Current Carrying Capacity

This test report presents the data and describes the procedures for testing the current carrying capacity for QA Technology's test probes and their respective mounting sockets or termination pins. The current carrying ability of a probe is ultimately determined with respect to probe temperature. (Refer to the Applications Note titled *Working Temperature Ranges* for additional information.) QA's testing was performed at a nominal ambient temperature of 20°C. The final current carrying capacity of a probe will depend upon many additional factors specific to the actual application.

The maximum temperature that a probe can handle is determined primarily by the spring material and the lubricant used. Ratings for probes with music wire springs are limited to 120°C, while stainless steel springs can handle up to 204°C. Ratings at both temperatures are outlined in their respective product pages. Note that only certain products use a stainless spring.

Although our current and temperature ratings are based on our product materials, many fixture materials will not tolerate temperatures up to 204°C (some plastics will not even withstand 120°C). Many solders may become weak or even melt well below this temperature. Precaution is advised if operating probes at very high temperatures.

Test Procedure

QA Technology's current test system consists of a multichannel data acquisition system, programmable DC power supplies, a test fixture chamber shielded from room air currents and an industrial PC to provide test configuration, control and data recording. The test fixture chamber provides connection points for one or two test fixtures at a time, and it also has thermocouples installed for measuring the ambient air temperature during the test.

For our conventional probe series, FR4 test fixtures were built to mount eight probes at a time for testing. Standard 0.250 [6.35] stroke probes were stroked to 2/3 of their nominal full stroke. Long stroke 0.400 [10.16] probes were tested at 0.075 [1.91] stroke which is commonly used in dual-level fixturing. The probes were spaced 1.00 [2.54] apart to provide effective thermal isolation between individual probes. A circuit board was designed to allow all eight probes in one fixture to be connected in series. The surface of the circuit board was coated with solder to simulate typical contact conditions between the probe tip and a circuit board under test. The sockets were interconnected to complete the series current path. The wire gauge used for interconnecting the sockets was selected according to the expected test current.

Fine gauge type T thermocouples (Copper/Copper-Nickel) were soldered to the sockets just below the bottom surface of the socket mounting plate. The fine gauge thermocouple wire minimized heat transfer from the socket and decreased the thermal response time. The thermocouples were then connected to the multi-channel data acquisition system.

In the case of QA's X Probes®, the test thermocouples were attached directly to the probe tube wall just above the tube's interconnect receptacle. The X Probe termination pins were connected in the same fashion as the sockets for conventional probes.

For testing wireless sockets and termination pins, the test fixtures were designed so that both the test probe and wireless interface probe are part of the current path. The interface board was spaced so that the plungers were compressed to the recommended stroke and a flat gold pad was used for the contact point. The gold contacts on the interface board were wired to complete the series current path and a thermocouple was soldered to the wireless interface probe tube to monitor the temperature of the interface probe assembly. In general, the current carrying capacity of the wireless sockets and termination pins were less than a standard wired socket and termination pin assembly due to the additional interface probe.

A programmable DC power supply was used to provide a constant test current through the probes and sockets or termination pin being tested. The current was programmatically incremented and the assemblies were allowed to reach a stable temperature before the readings were recorded. This process was repeated until the required temperature rise was achieved across a majority of the probes under test.

The wire gauge used for interconnecting the sockets or termination pins of the probes under test varied depending on the final current requirements for the test. Indeed, the choice of interconnect wire gauge played a significant role in determining the temperature of a particular probe during testing. A heavier gauge wire ran cooler for any given current, with the copper conductor acting as a heat sink for the probe under test.

Three sets of tests were conducted and analyzed statistically to produce a temperature vs. current curve based upon a 3-sigma rise above the average data values. The final current carrying rating for the probe was derived from this curve. Using this 3-sigma standard, 99.7% of all probes will meet the current rating.

The M035-14, M08-89, and M100-75 probes' setup utilized fixtures designed around the typical applications for these probes and consisted of two plates with the probes captured between a top and bottom plate. A small cross-channel was machined in the plates to allow room for the thermocouple wires. Two circuit boards sandwiched the top and bottom plates to route the series test current through all eight probes.

Application Notes

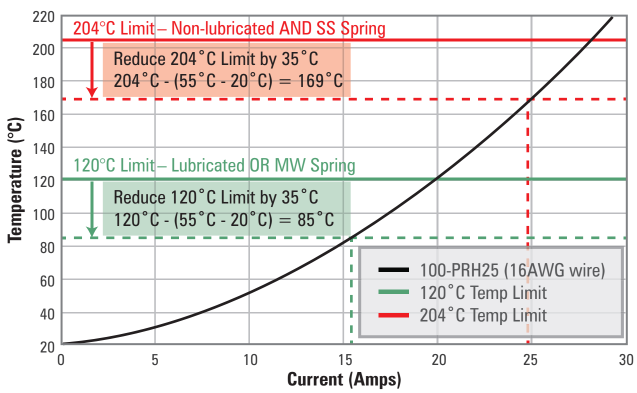
Probe Mounting Density – Higher probe mounting densities decrease the probe's current carrying ability. This is due to the combined heat generated by the probes and the decrease of air circulation via natural convection. Because each application is unique, it is recommended that appropriate tests be conducted before probes are put into service in applications with high currents, high probe densities, or limited airflow.

Probe Cooling – These temperature measurements were made in the absence of any forced convection. Providing airflow (by means of a fan, for example) around the sockets or termination pins will reduce the temperature for a given current. Also, tests have shown that the airflow present due to leaks in a typical vacuum fixture will reduce temperature.

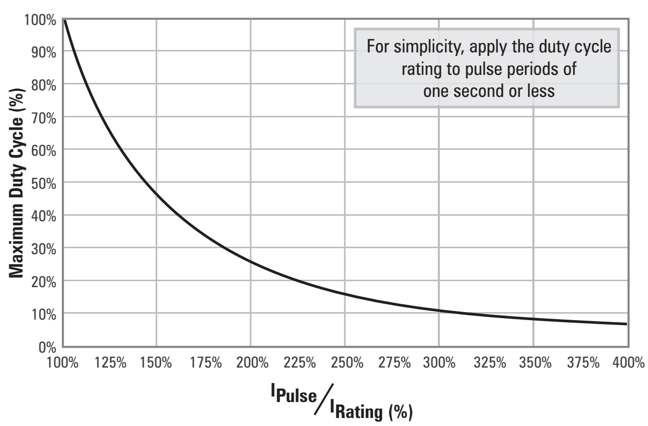
Elevated Ambient Temperatures – For conditions where the ambient temperature differs from the 20°C ambient of these tests, a simple graphical technique can be used to obtain a corrected current limit; shift the temperature limit line down by the same amount that the actual ambient temperature exceeds 20°C. For example, a 100-PRH25 series probe operating in an environment with an ambient temperature of 55°C will exceed 120°C at 15.4 amps and 204°C at 24.7 amps (instead of 19.8 amps and 28.3 amps respectively at 20°C ambient).

Duty Cycle for Pulsed Currents – This data reflects performance at 100% duty cycle. Higher currents can be carried for pulses of short duration. For simplicity, apply higher currents for no longer than one second (longer pulses may be carried, but require that thermal inertia and rate of temperature gain be known). A probe's ultimate temperature is determined by the dissipated power [P=I2R], so duty cycle adjustments should be made according to the square of the current ratio. For example, a 100-PRH2509X in a 100-SDH250W is rated for 19.8 amps. If you want to run it at 35 amps, the duty cycle would need to be $(19.8 \div 35)^2 = 0.566^2 = 0.32 = 32\%$. So, to avoid overheating this probe at 35 amps, power must be applied for no more than 320 milliseconds (1 second x 32%).

100-PRH25 Example Determining Current Limit at 55°C Ambient



Duty Cycle for Pulsed Currents Exceeding the Continuous Current Rating



Similarly, the 187-25 Series of probes and sockets are designed for high current applications given the larger component diameters and greater internal contact surfaces areas when compared to the other series. A 187-PRS2509H probe in a 187-SDH250S socket carries a maximum continuous current of 59 amps. To carry 75 amps it would need to be run at a 62% duty cycle $(59 \div 75)^2 = 0.619 = 62\%$.

Reference Point – For comparison purposes, note that a 16 AWG, Ø 0.051 [1.30] solid copper wire close to the same diameter as a 100-25 series probe tube, Ø 0.054 [1.37] reaches 120°C at 31 amps.

CENTER SPACING	PROBE	SOCKET	WIRE SIZE	CURRENT CAPACITY @ 120°C (AMPS)[1]	CURRENT CAPACITY @ 204°C (AMPS)[2]
0.025 [0.63]	025-PRP1640S	025-SBH160C-3	30	2.7	3.7
0.039 [1.00]	039-PRP1644X-S	039-SDC165J	28	3.1	4.2
0.039 [1.00]	039-PRP2544H-S	039-SDC165J	28	3.1	4.3
0.039 [1.00]	039-PRP2544X-S	*039-SDC255DS3	28	3.8	5.3
0.039 [1.00]	039-PRP406RS-S	039-SDC165J	28	2.6	3.6
0.039 [1.00]	039-PRP406RS-S	*039-SDC255DS3	28	2.8	3.8
0.050 [1.27]	050-PLP0543S	050-SBB050C6530	26	3.7	5.2
0.050 [1.27]	050-PLP1609H	050-SBN160S	26	4.9	7.4
0.050 [1.27]	050-PLP1609H	*050-SBB162DS3	22	4.2	5.8
0.050 [1.27]	050-PTP2509Y	050-STB255C6530	26	4.5	6.2
0.050 [1.27]	050-PTP2509Y	*050-STB255DS3	22	4.5	6.5
0.050 [1.27]	050-PRP2509X	050-SRB255C6530	26	3.9	5.4
0.050 [1.27]	050-PTP4046U	050-STB255C6530	26	4.3	5.9
0.050 [1.27]	050-PTP4046U	*050-STB255DS3	22	4.4	6.4
0.050 [1.27]	050-PRP4046S	050-SRB255C6530	22	3.7	5.0
0.075 [1.91]	075-PRP2509X 075-PRG2509X 075-PRN2509X	075-SDN250S	20	7.7 7.7 6.1	10.4 11.1 8.5
0.075 [1.91]	075-PRP2509X	*075-SDN250DS3	20	5.4	7.6
0.075 [1.91]	075-PRP4009U 075-PRG4009U 075-PRN4009U	075-SDN250S	20	7.3 7.2 6.1	10.0 9.0 9.9
0.075 [1.91]	075-PRP4009U	*075-SDN250DS3	20	4.9	7.1
0.100 [2.54]	100-PLP0502H 100-PLG0502H 100-PLN0502H	100-SDN050S	16	9.7 7.1 9.3	13.3 9.7 12.7
0.100 [2.54]	100-PLP1609U 100-PLG1609U 100-PLN1609U	100-SDN160S	16	14.0 12.0 10.0	21.0 16.5 15.5
0.100 [2.54]	100-PRP2509X 100-PRV2509X 100-PRG2509X 100-PRN2509X 100-PRH2509X	100-SDN250S 100-SDN250S 100-SDN250S 100-SDN250S 100-SDH250W	16	11.8 12.7 12.3 10.2 19.8	16.2 17.4 17.3 15.3 28.3
0.100 [2.54]	100-PRP2509X	*100-SDN250DS3	16	5.9	8.5
0.100 [2.54]	100-PRP4009U 100-PRV4009U 100-PRG4009U 100-PRN4009U 100-PRH4009U	100-SDN250S 100-SDN250S 100-SDN250S 100-SDN250S 100-SDH250W	16	10.2 12.7 12.2 8.8 15.9	14.3 17.5 17.5 13.2 22.0
0.100 [2.54]	100-PRP4009U	*100-SDN250DS3	16	6.2	9.0
0.100 [2.54]	100-PRP5043L	100-SDN250S	16	10.0	13.7

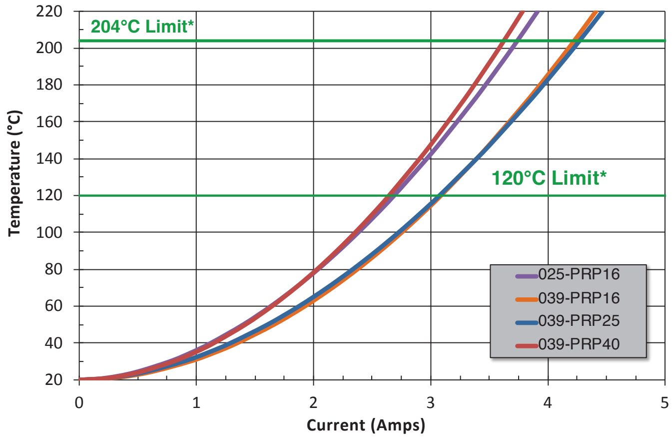
* Wireless
[1] 120°C temperature limit for MW springs **or** lubricated probes
[2] 204°C temperature limit for SS springs **and** non-lubricated probes

CENTER SPACING	PROBE	SOCKET	WIRE SIZE	CURRENT CAPACITY @ 120°C (AMPS)[1]	CURRENT CAPACITY @ 204°C (AMPS)[2]
0.125 [3.18]	125-PRG2509H 125-PRH2509H 125-PRN2509H 125-PRS2509H	125-SDN250S 125-SDH250S 125-SDN250S 125-SDH250S	12	16.9 30.0 13.7 32.8	23.0 41.0 18.8 48.0
0.156 [3.96]	156-PRH2509H 156-PRN2509H 156-PRS2509H	156-SDH250S	12	31 16 34	43 22 47
0.187 [4.75]	187-PRH2509H 187-PRN2509H 187-PRS2509H	187-SDH250S	10	39 24 48	55 32 59
0.031 [0.80]	X31-PRP16S44HS	X31-TR-2G	30	3.4	4.7
0.031 [0.80]	X31-PRP16S43PS	*X31-TDS3-00	30	3.7	5.1
0.031 [0.80]	X31-PRP2544H-S	X31-TG-3G	30	2.6	3.6
0.031 [0.80]	X31-PRP2544X-S	*X31-TDS3-02	30	3.2	4.4
0.031 [0.80]	X31-PRP406RS-S	X31-TG-3G	30	2.5	3.6
0.031 [0.80]	X31-PRP406RX-S	*X31-TDS3-02	30	2.9	4.0
0.039 [1.00]	X39-PRP16S44HS	X39-TR-2G	28	4.5	6.2
0.039 [1.00]	X39-PRP16B39HH	*X39-TDS3-00	28	5.5	7.6
0.039 [1.00]	X39-PRP2509Y	X39-TJ-3G	28	3.4	4.7
0.039 [1.00]	X39-PRP2509Y	*X39-TDS3-10	28	2.6	3.6
0.039 [1.00]	X39-PRP4044U	X39-TJ-3G	28	3.3	4.5
0.039 [1.00]	X39-PRP4044U	*X39-TDS3-10	28	4.2	5.9
0.050 [1.27]	X50-PRP16S44HS	X50-TR-2G	22	5.7	7.8
0.050 [1.27]	X50-PRP16B39HS	*XTDS3-00	22	7.1	9.7
0.050 [1.27]	X50-PRP2509X	X50-TJ-3G	28	5.6	7.8
0.050 [1.27]	X50-PRP2509X	*XTDS3-14	22	6.0	8.2
0.050 [1.27]	X50-PRP4009U	X50-TJ-3G	28	5.3	7.8
0.050 [1.27]	X50-PRP4009U	*XTDS3-14	22	5.9	8.2
0.075 [1.91]	X75-PRP16S44HS	X75-TR-2G	20	6.9	9.5
0.075 [1.91]	X75-PRP16B09HS	*XTDS3-00	20	7.3	10.0
0.075 [1.91]	X75-PRP2509X	X75-TWA-5G	20	8.4	12.0
0.075 [1.91]	X75-PRP2509X	*XTDS3-14	20	7.3	10.1
0.075 [1.91]	X75-PRP4009U	X75-TWA-5G	20	7.9	11.3
0.075 [1.91]	X75-PRP4009U	*XTDS3-14	20	7.3	10.2
0.35mm	M035PRH1440S-S	n/a	20	1.6	2.2
0.8mm	M08-PRG8944H	n/a	20	4.4	6.1
1.0mm	M100-DRP7563AS3	n/a	20	3.4	4.7

* Wireless
[1] 120°C temperature limit for MW springs **or** lubricated probes
[2] 204°C temperature limit for SS springs **and** non-lubricated probes

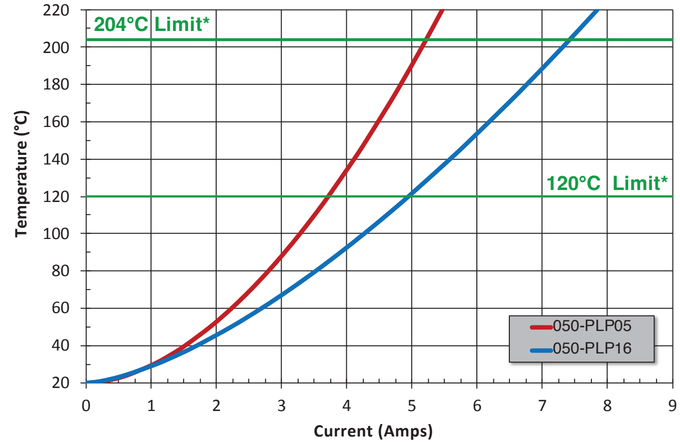
025-16 | 039-16 | 039-25 | 039-40 SERIES

Temperature vs. Current at 20°C Ambient



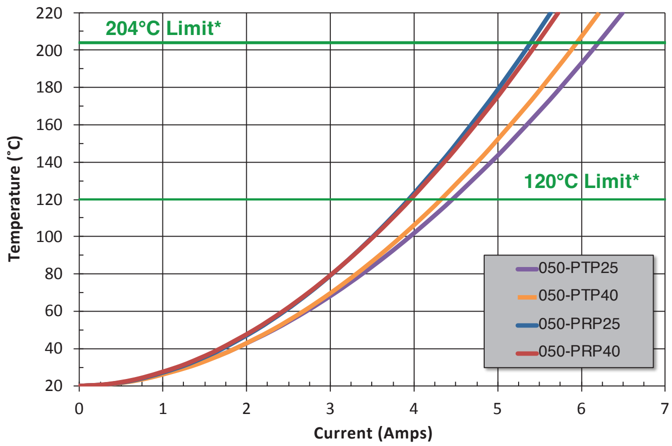
050-05 | 050-16 SERIES

Temperature vs. Current at 20°C Ambient



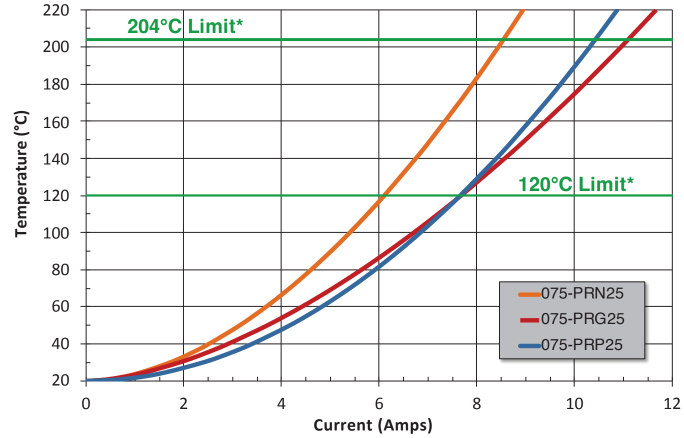
050-T25 | 050-T40 | 050-R25 | 050-T40 SERIES

Temperature vs. Current at 20°C Ambient



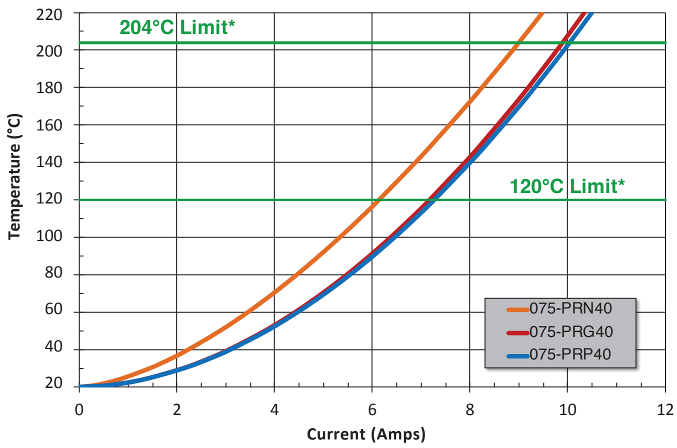
075-25 SERIES

Temperature vs. Current at 20°C Ambient



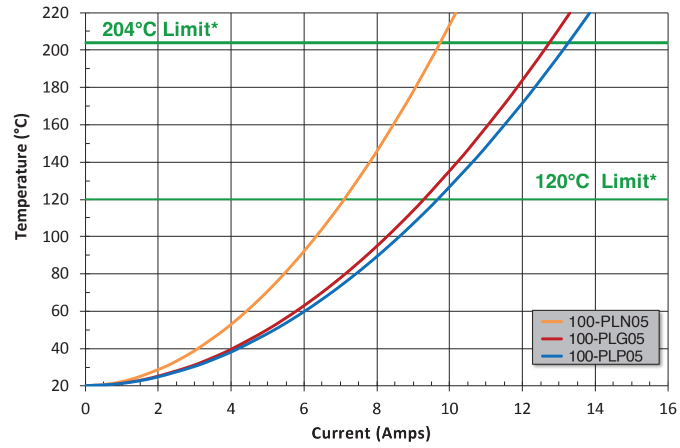
075-40 SERIES

Temperature vs. Current at 20°C Ambient



100-05 SERIES

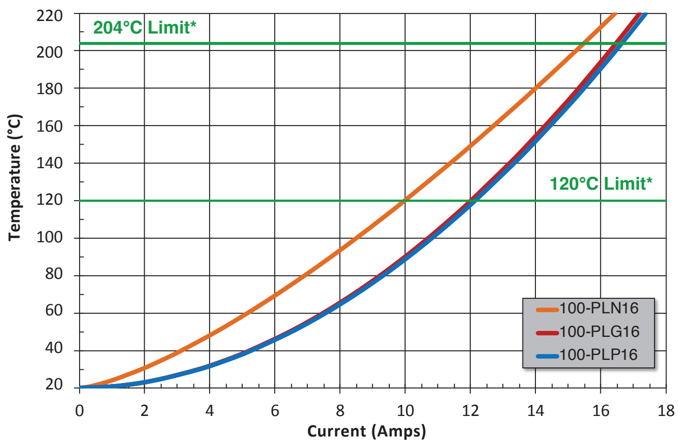
Temperature vs. Current at 20°C Ambient



*Check product specification for temperature limitations

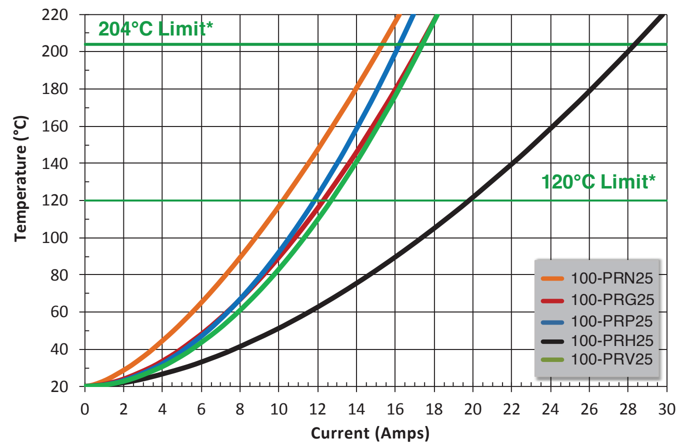
100-16 SERIES

Temperature vs. Current at 20°C Ambient



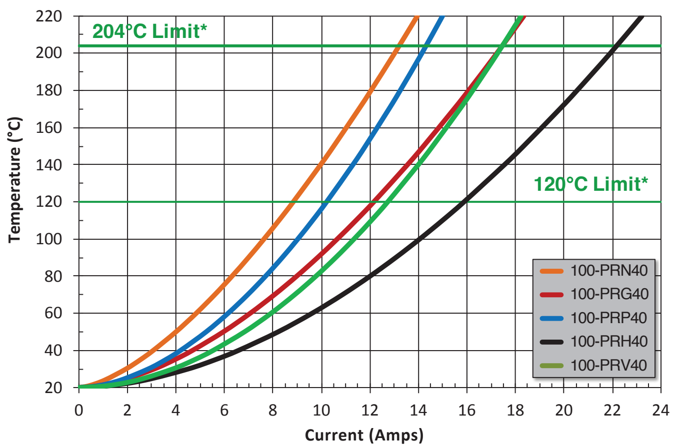
100-25 SERIES

Temperature vs. Current at 20°C Ambient



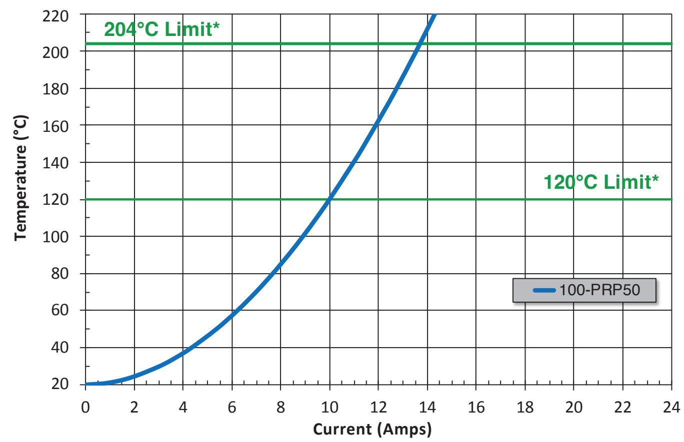
100-40 SERIES

Temperature vs. Current at 20°C Ambient



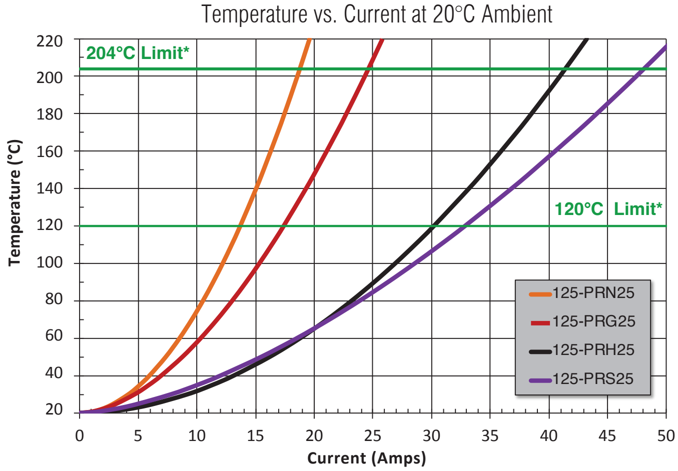
100-50 SERIES

Temperature vs. Current at 20°C Ambient



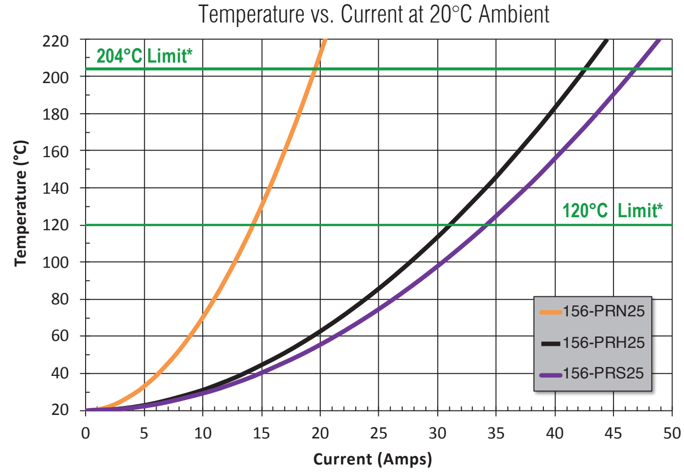
125-25 SERIES

Temperature vs. Current at 20°C Ambient



156-25 SERIES

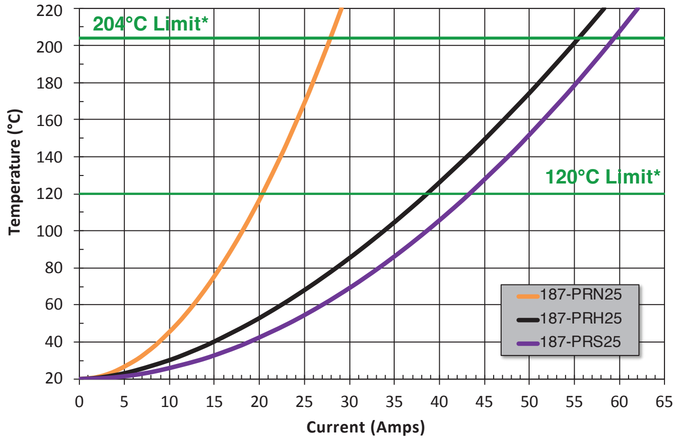
Temperature vs. Current at 20°C Ambient



*Check product specification for temperature limitations

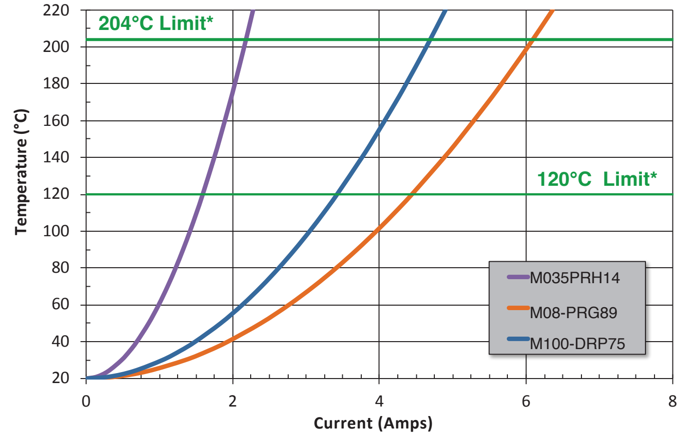
187-25 SERIES

Temperature vs. Current at 20°C Ambient



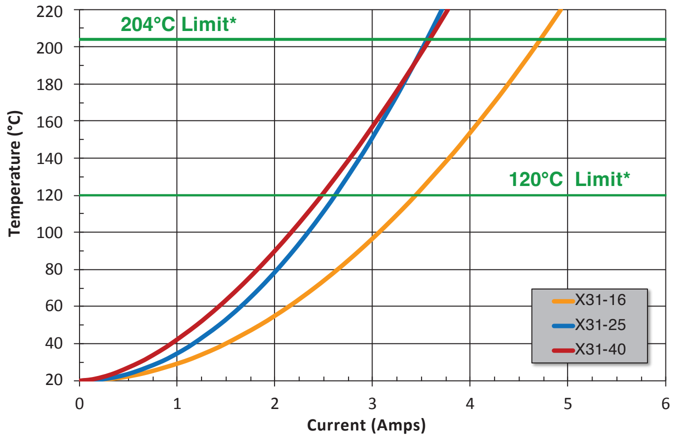
DOUBLE ENDED PROBES

Temperature vs. Current at 20°C Ambient



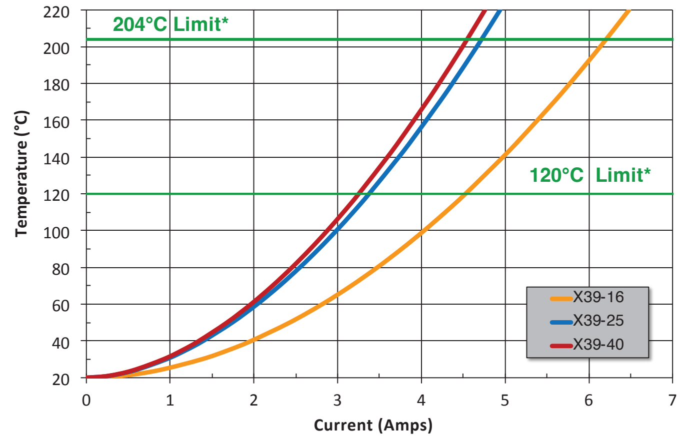
X31-16 | X31-25 | X31-40 SERIES

Temperature vs. Current at 20°C Ambient



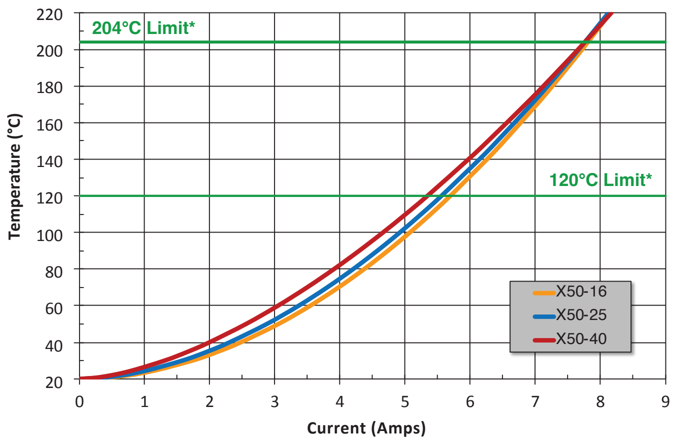
X39-16 | X39-25 | X39-40 SERIES

Temperature vs. Current at 20°C Ambient



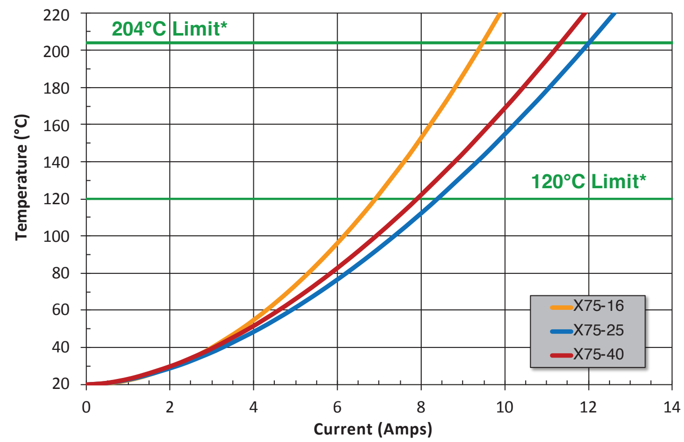
X50-16 | X50-25 | X50-40 SERIES

Temperature vs. Current at 20°C Ambient



X75-16 | X75-25 | X75-40 SERIES

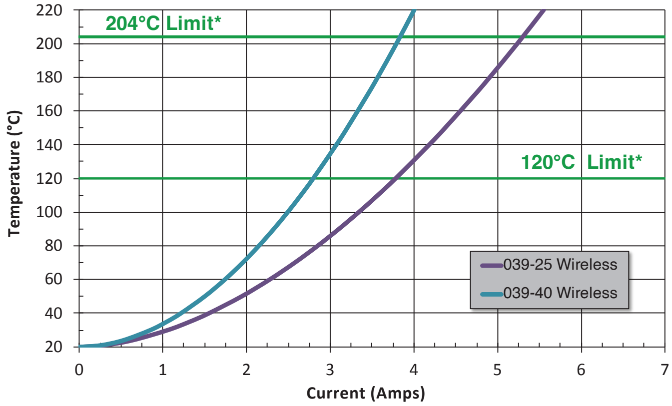
Temperature vs. Current at 20°C Ambient



*Check product specification for temperature limitations

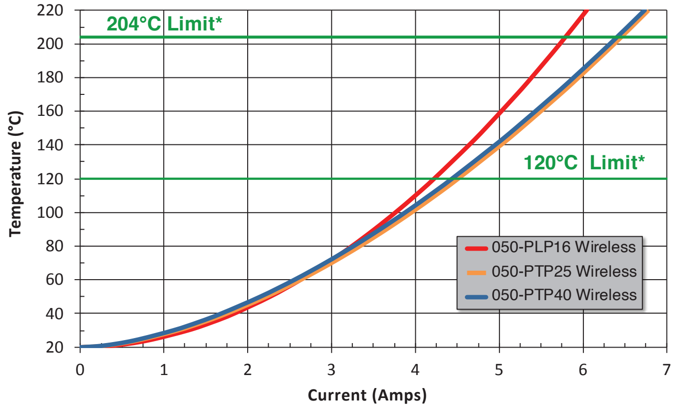
039-25 | 039-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



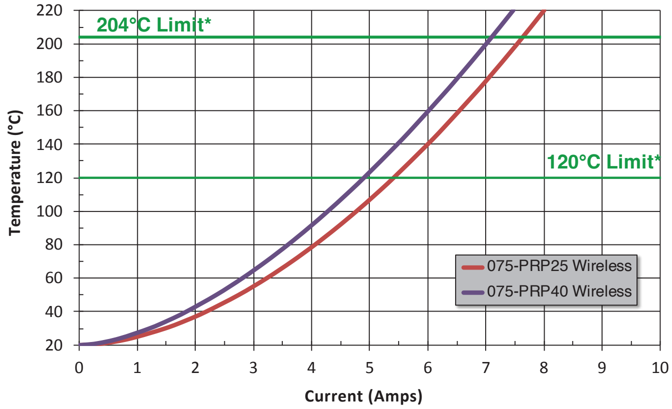
050-16 | 050-25 | 050-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



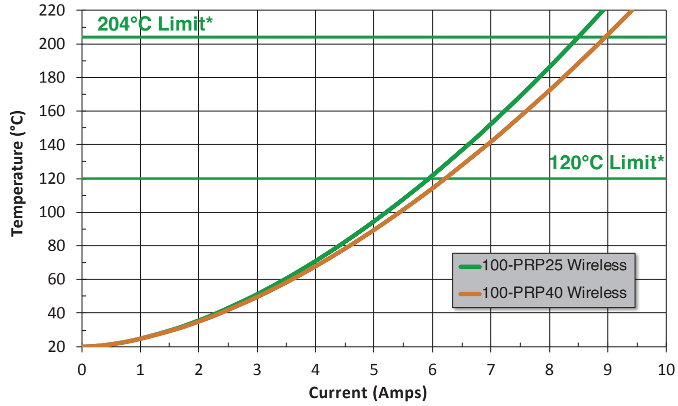
075-25 | 075-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



100-25 | 100-40 SERIES WIRELESS

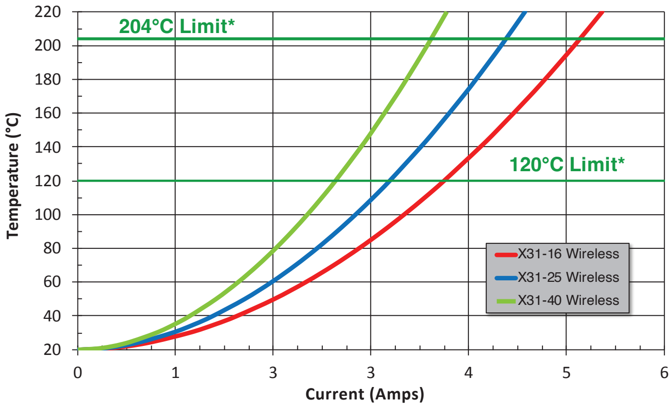
Temperature vs. Current at 20°C Ambient



*Check product specification for temperature limitations

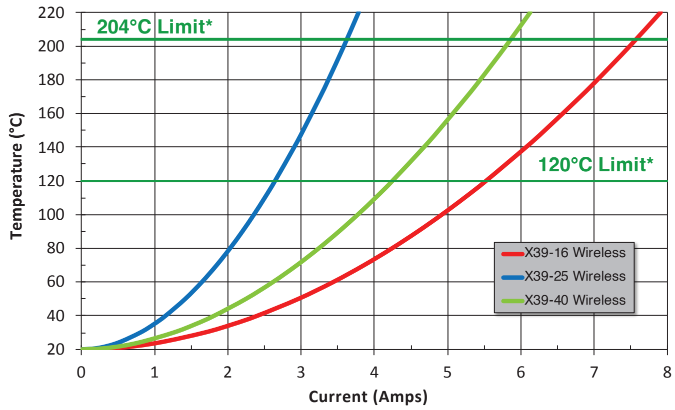
X31-16 | X31-25 | X31-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



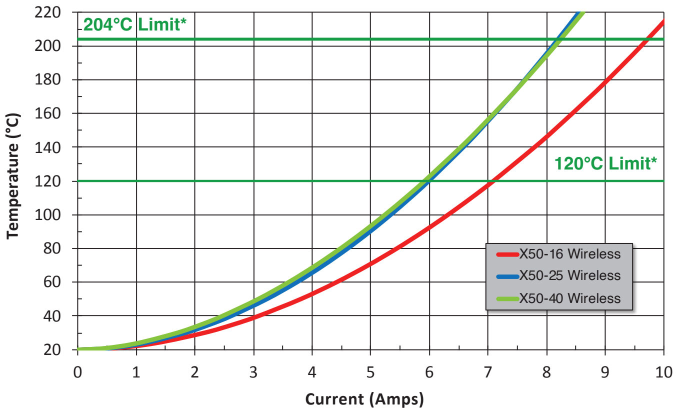
X39-16 | X39-25 | X39-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



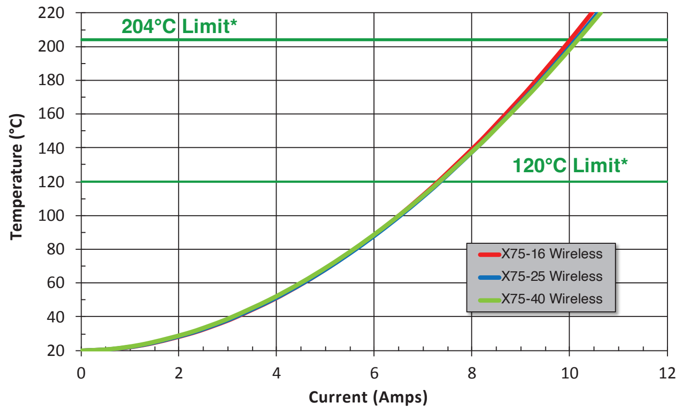
X50-16 | X50-25 | X50-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



X75-16 | X75-25 | X75-40 SERIES WIRELESS

Temperature vs. Current at 20°C Ambient



*Check product specification for temperature limitations