TEST REPORT

IEC 61727

Photovoltaic (PV) systems
Characteristics of the utility interface

Report reference number ..... :	**PV200917N006-8**
Date of issue ..... ::	2021-01-28
Total number of pages ..... ::	53
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Address ..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Test specification	
Standard..... :	IEC 61727:2004-12
Test Report Form No. ..... :	IEC/EN 61727 VER.2
TRF Originator ..... :	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF ..... :	Dated 2020-03-20
Test item description ..... :	**Solar Grid-tied Inverter**
Trademark..... :	SOFAR SOLAR
Model / Type ..... :	HYD 6000-EP, HYD 5500-EP, HYD 5000-EP, HYD 4600-EP, HYD 4000-EP, HYD 3680-EP, HYD 3000-EP

Ratings .....:	**HYD 3000-EP**	**HYD 3680-EP**	**HYD 4000-EP**
Full load MPP DC voltage range [V].:	160-520V	180-520V	200-520V
Input DC voltage range[V].....:	90-600V		
Input DC current [A].....:	Max. 13A/13A		
Output AC voltage [V].....:	L/N/PE, 220 / 230Vac, 50/60Hz		
Output AC current [A].....:	15,0	16,0	20,0
Output power [W].....:	3000	3680	4000
Max. output power [VA].....:	3300	3680	4400
Output DC voltage range [V].....: [Battery charge]……:	42-58V		
Input/Output DC current [A].....: [Battery charge/discharge] ……:	Max. 75A	Max. 80A	Max. 85A
Charge and discharge power[W].....:	Max. 3750	Max. 4000	Max. 4250
Output AC voltage [V].....:	L/N/PE, 220 / 230Vac, 50/60Hz		
Max. Input/Output AC current [A].....: [Battery charge/discharge mode] …:	13,6	16,0	18,2
Max. Input/Output AC power [VA]....: [Battery charge/discharge mode] …:	3000	3680	4000
Ratings .....:	**HYD 4600-EP**	**HYD 5000-EP**	**HYD 5500-EP**
Full load MPP DC voltage range [V].:	230-520V	250-520V	250-520V
Input DC voltage range[V].....:	90-600V		
Input DC current [A].....:	Max. 13A/13A		
Output AC voltage [V].....:	L/N/PE, 220 / 230Vac, 50/60Hz		
Output AC current [A].....:	20,9	21,7	25,0
Output power [W].....:	4600	5000	5000
Max. output power [VA].....:	4600	5000	5500
Output DC voltage range [V].....: [Battery charge]……:	42-58V		
Input/Output DC current [A].....: [Battery charge/discharge] ……:	Max. 100A		
Charge and discharge power[W].....:	Max. 5000		
Output AC voltage [V].....:	L/N/PE, 220 / 230Vac, 50/60Hz		
Max. Input/Output AC current [A].....: [Battery charge/discharge mode] …:	20,9	22,7	22,7
Max. Input/Output AC power [VA]....: [Battery charge/discharge mode] …:	4600	5000	5000

Ratings .....:	**HYD 6000-EP**
Full load MPP DC voltage range [V].:	300-520V
Input DC voltage range[V].....:	90-600V
Input DC current [A].....:	Max. 13A/13A
Output AC voltage [V].....:	L/N/PE, 220 / 230Vac, 50/60Hz
Output AC current [A].....:	27,3
Output power [W].....:	6000
Max. output power [VA].....:	6000
Output DC voltage range [V].....: [Battery charge]……:	42-58V
Input/Output DC current [A].....: [Battery charge/discharge] ……:	Max. 100A
Charge and discharge power[W].....:	Max. 5000
Output AC voltage [V].....:	L/N/PE, 220 / 230Vac, 50/60Hz
Max. Input/Output AC current [A].....: [Battery charge/discharge mode] …:	22,7
Max. Input/Output AC power [VA]....: [Battery charge/discharge mode] …:	5000

Testing Location ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China
Tested by (name and signature) ..... :	Lukes Lin 
Approved by (name and signature) ..... :	James Huang 
Manufacturer's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Manufacturer address ..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Factory's name ..... :	**Dongguan SOFAR SOLAR Co.,Ltd**
Factory address ..... :	1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2021-01-28	Lukes Lin	Initial report was written	0
Supplementary information:			

Test items particulars

Equipment mobility ..... :	Permanent connection
Operating condition ..... :	Continuous
Class of equipment ..... :	Class I
Protection against ingress of water .. :	IP65 according to EN 60529
Mass of equipment [kg] ..... :	Approx. 21,5 kg

Test case verdicts

Test case does not apply to the test object ..... :	N/A
Test item does meet the requirement ..... :	P(ass)
Test item does not meet the requirement ..... :	F(ail)

Testing

Date of receipt of test item ..... :	2020-09-17
Date(s) of performance of test ..... :	2020-09-17 to 2020-12-28

General remarks:

The test result presented in this report relate only to the object(s) tested.
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”(see Annex #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.

The IEC61727does not provide any limits of accuracy for the utility voltage and frequency measurement of the PV-system. Therefore the values for tolerances given in EN 50438, Table 2 are used.

Tolerances on trip values tabel 2 EN 50438:

- Voltage: +/- 1% of the nominal voltage;
- Frequency: +/- 0,5% of the nominal frequency
- Clearance time: +/- 10%

This Test Report consists of the following documents:

1. Test Results
2. Annex No. 1 – Pictures of the unit
3. Annex No. 2 – Test equipment list

Copy of marking plates:

SOFAR SOLAR
Hybrid Inverter

Model No:	HYD 3000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	75A
Max.Discharging Current	75A
Max.Charging&Discharging Power	3750W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	15.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	3000W
Backup Rated Current	13.6A
Backup Rated Apparent Power	3000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

SOFAR SOLAR
Hybrid Inverter

Model No:	HYD 3680-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	80A
Max.Discharging Current	80A
Max.Charging&Discharging Power	4000W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	16.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	3680W
Backup Rated Current	16.0A
Backup Rated Apparent Power	3680VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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SOFAR SOLAR
Hybrid Inverter

Model No:	HYD 4000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	85A
Max.Discharging Current	85A
Max.Charging&Discharging Power	4250W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	20.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	4000W
Backup Rated Current	18.2A
Backup Rated Apparent Power	4000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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SOFAR SOLAR
Hybrid Inverter

Model No:	HYD 4600-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	20.9A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	4600W
Backup Rated Current	20.9A
Backup Rated Apparent Power	4600VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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Copy of marking plates:

SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 5000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	21.7A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	5000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 5500-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	25.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	5000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 6000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	220/230Vac
Nominal Output Voltage	230Vac
Max.Output Current	27.3A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	6000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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General product information:

The Hybrid Inverter converts DC voltage into AC voltage.

The Hybrid Inverter is a single phase type inverter and it can be used in parallel.

The DC input of Hybrid Inverter can be supplied from PV array and batteries.

The charging current to batteries from PV array and power grid, battery management unit is integrated in External Energy storage.

The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and a two relays. This assures that the opening of the output circuit will also operate in case of one error.

Description of the electrical circuit:

The internal control is redundant built. It consists of Master DSP (U4) and Slave DSP (U43).

The Master DSP (U4) control the relays by switching signals; measures the Battery voltage, Battery currenet, PV voltage, PV current, Bus voltage, grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Slave DSP (U43) is measures the grid voltage, grid frequency, DCI and residual current, also can switch off the relays independently, and communicate with the Master DSP (U4) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Master DSP (U4). The Master DSP (U4) tests and calibrates before each start up all current sensors.

The unit provides two relays in series in all output conductors. When single fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up.

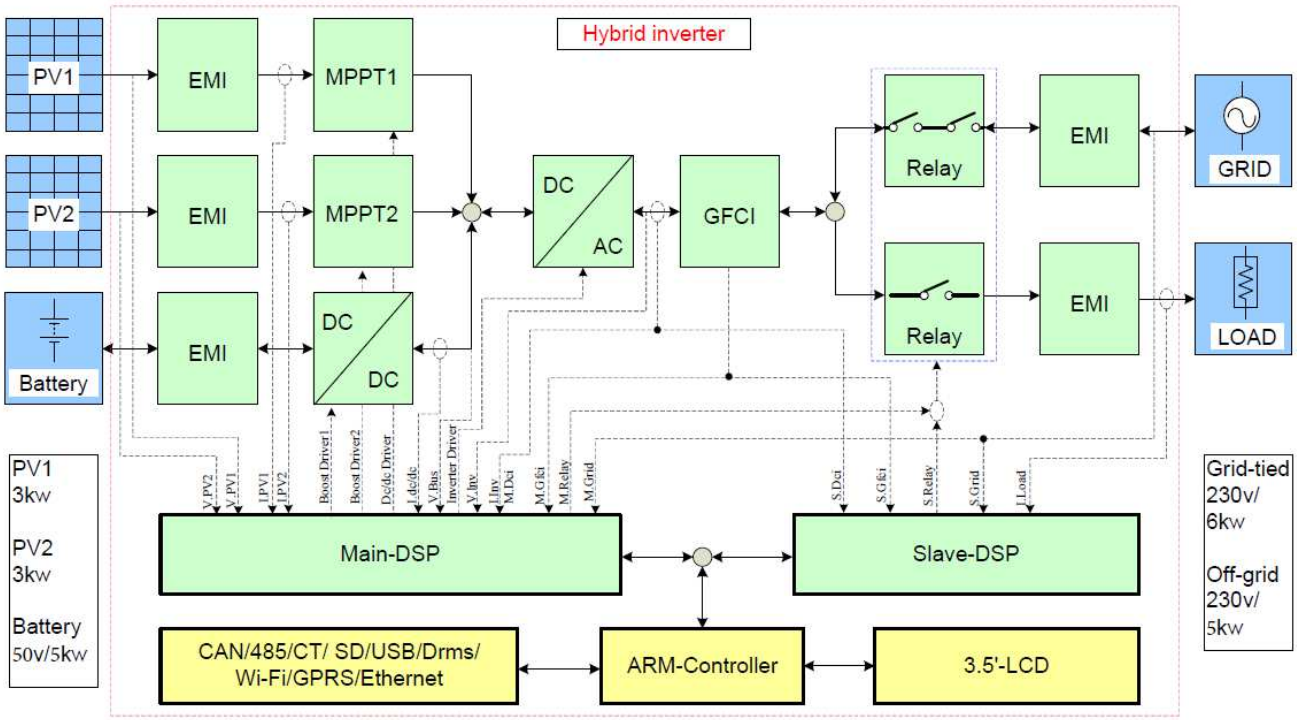


Figure 1- Block diagram

Model difference:

The models HYD 6000-EP, HYD 5500-EP, HYD 5000-EP, HYD 4600-EP, HYD 4000-EP, HYD 3680-EP and HYD 3000-EP are use the identical hardware platform, control unit, control system and software except the output power derated by software and in following table descripts for different.

	HYD 6000-EP	HYD 5500-EP	HYD 5000-EP	HYD 4600-EP	HYD 4000-EP	HYD 3680-EP	HYD 3000-EP
Resistor ↓ R332, R334, R336	(0Ω, NC, 0Ω)				(NC, 0Ω, NC)		
BUS capacitors	8 pcs				6 pcs		
Inductor	0,75mH				1.035mH		
Sampling resistor of output current (R123,R132)	(1,5kΩ, 1,5kΩ)				(499Ω, 499Ω)		

The product was tested on:

Hardware version: V001
Software version: V02000

All tests were performed on HYD 6000-EP and HYD 3000-EP are valid for the HYD 5500-EP, HYD 5000-EP, HYD 4600-EP, HYD 4000-EP and HYD 3680-EP since it's use the identical hardware and software construction except output power derated by software.

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4	**General** The quality of power provided by the PV system for the on-site AC loads and for power delivered to the utility is governed by practices and standards on voltage, flicker, frequency, harmonics and power factor. Deviation from these standards represents out-of-bounds conditions and may require the PV system to sense the deviation and properly disconnect from the utility system. All power quality parameters (voltage, flicker, frequency, harmonics, and power factor) must be measured at the utility interface/ point of common coupling unless otherwise specified.	Noticed	**P**
4.1	**Voltage, current and frequency** The PV system AC voltage, current and frequency shall be compatible with the utility system.	Derived from tests	**P**
4.2	**Normal voltage operating range** Utility-interconnected PV systems do not normally regulate voltage; they inject current into the utility. Therefore, the voltage operating range for PV inverters is selected as a protection function that responds to abnormal utility conditions, not as a voltage regulation function.	Derived from tests	**P**
4.3	**Flicker** The operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC 61000-3-3 for systems less than 16 A or IEC 61000-3-5 for systems with current of 16 A and above.	See table 4.3	**P**
4.4	**DC injection** The PV system shall not inject DC current greater than 1 % of the rated inverter output current, into the utility AC interface under any operating condition.	See table 4.4	**P**
4.5	**Normal frequency operating range** The PV system shall operate in synchronism with the utility system, and within the frequency trip limits defined in 5.2.2.	See table 4.5 and 5.2.2	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: Utility compatibility			
4.6	**Harmonics and waveform distortion** Low levels of current and voltage harmonics are desirable; the higher harmonic levels increase the potential for adverse effects on connected equipment. Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads/apparatus, and established utility practice. The PV system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. Total harmonic current distortion shall be less than 5 % at rated inverter output. Each individual harmonic shall be limited to the percentages listed in Table 1. Even harmonics in these ranges shall be less than 25 % of the lower odd harmonic limits listed. (see Clause 4.6 Table 1 – Current distortion limits)	See tables 4.6	**P**
4.7	**Power factor** The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50 % of the rated inverter output power.	See table 4.7	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5	**General** This Clause provides information and considerations for the safe and proper operation of the utility-connected PV systems.	Noticed	**P**
5.1	**Loss of utility voltage** To prevent islanding, a utility connected PV system shall cease to energize the utility system from a de-energized distribution line irrespective of connected loads or other generators within specified time limits. A utility distribution line can become de-energized for several reasons. For example, a substation breaker opening due to fault conditions or the distribution line switched out during maintenance. If inverters (single or multiple) have DC SELV input and have accumulated power below 1 kW then no mechanical disconnect (relay) is required.	The loss of utility voltage test report for IEC61727 according to IEC62116 is stored in archive at Bureau Veritas, Project No. PV200917N006-7	**P**
5.2	**Over/under voltage and frequency** Abnormal conditions can arise on the utility system that requires a response from the connected photovoltaic system. This response is to ensure the safety of utility maintenance personnel and the general public, as well as to avoid damage to connected equipment, including the photovoltaic system. The abnormal utility conditions of concern are voltage and frequency excursions above or below the values stated in this Clause, and the complete disconnection of the utility, presenting the potential for a distributed resource island.	See table 5.2.1 and 5.2.2	**P**
5.2.1	**Over/under voltage** When the interface voltage deviates outside the conditions specified in Table 2, the photovoltaic system shall cease to energize the utility distribution system. This applies to any phase of a multiphase system. All discussions regarding system voltage refer to the local nominal voltage. The system shall sense abnormal voltage and respond. The following conditions should be met, with voltages in RMS and measured at the point of utility connection. (see clause 5.2.1 Table 2 – Response to abnormal voltages) The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping. The unit does not have to cease to energize if the voltage returns to the normal utility continuous operation condition within the specified trip time.	See table 5.2.1	**P**

IEC61727:2004-12			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 5: Personnel safety and equipment protection			
5.2.2	**Over/under frequency** When the utility frequency deviates outside the specified conditions the photovoltaic system shall cease to energize the utility line. The unit does not have to cease to energize if the frequency returns to the normal utility continuous operation condition within the specified trip time. When the utility frequency is outside the range of ±1 Hz, the system shall cease to energize the utility line within 0,2 s. The purpose of the allowed range and time delay is to allow continued operation for short-term disturbances and to avoid excessive nuisance tripping in weak-utility system conditions.	See table 5.2.2	**P**
5.3	**Islanding protection** The PV system must cease to energize the utility line within 2 s of loss of utility.	The loss of utility voltage test report for IEC61727 according to IEC62116 is stored in archive at Bureau Veritas, Project No. PV200917N006-7	**P**
5.4	**Response to utility recovery** Following an out-of-range utility condition that has caused the photovoltaic system to cease energizing, the photovoltaic system shall not energize the utility line for 20 s to 5 min after the utility service voltage and frequency have recovered to within the specified ranges**.**	See table 5.2.1 and 5.2.2	**P**
5.5	**Earthing** The utility interface equipment shall be earthed/grounded in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.6	**Short circuit protection** The photovoltaic system shall have short-circuit protection in accordance with IEC 60364-7-712.	Stated in the manual.	**P**
5.7	**Isolation and switching** A method of isolation and switching shall be provided in accordance with IEC 60364-7-712.	Stated in the manual.	**P**

Test overview:		
IEC 61727:2004-12		
Clause	**Test**	**Result**
4	Type test:	
4.3	Voltage Fluctuations and Flicker	**P**
4.4	Monitoring of DC-Injection	**P**
4.5	Normal frequency operating range (see 5.2.2 below)	**P**
4.6	Harmonics and waveform distortion	**P**
4.7	Power factor	**P**
5.2.1	Voltage monitoring	**P**
5.2.2	Frequency monitoring	**P**

Test Results

4.3 Voltage fluctuation and flicker			P
inverter >16A			
Limit	dc% = 3.3	P_{st}=1.0	P_{lt}=0.65
Test value	See below		

HYD 3000-EP

230Va.c. / 50Hz

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.045	Pass	0.211	Pass	0.0	Pass	0.141	Pass		
2	0.059	Pass	0.223	Pass	0.0	Pass	0.138	Pass		
3	0.059	Pass	0.220	Pass	0.0	Pass	0.136	Pass		
4	0.068	Pass	0.211	Pass	0.0	Pass	0.135	Pass		
5	0.061	Pass	0.223	Pass	0.0	Pass	0.135	Pass		
6	0.051	Pass	0.214	Pass	0.0	Pass	0.136	Pass		
7	0.051	Pass	0.208	Pass	0.0	Pass	0.137	Pass		
8	0.047	Pass	0.216	Pass	0.0	Pass	0.138	Pass		
9	0.055	Pass	0.217	Pass	0.0	Pass	0.140	Pass		
10	0.048	Pass	0.211	Pass	0.0	Pass	0.140	Pass		
11	0.043	Pass	0.215	Pass	0.0	Pass	0.141	Pass		
12	0.050	Pass	0.219	Pass	0.0	Pass	0.141	Pass		
Result		Pass		Pass		Pass		Pass	0.138	Pass

230Va.c. / 60Hz

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.061	Pass	0.229	Pass	0.0	Pass	0.151	Pass		
2	0.049	Pass	0.222	Pass	0.0	Pass	0.151	Pass		
3	0.055	Pass	0.220	Pass	0.0	Pass	0.151	Pass		
4	0.059	Pass	0.227	Pass	0.0	Pass	0.149	Pass		
5	0.066	Pass	0.226	Pass	0.0	Pass	0.147	Pass		
6	0.065	Pass	0.224	Pass	0.0	Pass	0.148	Pass		
7	0.046	Pass	0.235	Pass	0.0	Pass	0.147	Pass		
8	0.048	Pass	0.230	Pass	0.0	Pass	0.146	Pass		
9	0.066	Pass	0.234	Pass	0.0	Pass	0.147	Pass		
10	0.058	Pass	0.231	Pass	0.0	Pass	0.148	Pass		
11	0.062	Pass	0.234	Pass	0.0	Pass	0.146	Pass		
12	0.069	Pass	0.228	Pass	0.0	Pass	0.148	Pass		
Result		Pass		Pass		Pass		Pass	0.148	Pass

HYD 6000-EP

230Va.c. / 50Hz

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.200	Pass	0.295	Pass	0.0	Pass	0.213	Pass		
2	0.168	Pass	0.283	Pass	0.0	Pass	0.210	Pass		
3	0.199	Pass	0.281	Pass	0.0	Pass	0.207	Pass		
4	0.169	Pass	0.266	Pass	0.0	Pass	0.207	Pass		
5	0.168	Pass	0.272	Pass	0.0	Pass	0.212	Pass		
6	0.173	Pass	0.284	Pass	0.0	Pass	0.214	Pass		
7	0.176	Pass	0.266	Pass	0.0	Pass	0.210	Pass		
8	0.168	Pass	0.271	Pass	0.0	Pass	0.213	Pass		
9	0.168	Pass	0.276	Pass	0.0	Pass	0.210	Pass		
10	0.171	Pass	0.277	Pass	0.0	Pass	0.210	Pass		
11	0.164	Pass	0.326	Pass	0.0	Pass	0.207	Pass		
12	0.183	Pass	0.279	Pass	0.0	Pass	0.209	Pass		
Result		Pass		Pass		Pass		Pass	0.210	Pass

230Va.c. / 60Hz

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.070	Pass	0.226	Pass	0.0	Pass	0.137	Pass		
2	0.061	Pass	0.228	Pass	0.0	Pass	0.137	Pass		
3	0.085	Pass	0.225	Pass	0.0	Pass	0.135	Pass		
4	0.076	Pass	0.217	Pass	0.0	Pass	0.133	Pass		
5	0.090	Pass	0.219	Pass	0.0	Pass	0.133	Pass		
6	0.078	Pass	0.217	Pass	0.0	Pass	0.134	Pass		
7	0.063	Pass	0.222	Pass	0.0	Pass	0.137	Pass		
8	0.073	Pass	0.228	Pass	0.0	Pass	0.140	Pass		
9	0.068	Pass	0.224	Pass	0.0	Pass	0.140	Pass		
10	0.075	Pass	0.235	Pass	0.0	Pass	0.140	Pass		
11	0.069	Pass	0.221	Pass	0.0	Pass	0.141	Pass		
12	0.064	Pass	0.216	Pass	0.0	Pass	0.142	Pass		
Result		Pass		Pass		Pass		Pass	0.137	Pass

Note:

*The stationary deviance of dc% is more relevant than the dynamic deviance of d_{max} at starting and stopping.

Mains Impedance according EN61000-3-11: **R_{max} = 0.24Ω; jX_{max}= 0.15Ω @50Hz ($|Z_{max}|$ = 0.283/0.4717Ω)**

for single phase inverter use also **R_n = 0.16Ω; jX_n= 0.1Ω**

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:

$Z_{max} = Z_{ref} * 3{,}3\% / d_c(P_n)$

The tests should be based on the limits of the EN 61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.

The tests had been performed on the HYD 6000-EP and HYD 3000-EP is valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.

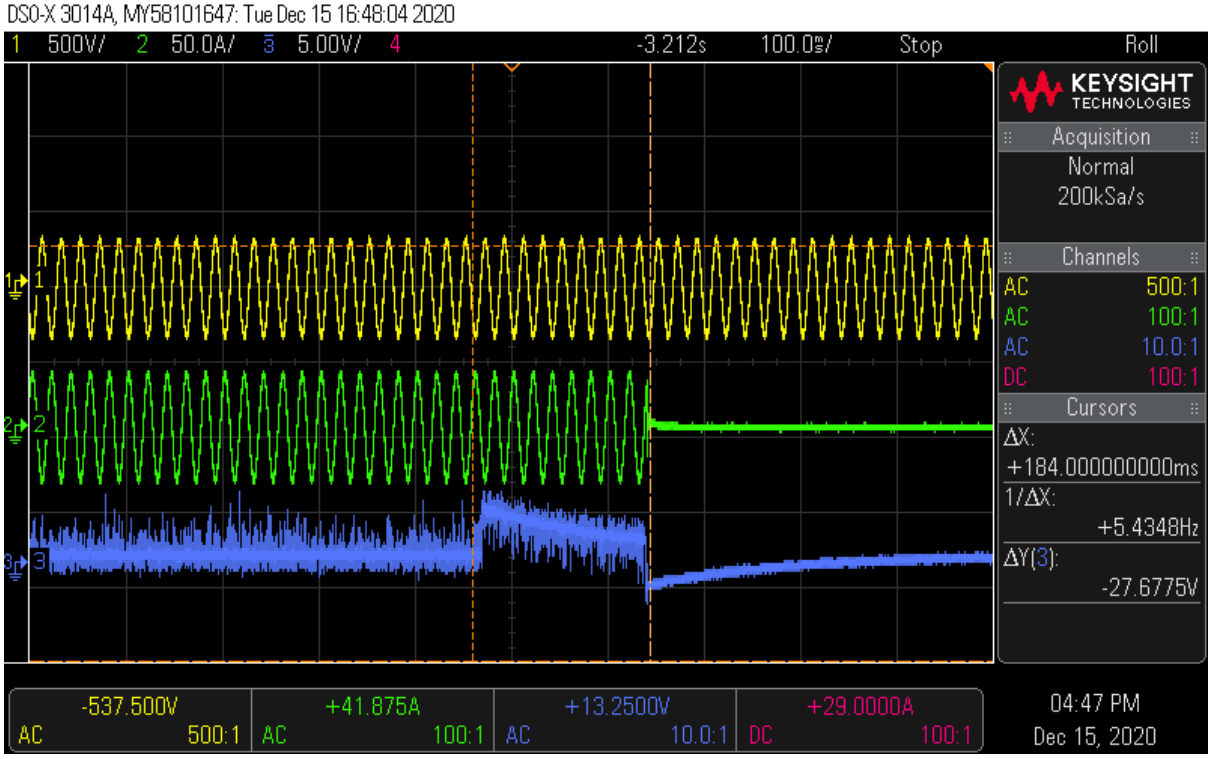
4.4 Monitoring of DC-Injection				P
HYD 6000-EP				
Test conditions:	U_N = 230Va.c. Uinput = 640Vd.c. Rated Power:15,0kW			
DC Injection [A]	**Limits**	**Trip Time [ms]**	**Trip Time [ms]**	**Trip Time [ms]**
L1 to N				
-1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	184	180	178
+1,0 A	I_{DC}:>1A than disconnection within 0,2 sec	178	180	182

Note:
A dc-current of 1A is injected, disconnection time of max. 0,2s

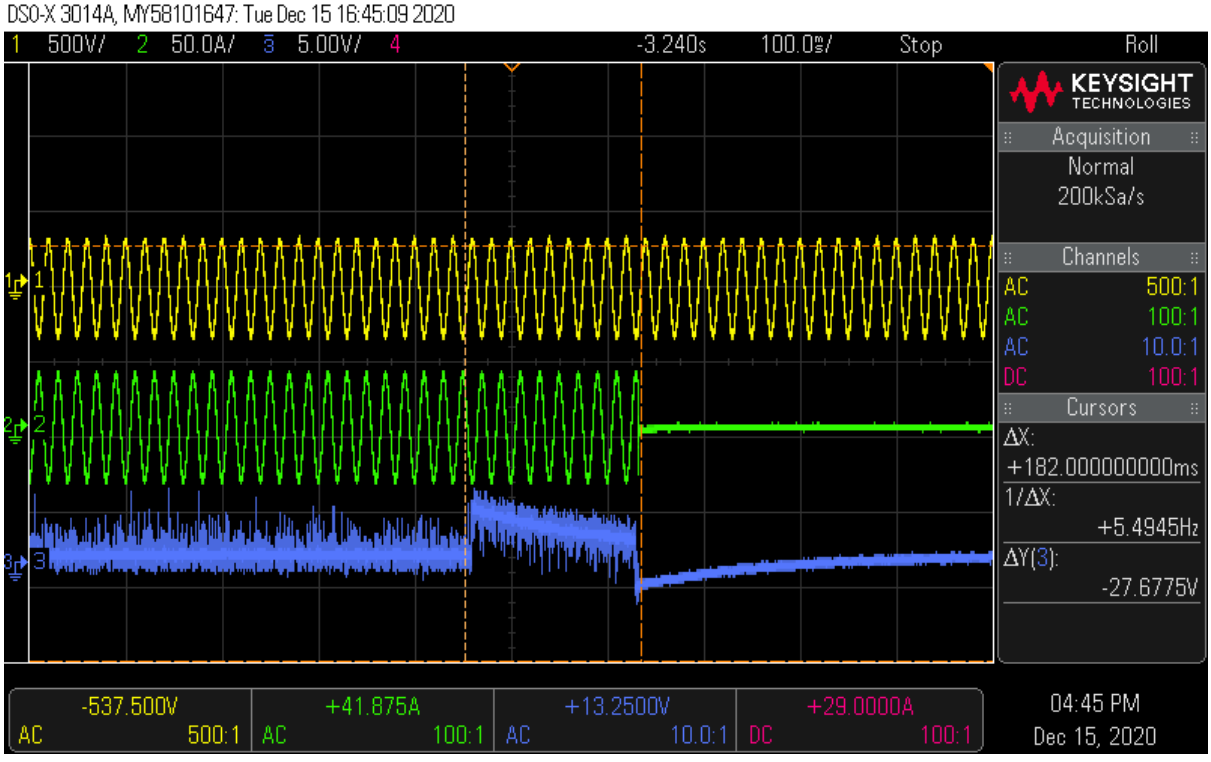
The tests had been performed on the HYD 6000-EP and is valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.

HYD 6000-EP

Negative DC-Injection

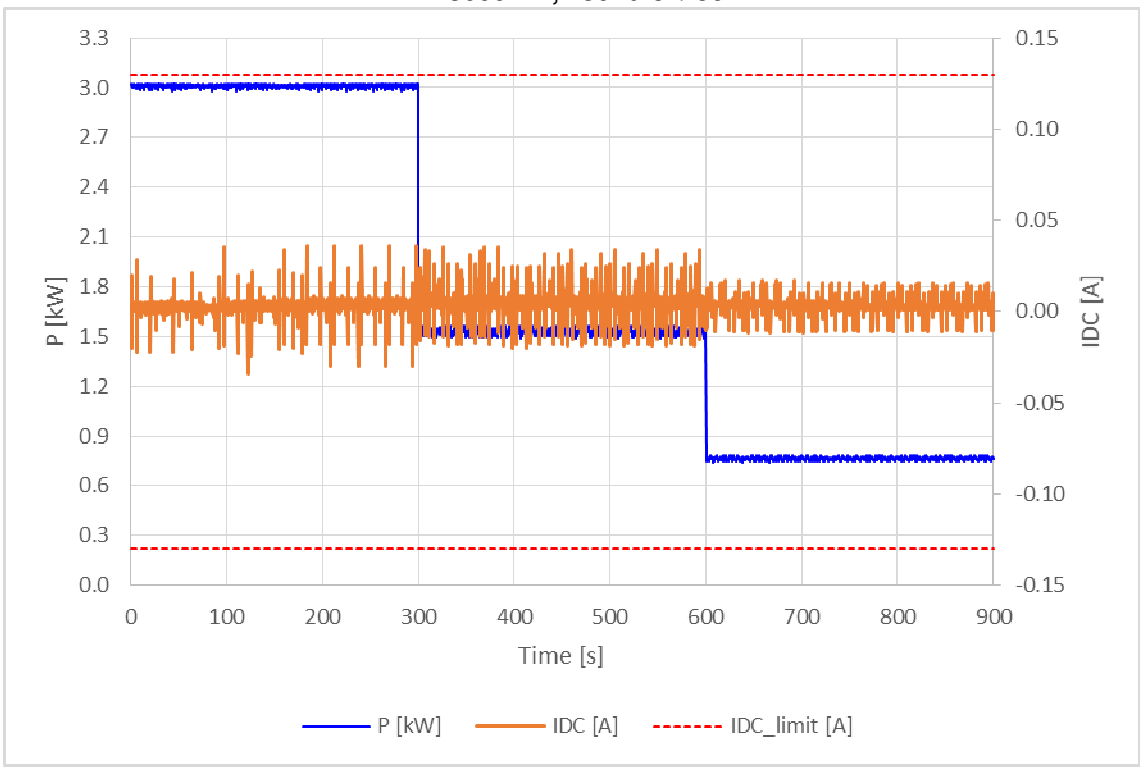


Positive DC-Injection

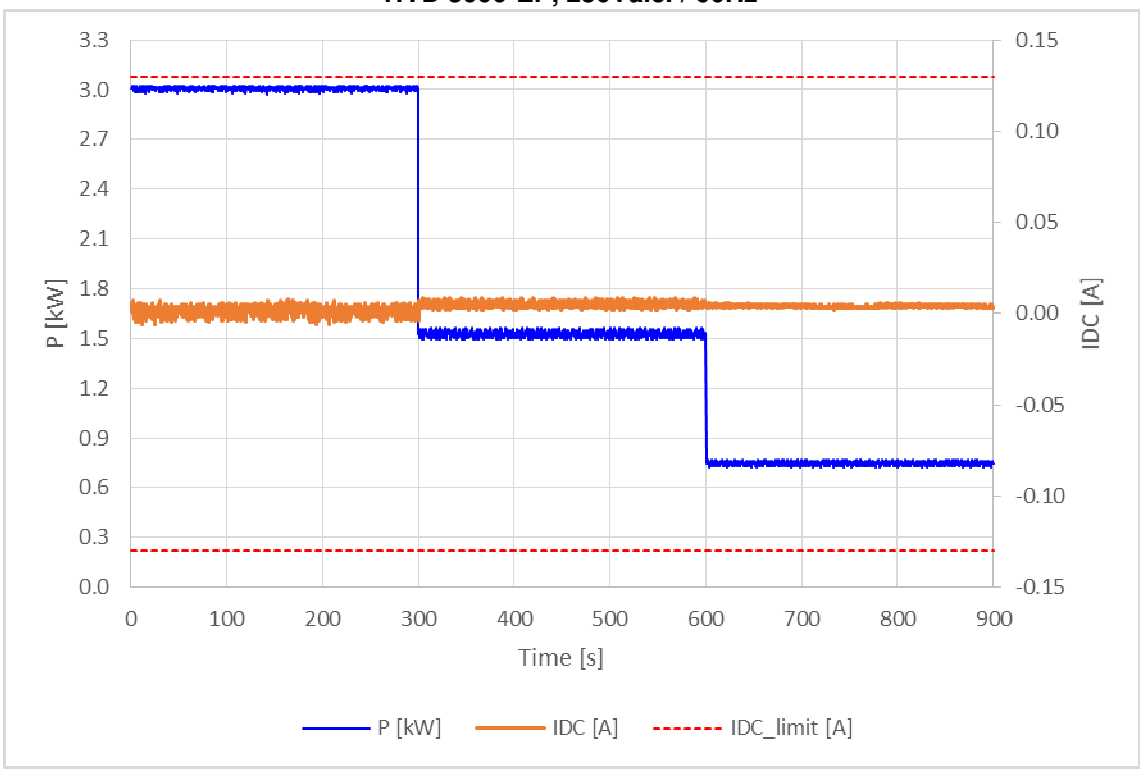


4.4 Monitoring of Permanent DC-Injection			P
HYD 3000-EP at 230Va.c. / 50Hz			
IEC61727 Limit:	**1% of Inom (0,130 A)**		
Output power:	25%	50%	100%
Abs. Max. Test Value	0,017	0,035	0,036
Abs. Ave. Test Value	0,004	0,007	0,004
HYD 3000-EP at 230Va.c. / 60Hz			
IEC61727 Limit:	**1% of Inom (0,130 A)**		
Output power:	25%	50%	100%
Abs. Max. Test Value	0,006	0,009	0,008
Abs. Ave. Test Value	0,004	0,005	0,003
HYD 6000-EP at 230Va.c. / 50Hz			
IEC61727 Limit:	**1% of Inom (0,261 A)**		
Output power:	25%	50%	100%
Abs. Max. Test Value	0,034	0,046	0,059
Abs. Ave. Test Value	0,007	0,010	0,019
HYD 6000-EP at 230Va.c. / 50Hz			
IEC61727 Limit:	**1% of Inom (0,261 A)**		
Output power:	25%	50%	100%
Abs. Max. Test Value	0,008	0,014	0,032
Abs. Ave. Test Value	0,003	0,007	0,015
Note: The tests had been performed on the HYD 6000-EP and HYD 3000-EP is valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.			

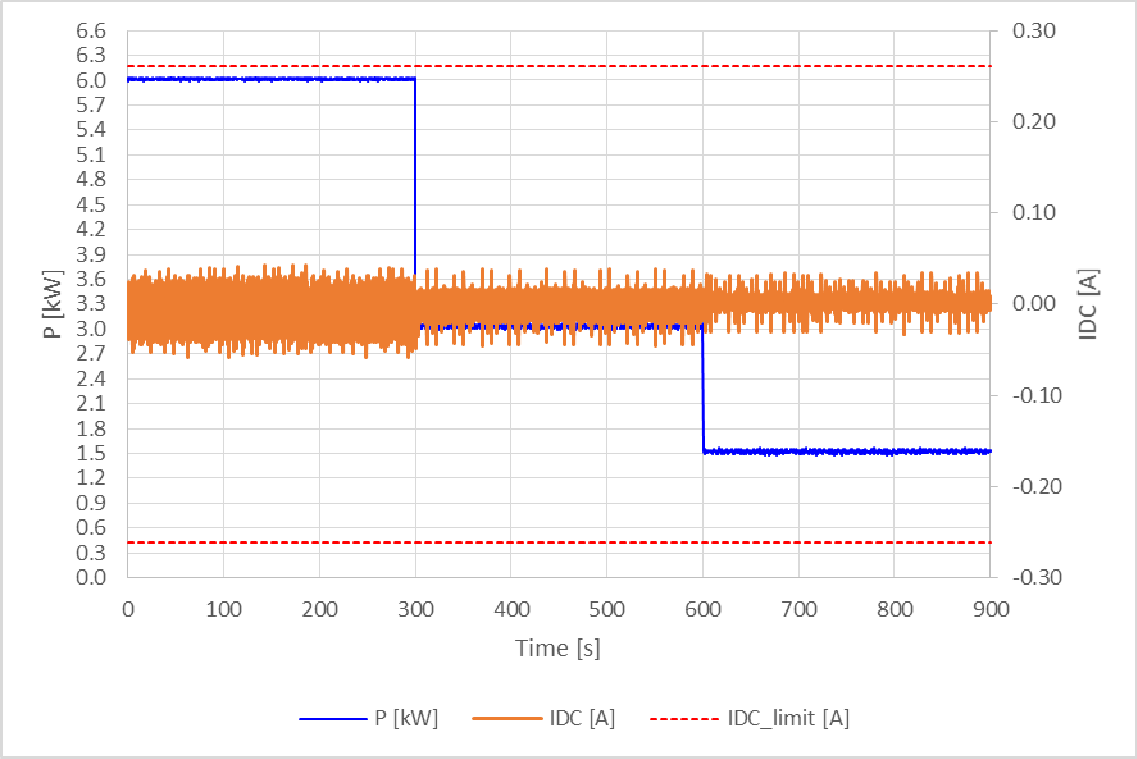
HYD 3000-EP, 230Va.c. / 50Hz



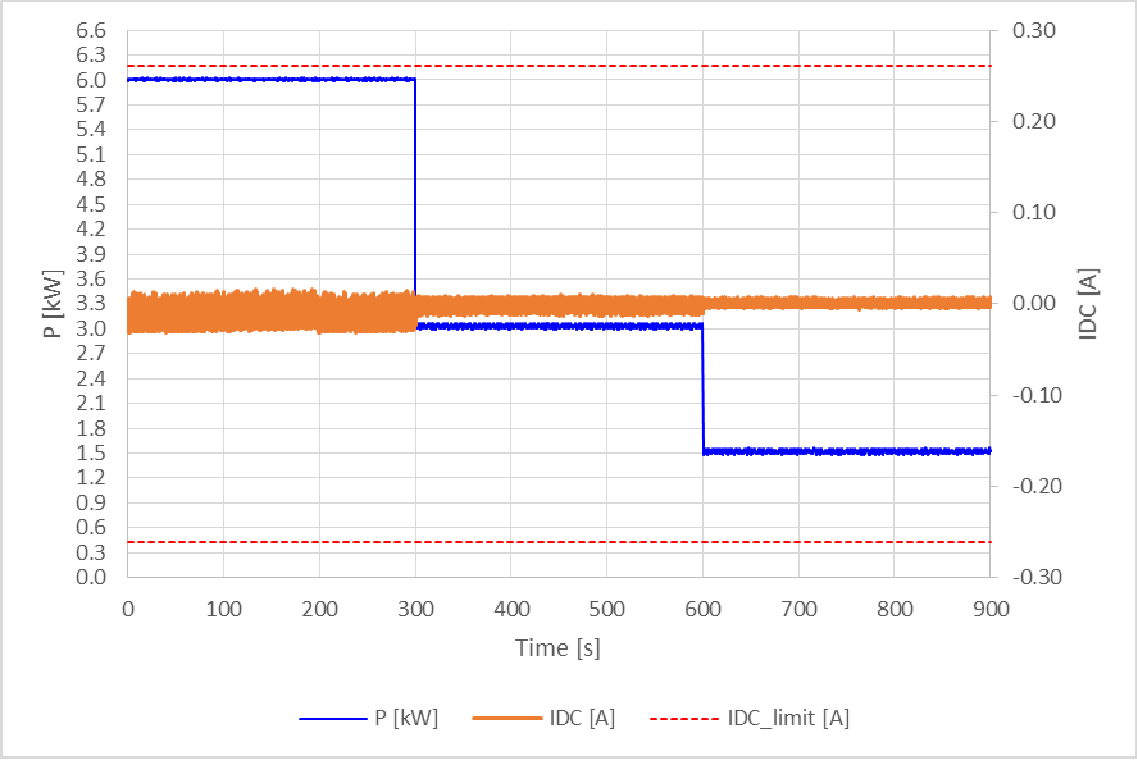
HYD 3000-EP, 230Va.c. / 60Hz



HYD 6000-EP, 230Va.c. / 50Hz



HYD 6000-EP, 230Va.c. / 50Hz



4.6 Harmonic Current Limit Test — P

HYD 3000-EP, 230Va.c. / 50Hz

Watts_[kW]	3,038
VA_[kVA]	3,040
Vrms_[Vac]	230,4
Arms_[A]	13,194
PF	0,999
Frequency_[Hz]	50,00
THD50_[%]	1,539

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	L1 Phase	L2 Phase	L3 Phase	L1 Phase	L2 Phase	L3 Phase		
1st	13,193	--	--	--	--	--	Three Phase	--
2nd	0,002	--	--	0,015	--	--	Three Phase	1
3rd	0,176	--	--	1,334	--	--	Three Phase	4
4th	0,001	--	--	0,008	--	--	Three Phase	1
5th	0,075	--	--	0,568	--	--	Three Phase	4
6th	0,001	--	--	0,008	--	--	Three Phase	1
7th	0,036	--	--	0,273	--	--	Three Phase	4
8th	0,001	--	--	0,008	--	--	Three Phase	1
9th	0,018	--	--	0,136	--	--	Three Phase	4
10th	0,001	--	--	0,008	--	--	Three Phase	0,5
11th	0,009	--	--	0,068	--	--	Three Phase	2
12th	0,001	--	--	0,008	--	--	Three Phase	0,5
13th	0,008	--	--	0,061	--	--	Three Phase	2
14th	0,001	--	--	0,008	--	--	Three Phase	0,5
15th	0,008	--	--	0,061	--	--	Three Phase	2
16th	0,001	--	--	0,008	--	--	Three Phase	0,5
17th	0,011	--	--	0,083	--	--	Three Phase	1,5
18th	0,001	--	--	0,008	--	--	Three Phase	0,5
19th	0,012	--	--	0,091	--	--	Three Phase	1,5
20th	0,001	--	--	0,008	--	--	Three Phase	0,5
21th	0,013	--	--	0,099	--	--	Three Phase	1,5
22th	0,001	--	--	0,008	--	--	Three Phase	0,5
23th	0,014	--	--	0,106	--	--	Three Phase	0,6
24th	0,001	--	--	0,008	--	--	Three Phase	0,5
25th	0,013	--	--	0,099	--	--	Three Phase	0,6
26th	0,001	--	--	0,008	--	--	Three Phase	0,5
27th	0,014	--	--	0,106	--	--	Three Phase	0,6
28th	0,001	--	--	0,008	--	--	Three Phase	0,5
29th	0,013	--	--	0,099	--	--	Three Phase	0,6
30th	0,001	--	--	0,008	--	--	Three Phase	0,5
31th	0,013	--	--	0,099	--	--	Three Phase	0,6
32th	0,001	--	--	0,008	--	--	Three Phase	0,5
33th	0,013	--	--	0,099	--	--	Three Phase	0,6
34th	0,001	--	--	0,008	--	--	Three Phase	--
35th	0,013	--	--	0,099	--	--	Three Phase	--
36th	0,001	--	--	0,008	--	--	Three Phase	--
37th	0,012	--	--	0,091	--	--	Three Phase	--
38th	0,001	--	--	0,008	--	--	Three Phase	--

4.6 Harmonic Current Limit Test								P
39th	0,013	--	--	0,099	--	--	Three Phase	--
40th	0,001	--	--	0,008	--	--	Three Phase	--
41th	0,012	--	--	0,091	--	--	Three Phase	--
42th	0,001	--	--	0,008	--	--	Three Phase	--
43th	0,012	--	--	0,091	--	--	Three Phase	--
44th	0,001	--	--	0,008	--	--	Three Phase	--
45th	0,012	--	--	0,091	--	--	Three Phase	--
46th	0,001	--	--	0,008	--	--	Three Phase	--
47th	0,012	--	--	0,091	--	--	Three Phase	--
48th	0,001	--	--	0,008	--	--	Three Phase	--
49th	0,011	--	--	0,083	--	--	Three Phase	--
50th	0,009	--	--	0,068	--	--	Three Phase	--

4.6 Harmonic Current Limit Test — P

HYD 3000-EP, 220Va.c. / 60Hz

Watts_[kW]	3,035
VA_[kVA]	3,036
Vrms_[Vac]	220,4
Arms_[A]	13,775
PF	0,999
Frequency_[Hz]	60,00
THD50_[%]	1,450

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	L1 Phase	L2 Phase	L3 Phase	L1 Phase	L2 Phase	L3 Phase		
1st	13,773	--	--	--	--	--	Three Phase	--
2nd	0,002	--	--	0,015	--	--	Three Phase	1
3rd	0,173	--	--	1,256	--	--	Three Phase	4
4th	0,001	--	--	0,007	--	--	Three Phase	1
5th	0,069	--	--	0,501	--	--	Three Phase	4
6th	0,001	--	--	0,007	--	--	Three Phase	1
7th	0,032	--	--	0,232	--	--	Three Phase	4
8th	0,001	--	--	0,007	--	--	Three Phase	1
9th	0,016	--	--	0,116	--	--	Three Phase	4
10th	0,001	--	--	0,007	--	--	Three Phase	0,5
11th	0,012	--	--	0,087	--	--	Three Phase	2
12th	0,001	--	--	0,007	--	--	Three Phase	0,5
13th	0,014	--	--	0,102	--	--	Three Phase	2
14th	0,001	--	--	0,007	--	--	Three Phase	0,5
15th	0,016	--	--	0,116	--	--	Three Phase	2
16th	0,001	--	--	0,007	--	--	Three Phase	0,5
17th	0,018	--	--	0,131	--	--	Three Phase	1,5
18th	0,001	--	--	0,007	--	--	Three Phase	0,5
19th	0,018	--	--	0,131	--	--	Three Phase	1,5
20th	0,001	--	--	0,007	--	--	Three Phase	0,5
21th	0,018	--	--	0,131	--	--	Three Phase	1,5
22th	0,001	--	--	0,007	--	--	Three Phase	0,5
23th	0,017	--	--	0,123	--	--	Three Phase	0,6
24th	0,001	--	--	0,007	--	--	Three Phase	0,5
25th	0,017	--	--	0,123	--	--	Three Phase	0,6
26th	0,001	--	--	0,007	--	--	Three Phase	0,5
27th	0,015	--	--	0,109	--	--	Three Phase	0,6
28th	0,001	--	--	0,007	--	--	Three Phase	0,5
29th	0,015	--	--	0,109	--	--	Three Phase	0,6
30th	0,001	--	--	0,007	--	--	Three Phase	0,5
31th	0,013	--	--	0,094	--	--	Three Phase	0,6
32th	0,001	--	--	0,007	--	--	Three Phase	0,5
33th	0,012	--	--	0,087	--	--	Three Phase	0,6
34th	0,001	--	--	0,007	--	--	Three Phase	--
35th	0,012	--	--	0,087	--	--	Three Phase	--
36th	0,001	--	--	0,007	--	--	Three Phase	--
37th	0,012	--	--	0,087	--	--	Three Phase	--
38th	0,002	--	--	0,015	--	--	Three Phase	--
39th	0,011	--	--	0,080	--	--	Three Phase	--

4.6 Harmonic Current Limit Test								P
40th	0,001	--	--	0,007	--	--	Three Phase	--
41th	0,011	--	--	0,080	--	--	Three Phase	--
42th	0,001	--	--	0,007	--	--	Three Phase	--
43th	0,010	--	--	0,073	--	--	Three Phase	--
44th	0,001	--	--	0,007	--	--	Three Phase	--
45th	0,011	--	--	0,080	--	--	Three Phase	--
46th	0,001	--	--	0,007	--	--	Three Phase	--
47th	0,010	--	--	0,073	--	--	Three Phase	--
48th	0,001	--	--	0,007	--	--	Three Phase	--
49th	0,011	--	--	0,080	--	--	Three Phase	--
50th	0,001	--	--	0,007	--	--	Three Phase	--

4.6 Harmonic Current Limit Test — P

HYD 6000-EP at 230Va.c. / 50Hz

Watts_[kW]	6,013
VA_[kVA]	6,014
Vrms_[Vac]	230,7
Arms_[A]	26,071
PF	1,000
Frequency_[Hz]	50,00
THD50_[%]	0,871

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	L1 Phase	L2 Phase	L3 Phase	L1 Phase	L2 Phase	L3 Phase		
1st	26,070	--	--	--	--	--	Three Phase	--
2nd	0,008	--	--	0,031	--	--	Three Phase	1
3rd	0,196	--	--	0,752	--	--	Three Phase	4
4th	0,005	--	--	0,019	--	--	Three Phase	1
5th	0,077	--	--	0,295	--	--	Three Phase	4
6th	0,005	--	--	0,019	--	--	Three Phase	1
7th	0,044	--	--	0,169	--	--	Three Phase	4
8th	0,002	--	--	0,008	--	--	Three Phase	1
9th	0,030	--	--	0,115	--	--	Three Phase	4
10th	0,002	--	--	0,008	--	--	Three Phase	0,5
11th	0,017	--	--	0,065	--	--	Three Phase	2
12th	0,002	--	--	0,008	--	--	Three Phase	0,5
13th	0,013	--	--	0,050	--	--	Three Phase	2
14th	0,002	--	--	0,008	--	--	Three Phase	0,5
15th	0,015	--	--	0,058	--	--	Three Phase	2
16th	0,002	--	--	0,008	--	--	Three Phase	0,5
17th	0,018	--	--	0,069	--	--	Three Phase	1,5
18th	0,002	--	--	0,008	--	--	Three Phase	0,5
19th	0,019	--	--	0,073	--	--	Three Phase	1,5
20th	0,002	--	--	0,008	--	--	Three Phase	0,5
21th	0,020	--	--	0,077	--	--	Three Phase	1,5
22th	0,002	--	--	0,008	--	--	Three Phase	0,5
23th	0,019	--	--	0,073	--	--	Three Phase	0,6
24th	0,001	--	--	0,004	--	--	Three Phase	0,5
25th	0,017	--	--	0,065	--	--	Three Phase	0,6
26th	0,001	--	--	0,004	--	--	Three Phase	0,5
27th	0,016	--	--	0,061	--	--	Three Phase	0,6
28th	0,001	--	--	0,004	--	--	Three Phase	0,5
29th	0,015	--	--	0,058	--	--	Three Phase	0,6
30th	0,001	--	--	0,004	--	--	Three Phase	0,5
31th	0,015	--	--	0,058	--	--	Three Phase	0,6
32th	0,001	--	--	0,004	--	--	Three Phase	0,5
33th	0,014	--	--	0,054	--	--	Three Phase	0,6
34th	0,001	--	--	0,004	--	--	Three Phase	--
35th	0,013	--	--	0,050	--	--	Three Phase	--
36th	0,002	--	--	0,008	--	--	Three Phase	--
37th	0,012	--	--	0,046	--	--	Three Phase	--
38th	0,001	--	--	0,004	--	--	Three Phase	--
39th	0,012	--	--	0,046	--	--	Three Phase	--

4.6 Harmonic Current Limit Test								P
40th	0,001	--	--	0,004	--	--	Three Phase	--
41th	0,009	--	--	0,035	--	--	Three Phase	--
42th	0,001	--	--	0,004	--	--	Three Phase	--
43th	0,009	--	--	0,035	--	--	Three Phase	--
44th	0,001	--	--	0,004	--	--	Three Phase	--
45th	0,009	--	--	0,035	--	--	Three Phase	--
46th	0,001	--	--	0,004	--	--	Three Phase	--
47th	0,007	--	--	0,027	--	--	Three Phase	--
48th	0,002	--	--	0,008	--	--	Three Phase	--
49th	0,008	--	--	0,031	--	--	Three Phase	--
50th	0,008	--	--	0,031	--	--	Three Phase	--

4.6 Harmonic Current Limit Test — P

HYD 6000-EP at 220Va.c. / 60Hz

Watts_[kW]	6,040
VA_[kVA]	6,040
Vrms_[Vac]	220,7
Arms_[A]	27,370
PF	1,000
Frequency_[Hz]	60,00
THD50_[%]	0,999

Harmonics	Current Magnitude [A]			% of Nominal current			Phase	Harmonic Current Limits [%]
	L1 Phase	L2 Phase	L3 Phase	L1 Phase	L2 Phase	L3 Phase		
1st	27,368	--	--	--	--	--	Three Phase	--
2nd	0,015	--	--	0,055	--	--	Three Phase	1
3rd	0,235	--	--	0,859	--	--	Three Phase	4
4th	0,005	--	--	0,018	--	--	Three Phase	1
5th	0,094	--	--	0,343	--	--	Three Phase	4
6th	0,007	--	--	0,026	--	--	Three Phase	1
7th	0,061	--	--	0,223	--	--	Three Phase	4
8th	0,004	--	--	0,015	--	--	Three Phase	1
9th	0,035	--	--	0,128	--	--	Three Phase	4
10th	0,003	--	--	0,011	--	--	Three Phase	0,5
11th	0,019	--	--	0,069	--	--	Three Phase	2
12th	0,003	--	--	0,011	--	--	Three Phase	0,5
13th	0,020	--	--	0,073	--	--	Three Phase	2
14th	0,003	--	--	0,011	--	--	Three Phase	0,5
15th	0,025	--	--	0,091	--	--	Three Phase	2
16th	0,003	--	--	0,011	--	--	Three Phase	0,5
17th	0,027	--	--	0,099	--	--	Three Phase	1,5
18th	0,002	--	--	0,007	--	--	Three Phase	0,5
19th	0,025	--	--	0,091	--	--	Three Phase	1,5
20th	0,002	--	--	0,007	--	--	Three Phase	0,5
21th	0,022	--	--	0,080	--	--	Three Phase	1,5
22th	0,001	--	--	0,004	--	--	Three Phase	0,5
23th	0,021	--	--	0,077	--	--	Three Phase	0,6
24th	0,001	--	--	0,004	--	--	Three Phase	0,5
25th	0,020	--	--	0,073	--	--	Three Phase	0,6
26th	0,001	--	--	0,004	--	--	Three Phase	0,5
27th	0,018	--	--	0,066	--	--	Three Phase	0,6
28th	0,001	--	--	0,004	--	--	Three Phase	0,5
29th	0,017	--	--	0,062	--	--	Three Phase	0,6
30th	0,001	--	--	0,004	--	--	Three Phase	0,5
31th	0,014	--	--	0,051	--	--	Three Phase	0,6
32th	0,001	--	--	0,004	--	--	Three Phase	0,5
33th	0,011	--	--	0,040	--	--	Three Phase	0,6
34th	0,002	--	--	0,007	--	--	Three Phase	--
35th	0,011	--	--	0,040	--	--	Three Phase	--
36th	0,001	--	--	0,004	--	--	Three Phase	--
37th	0,009	--	--	0,033	--	--	Three Phase	--
38th	0,002	--	--	0,007	--	--	Three Phase	--
39th	0,007	--	--	0,026	--	--	Three Phase	--

4.6 Harmonic Current Limit Test								P
40th	0,001	--	--	0,004	--	--	Three Phase	--
41th	0,006	--	--	0,022	--	--	Three Phase	--
42th	0,001	--	--	0,004	--	--	Three Phase	--
43th	0,005	--	--	0,018	--	--	Three Phase	--
44th	0,001	--	--	0,004	--	--	Three Phase	--
45th	0,002	--	--	0,007	--	--	Three Phase	--
46th	0,001	--	--	0,004	--	--	Three Phase	--
47th	0,002	--	--	0,007	--	--	Three Phase	--
48th	0,001	--	--	0,004	--	--	Three Phase	--
49th	0,003	--	--	0,011	--	--	Three Phase	--
50th	0,001	--	--	0,004	--	--	Three Phase	--

Note:
The tests had been performed on the HYD 6000-EP and HYD 3000-EP is valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.

4.7 Power factor					P
Test conditions:	**HYD 3000-EP**				
Output power / **Test AC voltage**	**~10%** **0,310kW**	**~25%** **0,748kW**	**~50%** **1,530kW**	**~75%** **2,265kW**	**~100%** **3,010kW**
230Va.c. / 50Hz	**0,9914c**	**0,9939c**	**0,9959c**	**0,9977c**	**0,9986c**
Test conditions:	**HYD 3000-EP**				
Output power / **Test AC voltage**	**~10%** **0,3318kW**	**~25%** **0,747kW**	**~50%** **1,527kW**	**~75%** **2,260kW**	**~100%** **3,010kW**
220Va.c. / 60Hz	**0,9916c**	**0,9937c**	**0,9959c**	**0,9978c**	**0,9987c**
Test conditions:	**HYD 6000-EP**				
Output power / **Test AC voltage**	**~10%** **0,609kW**	**~25%** **1,522kW**	**~50%** **3,036kW**	**~75%** **4,535kW**	**~100%** **6,015kW**
230Va.c. / 50Hz	**0,9921c**	**0,9949c**	**0,9984c**	**0,9990c**	**0,9991c**
Test conditions:	**HYD 6000-EP**				
Output power / **Test AC voltage**	**~10%** **0,607kW**	**~25%** **1,522kW**	**~50%** **3,032kW**	**~75%** **4,529kW**	**~100%** **6,008kW**
220Va.c. / 60Hz	**0,9920c**	**0,9949c**	**0,9986c**	**0,9991c**	**0,9990c**

Note:
*The PV system shall have a lagging power factor greater than 0,9 when the output is greater than 50% of the rated inverter output power.

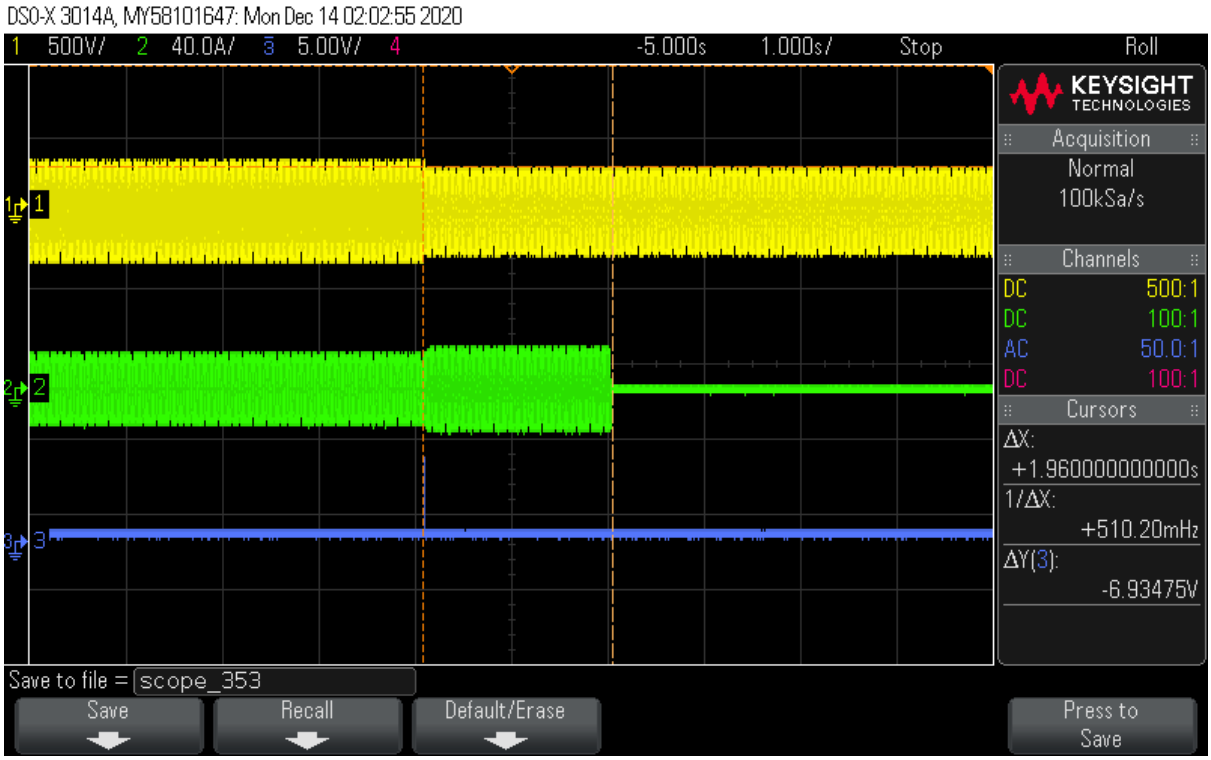
The letter “i” is short for “inductive” and indicates inductive power factor. In case of capacitive power factor the letter “c” is used instead.

The tests had been performed on the HYD 6000-EP and HYD 3000-EP is valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.

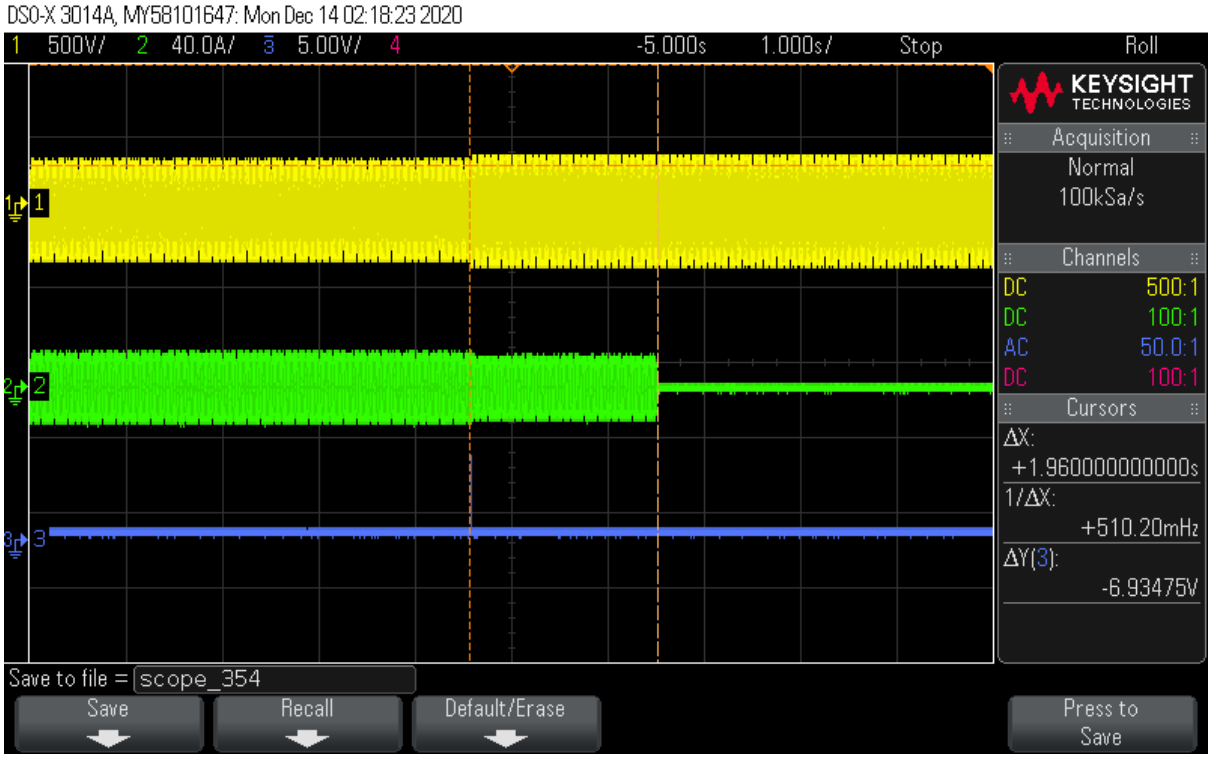
5.2.1 Voltage monitoring									P
IEC 61727: First Level									
230Va.c. / 50Hz									
Test conditions:	Output power: 3,0kW Frequency: 50Hz								
L1 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time			Voltage	Time			
Limit	**195,5**	**<= 2,0s**			**253,0**	**<= 2,0s**			
Trip value	194,9				254,2				
Disconnection time [ms]	200V to 190V	1,940	1,920	1,960	248V to 258V	1,960	1,940	1,920	
L2 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time			Voltage	Time			
Limit	**195,5**	**<= 2,0s**			**253,0**	**<= 2,0s**			
Trip value	N/A				254,2				
Disconnection time [ms]	200V to 190V	N/A	N/A	N/A	248V to 258V	N/A	N/A	N/A	
L3 phase									
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time			Voltage	Time			
Limit	**195,5**	**<= 2,0s**			**253,0**	**<= 2,0s**			
Trip value	N/A				254,2				
Disconnection time [ms]	200V to 190V	N/A	N/A	N/A	248V to 258V	N/A	N/A	N/A	
Reconnection time [s]	20s<t<300s	64s			20s<t<300s	66s			

IEC 61727: Second Level								
Test conditions:	Output power: 24,0kW Frequency: 50Hz							
L1 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	115,1				280,9			
Disconnection time [ms]	230V to 110V	80	88	88	230V to 290V	36	36	46
L2 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	N/A				N/A			
Disconnection time [ms]	230V to 110V	N/A	N/A	N/A	230V to 290V	N/A	N/A	N/A
L3 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**115,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	N/A				N/A			
Disconnection time [ms]	230V to 110V	N/A	N/A	N/A	230V to 290V	N/A	N/A	N/A
Reconnection time [s]	20s<t<300s	64s			20s<t<300s	66s		
Note: The tests had been performed on the HYD 6000-EP and is valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.								

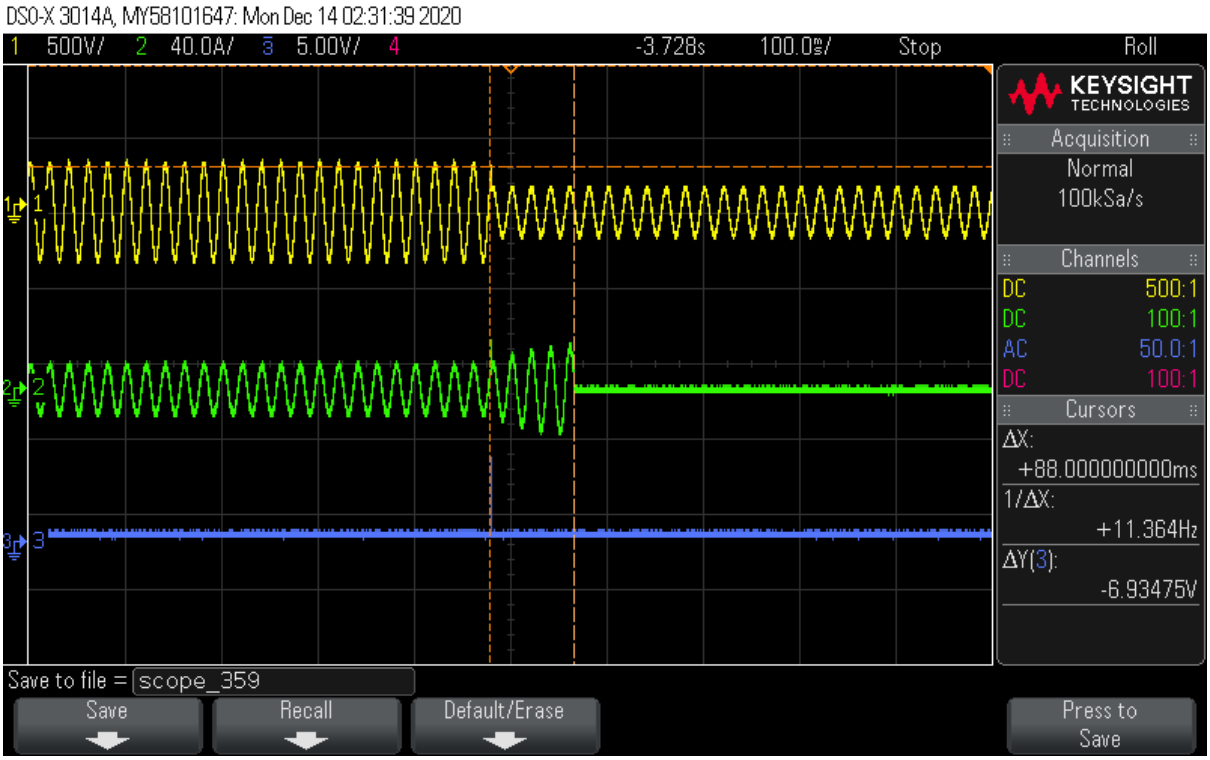
Under Voltage First Level, L1 phase



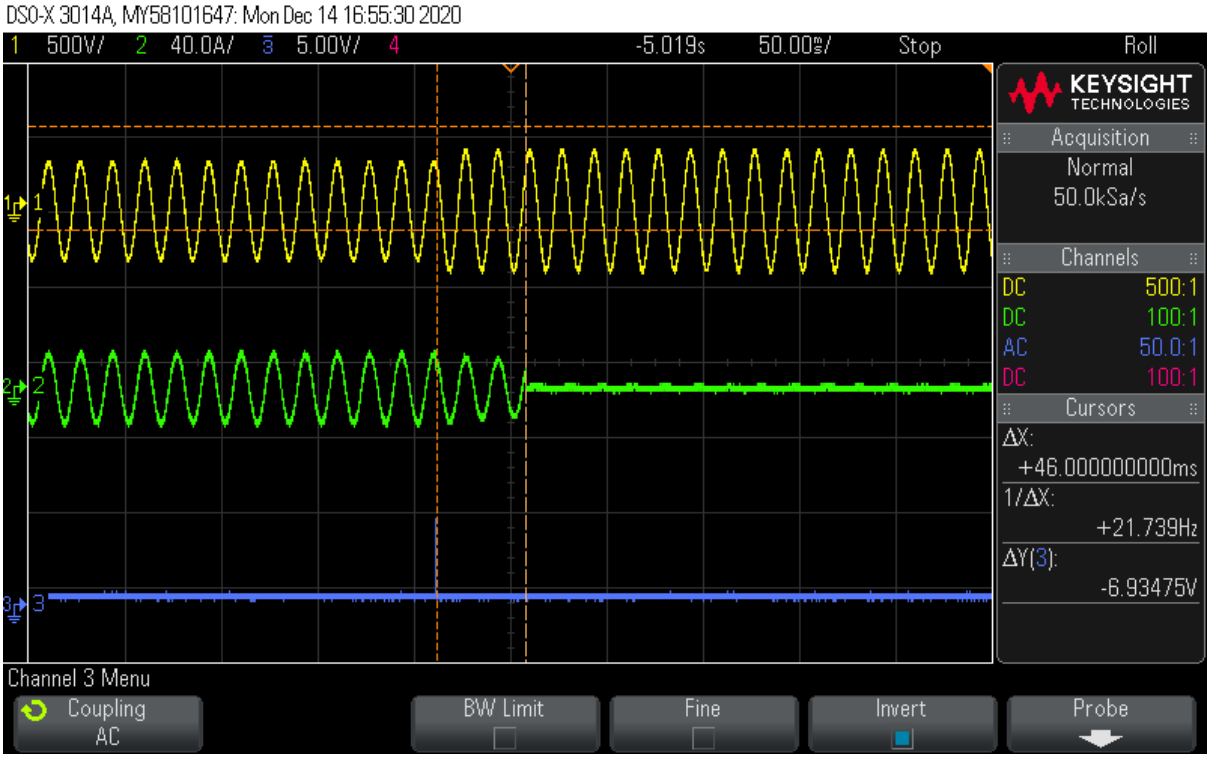
Over voltage First Level, L1 phase



Under Voltage Second Level, L1 phase



Over voltage Second Level, L1 phase



5.2.2 Frequency monitoring	P

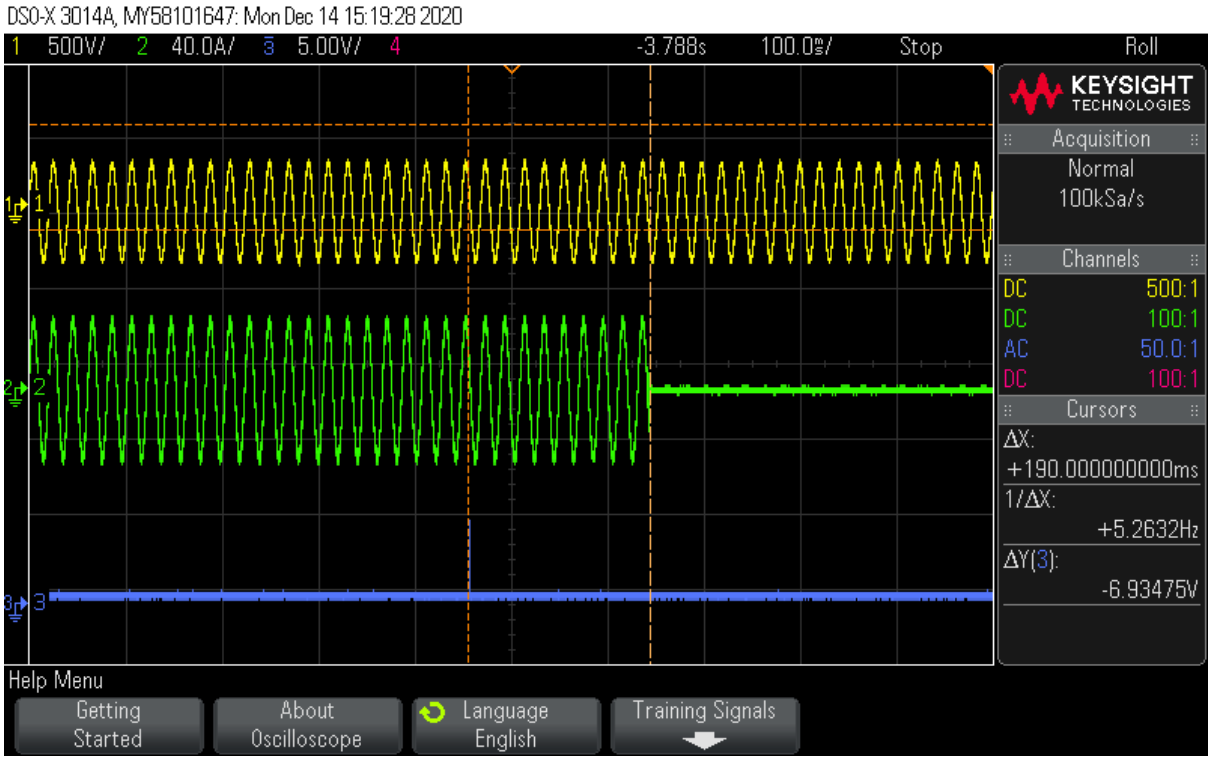
IEC 61727

230Va.c. / 50Hz

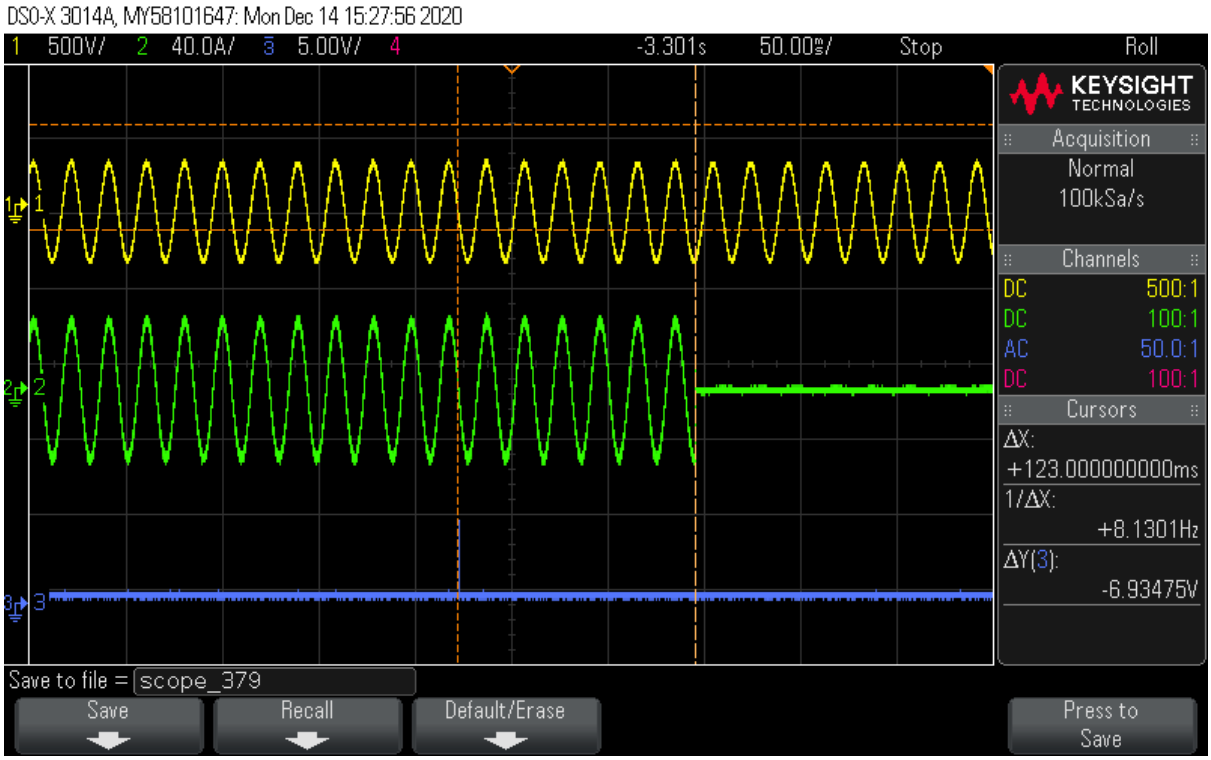
Test conditions:	Any output power level							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N
Limit	49,00Hz	200ms	200ms	200ms	51,00Hz	200ms	200ms	200ms
Trip value		49,00 Hz	49,00 Hz	49,00 Hz		50,99Hz	50,99Hz	50,99Hz
Disconnection time	49,5Hz to 48,5Hz	184	190	180	50,5Hz to 51,5Hz	107	114	123
Reconnection time	20s<t<300s	65s			20s<t<300s	65s		

Note:
The tests had been performed on the HYD 6000-EP and is valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.

Under Frequency:



Over Frequency:



5.2.1 Voltage monitoring	P

IEC 61727: First Level

230Va.c. / 60Hz

Test conditions:	Output power: 3,0kW Frequency: 50Hz

L1 phase

	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**187,0**	**<= 2,0s**			**242,0**	**<= 2,0s**		
Trip value	194,9				243,3			
Disconnection time [ms]	200V to 182V	1,960	1,940	1,960	237V to 247V	1,940	1,960	1,940

L2 phase

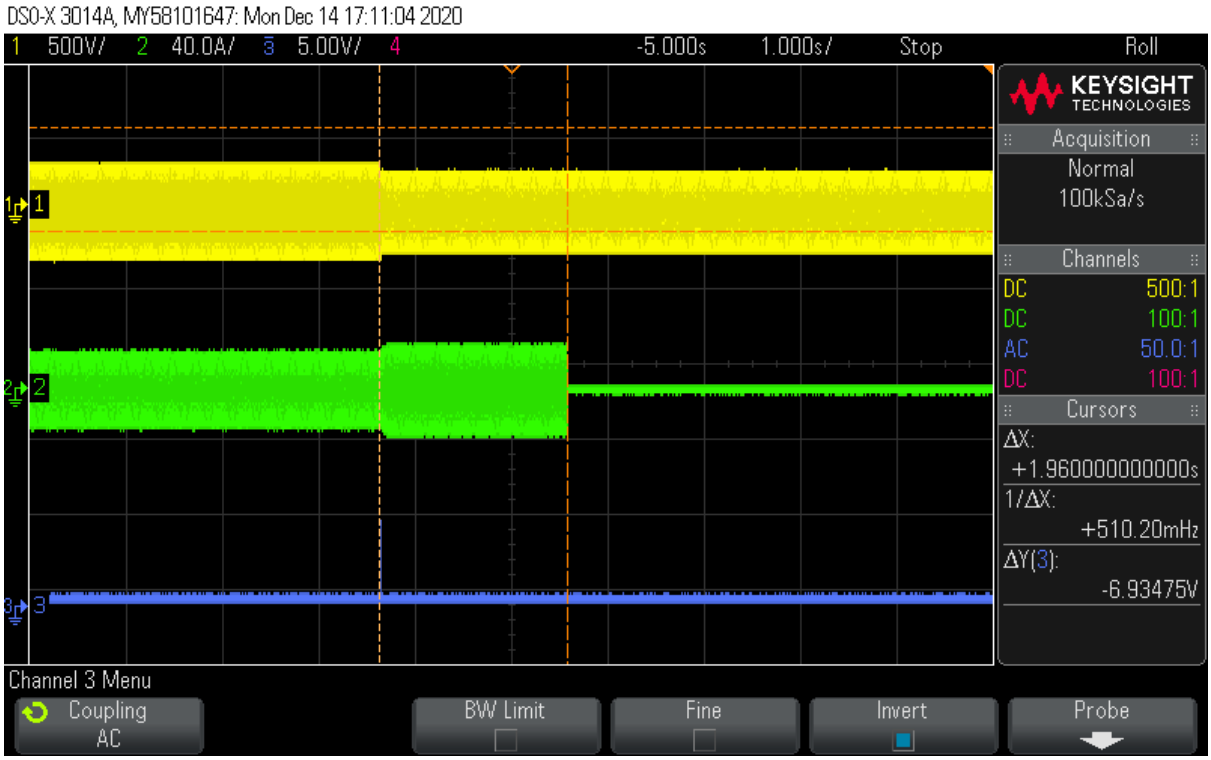
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**187,0**	**<= 2,0s**			**242,0**	**<= 2,0s**		
Trip value	N/A				254,2			
Disconnection time [ms]	200V to 182V	N/A	N/A	N/A	237V to 247V	N/A	N/A	N/A

L3 phase

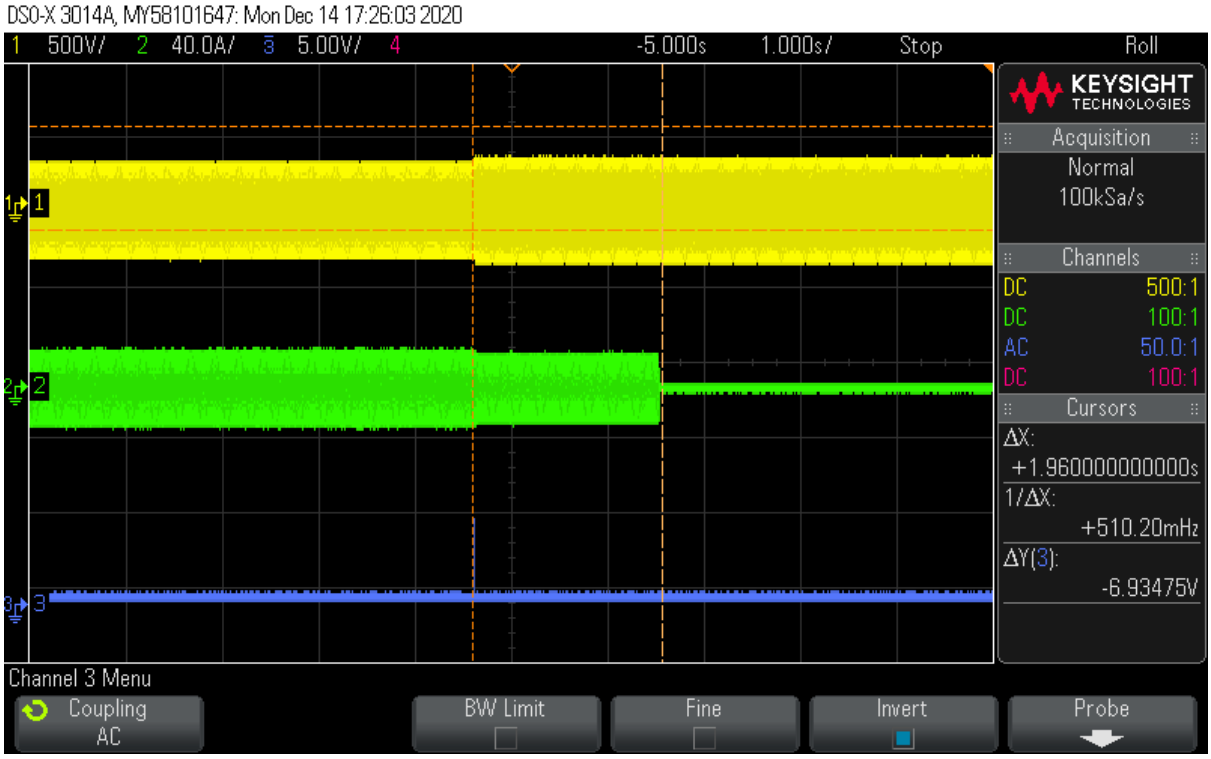
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**187,0**	**<= 2,0s**			**242,0**	**<= 2,0s**		
Trip value	N/A				254,2			
Disconnection time [ms]	200V to 182V	N/A	N/A	N/A	237V to 247V	N/A	N/A	N/A
Reconnection time [s]	20s<t<300s	65s			20s<t<300s	64s		

IEC 61727: Second Level								
Test conditions:	Output power: 24,0kW Frequency: 50Hz							
L1 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**110,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	111,8				280,9			
Disconnection time [ms]	230V to 105V	96	90	86	230V to 273V	46	43	32
L2 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**110,0**	**<= 100ms**			**280,0**	**<= 50ms**		
Trip value	N/A				N/A			
Disconnection time [ms]	230V to 105V	N/A	N/A	N/A	230V to 273V	N/A	N/A	N/A
L3 phase								
	Under Voltage				**Over Voltage**			
Parameter	Voltage	Time			Voltage	Time		
Limit	**110,0**	**<= 100ms**				**<= 50ms**		
Trip value	N/A				N/A			
Disconnection time [ms]	230V to 105V	N/A	N/A	N/A	230V to 273V	N/A	N/A	N/A
Reconnection time [s]	20s<t<300s	66s			20s<t<300s	63s		
Note: The tests had been performed on the HYD 6000-EP and is valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.								

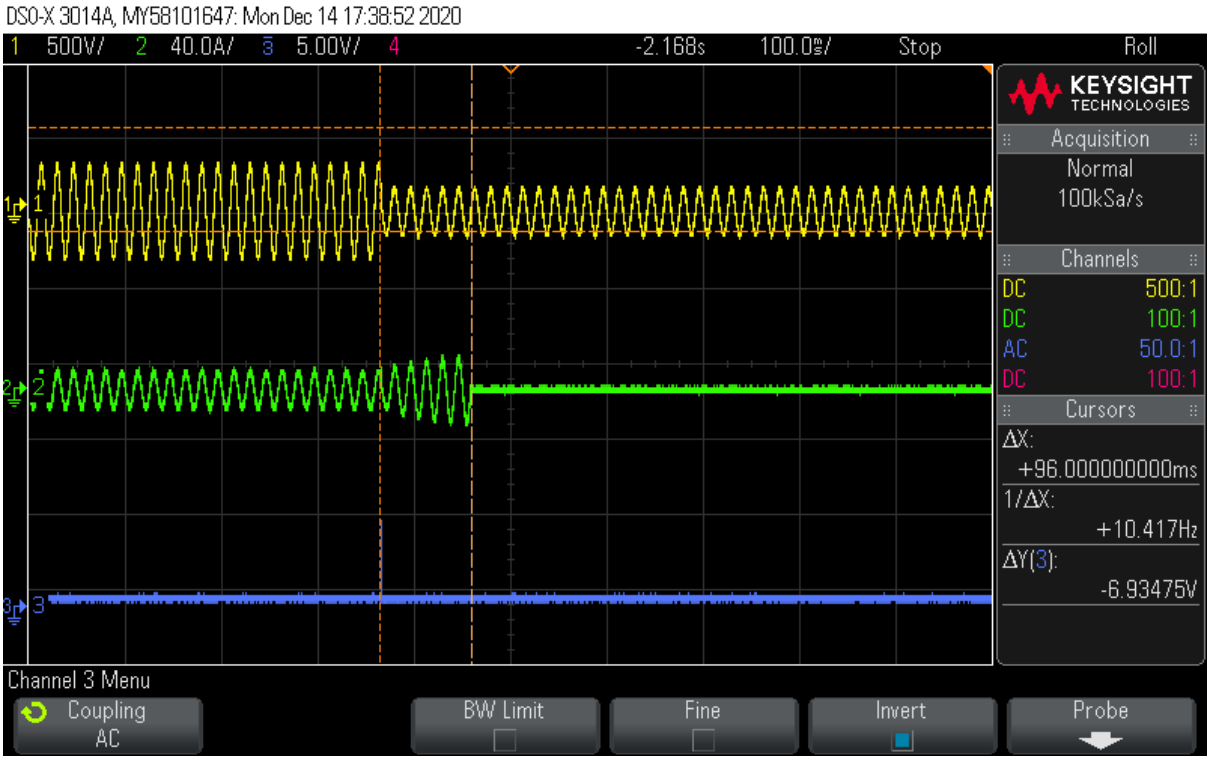
Under Voltage First Level, L1 phase



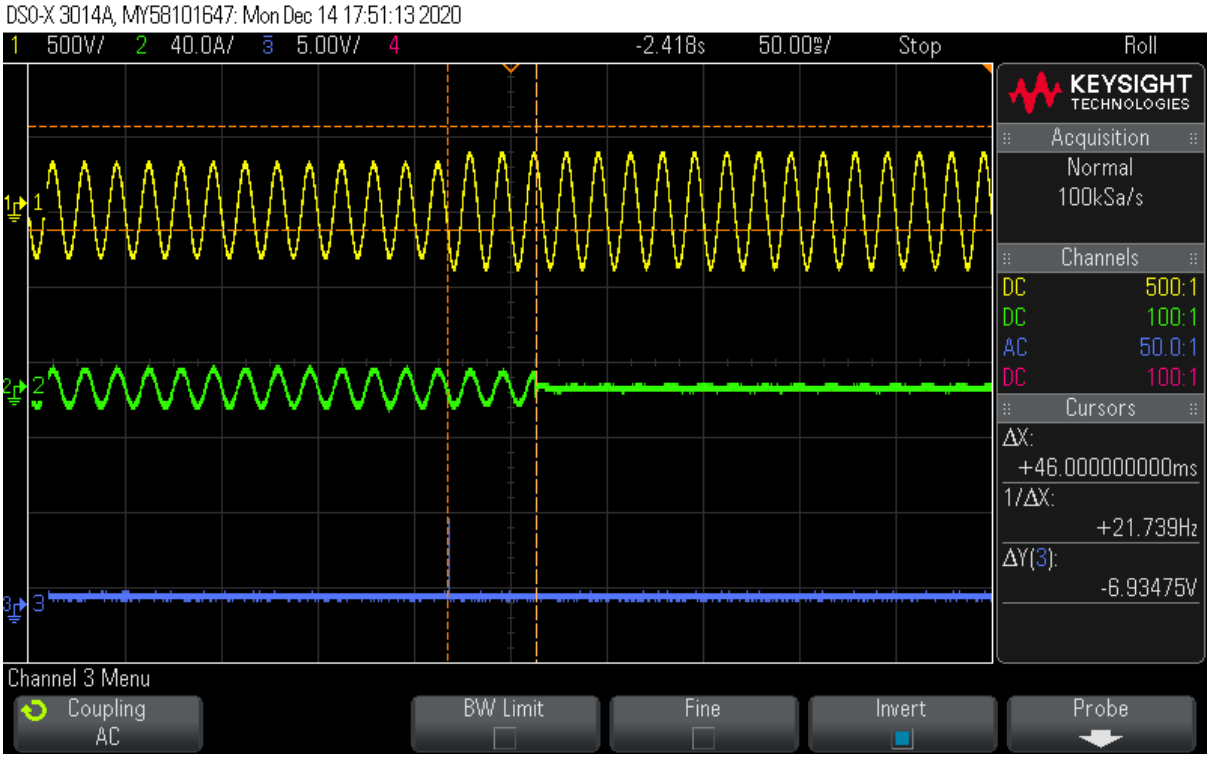
Over voltage First Level, L1 phase



Under Voltage Second Level, L1 phase



Over voltage Second Level, L1 phase



5.2.2 Frequency monitoring	P

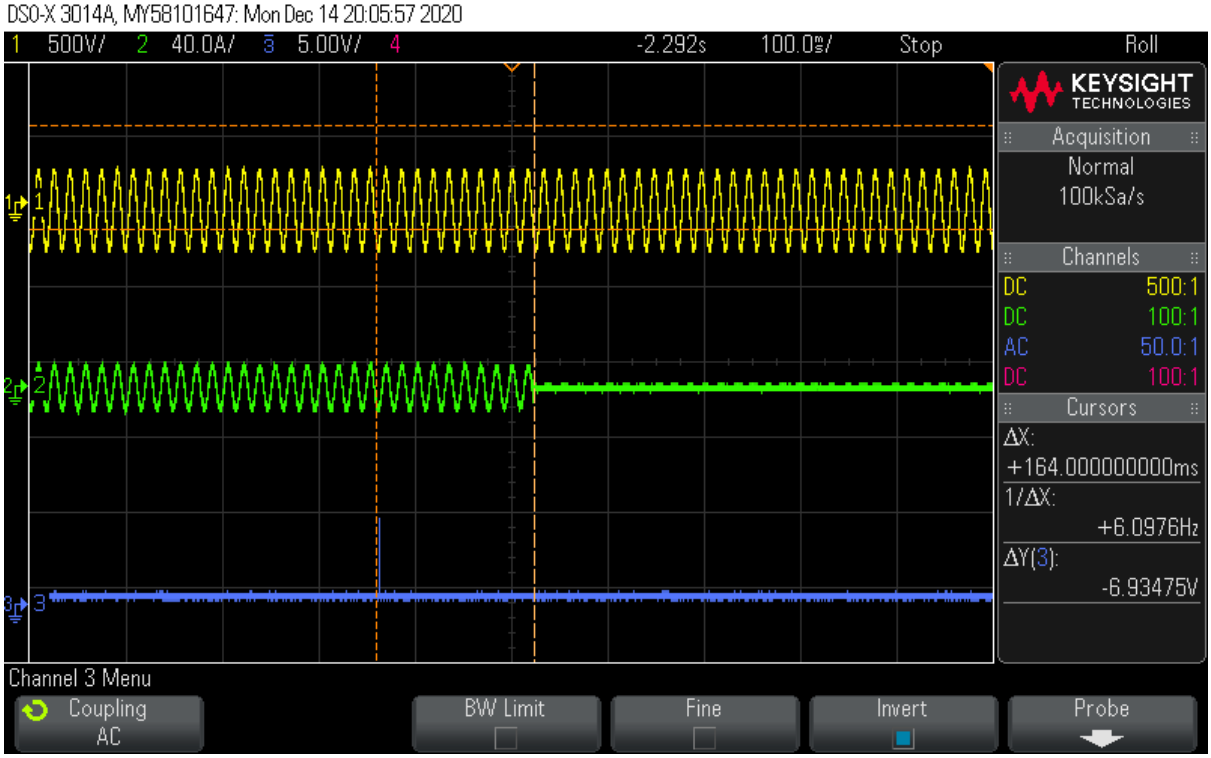
IEC 61727

220Va.c. / 60Hz

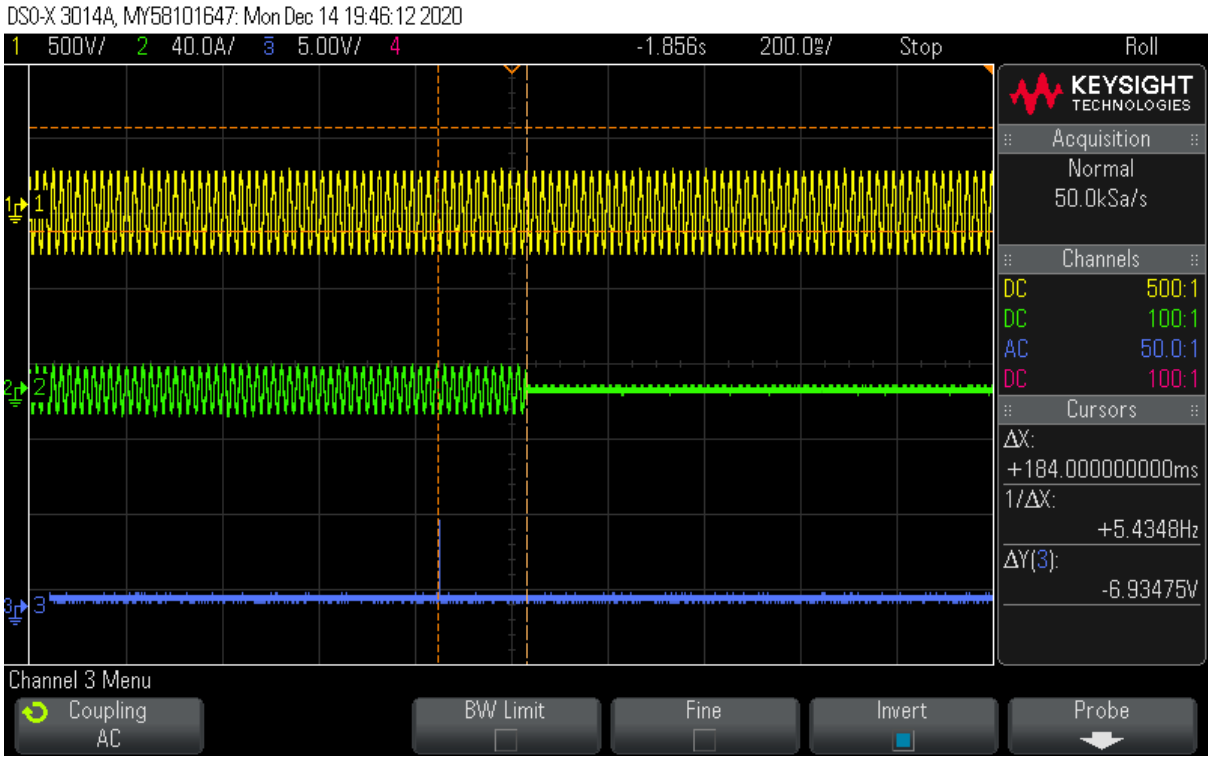
Test conditions:	Any output power level							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		85%U_N	U_N	110%U_N		85%U_N	U_N	110%U_N
Limit	59,00Hz	200ms	200ms	200ms	61,00Hz	200ms	200ms	200ms
Trip value		59,00 Hz	59,00 Hz	59,00 Hz		61,00Hz	61,00Hz	61,00Hz
Disconnection time	59,5Hz to 58,5Hz	184	174	164	60,5Hz to 61,5Hz	164	158	156
Reconnection time	20s<t<300s	65s			20s<t<300s	64s		

Note:
The tests had been performed on the HYD 6000-EP and is valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP, since it is identical in hardware and software construction except output power derated by software.

Under Frequency:



Over Frequency:

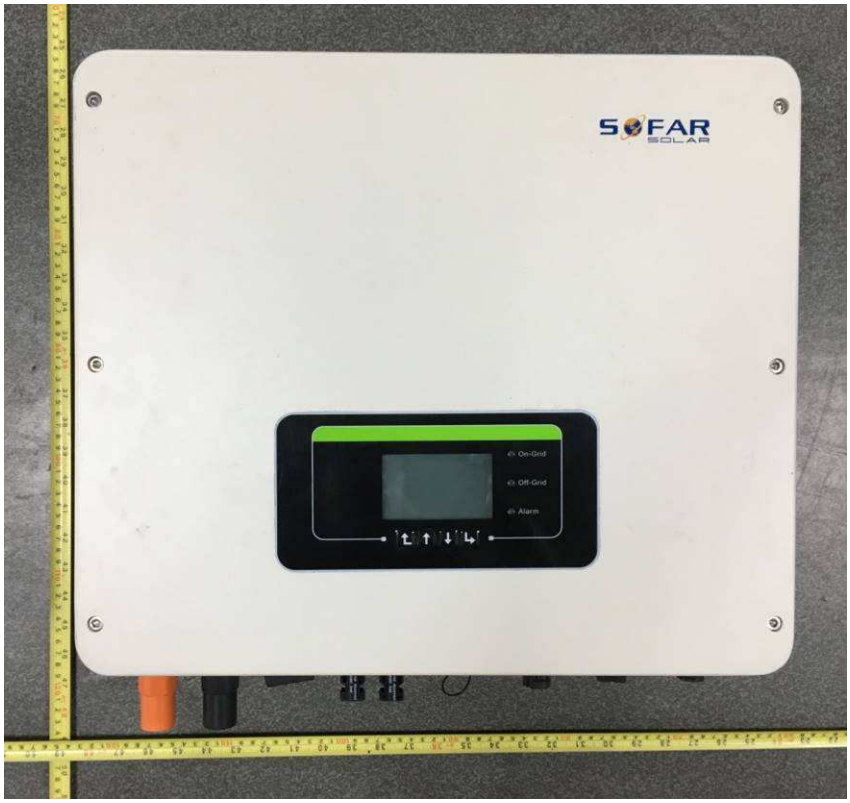


Annex 1

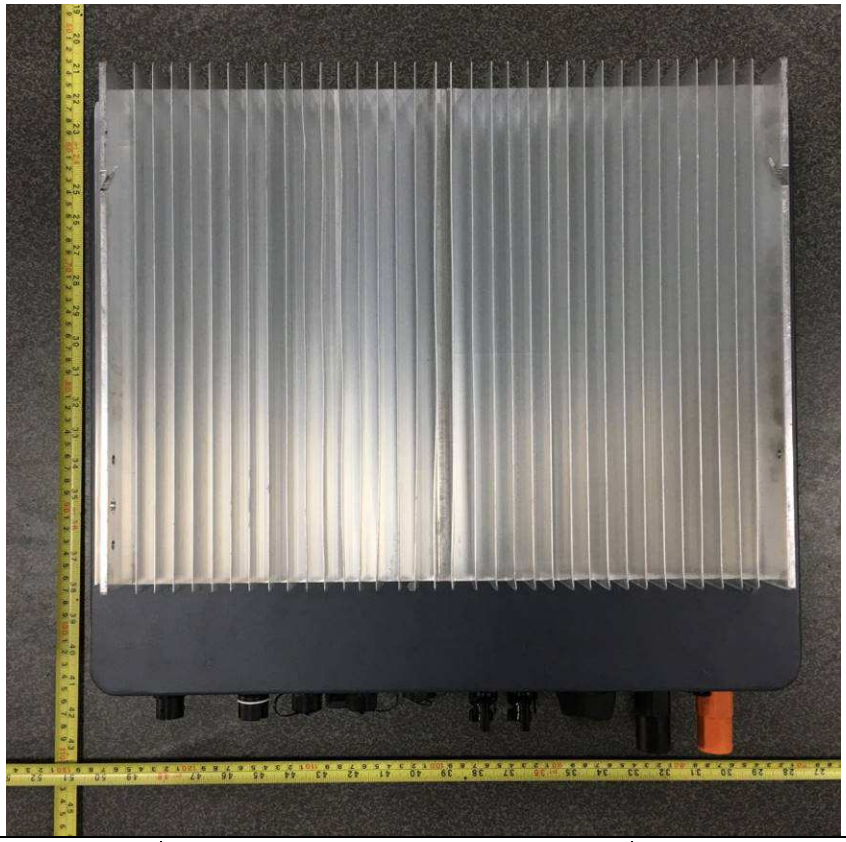
Pictures of the unit

EUT Photo

General view – 1 of Front



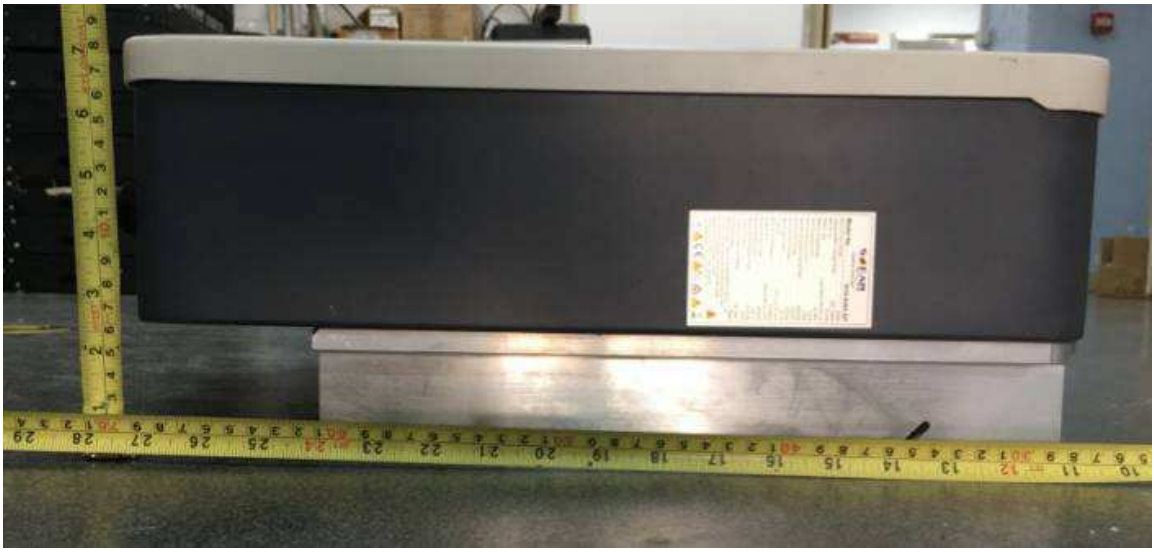
General view – 1 of Rear

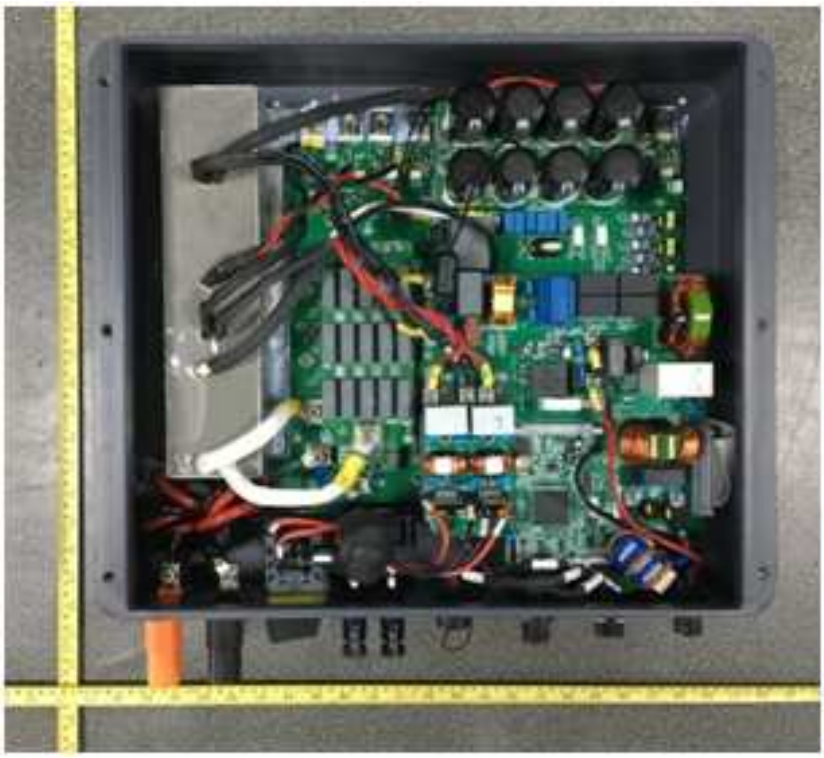
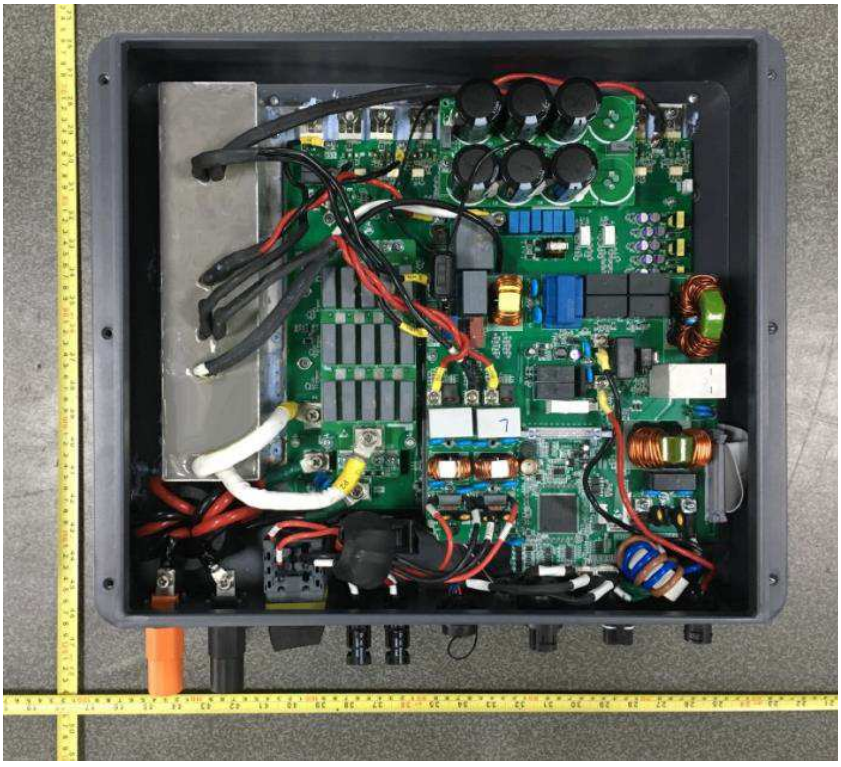


EUT Photo

General view – 1 of Bottom

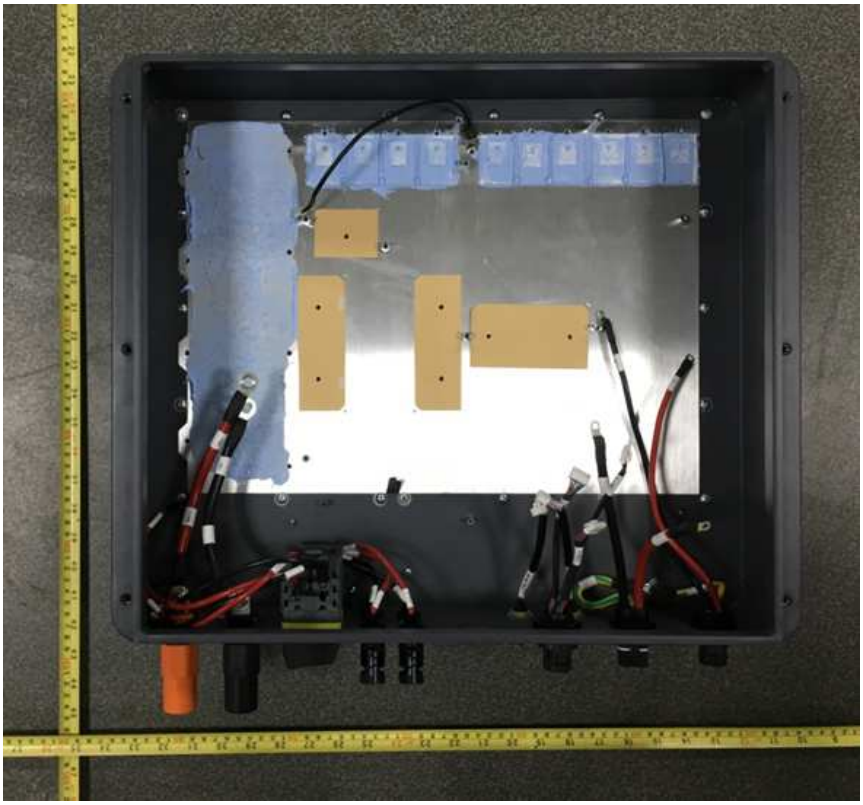
General view – 1 of Side



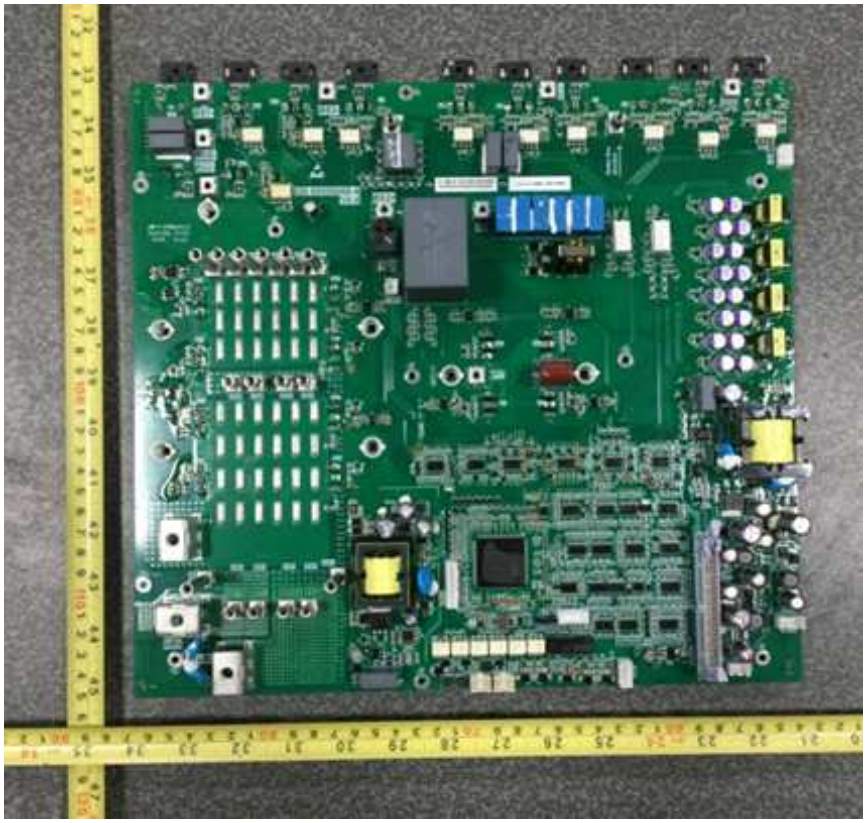
EUT Photo
Internal view – 1 **(**HYD 4600-EP, HYD 5000-EP, HYD 5500-EP,HYD 6000-EP) 
Internal view – 2 (HYD 3000-EP, HYD 3680-EP, HYD 4000-EP)


EUT Photo

Internal view - 3

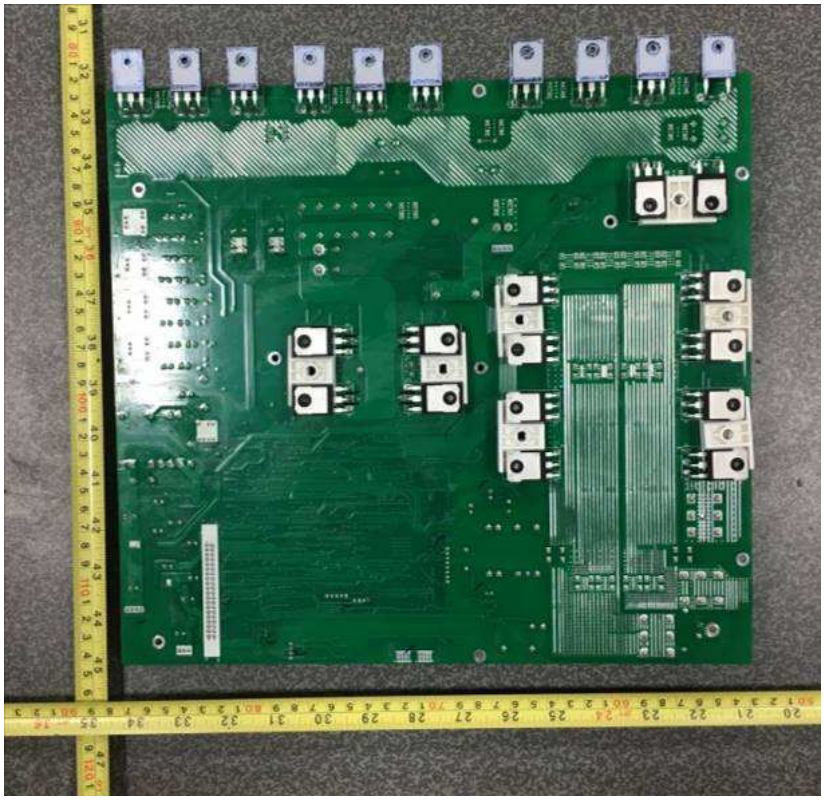


General view – 1 of Power board

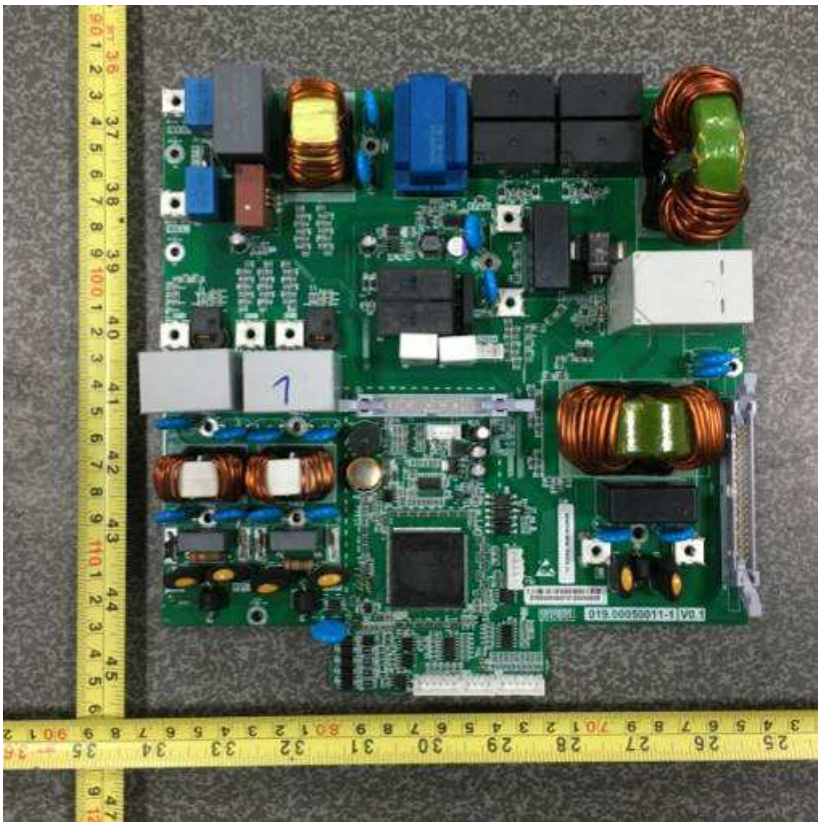


EUT Photo

General view – 2 of Power board

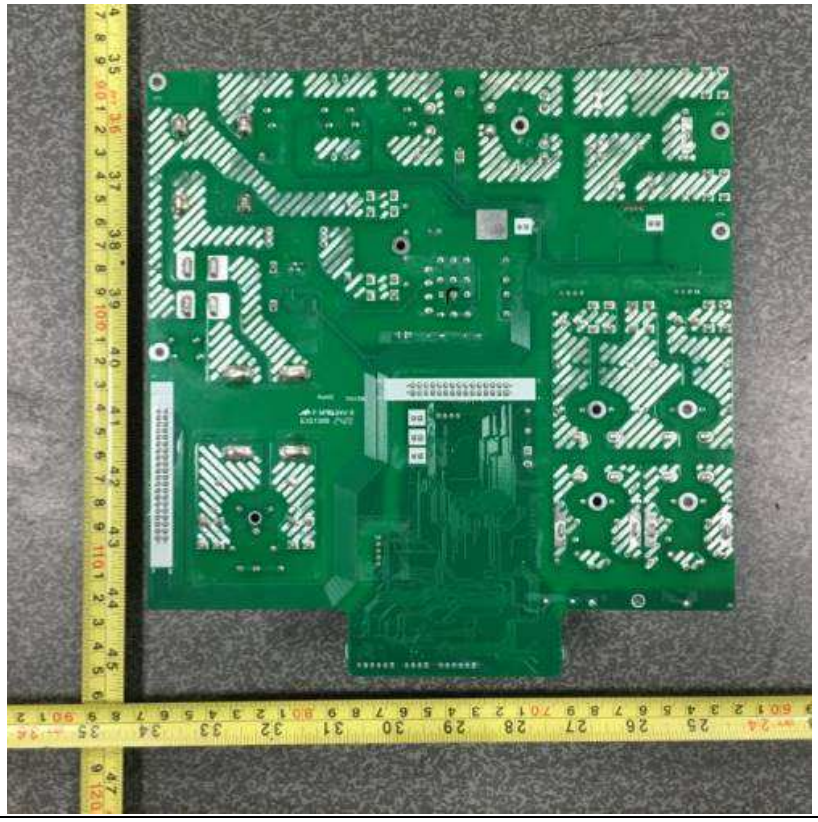


General view – 1 of Output board

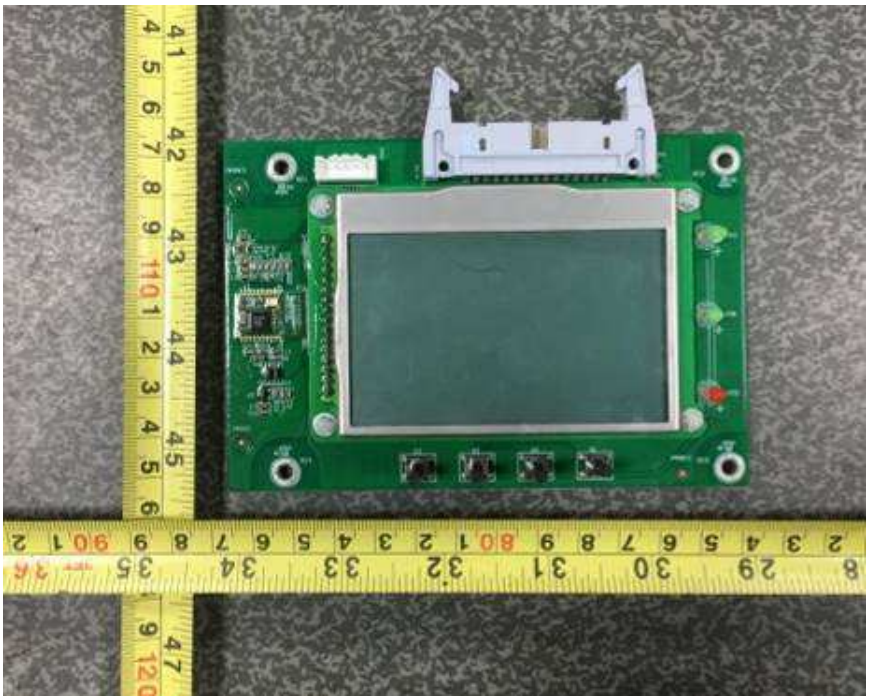


EUT Photo

General view – 2 of Output board

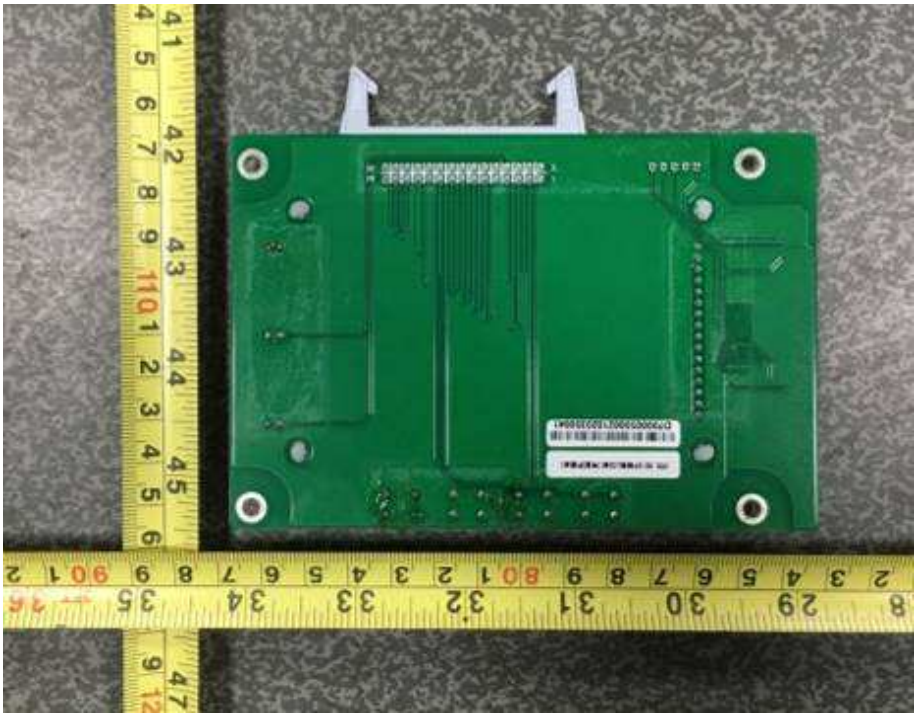


General view – 1 of LCD panel



EUT Photo

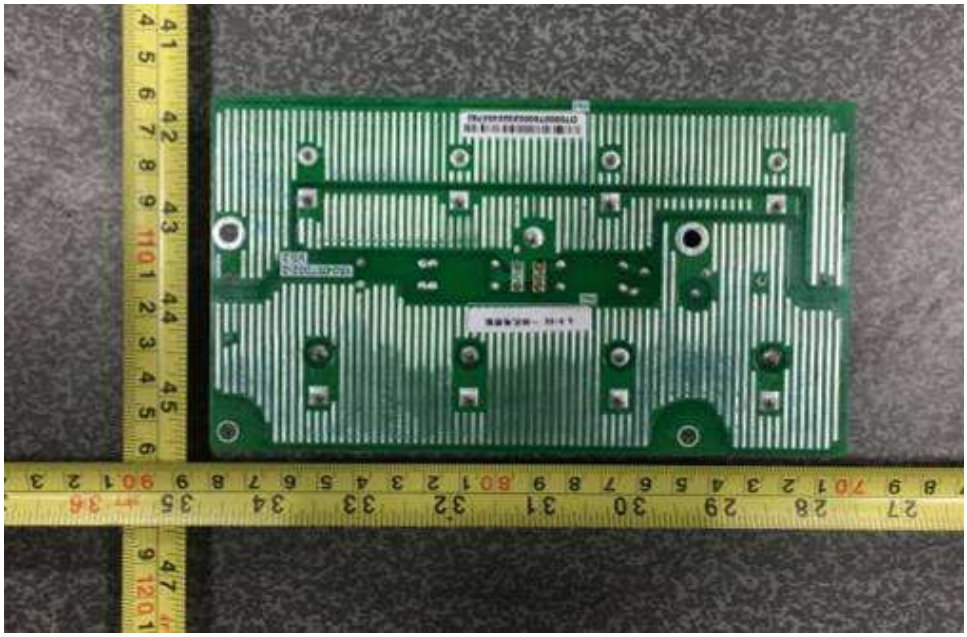
General view – 2 of LCD panel



General view - 1 of BUS board

EUT Photo

General view - 2 of BUS board



General view of Grouding point

Annex 2

Test equipment list

Testing Location: Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China

Date(s) of performance test: 2020-09-17 to 2020-12-28

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration date
Power Analyser	A4080002DG	YOKOGAWA	WT3000	91M210852	Jun. 16, 2021
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyser
	A7040020DG	Chroma	61512	61512000438	
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	
Eight Channel Digital Phosphor Oscilloscope	A4089017DG	YOKOGAWA	DL850	91N726247	Sep. 23, 2021
Oscilloscope probe	A4089008DG	Tektronix	TPP1000	C008230	Aug. 10, 2021
	A4089010DG	Tektronix	TPP1000	C008228	Aug. 10, 2021
	A4089011DG	Tektronix	TPP1000	C008229	Aug. 10, 2021
Current transducer	A1060007DG	YOKOGAWA	CT200	1130700012	Sep. 02, 2021
	A1060008DG	YOKOGAWA	CT200	1130700017	Sep. 02, 2021
	A1060012DG	YOKOGAWA	CT200	1130700018	Sep. 02, 2021
Power Analyser	//	ZLG	PA5000H	C820290908200 2110001	Mar. 02, 2021
Oscilloscope	//	Agilent	DS05014A	MY50070288	Jan. 13, 2021
Oscilloscope current probe	//	CYBERTEK	CP1000A	C181000922	Jan. 13, 2021
	//	CYBERTEK	CP1000A	C181000925	Jan. 13, 2021
	//	CYBERTEK	CP1000A	C181000929	Jan. 13, 2021
	//	CYBERTEK	CP1000A	C181000931	Jan. 13, 2021
Oscilloscope probe	//	SANHUA	SI-9110	152627	Jan. 13, 2021
	//	SIALENT	DS5034X	SDS5XEAC3R0 011	Jan. 13, 2021
	//	AGILENT	N2863B	YF0139	Jan. 13, 2021