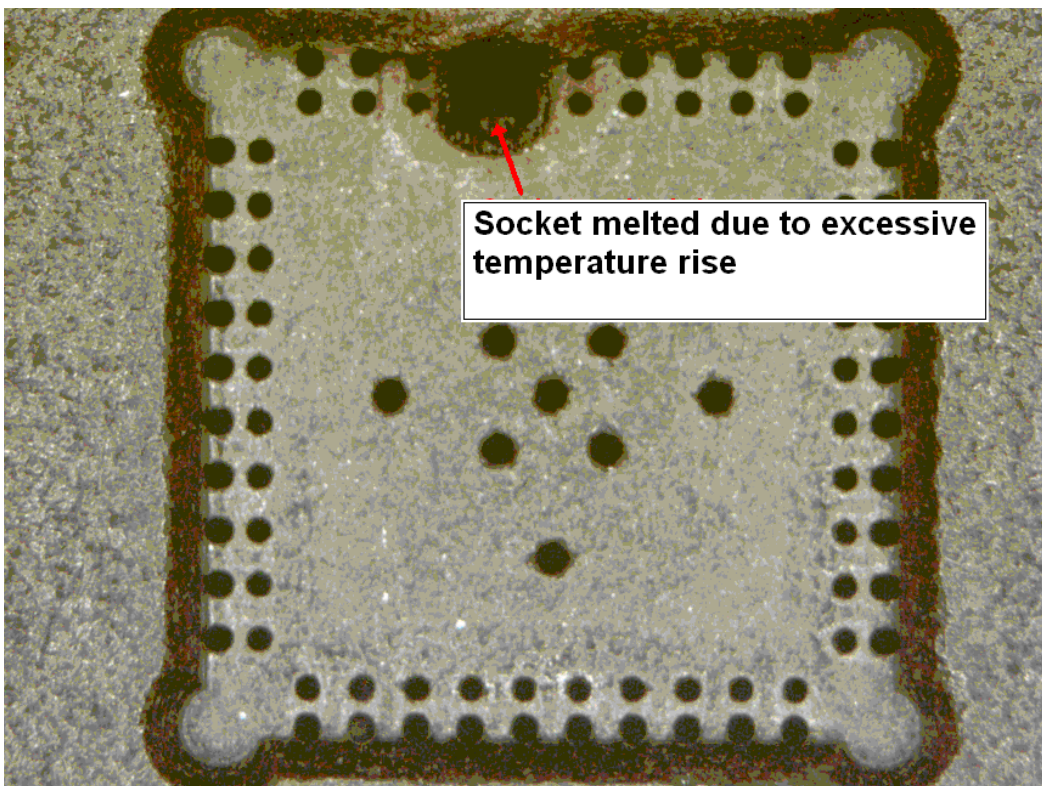
Can Your Socket Take the Heat?

In the semiconductor industry, many devices are shrinking in size, more functionality is being added to the devices, and the trend is to incorporate multiple chips into one package. As these packages become more complex, the input power and thermal requirements increase. Many users are now performing temperature testing at cold and hot, in addition to ambient, to meet the demands of the automotive, defense, and other applications.

What many users don't realize is that all contacts used in testing semiconductor devices are not created equal when it comes to current carrying capability, and many of them are not even tested to mimic users' exact test conditions or needs. Things to consider are effects of changing contact resistance, duty cycle, hot and cold temperature testing, and supplier specifications. It is impossible to test the contacts for each users test scenarios. However, it is possible to test the contacts with a standard procedure using proven techniques to make the necessary measurements so accurate data can be extrapolated to any customer requirement. If bad assumptions are made, catastrophic failure can occur as shown in Figure 1.

Figure 1 Cantilever Kelvin Socket with Similar Force and Sense Contact after Elevated Current Failure



Your Contact for Higher Performance

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Many users don't realize the importance of a reliable and consistent contact when testing at elevated currents. High or varying contact resistance in the contact's interface-to-device sometimes results in a significant voltage drop, which could soften or even melt the Matte Tin plating that is on the vast majority of devices. When one considers that the softening temperature of Matte Tin is reached at a voltage drop of 0.07V, and the melting temperature of Matte Tin is reached at 0.13V, then one bad insertion with an elevated contact resistance as low as 1A current could cause a catastrophic failure.

In a high current carrying test it is important to make sure the contact can break through the Matte Tin oxide that often forms on the device pads. There is a fine line between breaking through oxide layers and a contact that has a self-cleaning wipe function. A self-cleaning wipe contact will maintain a low Cres longer than technologies that probe through oxide layers because debris and oxides will form faster. The contact resistance will rise faster to the limit resulting in device plating melting and sticking to the contact, perhaps destroying both the device and contact.

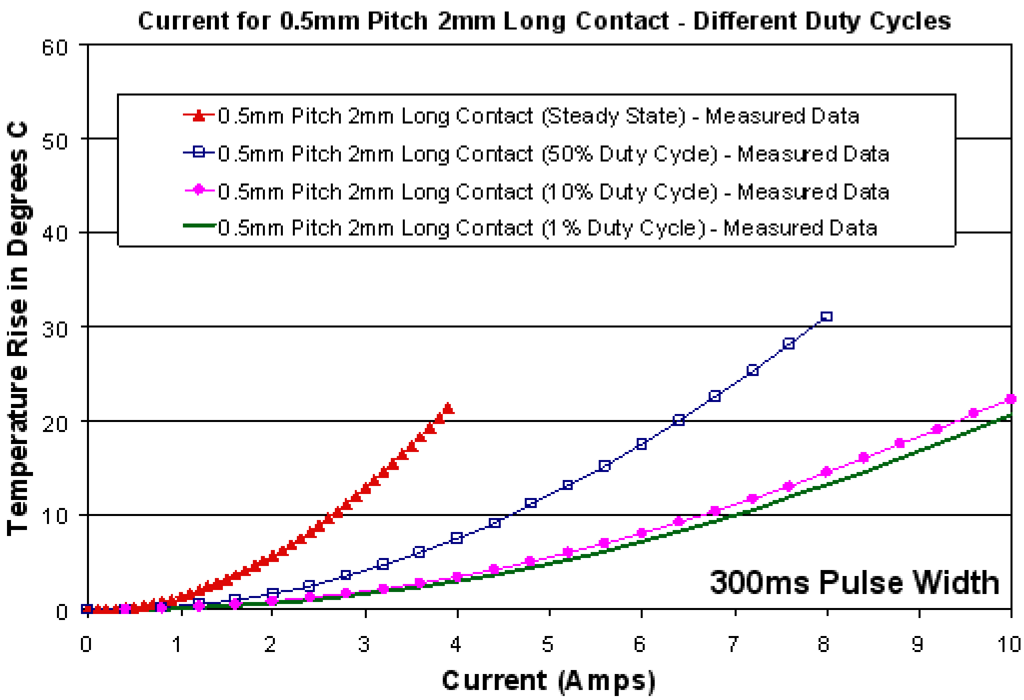
If the contactor isn't capable of maintaining a small temperature rise, it might result in testing at a lower temperature extreme to make sure the device junction temperature isn't exceeded. This results in not testing to the intended device specifications. Some contacts specify current under worst case scenarios such as steady state and allow for only a 20 degree Celsius temperature rise, which is assuring to users doing high temperature automotive testing. Other suppliers specify current carrying capabilities at higher temperature increases, while others specify at duty cycles of 50%, 10% or even a 1%. In many instances this requires the device to be turned on numerous times to conduct all the tests and make sure the device or contactor doesn't overheat. This method of testing increases test times and increases test costs.

Repeated production testing without sufficient cooling will result in the contact and housing temperature to rise potentially causing catastrophic failures. Figure 1 shows a Kelvin housing that uses circular holes to incorporate a cantilever technology. The force contact couldn't handle the temperature rise resulting from the current, which resulted in destroying the socket and welding the device to the contact. In a Kelvin test scenario the sense contact only handles a few picoamps of current and could be smaller and less robust. The force contact handles almost all the current and should be designed as a rigid contact with enough mass and a high conductivity to handle the expected current.

When testing contacts in a contactor it is essential to make sure the temperature probe is attached to the contact to get an accurate gauge of the temperature rise without impacting the contact's performance. If the probe is too large its mass will skew the data and make the contact appear to handle more current than it really can, which is bad news for the user when testing at high current levels or elevated temperatures.

Figure 2 shows the test results from using the standard current carrying procedure developed by industry leaders. For duty cycle testing of the 2mm long rigid contact the pulse width was 300 ms, which is a typical test time for many devices. With a smaller pulse width the contact can handle more current, but the device may not be able to be tested in production without multiple cycles, which adds test time. With this standard procedure using an extremely small temperature probe you can see that the temperature rise vs. current carrying capability is a non-linear relationship. This is because the device under test has adequate time to cool down before the next pulse of current is applied.

Figure 2 Current Carrying Capacity for a 2mm Long Rigid Contact



Pulse load testing is performed by providing a current pulse of 0.3 seconds length followed by a pause long enough to facilitate 50%, 10% and 1% duty cycles. The current handling capability is then determined for the allowable temperature rise. Triggering of the temperature measurement occurs at the falling edge of the last current pulse of a series. This ensures a measurement of temperature near the peak of the actually occurring instantaneous value. The measurement is therefore not an average value and represents the worst-case temperature rise. If the average temperature value (which is generally significantly lower) was used instead, a higher current handling capacity would result. [1]

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Using a standard test procedure that is similar to the test requirements of the device being tested makes it easy to compare data. Because of oxides and contact resistance, variations due to oxide buildup or debris results in the need for the contact to have some margin in terms of current carrying capacity to assure longer intervals between contact cleanings, which improves the tester's overall efficiencies.

1 *This paper is the result of a development effort at Johnstech and the independent third party test house GateWave Northern. Figure 2 represents data from testing with the standard current carrying capacity procedure on a ROL™200 contact developed by Johnstech International.*

Biography

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