

The CPCO Series (77mm) Current Probes are Clamp On current sensors capable of measuring ac and dc currents available in ranges of $\pm 500\text{A}$, $\pm 1000\text{A}$, ± 2000 , $\pm 4000\text{A}$, $\pm 8000\text{A}$ or $\pm 12000\text{A}$ with an accuracy of $\pm 1\%$ and non-linearity of $< \pm 0.5\%$. The bandwidth is dc to 40kHz. The Probe splits along a diameter allowing easy installation to existing cables without having to break the connection. A captive screw is used rather than a clip to ensure consistent closure under mechanical loading or vibration.

The Current Probes utilize Hall effect sensing technology with no magnetic core. This eliminates magnetic hysteresis and non-linearity effects present in conventional open loop sensors with magnetic cores.

FEATURES

- Clamp On
- Light Weight $< 120\text{g}$
- Low Power $< 0.5\text{W}$ for Voltage Output Signal;
 $< 0.8\text{W}$ for 4-20mA Output Signal
- Operating Voltage: Single rail power supply for all versions
- Current Ranges: ± 500 , ± 1000 , ± 2000 , $\pm 4000\text{A}$, $\pm 8000\text{A}$, $\pm 12000\text{A}$
- Accuracy: $\pm 1\%$
- Non-Linearity: $< \pm 0.5\%$
- Wide Bandwidth: dc to 40kHz
- Output Signal Options: Single Ended 5V, Bi Polar 5V, Bi Polar 10V, 4-20mA and RMS
- Power ON LED indicator
- Low noise $< 0.1\%$ of FS
- Reverse power supply voltage protected
- High rejection of external magnetic fields, e.g. from external conductors
- Output short circuit protection (except for 4-20mA version)



ORDERING INFORMATION

Part Number Format: CPCO - Current Range - Aperture - Output Signal Type

<u>CPCO</u>	<u>Aperture</u>
CPCO = Current Probe Clamp On	77mm
<u>Current Range</u>	<u>Output Signal Type</u>
500 = $\pm 500\text{A}$	SE = Single Ended, $5.0\text{V} \pm 5.0\text{V}$
1000 = $\pm 1000\text{A}$	BP5 = Bi Polar, $0.0\text{V} \pm 5.0\text{V}$
2000 = $\pm 2000\text{A}$	BP10 = Bi Polar, $0.0\text{V} \pm 10\text{V}$
4000 = $\pm 4000\text{A}$	RMS = RMS, 0-3V
8000 = $\pm 8000\text{A}$	MA = 4-20mA Source, $12\text{mA} \pm 8\text{mA}$
12000 = $\pm 12000\text{A}$	

e.g. CPCO-4000-77-BP10

Current Probe Clamp On, 4000A, 77mm Diameter Aperture, Bi Polar $\pm 10\text{V}$ Output Signal



CPCO Series (77mm)
DC-AC Current Probe, Clamp On
±500A, ±1000A, ±2000 or ±4000A, ±8000 or ±12000A

TABLE 1: ELECTRICAL SPECIFICATIONS

Specifications by Current Range							
Specification	Symbol	CPCO-500	CPCO-1000	CPCO-2000	CPCO-4000	CPCO-8000	CPCO-12000
Primary Current, Nominal	I_{PN}	±500A	±1000A	±2000A	±4000A	±8000A	±12000A
Primary Current, Max	I_{PSAT}	±625A	±1250A	±2500A	±5000A	±10000A	±15000A
Primary Current, Overload	I_{POL}	No Limit					
Sensitivity Accuracy	SA	±1 % of FS					
Non Linearity	NL	< ±0.5% of I_{PN} (Primary Current, Nominal)					
Sensitivity	SE Output	S	8mV/A	4mV/A	2mV/A	1mV/A	0.5mV/A
	BP5 Output		8mV/A	4mV/A	2mV/A	1mV/A	0.5mV/A
	BP10 Output		16mV/A	8mV/A	4mV/A	2mV/A	1mV/A
	RMS Output		8mV/Arms	4mV/Arms	2mV/Arms	1mV/Arms	0.5mV/Arms
	MA Output	S	0.016mA/A	0.008mA/A	0.004mA/A	0.002mA/A	0.001mA/A
Bandwidth (-3dB)	BW	dc to 40kHz					
Hysteresis after ± I_{PSAT}	V_{HYS} or I_{HYS}	<0.05 % of FS					
Noise (3Hz to 1kHz)	SE Output	V_{NO}	<2mVrms	<1mVrms	<0.5mVrms	<0.2mVrms	<0.1mVrms
	BP5 Output		<2mVrms	<1mVrms	<0.5mVrms	<0.2mVrms	<0.1mVrms
	BP10 Output		<4mVrms	<2mVrms	<1mVrms	<0.5mVrms	<0.5mVrms
	RMS Output		<1mVrms	<0.5Vrms	<0.3Vrms	<0.05mVrms	<0.02mVrms
	MA Output	I_{NO}	2 µArms	1 µArms	0.5 µArms	0.25 µArms	0.25 µArms
Resolution		Noise * (1 / Sensitivity)					
Dielectric Withstanding between Aperture ID and Connector Pins	U_W	>5000V (60Hz, Dwell Time 1 min.)					

Specifications by Output Signal Type						
Specification	Symbol	SE (single ended)	BP5 (Bi Polar 5V)	BP10 (Bi Polar 10V)	RMS (RMS)	MA (4-20mA)
Output Signal, Nominal	V_{OUT} or I_{OUT}	5.0 ± 4.0V	0.0V ± 4.0V	0.0 ± 8.0V	0.0 to 3.0V	12 ± 8mA
Output Signal, Max	V_{OUTSAT} or I_{OUTSAT}	5.0 ± 5.0V	0.0V ± 5.0V	0.0 ± 10.0V	0.0 to 4.0V	12 ± 10mA
Output Signal Current, Absolute Max	I_{OUTM}	2mA	±2mA	±2mA	2mA	22mA
Capacitive Load, Absolute Max	C_{OUTM}	10nF	10nF	10nF	10nF	100nF
Output Source Impedance	R_S	10 to 15Ω	10 to 15Ω	10 to 15Ω	10 to 15Ω	>100KΩ
Offset at $I_p = 0$	V_{OE} or I_{OE}	±10mV ¹	±10mV ¹	±20mV ¹	±6mV	±0.024mA
Maximum Response Time	T_R	<10µs	<10µs	<10µs	1s	<10µs
Power Supply Voltage	V_C	11 to 31V	11 to 31V	11 to 15.5V	11 to 31V	Loop Load Resistance
						100Ω 11-15V
						250Ω 11-20V
						750Ω 21-30V
Power Supply Current, Max	I_C	<47mA	<47mA	<47mA	<47mA	<47mA + I_{OUT}
Short Circuit Protection	I_{SHORT}	Continuous				
						<1 minute

¹ Except for CPCO-500 Series. For the CPCO-500 Series, $V_{OE} = \pm 15mV$.



CPCO Series (77mm)
DC-AC Current Probe, Clamp On
±500A, ±1000A, ±2000 or ±4000A, ±8000 or ±12000A

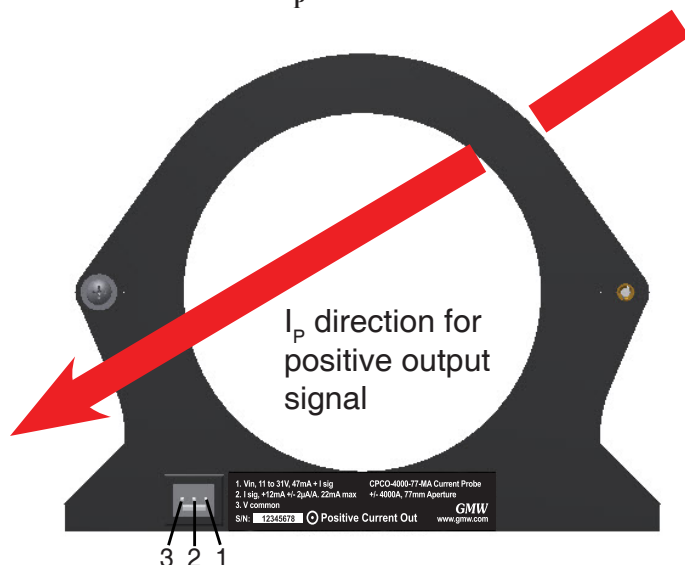
TABLE 2: MECHANICAL SPECIFICATIONS

Specification	
Aperture Diameter	77mm (3.0")
Overall Size	101mm x 127mm x 19mm (4" x 5" x 0.75")
Weight	120g (0.26lb)
Housing Material	Urethane Fire Retardant (UL 94 V-0)
Encapsulant Material	Polybutadiene Resin (UL 94 V-0)

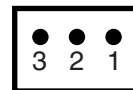
TABLE 2: ENVIRONMENTAL SPECIFICATIONS

Specification			
Temperature, Operating		-40 to 85°C	
Temperature, Storage		+15 to 85°C	
T _C of Sensitivity		± 200ppm/°C	
T _C of Zero		CPCO-500	± 0.2A/°C
		CPCO-1000	± 0.2A/°C
		CPCO-2000	± 0.4A/°C
		CPCO-4000	± 0.8A/°C
Sealed		NEMA 5 equivalent	
Humidity, Operating		0-90% RH	
Humidity, Storage		20-60% RH	
External Magnetic Field Component, <0.2% of FS Output Signal Shift	In Plane	CPCO-500	20mT (200G)
		CPCO-1000	40mT (400G)
		CPCO-2000	60mT (600G)
		CPCO-4000	60mT (600G)
		CPCO-8000	120mT (600G)
		CPCO-12000	120mT (600G)
	Longitudinal or Axial	All Models	200mT (2000 G)
Effect of Primary Conductor Position within Aperture (20mm diameter conductor)		< 0.5% of FS	
Effect of Another Conductor within 5mm of any outer surface of probe (20mm diameter conductor, I ≤ to I _{PN})		< 0.5% of FS	
Effect of Steel plate outside the Current Probe (200 x 200mm square plate)		In contact with any outer surface	< 0.5% of FS
		5mm from any outer surface	< 0.2% of FS

DRAWING 1: PIN AND I_p ORIENTATION

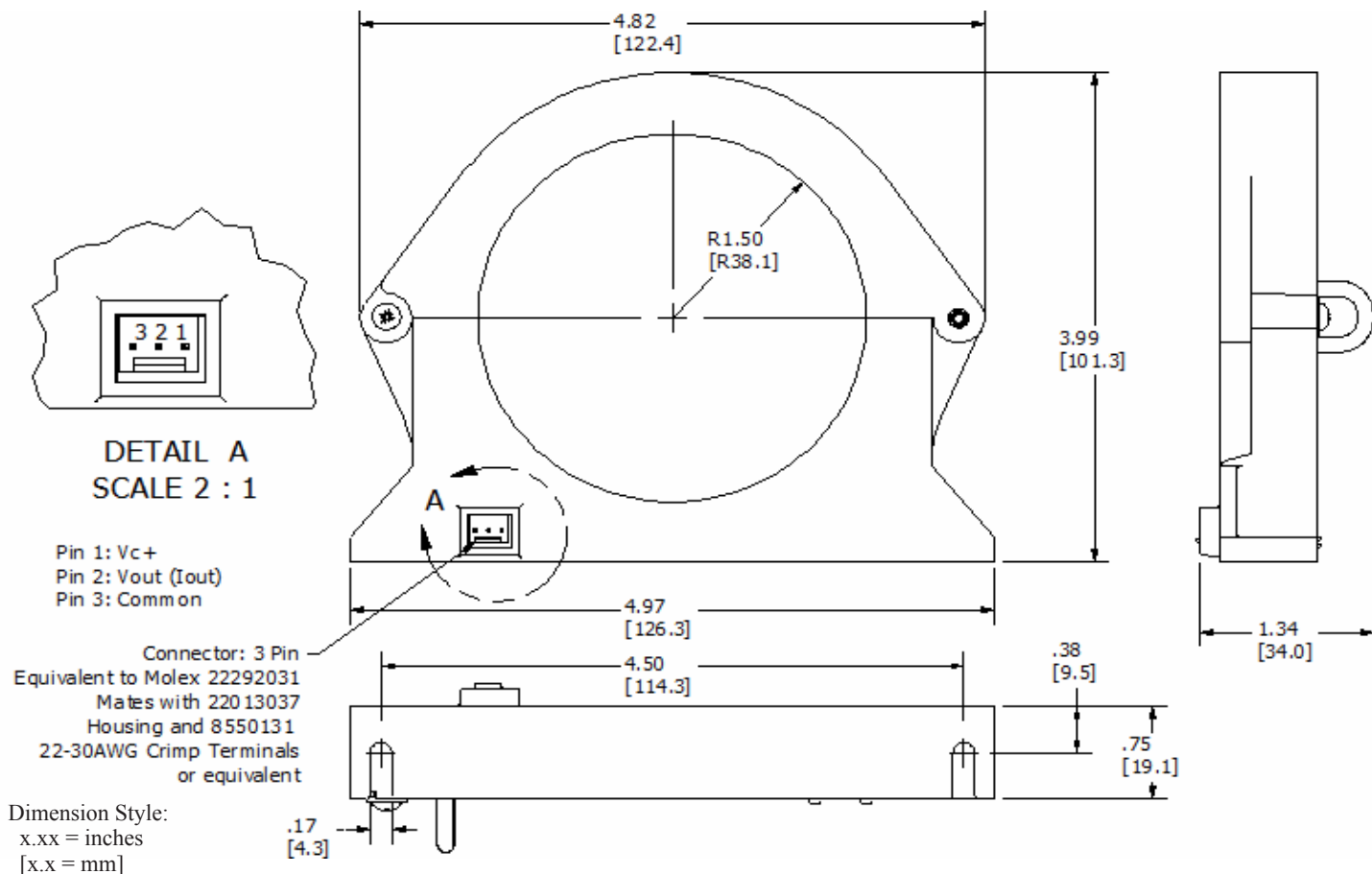


DRAWING 2: CONNECTION DIAGRAM



1. $+V_C$
2. $V_{OUT} (I_{OUT})$
3. Common

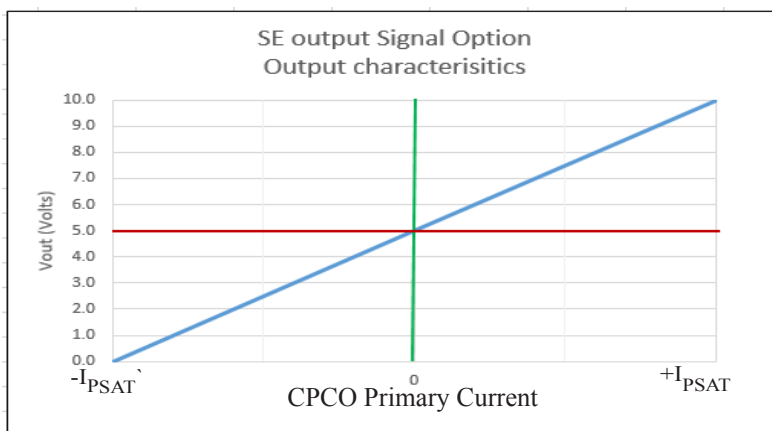
DRAWING 3: OUTLINE DRAWING



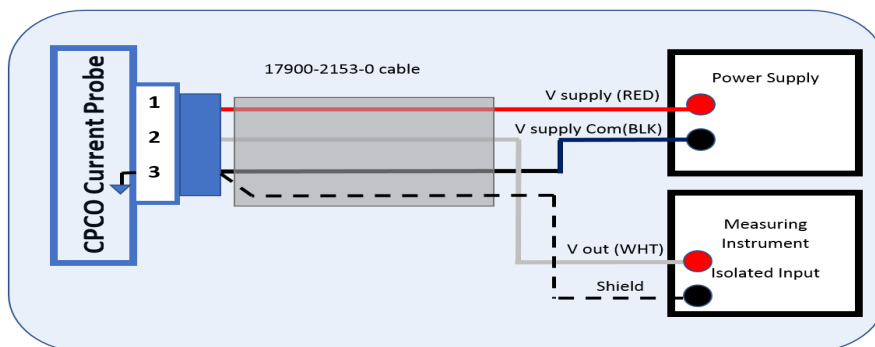
SIGNAL OUTPUT OPTION DESCRIPTIONS

SE Option - The SE stands for Single Ended and the output voltage from the CPCO will have a quiescent output voltage of 5.0V when there is no primary current ($I_p=0\text{A}$). As the primary current (I_p) increases in a positive direction, the output voltage will increase to the maximum level of 10.0V at $I_p=+I_{PSAT}$. When the primary current increases in the negative direction, the output voltage will decrease toward 0.0V at $I_p=-I_{PSAT}$. See below output characteristics.

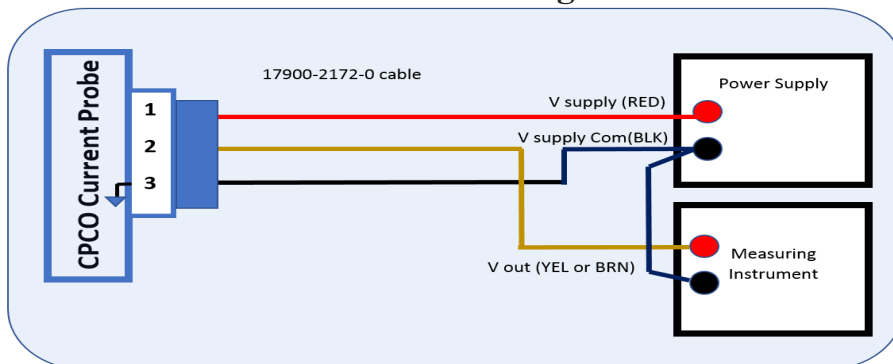
This option is useful for applications that drive circuitry that can only accommodate positive signal inputs voltages such as inputs to A/D's



Recommended Connection Diagram



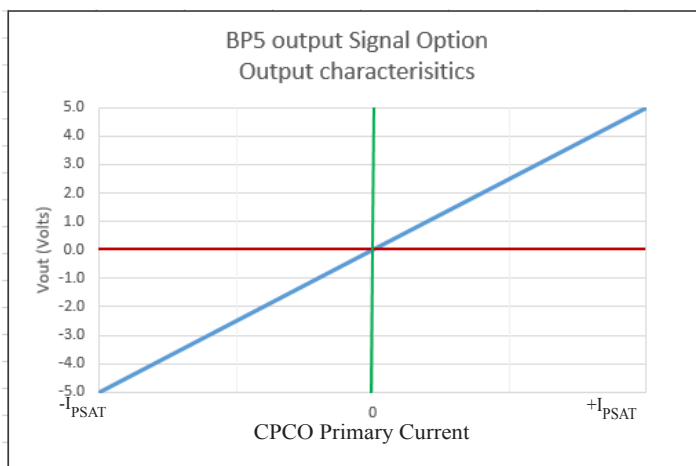
Alternate Connection Diagram



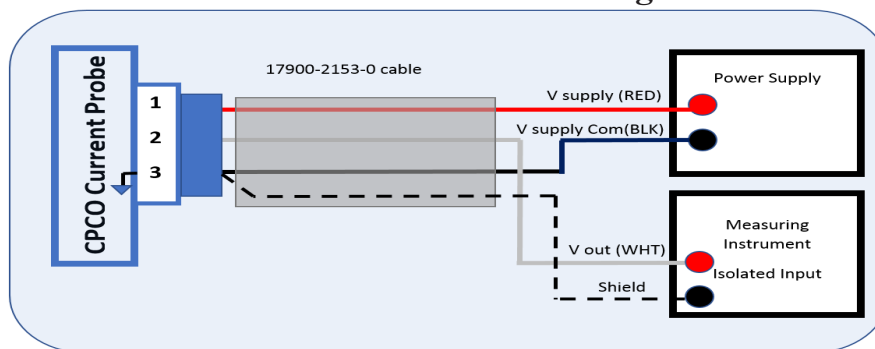
SIGNAL OUTPUT OPTION DESCRIPTIONS, CONTINUED

BP5 Option - The BP stands for Bi Polar and the output voltage from the CPCO will have a quiescent output voltage of 0.0V when there is no primary current ($I_p=0\text{A}$). As the primary current (I_p) increases in a positive direction, the output voltage will increase to the maximum level of 5.0V at $I_p=+I_{PSAT}$. When the primary current increases in the negative direction, the output voltage will decrease toward -5.0V at $I_p=-I_{PSAT}$. See below output characteristics.

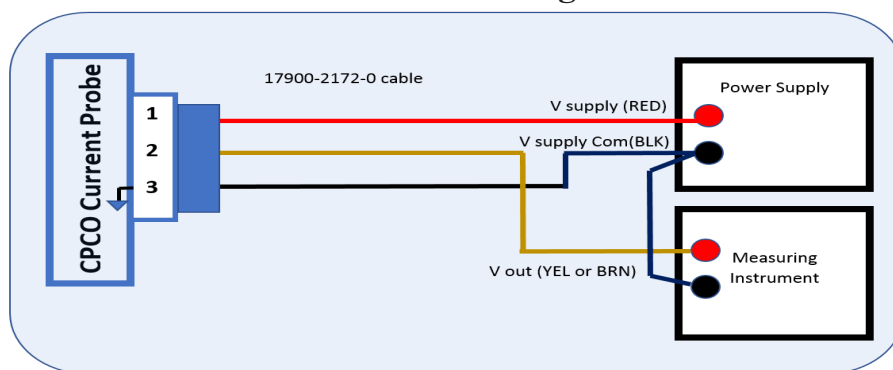
This option is useful for applications that drive circuitry that can accommodate Bi Polar signal inputs that swing around Com (0.0V) such as oscilloscopes, data loggers, multi-meters, etc.



Recommended Connection Diagram



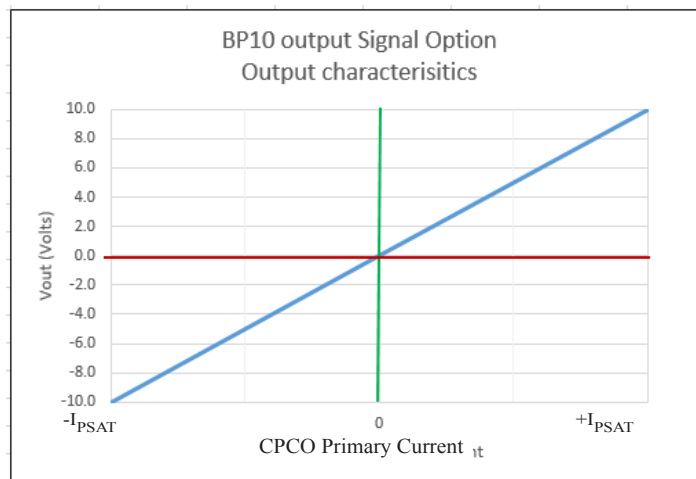
Alternate Connection Diagram



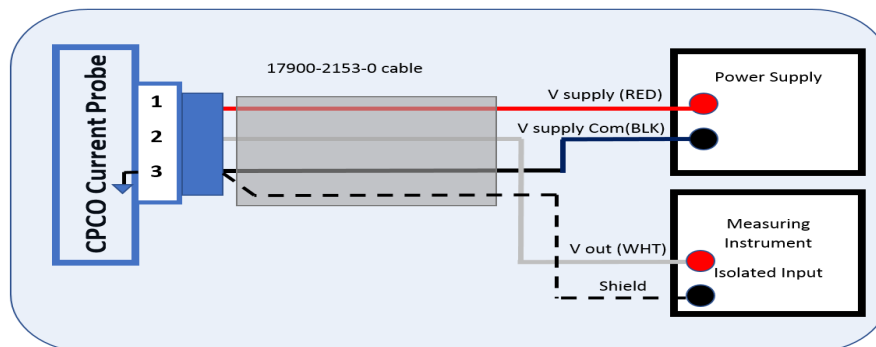
SIGNAL OUTPUT OPTION DESCRIPTIONS, CONTINUED

BP10 Option - The BP stands for Bi Polar and the output voltage from the CPCO will have a quiescent output voltage of 0.0V when there is no primary current ($I_P=0\text{A}$). As the primary current (I_P) increases in a positive direction, the output voltage will increase to the maximum level of 10.0V at $I_P=+I_{PSAT}$. When the primary current increases in the negative direction, the output voltage will decrease toward -10.0V at $I_P=-I_{PSAT}$. See below output characteristics.

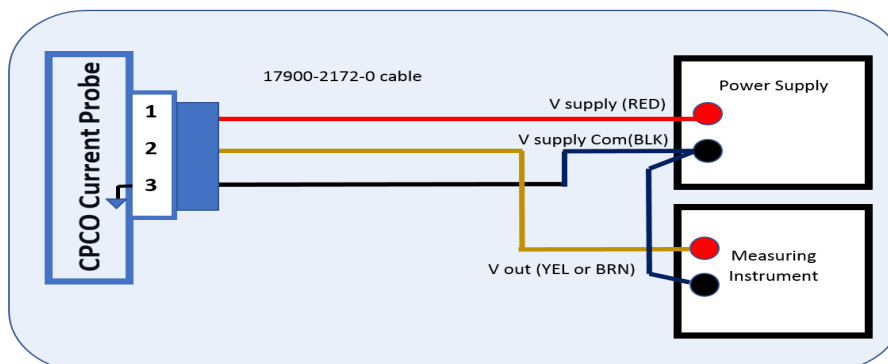
This option is useful for applications that drive circuitry that need higher voltages and can accommodate Bi Polar signal inputs that swing around Com (0.0V) such as oscilloscopes, data loggers, multi-meters, etc.



Recommended Connection Diagram



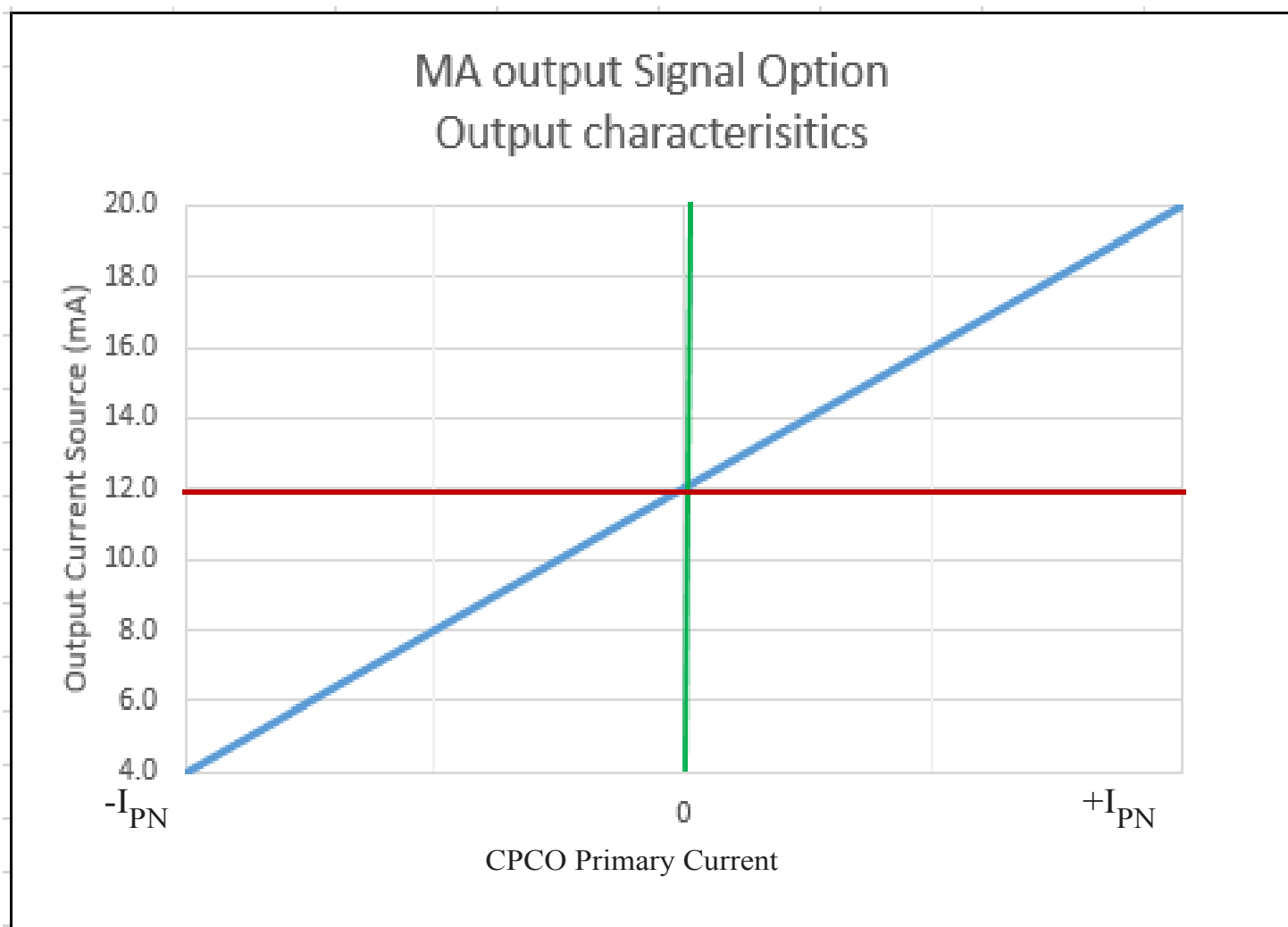
Alternate Connection Diagram



SIGNAL OUTPUT OPTION DESCRIPTIONS, CONTINUED

MA Option - The MA stands for Milli-Amp and the output from the CPCO will be a current source ranging from 4mA to 20mA. There is a quiescent output current source of 12mA when there is no primary current ($I_p=0A$). As the primary current (I_p) increases in a positive direction, the output current source will increase to the maximum level of 20.0mA at $I_p=+I_{PSAT}$. When the primary current increases in the negative direction, the output current source will decrease toward 4mA at $I_p=-I_{PSAT}$. The output current comes from the input power supply, therefore the CPCO power supply must be capable of providing the CPCO current of approx 50mA plus the output source current of up to 20mA. See below output characteristics.

This option is applicable to standard 4-20mA circuit configurations and optimum in noisy environments with long cable runs. The 4-20mA current source output is common with PLC's. Offset errors that can result from long cables are eliminated with the MA version.



SIGNAL OUTPUT OPTION DESCRIPTIONS, CONTINUED

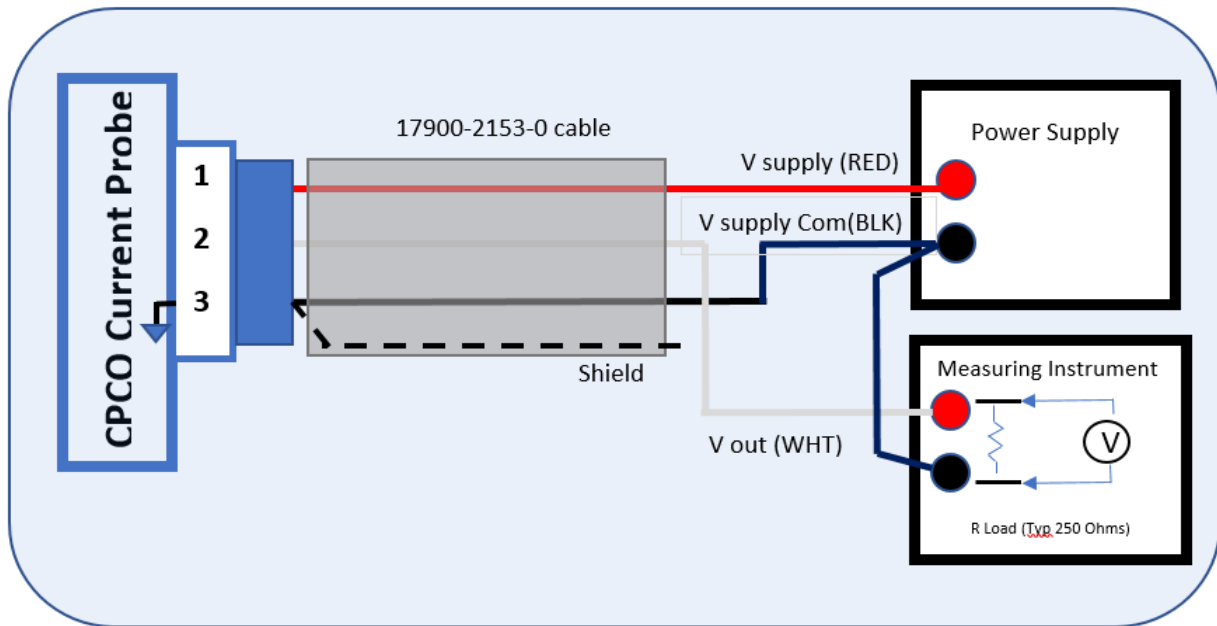
Typical MA option circuit diagram.

The 4-20mA current source flows from the PLC power supply, for example, to the CPCO and then back to the PLC, 4-20mA input. The typical PLC input load resistor is 250ohm.

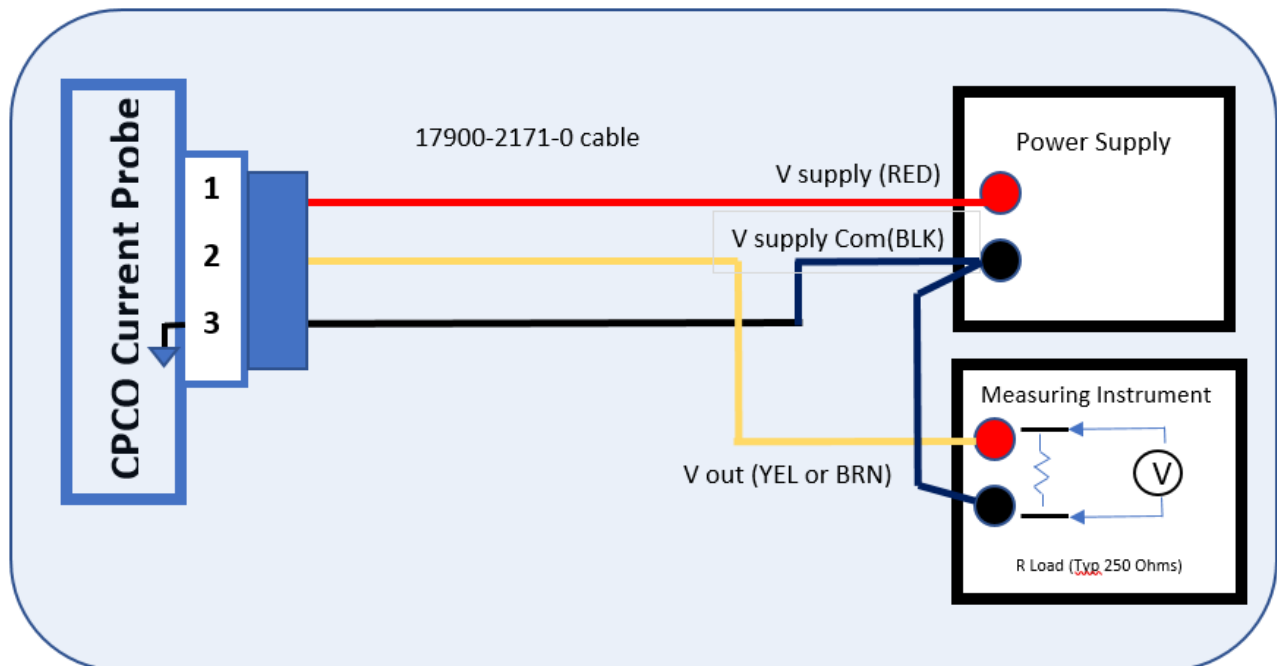
With a 250 ohm resistor, the voltage across the resistor will be :

$$V_{out} = I_{source} * R \text{ (example: at 12mA the } V_{out} = 3.00V \text{)}$$

Connection Diagram with 17900-2153-0 Cable



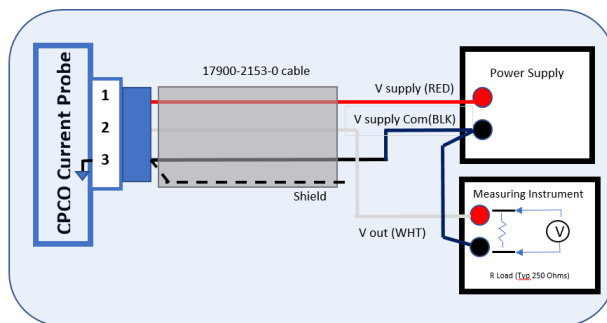
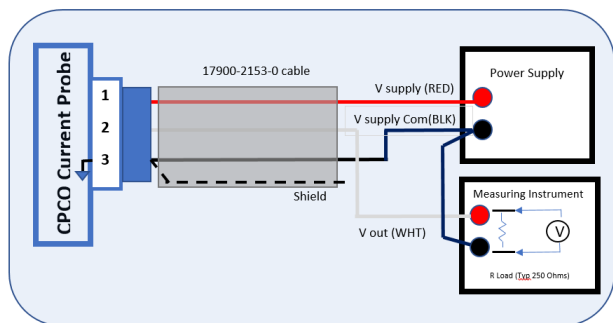
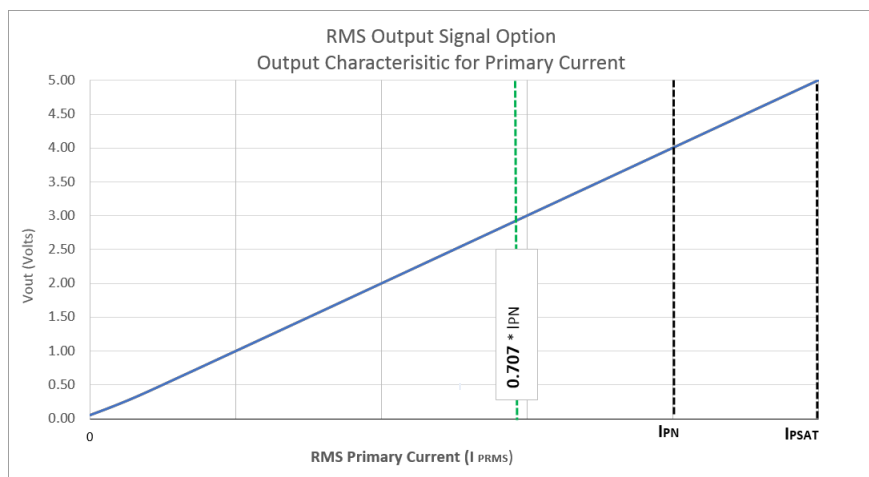
Connection Diagram with 17900-2171-0 Cable



SIGNAL OUTPUT OPTION DESCRIPTIONS, CONTINUED

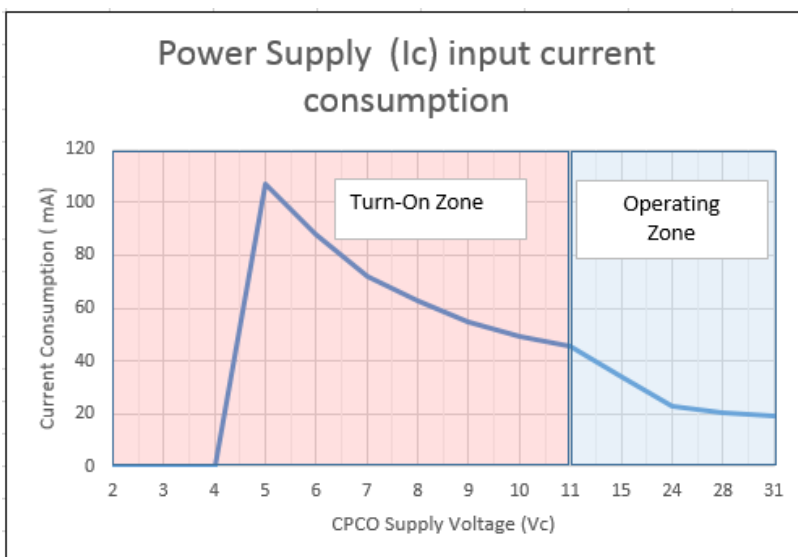
RMS Option - RMS stands for Root Mean Square and the output voltage from the CPCO has a quiescent output voltage in the range of 0.0V to 0.020V when there is no primary current ($I_P=0\text{A}$). The output is an analog voltage that is proportional to the RMS value of the primary current over the complete dc to 50kHz (-3dB) bandwidth of the primary current. See the output characteristic below.

Accurate RMS measurements of a time varying primary current require that the peak current never exceeds $\pm I_{PN}$ to ensure that the CPCO is operating within the linear electronic range to avoid limiting of the CPCO signal. For a sine wave primary current, I_{PRMS} is $0.707 * I_{PN}$. This implies that the maximum RMS primary sine current should be $< 0.707 I_{PN}$ for the highest accuracy RMS output signal. For primary currents with occasional high current transients it is essential that the transients do not exceed I_{PSAT} . For this type of primary current waveform, the maximum allowed RMS current may be much less than $0.707 I_{PN}$.



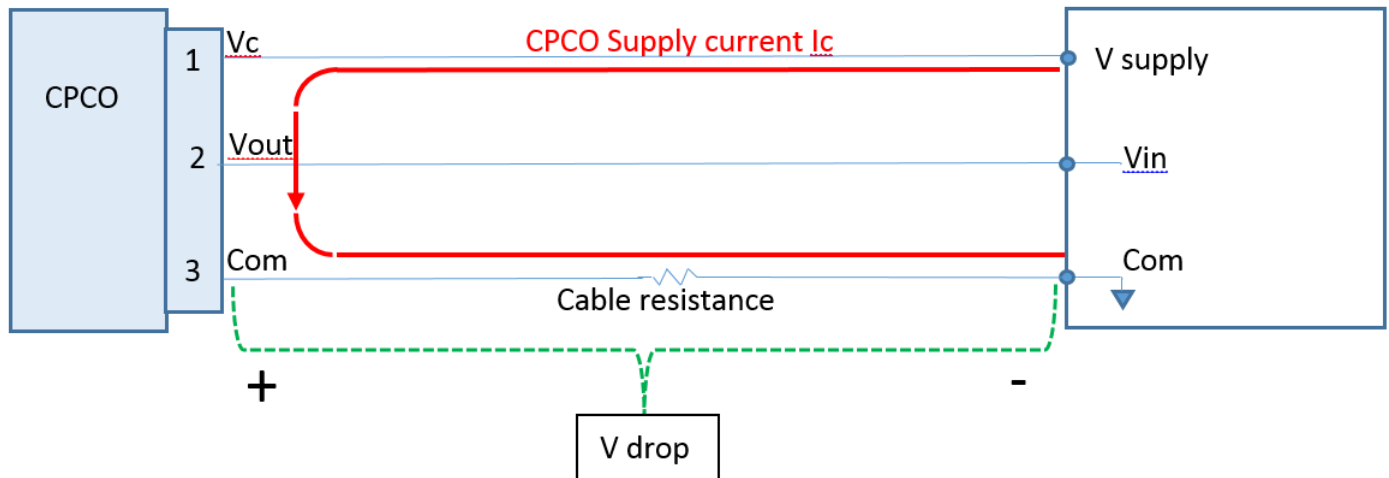
TECHNICAL NOTES: POWER SUPPLY (V_s)

The CPCO incorporates a switching power supply to convert the input power to the internal low voltage operating voltages and reduce the internal power dissipation. The power consumption is relatively constant, therefore the input current is inversely proportional to supply voltage, V_s . The max current is specified to be 47mA once the input voltage reaches the normal operating range of 11-31V, however during the turn-on the current required is higher. See the below graph for the power current required. The power supply used to operate the CPCO, must have at least 150mA capability otherwise the CPCO will not turn on.



TECHNICAL NOTE: OFFSET ERROR CAUSED BY CABLE RESISTANCE/LENGTH

The power supply return and signal return share a common wire, therefore any voltage drop caused by the supply current, I_c , will be added to the output signal voltage level. See below:



The amount of error voltage added to the offset voltage will be dependent on the cable length, wire gauge and operating voltage. The operating voltage affects the I_c current level.

$$\text{Offset voltage error (mV)} = I_c \text{ (mA)} * \text{wire resistance (milli-ohms/ft)} * \text{cable length (ft)}$$

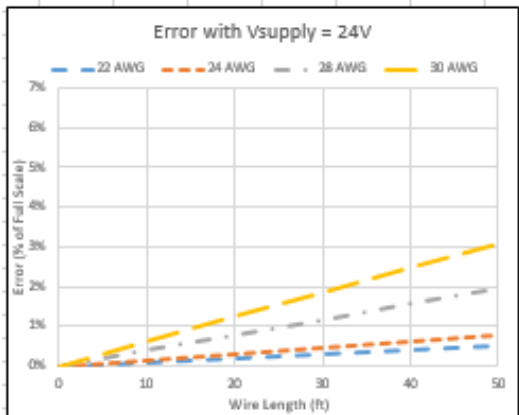
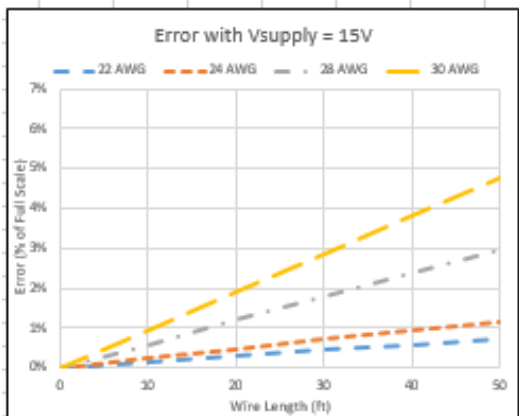
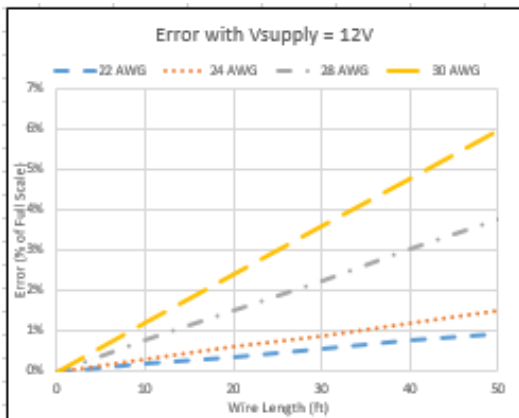
$$\% \text{ Offset error} = (\text{OS voltage error/Full Scale output range (mV)}) * 100\%$$

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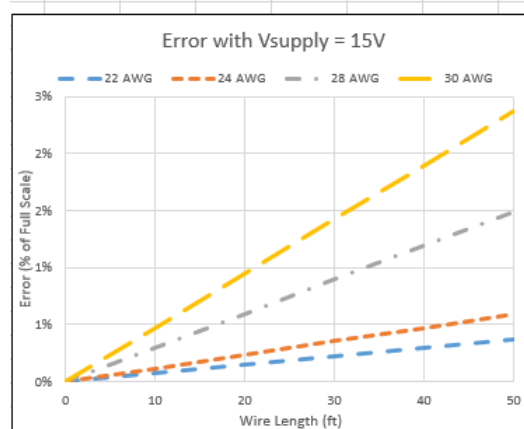
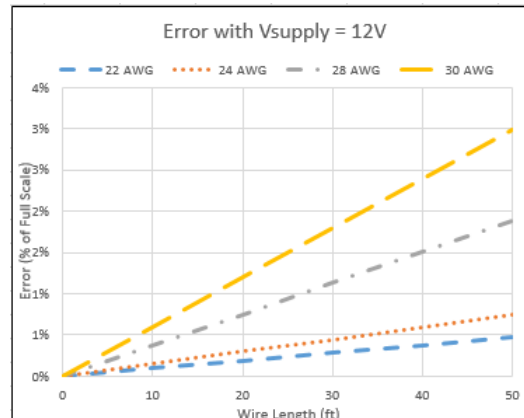
TECHNICAL NOTE, CONTINUED: OFFSET ERROR CAUSED BY CABLE RESISTANCE/LENGTH

The following graphs provide the % error for the various operating voltages, cable size and length for the various signal output options.

For the **SE**, **BP5** and **RMS** output options:



For the **BP10** output option:



For the **MA** output option: The current source is independent of the wire size and return lead, therefore there is **NO** offset errors from the cable type or length.

TECHNICAL NOTE: FOUR WIRE HOOKUP WITH AN ISOLATED INPUT INSTRUMENT

The effect of error voltage on the cable return can be minimized by using a four wire connection and an isolated input instrument. The current flowing in the signal path (GREEN) is in the micro amps, therefore there is no voltage drop across the return lead. The cable accessory (1700-2153-0) has three leads plus a shield. With this cable, the shield can be used as the signal return line (GREEN) for isolated input as long as it is not connected to the power ground (COM).

