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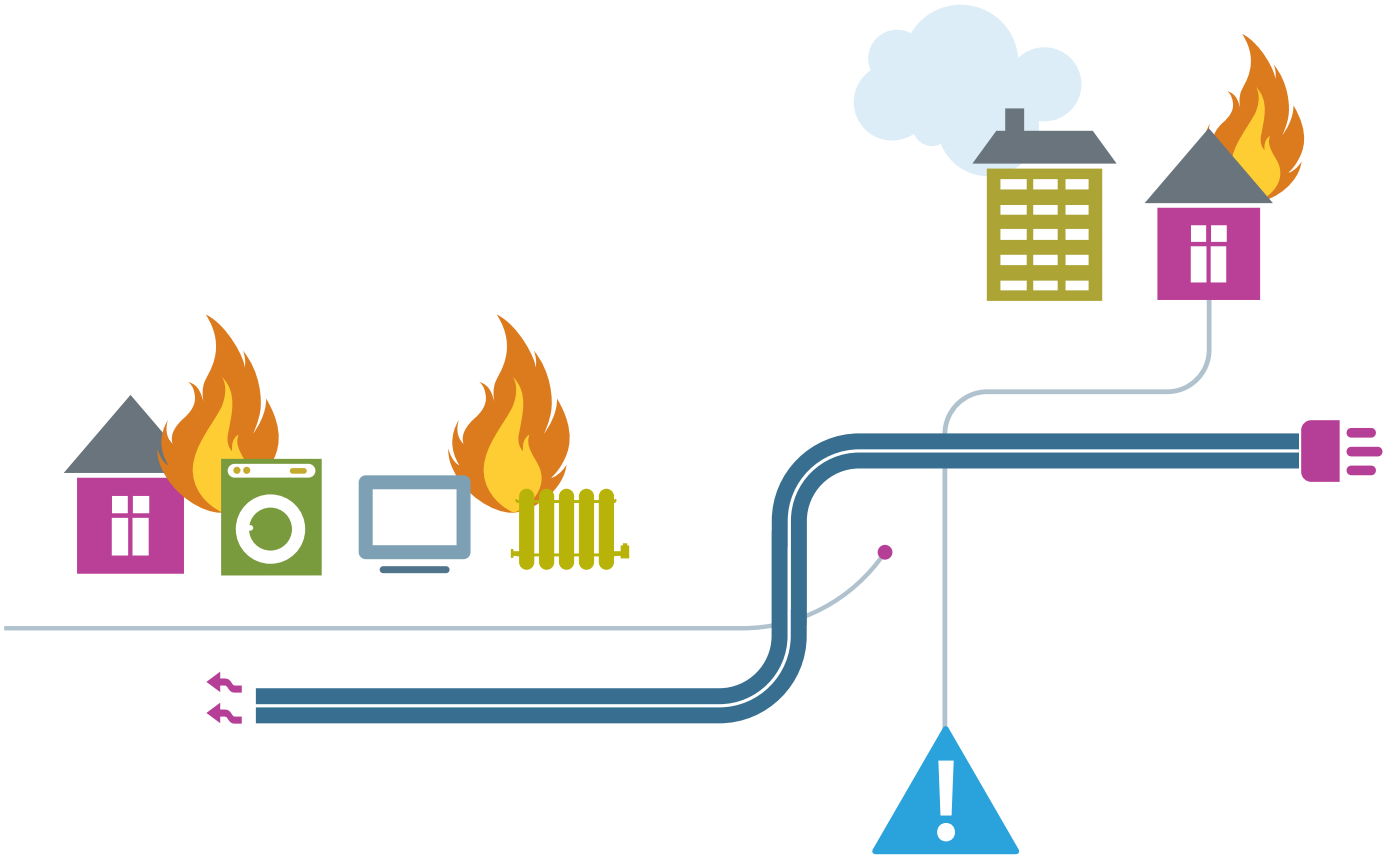
TECHNICAL BULLETIN

RESIDUAL CURRENT DEVICE (RCD) SELECTION



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ABOUT BEAMA

BEAMA is the long established and respected trade association for the electrotechnical sector. The association has a strong track record in the development and implementation of standards to promote safety and product performance for the benefit of manufacturers and their customers.

This Technical Bulletin is designed to help the specifier, installer and end user to decide on the appropriate residual current protection to be selected for specific applications.

This Technical Bulletin has been produced by BEAMA's Building Electrical Systems Portfolio which comprises of major UK manufacturing companies operating under the guidance and authority of BEAMA, supported by specialist central services for guidance on European Single Market, Quality Assurance, Legal and Health & Safety matters.

Details of other BEAMA Technical Bulletins and Guides can be found on the BEAMA website www.beama.org.uk

Acknowledgements
BEAMA would like to thank IEC and BSI for allowing references to their standards; Health and Safety Executive (HSE) for reference to their documents.

RCD SELECTION

This Technical Bulletin is designed to help the specifier, installer and end user to decide on the appropriate residual current protection.

Where it is intended to protect the whole or part of the fixed electrical installation by an RCD, the layman is strongly advised to seek expert advice.

Portable residual current devices (PRCDs) are available for use by the non specialist where normal socket-outlets are not protected by RCDs. They may be high sensitivity RCD adaptors, which plug into the socket-outlet, or extension units which include a plug, a high sensitivity RCD and one or more socket-outlets.

Although an essential part of any tradesman's toolkit, the PRCD is not part of the fixed electrical installation and only protects the equipment that is supplied through it.

It should be noted that BS 7671 Regulation 411.3.3 requires additional protection by means of an RCD.

In practice there may be specific protection issues which are not covered in this handbook. For additional guidance regarding the suitability of a particular RCD for specific applications it is recommended that readers consult any of the BEAMA RCD manufacturers listed at the beginning of this publication.

1.1 RCD SELECTION CRITERIA

1.1.1 Sensitivity

For every RCD there is normally a choice of residual current sensitivity (tripping current). This defines the level of protection afforded. Protection is divided into two broad categories:

Personal protection (additional protection of persons or livestock against direct contact) This is ensured when the minimum operating current of the RCD is no greater than 30 mA and the RCD operates to disconnect the circuit, within the specified time, in the event of an earth leakage.

Installation protection This is associated with devices that are used to protect against the risk of fire caused by an electrical fault. RCDs which operate at residual current levels up to and including 300 mA provide this type of protection.

1.1.2 Residual Current Devices (RCDs

The term RCDs covers a range of products some of which are listed below:,

- RCCB (Residual Current Operated Circuit-Breaker without Integral Overcurrent Protection)
- RCBO (Residual Current Operated Circuit-Breaker with Integral Overcurrent Protection)
- SRCD (Socket-Outlet incorporating a Residual Current Device)
- FCURCD (Fused Connection Unit incorporating a Residual Current Device) PRCD (Portable Residual Current Device)
- CBR (Circuit-Breaker incorporating Residual Current Protection) IC-CPD (In-Cable Control and Protective Device for mode 2 charging of electric road vehicles)
- MRCD (Modular Residual Current Device)

Table 1 aims to identify RCD use together with the benefits provided. However, before looking at Table 1 there are two other classifications of RCD that need to be considered – general and time-delayed operation each having Type AC, A, F or B characteristics.

1.1.3 General and Time-Delayed RCDs

RCCBs to BS EN 61008: Specification for residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) and RCBOs to *BS EN 61009: Specification for residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)* may be defined by the time they take to operate as follows.

WHERE IT IS INTENDED TO PROTECT THE WHOLE OR PART OF THE FIXED ELECTRICAL INSTALLATION BY AN RCD, THE LAYMAN IS STRONGLY ADVISED TO SEEK EXPERT ADVICE.

General RCDs operate 'instantaneously', i.e. they do not have an intentional delay in operation and thus cannot be guaranteed to 'discriminate'. This means that where there are two or more general RCDs installed in series in an installation; more than one device may trip in the event of an earth leakage current. This would result in healthy circuits being disconnected even though the initial fault occurred in a different part of the installation. Discrimination is essential in installations where it is important to ensure that a complete system is not 'shut down', for example in domestic installations to ensure that lighting and other circuits are not disconnected if an earth leakage occurs in a power circuit.

Time Delayed RCDs provide discrimination in circuits where RCDs are connected in series. It is essential to install devices which incorporate a time delay upstream of the general device, so that the device nearest a fault will trip. RCDs with built in time delays should not be used to provide personal protection.

For RCCBs complying with BS EN 61008 and RCBOs complying with BS EN 61009 the time delay feature is indicated by the letter 'S'.

1.1.4 Types AC, A, F and B RCDs.

Residual current devices may also be classified as Type AC., Type A, Type F and Type B as follows:

RCD Type AC: RCD tripping on alternating sinusoidal residual current, suddenly applied or smoothly increasing.

RCD Type A: RCD tripping on alternating sinusoidal residual current and on residual pulsating direct current, suddenly applied or smoothly increasing.

NOTE 1: For RCD Type A tripping is achieved for residual pulsating direct currents superimposed on a smooth direct current up to 6 mA.

RCD Type F: RCD for which tripping is achieved as for Type A and in addition: for composite residual currents, whether suddenly applied or slowly rising intended for circuit supplied between phase and neutral or phase and earthed middle conductor; for residual pulsating direct currents superimposed on smooth direct current.

NOTE 2: For RCD Type F tripping is achieved for residual pulsating direct currents superimposed on a smooth direct current up to 10 mA.

RCD Type B: RCD for which tripping is achieved as for Type F and in addition:

- for residual sinusoidal alternating currents up to 1 kHz;
- for residual alternating currents superimposed on a smooth direct current;
- for residual pulsating direct currents superimposed on a smooth direct current;
- for residual pulsating rectified direct current which results from two or more phases;
- for residual smooth direct currents whether suddenly applied or slowly increased independent of polarity.

NOTE 3: For RCD Type B, tripping is achieved for residual pulsating direct currents superimposed on a smooth direct current up to 6 mA.

Note: Product standards for RCDs for use in DC supply sytems are currently under development.

TYPE AC, TYPE A, TYPE F AND TYPE B RCDS ARE NOT SUITABLE FOR USE IN DC SUPPLY SYSTEMS.

In all cases equipment / appliance manufacturers instructions must be considered when selecting the Type of RCD.

RCD	Examples of type of equipment / load
Type AC	Resistive, Capacitive, Inductive loads generally without any electronic components, typically: • Immersion heater • Oven/Hob with resistive heating elements • Electric shower • Tungsten & halogen lighting
Type A	Single phase with electronic components, typically: • Single phase invertors • Class 1 IT and Multimedia equipment • Power supplies for Class 2 equipment • Appliances such as a washing machine that is not frequency controlled e.g. d.c. or universal motor • Lighting controls such as a dimmer switch and home and building electronic systems LED drivers • Induction hobs • Electric Vehicle charging where any smooth DC fault current is less than 6 mA **Type A is also suitable for Type AC applications.**
Type F	Frequency controlled equipment / appliances, typically: • Some washing machines, dishwashers and driers e.g. containing synchronous motors* • Some class 1 power tools • Some air conditioning controllers using variable frequency speed drives **Type F is also suitable for Type AC and Type A applications.**
Type B	Three phase electronic equipment typically: • Inverters for speed control • UPS • Electric Vehicle charging where any smooth DC fault current is greater than 6mA • Photo voltaic Power Electronic Converter Systems (PECS) typically: • industrial machines • cranes **Type B is also suitable for Type AC, Type A and Type F applications.**
Type B+	Type B+ RCDs are not recognised in BS 7671 and do not have an international or harmonised (BS EN) standard.

* Manufacturer's instructions should be taken into account.

Power electronic converter PEC

device or part thereof for the purpose of electronic power conversion, including signalling, measurement, control circuitries and other parts, if essential for the power conversion function

Power electronic converter system PECS

one or more power electronic converters intended to work together with other equipment
For PECS, if a Type B RCD is required, the product will be marked with the symbol ⚠.
The instructions shall include a caution notice highlighting that where an RCD is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side of this product.

TABLE 1 – APPLICATION EXAMPLES OF TYPES AC, A, B AND F RCDS

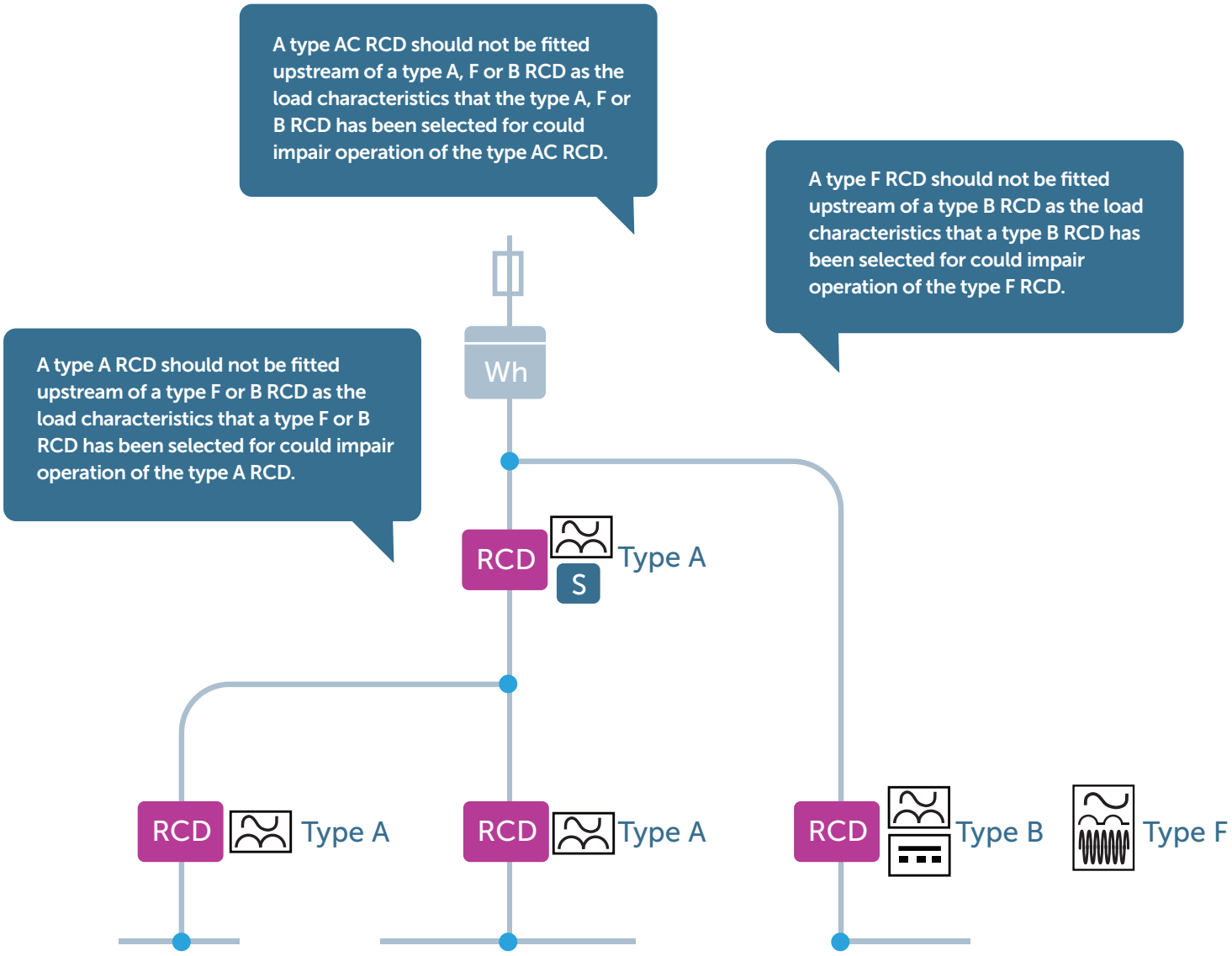


FIGURE 1 – EXAMPLE INSTALLATION ARRANGEMENT

DEVICE TYPE	RCCB						RCBO						SRCD		FCURCD		PRCD		CBR	MRCD
Earth Leakage Sensitivity mA (2)	10	30	100	300	100 Time Delay	300 Time Delay	10	30	100	300	100 Time Delay	300 Time Delay	10	30	10	30	10	30	10 up to many amps	30 up to many amps
Suitable for Domestic Applications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Suitable for Industrial & Commercial Applications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suitable as a Main Incoming Device (CU)	N	Y	Y	Y	Y	Y	N	Y (6)	Y (6)	Y (6)	Y (6)	Y (6)	N	N	N	N	N	N	N	N
Suitable as an Outgoing Device on a CU, DB, PB or SB (5,7)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y(1)
Part of the Incomer on a CU, DB, PB or SB (5,7)	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y
Provides Personal Protection	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y(3)	Y(3)
Provides Protection Against Electrical Fire(8)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Protection to Socket Outlets 20A or less	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N	N	N
Fixed Wiring Protection	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N
Portable Appliance Rated 20A or Less	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N
Can be used to Discriminate with Instantaneous Downstream Device	N	N	N	N	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N	Y(4)	Y(4)

TABLE 2 – RCDS FOR DIFFERENT APPLICATIONS

Notes:

(1) Only if used in conjunction with suitable overcurrent protection (e.g. Fuse/circuit-breaker).

(2) 10 mA RCDs are associated with highly sensitive equipment and high risk areas such as school laboratories and in hospital areas.

(3) Yes provided 30 mA or less, but not normally used.

(4) With time delay.

(5) CU – Consumer unit to BS EN 61439-3.

(6) Must provide double pole isolation

(7) DB – Distribution Board; PB – Panel Board; SB – Switch Board

(8) For agricultural and horticultural premises, the RCD is required to disconnect all live conductors

1.2 RCD SELECTION GUIDES

The following selection guides are intended to help the specifier or installer decide on the most appropriate solution to common installation arrangements.

1.2.1 Commercial/industrial system RCD protection options (figure 2)

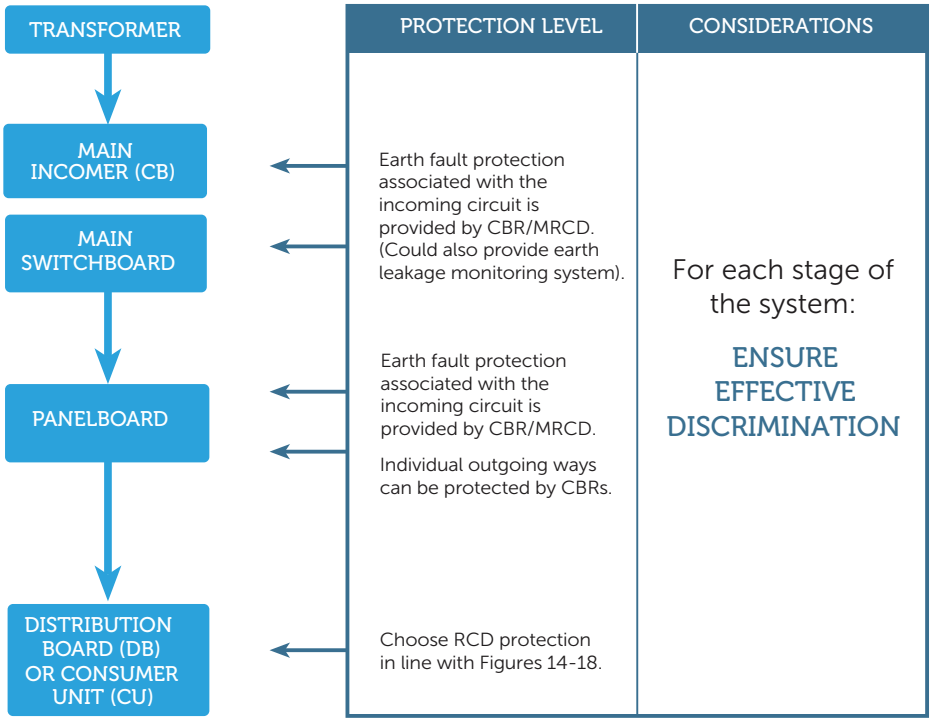


FIGURE 2 – COMMERCIAL/INDUSTRIAL SYSTEM RCD PROTECTION OPTIONS

1.2.2 Sub distribution and final circuit RCD protection options (figures 3 – 7)

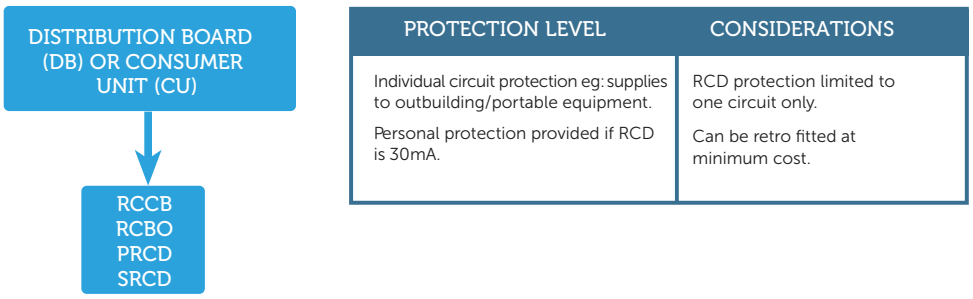


FIGURE 3 – OUTGOING CIRCUIT RCD PROTECTION, SEPARATE FROM THE DISTRIBUTION BOARD

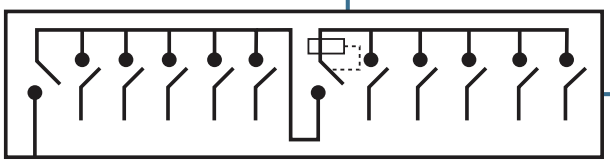
SPLIT LOAD CONSUMER UNIT (CU) OR DISTRIBUTION BOARD (DB) WITH MAIN INCOMING SWITCH – DISCONNECTOR AND RCCB(S), TO PROTECT A SPECIFIC GROUP(S) OF CIRCUITS	PROTECTION LEVEL	CONSIDERATIONS
	Commonly used to provide RCD protection to a group(s) of circuits e.g. Socket-Outlets supplying portable equipment. Personal protection provided if RCD is 30mA.	Fault on one of the RCD protected circuits will trip out the supply to all associated RCD protected circuits. Installation partially RCD protected.

FIGURE 4 – SPLIT LOAD PROTECTION (A)

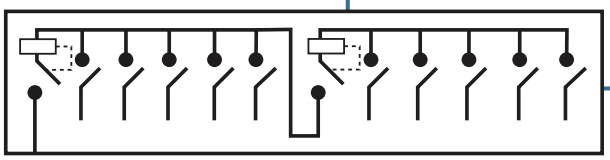
SPLIT LOAD CONSUMER UNIT (CU) OR DISTRIBUTION BOARD (DB) WITH MAIN INCOMING RCD AND SECONDARY RCCB(S), TO PROTECT A SPECIFIC GROUP(S) OF CIRCUITS DB - RCCB/CBR CU - RCCB	PROTECTION LEVEL	CONSIDERATIONS
	Main incoming RCD will provide protection to complete installation. (Typically100mA Time Delayed). Intermediate RCCB(s) commonly used to provide RCD protection to a group(s) of circuits e.g. Socket-Outlets supplying portable equipment. Personal protection provided if RCD is 30mA.	Installation is fully RCD protected. Main incoming RCD can be selected to provide fire protection for the complete installation. Intermediate RCCB can be selected to provide personal protection on high risk circuits. Fault on one of the RCD protected circuits will trip out supply to all associated RCD protected circuits. Correct selection of devices for the main incoming RCD and intermediate RCCBs will provide discrimination between devices.

FIGURE 5 – SPLIT LOAD PROTECTION (B)

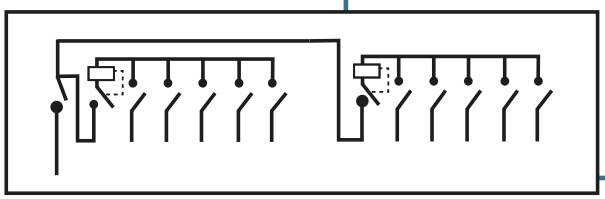
SPLIT LOAD CONSUMER UNIT (CU) OR DISTRIBUTION BOARD (DB) WITH MAIN INCOMING SWITCH DISCONNECTOR AND RCCB(S), TO PROTECT A NUMBER OF SPECIFIC GROUPS(S) OF CIRCUITS	PROTECTION LEVEL	CONSIDERATIONS
	Main incoming Switch Disconnector to isolate all circuits. 30mA RCDs will provide protection to groups of circuits. Personal protection and fire protection is provided to all circuits.	Installation is fully RCD protected. Fire protection and personal protection provided for the complete installation. Meets 17th Edition requirements for protection of Socket-Outlets and cables concealed in walls and partitions. A fault on one circuit will cause the upstream RCD to operate disconnecting the supply to all circuits associated with that RCD. Only a section of the installation is affected.

FIGURE 6 – DUAL SPLIT LOAD PROTECTION (C)

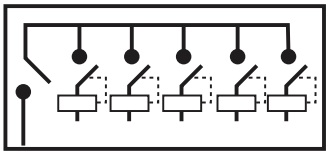
DISTRIBUTION BOARD (DB) OR CONSUMER UNIT (CU) WITH INCOMING MAIN SWITCH - DISCONNECTOR AND INDIVIDUAL RCBO OR CBR PROTECTION ON OUTGOING CIRCUITS	PROTECTION LEVEL	CONSIDERATIONS
	Outgoing circuits with individually RCBO or CBR protection will operate without affecting other circuits. Personal protection provided if RCD is 30mA.	Most comprehensive system.

FIGURE 7 – THE MOST COMPREHENSIVE OPTION – INDIVIDUAL OUTGOING PROTECTION ON ALL WAYS

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