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TECHNICAL SPECIFICATION

colour inside

Utility-interconnected photovoltaic inverters – Test procedure for low voltage ride-through measurements

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UTILITY-INTERCONNECTED PHOTOVOLTAIC INVERTERS – TEST PROCEDURE FOR LOW VOLTAGE RIDE-THROUGH MEASUREMENTS

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62910, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/884/DTS	82/1005/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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UTILITY-INTERCONNECTED PHOTOVOLTAIC INVERTERS – TEST PROCEDURE FOR LOW VOLTAGE RIDE-THROUGH MEASUREMENTS

1 Scope

This Technical Specification provides a test procedure for evaluating the performance of Low Voltage Ride-Through (LVRT) functions in inverters used in utility-interconnected PV systems.

The technical specification is most applicable to large systems where PV inverters are connected to utility HV distribution systems. However, the applicable procedures may also be used for LV installations in locations where evolving LVRT requirements include such installations, e.g. single-phase or 3-phase systems.

The assessed LVRT performance is valid only for the specific configuration and operational mode of the inverter under test. Separate assessment is required for the inverter in other factory or user-settable configurations, as these may cause the inverter LVRT response to behave differently.

The measurement procedures are designed to be as non-site-specific as possible, so that LVRT characteristics measured at one test site, for example, can also be considered valid at other sites.

This technical specification is for testing of PV inverters, though it contains information that may also be useful for testing of a complete PV power plant consisting of multiple inverters connected at a single point to the utility grid. It further provides a basis for utility-interconnected PV inverter numerical simulation and model validation.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61400-21:2008, *Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines*

3 Terms, definitions, symbols and abbreviations

3.1 Terms, definitions and symbols

For the purposes of this document, the following terms, definitions and symbols apply.

3.1.1
drop depth
magnitude of voltage drop during a fault or simulated fault, as a percentage of the nominal supply voltage

3.1.2
double drop
sudden decline of the nominal voltage to a value below 90 % of the voltage of PCC, followed after a short time by a voltage recovery, which happened twice. Voltage changes which do not

reduce the voltage to below 90 % of the voltage of PCC are not considered to be voltage drops

3.1.3
equipment under test
EUT
EUT indicates the equipment on which these tests are performed and refers to the utility-interconnected PV inverter. During test period, EUT is connected with PV simulator instead of real PV modules on the DC side, while AC side is connected with grid

3.1.4
IT system
IT power system has all live parts isolated from earth or one point connected to earth through an impedance. The exposed-conductive-parts of the electrical installation are earthed independently or collectively or to the earthing of the system

[SOURCE: IEC 60364-1:2005, 312.2.3]

3.1.5
I_q
output reactive current of EUT

3.1.6
low voltage ride through
LVRT
capability of an inverter to continue generating power to connected loads during a limited duration loss or drop of grid voltage

3.1.7
maximum MPP voltage
maximum voltage at which the EUT can convert its rated power under MPPT conditions

[SOURCE: EN 50530:2010]

3.1.8
maximum power point tracking
MPPT
control strategy of operation at maximum power point or nearby

3.1.9
minimum MPP voltage
minimum voltage at which the EUT can convert its rated power under MPPT conditions

[SOURCE: EN 50530:2010]

3.1.10
N_{EUT}
access point of the EUT during the test

3.1.11
P_N
rated power of EUT

3.1.12
point of common coupling
PCC
point of a power supply network, electrically nearest to a particular load, at which other loads are, or may be, connected

Note 1 to entry: These loads can be either devices, equipment or system, or distinct customer's installations.

Note 2 to entry: In some applications, the term "point of common coupling" is restricted to public networks.

[SOURCE: IEC 60050-161:1990, 161-07-15]

3.1.13
proportionality constant K
K-factor
voltage support of EUT in accordance with the voltage drops. The K-factor is to be specified by the EUT manufacturer.

3.1.14
PV array simulator
simulator that has I-V characteristics equivalent to a PV array

3.1.15
PV simulator MPP voltage
$U_{MPP, PVS}$
MPP voltage of the setting PV curve that is provided by the PV simulator

3.1.16
S_{EUT}
apparent short-circuit power at N_{EUT}

3.1.17
single drop
sudden decline of the nominal voltage to a value below 90 % of the voltage of PCC, followed after a short time by a voltage recovery, which happened once. Voltage changes which do not reduce the voltage to below 90 % of the voltage of PCC are not considered to be voltage drops

3.1.18
Z_{grid}
grid short-circuit impedance value of the MP1 (see Figure 1)

3.1.19
Z_i
impedance value between the fault point and PCC

3.1.20
Z_p
impedance value between the fault point and EUT

3.2 Abbreviations

AC alternating current
A/D analog to digital
DC direct current
HV high voltage
LV low voltage
MV middle voltage
RMS root mean square

4 Test circuit and equipment

4.1 General

The circuits and equipment described in this clause are developed to allow tests that simulate the full range of anticipated grid faults, including:

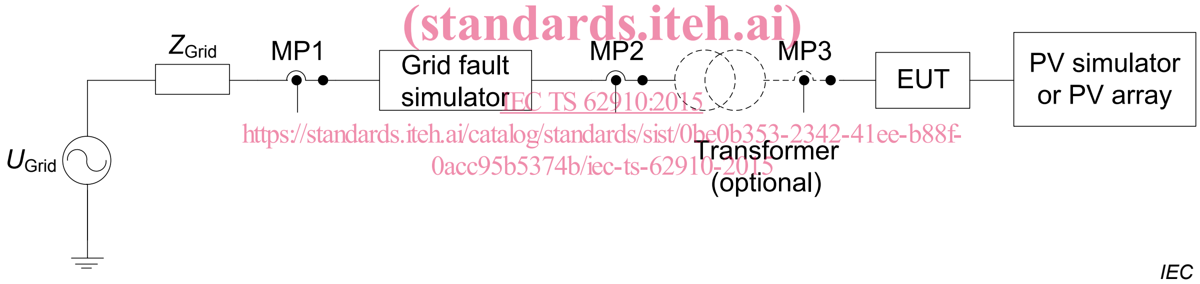
- Single phase to ground fault (any phase).
- Two phase isolated fault, between any two phases.
- Two phase grounded fault, involving any two phases.
- Three phase short-circuit fault.

A full discussion of these faults and the resulting impact on voltage magnitude and phase angles is included in Annex A.

The short circuit emulator and grid simulator described in 4.3.3 and 4.3.4 are informative examples and are not intended to restrict design flexibility. Other designs may be used to achieve equivalent test functionality.

4.2 Test circuit

The LVRT test circuit includes a DC source, the EUT, a grid fault simulator and the grid. A PV simulator (or PV array) provides input energy for the EUT. The output of the EUT is connected to the grid via a grid fault simulator, as shown in Figure 1.



NOTE MP1 is the measurement point between the grid and the grid fault simulator; MP2 is the measurement point at the high voltage side of the transformer; MP3 is the measurement point at the low voltage side of the transformer.

Figure 1 – Testing circuit diagram

4.3 Test equipment

4.3.1 Measuring instruments

Waveforms shall be measured by a device with memory function, for example, a storage or digital oscilloscope, or a high speed data acquisition device. Accuracy of the oscilloscope or data acquisition system should be at least 0,2 % of full scale. The analogue to A/D of the measurement device shall have at least 12 bit resolution (in order to maintain the required measurement accuracy).

Voltage transducers (or voltage transformers) and current transducers (or current transformers) are the required sensors for measurement. The accuracy of the transducers should be 0,5 % of full scale or better. It is necessary to select the transducer measuring range depending on the normal value of the signal to be measured. The selected measuring range shall not exceed 150 % of the normal value of the measured signal. The transducer accuracy requirements are shown in Table 1.

Table 1 – Accuracy of measurements

Measurement device	Accuracy
Data acquisition device	0,2 % full scale
Voltage transducer	0,5 % full scale
Current transducer	0,5 % full scale

4.3.2 DC source

A PV array, PV array simulator or controlled DC source with PV characteristics may be used as the DC power source to supply input energy for the LVRT test. As the EUT input source, the DC power source shall be capable of supplying the EUT maximum input power and other power levels during the test, at minimum and maximum input operating voltages of the EUT.

The PV simulator should emulate the current/voltage characteristic of the PV module or PV array for which the EUT is designed. The response time of a PV simulator should not be longer than the MPP tracking response time of EUT.

For a EUT under test without galvanic isolation between the DC side and AC side, the output of the PV simulator shall not be earthed.

The equivalent capacitance between the output of the PV simulator and earth should be as low as possible in order to minimize the impact on the EUT.

A PV array used as the EUT input source shall be capable of matching the EUT input power levels specified by the test conditions. It is necessary to select a period of time in which the solar irradiance is stable and does not vary by more than 5 % during the test.

4.3.3 Short-circuit emulator

As part of the grid simulator device, the short-circuit emulator is used to create the voltage drops due to short-circuits between the two or three phases, or between one or two phases to ground, via the impedance network Z_1 and Z_2 as shown in the test device layout in Figure 2.