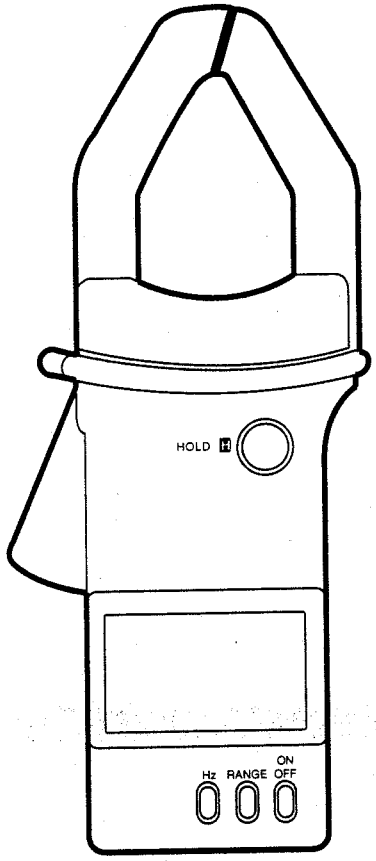
31/33 TRUE RMS CLAMP METER

INSTRUCTION MANUAL

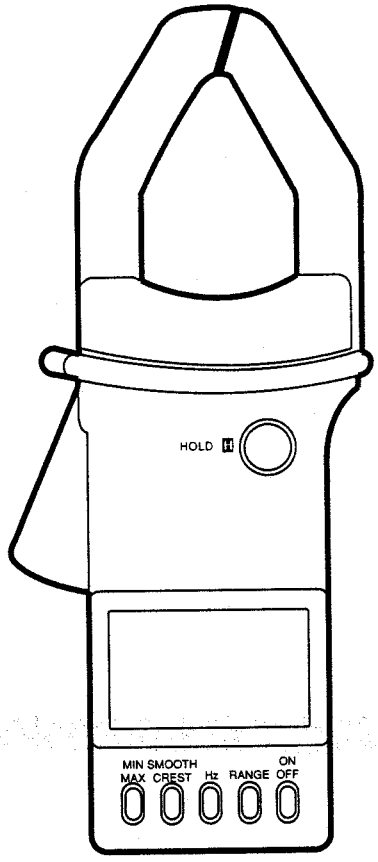
PN 896118
September 1991 Rev. 1 6/93

FLUKE®

CONTENTS



MODEL 31



MODEL 33

INTRODUCTION

NOTE

This meter has been designed and tested according to IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus (Protection Class II) and other safety standards (see "Specifications"). Follow all warnings to ensure safe operation.

WARNING

READ "SAFETY" (NEXT PAGE) BEFORE USING THE METER.

The Fluke 31 and 33 True RMS Clamp Ammeters are portable, battery operated, handheld alternating current (AC) measuring devices that combine the precision of a digital meter with the speed and versatility of a high resolution analog display. Both models measure the true rms value of alternating current over a basic range from 0.20A to 400.0A rms, in two display ranges: 0 to 40A and 0 to 400A. Measurements can be made above 400A with an absolute limit of 700A rms. Current measurements are from 10 Hz to 1 kHz, and frequency measurements are from 0.5 Hz to 10 kHz.

30-Series meters measure true rms current flow for accurate indications of the effective current. Meters that measure average current flow (displayed on an rms scale) are inaccurate for non-linear currents and their measurements may differ from those obtained using the Series-30 meters.

The meter lever opens the current clamp to allow entry of a conductor. The lever is then released to close the magnetic path around the conductor. Current flow is measured and displayed on the meter as amperes rms. Frequency can also be measured while simultaneously measuring current flow.

Models 31 and 33 provide:

- Automatic or manual display range selection.
- 40-segment analog bar graph that displays current while measuring frequency on the digital display. Bar graph responds eight times each second to track fast variations.
- HOLD function to freeze readings in digital display.
- Battery life indicator at power-up using bar graph and replace-battery indicator.
- Automatic power off battery saver after 10 minutes of inactivity.

Model 33 additionally provides:

- A "Smooth" mode to display a 3-second running average.
- A "Crest" mode that measures half-cycle current peaks.
- A "Record" mode to record maximum, minimum, and average values of rms current, smoothed rms, or frequency. Half-cycle peak (Crest mode) maximum may also be recorded.

Before using the meter in any application, review "Safety," "Controls and Indicators," and "Meter Tutorial." Typical uses of the meter are shown in "Applications." For maintenance information such as battery replacement or troubleshooting, see "Maintenance." For a summary of the meter specifications, see "Specifications." For customer assistance in the USA, telephone 1-800-44-FLUKE (1-800-443-5853).

UNPACKING THE METER

The contents of the shipping container includes the true rms clamp meter, a holster, a 9V battery (installed), and an Instruction Manual. If the meter is damaged or something is missing, contact the place of purchase immediately. Save the shipping container and packing material in case you have to reship the meter.

SAFETY

Read the following safety information carefully before attempting to operate or service the meter. In this manual, the word, "DANGER" identifies a severe or immediately accessible personnel hazard that can cause death or injury; the word "WARNING" identifies a personnel hazard about a condition or procedure that could cause death or injury; the word, "CAUTION" identifies an equipment hazard about a condition or procedure that could cause damage or destruction of the meter.

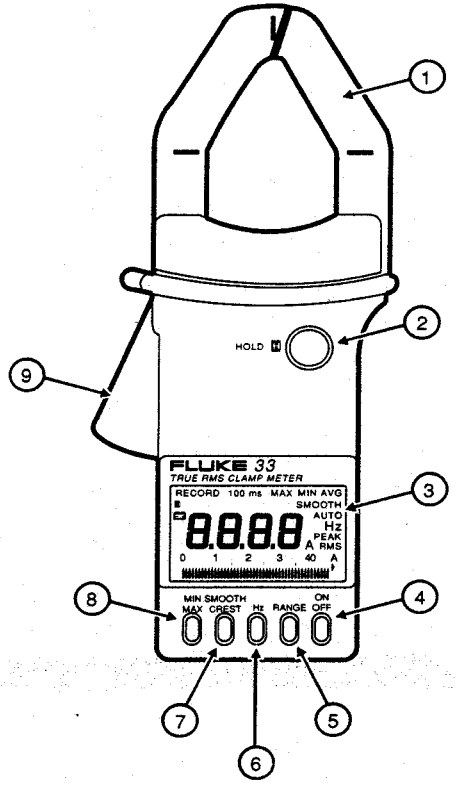
- Avoid working alone.
- Never clamp around a conductor at 600V or greater or a frequency of 10 kHz or greater.
- Never use a meter whose insulating protection has been impaired. Such meters should be made inoperative by taping the clamp shut to prevent unintended operation.
- Use extreme caution when clamping around uninsulated conductors or bus bars.
- Use the meter only as specified in this manual; otherwise the protection provided by the meter may be impaired.
- Read the operating instructions before use and observe the safety messages contained in the instructions.

Observe the International Electrical Symbols listed below.

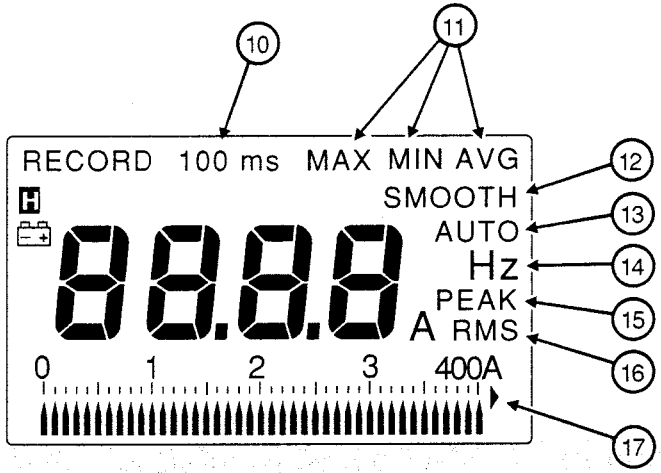
Meter is protected throughout by double insulation or reinforced insulation.

Warning! Risk of electric shock.

Caution! Refer to this manual before using the meter.



1. **CLAMP.** Opens 1.7 inches (42 mm) to enclose conductors.
2. **HOLD.** Freezes value in digital display.
3. **DISPLAY.** Liquid crystal display.
4. **ON OFF.** Selects meter power ON or power OFF.
5. **RANGE.** Selects 0 to 40A, 0 to 400A, or AUTO.
6. **Hz.** Selects frequency measurement mode.
7. **SMOOTH CREST.** (Model 33.) Select SMOOTH for a running 3-second average, or CREST for half-cycle peak amperes.
8. **MIN MAX.** (Model 33.) Selects RECORD mode and displays recorded MIN, MAX, and AVG.
9. **LEVER.** Opens and closes clamp jaws.



(10) **100 ms.** Displayed when current flow measurements are at normal 100 millisecond intervals.

(11) **MAX MIN AVG.** (Model 33.) Displayed in RECORD mode by pressing MIN MAX pushbutton.

(12) **SMOOTH.** (Model 33.) Displayed when current flow readings or Hz readings are smoothed out over 3-second intervals.

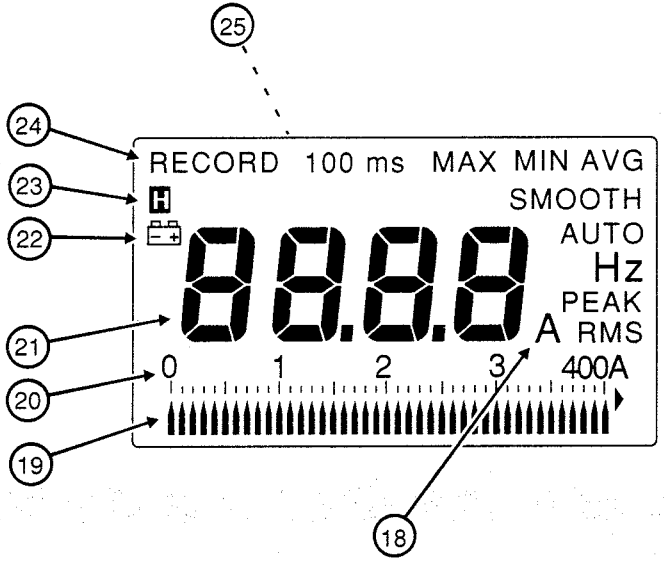
(13) **AUTO.** Displayed when autoranging controls bar graph scale (0 to 40A scale, or 0 to 400A scale) and controls position of decimal point on digital display.

(14) **Hz.** Displayed when measuring frequency.

(15) **PEAK.** (Model 33.) Displayed when current flow readings are in half-cycle peak amperes (Crest mode).

(16) **RMS.** Displayed when current reading is in amperes rms.

(17) **OFF-SCALE ARROW.** Displayed when bar graph pointer is off scale.



(18) **A**. Displayed when meter is measuring amperes.

(19) **POINTERS**. Displayed to indicate position on bar graph scale. Positions are updated eight times each second.

(20) **0 to 400A**. Numeric reference for the bar graph.

(21) **DIGITAL DISPLAY**. Displays 9999 counts, with two decimal points relative to the two ranges. Display is updated twice each second.

(22) **BATTERY**. Displayed when internal battery needs replacing.

(23) **H**. Displayed when HOLD pushbutton has been pressed.

(24) **RECORD**. (Model 33.) Displayed (blinking) when MAX, MIN, and AVG values are being recorded. Duration of RECORD is limited by battery life.

(25) **BEEPER**. Beeps for pushbutton operation or current overload.

ALIGNMENT MARKS

To meet the meter accuracy specifications, position the conductor within the jaws at the intersection of the indicated marks (Figure 1). If the conductor is positioned elsewhere within the jaws, the maximum additional error introduced is 1.5 percent.

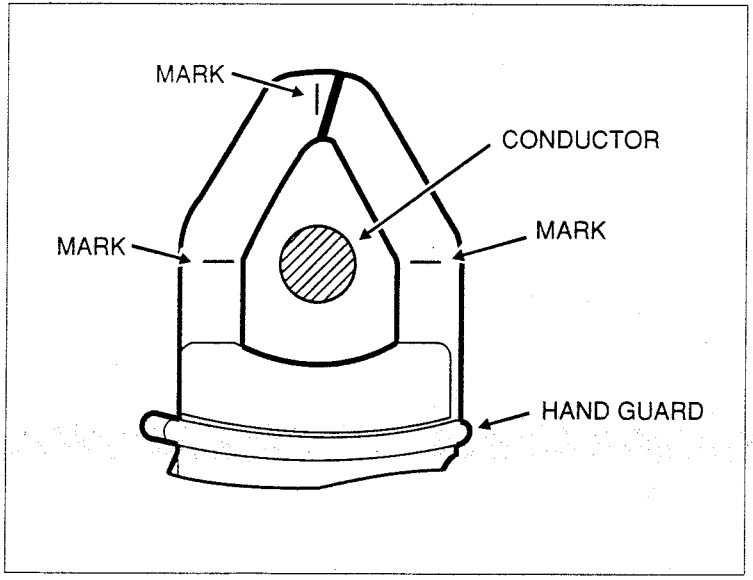


Figure 1. Current Clamp Alignment Marks

METER TUTORIAL

For a thorough understanding of meter operation, complete, in sequence, each of the following pages that apply to your meter model. It is not necessary to make a measurement to learn how to operate the meter. Complete the meter tutorial before attempting any meter applications because there are many meter features and operating sequences that are not readily apparent.

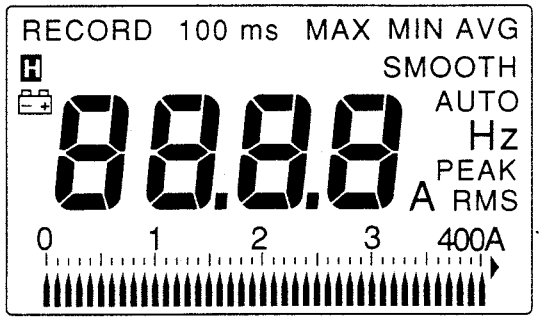
WARNING

TYPICAL METER APPLICATIONS ARE NEAR EXPOSED LETHAL VOLTAGES. USE CAUTION WHEN TAKING MEASUREMENTS. BEFORE THE METER IS CONNECTED TO ANY CIRCUIT, REVIEW THE SAFETY INFORMATION. ALWAYS KEEP HANDS BEHIND THE METER HAND GUARD (SEE FIGURE 1).

Each page in the tutorial indicates which meter models apply. Complete only those pages that correspond to your meter.

POWER UP/SELF TEST

① (Model 31, 33)



To power up and initiate self test, press and hold the ON OFF pushbutton. The meter beeps and provides a full function display (identical for both models). While still pressing the ON OFF pushbutton, observe a bar graph element blinks to indicate battery condition. The "off-scale" arrow blinks for a battery life in excess of 40 hours; a bar graph pointer blinks for a battery life of less than 40 hours (read the scale as 0 to 40 hours for this test). For example, a pointer under the 3 on the scale represents approximately 30 hours of remaining battery life.

Release the ON OFF pushbutton to initialize the meter.

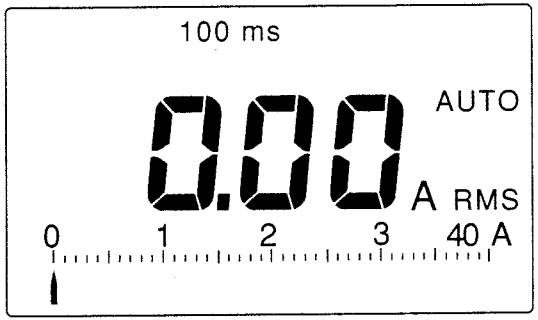
When the battery test gives a reading of only a few hours, replace the battery before using the meter. If the meter does not turn ON, the battery is missing or worn out. See the "Battery Replacement" procedure under "Maintenance."

The meter shuts OFF after 10 minutes if no pushbuttons are pressed (even if it is making a measurement). To disable the auto-off feature, turn the meter ON while holding down the RANGE pushbutton. Release the ON OFF pushbutton, pause until beep, then release the RANGE pushbutton. The meter is in manual range. Press RANGE for 2 seconds to return to AUTO.

(Model 33.) The meter auto-off feature is disabled when you are using the RECORD mode.

AMPERES MEASUREMENT

(2) (Model 31, 33)

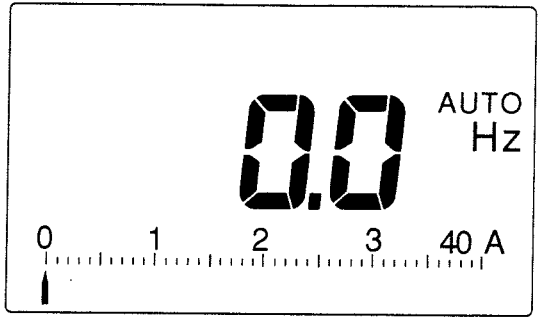


After the meter has been powered up, it is in the amperes mode with 100-ms measurement intervals, and autoranging (AUTO displayed), which automatically selects the proper range for both the bar scale and the digital display. Press the RANGE pushbutton to select a fixed scale instead of autoranging. Observe that each press alternates between the 40A and 400A scales, and AUTO is no longer displayed. OL appears when the reading is beyond the limits of the digital display, for example, 100A on a 40A scale.

To return to autoranging, press the RANGE pushbutton for 2 seconds and then release. The meter acknowledges with a beep and displays AUTO.

FREQUENCY MEASUREMENT

③ (Model 31, 33)



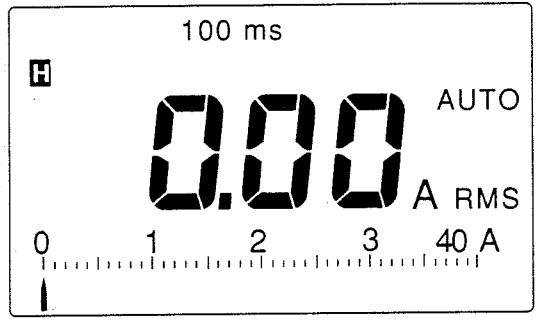
Press the Hz pushbutton to enable the frequency measurement mode. The meter displays Hz and AUTO. The frequency of the current flow is displayed. AUTO (autoranging) is applied to the bar graph, which indicates rms current flow. When in AUTO, frequency measurements use an auto trigger threshold based on one-half of the peak current measurement. This provides the best sensitivity and noise tolerance.

Press the RANGE pushbutton to select a fixed 40A or 400A bar graph display. With a fixed 40A or 400A scale (AUTO is no longer displayed), fixed trigger thresholds are imposed for frequency readings. The thresholds are 6A (40A scale) or 40A (400A scale). When a trigger threshold is not reached, the frequency display is 0.0 Hz.

To return to autoranging, press the RANGE pushbutton for 2 seconds and then release. The meter acknowledges with a beep and displays AUTO. Press the Hz pushbutton to exit the frequency mode.

USING DATA HOLD

④ (Model 31, 33)



Press the HOLD pushbutton to freeze the digital display reading. (HOLD is not applied to the bar graph.) When HOLD is enabled, H is displayed. You can change the resolution of the digital display while in HOLD by pressing the RANGE pushbutton.

When HOLD is used while measuring frequency, RANGE changes can be made. However, this has no effect other than to impose trigger thresholds of 6A on the 40A scale, and 40A on the 400A scale. When HOLD is released, if the trigger threshold is not met, the frequency reading will be 0.0 Hz.

When in the HOLD mode, the meter function cannot be changed from amperes to frequency, or frequency to amperes.

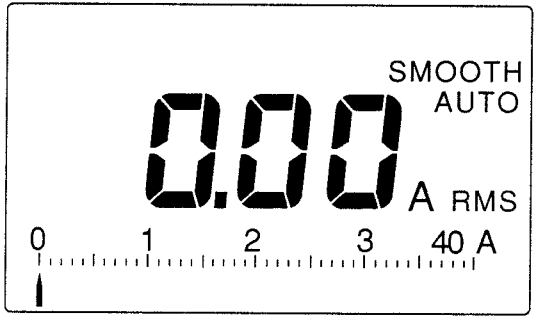
To exit HOLD, press the HOLD pushbutton again and normal operation is resumed.

To return to autoranging, press the RANGE pushbutton for 2 seconds and then release. The meter acknowledges with a beep and displays AUTO.

USING SMOOTH

(5)

(Model 33)



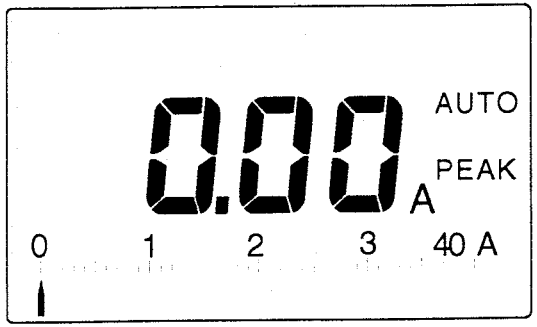
Press the SMOOTH CREST pushbutton once, and observe that SMOOTH is displayed. SMOOTH digitally displays a running average of readings over a 3-second interval to reduce meter fluctuations. The bar graph is unaffected by the SMOOTH function and updates eight times each second.

SMOOTH can be used for either ampere readings or frequency readings.

To exit SMOOTH, press the SMOOTH CREST pushbutton twice when in the amperes mode, or once when in the frequency mode.

USING CREST

⑥ (Model 33)



Press the SMOOTH CREST pushbutton twice and observe that PEAK is displayed. PEAK is available for ampere readings only and cannot be selected when in the frequency mode.

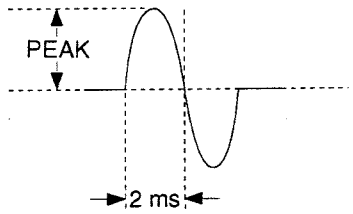
When PEAK is displayed, both the digital display and bar graph measure the half-cycle peak amperes.

The ratio of half-cycle peak amperes to rms amperes is the crest factor:

Crest Factor = Half-Cycle Peak Amperes/RMS Amperes

For linear current flow (no current wave distortion), the Crest Factor is a nominal 1.414. Crest factors other than 1.414 indicate the presence of harmonic current flow. (See the discussion, "Meter Operation and Non-Linear Loads.")

To exit CREST, press the SMOOTH CREST pushbutton once and observe that PEAK is no longer displayed.



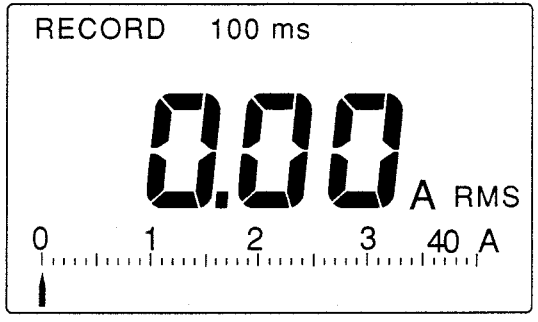
PEAK RECORD MODE
MINIMUM CAPTURE TIME

For minimum capture time, display reading is ≥ 90% of peak.

ENABLING RECORD

(7)

(Model 33)



Press the MIN MAX pushbutton to enable RECORD. RECORD (blinking) is displayed. Beeps indicate the recording of a new maximum or minimum. RECORD can be used in all meter modes, but meter modes cannot be changed while in RECORD (for example, from frequency to amperes).

In the rms amperes mode, the bar graph displays rms current flow plus blinking pointers at the recorded MIN and MAX. In the frequency mode, the bar graph displays rms current flow and no blinking pointers.

In SMOOTH, the smoothed values of rms current flow or frequency are recorded for MIN, MAX, and AVG. The bar graph displays instantaneous values of rms current with blinking pointers for MIN and MAX.

In PEAK (Crest mode), the half-cycle peak current is recorded for MAX. MIN and AVG are not available in PEAK. The bar graph displays a single blinking pointer for MAX. PEAK is not available in the frequency mode.

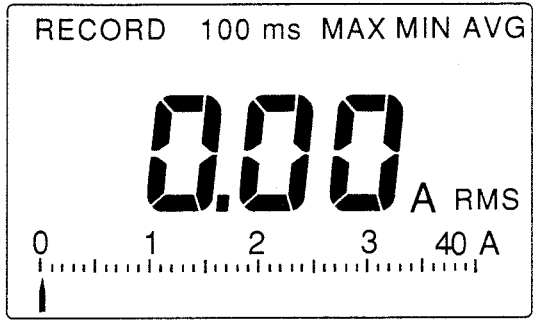
Use the HOLD pushbutton to stop recording (RECORD no longer blinks) and to freeze the values of MIN, MAX, and AVG. Press HOLD again to restart recording. (The values of MIN, MAX, and AVG are not reset, recording simply starts again from where it left off.)

To exit RECORD, press and hold the MIN MAX pushbutton for 2 seconds and then release. The meter acknowledges with a beep and RECORD is no longer displayed.

USING RECORD

(8)

(Model 33)



Press the MIN MAX pushbutton to enable RECORD. Press MIN MAX to cycle through the MAX, MIN, and AVG readings held in memory. (If the meter is in PEAK, only MAX is held in memory). The duration of RECORD is limited by battery life. The MAX reading is the maximum value detected since RECORD started. MIN is the minimum value detected. AVG is calculated continuously from the start of RECORD.

Press the HOLD pushbutton to stop recording and to freeze the values of MIN, MAX, and AVG in memory. Press the MIN MAX pushbutton to cycle through the readings, including a position where the H blinks. Readings may be taken in this mode without disturbing the values held in memory. Press HOLD again to restart recording (RECORD blinks).

When using HOLD and RECORD, remember that when RECORD is blinking, it is recording values; when RECORD is not blinking, it is not recording values. When the H (for HOLD) is blinking, the digital display is showing a real measurement; when H is not blinking, the digital display is showing a recorded measurement. HOLD and RECORD apply to the digital display only. The bar graph continues to show a real measurement at all times.

To exit RECORD (and HOLD if selected), press and hold the MIN MAX pushbutton for 2 seconds and then release. The meter acknowledges with a beep and RECORD is no longer displayed.

To turn off the meter, press the ON OFF pushbutton.

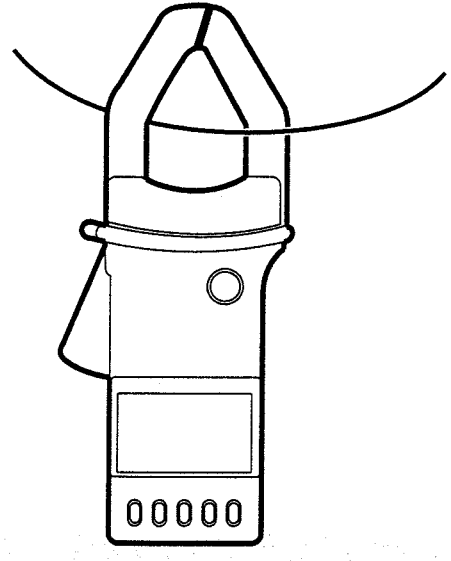
GENERAL

Measure any conductor carrying alternating current (conductor not at a potential above 600V AC or at a frequency above 10 kHz). True rms yields the effective current value (unlike average sensing meters that use an rms scale but are accurate only for current sine waves).

1. Press ON OFF to turn ON the meter.
2. Clamp around a conductor. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
3. Observe the display for true rms current flow.
4. Press Hz to measure frequency.
5. Press HOLD to freeze the digital display.

(Model 33)

6. Press SMOOTH CREST once to smooth readings (SMOOTH displayed) or twice to measure half-cycle peak current (PEAK displayed). The ratio of Half-Cycle Peak Current/RMS Current = Crest Factor. A crest factor other than 1.414 is an indication of non-linear current flow.
7. Press MIN MAX to RECORD readings and to view readings.
8. Press MIN MAX for 2 seconds to clear RECORD.



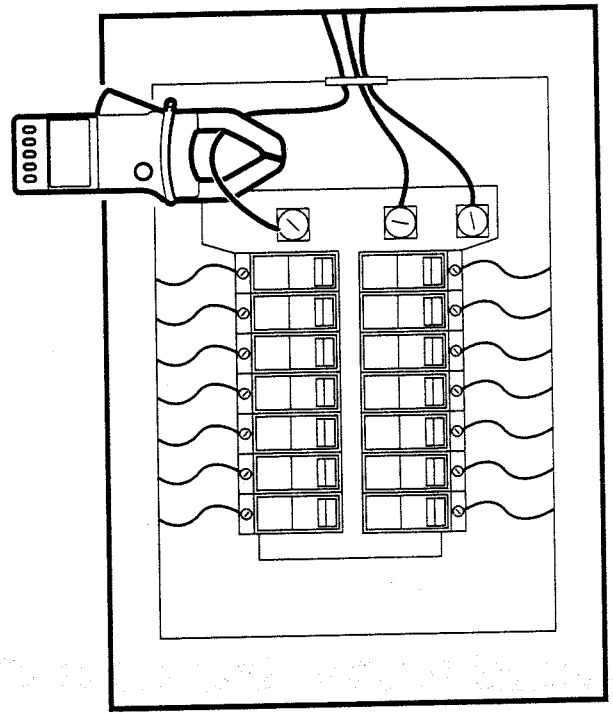
ELECTRICAL PANELS

Measure for excessive current (tripping of circuit breakers) and other general measurement uses such as level of current flow in each circuit.

1. Press ON OFF to turn ON the meter.
2. Clamp around a conductor. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
3. Observe the display for true rms current flow.
4. Press HOLD to freeze the digital display.

(Model 33)

5. Press MIN MAX to RECORD readings and to view minimum, maximum, and average values. The maximum value can be compared to the circuit breaker rating to determine if false tripping is occurring.
6. Press MIN MAX for 2 seconds to clear RECORD.



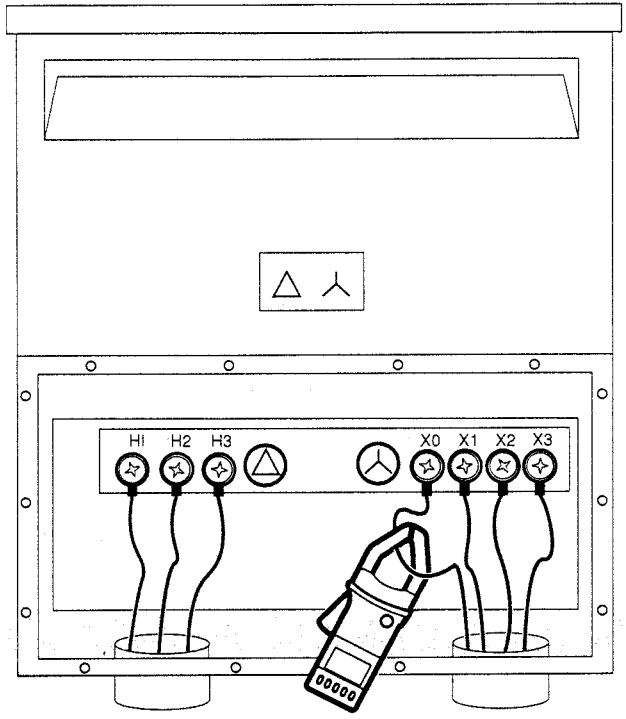
DISTRIBUTION TRANSFORMERS

Measure for excessive current, load balance between phases, true rms and frequency of neutral current. True rms yields the effective current value (unlike average sensing meters).

1. Press ON OFF to turn ON the meter.
2. Clamp around a phase wire. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
3. Observe the display for true rms current flow.
4. Repeat for each phase to observe balance. Unbalanced phases causes large neutral current flow.
5. Clamp around neutral.
6. Observe the display for true rms current flow. Significant flow, with balanced phases, indicates harmonic currents.
7. Press Hz to measure the frequency of neutral. Reading indicates the frequency of the dominant current flow (for a harmonic example, 180 Hz reading in a 60 Hz system).
8. Press HOLD to freeze the digital display.

(Model 33)

9. Press SMOOTH CREST twice to measure half-cycle peak current (PEAK displayed). The ratio of Half-Cycle Peak Current/RMS Current = Crest Factor. A crest factor other than 1.414 is an indication of harmonic current flow.
10. Press MIN MAX to RECORD readings and to view minimum, maximum, and average values.
11. Press MIN MAX for 2 seconds to clear RECORD.



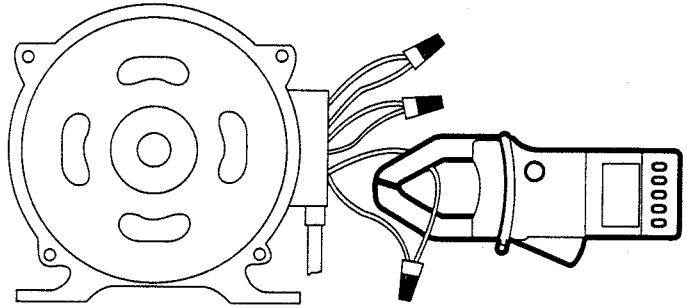
MOTORS

Measure for starting (inrush) current, running current, and current imbalance. Inrush current is typically six times the value of running current, depending on the motor type.

1. Press ON OFF to turn ON the meter.
2. Clamp around a motor phase conductor. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
3. While observing the bar graph, turn ON the motor and note the level of inrush current. (The bar graph response is faster than the digital display.)
4. When the motor reaches the desired speed, observe the running current.
5. Repeat for each motor phase. Unbalanced current may be caused by a voltage imbalance, or a shorted motor winding.

(Model 33)

6. Repeat steps 1 through 3, then press MIN MAX to enable RECORD.
7. Turn ON the motor. When the motor reaches the desired speed, note the upper (blinking) bar on the bar graph (inrush rms current), and the displayed level (running rms current).
8. Press MIN MAX once to view the maximum inrush current (MAX).
9. Repeat step 6 as required.
10. Press MIN MAX for 2 seconds to clear RECORD.



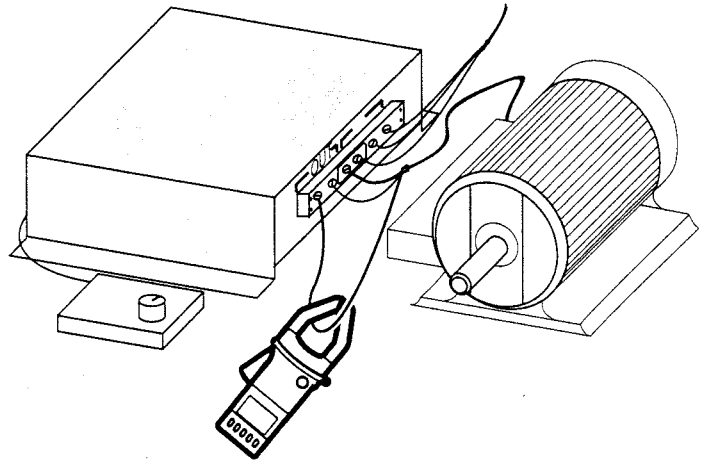
VARIABLE SPEED MOTOR CONTROLLERS

Measure input current, output current and frequency (motor speed). The output current frequency is used to calculate the rotating speed of the motor, while input current frequency is used to measure the frequency of the power line. The frequency of the output current is important because the voltage frequency is often meaningless for motor controller speed calculations. The noise rejection autotrigger feature of the 30-Series meters assures accurate frequency measurements.

1. Press ON OFF to turn on the meter.
2. Clamp around an input or output phase (as required), and run motor at desired speed. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
3. Observe the display for true rms current flow.
4. Measure a controller output phase and use Hz to measure frequency. Nominal motor speed is: RPM=120F/P, where F is the frequency measured, and P is the number of motor poles.

(Model 33)

5. Press MIN MAX to RECORD readings and to view readings.
6. Press MIN MAX for 2 seconds to clear RECORD.



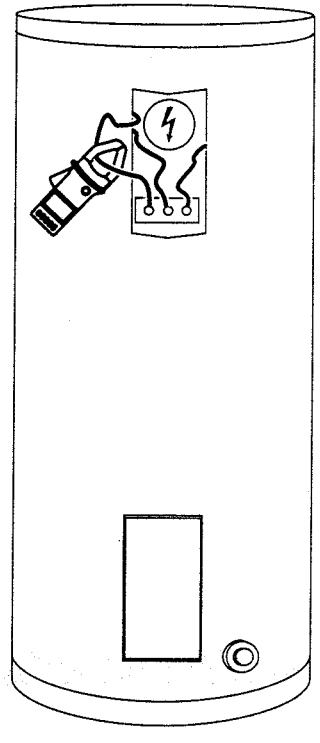
RESIDENTIAL

Measure current flow in electric stoves, heat pumps, water heaters (shown), baseboard heaters, cooling/heating fan motors, and distribution panels for comparison with specified values.

1. Press ON OFF to turn on the meter.
2. Clamp around a "hot" input service conductor. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
3. Observe the display for true rms current flow.
4. Repeat with other conductors (as required.)

(Model 33)

5. Press MIN MAX to RECORD readings and to view MAX, MIN, and AVG readings. Duration of RECORD is limited by battery life.
6. Press MIN MAX for two seconds to clear RECORD.



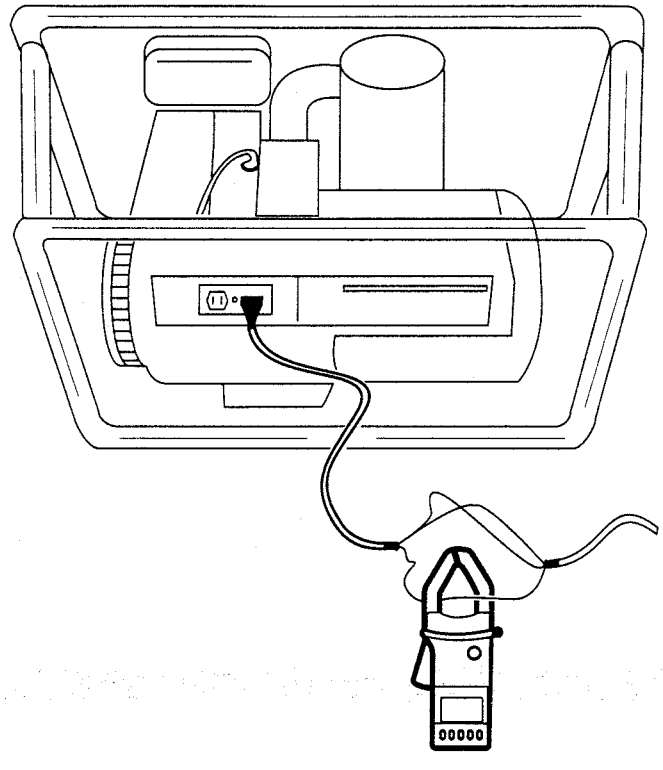
GENERATOR SETS

Measure for excessive current, proper frequency (adjust generator speed), and other general uses. (Small generator shown.)

1. Press ON OFF to turn ON the meter.
2. Connect the generator output to an adapter cord and connect at least a 100-watt load.
3. Clamp around an adapter cord conductor carrying the current, and start the generator. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
4. Observe the display for true rms current flow.
5. Press Hz to measure frequency. Adjust the generator speed control to achieve the correct frequency display. The noise rejection autotrigger feature assures accurate frequency measurements.
6. Press HOLD to freeze the digital display.

(Model 33)

7. Press MIN MAX to RECORD readings and to view readings.
8. Press MIN MAX for 2 seconds to clear RECORD.



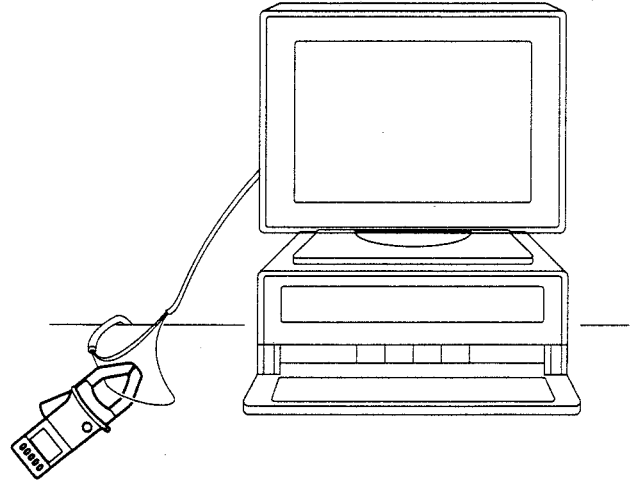
ELECTRONIC EQUIPMENT

Measure input current and crest factor. (Requires an adapter cord.) The equipment must draw at least 0.2A rms or the meter will not respond. Most electronic equipment represent non-linear loads due to their use of switching-type power supplies.

1. Press ON OFF to turn ON the meter.
2. Connect the equipment to an adapter cord.
3. Clamp around an adapter cord conductor carrying the current. Be sure the clamp jaws are securely closed, or measurements will not be accurate.
4. Observe the display for true rms current flow.
5. Press Hz to measure the frequency.
6. Press HOLD to freeze the digital display.

(Model 33)

7. Press SMOOTH CREST twice to measure half-cycle peak current (PEAK displayed). The ratio of Half-Cycle Peak Current/RMS Current = Crest Factor. A crest factor other than 1.414 is an indication of harmonic current flow.
8. Press MIN MAX to RECORD readings and to view readings.
9. Press MIN MAX for 2 seconds to clear RECORD.



METER OPERATION AND NON-LINEAR LOADS

True rms current flow is of primary interest because it directly relates to the amount of heat dissipated in transformers, wiring, and system connections. Most ammeters do not measure true rms current flow. Instead, they measure average current flow, which is displayed on a scale calibrated in rms. These average-sensing meters are accurate only for a pure current sine wave.

Virtually all current waveforms are distorted in some manner. The most common is harmonic distortion caused by nonlinear loads such as personal computers or speed controls for motor drives. An example of linear current flow is shown in Figure 2, and nonlinear current flow is shown in Figure 3. Harmonic distortion causes significant current flow at frequencies that are at odd multiples of the line frequency. For example, with harmonic distortion, current flow at 60 Hz also has significant current flow at 180 Hz (3rd harmonic), 300 Hz (5th harmonic), and so forth. The primary impact of harmonic current flow is on the neutral wires of wye-connected power distribution systems.

A typical U.S. power distribution system uses commercial three-phase 60-Hz power applied to a transformer with a delta-connected primary, and a wye-connected secondary. The secondary typically provides 120V ac from phase to neutral, and 208V ac from phase to phase. Historically, the only problem facing the electrical system designer was to balance the loads for each phase. In a correctly balanced system, the vector addition of the currents in the transformer neutral wire was zero (or quite low as perfect balance was rarely achieved). Devices connected to such a system consisted of incandescent lighting, electrical heating devices, small motors, and other devices that presented linear (and moderately inductive) loading. The result was a current flow in each phase that was essentially sinusoidal, and a low neutral current that was, of course, at a frequency of 60 Hz.

This scenario is changed by the connection of devices that cause nonlinear loading and subsequent nonlinear current flow. Devices such as fluorescent lighting, computers, video terminals, television sets, microwave ovens, and equipment using SCR or TRIAC controllers, have the common characteristic of drawing line current for only a fraction of each cycle. This generates odd harmonics of the 60-Hz line frequency. Therefore, the current in the transformer contains not only a 60-Hz component, but a 180-Hz component (3rd harmonic), a 300-Hz component (5th harmonic), and other significant harmonic components up to the 15th harmonic (900 Hz) and beyond.

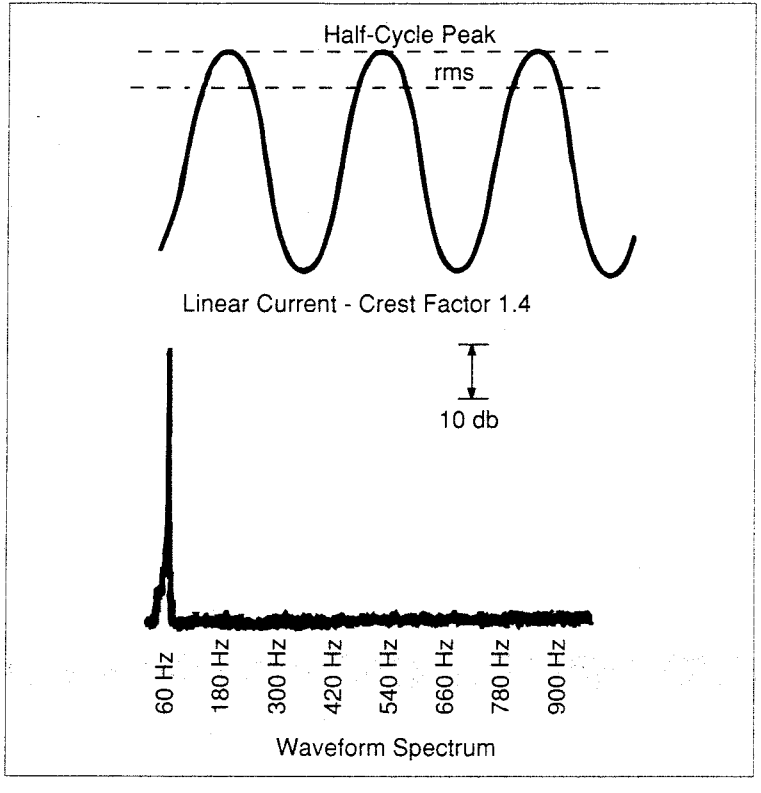


Figure 2. Linear Current Waveform (60 Hz)

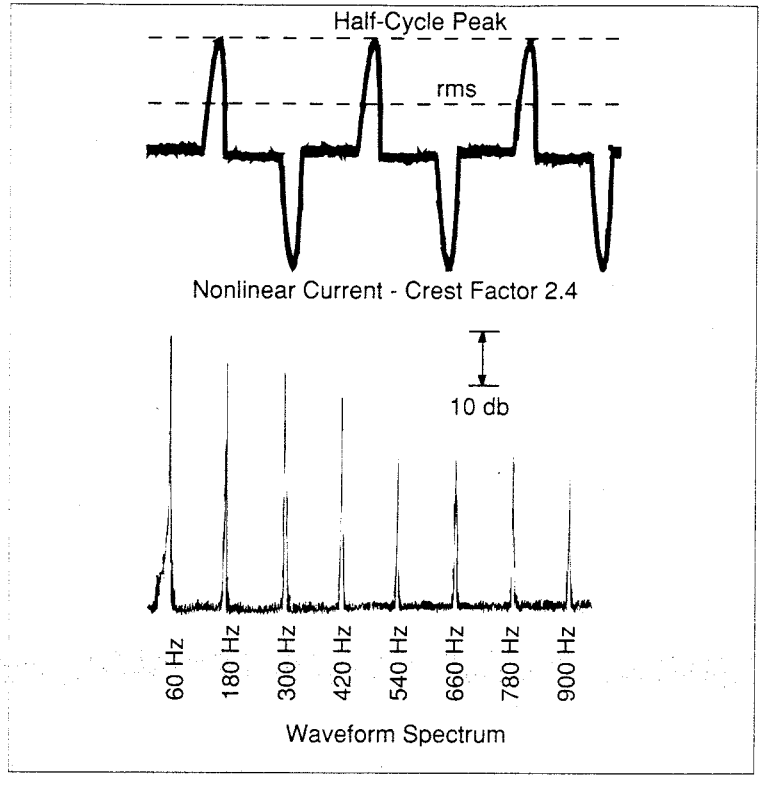


Figure 3. Nonlinear Current Waveform (60 Hz)

In a correctly balanced power distribution system feeding nonlinear loads, the vector addition of the 60-Hz currents and some of the harmonics in the distribution transformer neutral line may still be quite low. However, not all the harmonic currents cancel. In particular, the odd multiples of the 3rd harmonic (3rd, 9th, 15th, etc.) add together in the neutral. These harmonics, called the "triplens," can form a total rms current in the transformer neutral wire that is typically 130% of the total rms current measured in any individual phase, with a theoretical maximum of 173%. For example, phase currents of 100 amperes may cause harmonic current flow in the neutral of 130 amperes. Most often, the dominant current flow in the neutral is the 3rd harmonic, with a frequency reading of 180 Hz.

The existence of harmonic current flow causes three immediate considerations for the electrical system designer. First, the ac neutral wires must be of sufficient gauge to allow for harmonic current flow. Second, if the distribution transformer is not harmonic rated, it must have additional cooling to survive operation at its rated capacity. This is because harmonic current flow in the transformer secondary neutral wire is reflected to the delta-connected primary winding, where it simply circulates. This circulating harmonic current heats up the transformer; hence, the requirement for additional cooling or, alternately, for derating the transformer. Third, phase current harmonics are reflected to the transformer primary winding where they continue back towards the power source. This can cause distortion of the voltage wave, and since the harmonics are at a frequency higher than 60 Hz, any power factor correction capacitors on the line represent a lower impedance path for the harmonics, and the capacitors are easily overloaded.

The ability of the Fluke 30-Series Ammeters to measure true rms current flow and frequency allows an analysis of components such as distribution transformers and power-factor-correction capacitors.

The additional features of the Model 33 Ammeter allow the measurement of the half-cycle peak current (crest) using the CREST current feature. This allows the determination of the crest factor:

Crest Factor = Half-Cycle Peak Current/RMS Current

The crest factor is a convenient term that gives an indication of current flow nonlinearities. For a sine wave current, the crest factor is 1.414, that is, a half-cycle peak (crest) current of 1.414 amps is equal to 1.0A rms. Values other than 1.414 indicate the presence of harmonic current flow.

INTRODUCTION

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING PROCEDURES UNLESS YOU ARE QUALIFIED TO DO SO. READ THE INFORMATION TITLED "SAFETY" AT THE BEGINNING OF THIS MANUAL BEFORE PROCEEDING.

Repairs or servicing not covered in this manual should be performed only at Fluke Service Centers. A meter under warranty will be promptly repaired or replaced (at Fluke's option) and returned at no charge. See the registration card for warranty terms. If the warranty has lapsed, the meter will be repaired and returned for a fixed fee. A list of U.S. and international service centers is at the back of this manual.

To assure continued safety of the meter, inspect the meter before use for cracks or missing portions of the insulating cover, or for loose or weakened components. Pay particular attention to the insulation surrounding the clamp jaws and clamp lever. Any meter that fails this inspection should be made inoperative by taping the clamp shut to prevent unintended operation.

To assure meter calibration, complete the calibration procedure in this manual annually.

To check the meter performance, complete the "Calibration and Performance Check" procedure.

SERIAL NUMBER LOCATION

The seven-digit serial number is stamped on the back of the unit. The serial number should be used when ordering parts or requesting service/calibration information.

BATTERY REPLACEMENT

The meter is powered by a single 9V battery (NEDA Type 1604A, 6LF22, or 006P). Alkaline or other long-life batteries are recommended. Referring to Figure 4, use the following procedure to replace the battery:

1. Unclamp the meter from any conductor, and turn it OFF by pressing the ON OFF pushbutton.

2. Place the meter face down on a nonabrasive surface and completely loosen the two rear panel screws with a Phillips-head screwdriver.

3. Grasp the bottom of the rear cover and lift it free of the case.

4. Lift the battery from the case, and carefully disconnect the battery connector leads.

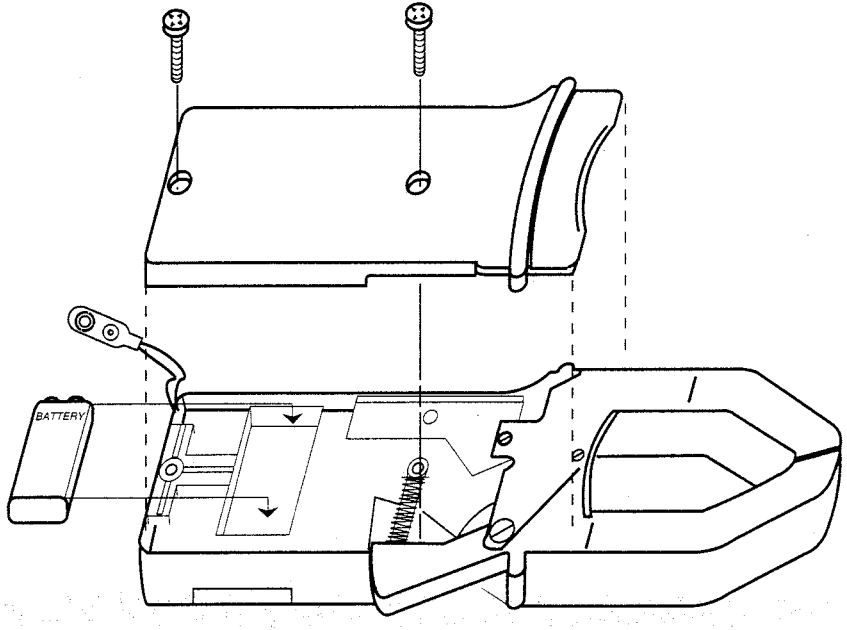


Figure 4. Battery Replacement

5. Snap the battery connector leads to the terminals of a new battery and insert the battery into position. Arrange the battery leads so that they will not be pinched between the case bottom and case top.

6. Replace the rear cover, ensuring it slips beneath the hold-down lip (next to the jaws) and fits securely into position.

7. Install the two securing screws.

CLEANING AND STORAGE

Periodically wipe the case with a damp cloth and detergent; do not use abrasives or solvents. Open the clamp jaws and wipe the magnetic pole pieces with a lightly oiled cloth. Do not allow rust or corrosion to form on the pole pieces. If the meter is not to be used for periods of longer than 60 days, remove the battery and store it separately.

CALIBRATION AND PERFORMANCE CHECK

The meter should be calibrated annually. The meter can be returned to a Fluke Service Center for calibration, or it can be calibrated using the procedure below. Complete calibration of the meter is done by adjusting the single potentiometer shown in Figure 5. If the performance of the meter is in doubt, a qualified technician should conduct the calibration procedure to verify the meter accuracy.

Equipment Required for Calibration

Table 1 lists the equipment required to perform the calibration procedure.

Table 1. Calibration Equipment

INSTRUMENT TYPE	RECOMMENDED MODEL
Calibrator	Fluke Model 5700A
Transconductance Amplifier	Fluke Model 5220A
Small Insulated Screwdriver	Spectrol
Magnet Wire Coil 50 Turns of #14 single conductor copper wire 4.0 inch diameter wound in a 270° toroid configuration.	(See Figure 7)

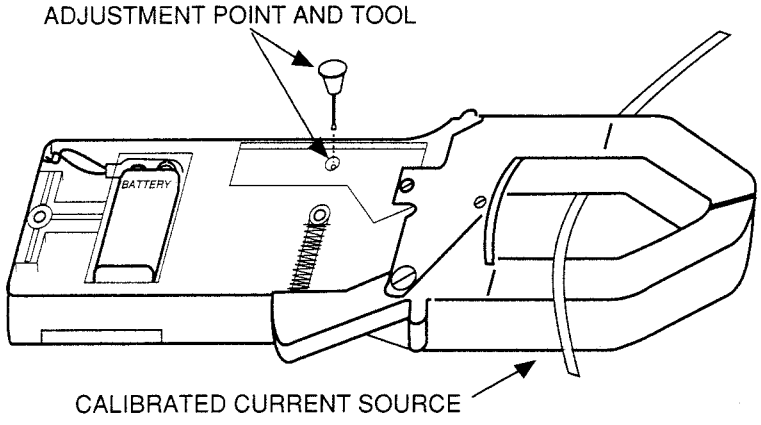


Figure 5. Calibration Adjustment Location

Step-by-Step Adjustment Procedure

Complete the following procedure to calibrate the meter. Refer to Figure 5 for the adjustment location, and Figure 6 for the test equipment configuration. Before starting the procedure, be sure the battery check indicates "above scale" at power up (see "Meter Tutorial"). This procedure uses a 50-turn toroid coil, which can be constructed as shown in Figure 7.

1. Connect the test equipment for the calibration procedure, including a 50-turn toroid coil, as shown in Figure 6.

2. Power up the test equipment and let it stabilize for 30 minutes.

3. While the test equipment is warming up, use a Phillips-head screwdriver to remove the back from the 30-Series meter to be calibrated. Wrap a rubberband around the case and battery to keep the battery in place. Note the location of the calibration point (Figure 5).

4. After the 30-minute stabilization period, set the 5700A calibrator controls to generate an output voltage of 6V ac at 50 Hz. Enable the 5220A transconductance amplifier for operation, which will, on a 1:1 ratio, convert an input 6V ac into an output 6A ac. This produces 300-amp turns in the center conductor bundle of the toroid coil (6A x 50 Turns).

5. Clamp the meter around the toroid coil center conductor bundle, positioning at the alignment marks (Figure 1). Turn ON the 30-Series meter, using the ON OFF pushbutton, and insert a small insulated screwdriver into the calibration potentiometer.

6. Adjust the calibration potentiometer for a measurement of 300.0A, then remove the adjustment tool.

7. Referring to Table 2, set the 5700A Calibrator controls as shown, and verify the measurements are between the specified values. If any ampere measurement is out of specification, the meter must be returned to the factory for repair. There is no adjustment for frequency measurements. If a frequency measurement is out of specification, the meter must be returned to a Fluke Service Center for repair.

8. Unclamp the meter and turn it OFF using the ON OFF pushbutton. Remove the rubberband securing the battery and reinstall the meter rear cover.

9. Power down the test equipment. This completes the meter calibration.

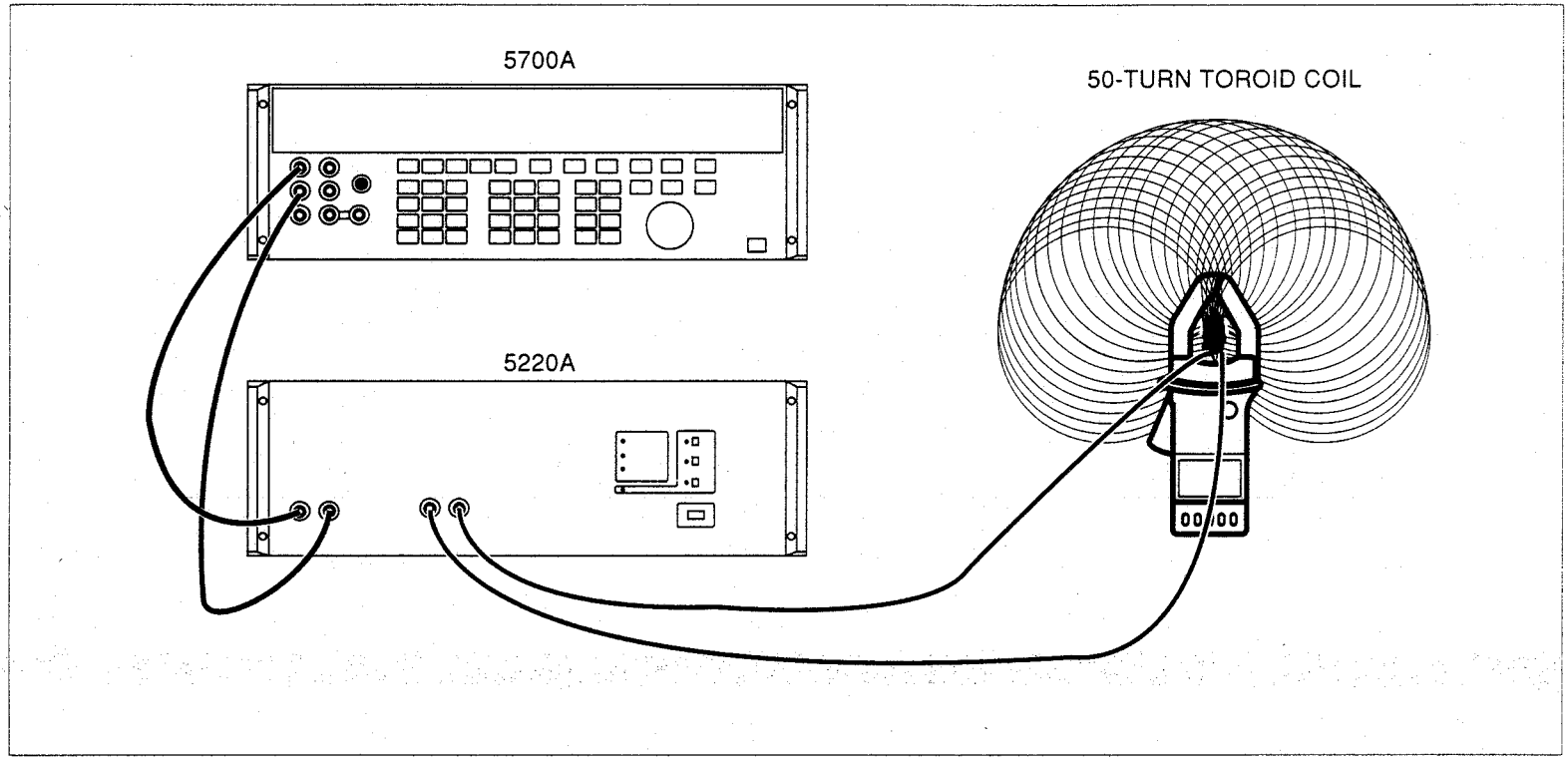


Figure 6. Calibration Procedure Equipment Configuration

Construction Procedure for 50-Turn Toroid Coil

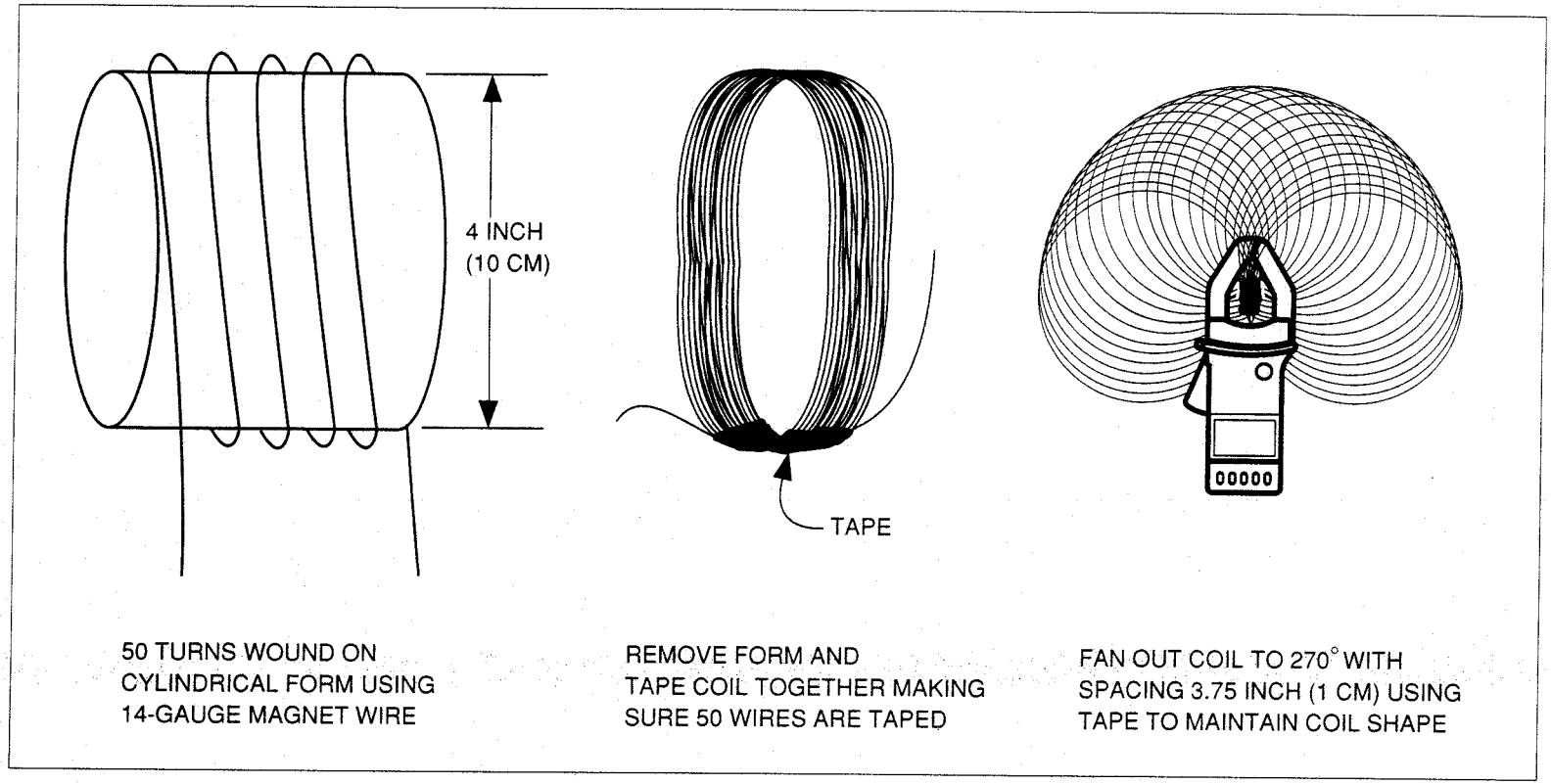


Figure 7. Construction Procedure for 50-Turn Toroid Coil

Table 2. Performance Test Measurement Points

5700A SETTINGS		RMS AMPS MEASURED	LOW LIMIT RMS AMPERES	HIGH LIMIT RMS AMPERES	LOW LIMIT PEAK AMPERES	HIGH LIMIT PEAK AMPERES	LOW LIMIT FREQ. Hz	HIGH LIMIT FREQ. Hz
VOLTS AC	FREQ. Hz							
0.02	50	1.00	0.78	1.22	1.07	1.76	49.6	50.4
0.04	50	2.00	1.76	2.24	2.44	3.21	49.6	50.4
0.08	60	4.00	3.72	4.28	5.19	6.13	59.6	60.4
0.16	60	8.00	7.64	8.36	10.67	11.95	59.6	60.4
0.20	400	10.00	9.30	10.70	13.28	15.01	398.9	401.1
0.40	400	20.00	18.90	21.10	26.85	29.72	398.9	401.1
0.80	50	40.0	39.0	41.0	54.6	58.6	49.6	50.4
1.60	50	80.0	78.2	81.8	109.4	116.8	49.6	50.4
2.00	60	100.0	97.8	102.2	136.9	146.0	59.6	60.4
4.00	60	200.0	195.8	204.2	274.1	291.6	59.6	60.4
8.00	60	400.0	391.8	408.2	548.6	583.0	59.6	60.4

Notes: All readings taken with autoranging active (AUTO displayed). Values for PEAK AMPERES assume a Crest Factor of 1.414.

TROUBLESHOOTING

Use the troubleshooting guide (Table 3) for hints regarding problems with meter operation. See the "Meter Tutorial," as required.

Table 3. Troubleshooting Guide

SYMPTOM	POSSIBLE CAUSE
Meter doesn't turn ON.	Battery missing, installed incorrectly, or voltage is low.
Short battery life.	Use alkaline or other long-life battery.
Inaccurate or missing ampere readings.	Verify correct operating mode and current flow is at least 0.2A. Verify the magnetic mating surfaces are clean and that the jaws close securely. Be sure conductor is centered at the alignment marks.
Inaccurate or missing frequency readings.	Be sure you understand what is being measured. Dominant harmonic current flow will cause readings at odd multiples of line frequency. Verify meter is in AUTO for rms bar graph display; otherwise, current thresholds are required to read frequency.
Unable to read DC amperes.	The 30-Series Ammeters read ac amperes only. For measuring dc amperes, use a Fluke 80i-Series Current/Power Probe.

REPLACEMENT PARTS

Replacement parts are shown in Figure 8 and listed in Table 4. To order replacement parts in the USA, call 1-800-526-4731. To order outside the USA, contact the nearest Service Center.

SERVICE

To return the meter for service, pack it securely in its original shipping container and forward it, postage paid, to the nearest Service Center (see list at back of manual). Include a description of the malfunction. Fluke assumes no responsibility for damage in transit.

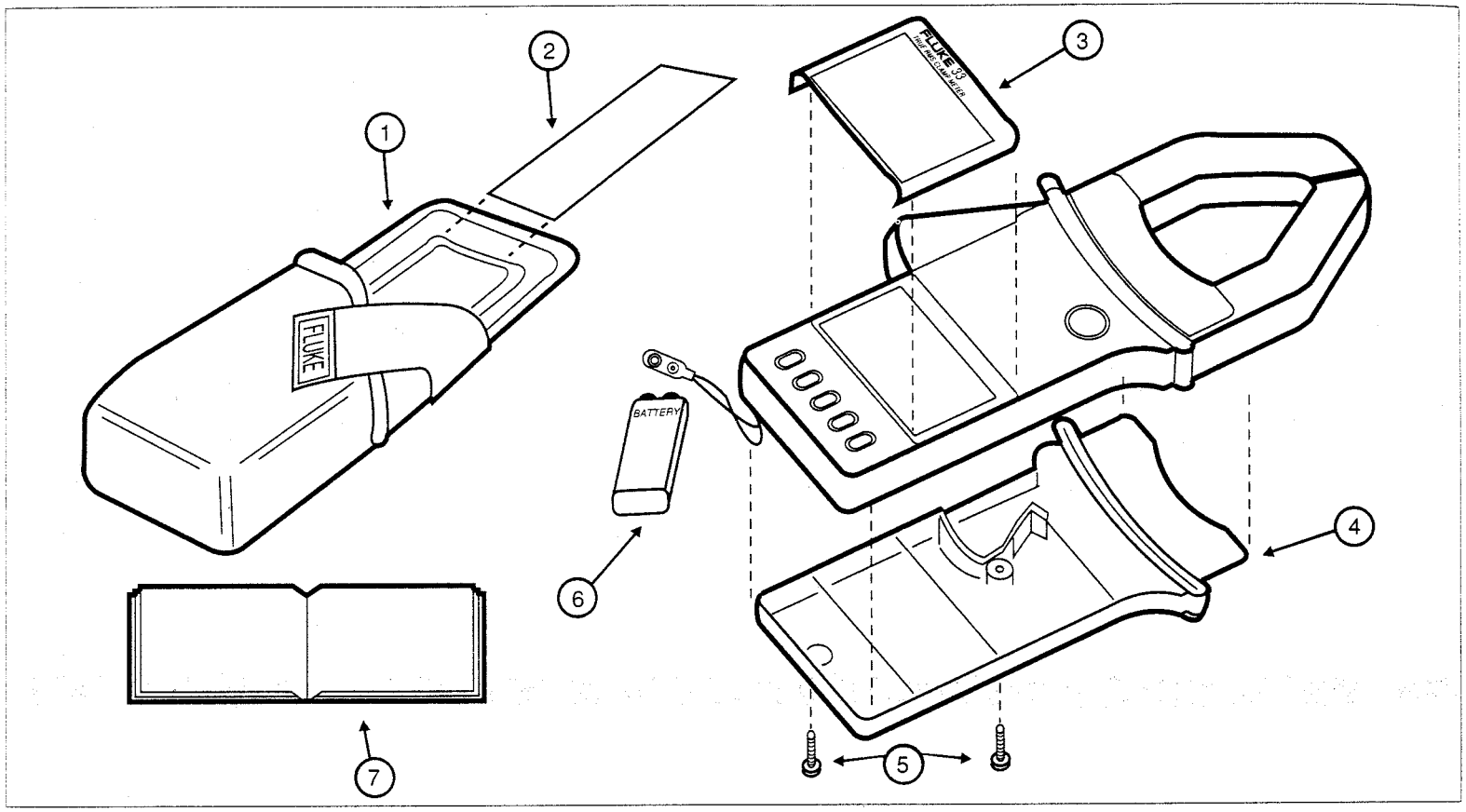


Figure 8. Replaceable Parts

Table 4. Replaceable Parts

ITEM	DESCRIPTION	FLUKE PART NUMBER	QUANTITY
1	Holster	896105	1
2	Card, Quick Reference	896121	1
3	Lens, LCD	896246 (Model 31) 896238 (Model 33)	1
4	Cover, Rear	896241	1
5	Screw, Case (metric)	896233	2
6	Battery, 9V Alkaline, 6LF22	614487	1
7	Manual, Instruction	896118 (English) 896113 (German/French/Italian/Spanish)	1

SPECIFICATIONS
RMS Amperes

RMS AMPERES (See Note 1)				
DISPLAY RANGE AMPS RMS	MEASUREMENT RESOLUTION AMPS RMS	ACCURACY (See Note 2)		
		BASIC	EXTENDED	LOW FREQUENCY
		45 to 65 Hz	30 to 45 Hz, 65 to 1000 Hz (See Note 3)	20 to 30 Hz (See Note 4)
0.30 to 99.99 (40A Scale)	0.01	±(2% + 20)	±(4% + 30)	±(8% + 30)
0.3 to 399.9 (400A Scale)	0.1	±(2% + 2)	±(4% + 3)	±(8% +3)
400.0 to 700.0 (400A Scale)	0.1	±5%	±7%	Not Specified

Note 1. Sine wave, measured with conductor centered at alignment marks, and reference conditions of 18 to 28 degrees C, relative humidity less than 90%, and battery life indication greater than 40 hours on meter power up.

Note 2. Accuracy is ± ([% of reading] + [number of least significant digits]).
For non-sinusoidal waveforms, add crest factor. (See General Specifications.)
RMS MIN/MAX: Add 10 Counts.

Note 3. 1A and above, 30 to 45 Hz.

Note 4. Model 33 AVG only, 2.5A and above.
RMS MIN MAX: Add 2% of reading.

HALF-CYCLE PEAK AMPERES (CREST MODE) (See Note 1)				
DISPLAY RANGE AMPS PEAK	MEASUREMENT RESOLUTION AMPS PEAK	ACCURACY		
		BASIC	EXTENDED	LOW FREQUENCY
		45 to 65 Hz	30 to 45 Hz, 65 to 1000 Hz (See Note 2)	20 to 30 Hz (See Note 3)
0.4 to 99.99 (40A Scale)	0.2	±(3% + 30)	±(4% + 30)	±(4% + 40)
0.4 to 399.9 (400A Scale)	2	±(3% + 3)	±(4% + 3)	±(4% + 4)
400.0 to 599.9 (400A Scale)	4	±3%	±4%	±4%
600.0 to 999.9 (400A Scale)	4	±7%	±7%	±7%

Note 1. Sine wave, measured with conductor centered at alignment marks, and reference conditions of 18 to 28 degrees C, relative humidity less than 90%, and battery life indication greater than 40 hours on meter power up.

Note 2. 1A and above, 30 to 45 Hz.

Note 3. 2.5A and above.

FREQUENCY (See Note 1)			
DISPLAY RANGE	**MEASUREMENT RANGE**	**RESOLUTION**	**ACCURACY**
Manual (See Note 2)	0.5 to 999.9 Hz	0.1	±(0.2% + 3)
Autorange (See Note 3)	1000 to 9999 Hz	1	±(0.2% + 3)

Note 1. Measured with conductor centered at alignment marks, and reference conditions of 18 to 28 degrees C, relative humidity less than 90%, and battery life indication greater than 40 hours on meter power up.

Note 2. Trigger Threshold, 10 Hz to 1000 Hz, 40A Range - 6A RMS or more will trigger. 400A Range - 40A RMS or more will trigger.

Note 3. Trigger Level, 10 Hz to 1500 Hz, 0.3A RMS or more, self-adjusting between 1/3 Peak and 1/2 Peak current.

GENERAL

Measurement Limits	True rms	0.2A to 700A (ac component only - no dc component)
Overrange Limits	True rms (45 Hz to 1 kHz)	400A to 700A; 10 min on, 10 min off (50%) 700A to 1000A; 5 min on, 20 min off (20%)
	Below 45 Hz	Reduces to 150A max @ 10 Hz
	Peak	1000A
Maximum Conductor Voltage	600V rms	
Frequency Range for Current Measurements	10 Hz to 2 kHz	
Frequency Range for Frequency Measurements	0.5 Hz to 10 kHz	
Crest Factor, Continuous Waveform (45 Hz to 65 Hz, less than 1000A Peak)	1.4 to 2.0, add 20 digits to accuracy below 100A 2.0 to 3.0, add 1% to accuracy (+20 digits below 100A) 3.0 to 5.0, add 2% to accuracy (+20 digits below 100A)	
Adjacent Conductor Effect	1 percent of current in adjacent conductor, maximum	
Operating Temperature	-10 to 55 degrees C	
Operating Humidity	0 to 90% @ 40 degrees C; 75% @ 50 degrees C	
Storage Temperature	-40 to 70 degrees C	

GENERAL (CONTINUED)	
Battery	9.0V Alkaline IEC 6LF22 or NEDA 1604A
Battery Life	80 Hours Typical (Alkaline Battery)
Safety Standards (Appropriate Parts)	UL1244, IEC 348/1010, IEC 664 Installation Category III, CSA C22.2 No. 231, ANSI/ISA S82, VDE 0411
Shock and Vibration	Meets IEC 68-2-13, 68-2-27
Warranty	One Year, Parts and Labor (see Warranty Card for details)