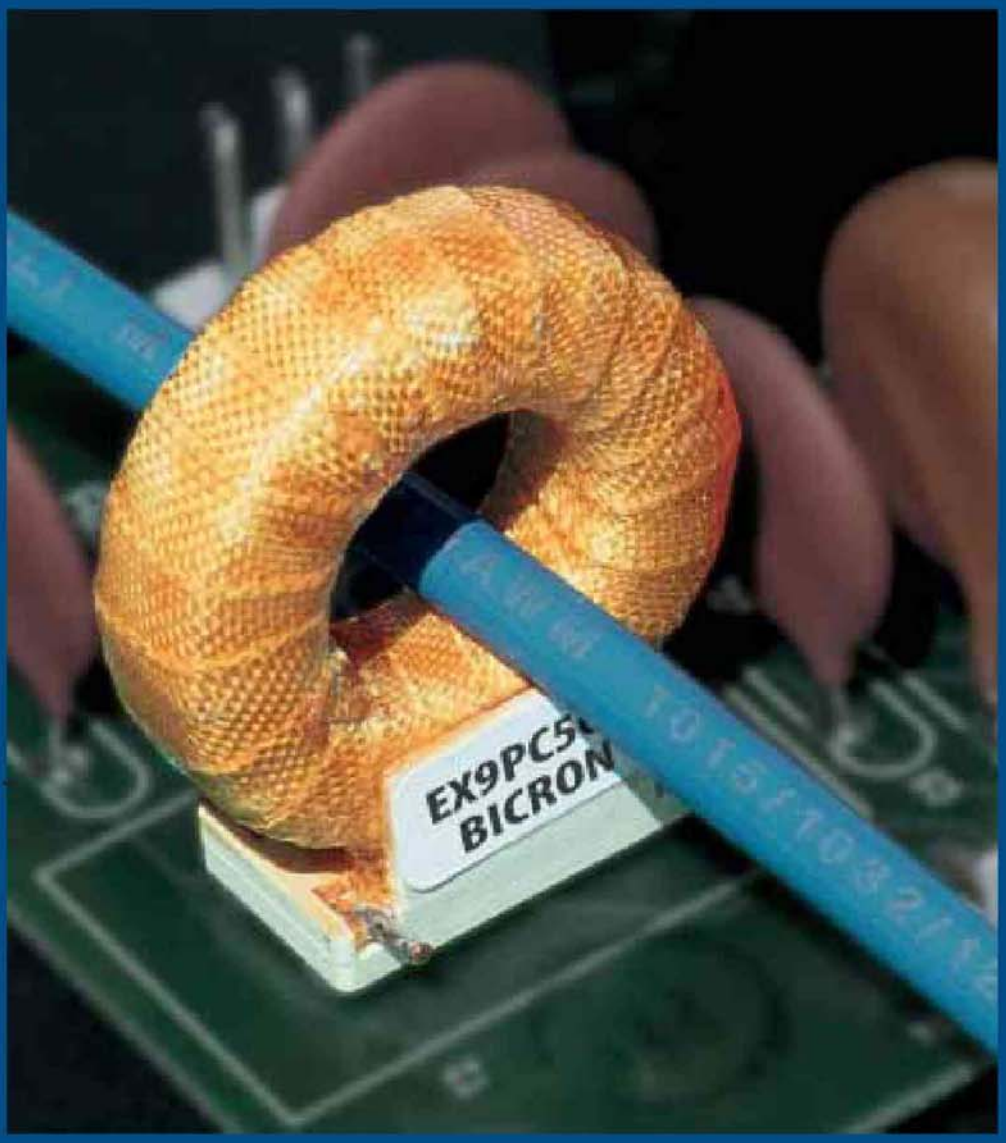
www.currentsensor.com

CURRENT SENSORS

TECHNICAL GUIDE & SPECIFICATIONS



Standard & Custom AC Current Sensors for OEM Applications

ISO 9001 CERTIFIED

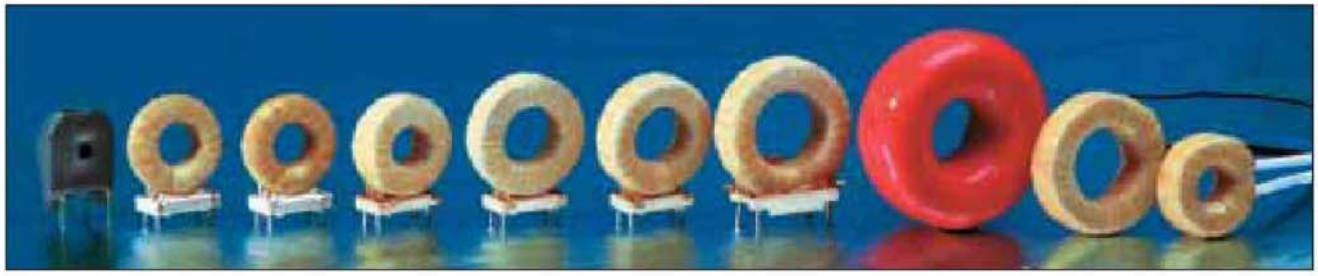
BICRON Electronics Company

The BICRON Advantage . . .

- ISO 9001 Certified
- A leader in electronic design and manufacturing since 1964
- State-of-the-art engineering development tools offering:
  - Finite element analysis
  - Circuit simulation
- Products designed to meet national and international safety standards
- Current transformers with window sizes from 0.02 to 350 in^2 and current ratings to 10,000A
- Long history servicing many of the Fortune 500 companies
- Capabilities to design/manufacture value added assemblies

BICRON Electronics Company
50 Barlow Street, Canaan, CT 06018
Tel: 860-824-5125, Fax: 860-824-1137
email: info@currentsensor.com
or: info@BicronUSA.com

Our goal is to exceed our customers' expectations by constantly seeking better ways to deliver service and value.



Solutions for AC Current Sensing

Need help? Call our design and sales engineers — 800-624-2766 or 860-824-5125

Bicron's Special Permeability ("SP") Cores offer important advantages:

- **Improved Performance Over a Wide Temperature Range.**
  - Bicron's Current Sensors offer excellent stability over the temperature range of -35°C to +80°C.
- **Improved Low Level Performance After Exposure to DC Shock**
  - A DC shock will leave most current sensors magnetized because of core hysteresis. This greatly limits performance, especially at low signal levels. Bicron's Current Sensors were designed to maintain a high permeability at levels as low as 1% of the CT's operating range.
- **Minimal Phase Angle ($I_{primary}$ vs $I_{secondary}$)**
  - Typical phase lag, I_p/I_s, will be less than one degree, making Bicron Current Sensors ideal for power measurement applications.
- **Excellent Coupling of Primary and Secondary Currents**
  - The toroid is one of the most efficient geometries in magnetic design, offering very little leakage flux.

Bicron's Grain Oriented Silicon Steel ("GOSS") Cores are the choice for high output voltages.

- **"GOSS" cores provide high output voltages suitable for self-powered, remote sensing.**

	Accuracy	Linearity	Low End Resolution	High Output Voltage	Low Cost	Temperature Sensitivity
BICRON SP* Toroid Core * Special Permeability	●	●	●	◑	◑	●
GOSS* Toroid Core * Grain Oriented Silicon Steel	◑	◑	○	●	◒	◑
Laminated Core	◒	◒	○	●	◑	◑
Ferrite Core	○	○	◒	○	●	○

● Excellent ◑ Good ◒ Acceptable ○ Poor

Bicron current sensors provide important advantages:

- Low cost AC current sensing
- Simple electronic interface
- Electrically isolated output
- No external power requirements
- Small size and weight
- Printed circuit board mounting
- Extreme reliability
- High linearity
- High repeatability
- U.S. and international safety recognitions
- Wide choice of configurations

Current sensors are the simple, low cost and reliable solution to many design problems:

- Current measurements and control
- Power demand measurements
- Current signature of motors
- Load sensing
- Ground fault sensing
- Monitoring of process parameters
- Status of lamps, heaters, etc.
- Power failure
- Loss of device

Current Sensor Selection Guide *(See pages 4 & 5 for detailed specifications.)*

Current Range (A_{RMS}) (CORE MATERIAL)	0 – 5 (SP)	0 – 20 (SP)	0 – 50 (SP)	0–100 (SP)	0 – 30 (GOSS)	0 – 50 (GOSS)	0 – 50 (GOSS)	0 – 200 (GOSS)
$Vout_{RMS}$	0.1	1.0	0.45	0.5	3.0	10.0	5.0	10.0
Turns Ratio	200:1	2000:1	1100:1	1000:1	1000:1	1600:1	1000:1	5000:1
Part Number (PC Mount)	EX9PA050	EX9PC200	*EX9PC500*	EX9PE101	*EX9PC300*	EX9PP500	*EX9PG500*	XXXX
Part Number (Leads)	XXXX	*EX9LC200*	EX9LC500	*EX9LE101*	EX9LC300	*EX9LP500*	EX9LG500	B5303*

Bold: Factory Stock Item • *Italic: Check with Factory* • XXXX: Not Available

** UL Recognized for indoor applications*

CURRENT SENSOR SPECIFICATIONS

Current Range (A_{RMS}) (CORE MATERIAL)	0 – 5 (SP)	0 – 20 (SP)	0 – 50 (SP)	0–100 (SP)	0 – 30 (GOSS)	0 – 50 (GOSS)	0 – 50 (GOSS)	0 – 200 (GOSS)
$Vout_{RMS}$	0.1	1.0	0.45	0.5	3.0	10.0	5.0	10.0
Turns Ratio	200:1	2000:1	1100:1	1000:1	1000:1	1600:1	1000:1	5000:1
DCR (Ohms)	1.6	130.0	18.0	8.3	19.0	63.0	16.6	210.0
Ratio Error (±%)	5.0	4.0	3.0	2.0	3.0	4.0	3.0	2.0
Frequency (Hz)	47 – 400	47 – 400	47 – 400	47 – 400	47 – 400	47 – 400	47 – 400	50 – 400
Overload Current (A_{RMS})	20	30	75	110	50	75	60	300
Ambient (°C)	-35 to +80	-35 to +80	-35 to +80	-35 to +80	-35 to +80	-35 to +80	-35 to +80	-35 to +80
Part Number (Leads)	XXXX	*EX9LC200*	EX9LC500	*EX9LE101*	EX9LC300	*EX9LP500*	EX9LG500	B5303
ID	na	0.40 (10.2)	0.31 (7.9)	0.56 (14.2)	0.48 (12.2)	0.40(10.2)	0.78 (19.8)	0.7 (17.8)
OD	na	1.1 (27.9)	1.1 (27.9)	1.58 (40.1)	1.1 (27.9)	1.25 (31.8)	1.45 (36.8)	2.0 (50.8)
Thickness	na	0.38 (9.7)	0.40 (10.2)	0.45 (11.4)	0.44 (11.2)	0.46 (11.7)	0.42 (10.7)	0.8 (20.3)
Lead Gauge	na	#22	#22	#22	#18	#22	#18	#24
Lead Length	na	24 (610)	24 (610)	24 (610)	36 (914)	24 (610)	20 (508)	12 (305)
Part Number (PC Mount)	EX9PA050	EX9PC200	*EX9PC500*	EX9PE101	*EX9PC300*	EX9PP500	*EX9PG500*	XXXX
ID	0.15 (3.8)	0.40 (10.2)	0.31 (7.8)	0.56 (14.2)	0.48 (12.2)	0.40 (10.2)	0.78 (19.8)	na
Height	1.11 (28.2)	1.25 (31.2)	1.25 (31.2)	1.64 (41.7)	1.25 (31.2)	1.37 (34.8)	1.51 (38.4)	na
Length	0.77 (19.6)	1.05 (26.7)	1.07 (27.2)	1.58 (40.1)	1.05 (26.7)	1.2 (30.5)	1.45 (36.8)	na
Width	0.48 (12.2)	0.68 (17.2)	0.68 (17.2)	0.63 (15.9)	0.68 (17.2)	0.68 (17.2)	0.63 (15.9)	na
Pinout	Fig.#1	Fig.#2	Fig.#2	Fig.#3	Fig.#2	Fig.#2	Fig.#3	na

Bold: Factory Stock Item • *Italic: Check with Factory* • XXXX: Not Available • All Sizes shown in inches (mm)

Data subject to change.

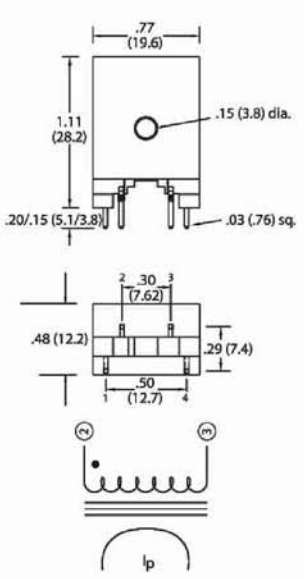


Fig.#1

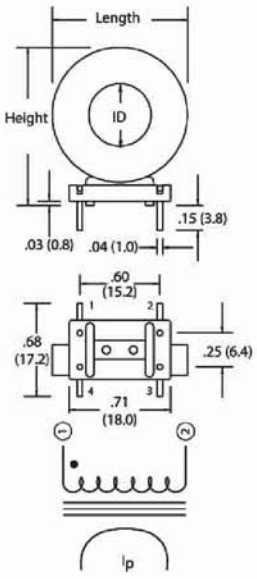


Fig.#2

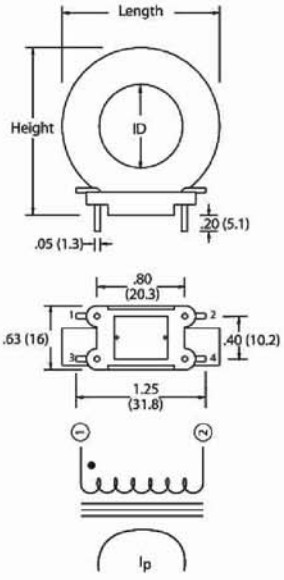
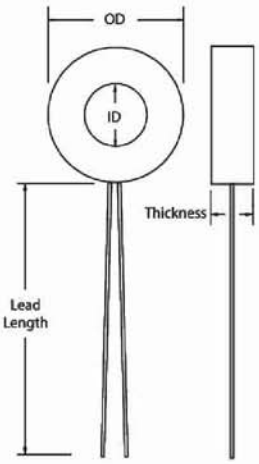


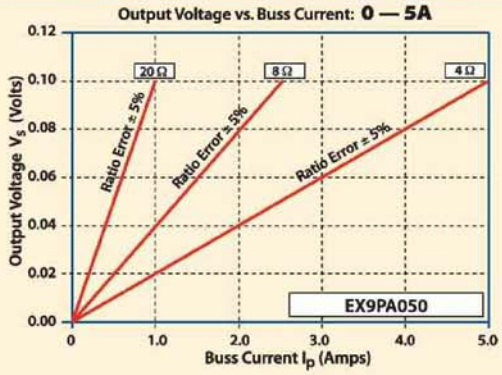
Fig.#3



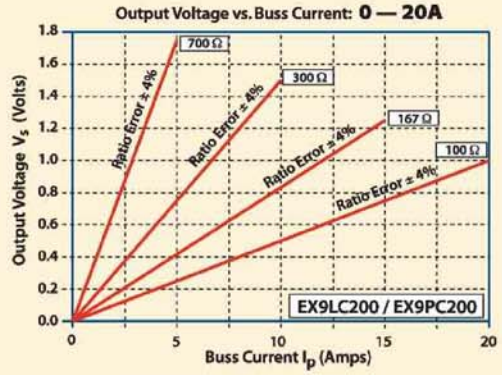
CURRENT SENSOR PERFORMANCE INFORMATION

BICRON SPECIAL PERMEABILITY (SP) CORES

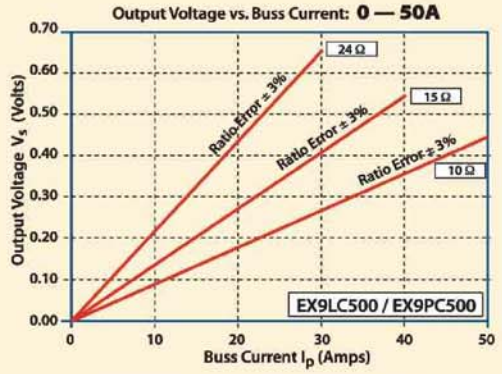
Output Voltage vs. Buss Current: **0 — 5A**



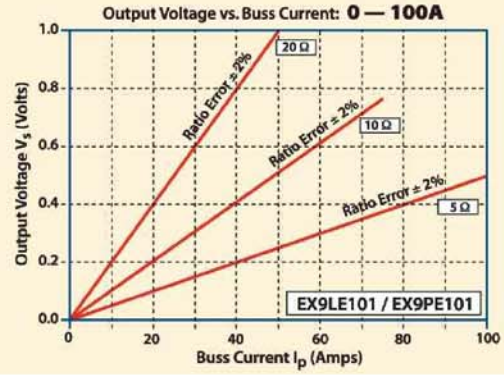
Output Voltage vs. Buss Current: **0 — 20A**



Output Voltage vs. Buss Current: **0 — 50A**

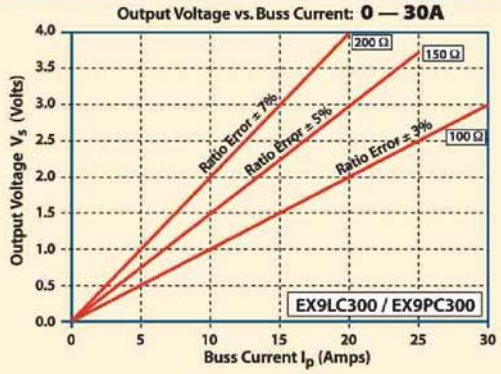


Output Voltage vs. Buss Current: **0 — 100A**

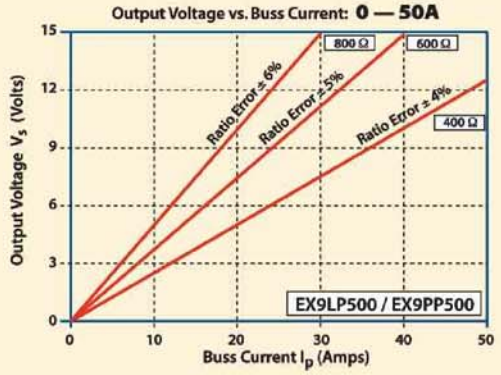


BICRON GRAIN ORIENTED SILICON STEEL (GOSS) CORES

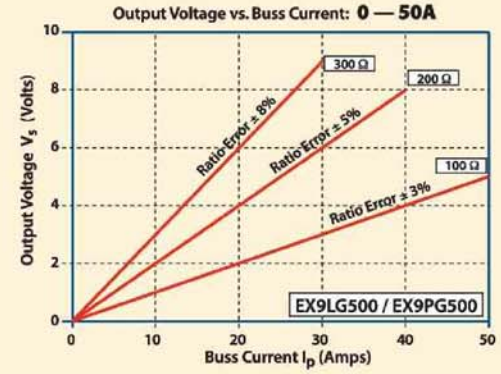
Output Voltage vs. Buss Current: **0 — 30A**



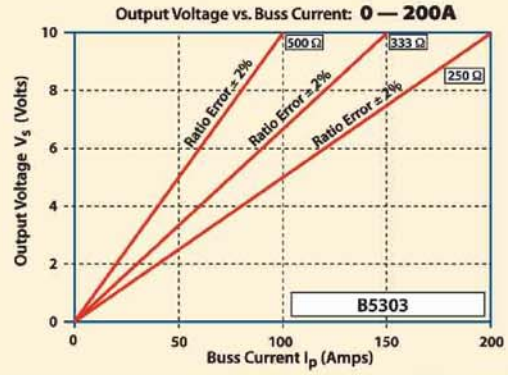
Output Voltage vs. Buss Current: **0 — 50A**



Output Voltage vs. Buss Current: **0 — 50A**



Output Voltage vs. Buss Current: **0 — 200A**



Data subject to change.

Introduction

Current transformers are used to measure or monitor the current in an AC power circuit.

The ratio of the primary current to the secondary current is a function of the turns ratio and the loss associated with the conversion. For example, copper losses in a voltage transformer affect the voltage regulation. In a current transformer, copper losses cause an increase in core loss, or a reduction in accuracy.

Accuracy

$$I_S N_2 = I_P N_1 - I_M N_1$$

Where:

$I_S N_2$ = the secondary current × the number of turns

$I_P N_1$ = primary current × the number of turns

$I_M N_1$ = ampere-turns required for core loss

The excitation current, (I_M), determines the maximum accuracy that can be achieved with a current transformer. This current is defined as that portion of the primary current which satisfies the core losses. While the excitation current can never be eliminated, it can, in some cases, be compensated by adjusting the turns ratio.

If it were not for the core losses, the primary and secondary currents would be exactly inversely proportional to the number of turns in the two windings. The error due to leakage flux is negligible in most current transformers using toroidal cores, and utilizing proper winding methods.

Burden

The total impedance of the devices connected to the secondary terminals (leads, meters, relay coil, resistance, etc.) of a current transformer is defined as its burden. Burden is expressed in volt-amperes (VA) or in ohms impedance.

Burden resistance should be kept as low as possible, since an increase in burden increases the core flux density (B), thereby increasing the core loss.

Utilizing Faraday's Law:

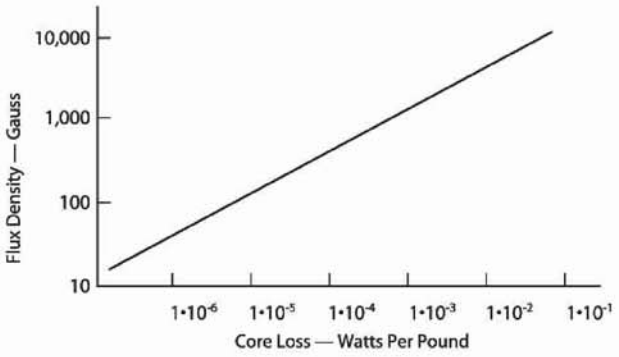
$$B = \frac{10^8 \times I_S(R + W_R)}{4.44 \times f \times N_2 \times A_C}$$

Where:

I_S = secondary current (amps)
R = burden (ohms)
W_R = winding resistance
f = frequency (Hz)
N_2 = turns
A_C = cross section area (cm^2)
B = flux density (Gauss)

Note: $I_S = (I_P N_1 - I_M N_1)/ N_2$

Typical Core Loss vs. Flux Density Graph.



$$\text{Excitation Current (Reflected to Primary)} = \frac{\text{core loss}}{\text{secondary voltage} \times N_1/N_2}$$

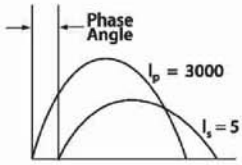
Where core loss = watts/lb × lb of core

Ratio-Correction Factor

The ratio-correction factor indicates the percentage amount that the secondary current value differs from the correct value.

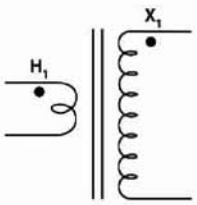
Phase Angle Error

The phase angle error is not applicable to current actuated devices but will affect the accuracy of devices that respond to the products, the sums or difference of currents.



Polarity

Current transformer polarity can be defined by permanent markings (typically $H_1 - X_1$) or polarity dots.



Short-Time Current Limits

Current transformers may have to carry very large currents in the event of short circuit, motor starting, etc. The windings heat very rapidly at a rate nearly proportional to the square of the current. The majority of the heat will be stored in the copper. The short-time current limit is the time to raise the temperature of the winding to 105°C, considering ambient temperature.

Continues on Page 7 >

Current Transformer Ratio

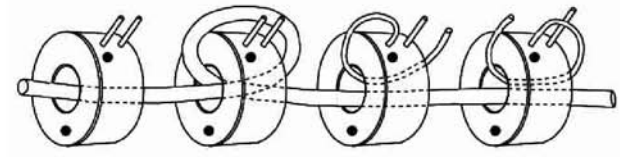
The relationship of ratio to turns is expressed in the formula:

$K_a = (K_n + N_{sa})/N_P$

Where:

K_a = new transformation ratio
K_n = nameplate ratio
N_{sa} = number of secondary turns added or subtracted
N_p = number of primary turns

The following diagram shows various ways to adjust the turns ratio using primary and secondary turns.



Single Primary Turn | Two Primary Turns | Single Primary Turn & Bucking Secondary Turn | Single Primary Turn & Aiding Secondary Turn

For example, consider a CT with 1200:5 nameplate rating with three primary bucking turns and two secondary bucking turns (passed through window so that the generated flux is opposing):

$K_n = 1200/5 = 240$
$K_a = (240-2)/3 = 79.3/1 = 396.66:5$

K_a = 396.66 amps in primary provides 5 amps in secondary when configured per example.

Consider the two secondary turns passed through the window in the other direction (adding), in this case, the ratio obtained would be:

$K_a = (240+2)/3 = 80.66/1 = 403.33:5$

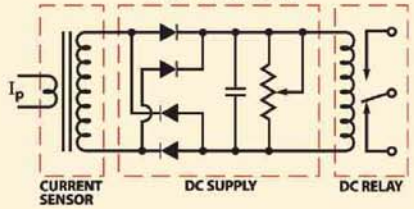
Safety Precautions

The secondary winding should always be loaded. If the secondary circuit is opened with primary current flowing, all the primary ampere-turns become magnetizing ampere-turns and usually will produce an excessively high secondary voltage across the open circuit.

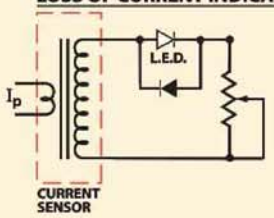
Magnetization of the core, due to excessive fault currents or accidental open circuiting of the secondary, has the effect of increasing the ratio errors.

The diagrams to the right show application of current sensors to typical electrical circuits. Self-powered devices, as shown in the first diagram, would normally employ high voltage output sensors such as the B5303, EX9LP500, or the EX9LG500.

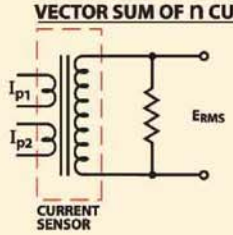
CURRENT MONITOR – CONTACT OUTPUT (SELF POWERED)



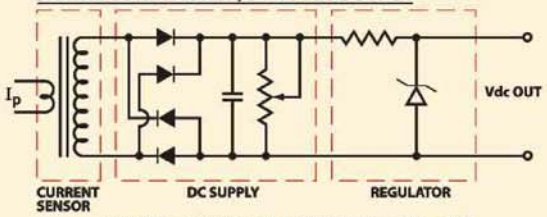
LOSS OF CURRENT INDICATOR



VECTOR SUM OF n CURRENTS

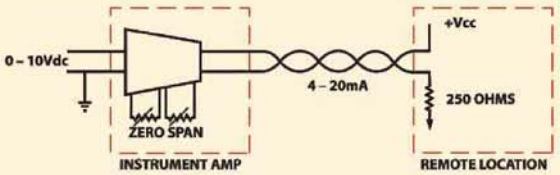


SIGNAL CONDITIONER, 0 – 10Vdc OUTPUT



$V_{dc\ OUT} = 2^{-2} \cdot (V_S - 2V_D - V_R)$ WHERE $V_S = 2|_P R_S \cdot 10^{-4}$

4 – 20mA TRANSMITTER



Since our inception in 1964, Bicron Electronics has been a leader in designing and manufacturing coil based electrical products and assemblies to meet specific requirements. Today Bicron is a preferred supplier of specialized current sensors to many of the world's largest and best known electrical equipment manufacturers. Our manufacturing program includes window sizes up to 350 square inches with current ratings up to 10,000A and current ratios from 10:1 to 6000:5. Bicron current sensors are UL recognized for indoor application.

Because of our extensive design and manufacturing experience, we have a very large collection of proven designs which can be used as starting points for meeting closely related new requirements. Bicron's "Modified Standard" program permits us to substantially modify our standard electrical and mechanical specifications without incurring significant engineering or manufacturing charges. This allows you to optimize your system without delay, at the lowest possible cost.

VALUE-ADDED ASSEMBLIES

Bicron can also be of great value when it comes to providing finished assemblies or sub-assemblies.

We can:

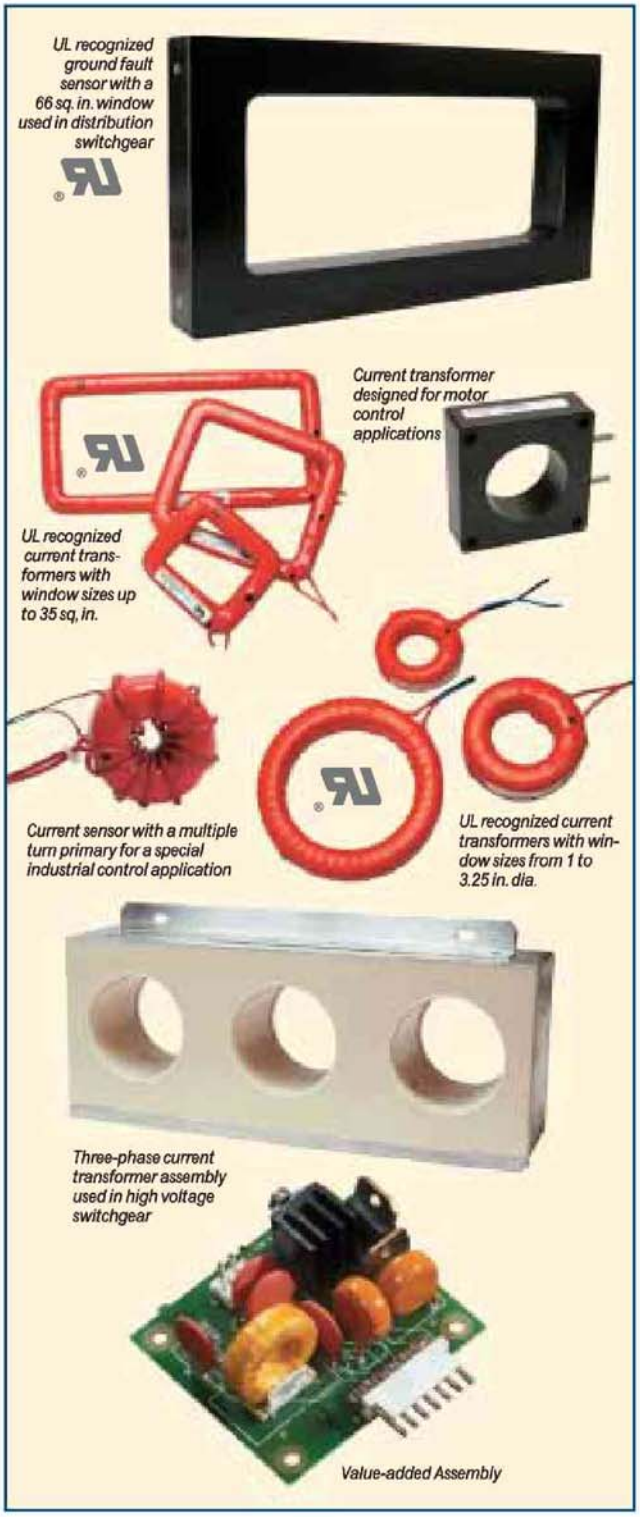
- Custom design and fabricate, typically, power supplies and conditioning equipment, battery chargers, current monitoring or control systems, and sub-assemblies utilizing electromechanical/electromagnetic devices such as solenoids, transformers, inductors and coils.
- Produce virtually any quantity you need ... from less than a hundred to hundreds of thousands ... all at globally competitive pricing.
- Ensure highest quality and reliability, efficient workflow, very competitive pricing, and on-time delivery through the use of the well proven Bicron Production Management System.
- Exceed our customers' expectations by constantly seeking better ways to deliver service and value.

ADDITIONAL CAPABILITIES

Bicron is well known for its expertise in designing and manufacturing electrical coil based products covering a wide range of applications:

- Bicron Toroidal Power and Isolation Transformers
- Bicron High Isolation Voltage Magnetics
- Bicron Tubular and Frame DC Solenoids

Please ask for specific literature or visit our web site at www.BicronUSA.com.



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For fast, up to date information and complete product data sheets, visit our web site at www.currentsensor.com.

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