

The existing Regulations and guidance for small PV installations have been in place for several years, however there still appears to be a lot of confusion and miss information circulating within the Industry, relating to the use of Type “A” and Type “B” RCCBs in PV installations. “Getting it wrong can be costly for the PV Installer and could potentially be life threatening for Property Owner!”

## Solar Power Installations – Do you know what type of RCCB to use and why?

The opening statements in the \*IEE Wiring Regs (BS7671) make it quite clear that “*all parties must rely upon their own skill and judgement when making use of it*” this is based on the definition of a “competent person” page 22

Before an Electrical Installer can “safely” design, select, build and commission a system for any application, they need to understand the application and the interaction of the individual products within the installation – *see Chapter 33 specifically 331.1*

These two basic principles place a clear obligation on the installer to look at the PV installation as a complete system (for example SSEG) and not at the individual components as standalone elements. We all know that ignorance and or cutting corners based on financial decisions cannot be used as a defence or reason for doing something which could put property or lives at risk. Some of you might say that these are obvious statements!

We come across examples every week, where some installers appear to have considered the PV inverter as a standalone unit when making their RCCB selection! And consequently end up re-engineering /buying additional product once they have submitted their design / request for connection (G83-1-1).

### So do I need an “A” or “B” Type RCCB for my PV System?

Assuming an RCCB is required for automatic disconnection - no other design option is available, the PV Installer has to have at the very least the following knowledge and information to make a safe and informed decision.

#### 1. Basic understanding of the difference between A and B type RCCBs and RCMs

**Type A RCCB** / EN61008-1 Suitable for use with sinusoidal AC at fixed frequency (e.g. 50Hz) and pulsating DC with a maximum DC content of <6mA (Fig1). They will not sense AC residual currents at frequencies above their nominal design frequency, and if more than 6 mA DC flows through the RCCB, the tripping characteristic will be altered due to the saturation effect of the DC current on the A Type sensing coil. As the level of DC current increases the tripping time will increase to a point where the coil is completely saturated and the RCCB may not operate at all – *see clause 133.1.3*

**Type B RCCB** / *additional requirements IEC60755 / IEC62423* Designed for use in installations where the residual currents present will not be detected by a Type A RCCB. Note here that due to the existing standards, you will need to refer to individual manufactures data for trip characteristics - Current /Frequency Range to check that the B Type RCCB can detect the full range of residual currents present in the installation. - See IEC60479 current /frequency effect on the human body and fire protection limit of 300mA if applicable - *example Reg 331. , 422.3.and 705.411*

**RCM** / EN62020 Residual current monitors are used to monitor a supply and give a warning signal of possible problem. RCMs used in PV inverters, because of their design cannot and are not intended to replace the RCCB installed on the AC side of inverter. Their function is completely separate and not related to the installation regulation requirements for automatic disconnection. *see Reg 411.1.*

**2. The likely effects of the PV Installation** as a whole (not just the PV Inverter) on the ability of the RCCB to perform its safety function when called upon to do so - *Reg 331.1 and 411.* Remember RCCBs are classed as an additional protection measure, so it is imperative that they are used within their design limits *Reg 133.2*

In a PV installation which does not contain simple separation between the PV inverter and the RCCB (transformer required to block DC components being transferred between AC/DC side), in the event of a restricted earth fault on the DC side of the installation (Fig 2), the DC and AC components of the residual current depend upon the topology of the PV inverter and level of DC voltage (PV array). The residual current will be the algebraic sum of the AC component (50Hz /UK), DC component and a high frequency component determined by the PV inverters switching frequency and EMC filters( typically 16 -22kHz). The form of the residual current will thus vary along with the DC content, which means it would not be safe to use a Type A RCCB, hence the reason for using a Type B RCCB - *Reg 712.411.3.2.1.2*

The statement in the above regulation *where the PV converter is by construction not able to feed DC fault currents back into the installation....* needs to be considered in context. With existing technology that is readily available, the only way of guaranteeing that any DC fault currents will not flow through the RCCB, is to use an Inverter with an isolating transformer. If you use an inverter without a transformer and an A type RCCB, you have no way of confirming, that the device will not be subject to residual currents with a smooth DC content  $>6\text{mA}$ , you would be outside of the scope of the standard for the RCCB (see Reg 133.1.3).

### **(Buyer beware)**

If you are relying on a statement from your Inverter supplier to cover you for using a Type A RCCB with a transformerless Inverter, read the declaration very carefully. The ones we have seen do not actually cover the Installer ...in fact it is quite the opposite:

The wording tends to focus on the inverter as source of DC fault current and faults within the inverter as reason for not using a Type B RCCB, it does not say anything about earth faults on the PV array as potential source of DC current being fed back into the system. They also warn quite clearly that in the case where a Type A RCCB is used, the smooth DC content of the residual current can affect the tripping characteristic by as much as 30% based on their tests.

Using a Type A RCCB on the basis of the above would be in direct contravention of IEE Wiring Regulation 133.1.3

This point about taking the whole system into consideration is also covered in the Electrical Safety Council's best practice guide relating to the *Connection of microgeneration systems to domestic or similar electrical installations*. Page 12 gives "essential criteria which must be met" Clause IV makes it quite clear that you need to look at the microgenerator (SSEG) as whole when selecting the RCCB and not just the PV inverter. The "supplier (normally the Installer) of the SSEG would have to guarantee that the smooth DC content would not exceed 6mA, before using A type RCCBs.

MCS installers working to the requirements of MIS3002 / DTI "Guide to the installation of PV systems" are required to fit Type B RCCB for transformerless inverters. Clause 2.3.1 is a mandatory requirement.

### **3. The level and frequency of leakage currents present in normal operation. See - Reg 331.1 and 133.2.3 and 422.3.9**

Remembering that PV Inverters due to their inherent function and the requirement for EMC protection, produce leakage currents at various frequencies above 50Hz up to approximately 22kHz, it is important from a safety and design aspect to determine these values before purchasing the inverter. Identify the leakage current at 50Hz, the maximum leakage current at given frequency and the leakage current at the maximum frequency. This is to ensure that the characteristics of the inverter are compatible with the leakage current limits and RCCB protection level required for the intended installation. It will reduce the risk of costly re-work on site at the commissioning stage, or when for example the SSEG Installation commissioning confirmation sheet is completed (Appendix 3 of G83/1-1), and the Installer signs to confirm that the installation complies with BS7671. Further more if these values are not determined, it is possible that SSEG will cause the RCCB to trip, with no apparent fault present. If they do not have a current/frequency analyser available on site, they will not be able to determine the leakage currents present on the system.

It is hoped that following these simple steps and the best practice advice given the IEE Regs will help to make the selection process simple and efficient and reduce the risk of the Installer selecting and buying inappropriate equipment for the application, or worse installing a system that is potentially dangerous. B safe don't be sorry.

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Reference Documents: \* IEE Wiring Regulations up to and including Dec 2011 for installations made in 2011  
Electrical Safety Council Best Practice Guide for SSEGs  
Microgeneration Installation Standard MIS3002  
Engineering Recommendation G83-1-1

