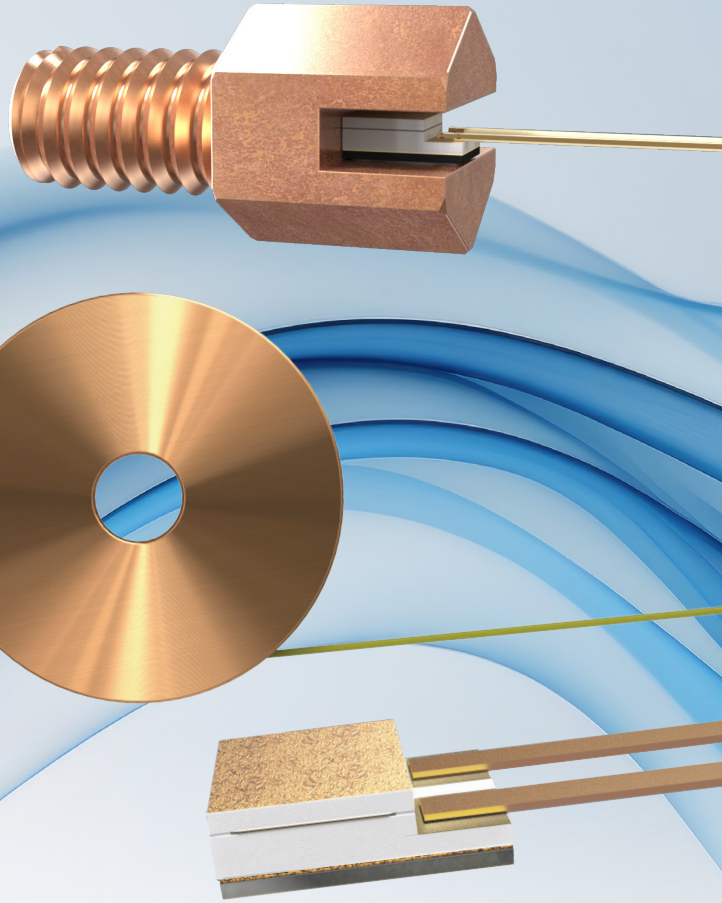


Silicon Diode

Cryogenic Temperature Sensor



Product Features

Temperature range: 1.4 K to 500 K

Calibration curve:

Interchangeable options available

Accuracy: ± 12 mK at 1.4 K

Magnetic fields: Not recommended

Radiation:

Recommended only for low-level radiation

Packages:

BO, CU, DI, CY, BR, SD, LR, ET, MT, CO

Temperature controller: 346, 336, 335, 325

Product Overview

DT-670 silicon diode cryogenic temperature sensors have options for a single voltage-versus-temperature calibration curve, with multiple tolerance bands. The SD package offers direct sensor-to-sapphire mounting, a hermetic seal, and brazed Kovar leads that route lead heat past the chip, delivering exceptional ruggedness, UHV compatibility, and survivability for several thousand hours at 500 K; a no-Kovar option is available when needed. The DT-670E-BR bare die variant delivers the smallest footprint and fastest thermal response with non-magnetic construction, making it ideal for space-constrained or dynamic applications. DT-670 diodes are a great choice for cryogenic measurements that do not involve magnetic fields or radiation, and individually calibrated DT-670 versions are available when full-range absolute accuracy is required.

Accuracies

DT-670 silicon diode sensors use a single voltage-versus-temperature calibration curve and are offered in multiple accuracy bands within multiple packages. Because they share a standard curve, the same curve can be applied across sensors of the same model, which makes them ideal for high-volume systems where a single curve can be hard-coded. Interchangeable sensors are not individually calibrated; each device undergoes quality control to ensure it meets its band's specified accuracy.

For maximum precision, DT-670 sensors are available with individual calibration across 1.4 K to 500 K, providing the best accuracy but requiring use of the sensor's unique curve. Within most packages, four bands are offered, starting from the best accuracy: A, A1, B, B1, C, D. Bare-die DT-670E-BR delivers the smallest size and fastest thermal response, useful when tight mid-temperature accuracy and dynamic performance are both critical.

Interchangeable							
	Band A	Band A1	Band B	Band B1	Band C	Band D2	Band E
2 K to 30 K	±0.25 K	±0.25 K	±0.5 K	±0.5 K	±1 K	—	±1.5 K typical
30 K to 100 K	±0.25 K	±0.25 K	±0.5 K	±0.5 K	±1 K	±0.25 K	±1.5 K typical
100 K to 300 K	±0.5 K	±1.5% of temp	±0.5 K	±1.5% of temp	±1 K	±0.50 K	±1.5% of temp typical
300 K to 500 K	±0.5 K	±1.5% of temp	±0.33% of temp	±1.5% of temp	±0.50% of temp	±0.20% of temp	±1.5% of temp typical

Calibrated ¹ (not interchangeable)	
1.4 K	±12 mK
4.2 K	±12 mK
10 K	±12 mK
77 K	±22 mK
300 K	±32 mK
500 K	±50 mK

¹ [(Calibration uncertainty)² + (reproducibility)²]^{0.5} for more information see Appendices B, D, and E



Caution:

These sensors are sensitive to electrostatic discharge (ESD). Use ESD precautionary procedures when handling, or making mechanical or electrical connections to these devices in order to avoid performance degradation or loss of functionality.

Performance specifications

Operational temperature range SD, CU-HT ² , BR	1.4 K to 500 K
Operational temperature range CU, LR, CY, ET, MT, B0, HR	1.4 K to 420 K
Recommended excitation	16 µW at 4.2 K; 10 µW at 77 K; 5 µW at 300 K
Thermal response time	SD: typical <10 ms at 4.2 K, 100 ms at 77 K, 200 ms at 305 K; BR: 1 ms at 4.2 K, 13 ms at 77 K, 20 ms at 305 K
Dissipation at rated excitation (typical)	16 µW at 4.2 K; 10 µW at 77 K; 5 µW at 300 K
Magnetic field use	Not recommended below 60 K. Low magnetic field dependence when used in fields up to 5 T above 60 K.
Radiation	Recommended for use only in low-level radiation

² The high-temperature variant of the CU package (CU-HT) requires immersion in liquid cryogen or vapor to achieve the specified performance. Sensors mounted in vacuum may operate with reduced performance close to base temperature due to reduced thermal performance.

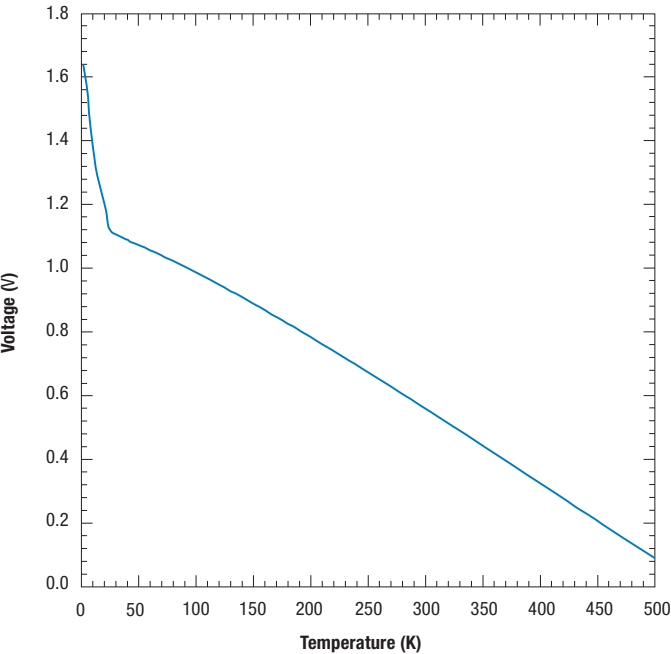
Long-term stability

	Use to 300 K ³	Use to 500 K ⁴
4.2 K	±10 mK	±40 mK
77 K	±40 mK	±100 mK
305 K	±25 mK	±50 mK
500 K	—	±150 mK

³ Long-term stability data is obtained by subjecting sensor to 200 thermal shocks from 305 K to 77 K

⁴ Based on 670 h of baking at 500 K

Typical voltage



Typical sensitivity

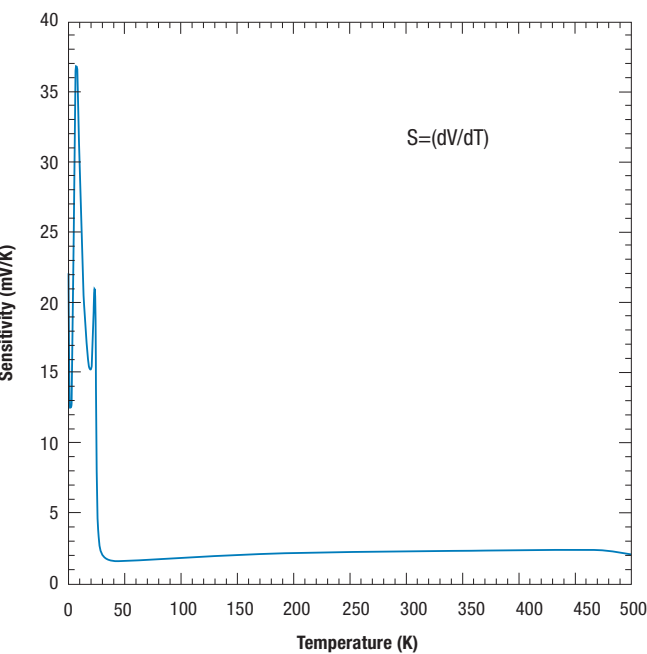


Figure 1 and 2
Diode thermometry is based on the temperature dependence of the forward voltage drop in a p-n junction biased at a constant current, typically 10 μ A. Because the voltage signal is relatively large, between 0.1 V and 6 V, diodes are easy to use, and instrumentation is straightforward

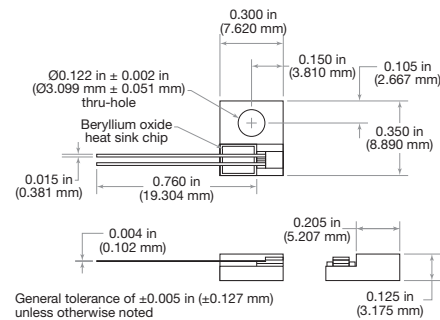
Temperature response

Temperature (K)	Voltage (V)	dV/dT (mV/K)
1.4	1.66429	-12.49
4.2	1.57848	-31.59
10	1.38373	-26.84
20	1.19775	-15.63
30	1.10624	-1.96
50	1.07310	-1.61
77	1.02759	-1.73
100	0.98697	-1.85
150	0.88911	-2.05
200	0.78372	-2.16
250	0.67346	-2.24
300	0.55964	-2.30
350	0.44337	-2.34
400	0.32584	-2.36
450	0.20676	-2.39
500	0.09068	-2.12

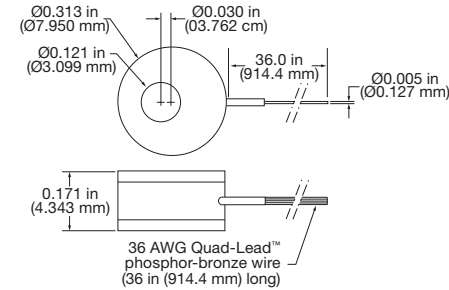
Physical specifications

	SD package	BR package
Mass	37 mg	72.7 µg
Lead type	2—nickel and gold-plated Kovar	None
Lead polarity	Positive lead on right with package lid up and leads towards user	Positive connection made through bottom of chip; negative connection made on base top of chip

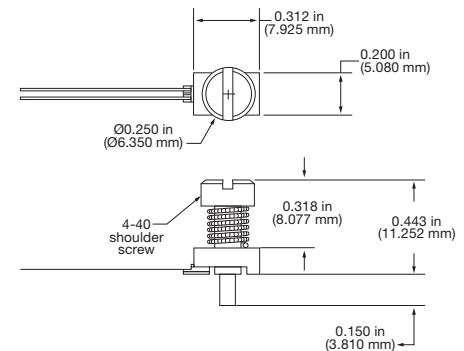
BO



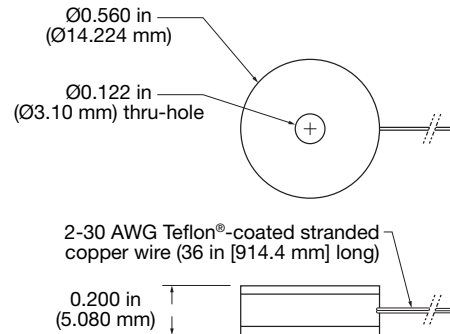
CU



CO

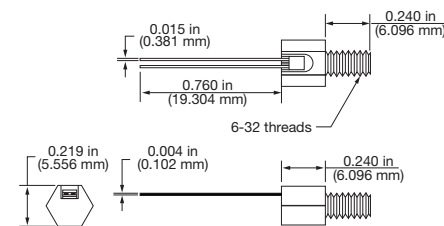


CY

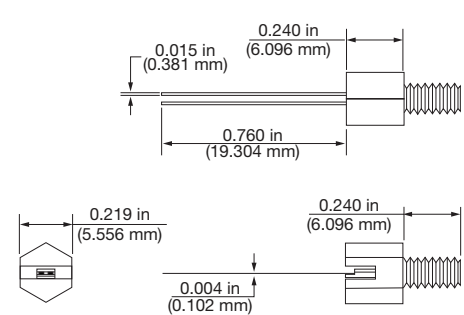


General tolerance of ± 0.005 in (± 0.127 mm) unless otherwise noted

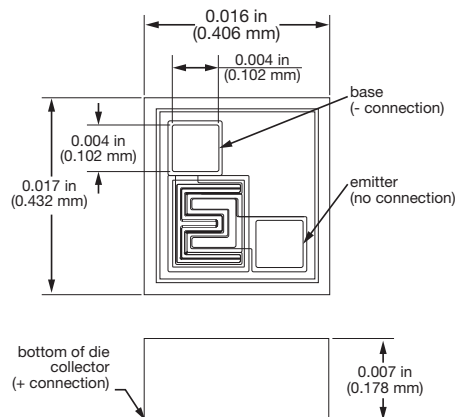
ET



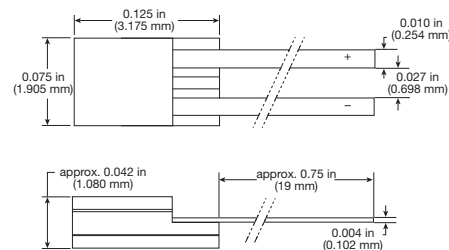
MT



BR



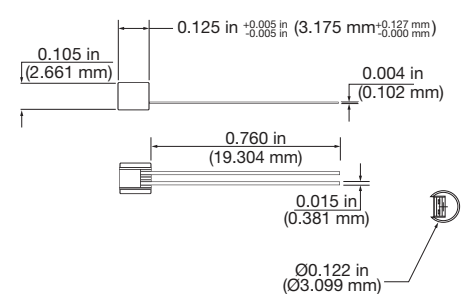
SD



General tolerance of ± 0.005 in (± 0.127 mm) unless otherwise noted

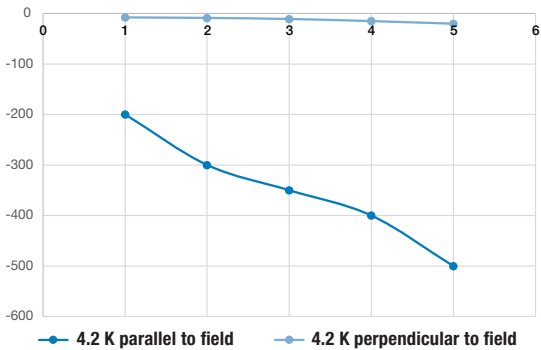
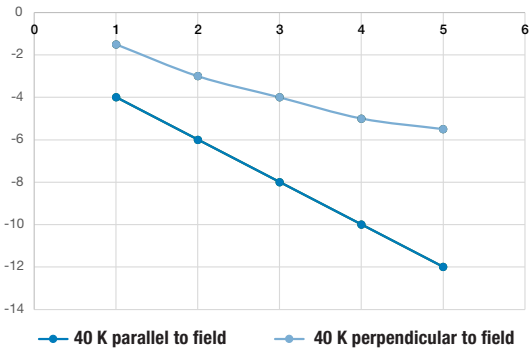
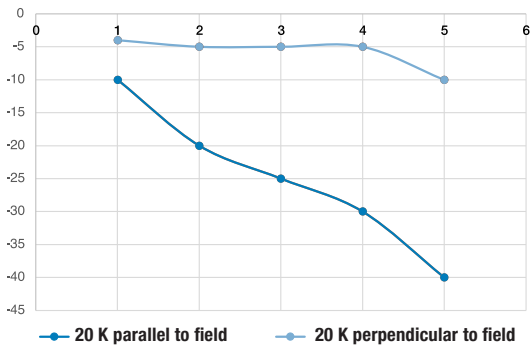
CAUTION: (+) lead connected electrically to external braze ring—take care not to cause a short

LR



Magnetic field-dependance⁵

Temperature (K)	Magnetic field (T)	$\frac{\Delta T}{T}$ (%) Parallel	$\frac{\Delta T}{T}$ (%) Perpendicular
4.2	1	-200	-8
	2	-300	-9
	3	-350	-11
	4	-400	-15
	5	-500	-20
20	1	-10	-4
	2	-20	-5
	3	-25	-5
	4	-30	-5
	5	-40	-10
40	1	-4	-1.5
	2	-6	-3
	3	-8	-4
	4	-10	-5
	5	-12	-5.5
60	1	-0.5	-0.5
	2	-1	-0.7
	3	-2	-0.8
	4	-3	-1
	5	-3.5	-1.1
80	1	0.1	-0.1
	2	-0.5	-0.3
	3	-0.8	-0.5
	4	-1.1	-0.6
	5	-1.5	-0.7
300	1	-0.1	0.1
	2	-0.1	0.2
	3	-0.1	0.5
	4	-0.1	0.6
	5	-0.1	0.6



⁵ To minimize magnetic field-induced temperature errors, the sensor should be oriented so that the package base is perpendicular to the magnetic field flux lines—this results in the diode current being parallel to the magnetic field

Ordering information

Interchangeable uncalibrated diodes

Part number	Package	Band	Maximum operational temperature	Part number	Package	Band	Maximum operational temperature
DT-670A-SD	 SD	Band A	500 K	DT-670A-C0	 C0	Band A	420 K
DT-670A1-SD		Band A1		DT-670A1-C0		Band A1	
DT-670B-SD		Band B		DT-670B-C0		Band B	
DT-670B1-SD		Band B1		DT-670B1-C0		Band B1	
DT-670C-SD		Band C		DT-670C-C0		Band C	
DT-670D-SD		Band D		DT-670D-C0		Band D	
DT-670A-LR	 LR	Band A	420 K	DT-670A-B0	 B0	Band A	420 K
DT-670A1-LR		Band A1		DT-670A1-B0		Band A1	
DT-670B-LR		Band B		DT-670B-B0		Band B	
DT-670B1-LR		Band B1		DT-670B1-B0		Band B1	
DT-670C-LR		Band C		DT-670C-B0		Band C	
DT-670D-LR		Band D		DT-670D-B0		Band D	
DT-670A-CY	 CY	Band A	420 K	DT-670A-ET	 ET	Band A	420 K
DT-670A1-CY		Band A1		DT-670A1-ET		Band A1	
DT-670B-CY		Band B		DT-670B-ET		Band B	
DT-670B1-CY		Band B1		DT-670B1-ET		Band B1	
DT-670C-CY		Band C		DT-670C-ET		Band C	
DT-670D-CY		Band D		DT-670D-ET		Band D	
DT-670A-CU	 CU	Band A	420 K	DT-670A-MT	 MT	Band A	420 K
DT-670A1-CU		Band A1		DT-670A1-MT		Band A1	
DT-670B-CU		Band B		DT-670B-MT		Band B	
DT-670B1-CU		Band B1		DT-670B1-MT		Band B1	
DT-670C-CU		Band C		DT-670C-MT		Band C	
DT-670D-CU		Band D		DT-670D-MT		Band D	
DT-670A-CU-HT	 CU-HT	Band A	500 K	DT-670C-DI	 DI	Band C	420 K
DT-670A1-CU-HT		Band A1		DT-670E-BR-10	 BR	Band E ⁶	500 K
DT-670B-CU-HT		Band B		DT-670E-BR		Band E	
DT-670B1-CU-HT		Band B1					
DT-670C-CU-HT		Band C					
DT-670D-CU-HT		Band D					

⁶ Quantity of 10

Ordering information

Calibrated diodes

Part number	Package	Minimum calibration	Maximum calibration	Maximum operational temperature
DT-670-B0-1.4L		1.4 K	325 K	325 K
DT-670-B0-70L		70 K	325 K	325 K
DT-670-C0-1.4L		1.4 K	325 K	325 K
DT-670-C0-1.4H		1.4 K	500 K	500 K
DT-670-C0-70L		70 K	325 K	325 K
DT-670-C0-70H		70 K	500 K	500 K
DT-670-CU-1.4L		1.4 K	325 K	325 K
DT-670-CU-HT-1.4L		1.4 K	325 K	500 K
DT-670-CU-HT-1.4H		1.4 K	500 K	500 K
DT-670-CU-70L		70 K	325 K	325 K
DT-670-CU-HT-70L		70 K	325 K	500 K
DT-670-CU-HT-70H		70 K	500 K	500 K
DT-670-CY-1.4L		1.4 K	325 K	325 K
DT-670-CY-70L		70 K	325 K	325 K
DT-670-ET-1.4L		1.4 K	325 K	325 K
DT-670-ET-70L		70 K	325 K	325 K
DT-670-LR-1.4L		1.4 K	325 K	325 K
DT-670-LR-70L		70 K	325 K	325 K
DT-670-MT-1.4L		1.4 K	325 K	325 K
DT-670-MT-70L		70 K	325 K	325 K
DT-670-SD-1.4L		1.4 K	325 K	325 K
DT-670-SD-1.4H		1.4 K	500 K	500 K
DT-670-SD-70L		70 K	325 K	325 K
DT-670-SD-70H		70 K	500 K	500 K

Temperature controller

Use with a 346, 336, 335, or 325 temperature controller.



Lead extensions

Extensions can be added to your device down to (1 in) to extend lead length, with a variety of wire types available to suit your application. Below are the most common configurations.

Refer to the [Lead Extensions datasheet](#) for the complete list.

-QT	Quad-Twist™, 36 AWG, 2 m
-QT	Quad-Twist™, 36 AWG, 2 m



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