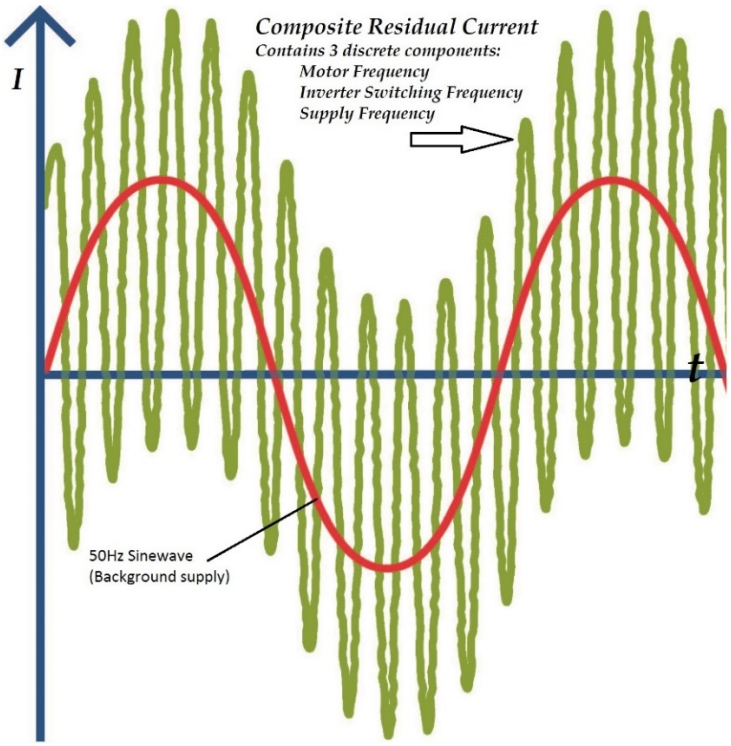
18th Edition – Type F RCD, Deep Dive

A recent discussion with a customer, highlighted that apart from the basic characteristics, when you look on the WEB information on Type F RCDs is quite limited. This article attempts to fill in the gaps.

For reference see Regulation 531.3.3 (Page 154): RCD behaviour in the presence of DC components and frequencies, and Figure A53.1 (Page 192)- possible fault currents in semiconductor based systems.

For basic information on Type F RCCBs see http://www.doepke.co.uk/rcd/rcd-F.html

Background



Operational leakage currents and residual currents associated with circuits containing non – linear loads i.e. current drawn is not proportional to the supply voltage, will consist of mixed frequency components creating a composite residual current - see Figure 1.

Application problems associated with conventional RCD protection and the addition of non-linear loads e.g. RCD failing to trip when tested, tripping for no apparent reason, tripping during connection or disconnection of the equipment, may not immediately be recognised as a problem with the load and the selection of correct RCD. It is probably not uncommon for the original RCD to be replaced first, to find the problem is still there.

In the previous decade, the increasing use of non-liner loads in domestic installations, resulted in the inclusion of Type F RCDs in IEC62423:2009 for household and similar use. This standard applied in conjunction with 61008-1 & 61009-1, detailed specific tests and characteristics for Type F RCDs.

In this decade we have seen a proliferation of energy saving appliances containing inverters, LED lighting, EV charging and of course switch-mode power supplies (SMPS) which are associated with many portable and desk top home technology devices.

Don't hide the problem

Surge resistant Type A RCCBs e.g. KV, super immune, super resistant; where originally designed to handle transient currents associated with capacitive or inductive loads i.e. Test for RCCB detailed in IEC61008. These products generally contain low pass filters, which can hide the effects of high frequency leakage currents covered by tests in IEC62423.

Using the wrong product to hide the problem does not solve the problem. Type F RCDs are specifically designed to detect composite residual currents – see Regulation 531.3.3 (iii)(a) i.e. the behaviour of the RCD is defined, it's tripping characteristic is not random, as may be the case with Type A RCDs subjected to different frequencies.

Composite Residual Current

In addition to the requirements of EN61008 or EN61009 for Type A currents , Type F must also meet EN62423: Composite residual current containing three frequency components, based on the rated residual operating current $I_{\Delta n}$ of the RCD and its rated frequency.

The values given in Table 3 of EN62423 are tabulated below. These values are used to calibrate the test waveform (Manufactures & Test Laboratories), prior to verifying the tripping performance of the RCD:

- The addition of these currents would give a waveform similar to Fig 1 on the previous page.
- 50 Hz represents the rated supply frequency for the RCD
- 1 kHz represents the switching frequency (clock frequency) of the inverter.
- 10 Hz represents the motor frequency.
- These values are used to replicate the most severe residual current conditions for the RCD.
- The composite test current is steadily increased from a value of 0.2 $I_{\Delta n}$
- The RCD must trip between 0.5 $I_{\Delta n}$ and 1.4 $I_{\Delta n}$ – reference Table 4 of EN62423

RMS test current value for the three frequency components			RMS composite starting current value
I at 50 Hz	I at 1 kHz	I at motor frequency (10 Hz)	I_{Δ}
0.138 $I_{\Delta n}$	0.138 $I_{\Delta n}$	0.035 $I_{\Delta n}$	0.2 $I_{\Delta n}$

Type F Detection Technology

Manufactures use various detection systems. The Doepke Type F uses a sophisticated, patented electronics system, powered from the energy within the summation current transformer, generated by the residual current. Therefore, the residual current circuit-breaker works independent of supply voltage for the detection of Type A and Type F residual currents.

Checking Compliance - Regulation 642.2 (i)

Type F tests are complex and are unlikely to be replicated on site with conventional test instruments.

In the absence of any other recommendations within the Regulations, Type A tests would have to be used to verify the basic operation of the device. Refer to Technical Publication 19 for additional info on testing.

The person responsible for the Design, Construction, Inspection & Testing will rely on the manufacture's documentation, certification and marking to verify that the RCCB meets the Type F requirements.

For example, Doepke's Type F RCCB has been independently certified by the VDE Testing Authority and carries the VDE Mark on the product supported by the appropriate Certificate.

Type F Applications

With regard to where and when to apply Type F:

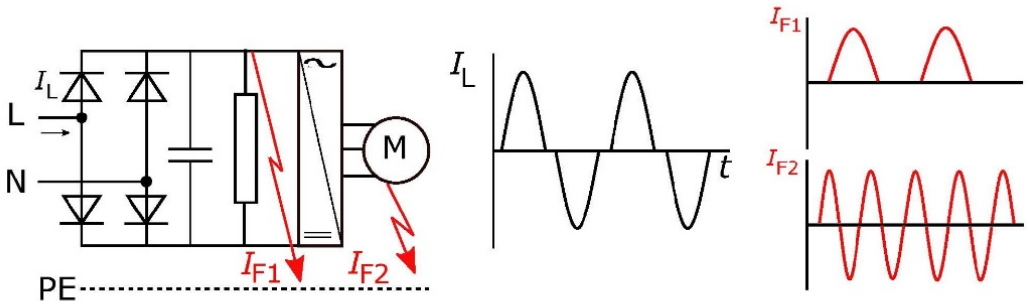
1. The Regulations make reference to their use
2. The appliance / equipment / EV manufacturer specifies the use of Type F
3. Personal experience of the installer who is involved in specific applications
4. Problems with conventional RCDs i.e. irregular tripping should be investigated fully
5. Select RCDs based on Reg. 531.3.3 and characteristics of the connected equipment

Common Example.
Washing machine with 13A plug and inverter output to 3 phase motor, allowing digital speed control. This enables the various washing and spin cycles to be closely controlled, to save energy.

Fault IF1: On the output of the DC link, before the inverter input, produces a pulsed (Type A) residual current.

Fault IF2: On the output side of the inverter produces a composite (Type F) residual current.

The composite residual current contains 3 components (see page 2): Supply 50Hz, Inverter clock frequency and the motor frequency component based on the speed of the motor. The composite residual current fault IF2 can only be reliably detected by a Type F RCD (Reg 531.3.3 (iii)(a).



Other common applications using single phase inverters, pumps, tools, battery charging. Mode 3 Charging of certain vehicles may require Type F (IEC60364-7-722 Ed2 Sept. 18 Now makes reference to Type F).

Conclusion

Always check the equipment manufactures instructions, as some single phase inverters require the use of Type B RCDs. This is due to the individual inverter design frequency characteristics and the level of smooth DC residual current produced under certain fault conditions.

The complexity of modern installations particularly those associated with special locations, due to the nature, characteristics and variation of the appliances, fixed loads and improved safety requirements, requires specific competences and knowledge. The IET resources web site gives access to a wide range of additional books and guidance for special locations. These publications contain additional information on RCD requirements, supporting the Wiring Regulations

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