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TECHNICAL NEWS

Issue 33 July 2001

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Quarterly Technical Newsletter of Australia's leading supplier of low-voltage motor control and switchgear.

IN THIS ISSUE

A LEAK TO EARTH CAN BE ELECTRIC

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Introduction

The application of earth leakage protection (provided by residual current devices or RCDs) has improved electrical safety and saved lives. While RCDs are only effective in cases where there is a current flow from active to earth, this covers most instances of electric shock.

Earth leakage protection is available from a wide range of devices.

As RCDs become more common as a result of the mandatory requirements in the Australian Wiring Rules, more installation issues arise. A basic understanding of how the devices work can help to ensure a successful installation.

The Rules

In domestic installations RCDs are mandatory on power and lighting circuits. The only circuits offered exclusion are those for cooking appliances. These are only excluded because cooking appliances can have leakage currents to earth as part of their normal operation.

In residential type installations such as hotels and boarding houses the lighting circuits are excluded from mandatory RCD protection.

For other electrical installations the risk of electric shock needs to be considered and RCDs fitted if the connection of electrical equipment "represents an increase in the risk of electric shock to the user".

If alterations are made to an existing installation involving say the addition of a new circuit, RCD protection is required to be fitted in accordance to the Rules.

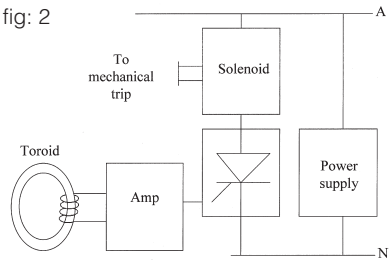
How it Works Electronic/ Electromagnetic

For the sensing of leakage current the conductors are passed through a special current transformer (or toroid). If the

currents in the conductors are equal, the output from the toroid is zero. Any current flow to earth downstream of the toroid will have a return path that bypasses the toroid. This creates an out of balance and there will be an output from the toroid. (See fig. 1)

With electronic devices the toroid output is amplified and at a preset value a solenoid is actuated to trip the circuit breaker section of the device. The power to operate the

fig: 2

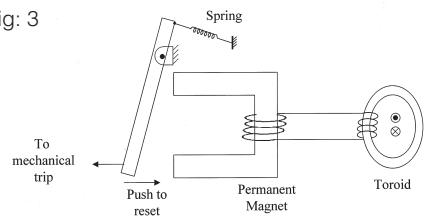


Typical arrangement of electronic RCD

device is normally derived from the circuit being protected. (fig. 2)

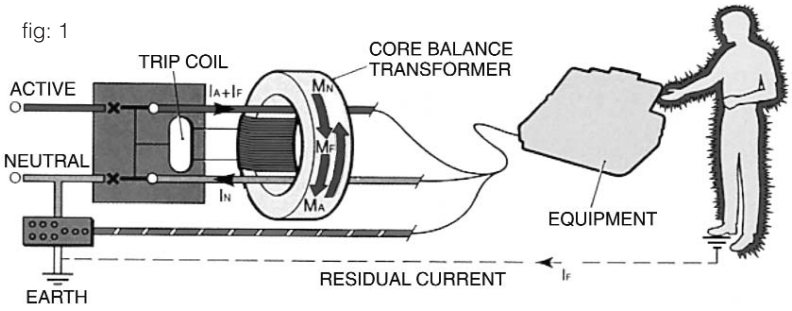
Electromechanical devices use an electromagnet that is held closed with a permanent magnet. When the toroid output flows through the coil it produces a magnetic flux that opposes the magnet and the armature is released. A spring is used to provide sufficient energy to trip the circuit breaker. In this type of device the energy required for operation is derived only from the output of the toroid. The

fig: 3



Typical arrangement of electromechanical device

fig: 1



The core balance transformer responds to the difference between active and neutral currents

spring is "charged" when the armature is mechanically reset by hand operation of the toggle. (fig.3)

Typical Circuits

The correct operation of these devices requires that there is no downstream connection of neutral and earth (MEN points). (fig. 4) This can happen inadvertently when using one device to protect a number of circuits. A split neutral bar is required to allow connection of the protected

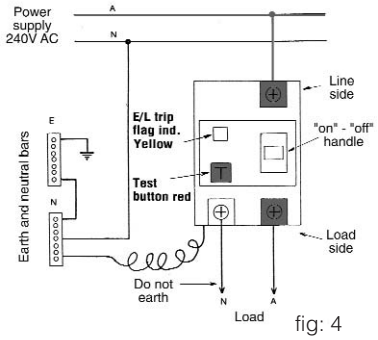


fig: 4

All MEN connections must be upstream of the sensing toroid

circuits. A section of the bar is fed via the earth leakage device for the protected circuits with the other section being used for unprotected circuits and the MEN connection to earth.

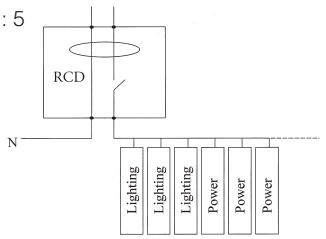
Nuisance Tripping

Because RCDs are very sensitive, interference or inherent errors can cause tripping problems. Consideration of the possible problems can sometimes avoid costly installation errors.

With the new requirement to provide RCD protection of lighting circuits in houses it is possible to comply with the Wiring Rules by installing one RCD to protect the whole installation. A small fault can then cause complete loss of power. (fig. 5) This is undesirable, particularly at night. As a minimum, separate units on light and power circuits are recommended. The best solution is to use combined RCD and MCB (RCBOs) on each circuit. As the price of these units trends down this solution becomes more attractive.

In commercial or industrial installations the length of cable and diverse range of equipment that may be connected can cause problems. Capacitive and normal leakage currents to earth can cause tripping or alter the trip threshold. These problems are compounded if multiple circuits are protected by one device. Cost savings

fig: 5

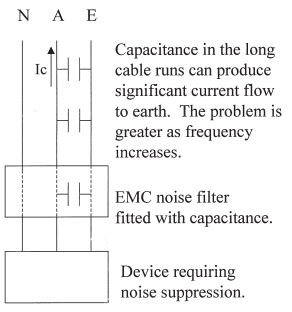


The use of a single device for protecting multiple circuits can cause problems

achieved by combining circuits onto the one RCD can be expensive in the long run.

There are now strict requirements on electrical and electronic devices not to emit electromagnetic interference. The techniques used to prevent interference often involve capacitors connected to earth. At steady state conditions these can cause leakage currents in the order of 1 mA per device. The initial turn on of these devices can create a surge that may cause tripping. They can also pass currents greater than 1 mA at the higher frequencies created by some devices. Electronic variable speed motor drives often create problems for RCDs because of the current flow to earth via the filter capacitors. (fig. 6)

fig: 6



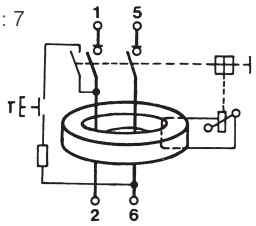
Capacitance can produce significant 1-10 earth

This problem can be overcome by using RCDs with low pass filters designed to ignore the high frequencies.

Fail to Trip/Testing

RCDs are fitted with a test means so that operation can be tested at regular intervals. This is required as they may fail and the failure can go completely unnoticed. While the Standards covering these devices require extensive testing to try and ensure long term reliability they can be damaged by environmental factors such as humidity, temperature extremes,

fig: 7

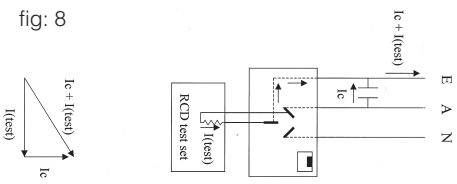


Typical test circuit with one turn through toroid

corrosive atmospheres and electrical surges in excess of the testing requirements. Unless they are tested at regular intervals this damage can go unnoticed. (fig. 7)

RCD testers that can be plugged into a socket outlet can give misleading results as the test current is added vectorally to any natural leakage in the circuit. The RCD may appear too sensitive when tested this way. Using these devices however does prove the overall installation and this type of test is well worthwhile at commissioning of the circuit. (fig. 8)

fig: 8

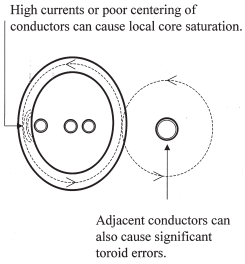


Standing leakage currents can cause apparent errors when using plug in test sets

High Currents

RCD protection is sometimes applied to circuits carrying quite high currents. A point is reached however where sensitivity must be reduced. If you consider a 1000 A circuit fitted with 30 mA earth leakage protection the accuracy of the toroid in summing the currents must be

fig: 9



High currents and adjacent conductors can cause significant errors

within say 3 mA giving a ratio of 1000/0.003 or 330,000:1. Few devices will achieve this.

While sensitive earth leakage is often used on circuits involving several hundred ampere, if it is a motor circuit the high currents during starting often will cause problems. Cables carrying high currents placed near the toroid will cause additional errors and may cause tripping. (fig. 9)

Conclusion

Earth leakage protection provides added protection against direct and indirect contact with electrical conductors. The sensitive nature of the devices however requires careful consideration when circuits with high currents, long cable runs or EMC filters are involved.

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☐ What's the difference about safety (Safety devices and their application)

☐ Talk about torque (Motors and torque)

☐ Keep your cables cool (Installation of cables)

We Apologise

In the last Technical News "Keep your cables cool" there was an error in the Normal Load paragraph. A replacement issue is now available

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