

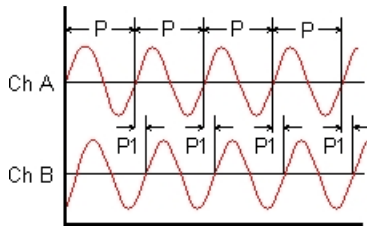


Features

- Programmable to read phase angle or power factor with two waveshapes of identical period
- Reads phase angle with resolution of 1°, 0.1° or 0.01° and accuracy of 0.05° at AC line frequency
- Reads power factor from 1.000 to 0.000 with sinusoidal signals
- Accepts AC signals from 1 Hz to 10 kHz, AC line voltages up to 250 Vrms
- Universal AC power Input, 85-264 Vac
- NEMA 4X, 1/8 DIN case
- Optional serial I/O: Ethernet, USB, RS232, RS485, Ethernet-to-RS485 converter
- Optional relay outputs: dual or quad relays, contact or solid state
- Optional isolated analog output: 4-20 mA, 0-20 mA, 0-10V, -10 to +10V
- Optional low voltage power: 10-48 Vdc or 12-32 Vac



Description



and an accuracy of 0.1% for sinusoidal signals at 50/60 Hz power line frequency. While power factor is always positive, the meter artificially assigns a minus sign to power factor for negative phase angles, and it sets power factor to 0 for phase angles greater than 90°.

The power factor of an AC power system is the ratio of real power in watts (W) divided by apparent power in volt-amperes (VA). For sinusoidal signals differing by a phase angle power factor will be $\cos(\theta)$.

AC Phase Angle Measurement

The Laureate™ Phase Angle & Power Factor Meter computes phase angle θ by timing zero crossings of two signals applied to Channels A and B. The phase angle range is selectable as 0° to 360° or -180° to +180°. Resolution is selectable as 1°, 0.1° or 0.01°. Typical accuracy is 0.01% from 1 Hz to 100 Hz, 0.1% at 1 kHz, and 1% at 10 kHz.

Phase angle in degrees indicates the phase lead or lag between two periodic signals of the same period, as determined from their zero crossings. These two signals will typically be the voltage and current applied to a load. As illustrated, the phase angle θ in degrees is $+360 \times P1/P$.

AC Power Factor Measurement

The Laureate™ Phase Angle & Power Factor Meter computes power factor as $\cos(\theta)$ from phase angle θ . Power factor readings can range from 1.000 to 0.000 with three decimal places

Designed for flexibility

The Laureate Phase Angle & Power Factor Meter utilizes the Laureate Extended counter main board and the FR dual-channel signal conditioner board, which accepts AC signals from 12 mV p-p to 250 Vrms. Optional plug-in boards for communications and control include Ethernet and other serial communication boards, dual or quad relay boards, and single or dual isolated analog output boards.

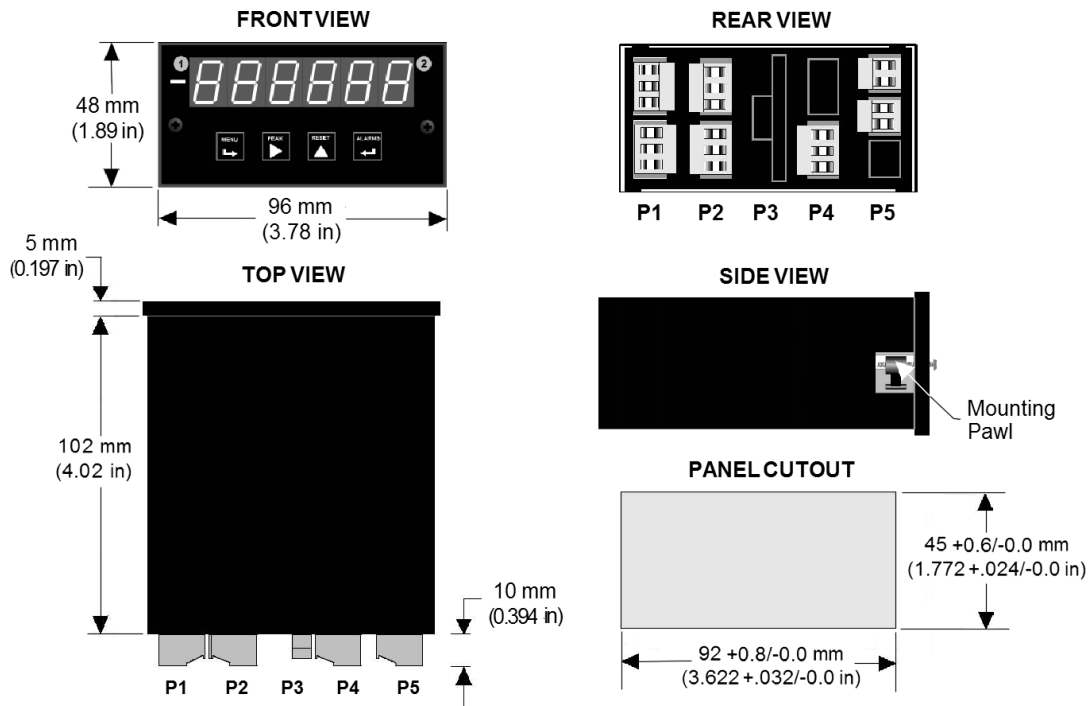
Laureates may be powered from 85-264 Vac or optionally from 12-32 Vac or 10-48 Vdc. The display is available with red or green LEDs. The 1/8 DIN case meets NEMA 4X (IP65) specifications from the front when panel mounted. Any setup functions and front panel keys can be locked out for simplified usage and security. All power and signal connections are via UL / VDE / CSA rated screw clamp plugs.

Specifications

Phase Angle Mode	
Item Displayed	Phase angle difference between two waves of same period
Display Units	1°, 0.1°, 0.01°
Frequency Range	0.005 Hz to 10 kHz
Resolution	0.01°, 1 Hz to 100 Hz; 0.1° at 1 kHz; 1° at 10 kHz
Accuracy	0.03° at 50 or 60 Hz
Maximum Timing Interval	200 sec
Power Factor Mode	
Item Displayed	Power factor between two sine waves of same period
Display Units	1.000 to 0.000, 1.00 to 0.00, or 1.0 to 1.0
Polarity	Negative sign indicates negative phase angle
Frequency Range	0.005 Hz to 10 kHz
Accuracy	0.1% at power line frequencies
Update Rate	
Timing interval	Gate time + 30 ms+ 0-2 signal periods
Gate Time	Selectable 10 ms to 199.99 s
Time Before Zero Out	Selectable 10 ms to 199.99 s (to indicate loss of signal)
Display	
Readout	6 LED digits, 7-segment, 14.2 mm (.56"), red or green
Range	-999999 to +999999
Indicators	Four LED lamps
Inputs	
Signal ranges	Nine AC signal ranges from 12 mVp-p to 250 Vac
Signal ground	Common ground for channels A & B
Noise filter	1 MHz, 30 kHz, 250 Hz (jumper selectable) + digital filter
Power	
Voltage, standard	85-264 Vac or 90-300 Vdc
Voltage, optional	12-32 Vac or 10-48 Vdc
Power frequency	DC or 47-63 Hz
Power consumption (typical, base meter)	1.2W @ 120 Vac, 1.5W @ 240 Vac, 1.3W @ 10 Vdc, 1.4W @ 20 Vdc, 1.55W @ 30 Vdc, 1.8W @ 40 Vdc, 2.15W @ 48 Vdc
Power isolation	250V rms working, 2.3 kV rms per 1 min test
Excitation Output (standard)	
5 Vdc	5 Vdc ± 5%, 100 mA
10 Vdc	10 Vdc ± 5%, 120 mA
24 Vdc	24 Vdc ± 5%, 50 mA
Output Isolation	50 Vdc to meter ground
Analog Output (optional)	
Output Levels	4-20 mA, 0-20 mA, 0-10V, -10 to +10V (jumper selectable)
Current compliance	2 mA at 10V (> 5 kΩ load)
Voltage compliance	12V at 20 mA (< 600Ω load)
Scaling	Zero and full scale adjustable from -99999 to +99999
Resolution	16 bits (0.0015% of full scale)
Isolation	250V rms working, 2.3 kV rms per 1 min test
Relay Outputs (optional)	
Relay Types	2 Form C contact relays or 4 Form A contact relays (NO) 2 or 4 Form A, AC/DC solid state relays (NO)
Current Ratings	8A at 250 Vac or 24 Vdc for contact relays 120 mA at 140 Vac or 180 Vdc for solid state relays
Output common	Isolated commons for dual relays or each pair of quad relays
Isolation	250V rms working, 2.3 kV rms per 1 min test

Serial Data I/O (optional)	
Board Selections	Ethernet, Ethernet-to-RS485 server, USB, USB-to-RS485 server, RS485 (dual RJ11), RS485 Modbus (dual RJ45), RS232.
Protocols	Modbus RTU, Modbus ASCII, Laurel ASCII protocol
Data Rates	300 to 19200 baud
Digital Addresses	247 (Modbus), 31 (Laurel ASCII),
Isolation	250V rms working, 2.3 kV rms per 1 min test
Environmental	
Operating Temperature	0°C to 55°C
Storage Temperature	-40°C to 85°C
Relative Humidity	95% at 40°C, non-condensing
Protection	NEMA-4X (IP-65) when panel mounted
Signal Connections	

Mechanical



Application Examples

Optimizing Meter Inputs for Phase Angle & Power Factor Measurement

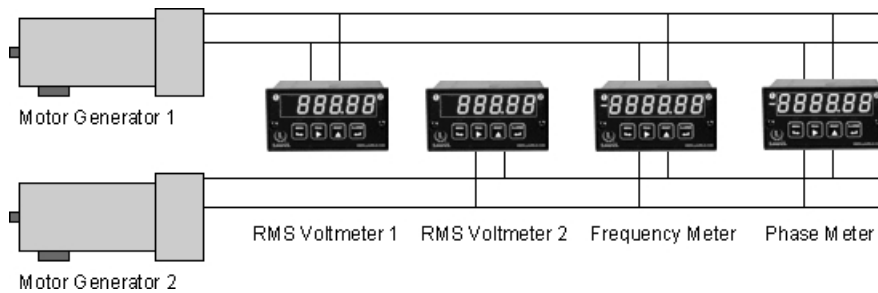
Phase angle and power factor measurement with the Laureate™ Phase Angle & Power Factor Meter require that two signals of identical periods be applied to Channels A and B. For best accuracy, both signals should have the same amplitude, the signal amplitude should be larger than 1V, and the trigger level should be minimized by selecting the ± 12 mV jumper position.

The meter times zero crossings to 0.1 μ s resolution over a user-selectable gate time from 10 ms to 199.99 s. By selecting the minimum gate time of 10 ms, the meter update rate will be approximately 20/s for 50/60 Hz AC line frequency.

Improved accuracy will be obtained by making the gate time long enough so that multiple cycles are averaged.

Both signals applied to the meter should be mutually isolated by transformer coupling, so that they can then share the same ground in the meter. The current signal is typically obtained from a current transformer (CT). This should ideally be a CT with a voltage output or a current output in the mA range, which can then be converted to a voltage higher than 1V across an external dropping resistor without excessive heat generation.

Using Laureate Meters and Counters to Synchronize Motor Generators



Synchronization of two motor generators requires that the two frequencies be identical, that the lines be in phase, and that the line voltages be close to each other. In this illustration, a single Laureate dual channel counter measures both frequencies to six-figure accuracy in a few line

cycles. Another Laureate dual channel counter measures phase angle to 0.1° resolution. Two Laureate AC RMS Voltmeters, which offer ranges of 200.00 V and 600.0 V, are used to display the two RMS voltages to 0.1% accuracy

Ordering Guide

Create a model number in this format: **L70000FR, IPC**

Main Board	L7 Extended Main Board, Green LEDs L8 Extended Main Board, Red LEDs
	Note 1: Use of the Extended Main Board also makes this counter suitable for A-B time interval, stopwatch, frequency, rate, period, square root of rate, up or down total, arithmetic functions, simultaneous rate and total, duty cycle, batching, and custom curve linearization. Note 2: If the meter is to be used for power factor, please so indicate in a note at the time order.
Power	0 Isolated 85-264 Vac 1 Isolated 12-32 Vac or 10-48 Vdc
Relay Output (isolated)	0 None 1 Two 8A Contact Relays 2 Two 120 mA Solid State Relays 3 Four 8A Contact Relays 4 Four 120 mA Solid State Relays
Analog Output (isolated)	0 None 1 Single isolated 4-20 mA, 0-20 mA, 0-10 V, -10 to +10V 2 Dual isolated 4-20 mA, 0-20 mA, 0-10V
Digital Interface (isolated)	0 None 1 RS-232 2 RS485 (dual RJ11 connectors) 4 RS485 Modbus (dual RJ45 connectors) 5 USB 6 USB-to-RS485 converter 7 Ethernet 8 Ethernet-to-RS485 converter
Input Type	FR Dual-Channel Pulse Input Signal Conditioner
Add-on Options	CBL01 RJ11-to-DB9 cable. RJ11 to DB9. Connects RS232 ports of meter and PC. CBL02 USB-to-DB9 adapter cable. Combination of CBL02 and CBL01 connects meter RS232 port to PC USB port. CBL03-1 6-wire data cable, RJ11 to RJ11, 1 ft. Used to daisy chain meters via RS485. CBL03-7 6-wire data cable, RJ11 to RJ11, 7 ft. Used to daisy chain meters via RS485. CBL05 USB cable, A-B. Connects USB ports of meter and PC. CBL06 USB to RS485 adapter cable, half duplex, RJ11 to USB. Connects meter RS485 port to PC USB port. CASE1 Benchtop laboratory case for one 1/8 DIN meter CASE2 Benchtop laboratory case for two 1/8 DIN meters IPC Splash-proof cover BOX1 NEMA-4 Enclosure BOX2 NEMA-4 enclosure plus IPC BL Blank Lens without button pads NL Meter lens without button pads or Laurel logo