

Circuit breakers	2
Ingress protection	4
Nuisance / unwanted tripping	5

Prospective Fault Current

Calculation of Prospective Short Circuit Current

Several excellent proprietary computer programs are now available for calculating the prospective fault level at any point in the installation. They are also able to select the correct size and type of cable and match this with the correct circuit protective device.

Estimation of Prospective Fault Current

Actually calculating prospective short-circuit current is not in itself difficult but it does require basic data which is not always available to the electrical installation designer.

It is therefore usual to use a simple chart as shown in FIGURE 1 to estimate the prospective short circuit current. This type of chart always gives a prospective fault level greater than that which would have been arrived at by calculation using accurate basic data. Therefore it is safe to use but sometimes may result in an over engineered system.

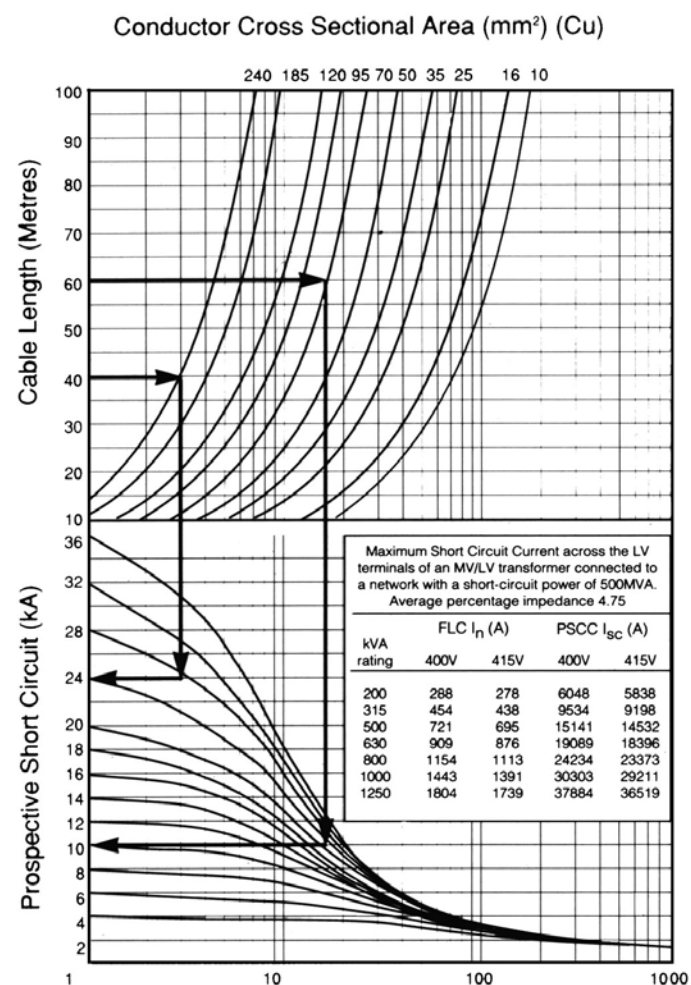


Figure 1

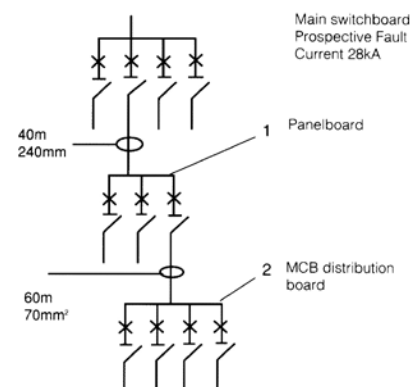


Figure 2

Example in figure 2

- 1 Project 40m of cable length across on to the 240mm² cable curve. From this point project down onto the 28kA curve. From this point projecting across we note that the prospective fault level at the panelboard is 24kA.
- 2 Project 60m of cable length across onto the 70mm² cable curve. From this point project down on to the 24kA curve. From this point projecting across we see that the prospective fault level at the MCB distribution board is 10kA.

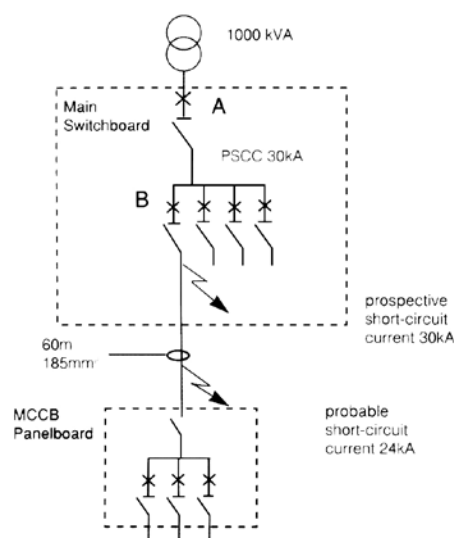


Figure 3

The relationship between probable short-circuit current and service short-circuit breaking capacity is explained. The probable short circuit is the type of short circuit which is most likely to occur; this is nearly always at the extremity of the protected cable and more often than not a single phase or earth fault.

Figure 3 shows a typical 3 phase 4 wire 400V system fed by a 1000 kVA transformer. The transformer is adjacent to the main switchboard so the prospective short-circuit current (PSCC*) on the main switchboard busbars is estimated as 30kA. The probable short-circuit current on the panelboard feeder circuit is estimated as 24kA, if it were a 3 phase symmetrical fault, or 12kA for a phase to neutral fault, which in fact would be the most likely type of fault. (Note: when estimating a phase to neutral prospective short-circuit current, the length of conductor is doubled.) Therefore for this application the main switchboard incoming circuit breaker (A) should have an Ics 30kA and an Icu 30kA. The panelboard feeder circuit breaker (B) should have an Icu 30kA and an Ics 24kA.

Fault loop impedance

With the introduction of AS/NZS 3000:2007 there are new wiring rules for electrical contractors and electrical consultants to consider when designing an electrical installation.

This guide is only concerned with one new area, fault loop impedance, and its affect on the choice of conductor and circuit breaker for a given circuit. Voltage drop and overcurrent requirements should also be given consideration.

An earth fault situation is caused when an active conductor comes into contact with an earthed conductor - fault current then flows. Contractors and consultants must make sure that the conductors in a circuit will allow sufficient energy to flow to cause the circuit breaker to trip in the required time (disconnection time for 230V supply is 0.4s for socket-outlets up to 63A, or handheld Class 1 equipment intended for manual movement during use. 5 seconds for other circuits including submains and final sub circuits supplying fixed or stationary equipment (clause 1.5.5.3)

To make sure that this fault current is large enough to trip a circuit breaker in the required time the fault loop impedance (Z_s) must be below a certain value. If Z_s is too large then the circuit breaker may take too long to trip (> 0.4s) or may not trip at all.

- Circuit length: Circuit impedance increases with the length of a circuit.
- Cross-sectional area of cable: The smaller the cross-sectional area of a cable, the higher its impedance per meter will be.
- Thermal and magnetic settings of a circuit breaker: Hager circuit breakers have both rated current and magnetic characteristics.

The higher the rated current and magnetic settings, the more energy is required to trip the circuit breaker in the required time (< 0.4 s). So a circuit breaker with a magnetic setting of $14 \times I_n$ will require more energy to trip it (in the required time) than a circuit breaker with a magnetic setting of $7.5 \times I_n$.

If more energy is required to flow, then a larger cross-sectional area cable may be needed. If this is not possible then installing a Hager RCD will provide a simple and economical solution.

So circuit length, cross sectional area of the cable and circuit breaker settings all need to be taken into account to ensure correct function of a circuit.

The tables below are a guide to the maximum circuit length for a given Hager circuit breaker. Using these tables will help ensure that the disconnection time for a 230V a.c. supply is met according to AS/NZS 3000:2007.

Conductor size		Protective device rating	Hager circuit breaker (AS/NZS60898)	
Active	Earth		Type C	Type D
mm ²	mm ²	A	MCL (max circuit length in meters)	
1	1	6	91	55
1	1	10	55	33
1.5	1.5	10	82	49
1.5	1.5	16	51	31
2.5	2.5	16	85	51
2.5	2.5	20	68	41
4	2.5	25	67	40
4	2.5	32	52	31
6	2.5	40	48	29
10	4	50	62	37
16	6	63	76	45
16	6	80	59	36
25	6	80	66	40
25	6	100	53	32
35	10	100	85	51
35	10	125	68	41
50	16	125	106	63
50	16	160	83	50
70	25	160	126	75
70	25	200	100	60

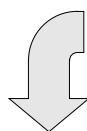
Maximum circuit length (MCL) and maximum circuit impedance (Z_s) for Hager MCBs (MSNxxx, NTxxxC & NDNxxxA ranges).

Where: MCL = Maximum circuit length

Above table based on supply of voltage of 230V (AS/NZS 3000: 2007)

The first character numeral

indicates the degree of protection provided by the enclosures with respect to persons, also the equipment inside the enclosure.



The first character numeral : protection against solid substances

IP		Designation
0		Non - protected
1		Protected against solid objects greater than 50mm
2		Protected against solid objects greater than 12.5mm
3		Protected against solid objects greater than 2.5mm
4		Protected against solid objects greater than 1.0mm
5		Dust protected
6		Dust - tight

The second character numeral

indicates the degree of protection provided by the enclosures with respect to harmful ingress of water; a third character may be used to indicate mechanical strength. An x signifies that no test has been carried out.



The second character numeral : protection against liquid substances

IP		Designation
0		Non - protected
1		Protected against dripping water
2		Protected against dripping water when tilted up to 15°
3		Protected against spraying at an angle up to 60°
4		Protected against splashing water from any direction
5		Protected against water jets
6		Protected against heavy seas
7		Protected against the effect of immersion
8		Protected against submersion to limits set by manufacture

RCD Nuisance tripping or Unwanted tripping ?

It is very tempting to describe RCD tripping due to intermittent electrical fault as 'Nuisance Tripping'. However, 'Nuisance Tripping' probably best describes an RCD that trips for no electrically based reason whatsoever.

Intermittent tripping that typically occurs after a new installation, maintenance or wiring modification would suggest that the RCD is performing the very function for which it was designed / installed for (i.e. fault detection & protection). This intermittent or 'Unwanted Tripping' can actually highlight potential problems within the installation, turning the simple exercise of fitting of an RCD, into a huge fault finding exercise. This is not a relished thought for any sparky!

Typically 'Unwanted Tripping' on RCDs can stem from misplaced or combined Neutrals. At times, Neutrals intended for protection by the RCD are incorrectly wired to the 'pre-RCD' Neutral bar. Other times, current is accidentally shared between the 'pre-RCD' Neutral bar and 'post-RCD' Neutral bar (e.g. via a common bond that should not exist in the first place). Another important consideration is the effect of Standing Leakage Current & how it relates to 'Unwanted Tripping'

Standing Leakage Current & how it relates to Unwanted Tripping on RCDs.

Standing Leakage Current is inherently present in all electrical appliances due to the RFI filters and suppressors inside switch mode power supplies on modern appliances such as LCD TVs, Hi-fi systems, PCs and Laptops. This also occurs in leaky cable appliances with pre-existing poor insulation resistance, or an insulation breakdown developed over time.

Typically 'Unwanted Tripping' is blamed on the RCD being overly sensitive. More often than not, it is the Standing Leakage Current that is the problem. The steady state sum of Standing Leakage Current in the circuit must be significantly less than the RCD tripping threshold. If this is very close to the RCD tripping threshold, then even the slightest transient disturbance will cause the RCD to trip.

Generally, RCDs may trip at any value in excess of 50% of the rated residual current (e.g. 15mA on 30mA RCD). Further care should be taken on installations that are susceptible to high transient disturbances or where particularly leaky appliances may be connected. The recommended Standing Leakage Current steady state threshold is less than 33% of the rated residual current (i.e. 10mA on 30mA RCD).

A list of appliance types and corresponding Standing Leakage Currents are listed below:

Appliance type	Standing Leakage Current up to (mA) / unit
Handheld tools and portable appliances	0.75 mA / unit
Other household appliances	0.75 mA / unit
Information Technology (Portable)	0.75 mA / unit
Lighting Appliances	1
Information Technology (Stationary)	3.5
Electric Stove / Oven	Up to 0.75 / kW

As an example, for a 30mA RCD to stay under the threshold and avoid 'Unwanted Tripping', it is recommended that a maximum of four computers (desktops/towers) are connected to a single RCD circuit at any one time. The number of computers may need to be further reduced if they have particularly high Standing Leakage Current or when the installation is particularly susceptible to transient disturbances.