IEC TS 62910

Edition 2.0 2020-07
REDLINE VERSION

TECHNICAL SPECIFICATION

colour inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-8736-1

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
1 Scope 7
2 Normative references 7
3 Terms, definitions, symbols and abbreviated terms 7
3.1 Terms, definitions and symbols 7
3.2 Abbreviated terms 10
4 Test circuit and equipment 10
4.1 General 10
4.2 Test circuit 10
4.3 Test equipment 11
4.3.1 Measuring instruments 11
4.3.2 DC source 11
4.3.3 Short-circuit emulator 11
4.3.4 Converter based grid simulator 14
5 Test 14
5.1 Test protocol 14
5.2 Test curve 16
5.3 Test procedure 17
5.3.1 Pre-test 17
5.3.2 No-load test 17
5.3.3 Tolerance 17
5.3.4 Load test 17
6 Assessment criteria 18
Annex A (informative) Circuit faults and voltage drops 19
A.1 Fault types 19
A.2 Voltage drops 21
A.2.1 General 21
A.2.2 Three-phase short-circuit fault 22
A.2.3 Two-phase short-circuit fault with ground 22
A.2.4 Two-phase short-circuit fault without ground 23
A.2.5 Single-phase short-circuit fault with ground 24
Annex B (informative) Determination of critical performance values in ~~LVRT~~ UVRT testing 26
B.1 General 26
B.2 Drop depth ratio 26
B.3 Ride-through time 26
B.4 Reactive current 26
B.5 Active power 27
Annex C (informative) Requirements of the UVRT curve 28
C.1 General 28
C.2 UVRT curve 28
C.3 Test points 28
Bibliography 29

Figure 1 – Testing circuit diagram 10

Figure 2 – Short-circuit emulator 12
Figure 3 – Converter device example 14
Figure 4 – ~~LVRT~~ UVRT curve example 16
Figure 5 – Tolerance of voltage drop 17
Figure A.1 – Grid fault diagram 21
Figure A.2 – Diagram of voltage vector for three-phase short-circuit fault 22
Figure A.3 – Diagram of voltage vector of two-phase (BC) short-circuit fault with ground 23
Figure A.4 – Diagram of voltage vector of two-phase (BC) short-circuit fault 24
Figure A.5 – Diagram of voltage vector of single-phase (A) short-circuit fault with ground 25
Figure B.1 – Determination of reactive current output 27
Figure B.2 – Determination of active power recovery 27
Figure C.1 – The typical curve of UVRT 28

Table 1 – Accuracy of measurements 11
Table 2 – Fault type and switch status 13
Table 3 – Test specification for ~~LVRT~~ UVRT (Indicative) 15
Table A.1 – Short-circuit paths for different fault types 19
Table A.2 – Amplitude and phase changes in three-phase short-circuit fault 22
Table A.3 – Amplitude and phase changes in two-phase (BC) ~~short-circuit fault with ground~~ 23
Table A.4 – Amplitude and phase changes in two-phase (BC) short-circuit fault 24
Table A.5 – Amplitude and phase changes in single-phase (A) ~~short-circuit fault with ground~~ 25

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

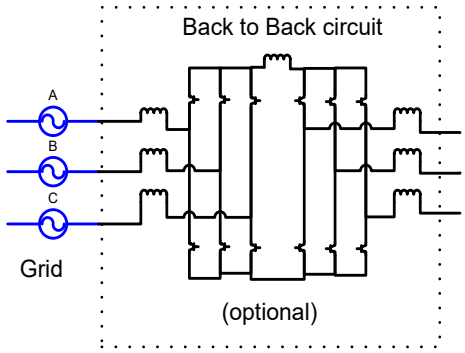
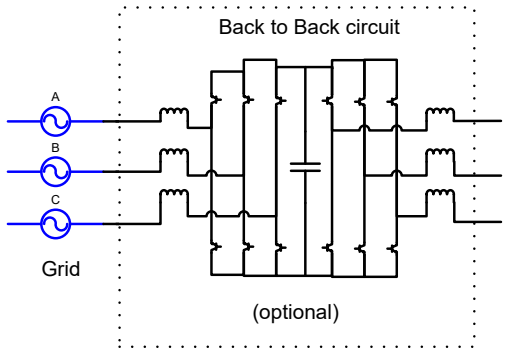
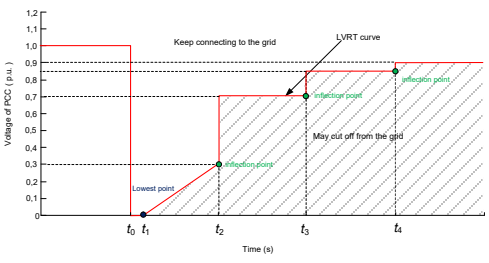
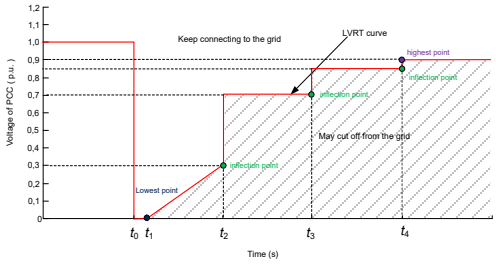
Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

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

This second edition cancels and replaces the first edition issued in 2015, and constitutes a technical revision.

It remains a TS because it is limited to providing recommended practices for UVRT testing in the context of non-uniform grid-codes lacking international consensus, and the rapid development of test technology in recent years.

The main technical changes with regard to the previous edition are as follows:

Clause	Previous edition	Present edition
3.1.12	the voltage support of EUT in accordance with the voltage drops. The K-factor is to be specified by the EUT manufacturer	the K-factor is to be supplied by the EUT manufacturer meeting additional requirements imposed by national standards and/or local codes
Figure 2		
4.3.4	The test circuit essentially comprises a voltage source with a low internal resistance combined with broadband amplifiers.....	The test circuit essentially comprises a voltage source with a low internal resistance combined optionally with broadband amplifiers.....
Table 3	d The test should be carried out under specified K-factor provided by local manufacture.	d The test should be carried out under specified K-factor provided by manufacture meeting additional requirements imposed by national standards and/or local codes.
Figure 4		

5.2	NOTE The example shows two types of points on the UVRT curve: the lowest point and the inflection point. Tests must be carried out at both types of points	The example shows three types of points on the UVRT curve: the highest point, the lowest point and the inflection point. Tests shall be carried out at above types of points.
5.3.1	Prior to the fault simulation tests, the EUT should run in normal operating mode. The selected UVRT curve should be used to identify voltage drop points, including the lowest point and the inflection point, ...	Prior to the fault simulation tests, the EUT should run in normal operating mode. The selected UVRT curve should be used to identify voltage drop points, including the highest point, the lowest point and the inflection point, ...

The text of this Technical Specificationis based on the following documents:

Draft TS	Report on voting
82/1607/DTS	82/1640A/RVDTS

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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

1 Scope

This document provides a test procedure for evaluating the performance of ~~Low~~ Under Voltage Ride-Through (~~LVRT~~ UVRT) functions in inverters used in utility-interconnected Photovoltaic (PV) systems.

This document is most applicable to large systems where PV inverters are connected to utility high voltage (HV) distribution systems. However, the applicable procedures may also be used for low voltage (LV) installations in locations where evolving ~~LVRT~~ UVRT requirements include such installations, e.g. single-phase or 3-phase systems.

The assessed ~~LVRT~~ UVRT 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~~ UVRT response to behave differently.

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

This document 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 are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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*~~

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC TS 62910

Edition 2.0 2020-07

TECHNICAL SPECIFICATION

colour inside

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



IEC TS 62910:2020-07(en)

CONTENTS

FOREWORD 4
1 Scope 7
2 Normative references 7
3 Terms, definitions, symbols and abbreviated terms 7
3.1 Terms, definitions and symbols 7
3.2 Abbreviated terms 9
4 Test circuit and equipment 10
4.1 General 10
4.2 Test circuit 10
4.3 Test equipment 10
4.3.1 Measuring instruments 10
4.3.2 DC source 11
4.3.3 Short-circuit emulator 11
4.3.4 Converter based grid simulator 14
5 Test 14
5.1 Test protocol 14
5.2 Test curve 16
5.3 Test procedure 17
5.3.1 Pre-test 17
5.3.2 No-load test 17
5.3.3 Tolerance 17
5.3.4 Load test 17
6 Assessment criteria 18
Annex A (informative) Circuit faults and voltage drops 19
A.1 Fault types 19
A.2 Voltage drops 21
A.2.1 General 21
A.2.2 Three-phase short-circuit fault 22
A.2.3 Two-phase short-circuit fault with ground 22
A.2.4 Two-phase short-circuit fault without ground 23
A.2.5 Single-phase short-circuit fault with ground 24
Annex B (informative) Determination of critical performance values in UVRT testing 26
B.1 General 26
B.2 Drop depth ratio 26
B.3 Ride-through time 26
B.4 Reactive current 26
B.5 Active power 27
Annex C (informative) Requirements of the UVRT curve 28
C.1 General 28
C.2 UVRT curve 28
C.3 Test points 28
Bibliography 29

Figure 1 – Testing circuit diagram 10
Figure 2 – Short-circuit emulator 12

Figure 3 – Converter device example 14
Figure 4 – UVRT curve example 16
Figure 5 – Tolerance of voltage drop 17
Figure A.1 – Grid fault diagram 21
Figure A.2 – Diagram of voltage vector for three-phase short-circuit fault 22
Figure A.3 – Diagram of voltage vector of two-phase (BC) short-circuit fault with ground 23
Figure A.4 – Diagram of voltage vector of two-phase (BC) short-circuit fault 24
Figure A.5 – Diagram of voltage vector of single-phase (A) short-circuit fault with ground 25
Figure B.1 – Determination of reactive current output 27
Figure B.2 – Determination of active power recovery 27
Figure C.1 – The typical curve of UVRT 28

Table 1 – Accuracy of measurements 11
Table 2 – Fault type and switch status 13
Table 3 – Test specification for UVRT (Indicative) 15
Table A.1 – Short-circuit paths for different fault types 19
Table A.2 – Amplitude and phase changes in three-phase short-circuit fault 22
Table A.3 – Amplitude and phase changes in two-phase (BC) 23
Table A.4 – Amplitude and phase changes in two-phase (BC) short-circuit fault 24
Table A.5 – Amplitude and phase changes in single-phase (A) 25

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

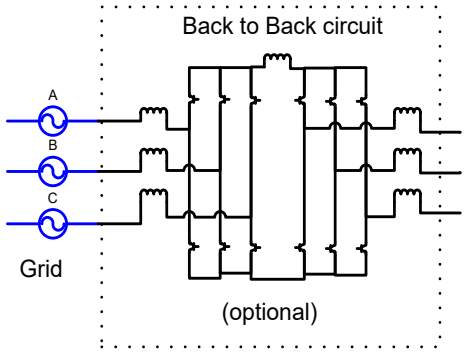
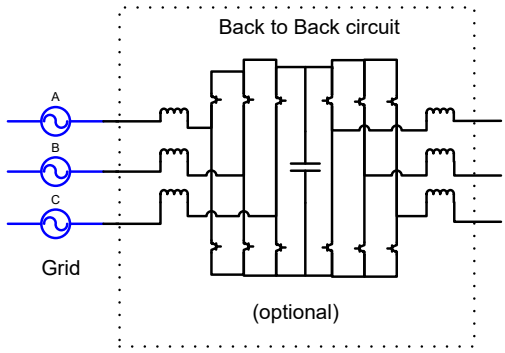
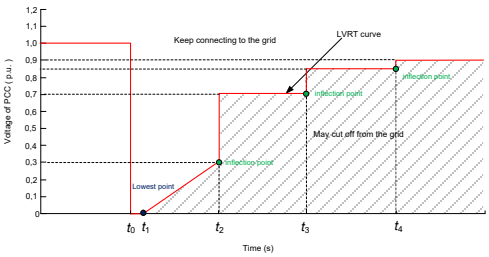
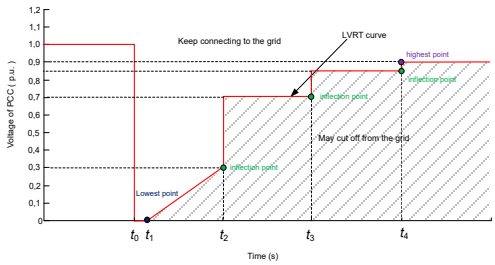
Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

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

This second edition cancels and replaces the first edition issued in 2015, and constitutes a technical revision.

It remains a TS because it is limited to providing recommended practices for UVRT testing in the context of non-uniform grid-codes lacking international consensus, and the rapid development of test technology in recent years.

The main technical changes with regard to the previous edition are as follows:

Clause	Previous edition	Present edition
3.1.12	the voltage support of EUT in accordance with the voltage drops. The K-factor is to be specified by the EUT manufacturer	the K-factor is to be supplied by the EUT manufacturer meeting additional requirements imposed by national standards and/or local codes
Figure 2		
4.3.4	The test circuit essentially comprises a voltage source with a low internal resistance combined with broadband amplifiers.....	The test circuit essentially comprises a voltage source with a low internal resistance combined optionally with broadband amplifiers.....
Table 3	d The test should be carried out under specified K-factor provided by local manufacture.	d The test should be carried out under specified K-factor provided by manufacture meeting additional requirements imposed by national standards and/or local codes.
Figure 4		
5.2	NOTE The example shows two types of points on the UVRT curve: the lowest point and the inflection point. Tests must be carried out at both types of points	The example shows three types of points on the UVRT curve: the highest point, the lowest point and the inflection point. Tests shall be carried out at above types of points.
5.3.1	Prior to the fault simulation tests, the EUT should run in normal operating mode. The selected UVRT curve should be used to identify voltage drop points, including the lowest point and the inflection point, ...	Prior to the fault simulation tests, the EUT should run in normal operating mode. The selected UVRT curve should be used to identify voltage drop points, including the highest point, the lowest point and the inflection point, ...

The text of this Technical Specificationis based on the following documents:

Draft TS	Report on voting
82/1607/DTS	82/1640A/RVDTS

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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

1 Scope

This document provides a test procedure for evaluating the performance of Under Voltage Ride-Through (UVRT) functions in inverters used in utility-interconnected Photovoltaic (PV) systems.

This document is most applicable to large systems where PV inverters are connected to utility high voltage (HV) distribution systems. However, the applicable procedures may also be used for low voltage (LV) installations in locations where evolving UVRT requirements include such installations, e.g. single-phase or 3-phase systems.

The assessed UVRT 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 UVRT response to behave differently.

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

This document 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 are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*