2) Clamp voltage test lead probe between jaws (See fig. 5).
3) Plug ohmmeter lead into jack on the right side of the instrument (See fig. 1).
4) Position the "sensing mode" selector switch to "RMS" or "AVG".
5) Short ohmmeter probe tip to voltage probe tip and press the PTR button.
   (a) If fuse is good, reading should be below one ohm.
   (b) If fuse is blown, the display will indicate "OL".
6) With instrument in one hand and ohmmeter test probe in the other hand, apply probe tips to circuit or device. Press the "Press-to-Read" button and read the display.

NOTE: When measuring low resistances, subtract the resistance value obtained in 5(a) above from the reading obtained in the actual test. Instrument measures its own lead resistance at the same time it measures circuit or device resistance. Subtracting the test lead resistance gives a more accurate resistance measurement. Also, make certain good electrical contact is made with test points. Because of the sensitivity of the instrument, even slight corrosion on probe tips or test points may cause erroneous readings. To clean probe tips, use fine steel wool.

PEAK HOLD OPERATION

Read and understand "Precautions for Personal and Instrument Safety" before proceeding.

The ACD-2000/2001 can be used to continuously monitor a variable (current, voltage or resistance) in "RMS" or "AVG" mode. It can measure the peak (surge) value of a variable, such as motor starting current in the "peak hold" mode. Peaks must last at least 0.08 seconds. Motor starting currents normally persist for approximately 0.17 seconds.

For continuous operation, move the "sensing mode" selector to "RMS" or "AVG" position. For peak measurements, move the "sensing mode" selector switch to "peak" position (see fig. 1) and wait 3 seconds for the "peak hold" annunciator to appear in the display before taking a reading.

CEBMA TRANSFORMER DERATING FACTOR

The CEBMA Transformer Derating Factor is the most commonly used calculation for derating transformers to prevent overheating or failure on lines where harmonics are present.

The CEBMA Transformer Derating Factor is defined as: ——

This industry-standard calculation is equivalent to: ——

Since Amprobe's Peak Hold circuit is scaled to RMS (i.e. it reads $0.707 \times I_{PEAK}$, rather than I_{PEAK} itself), this calculation is greatly simplified. To obtain the CEBMA derating factor divide the RMS reading by the PEAK reading.

AMPROBE INSTRUMENT
DIVISION OF CORE INDUSTRIES INC., LYNBROOK, NEW YORK 11563

OPERATING INSTRUCTIONS

AMPROBE
True RMS Digital Clamp-On Volt/Amp/Ohmmeter
Models ACD-2000 and ACD-2001

SEE PRECAUTIONS FOR PERSONAL AND INSTRUMENT SAFETY INSIDE

SPECIFICATIONS

Ranges: (Automatically Selected)

ACD-2000	Volts *AC, Amps AC, Peak AMPS	0.1-199.9/999
	Ohms	0.1-199.9/1999
ACD-2001	Volts *AC, Amps AC Peak	0.1-199.9/999
	Amps AC Continuous	0.1-199.9/300
	Ohms	0.1-199.9/1999

**Input Impedance 10 Megohms*

Ohmmeter test voltage (full-scale): 200 mV
Ohmmeter open-circuit voltage: 2.5 volts max
Accuracy:
Volts and Amps: 2% of reading ±2LSD**, 40-400 HZ
For true RMS (AC-coupled) mode, the above spec applies for waveforms with crest factor of 3:1 max. Average and peak-hold modes are specified for sine waves only.
In peak-hold mode, the measured surge must last at least 0.08 sec. Peak-hold readings are non-decaying.
Ohms: 2% of reading ±2LSD**
See instructions for low-resistance measurements
**Least significant digit(s).

Battery Life: 65 hours, continuous operation.

Resolution: .1 (Volt, Amp, Ohm) on low range, 1 (Volt, Amp, Ohm) on high range.

Case Voltage Breakdown Test: 3000 Volts AC.

Operating Temperature and Humidity: 32°F to 120°F, 0°C to 49°C. Up to 80% RH, non-condensing.

Sampling Rate: 2.5 times/sec.

Digit size: 0.4".

Power: One No. MN1604, 9V alkaline battery (not supplied).

Display: A custom 3½ digit liquid crystal display has been designed into model ACD-2000/2001 for ease of reading and reliability. This display includes annunciators for "low battery" and "peak hold."

Circuit Protection: Fused protected to 600 volts on the Ohms range.

AMPROBE INSTRUMENT
DIVISION OF CORE INDUSTRIES INC., LYNBROOK, NEW YORK 11563

Your AMPROBE instrument has a limited warranty against defective materials and/or workmanship for one year from the date of purchase provided the seal is unbroken or, in the opinion of the factory, the instrument has not been opened, tampered with, or taken apart.

Should your instrument fail due to defective materials and/or workmanship during the one-year warranty period, return it along with a copy of your dated bill of sale which must identify the instrument by model number and serial number (located on the back of the instrument).

For your protection, please use the instrument as soon as possible. If damaged, or should the need arise to return your instrument, it must be securely wrapped (to prevent damage in transit) and sent prepaid via Air Parcel Post, insured, or UPS to: Service Division, AMPROBE INSTRUMENT, 630 Merrick Road (UPS) P.O. Box 329 Lynbrook, New York 11563. Outside of the U.S.A. your AMPROBE representative will assist you.

Above limited warranty covers repair and replacement of instrument only and no other obligation is stated or implied.

PRECAUTIONS FOR PERSONAL AND INSTRUMENT PROTECTION

IMPORTANT:

1) Before using any electrical instrument or tester for actual testing, the unit should be checked on a known, live line to make certain it is operating properly.
2) In many instances, you will be working with dangerous levels of voltage and/or current; therefore, it is important that you avoid direct contact with any uninsulated, current-carrying surfaces. Appropriate insulating gloves and clothing should be worn.
3) The jaws of clamp-on instruments should not, under any circumstances, be used as a device to hold the instrument when taking other than a current reading. When using a clamp-on as a voltmeter or ohmmeter, never clamp the jaws around or onto a conductor, box or anything else conducting or non-conducting, except a test lead. (See fig. 6)
4) Before applying test leads to circuit under test, make certain that test leads are plugged into proper instrument jacks.
5) Make certain no voltage is present in circuit before connecting ohmmeter to circuit.
6) Should the instrument accidentally be used to try to measure a voltage or current beyond the range of the instrument, immediately remove the instrument from the circuit. See Over-Range Indication.
7) When not in use, keep instrument in its carrying case.
8) When instrument will not be used for a period of time, remove the battery from instrument.

INTRODUCTION & DESCRIPTION

Congratulations! You are now the owner of an AMPROBE INSTRUMENT, Model ACD-2000/2001. It has been union crafted according to quality standards of workmanship and contains quality components. This instrument has been inspected for proper operation of all of its functions. It has been tested by qualified factory technicians according to the long-established standards of AMPROBE INSTRUMENT.

Models ACD-2000/2001 can measure AC volts and AC current by three different modes. The user can select:

scaled to RMS. TRMS allows the measurement of sinusoidal and non-sinusoidal waveforms. Average allows the measurement of sinusoidal waveforms and Peak Hold allows the measurement of motor-starting current and voltage surges that last a minimum of 80 ms. A difference between TRMS and average readings indicates the presence of distortion. In most cases, the greater the difference in reading, the greater the distortion. Models ACD-2000/2001 represent a significant advance in clamp-on instrumentation. Please read and understand this instruction booklet thoroughly so that maximum accuracy and safety can be realized. Thank you for your purchase and confidence.

AMPROBE INSTRUMENT

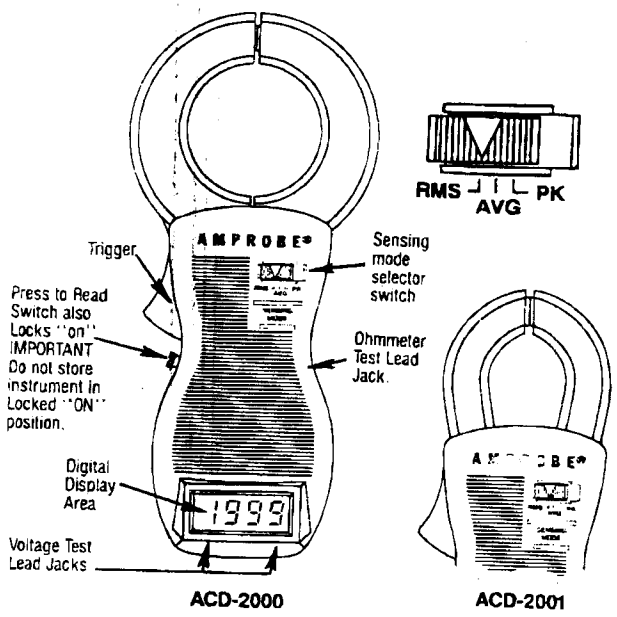

Fig. 1

INSTALLING BATTERY AND FUSE

CAUTION: To avoid possible electrical shock, turn off ACD-2000/2001 and remove it and its test leads from any voltage or current before replacing battery and/or fuse. The ACD-2000/2001 uses one No. MN1604-9V alkaline battery (not supplied) and one No. 8AG, 1 Amp-600V special fast blow fuse. (Cat. No. 8AG-360X023).

To install battery:

1. Loosen screw located toward the bottom center on the back of the instrument (see fig. 2).
2. Lift battery compartment cover.
3. Firmly snap connector onto battery terminals.
4. Replace cover and tighten screw.

Note: Do not operate instrument without battery cover in place.

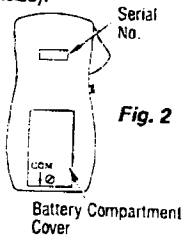

Fig. 2

To install fuse:

A. Unscrew the top (probe tip) section from the bottom section of the ohmmeter attachment.
B. Insert fuse into top section.
C. Screw two sections together.

Replace the battery when the battery symbol appears in the ACD-2000/2001 display or the display digits do not light up.

Low Battery

Fig. 3

OVER RANGE INDICATION

The maximum current or voltage that can be measured without causing damage to the instrument is 1000 amps or volts, but the display can go up to 1999. There will not be an over-range indication to tell you that you are overloading the instrument if you try to measure more than 1000 amps or volts.

WARNING: Do not apply more than 1000 amps or volts. If you inadvertently do apply more than 1000 amps or volts, remove instrument immediately. In the ohmmeter mode, if you try to measure a resistance larger than 1999 ohms, the display will read "OL" (overload). You can observe this by plugging in the ohmmeter test lead without connecting it to a resistance. The display will read "OL".

PRESS-TO-READ SWITCH (PTR)

To take a reading once the instrument has been connected as per the following instructions, push in the PTR button, (See fig. 1) to lock the PTR button "on" for a constant readout, gently push in the PTR button and while depressed turn it counterclockwise 1/8 turn (fig 4.) When taking a peak reading, press the PTR button and wait 3 seconds for the "peak hold" annunciator to appear on the display before taking a reading.

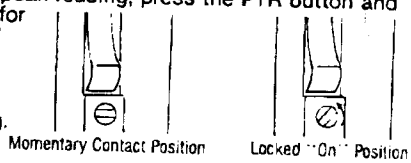

Figure 4

The ACD-2000/2001 instrument are specified to have an accuracy of ±2% of reading ±2LSD.

Example: Instrument is reading 20.0 (volts, amps or ohms) ±2% of 20.0 equals ±0.4 or 19.6 to 20.4. Taking ±2LSD into consideration, actual value is between 19.4 (19.6-0.2) and 20.6 (20.4+0.2).

Supplied Accessories:

One No. 8AG-360X023, 1AMP/600V fast blow fuse, one set voltage test leads (DTL-2 for ACD-2000 & DTL-3 for ACD-2001), one OHB-4HE Ohmmeter attachment, one case and instructions. A full line of accessories are available for this instrument.

ACCESSORIES & REPLACEMENTS

Description	Model
Standard carrying case for ACD-2000	AE
Standard carrying case for ACD-2001	AE-2
Deluxe carrying case	ADM
All-weather test leads with replaceable probe tips for ACD-2000	DTL-2
All-weather test leads with replaceable probe tips for ACD-2001	DTL-3
Fused ohmmeter test lead	OHB-4HE
Alligator clip adaptor for DTL-2 & DTL-3	VRC-320
Fuse, 1 amp fast blow, 600 volt	8AG-360X023
Battery, 9V alkaline	MN-1604
AMPTRAN® flexible link 50:1 transformer (5000 amp)	CT50-1
AMPTRAN® flexible link 50:1 transformer (3000 amp)	CT50-2
Energizer, increases sensitivity by 10 times	A-47L
Replacement probe tips for DTL-2 & DTL-3	VPT

PERFORMANCE FROM YOUR DIGITAL CLAMP-ON

A. Make certain the "sensing mode" selector switch is moved completely into its respective position.

B. When measuring resistance, make certain the voltage test lead that is being used is inserted into the jack marked "COM" on the back of the instrument.

C. When measuring currents of widely varying values, the accuracy of the lower-value current readings may be affected by retained magnetism in the jaws. To reduce this possibility, open the jaws and allow them to snap shut between readings.

D. When using the "peak hold" mode to take and lock in a low current measurement that is to be read away from the conductor, open the jaws slowly and remove them from around the conductor.

E. When measuring resistance, the "sensing mode" selector switch should be in the "RMS" or "AVG" position. (In the "peak hold" position, any accidental opening of the circuit will cause a locked-in, over-range (OL) indication).

F. The temperature operating range of your ACD-2000/2001 is +32°F to +120°F. If the instrument has been in a location where the temperature was lower than 32°F or higher than 120°F, allow the instrument to adjust to within the operating temperature range.

G. The "peak hold" mode can also be used to take and lock in a measurement when the display cannot be read because of instrument position. Lock the PTR button. Connect instrument for the measurement (volts or amps). Move "sensing mode" switch to peak position. Wait at least 3 seconds and then remove instrument to a position where it can be read. (Note: Reading will be "peak" sensing scaled to RMS).

SCALING AND CREST FACTOR

Models ACD-2000/2001 have three measuring modes: true RMS (TRMS), average-sensing scaled to RMS, and peak-sensing scaled to RMS.

On a pure sine wave, the RMS value is 70.7% of the instantaneous value at the peak of the sine wave. Conversely, the peak value is 1.414 times the RMS. "Peak-sensing scaled to RMS" means that the peak is detected and divided by 1.414 to yield the RMS. If it is desired to know the actual peak value, the "peak" reading must be multiplied by 1.414.

Similarly, the full-wave-rectified average value of a sine wave is 63.7% of its peak value, which means the average value is 90% of the RMS. Hence the RMS value is 1.111 times the average. "Average-sensing scaled to RMS" means that the average is detected and multiplied by 1.111 to yield the RMS. If it is desired to know the actual average value, the "average" reading must be divided by 1.111.

Crest factor is the peak value of a waveform divided by its RMS value. For a sine wave, the crest factor is 1.414. To determine the crest factor of a waveform, take a peak-hold reading and a TRMS reading. Multiply the peak-hold reading by 1.414 (to get the actual peak value) and then divide by the TRMS reading. When taking peak-hold readings for this purpose, it is best to take several readings to make sure you have measured the *typical* peak of the waveform, and not the peak of a surge.

Note, however, that the accuracy of the peak-sensing mode is specified only for sine waves from 40 to 400Hz. The peak-sensing mode becomes less accurate for highly distorted waveforms, especially waveforms with very narrow peaks (as seen on an oscilloscope). Remember too that neither the peak reading nor the TRMS reading may exceed 1000 volts or amps.

THE IMPORTANCE OF TRMS MEASUREMENTS

Until recently, loads connected to AC mains were almost always "linear" responding. When a sinusoidal voltage is applied to a linear load, the resultant current waveform will also be sinusoidal. The current in a linear load is directly proportional to the instantaneous voltage applied to the load. Lately, many modern electrical and electronic loads are not linear. When non-linear loads are connected to the AC mains, current (and sometimes voltage) waveform distortion results. Waveform distortion is referred to as "Harmonic Distortion". Harmonics are multiples of the fundamental power frequency. They are generated and imposed on the power lines by non-linear loads.

As harmonics are added to the fundamental power frequency, distortion of the original wave form results. The new waveform reflects the arithmetic sum of the ***instantaneous RMS*** values of all the harmonic components and the fundamental frequency. Harmonics which are present on only one phase of a three-phase system will appear on the neutral conductor, requiring that conductor to handle more current than (in many cases) it was originally designed to handle. Worse yet, triplen harmonics (the 3rd, 6th, 9th, etc.) that do appear on all three phases will be additive in the neutral conductor. The problem is not limited to the neutral conductor, as harmonic currents will also be present in all transformers and generators associated with three-phase systems and single phase branch circuits supplying non-linear loads.

Waveform distortion can cause equipment problems. (For example, a distorted voltage may cause a 3-phase motor to overheat)

Waveform distortion can also cause severe instrument reading errors if the proper measuring system is not used. Most portable instrumentation is "average responding calibrated in terms of RMS". For a pure sine wave, the average responding instrument will indicate the RMS value of the waveform with reasonable accuracy. However, for an SCR waveform with a conduction angle of 90°, this same average responding instrument will read 29% low. Other types of distorted waveforms can produce even worse errors.

To overcome this inaccuracy, a different measuring system is required. This system is called "True RMS" responding. "True RMS" (TRMS) is a complex mathematical equation that computes the true effective heating value of any waveform. "True RMS" and "average" sensing modes will both read exactly the same on pure sine waves. On distorted waveforms, only the "True RMS" sensing mode will produce accurate RMS readings.

For the distorted ***current*** waveforms found on most power lines, the average-sensing reading will usually be *lower* than TRMS reading. This means that with an average-sensing meter, one can easily underestimate the potential for over-heating. Only the TRMS reading should be relied upon for this purpose.

Power-line voltages will usually remain more nearly sinusoidal than the current. If the average-sensing voltage reading is significantly ***greater*** than the TRMS reading, this usually means that the waveform's crest factor is below 1.414. (Conversely, an average-sensing reading *lower* than the TRMS reading usually means that the waveform's crest factor is greater than 1.414). The AMPROBE INSTRUMENT model ACD-2000 or 2001 clamp-on instruments have the ability to measure AC waveforms with both types of sensing techniques. This feature allows the user to determine if distortion is present.

HOW TO MEASURE AC CURRENT

Read and understand "Precautions for Personal and Instrument Safety" before proceeding.

1. Disconnect voltage test leads and ohmmeter attachment from instrument.
2. Position the "sensing mode" selector switch to RMS or AVG position. (See "The Importance of True RMS Measurements" in Appendix).
3. Press trigger to open jaws.
4. Encircle *single* conductor with jaws. (Note: If you encircle more than one conductor, especially if currents are going in the opposite directions or are out of phase, readings will cancel).
5. Release finger pressure on trigger and allow jaws to close around the conductor.
6. Press the "Press-to-Read" (PTR) button and read display.

HOW TO MEASURE AC VOLTAGE

Read and understand "Precautions for Personal and Instrument Safety" before proceeding.

Note: Because the ACD-2000/2001 is a high impedance voltmeter (10 megohms), and RF signals exists almost everywhere, it is possible to get a voltage reading even when the instrument is not connected to a circuit. This will not, however, affect your actual voltage measurement. If you connect both test leads together, reading should be zero.

Fig. 5

1. Disconnect ohmmeter attachment from instrument and/or remove jaws from around any conductor.
2. Position the "sensing mode" selector switch to RMS or AVG position (see "The Importance of True RMS Measurements" in Appendix).
3. Insert insulated voltage test lead connectors into voltage receptacles in bottom of instrument (see fig. 1). Push in against receptacle spring and twist clock-wise to lock in place.
4. Clamp jaw on voltage test probe handle (see fig. 5).
5. With instrument in one hand and the second voltage test probe in the other, apply test probes to the test points of the circuit.
6. Press the PTR button and read the display.

HOW TO MEASURE RESISTANCE

Read and understand "Precautions for Personal and Instrument Safety" before proceeding.

1) Insert one insulated voltage test lead connector into the right hand voltage receptacle (viewing instrument from front) in the bottom of the instrument. Looking at the back of the instrument, this voltage receptacle is marked "COM". (See fig. 2).