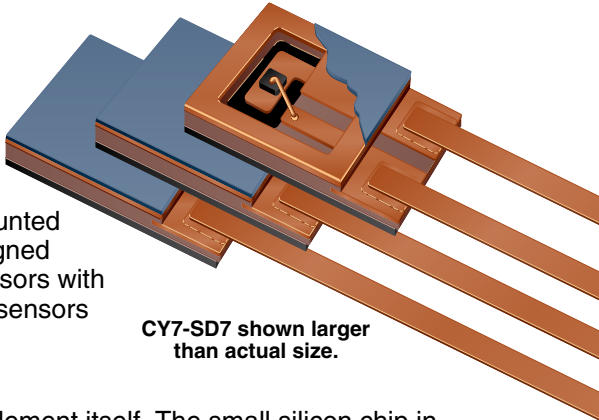


Cryogenic Temperature Sensors

CY7 Series Silicon Diodes

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

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.



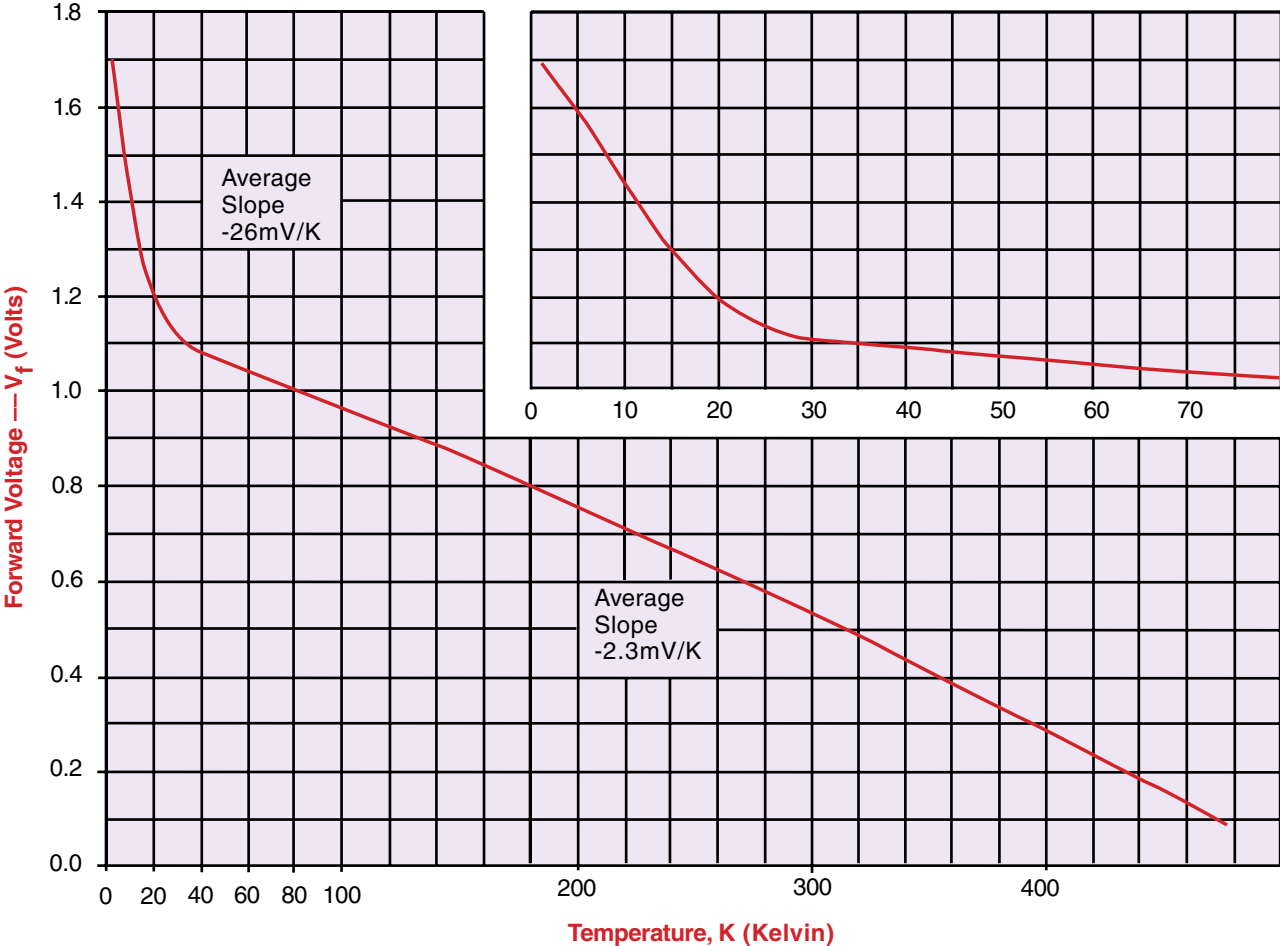
CY7-SD7 shown larger than actual size.

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 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 μ 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

Model No.	Description	Temperature Range
OB-CY20-2	Low temperature epoxy for mounting sensor, twenty 2 g packets (approximately 0.1 oz. each)	1.4 K to 330 K
CYIF	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")]	
CYAV	Adhesive varnish for tacking sensor extension leads [1 pt can (0.6 liter)]	
CYCO	Clamps with springs for CY7-CO sensors (package of 10)	
CYAG	General purpose thermal grease, used between sensor and surface [25 g tube (approximately 1 oz.)]	
		1.4 to 316 K

Ordering Examples: **OB-CY20-2**, low temperature epoxy for mounting sensor. **CYAG**, general purpose thermal grease.

Cryogenic Temperature Sensors

CY7 Series

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 ± 0.25 K for the tightest band (#1) to ± 1.5 K for the loosest (#7).

See accuracy table in "To Order" chart below.

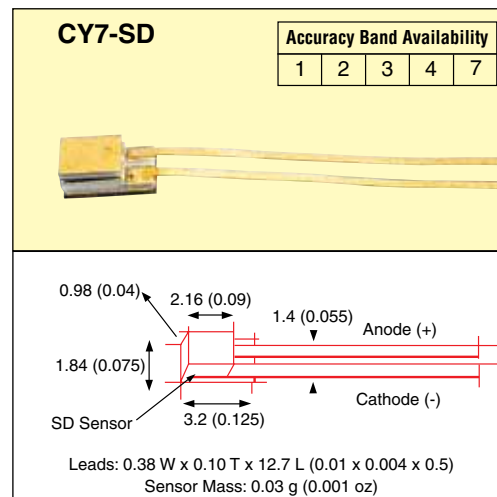
Probe Configuration Type*	Temperature Range	Maximum Installation Temperature Range
-SD	1.4 to 475 K	200°C (392°F)
-ET	1.4 to 325 K	60°C (140°F)
-BO	1.4 to 325 K	60°C (140°F)
-CU	1.4 to 325 K	60°C (140°F)
-LR	1.4 to 325 K	60°C (140°F)
-MT	1.4 to 325 K	60°C (140°F)
-CO	1.4 to 475 K	200°C (392°F)
-CY	1.4 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.

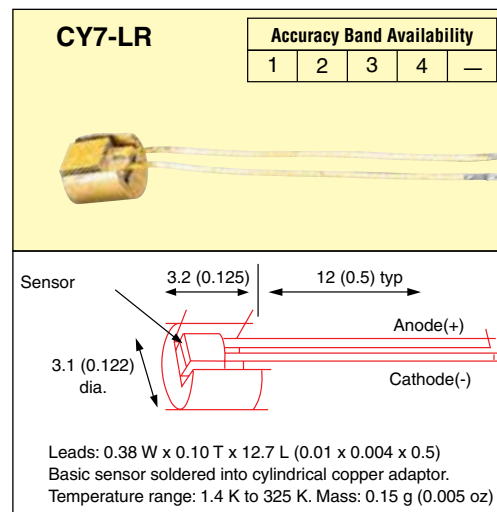
Model CY7-SD7 Economical Sensor

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 ± 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.



Dimensions: mm (inch)



To Order				
Model No.	Band Suffix (Range)	Accuracy (Tolerance)		
		2 to 100 K	100 to 305 K	305 to 475 K
CY7-(*)2	2	± 0.5 K	± 1.0 K	± 2.0 K
CY7-(*)3	3	± 0.5 K	$\pm 1\%$ of T	$\pm 1\%$ of T
CY7-(*)4	4	± 1 K	$\pm 1\%$ of T	$\pm 1\%$ of T
CY7-DI4				
CY7-SD7	7	± 1.5 K	$\pm 1.5\%$ of T	$\pm 1.5\%$ of T

* Insert probe configuration type from chart above.
Ordering Example: CY7-D14, cryogenic sensor.

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.

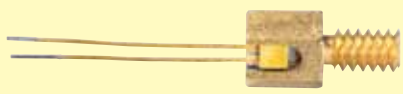
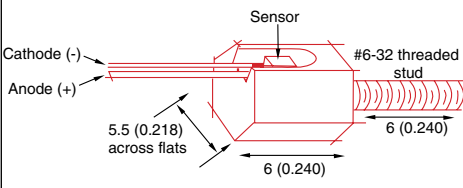
Cryogenic Temperature Sensors

CY7 Series Probe Configuration and Dimension Chart

Pictures shown larger than actual size.

CY7-ET

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


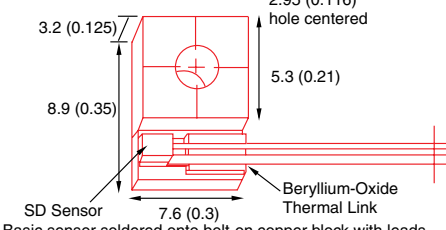
Cathode (-)
 Anode (+)

Sensor
 #6-32 threaded stud
 5.5 (0.218) across flats
 6 (0.240)

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	—


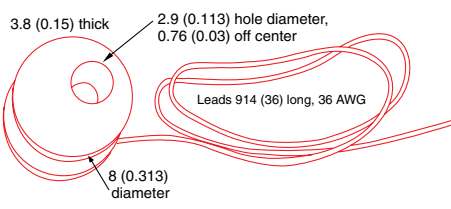
3.2 (0.125)
 2.95 (0.116) hole centered
 5.3 (0.21)
 8.9 (0.35)
 7.6 (0.3)
 SD Sensor
 Beryllium-Oxide Thermal Link

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


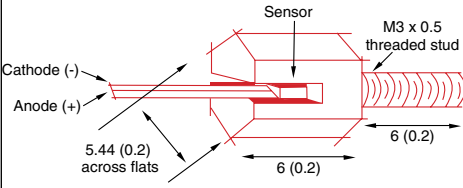
3.8 (0.15) thick
 2.9 (0.113) hole diameter, 0.76 (0.03) off center
 8 (0.313) diameter
 Leads 914 (36) long, 36 AWG

Basic sensor mounted into bolt-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 (inch)

CY7-MT

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

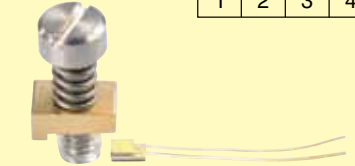
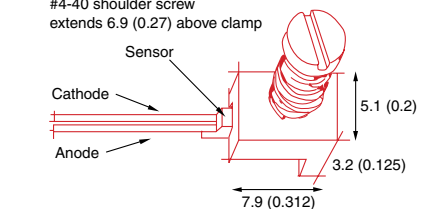
Cathode (-)
 Anode (+)

Sensor
 M3 x 0.5 threaded stud
 5.44 (0.2) across flats
 6 (0.2)

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	—


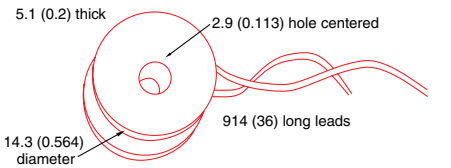
#4-40 shoulder screw extends 6.9 (0.27) above clamp
 Sensor
 Cathode
 Anode

5.1 (0.2)
 3.2 (0.125)
 7.9 (0.312)

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	—

5.1 (0.2) thick
 2.9 (0.113) hole centered
 14.3 (0.564) diameter
 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 ($\pm 0.05\%$ to meet listed specifications)

Temperature Response Curve: See figure for standards interchangeability curve (curve #10); Nominal output at recommended current is 1.7 V 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 1×10^{-8} std cc/s; cavity size: $<1 \text{ mm}^3$

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