the parts list for your product. Fuse replacement should be performed by qualified service personnel only.

Do Not Operate in Explosive Atmospheres — To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels — To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

Operating Temperature

The AM 503A Current Probe Amplifier can be operated in ambient temperatures between 0° C and +50° C and stored in ambient temperatures from -55° C to +75° C. If stored at temperatures outside the operating limits, allow the chassis to reach the specified operating temperature range before applying power.

Operating Voltage

The TM 502A Power Module can operate from one of four AC line voltages. The operating voltage is determined by the voltage selector, located on the rear panel of the TM 502A (see Figure 1-2).

WARNING

To avoid personal injury or equipment damage, do not connect the power module to the AC line receptacle or turn the power module on until you have verified that the proper operating voltage is selected.

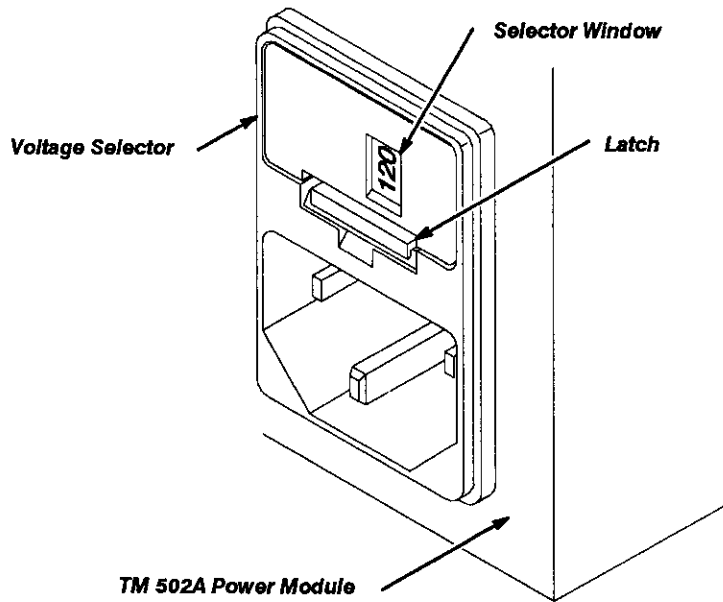


Figure 1-2: TM 502A Voltage Selector

The value displayed in the voltage selector window should match the value of your line voltage. If the two values don't match, perform these steps to select the correct value:

- Step 1:** Push up on the latch and pull the voltage selector assembly out.
- Step 2:** Disassemble the voltage selector as shown in Figure 1-3.
- Step 3:** Rotate the selector until the proper voltage appears in the window.
- Step 4:** Reassemble the voltage selector and push it back into the power module until it snaps into place.
- Step 5:** Using the correct power cord, connect the power module to the AC line receptacle.

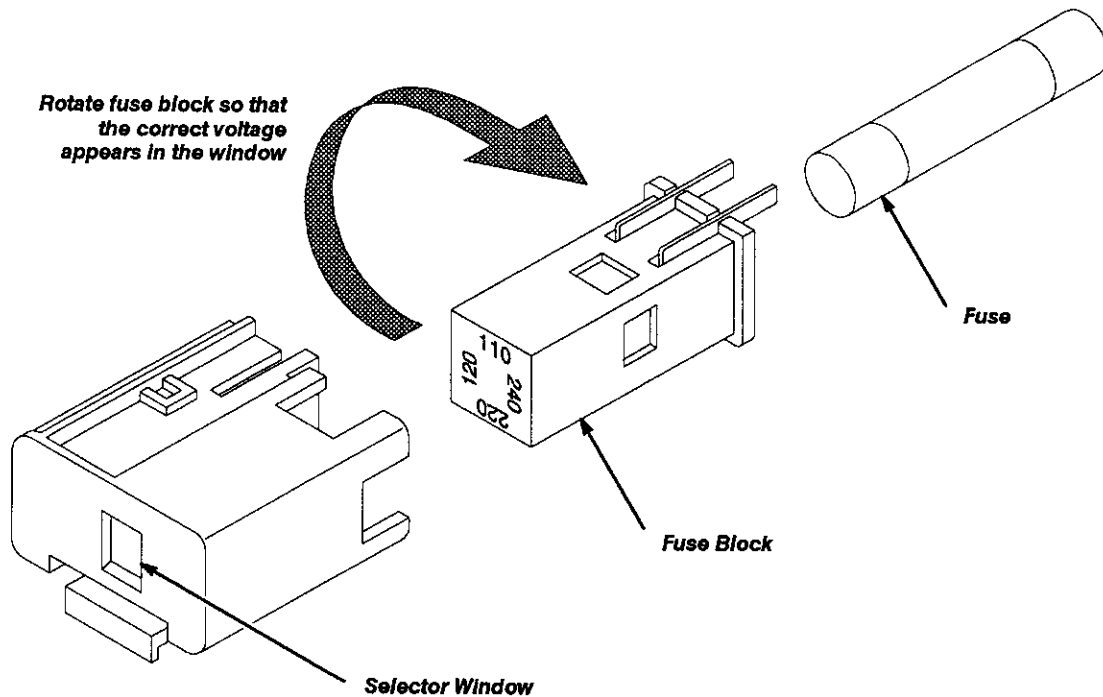


Figure 1-3: Changing the TM 502A Operating Voltage

Installing the AM 503A Into the Power Module

After you have connected the power module to the correct line source and have verified that the power switch is off, you may install the AM 503A amplifier into the power module.



Make sure the power switch of the power module is off before installing the AM 503A (and before connecting a current probe to the AM 503A). If you install or remove a plug-in instrument while the power module is on, you might damage the equipment.

Align the grooves of the AM 503A with the rails of the power module and push the AM 503A into the power module until the instrument snaps into place (see Figure 1-4). To remove the AM 503A, grasp the release lever and pull the instrument out of the power module.

After you have installed the AM 503A and any other desired plug-in instruments into the power module, you may turn the power module on. A digital readout should appear on the AM 503A front panel and a coupling light should come on (see Section 2, *Control Summary* for the location of the coupling lights).

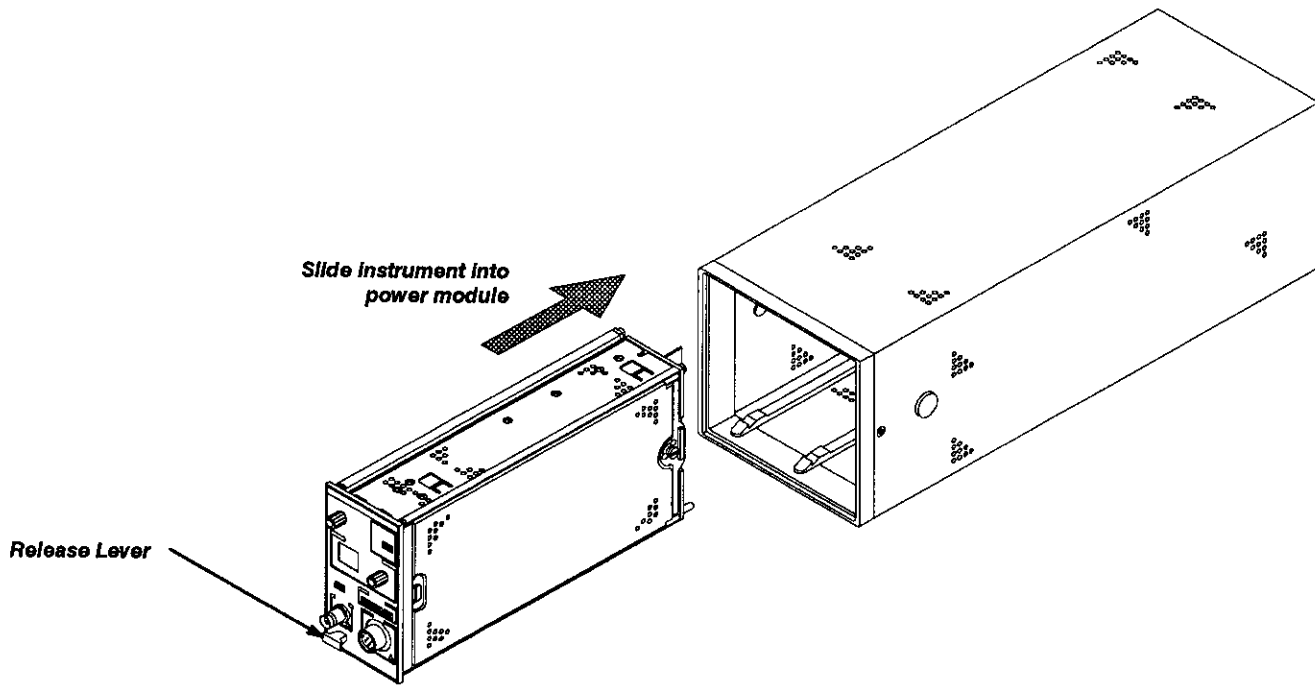


Figure 1-4: Installing the AM 503A Into the Power Module

Packaging for Shipment

Should you ever need to return an AM 503S component to Tektronix for repair, attach a tag to it with the following information:

- name and address of owner
- name of a contact person at your firm
- type of AM 503S component and serial number
- description of the service required

If available, reuse the original shipping carton and packing material when shipping the AM 503S component. If the original carton is not available, then wrap the instrument in anti-static sheeting to reduce the risk of static damage and surface scratches and pack the instrument in a carton with specifications similar to the original. If you have any questions about shipping the instrument, contact your Tektronix representative.

Customer Support

To help you get the best performance from your AM 503S system, Tektronix offers the following customer support services.

Service Support

Should your AM 503S system need repair and you do not wish to service it yourself, contact your nearest Tektronix Service Center.

Sales Support

To order optional equipment and accessories, call the Tektronix National Marketing Center at 1-800-426-2200.



Control Summary

This section describes the function of each AM 503A front panel control and connector. The overview in Figure 2-1 is followed by a more detailed description of each item. For more information about using these controls in measurement applications, see Section 3, *Operation*, and Section 4, *Applications*.

The AM 503A has two modes of operation: normal and test mode. This section describes the normal-mode function of each control and connector. The test-mode function is described in Section 3, *Operation*.

The DC LEVEL knob vertically positions the signal on the oscilloscope screen. Rotate the knob to move the signal up or down the screen.

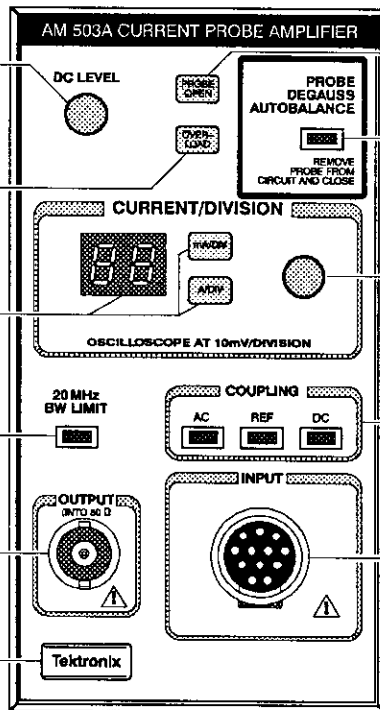
The OVERLOAD indicator lights when a measurement exceeds the maximum continuous current ratings of the AM 503S system.

The CURRENT/DIVISION display shows the current AM 503A scale factor in either mA/division or A/division.

The 20 MHz BW LIMIT button alternately selects or deselects a 20 MHz bandwidth limit for noise filtering.

The AM 503A output appears at the OUTPUT connector. Connect this output to a 50 Ω input of your oscilloscope.

Pull the release lever to remove the AM 503A from the power module.



The PROBE OPEN indicator lights when the attached current probe is unlocked.

The PROBE DEGAUSS AUTOBALANCE button removes magnetism from the attached current probe. The probe must be removed from the test circuit and locked.

The CURRENT/DIVISION knob changes the AM 503A scale factor.

The COUPLING switches select AC or DC probe coupling or a zero-current reference.

The current probes connect to the AM 503A at the INPUT connector.

Figure 2-1: The AM 503A Front Panel

DC LEVEL DC LEVEL Control



The **DC LEVEL** control adjusts the DC offset that appears at the AM 503A output connector. The **DC LEVEL** control has the same effect on the displayed waveform as the vertical position control of the oscilloscope. (After setting a zero-current reference, the oscilloscope vertical position control is not used.) Turn the **DC LEVEL** control clockwise to move the displayed waveform up the oscilloscope screen. Turn it counterclockwise to move the waveform down the screen.

The adjustment sensitivity changes from fine to coarse if the waveform is moved more than approximately one major division during an adjustment. Reversing direction restores the fine adjustment mode.

If **REF** coupling is selected when the **PROBE DEGAUSS AUTOBALANCE** button is pressed, the DC level is reset to zero (no offset) after the routine. If either **AC** or **DC** coupling is selected when the **PROBE DEGAUSS AUTOBALANCE** button is pressed, the DC level remains at its current setting.

NOTE

*To maintain measurement accuracy, position the signal with the AM 503A **DC LEVEL** control. Do not adjust the vertical position control of your oscilloscope once you have established a zero-current reference.*



OVERLOAD Indicator

When lighted, this indicator informs you that the measurement you are taking exceeds the continuous amplitude limit of the AM 503S. To correct an overload situation, use an A6303 probe or use a CT-4 High-Current Transformer with the A6302 Probe. If the overload problem persists, then the current is too high to accurately measure with the AM 503S system. Since overloads can magnetize the probe, you should always degauss the probe after an overload condition occurs.

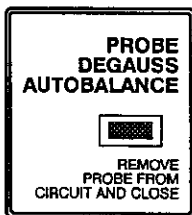
WARNING

To avoid personal injury or equipment damage, do not exceed the specified electrical limits of the AM 503S or any applicable accessories.



PROBE OPEN Indicator

When lighted, this indicator informs you that the current probe is unlocked or that no probe is connected to the AM 503A input. You must have the probe slide locked in order to degauss the probe or to accurately measure current.



PROBE DEGAUSS AUTOBALANCE Button

When pressed, this button performs two functions that maximize measurement accuracy. First, the AM 503A generates a degauss signal to remove any residual magnetism from the attached current probe. Second, the AM 503A initiates an operation to remove any undesired DC offsets from its circuitry.

NOTE

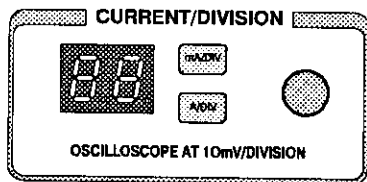
*The probe degauss/autobalance routine will not work if the current probe is unlocked or disconnected from the AM 503A input. To properly degauss the current probe, **remove the probe from the conductor under test and lock the probe.***

To initiate the probe degauss/autobalance function, press the **PROBE DEGAUSS AUTOBALANCE** button momentarily. The button will light while operating and go out after the operation is complete.

If **REF** coupling is selected when the **PROBE DEGAUSS AUTOBALANCE** button is pressed, the DC level is reset to zero (no offset) after the routine. If either **AC** or **DC** coupling is selected when the **PROBE DEGAUSS AUTOBALANCE** button is pressed, the DC level remains at its current setting.

NOTE

The AM 503A front panel digital readout will display an error code (54) if the AM 503A is not properly terminated into 50 Ω at the oscilloscope input. Refer to "Connecting the AM 503A to an Oscilloscope" in Section 3, Operation, for more information.

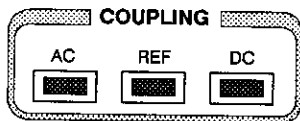


CURRENT/DIVISION Control

The **CURRENT/DIVISION** control sets the scale factor (sensitivity) of the AM 503A in a 1-2-5 sequence. The setting of this control is displayed on the digital readout and the units indicator. Rotate the knob clockwise to decrease the scale factor (increase the instrument sensitivity) and counter-clockwise to increase the scale factor (decrease the instrument sensitivity). The **CURRENT/DIVISION** display indicates the AM 503A scale factor only. The measurement output is displayed on the oscilloscope.

NOTE

To maintain accurate measurements, the vertical gain of the oscilloscope must remain at 10 mV/div.



COUPLING Buttons

The **COUPLING** buttons determine the coupling between the current probe and the AM 503A. To couple the current probe for DC plus AC measurements, press the **DC** button. To couple the current probe for AC measure-

ments only, press the **AC** button. To establish a zero-current reference, press the **REF** button and adjust the **DC LEVEL** control (described earlier). When pressed, a coupling button lights to indicate the selected mode.

NOTE

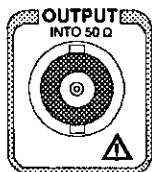
To maintain correct operation of the AM 503A coupling buttons, leave the input coupling of your oscilloscope at DC.

**20 MHz
BW LIMIT**



BW LIMIT Button

Pressing the **BW LIMIT** (bandwidth limit) button alternately selects the full bandwidth capability of the current probe/AM 503A combination or a limited 20 MHz bandwidth. Use the bandwidth limit function when you are measuring DC or low-frequency currents and you want to filter high-frequency noise. When the **BW LIMIT** button lights, the bandwidth limit is on and when the button is unlighted, the bandwidth limit is off.

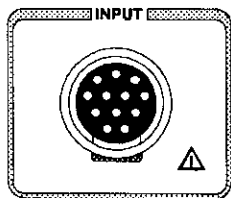


OUTPUT Connector

The AM 503A measurement output appears at the **OUTPUT** connector. Attach one end of a 50 Ω BNC cable to this connector and the other end to a 50 Ω vertical input of your oscilloscope. The output impedance of the AM 503A is 50 Ω .

NOTE

To obtain accurate measurements, the input impedance of your oscilloscope must be 50 Ω . With 1 M Ω oscilloscopes, use a 50 Ω feedthrough termination (one is supplied with the AM 503S system). Connect the termination to the oscilloscope input, not the AM 503A output. Failure to properly terminate the AM 503A will result in an error code (54) being displayed on the AM 503A front panel digital readout.



INPUT Connector

The current probes attach to the AM 503A at the **INPUT** connector, a 12-pin female connector. For information about attaching a probe to this connector, see Section 3, *Operation*.

The logo consists of the word "Tektronix" in a bold, sans-serif font, enclosed within a double-line rectangular border.

Release Lever

The release lever has the Tektronix name printed on it. Pull the release lever to remove the AM 503A from the power module.

A rectangular warning symbol with a jagged, wavy border. The word "CAUTION" is printed in bold, uppercase letters in the center of the rectangle.

CAUTION

To avoid equipment damage, turn the power module off before removing or installing any plug-in unit.



Operation

This section describes how to operate the AM 503S and discusses factors you should consider when measuring current with the AM 503S system. Appendix C, *Troubleshooting Guide*, provides a list of common measurement problems and their solutions.

Choosing an Oscilloscope to Use with the AM 503S

You will need an oscilloscope to display the AM 503A measurement output. To utilize the full bandwidth capability of the AM 503A and attached current probe, the oscilloscope bandwidth should be approximately four times that of the current probe. For example, when using an A6302 probe, the oscilloscope bandwidth should be at least 200 MHz. When using an A6303 probe, the oscilloscope bandwidth should be at least 60 MHz. The oscilloscope must also be capable of displaying a vertical scale factor of 10 mV/div.

Connecting the AM 503A to an Oscilloscope

To connect the AM 503A output connector to your oscilloscope, use a 50 Ω BNC cable (one is supplied with your AM 503S system). Connect one end of the cable to the AM 503A output connector and the other end to the input of the desired vertical channel of your oscilloscope (see Figure 3-1). The input impedance of the oscilloscope channel must be 50 Ω , otherwise you will encounter slowed pulse response, increased aberrations, or incorrect DC measurement amplitudes.

NOTE

If your oscilloscope impedance is 1 M Ω , install a 50 Ω feedthrough termination at the oscilloscope input connector, not at the AM 503A output connector (a 50 Ω termination is supplied with the AM 503S). Failure to properly terminate the AM 503A will result in an error code (54) being displayed on the AM 503A front panel digital readout if you attempt to degauss/autobalance the system.

Some optional power modules allow you to re-route the plug-in instrument output to the rear interface of the power module (refer to the Tektronix catalog or your Tektronix sales representative). The AM 503A can be configured for operation with these power modules. Instructions for configuring

the AM 503A for rear interface operation are contained in the *AM 503S Service Manual* and should be performed only by qualified service personnel.

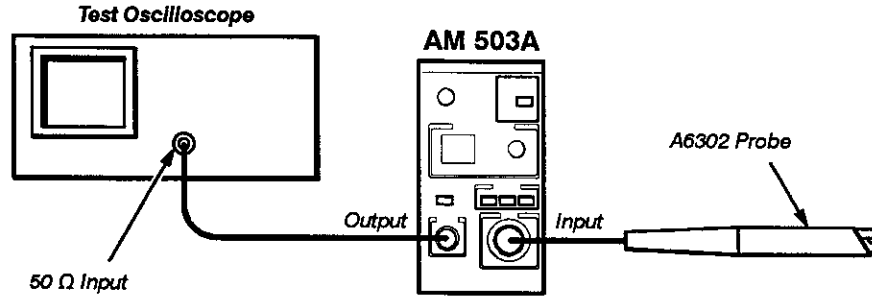


Figure 3-1: Connecting the AM 503A to an Oscilloscope

Adjusting the Oscilloscope

After you have connected the AM 503A to the oscilloscope, make the following adjustments to the corresponding oscilloscope channel.

NOTE

Before making any adjustments, allow the equipment, including the current probe, to warm up for at least 20 minutes.

- Step 1:** Set the vertical gain of the oscilloscope to 10 mV/div.
- Step 2:** Set the oscilloscope ground reference so the trace appears at the center graticule line or at the desired zero-current reference.
- Step 3:** Set the input coupling of the oscilloscope to DC.
- Step 4:** Turn off any oscilloscope bandwidth filters.
- Step 5:** Make sure the oscilloscope input is terminated with a 50 Ω impedance.

NOTE

Do not change the vertical amplifier settings of the oscilloscope while using the AM 503S. All subsequent measurement adjustments should be made on the AM 503A amplifier. To maintain accurate readings, the vertical gain of the oscilloscope channel must remain at 10 mV/DIV and the coupling must remain at DC.

Using the Current Probes

This section describes how to select a current probe for your application and how to operate the current probes available with the AM 503S.

Choosing a Probe

Before choosing a current probe, carefully consider your application. If you need to measure low-amplitude or high-frequency currents, try using an A6302 probe. If you need to measure higher current values at lower frequencies, consider using the A6303 probe, or a CT-4 High-Current Trans-

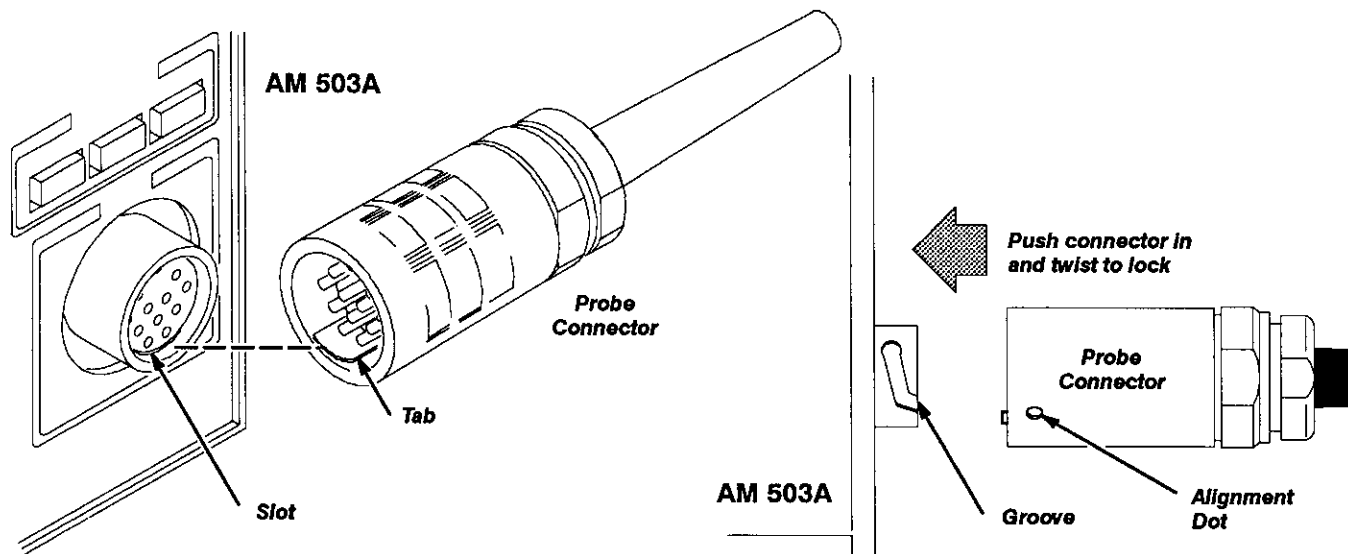
former with an A6302 probe. Consult the specification tables in Appendix A, *Specifications*, to determine which probe will work best with your specific application and read Section 4, *Applications*.

Connecting a Current Probe to the System



Handle the current probes with care. To avoid damaging the probe core, do not drop the probe or subject it to impact. Also, to avoid damaging the AM 503A, do not connect or disconnect a current probe while the probe is clamped around a live conductor or while the AM 503A is turned on. Excessive voltages and surge currents can result.

To connect a current probe to the AM 503A input connector, align the tab of the probe connector with the slot in the AM 503A input connector (see Figure 3-2a). Align the dot on the probe connector with the groove opening of the input connector as shown in Figure 3-2b. Push the probe connector in while twisting the barrel clockwise to lock the connector.



(a) Aligning the Tab with the Connector Slot

(b) Inserting the Connector into the AM 503A

Figure 3-2: Connecting a Current Probe to the AM 503A

Each current probe is calibrated before it is shipped and should not require further adjustment. If a probe requires calibration, refer to the AM 503S Service Manual for calibration instructions or contact your Tektronix service representative.

Operating the Probe Slide

The A6302 and A6303 current probes each have a slide mechanism that opens and closes the probe jaw, allowing you to clamp the probe around a test conductor. The slide must be locked to accurately measure current or to degauss the probe. If a probe is unlocked or disconnected from the AM 503A, the **PROBE OPEN** indicator will light.

Figure 3-3 illustrates the slide operation of the A6302 probe. To open the probe, pull the slide back until the jaw is open. To lock the probe, push the slide forward until the detent snaps into place.

Figure 3-4 illustrates the slide operation of the A6303 probe. To open the probe, press the bottom of the lock button and squeeze the handle until the core is open. To lock the probe, release the squeeze handle and press the top of the lock button.

CAUTION

The exposed core pieces are not insulated. To avoid equipment damage, remove power from an uninsulated wire before clamping the current probe around it.

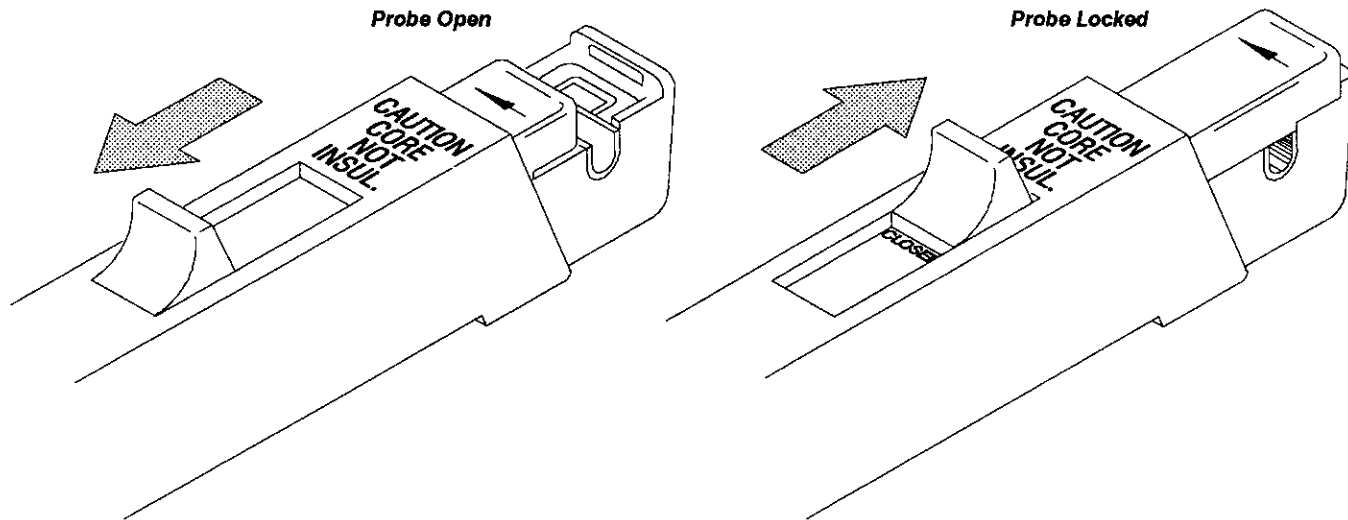


Figure 3-3: Operating the A6302 Current Probe Slide

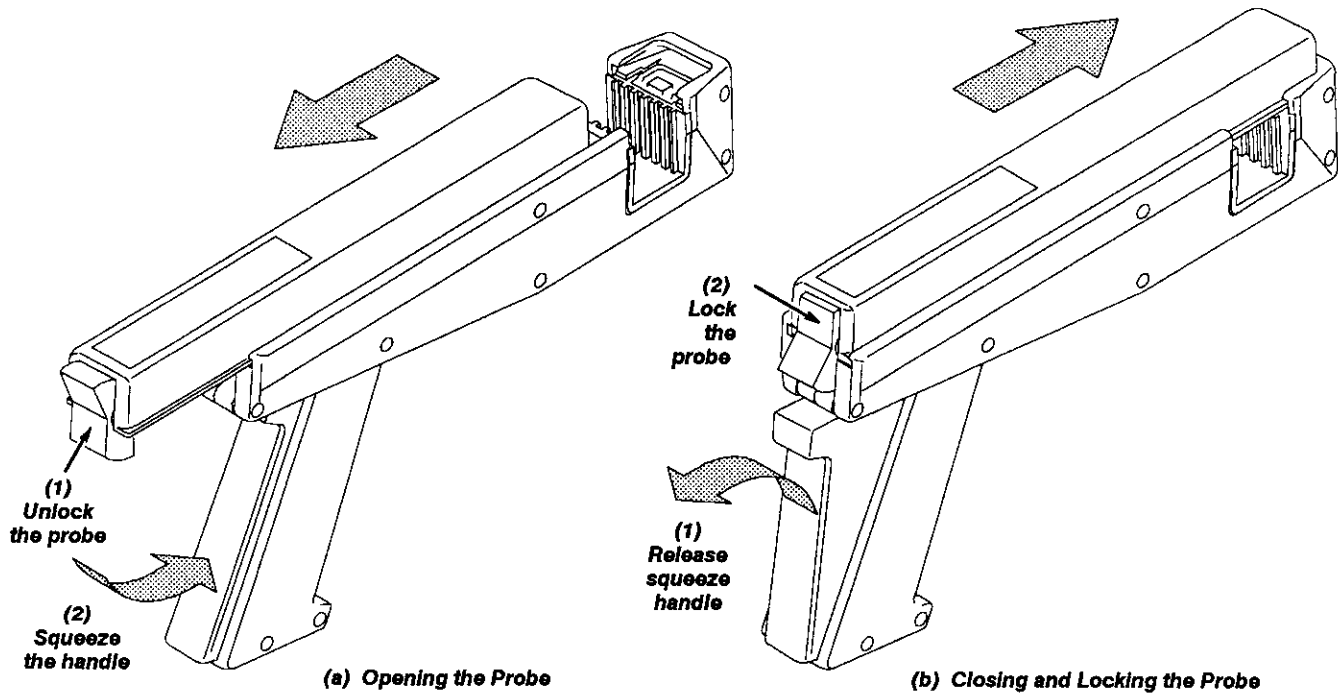


Figure 3-4: Operating the A6303 Current Probe Slide

Degaussing the Probes

Before measuring current, perform the probe degauss/autobalance routine. Degaussing the probe removes residual magnetism from the probe core. Magnetism can introduce a measurement error, such as an extraneous DC offset. Autobalancing removes unwanted DC offsets in the amplifier circuitry. The AM 503A combines and automates these functions in one button. To initiate the degauss/autobalance routine, perform these steps:

- Step 1:** Verify that the current probe is connected to the AM 503A and removed from the conductor under test.
- Step 2:** Lock the probe slide (see Figures 3-3 and 3-4).
- Step 3:** Press the **PROBE DEGAUSS AUTO BALANCE** button.

NOTE

The AM 503A front panel digital readout will display an error code (54) if the AM 503A is not properly terminated into 50 Ω at the oscilloscope input. Refer to "Connecting the AM 503A to an Oscilloscope," in this section, for more information.

To maintain measurement accuracy, degauss your probe for each of these circumstances:

- after turning the AM 503A on and allowing a 20-minute warm-up period
- before connecting the probe to a conductor or changing conductors
- whenever an overload condition occurs
- whenever the probe is subjected to a strong external magnetic field

You should degauss the probe periodically during use. Failure to degauss the probe is a leading cause of measurement errors.

Making Current Measurements

After you have completed the oscilloscope adjustments and the AM 503S degauss/autobalance procedure, your system is ready to measure current. This section describes how to make DC and AC measurements (for more measurement examples, see Section 4, *Applications*).

DC Measurements

To measure DC current, perform these steps:

- Step 1:** Verify that the vertical gain of the oscilloscope is 10 mV/div, the input coupling is DC, and the input impedance is set to 50 Ω .
- Step 2:** Adjust the ground reference of the oscilloscope so the zero-current trace appears at the desired graticule line.
- Step 3:** Lock the probe, press the AM 503A REF coupling button, and then press the AM 503A PROBE DEGAUSS AUTOBALANCE button.
- Step 4:** After the degauss/autobalance routine completes, reposition the ground reference (if necessary) on your oscilloscope using the AM 503A DC LEVEL control.
- Step 5:** Open the probe slide, place the probe around the conductor under test, and then lock the slide.

NOTE

For correct measurement polarity, make sure the probe arrow is pointing in the direction of conventional current flow (conventional current flow is from positive to negative).

- Step 6:** Press the AM 503A DC coupling button and set CURRENT/DIVISION to the desired scale.

- Step 7:** To vertically position the resulting waveform, use the **DC LEVEL** control of the AM 503A.
- Step 8:** Adjust the oscilloscope time base as needed.

Figure 3-5 shows a current probe connected to a power supply line. Notice that the probe arrow points toward the negative terminal of the power supply.

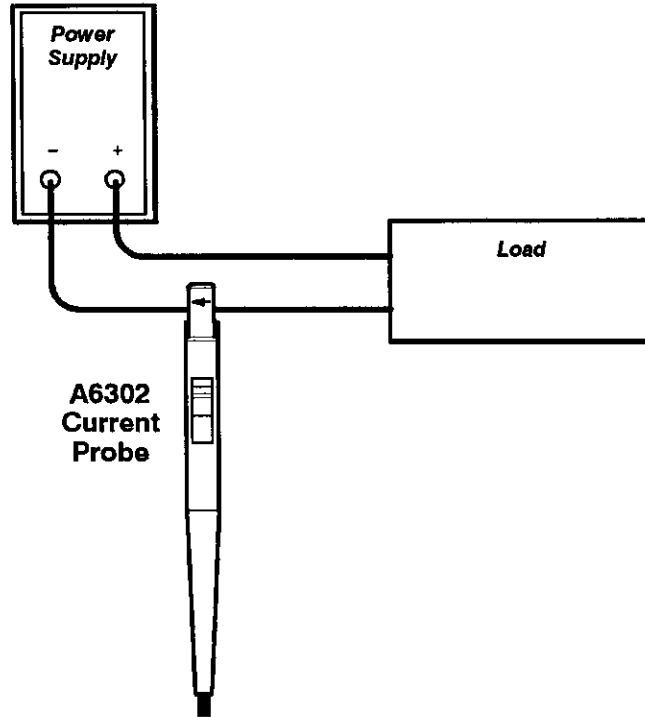


Figure 3-5: Measuring Current with the AM 503S

AC Measurements

To measure AC current only, follow the same basic instructions for DC current measurements except change the AM 503A coupling to AC.

NOTE

Even when making AC current measurements, leave the oscilloscope coupling on DC. You need only change the AM 503A coupling to AC.

If you need to measure high-amplitude AC currents, consider using a CT-4 High-Current Transformer with an A6302 probe. The CT-4 provides step-down ratios of 20:1 or 1000:1. For more information about the CT-4, consult your Tektronix sales representative.

Probe Coupling Considerations

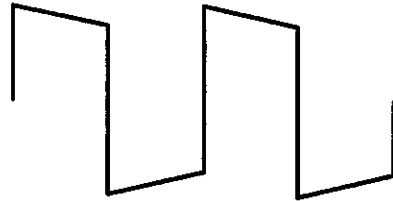
You can couple the current probe to the AM 503A with either DC or AC coupling. DC coupling shows the DC and AC measurement components while AC coupling quickly and conveniently removes the DC component.

AC coupling can present some problems at frequencies below 7 Hz. For example, pulsed currents may exhibit rolloff or decreased amplitude. Figure 3-6a shows a low-frequency square wave observed using AC coupling. The signal exhibits low-frequency rolloff. By changing the AM 503A coupling to DC, the pulse flattens out, as shown in Figure 3-6b.

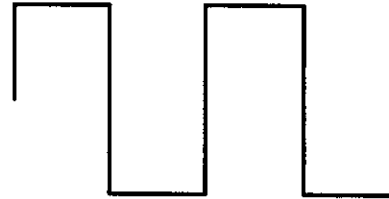
If you are trying to examine a low-frequency signal that is superimposed on a comparatively large DC component, you can resolve the signal by performing these steps:

- Step 1:** Set the AM 503A coupling to **AC**.
- Step 2:** Adjust the **CURRENT/DIVISION** control of the AM 503A so that the signal shows maximum detail without going off the oscilloscope screen.
- Step 3:** Set the AM 503A coupling to **DC**. Center the DC component on the zero-current line by adjusting the **DC LEVEL** control of the AM 503A.

Now you can view large DC component signals without the signal degradation that can occur when low-frequency signals are AC coupled.



(a) AC-Coupled signal



(b) DC-Coupled signal

Figure 3-6: Effect of Probe Coupling on Low-Frequency Measurements

Probe Bandwidth Considerations

If you want to observe a low-frequency signal (either DC or AC below 20 MHz) that has high-frequency noise, activate the AM 503A bandwidth limit. The noise level will be reduced.

WARNING

To avoid personal injury or equipment damage, do not exceed the specified bandwidth limits of your current probe. Measuring frequencies in excess of the specified limit can cause the probe to overheat severely.

Maximum Current Limits of the Probes

The current probes have three maximum current ratings: continuous, pulsed, and amp · second product. Exceeding any of these ratings can saturate the probe core, magnetizing the core and causing measurement errors. Appendix A, *Specifications*, lists the maximum current ratings for each probe.

Maximum Continuous Current

This rating refers to the maximum current that can be continuously measured at DC or at a specified AC frequency. The maximum continuous current value is derated with frequency; as the frequency increases, the maximum continuous current rating decreases.

Maximum Pulsed Current

This rating defines the maximum peak value of pulsed current the probe can accurately measure, regardless of how short (within bandwidth limitations) the pulse duration is.

Amp · Second Product

The amp · second product defines the maximum width of pulsed current that you can measure when the pulse amplitude is between the maximum continuous and maximum pulsed current specifications (don't forget to derate the maximum continuous specification according to the pulse frequency). If a measurement exceeds the specified amp · second product, probe saturation occurs. For convenience, Appendix A, *Specifications*, rates the probes in amp · microseconds and provides an amp · second curve for each probe.

To determine if your measurement exceeds the amp · second product, perform one of the following steps:

- Step 1:** To determine the maximum allowable pulse width, measure the peak current of the pulse (see Figure 3-7). Divide the specified amp-second (or microsecond) product of your probe by the measured peak current of the pulse. The quotient is the maximum allowable pulse width. The pulse width at the 50% point of the measured signal *must be less* than this value. For example, if a pulse measured with an A6302 probe had a peak current of 40 A, the maximum allowable pulse width would be 100 A · μ s divided by 40 A, or 2.5 μ s.

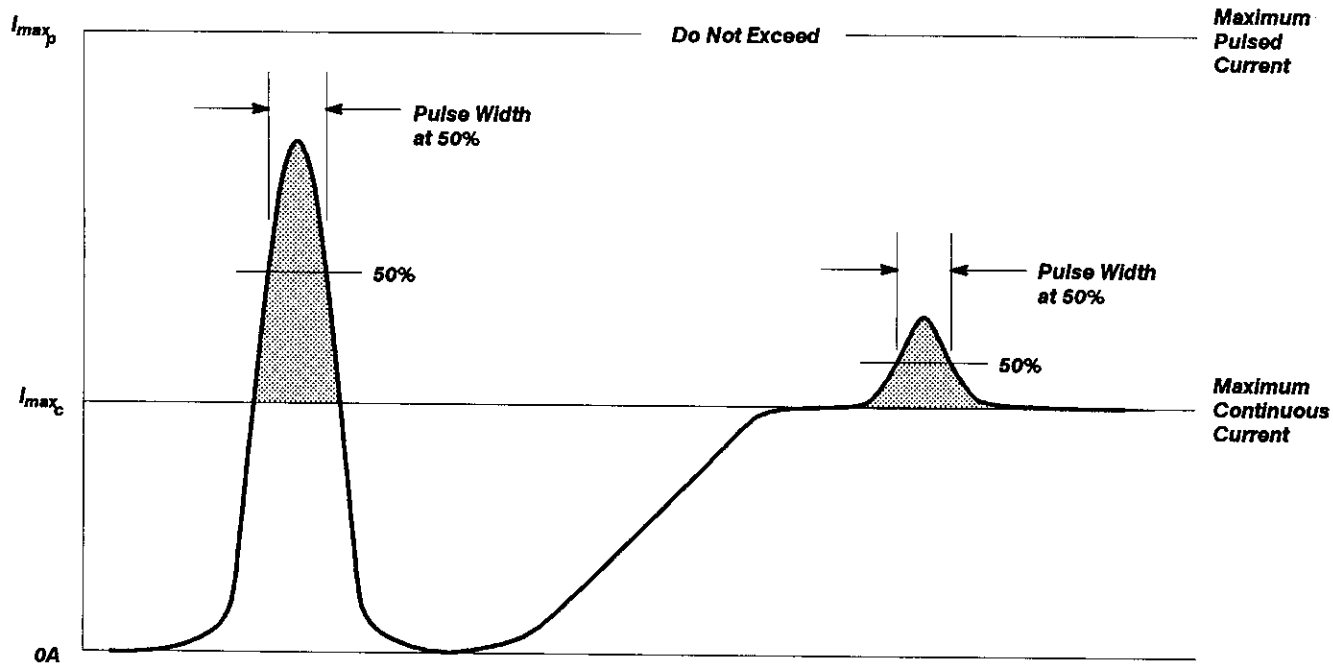


Figure 3-7: Applying the Amp · Second Product Rule

- **Step 2:** To determine the maximum allowable pulse amplitude, measure the pulse width at the 50% points (see Figure 3-7). Divide the specified amp · second (or μs) product of your probe by the pulse width in seconds (or μs). The quotient is the maximum allowable current. The peak amplitude of the measured pulse must be less than this value. For example, if a pulse measured with an A6302 probe had a width of 3 μs , the maximum allowable peak current would be 100 A · μs divided by 3 μs , or 33.3 A.

NOTE

Always degauss the probe after measuring a current that exceeds the maximum continuous current, maximum pulsed current, or amp · second product rating of the probe. Exceeding these ratings can magnetize the probe and cause measurement errors.

How to Extend the Measurement Range of the AM 503S

You may encounter situations where your measurement exceeds the maximum current rating of the connected probe. This section discusses methods for extending AC and DC current ranges.

WARNING

To avoid personal injury or equipment damage, do not exceed the specified electrical limits of the AM 503S or any applicable accessories.

Extending the AC Range

You can extend the AC amplitude limit of the AM 503S by using the Tektronix CT-4 High-Current Transformer. The CT-4, designed for use with the A6302 current probe, extends the A6302 range by a factor of 20:1 or 1000:1 and can provide external DC bucking current up to 300 A. For more information about the CT-4, consult your Tektronix sales representative.

Because the CT-4 has a lower AC bandwidth limit than the A6302 probe, set the AM 503A coupling to DC when using the CT-4.

Extending the DC Range

If you want to measure a low-amplitude AC component that is superimposed on an extremely large steady state DC component (such as in a power supply), or if you want to extend the DC current range of your probe, you can add offset (bucking) current with a second conductor.

To supply additional bucking current, place a second conductor that has a *pure* DC component of known value in the probe jaw with the conductor under test (see Figure 3-8a). Orient the second conductor so that the bucking current flows in the opposite direction of the DC flow in the conductor under test.

You can increase the value of the bucking current by winding multiple turns of the second conductor around the probe, as shown in Figure 3-8b. The bucking current is equal to the current flowing in the conductor times the number of turns wound around the probe. For example, if the second conductor has a current of 100 mA DC flowing through it and it is wrapped around the probe five times, the additional DC bucking current is 100 mA multiplied by 5, or 500 mA DC.

To determine measurement values, simply add the value of the extra bucking current to the displayed measurement.

WARNING

Under no circumstances should you exceed the maximum continuous or pulsed current limits of the probe or the conductors. If the probe limits are exceeded, remove the conductors from the probe and perform the probe degauss/autobalance routine.

NOTE

Adding a second conductor to the probe increases the insertion inductance and reduces the upper bandwidth limit of the probe. Winding multiple turns further increases the insertion inductance, further reducing the upper bandwidth limit.

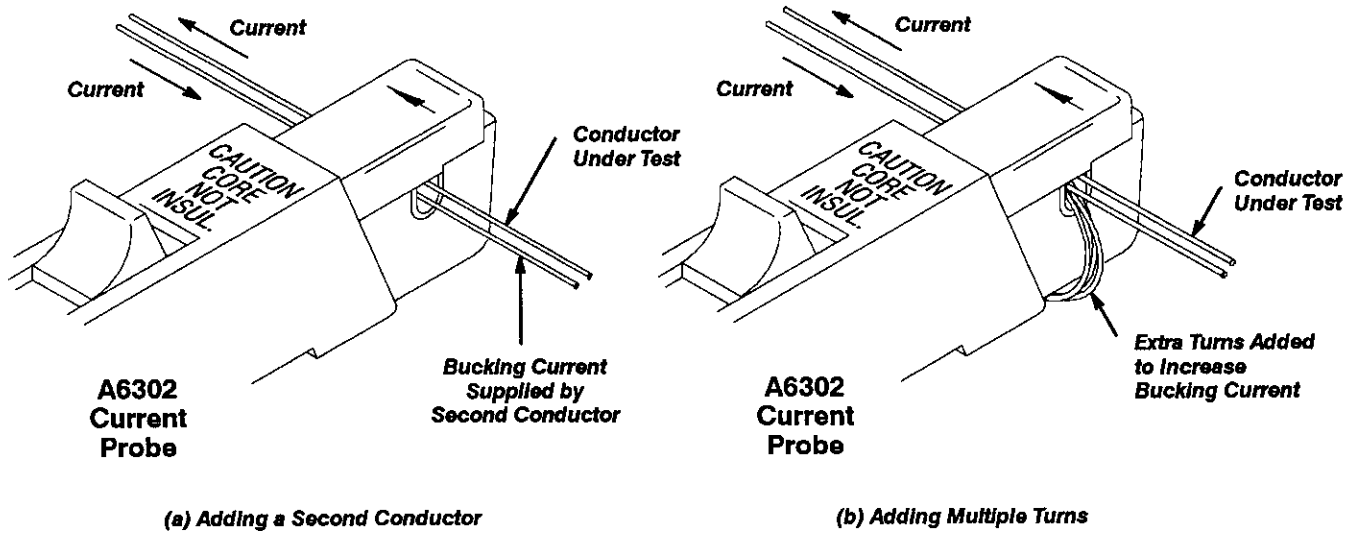


Figure 3-8: Increasing the DC Measurement Range

How to Increase the Sensitivity of the AM 503S

If you are measuring DC or low-frequency AC signals of very small amplitudes, you can increase measurement sensitivity by winding several turns of the conductor under test around the probe as shown in Figure 3-9. The signal is multiplied by the number of turns around the probe. When viewing the signal on the oscilloscope screen, divide the displayed amplitude by the number of turns to obtain the actual current value. For example, if a conductor is wrapped around the probe five times and the oscilloscope shows a reading of 5 mA DC, the actual current flow is 5 mA divided by 5, or 1 mA DC.

NOTE

Winding multiple turns around the probe increases insertion inductance and reduces the upper bandwidth limit of the probe.

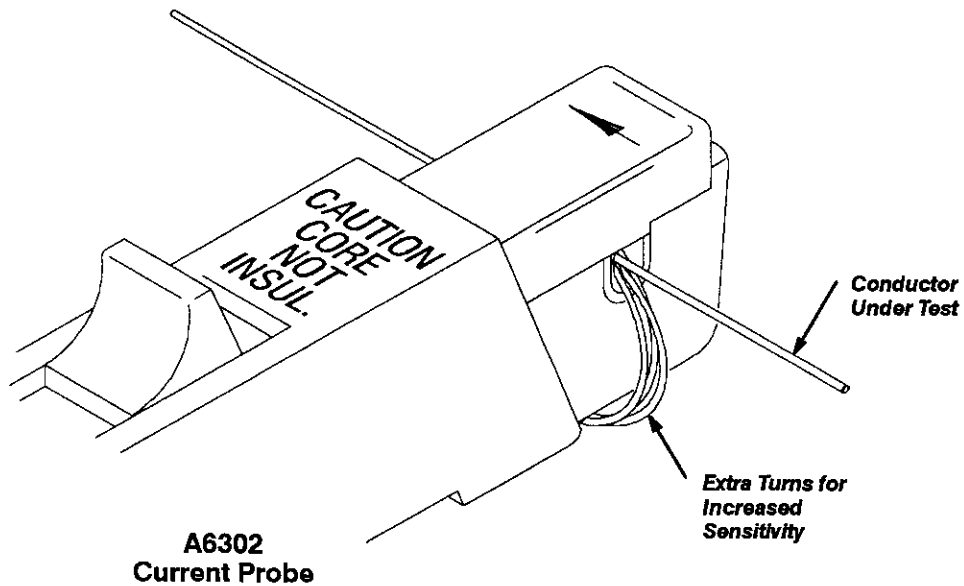


Figure 3-9: Increasing Probe Sensitivity

Measuring Differential Currents or Current Nulls

You can use two AM 503A amplifiers, two identical current probes, and a differential amplifier with your oscilloscope to measure differential current; however, you can also measure differential current or adjust current nulls with just one AM 503A amplifier and one current probe by performing these steps:

- Step 1:** Orient the two conductors under test so that the polarities oppose each other and clamp the current probe around them (see Figure 3-10).
- Step 2:** Measure the current. The polarity of the displayed measurement indicates which conductor is carrying the greater current.
- Step 3:** To adjust for a current null, adjust the current in one of the conductors until the displayed measurement is zero.

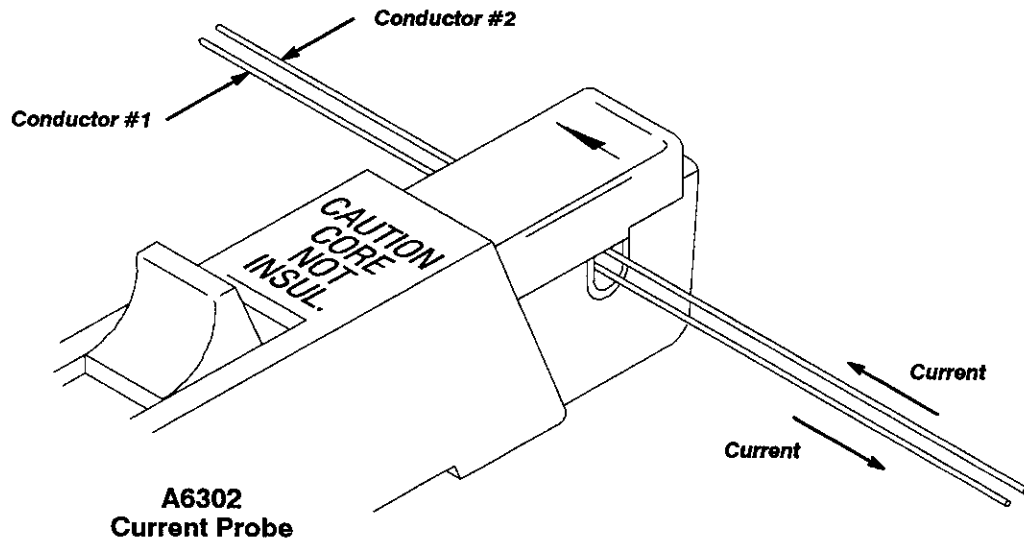


Figure 3-10: Measuring Differential Current and Nulls

Error Codes

During normal operation, the digital readout of the AM 503A displays the current/division scale factor. In the unlikely event an instrument failure occurs, the display will flash an error code number ranging from 10 to 88.

NOTE

The AM 503A front panel digital readout will display error code 54 if the AM 503A is not properly terminated into 50 Ω at the oscilloscope input. Refer to "Connecting the AM 503A to an Oscilloscope," in this section, for more information.

If the AM 503A is totally inoperative, a seven-segment readout inside the AM 503A may display an internal error code ranging from 1 to 5.

If an error code other than 54 appears, turn the instrument off and then on again. If the error condition persists, have the instrument serviced by qualified service personnel. For a definition of error codes, refer to the AM 503S Service Manual.

When the internal backup battery becomes weak, the CURRENT/DIV display will momentarily flash the characters **L0** when the instrument is turned on. For battery replacement instructions, refer to the AM 503S Service Manual.

Test Mode

In addition to normal operation, the AM 503A has a test mode which is used exclusively for servicing the instrument. The test mode is briefly mentioned here so that you can recover should you accidentally initiate it (for more information about the test mode, refer to the AM 503S Service Manual).



Do not run test mode routines. Some routines can destroy RAM data and impair instrument operation. Test mode should be operated by qualified service personnel only.

Test mode is entered by performing these steps:

- Step 1:** Press and hold the **BW LIMIT** button.

- Step 2:** Momentarily press the **PROBE DEGAUSS AUTOBALANCE** button.
- Step 3:** Release the **BW LIMIT** button. The AM 503A readout will display a routine number.

To exit the test mode, perform these steps:

- Step 1:** Press the **BW LIMIT** button so that the button is dark.
- Step 2:** Rotate the **DC LEVEL** knob or press one of the **COUPLING** buttons. The instrument should return to normal operation.

Maintenance

The AM 503S requires little maintenance during normal use. The primary maintenance involves cleaning accumulated dirt from the probe body and, if necessary, cleaning the exposed core surfaces in the probe jaw. To clean the probe body, use a soft cloth dampened in a solution of mild detergent and water. To clean the core, open the jaw and clean the exposed core surfaces with the cloth.



Avoid using chemical cleaning agents that damage plastic. For example, avoid using chemicals that contain benzene, toluene, xylene, acetone, or similar solvents. Recommended cleaning agents are isopropyl alcohol (Isopropanol) or ethyl alcohol (Fotocol or Ethanol).

For additional maintenance and repair information, refer to the AM 503S Service Manual (available as an optional accessory) or send the component to your nearest Tektronix service center.

WARNING

To avoid injury or equipment damage, refer servicing to qualified service personnel only.



Applications

This section describes the following typical measurement applications of the AM 503S Current Probe System:

- automobile charging systems
- inductance measurements
- inductor turns measurements
- continuity checks

Automobile Charging Systems

This application examines the charging current from an automobile alternator circuit. Most automotive charging systems are three-phase alternators with a corresponding diode network. Observing the charge current waveform can quickly reveal if a diode circuit is shorted or open. A simple current meter will not detect a single-phase diode problem because the meter averages the total charge current. The AM 503S current measurement system can detect a diode failure by instantaneously monitoring any abnormal fluctuation in charge current.

The diagram in Figure 4-1 shows the equipment setup. Since the currents associated with charging systems are somewhat high and the frequencies are fairly low, an A6303 Current Probe was used for this application. The A6303 was degaussed and then clamped around the positive battery lead from the alternator. Because the probe is referenced to conventional current flow, the probe arrow points away from the alternator and toward the battery side of the circuit. The automobile was started and the lights were turned on to add a significant load to the circuit.

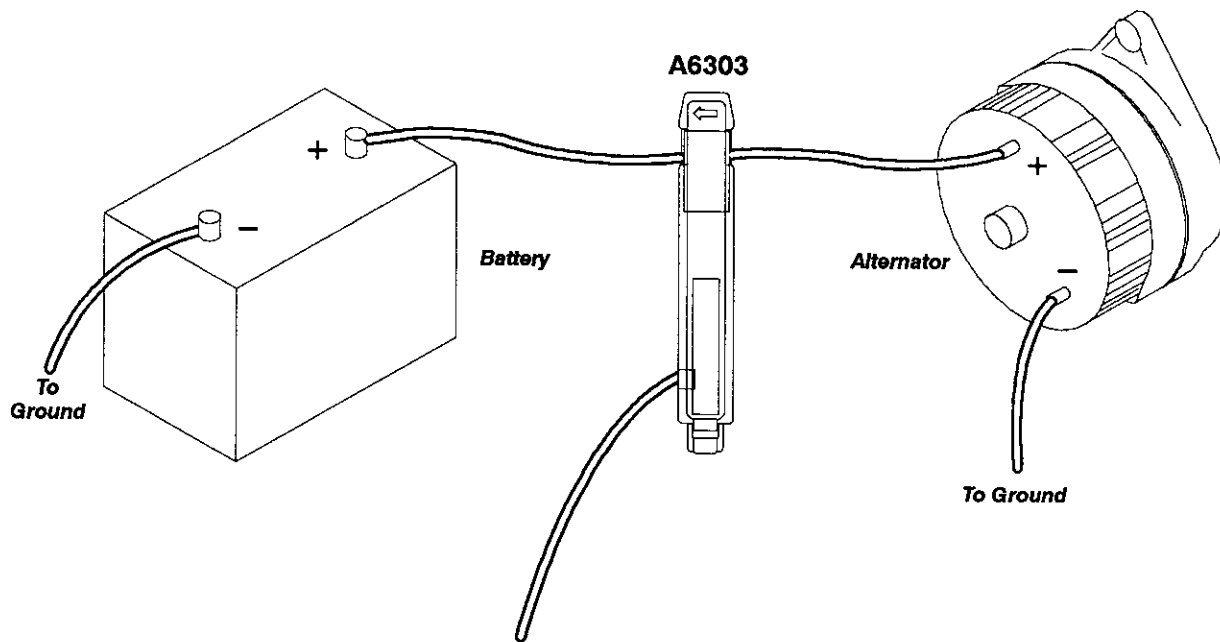


Figure 4-1: Setup for Measuring Charging Current

After adjusting the equipment to the following settings, the waveform represented in Figure 4-2a was obtained.

AM 503A

COUPLING DC
DC LEVEL 0 V (zero-current reference is set at
oscilloscope ground reference line)
CURRENT/DIVISION 10 A
BW LIMIT off

Oscilloscope

Coupling DC
Volts/Division 10 mV
Zero-Current Reference center graticule line
Timebase 200 μ s/division

The waveform in Figure 4-2a shows the three-phase ripple frequency. The average charge current is about 27 A with a minimum peak of about 23 A and a maximum peak of about 31 A. The waveform shows a continuous cycle with no dropouts, so the alternator circuit appears to be functioning properly. A single-phase diode failure would normally appear as an extreme drop in charge current every third cycle, as shown in Figure 4-2b.

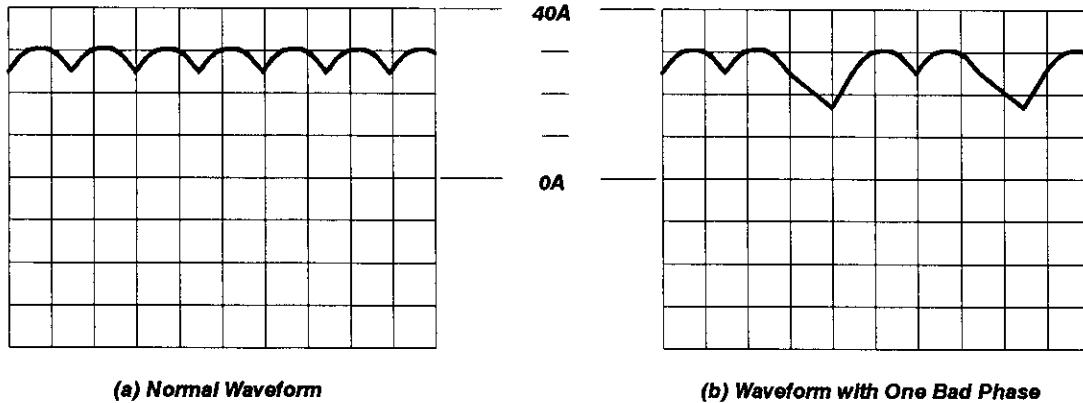


Figure 4-2: Charge Current Waveforms

Inductance Measurements

You can use the AM 503S to measure inductance of coils. Two different methods can be used. One method applies to low-impedance pulse sources and the other method applies to higher-impedance pulse sources of known value.

Low-Impedance Pulse Sources

Figure 4-3 shows a measurement setup using a constant-voltage pulse generator of extremely low output impedance. The inductor is connected across the output terminals of the pulse source. The current probe is attached to one of the source leads and the current ramp is measured.

The inductance is effectively defined by the slope of the current ramp, shown in Figure 4-4, and is mathematically expressed by the following formula:

$$L = E \frac{dt}{di}$$

where L is the inductance in henries, E is the voltage of the pulse generator, dt is the change in time, and di is the change in current.

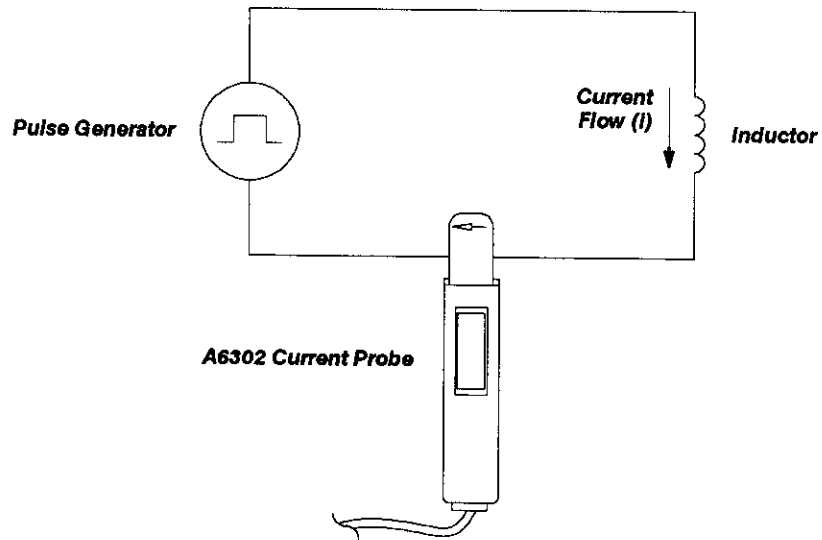


Figure 4-3: Measuring Inductance with a Low-Impedance Source

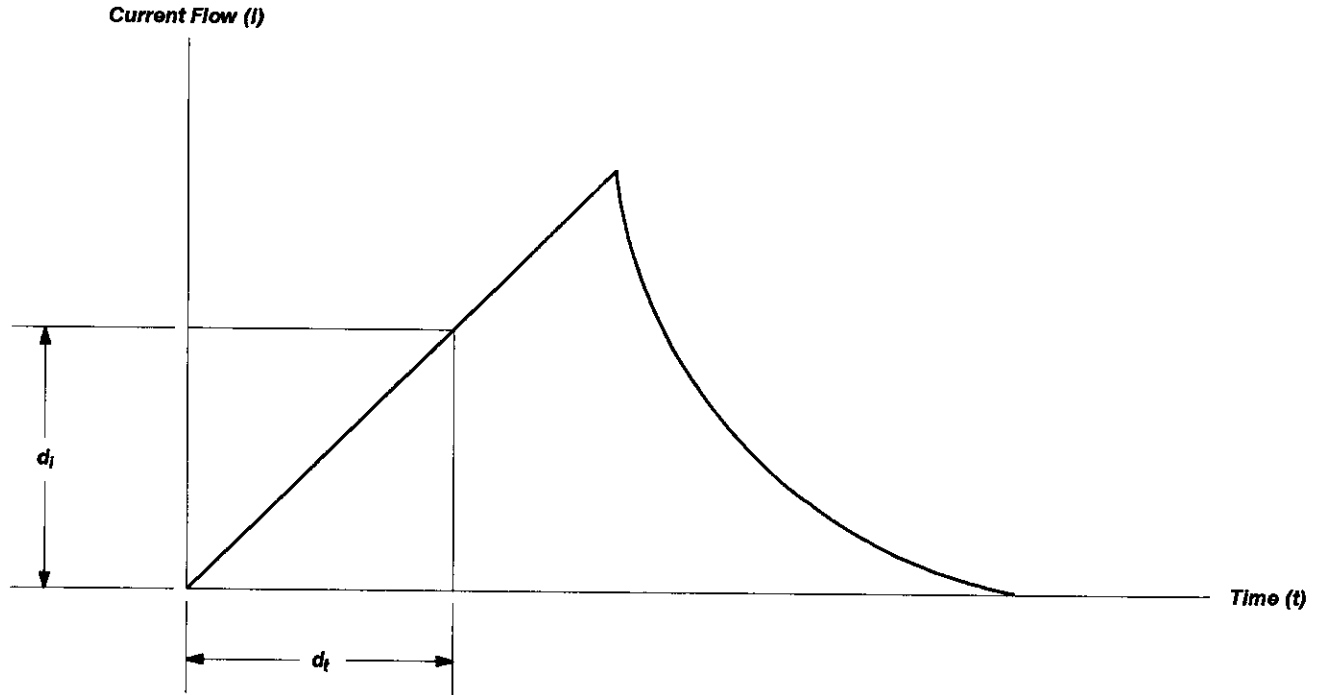


Figure 4-4: Linear Current vs. Time Ramp

Higher-Impedance Pulse Sources

If the pulse source has a higher impedance of known resistance, such that the output voltage drops as the current increases, the inductance of a coil can be calculated by the time constant of the charge curve. Figure 4-5 shows the setup diagram, which is similar to the previous example. The current ramp represented in Figure 4-6 shows how the values for the inductance formula are obtained.

Use this formula to calculate the inductance based on the current measurement:

$$L = \tau R$$

where L is the inductance in henries, τ is the time required for the current to rise or fall 63.2% of the total current value, and R is the source resistance of the pulse generator.

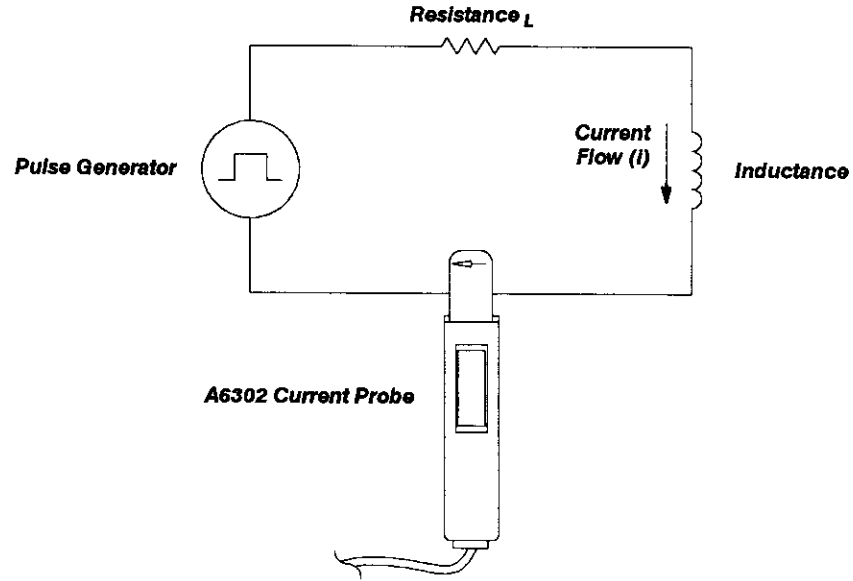


Figure 4-5: Measuring Inductance with a High-Impedance Source

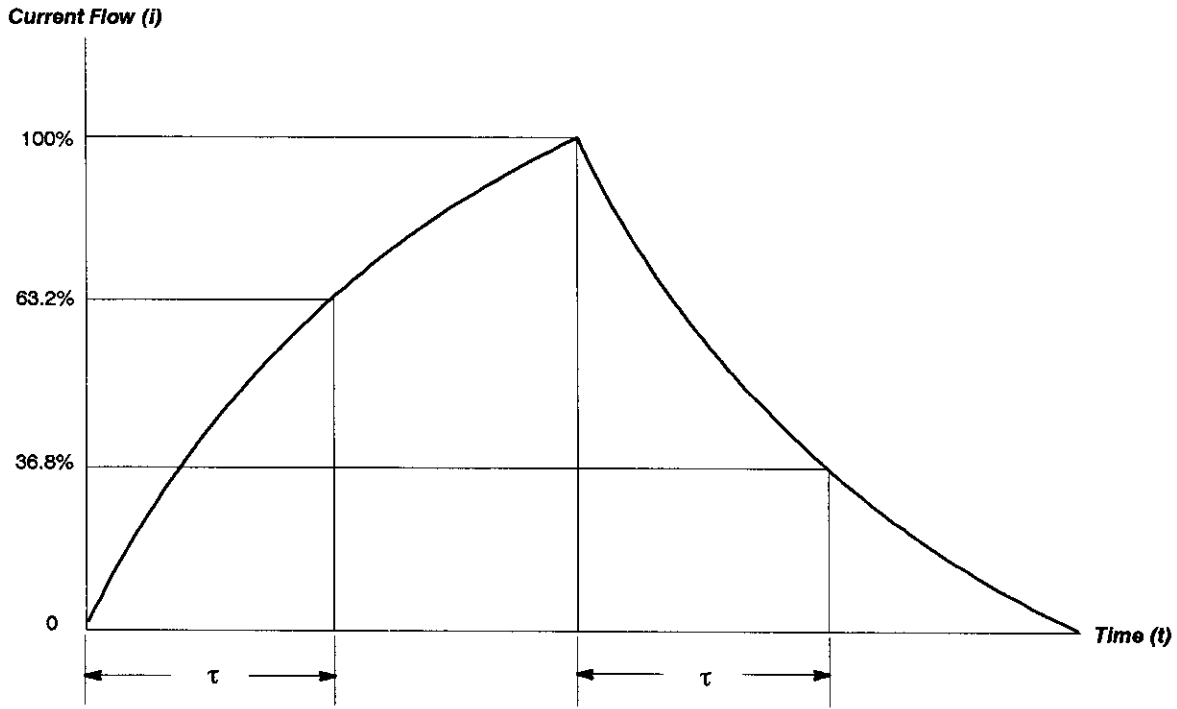


Figure 4-6: High-Impedance Source Current Ramp

Measuring Inductor Turns Count

To obtain an approximate turns count of an inductor, connect the inductor to a current limited source, as shown in Figure 4-7. Measure the input current on one of the inductor leads, then clamp the current probe around the inductor and note the current value. The number of turns is equal to the ratio of coil current to input current. The accuracy of this method is limited by the current measurement accuracy. The following method allows more precise turns measurement.

For a more precise turns count, you need a coil with a known number of turns to use as a reference. The measurement setup is similar to the previously described one, except the reference coil and the test coil are inserted into the current probe so that the currents oppose each other (see Figure 4-8). You must observe the polarity of coil current to determine whether the test coil has more or fewer turns than the reference coil. The turns are calculated by using the formula:

$$N_2 = N_1 - \frac{I_m}{I_1}$$

where N_2 is the number of turns in the test coil, N_1 is the number of turns in the reference coil, I_m is the measured coil current, and I_1 is the input current.

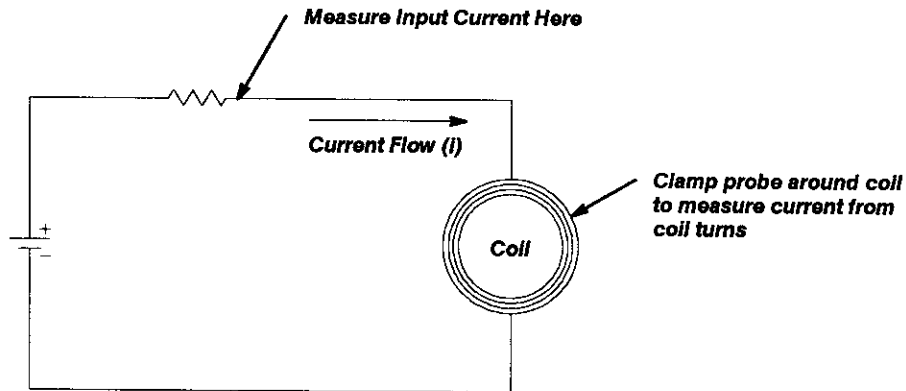


Figure 4-7: Measuring the Number of Turns In a Coil

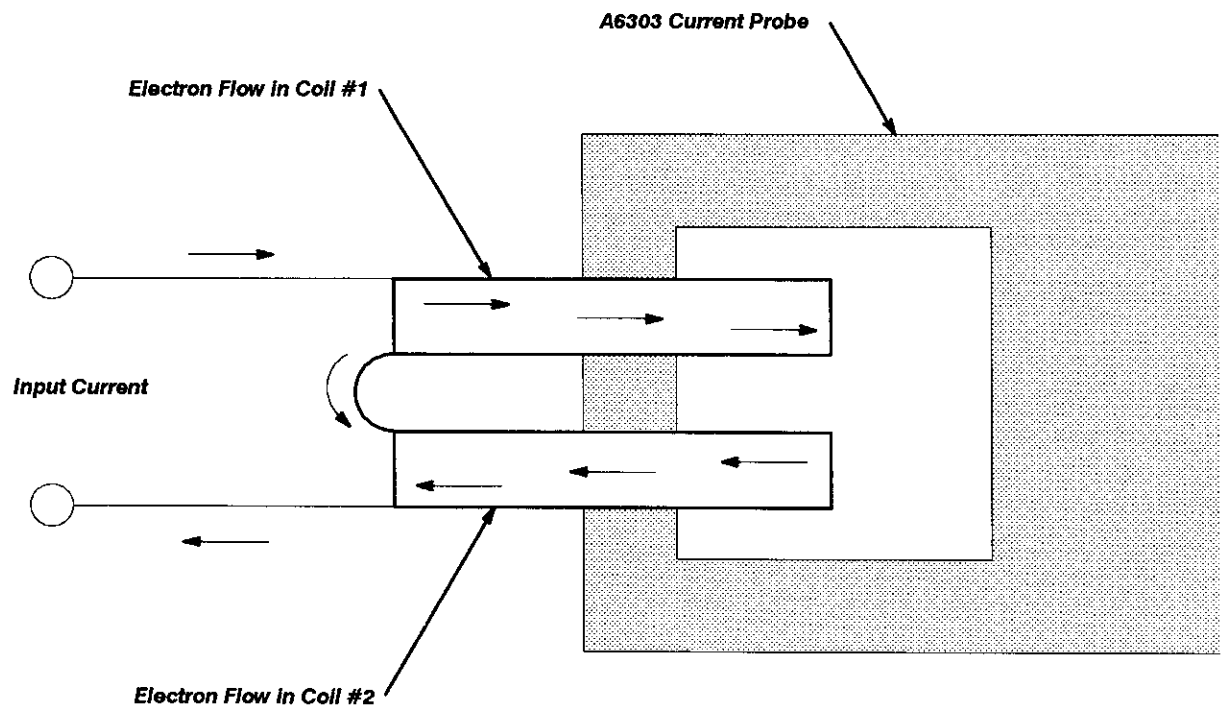


Figure 4-8: Turns Measurement Using Reference Coil

Continuity Test of Multiple-Conductor Cable

Individual conductors of a multiple conductor cable can be tested with the AM 503S. To check a conductor, clamp the current probe around the entire cable and check for a specific, known current signal. If there is no current or the current is abnormally low, then the conductor has a continuity problem. If the current is abnormally high, then the conductor may have a short to ground.



Appendix A: Specifications

Appendix A lists some specifications of the AM 503S Current Probe System (the system includes an AM 503A amplifier, a current probe, and a TM 502A power module). These specifications are valid only under the following conditions:

- the system has been calibrated at an ambient temperature between +20° C and +30° C
- the system is operating in an environment whose limits are described in Table A-3 (the operating temperature limits are 0° C to +50° C, unless otherwise stated)
- the system has had a warm-up period of at least 20 minutes
- the probe degauss/autobalance routine has been performed after the 20-minute warm-up period
- the AM 503A is properly terminated into 50 Ω

Because of a connector change, these specifications apply only to probes above certain serial numbers. Refer to the AM 503S Service Manual for more information. Specifications are subject to change without notice.

Specifications are separated into two categories, warranted specifications, and nominal or typical characteristics.

Warranted characteristics, Table A-1, are guaranteed performance specifications. See the AM 503S Service Manual for the performance verification procedures.

Nominal and typical characteristics, Table A-2, are not guaranteed and are provided to characterize the configuration, performance or operation of typical systems.

Table A-1: Warranted AM 503S Characteristics

Characteristic	AM 503A with A6302	AM 503A with A6303
Bandwidth	DC to 50 MHz	DC to 15 MHz
DC Measurement Accuracy	±3%	±3%
Rise Time	≤ 7 ns	≤ 23 ns

Table A-2: Nominal and Typical AM 503S Characteristics

Characteristic	AM 503A with A6302	AM 503A with A6303
Aberrations	±5%	±5%
Amp · Second Product	100×10^{-6} (100 A · μs) (see amp · second curve in Figure A-2)	$10,000 \times 10^{-6}$ (10,000 A · μs) (see amp · second curve in Figure A-3)
Deflection Factor oscilloscope at 10 mV/div	1 mA/div to 5 A/div in 1–2–5 increments	10 mA/div to 50 A/div in 1–2–5 increments
Frequency Derating	maximum continuous current rating decreases above 20 kHz (see frequency derating curve in Figure A-1)	maximum continuous current rating decreases above 20 kHz (see frequency derating curve in Figure A-1)
Insertion Impedance	0.1 Ω at 1 MHz 0.5 Ω at 50 MHz (see insertion impedance curve in Figure A-4)	0.02 Ω at 1 MHz 0.15 Ω at 15 MHz (see insertion impedance curve in Figure A-5)
Low-Frequency Limit AC coupled	≤7 Hz	≤7 Hz

Table A-2: Nominal and Typical AM 503S Characteristics (Cont.)

Characteristic	AM 503A with A6302	AM 503A with A6303
Maximum Continuous Current (derated with frequency— see Figure A-1)	20 A (DC + peak AC) 14.14 A _{RMS}	100 A (DC + peak AC) 70.7 A _{RMS}
Maximum Pulsed Current (not to exceed the amp · second product)	50 A	500 A
Maximum Voltage (bare wire)	500 V	700 V
Power Consumption	17 Watts maximum	17 Watts maximum
Random Noise	<4 mV _{RMS}	<4 mV _{RMS}

Table A-3: AM 503S Environmental Characteristics

Name	Description
Ambient Temperature	
Operating	0° C to +50° C
Non-Operating	-55° C to +75° C
Humidity	
Operating	50° C, to 95% R.H.
Non-Operating	60° C, to 95% R.H.
Altitude	
Operating	4,570 m (15,000 ft) maximum
Non-Operating	15,200 m (50,000 ft) maximum

Table A-4: AM 503S Physical Characteristics

Name	Description
TM 502A/AM 503A (excluding knobs)	40.7 cm (16.6 in)
Length	14.5 cm (5.7 in)
Width	14.0 cm (5.5 in)
Height	
Net Weight	4.0 kg (8.75 lb)
TM 502A	0.91 kg (2 lb)
AM 503A	250 g (8.8 oz)
A6302	669 g (1.475 lb)
A6303	

Figure A-1: Frequency Derating Curves

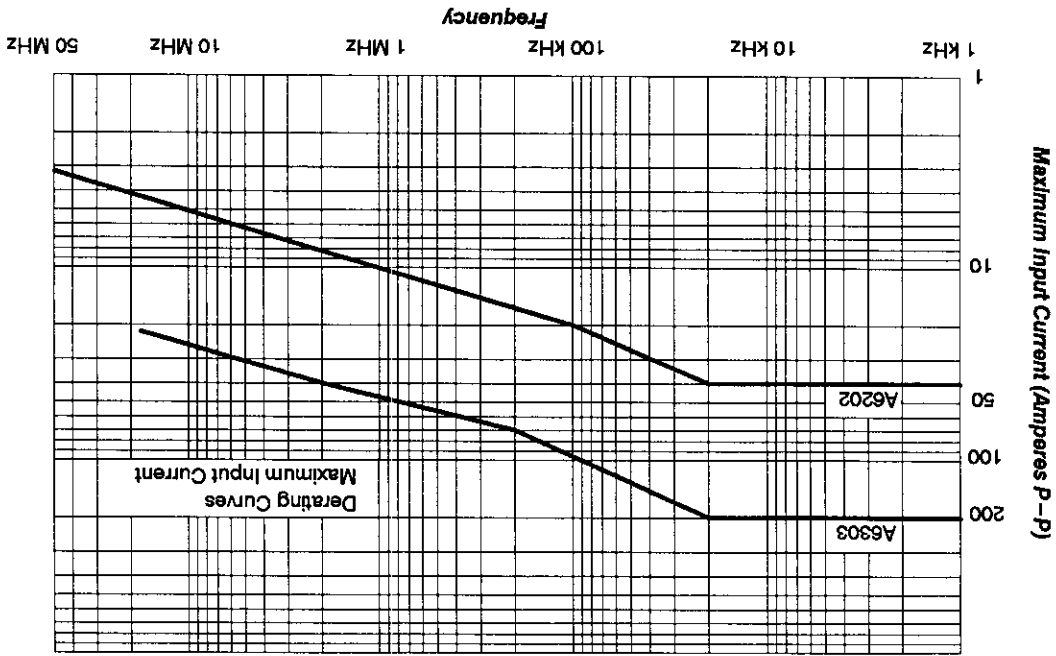


Figure A-2: A6302 Amp · Second Product Curve

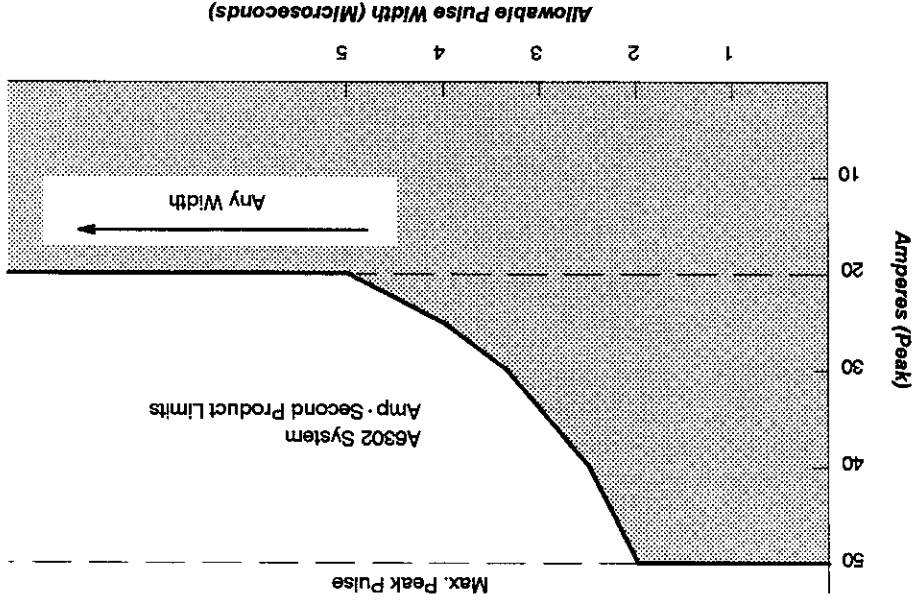


Figure A-3: A6303 Amp · Second Product Curve

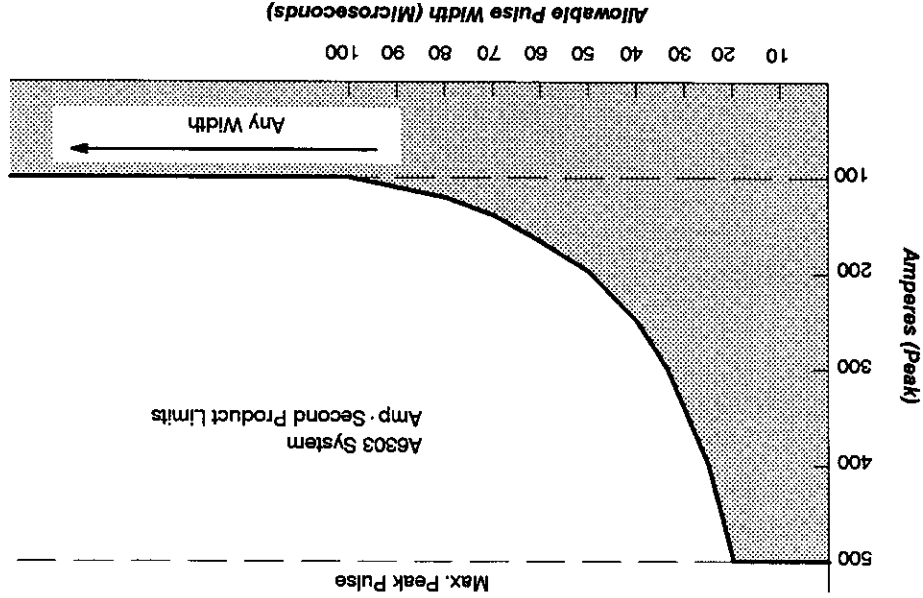


Figure A-4: A6302 Insertion Impedance Curve

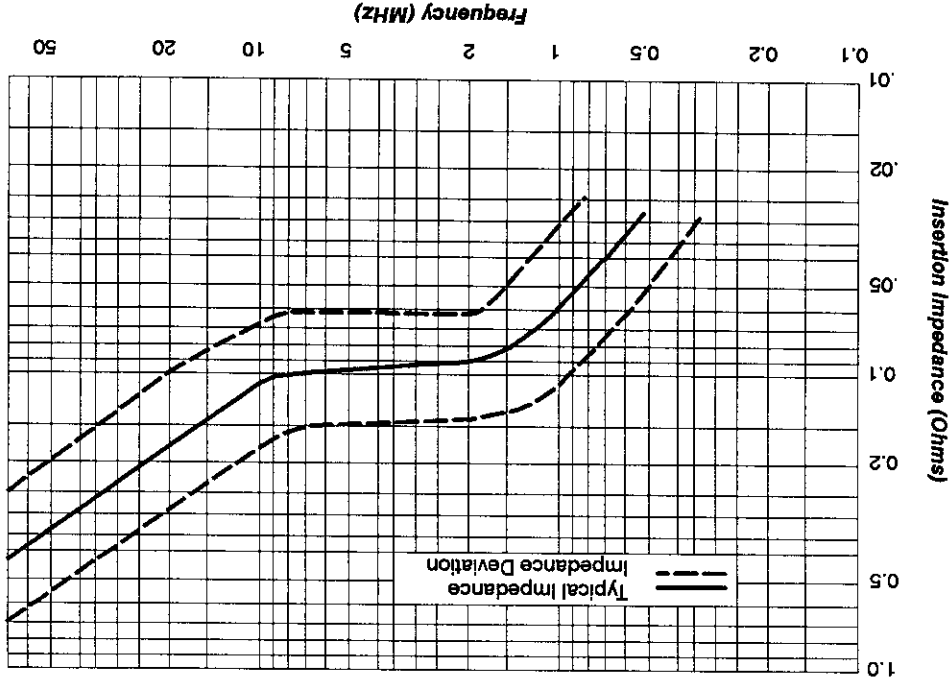


Figure A-5: A6303 Insertion Impedance Curve

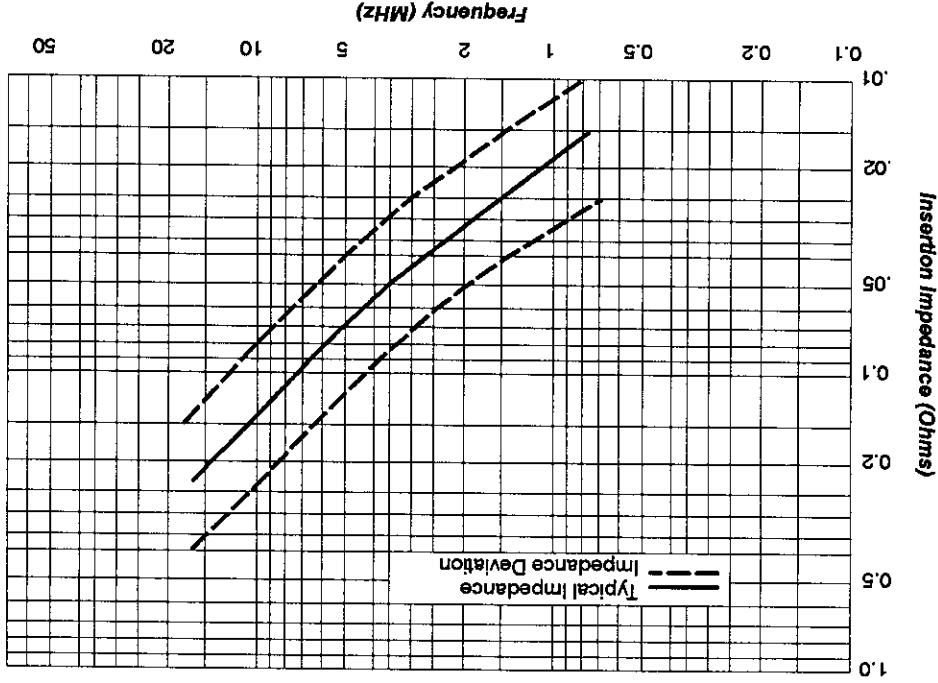
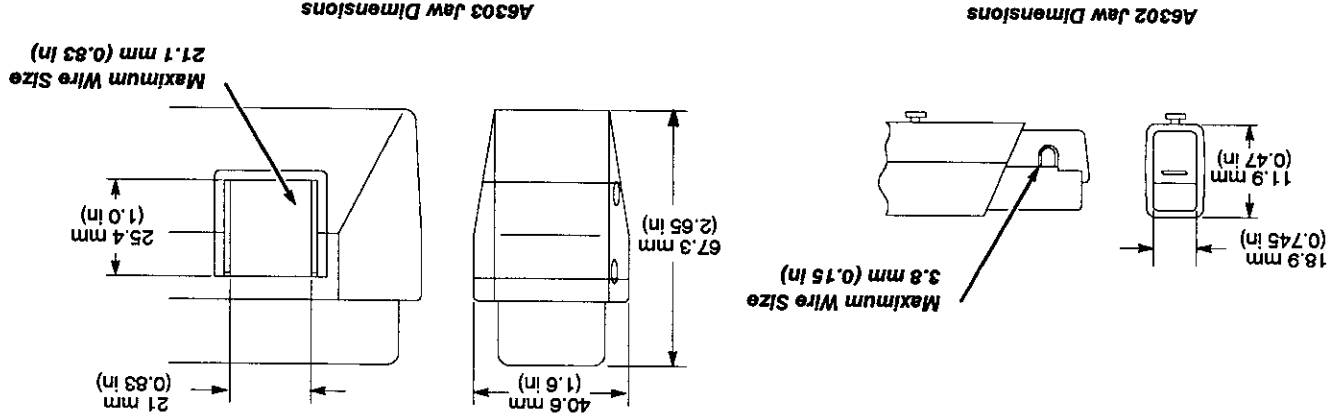


Figure A-6: Probe Jaw Dimensions



Appendix B: Glossary of Terms



This appendix defines some technical terms used in this manual.

amp · second product: the unit of measure defining the maximum amount of pulsed current that can be measured before the probe core becomes saturated. The amp · second rating applies only to measurement values between the maximum continuous and maximum pulse current ratings of the probe. The amp · second rating is equal to the peak current times the pulse width at the 50% point.

auto-balance: a process that removes unwanted DC offsets from the AM 503A circuitry to ensure maximum measurement accuracy. This process is performed during the probe degauss routine.

bucking current: current fed back by the AM 503A to the current probe during DC and low-frequency AC measurements. Bucking current nulls most of the magnetic field in the probe core, allowing linear DC and AC measurements simultaneously.

conventional current flow: the flow of the positive charge in a conductor. Conventional current flow is from positive to negative. The arrows on the A6302 and A6303 current probes point in the direction of conventional current flow. Conventional current flow is in the opposite direction of electron flow.

degauss: a process of eliminating residual magnetism from the probe core by feeding a decaying sine wave into the core. The degaussing process should be performed before clamping the probe around a conductor, whenever the probe becomes saturated by current overloads, or when- ever the probe is exposed to a magnetic field. One of the units used to describe magnetic flux density is the Gauss.

electron current flow: the flow of the electrons in a conductor. Electron current flow is from negative to positive. The arrows on the A6302 and A6303 current probes point in the opposite direction of electron current flow. Electron current flow is in the opposite direction of conventional flow.

flux: the density of a magnetic field. As the number of flux lines increases, the magnetic field strength increases. Current in the conductor under test generates flux lines in the probe core by inducing a voltage in the core.

Hall device: a thin, rectangular piece of semiconductor material located in the core of the current probe. The Hall device uses the Hall effect for DC and low-frequency AC measurements.

Hall effect: the effect that produces a voltage potential in the Hall device when magnetic lines of force pass through the device. The voltage potential is directly proportional to the magnetic field strength. The voltage polarity is determined by the magnetic field polarity. A bias supply is required to produce the Hall effect. The AM 503S current probes use the Hall effect for DC and low-frequency AC measurements.

insertion impedance: the equivalent series impedance introduced to a test circuit when the current probe is clamped around a test conductor.

magnetic susceptibility: a figure expressing the amount of current induced into the probe by an external magnetic field of known intensity. The lower the figure is, the less the probe is influenced by external magnetic fields.

saturation: a condition that occurs when the magnetic field strength in the probe core exceeds the maximum level that the core can absorb. When saturation occurs the probe no longer responds linearly to an increase in magnetic field strength, resulting in measurement inaccuracies. The probe core usually retains residual magnetism, also producing inaccuracies. A current overload condition will cause core saturation. The probe should be degaussed after saturation occurs.

Appendix C: Troubleshooting Guide



This appendix lists possible problems that you may encounter when measuring current with the AM 503S. Use this appendix as a quick troubleshooting reference. For a more in-depth discussion of current measurement problems, see Section 3, *Operation*.

Problem

Remedy

- Front panel displays error code 54.
Probe is not terminated into 50 Ω . Set oscilloscope input impedance to 50 Ω ; set the oscilloscope input coupling to DC.
- If oscilloscope input impedance is fixed at 1 M Ω , attach 50 Ω termination (AM 503S standard accessory) to oscilloscope input. Do not attach termination to AM 503A output.
- Termination is attached to AM 503A output. Remove and re-attach termination to oscilloscope input.
- Front panel display flashes LO during power-up.
Battery is weak. Battery replacement should be performed by qualified service personnel. Refer to the AM 503S Service Manual for more information.

Problem	Remedy
Front panel displays an error code.	<ul style="list-style-type: none"> ■ Turn the instrument off, wait a few seconds, then power up the instrument. Review installation and operating information in this manual. If the error condition persists, refer the instrument to qualified service personnel for repair.
Can't make current measurement.	<ul style="list-style-type: none"> ■ Probe is not locked. ■ Probe is improperly connected to the AM 503A input connector. ■ Coupling is set to REF position. Change to AC or DC.
Can't degauss the probe.	<ul style="list-style-type: none"> ■ Probe is not locked. ■ Probe is improperly connected to the AM 503A input connector.
Stray DC component in measurement.	<ul style="list-style-type: none"> ■ Probe has been overloaded, bumped, or exposed to magnetic field. Degauss the probe.

Problem

Remedy

- Measurements are inaccurate.
- AM 503A output is not terminated into 50 Ω load. Set input impedance of oscilloscope to 50 Ω or connect a 50 Ω feed-through termination to the oscilloscope input, *not* to the AM 503A output.
 - Vertical amplifier of oscilloscope is not at 10 mV/div.
 - The oscilloscope ground reference is improperly adjusted.
 - The AM 503A DC LEVEL control is not adjusted to the zero-current reference line.
 - The measurement exceeds the maximum continuous current or amp-second product ratings of the probe (see Section 3, *Operation* for more information about maximum current ratings). If possible, upgrade to a probe with a higher current rating or use a CT-4 transformer.
-
- Measurements roll off at high frequencies.
- Bandwidth limit is turned on. Verify that bandwidth limit switches of *both* the AM 503A and the oscilloscope are set to the full bandwidth position.
-
- Measurements roll off at low frequencies.
- The coupling is set to AC. Verify that the coupling switches of *both* the AM 503A and the oscilloscope are set to the DC position.

Problem	Remedy
Measurements exhibit excessive noise.	<ul style="list-style-type: none"> ■ Probe is not locked. ■ Probe is improperly connected to the AM 503A input.
Measurement aberrations exceed the specified limit.	<ul style="list-style-type: none"> ■ AM 503A output is not terminated into 50 Ω load. Set input impedance of oscilloscope to 50 Ω or connect a 50 Ω feed-through termination to the oscilloscope input, <i>not</i> to the AM 503A output. ■ The measurement exceeds the maximum continuous current or amp · second product ratings of the probe (for more information, see Section 3, <i>Operation</i>). If possible, upgrade to a probe with a higher current rating or use a CT-4 transformer.

Problem

Measurements exhibit excessive delay or slowed pulse response.

Remedy

- AM 503A output is not terminated into 50 Ω load. Set input impedance of oscilloscope to 50 Ω or connect a 50 Ω feed-through termination to the oscilloscope input, *not* to the AM 503A output.
- The measurement exceeds the amp · second product of the probe (see Section 3, *Operation* for more information about amp · second product). If possible, upgrade to a probe with a higher current rating or use a CT-4 transformer.
- Bandwidth limit is turned on. Verify that bandwidth limit switches of *both* the AM 503A and the oscilloscope are set to the full bandwidth position.



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MANUAL CHANGE INFORMATION

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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 the following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

