Introduction

When installing frequency converters and other electrical equipment the use of fuses is not always sufficient protection to people and installation.

To increase protection Residual Current Devices (RCDs) also known as Earth Leakage Circuit Breakers (ELCBs) are often applied. Using RCD is often a legal requirement. Generally it is required in laboratories, bathrooms and on construction sites. and almost always where electrical equipment is connected to a plug. This is mainly required to protect people against hazardous electric shock. In farms and similar buildings RCDs are often required as fire guard.

The RCD embraces all live conductors (L1, L2, L2, N) except the protective conductors PE and PEN (see figure 1).

This instruction will guide you how to select the right RCD. As for information on where RCDs have to be applied, local legislation should be observed.

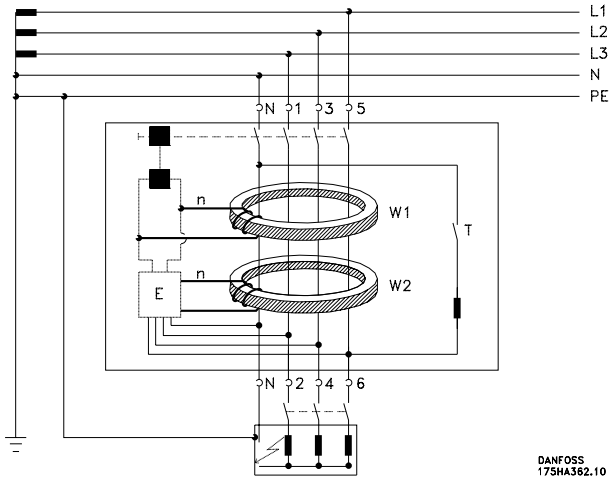

Fig. 1

E	Electronics for tripping in the event of smooth DC fault current.
T	Test facility.
n	Secondary winding
W1	Core balance transformer to detect sinusoidal currents.
W2	Core balance transformer to detect smooth DC fault currents.

RCD types

Figure 2 shows the fault currents which can be detected by the different RCD types.

	Form of residual current	Correct functionning of RCD		
		AC	A	B
Sinusoidal A.C.	Suddenly applied Slowly rising	+	+	+
Pulsating D.C.	Suddenly applied With or without 0,06A Slowly rising		+	+
Smooth D.C				+

Fig. 2

- RCD type AC is the oldest type and it can only detect AC fault currents.
- RCD type A is the most commonly used RCD type today. It can detect AC and pulsating DC fault currents, provided the DC fault currents cross or touch zero at least once in every 360° mains voltage cycle.
- RCD type B is a new type. It can detect AC, pulsating DC and smooth DC fault currents. There are three vendors today: Siemens, ABB and Bender. The Bender type B, however, does not incorporate a switch and is therefore to be considered a monitoring device only (an RCMA). If installed in accordance with Benders instruction, it can be used as an RCD.

Fig. 1 shows the diagram of an RCD type B. Type A or AC only has one coil (W1), in other respects it is similar to type B.

Local authorities should be consulted for information on where the use of Bender RCMA type B is allowed to substitute RCD´s.

Unfortunately RCDs of type B are quite expensive. Besides they have to be installed separately from any RCD type AC and type A. Planning example from EN 50178 is shown in figure 3.

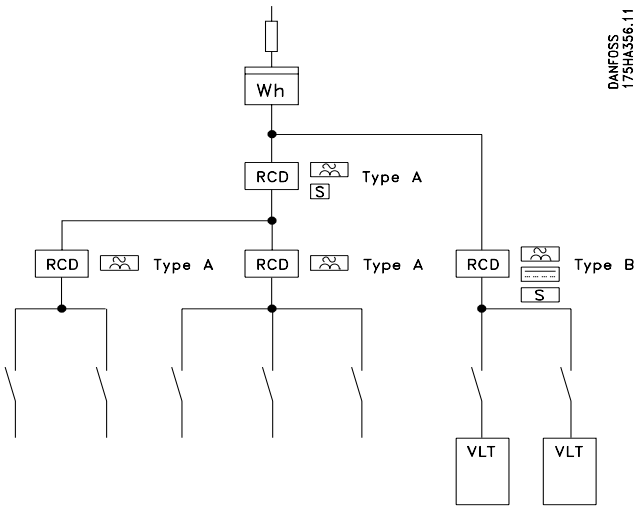

Fig. 3

■ Fault currents

For common line-side circuit configurations of frequency converters figure 4 shows waveforms of the fault current and where a DC content can occur in the fault current in the event of wrong connection to earth.

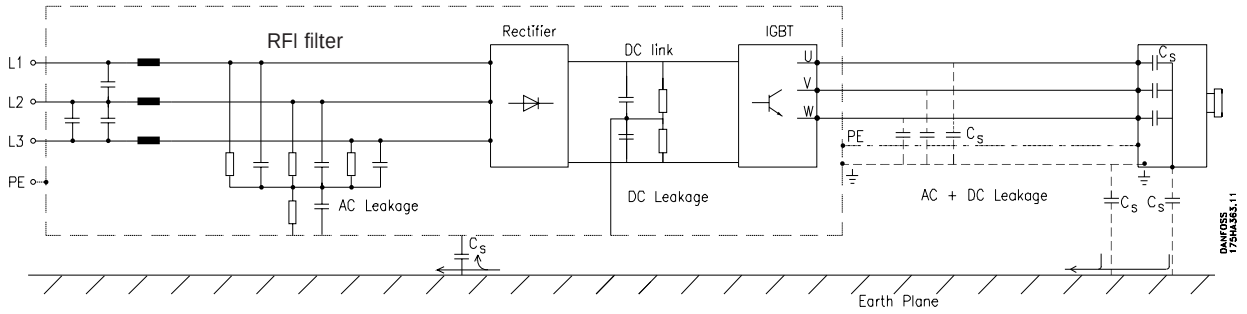

Fig. 4

■ Choosing RCD type

The RCD type AC is never to be used with frequency converters, since fault currents are never clean AC fault currents.

A single phase frequency converter has a B4 rectifier as shown in figure 5. The fault current is a combination of AC and pulsating DC. The pulsating DC fault current always touches zero in between two pulses. The RCD coil (W1 in figure 1) therefore will not saturate due to the DC content in the fault current and RCD type A may be applied.

Three phase frequency converters have a B6 rectifier. As shown in figure 5, the fault current does not cross zero. This is because all the diodes are never off at the same time.

The DC content in the fault current from a B6 rectifier will therefore most likely cause the RCD coil W1 to saturate. Therefore RCD type B must be applied. This RCD type has two monitoring circuits, one of which is designed for monitoring DC fault currents (W2 + E in figure 1). The RCD coil W2 will not saturate due to the electrical circuit to which it is connected.

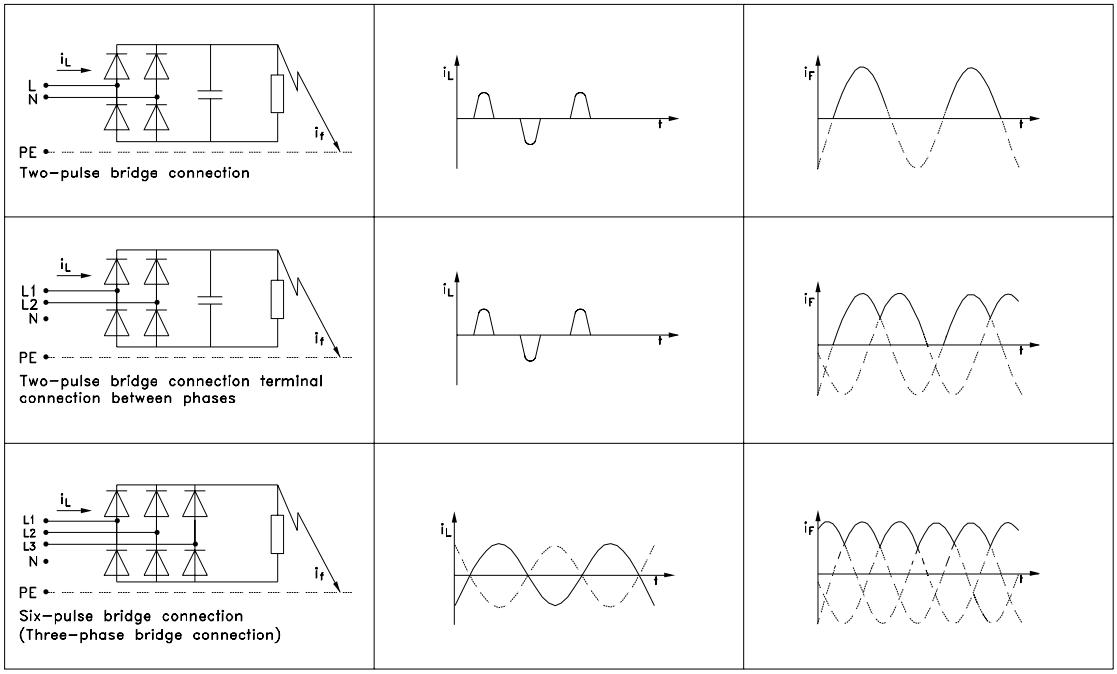

Fig. 5

How to apply RCDs with VLT

Three phase VLT frequency converters require a 300 mA RCD type B.

If an RFI filter is mounted in the drive and either the switch of the RCD or a manually operated switch is used to connect the drive to the mains voltage a time delay of minimum 40 ms is required.

At the moment this time delay can only be achieved by connecting the Bender RCMA to an external circuit breaker with undervoltage release (CTI and CBI-UA).

If no RFI filter is mounted or a CI contactor is used for mains connection, no time delay is required. This will make the use of the Siemens and ABB RCD type B possible. Further versions of these two RCD´s with built-in time delay is being developed at the moment and is expected primo 1998.

The reason why the RFI filter may cause problems at start is that simultaneous cut-in of the three phases will have the result that the earth leakage current from the capaciptors will be close to zero. See figure 4 for the diagram of an RFI filter.

If the phase is cut in before the other two phases the resulting current will exceed the trip level of the RCD.

If a manual switch is cut in very fast, the time delay between the three phases should be short enough, but trip-out may occur on occasion.
Single phase VLT frequency converters require a 300 mA RCD type A. There is no particular need for a time delay regardless if RFI filters are mounted or not.

The market situation

Since the introduction of the RCD type B the authorities have become more stringent as regards the use of RCDs. The RCD type B is seen as *the* solution to all the problems.

However, the above clearly shows that great precaution should be taken when applying RCDs in an installation with frequency converters.

It is possible that RCD type A will work, but with three-phase frequency converters you may risk that the RCD will not operate properly due to saturation of the RCD coil (W1 in figure 1).

The use of RCDs is demanded by the authorities all over the world. Local legislation should therefore be investigated before installing a frequency converter. Some installations do not require the use of RCDs and in such cases the installation costs are reduced substantially.