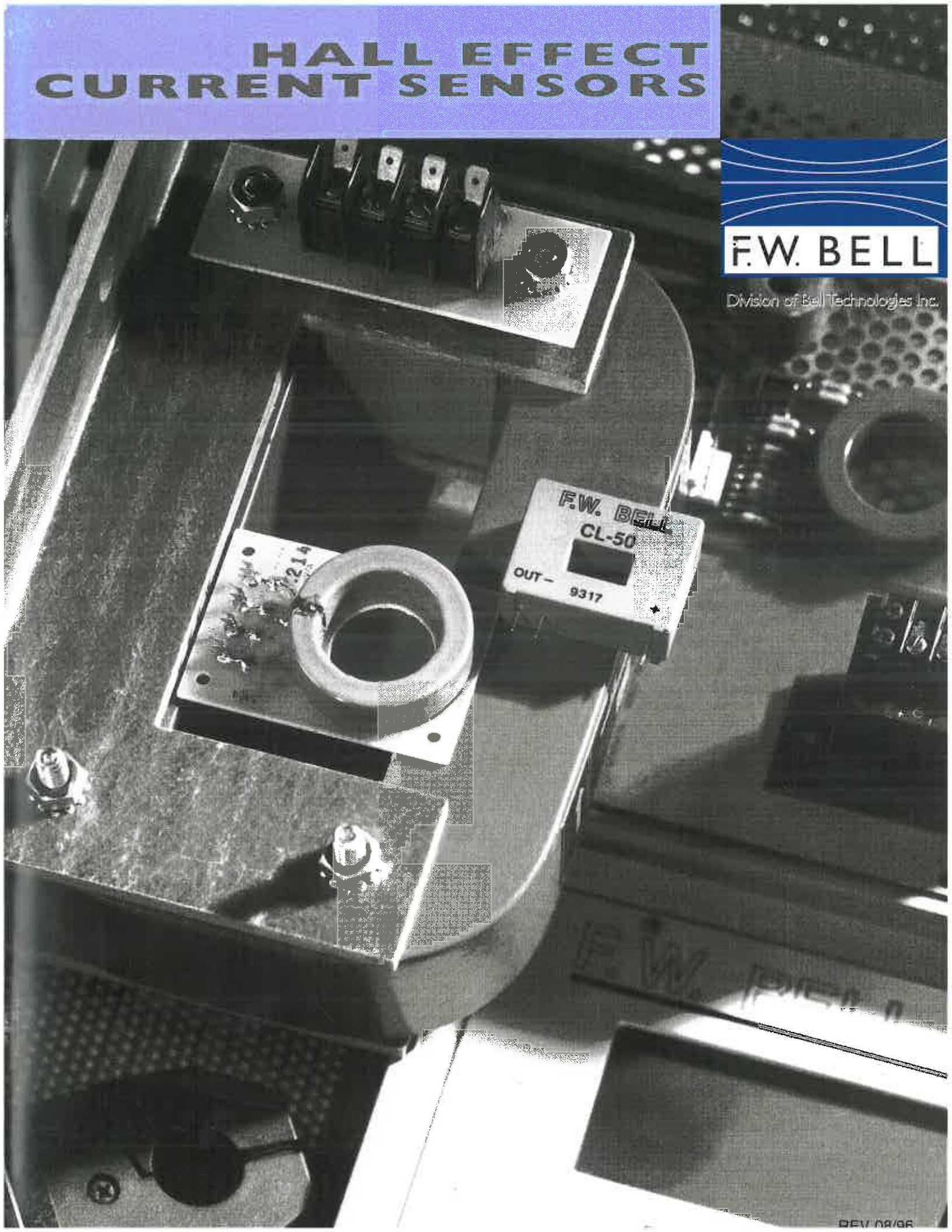
HALL EFFECT CURRENT SENSORS



F.W. BELL

Division of Bell Technologies Inc.

REV 09/96

TABLE OF CONTENTS

FEATURES

OPEN LOOP CURRENT SENSORS

- Measures ac and dc currents
- No dc insertion loss
- Provides electrical isolation
- Low operating power
- Low cost

CLOSED LOOP CURRENT SENSORS

- Fast response
- Excellent linearity
- Wide bandwidth
- Low temperature drift

AC CURRENT SENSORS WITH 4-20 mA OUTPUT

- Split core for easy installation
- Loop powered
- Simple two wire connection
- 4-20 mA dc output
- Choice of ranges

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

1. PRODUCT INDEX

OPEN LOOP CURRENT SENSORS

Model	Rated Current (±A)	Full Scale Output (±V)	Linearity ±% Full Scale	Frequency Range	Aperture Inches (mm)	Mounting	Page
NA-25	25	.0225 to .0625	1	dc to 1 kHz	0.2 (5.1)	PCB	9
NAP-25	25	.0225 to .0625	1	dc to 1 kHz	PCB connections	PCB	9
BB-25	25	1	1	dc to 60 kHz	0.4 (10.2)	PCB	11
BB-100	100	5	1	dc to 60 kHz	0.4 (10.2)	PCB	11
BB-150	150	6	0.6	dc to 60 kHz	0.8 (20.3)	Panel	13
BB-300	300	6	0.7	dc to 10 kHz	0.8 (20.3)	Panel	13
BB-600	600	6	1.25	dc to 10 kHz	0.8 (20.3)	Panel	13
BBP-150F	150	6	0.6	dc to 60 kHz	0.8 (20.3)	Panel/Flat	15
BBP-300F	300	6	0.7	dc to 10 kHz	0.8 (20.3)	Panel/Flat	15
BBP-600F	600	6	1.25	dc to 10 kHz	0.8 (20.3)	Panel/Flat	15
BBP-150H	150	6	0.6	dc to 60 kHz	0.8 (20.3)	Panel/Horizontal	16
BBP-300H	300	6	0.7	dc to 10 kHz	0.8 (20.3)	Panel/Horizontal	16
BBP-600H	600	6	1.25	dc to 10 kHz	0.8 (20.3)	Panel/Horizontal	16
IHA-25	25	1	1	dc to 50 kHz	0.38 (9.6)	PCB/Panel	17
IHA-100	100	5	1	dc to 50 kHz	0.38 (9.6)	PCB/Panel	17
IHA-150	150	5	1	dc to 50 kHz	0.84 (21.3)	PCB/Panel	19
PI	350	0.175-0.385	1.5	dc to 1 kHz	0.8 (20.3)	PCB	21
PI-600	600	0.150-0.330	2	dc to 1 kHz	0.8 (20.3)	PCB	21
IA-0100	100	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-0250	250	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-0500	500	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-1000	1000	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-2000	2000	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-3000	3000	10	0.6	dc only	1.67 (42.4)	Panel	23
IF-0100	100	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-0250	250	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-0500	500	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-1000	1000	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-2000	2000	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-3000	3000	10	0.6	dc to 1 kHz	1.67 (42.4)	Panel	25

CLOSED LOOP CURRENT SENSORS

Model	Nominal current (I_N)	Output mA at I_N	Linearity (%)	Frequency Range	Aperture Inches (mm)	Mounting	Page
CL-25	25*	25	0.2	dc to 150 kHz	PCB connections	PCB	29
CL-50	50	50	0.15	dc to 200 kHz	0.276 • 0.5 (7 • 12.7)	PCB	31
CL-100	100	100	0.1	dc to 150 kHz	0.394 (10)	PCB	33
CL-200	200	100	0.1	dc to 150 kHz	0.787 (20)	Panel	35
CL-300	300	150	0.1	dc to 150 kHz	0.787 (20)	Panel	37
CL-500	500	100	0.1	dc to 150 kHz	0.984 (25)	Panel	39
CL-1000	1000	200	0.1	dc to 100 kHz	1.575 (40)	Panel	41

AC CURRENT SENSORS WITH 4-20 mA OUTPUT

Model	Current Range	Output mA	Linearity %	Frequency Range	Aperture Inches (mm)	Mounting	Page
PC-50	50	4-20	0.1	20 to 100 Hz	0.73 (18.5)	Panel	45
PC-200	200	4-20	0.1	20 to 100 Hz	0.73 (18.5)	Panel	45
PCS-50	50	4-20	0.3	20 to 100 Hz	0.85 (21.6)	Panel	45
PCS-200	200	4-20	0.3	20 to 100 Hz	0.85 (21.6)	Panel	45

* CL-25 offers a choice of 5 current ranges: 5,6,8,12, or 25 Arms

Due to continuous process improvement, specifications are subject to change without notice.

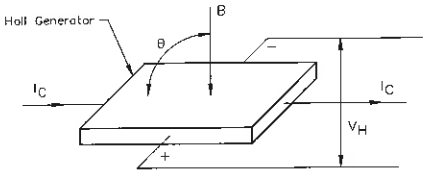
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

2. GENERAL INFORMATION

2.1 Hall Generator

A Hall generator is a four terminal solid state device that produces an output voltage (V_H) proportional to the product of the input current (I_C), the magnetic flux density (B) and the sine of the angle between B and the plane of the Hall generator. A reversal of the direction of either the magnetic field or the control current will result in a polarity change of V_H. By holding the control current constant, the Hall voltage will be proportional to the magnetic field. The Hall generator can be used as a multiplier by varying both the control current and the magnetic field.

F.W. Bell manufactures a wide range of Hall generators. A complete catalog is available upon request.



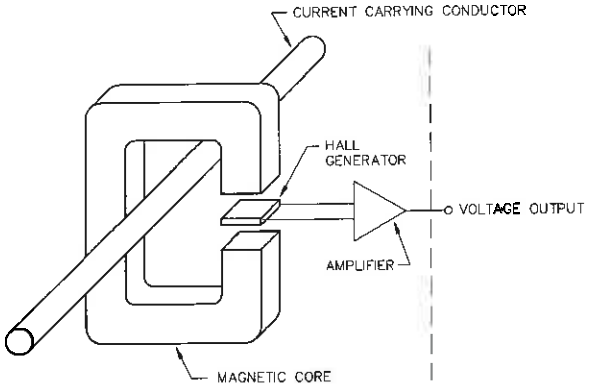
Schematic Representation of a Hall Generator

2.2 Open Loop Current Sensor

An open loop current sensor consists of a Hall generator mounted in an air gap of a magnetic core. The current carrying conductor placed through the aperture of the sensor produces a magnetic field that is proportionate to the current. The field is concentrated by the core and measured by the Hall generator. Most open loop sensors contain circuitry to provide temperature compensation and a calibrated high level voltage output.

Open loop current sensors measure dc and ac currents and provide electrical isolation between the circuit being measured and the output of the sensor. Typically, open loop sensors cost less than closed loop sensors. They are preferred in battery powered circuits due to their low operating power requirements.

OPEN LOOP CURRENT SENSOR



2.3 Closed Loop Current Sensor

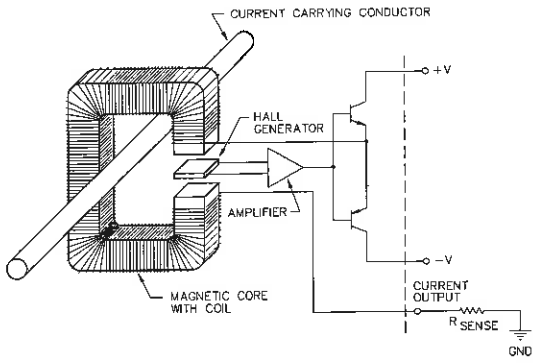
A closed loop current sensor consists of a Hall generator mounted in an air gap of a magnetic core, a coil wound around the core and a current amplifier. The current carrying conductor placed through the aperture of the sensor produces a magnetic field that is proportionate to the current. This field is concentrated by the core and sensed by the Hall generator.

The Hall generator is connected to the input of the current amplifier, which drives the coil. The current through the coil produces an opposing field to that provided by the current through the aperture. Thus the flux in the core is constantly driven to zero.

The coil connects to the output of the sensor. Therefore the output is a current proportional to the aperture current multiplied by the number of turns on the coil. A sensor with a 1000 turn coil provides an output of 1 mA per ampere. The current output is converted to a voltage by connecting a resistor to the output of the sensor and ground. The output is scaled by selecting the resistor value.

Closed loop sensors measure dc and ac currents and provide electrical isolation. They offer fast response, high linearity and low temperature drift. The current output of the closed loop sensor is relatively immune to electrical noise. They are the sensor of choice when high accuracy is essential.

CLOSED LOOP CURRENT SENSOR



6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

3. MOST FREQUENTLY ASKED QUESTIONS

1. What happens when an in-rush current far exceeding the sensor's rating is applied?

An open loop sensor will not be damaged. There may be a slightly larger offset due to the magnetization of the core. This additional offset is temporary and will be removed if a current is applied in the opposite direction.

A closed loop sensor may be damaged depending on the duration, duty cycle and amplitude of the over current. Consult F.W. Bell with exact requirements.

2. Why do most sensors require a bipolar plus and minus 15 Vdc? Will they operate on ± 12 Vdc?

F.W. Bell current sensors measure current in both the positive and negative direction. A positive current flow as defined in the specification sheet will result in a positive output and a negative current will result in a negative output. With the exception of zero offset, the sensor will have zero output at zero current. This allows the sensor to provide the most accurate representation of dc, ac and ac superimposed on top of dc current wave forms.

Most F.W. Bell sensors will operate on ± 12 Vdc. In some cases there may be some additional zero current offset. The measuring range and sense resistor values may be effected on the closed loop sensors.

3. I want to measure currents below 2 amperes. How can I do this when the lowest rated sensor you manufacture is 25 amperes?

By winding turns through the aperture of the sensor, the current is magnetically multiplied by the number of turns. For example, a sensor with 10 turns through the aperture will see 10 A when 1 A is flowing through the conductor.

Besides greater sensitivity, ampere turns also decreases the effect of zero offset and offset temperature drift proportionately to the number of turns. For example, at 1 A the Model BB-25 has an output of 40 mV with a typical offset of 5 mV and a typical offset temperature drift of 0.30 mV/ ° C. Assuming the worst case, over a 10 ° C change the output could vary from 32 mV to 48 mV, a 20% error. With 10 turns, the sensor sees 10A and has an output of 400 mV. Assuming the same conditions as above, the output could vary from 392 mV to 408 mV, a 2% error. The 10 turns results in a reduction in error of 10 times!

4. Why is there a specification for a minimum and maximum sense resistor on a closed loop sensor?

Closed loop current sensors require a resistor to be connected between the output of the sensor and ground to complete the circuit. This resistor is in series with a compensation coil and one of the drive transistors (depending on the polarity of the aperture current), which is connected to one leg of the bipolar power supply. Each component exhibits a voltage drop, which is both current and temperature dependent. As the current being measured increases, more current is required to drive the coil which nulls the field. This results in a larger voltage drop across the coil and sense resistor. The total of these voltage drops can not exceed the supply voltage minus the voltage drop across the collector/emitter leads of the transistor. Therefore it is the maximum sensed current that determines the maximum value of the sense resistor.

For dc analysis, the voltage drop across the sense resistor, compensation coil and drive transistor must total the supply voltage. If less voltage is dropped across the sense resistor, more voltage must be dropped across the drive transistor, since the coil can be treated as a fixed value resistor. The maximum power dissipation of the drive transistor determines the minimum value of the sense resistor.

5. What determines the frequency range of an open loop current sensor?

In most applications, it is the eddy current heating of the core that sets the upper limit of the frequency. This limit is specified as ampere kilohertz, which is the product of the frequency and current.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

6. Which is better suited for my application, open or closed loop current sensors?

Open loop sensors are preferred in battery powered applications, such as electric cars. They take considerably less power to operate and above 100 A, they are considerably lighter. They also have a higher ability to withstand sustained overloads than closed loop sensors. If cost is a major consideration, the open loop sensors should be the first choice.

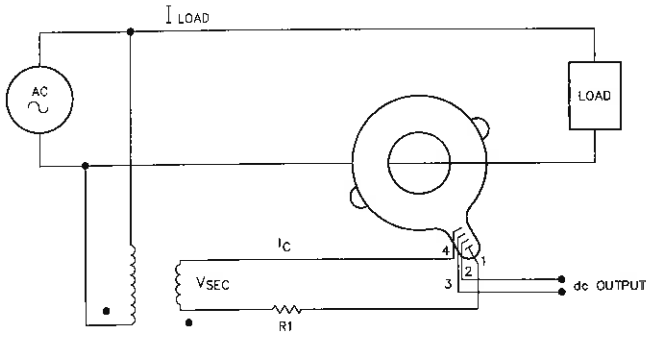
Closed loop sensors offer fast response and excellent linearity. The closed loop's current output is less susceptible to electrical noise. They are often preferred in high frequency circuits, such as switching power supplies, when quick response and noise immunity to high di/dt's and dv/dt's are critical.

7. Can I use the Hall effect sensor to measure true power (P = V x I x COS Ø)?

The Model PI can provide a dc output which is accurately proportional to Real Power. This is possible because of the multiplying ability of the Hall generator used in the PI.

The drawing below illustrates a typical schematic for a Real Power measurement application. The load current is sensed by passing the load current carrying conductor through the aperture of the sensor, eliminating the need for a current transformer (CT). The Hall generator excitation current (I_C) is derived from a step down potential transformer and resistor (R_1).

The output of the sensor is an instantaneous multiple of the excitation current and aperture current. The output wave form is an ac ripple on top of a dc component. This dc component is proportionate to Real Power.



AC Power Measurement

$$R1 = \frac{V_{SEC}}{I_C} \qquad W_{R1} = (I_C)(V_{SEC})$$

V_{SEC} = Maximum Anticipated Secondary Voltage

I_C = Maximum Anticipated Excitation Current (Not to Exceed 40 mA)

W_{R1} = Wattage Requirement for R1

8. Can I operate multiple sensors from a common power supply?

All F.W. Bell current sensors that operate from a bipolar power supply can have several sensors connected in parallel to the supply. Connections to the power supply ground and output ground should be made separately. Also, all the sensor output grounds should be tied to a common ground connection in order to prevent ground loops and possible noise problems.

9. How does the position of the conductor inside the aperture effect the reading?

For best accuracy, keep the conductor in the center of the aperture. The effect of positioning is more noticeable when the size of the conductor is significantly smaller than the sensor aperture.

10. What precautions should be used when positioning the current sensor?

For best results, keep the sensor away from ferrous metals. Other nearby conductors may have a small effect on the reading. This is more noticeable if the nearby conductor is carrying a large current relative to the aperture current.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

4. F.W. BELL CURRENT SENSOR APPLICATION FORM

Date: _____

Company: _____

Address: _____ Mail Stop: _____

City: _____ State (Province) _____ Zip (Postal Code) _____

Country: _____

Name: _____ Title: _____

Phone: _____ Ext: _____ FAX: _____

Annual Usage: _____ Production Start Date: _____ Month _____ Year

What is the end product where the sensor will be used: _____

Specifications

Minimum current to be measured _____ A Accuracy ± _____ A

Maximum current to be measured _____ A Accuracy ± _____ A

Linear Range: From _____ A to _____ A _____ % of reading

Temperature Range above stated accuracy to be maintained: From _____ ° C To _____ ° C

Frequency range: From _____ To _____

Slew rate needed: _____ A/µs Response time needed (10 to 90% Max. current) : _____ µs

Excitation: Available bipolar voltage ± _____ V Max. available current: _____ mA
Available unipolar voltage ± _____ V

Output preferred _____ mA/A _____ mV/A

Size restrictions: Height _____ inches - mm (circle one) Width _____ Depth _____

Mounting: PCB - Panel - Other (circle one) Describe: _____

Conductor size: _____ inches - mm (circle one)

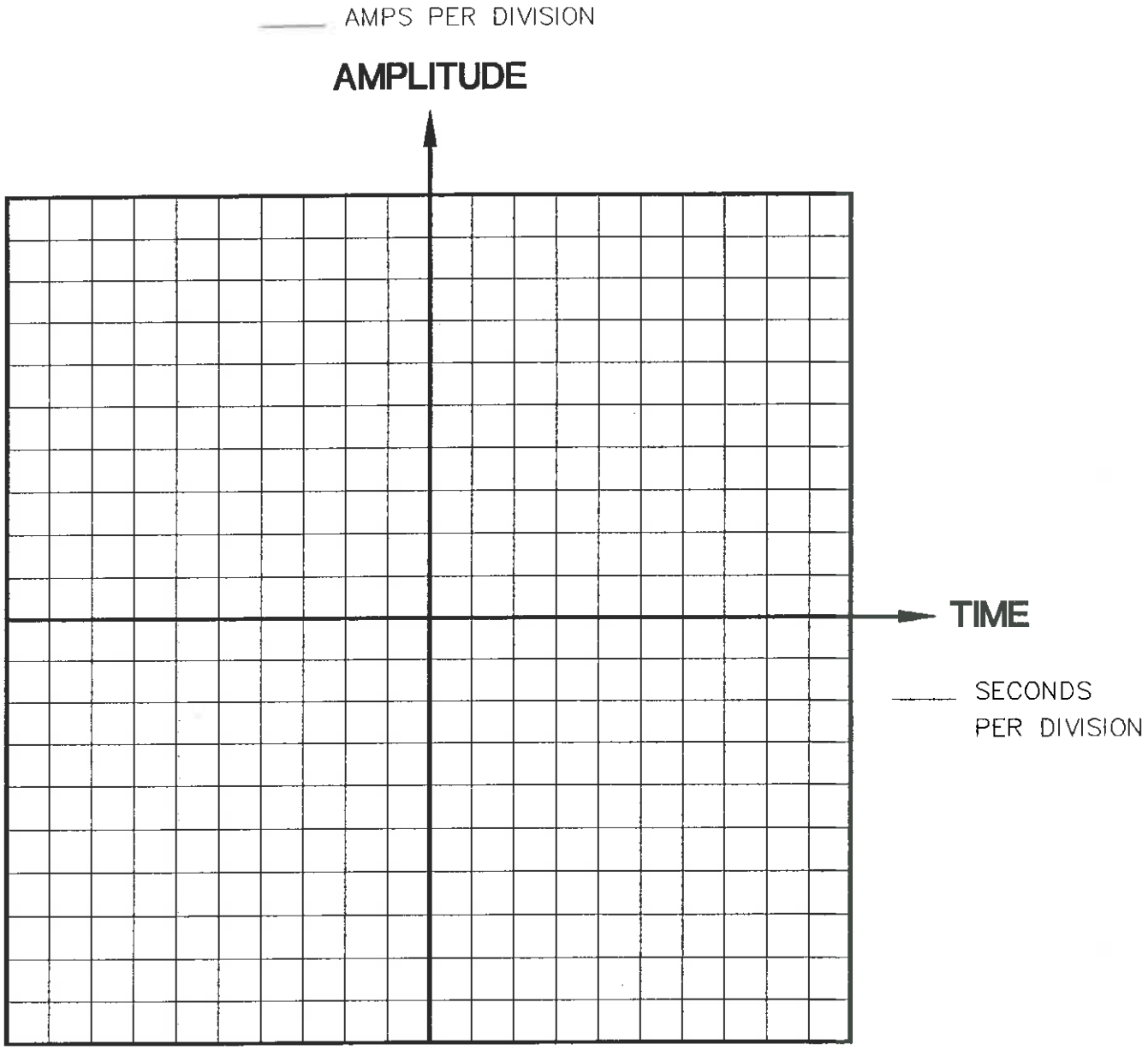
Other important details: _____

Use Other Side Of This Form to Sketch Current Wave Form

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL CURRENT SENSOR APPLICATION FORM

Please Sketch Current Wave Form Below



6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

5. OPEN LOOP CURRENT SENSORS

Index

Model	Rated Current (±A)	Full Scale Output (±V)	Linearity ±% Full Scale	Frequency Range	Aperture Inches (mm)	Mounting	Page
NA-25	25	.0225 to .0625	1	dc to 1 kHz	0.42 (5.1)	PCB	9
NAP-25	25	.0225 to .0625	1	dc to 1 kHz	PCB connections	PCB	9
BB-25	25	1	1	dc to 60 kHz	0.4 (10.2)	PCB	11
BB-100	100	5	1	dc to 60 kHz	0.4 (10.2)	PCB	11
BB-150	150	6	0.6	dc to 60 kHz	0.8 (20.3)	Panel	13
BB-300	300	6	0.7	dc to 10 kHz	0.8 (20.3)	Panel	13
BB-600	600	6	1.25	dc to 10 kHz	0.8 (20.3)	Panel	13
BBP-150F	150	6	0.6	dc to 60 kHz	0.8 (20.3)	Panel/Flat	15
BBP-300F	300	6	0.7	dc to 10 kHz	0.8 (20.3)	Panel/Flat	15
BBP-600F	600	6	1.25	dc to 10 kHz	0.8 (20.3)	Panel/Flat	15
BBP-150H	150	6	0.6	dc to 60 kHz	0.8 (20.3)	Panel/Horizontal	16
BBP-300H	300	6	0.7	dc to 10 kHz	0.8 (20.3)	Panel/Horizontal	16
BBP-600H	600	6	1.25	dc to 10 kHz	0.8 (20.3)	Panel/Horizontal	16
IHA-25	25	1	1	dc to 50 kHz	0.38 (9.6)	PCB/Panel	17
IHA-100	100	5	1	dc to 50 kHz	0.38 (9.6)	PCB/Panel	17
IHA-150	150	5	1	dc to 50 kHz	0.84 (21.3)	PCB/Panel	19
PI	350	0.175-0.385	1.5	dc to 1 kHz	0.8 (20.3)	PCB	21
PI-600	600	0.150-0.330	2	dc to 1 kHz	0.8 (20.3)	PCB	21
IA-0100	100	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-0250	250	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-0500	500	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-1000	1000	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-2000	2000	10	0.5	dc only	1.67 (42.4)	Panel	23
IA-3000	3000	10	0.6	dc only	1.67 (42.4)	Panel	23
IF-0100	100	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-0250	250	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-0500	500	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-1000	1000	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-2000	2000	10	0.5	dc to 1 kHz	1.67 (42.4)	Panel	25
IF-3000	3000	10	0.6	dc to 1 kHz	1.67 (42.4)	Panel	25

Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

5.1 Open Loop Current Sensor Glossary of Terms

Full Scale (F.S.): The total range over which a current sensor is designed to measure

Full Scale output: The voltage output of the sensor when measuring current at Full Scale

AC Bandwidth: The frequency range over which the sensor is designed to measure

Response time: The time required for the sensor to respond to a step function change in current

Slew rate: A linear rate of change in current that the sensor can accurately measure

Supply voltage: The voltage required to operate the sensor

Sensitivity: The change of output voltage per ampere of measured current

Linearity: Output deviation from a straight line response to the current being measured

Calibration point: The accuracy of the reading at which the sensor is calibrated

Typical zero current offset: The typical output offset at 25 °C when the sensor is measuring zero current

Maximum zero current offset: The maximum output offset at 25 °C when the sensor is measuring zero current due to the magnetic remnant of the core

Maximum hysteresis of offset: The maximum output voltage offset when zero current is flowing through the sensor after measuring current at its Full Scale rating

Minimum load resistance: The minimum load that can be placed on the output of the sensor without effecting its operation within specifications

Typical offset drift with temperature: The typical change in offset voltage due to a change in temperature

Maximum offset drift with temperature: The maximum change in offset voltage due to a change in temperature

Excitation change of 1% Max. sensitivity change: The maximum change in sensitivity with a 1% change in the supply voltage (either plus or minus or both)

Typical sensitivity drift with temperature: The typical change in sensitivity due to a change in temperature

Maximum sensitivity drift with temperature: The maximum change in sensitivity due to a change in temperature

Dielectric test: AC RMS voltage potential between the conductor through the aperture of the sensor and the output which the sensor can withstand for a stated time period

Operating temperature: The temperature range over which the sensor is designed to operate within specifications

Storage temperature: The temperature range over which the sensor can be stored without damage

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODELS NA-25 and NAP-25

Description:

The NA-25 and NAP-25 Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

	Units	NA-25	NAP-25
Measuring Circuit			
Full Scale (FS) dc or ac peak (1)	± A	25	
Full Scale output (2)	± mV	22.5 to 62.5	
Excitation Circuit			
Nominal excitation current (I_C)	mA	7	
Maximum excitation current (I_C)	mA	10	
Input resistance	ohms	450 to 900	
Output			
Sensitivity (2)	mV/A	0.9 to 2.5	
Linearity	%FS	1	
Maximum zero offset	± mV	25	
Maximum hysteresis of offset (3)	± mV	0.15	
Minimum load resistance	k ohms	10	
Output resistance	ohms	<3200	
Influence on Accuracy			
Maximum offset drift with temperature	± µV/°C	40	
Excitation change of ±1% Max. sensitivity change	±%	1	
Maximum sensitivity drift with temperature	±%/°C	-.07	
Withstand Capabilities			
Dielectric test (4)	kV	0.5	
Output short or open		NO DAMAGE	
General Information			
Operating temperature range	°C	-40 to +85	
Storage temperature range	°C	-40 to 100	
Aperture opening (NA-25 only)	inches (mm)	0.20 (5.1)	
Current carrying conductor diameter (12 AWG–NAP-25 only)	inches (mm)		0.84 (21.33)
Weight	grams	3.4	7
Output short or open circuit		NO DAMAGE	
Output reference		Conventional current flowing in direction of dot or arrow results in a positive difference in V_H.	

Notes:

(1) With a duty cycle less than 30% (conductor limited), linearity to 100 A Full Scale is 1% FS.

(2) At a nominal control current of 7 mA.

(3) Hysteresis specifications given for a Full Scale aperture current remnant.

(4) The dielectric test consists of 0.5 kVac at 60 Hz for one minute between a bare 0.10 inch diameter conductor and the output of the sensor.

Due to continuous process improvement, specifications subject to change without notice

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

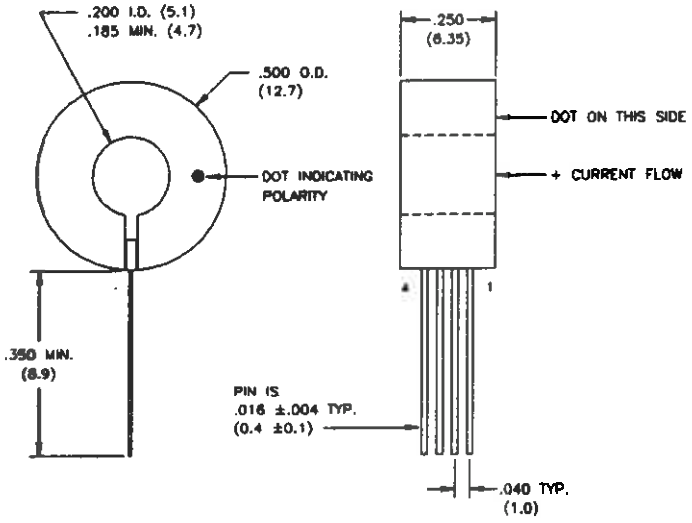
155140 / 155145

MODEL NA-25/NAP-25

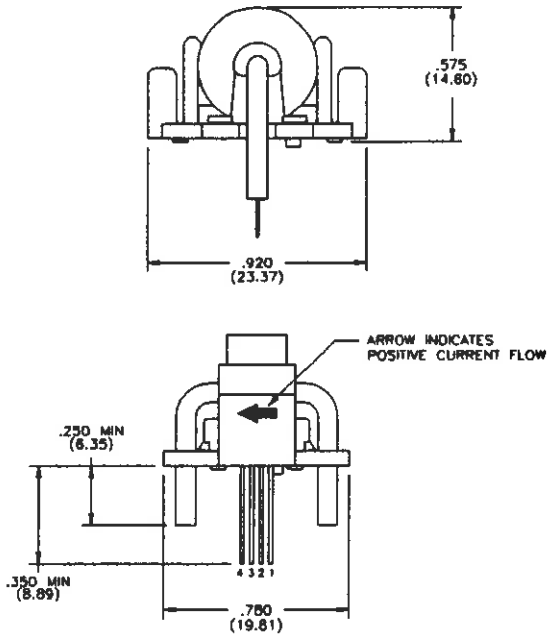
MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

NA-25

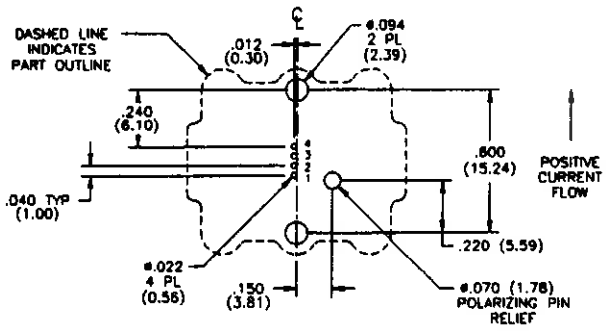


NAP-25



PIN	SIGNAL	DESCRIPTION
1	$+I_C$	+ CONTROL CURRENT
2	$+V_H$	+ OUTPUT VOLTAGE
3	$-I_C$	- CONTROL CURRENT
4	$-V_H$	- OUTPUT VOLTAGE

RECOMMENDED P.C.B. HOLE PATTERN



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODELS BB-25 and BB-100

Description:

The BB Series Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

	Units	BB-25	BB-100
Measuring Circuit			
Full Scale (FS) dc or ac peak	± A	25	100
Full Scale output	± V	1.0	5.0
AC Bandwidth (± 1 dB) (1)	kHz	dc to 60	
Response time (2)	µs	<2	
Slew rate	A/µs	>60	
Excitation Circuit			
Supply voltage	± Vdc	15	
Maximum supply current, positive supply	mA	6	
Maximum supply current, negative supply	mA	15	
Output			
Sensitivity	mV/A	40	50
Linearity	± %FS	1	
Calibration point (3)	± % RDG	1.25	
Typical zero current offset	± mV	5	
Maximum zero current offset	± mV	20	
Maximum hysteresis of offset (4)	± mV	5	20
Minimum load resistance	k ohms	2	
Influence on Accuracy			
Typical offset drift with temperature	± mV/°C	0.30	0.40
Maximum offset drift with temperature	± mV/°C	1.30	1.80
Excitation change of ±1% Max. sensitivity change	±%	0.15	
Typical sensitivity drift with temperature	±%/°C	0.04	
Maximum sensitivity drift with temperature	±%/°C	0.065	
Withstand Capabilities			
Dielectric test (5)	kV	1.0	
Output short or open circuit		NO DAMAGE	
General Information			
Operating temperature range	°C	-25 to +85	
Storage temperature range	°C	-40 to +95	
Aperture opening	inches (mm)	0.40 (10.1)	
Weight	grams	14	
Mounting		Designed to mount directly on PCB via through hole pins	
Output reference		To obtain a positive output on pin marked "Vo", positive conventional current must flow into the component side (See mechanical dimensions)	

Notes:

(1) Consult F.W. Bell if the product of the aperture current and frequency exceeds 1000 ampere-kilohertz

(2) Response time is effected by the positioning of the conductor in the aperture, the proximity of the return conductor and ferrous metals. It is best to test the sensor in the actual environment to obtain representative performance.

(3) The sensors are calibrated at 80% of Full Scale.

(4) Hysteresis specifications given for a Full Scale aperture current remnant.

(5) The dielectric test consists of 1.0 kVac at 60 Hz for one minute between a bare 0.375 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

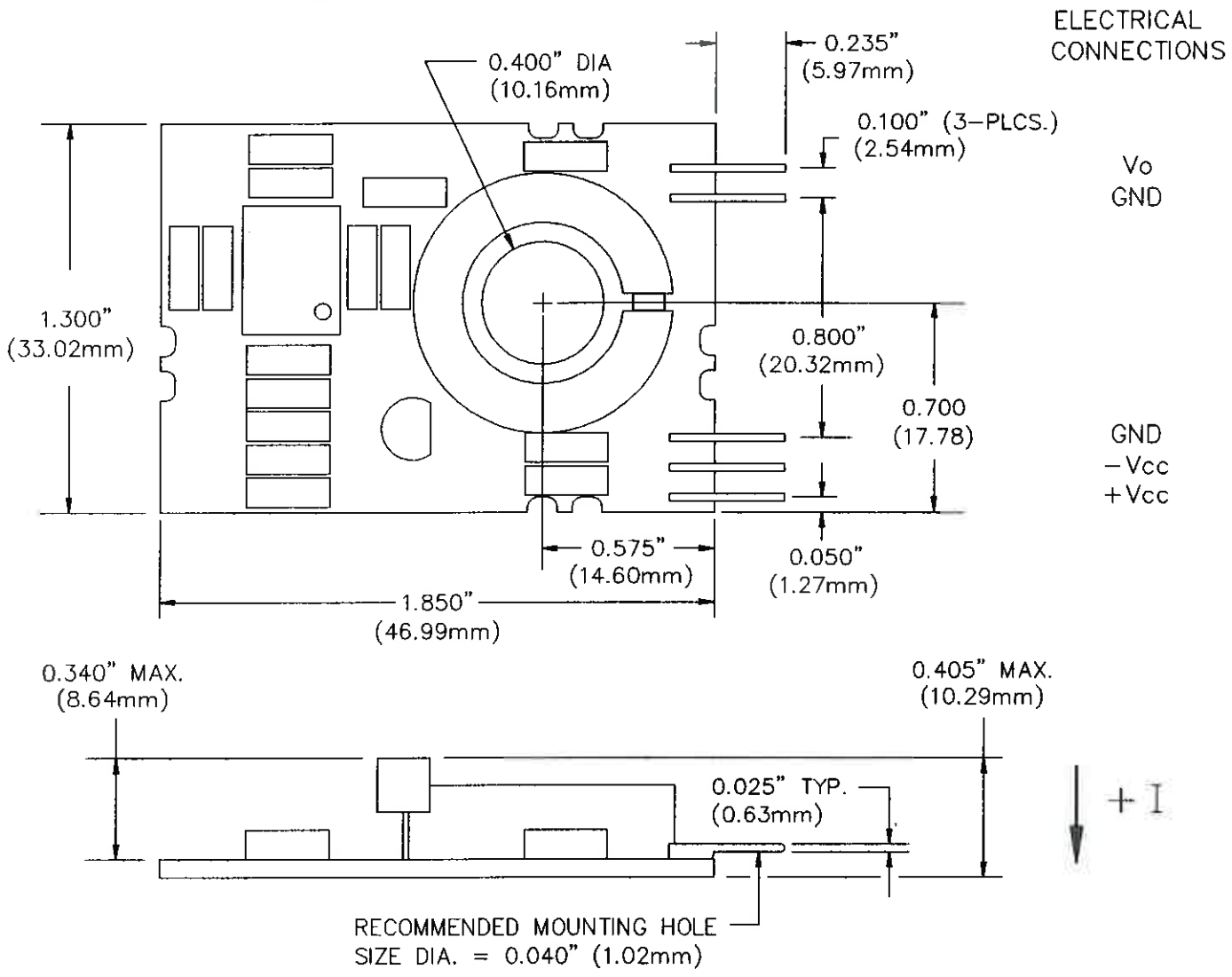
Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODELS BB-25/BB-100

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODELS BB-150,BB-300 and BB-600

Description:

The BB Series Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

Measuring Circuit	Units	BB-150	BB-300	BB-600
Full Scale (FS) dc or ac peak	± A	150	300	600
Full Scale output	± V		6	
AC Bandwidth (± 1 dB) (1)	kHz	60	10	10
Response time (2)	µs	<2	<3	<3
Slew rate	A/µs	>60	>50	>50
Excitation Circuit				
Supply voltage	± Vdc		15	
Maximum supply current, positive supply	mA		6	
Maximum supply current, negative supply	mA	15	10	10
Output				
Sensitivity	mV/A	40	20	10
Linearity	± %FS	0.6	0.7	1.25
Calibration point (3)	± % RDG		1.25	
Typical zero current offset	± mV		5	
Maximum zero current offset	± mV		20	
Maximum hysteresis of offset (4)	± mV	35	20	15
Minimum load resistance	k ohms		2	
Influence on Accuracy				
Typical offset drift with temperature	± mV/°C	0.30	0.15	0.15
Maximum offset drift with temperature	± mV/°C	1.50	1.00	0.50
Excitation change of ±1% Max. sensitivity change	±%		0.15	
Typical sensitivity drift with temperature	±%/°C		0.04	
Maximum sensitivity drift with temperature	±%/°C		0.065	
Withstand Capabilities				
Dielectric test (5)	kV		1.0	
Output short or open circuit			NO DAMAGE	
General Information				
Operating temperature range	°C		-25 to +85	
Storage temperature range	°C		-40 to +95	
Aperture opening	inches (mm)		0.80 (20.3)	
Weight	grams		60	
Mounting		Four mounting holes 0.120 inch (3.05 mm) diameter		
Output reference		To obtain a positive output on pin marked "Vo", positive conventional current must flow into the component side (See mechanical dimensions)		

Notes:

(1) Consult F.W. Bell if the product of the aperture current and frequency exceeds 1000 ampere-kilohertz for the BB-150 and 400 ampere kilohertz for the BB-300 and BB-600.

(2) Response time is effected by the positioning of the conductor in the aperture, the proximity of the return conductor and ferrous metals. It is best to test the sensor in the actual environment to obtain representative performance.

(3) The sensors are calibrated at 80% of Full Scale.

(4) Hysteresis specifications given for a Full Scale aperture current remnant.

(5) The dielectric test consists of 1.0 kVac at 60 Hz for one minute between a bare 0.775 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

Due to continuous process improvement, specifications are subject to change without notice.

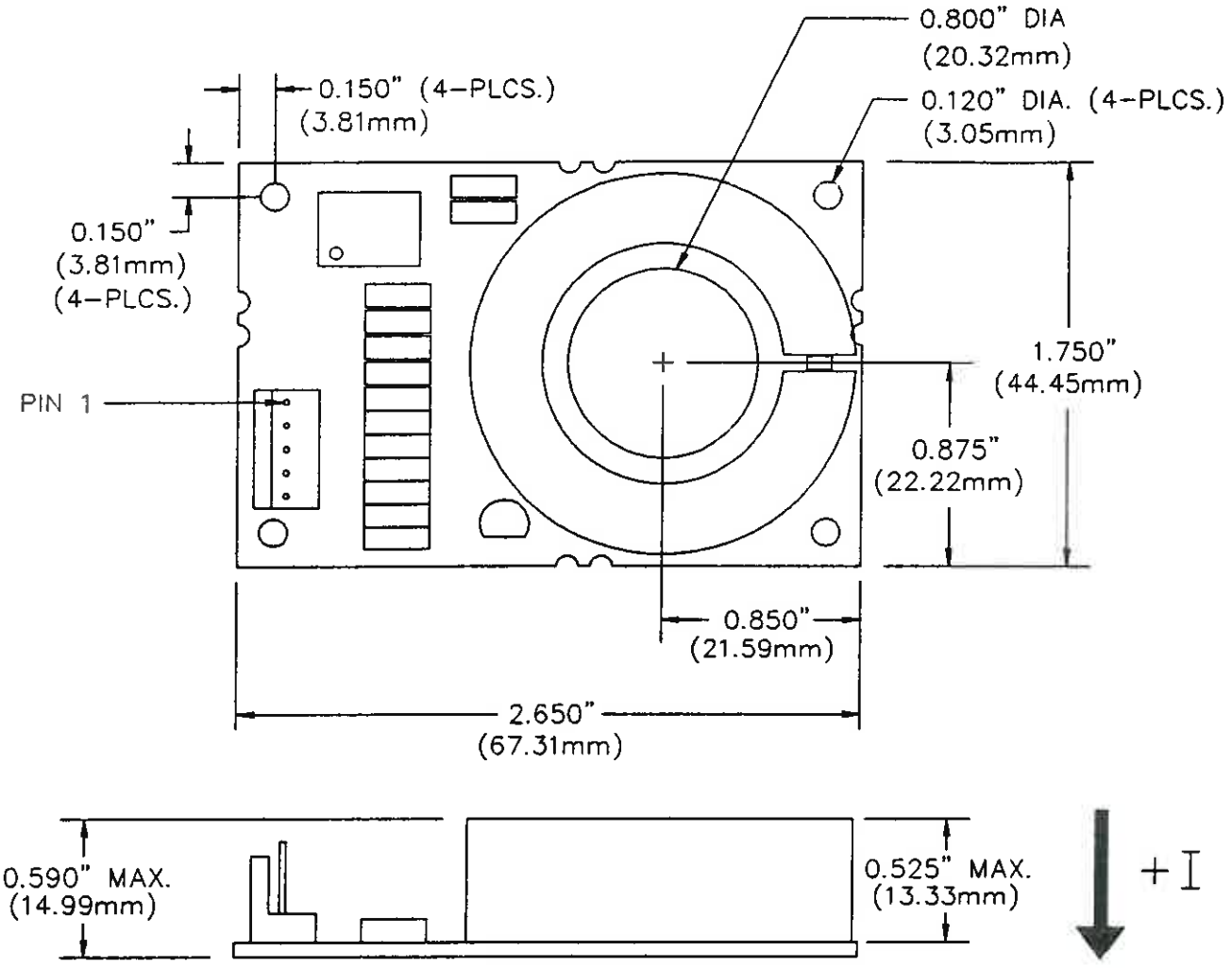
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODELS BB-150/BB-300/BB-600

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



Mating Connector: Panduit No. CE100F26–5 (331577)

ELECTRICAL CONNECTIONS

PIN 1	Vo
PIN 2	Vo GND
PIN 3	GND
PIN 4	–Vcc
PIN 5	+Vcc

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

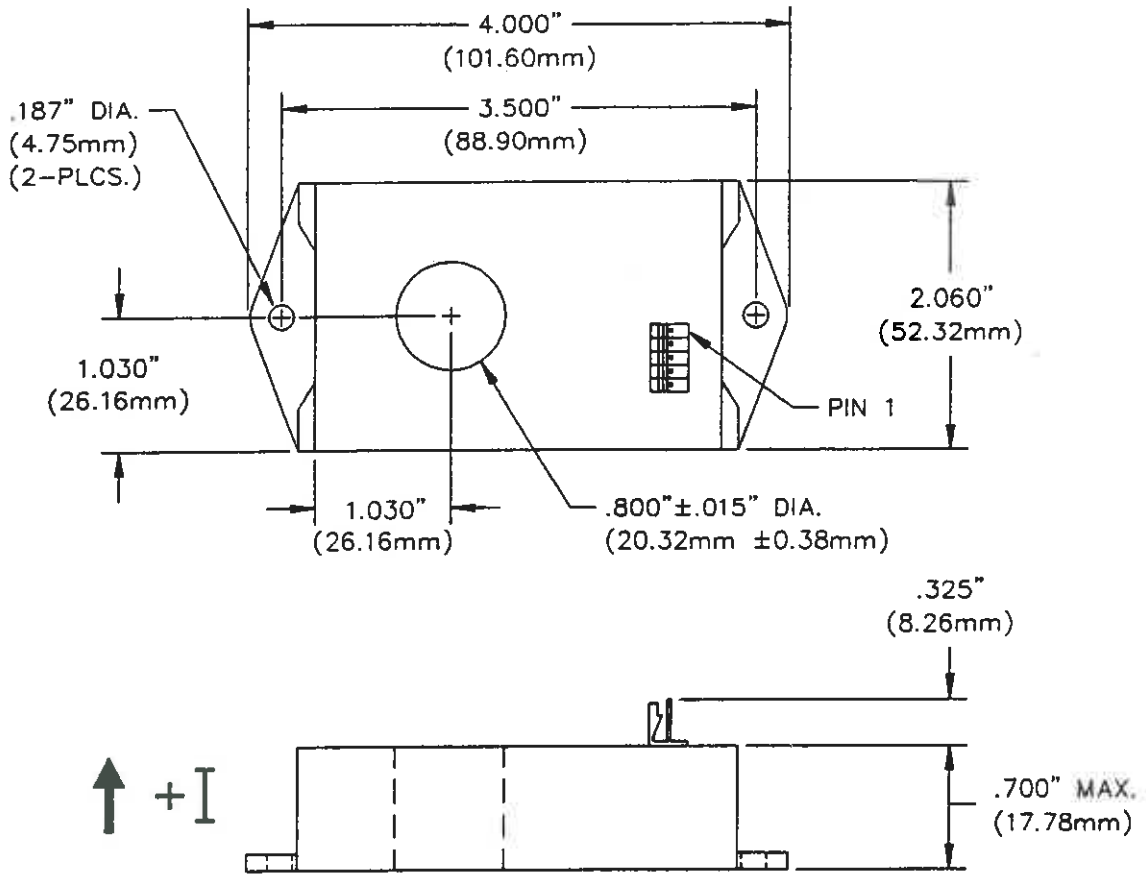
F.W. BELL

MODELS BBP-150F, BBP-300F and BBP-600F

Description:
The BBP Series Hall effect current sensors are potted in a flame retarded plastic case. Each sensor weighs 130 grams. The model number indicates the amperage rating (Example: BBP-150F = 150 A). Electrical specifications are the same as Models BB-150, BB-300 and BB-600, except the dielectric test is 4.0kV. (Refer to page 11 in catalog.)

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



Mating Connector: Panduit No. CE100F26-5 (331577)

ELECTRICAL CONNECTIONS

PIN	SIGNAL
1	Vo
2	Vo GND
3	GND
4	-Vcc
5	+Vcc

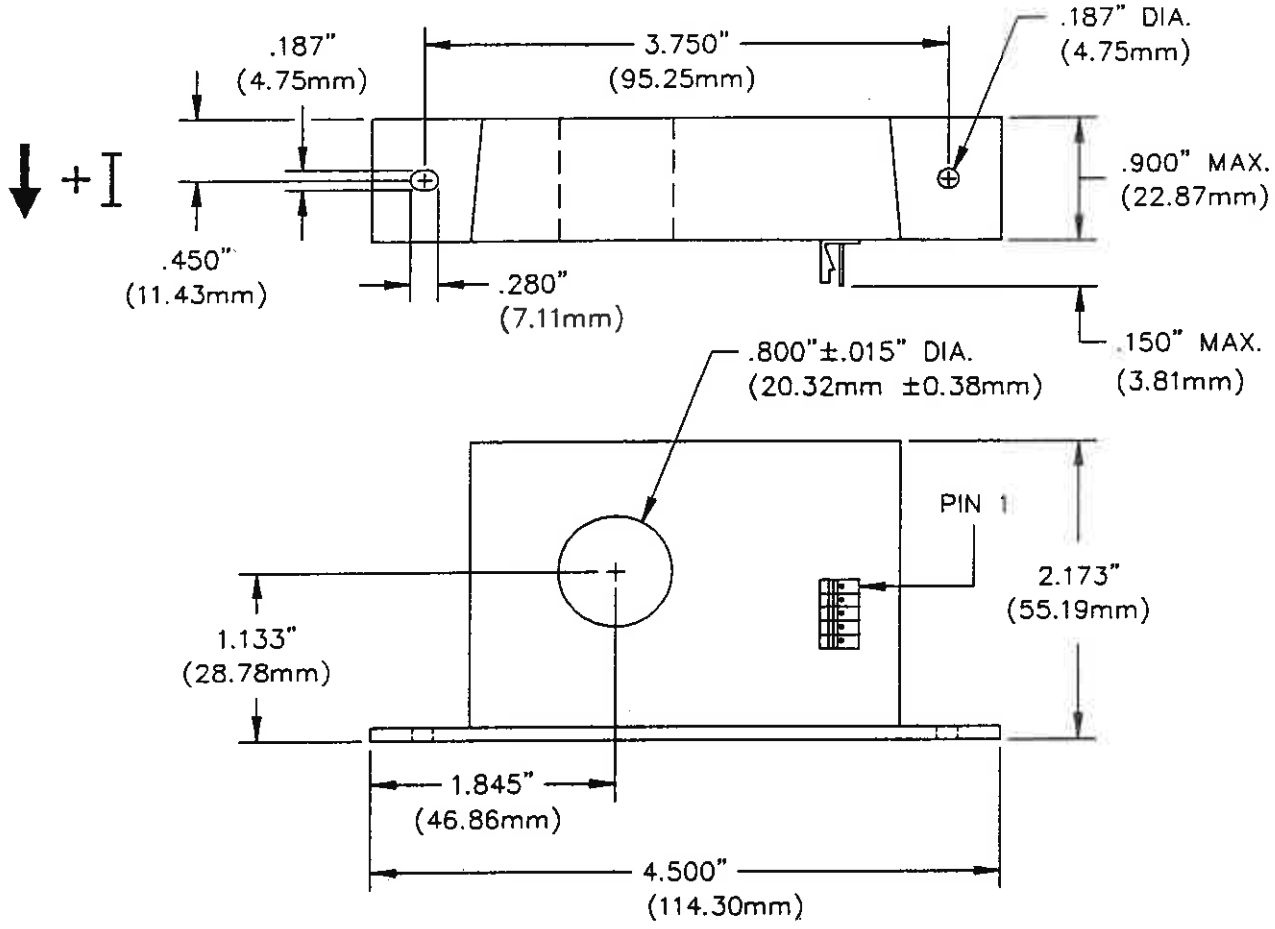
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODELS BBP-150H,BBP-300H and BBP-600H

Description:
The BBP Series Hall effect current sensors are potted in a flame retarded plastic case. Each sensor weighs 130 grams. The model number indicates the amperage rating (Example: BBP-150H = 150 A). Electrical specifications are the same as Models BB-150, BB-300 and BB-600, except the dielectric test is 4.0kV. (Refer to page 11 in catalog.)

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



Mating Connector: Panduit No. CE100F26-5 (331577)

ELECTRICAL CONNECTIONS

PIN	SIGNAL
1	Vo
2	Vo GND
3	GND
4	−Vcc
5	+Vcc

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODELS IHA-25 and IHA-100

Description:

The IHA Series Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

	Units	IHA-25	IHA-100
Measuring Circuit			
Full Scale (FS) dc or ac peak	± A	25	100
Full Scale output	± V	1	5
AC bandwidth (±1% of reading) (1)	kHz	50	
Response time (2)	µs	<1	
Slew rate	A/µs	>150	
Excitation Circuit			
Supply voltage	±Vdc	12 to 17	
Maximum supply current, positive supply (at 15V)	mA	10	
Maximum supply current, negative supply (at 15V)	mA	5	
Output			
Sensitivity	mV/A	40	50
Linearity	± % FS	<1	
Calibration point (3)	± % RDG	1.0	
Typical zero current offset	± mV	10	
Maximum zero current offset	± mV	20	
Maximum hysteresis of offset (4)	± mV	5	20
Minimum load resistance	k ohms	> 10	
Influences on accuracy			
Typical offset drift with temperature	± mV/° C	1	
Maximum offset drift with temperature	± mV/° C	2	
Excitation change of ±1% - Max. sensitivity change	± %	0.005	
Typical sensitivity drift with temperature	± %/° C	0.010	
Maximum sensitivity drift with temperature	± %/° C	0.015	
Withstand Capabilities			
Dielectric test (5)	kV	6	
Output short or open		NO DAMAGE	
General Information			
Operating temperature range	° C	0 to +75	
Storage temperature range	° C	-25 to +85	
Package		flame retarded plastic case	
Aperture opening	inches (mm)	0.38 (9.65)	
Weight	grams	25.9	
Mounting		Mounting tabs accept No. 6 screws. Can be mounted on PCB or panel via use of appropriate connector	
Output reference		To obtain a positive output on pin marked "Vo", positive conventional current must flow as per the direction of arrow marked on sensor.	

Notes:

(1) Consult F.W. Bell if the product of the aperture current and frequency exceeds 1000 ampere-kilohertz.

(2) Response time is effected by the output leads and the conductor in the aperture, the proximity of the return conductor and ferrous metals. It is best to test the sensor in the actual environment to obtain representative performance.

(3) The sensors are calibrated at 80% of Full Scale.

(4) Hysteresis specifications given for Full Scale aperture current remnant.

(5) The dielectric test consists of 6 kVac at 60 Hz for one minute between a bare 0.375 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

Due to continuous process improvement, specifications are subject to change without notice.

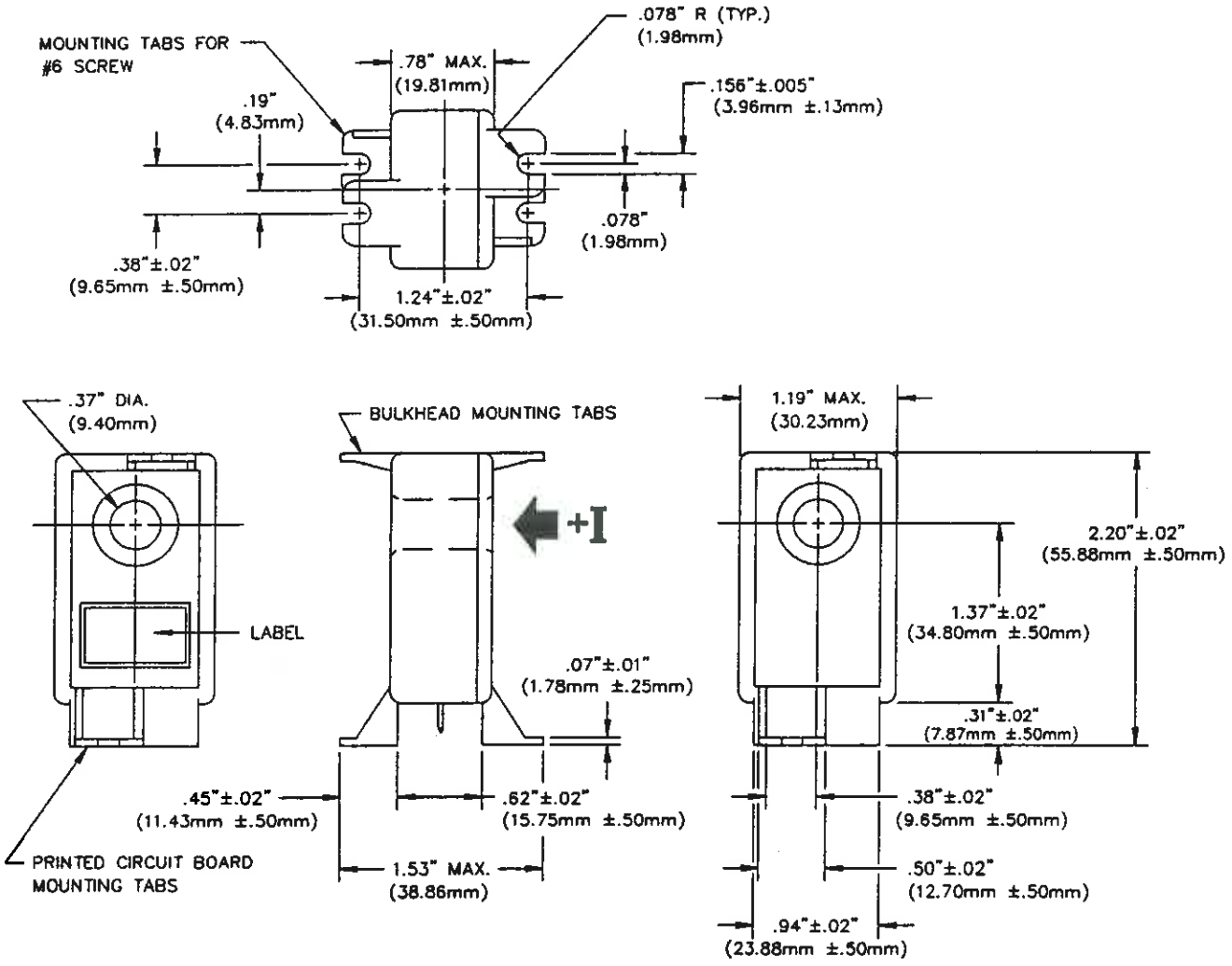
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

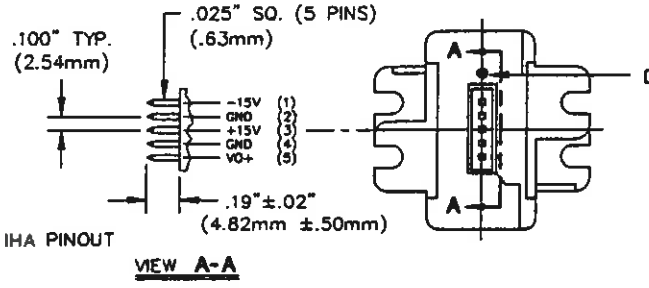
F.W. BELL

MODELS IHA-25/IHA-100

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)





MATING CONNECTOR

TYPE	F.W. BELL NO.	VENDOR NO.
PCB SOLDER	331569	SAMTEC SSW-105-02-G-S
RIBBON CABLE	331570	SAMTEC IDS-05-G

Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL IHA-150

Description:

The IHA-150 Hall effect current sensor accurately measures dc and ac currents and provides electrical isolation between the output of the sensor and the current carrying conductor.

Measuring Circuit	Units	IHA-150
Full Scale (FS) dc or ac peak	± A	150
Full Scale output	± V	5
AC bandwidth (±1% of reading) (1)	kHz	50
Response time (2)	µs	>1
Slew rate	A/µs	>150
Excitation Circuit		
Supply voltage	±Vdc	12 to 17
Maximum supply current, positive supply (at 15V)	mA	10
Maximum supply current, negative supply (at 15V)	mA	5
Output		
Sensitivity	mV/A	33.3
Linearity	± % FS	<1
Calibration point (3)	± % RDG	1.0
Typical zero current offset	± mV	10
Maximum zero current offset	± mV	20
Maximum hysteresis of offset (4)	± mV	35
Minimum load resistance	k ohms	>10
Influences on accuracy		
Typical offset drift with temperature	± mV/° C	1
Maximum offset drift with temperature	± mV/° C	2
Excitation change of ±1% - Max. sensitivity change	± %	0.005
Typical sensitivity drift with temperature	± %/° C	0.010
Maximum sensitivity drift with temperature	± %/° C	0.015
Withstand Capabilities		
Dielectric test (5)	kV	6
Output short or open		NO DAMAGE
General Information		
Operating temperature range	° C	0 to +75
Storage temperature range	° C	-25 to +85
Package		flame retarded plastic case
Aperture opening	inches (mm)	0.84 (21.33)
Weight	grams	94
Mounting		Mounting tabs accept No. 6 screws. Can be mounted on PCB or panel via use of appropriate connector.
Output reference		To obtain a positive output on pin marked "Vo", positive conventional current must flow as per the direction of arrow marked on sensor.

Notes:

(1) Consult F.W. Bell if the product of the aperture current and frequency exceeds 1000 ampere-kilohertz.

(2) Response time is effected by the output leads and the conductor in the aperture, the proximity of the return conductor and ferrous metals. It is best to test the sensor in the actual environment to obtain representative performance.

(3) The sensors are calibrated at 80% of Full Scale.

(4) Hysteresis specifications given for Full Scale aperture current remnant.

(5) The dielectric test consists of 6 kVac at 60 Hz for one minute between a bare 0.750 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

Due to continuous process improvement, specifications are subject to change without notice.

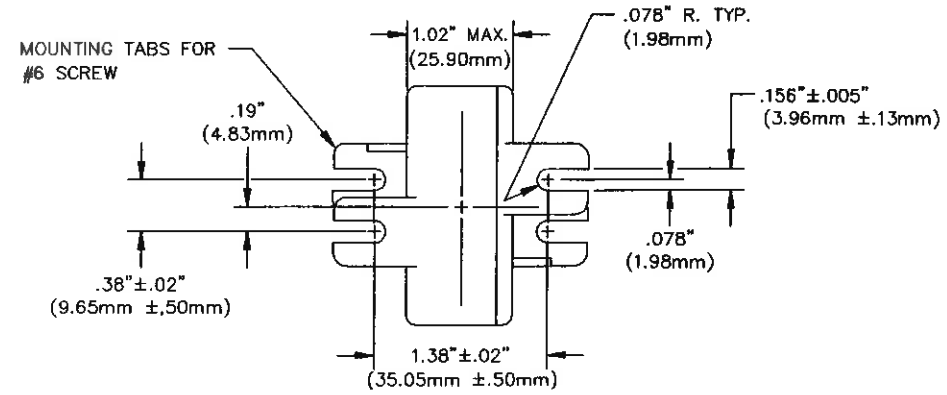
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

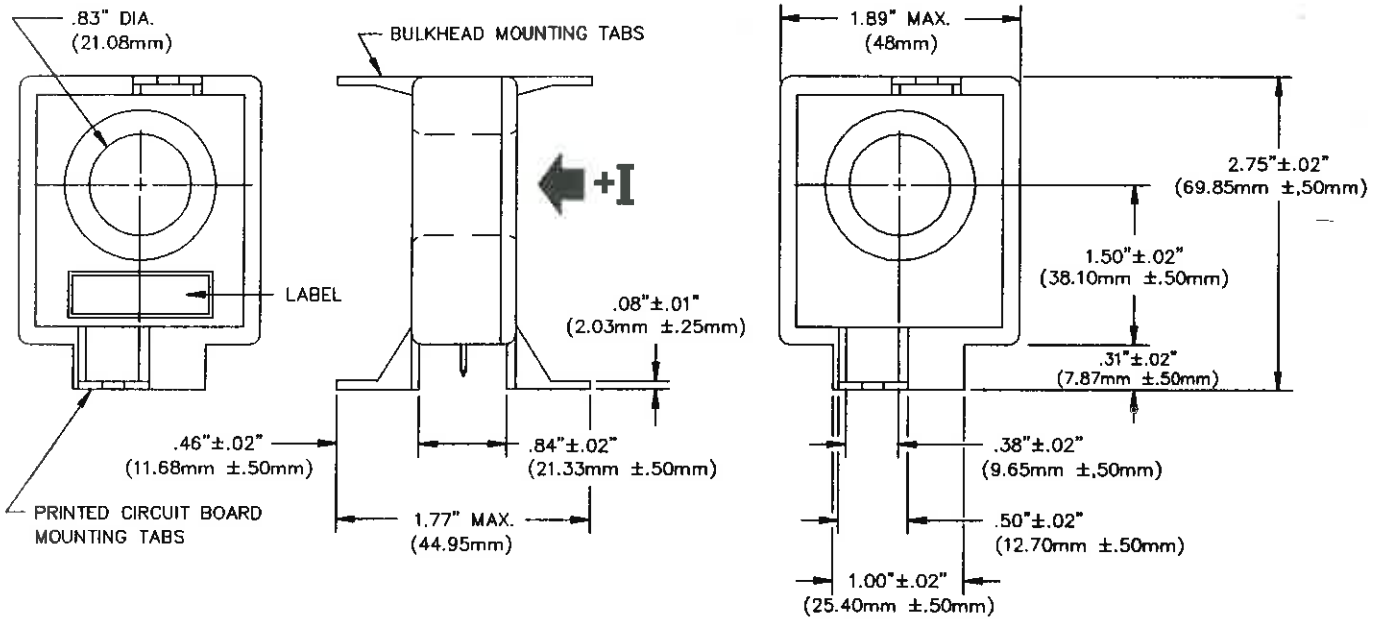
F.W. BELL

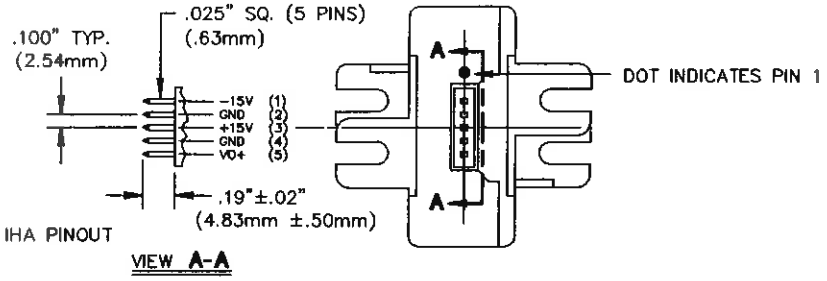
MODEL IHA-150

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)







MATING CONNECTOR

TYPE	F.W. BELL NO.	VENDOR NO.
PCB SOLDER	331569	SAMTEC SSW-105-02-G-S
RIBBON CABLE	331570	SAMTEC IDS-05-G

Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODELS PI and PI-600

Description:

The PI & PI-600 Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

	Units	PI	PI-600
Measuring Circuit			
Full Scale (FS) dc or ac peak	± A	350	600
Full Scale output (1)	± mV	175 to 385	150 to 330
AC bandwidth (±3 dB of reading) (2)	kHz	dc to 1	
Response time	µs	<50	
Excitation Circuit			
Maximum excitation current (I_C)	mA	40	
Input resistance	ohms	30 to 120	
Output			
Sensitivity	mV/A	0.5 to 1.1	0.25 to 0.55
Linearity	0-100 A	±1.5 A	
	100-350 A	±5.25 A	
	0-600 A		±12 A
Typical zero current offset	± mV	3	
Maximum zero offset	± mV	16	
Maximum hysteresis of offset (3)	± mV	2	1.4
Minimum load resistance	k ohms	> 10	
Output resistance	ohms	70 to 300	
Influences on accuracy			
Typical offset drift with temperature	± µV/° C	20	
Maximum offset drift with temperature	± µV/° C	50	
Excitation change of ±1% - Max. sensitivity change	± %	1	
Typical sensitivity drift with temperature	± %/° C	0.05	
Maximum sensitivity drift with temperature	± %/° C	0.07	
Withstand Capabilities			
Dielectric test (4)	kV	6	
Output short or open		NO DAMAGE	
General Information			
Operating temperature range	° C	-40 to +100	
Storage temperature range	° C	-40 to +110	
Package		Potted in flame retarded plastic case	
Aperture opening	inches (mm)	0.8 (20.3)	
Weight	grams	71	
Mounting		Hold down tabs secure sensor to PCB	
Output reference		To obtain a differentially positive output on pin marked $+V_H$, positive conventional current must flow as per the direction of arrow marked on sensor.	

Notes:

(1) All specifications are given with a control current (I_C) of 40 mA

(2) Consult F.W. Bell if the product of the aperture current and frequency exceeds 400 ampere-kilohertz.

(3) Hysteresis specifications given for Full Scale aperture current remnant.

(4) The dielectric test consists of 6 kVac at 60 Hz for one minute between a bare 0.750 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

Due to continuous process improvement, specifications are subject to change without notice.

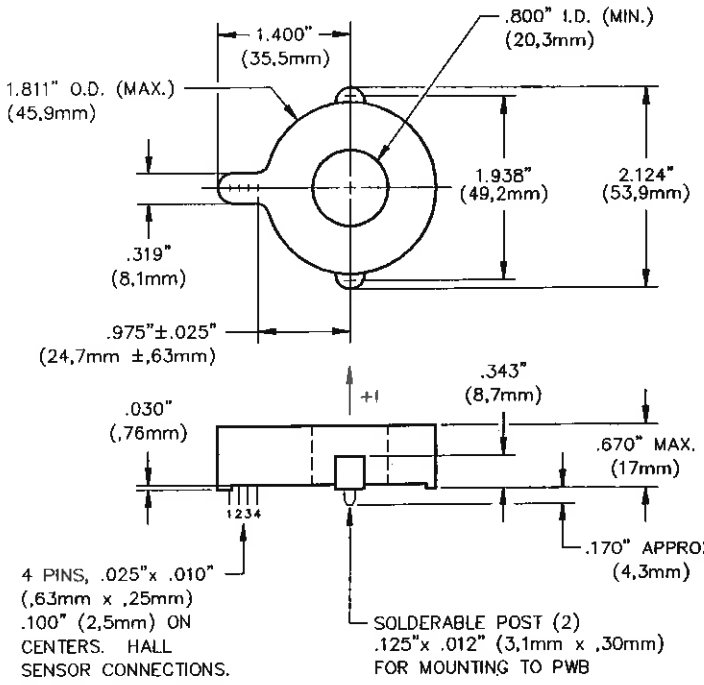
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODELS PI/PI-600

MECHANICAL DIMENSIONS

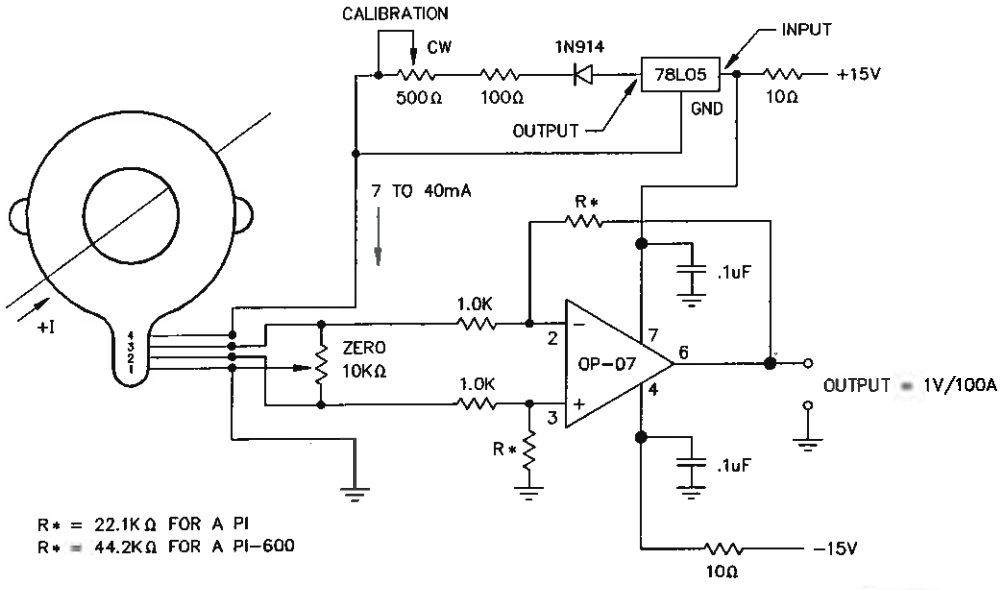
ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



PIN IDENTIFICATION

1	$-I_C$	NEGATIVE CONTROL CURRENT
2	$+V_H$	POSITIVE OUTPUT VOLTAGE
3	$-V_H$	NEGATIVE OUTPUT VOLTAGE
4	$+I_C$	POSITIVE CONTROL CURRENT

TYPICAL AMPLIFIER CIRCUIT FOR
CURRENT MEASUREMENTS



CAUTION: Either the excitation circuit or the output circuit may be grounded, but not both. When feeding two or more sensors from a common excitation supply, the output circuits must be kept isolated from each other.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

IA SERIES

Description:

The IA Series Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

Measuring Circuit	Units	IA-0100	IA-0250	IA-0500	IA-1000	IA-2000	IA-3000
Full Scale (FS) dc or ac peak	± A	100	250	500	1000	2000	3000
Full Scale output	± V	10					
Frequency range		dc (permissible ripple content <200 A rms at 360 Hz)					
Response time (1)	µs	<150					
Excitation Circuit							
Supply voltage	±Vdc	15					
Max. positive supply current	mA	50					
Max. negative supply current	mA	10					
Output							
Sensitivity	mV/A	100	40	20	10	5	3.3
Linearity	± %FS	0.5	0.5	0.5	0.5	0.5	0.6
Calibration point (2)	± %RDG	0.5					
Typical zero current offset	± mV	10					
Maximum zero current offset	± mV	50					
Maximum hysteresis of offset (3)	± mV	200	100	50	25	15	15
Minimum load resistance	k ohms	≥2					
Influences on accuracy							
Typical offset drift with temp.	± mV/° C	1					
Max. offset drift with temp.	± mV/° C	2					
Excitation change of ± 1%							
Max. sensitivity change	± %	0.03					
Typical sensitivity drift with temp.	± %/° C	.015					
Max. sensitivity drift with temp.	± %/° C	.02					
Withstand Capabilities							
Dielectric test (4)	kV	2.5					
Output short or open		NO DAMAGE					
General Information							
Operating temperature range	° C	-30 to +75					
Storage temperature range	° C	-40 to +85					
Package		rugged metal case					
Aperture opening	inches (mm	1.67 (42.4)					
Weight	Lbs. (grams)	5 Lbs.10 oz. (2.6 kg)					
Mounting	Five mounting holes 0.281 inch (7.5 mm) diameter on steel base plate						
Output reference	To obtain a positive output on the terminal marked "+Vo", positive conventional current must flow as per the direction of the arrow marked on the sensor.						

Notes:

(1) Response time is effected by the output leads and the conductor in the aperture, the proximity of the return conductor and ferrous metals. It is best to test the sensor in the actual environment to obtain representative performance.

(2) The sensors are calibrated at 80% of Full Scale.

(3) Hysteresis specifications given for Full Scale aperture current remnant.

(4) The dielectric test consists of 2.5 kVac at 60 Hz for one minute between a bare 1.5 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

Due to continuous process improvement, specifications are subject to change without notice.

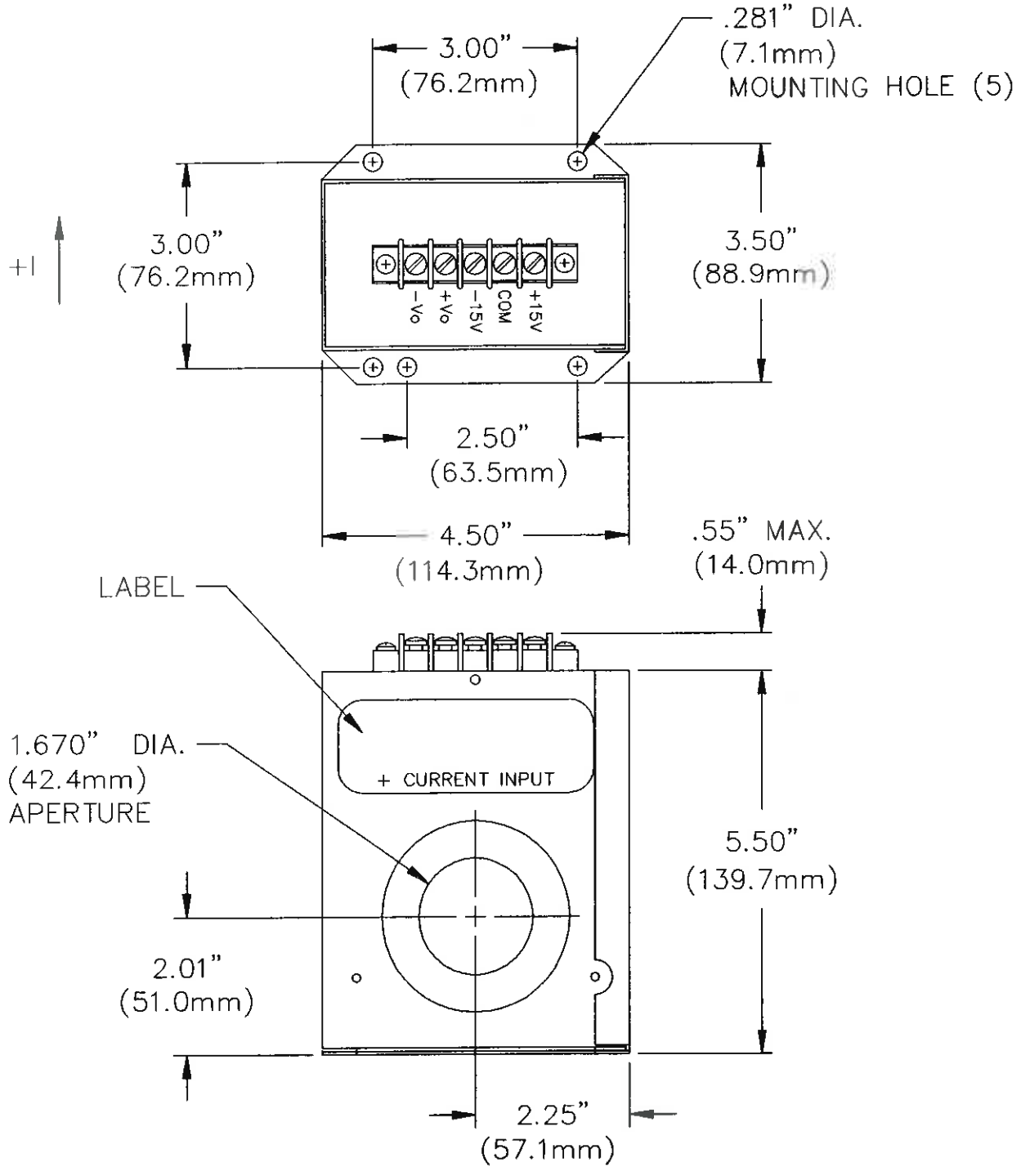
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

IA SERIES

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

IF SERIES

Description:

The IF Series Hall effect current sensors accurately measure dc and ac currents and provide electrical isolation between the output of the sensor and the current carrying conductor.

Measuring Circuit	Units	IF-0100	IF-0250	IF-0500	IF-1000	IF-2000	IF-3000
Full Scale (FS) dc or ac peak	± A	100	250	500	1000	2000	3000
Full Scale output	± V	10					
AC Bandwidth (1)	kHz	dc to 1					
Response time (2)	µs	<150					
Excitation Circuit							
Supply voltage	±Vdc	15					
Max. positive supply current	mA	50					
Max. negative supply current	mA	10					
Output							
Sensitivity	mV/A	100	40	20	10	5	3.3
Linearity	± %FS	0.5	0.5	0.5	0.5	0.5	0.6
Calibration point (3)	± %RDG	0.5					
Typical zero current offset	± mV	10					
Maximum zero current offset	± mV	50					
Maximum hysteresis of offset (4)	± mV	200	100	50	25	15	15
Minimum load resistance	k ohms	≥2					
Influences on accuracy							
Typical offset drift with temp.	± mV/° C	1					
Max. offset drift with temp.	± mV/° C	2					
Excitation change of ± 1%							
Max. sensitivity change	± %	.03					
Typical sensitivity drift with temp.	± %/° C	.015					
Max. sensitivity drift with temp.	± %/° C	.02					
Withstand Capabilities							
Dielectric test (5)	kV	2.5					
Output short or open		NO DAMAGE					
General Information							
Operating temperature range	° C	-30 to +75					
Storage temperature range	° C	-40 to +85					
Package		flame retarded plastic case					
Aperture opening	inches (mm)	1.67 (42.4)					
Weight	Lbs. (grams)	3 Lbs. 6 oz. (1.5 kg)					
Mounting		Four through holes 0.193 inch (4.9 mm) diameter					
Output reference		To obtain a positive output on the terminal marked "Vo", positive conventional current must flow as per the direction of the arrow marked on the sensor.					

Notes:

(1) Consult F.W. Bell if the product of the aperture current and frequency exceeds 400 ampere-kilohertz.

(2) Response time is effected by the output leads and the conductor in the aperture, the proximity of the return conductor and ferrous metals. It is best to test the sensor in the actual environment to obtain representative performance.

(3) The sensors are calibrated at 80% of Full Scale.

(4) Hysteresis specifications given for Full Scale aperture current remnant.

(5) The dielectric test consists of 2.5 kVac at 60 Hz for one minute between a bare 1 1/2 inch diameter conductor (located concentrically through the aperture) and the output of the sensor.

Due to continuous process improvement, specifications are subject to change without notice.

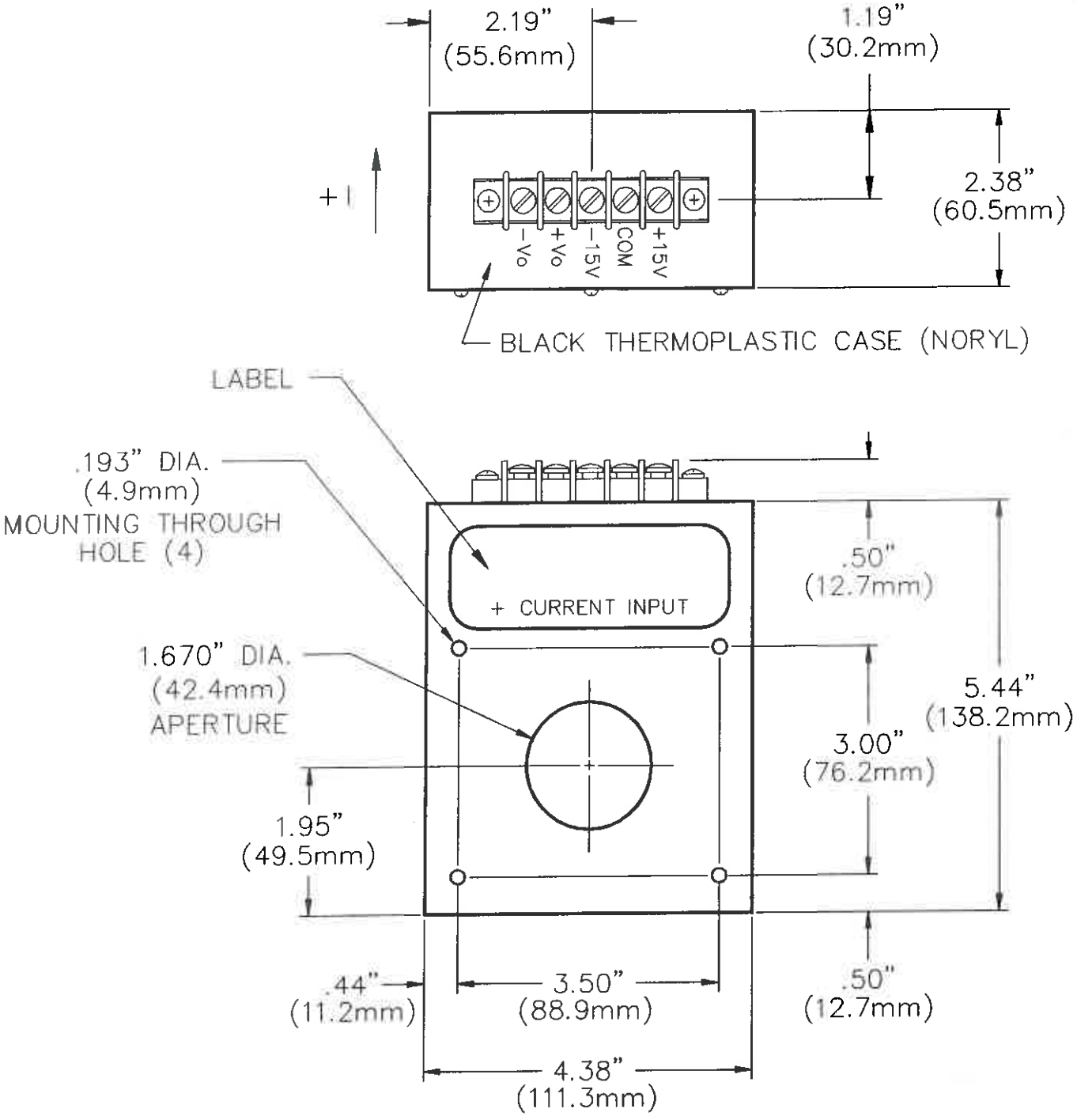
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

IF SERIES

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

6. CLOSED LOOP CURRENT SENSORS

- **Fast response**
- **Wide bandwidth**
- **Excellent linearity**
- **Low temperature drift**

Index

* CL-25 offers a choice of 5 current ranges: 5,6,8,12, or 25 Arms

Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

6.1 Closed Loop Current Sensor Glossary of Terms

Nominal current (I_N): The continuos current that the sensor can accurately measure

Measuring range: The peak current that the sensor can measure within its specifications

Sense resistor: The minimum and maximum resistance needed across the output of the sensor in order to safely operate within specifications

Nominal analog output current: The output current when the sensor is measuring current at its nominal rating (I_N)

Turns ratio: The ratio of the number of turns through the aperture of the sensor to the number of turns on the compensation coil

Overall accuracy: The accuracy stated as a percentage of reading when measuring current at its nominal rating (I_N)

Supply voltage: The voltage required to operate the sensor within specifications

Dielectric strength: AC RMS voltage potential between the conductor through the aperture of the sensor and the output which the sensor can withstand for a stated time period

Zero current offset at 25 °C: The output offset when the sensor is measuring zero current

Offset current temperature drift: The change in offset over the sensor's operating temperature range

Linearity: Output deviation from a straight line response to the current being measured

Response time: The time required for the sensor to respond to a step function change in current

di/dt accurately followed: A linear rate of change in current that the sensor can accurately measure

Bandwidth: The frequency range over which the sensor is designed to measure

Operating temperature: The temperature range over which the sensor is designed to operate within specifications

Storage temperature: The temperature range over which the sensor can be stored without damage

Current drain: The current necessary to operate the sensor

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODEL CL-25

Description:

The Model CL-25 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Electrical Specifications

Nominal current (I_N)	25 Ampere turns rms	
Measuring range *	0 to 36 Ampere turns (A.t.)	
Sense resistor	R. min.	R. max.
with ± 12 V at 25 A.t. peak	22 ohms	200 ohms
at 36 A.t. peak	22 ohms	140 ohms
with ± 15 V at 25 A.t. peak	100 ohms	320 ohms
at 36 A.t. peak	100 ohms	190 ohms
Nominal analog output current	25 mA	
Turns ratio	1-2-3-4-5:1000	
Overall accuracy at 25 °C and ±12 V	± 0.7% of I_N	
Overall accuracy at 25 °C and ± 15 V	± 0.6% of I_N	
Supply voltage (Vdc)	± 12 to ± 15	
Dielectric strength	between the current carrying conductor and the output of the sensor: 2.5 kV rms/50 Hz/1 min.	

Accuracy-Dynamic Performance

	Typical	Max.
Zero current offset at 25 °C (± 15V)	± 0.05 mA	± 0.15 mA
Residual current offset after an overload of 3 x I_N	± 0.05 mA	± 0.15 mA
Offset current temperature drift (± 15V)		
(between 0 °C and +25 °C)	± 0.06 mA	± 0.25 mA
(between +25 °C and +70 °C)	± 0.1 mA	± 0.35 mA
Linearity	better than ±0.2%	
Response time	less than 1 µs	
di/dt accurately followed	better than 50 A/µs	
Bandwidth	0 to 150 kHz (- 1 dB)	

General Information

Operating temperature	0 °C to +70 °C
Storage temperature	-25 °C to +85 °C
Current drain	10 mA (at ± 15 V) plus output current
Coil resistance	110 ohms (at 70 °C)
Package	Potted in flame retarded plastic case
Weight	22 grams
Mounting	Designed to mount directly on PCB via through hole connection pins
Output reference	To obtain a positive output on the terminal marked "OUT", current must flow from terminals 1,2,3,4 and 5 to terminals 10,9,8,7 and 6 (conventional flow)

Notes: *The CL-25 offers a choice of 5 measuring ranges (refer to the back side of this sheet)
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODEL CL-25

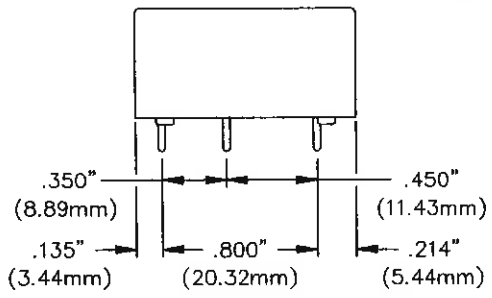
Measuring Range Table

NUMBER OF TURNS OF I_N	I_N (A)	peak (A)	NOMINAL OUTPUT CURRENT (mA)	TURN RATIO	INSERTION LOSS RESISTANCE (mΩ)	INSERTION LOSS INDUCTANCE (uH)	RECOMMENDED CONNECTIONS
1	25	36	25	1/1000	0.3	0.023	
2	12	18	24	2/1000	1.1	0.09	
3	8	12	24	3/1000	2.5	0.21	
4	6	9	24	4/1000	4.4	0.37	
5	5	7	25	5/1000	6.3	0.58	

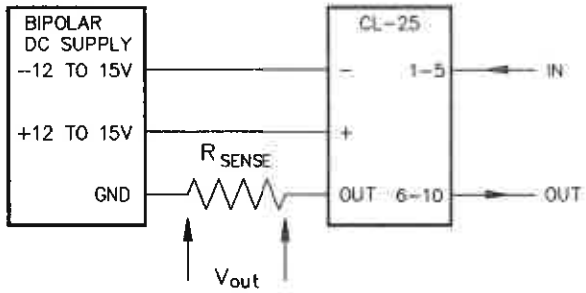
MECHANICAL DIMENSIONS

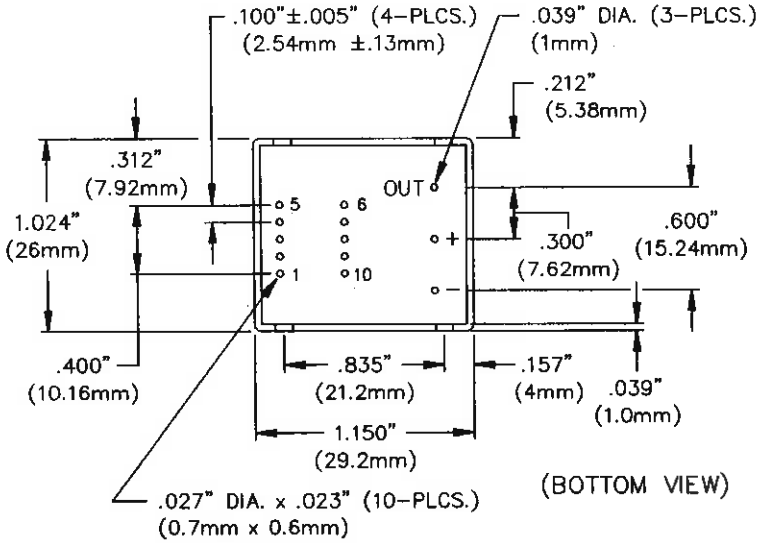
ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

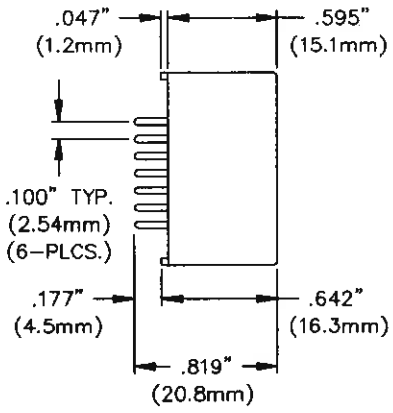
RECOMMENDED MOUNTING HOLE DIAMETER: .047" (1.2mm)



CONNECTION SCHEMATIC:







Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL CL-50

The Model CL-50 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Description:

Nominal current (I_N)	50 A rms
Measuring range	0 to ± 70 A

Electrical Specifications

	at 70 °C			at 85 °C	
Sense resistor	R min.	R max.		R min.	R max.
with ± 12 V at ± 50 A peak	10 ohms	100 ohms		60 ohms	95 ohms
at ± 70 A peak	10 ohms	50 ohms	(± 60 A max.) *	60 ohms	60 ohms
with ± 15 V at ± 50 A peak	50 ohms	160 ohms		135 ohms	155 ohms
at ± 70 A peak	50 ohms	90 ohms	(± 55 A max.) *	135 ohms	135 ohms

Nominal analog output current	50 mA
Turns ratio	1:1000
Overall accuracy at 25 °C and ± 12 V	± 0.9% of I_N
Overall accuracy at 25 °C and ± 15 V	±0.65% of I_N
Supply voltage (Vdc)	± 12 to ± 15
Dielectric strength	between the current carrying conductor and the output of the sensor: 2 kV rms/50 Hz/1 min.

Accuracy-Dynamic Performance

Zero current offset at 25 °C	± 0.2 mA max.	
Residual current offset after an overload of 3x I_N	±0.3 mA max.	
Offset current temperature drift		
(between 0 °C and +70 °C)	± 0.1 mA typical	± 0.5 mA max.
(between -25 °C and +85 °C)	± 0.1 mA typical	± 0.6 mA max.
Linearity	better than ±0.15%	
Response time	less than 500 ns	
di/dt accurately followed	better than 200 A/µs	
Bandwidth	0 to 200 kHz (- 1 dB)	

General Information

Operating temperature	-25 °C to +85 °C	
Storage temperature	-40 °C to +90 °C	
Current drain	10 mA (at ± 15 V) plus output current	
Coil resistance	80 ohms (at 70 °C)	85 ohms (at +85 °C)
Package	flame retarded plastic case	
Weight	18 grams	
Mounting	Designed to mount directly on PCB via through hole connection pins.	
Aperture size	0.500" x 0.276" (12.7 mm x 7 mm)	
Output reference	To obtain a positive output on the terminal marked "OUT", aperture current must flow in the direction of the arrow (Conventional flow)	

Notes:

* Peak current at +85 °C
- The temperature of the current carrying conductor should not exceed 90 °C
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

Due to continuous process improvement, specifications are subject to change without notice.

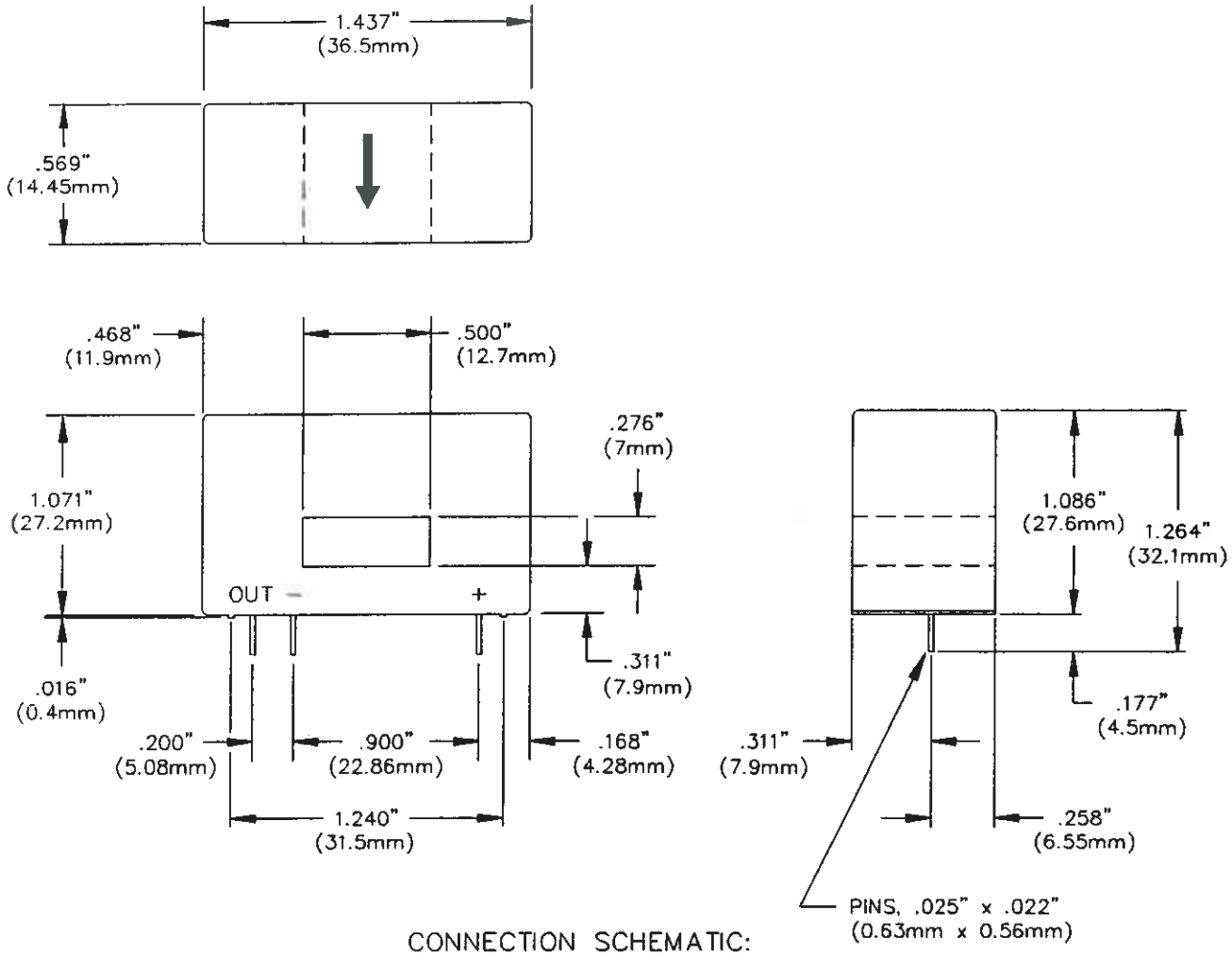
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODEL CL-50

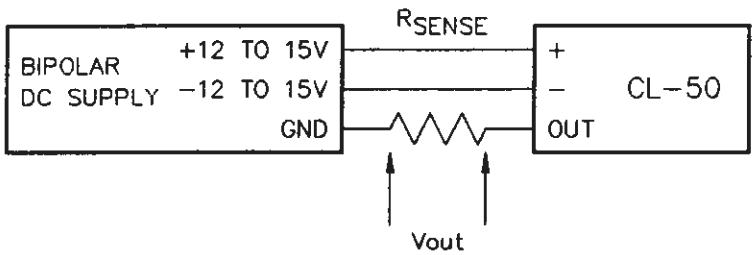
MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

RECOMMENDED MOUNTING HOLE DIAMETER: .035" (0.9mm)



CONNECTION SCHEMATIC:



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL CL-100

Description:

The Model CL-100 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Electrical Specifications

Nominal current (I_N)		100 A rms	
Measuring range		0 to ±150 A	
Sense resistor		R. min.	R. max.
with ± 12 V	at 100 A peak	30 ohms	55 ohms
	at 150 A peak	30 ohms	30 ohms
with ± 15 V	at 100 A peak	30 ohms	85 ohms
	at 150 A peak	30 ohms	45 ohms
Nominal analog output current		100 mA	
Turns ratio		1:1000	
Overall accuracy at 25 °C and ±12 V		± 0.7% of I_N	
Overall accuracy at 25 °C and ± 15 V		± 0.5% of I_N	
Supply voltage (Vdc)		± 12 to ± 15	
Dielectric strength		between the current carrying conductor and the output of the sensor: 3 kV rms/50 Hz/1 min.	

Accuracy-Dynamic Performance

Zero current offset at 25 °C	± 0.4 mA max.
Offset current temperature drift (between 0 °C and +70 °C)	± 0.3 mA typical ± 0.6 mA max.
Linearity	better than ±0.1%
Response time	less than 1 µs
di/dt accurately followed	better than 50 A/µs
Bandwidth	0 to 150 kHz (- 1 dB)

General Information

Operating temperature	0 °C to +70 °C
Storage temperature	-25 °C to +85 °C
Current drain	10 mA (at ± 15 V) plus output current
Coil resistance	30 ohms (at 70 °C)
Package	Potted in flame retarded plastic case
Weight	50 grams
Mounting	Designed to mount directly on PCB via through hole connection pins. Two self threading holes for mounting screws
Aperture size	0.394" (10 mm)
Output reference	To obtain a positive output on the terminal marked "OUT", aperture current must flow in the direction of the arrow (conventional flow)

Notes:
- The temperature of the current carrying conductor should not exceed 100 °C
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

Due to continuous process improvement, specifications are subject to change without notice.

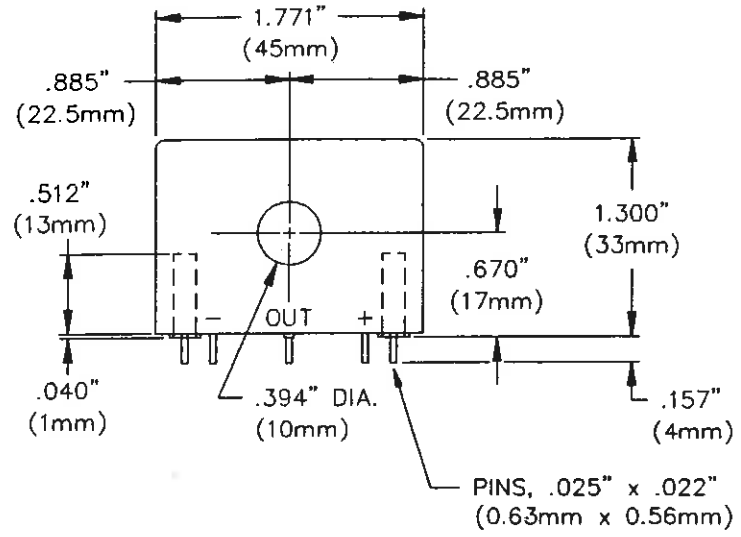
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODEL CL-100

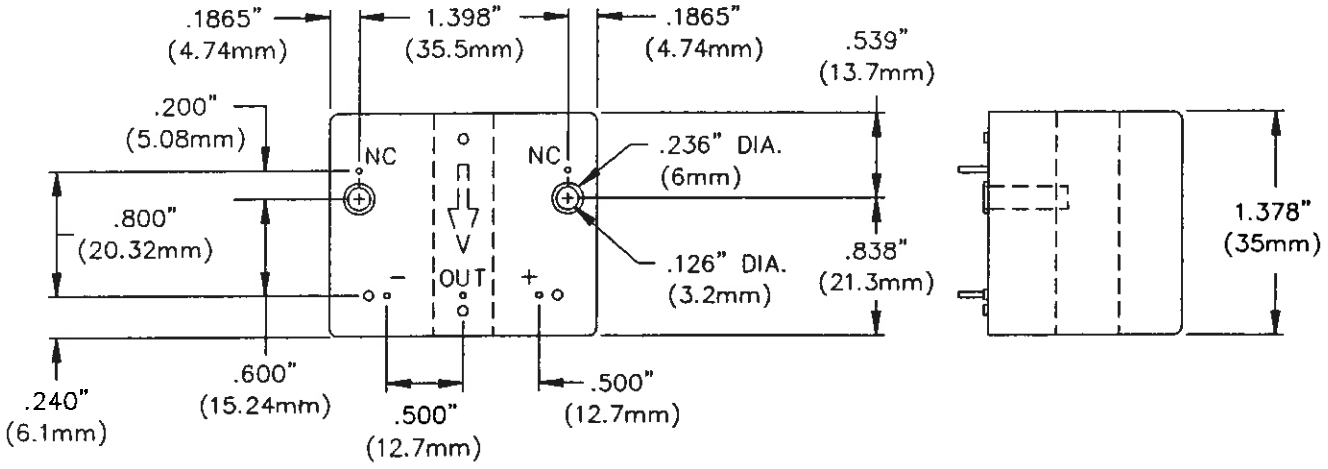
MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

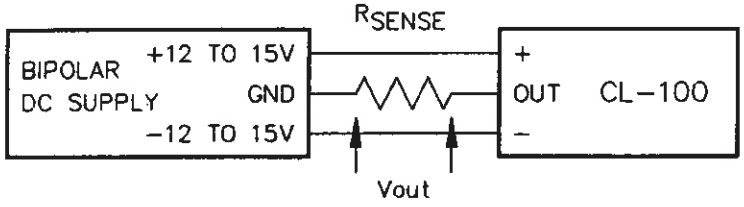
RECOMMENDED MOUNTING HOLE DIAMETER .040" (1mm)



OPTIONAL MOUNTING SCREW
NO. KA35X12 A2
(2–PLCS.)



CONNECTION SCHEMATIC:



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL CL-200

Description:

The Model CL-200 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Electrical Specifications

Nominal current (I_N)		200 A rms	
Measuring range		0 to ± 300 A	
Sense resistor		R. min.	R. max.
with ± 12 V	at ± 200 A peak	0 ohms	65 ohms
	at ± 300 A peak	0 ohms	30 ohms
with ± 15 V	at ± 200 A peak	20 ohms	80 ohms
	at ± 300 A peak	20 ohms	40 ohms
with ± 18 V	at ± 200 A peak	50 ohms	120 ohms
	at ± 300 A peak	50 ohms	65 ohms
Nominal analog output current		100 mA	
Turns ratio		1:2000	
Overall accuracy at 25 °C		± 0.5% of I_N	
Supply voltage (Vdc)		± 12 to ± 18	
Dielectric strength		between the current carrying conductor and the output of the sensor: 6 kV rms/50 Hz/1 min.	

Accuracy-Dynamic Performance

Zero current offset at 25 °C	± 0.3 mA max.	
Offset current temperature drift (between 0 °C and +70 °C)	± 0.3 mA typical	± 0.5 mA max.
Linearity	better than ±0.1%	
Response time	less than 1 µs	
di/dt accurately followed	better than 50 A/µs	
Bandwidth	0 to 150 kHz (- 1 dB)	

General Information

Operating temperature	0 °C to +70 °C
Storage temperature	-25 °C to +85 °C
Current drain	10 mA (at ± 18 V) plus output current
Coil resistance	35 ohms (at 70 °C)
Package	flame retarded plastic case
Weight	200 grams
Mounting	Panel mount via 2 holes in base plate
Aperture size	0.787 inch diameter (20 mm)
Output connection	3 Faston terminals 0.250" x .032" (6.35 mm x 0.81mm)
Output reference	To obtain a positive output on the terminal marked "OUT", aperture current must flow in the direction of the arrow (Conventional flow)

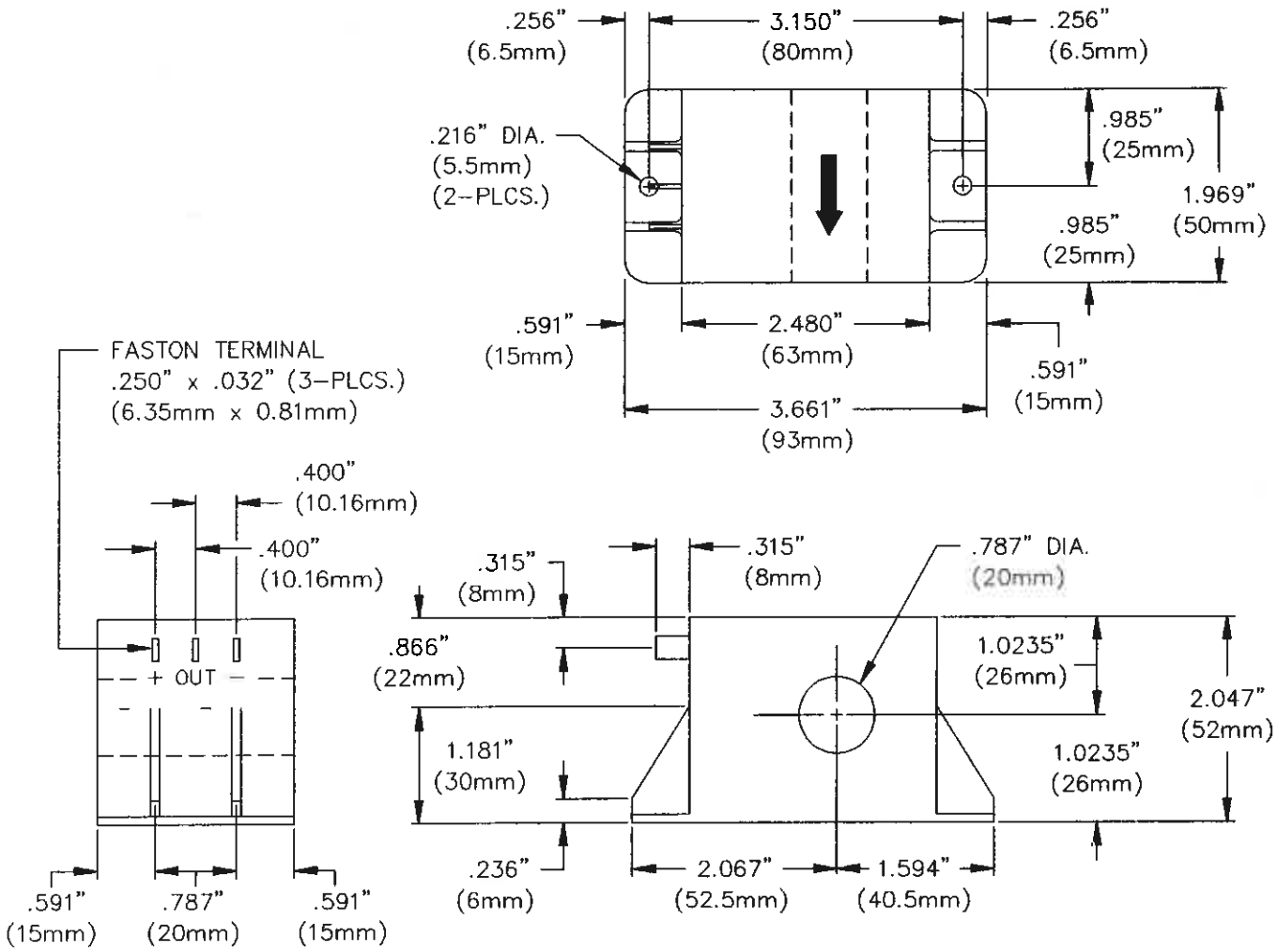
Notes:
- The temperature of the current carrying conductor should not exceed 100 °C
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

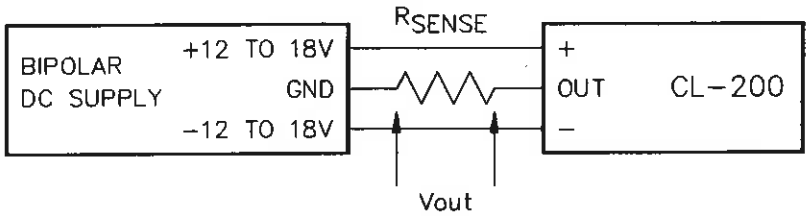
MODEL CL-200

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



CONNECTION SCHEMATIC:



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL CL-300

Description:

The Model CL-300 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Electrical Specifications

Nominal current (I_N)	300 A rms	
Measuring range	0 to ± 500 A	
Sense resistor	R. min.	R. max.
with ± 12 V at ± 300 A peak	0 ohms	30 ohms
at ± 500 A peak	0 ohms	5 ohms
with ± 15 V at ± 300 A peak	5 ohms	50 ohms
at ± 500 A peak	5 ohms	15 ohms
with ± 18 V at ± 300 A peak	20 ohms	70 ohms
at ± 500 A peak	20 ohms	25 ohms
Nominal analog output current	150 mA	
Turns ratio	1:2000	
Overall accuracy at 25 °C	± 0.5% of I_N	
Supply voltage (Vdc)	± 12 to ± 18	
Dielectric strength	between the current carrying conductor and the output of the sensor: 6 kV rms/50 Hz/1 min.	

Accuracy-Dynamic Performance

Zero current offset at 25 °C	± 0.3 mA max.	
Offset current temperature drift (between 0 °C and +70 °C)	± 0.3 mA typical	± 0.5 mA max.
Linearity	better than ±0.1%	
Response time	less than 1 µs	
di/dt accurately followed	better than 50 A/µs	
Bandwidth	0 to 150 kHz (- 1 dB)	

General Information

Operating temperature	0 °C to +70 °C
Storage temperature	-25 °C to +85 °C
Current drain	28 mA (at ± 18 V) plus output current
Coil resistance	35 ohms (at 70 °C)
Package	flame retarded plastic case
Weight	230 grams
Mounting	Panel mount via 2 holes in base plate
Aperture size	0.787 inch diameter (20 mm)
Output connection	3 Faston terminals 0.250" x 0.32" (6.32 mm x 0.81 mm)
Output reference	To obtain a positive output on the terminal marked "OUT", aperture current must flow in the direction of the arrow (Conventional flow)

Notes:
- The temperature of the current carrying conductor should not exceed 100 °C
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

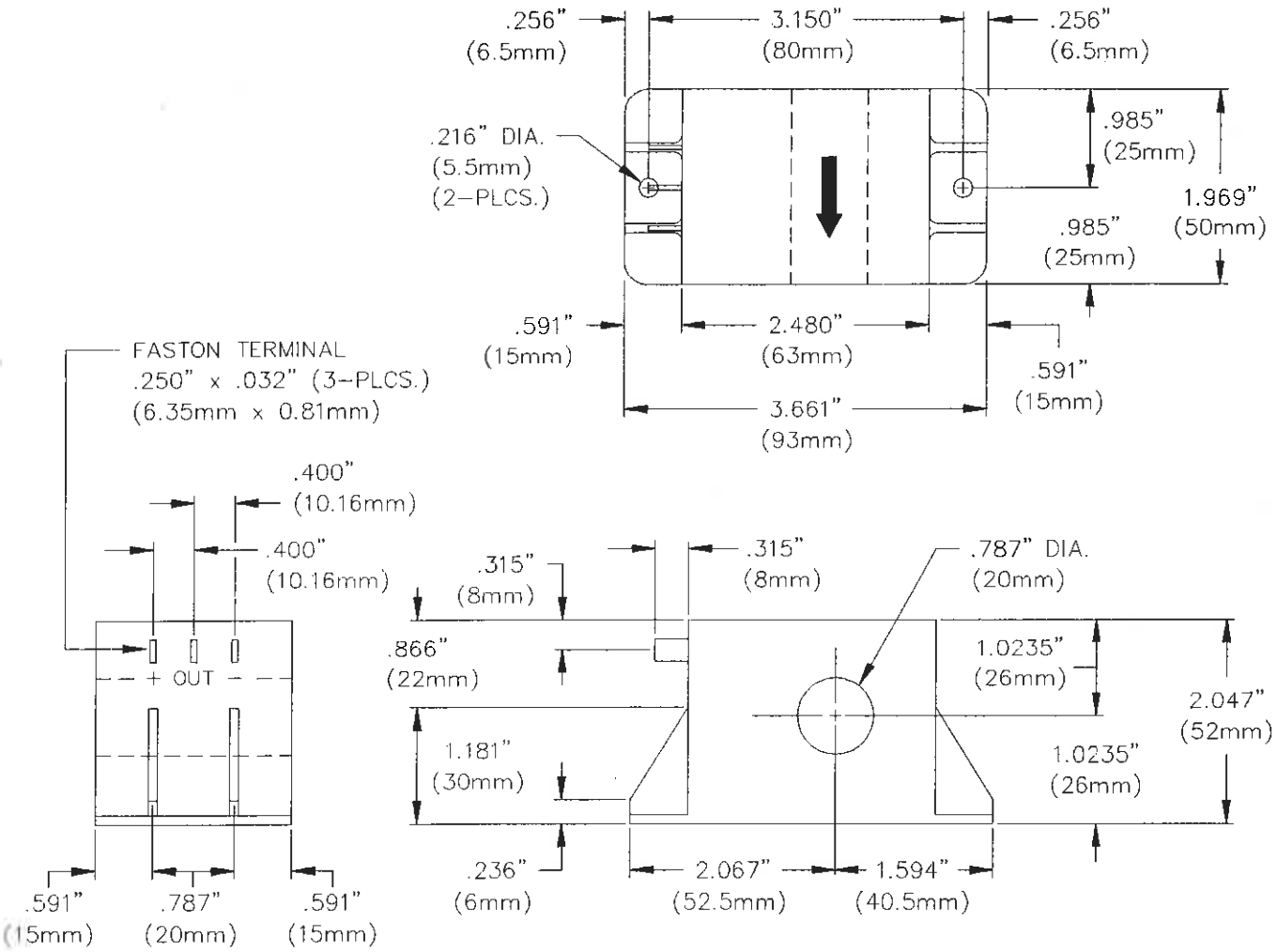
Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

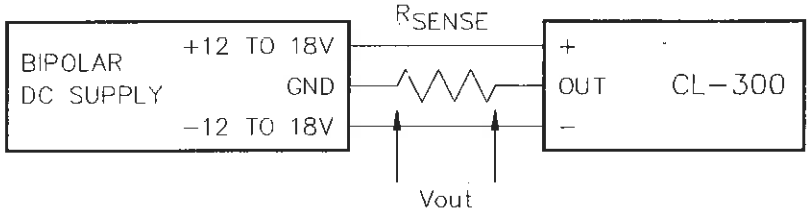
MODEL CL-300

MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



CONNECTION SCHEMATIC:



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL CL-500

Description:

The Model CL-500 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Electrical Specifications

Nominal current (I_N)		500 A rms	
Measuring range		0 to ± 1000 A	
Sense resistor		R. min.	R. max.
with ± 15 V	at ± 500 A peak	0 ohms	50 ohms
	at ± 800 A peak	0 ohms	5 ohms
with ± 24 V	at ± 500 A peak	10 ohms	130 ohms
	at ± 1000 A peak	10 ohms	25 ohms
Nominal analog output current		100 mA	
Turns ratio		1:5000	
Overall accuracy at 25 °C		± 0.3% of I_N	
Supply voltage (Vdc)		± 15 to ± 24	
Dielectric strength		between the current carrying conductor and the output of the sensor: 6 kV rms/50 Hz/1 min.	

Accuracy-Dynamic Performance

Zero current offset at 25 °C	± 0.2 mA max.	
Offset current temperature drift (between 0 °C and +70 °C)	± 0.2 mA typical	± 0.3 mA max.
Linearity	better than ±0.1%	
Response time	less than 1 µs	
di/dt accurately followed	better than 50 A/µs	
Bandwidth	0 to 150 kHz (- 1 dB)	

General Information

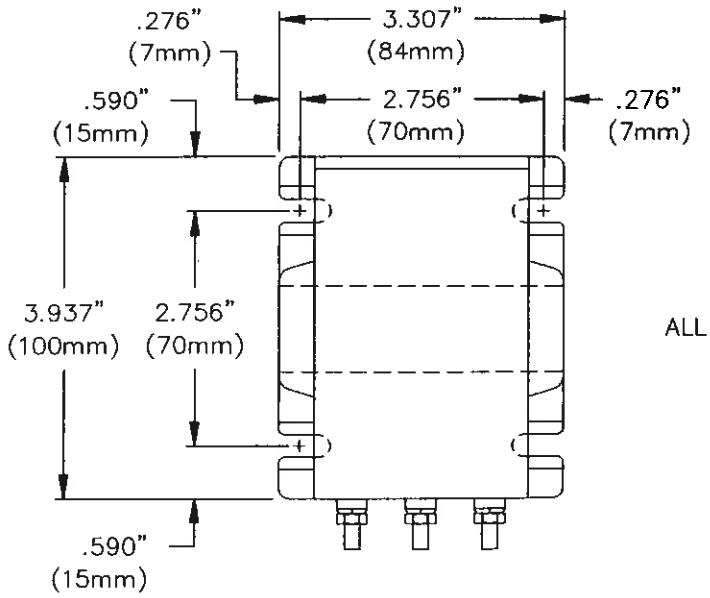
Operating temperature	0 °C to +70 °C
Storage temperature	-25 °C to +85 °C
Current drain	35 mA (at ± 24 V) plus output current
Coil resistance	80 ohms (at 70 °C)
Package	flame retarded plastic case
Weight	480 grams
Mounting	Panel mount via 4 slots in base plate
Aperture size	0.984 inch diameter (25 mm)
Output connection	Three M5 threaded studs
Output reference	To obtain a positive output on the terminal marked "OUT", aperture current must flow in the direction of the arrow (Conventional flow)

Notes:
- The temperature of the current carrying conductor should not exceed 100 °C
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

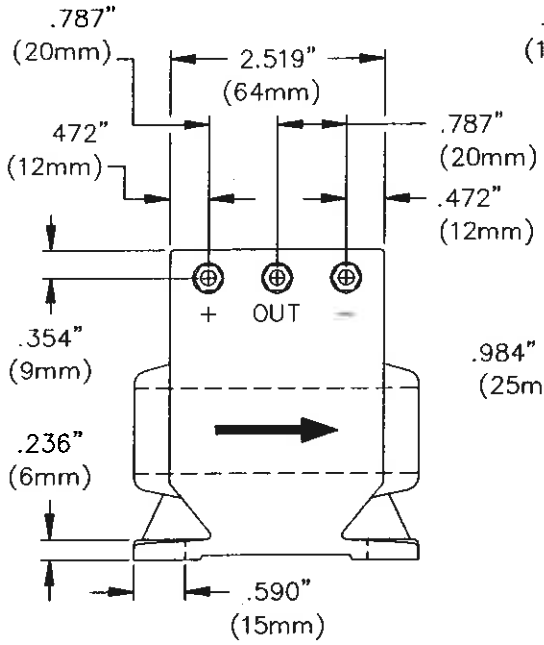
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

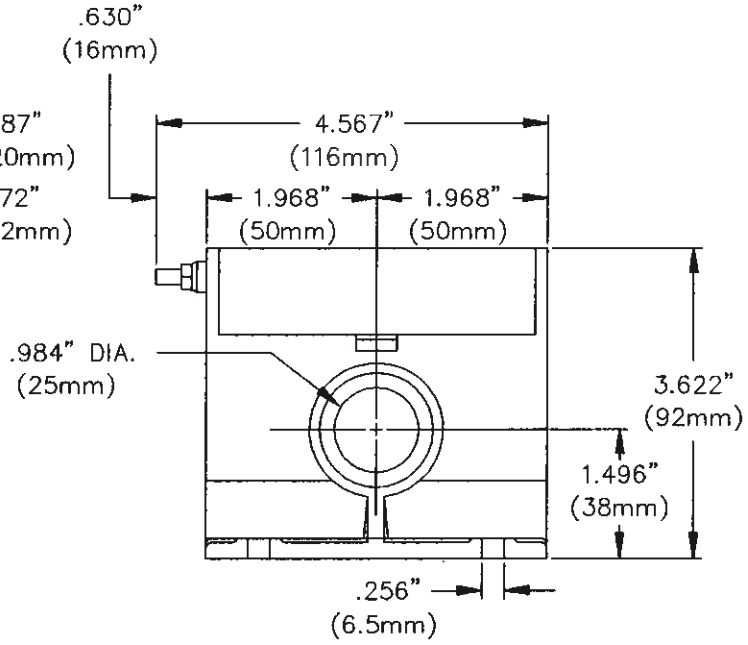
MODEL CL-500

MECHANICAL DIMENSIONS

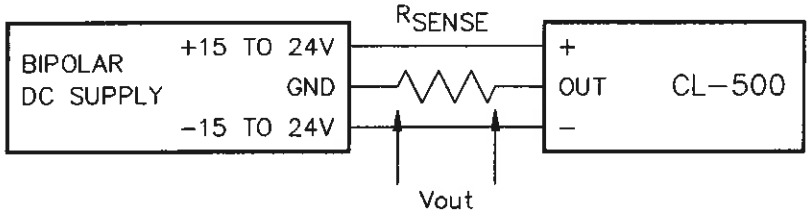


ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)





CONNECTION SCHEMATIC:



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

MODEL CL-1000

Description:

The Model CL-1000 is a closed loop Hall effect current sensor that accurately measures dc and ac currents and provides electrical isolation between the current carrying conductor and the output of the sensor.

Electrical Specifications

Nominal current (I_N)	1000 A rms	
Measuring range	0 to ± 1500 A	
Sense resistor	R. min.	R. max.
with ± 15 V at ± 1000 A peak	0 ohms	25 ohms
at ± 1500 A peak	0 ohms	5 ohms
Nominal analog output current	200 mA	
Turns ratio	1:5000	
Overall accuracy at 25 °C	± 0.3% of I_N	
Supply voltage (Vdc)	± 15	
Dielectric strength	between the current carrying conductor and the output of the sensor: 6 kV rms/50 Hz/1 min.	

Accuracy-Dynamic Performance

Zero current offset at 25 °C	± 0.4 mA max.	
Offset current temperature drift (between 0 °C and +70 °C)	± 0.2 mA typical	± 0.3 mA max.
Linearity	better than ±0.1%	
Response time	less than 1 µs	
di/dt accurately followed	better than 50 A/µs	
Bandwidth	0 to 100 kHz (- 1 dB)	

General Information

Operating temperature	0 °C to +70 °C
Storage temperature	-25 °C to +85 °C
Current drain	25 mA plus output current
Coil resistance	40 ohms (at 70 °C)
Package	flame retarded plastic case
Weight	700 grams
Mounting	Panel mount via 4 slots in base plate
Aperture size	1.575 inch diameter (40 mm)
Output connection	3 Faston terminals 0.250" x .032" (6.35 mm x 0.81mm)
Output reference	To obtain a positive output on the terminal marked "M" (OUT), aperture current must flow in the direction of the arrow (Conventional flow)

Notes:
- The temperature of the current carrying conductor should not exceed 100 °C
- Plus and minus supply voltages must be within ±5% of each other
- Contact F.W. Bell for other models

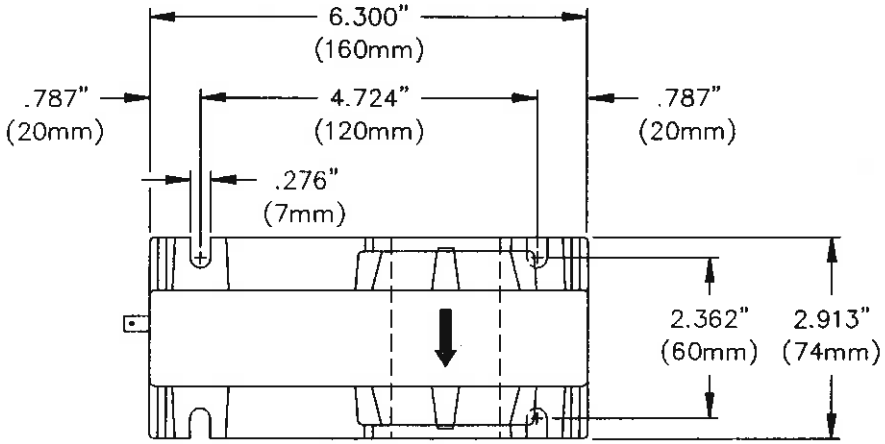
Due to continuous process improvement, specifications are subject to change without notice.

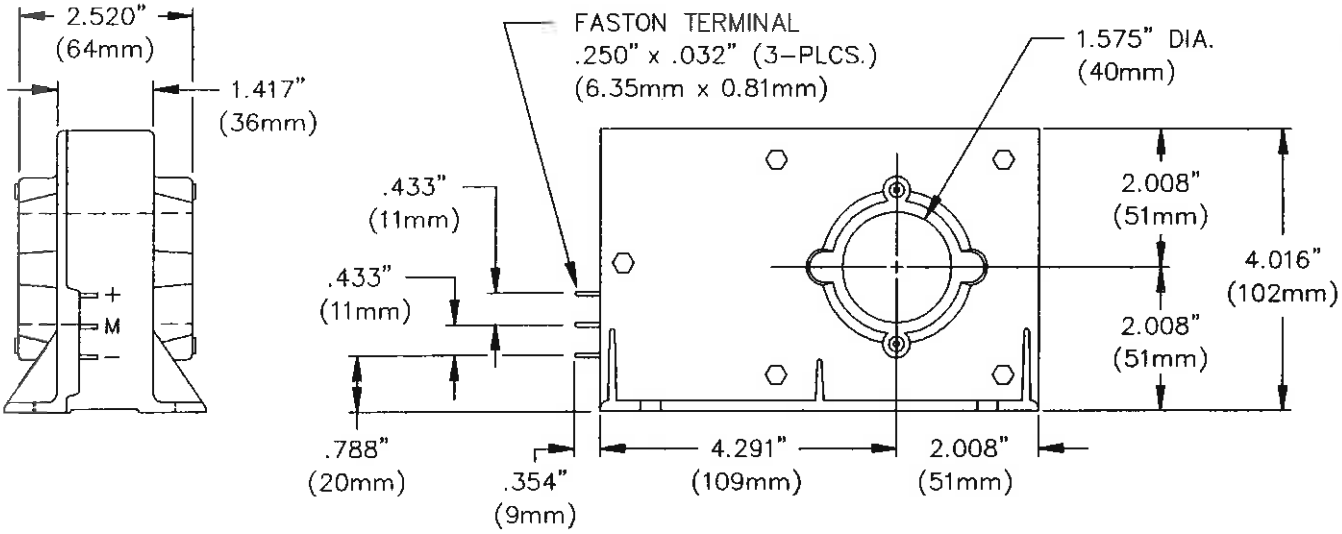
6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

MODEL CL-1000

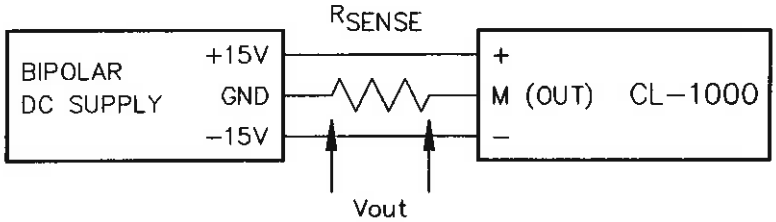
MECHANICAL DIMENSIONS

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)





CONNECTION SCHEMATIC:



Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

7. AC CURRENT SENSORS WITH 4-20 mA dc OUTPUT

- **4-20 mA dc output**
- **Range selected on sensor**
- **UL listed**
- **Split core eases installation**
- **Loop powered - Only requires two wires**
- **Extremely low insertion loss**

Index

Model	Current Range	Output mA	Linearity %	Frequency Range	Aperture Inches (mm)	Mounting	**Page**
PC-50	50	4-20	0.1	20 to 100 Hz	0.73 (18.5)	Panel	45
PC-200	200	4-20	0.1	20 to 100 Hz	0.73 (18.5)	Panel	45
PCS-50	50	4-20	0.3	20 to 100 Hz	0.85 (21.6)	Panel	45
PCS-200	200	4-20	0.3	20 to 100 Hz	0.85 (21.6)	Panel	45

Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

7.1 AC Sensor Glossary of Terms

Current range: The continuos current that the sensor can measure within its specifications

Frequency range: The frequency range the sensor can measure within specifications

Supply voltage: The minimum voltage that the sensor must drop in order to operate over its full range and the maximum voltage the sensor can safely drop within its specifications

Accuracy: The actual measurement plus and minus a percentage of the Full Scale rating of the sensor

Repeatability: The ability of the sensor to provide the same reading on a repeatable basis within a given percentage

Response time: The time required for the sensor to respond to a step function change in current

Ripple and noise: Internal noise and external ripple produced by the sensing circuit

Over-Range capability: The ability of the sensor to safely withstand currents above its maximum current rating

Operating temperature: The temperature range over which the sensor is designed to operate within specifications

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

PC/PCS SERIES

Description:

The PC/PCS Series current sensors accurately measure ac current and provide a 4-20 mA dc output proportional to the RMS value. They are loop powered requiring only a two wire connection. The PCS-50 and PCS-200 clamp over existing wiring for easy installation.

Specifications	Units	PC-50	PC-200	PCS-50	PCS-200
Current range (1)	A ac RMS	50	200	50	200
Output (2)	mA dc	4 to 20			
Frequency range	Hz	20 to 100			
Supply Voltage (3)	Vdc	5 to 40			
Accuracy	±% Full Scale (FS)	0.5			
Repeatability	±% FS	0.1			
Linearity	±% FS	0.1	0.1	0.3	0.3
Response time (Max.)	ms	300			
Ripple and noise (Max.)	mV Peak to Peak	8			
Over-Range capability (4)	mA	25 Min.			
Internal protection		Reverse voltage protection; High over-current capability			
Dielectric Test (6)	kV	5			

General Information

Operating temperature (5)	° C	-10 to +70			
Aperture opening	inches (mm)	0.73 (18.5)	0.73 (18.5)	0.85 (21.6)	0.85 (21.6)
Weight	grams	92	92	121	121
Mounting		Panel mount via two #6 screws			
Package		ABS plastic case meets UL flammability rating 94V-O			

Notes:

(1) Refer to Table 1 for choice of current ranges.

(2) Refer to Table 2

(3) Minimum voltage is 5 volts (for the sensor) plus voltage dropped across total load resistance when sensor is at 20 mA. Example: 20 mA will drop 16 volts across 800 ohms total load resistance. 16 volts plus 5 volts equals 21 volts minimum requirement.

(4) Sensor self-limits output current to 50 mA maximum.

(5) The UL approval is for an operating temperature range of - 10 °C to +40 °C

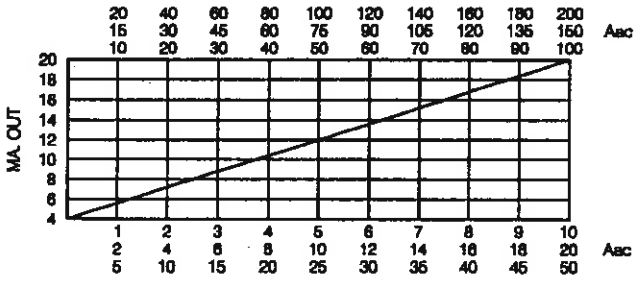
(6) The dielectric test consists of 5.0 kVac 60 Hz for one minute between a bare 0.8 inch diameter conductor (located concentrically through the aperture) and the output of the sensor

Table 1

Model	Range	Jumper	Maximum Currents
PC-50/ PCS-50	0 to 10 Amps 0 to 20 Amps 0 to 50 Amps	None Mid High	Maximum continuous current is 200 Amperes on any range
PC-200/ PCS-200	0 to 100 Amps 0 to 150 Amps 0 to 200 Amps	None Mid High	Maximum current for 15 seconds is 1200 Amperes on any range

Table 2

Models PC-200 and PCS-200



Models PC-50 and PCS-50

Due to continuous process improvement, specifications are subject to change without notice.

6120 Hanging Moss Road • Orlando, Florida 32807 • 407-678-6900 • FAX: 407-677-5765

F.W. BELL

TABLE OF CONTENTS

F. W. BELL has been a quality supplier to a broad sector of the marketplace for more than 50 years. Bell's dedication to strict quality control and it's progressive technology have earned it an international reputation for supplying rugged, high-quality products.

6120 Hanging Moss Road
Orlando, Florida 32807
407-678-6900
Fax 407-677-5765

F.W. BELL
Division of Bell Technologies Inc.