

# PHIL TEC 光纤位移传感器

## SERIES 88 SENSORS

### Description

The basic elements of these devices are:

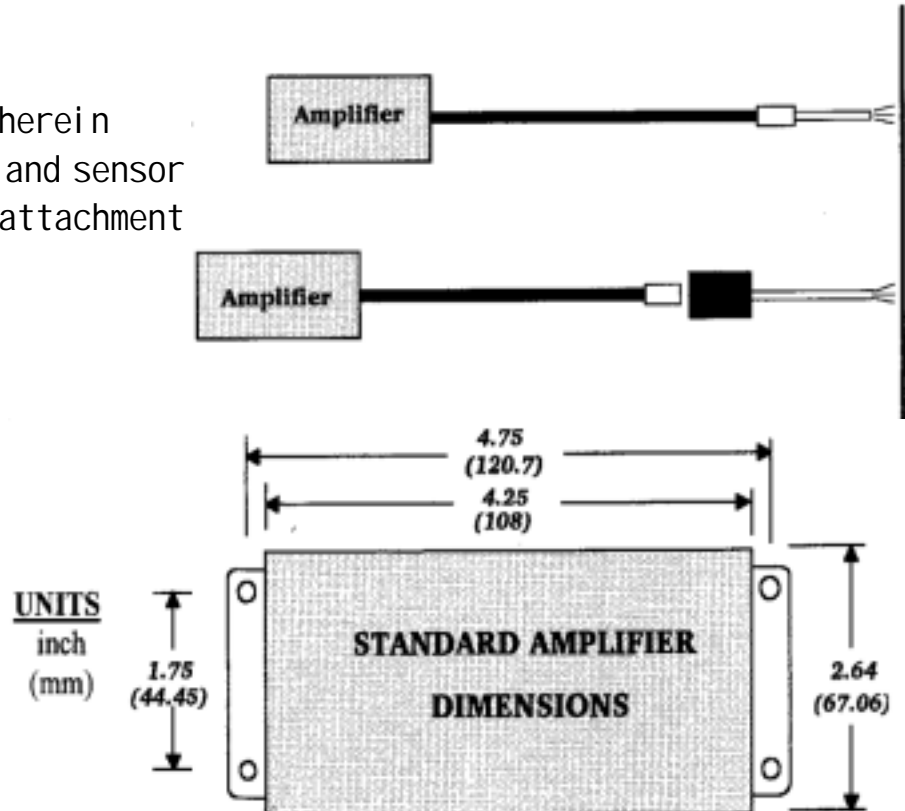
- A Sensor Tip
- A Fiber Optic Cable
- An Optoelectronic Amplifier

The amplifiers require user supplied DC power. Analog voltage outputs are provided on a barrier terminal block. The electronics and fiber optic cable are set into the amplifier housing with an epoxy potting compound, thereby providing an extremely rugged and inert device.

### Configurations

A "one-piece" system wherein the fiber optic cable and sensor tip are an integral attachment to the amplifier.

A "two-piece" system with replaceable tips wherein the sensor tip and/or fiber optic cable (or part of it) can be detached from the amplifier.



# General Specifications

## STANDARD MODELS

### *Amplifier*

Light Source, (not visible)	LED, 880nm	Used in most models
(not visible)	LED, 940nm	Is available by request
(visible)	Laser Diode, 670nm	models D6, D170, RC90, RC140
Input Voltage	+9to+30Volts DC unregulated	
Input Current	100ma max	
Analog Output Current	0 to +5 VDC	
Analog Output Current	5ma max	
Frequency Response	DC to 20 KHz	Flat to 4 KHz 3 db down at 20 KHz
Stability(electronic drift)	<0.1%Full Scale(i.e., <5mv)	
Operating Temperature	50 to 110 (10 to 43 )	
Weight	1.5l bs. (0.68kg)	

### *Sensor Tips*

	(Non-contact)	
Operating Temperature	-100 to 525 (-73 to 274 )	
Operating Pressure	-14 to 500 psig (-10 to 345 N/cm <sup>2</sup> )	

### *Sensor Tips*

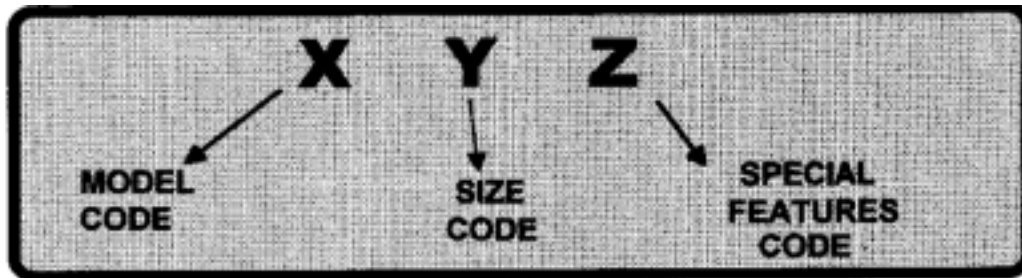
	(Fibertouch)	
Operating Temperature	-50 to +300 (10 to 150 )	
Operating Pressure	Ambient	

### *Fiber Optic Cable*

Sheathing	PVC over steel monocoil wrap	
Length	6 FT(1.82m)	model models
	3 FT(0.91m)	model RC18, D6, D20, D170
	2 FT(0.61m)	model RC90
Operating Temperature	-50 to +225 (10 to 107 )	

# Model Number Format

Use the following format to specify model numbers for SERIES 88 sensors:



## X-MODEL CODES

- D-Reflectance Dependent Sensor
- RC-Reflectance Compensated Sensor
- F-Fibertouch Sensor

## Y-SIZE CODES

- Fiber Bundle Diameter For D Models: 6, 20, 63, 100, 125, 169, 170
- Fiber Bundle Width For RC Models: 18, 25, 62, 63, 89, 90, 140
- Cable Length in Feet for Fibertouch Sensors

## Z-SPECIAL FEATURE CODES

CODE	FEATURE	CODE	FEATURE
Blank	Standard Sensor	M	Digital Panel Meter
A	High Accuracy (D And F Models Only)	N	NPN Transistor Output
B	Replaceable Tip Configuration	O	Adjustable DC Offset
C	Non-Standard Fiber Optic Cable Sheathing Materials	P	Variable Phase Reflectance Compensation (RC Models Only)
D	Reflectance Dependent Output (RC Models Only)	S	Side View Probe Tip
E	Extra Cable Length (State Length After Model Number)	T	Non-Standard Tip Configuration (Add Text After Model Number)
G	High Gain Output	V	TTL Voltage Logic Output
H	High Frequency Amplifier	W	Window Probe Tip
I	Inversion Lensed Tip	.	Custom For Special Sensors
L	Low Frequency Amplifier		

*Examples:* Model D20 provides a standard unit.

Model RC62BLO provides a replaceable tip unit with 100 Hz amplifier and DC offset.

## Explanation Of Special Features Codes

A1.... Adjustable GAIN on standard units is provided by means of a trimmer potentiometer, and the standard specification for electronic drift is <0.1% full scale; i.e., <5.0mv. With high accuracy option A1, electronic drift is minimized to <0.005% full scale (<0.25mv). This is accomplished by including an 8-bit dip-switch in series with a fine tuning trimmer potentiometer. Only available for D and F models.

- A2... With high accuracy option A2 (for D models only), means are provided that enable substitution of a fixed value resistor in place of the standard GAIN control. This feature is reversible: i.e., with this option, the sensor can be operated as a standard unit with adjustable gain OR as an extremely stable unit with fixed gain. Dynamic displacement measurements as small as 1 Angstrom Unit have been reported when using this option.
- B... With option B selected, the sensor is provided as a two-piece system comprised of an amplifier/fiber optic cable with a replaceable sensor tip.
- C... Provides alternative sheathing materials for the fiber optic cable.

CODE	MATERIALS	MAX. TEMP.	FEATURES
Blank	PVC over Steel Monocol Wrap	225°F	Standard sheathing, suitable for most applications
C1	Interlocking Stainless Steel Hose	800°F	Maximum strength and temperature range
C2	Silicon Rubber	450°F	Maximum flexibility, no crush resistance
C3	Silicon Over Teflon Spiral Wrap	450°F	Non-metallic with moderate crush resistance
C4	Silicon Over Steel Monocol	450°F	Higher temperature range than standard

- D... Provides a reflectance dependent output for RC sensors in addition to the standard RC output. This output lets the sensor "see" reflectance changes that are not seen in the RC output. It is rather insensitive to gap variations and not intended to provide a measure of distance to the target.
- E... Provides non-standard cable lengths (up to 30FT maximum). Specify desired length after model number.
- G... Provides an additional output with 10x Gain unless otherwise specified by customer.
- H... Provides sensor amplifier with DC-200KHz bandwidth unless otherwise specified by customer. Consult the factory if bandwidths exceeding 200KHz are required. Bandwidths to 1 megahertz can be configured.
- I... Provides a threaded sensor tip and a removable Inversion Lens cartridge. The sensor can be operated either as an Inversion Lensed unit or as a standard sensor. Only available for models D6 and D20.
- L... Provides sensor amplifier with DC-100Hz bandwidth unless specified otherwise by customer.
- M... Provides amplifier with 3<sup>1/2</sup> digit panel meter.
- N... Provides an additional sensor output with NPN transistor logic. The NPN (switch closure) output pulls to ground when the analog output exceeds a threshold setpoint. The switch closure set point is controlled via a user supplied 0 to +5 VDC analog logic signal.
- O... Provides an adjustable DC offset capability. Offsets ranging from 0 to -4 volts can be applied to the analog output. This feature is used to eliminate the DC offset on the sensor analog output.
- P... Provides RC sensor amplifiers with phase adjustment controls to implement in-phase reflectance compensation.
- S... Provides a sensor tip fitted with a right angle prism for side viewing measurements. Only available for models D63, D100, D169, D170.
- T... Indicates a non-standard tip configuration which is described in the text following the model number. Some of the tip options available are:
  - Non-standard tip lengths
  - Threaded tips
  - Round Tips For RC Models
  - Right angle tips\*\*
  - High temperature tips (800 max. for D models; 600 max. for RC models)
  - Non-metallic tips
  - Custom design tips
- V... Provides an additional sensor output with TTL voltage logic. The TTL output is at 0 volts with the sensor tip close to target and at 5 volts far away. The change in logic state can be set by the user to occur anywhere along the operating range of the sensor.
- W... Provides a sensor tip fitted with a sapphire window for high pressure applications or hermetically sealed for high vacuum applications. Consult with factory for details.

## MOTES

\* Linear range can be reduced as much as 30% with replaceable tips (see Option B).

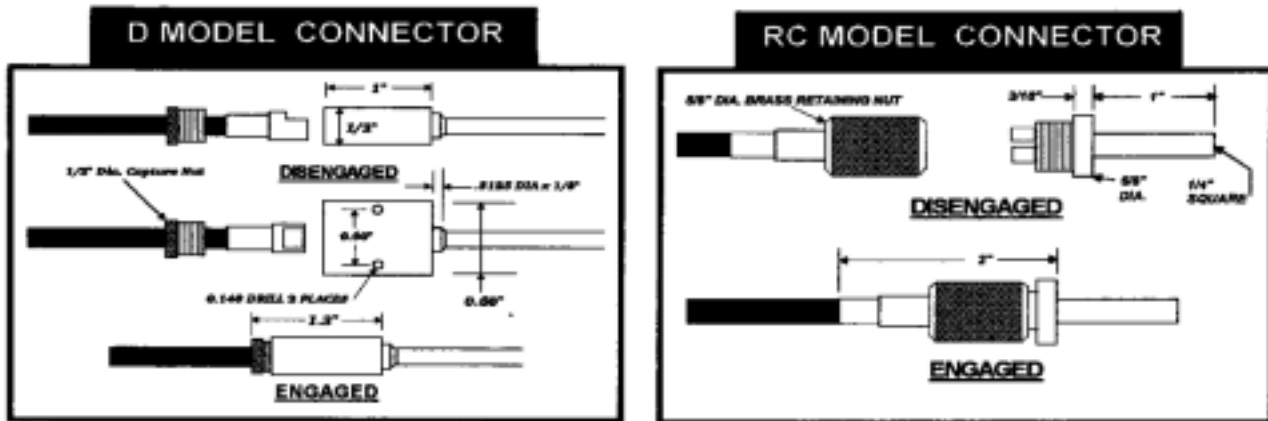
\*\* Sharp bends can cause a reduction in linear range by as much as 30%. A minimum bend radius of 1/2" is required to maintain standard sensor specifications (see Option T)

# Replaceable Tips

Sensors can be supplied in a two-piece configuration where the tip is a replaceable item. Additional replaceable tips can also be ordered separately for each sensor. Tips and amplifiers can not be mixed, i.e., tip TD6 can only be used with sensor D6, tip TRC25 can only be used with sensor RC25, etc. Standard connectors for replaceable tips are shown below.

Custom tips can be provided with non-standard tip lengths or cross-sections, with or without right angles, or with flexible lengths of fiber optic cable between the tip hardware and an in-line connector. Connectors can also be mounted on the amplifier bulkhead, thereby allowing for replacement of the entire fiber optic cable.

NOTE: Due to light losses at the connector interface and attendant reductions in linear range (which can be as much as 30%) and sensor bandwidth capability, we do not recommend more than one in-line connector per unit.

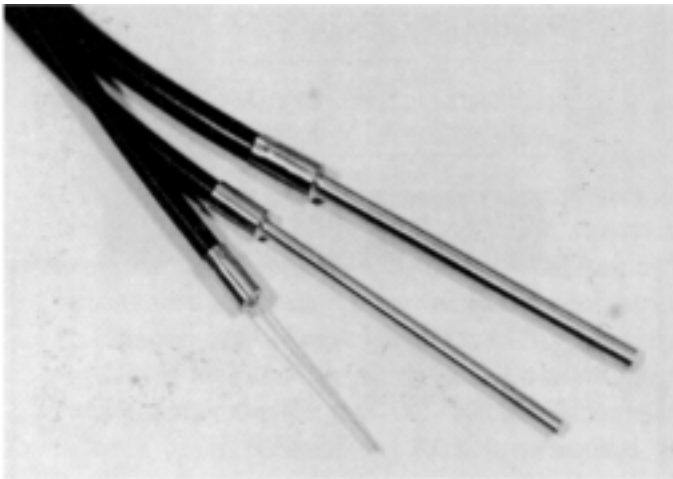


## STANDARD REPLACEABLE TIPS

TYPE	MODEL NO.	FIBER AREA	TIP SIZE
REFLECTANCE DEPENDENT	TD6a	.006" dia.	.020" dia x 1.5" L
	TD6b	.006" dia.	.020" dia x 1/4" L
	TD20	.020" dia.	.032" dia. x 1.5" L
	TD63	.063" dia.	.125" dia. x 3" L
	TD100	.100" dia.	.125" dia. x 3" L
	TD125	.125" dia.	.156" dia. x 3" L
	TD169	.169" dia.	.218" dia. x 3" L
REFLECTANCE COMPENSATED	TD170	.170" dia.	.218" dia. x 3" L
	TRC18	.018" x .062"	1/4" Square x 1" L
	TRC25	.025" x .125"	1/4" Square x 1" L
	TRC62	.062" x .125"	1/4" Square x 1" L
	TRC63	.063" x .125"	1/4" Square x 1" L
	TRC89	.089" x .187"	1/4" Square x 1" L
	TRC90	.090" x .187"	1/4" Square x 1" L
	TRC140	.140" x .187"	1/4" Square x 1" L

# REFLECTANCE DEPENDENT

Type D sensors can be used in a variety of applications from the production floor to laboratory environments, for large amplitude reciprocating motion, or where small amplitude displacement measurements of vibrating targets are required. Superior noise characteristics permit resolution to submicron levels.



## TYPICAL RESPONSE

The typical shape of the output function for TYPE D sensors is shown below. The region of maximum output voltage is referred to as the OPTICAL PEAK. The useable operating range of these devices includes linear ranges on both sides of the peak, as well as operation at the peak itself. Operation in the NEAR SIDE region gives high sensitivity with limited operating range. Operation on the FAR SIDE gives moderate sensitivity with greater operating range.

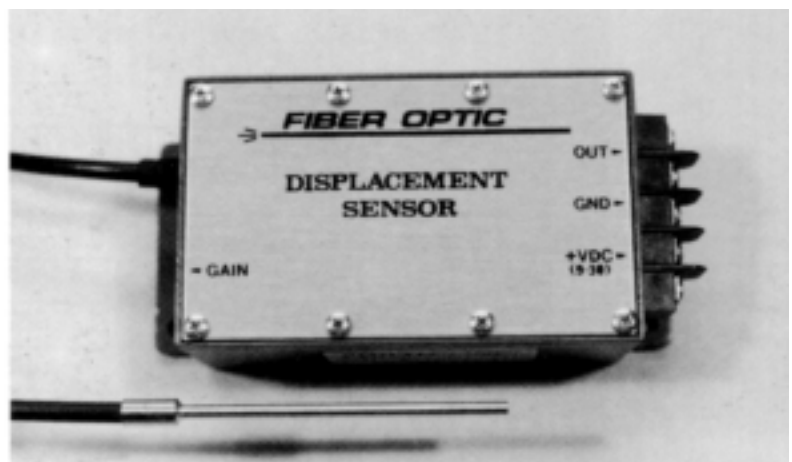


## REFLECTIVITY DEPENDENCE

The output amplitude also varies proportionately with the reflectivity of the target surface. The effect of changing reflectance is to shift the output voltage higher or lower. A gain adjustment is provided for calibration to various target surfaces. In-situ calibration is performed simply, by positioning the sensor's tip-to-target gap until the peak output is attained, and then adjusting the gain control to set the peak reading to full scale. This allows the sensor to be used to perform precision linear displacement measurements on almost any material.

## APPLICATIONS

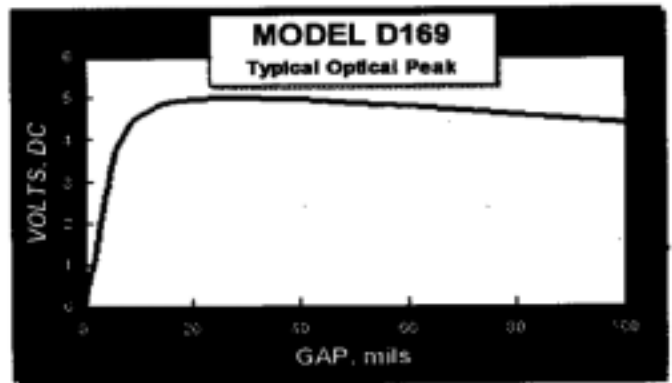
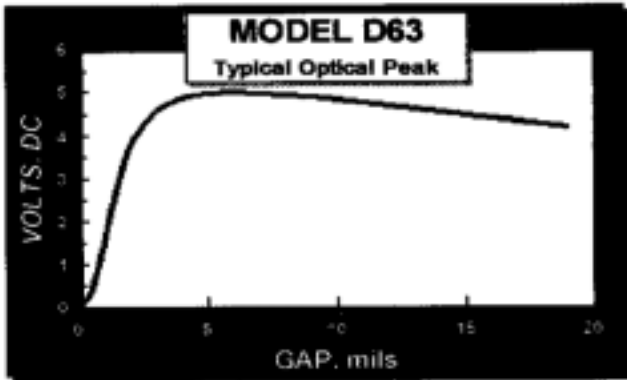
- Acoustic Speaker Vibrations
- Aircraft Structural Vibrations
- Bearing & Shaft Vibrations
- Bioengineering
- Parts Positioning
- Piezoelectric Crystals
- Piston Registry & Stroke
- Pressure Diaphragms
- Reciprocating Motion
- Speed Sensing
- Structural Deflections
- Surface Finish Inspection
- Ultrasonic Horn Vibrations
- Valve Stem Motions



## Measurements At The Optical Peak

Type D sensors are total ly insensi tive to target motion at their optical peak. Larger di ameter sensors have wider peaks than smaller sensors. A target can be scanned by a sensor, with the target-to-sensor gap maintained wi thin the bounds of the optical peak, for the purpose of.

- ▶ Measuring relative surface conditions(changes in surface finish or reflectivity)
- ▶ Searching for surface defects, scratches, holes, flaws, etc.

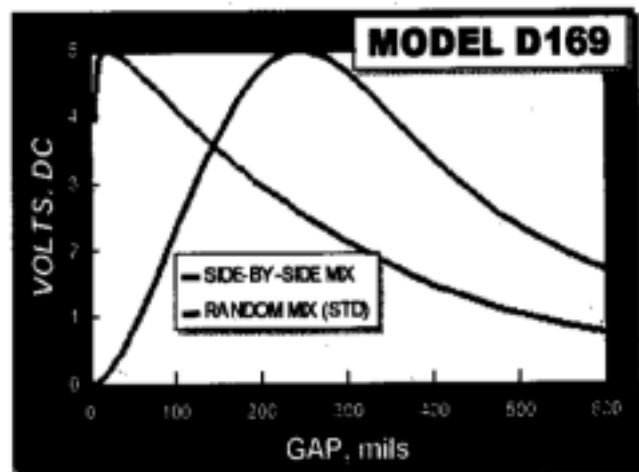
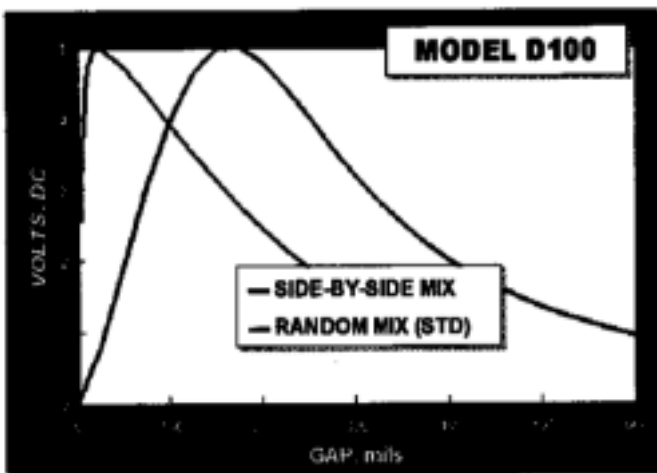
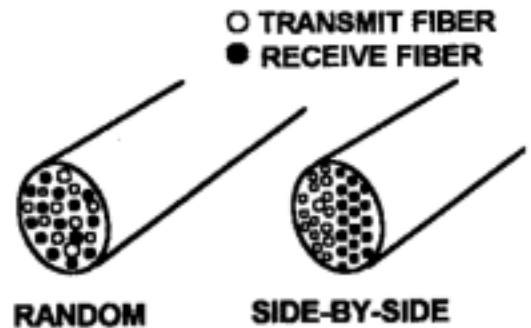


## Non-standard and Custom Models

We invite consultation with the factory for applications where our standard models are not suitable for the measurement requirements.

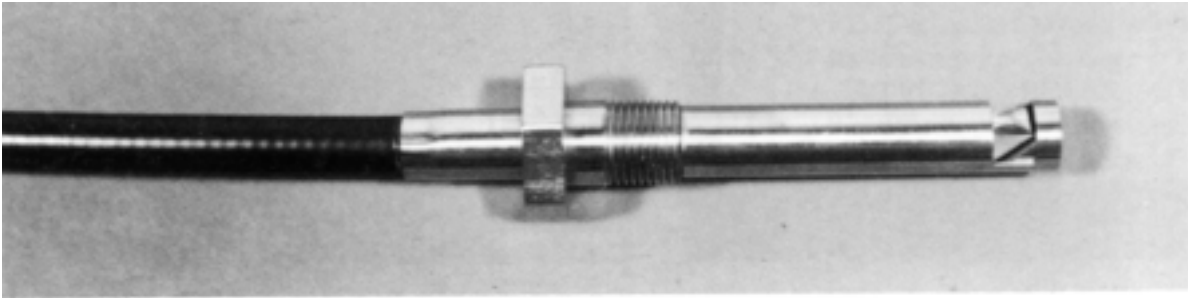
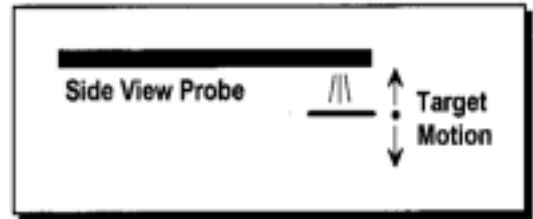
Standard models use a random di stributi on of transmit and receive fibers, which yields the steepest near side response and optical peaks occurring relatively colse to the targets. Side-by-side fiber di stributi ons can be provided. for any Type D sensor. Side-by-side di stributi ons shift the optical peak to large gap values.

Two examples are shown below.



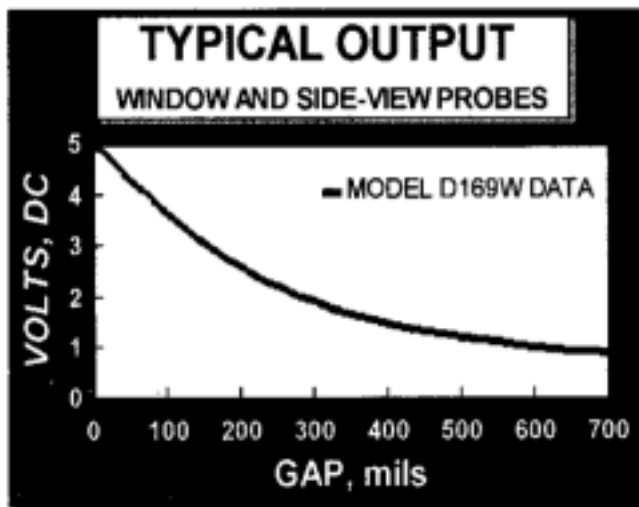
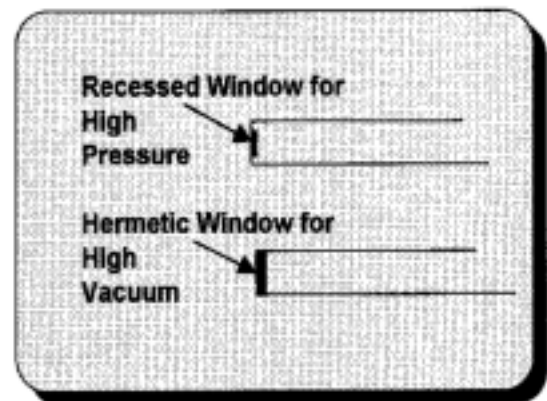
## Side View Probes

Side viewing probes are used for sensing in confined areas where a standard end view probe or one with a right angle tip can not be installed. Four models can be made available for side viewing applications: D63, D100, D169 or D170. Models D63 and D100 are packaged in a 0.148 diameter tip. Models D169 and D170 are supplied with a 5/16 diameter tip.



## Window Probes

Window probes are used in high pressure and vacuum applications. A sapphire window is recessed into the sensor tip to seal the fiber bundle from the target's environment. Successful applications have been recorded at pressures as high as 30,000 psi. Special hermetically sealed sapphire windows can be configured to exhibit a maximum leak rate of  $1 \times 10^{-9}$  c.c. Helium/sec at  $10^{-9}$  Torr vacuum.



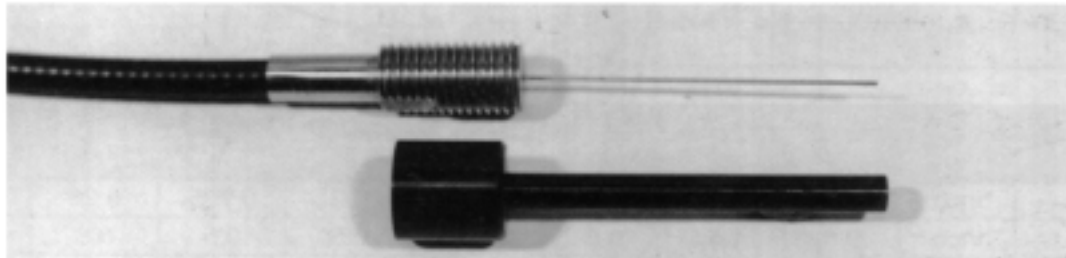
### MOTE

Side view and window probes do not have near side and optical peak regions of operation. Their output response is at its maximum value when in contact with a target.

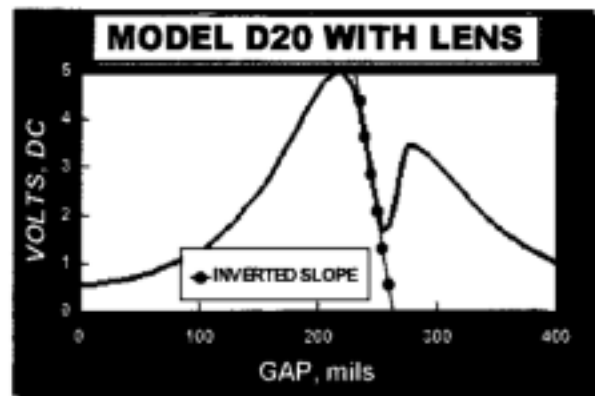
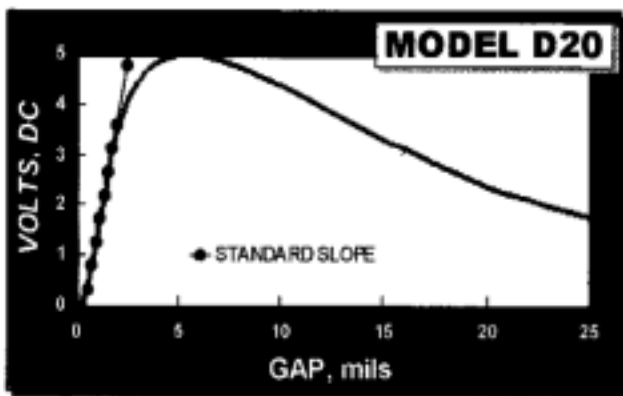


# Inversion Lens

The Inversion Lens allows the near side high sensitivity displacement measurements to be performed at standoff distances that are much larger than those with unensed sensors. It is available for sensor models D6 and D20.



The Inversion Lens is supplied in a removable cartridge. Sensors ordered with this option can be used with or without the lens cartridge. Without the lens, the sensor performance is the same as a standard unit. With the lens cartridge installed, standoffs for high sensitivity measurements are increased from less than 10 mils to about 1/4 . The inversion lens effect, which is to shift and invert the near side slope from positive to negative, is illustrated in the charts below.

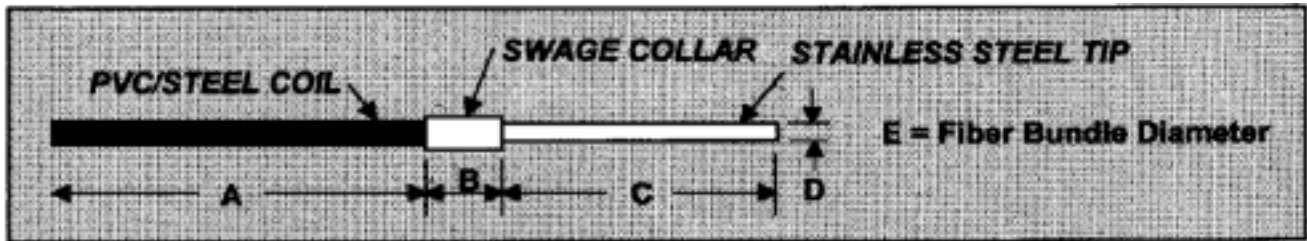


**Table Of Nominal Values**

	D6		D20	
	STD	LENSED	STD	LENSED
STANDOFF, mils	2.5	225	1.3	250
RANGE, mils	1.5	7	1	20
SENSITIVITY, $\mu\text{N/mv}$	0.7	3.5	0.4	9

NOTE: The lens will increase the target spot size by an order or magnitude.

# Standard D Models



FEATURES	UNITS	D6a	D6b	D20	D63	D100	D125	D169	D170
A	feet	3	3	3	6	6	6	6	3
AØ	inch	0.2	0.2	0.2	0.2	0.2	0.225	0.26	0.26
B	inch	0.5	1.5	0.5	0.5	0.5	0.5	0.6	0.6
BØ	inch	0.25	0.375	0.25	0.25	0.25	0.25	0.31	0.31
C	inch	1.5	0.25	1.5	3	3	3	3	3
D	inch	0.02	0.02	0.031	0.125	0.125	0.156	0.188	0.188
E	mils	6	6	20	63	100	125	169	170

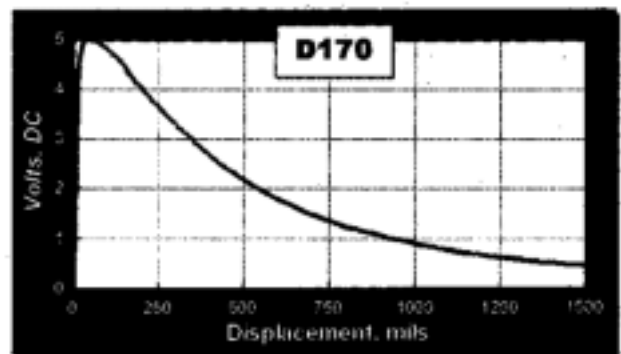
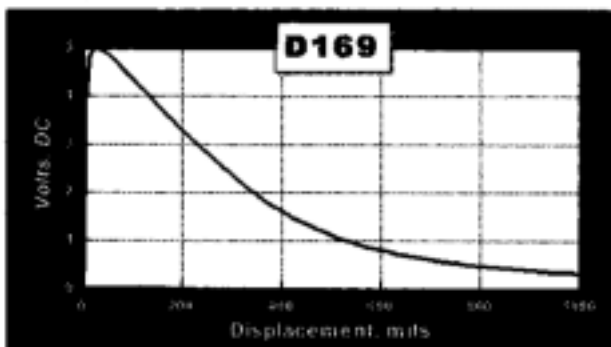
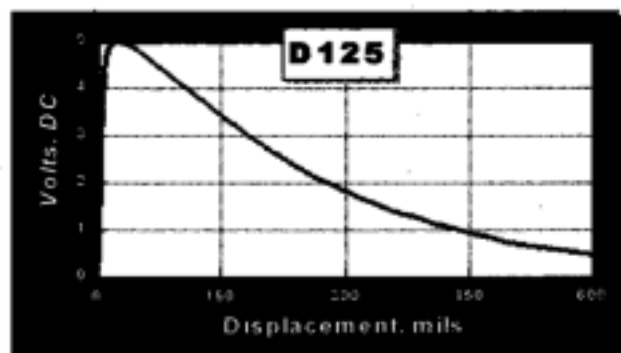
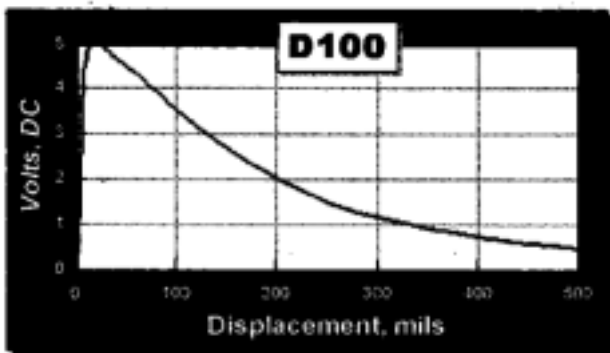
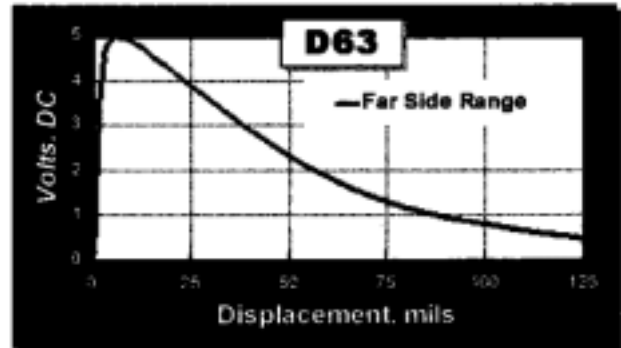
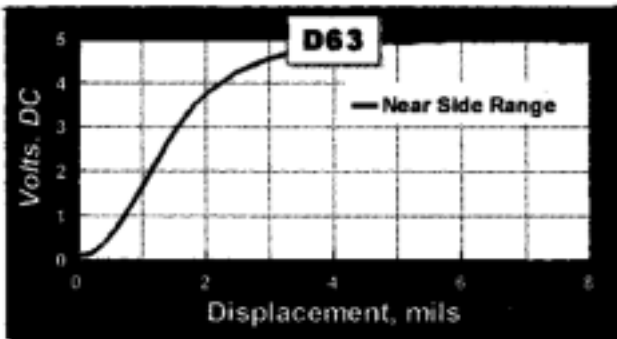
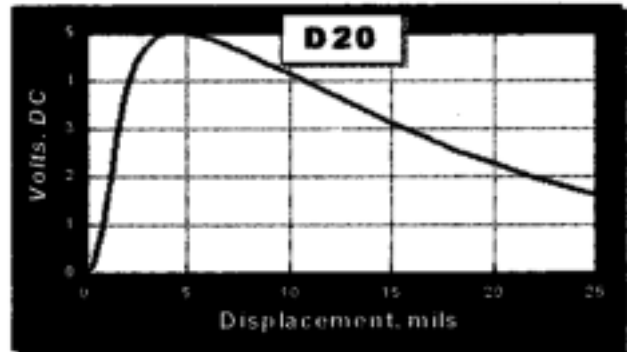
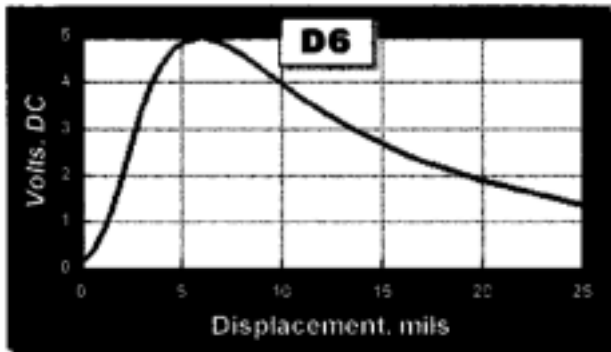
## NOMINAL OUTPUT SPECIFICATIONS

	UNITS	D6	D20	D63	D100	D125	D169	D170
OVERALL RANGE	mils	50	40	125	500	650	1,000	1,500
OPTICAL PEAK	mils	6	5	7	24	25	25	40
				<i>Near</i>	<i>Side</i>			
Standoff	mils	25	13	13	35	35	35	55
Linear Range, ±1%	mils	15	1	1	25	25	25	5
Sensitivity	µinch/mv	0.7	0.4	0.4	1.2	1.2	1.2	2.2
Resolution DC- 100Hz	µinch	0.3	0.1	0.1	0.2	0.2	0.2	0.4
DC- 20 KHz	µinch	3	1	1	2.5	2	2	4.5
DC- 200 KHz	µinch	10	4	4	10	7	7	15
				<i>Far</i>	<i>Side</i>			
Standoff	mils	13	11	26	95	110	120	210
Linear Range, ±1%	mils	9	10	30	110	140	160	175
Sensitivity	µinch/mv	5	4.5	15	60	75	90	145
Resolution DC- 100Hz	µinch	2	1	3	10	10	10	30
DC- 20 KHz	µinch	20	10	30	120	110	110	300
DC- 200 KHz	µinch	60	45	100	400	400	400	1,000

1. The Overall Operating Range runs from 0 mils to the gap at which the far side output is about 10% of full scale.
2. Standoff is the distance from the target to the center of the linear operating range.
3. Resolution(microinches)=Sensitivity(microinch/millivolt) × Noise(millivolts);where Noise is the pk-pk amplitude of the noise ripple,in the time domain,over the frequency passband.

· Conversions: 1mm=39.4mils    1 micrion=39.4uinch    1 mil=0.001inch    µ inch=0.000001 inch ·

## Typical Sensor Response Curves



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