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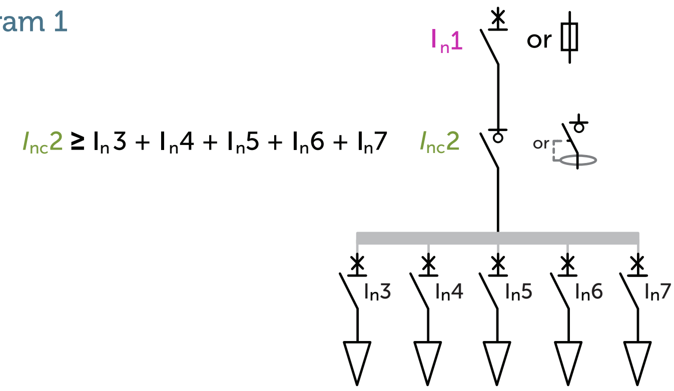
# Overload protection of an RCCB or switch in an LV assembly to BS EN 61439-3

BS 7671: 2018 IET Wiring Regulations 18th Edition specifies requirements for overload protection of an RCCB or switch in an LV assembly, Regulations 536.4.3.2, 536.4.5 and 536.4.202 refer. This bulletin provides BEAMA member's guidance for RCCB and switch overload protection however; individual manufacturer's instructions must be followed, particularly the rated current of the related assembly circuit $I_{nc}$ (A) which must be stated in the documentation supplied with the LV assembly e.g. distribution board or consumer unit.

The rated current in the assembly circuit $I_{nc}$ (A) of the switch or RCCB shall be derived from one of the following two methods in diagrams 1 and 2. In both methods, circuits shall be designed so that a small overload of long duration is unlikely to occur.

1. Be greater than or equal to the sum of the rated current of all outgoing circuit OCPDs[1] e.g. MCBs, fuses; see diagram 1.

Diagram 1




| | |
|---|---|
| $I_{nc}2$ = | Rated current of a circuit (A) stated by the assembly manufacturer which may be lower than the unenclosed rated current marked on the device (switch disconnector or RCCB) due to grouping & internal enclosure temperature etc. |
| $I_n3$ to $I_n7$ = | Rated current of outgoing protective device (A) |
| $I_n1$ = | The rated current of the overload protective device conforming to one of the following: a general-purpose type (gG) fuse to BS 88-2, a fuse to BS 88-3, a circuit-breaker to BS EN 60898, a circuit-breaker to BS EN 60947-2 or a residual current circuit-breaker with integral overcurrent protection (RCBO) to BS EN 61009-1 |

= Circuit-breaker

= Fuse

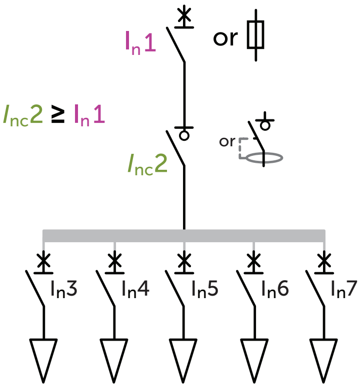
= Isolating switch / disconnector (without integral overload protection)

= RCCB (without integral overload protection)

Note[1]. For individual circuits with load currents that are unlikely to be increased, cannot be overloaded and where spare way(s) cannot introduce a total sum exceeding the original calculated value, the installation designer may decide to use the design current of the circuit instead of the rated current of the OCPD. For a group of circuits likely to be on simultaneously e.g. electric heating, no diversity between circuits is permitted.

2. Have a rated current based upon diversity[1] and a suitably rated overload protective device conforming to one of the following: a general-purpose type (gG) fuse to BS 88-2, a fuse to BS 88-3, a circuit-breaker to BS EN 60898, a circuit-breaker to BS EN 60947-2 or a residual current circuit-breaker with integral overcurrent protection (RCBO) to BS EN 61009-1; see diagram 2.

Diagram 2




$I_{nc}2 \geq$ **$I_n3 + I_n4 + I_n5 + I_n6 + I_n7$ x % diversity**

**OR**

$I_{nc}2 \geq$ **$I_b3 + I_b4 + I_b5 + I_b6 + I_b7$ x % diversity**

$I_{nc}2$ = Rated current of a circuit (A) stated by the assembly manufacturer which may be lower than the unenclosed rated current marked on the device (switch disconnector or RCCB) due to grouping & internal enclosure temperature etc.

 = Circuit-breaker

 = Fuse

 = Isolating switch / disconnector (without integral overload protection)

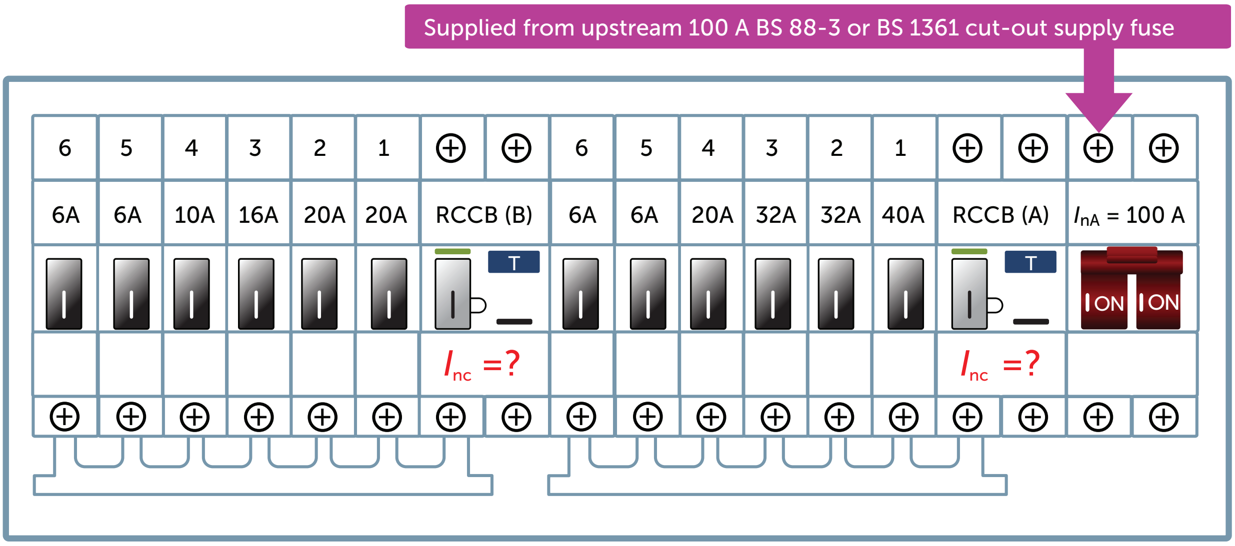
 = RCCB (without integral overload protection)

**$I_n3$ to $I_n7$** = Rated current of outgoing protective device (A)

**$I_n1$** = The rated current of the overload protective device conforming to one of the following: a general-purpose type (gG) fuse to BS 88-2, a fuse to BS 88-3, a circuit-breaker to BS EN 60898, a circuit-breaker to BS EN 60947-2 or a residual current circuit-breaker with integral overcurrent protection (RCBO) to BS EN 61009-1

The following are Indicative examples of methods in diagrams 1 & 2 applied to a split-load consumer unit arrangement as illustrated in diagram 3 below.

### Diagram 3 – Split-load / dual RCCB consumer unit supplying mixed standard circuits / loads




### $I_{nA}$ is the rated current of the assembly i.e. the maximum load current that it is designed to distribute.

### RCCB (A) required minimum $I_{nc}$ in the circuit of the consumer unit assembly

**Step 1.** Using diagram / method 1, calculate the sum of the MCBs[2] rated current ($I_n$) i.e.

- 40 + 32 + 32 + 20 + 6 + 6 = 136 A.

*(See note 1 on page 1 in relation to using $I_b$ instead of $I_n$)*

**Step 2.** 136 A exceeds the 100 A supply fuse therefore, use diagram / method 2 applying diversity.

**Step 3.** Apply diagram / method 2 in two stages:

- Stage 1. Apply diversity to the group of circuits to determine a minimum rated $I_{nc}$, Regulation 536.4.202 refers. One method for a domestic installation could be 100% of the highest $I_n$ plus 40% of all other i.e. 40 + (0.4 x (32 + 32 + 20 + 6 + 6)) = 78.4 A. *(See note 1 on page 1 in relation to using $I_b$ instead of $I_n$)*
- Stage 2. Apply the overload coordination principle $I_{nc} \geq I_n$. The supply fuse affording overload protection is a 100 A BS 88 or BS 1361 therefore, the minimum RCCB (A) circuit $I_{nc}$ is 100 A for overload coordination.

### Conclusion

The minimum rated current $I_{nc}$ of the circuit in the consumer unit for the RCCB (A) based upon diversity is 78.4 A. However, overload protection shall not solely be based on the use of diversity factors of the downstream circuits, see Regulation 536.4.202. **To achieve overload protection** of the RCCB circuit, the rated current of the OCPD shall be selected according to the manufacturer's instructions, which for BEAMA members, is coordinating with the upstream OCPD, in this case a 100 A fuse.

Therefore, the required minimum rated current $I_{nc}$ in the circuit of the consumer unit for the RCCB (A) is **100 A.**

**Note**[2]. MCB is used as a generic term for a circuit-breaker to BS EN 60898.

### RCCB (B) required minimum $I_{nc}$ in the circuit of the consumer unit assembly

Step 1. Using diagram / method 1, calculate the sum of the MCBs[2] rated current ($I_n$) i.e.

- 20 + 20 + 16 + 10 + 6 + 6 = 78 A which does not exceed the 100 A supply fuse.

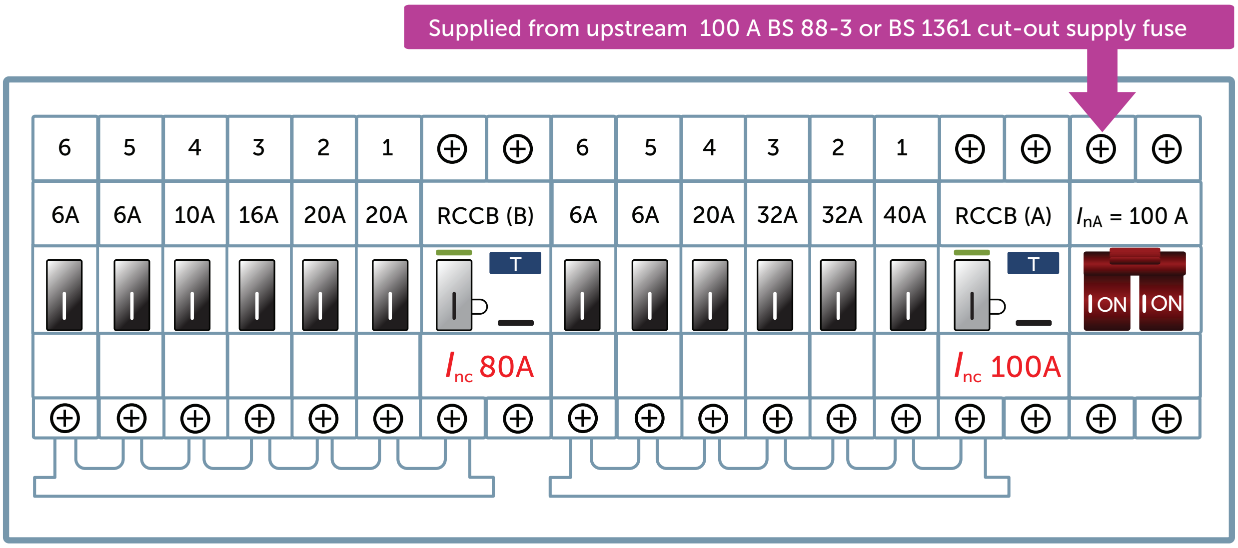
### Conclusion

The required minimum rated current $I_{nc}$ of the circuit in the consumer unit for the RCCB (B) is **78 A.** It is likely, that the rated current $I_{nc}$ would be a standardised value of **80 A.**

Method 2 using diversity could be applied and a lower RCCB rating selected however, this would require a supplementary OCPD lower than 100 A for overload coordination with the RCCB.

### Diagram 4 – Conclusion to minimum $I_{nc}$ of the RCCB circuits in the consumer unit assembly

The methods above conclude that, for the split-load / dual RCCB consumer unit, the $I_{nc}$ ratings of the RCCB circuits would be 80 A and 100 A as illustrated below for the mixed standard circuit configuration shown in Diagram 3.




The methods illustrated are not intended for calculating the maximum demand of the complete installation, they relate to the demand of the specific group of circuits supplied through each RCCB. One method for calculating the maximum demand of the complete domestic installation where there are mixed standard circuits, is by taking 100% of the highest $I_n$ plus 40% of all other e.g. applying to our example above: 40 + (0.4 x (32 + 32 + 20 + 6 + 6 + 20 + 20 + 16 + 10 + 6 + 6)) = 109.6 A. The allowances for the conventional circuits are applied to $I_n$ and engineering judgement could conclude, that given this cautious approach, a maximum demand of 100 A would be appropriate. The designer could, from knowledge and experience, reduce the 0.4 factor, the use of lower factors or other methods of determining maximum demand is not precluded where specified by a competent electrical design engineer.

# FAQs for the RCCB in split-load / dual RCCB consumer units

## **Q1.** Were the new requirements for overload protection of an RCCB introduced into the 18th Edition for improved safety?

**A1. Yes**.

The need for change was originally highlighted from within the electrical installation industry where it was agreed, that diversity cannot be used for overload protection and that some RCCBs in consumer units were not afforded appropriate overload protection. Also, a lack of overload coordination could result in overheating and adverse effects upon the operating characteristics of RCCBs. These concerns were highlighted to the UK committee responsible for BS 7671.

The wiring regulations take account of the technical substance of agreements reached at CENELEC level in harmonised documents (HD). The technical intent of HD 60364-5-53 November 2015 was implemented into the 18th Edition which included Regulation 536.4.3.2 covering overload protection of an RCCB.

## **Q2.** The consumer unit has a 16 kA conditional short-circuit rating when used with an upstream 100 A BS 88-3 fuse-link. Does this mean a 100 A fuse-link also affords overload protection to say a 63 A or 80 A RCCB?

**A2. No.**

This is a short-circuit test and does not relate to overload protection of the RCCB.

## **Q3.** Can diversity be used as the means of overload protection of the RCCB?

**A3. No.**

Overload protection cannot solely be based on the use of diversity factors of the downstream circuits. The **rated current** of the RCCB can be established using diversity however, **overload protection** of the RCCB can require the rated current of the RCCB to be coordinated with the upstream service fuse-link rated current; please see step 3 stage 2 in diagram 3 above.

Sometimes, designers are misreading Regulation 536.4.202, which allows the **rated current** of the RCCB to be derived from the application of diversity factors however; it states that **overload protection shall not solely be based on the use of diversity factors,** *it is important to note that the method to determine the RCCB minimum rated current is not the same as for RCCB overload protection.* Regulations 536.4.3.2 and 536.4.202 refer.

**Note** *The RCCB enclosed rated current of the circuit inside the consumer unit is denoted by the symbol $I_{nc}$ and should be stated in the documentation supplied with the consumer unit.

## **Q4.** Can a RCCBs ability to withstand a short-time peak load current, achieve the overload protection required by Regulation 536.4.3.2, without coordination with a suitable overcurrent protective device?

**A4. No.**

Regulation 536.4.3.2 relates to overload protection not peaks in maximum demand. A short-time peak capability is not overload protection as required by 536.4.3.2. as the overload current magnitude and duration cannot be predicted. Therefore, for safety, Regulation 536.4.3.2 prescribes that the RCCB shall be protected by an overcurrent protective device (OCPD) which in general, is installed upstream of the RCCB e.g. service cut-out fuse-link unless overload protection is omitted under the specific conditions in BS 7671; please see Q.8.

## **Q5.** Is RCCB overload protection the same fundamental principles as conductor overload protection?

**A5. Yes.**

Basically, if the service cut-out fuse-link is 100 A, a minimum 100 A conductor would be selected for **overload protection coordination.** Therefore, if the upstream fuse-link is 100 A, for overload protection, the RCCB would be a minimum 100 A* and for an upstream 80 A fuse-link the RCCB would be minimum 80 A* etc. Regulation 536.4.3.2 refers to overload protection and an upstream overcurrent protective device (OCPD).

## **Q6.** Does the product standard BS EN 61439-3 limit the RCCB in a split-load consumer unit to 80 A?

**A6. No.**

The test shown in Fig 101 BS EN 61439-3 shows an **example** of the temperature rise verification by test of a complete DBO as described in 10.10.2.3.6. The 80 A devices shown are an **example** of $I_{nc}$ only as a means of verification of temperature rise under normal operation of the outgoing unit at the rated current.

## **Q7.** Will any consumer unit conforming to BS EN 61439-3, automatically meet the requirements of BS 7671 in relation to **rated currents** and **overload protection?**

**A7. No.**

As with any item of equipment / cable etc. the electrical installation designer must select the correct ratings and overload protection for the electrical installation arrangements. For a consumer unit, the correct interface characteristics and overload protection arrangements must be specified. The designer of the installation whose name will go on the Electrical Installation certificate needs to make these decisions. Regulations 536.4.5 and 536.4.202 refer.

**Note** *The RCCB enclosed rated current of the circuit inside the consumer unit is denoted by the symbol $I_{nc}$ and should be stated in the documentation supplied with the consumer unit.

## Q8. Are there two methods for overload protection of the RCCB detailed in this guide?

**A8. Yes.**

**Method 1 –** Omission of overload protection because of the characteristics of the load. The rated current ($I_n$) of the sum of the downstream MCBs does not exceed the rated current of the RCCB when installed within the consumer unit ($I_{nc}$).

$I_n$ of the downstream MCBs is taken to be $I_b$ for this specific calculation as it errs on the safe side. For individual circuits with load currents that are unlikely to be increased, cannot be overloaded and where spare way(s) cannot introduce a total sum exceeding the original calculated value, the installation designer may decide to use the design current of the circuit instead of the rated current of the OCPD.

It must be noted, that omission of overload protection is on the basis that the RCCB is not likely to carry overload current and therefore its rated current can be lower than the upstream overload protective device rated current e.g. the house service fuse-link. The electrical installation designer should be confident, that the characteristics of the load **without diversity** i.e. the total connected load, is unlikely to cause an overload. Consideration should always be given to variables such as spare ways, increased future loads and upgrading the service fuse-link Regulations 433.3.1, 536.4.3.2 and 536.4.202 refer.

**Method 2 –** The rated current of the RCCB in the related assembly circuit in the consumer unit ($I_{nc}$) stated by the assembly manufacturer, must not be less than the rated current of the upstream overcurrent protective device (OCPD). For a domestic installation this is likely to be the service cut-out fuse-link rated at 63 A, 80 A or 100 A.

## Q9. What is the simplest, most flexible method for RCCB overload protection in split-load / dual RCCB consumer units, to cover all the variables for domestic installations, such as different circuit load arrangements and varying service fuse-link current ratings?

**A9. A split-load / dual RCCB consumer unit with 100 A* RCCBs.**

This does not preclude the use of 63 A* or 80 A* rated RCCBs where the electrical installation designer has determined their conformity by using method 1 or 2.

**Note** *The RCCB enclosed rated current of the circuit inside the consumer unit is denoted by the symbol $I_{nc}$ and should be stated in the documentation supplied with the consumer unit.

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