

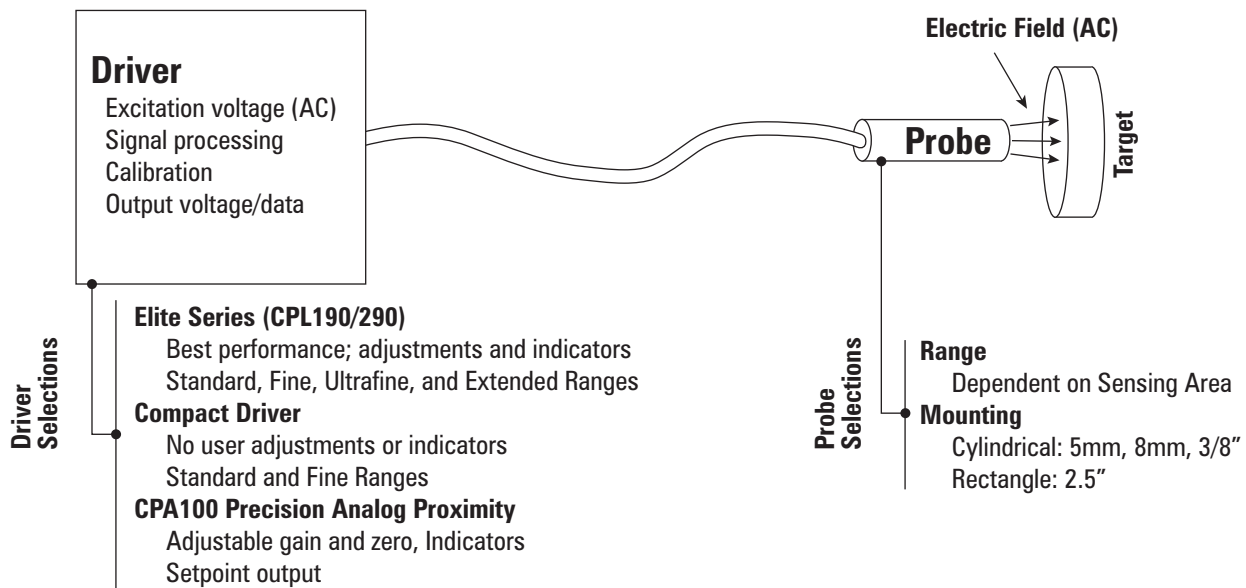
**LION**  
PRECISION

# CAPACITIVE SENSORS

Position • Displacement | High Speed • High Resolution



# A Capacitive Sensor System



## Capacitive Sensors

### Basics

When two conductive surfaces are near each other, there is an electrical property called capacitance that exists between them. The amount of capacitance depends on the distance and material between the two conductors. A capacitive sensor uses an electric field to measure changes of capacitance between the probe surface and a conductive target surface.

### Conductive Targets

If the material between the two conductive surfaces remains constant, any change in capacitance is due to a change in the distance between them. Capacitive sensors are calibrated to produce a repeatable output for a given change in distance between the probe and the target. This technique works over small ranges ( $10\mu\text{m}$  -  $6000\mu\text{m}$ ) with resolutions as low as  $0.4\text{nm}$ .

### Nonconductive Targets

Capacitance also depends on the material between the probe and a conductive target surface. If the distance between the probe and a target surface is fixed, capacitive sensors can measure changes in the material between them. This technique is traditionally used to detect changes in thickness of material, but could also detect changes in material composition or density.

### Maximizing Accuracy

Accuracy at the high resolutions created by capacitive sensors may be greatly affected by the environment and measurement setup. Probes must be positioned in a stable mechanical system in a stable environment. Even small changes in temperature cause expansions of the target that are detectable by high-resolution capacitive sensors.

### Resolution

Resolution is a measurement system's smallest possible measurement. Resolution is essentially a measurement of electrical noise present at the sensor output. Capacitive sensor resolution is a function of the bandwidth of the system. The lower the bandwidth, the better the resolution. *When comparing specifications, be sure you know the bandwidth at which the resolution is specified.*

**See the complete capacitive sensor tutorial TechNote at:**  
**[www.lionprecision.com](http://www.lionprecision.com); click on Technical Library.**

# Elite Series

sensors  
**PLUG&PLAY**

*Our top performing capacitive sensor system*

Elite Series sensors combine high performance, easy DAQ interface, and the flexibility of custom configurations.

- 1-8 Sensors in a single system
- Sensors Plug&Play (TEDS) for easy LabVIEW™ interface with LabVIEW drivers available at [www.lionprecision.com](http://www.lionprecision.com)
- Rear-panel 68-pin connector configured for National Instruments™
- Support modules available:  
Temperature Sensors, Signal Processing/Display



## Enclosures

*Intelligent Enclosures*

Enclosures provide power and drive signals.

Extra slots can be included for future expansion.

- Direct connect to National Instruments DAQ hardware
- Input power: 100-240VAC 50/60Hz
- 1-, 2-, 3-, 6-, 8-slot Options
- Mounting flanges on 1-, 2-, and 3-slot
- Tip-up handle on 6- and 8-slot

1-, 2-, and 3-slot enclosures include an external power supply.



Each 6- and 8-slot enclosure includes internal power supply and standard IEC line-power cord.



Elite Series Modules →

# Elite Series

## CPL190 /CPL290 Sensor Modules

Single Range / Dual Range

The CPL190 has one range (sensitivity); the CPL290 has two ranges.

- |  |                           |                                    |
|--|---------------------------|------------------------------------|
| • Five-element range indicator                                 | Resolution <sup>1</sup> : | 0.2 - 200 nm                       |
| • Coarse/Fine zero adjusts                                     |                           | 0.04 - 8.0 $\mu$ inch              |
| • Zero adjust disable  | Bandwidth:                | Selectable                         |
| • Front-panel BNC analog output                                |                           | 100 Hz, 1 kHz,                     |
| • Differential output to National Instruments 68-pin connector |                           | 10 kHz, 15 kHz                     |
| • Remote selection of sensitivity and bandwidth with LabView™  | Linearity <sup>2</sup> :  | <0.2% F.S. typical                 |
| • LabView™ Plug&Play Compatibility with LabVIEW drivers        | Max Drift:                | 0.04% F.S./°C                      |
|  | Front-Panel BNC:          | $\pm 10$ V, 0 $\Omega$ , 15 mA max |
|  | National Inst.            |                                    |
|  | Rear Conn.:               | $\pm 10$ V, Differential           |
|  | Operating Temp:           | 4°C-50°C                           |

sensors  
**PLUG&PLAY**



<sup>1</sup>Dependent on probe, range, and bandwidth. See Ranges/Probes section for details.

<sup>2</sup>Dependent on probe and range. See Ranges/Probes section for details.

## MM190 Meter Module

### Signal Processing and Five-Digit Display Module

Two-channel summing and peak-capture functions

- Five-digit display: Metric or inch units
- Summing: A, B, A + B, A - B of any two channels in the system
- Peak-capture functions: Max, Min, TIR, Tracking TIR (Self-resetting TIR)
- Analog output of conditioned signal through BNC
- Differential, analog output of conditioned signal through National Instruments 68-pin connector
- Display accuracy: 0.1%



## TMP190 Temperature Module

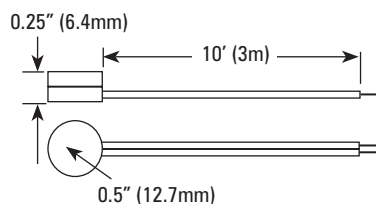
### Seven-Channel Temperature Sensor

Used in conjunction with LabVIEW™ or Lion Precision SEA™ V8 software

to read temperature sensors and encoder/index inputs.

- Seven thermistors included
- Index and encoder inputs for SEA™
- +5V and +15V encoder/prox power
- Single-ended or differential encoder input
- Encoder and index state indicators

Magnetic Mount Thermistor



## Ranges/Probes

Probes for use with the CPL190 and CPL290 Capacitive Sensor Modules

See "Probes" page for probe mechanical details.

**Range is determined by the probe Sensing Area.** The larger the area, the larger the range.

Sensing Areas are coded by letters (A, B...).

**Different probe body styles/sizes are available for each Sensing Area.**

Body styles are coded by a letter (C=Cylindrical, R = Rectangular) and a numerical designator.

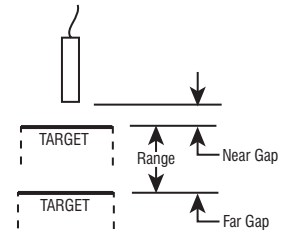
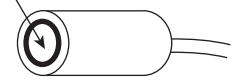
Probe model numbers consist of the Body Style and the Sensing Area, such as: C30-B or C5-E.

Range is the distance between the Near Gap and Far Gap; Near Gap is never zero.

Four sets of ranges are available for the Elite Series:

Standard, Fine, Ultrafine, and Extended

Sensing Area



Sensing Area	Body Styles	Ultrafine					Fine					Standard					Extended				
		Range μm mils	Near Gap μm mils	Resolution*		Lin.* %F.S.	Range μm mils	Near Gap μm mils	Resolution*		Lin.* %F.S.	Range μm mils	Near Gap μm mils	Resolution*		Lin.* %F.S.	Range μm mils	Near Gap μm mils	Resolution*		Lin.* %F.S.
Min. Target Ø mm inch				BW Hz	nm μin				BW Hz	nm μin				BW Hz	nm μin				BW Hz	nm μin	
F <sup>†</sup>	5 mm Ø C3 C5 C6	—	—	—	—	—	10 0.4	20 0.8	100 0.04 10k 0.07	1.1 0.04 2.0 0.07	0.25	50 2.0	50 2	100 0.15 10k 0.27	3.8 0.15 6.8 0.27	0.30	80 3.0	60 2.5	100 0.27 10k 0.49	6.8 0.27 12 0.49	0.85
E <sup>†</sup>	5 mm Ø C3 C5 C6	—	—	—	—	—	25 1.0	75 3.0	100 0.12 10k 0.22	3.0 0.12 5.4 0.22	0.15	100 4.0	100 4	100 0.30 10k 0.54	7.5 0.30 14 0.54	0.15	—	—	—	—	—
D	5 mm Ø C3 C5 C6 8 mm Ø C30 C36	10 0.4	20 0.8	100 0.2 0.01 15k 0.4 0.02	0.2 0.01 0.4 0.02	0.15	50 2.0	75 3.0	100 1.0 0.04 15k 2.0 0.08	1.0 0.04 2.0 0.08	0.15	250 10.0	125 5	100 4.5 0.18 15k 9 0.35	4.5 0.18 9 0.35	0.10	500 20.0	125 5	100 9.0 0.36 15k 18.0 0.71	9.0 0.36 18.0 0.71	0.15
B	8 mm Ø C30 C36	—	—	—	—	—	50 2.0	125 5.0	100 0.04 15k 2.0 0.08	1.0 0.04 2.0 0.08	0.20	500 20.0	250 10	100 5.0 0.20 15k 10 0.40	5.0 0.20 10 0.40	0.15	1250 50.0	250 10	100 20.0 0.79 15k 40.0 1.6	20.0 0.79 40.0 1.6	0.20
A	3/8" Ø C1 C2	—	—	—	—	—	50 2.0	225 9.0	100 0.8 0.03 15k 1.5 0.06	0.8 0.03 1.5 0.06	0.20	500 20.0	500 20	100 6.0 0.24 15k 12 0.47	6.0 0.24 12 0.47	0.20	2000 80.0	250 10	100 20.0 0.79 15k 40.0 1.6	20.0 0.79 40.0 1.6	0.45
H	R2	—	—	—	—	—	—	—	—	—	—	2500 100	5000 200	100 100 3.9 15k 50 2.0	100 3.9 50 2.0	0.20	6000 250.0	3000 100	100 180 7.1 15k 90 3.5	180 7.1 90 3.5	0.25

\*For other bandwidths use 100Hz values with these multipliers: 1kHz-1.4, 10kHz-1.8, 15kHz-2.0 (standard = unfiltered).

Resolution values are RMS. Peak-to-peak values are typically 8-10 times greater than the RMS values.

†10kHz maximum bandwidth for these sensing areas.



# Compact Driver

*High-Density, Multi-Channel Sensor*

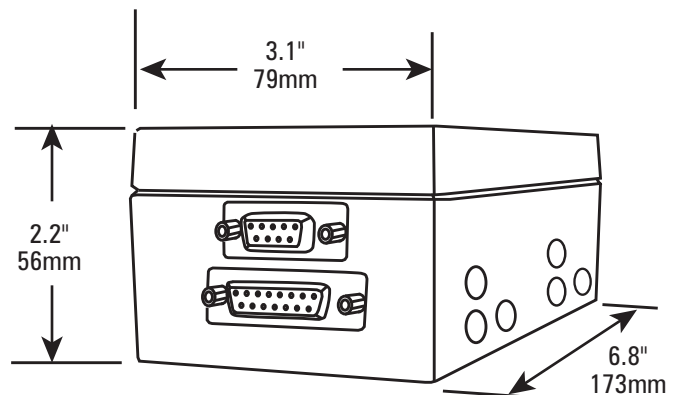
- Up to Six Channels
- $\pm 10$  V Output
- Individually calibrated for maximum performance
- No User Adjustments
- Differential and Single-Ended Outputs
- Small Size, High Density Package
- OEM and Embedded Applications
- Separate Power and Signal Connectors

## Specifications

Resolution <sup>1</sup> :	0.4 - 400 nm 0.08 - 16.0 $\mu$ inch
Bandwidth:	15 kHz
Linearity <sup>2</sup> :	<0.4% F.S. typical
Maximum Drift:	0.04% F.S./°C
Output:	$\pm 10$ V Single-Ended or Differential
Operating Temp:	4°C-50°C
Input Power:	$\pm 15$ VDC, 50 mA/channel

<sup>1</sup>Dependent on probe, range, and bandwidth. See Ranges/Probes section for details.

<sup>2</sup>Dependent on probe and range. See Ranges/Probes section for details.



# Compact Driver

## Ranges/Probes

### Probes for use with the Compact Driver Capacitive Sensor

See “Probes” page for probe mechanical details.

**Range is determined by the probe Sensing Area.** The larger the area, the larger the range.

Sensing Areas are coded by letters (A, B,...).

**Different probe body styles/sizes are available for each Sensing Area.**

Body styles are coded by a letter (C=Cylindrical, R = Rectangular) and a numerical designator.

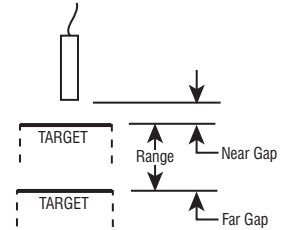
Probe model numbers consist of the Body Style and the Sensing Area, such as: C30-B or C5-E.








Range is the distance between the Near Gap and Far Gap; Near Gap is never zero.

Two sets of ranges are available for the Compact Driver:

Standard and Fine

### Sensing Area



Sensing Area		Body Styles	Fine				Standard					
			Range μm mils	Near Gap μm mils	Resolution*		Lin.* %F.S.	Range μm mils	Near Gap μm mils	Resolution*		Lin.* %F.S.
					BW Hz	nm μin				BW Hz	nm μin	
D		50 2.0	75 3.0	100	2.0 0.08	0.3	250 10.0	125 5	100	9.0 0.36	0.20	
2.5 0.10				15k	4.0 0.16				15k	18 0.70		
B		50 2.0	125 5.0	100	2.0 0.08	0.40	500 20.0	250 10	100	10 0.40	0.30	
4.1 0.16				15k	4.0 0.16				15k	20 0.80		
A		50 2.0	225 9.0	100	1.6 0.06	0.40	500 20.0	500 20	100	12 0.24	0.40	
7.6 0.30				15k	3.0 0.12				15k	24 0.47		
H		—	—	—	—	—	2500 100	5000 200	100	10 4.0	0.40	
25 1.0				—	—				15k	200 7.8		

\*For other bandwidths use 100Hz values with these multipliers: 1kHz-1.4, 10kHz-1.8, 15kHz-2.0 (standard = unfiltered).

Resolution values are RMS. Peak-to-peak values are typically 8-10 times greater than the RMS values.

†10kHz maximum bandwidth for these sensing areas.

# CPA100

## Precision Analog Proximity Switch

- Lower Cost
- 0-10 V Nonlinear Analog Output
- Setpoint/Switched Output
- Adjustable Gain and Zero
- Visual Range Indicator
- Remote Gain and Zero adjustment connections
- DIN Rail Case
- Multiple Channel Sync

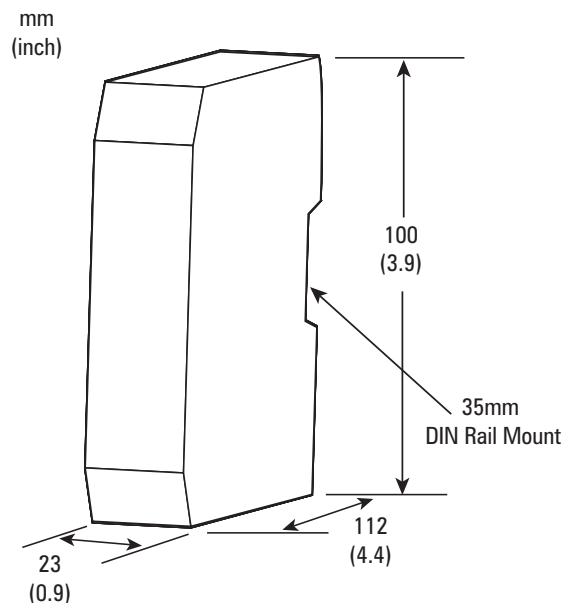
### Specifications

Resolution <sup>1</sup> :	0.03% F.S.
Bandwidth:	15 kHz
Linearity:	Nonlinear
Maximum Drift:	0.04% F.S./°C
Analog Output:	0-10 V, 0 $\Omega$ , 15 mA max.
Setpoint:	Fixed at 5 V (mid-range)
Setpoint Output:	Solid state switch closure 30 VAC/60 VDC max On state: 2.5 $\Omega$ , 100mA max Off state leakage: 10 $\mu$ A max
Operating Temp.:	4°C-50°C
Input Power:	15-24 VDC, 2.5 W

<sup>1</sup>Dependent on probe, range, and bandwidth. See Ranges/Probes section for details.

### Export License

The CPA101 is a special version of the CPA100 with resolution guaranteed to be 3  $\mu$ m or higher so that an export license is not required. All other specifications are the same.





## Ranges/Probes

### Probes for use with the CPA100 Capacitive Sensor

See “Probes” page for probe mechanical details.

**Range is determined by the probe Sensing Area.** The larger the area, the larger the range.

Sensing Areas are coded by letters (A, B...).

**Different probe body styles/sizes are available for each Sensing Area.**

Body styles are coded by a letter (C=Cylindrical, R = Rectangular) and a numerical designator.

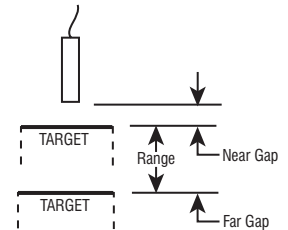
Probe model numbers consist of the Body Style and the Sensing Area, such as: C30-B or C5-E.

Range is the distance between the Near Gap and Far Gap; Near Gap is never zero.

Two sets of ranges are available for the CPA100:

Standard and Extended

### Sensing Area



Sensing Area	Min. Target Ø mm inch	Body Styles	Standard		Extended	
			Range µm mils	Near Gap µm mils	Range µm mils	Near Gap µm mils
F <sup>1</sup>	5 mm Ø	C3	50	50	80	60
	0.8 0.03	C5 C6	2.0 2	3.0 2.5		
E <sup>1</sup>	5 mm Ø	C3	100	100	—	—
	1.0 0.04	C5 C6	4.0 4			
D	5 mm Ø	C3	250	125	500	125
	8 mm Ø	C30 C36	10.0 5	20.0 5		
B	8 mm Ø	C30	500	250	1250	250
	4.1 0.16	C36	20.0 10	50.0 10		
A	3/8" Ø	C1	500	500	2000	250
	7.6 0.30	C2	20.0 20	80.0 10		
H			—	—	6000	3000
	25 1.0	R2			250.0 100	

<sup>1</sup>10kHz maximum bandwidth for these sensing areas.

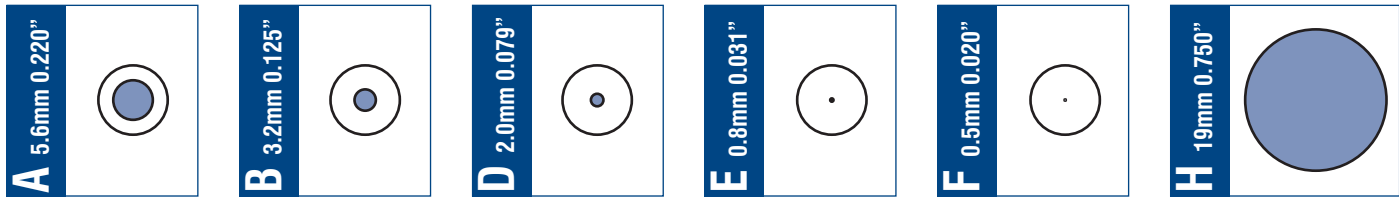
# Probes

Operating and storage temperature range: 4°C - 50°C. C30 and C36 probes can be heated to 150°C for bake-out (nonoperating).

Include two-meter cables and can be ordered as *vacuum compatible*.

Shorting the Sensing Area or guard ring to ground, will not damage the probe or driver.

## Sensing Areas (Target area diameter must be at least 1.3 times larger)

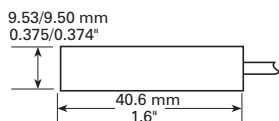


## Probe Body Styles/Sizes



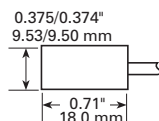
**Sensing Areas:** Ranges

**A:** 50, 500, 2000  $\mu\text{m}$   
2, 20, 80 mils



**Sensing Areas:** Ranges

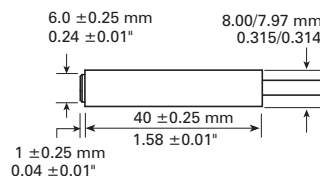
**A:** 50, 500, 2000  $\mu\text{m}$   
2, 20, 80 mils



**Sensing Areas:** Ranges

**B:** 50, 500, 1250  $\mu\text{m}$   
2, 20, 50 mils

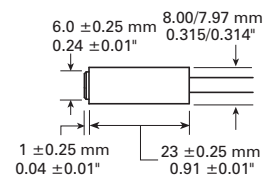
**D:** 10, 50, 250, 500  $\mu\text{m}$   
0.4, 2, 10, 20 mils



**Sensing Areas:** Ranges

**B:** 50, 500, 1250  $\mu\text{m}$   
2, 20, 50 mils

**D:** 10, 50, 250, 500  $\mu\text{m}$   
0.4, 2, 10, 20 mils

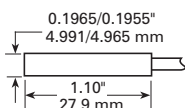


**Sensing Areas:** Ranges

**D:** 10, 50, 250, 500  $\mu\text{m}$   
0.4, 2, 10, 20 mils

**E:** 25, 100  $\mu\text{m}$   
1, 4 mils

**F:** 10, 50, 80  $\mu\text{m}$   
0.4, 2, 3 mils

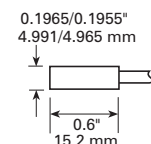


**Sensing Areas:** Ranges

**D:** 10, 50, 250, 500  $\mu\text{m}$   
0.4, 2, 10, 20 mils

**E:** 25, 100  $\mu\text{m}$   
1, 4 mils

**F:** 10, 50, 80  $\mu\text{m}$   
0.4, 2, 3 mils

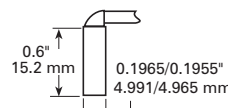


**Sensing Areas:** Ranges

**D:** 10, 50, 250, 500  $\mu\text{m}$   
0.4, 2, 10, 20 mils

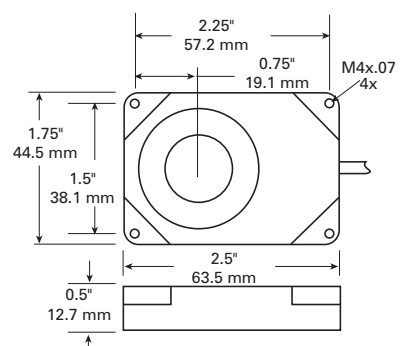
**E:** 25, 100  $\mu\text{m}$   
1, 4 mils

**F:** 10, 50, 80  $\mu\text{m}$   
0.4, 2, 3 mils



**Sensing Areas:** Ranges

**H:** 2.5 to 6 mm  
100 to 250 mils



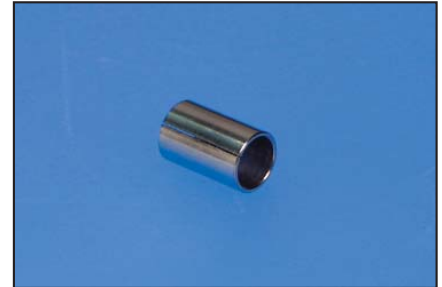
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# Accessories

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## 8 mm to 3/8" Adapter for 8 mm Probes

For easy installation of 8 mm probe bodies into existing 3/8" mounting clamps.



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## Power Supply for Compact Driver and Elite Series 1-, 2-, and 3-Slot Enclosures

A high frequency, switching power supply is available for the Elite Series system which do not have internal power supplies (1-, 2-, and 3-slot) and the Compact Driver. Use of CE compliant high frequency (or linear) power supplies is required for listed sensor resolutions.



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## Power Supply for CPA100

A DIN-rail mount, high frequency, switching power supply is available. Use of a CE compliant, high frequency (or linear) power supply is required for listed sensor resolutions.



# Custom Sensor Design

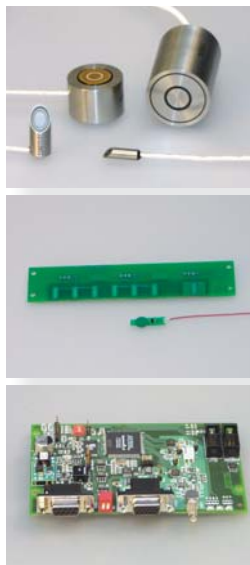
*Custom probes and electronics for your specific application*

Lion Precision's stated purpose is:

"Provide optimized sensing solutions by partnering with our customers to ensure mutual success."

Our customers have enjoyed our assistance and willingness to develop customized solutions to their unique measurement problems, and our internal systems are designed to do just that. Communication tools connecting sales, engineering, and manufacturing provide the fastest response possible to custom orders.

Custom probes and electronics make up a significant portion of our annual production. We can help you with a solution that cannot be purchased off the shelf.



## Complete Technical Detail

[www.lionprecision.com](http://www.lionprecision.com)

The Lion Precision web site provides a high level of technical detail about our products and about capacitive sensing in general. Our Capacitive Sensing Tutorial is viewed thousands of times a month. The tutorial enables you to better understand the sensing technology, what pitfalls to avoid, and how to maximize the effectiveness of your measurement.

The web site also provides detailed TechNotes providing insight into the specific operation of our sensors and answering your questions about an entire range of issues.

Of course, all of the product manuals are available from the web site as well as information about the company, its history, vision, and way of doing business.

## Expert Opinion

*"Lion Precision worked with us to develop a set of tools that have allowed us to see deeper into the inner working of our products. The collaborative relationship that developed is unique and has allowed us to push the state of the art in ways that were simply not possible before. The quality products they produce and the willingness to listen to our needs allow us to have confidence that our products are being tested to the highest standards possible. Lion Precision's products are of great value in our ongoing pursuit of 'the next decimal point.'"*

James Arneson

President

Professional Instruments

*"We have been using Lion Precision probes and drivers for ten years and have enjoyed the consistently excellent quality, reliability, and accuracy that these systems offer. Most importantly, we have saved a huge amount of time and money because we get fast, repeatable, and accurate results with no hassles.*

*Please accept my congratulations on your superb capacitive measurement systems. We thank you for your dedication to developing the world's best sensors."*

Dr. Eric Marsh

Professor of Mechanical Engineering  
The Pennsylvania State University

**LION**  
**PRECISION**

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