CONTINUOUS MONITORING AND AVOIDANCE OF RESIDUAL CURRENTS IN DATA CENTRES WITH RCM

White paper

Revision 3

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Introduction

Operators and managers consider outages, operational faults and interruptions to a data centre nightmare scenarios. If they occur as a result of avoidable mistakes, it's even more annoying. Meeting the stringent availability and safety requirements of modern data centres is no longer simply a matter of addressing issues such as infrastructure and power with load distribution, capacity planning and switchable circuits. The power setup has to be considered in much more detail and the residual currents, compensating currents and insulation errors recorded and assessed in depth.

Problem

Faults in the energy supply and resultant operational impacts on a data centre may be caused by insulation errors, stray currents, N conductor overload due to harmonics or asymmetrical loads, interruptions to the PE and N conductors and last but not least EMC factors. The consequences range from tripping various protective devices, corrosion on piping and lightning protection systems and unexplained IT system functional faults to fire damage or even personal injury. Depending on where the damage occurs and the availability class of the data centre, this may soon result in costs running into hundreds of thousands. Any personal injury must of course be avoided at any cost and a figure cannot therefore be placed on it.

If final circuits with socket outlets are used by non-technical specialists or intended for general use, DIN VDE 0100-140:2007-06 "Protection against electric shock" has applied to their safety since 1 June 2007. This standard prescribes extra protection in the form of RCDs / residual current circuit breakers for all socket outlets in alternating current systems. Measures must be in place to ensure that mistakes or damage are rectified immediately by an electrician. This also applies to connected devices, consumables or operating equipment.

Alongside personal protection, fire protection is also very important. Insulation errors occur in devices or their supply cables. They may be caused by mechanical, thermal or chemical damage to insulation. What are known as collective residual currents also result from EMC faults in the many switching power supplies in a data centre. The size of the residual current produced is determined by the rating of the voltage source, the earth resistance and the insulation error (RF). This residual current may flow between active, live conductors or from active, live conductors via the insulation error and/or the conductive parts to earth. These may include the fitted multiple-socket outlets or the racks themselves. If racks are insufficiently earthed, the error could even spread into other parts of the data centre via the shielding of the network cable used. If the current is high enough (only with complete short circuit or earth fault), the upstream protective device is tripped and the faulty consumer or system part disconnected from the mains. However, if the residual current isn't sufficient to trip the protective device (due to partial short circuit or earth fault), there is an acute risk of fire if the erroneous power exceeds roughly 60 W at the point of the fault. This is roughly the equivalent of 260 mA at 230 V. RCDs with a rated current of

less than 300 mA, which reliably shut down equipment in the event of danger, provide safe and reliable protection.

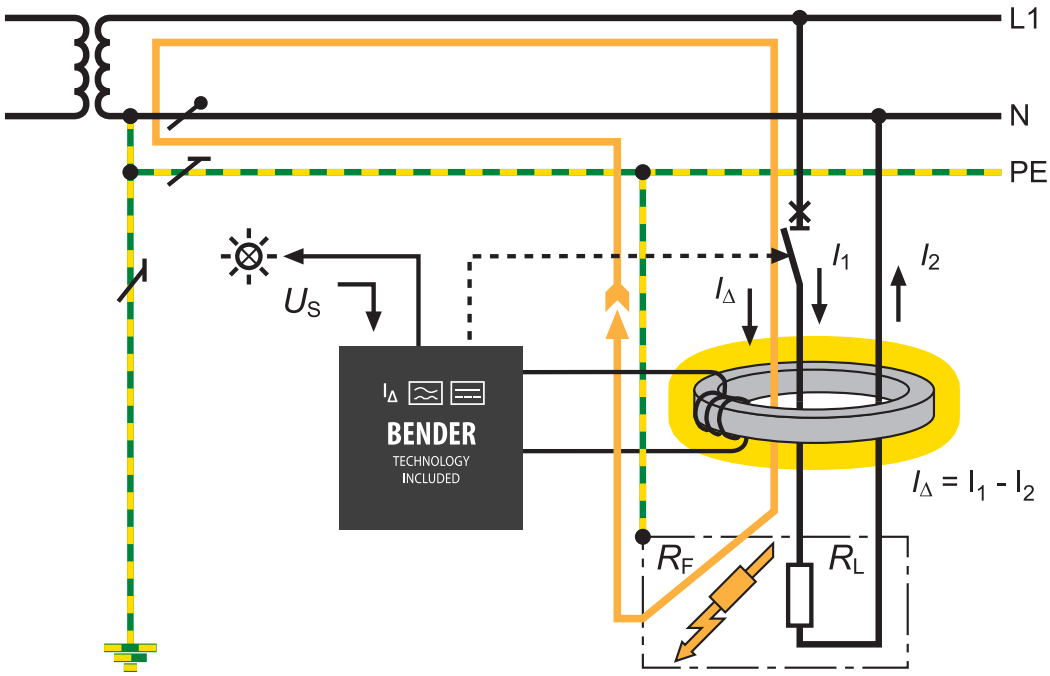

Figure 1 Function of RCM

Solution

Because maintaining operation is of course the number one priority in data centres, immediate shutdown of equipment and the major impacts this brings is usually not desired. Despite this, personal safety and fire protection must be ensured. This dilemma can be resolved by means of permanent monitoring with an RCM (Residual Current Monitor) system and organisational measures for rapid error rectification. RCDs do not then have to be used and the requirements of the standard are still met. RCMs are capable of recording residual currents of 5mA or more. The RCMs work by measuring the residual current. The conductors of the output requiring protection (with the exception of protective earth conductors) are guided through a measuring current converter with a secondary winding and analysed by electronics. If the power supply and distribution system is free of errors, the vectorial sum of all currents is zero and no voltage is induced in the secondary winding of the measuring current converter. On the other hand, if a residual current discharges to earth, the difference in current in the measuring current converter produces a current which is recorded and analysed by the electronics. Visual and acoustic displays and messages to the building control system or a DCIM (Data Center Infrastructure Management) system then indicate whether the set activation values and times have been exceeded. Because data centre availability has absolute priority, an RCM has an advantage over RCDs because there is no unexpected shutdown. The measured value display also allows gradual changes to be detected with ease. Imminent problems can be remedied at an early stage before a critical situation arises. RCMs correspond to DIN VDE 62020 (VDE 0663).

Certain types of circuits in electronic operating equipment produce smooth DC residual currents or currents with a low residual ripple in the event of errors. Operating equipment for control electronics
produces AC and pulsed DC residual currents of 50 Hz, smooth DC residual currents and AC residual currents of various frequencies. Many RCDs and RCMs currently in use are not able to record smooth DC residual currents and their tripping function may even be impaired. This is due to pre-magnetisation of the converter cores by DC residual currents. This raises the tripping threshold of the RCDs for AC residual currents arising at the same time to the point where
they don't trip at all. Personal protection is then no longer guaranteed.

RCDs and RCMs are classified into various types in accordance with IEC 60755 or DIN EN 62020 (VDE 0663). The types are AC, A, B and B+ (see Table 1).

B(+) RCMs should be used wherever possible in data centres. As well as recording sinusoidal AC residual currents
and pulsed DC residual currents, these also record smooth DC residual currents. Type B RCMs are known as AC / DC sensitive
RCMs.

		Correct function		
		RCD / RCM type		
	Type of residual current	AC	A	B
AC sinusoidal	sudden appearance	●	●	●
	slow increase			
DC pulsed	sudden appearance		●	●
	slow increase			
DC smooth				●
Symbol				

Table 1 RCM / RCD types

These days, RCM solutions are usually used in the sub-distribution or at the central earthing point of a TN-S system. So residual currents can be detected and reported and the protective standards met but there is still no scope for quickly localising and rectifying errors. Intelligent multiple-socket outlets with integrated RCMs can do this. Here the residual current is measured at rack level, per phase and can therefore be reported at an early stage and with accurate location information. Bachmann BlueNet RCM multiple-socket outlets (PDUs) use one type B AC / DC sensitive RCM per phase, which records the sinusoidal AC residual currents, pulsed DC residual currents and smooth DC residual currents, providing sufficient monitoring for the supply cables and switching power supplies of the servers and network equipment used.

Figure 2 The BACHMANN solution: BlueNet PDU with RCM

The BlueNet RCM multiple-socket outlets (PDUs) have four different activation values. Two fixed alarms at 30 mA and 3.5 mA meet the requirement for hazardous residual currents to be reliably reported. Two further adjustable alarms for AC residual currents between 3.5 mA and 100 mA and DC residual currents between 6 mA and 100 mA provide additional monitoring options.

In addition to an alarm LED on the multiple-socket outlet (PDU), reports can also be sent to the building control system via Modbus RTU/TCP or to the DCIM (Data Center Infrastructure Management) by means of SNMP Trap. There is also an option of e-mails being sent, e.g. to the data centre manager. A history of previous residual currents and reports can also be made visible in the building control system or in the DCIM (Data Center Infrastructure Management) through specific retrieval of measured values.

As well as RCM, the Bachmann BlueNet multiple-socket outlets (PDUs) of course provide other necessary features such as measuring currents and ratings of individual socket outlets. Depending on the model, they also have a switching function provided

by a power-saving bi-stable relay. This makes extensive monitoring, management and avoidance of outages possible.

Summary

The safety, maximum availability and economic viability of data centres and servers are absolutely essential for businesses these days. A faultless power supply to the racks is also important. Despite complying with the standards, modern consumers increasingly cause problems in the electrical systems used, presenting a growing challenge to safe operations. Potential risks include operational interruptions, unexplained functional faults, unexpected tripping of protective devices, fire and even personal injury. The use of RCMs helps to prevent problems, detect them at an early stage and ensure smooth data centre operation. If this monitoring is thorough enough, the time needed to localise and rectify the error can be further reduced and in a best-case scenario, intervention can take place before serious problems arise.

About the author

Thomas B. Jones is a product manager at Bachmann GmbH and is responsible for the IT Power Solutions product area. He handles the development, sales and marketing of Bachmann products for data centres and server rooms.