HIOKI

INSTRUCTION MANUAL

3108-01, 3109-01

DC CLAMP ON HiTESTER

CONTENTS

Introduction

Thank you for purchasing this HIOKI 3108-01・3109-01 DC CLAMP ON HiTESTER. "To get the maximum performance from the unit, please read this manual first, and keep this at hand.

Safety

- In some cases, industril power lines may carry voltage spikes of several times the normal supply voltage. When measuring such power lines, there is a danger of electric accidents that may result in injury or death. For safety reasons, this tester should not be used to measure industrial power lines carrying more than 250 V. When measuring such industrial power lines, always use a tester with built-in overcurrent protection to guard against short circuits.(Suitable tester:3008, 3255)
- This tester cannot be used to measure current in high-voltage lines (industrial power lines carrying voltages of 500 V or more). If this tester is used to measure current in high-voltage lines, a short circuit or accident resulting in injury or death could occur.

NOTE

The term "industrial power line" refers to electrical lines that supply power to electrical equipment and industrial machinery in factories, buildings, etc. It does not include indoor lines in ordinary residences(lines protected by fuses or circuit breakers.)

- To avoid short circuits and accidents that could result in injury or death, use clmap testers only with power lines carrying 500 VAC or less.
- To avoid short circuits and accidents that could result in injury or death, when the tips of jaws are open, do not use on bare conductors.(The core and shield case are not insulated.)

⚠ DANGER	The voltage terminals and the output terminals, also the output terminals and the AC adapter jack are not insulated. Handle these items carefully in order to avoid electric shock or a short circuit accident.

This Instruction Manual provides information and warnings essential for operating this equipment in a safe manner and for maintaining it in safe operating condition. Before using this equipment, be sure to carefully read the following safety notes.

	In the manual, this mark indicates explanations which it is particularly importnat that the user read before using the equipment.

The following symbols are used in this Instruction Manual to indicate the relative importance of cautions and warnings.

⚠ DANGER	Indicates that incorrect operation presents extreme danger of accident resulting in death or serious injury to the user.
⚠ WARNING	Indicates that incorrect operation presents significant danger of accident resulting in death or serious injury to the user.
⚠ CAUTION	Indicates that incorrect operation presents possibility of injury to the user or damage to the equipment.
NOTE	Denotes items of advice related to performance of the equipment or to its correct operation.

Notes on Use

⚠ DANGER	Always connect the clamp sensor, or the end of voltage lead to the secondary side of a breaker. On the secondary side of a breaker, even if the lines are shorted the breaker can trip and prevent an accident. On the primary side, however, the current capacity may be large, and in the event of a short-circuit there may be a serious accident.
⚠ WARNING	• When working with live circuits, take all suitable precautions against accidents, including the use of electrical safety gear such as rubber gloves, rubber boots, and safety helmets. • To prevent electric shock, do not allow the unit to become wet and do not use the unit when your hands are wet.
⚠ CAUTION	• Do not store or use the unit where it will be exposed to direct sunlight, high temperatures, high humidity, or condensation. If exposed to such conditions, the unit may be damaged, the insulation may deteriorate, and the unit may no longer satisfy its specifications. • To avoid damage to the unit, do not subject the equipment to vibrations or shocks during transport or handling. Be especially careful to avoid dropping the equipment. • Note that the unit may be damaged if current in excess of the measurement limit is input. • Before using the unit, make sure that the sheathing on the leads is not damaged and that no bare wire is exposed. If there is damage, using the unit could cause electric shock. Replace the lead with the specified 9060.

NOTE • Accurate measurement may be impossible in locations subject to strong external magnetic fields, such as transformers and high-current conductors, or in locations subject to strong external fields, such as radio transmission equipment.
• If the split face of the core becomes dirty, clean it by wiping lightly with a soft cloth.
• Be careful to avoid dropping the clamps or subjecting them to other mechanical shock. This can damage the mating surfaces in the core, adversely affecting measurement.

Inspection

When the unit is delivered, check and make sure that it has not been damaged in transit. In particular, check the accessories, panel switches, and connectors. If the unit is damaged, or fails to operate according to the specifications, contact your dealer or HIOKI representative.

1. Prodct Overview

The 3108-01 / 3109-01 is a compact, portable instrument designed to take AC/DC current and voltage measurements from current-carrying power lines. Its clamp on sensor feature means that the equipment does not require shutting down, nor do conductors require cutting for the measurement set up.

The sensor portion of the clamp consists of a magnetic circuit developed by HIOKI using high-permeability magnetic materials and Hall elements. Sensor circuit linearity is superior, and measurement error induced by the positioning of the conductor within the clamp core is reduced to a minimum.

The portability and convenience of battery operation makes the instrument ideal for various inspection-maintenance applications in electrical systems of facilities engaged in

chemical production, automotive production and repair, welding, and railroad-related industries.
Output terminals are provided on the instrument for system expansion, increasing substantially the range of application possibilities through the use of recorders and waveform monitors, etc.

2. Features

(1)Extremely wide measurement range capability(10 to 250 A range and 100 to 2500 A range). Additionally, measurements are easily made by simply clamping the sensor over current-carrying conductors. No need to interrupt power to equipment under test.
(2)Good frequency response characteristics mean that AC current at frequencies ranging from 20 to 500 Hz can be measured with virtually no error.
(3)The unique construction of the clamp on sensor minimizes the effect of conductor positioning within the clamp core. The meter reading is accurate within ±1% at any conductor position within the jaws of the clamp.
(4)Thorough shielding allows the instrument to be used in the presence of high-current conductors with minimum affect on the reading due to magnetic fields.
(5)Degaussing not required. The high permeability-low coercivity magnetic materials used in the construction of the clamp core means that DC current reading are minimally affected by core magnetization.
(6)True RMS readings available via an adapter for accurate measurements of current waveforms containing the type of distortion typically produced in thyristor-control circuits.
(7)Two versatile output terminals are provided on the instrument for connecting a recorder(AC), or waveform monitor(DC). This convenient function permits transients and other phenomena to be monitored, or recording

made for permanent records.

(8)AC/DC superimposed components may be measured separately to eliminate errors inherently produced in such cases.

(9)DC current flow polarity may be instantly detected, making the instrument a valuable asset in analyzing unknown or complex circuits.

(10)A center-zero function permits DC function in circuits varying between positive(+) and negative(−) values to be measured directly with the flick of a switch.

(11)Thorough overcurrent protection extends to both the clamp sensor and the internal meter circuitry for instrument safety.

(12)AC plus DC voltage measurement capability makes the instrument valuable as an all-around assistant in power line maintenance and inspection programs.

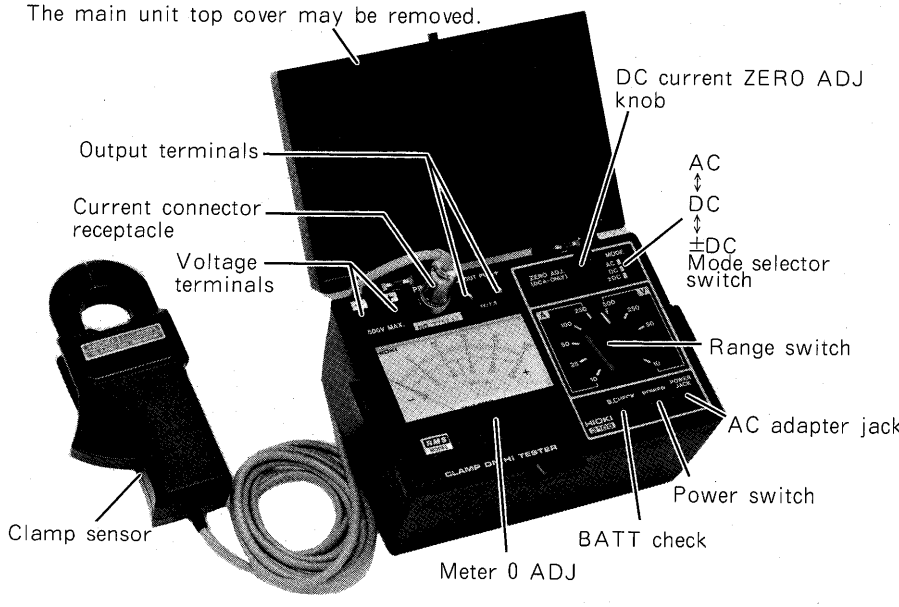
(13)Safety-first design. All test lead inputs, voltage and output terminals are designed to minimize the chance of operator contact.

(14)Dual-power source method permits the meter to be operated by internal batteries, or by optional 9035 AC ADAPTER.

(15)The compact, lightweight design of the instrument means that it can be used for field service applications, or wherever measurements are required.

3. Names of Parts

The 3108-01 is shown in the figure below. The range scale and clamp on sensor for the 3109-01 are slightly different.



4. Specifications

Model No.	3108-01	3109-01
AC／DC Current Range	10,25,50,100,250 A	100,250,500,1000, (2500)A *2000 A Max.
AC／DC Voltage Range	10,25,50,250,500 V(Input resistance:6 kΩ/V)	
Accuracy (23±5℃)	±2.5% f.s.(1500～2000 A:±5% F.S.)	
Maximum Circuit Voltage	500 Vrms	
Output Terminals	1V output at full-scale in each range. (DC:MONITOR;AC:RECORD OUT)	
Clamp on Sensor	9001	9002
Clamp Jaw Diameter	30 mm Max.	46 mm Max.
Dimensions (Clamp)	85(W)×175(H)×40(D)mm	90(W)×180(H)×40(D)mm
Mass／Cable length(Clamp)	Approx.600 g/2m	Approx.650 g/2m

Crest Factor : 3 or less

Frequency Characteristics(AC current) : At frequencies 20 to 500 Hz, Within ±1% of 50/ 60 Hz scale accuracy.

Effect of External Magnetic Field(400 A/m)

The 3108-01:Less than 0.1A equivalent.

The 3109-01:Less than 0.2A equivalent.

Effect of Conductor Positioning : Less than ±1% at any position within the clamp core.

Temperature Characteristics:Less than ±1.5%, 0 to 40℃

Operating Temperature and Humidity range : −10 to 50℃ 85% RH or less (with no condensation)

Dielectric Strength:2 kVAC, 50/60 Hz, for one minute(between

voltage input pins and case, clamp sensor and case, output terminal and case)
Power Source:6VDC, R14P battery ×4 (continuous life 29 hours)
Power Consumption : approx. 360mW
Dimentions/Mass : 200(W)×115(H)×135(D)mm/aoorox. 1.25kg
Accessories : Clamp on sensor, 9083 CARRYING CASE, 9060 TEST LEAD, Instruction manual, R14P batteries 4
Optional Accessories : CT101A LINE SPLITTER

5. Basic Operating Principle

The basic principle of the 3108-01 and the 3109-01 is illusrated in Figure 5-A and B. The clamp-jaw portion consists of core constructed from high-permeability magnetic materials and a Hall element sensor. Now, if i is considered as the current flowing through the conductor under test, and the opposition presented to magnetic flux flow in the gap cut through the core and sensor element is represented as Rc and Rg respectively, then magnetic flux flow (Φ) across the gap can be calculated as:

$$\Phi = i/(Rg + Rc)$$

Rg:Gap reluctance
Rc:Core reluctance

Magnetic flux density (Bg) can also be derived using the above relationship when the surface area of the gap (Sg) is known. This becomes:

$$Bg = \Phi/Sg = i/(Rc+Rg)\ Sg$$

Now, when a control current Ic is applied to the Hall element, voltage output V_H from the element will become:

$$V_H = K \cdot Ic \cdot Bg = K \cdot Ic \cdot i/(Rg+Rc)\ Sg$$

K:Hall element sensitivity constant

Thus, it is evident that if the reluctance components within the magnetic circuit are linear quantities, then the output voltage produced by the Hall element will be proportional to the current flow in the conductor. Consequently, DC current

measurements may be accurately made simply by amplifying Hall output voltage, and do not require further processing. On the other hand, the sinusoidal wave of AC current is passed through a linear detector for modulation prior to activating the meter pointer.

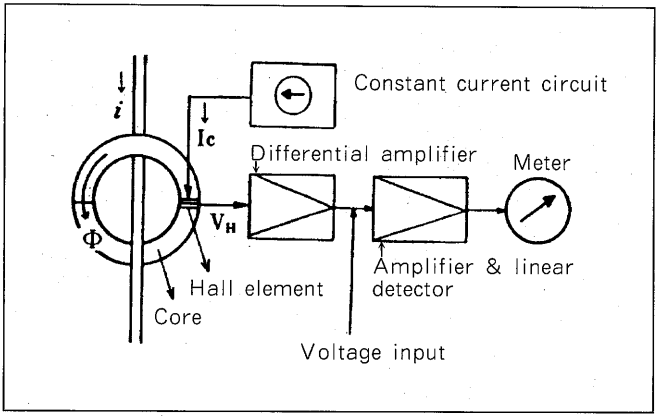


Figure. 5-A The 3108-01 Basic Operating Principle

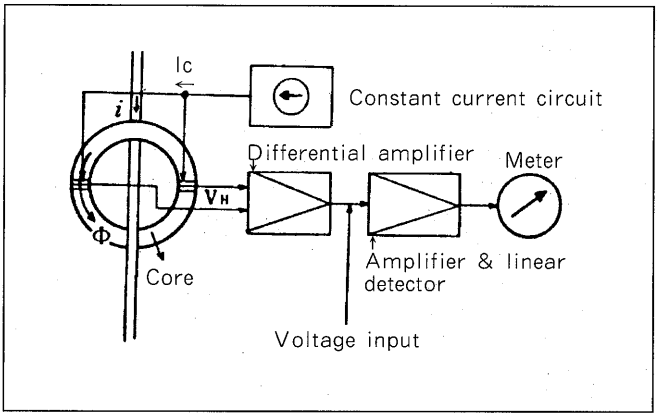


Figure 5-B The 3109-01 Basic Operating Principle

6. Measurement Method

Always trun the power ON when start measurement.

6.1 Preparations

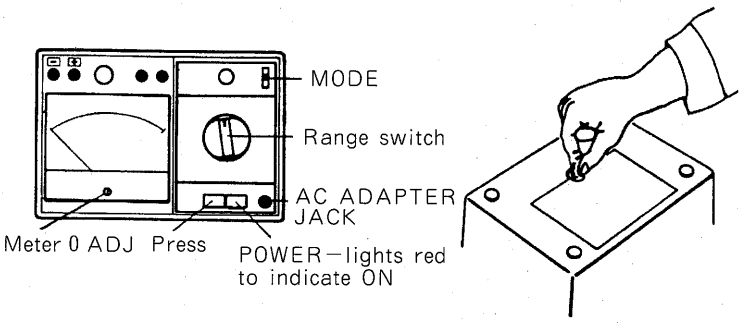


Figure. 6.1 Battery Replacement

(1)Zero Adjustment

If the instrument is not permanently leveled (bench-mounted etc.), the pointer will usually not be on "0". Set it to "0" using a screwdriver to turn the METER 0 ADJ screw located at the pointer pivot point.

(2)Press the POWER switch ON. (ON will be indicated by the switch lighting red.) Always turn POWER back OFF when the measurement is complete.

(3)Battery Check

Check the condition of the batteries by pressing the BATT check switch. If the pointer rises to or above the BATT OK zone, the batteries are in a good condition.

NOTE Pressing the power switch OFF will sometimes result in the pointer momentarily deflecting to the stop. Note that this is not a malfunction.

Replacing the Batteries

⚠WARNING	• To avoid electric shock when replacing batteries, first disconnect the leads from the object to be measured. Also, after replacing the batteries, always replace the cover and tighten the screw before using the unit. • When replacing the batteries, do not install old batteries with new ones, and do not mix different types of batteries. Check the battery polarity carefully when inserting the batteries. • Do not short-circuit used batteries, disassemble them, or throw them in a fire. Doing so may cause the batteries to explode. • Be sure to dispose of used batteries according to their type in the prescribed manner and in the proper location.

- If the pointer fails to reach the BATT OK zone, the batteries require replacement. This may be accomplished by using coin to loosen the battery cover screw and replacing the batteries inside, observing the correct pole polarity. The instrument uses four R14P battery. (Refer to Figure 6.1)

* Battery check may also be performed during the measurement by pressing the BATT check switch.

(4)Connecting the cables.

- Voltage test lead .....Voltage measurements
  The voltage terminals are marked with + and −. Plug the black lead into the − terminal, and the red lead into the + terminal.
- Clamp on sensor(PROBE)....Current measurements
  Align the guide key on the sensor connector with the cut-out on the receptacle and plug it in as far as it will

go. Screw the connector ring down to secure it. When clamping the sensor over the conductor, make sure that the arrow on the sensor faces the load.

NOTE Clamp on sensors are not interchangeable with other instruments (even of the same model). Thus, always make sure that you are using the sensor with the same serial number as the instrument.

● Output terminals (OUTPUT)

Output cables are not provided with the instrument.

A standard cable terminated with banana plug may be used for this purpose. Connect the + terminal to the + input on the recorder or other device, and the − terminal to the − input.

⚠WARNING	• The output terminals, the volatge terminals and the jaws are not insulated. Handle these items carefully in order to avoid electric shock or a short circuit accident. • To avoid possible electrical shock or damage to the clamp sensor, avoid touching the exposed metallic parts of the clamp sensor with your hands or any other metallic objects while measuring voltage.

6.2 Current Measurement

⚠DANGER	• To avoid short circuits and accidents that could result in injury or death, use clamp testers only with power lines carrying 500 V or less. • To avoid short circuits and accidents that could result in injury or death, when the tips of jaws are open, do not use on bare conductors.

(1) DC Current Measurement

• Position the mode selector switch to DC or ±DC.

- Set the range switch to the range nearest expected circuit current, then zero the pointer by turning the ZERO ADJ knob. (Make certain the clamp jaws are closed when adjusting zero.)

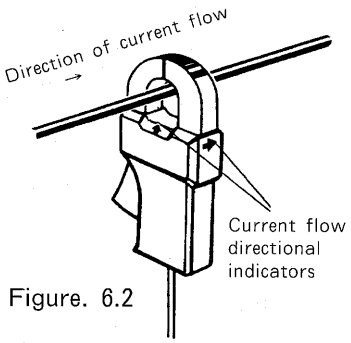


Figure. 6.2

- Clamp the sensor over the conductor noting the current direction marks (arrows) on the front and side panels of the clamp. These should be facing with the flow of current, or toward the load. (See Figure 6.2.)

NOTE When performing measurements over long periods of time, periodic zero adjustment is recommended.

(2) AC Current Measurement

- Place the mode selector switch in the AC position.
- Set the range switch to the range nearest expected circuit current. (ZERO ADJ is not required here.)
- Clamp the sensor over the conductor. (The direction of current flow is not important for AC measuerment.)

6.3 Voltage Measurement

⚠DANGER	• The maximum permissible input is 500 V AC/DC. Do not measure voltage in excess of these limitations, as doing so may damage the unit or cause an accident that might result in injury or death. • Always use the batteries when measuring voltage. The voltage terminals and AC adapter are not insulated. Input-level voltages may appear at the AC adapter.

(1) DC Voltage Measurement

- Position the mode selector switch to DC or ±DC.
- Set the range switch to the range nearest expected circuit voltage. (ZERO ADJ is not required here.)

(2) AC Voltage Measurement

- With the exception of setting the range selector switch to AC, measurement procedures follow those listed for DC voltage.

6.4 Output Terminal

⚠DANGER	• The voltage terminal and the output terminal are not insulated. • During voltage measurement, input-level voltage may appear at the output terminals. Therefore, to prevent electrical accidents, never use the output terminals when measuring voltage. • To avoid damage to the unit, do not short the output terminal and do not input voltage to the output terminal.

The output voltage produced through these terminals is 1 V relative to a full-scale meter reading. When the instrument is in the ±DC mode, the output through the + terminal will be +1 V f.s. and that through the − terminal will be −1 V f.s. The output terminals function in the RECORD OUT mode for AC mode setting, and in the MONITOR OUT mode for both DC and ±DC mode settings.

Mode (Instrument)	Output Mode	Input Signal	Output Voltage	Frequency Range
AC	Note 1 RECORD OUT	AC	1 VDC	20 to 500 Hz
		DC	Note 3	
DC	Note 2 MONITOR OUT	AC	1 VAC	DC to 500 Hz
		DC	1 VDC	
±DC	Same	AC	1 VAC	DC to 500 Hz
		DC	1 VDC	

Note1: In RECORD OUT, an AC input is converted to DC output. (See Figure 6.4-1.)

Note2: In MONITOR OUT, both AC and DC input are output directly. (See Figure 6.4-2.)

Note3: When AC and DC signals are superimposed, output includes only the DC voltage portion of the AC signal components.

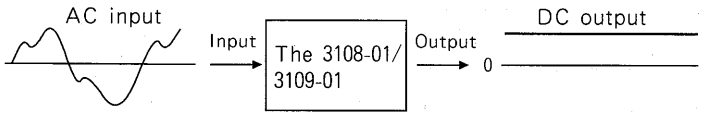


Figure. 6.4-1 RECORD OUT Mode Operations

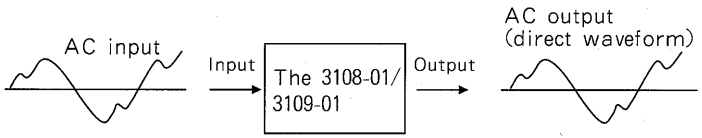


Figure. 6.4-2 MONITOR OUT Mode Operations

NOTE When the instrument is in the DC or ±DC mode and an AC input is applied to the output terminals (MONITOR OUT), the measurement value cannot be read from the meter.

- Response rate (time constant): Approx. 270 ms (RECORD OUT)
- Load impedance: More than 100 Ω
- Output current: Approx. 10 mA (Max)

(1) Recording DC current

- With the instrument set up for DC current measurements, 1 VDC will be produced through the output terminals. (Print-out and monitoring the waveform can be done by connecting a recorder.)

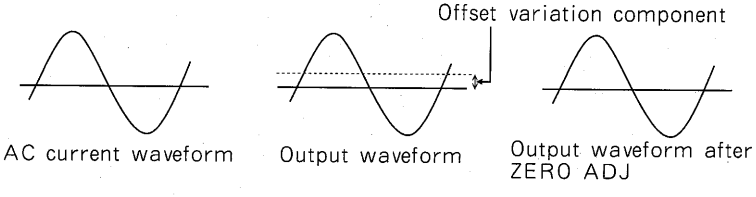
NOTE When making recordings over a long period of time,

periodic zero adjustment is recommended.

(2) Recording AC current

- With the instrument set up for AC current measurements, 1 VDC will be produced through the output terminals.(Print-out can be done by connecting a printer.)
- When monitoring AC current waveforms, place the mode selector switch to DC and monitor the waveform directly. Output level for AC is 1 V. (Use a high-speed recorder.)

NOTE Any existing offset variations within the circuit will occur as superimposed DC components. This necessitates performing ZERO ADJ prior to the measurement as is done for DC current measurements.



6.5 AC Adapter

⚠DANGER	Always use the batteries when measuring voltage. The voltage terminals and AC adapter are not insulated. Input-level voltage may appear at the AC adapter.

⚠WARNING	Use, an AC adapter that conforms to IEC 950 standards in respect to safety is rated for 6 V-300 mA, has 5 mm-dia.-terminals and has a center pin with negative polarity.

When an 100 VAC power supply is available, using 9035 AC ADAPTER(option)is recommended. Plug the 9035 into the wall socket, then plug the output cable into POWER JACK on the instrument.

⊕ —— (•—— ⊖ 6 VDC 300mA

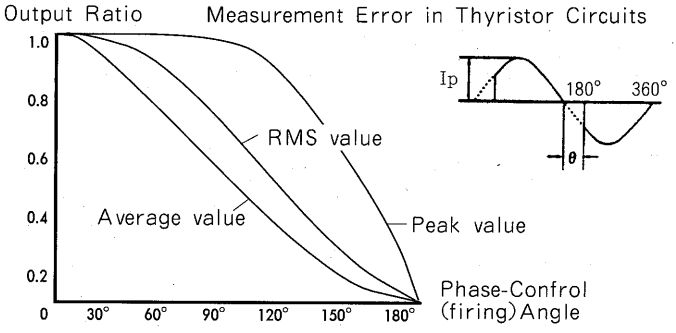
NOTE The internal battery is disconnected when using the AC adapter.

6.6 RMS Value

The most common method of specifying AC voltage and current is by its root-mean-square (RMS) value. However, most measureing instruments (including clamp on current meters) are restricted to indicating RMS of average-value rectified current, and this results in serious error when measurements are made on waveforms of SCR outputs, inverters, or other waveforms distorted to non-sinusoidal shape. If accuracy is a requirement in quantifying such phenomena, a circuit that performs the computations needed to produce true RMS (TRMS) readings must be built into the instrument.

The RMS Adapter Module is a unique feature of the 3108-01 /3109-01 in that it may be installed as required. This module contains a monolithic IC capable of performing log/ antilog computations in converting the measurement to TRMS. It additionally features ideal PN junction rise characteristics, and the temperature stability needed for accurate conversion operations.

Example:Figure 6.6 shows the magnitude of error resulting when current is measured in a thyristor (SCR) circuit at different phase control (firing) angles.



Average value: $\frac{1}{\pi}\int_{\theta}^{\pi} Ip \sin \omega t \, dt$

RMS value: $\sqrt{\frac{1}{\pi}\int_{\theta}^{\pi} (Ip \sin \omega t)^2 dt}$

Peak value: Ip

Figure. 6.6

The above figure clearly illustrates that the difference between RMS value and average value is a function of firing angle Φ. (Note that when firing angle is delayed 90° , the difference (hence, error) between the average responding and TRMS-responding meter is approx. 30%.)

● Crest factor

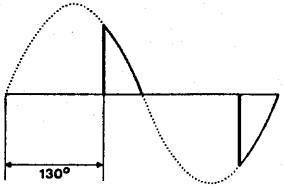
The dynamic range of the meter circuitry is expressed as its crest factor derived from the following equation.

$$\text{Crest factor} = \frac{\text{Peak value}}{\text{RMS value}}$$

Thus when measuring phenomena with a high peak value and relatively small rms value (thyristor output), selecting the proper range for RMS will likely result the peak value of the waveform exceeding the dynamic range of the meter circuit. Measurement accuracy will thus be affected, because the portion of the waveform that exceeded the dynamic range will be lost as a computation factor.

Crest factor for the 3108-01/3109-01 is 3 (or less), meaning that any waveform whose peak value exceeds its RMS by a factor of 3 will be properly computed.

Example: The measurement of thyristor-control current is an area where crest factors are of concern. Here, crest factors are controlled by the firing angle ; and delays of up to approx. 130° can be handled without exceeding circuit dynamics. If the firing angle delay exceeds this value, switch to the next higher range.



7. Notes and Precautions

7.1 Measurements in the Presence of Magnetic Fields

When using the instrument in low ranges for DC current measurement, excessively high inputs applied to the sensor core, or approaching a strong magnetic force field will cause the core to become weakly magnetized, resulting in a slight shift of meter zero. This can normally be compensated for by performing ZERO ADJ prior to the measurement, and error should be insignificant.

Note also that ZERO ADJ should always be performed with the clamp jaws closed. If magnetization is present, pointer position will be different for the open and closed position.

Measurements other than for DC current are unaffected by core magnetization. (Refer to Figure 7.1)

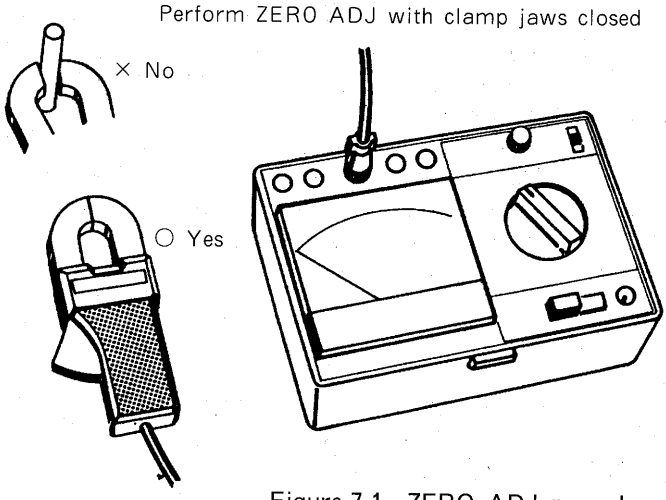
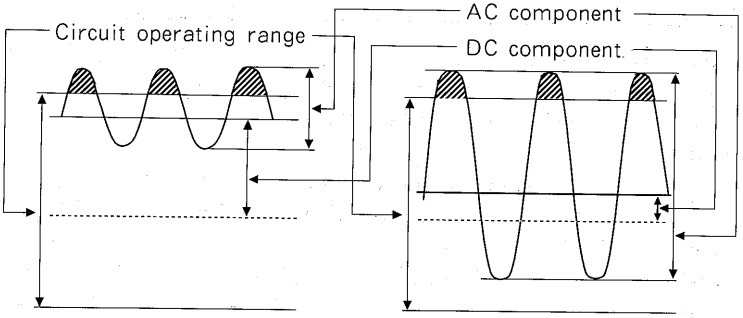


Figure.7.1 ZERO ADJ procedure

7.2 Measuring AC/DC Superimposed Components

The 3108-01/3109-01 is designed to separate AC and DC components so that the unwanted component has no affect on the desired mode of measurement, and in most cases this is effective. Note however, that when the unwanted components are several times greater in magnitude than the measurement mode components (when attempting to measure DC current and the superimposed AC component is several times greater, or vice versa), the operating level of the meter circuitry is likely to be exceeded, resulting in an erroneous reading. When this is the case, the affect of the unwanted component can be eliminated by switching the range selector to the next higher range. (For example, if you are now in the 100 A range, switch to the 250 A range.)



AC current (or voltage)measurement with a large DC superimposed component

DC current (or voltage)measurement with a large AC superimposed component

7.3 Zero Adjustment

(1)For DC current measurements, when sudden changes of temperature occur, the zero point will change, thus requir ing zero adjustment.

(2)When using for a long period of time, the zero point will also change and this requieres periodic zero ad justment.

7.4 Care of the Clamp on Sensor

The clamp on sensor consists of a core enclosed in a protective housing made of high-strength, heat-resistant plastic with core ends ground to a precision finish. Do not scratch or otherwise damage the ends of the core. Also, wipe off any dust or dirt accumulation on the end of the cores with a soft cloth. Rust should not be a problem under normal usage conditions, however, any rust that does accumulate here can be removed by gently sanding with an extremely fine grade of sandpaper.

Be careful to avoid dropping the clamps or subjeting them to other mecbanical shock. This can damage the mating

surfaces in the core, adversely affecting measurement.

8. Maintenance

Gently wipe dirt from the surface of the unit with a soft cloth moistened with a small amount of water or mild detergent.

Do not try to clean the unit using cleaners containing organic solvents such as benzine, alcohol, acetone, ether thinners, gasoline, or ketones.

The may cause discoloration or damage.

9. Service

If the unit is not functioning properly, check the batteries and the probe. If a problem is found, contact your dealer or HIOKI representative. Pack the unit carefully so that it will not be damaged during transport, and write a detailed description of the problem. HIOKI cannot bear any responsibility for damage that occurs during shipment.

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