

**THE H3C and P3C SERIES  
HALL EFFECT**

**HALL-EFFECT AC and DC CURRENT CLAMPS**

**OPERATION MANUAL**

OM-H/P3C

**AYA-Instruments, Inc.  
Pittsburgh, PA 15213**

July 14, 2000

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PART NUMBER OM-H/P3C

## 1.0 INTRODUCTION

This manual includes information and instructions for the operation and maintenance of the H3C and P3C families of Clamp-On current transformers for measuring either AC or DC electric currents.

## 2.0 WARRANTY

AYA-Instruments products are warranted against defects in workmanship and material for a one-year period after the date of purchase. During this period, AYA-Instruments will repair or replace, at its own option, any components found to be defective under normal use. AYA's obligation under this warranty is limited only to repairing any such instrument which, in AYA's opinion, is found to be defective within the scope of the warranty when returned to the factory or to an AYA authorized service center. Transportation to and from the main office or the service center will be paid by the purchaser. Buyer shall pay all duties and taxes for products returned to AYA or to its service center from another country. Shipment should not be made without obtaining a **Returned Material Authorization** from AYA.

This warranty will not apply to products repaired or modified by persons not authorized by AYA or not in accordance with instructions furnished by AYA. If the product is found to be defective as a result of misuse, improper repair or abnormal operating conditions, operation outside the environmental specifications of the product, or improper installation or maintenance, repairs will be billed at cost.

AYA assumes no liability for secondary charges or consequential damages associated with the misuse of its products.

## 3.0 GENERAL DESCRIPTION

The AYA H3C and P3C current measuring clamps are designed for measuring either AC or DC currents. The clamps incorporate HALL-EFFECT sensors with associated circuitry that generate an analog output voltage signal proportional to the strength of the magnetic field generated by the primary current passing through the clamp. Models are available with different current measuring ranges and for accommodating different sizes of current conductors. Standard models have dual ranges and can be supplied with various combinations of current ranges from 150 Amperes full scale to 7,500 Amperes full scale. Single-range clamps are available optionally.

The H3C and P3C clamps are ideally suited for electrical installation and maintenance work. Their rugged thermoplastic construction provides the durability required for the most demanding applications. All units feature hinges that permit easy access to large conductors and busbars. The clamps are designed for use with common analog or digital multimeters, power analyzers, oscilloscopes and chart recorders.

The H3C and P3C clamps incorporate an excitation power supply and an amplifier located in their handles. This electronic circuit is powered by a 9-volt battery that is easily accessible by removing the battery cover located at the end of the handle. The frequency range is from DC to 1000 Hz. The amplitude of the output signal depends on the model selected.

An optional carrying case is available with space for the signal processing electronics and for accessories such as test leads or a spare battery.

The standard package includes the following items:

- 1 Clamp
- 1 9-volt Battery
- 1 Operation Manual

The following optional items are available when ordered with the transducers:

- Carrying case
- Male-to-Male cable set
- Male-to-Female cable set
- Male-to-BNC cable set

The H1C and the P1C models are special versions that do not have an internal battery. They are designed for use with an external power supply of 9 to 15 Volts DC and are supplied with a shielded cable. The wires are color coded as follows:

- RED wire: + of the Power Supply
- BLUE wire: - of the Power Supply
- WHITE wire: + of the Output Signal (S1)
- YELLOW wire: - of the Output Signal (S2)

**CAUTION:** Neither side of the power supply should be connected to S1 or to S2. The power supply is used as excitation of a bridge and cannot be grounded to the signal output.

If the power supply provides + 5 Volts and -5 Volts in reference to ground, the output YELLOW wire can be grounded. In this case the output signal on the white wire is in reference to ground.

## 4.0 LIST OF MODELS AVAILABLE

This section includes the mechanical dimensions and a list of the HC and PC models of Hall-Effect Clamp-On current transformers.

### AC/DC HALL-EFFECT CURRENT CLAMPS

MEETING IEC SAFETY STANDARDS 1010-1 CATEGORY III 600 VOLTS

#### GENERAL SPECIFICATIONS

**ACCURACY CLASS:** 1.5%  
**OPERATING VOLTAGE:** 600 VOLTS MAX.  
**ISOLATION TEST:** 5.55 kV - 1 MINUTE  
**CURRENT RATING:** FULL SCALE - CONTINUOUS  
 100% OVERRANGE - 3 MINUTES  
**TEMPERATURE RANGE:** -10 to + 50 Deg. C  
**CABLE SIZE:** 2.84"  
**BUSBAR SIZE:** 5.0" x 1.7" or 4.0" x 2.05"  
**DIMENSIONS:** 13.23" x 5.0" x 2.0"  
**WEIGHT:** 3 to 3.25 lb  
**OUTPUT:**  
   H1C Clamps: 6-ft open-ended cable  
   H3C Clamps: Include a 9-VDC Battery  
**COLOR:** Red

Specifications subject to change without notification.

### HC-SERIES

**NOTE:** Ranges are in DC or AC P-T-P, where P-T-P is Peak-to-Peak AC Current.  
The maximum P-T-P value is twice the value of each DC current range.

MODEL	HIGH RANGE		LOW RANGE		MAX CURRENT	FREQUENCY RANGE(Hz)	
	Primary Current	Output	Primary Current	Output		For 3%	For -3 db
AC/DC CLAMPS REQUIRING EXTERNAL 9 to 24 Volt POWER SUPPLY							
H1C-2000-2	20 - 2000 ADC 40 - 4000 A P-T-P	2.0 VDC 4 V P-T-P			4000 ADC	DC to 3,000	DC to 5,000
H1C-4000-2	40 - 4000 ADC 80 - 8000 A P-T-P	2.0 VDC 4 V P-T-P			8000 ADC	DC to 3,000	DC to 5,000
H1C-5000-2	50 - 5000 ADC 100-10000 A P-T-P	2.0 VDC 4 V P-T-P			10000 ADC	DC to 3,000	DC to 4,000
AC/DC CLAMPS WITH INTERNAL 9-VOLT BATTERY							
H3C-2000-2	20 - 2000 ADC 40 - 4000 A P-T-P	2.0 VDC 4 V P-T-P	2 - 200 ADC 40 - 400 A P-T-P	2.0 VDC 4 V P-T-P	4000 ADC	DC to 3,000	DC to 5,000
H3C-4000-2	40 - 4000 ADC 80 - 8000 A P-T-P	2.0 VDC 4 V P-T-P	5 - 500 ADC 10 - 1000 A P-T-P	2.0 VDC 4 V P-T-P	8000 ADC	DC to 3,000	DC to 5,000
H3C-5000-2	50 - 5000 ADC 100-10000 A P-T-P	2.0 VDC 4 V P-T-P	10 - 1000 ADC 20 - 2000 A P-T-P	2.0 VDC 4 V P-T-P	10000 ADC	DC to 2,000	DC to 4,000

# AC/DC HALL-EFFECT CURRENT CLAMPS

# PC-SERIES

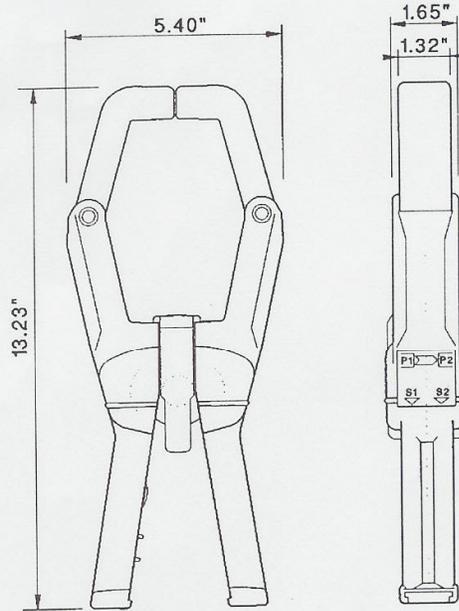
MEETING IEC SAFETY STANDARDS 1010-1 CATEGORY III 600 VOLTS

## GENERAL SPECIFICATIONS

**ACCURACY CLASS:** 1.5%  
**OPERATING VOLTAGE:** 600 VOLTS MAX.  
**ISOLATION TEST:** 5.55 kV - 1 MINUTE  
**CURRENT RATING:** FULL SCALE - CONTINUOUS  
 100% OVERRANGE - 3 MINUTES  
**TEMPERATURE RANGE:** -10 to + 50 Deg. C  
**CABLE SIZE:** 3.27"  
**BUSBAR SIZE:** 4.8" x 2.13" or 4.0" x 2.5"  
**DIMENSIONS:** 13.23" x 5.40" x 2.0"  
**WEIGHT:** 4.0 to 4.25 lb  
**OUTPUT:**  
 P1C Clamps: 6-ft open-ended cable  
 P3C Clamps: Include a 9-VDC Battery

**COLOR:** Red

Specifications subject to change without notification



**NOTE:** Ranges are in DC or AC P-T-P, where P-T-P is Peak-to-Peak AC Current.  
The maximum P-T-P value is twice the value of each DC current range.

MODEL	HIGH RANGE		LOW RANGE		MAX CURRENT	FREQUENCY RANGE (Hz)	
	Primary Current	Output	Primary Current	Output		For 3%	For -3 db
AC/DC CLAMPS REQUIRING EXTERNAL 9 to 24 Volt POWER SUPPLY							
P1C-2000-2	20 - 2000 ADC 40 - 4000 A P-T-P	2 VDC 4 V P-T-P			4000 ADC	DC to 3,000	DC to 5,000
P1C-4000-2	40 - 4000 ADC 80 - 8000 A P-T-P	2 VDC 4 V P-T-P			8000 ADC	DC to 3,000	DC to 5,000
P1C-5000-2	50 - 5000 ADC 100-10000 A P-T-P	2 VDC 4 V P-T-P			10000 ADC	DC to 2,000	DC to 4,000
P1C-7500-2	75 - 7500 ADC 150-15000 A P-T-P	1.5 VDC 3 V P-T-P			10000 ADC	DC to 2,000	DC to 4,000
AC/DC CLAMPS WITH INTERNAL 9-VOLT BATTERY							
P3C-2000-2	20 - 2000 ADC 40 - 4000 A P-T-P	2.0 VDC 4 V P-T-P	2 - 200 ADC 4 - 400 A P-T-P	2 VDC 4 V P-T-P	4000 ADC	DC to 3,000	DC to 5,000
P3C-4000-2	40 - 4000 ADC 80 - 8000 A P-T-P	2.0 VDC 4 V P-T-P	5 - 500 ADC 10 - 1000 A P-T-P	2 VDC 4 V P-T-P	8000 ADC	DC to 3,000	DC to 5,000
P3C-5000-2	50 - 5000 ADC 100-10000 A P-T-P	2.0 VDC 4 V P-T-P	10 - 1000 ADC 20 - 2000 A P-T-P	2 VDC 4 V P-T-P	10000 ADC	DC to 2,000	DC to 4,000
P3C-7500-A	75 - 7500 ADC 150-15000 A P-T-P	1.5 VDC 3 V P-T-P	10 - 1000 ADC 20 - 2000 A P-T-P	2 VDC 4 V P-T-P	10000 ADC	DC to 2,000	DC to 4,000
P3C-7500-C	75 - 7500 ADC 150-15000 A P-T-P	1.5 VDC 3 V P-T-P	40 - 4000 ADC 80 - 8000 A P-T-P	2 VDC 4 V P-T-P	10000 ADC	DC to 2,000	DC to 4,000

FIGURE 4-1: Dimensions of the HC and the PC clamps

**SPECIFICATIONS**

**The specifications of the HC and PC families are subject to change without notice.**

AC or DC Accuracy:	$\pm 1.5\%$ of Reading $\pm 2\text{mV}$ from 0.1 to 0.7 of Full Scale $\pm 2.0\%$ of Reading $\pm 2\text{mV}$ from 0.7 to 1.0 of Full Scale
Current Overrange:	100 %
Operating Frequency:	DC to 1,000 Hz for stated accuracy DC to 4,000 Hz for -3db
Phase Error:	$\pm 1$ Degree from DC to 1,000 Hz.
Isolation Test Voltage:	5,500 Volts 50-60 Hz, 1 minute
Max. Operating Voltage:	600 Volts for IEC 1010-1 Standard Category III
Temperature Range:	23°F to +122°F (-5°C to +50°C)
Safe Storage Temperature:	-6°F to +176°F (-20°C to +80°C) (with battery removed)
Jaw Opening:	See Figures 7-1 and 7-2.
Weight:	See selection chart.
Power:	9-Volt battery.
Battery Life:	Approximately 75 hours

Accuracy is specified at room temperature range of 18°C to 23°C with the ZERO adjustment performed and the current conductor located at the center of the clamp.

For AC current, the crest factor is 1.4 for a full sinusoidal signal.

## 6.0 **SAFETY PRECAUTIONS**

The H3C and P3C clamps are designed for operation in an indoor environment. Care must be taken to operate them according to the instructions described in this manual. Disassembly of the transducer should not be attempted by field personnel. High voltages present in the transducer are dangerous and could cause injury. Any contact with active conductors is dangerous.

This manual includes metrology information. The user or operator is assumed to be familiar with, and will abide by, all safety regulations concerning electric power measurements. The user is further assumed to select the proper model for his specific application.

AYA-Instruments, Inc. assumes no responsibility for any damage to its products or any injury or death resulting from misuse or deviation from specified instructions.

### **CAUTION:**

The clamp and/or the signal converter may be damaged if any voltage is applied to the output terminals.

## 7.0 PREPARATION FOR USE OF THE H3C and P3C Clamps

### 7.1 INTRODUCTION

This section provides information for using H3C and P3C clamps. The outside dimensions of the current clamps are shown in the selection chart, which is in Section 4.0 of this manual. The following is a description of the clamps.

Figure 7-1 shows the HC clamps where the Gray areas marked [A] and [B] are the handles. These are the only areas that can safely be held by the user. **Physical contact with the clamp MUST be restricted to this safe area.** The end of the safe area is indicated by a colored tactile safety barrier marked [G] on the drawing. **At no time should any other part of the clamp be touched when placing the clamps on a conductor or when removing it.**

The opening marked [E] for the H3C clamps is 2.9". The clamp can accommodate a circular conductor up to 2.84" and a busbar up to 5.0" x 1.7" or 4.0" x 2.05".

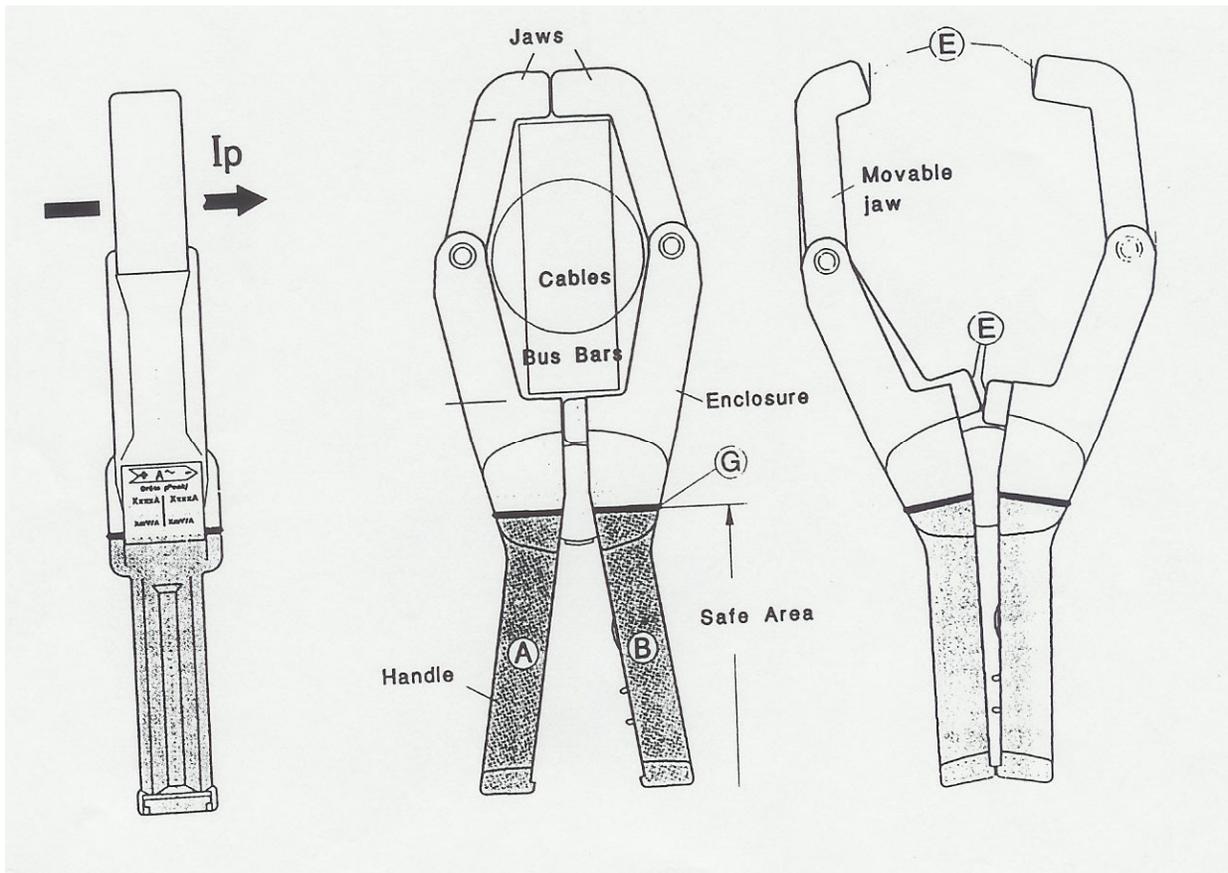


FIGURE 7-1: Mechanical drawing of the H3C clamps

Figure 7-2 shows the PC clamps where the gray areas marked [A] and [B] are the handles, which are the only areas that can safely be held by the user. **Physical contact with the clamp MUST be restricted to this safe area.** The end of the safe area is indicated by a colored tactile safety barrier marked [G] on the drawing. **At no time should any other part of the clamp be touched when placing the clamp on a conductor or when removing it.**

The opening marked [E] for the P3C clamps is 3.3". The clamp can accommodate a circular conductor up to 3.27" and a busbar up to 4.8" x 2.13" or 4.0" x 2.5".

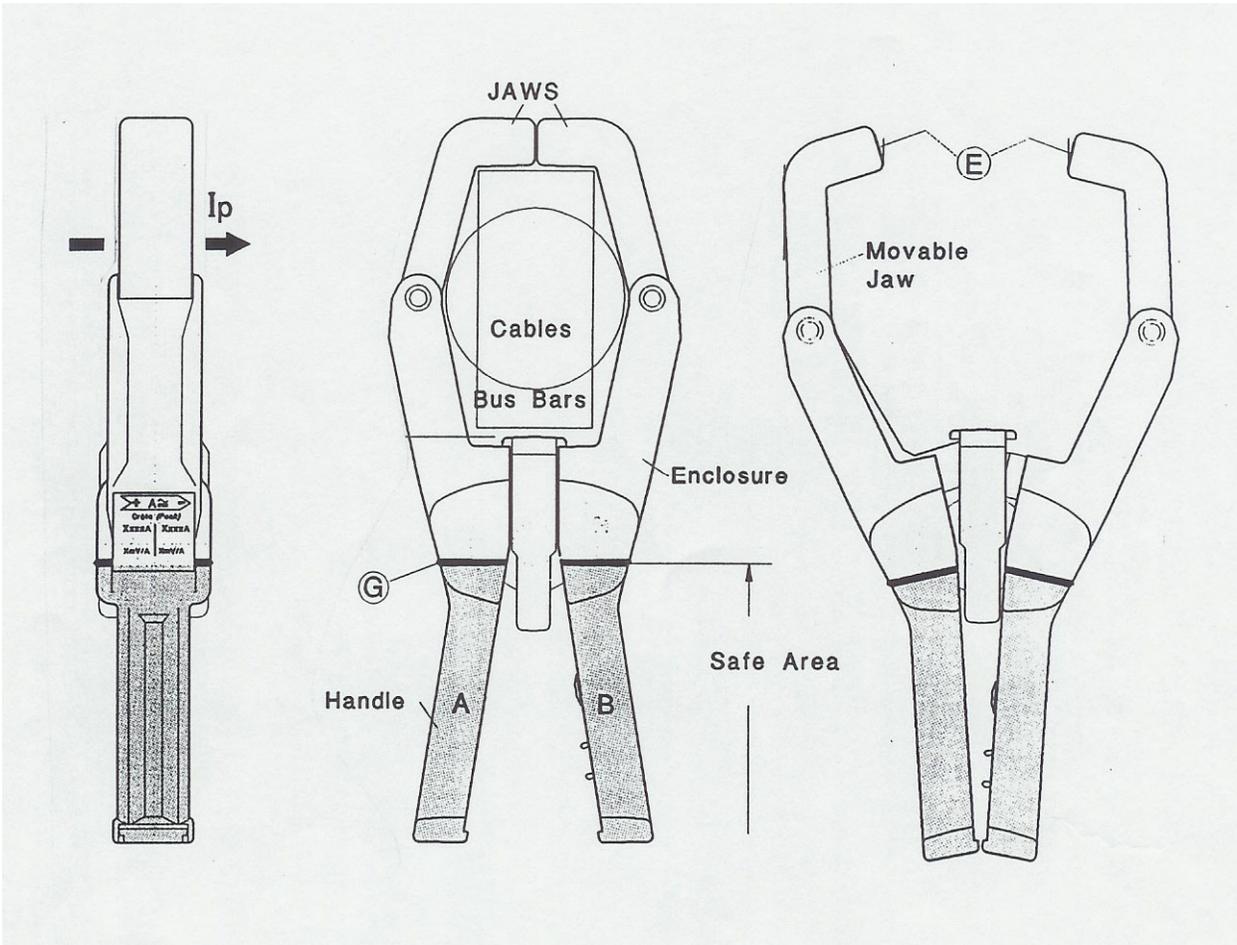
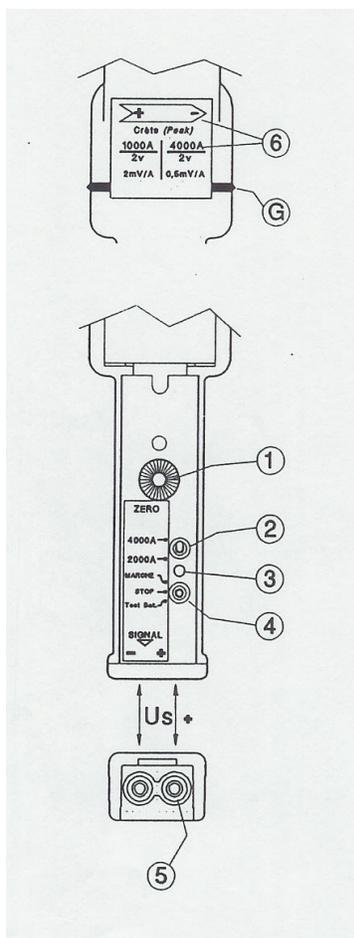


FIGURE 7-2: Mechanical drawing of the P3C clamps

Figure 7-3 shows the details of the H3C and the P3C clamp controls.



- 1) ZERO OFFSET multiturn potentiometer  
For DC application, the ZERO OFFSET potentiometer must be set prior to measurement. For AC applications, the ZERO setting is immaterial.
- 2) RANGE SELECTOR is a two-position switch.
- 3) LED BATTERY INDICATOR. It is OFF when the switch is OFF or when the battery is low. It is ON when the instrument is functioning properly.
- 4) Three position POWER switch:  
Power ON position, Power OFF position and  
BATTERY TEST momentary position. To test the battery, hold the switch in this position for 10 seconds. If the LED remains ON for 10 seconds, the remaining battery life should be approximately 72 hours. If the LED is OFF, the battery should be changed.
- 5) OUTPUT TERMINALS. Standard 4mm banana-type safety sockets.
- 6) CLAMP LABEL. The arrow indicates the reference direction of the DC current. This enables the polarity determination of the circuit under test.
- (G) TACTILE STRIPS. Indicate the limit of the safe area for clamp handling.

FIGURE 7-3: Clamp Controls

## 7.2 OUTPUT SIGNAL CONNECTIONS

The output signal terminals are located on the handle as shown in figure 7-3. The OUTPUT voltage is present between the terminal marked "OUTPUT". To obtain the specified accuracy, DO NOT LOAD THE OUTPUT with a resistance that is lower than 25,000 Ohms.

## 7.3 DC MEASUREMENT

- \* Set the switch to the LOW range and the ON-OFF switch to ON.
- \* Check that the LED is ON.
- \* Connect the measuring instrument, paying attention to the polarity.
- \* Set the measuring instrument to a 2 VDC range.
- \* Check the ZERO signal and adjust it, if necessary, until the output voltage is 0.00.
- \* Place the clamp around the conductor and measure the current. If the reading exceeds the full scale of the LOW range, change the range switch to the HIGH range position.

## 7.4 AC MEASUREMENT

- \* Set the switch to the LOW range.
- \* Check that the LED is ON.
- \* Connect the measuring instrument.
- \* Set the measuring instrument to a 2 VAC range and check that it reads ZERO. (The position of the ZERO potentiometer is not important.)
- \* Place the clamp around the conductor and measure the current. If the reading exceeds the full scale of the LOW range, change the range switch to the HIGH range position.

## 7.5 MEASUREMENT DURATION

Theoretically, the duration of measurement is limited by the battery life. However, the user must pay attention to other constraints such as thermal, mechanical, chemical and other environmental limitations.

## 7.6 OTHER CONSIDERATIONS

Attention should be paid to electromagnetic fields that may effect the accuracy of the measurements. To remove any possible effect of permanent magnetism when measuring DC currents, retake any reading with the clamp reversed. If the absolute value of the reading is not the same, take the average of the two readings. If the conductor size is small in relation to the clamp's jaw opening and the current is high, some variations may exist if the conductor is not centered. In that case, take the average of the two most extreme readings to obtain the highest accuracy.

## 8.0 THEORY OF OPERATION

This section includes the theory of operation of the H3C and P3C Hall Effect current transformers.

The heart of the system is a high quality split core which consists of two semi-diamond shaped sections. The HALL EFFECT sensors are located in the magnetic field that is generated by the primary current. The HALL-EFFECT sensors are located in pairs to cancel any errors that may be present due to signals that are not generated by the primary currents under measurement.

The signals generated by the sensors are then amplified and processed by the electronic signal conditioning converter. The output voltage is proportional to the flux density that is generated by the primary current.

The clamp is calibrated at the factory to set the gain of the signal conditioner for a scale factor that depends on the model. (The scale factor for the Model H3C-2000-2 is 1mV per ampere in the HIGH range and 10mV per ampere in the LOW range.) A zero offset potentiometer, located in the handle, enables the operator to set the output voltage to zero when the primary current is zero.

HALL-EFFECT AC/DC clamps can measure both AC and DC currents simultaneously. An AC current which is present together with a DC current in the same conductor can be measured accurately, and the combined waveshape of the AC and DC components can be observed on an oscilloscope.

The AYA AC/DC current clamps are bidirectional. Their current is specified to indicate the full scale DC current and the full scale AC current in Peak-to-Peak values. If the AC current is a pure sine wave, its RMS value is 0.707 of the DC rating, and its Peak-to-Peak value is twice the DC rating.

For example:

The Model P3C-7500-A clamp has a full scale of either +7,500 Amperes DC or -7,500 Amperes DC. It can accurately measure any AC current whose positive peak is as high as +7,500 Amperes and whose negative peak is as high as -7,500 Amperes, or 15,000 Amperes Peak-to-Peak. If the AC current is a pure sine wave, its RMS value is as shown below:

$$0.707 \times 7,500 = 5302.50 \text{ Amperes RMS}$$

## 9.0 MAINTENANCE

The maintenance of the HALL EFFECT type current clamps is simple and straight forward. The clamp must be kept clean and must be dust free.

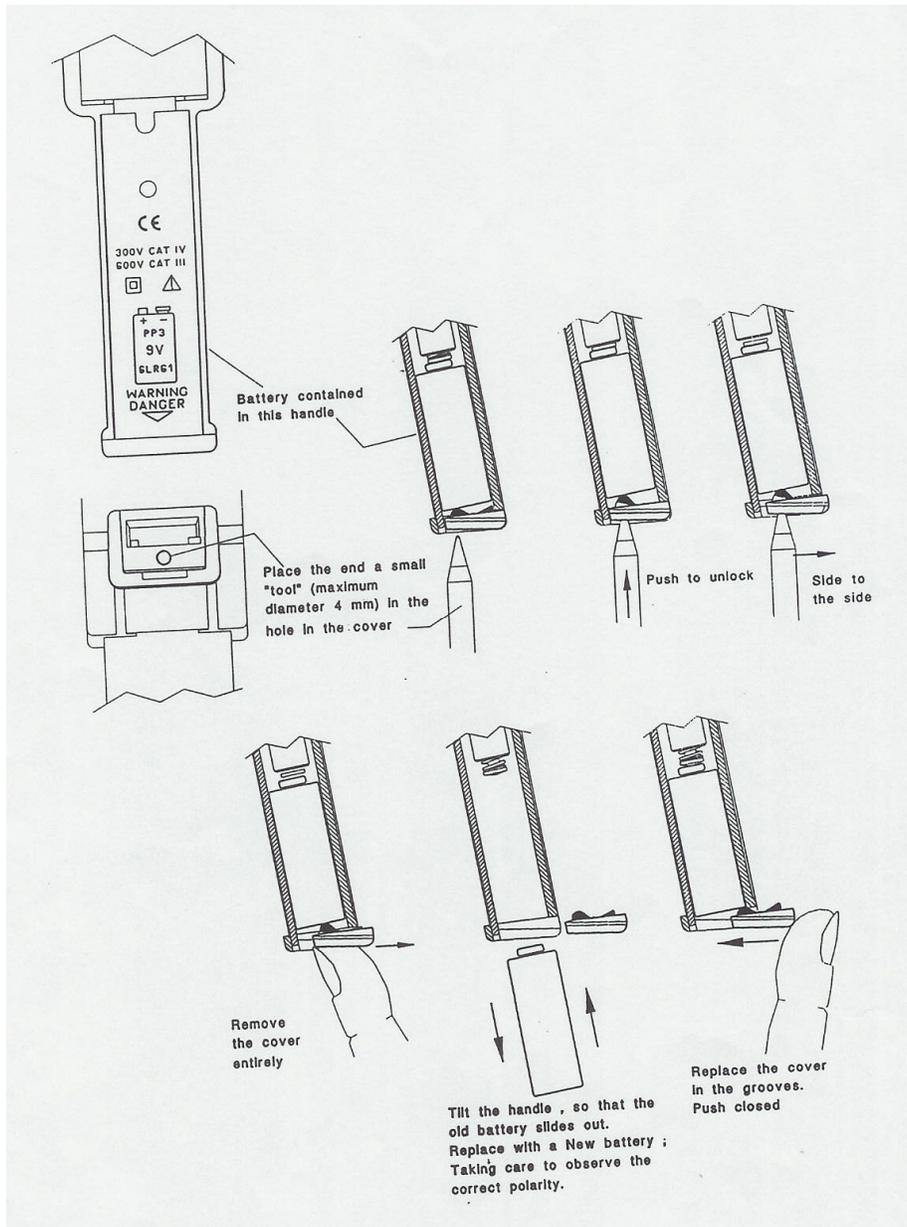
Depending on the frequency of use and on the environment where the instrument is located, it may be desirable to clean the transducer periodically using alcohol, to visually inspect the transducer and to remove any accumulation of dust and dirt using an air pressure blower.

Periodically check the battery. To replace the battery, follow the instructions in Section 10.0 of this manual.

For the convenience of transporting the clamps from one location to another, an optional carrying case is available. It can accommodate accessories such as cables, multimeters and similar items.

## 10.0 REPLACING THE BATTERY

**WARNING:** Before opening the battery compartment, remove the clamp from any current-carrying conductor and make sure that it is not connected to a live electrical wire. To maintain the warranty, use only an Alkaline Battery.



## 1.0 **DISASSEMBLY AND REASSEMBLY**

Disassembly of the transducer will automatically void its warranty.

## 12.0 **STORAGE INSTRUCTIONS**

When not in use for extended periods of time, the clamp should be stored without the battery in a packing enclosure to protect it from exposure to dust or other environmental effects. Care should be taken to ensure that environmental storage conditions are not exceeded. The temperature should be between -20°C and +80°C, and the humidity should be between 20% and 80% relative humidity non-condensing.

## ADDENDUM A

### HALL EFFECT CLAMPS FOR EXTERNAL POWERING

The H1C and P1C Hall-Effect current clamps are special versions of the HC and PC series. They are designed for use in installations where an internal battery is not required and an external powering voltage is available. A 4-wire cable is provided at one of the handles of the clamp, with two wires for connection to a 12-Volt DC external power source. The other two wires provide the output signal.

The H1C and P1C clamps have only one current range. The models that are available are:

MODEL	CURRENT RANGE	OUTPUT
H1C-200-2	200 ADC	2 VDC
H1C-500-2	500 ADC	2 VDC
H1C-1000-2	1000 ADC	2 VDC
H1C-2000-2	2000 ADC	2 VDC
H1C-4000-2	4000 ADC	2 VDC
H1C-5000-2	5000 ADC	2 VDC
P1C-200-2	200 ADC	2 VDC
P1C-500-2	500 ADC	2 VDC
P1C-1000-2	1000 ADC	2 VDC
P1C-2000-2	2000 ADC	2 VDC
P1C-4000-2	4000 ADC	2 VDC
P1C-5000-2	5000 ADC	2 VDC
P1C-7500-1.5	7500 ADC	1.5 VDC