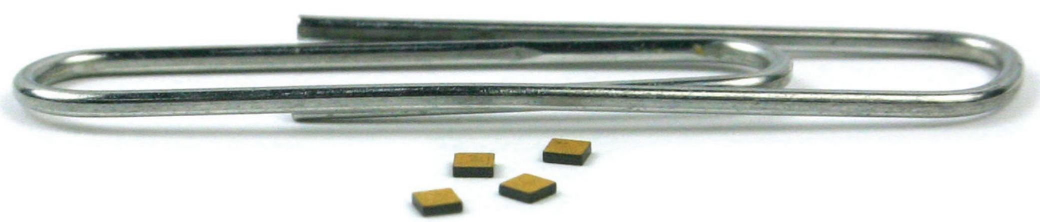
Sensing Solutions

WHITE PAPER

T020/T040 SERIES STABILITY

QTI Engineering Department



T020/T040 SERIES STABILITY TEST: 50 µA APPLIED BIAS CURRENT

QTI compiled data on an aging study of the T021D103.02.H leadless chip thermistor with thick film gold contacts, epoxy bonded by the customer. The aging was performed with an applied bias current of 50 µA. Customer's application: temperature monitoring of optical networks. Study period: July 2004 to March 2005.

To prepare the product for testing, QTI's customer assembled QTI's T021D103.02.H leadless chip thermistors into the customer's package. The customer used propriety methods to mount the thermistors with conductive epoxy onto the customer's substrate, perform the gold wire bonding operation, and seal them into TO-46 packages that were soldered to test fixtures designed and built by the customer. The fixtures were separated into 3 groups and aged at 3 different temperatures for just over 5400 hours: 37 thermistors aged at 70°C, 40 thermistors aged at 100°C, and 40 thermistors aged at 130°C. The 70°C fixture had 3 contacts that gave an open circuit condition, which left 37 readable thermistors. The customer did not provide an explanation for the open circuit condition. The aging and testing functions were performed at the QTI facility in San Diego, CA. The thermistors mounted on the customer-supplied test fixtures were aged in air circulating ovens with an applied bias current of 50 µA. The fixtures were removed at intervals specified by the customer and the thermistors were tested in a well-stirred ambient oil bath with readings normalized to a 25°C temperature controlled bath via a comparison standard. These measurements were estimated to have an expanded uncertainty of ±0.20 % or ±0.046°C (with a coverage factor k = 2), which provided a measurement uncertainty 10 times better than the specified ±2% thermistor tolerance. The data tables and graphs below illustrate the stability information in terms of percent change in resistance and thermometric drift for the duration of the 5400 hour test period. Upon completion of the study, the customer determined that QTI's T021D103.02.H thermistor was well qualified for use in the customer's application.

Cumulative Aging Time (hrs)	**24**	**72**	**168**	**336**	**672**	**1032**	**1512**	**2016**	**3384**	**4169**	**5408**
Avg. Cum. Drift aged at 70˚C	0.04%	0.04%	0.05%	0.06%	0.10%	0.18%	0.15%	0.17%	0.25%	0.25%	0.26%
Avg. Cum. Drift aged at 100˚C	0.08%	0.13%	0.18%	0.32%	0.49%	0.55%	0.74%	0.84%	1.05%	1.09%	1.16%
Avg. Cum. Drift aged at 130˚C	0.23%	0.44%	0.63%	0.89%	1.19%	1.43%	1.67%	1.86%	2.18%	2.34%	2.63%

Table 1. Average cumulative drift in percent change in resistance at 25˚C.

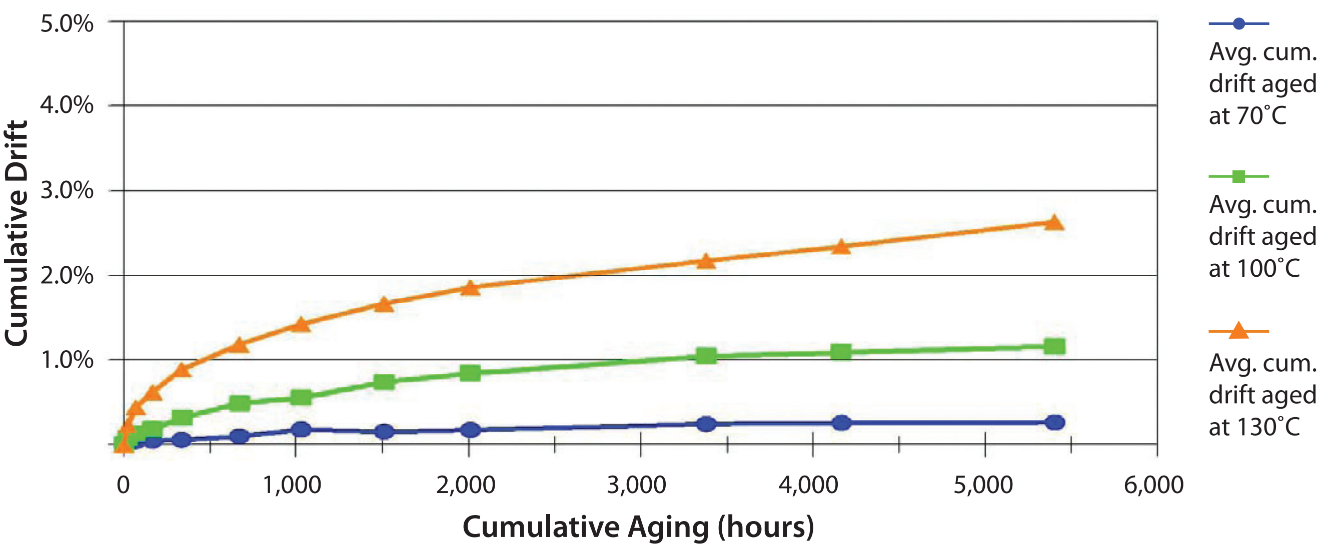


Figure 1. QTI T021D103.02.H aging characteristics for epoxy die bond, gold wire bond with 50microA bias current applied, July 2004 to March 2005.

Cumulative Aging Time (hrs)	24	72	168	336	672	1032	1512	2016	3384	4169	5408
Avg. Cum. Drift Aged at 70˚C	-0.008	-0.010	-0.010	-0.013	-0.023	-0.041	-0.035	-0.039	-0.056	-0.058	-0.060
Avg. Cum. Drift Aged at 100˚C	-0.017	-0.029	-0.041	-0.073	-0.112	-0.126	-0.169	-0.191	-0.239	-0.247	-0.264
Avg. Cum. Drift Aged at 130˚C	-0.051	-0.100	-0.143	-0.203	-0.270	-0.325	-0.380	-0.423	-0.496	-0.534	-0.599

Table 2. Average cumulative thermometric drift in ˚C (% change in R25 resistance/-4.39% /˚C).

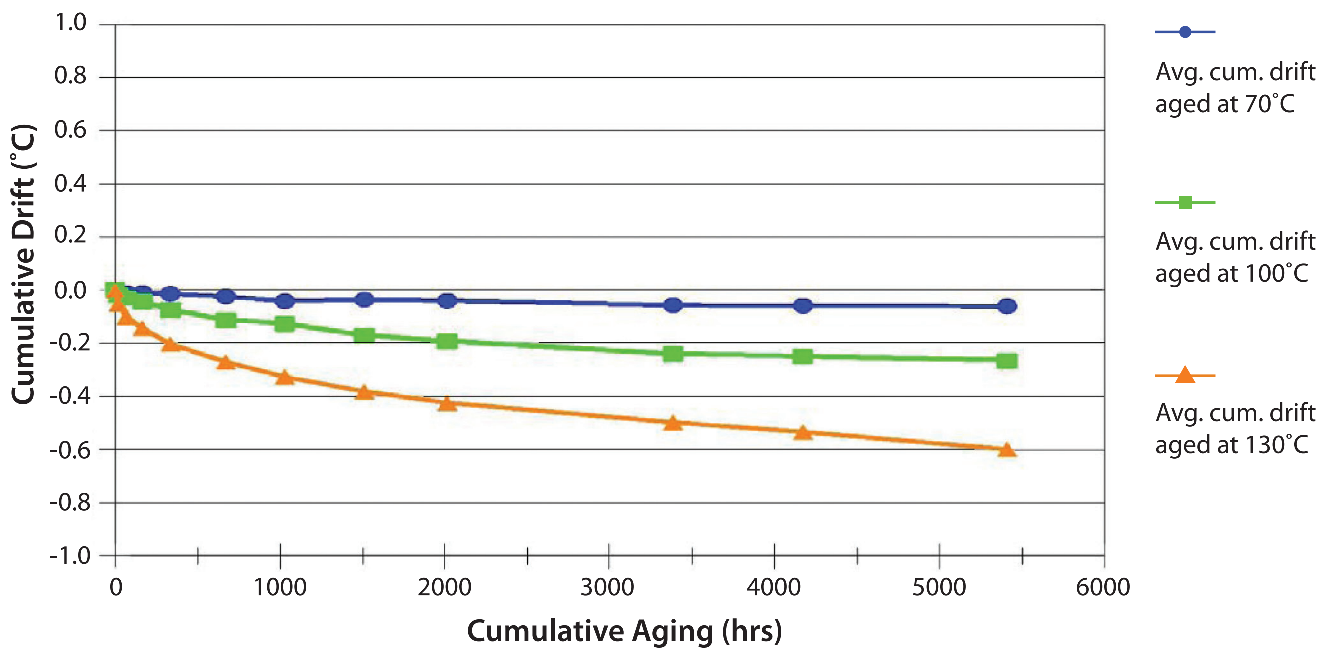


Figure 2. QTI T021D103.02.H aging characteristics for epoxy die bond, gold wire bond with 50microA bias current applied, July 2004 to March 2005.

T020/T040 SERIES STABILITY TEST: 3 mA APPLIED BIAS CURRENT

Aging study for QTI T021D103.02.H leadless chip thermistor with thick film gold contacts, epoxy bonded by the customer. Aging performed with an applied bias current of 3 mA. Customer's application: temperature monitoring of optical networks. Study period: December 2005 to June 2006.

The customer initiated this study to test the effects of operating the thermistor at a higher-than-normal bias current in the event the thermistor might experience such a condition in the field application of the customer's product. As a general rule, for precise temperature measurement, QTI does not recommend the operation of a small thermistor such as the T021D103.02.H with a bias current above 50 µA, due to the possible introduction of temperature error caused by selfheating. QTI's customer assembled QTI's T021D103.02.H leadless chip thermistors into the customer's package. The customer used propriety methods to mount the thermistors with conductive epoxy onto the customer's substrate, perform the gold wire bonding operation, and seal them into TO-46 packages that were soldered to test fixtures designed and built by the customer. The fixture, which contained 38 thermistors, was aged at 90°C with an applied bias current of 3 mA at the customer's facility. Two of the 40 contacts on the fixture gave an open circuit condition, which left 38 readable thermistors. The customer did not provide an explanation for the open circuit condition. The aging functions were performed at the customer's facility and the testing functions were performed at the QTI facility in San Diego, CA. At each aging/test interval specified by the customer, the fixture was removed from the customer's oven and shipped overnight to the QTI facility for testing. Upon completion of the test at each interval the fixture was returned to the customer facility via overnight shipment for the next aging interval. At QTI's facility, the thermistors were tested in a well-stirred ambient oil bath with readings normalized to a 25°C temperature controlled bath via a comparison standard. These measurements were estimated to have an expanded uncertainty of ±0.20% or ±0.046°C (with a coverage factor k = 2), which provided a measurement uncertainty 10 times better than the specified ± 2% thermistor tolerance. The data tables and graphs below illustrate the stability information in terms of percent change in resistance and thermometric drift for the duration of the 3000 hour test period. Upon completion of the study, the customer determined that QTI's T021D103.02.H thermistor was well qualified for use in the customer's application.

Cumulative Aging Time (hrs)	**24**	**72**	**168**	**336**	**500**	**1000**	**2000**	**3000**
Avg. Cumulative Drift Aged at 90˚C	0.05%	0.10%	0.14%	0.20%	0.17%	0.32%	0.47%	0.53%

Table 3. Average cumulative drift in percent change in resistance at 25˚C.

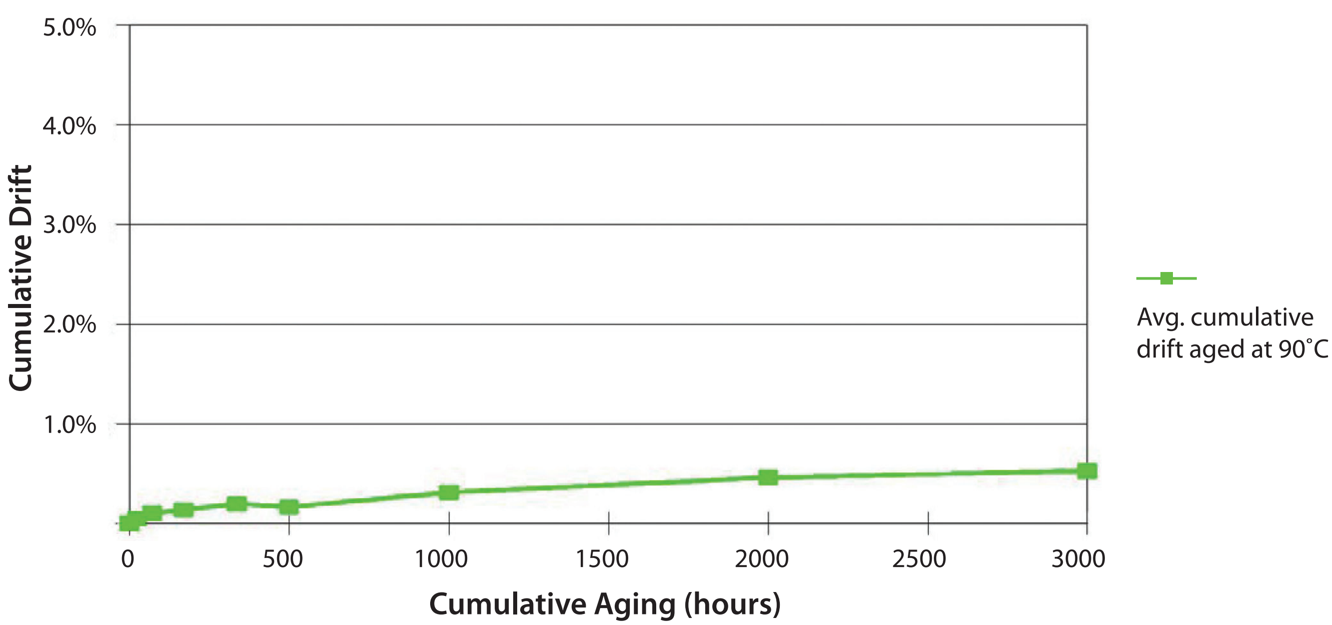


Figure 3. QTI T021D103.02.H aging characteristics for epoxy die bond, gold wire bond with 3 mA bias current applied, January 2006 to June 2006.

Cumulative Aging Time (hrs)	24	72	168	336	500	1000	2000	3000
Avg. Cumulative Drift Aged at 90˚C	-0.012	-0.023	-0.031	-0.046	-0.039	-0.072	-0.106	-0.121

Table 4. Average cumulative thermometric drift in ˚C (% change in R25 resistance/-4.39 %/˚C).

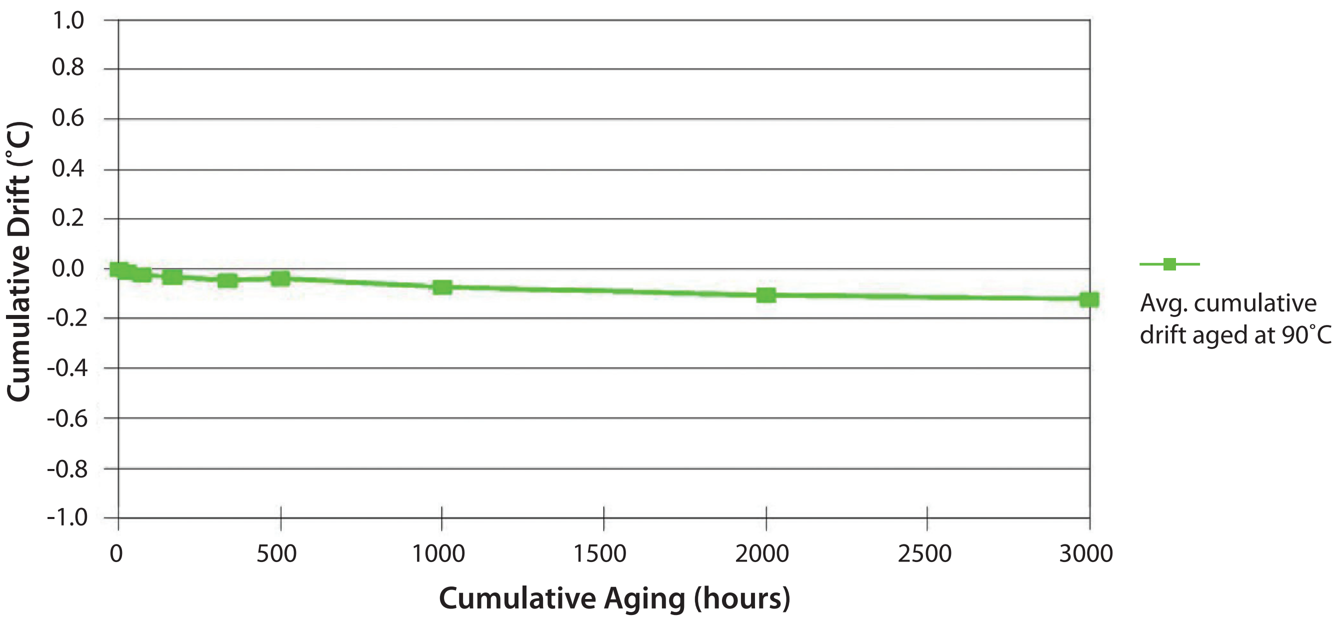


Figure 4. QTI T021D103.02.H aging characteristics for epoxy die bond, gold wire bond with 3 mA bias current applied, January 2006 to June 2006.

NOTES

1. The studies described in this white paper were performed on QTI T021D103.02.H leadless chip thermistors with thick film gold metallization. This product is suitable for die bonding with conductive epoxy. Based on reports from various customers, the T021 product is not recommended for applications requiring high temperature soldering such as Au/Sn eutectic, since this type of contact is susceptible to leaching during such soldering processes. See Notes 3. and 4. below for more information about QTI T041 and T051 products with solder leach resistant contacts.

2. The study described on pages four and five was performed by the customer to determine the effects of aging the thermistor at 90°C with a relatively high applied bias current (3 mA) condition. QTI does not recommend operating a small thermistor such as the T021D103.02.H with an applied bias current greater than 50 µA, due to the possible introduction of temperature error caused by self-heating. Based on the customer's evaluation of the data, QTI's T021 thermistor performed extremely well throughout the testing period that was run for 3,000 hours.

3. For applications requiring the thermistor to be die mounted with high temperature solder such as Au/Sn eutectic, QTI's T041 or T051 products may be better alternatives. QTI's patented metallization technology used on the T041 and T051 products is designed for die mounting processes requiring high temperature solder such as Au/Sn eutectic. The unique gold metallized contacts of the QTI T041 product provide exceptional solder leach resistance as tested and qualified by many of QTI's customers. The T051 product is similar to the T041 product with the exception that there is a 5 µm to 8 µm of 80/20 Au/Sn solder predeposited on the bottom contact of the thermistor.

5. Due to the variety of die bonding methods and processes used in the microelectronics assembly industry, QTI does not make any representation as to what product is fit for a particular assembly method or use, but encourages customers to test which thermistor would be most suitable for the particular requirements of an application. For each of the studies described in this white paper, QTI supplied products to meet the customers' anticipated requirements based on discussions about such requirements. QTI is not aware of other annealing or stabilization processes performed during the customers' assembly processes and/or reliability studies.

ABOUT QTI SENSING SOLUTIONS

QTI Sensing Solutions was founded in 1977 to meet the increasing demand for high quality electronic components for the aerospace industry. Since then, QTI has exceeded the requirements of some of the most stringent high cost of failure applications, changing the landscape of the supply chain for the entire industry.

Today, QTI continues to maintain its leadership position for mission-critical applications as well as for medical and industrial applications by supplying the world's top companies with innovative products and services. In fact, QTI developed the highest standard for surface mount thermistors with the introduction of qualified surface mount parts to MIL-PRF-32192; supplying design engineers with fully qualified Defense Logistics Agency options for two PTC and three NTC surface mount package styles. Additionally, QTI has partnered with the NASA Goddard Space Flight Center for surface mount thermistors qualified to S311-P827, an industry first!

In addition to QTI's accomplishments, our ISO:09001:2000 and AS9100 certified manufacturing and testing facilities in Idaho enhances our ability to meet the needs of today's challenging temperature measurement and control applications.

LEARN MORE

If you would like to learn more about how QTI can help you, please contact us today. We would be happy to discuss your project with you and help with the product selection process. Additionally, if you are unable to find the item you need, our engineers may be able to produce a custom component for your individual application.