BLAKLEY ELECTRICS

Celebrating 50 years

MICROLOGIC SET-UP GUIDE

22nd April 2009

THE POWER PROFESSIONALS

HIGHER POWER TRANS POWER SAFE POWER TEM POWER PRO POWER GREEN POWER

CONTENTS

Scope

This document covers the following Micrologic units from the Schneider Electric range:

Micrologic 2.0A
Micrologic 5.0A
Micrologic 6.0A
Micrologic 7.0A

These devices are used extensively within Blakley Electrics Mains Distribution Assemblies and related products. To derive the maximum benefit from the devices it is important that they are set correctly, and this document provides guidance on configuring Micrologic units so that they correctly discriminate with each other. Achieving total discrimination will ensure that the protective devices will operate most efficiently, therefore minimising the occurrence of nuisance tripping and restricting as far as possible the level of disruption caused to the site.

Exclusions from scope

This article provides no specific guidance on configuring the following products, however some of the information contained will apply to other units.

Micrologic devices suffixed with ‘P’ or ‘H’

Definitions

Discrimination. This is the selection of protective devices so that the device nearest to a fault will operate rather than any upstream device.

Earth fault current. An overcurrent resulting from a fault of negligible impedance between a line conductor and an exposed-conductive-part or a protective conductor.

Earth fault protection. This is the protection in place to protect the installation from a current resulting from a fault of negligible impedance between a line conductor and an exposed-conductive-part or a protective conductor. An example of this could be damage to a steel wire armoured cable causing the armouring to come into contact with a live conductor.

Earth Leakage current. Electric current appearing in a protective conductor, such as a leakage current or electric current resulting from an insulation fault.

Electrical Installation. An assembly of associated electrical equipment having co-ordinated characteristics to fulfil specific purposes.

Ig. This is the earth fault protection setting for the device, variable between 0.2 x to 1x of In (Micrologic 6.0A only).

Ii. This is the instantaneous-protection function which protects the installation against solid short circuits. There is no variable time delay associated with this function. There is a fixed time delay of 20 milliseconds.

In. This is the maximum rating of the protective device.

IΔn. This is earth leakage protection function which protects the installation against earth leakage currents at a variable set between 0.5A to 30A (Micrologic 7.0A only).

Instantaneous-protection (Ii). This is the protection in place to protect the installation against a solid short circuit, whereby exceptionally high fault currents would begin to flow due to low impedances. An example of this could be a digger unit cutting through a distribution cable close to the origin of an installation, creating a high current short circuit.

Ir. This is the long time protection setting for the device, variable between 0.4x to 1x the maximum rating of the protective device (In).

Isd. This is the short time protection setting for the device, variable between 1.5x to 10x the set rating of the protective device (Isd=Ir x …). This is the protection in place to protect the installation against high inrush currents associated with equipment connected to the installation. An example of this could be the high inrush currents from a large motor starting, which the components can withstand for short durations. However, if the current continues to flow for a period in excess of a predetermined time or magnitude, the device will operate.

Ipf. This is the prospective fault current. The value of overcurrent at a given point in a circuit resulting from a fault of negligible impedance between live conductors having a difference of potential under normal operating conditions, or between a live conductor and an exposed-conductive part.

Long time protection (Ir). This is the protection in place for the installation against overload currents. An example of this would be where too many pieces of equipment are distributed over a supply where the total current drawn would exceed that of the current carrying capacity of the cable.

MCCB (Moulded Case Circuit Breaker). A device capable of making, carrying and breaking normal load currents and also making and automatically breaking, under pre-determined conditions, abnormal currents such as short-circuit currents. It is usually required to operate infrequently.

Δt. This is the time delay function associated with IΔn on a Micrologic 7.0A devices only. If an earth leakage fault current flows (IΔn) then the device will operate within Δt variable between 60ms to 800ms.

tg (set in the 'Off' range)**.** This is the time delay that the protective device will operate within when the earth fault current reaches Ig, variable between 0 x to 0.4 seconds. This time delay is available on Micrologic 6.0A devices only.

tg (set in the 'On' range)**.** This is the time delay that the protective device will operate within when the earth fault current reaches up to a maximum of 10 x In, variable between 0.1 x to 0.4 seconds. This time delay is available on Micrologic 6.0A devices only.

tr. This is the time delay that the protective device will operate within when the fault current is 6x Ir (accuracy 0 to -20%). This adjustment is available on Micrologic 2.0A,5.0A, 6.0A and 7.0A devices.

tsd (set in the 'Off' range)**.** This is the time delay that the protective device will operate within when the fault current reaches Isd, variable between 0 x to 0.4 seconds. This adjustment is available on Micrologic 5.0A, 6.0A and 7.0A devices.

tsd (set in the 'On' range)**.** This is the time delay that the protective device will operate within when the fault current reaches up to a maximum of 10 x Ir, variable between 0.1 x to 0.4 seconds. This adjustment is available on Micrologic 5.0A, 6.0A and 7.0A devices.

Discrimination

Discrimination is the selection of protective devices so that the device nearest to a fault will operate rather than any upstream device. The purpose is to ensure that the fault is isolated and supply is maintained to other parts of the installation without disruption. The term discrimination is also often referred to as ‘Selectivity’ or ‘Co-ordination’.

For example, in any installation, a fault in a final circuit should result in the protective device for that circuit operating, whilst lighting and other separate circuits remain energised. If the fault results in operation of the supply authority's service fuse, loss of power for all circuits on the installation could potentially present a safety risk and would result in unnecessary cost.

Discrimination can be applied to both:

- Devices offering overload and fault current protection
- Devices offering protection against residual current

Where devices require discrimination BS7671 : 2008 states:-

‘536.1 General

Where co-ordination of series of protective devices is necessary to prevent danger and where required for proper functioning of the installation, consideration shall be given to selectivity and/or any necessary back-up protection.

Selectivity between protective devices depends on the co-ordination of the operating characteristics of two or more protective devices such that, on the incidence of fault currents within stated limits, only the device intended to operate within these limits does so.’

Forms of discrimination

Overload discrimination. This relates to the magnitude of the fault current - for this the upstream device must always have a higher continuous current rating and a higher instantaneous pick-up value than the next device downstream.

Short-circuit discrimination. This must be considered in any situation where high prospective fault levels exist. This occurs where the fault loop impedance is low, for example if the installation is close to the local transformer substation. A short-circuit at, or close to, the protective device will involve exceptionally high energy levels (bearing in mind that energy, I^2t, is related to the square of the current).

Time discrimination. This relates to the time during which the protective device 'sees' the fault current. This requires the use of adjustable time delay settings in upstream devices. In addition the upstream device must be able to withstand the thermal and electro-dynamic effects of the full prospective fault current during the delay period.

Time Current Coordination Curves

Any protective device such as a fuse or circuit breaker will have its own tripping characteristic unique to that device. When introducing multiple protective devices into an installation it is important that these properties are taken into consideration to ensure that each device works in harmony with each other. With these considerations made it should be possible to create an installation where the protective devices discriminate between each other to avoid nuisance tripping and give greater stability to the installation.

Fig1.1 shows an example of the tripping characteristics of a typical protective device. As can be seen, if the device sees up to 100 Amps the device will not operate at all. However if the device sees a current of 500 Amps the protective device will clear the fault in 0.75 seconds. If we increased the current further to 1200 Amps we can see that the device will clear the fault considerably quicker at 0.01 seconds!

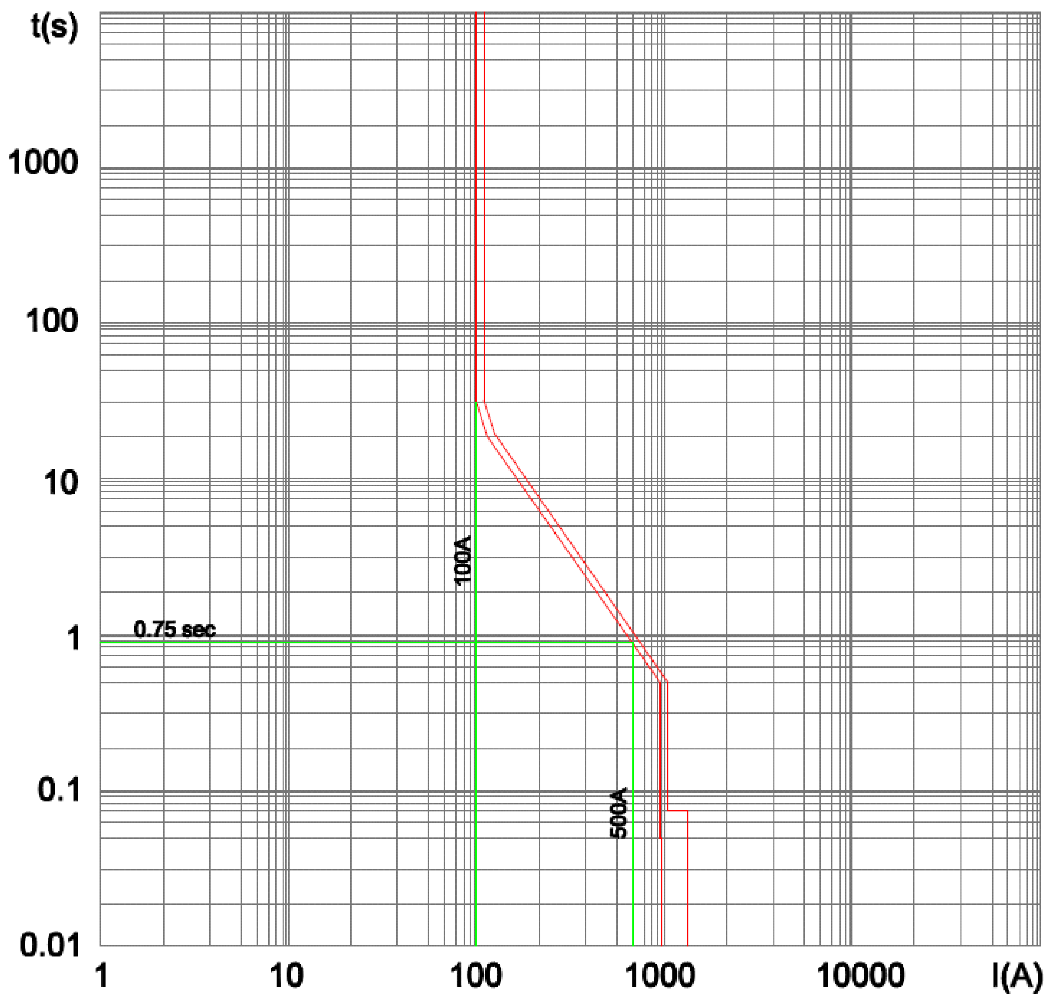


Fig 1.1

Now let's consider three devices working together Fig1.2. The first device is at the origin of the installation offering protection for an entire site. The second and third devices are downstream providing localised protection to a crane and the lighting for the installation.

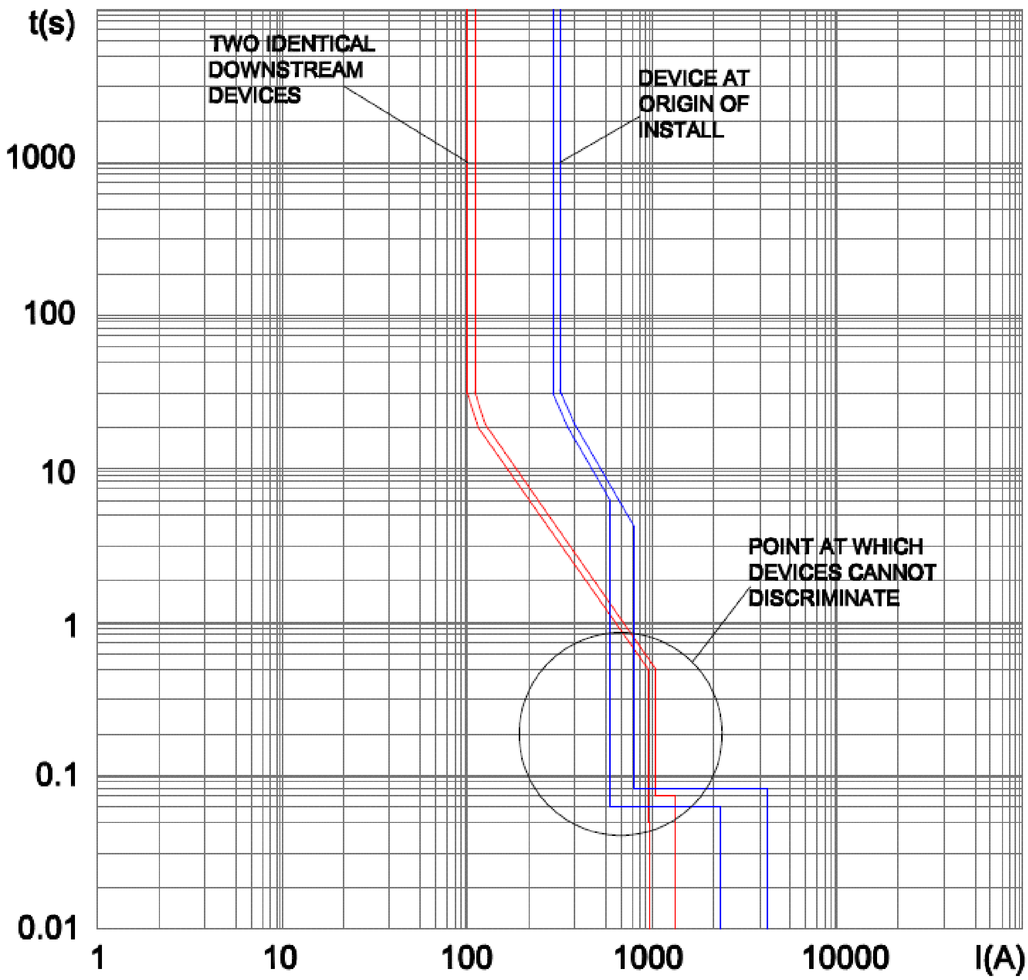


Fig1.2

We can see that the downstream devices would provide some discrimination but there is a point where the protective device at the origin overlaps the characteristics of the downstream device. This would mean that if a fault current or overload of 400 Amps appeared on one of the downstream devices for a duration of 1 second then the downstream device would not operate and the upstream device would. This would also cause a loss of power to the other downstream device which had no overcurrent or overload present. This would not be suitable for general operation due to the disruption created.

With the use of the Micrologic range of products it makes it possible to vary these characteristics (trip curves) within a finite set of values. Varying these values allow the curves to be manipulated so that they do not overlap and therefore they will operate in a much more logical pattern. We can then have an installation whereby each branch of an electrical installation will be independent from each other, therefore reducing nuisance tripping.

A final example fig 1.3 shows that with all protective devices correctly adjusted discrimination can be achieved to minimise disruption caused on site.

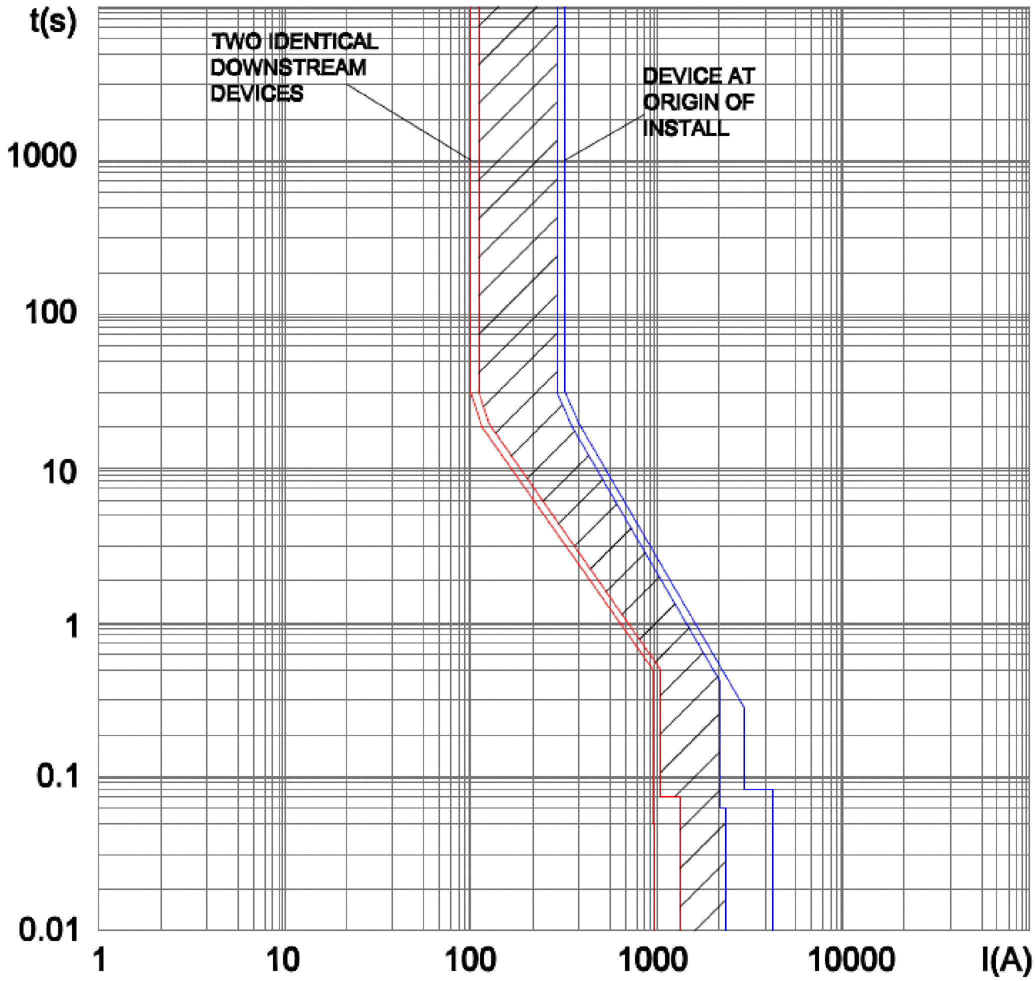


Fig 1.3

Micrologic Adjustable trip curves

Fig 1.4 shows a generic trip curve for Micrologic 2.0A protected devices. Setting the devices so that each trip curve is clear from the device downstream of it will ensure discrimination between devices.

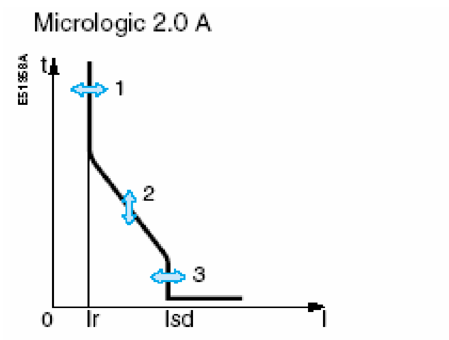
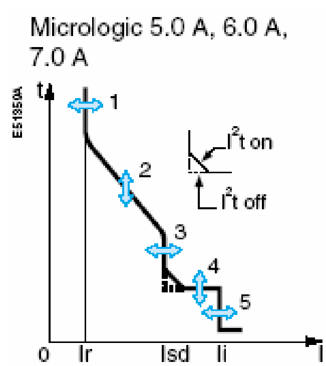


Fig 1.4

1. Current setting Ir (long time)
2. Tripping delay tr (long time) for 6 x Ir
3. Pick-up Isd (short time)

Fig1.5 shows a generic trip curve for Micrologic 5.0A, 6.0A and 7.0A protected devices. Similarly, by setting the devices so that each trip curve is clear from the device downstream of it will ensure discrimination between devices. It can be seen that the Micrologic 5.0A, 6.0A and 7.0A have a greater range of adjustment. These models also have the added ability to adjust the short time tripping delay (tsd) and the instantaneous pick-up (Ii) of the device.



1. Current setting Ir (long time)
2. Tripping delay tr (long time) for 6 x Ir
3. Pick-up Isd (short time)
4. Tripping delay tsd (short time)
5. Pick-up Ii (instantaneous)

Fig1.5

For Micrologic 6.0A devices only, there is also the provision for earth fault detection. This is the protection in place to protect the installation from an overcurrent resulting from a fault of negligible impedance between a line conductor and an exposed-conductive-part or a protective conductor. The way in which this fault is detected can also be adjusted and Fig 1.6 shows the parameters.

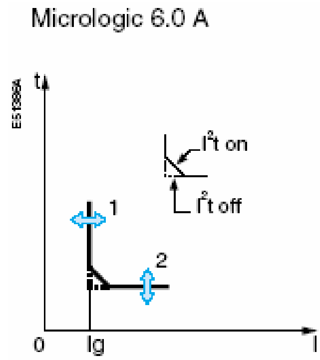
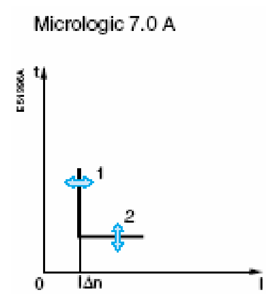


Fig 1.6

1. Pick-up <u>Ig</u> (ground fault)
2. Tripping delay <u>tg</u> (ground fault)

For Micrologic 7.0A devices the provision for earth fault detection is omitted and replaced with earth leakage protection. This form of protection is primarily in place to protect people against indirect contact because an earth leakage current can provoke an increase in the potential of the exposed conductive parts. The earth-leakage pick-up value <u>IΔn</u> is displayed directly in amperes and the tripping delay follows a constant time curve as shown in Fig 1.7.



1. Pick-up <u>IΔn</u> (earth leakage fault)
2. Tripping delay <u>Δt</u> (earth leakage fault)

Fig 1.7

Achieving discrimination with Blakley products

Blakley Electrics Residual Current Sensors were originally designed for incorporation within our range of Residual Current Protection and Distribution Assemblies, which have found wide usage in industry and education. The many features and benefits of Blakley Sensors has resulted in their extensive incorporation by panel builders within control gear and switchgear assemblies, as well as by OEMs making special assemblies.

Within complex distribution systems it is common for more than one device to be installed which provides core balance earth leakage protection. It is essential that consideration be given to the ratings of these devices to ensure that discrimination is achieved.

BS7671:2008 refers to this directly:-

‘531.2.9 Where, for compliance with the requirements of the regulations for fault protection or otherwise to prevent danger, two or more RCDs are in series, and where discrimination in their operation is necessary to prevent danger, the characteristics of the devices shall be such that the intended discrimination is achieved.’

The Blakley range of Core Balance Earth Leakage sensors is based on three models: the ELS series which has a fixed sensitivity; the VELS series, which is similar to the ELS but has adjustable sensitivity and time delay; the VRCD series, which also has adjustable sensitivity and time delay but has a separate current transformer and is therefore suitable for higher current applications. The images below show each model type.

ELS

VELS

VRCD

The range of sensitivity which Blakley products operate within, subject to the model installed, is 5mA to 2A. It can be seen that there is a crossover with the earth leakage range covered by the Micrologic 7.0A units, for which the range is adjustable from 0.5A to 30A. In addition to this, both Blakley and Micrologic products have operating times which could overlap if not correctly set. For example:-

Let’s consider an MCCB, fitted with a Micrologic 7.0A unit with a rating of 2000A providing protection for an entire construction site, with another MCCB with a rating of 250A downstream of it providing local protection to distribution circuits. Now assume that the downstream device is protected by a Blakley VELS which is set at 0.5A and a time delay of 1 second. If the upstream device is also set to operate at 0.5A but with a time delay of 140mS, it can be seen that if an earth leakage fault of magnitude 0.5A was to occur on one of the distribution circuits of the downstream device, both protective devices would see the fault but it would be the upstream device which would clear the fault first. This would cause unwanted disruption to the entire site. The situation could be remedied in several ways providing the installations protective function was still within its intended design. These solutions in this example could be;

1. Increase the time delay of the upstream device above that of the downstream device.
2. Decrease the time delay of the VELS below the time delay of the upstream device.

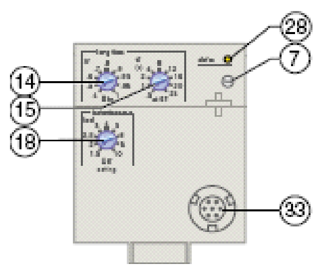
By considering the design of an installation and how it is intended to operate both during normal conditions and when fault conditions are present, it should be possible to achieve total discrimination between devices, and provide a reliable and safe electrical installation.

It is important to note at this point the difference between an earth fault and an earth leakage current, as Micrologic 6.0A devices are designed to detect earth faults, where Blakley Electrics residual current sensors are designed to detect earth leakage currents. As described earlier in the definitions section of this guide an earth fault current is an overcurrent resulting from a fault of negligible impedance between a line conductor and an exposed-conductive part, or protective conductor. An example of this could be damage to a steel wire armoured cable causing the armouring to come into contact with a live conductor. The resultant current flow would likely be very high but would appear to both devices in the same way. In contrast to this a Blakley Electrics residual current sensor would typically be detecting currents of a much smaller magnitude. These currents are likely to be caused by a relatively high impedance to earth causing a relatively low current to flow. Sometimes earth leakage currents can be inherent to the design of an installation although the size of the current would need to be monitored and the supply disconnected if the earth leakage current exceeded a predetermined value.

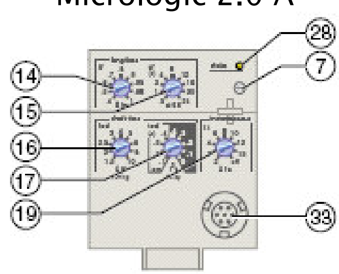
Device layout

The previous section showed examples of the Micrologic trip curves and the parameters that are available for adjustment. The following illustrations show the Micrologic range and the location of points for adjustment.

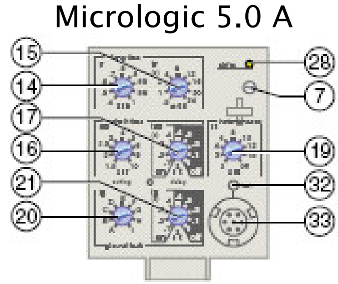
7. Screw for long time rating plug
13. Three-phase ammeter
14. Long-time current setting Ir
15. Long-time tripping delay tr
16. Short-time pickup Isd
17. Short-time tripping delay tsd
18. Instantaneous pick-up Isd
19. Instantaneous pick-up Ii
20. Ground-fault pick-up Ig
21. Ground-fault tripping delay tg
22. Earth-leakage pick-up IΔn
23. Earth-leakage tripping delay Δt
24. LED indicating long-time tripping
25. LED indicating short-time tripping
26. LED indicating ground/earth fault tripping
27. LED indicating auto-protection tripping
28. LED indicating an overload
29. Nav button to change menus
30. Nav button to view menu contents
31. Button for fault trip reset
32. Test button for ground/earth fault protection
33. Test connector



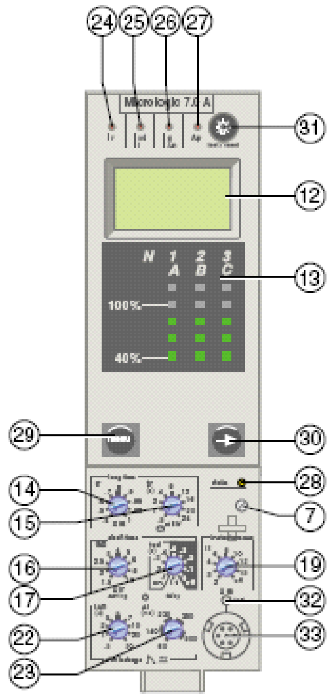
Micrologic 2.0 A



Micrologic 5.0 A



Micrologic 6.0 A



Micrologic 7.0A

7. Screw for long time rating plug
13. Three-phase ammeter
14. Long-time current setting Ir
15. Long-time tripping delay tr
16. Short-time pickup Isd
17. Short-time tripping delay tsd
18. Instantaneous pick-up Isd
19. Instantaneous pick-up Ii
20. Ground-fault pick-up Ig
21. Ground-fault tripping delay tg
22. Earth-leakage pick-up IΔn
23. Earth-leakage tripping delay Δt
24. LED indicating long-time tripping
25. LED indicating short-time tripping
26. LED indicating ground/earth fault tripping
27. LED indicating auto-protection tripping
28. LED indicating an overload
29. Nav button to change menus
30. Nav button to view menu contents
31. Button for fault trip reset
32. Test button for ground/earth fault protection
33. Test connector

Overview of Micrologic settings

Long time protection (Ir) and tripping delay (tr)

Micrologic control unit		Accuracy	2.0A, 5.0A, 6.0A and 7.0A								
current setting tripping between 1.05 and 1.2 x Ir	Ir = In (*) x ...		0.4	0.5	0.6	0.7	0.8	0.9	0.95	0.98	1
time delay (s)	tr at 1.5 x Ir	0 to -30%	12.5	25	50	100	200	300	400	500	600
	tr at 6 x Ir	0 to -20%	0.5	1	2	4	8	12	16	20	24
	tr at 7.2 x Ir	0 to -20%	0.34	0.69	1.38	2.7	5.5	8.3	11	13.8	16.6

Short time protection (Isd) and tripping delay (tsd)

Micrologic control unit		Accuracy	2.0A, 5.0A, 6.0A and 7.0A								
pick-up	Isd = Ir x ...	± 10%	1.5	2	2.5	3	4	5	6	8	10
	settings I^2t OFF		0	0.1	0.2	0.3	0.4				
time delay (ms) at 10Ir	I^2t ON			0.1	0.2	0.3	0.4				
I^2t ON or	tsd (max resettable time)		20	80	140	230	350				
I^2t OFF	tsd (max break time)		80	140	200	320	500				

Instantaneous pick-up (Isd)

Micrologic control unit		Accuracy	2.0A								
pick-up	Isd = Ir x ...	± 10%	1.5	2	2.5	3	4	5	6	8	10

Instantaneous pick-up (Ii)

Micrologic control unit		Accuracy	5.0A, 6.0A and 7.0A								
pick-up	Ii = In (*) x ...	± 10%	2	3	4	6	8	10	12	15	OFF

* In:circuit breaker rating

Ground-fault protection (Ig) and tripping delay (tg)

Micrologic control unit		Accuracy	6.0A								
current setting	Ir = In (*) x ...	± 10%	A	B	C	D	E	F	G	H	I
tripping between 1.05	In ≤ 400A		0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
and 1.2 x Ir	400A < In ≤ 1200A		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
	In >1200A		500A	640A	720A	800A	880A	960A	1040A	1120A	1200A
time delay (ms) at	settings I^2t OFF		0	0.1	0.2	0.3	0.4				
10In (*)	I^2t ON			0.1	0.2	0.3	0.4				
I^2t ON or	tsd (max resettable time)		20	80	140	230	350				
I^2t OFF	tsd (max break time)		80	140	200	320	500				

* In:circuit breaker rating

Earth leakage protection IΔn and tripping delay Δt

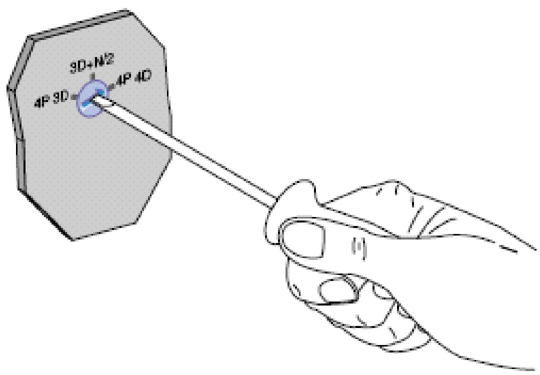
Micrologic control unit		Accuracy	7.0A								
pick-up	IΔn	0 to -20%	0.5	1	2	3	5	7	10	20	30
time delay (ms)	settings										
	tsd (max resettable time)		60	140	230	350	800				
	tsd (max break time)		140	200	320	500	1000				

Typical field setup example

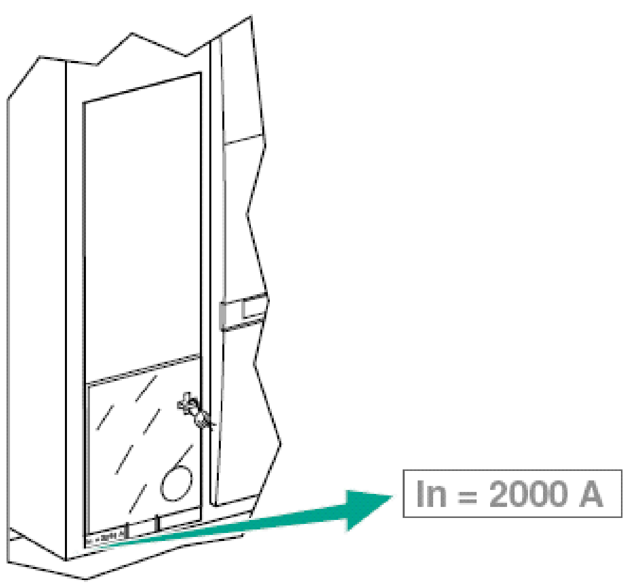
The setup guides that follow show the user how to set the

Micrologic 2.0A

1. **Protection of neutral.**
   On four-pole circuit breakers, it is possible to select the type of neutral protection for the forth pole:
   - Neutral unprotected (4P 3D)
   - Neutral protection at 0.5 In (3D + N/2)
   - Neutral protection at In (4P 4D)

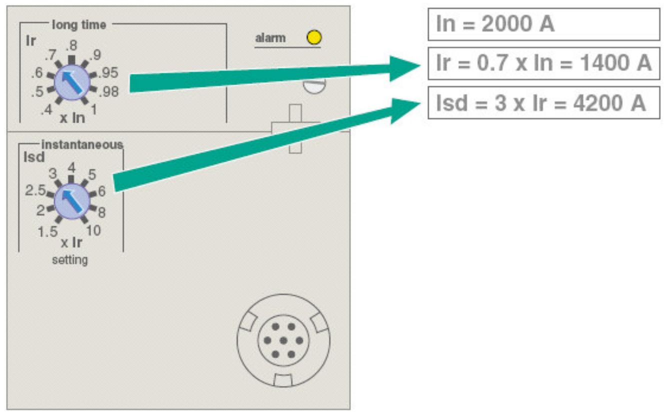


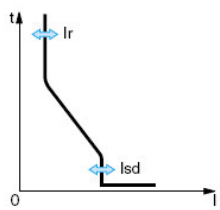
2. **Setting the trip levels.**
   The rating of the circuit breaker in this example is 2000A.



3. Set the threshold values

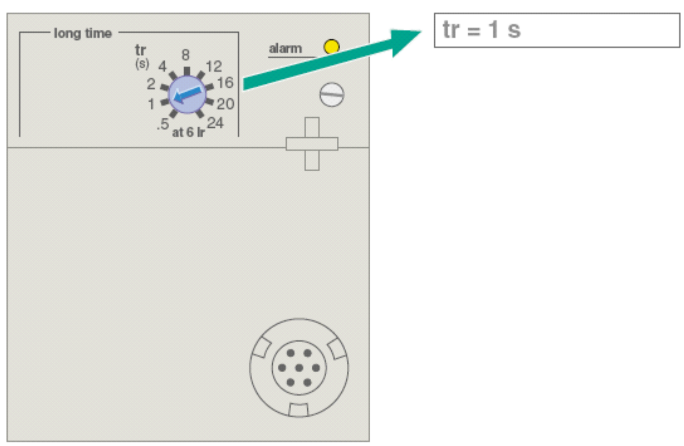
Long time (Ir) and short time (Isd) protection

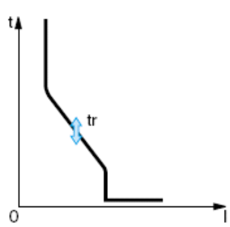




4. Set the tripping delay

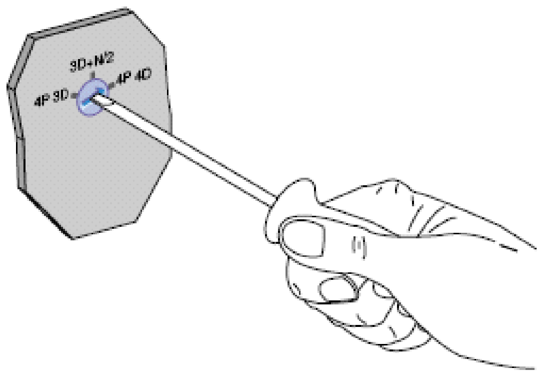
Long time delay (tr)



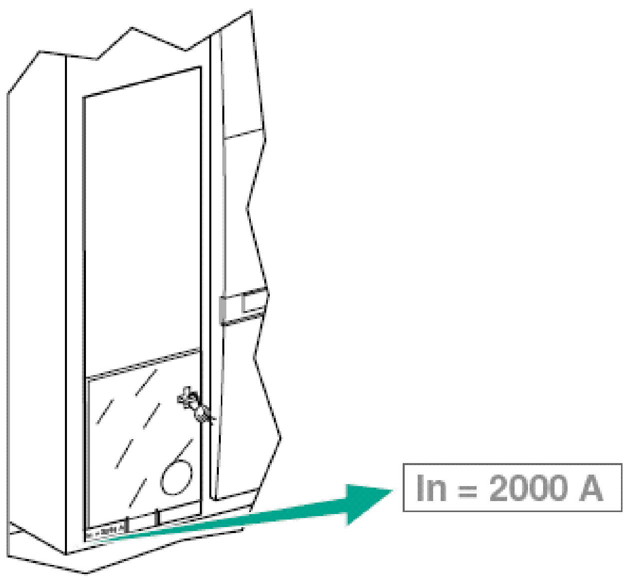


Micrologic 5.0A

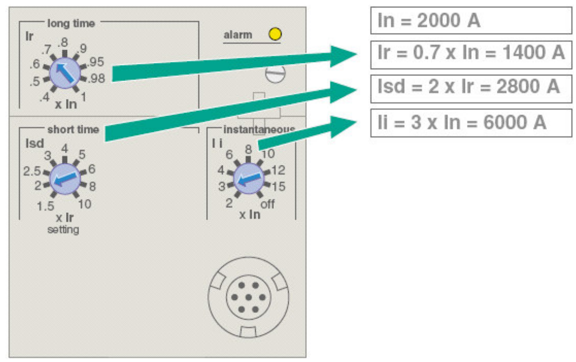
1. **Protection of neutral.**
   On four-pole circuit breakers, it is possible to select the type of neutral protection for the forth pole:
   - Neutral unprotected (4P 3D)
   - Neutral protection at 0.5 In (3D + N/2)
   - Neutral protection at In (4P 4D)

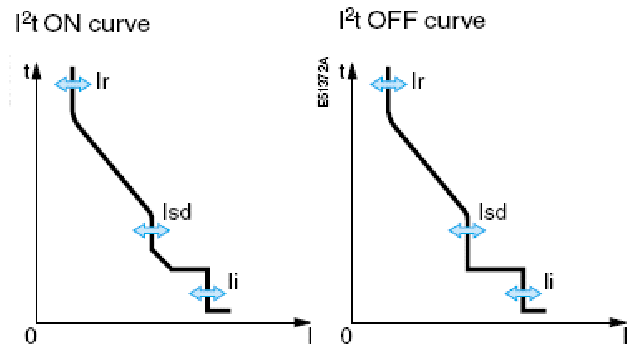


2. **Setting the trip levels.**
   The rating of the circuit breaker in this example is 2000A.

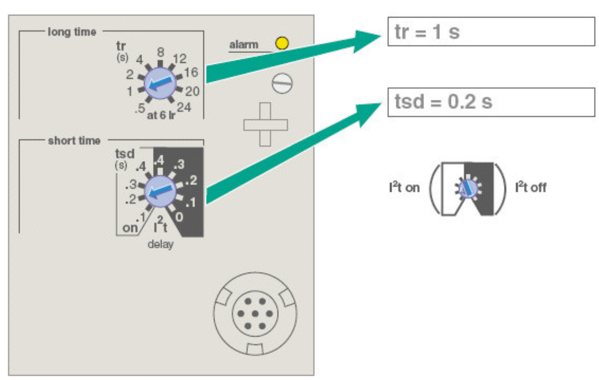


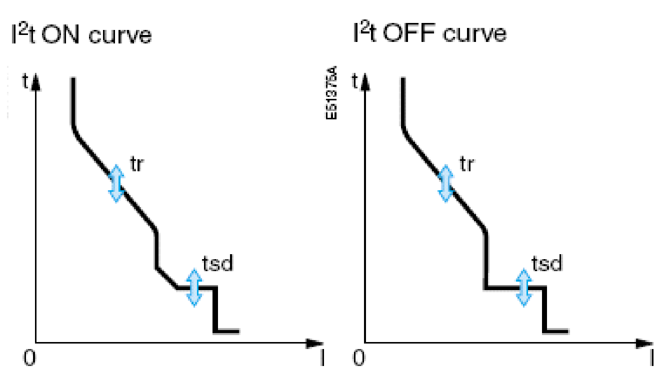
3. **Set the threshold values**
Long time (Ir), Short time (Isd) and instantaneous protection (Ii).





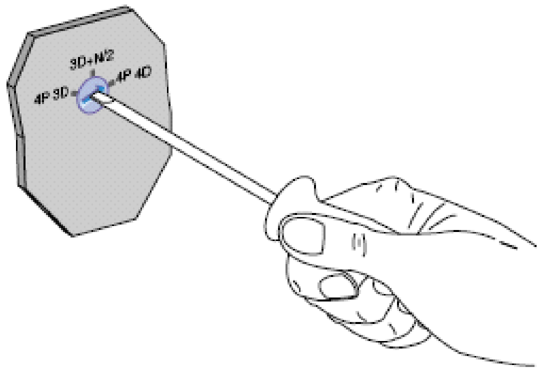
4. **Set the tripping delay**
Long time delay (tr) and Short time delay (tsd).



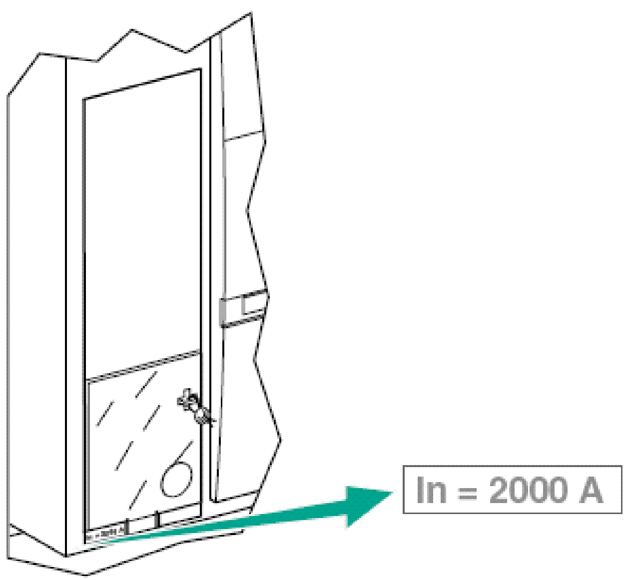


Micrologic 6.0A

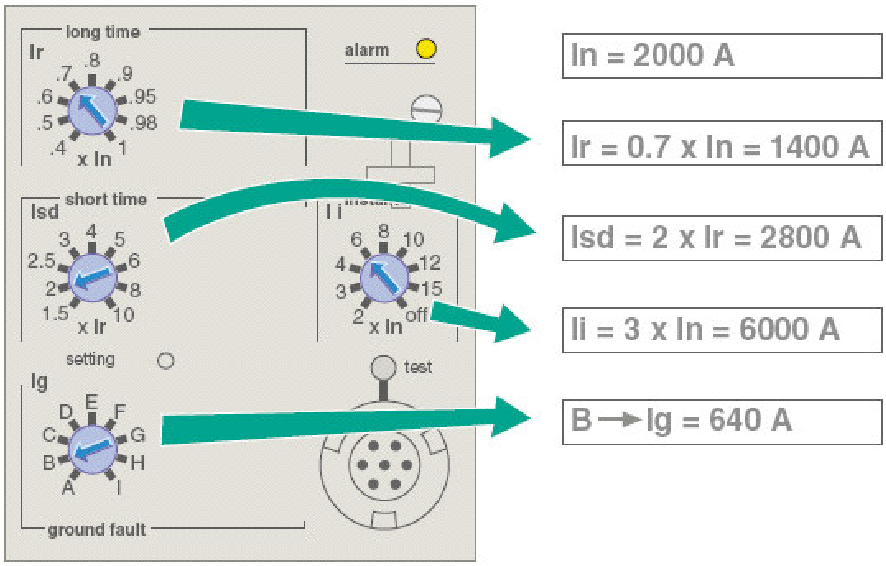
1. **Protection of neutral.**
   On four-pole circuit breakers, it is possible to select the type of neutral protection for the forth pole:
   - Neutral unprotected (4P 3D)
   - Neutral protection at 0.5 In (3D + N/2)
   - Neutral protection at In (4P 4D)

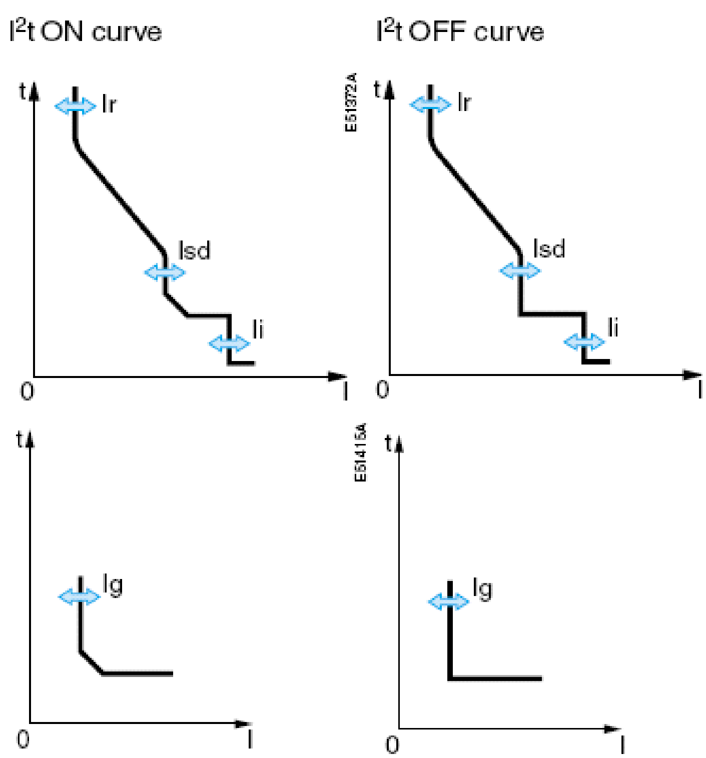


2. **Setting the trip levels.**
   The rating of the circuit breaker in this example is 2000A.

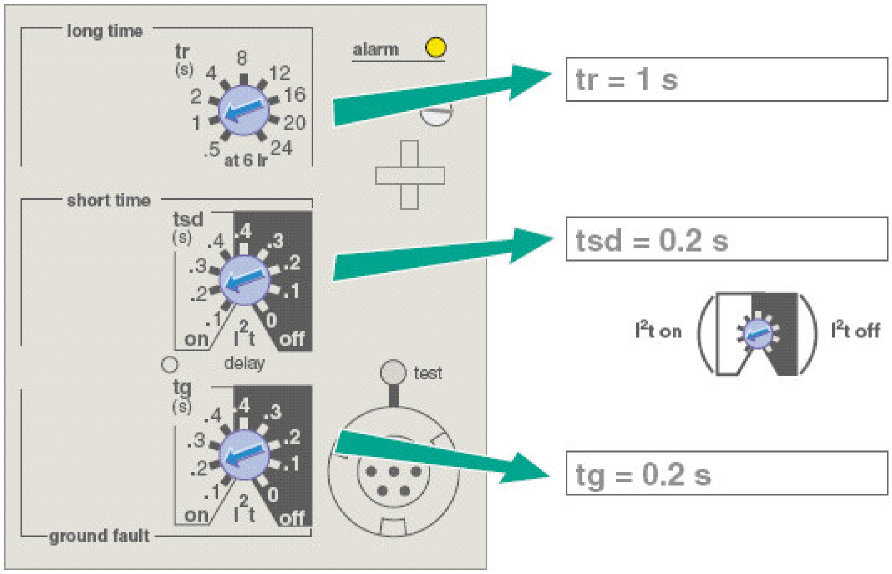


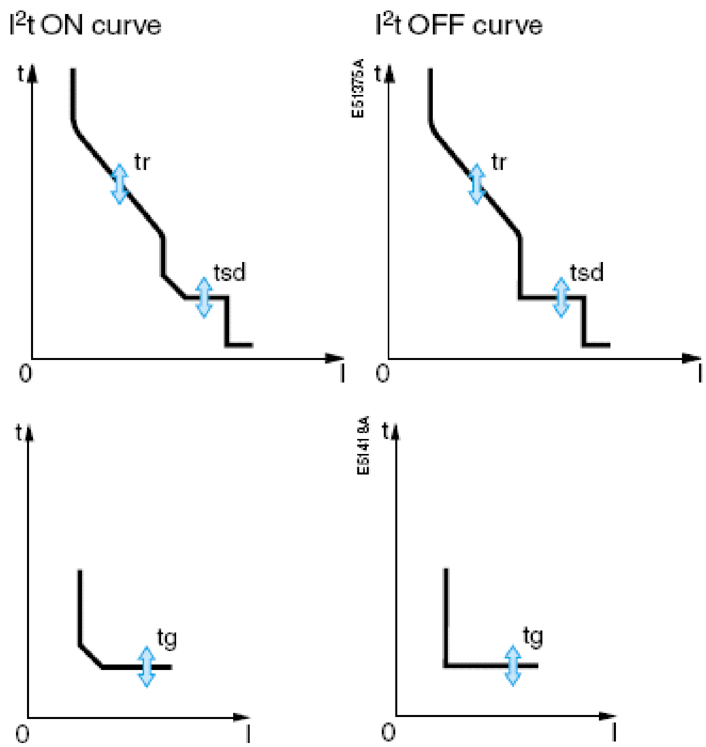
3. **Set the threshold values.**
Long time (Ir), Short time (Isd) and Ground fault (Ig) protection.





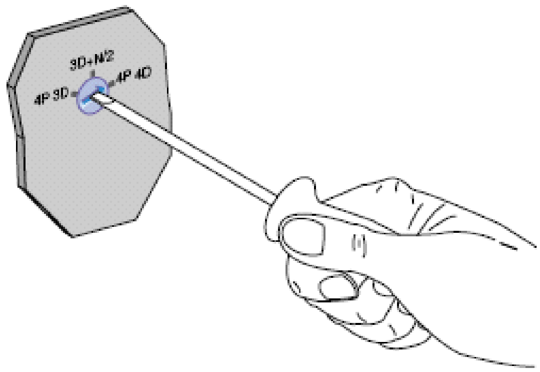
4. **Set the tripping delay.**
   Long time (tr), Short time (tsd) Ground fault (tg) tripping delay.



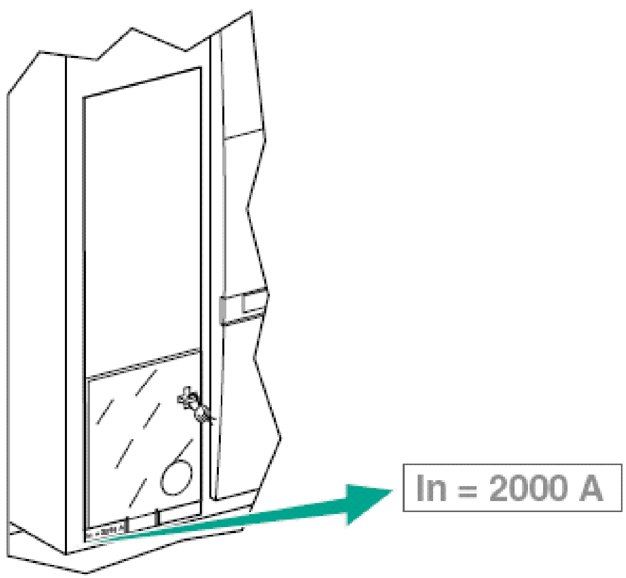


Micrologic 7.0A

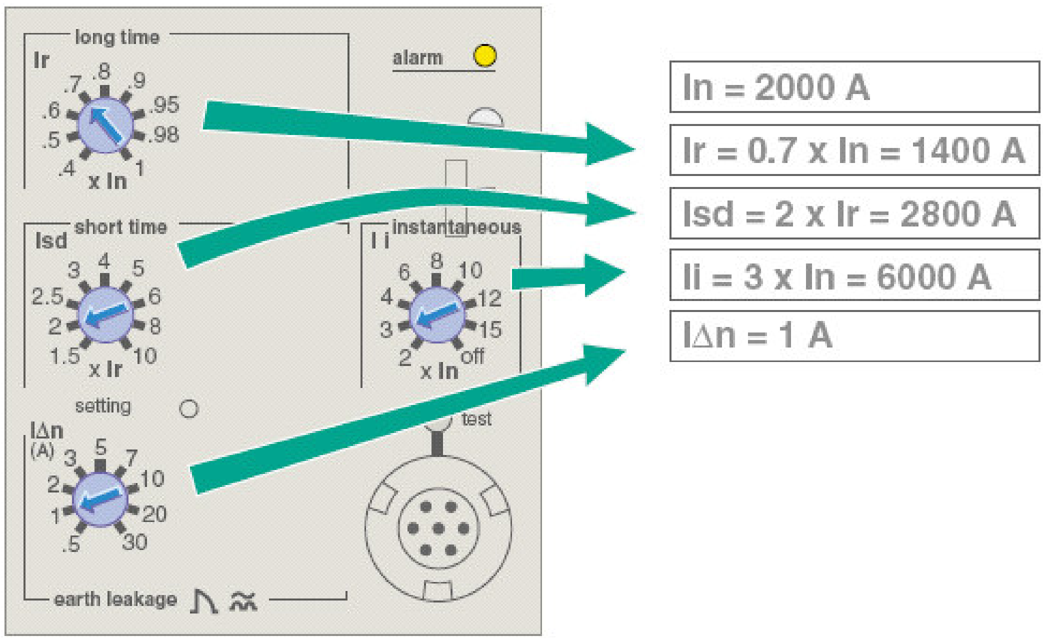
1. **Protection of neutral.**
   On four-pole circuit breakers, it is possible to select the type of neutral protection for the forth pole:
   - Neutral unprotected (4P 3D)
   - Neutral protection at 0.5 In (3D + N/2)
   - Neutral protection at In (4P 4D)

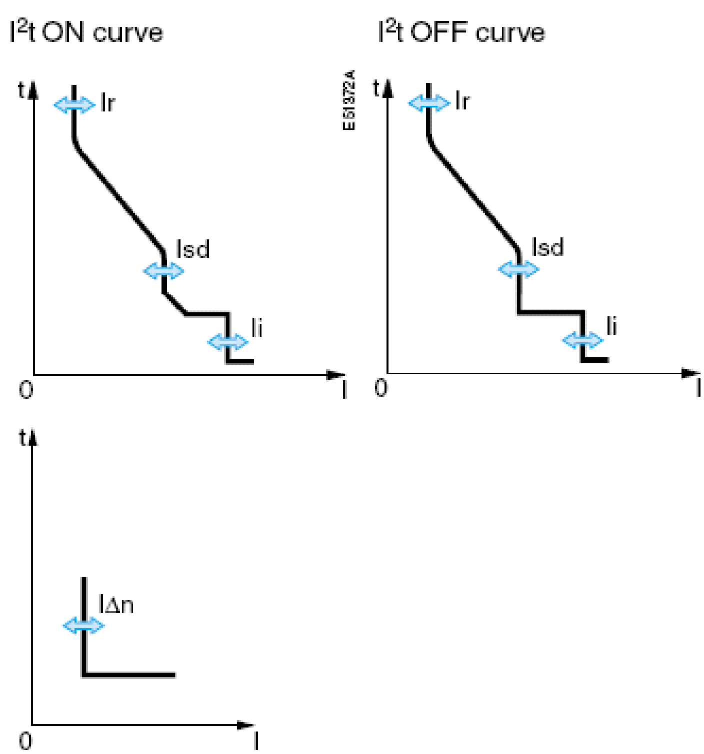


2. **Setting the trip levels.**
   The rating of the circuit breaker in this example is 2000A.



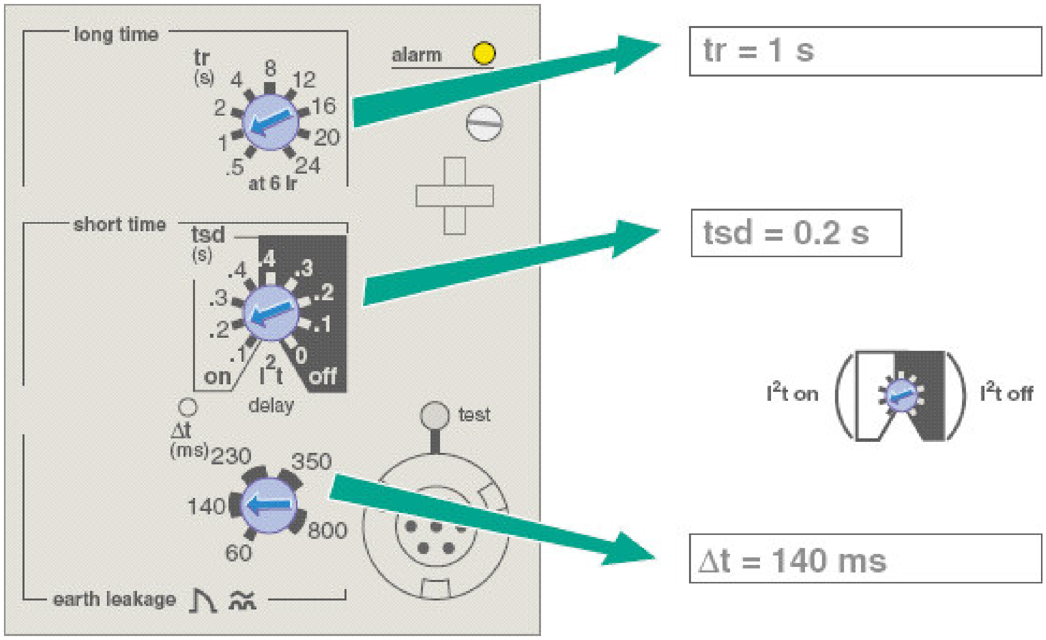
3. **Set the threshold values.**
   Long time (Ir), Short time (Isd) and Earth Leakage (IΔn) protection.

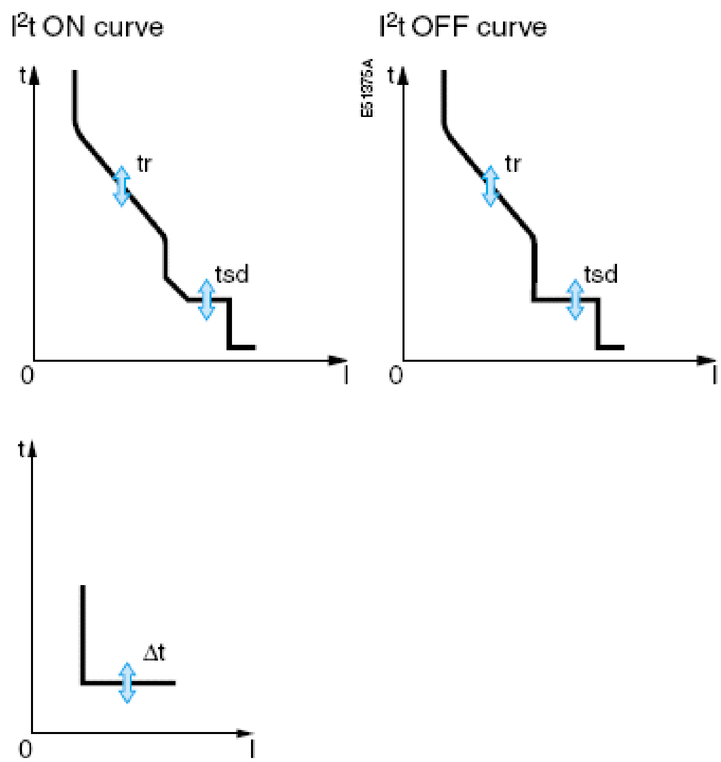




4. Set the tripping delay.

Long time (tr), Short time (tsd) and earth leakage(Δt) delay.





Further Reading

This guide has been produced to help understand the principles of discrimination and why it should be achieved. It references the Micrologic range of products currently on offer from Schneider Electrics. This document only intends to explain terminology used and any settings shown in examples are not intended for general use in the field.

Any settings made on Micrologic protective devices should be made by a competent person, giving consideration to the arrangement of the installation.

If you would like further assistance setting MCCB trip thresholds to achieve full discrimination, please contact us with details of the installation. This information should include:-

1. Schematic of the installation detailing the type of protection at each level.
2. PFC (Prospective Fault Current) at each assembly.
3. Level of earth leakage detection (If required) at each assembly.
4. Cable cross-sectional area between assemblies.
5. Magnitude and duration of any high inrush currents from external equipment connected to the installation.

Further information on trip curves and Micrologic products can be found at:

www.schneider-electric.com