

SHORT-CIRCUIT BACK-UP AND CABLE PROTECTION

May 11

Back-up protection

BS 7671 permits the breaking capacity of a circuit-breaker to be less than its associated prospective fault current when back-up protection is employed. Back-up, is also referred to as cascading. Back-up protection consists of an upstream short-circuit protective device (^aSCPD) that helps a downstream circuit-breaker to break fault currents greater than its maximum breaking capacity (I_{cu} for an ^bMCCB and I_{cn} for an ^cMCB), which in effect is a conditional rating, see figure 1.

Circuit-breaker product standards prescribe back-up protection requirements, which can only accurately be verified by test. The energy let-through (proportional to I^2t) of the back-up combination, when required, must be derived from testing and obtained from the manufacturer.

Back-up protection methodology

Desk top studies frequently indicate that back-up coordination requires the upstream SCPD to independently limit the energy let-through and peak current, to values that can be withstood by the downstream SCPD, assuming that the downstream SCPD makes no contribution to the fault interruption process. This approach errs on the side of caution in relation to device coordination and cable protection studies.

However, where an MCCB, MCB or fuse is the upstream SCPD, and the downstream SCPD is an MCB, coordination tests can be used to validate that the I^2t of the specific combination, will not exceed the I^2t value of the downstream MCB at its maximum breaking capacity. This reduction in the energy let-through is a result of having two protective devices interrupting the fault current and thus creating superior current limitation and arc extinction than the individual upstream SCPD "A" alone, this is illustrated in figure 2.

Back-up protection can also be achieved by coordinating the upstream circuit-breaker to open momentarily with the downstream circuit-breaker. This arrangement allows the upstream device to return to the closed position, having assisted the downstream circuit-breaker to interrupt the fault current.

Cable protection

The application of fault current protective devices to cable protection is detailed in BS 7671 and is given by:

$$I^2t \leq k^2S^2$$

Where:

I^2t is proportional to the energy let-through of the protective device

k^2S^2 is proportional to the energy withstand of the cable

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In figure 1 the I^2t of the upstream SCPD “A” and downstream MCB “B” operating together at 20 kA, will be equal to or less than the I^2t of MCB “B” at 10 kA. The I^2t to be used in the conductor fault current assessment would be that of MCB “B” at 10 kA. This combination has to be confirmed by the manufacturer, together with the maximum prospective fault current applicable.

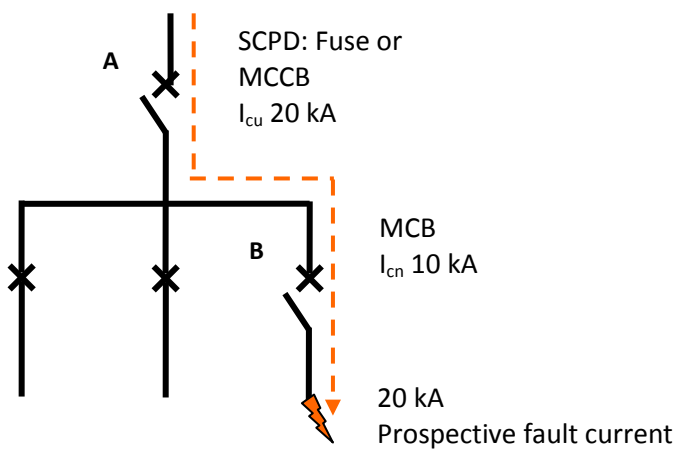


Figure 1. Example of back-up protection

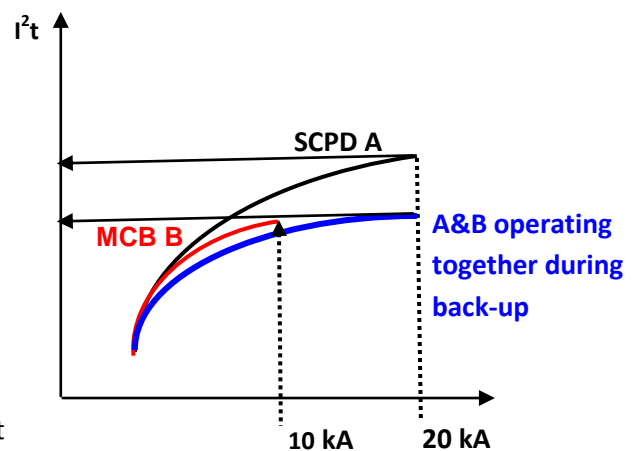


Figure 2. Example of I^2t

Cable protection and MCCBs

Back-up protection for MCCBs is proven by testing in accordance with British Standards. The test circuit used includes a conductor, sized according to the downstream circuit-breaker rating. Thus the manufacturer’s published rating for the combination of upstream (back-up) and downstream devices, includes protection of the cable of the specified size. The cable sizes used for testing are shown in the table 1 below. When it is necessary to use a smaller conductor than shown in the table, the manufacturer’s energy let-through data is needed to verify the requirement $I^2t \leq K^2S^2$.

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Downstream MCCB circuit-breaker rating [A]	Test conductor size BSEN 60947-2 * Annex A
1	1
2	1
4	1
6	1
8	1
10	1.5
13	2.5
16	2.5
20	2.5
25	4
32	6
40	10
50	10
63	16
80	25
100	35
125	50

Table 1

* In the case of breakers rated $\leq 20A$ the BS allows the tests to be made with larger cables. In this case the size will be marked on the breaker or given in the manufacturer's instructions.

Low-voltage switchgear and controlgear and assemblies.

The assembly manufacturer is responsible for ensuring the short-circuit capability of the equipment between the incoming and outgoing terminals of the assembly (incoming and outgoing devices, busbars, connections, etc.). The short-circuit rating is determined in accordance with the applicable product standard and stated by the manufacturer.

LV assemblies are known as: Consumer Units, Distribution Boards, Panelboards and Switchboards.

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Consumer Unit fuse conditional rating

Fuse back-up protection to 16 kA is a mandatory test for protective devices in Consumer Units complying with BS EN 60439-3 Annex ZA. This is a conditional rating, as the conditions specifically relate to the use of an upstream BS 88-3 (formerly BS 1361) 100 A fuse.

Notes

^aShort-circuit protective device (SCPD) is the terminology used in circuit-breaker standards. In the context of this guidance, it is taken to mean a device providing fault current protection between live conductors and / or between a live conductor and an exposed-conductive-part.

^bSome circuit-breakers complying with BS EN 60947-2 are known as moulded case circuit-breakers (MCCBs).

^cCircuit-breakers complying with BS EN 60898 are known as miniature circuit-breakers (MCBs).