Abstract Title: Earthing unit for solar panel array

A unit for earthing the positive side of a solar panel array via a high resistance path, comprising an enclosure 2 housing a rail-type mounting which carries a first terminal block 20 which connects a negative input 4 of the unit to a negative output 8 and a second terminal block which connects a positive input 6 of the device to a positive output 10, the second terminal block also being connected to one side of a series circuit of a high value resistor 28 and a fuse 32 whose other side is adapted to be connected to earth 34. The rail type mounting may be a DIN rail.
"Photovoltaic Functional Earthing Unit"

This invention relates to photovoltaic generators, and in particular, to a device for preventing the possibility of charge build-up which can occur on the surface of a high efficiency crystalline solar cell array, in use. It is particularly adapted for use with solar panel installations, arranged to drive inverters.

It is known that charge build-up on the surface of solar cells can reduce the energy yield in both conventional and back contact-type performance crystalline solar cells. This can occur when the cells are operated at a high positive voltage and is explained in more detail below. The effect is, however, more significant with back contact cells.

Accordingly, the present invention provides means for earthing the positive side of the array, by placing a large resistor, in line with a suitable fuse, between the positive DC connection to the photovoltaic array, and an earth connection, so that the voltage developed across the array is negative relative to earth rather than positive.

According to the present invention there is provided a unit for earthing the positive side of a solar panel array via a high resistance path, comprising an enclosure housing a rail-type mounting carrying a first terminal block which connects a negative input of the unit to a negative output, and a second terminal block which connects a positive input of the unit to a positive output, the second terminal block also being connected to one side of a series circuit comprising a high value resistor and a fuse, whose other side is adapted to be connected to earth.

Preferably the enclosure has a first pair of connection means for positive and negative inputs from a solar panel array; a second pair of connection means for corresponding positive and negative outputs to an inverter; a first terminal block for connecting the negative side of the solar panel array connection, to the negative side of the inverter connection; a second terminal block for connecting the positive side of the solar panel connection to the positive side of the inverter connection; and a mounting for a high value resistor and a fuse, the resistor and the fuse being connected in series.
between the second terminal block on the positive side of the circuit and a further external connection, which is in turn adapted to be attached to an earth point on the AC side of the inverter circuit. The mounting preferably comprises a further rail-mounted terminal block for each of the resistor and the fuse.

In this way the positive side of the solar panel array is connected to ground so that the voltage developed across it is negative, which ensures that current leakage from the surface of the cell to earth, caused by an accumulation of negative charge on the surface, is effectively prevented.

Preferably, the device incorporates standard terminal blocks which are mounted on a "DIN" rail, and the external connections can be made with standard multi-contact solar cable connectors, or flying leads as appropriate.

In use, the unit is preferably installed between a DC isolator switch which receives the power input from the solar panels, and the DC side of the inverter, with its earth connection shared with that of the point of grid connection.

The unit may be utilised in conjunction with inverters that have galvanic isolation and with non-earth or "floating" PV array frameworks, and may be fitted at initial installation, or retro-fitted to an existing array.

Instead of being housed in a separate enclosure, the equipment can be included inside the same enclosure as a DC isolator, so as to minimise the number of external connections.

One embodiment of the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a unit according to the present invention with the cover removed to illustrate internal connections; and

Figure 2 is a schematic diagram showing the connection of the device in a typical solar installation.
Referring to Figure 1, the earthing unit comprises a standard electrical enclosure having solar cable connectors 4 and 6 of a standard kind, extending through apertures in one side, which are adapted to be connected to a DC isolator at the output of a solar panel array.

At the other side of the enclosure, a pair of solar cables 8 and 10 are provided with flying leads and solar cable connectors (not shown) which are again of a standard type which are complementary to the connectors 4 and 6. These are connected to the DC side of an inverter which enables the output power of the system to be supplied to an AC circuit.

It will be appreciated, therefore, that because of the arrangement of the cable connectors, the device can easily be retro-fitted into an existing circuit, between its DC isolator and its corresponding inverter.

The housing contains a standard DIN-rail mounting 12, which carries an assembly of standard terminal blocks 14 in a conventional fashion, the terminal blocks being held in position by end stops 16 at each end of the assembly.

The electrical connections through the unit comprise a first negative lead 18 extending from the connector 4, and connected into one end of a first terminal block 20, at the other end being connected to the negative lead 8 through the inverter. Similarly, a positive lead 22 from the connector 6 is connected via a second terminal block 24, to the inner end of the positive lead 10 to the inverter.

The second terminal block 24 also has a further terminal to which is connected a short jump lead 26 connecting the positive side of the circuit to a third terminal block 28 which houses a high value resistor, for example, between 0.5 - 2MΩ. The other end of the terminal block 28 is connected, via another short jump lead 30, to a fourth terminal block 32 which houses a correspondingly small value fuse, for example, 10 - 100mA.

The other end of the fourth terminal block 32 is connected to a flying lead 34 which passes through a further aperture 36 in the housing, and constitutes an earth lead
It will be appreciated that the arrangement of the connections, resistor, and fuse in an assembly of terminal blocks mounted on a DIN rail, as illustrated, provides a particularly convenient method of arranging and interconnecting the components, which renders the device simple to assemble and also, easy to inspect. If the fuse should fail, for example, as a result of an accidental short circuit, it is also easy to replace.

In use, the end of the flying lead 34 is connected to an earthing point on the other side of the inverter, as shown in more detail in Figure 2 which is a schematic diagram showing the layout of an entire installation. As illustrated in this Figure, a solar array 40 is connected by solar cable connectors to a 20 amp DC isolator 42, and the outputs of the isolator 42 are connected to the inputs 4 and 6 of the earthing device 2. The outputs 8 and 10 of the earthing device 2 are in turn connected to an inverter 44.

The “flying lead” 34 is then connected to the grid earth connection at an AC isolator 46.

The output from the AC isolator 46 feeds a standard kind of single phase kilowatt hour meter 48 which is in turn connected to a consumer unit in a conventional manner. The details of the subsequent circuitry are conventional, and will not be described any further here.

In operation, the fact that the positive side of the solar panel array is connected to earth ensures that the voltage developed across the array is a negative voltage. If the voltage across the array was a large positive voltage, there would be a danger of leakage to earth, from the solar panel through the covering glass and frame, which, over a period of time, can result in a residual negative charge being left on the front surface of the cells. Depending upon the exact structure of the cell, and particularly, its outer surface treatment, this can result in positive charge carriers within the cell being attracted to the front surface where they recombine with the negative charges (i.e. electrons) and are lost. Consequently, the output power of the cell is reduced.
On the other hand, when the module is operated at a negative voltage with respect to ground, if current leaks from ground through the glass cell surface, this will leave a positive charge on the surface. Consequently, positive charge carriers in the device below the surface are repelled, so that they move away from the surface and are eventually collected as part of the output current of the cell. In this way, the connection of the earthing unit first of all acts to neutralise any negative surface charges already accumulated on the surface, and subsequently acts as a barrier to the further leakage of current from the front surface.

Although not illustrated, it is also envisaged that an LED indicator could be provided to give a warning of any failure of the fuse. Alternatively a monitoring signal could be provided by an RFID device, so as to communicate with a suitable external device.
CLAIMS:

1. A unit for earthing the positive side of a solar panel array via a high resistance path, comprising an enclosure housing a rail-type mounting which carries a first terminal block which connects a negative input of the unit to a negative output, and a second terminal block which connects a positive input of the device to a positive output, the second terminal block also being connected to one side of a series circuit of a high value resistor and a fuse whose other side is adapted to be connected to earth.

2. A unit according to claim 1 in which the high value resistor and the fuse are each mounted in a respective further terminal block.

3. A unit according to claim 1 or claim 2 in which the terminal blocks are mounted parallel to one another on a DIN rail.

4. A unit according to any one of the preceding claims further comprising an LED indicator which is arranged to give a warning of the failure of the fuse.

5. A unit according to any one of the preceding claims further comprising an RFID device adapted to communicate with an external monitoring device.

6. An earthing unit substantially as herein described with reference to the accompanying drawings.

7. A solar panel installation including an earthing unit according to any one of the preceding claims.
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

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<thead>
<tr>
<th>Category</th>
<th>Relevant to claims</th>
<th>Identity of document and passage or figure of particular relevance</th>
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<tbody>
<tr>
<td>A</td>
<td>-</td>
<td>JP 2005175350 A (MATSUSHITA) see abstract and figure 1 - resistor 4 in series with fuse 1</td>
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<tr>
<td>A</td>
<td>-</td>
<td>US 6243243 B1 (GELDERLOOS et al.) see figure 2 - high impedance device 32 between solar array 26 and spacecraft ground 30</td>
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<tr>
<td>A</td>
<td>-</td>
<td>EP 0878850 A2 (CANON) see figure 1</td>
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<td>JP 07177646 A (TOSHIBA) see abstract and figure 1 - resistor R</td>
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Categories:

| X | Document indicating lack of novelty or inventive step |

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| A | Document indicating technological background and/or state of the art |

| P | Document published on or after the declared priority date but before the filing date of this invention. |

| E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC:

H2H

Worldwide search of patent documents classified in the following areas of the IPC:

H01L; H02H

The following online and other databases have been used in the preparation of this search report:

EPODOC, WPI