

ARBITER SYSTEMS

Model 911 A

Phase Angle Meter

Operation Manual

Arbiter Systems, Inc.

Paso Robles, California U.S.A.

Printed in U.S.A.

This manual is issued for reference only at the convenience of Arbiter Systems. Arbiter Systems has made reasonable effort to verify that all diagrams, to the best of our knowledge, are accurate as of July 1, 1991. However, due to production changes and availability of parts, these diagrams are subject to revisions and modifications. Check with Arbiter Systems at <http://www.arbiter.com/ftp/manuals/> since this publish date.

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Model 911 A PHASE ANGLE METER

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PD0008100A

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1.0 Introduction

The Arbiter Systems, Inc. Model 911.A Phase Angle Meter is a hand-held, battery-operated meter, which measures the phase-angle between a voltage and a current input. The instrument's operating characteristics are optimized for use in the maintenance of utility transmission and distribution systems, for example, in relaying and instrumentation circuits.

The Model 911A's current input is a clamp-on current transformer (CT) which enables measurements without breaking the current-carrying circuit. This makes possible many measurements on operating circuits, which would otherwise have required an outage to connect and disconnect the phase meter. Therefore, with the Model 911A Phase Angle Meter, you can make many measurements quickly without interrupting the customer's service.

1.1 Accessories Included

Along with the Phase Angle Meter, Arbiter Systems, Inc. provides the following accessories:

- Test-probe kit, with screw-on adapters; part no. AP0001000A
- Battery charger, 120 VAC/60Hz; part no. AP0001100A (see "International Power" below for other line voltages and frequencies)
- Current transformer assembly, part no. AS0015800A
- Current transformer cable, part no. CA0013800A
- Soft carrying case, part no. HD0029500A
- Operating manual, part no. PD0008100A

1.2 Accessories Available

- Maintenance Manual, part no. PD0009100A.
- Plug-in CT/adapter, 0.01 - 2.5 Amp input, Model 09112A.
- Plug-in CT/adapter, 0.1 – 25 Amp input, Model 09112B.
- 1000 Amp Current Transformer, Model 09113A.

1.3 International Power

At the time of this printing, battery chargers for international operation are planned but have not yet been introduced. Contact Arbiter Systems, Inc. for more information about these chargers.

If operation on other mains voltages than that required by the charger provided with your instrument is needed, any plug-in power supply capable of generating 15 volts dc at 100 mA minimum may be used for charging. A 3.5 mm phone plug, tip to positive and sleeve to negative, will allow such a power supply to be used to charge the PAM.

1.4 Safety Precautions

Observe all safety markings and instructions before beginning operation of the PAM. Safety information for connections and operation is found in the appropriate places throughout this manual. General Safety instructions are provided below.

1.4.1 General Instructions

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards for the design, manufacture, and intended use of the instrument. Arbiter Systems, Inc. assumes no liability for the user's failure to comply with these requirements.

1.4.2 Do Not Substitute Parts or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to Arbiter Systems for service and repair to ensure that the safety features are maintained.

1.5 Factory Service

Should your instrument need to be returned for factory service, please contact the Arbiter Systems Service Department to obtain a Return Material Authorization (RMA) number. If an instrument return is authorized, forward the instrument prepaid to Arbiter Systems. If the instrument is not covered by warranty, an estimate will be provided upon request.

2.0 Operation

The Model 911A Phase Angle Meter (PAM) has only one operating control: the on-off switch. To measure phase angle, follow this procedure:

1. Disconnect the charger from the PAM (Do not operate the unit while charging).
2. Turn the PAM on using the front- panel slide switch.
3. Connect the current transformer (CT) to the PAM using the supplied cable assembly. For proper phase indication, be sure to observe polarity.
4. Clip the CT around the current- carrying conductor to be measured (not to exceed 30 amps rms).

WARNING! The PAM is capable of measuring voltages, which are hazardous to life. Use proper precautions when connecting the PAM voltage inputs. If you are not sure of the proper precautions, **DO NOT PROCEED**.

5. Using the test probe kit, connect the voltage to be measured (not to exceed 750 volts rms) to the PAM voltage input.
6. The display will indicate phase in degrees. A positive angle means current leads voltage; a negative angle means current lags voltage.

2.1 LO BAT Annunciator

The PAM is capable of approximately 200 hours of operation on a battery charge when idling or measuring small currents (under 2 amperes). At larger currents, the operating life per charge decreases, to approximately 40 hours at 20 amps rms. When the charge state of the battery decreases to approximately 5%, the LO BAT annunciator will appear in the display. The PAM will still perform measurements accurately for several hours, but needs to be charged at the next opportunity.

2.2 Battery Charging

With the supplied charger, the PAM's battery requires 15 hours nominally to accept a full charge. It is preferable to operate the PAM until the LO BAT indication appears, and then to perform a complete charge cycle. Repeated shallow discharge or partial- charge will reduce the battery capacity. However, if it is necessary to partially charge a discharged battery to make measurements immediately, a charge time of approximately one hour will leave a charge state of approximately 10%, which should be adequate for a substantial amount of use.

Do not leave the charger on continuously, as the charging current will cause heating and gas formation in the battery, eventually reducing capacity. For best performance, always charge the battery for 15 hours and then disconnect.

The PAM's battery should be capable of over 500 charge - discharge cycles before the capacity is reduced to 80% of initial capacity. This should be adequate for up to 100,000 hours of operation under normal conditions.

For battery replacement instructions, see the Model 911A Maintenance Manual.

2.3 Current Transformer Maintenance

The current transformer supplied with the PAM is a precision mechanical assembly. Proper operation requires that the metal core halves (within the CT's jaws) close firmly and consistently. Failure to do so can result in phase errors of several degrees.

The design of the CT is intended to minimize phase errors by controlling the mating force between the core halves. However, any dirt or corrosion will degrade performance. To ensure continued performance of your CT, a light coating of machine oil should be applied to the core halves periodically. The core halves should be wiped with a clean shop rag to remove dirt before oiling. This procedure will maximize CT life by reducing corrosion and ensuring proper lubrication.

3.0 Specifications Phase Measurement

Accuracy: ≤ 1 degree (5A, 120V, 60Hz, 25°C)

Display: ≤ 180.0 degrees

Frequency: 50-70 Hz, min. (40-500 Hz, typical)

Voltage Input

Range: 5 Vrms - 750 Vrms

Impedance: 560 K Ω , typical

Current Input

Type: Clamp-on current transformer (supplied with unit)

Range: 10 mA - 20 Arms at CT input

Battery Type: NiCd, 9.6 V 500 mAh, built-in

Operating Time: 200 hours, typ., $I_{in} < 1$ Arms (decreases to 40 hours at $I_{in} = 20$ Arms)

Charger: External, plug-in type (supplied)

Charging time: 13-15 hours, typical

General

Size: 143H x 83W x 38D - meter only

(5.63" x 3.25" x 1.50") Weight: 400 gm (14 oz.) - meter only

Temp.: 0° C to +50° C, operating -40° C to +75° C, non- operating

4.0 Performance Tests

In order to verify that the Model 911A Phase Angle Meter (PAM) is operating properly, you can perform the following procedure. If any discrepancies are noted, service and/or adjustments are indicated. See the Model 911A Maintenance Manual for corrective procedures.

4.1 Equipment Required

Panel Meter Calibrator, Arbiter Systems, Inc. Model 1040C or equivalent.

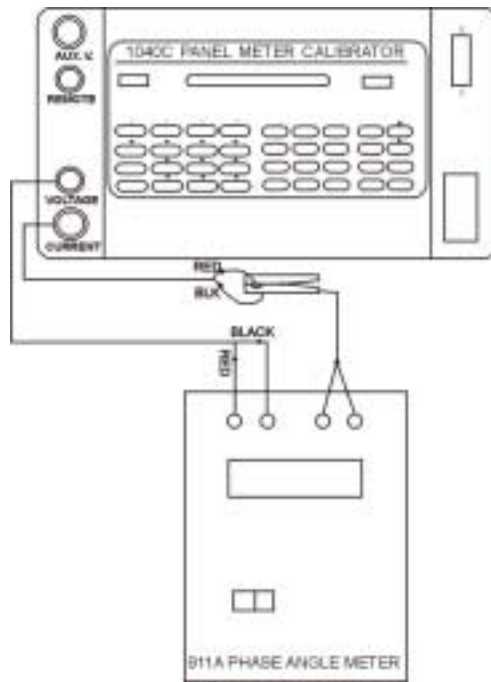
(3) Banana plug jumper cables, Pomona Model B-12 or equivalent.

4.2 Procedure

4.2.1 Phase Accuracy Test

Connect as shown in Figure 4.1. Set the Panel Meter Calibrator as follows: RESET, 60 Hz, POWER, VOLTAGE 120 Volts, CURRENT 5 Amps, PHASE 0 Degrees; OPERATE.

The PAM should show an indication of 0 ± 1 degrees.



**Figure 4.1 911A Phase Angle Meter
Performance Check**

(If desired, you may repeat this test at other voltage and current levels within the instruments' ranges. Although not guaranteed for every combination of voltage and current, the PAM indication will normally be 0 ± 1 degree for all combinations. For currents higher than the Panel Meter Calibrator's range, you may coil the current-carrying conductor twice or three times through the CT jaws. This will effectively multiply the current by the number of turns.)

4.2.2 Phase Linearity Test

Connect as shown in Figure 4.1. Set the Panel Meter Calibrator as follows: RESET, 60 Hz, POWER, VOLTAGE 120 Volts, CURRENT 5 Amps, PHASE +150 Degrees; OPERATE. The PAM should show an indication of $+150\pm 1$ degrees.

Make the following change:

PHASE -150 Degrees; OPERATE. The PAM should show an indication of -150 ± 1 degrees.

(If desired, you may repeat this test at other phase settings. However, the design of the PAM provides inherent linearity from zero to +180 and -180 degrees. Verification at zero and values near positive and negative full scale provide complete verification of the PAM's phase detector.)

4.2.3 Optional Phase Range Limit Test

This test verifies the phase auto-ranging circuit in the PAM. The PAM's design should automatically cause the "sense" of the display to shift from positive to negative, and vice versa, as the phase angle slews past 180 degrees. Hysteresis is provided to eliminate "jumping" or ambiguity around 180 degrees; the purpose of this test is to check this hysteresis.

Connect as shown in Figure 4.1. Set the Panel Meter Calibrator as follows: RESET, 60 Hz, POWER, VOLTAGE 120 Volts, CURRENT 5 Amps, PHASE +160 Degrees; OPERATE.

The PAM should show an indication of $+160\pm 1$ degrees. Using the Panel Meter Calibrator's knob, slowly increase the phase setting while watching the PAM indication. The indication should increase past +180 degrees, and then switch to a negative indication. The maximum positive indication should be in the range of +185 to +195 degrees.

Repeat the procedure, starting at -160 degrees and decreasing (i.e., making more negative) the phase setting of the Panel Meter Calibrator. The maximum negative indication should be between -185 and -195 degrees.

This completes verification of the performance of the Model 911A Phase Angle Meter. If any indications were abnormal, refer to the 911A Maintenance Manual for corrective procedures.

LIMITED WARRANTY

Arbiter Systems makes no warranty, expressed or implied, on any product manufactured or sold by Arbiter Systems except for the following limited warranty against defects in materials and workmanship on products manufactured by Arbiter Systems.

Products manufactured by Arbiter Systems are guaranteed against defective materials and workmanship under normal use and service for one year from date of delivery. The responsibility of Arbiter Systems under this warranty is limited to repair or replacement, at Arbiter Systems' option, of any product found to be defective. Arbiter Systems shall have no liability under this warranty unless it receives written notice of any claimed defect within the earlier of thirty days of discovery by Buyer or one year from the date of delivery. For warranty service or repair, products must be returned to a service facility designated by Arbiter Systems. Buyer shall prepay all shipping charges to Arbiter Systems and Arbiter Systems shall pay shipping charges and return the product to Buyer. However, Buyer shall pay all shipping charges, duties and taxes for products returned to Buyer in a country other than the United States of America.

THE WARRANTY SET FORTH HEREIN CONSTITUTES THE ONLY WARRANTY OBLIGATIONS OF ARBITER SYSTEMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW, OR OTHERWISE. ARBITER SYSTEMS DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND BUYER EXPRESSLY WAIVES ALL OTHER WARRANTIES.

This limited warranty does not extend to any product which has been subject to (i) improper use or application, misuse, or abuse, or operation beyond its rated capacity, or contrary to the instructions in the operation and maintenance manuals, if any (ii) accident (iii) repair or maintenance, except in accordance with the operation and maintenance manuals, if any, and any special instructions of Arbiter Systems, or (iv) modification without the prior written authorization of Arbiter Systems (whether by the substitution of non-approved parts or otherwise).

The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall Arbiter Systems be liable for direct, indirect, incidental or consequential damages (including loss of profits), whether based on contract, tort, or other legal theory .

FOR THE FASTEST POSSIBLE SERVICE, SHOULD FAULT UNDER THIS WARRANTY DEVELOP, PLEASE PROCEED AS FOLLOWS:

- 1) Notify Arbiter Systems, Inc., specifying the instrument model number and serial number and giving full details of the difficulty. Service data or instrument-return authorization will be provided upon receipt of this information.
- 2) If instrument return is authorized forward prepaid to the manufacturer. If the instrument is not covered by this warranty, an estimate will be made before the repair work begins, if requested.

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