DERATING CURVES (Current carrying capacity)
IEC 60512-5-2 Test 5b

2 Test 5b: current carrying capacity (derating curve)

2.1 Purpose

This test is designed to determine the current carrying capacity of an electro-mechanical component.

2.2 Principles
2.2.1 Determination of the current carrying capacity curve

The current carrying capacity is limited both through the thermal properties of the materials used for the contacts and connections and the insulation elements. Thus it is a function of both the self-heating and the ambient temperature at which the component part is operated.
When the test measuring method in accordance with sub clause 2.4 is applied, the temperature *tb* at one measuring point of the component (app. hottest point) and the temperature *tu* in the immediate proximity of the component are measured with varying currents. The difference between the two temperatures is the self-heating or the excess temperature caused by the current load. This may be expressed by means of the following relationship:

$$tb - tu - \Delta t$$

The relationship between current, temperature increase and the ambient temperature of the component is shown by the curve as shown in Figure 1 on page 5. Unless otherwise specified, the mean current load of three test specimens shall serve as the basis for the temperature increase. The mean value derived from the measured values of the three test specimens forms the basis for the current carrying capacity curve. At least three points of the basic curve of the current carrying capacity shall be determined.

In a linear co-ordinate system with current *I* as the ordinate and the temperature as the abscissa axis, as shown in Figures 1 and 2, the upper limit temperature given by the thermal rating of the materials is entered as a straight vertical line. The excess temperature calculated Δt (as the mean value of measurements on three test specimens) with the current *I* is subtracted from this temperature. This yields the highest permissible ambient temperature *tu* for loading with current *In* as the sum of ambient temperature *tu* and excess temperature Δt may not exceed the upper limit given by the thermal rating of the materials.

2.2.2 Corrected current carrying capacity curve (derating curve)

A corrected current carrying capacity curve (derating curve), derived from the basic curve (cf. Figure 2) which is calculated in accordance with sub clause 2.2.1, shall be indicated in the corresponding detail specification. This curve takes manufacturing tolerances into consideration as well as uncertainties in temperature measurement and the measuring set-up.

The correction factor is justified as the current carrying capacity is capable of limitation by additional external factors, e.g. wire cross section and unequal current distribution. If these factors yield a different current carrying capacity other than that which is to be expected in accordance with the thermal limits a corrected value shall be applied.

NOTE: In practice, it is customarily the case that not all connections are simultaneously loaded with the maximum permissible current. In such cases the individual contacts are capable of being pulsed with more current than indicated in the derating curve if less than twenty percent of the entirety is loaded.
No generally valid rules may be established for such cases; the limits have to be determined from one case to the next. It is recommended that the rules be observed which are specified in this standard.

2.2.3 Application of the current carrying capacity curve

The corrected current carrying capacity curve calculated in accordance with sub clause 2.2.2 shows the official current carrying capacity defined in this standard. The hatched area under the corrected current carrying capacity curve in Figure 2 shows the permissible operating range.

NOTE: If data on the current carrying capacity is provided in detail specifications, the corrected current carrying capacity curve shall be indicated in accordance with this standard. If it is more advantageous to provide individual values (in tabular form) instead of the curve, then such values should agree with the corrected current carrying capacity curve.

2.3 Test conditions

2.3.1 Testing facility

The measurement shall be performed in air that is as far as possible at rest. Thus the test specimen shall be mounted in a closed room in order to protect the immediate surroundings from external air movements. The room should consist of a non-reflecting material.

The sides of the test room may be capable of adjustment in order to accommodate the various sizes of test specimens. The sides should be located at least 20 cm (8 inches) away from the corners of the test specimen. A cover is not required.

To the extent that it is possible, the test specimen shall be suspended in a horizontal position at 5 cm (2 inches) above the floor of the test room and at least 15cm (6 inches) below the ceiling and equidistant from the sidewalls. If this is not possible, then the test specimen may be supported by means of a thermally insulating material having a heat conductivity of not less than 2 W/mK. However, the supporting surface may not amount to more than twenty percent of the basic surface of the test specimen.

The test specimen shall be provided with connection wires, the cross section of which is determined by the maximum current or the size of the connections. In order to keep outward heat conductivity to a minimum, at least 25cm (10 inches) of the leads shall be in the test room. For test specimens having multiple poles all of the contacts with leads of equal cross section shall be connected in series like the connection leads. These bridges shall have a length of 25cm (10 inches).

NOTE 1: Care should be taken, in the case of test specimens with moveable contacts, that the function of the contacts is not hampered by the connection wires.

NOTE 2: A pair of connectors shall be regarded as a test specimen.

NOTE 3: In the case of a cable connector at least 25cm (10 inches) of the cable shall be in the test room. Series connection of the contacts shall be performed by means of bridges which are 25cm (10 inches) from the test specimen.

2.3.2 Details of temperature measurement

The temperature is measured by means of two temperature sensors. The leads are insulated through a sidewall of the test room.
The measuring point for measurement of the ambient temperature shall be in a horizontal plane, which traverses the axis of the test specimen. It should be 5cm (2 inches) away from the test specimen at he centre of the longer side of the test specimen.

The point of measurement for the test specimen temperature shall correspond to the data provided in the detail specification.

NOTE: Thin thermal elements, e,g, NICr/Ni with a diameter of ≤ 0,3mm (0,012 inches) may be used as temperature sensors. If thermal elements with the same calibration curves are used for both temperature probes, then they may be connected opposite to each other in the measuring circuit; in this case the temperature increase Δt is directly measured (cf. Figure 3). However, the temperature *tb* shall be observed in order to make certain that the upper limit temperature of the materials is not exceeded.

2.4 Method of measurement

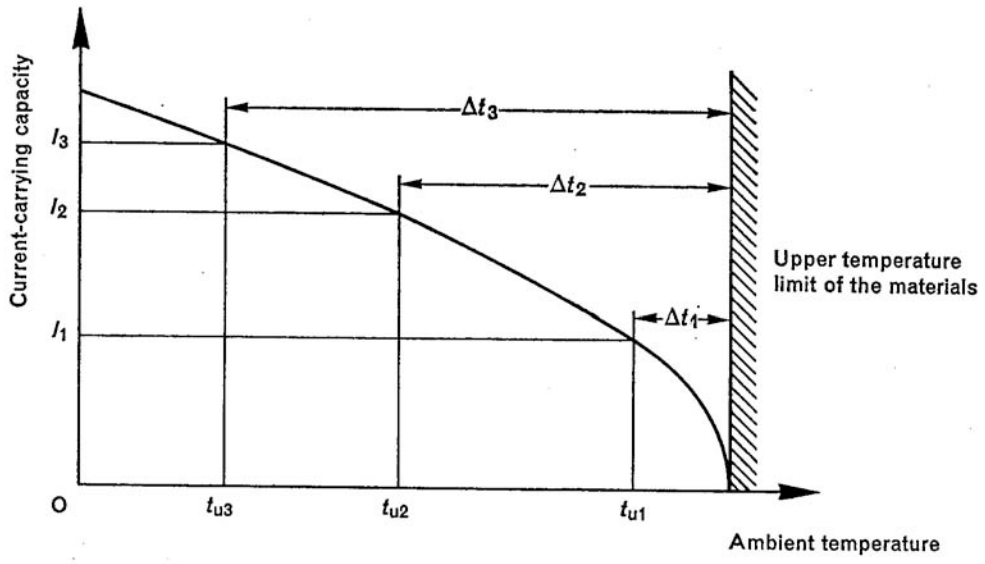
The test specimen shall be arranged in the test room in accordance with sub clause 2.3.1. and its connections shall be connected to a controlled main unit via a current measuring device.
The load current may be either direct or alternating current. If alternating current is used, then the mean effective value shall apply.

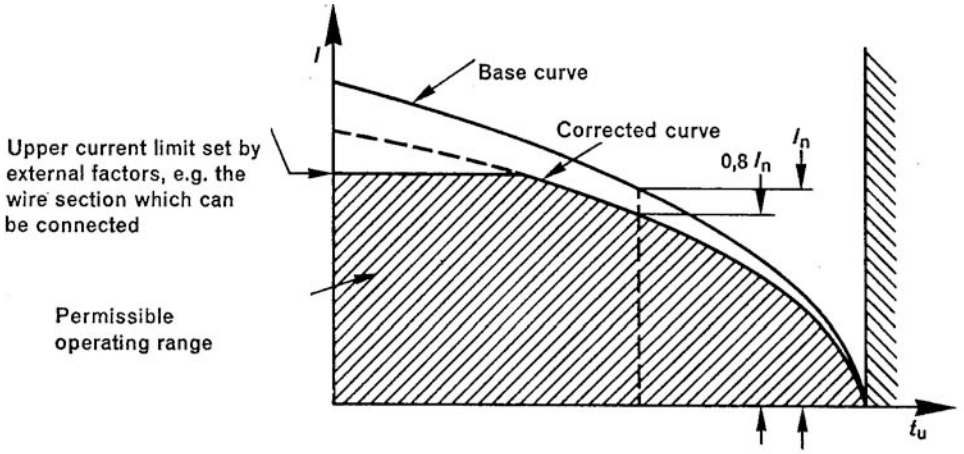
Any current selected shall be applied for one hour at most or until thermal equilibrium has been reached.

2.5 Data specified by the detail specification

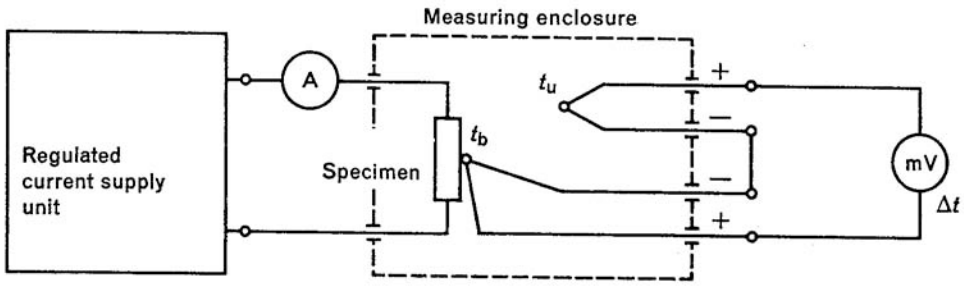
The following information shall be provided if this test specimen is required in the detail specification:

a) Preparation of the test specimen
b) Type and dimensions of leads used
c) Measuring point for the test specimen temperature
d) Upper temperature limit
e) Number of test specimens if other than three
f) Each departure from the specifications of this standard





Example of a derating curve.



Measuring apparatus arrangement.