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SINVERT

PV Field Grounding

Technical description

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Contents

- 1 PV Field Grounding 3**
 - 1.1 General..... 3
 - 1.2 PV field grounding - negative-pole grounding..... 4
 - 1.2.1 General 4
 - 1.2.2 Counter-measure - negative-pole grounding..... 4
 - 1.2.3 Circuit diagram - negative-pole grounding 4
 - 1.3 PV field grounding - positive-pole grounding..... 5
 - 1.3.1 Counter-measure - positive-pole grounding 5
 - 1.3.2 Circuit diagram - positive-pole grounding 6
 - 1.4 Additional option – terminal box PV field grounding..... 7

1 PV Field Grounding

1.1 General

Solar module manufacturers are launching a steadily increasing stream of new cell technologies or advances in the design of conventional modules. These new technologies include thin-film modules and back contact cells which require specific operating conditions.

The primary difference between traditional solar cells (crystalline solar cells based on silicon wafers) and thin-film cells is the method of manufacture and the thicknesses of the materials used.

Thin-film technology offers the following advantages:

- Low use of materials and energy
- Automated production process suitable for large areas
- High vertical range of manufacture: Cell manufacture, circuit connection and encapsulation are all undertaken in an integrated production process
- Good energy yields, versatile application

Siemens maintains close contact with module manufacturers so that it can continually adapt and optimize its SINVERT systems in line with developing trends.

With the optional feature "Positive / Negative PV Field Grounding", the SINVERT inverters offer an ideal choice for manufacturers who require a module ground.



Remember: For the latest information about the necessity for and type of grounding, please contact your module manufacturer!

Some module manufacturers recommend positive or negative grounding of the PV generator when certain types of module are used!



PV systems no longer constitute a DC IT system when their modules are grounded. For safety reasons, the PV system must be fenced in and designated as an electrical operating area. Access must be prohibited to all persons except qualified electricians.

1.2 PV field grounding - negative-pole grounding

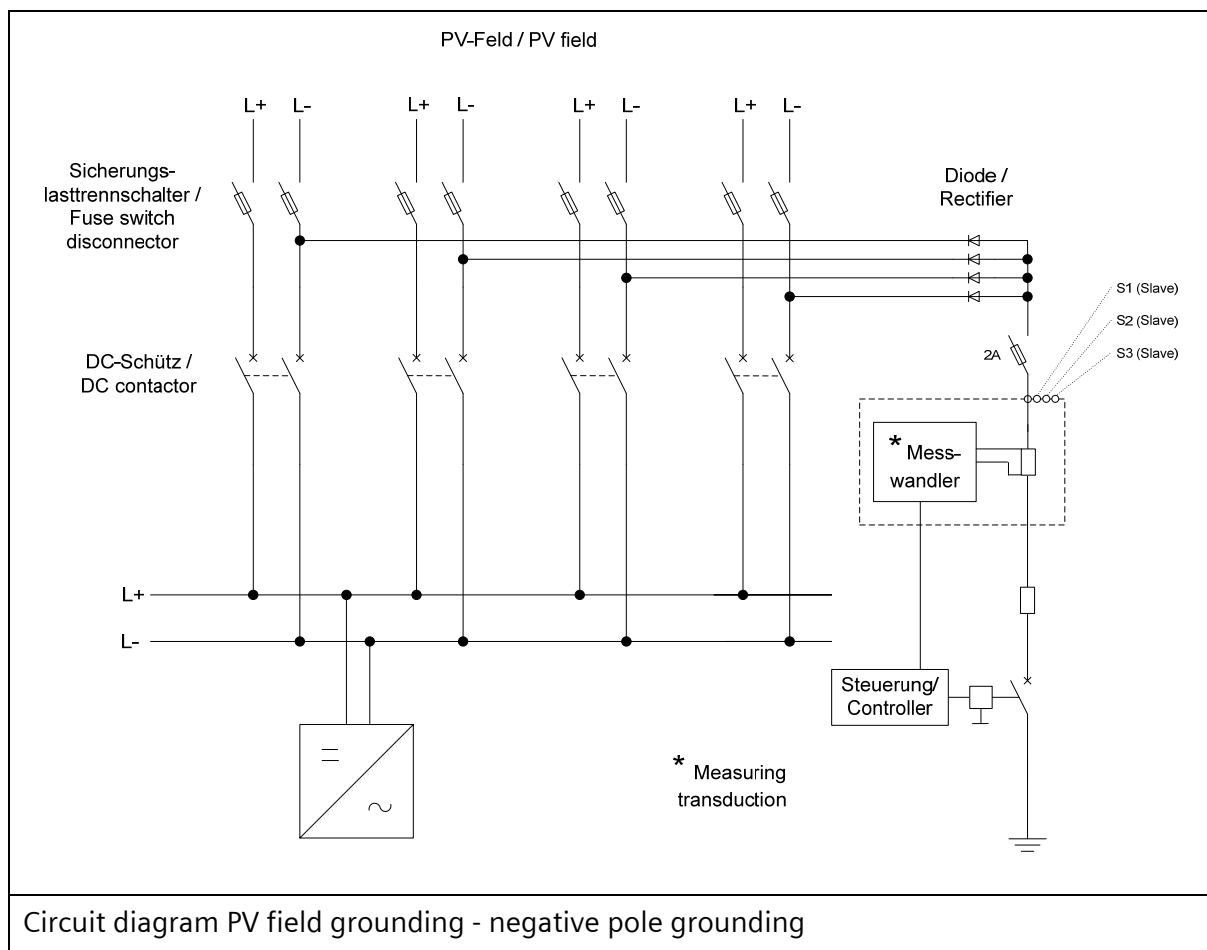
1.2.1 General

Some types of thin-film module are susceptible to increased degradation. The main problem is caused by the potential destruction of the TCO layer (TCO: Transparent Conductive Oxide). This transparent, conducting layer on the "sun-facing" side of the module is used to divert the solar-generated direct current and is thus a key component of the system. Damage to this TCO layer is irreparable and results in a significant loss of performance.

1.2.2 Counter-measure - negative-pole grounding

Grounding the negative pole of the PV generator reliably protects the TCO layer against corrosion, thereby preventing any loss of performance in the modules.

1.2.3 Circuit diagram - negative-pole grounding



PV systems normally constitute a DC IT system. In a DC IT system, neither the positive nor negative pole is grounded. The SINVERT inverters are equipped with an insulation meter as standard. This monitors the system for low resistance to ground caused by insulation damage (e.g. to cable). This monitoring function ensures the safety of personnel.

Grounding the solar modules changes the characteristics of the photovoltaic system in such a way that it no longer constitutes a DC IT system.

With negative-pole grounding, the DC cables are interconnected via diodes with the DC inputs of the inverter (see circuit diagram). This DC cable is then taken to a central grounding point via a fuse, a high resistance and a DC disconnecter.

Grounding an active conductor (negative pole) means that the inverter's insulation measuring function no longer works in the normal way. A hazardous current can start to flow as soon as the first insulation damage occurs. For this reason, the condition of the system is monitored through measurement of the current between the negative pole and ground. If the current level measured is deemed to pose a risk, the connection is automatically broken by means of a motor-operated DC disconnecter. The disconnecter is driven by the inverter's control system. In this context, it is important to note that the connection between the module field and inverter ground must be of high quality. If the connection resistance is high as a result of very dry conditions or unfavorable ground conditions, it will not be possible for a sufficiently high current to flow. It is also important to note that a fault at the same potential when grounded will not drive a current. In order to counter this problem, the grounding connection is disabled at night by the motor-operated DC disconnecter. The insulation monitor then scans the now ungrounded DC inputs for ground faults. Any unusual scan results can be signaled.

The DC disconnecter has three settings:

- 1) Remote-controlled operation
- 2) Local operation
- 3) "Off" signal position (lockable)

When the DC disconnecter is opened, the ground connection between negative pole and ground is deactivated. An insulation (resistance) measurement is taken.

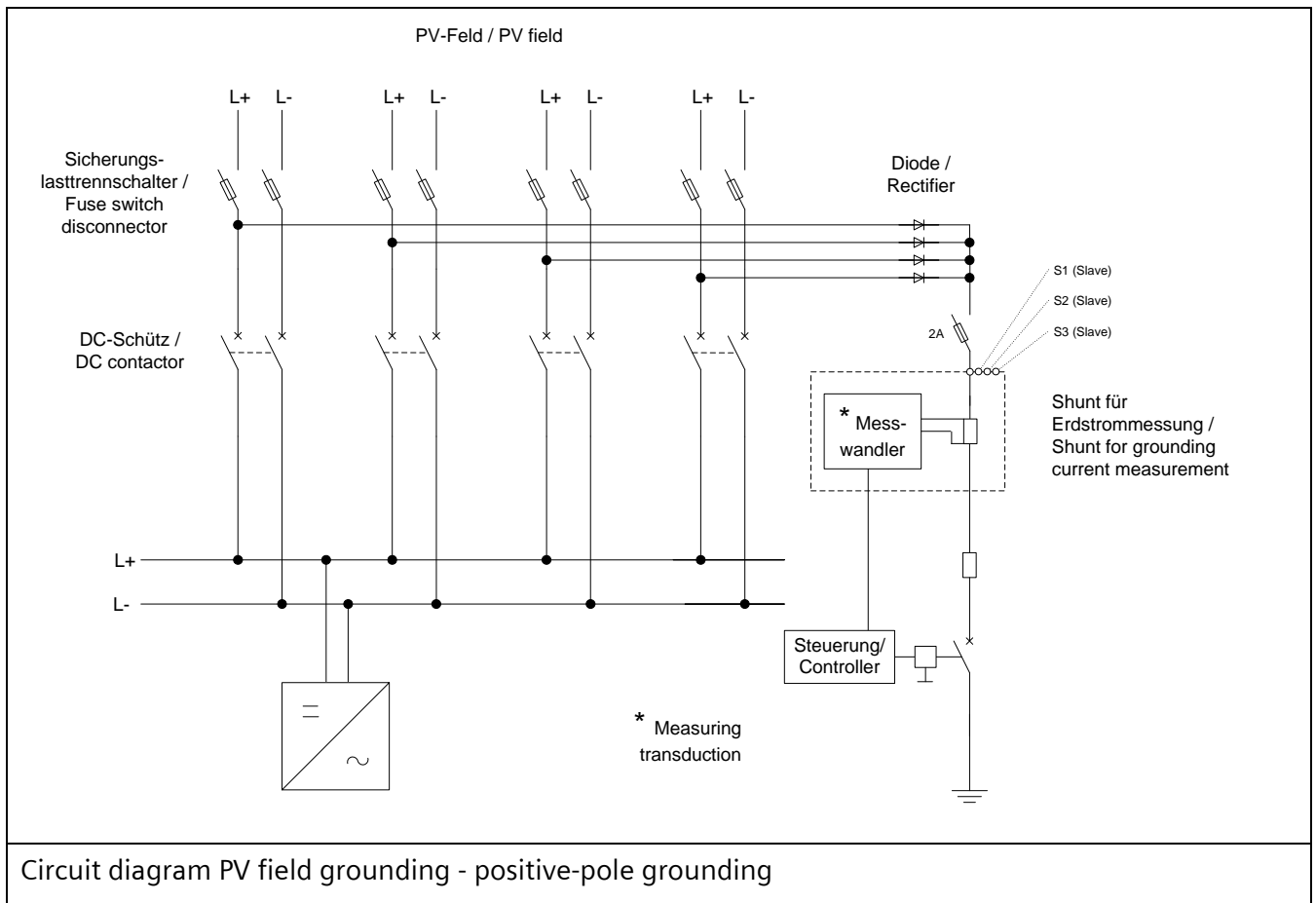
1.3 PV field grounding - positive-pole grounding

When back contact solar cell modules (e.g. SunPower A-300) are in operation, negative charge carriers collect on the cell surface. This static charge on the front face of the cell cannot be discharged because the front face is insulated from the arresters on the rear face. This effect is also referred to as "surface polarization" and it is known to gradually impair the performance of modules.

1.3.1 Counter-measure - positive-pole grounding

It is however possible to reverse the effect of surface polarization. This is done by connecting the positive pole of the solar generator to ground potential across a high resistance; the connection is fuse-protected. This arrangement completely discharges the negative charge carriers on the cell surface, restoring the module to its original performance level, and even increasing the efficiency of the cell slightly. If the positive pole is not grounded, the system performance will be impaired.

Grounding the solar modules changes the characteristics of the photovoltaic system in such a way that the inverter's insulation measuring function no longer works in the normal way.



1.3.2 Circuit diagram - positive-pole grounding

PV systems normally constitute a DC IT system. In a DC IT system, neither the positive nor negative pole is grounded. The SINVERT inverters are equipped with an insulation meter as standard. This monitors the system for low resistance to ground caused by insulation damage (e.g. to cable). This monitoring function ensures the safety of personnel.

Grounding the solar modules changes the characteristics of the photovoltaic system in such a way that it no longer constitutes a DC IT system.

With positive-pole grounding, the DC cables are interconnected via diodes with the DC inputs of the inverter (see circuit diagram). This DC cable is then taken to a central grounding point via a fuse, a high resistance and a DC disconnector.

Grounding an active conductor (positive pole) means that the inverter's insulation measuring function no longer works in the normal way. A hazardous current can start to flow as soon as the first insulation damage occurs. For this reason, the condition of the system is monitored through measurement of the current between the positive pole and ground.

If the current level measured is deemed to pose a risk, the connection is automatically broken by means of a motor-operated DC disconnect. The disconnect is driven by the inverter's control system. In this context, it is important to note that the connection between the module field and inverter ground must be of high quality. If the connection resistance is high as a result of very dry conditions or unfavorable ground conditions, it will not be possible for a sufficiently high current to flow. It is also important to note that a fault at the same potential when grounded will not drive a current. In order to counter this problem, the grounding connection is disabled at night by the motor-operated DC disconnect. The insulation monitor then scans the now ungrounded DC inputs for ground faults. Any unusual scan results can be signaled.

The DC disconnect has three settings:

- 1) Remote-controlled operation
- 2) Local operation
- 3) "Off" signal position (lockable)

When the DC disconnect is opened, the ground connection between negative pole and ground is deactivated. An insulation (resistance) measurement is taken.

1.4 Additional option – terminal box PV field grounding

To allow safe access to the PV plant, an option is available which enables the connection between the negative or positive pole and ground to be disabled temporarily. This is achieved by attaching a separate terminal box to the outer wall of the inverter building/container. This terminal box contains a control switch and two signaling lamps. In the rest state, the control switch is closed and the "yellow" signaling lamp is illuminated. If the control switch is opened manually, a signal is sent to the S7 in the inverter which responds by opening the DC disconnect. An insulation measurement is then performed on this PV sub-field. The insulation test takes about 10 minutes. If the insulation measurement returns an acceptable insulation value, the "yellow" signaling lamp goes out and the "green" lamp turns on. The relevant PV sub-field can be safely accessed. If the warning lamp remains at "yellow", an unacceptable insulation value has been measured which means that an insulation fault may be present. The system is operated in solo mode if possible. In this situation, only specially instructed electricians may be allowed access to the PV sub-field. The negative/positive pole must be reconnected to ground by means of the control switch when the PV sub-field area is exited again (the S7 is again involved in the connection process). This arrangement can be applied to the entire solar park or selected parts of it (requires multiple terminal boxes). The terminal box can be used for more than one container if necessary. In this case, however, the signals must be looped through from one container to the others. As the inverters need to be specially equipped for this purpose, the signal looping must be included in the system plan and order.

