

# Cryogenic Temperature Sensors

## Silicon Diodes

**PATENTED**  
Covered by U.S. and International patents and pending applications

CY7 Series Starts at **\$140**



The CY7 Series sensors from OMEGA represent the first truly new cryogenic sensor technology introduced in the last decade. The sensors incorporate uniform sensing elements that exhibit precise, repeatable, monotonic temperature response over a wide range. The elements are mounted into rugged, hermetically sealed packages that have been specifically designed for proper behavior in a cryogenic environment. The result is a family of sensors with temperature responses so predictable, tightly

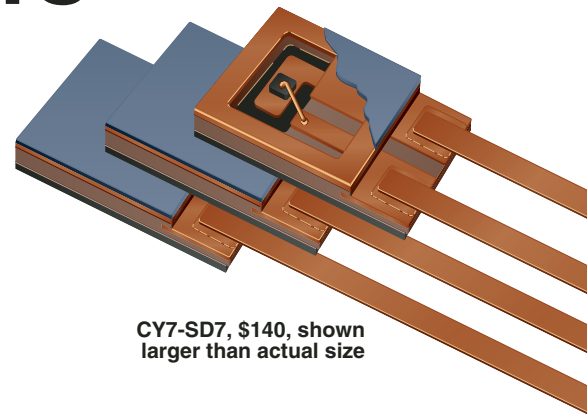
grouped, and stable that the sensors can be routinely interchanged with one another.

### A New Silicon Diode Chip

The key to the sensor's temperature response lies with the basic sensing element itself. The small silicon chip in each sensor has a temperature characteristic that is so stable, so predictable, and conforms so well from chip to chip, that the CY7's sensors are the first mass produced, interchangeable cryogenic sensors.

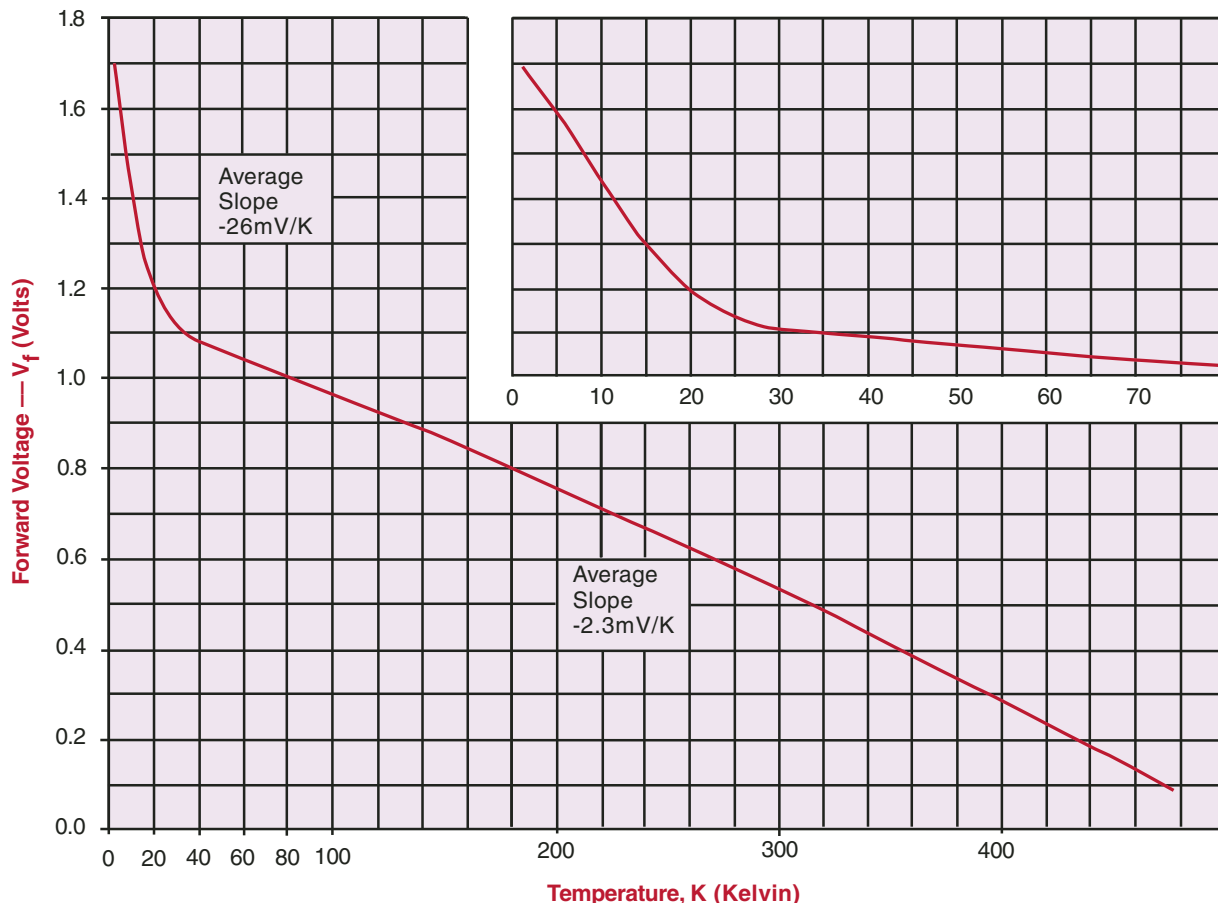
### A Sensor Package Designed for Cryogenics

Sensors for higher temperatures fall far short for cryogenic use. The complex thermal link between the



CY7-SD7, \$140, shown larger than actual size

sensing element and its entire environment must be taken into account, as does the effect of any measurement induced self-heating of the sensor itself, to achieve accurate results. In addition, the package must also withstand repeated cycling to low temperatures without mechanical failure.



**Standard Temperature Response (Curve 10) for CY7 Series Sensors. All Sensors Track this Curve Within Specified Tolerance Bands.**

# Cryogenic Temperature Sensors

## Standard Curve #10 for CY7 Silicon Diodes

Measurement Current = 10 $\mu$ A  $\pm$ 0.05%

T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)
1.40	1.69812	-13.1	16.0	1.28527	-18.6	95.0	0.98564	-2.02
1.60	1.69521	-15.9	16.5	1.27607	-18.2	100.	0.97550	-2.04
1.80	1.69177	-18.4	17.0	1.26702	-18.0	110.	0.95487	-2.08
2.00	1.68786	-20.7	17.5	1.25810	-17.7	120.	0.93383	-2.12
2.20	1.68352	-22.7	18.0	1.24928	-17.6	130.	0.91243	-2.16
2.40	1.67880	-24.4	18.5	1.24053	-17.4	140.	0.89072	-2.19
2.60	1.67376	-25.9	19.0	1.23184	-17.4	150.	0.86873	-2.21
2.80	1.66845	-27.1	19.5	1.22314	-17.4	160.	0.84650	-2.24
3.00	1.66292	-28.1	20.0	1.21440	-17.6	170.	0.82404	-2.26
3.20	1.65721	-29.0	21.0	1.19645	-18.5	180.	0.80138	-2.28
3.40	1.65134	-29.8	22.0	1.17705	-20.6	190.	0.77855	-2.29
3.60	1.64529	-30.7	23.0	1.15558	-21.7	200.	0.75554	-2.31
3.80	1.63905	-31.6	24.0	1.13598	-15.9	210.	0.73238	-2.32
4.00	1.63263	-32.7	25.0	1.12463	-7.72	220.	0.70908	-2.34
4.20	1.62602	-33.6	26.0	1.11896	-4.34	230.	0.68564	-2.35
4.40	1.61920	-34.6	27.0	1.11517	-3.34	240.	0.66208	-2.36
4.60	1.61220	-35.4	28.0	1.11212	-2.82	250.	0.63841	-2.37
4.80	1.60506	-36.0	29.0	1.10945	-2.53	260.	0.61465	-2.38
5.00	1.59782	-36.5	30.0	1.10702	-2.34	270.	0.59080	-2.39
5.50	1.57928	-37.6	32.0	1.10263	-2.08	280.	0.56690	-2.39
6.00	1.56027	-38.4	34.0	1.09864	-1.92	290.	0.54294	-2.40
6.50	1.54097	-38.7	36.0	1.09490	-1.83	300.	0.51892	-2.40
7.00	1.52166	-38.4	38.0	1.09131	-1.77	310.	0.49484	-2.41
7.50	1.50272	-37.3	40.0	1.08781	-1.74	320.	0.47069	-2.42
8.00	1.48443	-35.8	42.0	1.08436	-1.72	330.	0.44647	-2.42
8.50	1.46700	-34.0	44.0	1.08093	-1.72	340.	0.42221	-2.43
9.00	1.45048	-32.1	46.0	1.07748	-1.73	350.	0.39783	-2.44
9.50	1.43488	-30.3	48.0	1.07402	-1.74	360.	0.37337	-2.45
10.0	1.42013	-28.7	50.0	1.07053	-1.75	370.	0.34881	-2.46
10.5	1.40615	-27.2	52.0	1.06700	-1.77	380.	0.32416	-2.47
11.0	1.39287	-25.9	54.0	1.06346	-1.78	390.	0.29941	-2.48
11.5	1.38021	-24.8	56.0	1.05988	-1.79	400.	0.27456	-2.49
12.0	1.36809	-23.7	58.0	1.05629	-1.80	410.	0.24963	-2.50
12.5	1.35647	-22.8	60.0	1.05267	-1.81	420.	0.22463	-2.50
13.0	1.34530	-21.9	65.0	1.04353	-1.84	430.	0.19961	-2.50
13.5	1.33453	-21.2	70.0	1.03425	-1.87	440.	0.17464	-2.49
14.0	1.32412	-20.5	75.0	1.02482	-1.91	450.	0.14985	-2.46
14.5	1.31403	-19.9	80.0	1.01525	-1.93	460.	0.12547	-2.41
15.0	1.30422	-19.4	85.0	1.00552	-1.96	470.	0.10191	-2.30
15.5	1.29464	-18.9	90.0	0.99565	-1.99	475.	0.09062	-2.22

### Accessories

For Mounting CY7 Series Silicon Diode Sensors

  **MOST POPULAR MODELS HIGHLIGHTED!**

Model No.	Price	Description	Temperature Range
<b>OB-CY20-2</b>	<b>\$235</b>	Low temperature epoxy for mounting sensor, twenty 2 g packets (approx. 0.1 oz. each)	1.4 K to 330 K
<b>CYIF</b>	<b>140</b>	5 pieces of Indium foil, high thermal conductivity, highly malleable, used as a mechanical alternative to CYAG grease to mount a sensor. [0.127 mm thick x 50 x 50 mm square (0.005 thick x 2 x 2")]	
<b>CYAV</b>	<b>115</b>	Adhesive varnish for tacking sensor extension leads [1 pt can (0.6 liter)]	
<b>CYCO</b>	<b>360</b>	Clamps with springs for CY7-CO sensors (package of 10)	
<b>CYAG</b>	<b>335</b>	General purpose thermal grease, used between sensor and surface [25 g tube (approx. 1 oz)]	
			1.4 to 316 K

Ordering Examples: **OB-CY20-2**, low temperature epoxy for mounting sensor, **\$235**.

**CYAG**, general purpose thermal grease, **\$335**.



# Cryogenic Temperature Sensors



## Clean Room Assembly Keeps Out Contaminants

All CY7 sensors are meticulously assembled in semiconductor grade clean rooms on state-of-the-art bonding equipment. Special effort is made to keep them free of epoxies, polyimides, fluxes, chlorine, and other contaminants which have a detrimental effect on sensor performance.

## Choose the Sensor Style That Best Fits Your Application and Level of Interchangeability You Want

It's easy to pick the CY7 sensor you should use. OMEGA starts with the same basic sensor style and offers it unmounted or in a variety of mounting adapters that will simplify installation in your system. Choose from a simple cylinder that slides into a mounting hole, metric or SAE threaded stud mounts, or bolt-on flat mounts. Probes, thermowells and other mounts can be special ordered.

All CY7 sensors follow the temperature response curve shown in standard curve #10. Five bands of tracking accuracy (#1, 2, 3, 4, and 7) are offered to allow sensor selection to be suited to both the technical and economical considerations of any application. Low temperature accuracy ranges from  $\pm 0.25$  K for the tightest band (#1) to  $\pm 1.5$  K for the loosest (#7).

See accuracy table in "To Order" chart below.

### **MOST POPULAR MODELS HIGHLIGHTED!**

Probe Configuration Type*	Add'l. Price	Temperature Range	Maximum Installation Temperature Range
-SD	N/C	1.4 to 475 K	200°C (392°F)
-ET	\$25	1.4 to 325 K	60°C (140°F)
-BO	50	1.4 to 325 K	60°C (140°F)
-CU	60	1.4 to 325 K	60°C (140°F)
-LR	25	1.4 to 325 K	60°C (140°F)
-MT	25	1.4 to 325 K	60°C (140°F)
-CO	25	1.4 to 475 K	200°C (392°F)
-CY	70	1.4 to 325 K	60°C (140°F)

\* All of the above are valid for accuracy bands, 1, 2, 3 and 4, except '-CY' which cannot be manufactured with Band 1.

## CY7-SD7 Economical Sensor

For applications where temperature measurements below 10 K are not required, the CY7-SD7 series offers an inexpensive alternative to the other CY7-SD series temperature sensor. The upper operating temperature is limited to 475 K for the CY7-SD7. Since the package configuration of the CY7-SD7 is identical to the CY7-SD, the installation and operation of the device follow the same procedures as the CY7-SD.

The CY7-SD7 follows Standard Curve #10 (on previous page) to a tolerance of  $\pm 1.5$  K or 1.5% of temperature, whichever is greater. Due to possible irregularities and non-monotonic behavior below 10 K, extrapolations or interpolations outside of the operating temperature range should not be attempted.

**CY7-SD**

Accuracy Band Availability				
1	2	3	4	7

Leads: 0.38 W x 0.10 T x 12.7 L (0.01 x 0.004 x 0.5)  
Sensor Mass: 0.03 g (0.001 oz)

Dimensions: mm (in)

**CY7-LR**

Accuracy Band Availability				
1	2	3	4	—

Leads: 0.38 W x 0.10 T x 12.7 L (0.01 x 0.004 x 0.5)  
Basic sensor soldered into cylindrical copper adaptor.  
Temperature range: 1.4 K to 325 K. Mass: 0.15 g (0.005 oz)

### **MOST POPULAR MODELS HIGHLIGHTED!**

<b>To Order (Specify Model Number)</b>					
Model No.	Base Price	Band Suffix (Range)	Accuracy (Tolerance)		
			2 K-100 K	100 K-305 K	305 K-475 K
CY7-(*)2	\$334	2	$\pm 0.5$ K	$\pm 1.0$ K	$\pm 2.0$ K
CY7-(*)3	260	3	$\pm 0.5$ K	$\pm 1\%$ of T	$\pm 1\%$ of T
CY7-(*)4	235	4	$\pm 1$ K	$\pm 1\%$ of T	$\pm 1\%$ of T
CY7-DI4	299				
CY7-SD7	140	7	$\pm 1.5$ K	$\pm 1.5\%$ of T	$\pm 1.5\%$ of T

\* Insert probe configuration type from chart above.

Ordering Examples: **CY7-DI4**, cryogenic sensor, \$299.  
**CY7-SD7**, cryogenic sensor, \$140.

OMEGA also offers platinum resistance devices and thermocouples for low temperature sensors. For additional information please contact our Cryogenic Applications Engineers at 1-800-TC-OMEGA.

# Cryogenic Temperature Sensors

## Probe Configuration and Dimension Charts

All models shown larger than actual size.

**CY7-ET**

Accuracy Band Availability				
1	2	3	4	—
1	2	3	4	—

Leads: 0.38 W x 0.10 T x 12.7 L (0.01 x 0.004 x 0.5)  
Basic sensor soldered onto SAE-threaded copper adaptor.  
Temperature range: 1.4 K to 325 K. Mass: 1.4 g (0.05 oz)

**CY7-BO**

Accuracy Band Availability				
1	2	3	4	—
1	2	3	4	—

Basic sensor soldered onto bolt-on copper block with leads thermally anchored to block.  
Temperature range: 1.4 K to 325 K. Mass: 1.5 g (0.05 oz)

**CY7-CU** **CY7-DI4**

Accuracy Band Availability				
1	2	3	4	—
1	2	3	4	—

4-Leads    2-Leads

Leads 914 (36) long, 36 AWG

Basic sensor mounted into bold-on disk with leads thermally anchored to disk with low temperature epoxy.  
**CU version is 4-leaded. DI is 2-leaded.**  
Temperature range: 1.4 K to 325 K. Mass (excl. leads) 1.0 g (0.04 oz)

Dimensions: mm (in)

**CY7-MT**

Accuracy Band Availability				
1	2	3	4	—
1	2	3	4	—

Leads: 0.38 W x 0.10 T x 12.7 L (0.01 x 0.004 x 0.5)  
Basic sensor soldered into metric-threaded copper adaptor.  
Temperature range: 1.4 K to 325 K. Mass: 1.4 g (0.05 oz)

**CY7-CO**

Accuracy Band Availability				
1	2	3	4	—
1	2	3	4	—

Basic sensor with spring-loaded brass clamp to hold sensor to sample  
Temperature range: 1.4 K to 475 K. Mass (w/o sensor): 1.7 g (0.06 oz)

**CY7-CY**

Accuracy Band Availability				
—	2	3	4	—
—	2	3	4	—

914 (36) long leads

Basic sensor epoxied into relatively large copper disk. 30 AWG stranded copper lead pair is thermally anchored to disk.  
Temperature range: 1.4 K to 325 K. Mass (excl. leads): 4.3 g (0.15 oz)

## Specifications

**Sensing Element:** Silicon diode

**Temperature Range, CY7-SD or CY7-CO:**

1.4 to 475 K (10 to 425 K for CY7-SD7)

**Temperature Range, Other Configurations:** 1.4 to 325 K

**Recommended Excitation Current:** 10 microamperes

(±0.05% to meet listed specifications)

**Temperature response curve:** See figure for standards

interchangeability curve (curve #10); nominal output at recommended current is 1.7V at 1.4 K, 0.1 V at 475 K.

**Repeatability (at 4.2 K):** Typically ± 10 millikelvin over multiple thermal cycles

**Thermal Time Constants (Typical, CY7-SD):**

10 ms at 4.2 K, 100 ms at 77 K, 200 ms at 305 K

**Accuracy, Interchangeability:** Sensors track above standard interchangeability curve (curve #10) within the tolerance bands

**Temperature Offset, Vacuum to Liquid at 4.2 K:**

Typically 5 to 35 millikelvin depending on configuration

**Magnetic Field Use:** Not recommended

**Maximum Recommended Storage Temperature:**

60°C (140°F)

**Maximum Installation Temperature,**

**CY7-SD or CY7-CO:** 200°C (392°F)

**Maximum Installation Temperature,**

**Other Configurations:** 60°C (140°F)

**CY7-SD Construction:** Sapphire base with alumina body and lid; molybdenum/manganese metallization on base bottom and lid top with nickel and gold plating, 150 µm thick; gold-tin solder as lid seal; hermeticity: less than 1 x 10<sup>-8</sup> std cc/s; cavity size: < 1 mm<sup>3</sup>

**Leads:** Gold plated Kovar, uninsulated; 0.38 W x 0.01 T x 12.7 mm L (0.01 x 0.004 x 0.5"); Designed to withstand at least five right angle bends; polarity-positive lead on right with package lid up and leads toward user

**Configuration Adaptors:** Gold plated OFHC copper except for CO adaptor which is brass with steel spring





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