DT-670 Silicon Diodes

DT-670-SD features

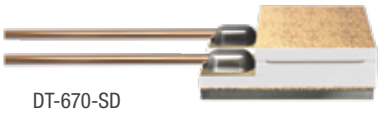
- Best accuracy across the widest useful temperature range—1.4 K to 500 K—of any silicon diode in the industry
- Tightest tolerances for 30 K to 500 K applications of any silicon diode to date
- Rugged, reliable Lake Shore SD package designed to withstand repeated thermal cycling and minimize sensor self-heating
- Conformance to standard DT-670 temperature response curve
- Variety of packaging options

DT-670E-BR features

- Temperature range: 1.4 K to 500 K
- Bare die sensors with the smallest size and fastest thermal response time of any silicon diode on the market today
- Non-magnetic sensor

DT-621-HR features

- Temperature range: 1.4 K to 325 K (uncalibrated down to 20 K)
- Non-magnetic package
- Exposed flat substrate for surface mounting



DT-670-SD

DT-670 Series silicon diodes offer better accuracy over a wider temperature range than any previously marketed silicon diodes. Conforming to the Curve DT-670 standard voltage versus temperature response curve, sensors within the DT-670 series are interchangeable, and for many applications do not require individual calibration. DT-670 sensors in the SD package are available in four tolerance bands—three for general cryogenic use across the 1.4 K to 500 K temperature range, and one that offers superior accuracy for applications from 30 K to room temperature.

DT-670-SD diodes are available with calibration across the full 1.4 K to 500 K temperature range.

The bare die sensor, the DT-670E-BR, provides the smallest physical size and fastest thermal response time of any silicon diode on the market today. This is an important advantage for applications where size and thermal response time are critical, including focal plane arrays and high temperature superconducting filters for cellular communication.

Packaging options

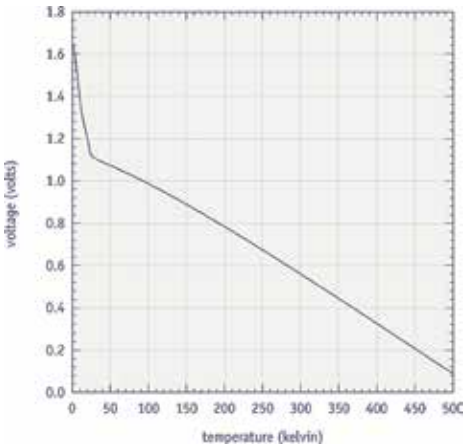
BO, BR, CO, CU, CY, DI, ET, LR, MT

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.

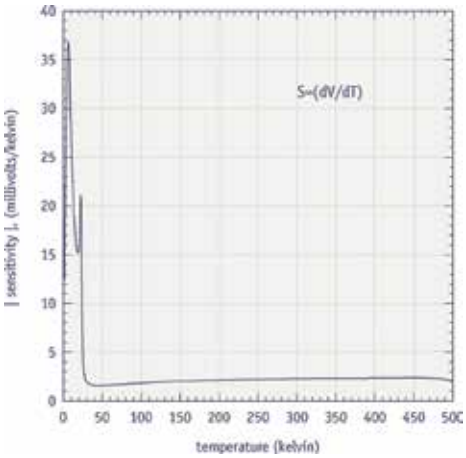
The Lake Shore SD package — the most rugged, versatile package in the industry

The SD package, with direct sensor-to-sapphire base mounting, hermetic seal, and brazed Kovar leads, provides the industry's most rugged, versatile sensors with the best sample to chip connection. Designed so heat coming down the leads bypasses the chip, it can survive several thousand hours at 500 K (depending on model) and is compatible with most ultra high vacuum applications. It can be indium soldered to samples without shift in sensor calibration. If desired, the SD package is also available without Kovar leads.

Typical DT-670 diode voltage



Typical DT-670 diode sensitivity



Specifications

Standard curve Curve DT-670—see next page

Recommended excitation 10 µA ±0.1%

Max reverse voltage 40 V

Max current before damage 1 mA continuous or 100 mA pulsed

Dissipation at 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

Use in radiation Recommended for use only in low level radiation—see Appendix B

Use in magnetic field Not recommended for use in magnetic field applications below 60 K. Low magnetic field dependence when used in fields up to 5 tesla above 60 K—see Appendix B

Reproducibility[1] ±10 mK at 4.2 K

Soldering standard J-STD-001 Class 2

[1] Short-term reproducibility data is obtained by subjecting sensor to repeated thermal shocks from 305 K to 4.2 K

Range of use

Package	Minimum limit	Maximum limit
SD, CU-HT, BR	1.4 K	500 K
CU, LR, CY, ET, MT, BO, HR	1.4 K	420 K

DT-621-HR miniature silicon diode

The DT-621 miniature silicon diode temperature sensor is configured for installation on flat surfaces. Due to the absence of magnetic materials in its construction, this package is suited for applications where minimal interaction between the diode and sample space magnetic field is desired. The DT- 621 sensor package exhibits precise, monotonic temperature response over its useful range. The sensor chip is in direct contact with the epoxy dome, which causes increased voltage below 20 K and prevents full range Curve DT-670 conformity. For use below 20 K, calibration is required.

DT-621-HR



Calibrated accuracy

	Typical sensor accuracy[2]
1.4 K	±21 mK
4.2 K	±12 mK
10 K	±12 mK
77 K	±34 mK
300 K	±35 mK
500 K	±54 mK

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

Temperature response data table (typical)

	DT-670		DT-621-HR	
	V (volts)	dV/dT (mV/K)	V (volts)	dV/dT (mV/K)
1.4 K	1.64	-12.5	—	—
4.2 K	1.58	-31.6	1.678	-35
10 K	1.38	-26.8	—	—
77 K	1.03	-1.73	1.03	1.73
305 K	0.560	-2.30	0.560	-2.3

See Appendix G for expanded response table

Long-term stability

	Use to 305 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

Standard curve DT-670 tolerance bands

	2 K to 100 K	100 K to 305 K	305 K to 500 K
Band A	±0.25 K	±0.5 K	±0.5 K
Band A1	±0.25 K	±1.5% of temp	±1.5% of temp
Band B	±0.5 K	±0.5 K	±0.33% of temp
Band B1	±0.5 K	±1.5% of temp	±1.5% of temp
Band C	±1 K	±1 K	±0.50% of temp

	30 K to 100 K	100 K to 305 K	305 K to 500 K
Band D[5]	±0.25 K	±0.50 K	±0.20% of temp

[5] For T < 30 K ±1.5 K

	2 K to 100 K	100 K to 500 K
DT-670E-BR	±1.5 K typical	±1.5% of temp typical

	20 K to 325 K
DT-621-HR	±2.5 K or ±1.5% of temperature, whichever is greater

Physical specifications

	Mass	Lead type	Lead polarity
DT-670-SD	37 mg	2—nickel and gold-plated Kovar	Positive lead on right with package lid up and leads towards user
DT-670E-BR (bare die)	72.7 µg	None	Positive connection made through bottom of chip; negative connection made on base pad on top of chip
DT-621-HR	23 mg	2—platinum ribbon with tinned 60/40 SnPb solder	Positive lead is right-hand ribbon with platinum disk down and leads towards user

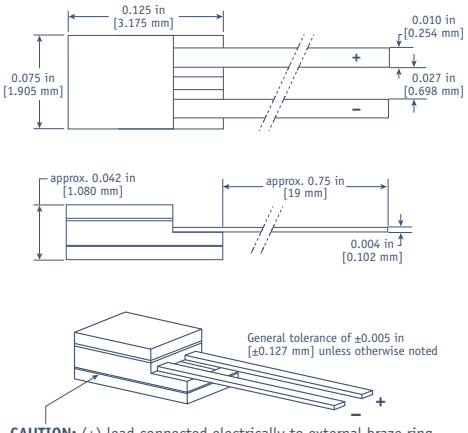
Typical magnetic field-dependent temperature errors[6] ΔT/T (%) at B (magnetic induction)

Package base parallel to field B					
	1 T	2 T	3 T	4 T	5 T
4.2 K	-200	-300	-350	-400	-500
20 K	-10	-20	-25	-30	-40
40 K	-4	-6	-8	-10	-12
60 K	-0.5	-1	-2	-3	-3.5
80 K	< 0.1	-0.5	-0.8	-1.1	-1.5
300 K	<-0.1	<-0.1	<-0.1	<-0.1	<-0.1

Package base perpendicular to field B					
	1 T	2 T	3 T	4 T	5 T
4.2 K	-8	-9	-11	-15	-20
20 K	-4	-5	-5	-5	-10
40 K	-1.5	-3	-4	-5	-5.5
60 K	-0.5	-0.7	-0.8	-1	-1.1
80 K	-0.1	-0.3	-0.5	-0.6	-0.7
300 K	<0.1	0.2	0.5	0.6	0.6

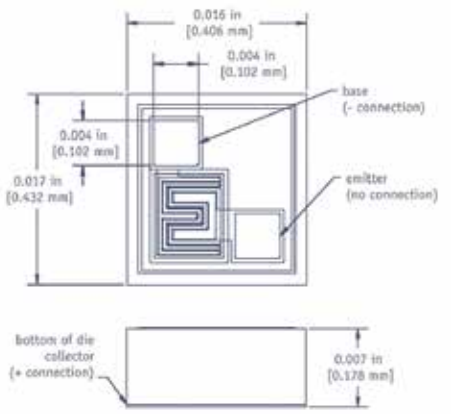
[6] To minimize magnetic field-induced temperature errors, the sensor should be oriented so that the package base is perpendicular to the magnetic field flux lines—this results in the diode current being parallel to the magnetic field

DT-670-SD

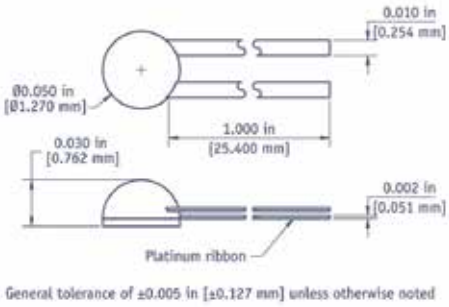


CAUTION: (+) lead connected electrically to external braze ring—take care not to cause a short

DT-670E-BR

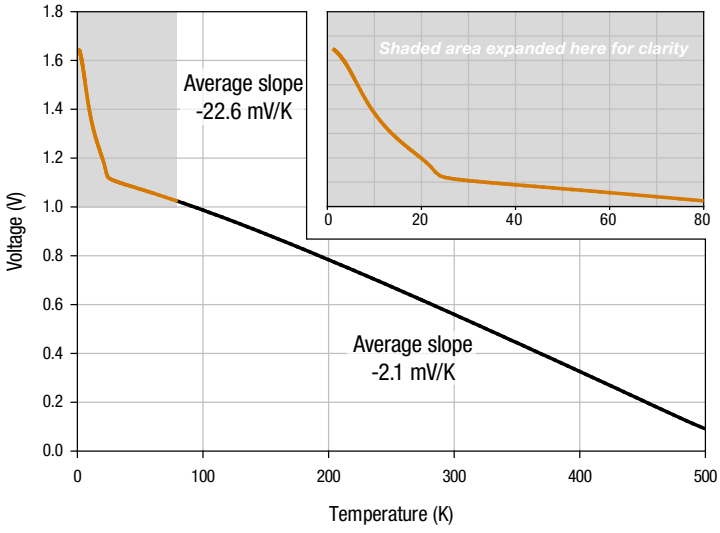


DT-621-HR

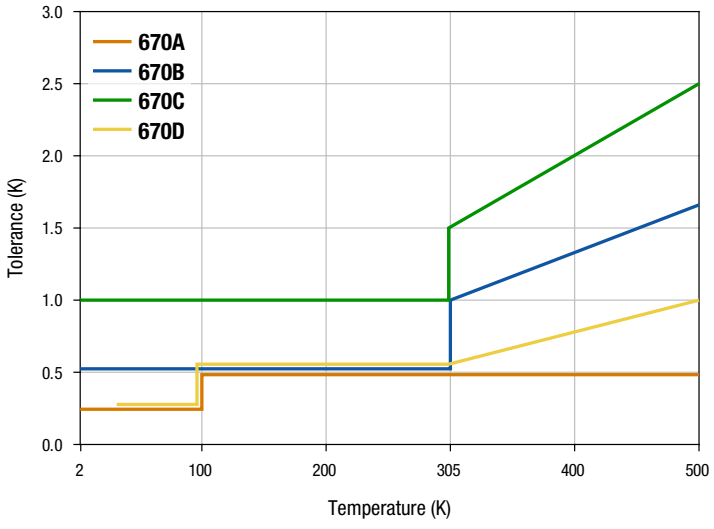


General tolerance of ±0.005 in [±0.127 mm] unless otherwise noted

DT-670 temperature response curve



Curve DT-670 tolerance bands



DT-670 Series expanded temperature response data table

T (K)	Voltage (V)	dV/dT (mV/K)	T (K)	Voltage (V)	dV/dT (mV/K)	T (K)	Voltage (V)	dV/dT (mV/K)	T (K)	Voltage (V)	dV/dT (mV/K)
1.4	1.644290	-12.5	**6.0**	1.51541	-36.7	**28.0**	1.110421	-2.25	**160.0**	0.868518	-2.07
1.5	1.642990	-13.6	**6.5**	1.49698	-36.9	**29.0**	1.108261	-2.08	**170.0**	0.847659	-2.10
1.6	1.641570	-14.8	**7.0**	1.47868	-36.2	**30.0**	1.106244	-1.96	**180.0**	0.826560	-2.12
1.7	1.640030	-16.0	**7.5**	1.46086	-35.0	**31.0**	1.104324	-1.88	**190.0**	0.805242	-2.14
1.8	1.638370	-17.1	**8.0**	1.44374	-33.4	**32.0**	1.102476	-1.82	**200.0**	0.783720	-2.16
1.9	1.636600	-18.3	**8.5**	1.42747	-31.7	**33.0**	1.100681	-1.77	**210.0**	0.762007	-2.18
2.0	1.634720	-19.3	**9.0**	1.41207	-29.9	**34.0**	1.098930	-1.73	**220.0**	0.740115	-2.20
2.1	1.632740	-20.3	**9.5**	1.39751	-28.3	**35.0**	1.097216	-1.70	**230.0**	0.718054	-2.21
2.2	1.630670	-21.1	**10.0**	1.38373	-26.8	**36.0**	1.095534	-1.69	**240.0**	0.695834	-2.23
2.3	1.628520	-21.9	**10.5**	1.37065	-25.5	**37.0**	1.093878	-1.64	**250.0**	0.673462	-2.24
2.4	1.626290	-22.6	**11.0**	1.35820	-24.3	**38.0**	1.092244	-1.62	**260.0**	0.650949	-2.26
2.5	1.624000	-23.2	**11.5**	1.34632	-23.2	**39.0**	1.090627	-1.61	**270.0**	0.628302	-2.27
2.6	1.621660	-23.6	**12.0**	1.33499	-22.1	**40.0**	1.089024	-1.60	**273.0**	0.621141	-2.28
2.7	1.619280	-24.0	**12.5**	1.32416	-21.2	**42.0**	1.085842	-1.59	**280.0**	0.605528	-2.28
2.8	1.616870	-24.2	**13.0**	1.31381	-20.3	**44.0**	1.082669	-1.59	**290.0**	0.582637	-2.29
2.9	1.614450	-24.4	**13.5**	1.30390	-19.4	**46.0**	1.079492	-1.59	**300.0**	0.559639	-2.30
3.0	1.612000	-24.7	**14.0**	1.29439	-18.6	**48.0**	1.076303	-1.60	**310.0**	0.536542	-2.31
3.1	1.609510	-25.1	**14.5**	1.28526	-17.9	**50.0**	1.073099	-1.61	**320.0**	0.513361	-2.32
3.2	1.606970	-25.6	**15.0**	1.27645	-17.3	**52.0**	1.069881	-1.61	**330.0**	0.490106	-2.33
3.3	1.604380	-26.2	**15.5**	1.26794	-16.8	**54.0**	1.066650	-1.62	**340.0**	0.466760	-2.34
3.4	1.601730	-26.8	**16.0**	1.25967	-16.3	**56.0**	1.063403	-1.63	**350.0**	0.443371	-2.34
3.5	1.599020	-27.4	**16.5**	1.25161	-15.9	**58.0**	1.060141	-1.64	**360.0**	0.419960	-2.34
3.6	1.596260	-27.9	**17.0**	1.24372	-15.6	**60.0**	1.056862	-1.64	**370.0**	0.396503	-2.35
3.7	1.59344	-28.4	**17.5**	1.23596	-15.4	**65.0**	1.048584	-1.67	**380.0**	0.373002	-2.35
3.8	1.59057	-29.0	**18.0**	1.22830	-15.3	**70.0**	1.040183	-1.69	**390.0**	0.349453	-2.36
3.9	1.58764	-29.6	**18.5**	1.22070	-15.2	**75.0**	1.031651	-1.72	**400.0**	0.325839	-2.36
4.0	1.58465	-30.2	**19.0**	1.21311	-15.2	**77.35**	1.027594	-1.73	**410.0**	0.302161	-2.37
4.2	1.57848	-31.6	**19.5**	1.20548	-15.3	**80.0**	1.022984	-1.75	**420.0**	0.278416	-2.38
4.4	1.57202	-32.9	**20.0**	1.197748	-15.6	**85.0**	1.014181	-1.77	**430.0**	0.254592	-2.39
4.6	1.56533	-34.0	**21.0**	1.181548	-17.0	**90.0**	1.005244	-1.80	**440.0**	0.230697	-2.39
4.8	1.55845	-34.7	**22.0**	1.162797	-21.1	**100.0**	0.986974	-1.85	**450.0**	0.206758	-2.39
5.0	1.55145	-35.2	**23.0**	1.140817	-20.8	**110.0**	0.968209	-1.90	**460.0**	0.182832	-2.39
5.2	1.54436	-35.6	**24.0**	1.125923	-9.42	**120.0**	0.949000	-1.94	**470.0**	0.159010	-2.37
5.4	1.53721	-35.9	**25.0**	1.119448	-4.60	**130.0**	0.929390	-1.98	**480.0**	0.135480	-2.33
5.6	1.53000	-36.2	**26.0**	1.115658	-3.19	**140.0**	0.909416	-2.01	**490.0**	0.112553	-2.25
5.8	1.52273	-36.5	**27.0**	1.112810	-2.58	**150.0**	0.889114	-2.05	**500.0**	0.090681	-2.12

Ordering information

Uncalibrated sensor
Step 1: Choose diode series, for example DT-670.
Step 2: Choose tolerance band (if applicable), for example DT-670A.
Step 3: Choose package or mounting adapter—if ordering adapter, substitute the adapter suffix for the SD suffix, for example DT-670A-CU.

Calibrated sensor
Step 1: Choose diode series, for example DT-670.
Step 2: Choose package or mounting adapter—if ordering adapter, substitute the adapter suffix for the SD suffix, for example DT-670-CU.
Step 3: Specify the calibration range suffix code after the model number and package suffix, for example DT-670-CU-1.4L.

DT-670	Calibration range suffix codes Numeric figure is the low end of the calibration Letters represent the high end: L=325 K, H=500 K				
Model number	Uncal	1.4L	1.4H	70L	70H
DT-621-HR	■	■		■	
DT-670A-SD	■				
DT-670A1-SD	■				
DT-670B-SD	■				
DT-670B1-SD	■				
DT-670C-SD	■				
DT-670D-SD	■				
DT-670-SD		■	■	■	■
Mounting adapters are available for use with the SD package—replace SD suffix with mounting adapter suffix					
CO	■	■	■	■	■
CU, LR, CY, ET, BO, MT	■	■		■	
CU-HT	■	■	■	■	■
DI	■				
DT-670E-BR-10	■	bare chip silicon diode sensor, quantity 10			

Note: upper temperature limit package dependent—see Sensor Packages section
Other packaging available by special order—please consult Lake Shore

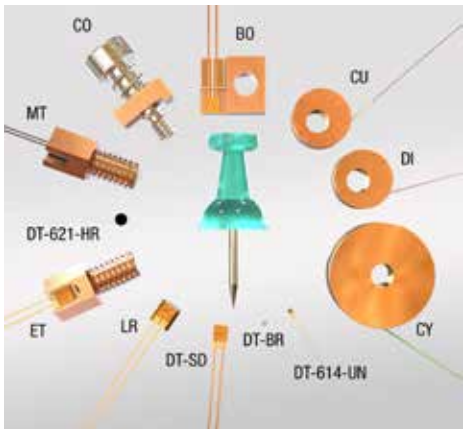
Accessories available for sensors

SN-CO-C1	SD package sensor clamp, qty 1
SN-CO-C10	SD package sensor clamp, qty 10
8000-CD	Calibration report on CD-ROM
8000-USB	Calibration report on USB
COC-SEN	Certificate of conformance

Accessories suggested for installation—see Accessories section for full descriptions
Stycast® epoxy
Apiezon® grease
90% Pb, 10% Sn solder
Indium solder
VGE-7031 varnish
Phosphor bronze wire
Manganin wire

Packaging options

For more information on sensor packages and mounting adapters, see page 20.





CO adapter — spring loaded clamp for easy sensor interchangeability

Upgrade conversion chart

	From:	To:
Sensor	DT-470	DT-670
Band	11	A
	11A	A1
	12	B
	12A	B1
	13	C

See the appendices for a detailed description of:
Installation
Uncalibrated sensors
SoftCal™
Calibrated sensors
CalCurve™
Sensor packages

To add length to sensor leads, see page 25.