

Specifying Current for the Real World

Can a contact rated at 10 amps carry 10 amps? Maybe yes, probably not. The reason lies in the test conditions used to rate the contact. If these conditions do not adequately reflect application conditions, actual allowable current levels may be lower than specified levels. For example, many manufacturers test a single contact in air. This gives an accurate measure of the **basic** current-carrying capacity of the contact. Use the contact alone in air and it can certainly carry 10 amps. Use it in a multiposition connector surrounded by other current-carrying contacts or in high ambient temperatures, and the contact should carry less current.

Similarly, as the contact ages and stress relaxation, environmental cycling, and other degradation factors take their toll, its current-carrying capacity decreases. A prudent design must set current levels for such end-of-design-life (EODL) conditions.

Practical current-carrying capacity is not an absolute, but an application-dependent condition.

New Method Simplifies Ratings

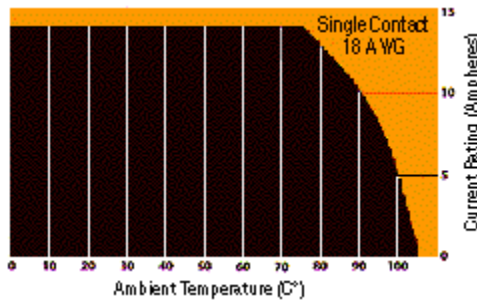
To help the designer set the appropriate current level, AMP has developed a new method of specifying current-carrying capacity. This new method takes into account the various application factors that influence current rating.

The method can be summarized as follows:

- The contact is aged to EODL conditions by durability cycling, thermal cycling, and environmental exposure
- The contact's resistance stability is verified
- The current necessary to produce the specified temperature rise is measured. This t-rise is usually 30 degrees C
- A rating factor is determined to allow derating of multiple contacts in the same housing and for different conductor sizes

Temperature, Temperatures

One other factor influencing current levels is the maximum operating temperature, usually 105 degrees C. If the application has a high ambient temperature (over 75 degrees C), the contact's t-rise is limited by the maximum operating temperature. For example, an application temperature of 90 degrees C limits the contact t-rise to 15 degrees C. Since current produces heat (the I squared R law), the current must be lowered to limit the t-rise.



This graph clearly shows the relationship between base current, ambient temperature, and contact t-rise.

A contact's t-rise depends not only on its I squared R Joule heating, but also on its ability to dissipate the heat. Consider a contact in multicontact housing. Joule heating in multiple contacts will raise the local ambient temperature. Since the contact will not be able to dissipate its own heat as well by convection, the maximum t-rise will be realized at a lower current level. Consequently, the allowable current level must be lower to maintain an acceptable t-rise.

For a given connector, the current level will be set by the loading density. A connector containing 50% current-carrying contacts will permit higher currents (per contact) than a connector will at 75% loading. The loading percentage assumes an even distribution of contacts within the housing. If all 10 contacts are grouped together in one section of the 20-position connector, the loading density may approach 100%.

The Importance of EODL

As noted, t-rise in a contact depends on both resistance and current. As it ages, a contact's resistance will increase. The contact designer will specify a maximum resistance for the contact: this level is the end-of-design-life resistance. Before the contact is tested for current, AMP subjects it to a sequence of tests that exercises the major failure mechanisms and thereby simulates EODL conditions. Conditioning includes mating cycling, industrial mixed-flowing gases, humidity and temperature cycling, and vibration to sequentially introduce wear, corrosion, stress relaxation, and mechanical disturbances.

Presentation

The presentation of current-carrying capacity in AMP product specifications includes two parts. First is a base curve showing current levels versus t-rise for a single circuit and the largest wire size. This represents the maximum current capacity of the contact. The curve is usually flat up to 75 degrees C ambient and then drops off. Up to 75 degrees C, the 30 degrees C t-rise limits the amount of current, and above 75 degrees C the current must be reduced to keep the combination of ambient temperature and t-rise from exceeding the maximum operating temperature of 105 degrees C.

Second are rating factors, a table of multipliers to account for connector loading and for smaller wire sizes.

		AWG				
		18	20	22	24	26
% Loading	Single	1	.83	.69	.59	.50
	30%	.97	.80	.66	.57	.49
	50%	.83	.68	.57	.48	.42
	70%	.65	.53	.45	.38	.33
	100%	.55	.45	.38	.32	.28

Uniformly Loaded Connector

Rating factors allow the base current to be adjusted for various connector loadings and wire sizes.

The designer first determines the base current for the ambient conditions of his application. He then multiplies this base current by the rating factors to find the current level for the application's loading factor and wire size.

An Example

To demonstrate the method of specifying current, consider the following application conditions: an ambient temperature of 65 degrees C, a 50% loading of contacts in the housing, and 20 AWG wire.

- From the base rating curve shown in the article, the base current rating is 14 amps with 18 AWG wire
- From the rating factors table, the rating factor for 50% loading and 20 AWG wire is 0.68
- The specific rating for this application is the product of the base rating and the rating factor: $14 \times 0.68 = 9.5$ amps
- Each of the contacts can carry 9.5 amps
- Notice, however, if the ambient temperature is 80 degrees C, the allowable t-rise becomes 25 degrees C. The base current must be lowered to 12.8 amps so that the 105 degrees C maximum operating temperature is not exceeded. The current rating then becomes: $12.8 \times 0.68 = 8.7$ amps

Real-World Values

The new current-rating method gives designers practical values applicable to their applications. While the specified current levels for a contact may be lower for other testing methods, they are more realistic and simplify the system design process. Specmanship is replaced by a realistic assessment of the real-world current-carrying capacity of a contact under varying conditions of temperature, connector loading, and wire size.