PROFESSIONAL ELECTRICIAN & INSTALLER

NAPIT's Advice on Thermal Magnetic MCCB Data Sheets

NAPIT's Bill Allan with advice on thermal magnetic MCCB data sheets and how to ensure that your calculations are correct.

Moulded-case circuit-breakers or MCCBs – manufactured to the standard of BS EN 60947-2 – are referred to in the Wiring Regulations but unfortunately there is little published information on them to help the electrician.

Installers are commonly advised to refer to the manufacturers' data for values such as the maximum earth fault loop impedance (Z_S). But these data sheets on MCCBs can be daunting for the uninitiated and, understandably, questions concerning maximum Z_s values are common.

The topic of MCCBs is a large and complex one, not least because of the variety of types available. As with other circuit-breakers, specification items such as rated current (In), ultimate breaking capacity (Icu) and rated making capacity (Icm) are all important but space dictates that they are beyond the scope of this article.

In this instance I will also ignore electronic and microprocessor-based MCCBs but I will give you a general introduction on how thermal magnetic MCCBs operate and explain how maximum Z_s values can be determined.

Moulded case circuit-breakers to BS EN 60947-2

BS EN 60947-2 is part of a series of standards for low voltage electrical switchgear which applies to circuit-breakers and their associated units.

This contains annexes on specific circuit-breaker functions. For example, Annex L concerns circuit-breakers without overcurrent protection which are used for isolation and switching.

MCCBs are electro-mechanical devices which protect circuits from overload and fault (short-circuit) currents. They are often preferred to HBC fuses as they do not require replacement when an overcurrent is detected and they can be easily reset.

Some types of thermal magnetic MCCBs have adjustable thermal or magnetic trip mechanisms – or both – which ensure optimum protection and co-ordination of devices.

Operation of MCCBs

Like circuit-breakers to BS EN 60898, and RCBOs to BS EN 61009-1, thermal magnetic MCCBs are automatic switching devices with two modes of operation – thermal and magnetic. The thermal operation has an inverse characteristic and provides overload protection. At high levels of overcurrent – such as short-circuit current – a magnetic trip coil energises and disconnects the circuit instantaneously with no intentional delay.

Adjustable thermal operation

Some MCCBs have an adjustable thermal operation within a fixed band stated by the manufacturer. Typically, the thermal adjustment is 63% to 100% of the nominal current rating (I_n) and is known as the rated current (I_r).

Adjustable magnetic operation

Some MCCBs permit the instantaneous disconnection time to be varied. Commonly, this magnetic setting, known as I_m, can be varied from five to 20 times the nominal current, I_n. There is some variation between manufacturers on both settings.

Smaller MCCBs – those up to around 160A – may have thermal adjustment only, with the magnetic operation fixed. Larger types would normally have adjustment on both.

Magnetic tolerance

A tolerance is included with the magnetic current value and the standard tolerance is +/- 20%.

Category A and Category B

BS EN 60947-2 recognises Category A, for which no intentional time delay is provided, and Category B circuit-breakers, for which a time delay facility is provided.

Calculating the maximum Z_s value

To help you calculate maximum Z_s value I have included two worked examples, one showing disconnection on the magnetic line and the other on the thermal curve.

Worked example 1

An MCCB with an I_n value of 32A has a characteristic as shown in Fig. 1. It is connected to a circuit forming part of a TN system and has a U_o value of 230V. The magnetic adjustment is set on I_n x 20 and the magnetic tolerance is +/- 20%. It is required to disconnect within 0.4 seconds. Calculate the maximum earth fault loop impedance value (Z_s)?

Notes

1. The horizontal current axis is in multiples of the rated current I_n, enabling the same characteristic to be used for different values of I_n.
2. The 0.4S disconnection is shown, although the device actually disconnects instantaneously (i.e. around 0.01s).

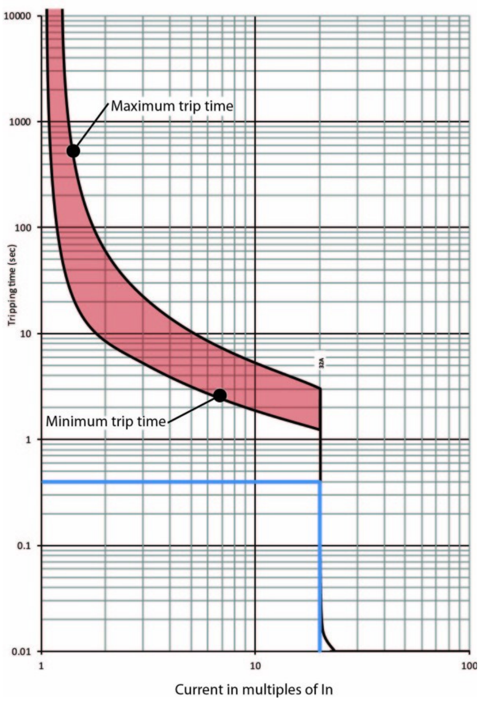

Fig 1- Time/current characteristics for the 32A MCCB in Worked example 1

Solution

Regulation 411.4.5 gives the formula:

$Z_s \times I_a \leq U_0 \times C_{min}$

Where:

Z_s = the impedance in ohms of the earth fault loop.

I_a = the current in amps causing operation of the protective device (MCCB) within the time specified in Regulation 411.3.2.2 (in this case, 0.4s).

U_0 = the nominal a.c. voltage to Earth.

C_{min} = the minimum voltage factor which is given the value 0.95.

From Fig. 1, the 32A device trips instantaneously at 20 times I_n (32A) which equals 640A. When calculating the maximum Z_s on the instantaneous line, the setting of the magnetic adjustment, i.e. 20%, must be added.

Therefore I_a = 640A + 128 (20% of 640) which equals 768A.

Transposing the formula gives:

$$Z_s \leq \frac{U_0 \times C_{min}}{I_a}$$

$$Z_s \leq \frac{230 \times 0.95}{768}$$

$$\leq 0.28 \text{ ohms.}$$

Worked example 2

An MCCB with an I_n value of 100A has a characteristic as shown in Fig. 2. It is connected to a circuit which forms part of a TN system and has a U_o value of 230V. The MCCB is required to disconnect within five seconds (Regulation 411.3.2.3). Calculate the maximum earth fault loop impedance value (Z_s)?

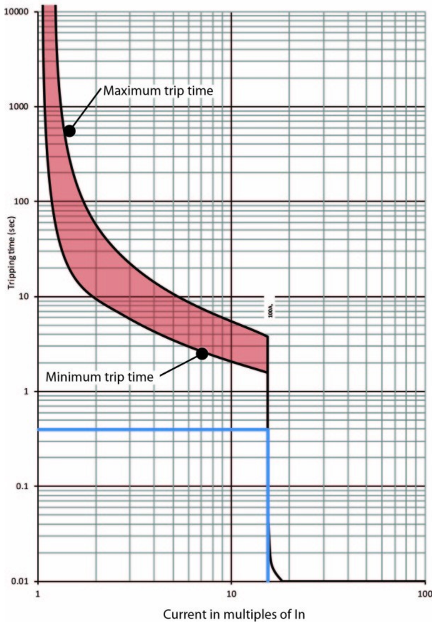

Fig 2- Time/current characteristics for the 100A MCCB in Worked example 2

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