TEST REPORT

Engineering recommendation G99/1

Requirements for the connection of generation equipment in parallel with public distribution networks

Report reference number ..... :	**PVUK200917N006-2**
Date of issue ..... ……..:	2021-01-29
Total number of pages ..... ……..:	65
Testing laboratory name ..... :	**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
Accreditation ..... :	ilac-MRA A2LA ACCREDITED Certificate # 2951.01
Applicant's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Address ..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Test specification	
Standard ..... :	G99/1-6:2020
	For Type A inverter connected Power Generating Modules
Test Report Form No. ..... :	G99/1 VER.2
TRF Originator ..... :	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF ..... :	Dated 2020-03-07
Test item description ..... :	**Hybrid 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, 230Vac, 50Hz		
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, 230Vac, 50Hz		
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, 230Vac, 50Hz		
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, 230Vac, 50Hz		
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, 230Vac, 50Hz
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, 230Vac, 50Hz
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 1 ..... :	**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**
2021-01-29	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. 21,5kg

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 2021-01-08

General remarks:

The test result presented in this report relate only to the object(s) tested. The report shall state compliance of the tested objects with the requirements of G99/1. This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

”(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 comma is used as the decimal separator.

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 plate

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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

Copy of marking plate

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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

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	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

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
Address : 401, Building 4, AnTongDa Industrial Park,
District 68, XingDong Community,XinAn Street,
BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105
G98,AS4777,UTE C15-712-1

General product information:

The Hybrid Inverter converts DC voltage into AC voltage.
The DC input of Solar converter 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 Hybrid Inverter is a single-phase type and it can be used in parallel.

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 two relays. This assures that the opening of the output circuit will also operate in case of one error.

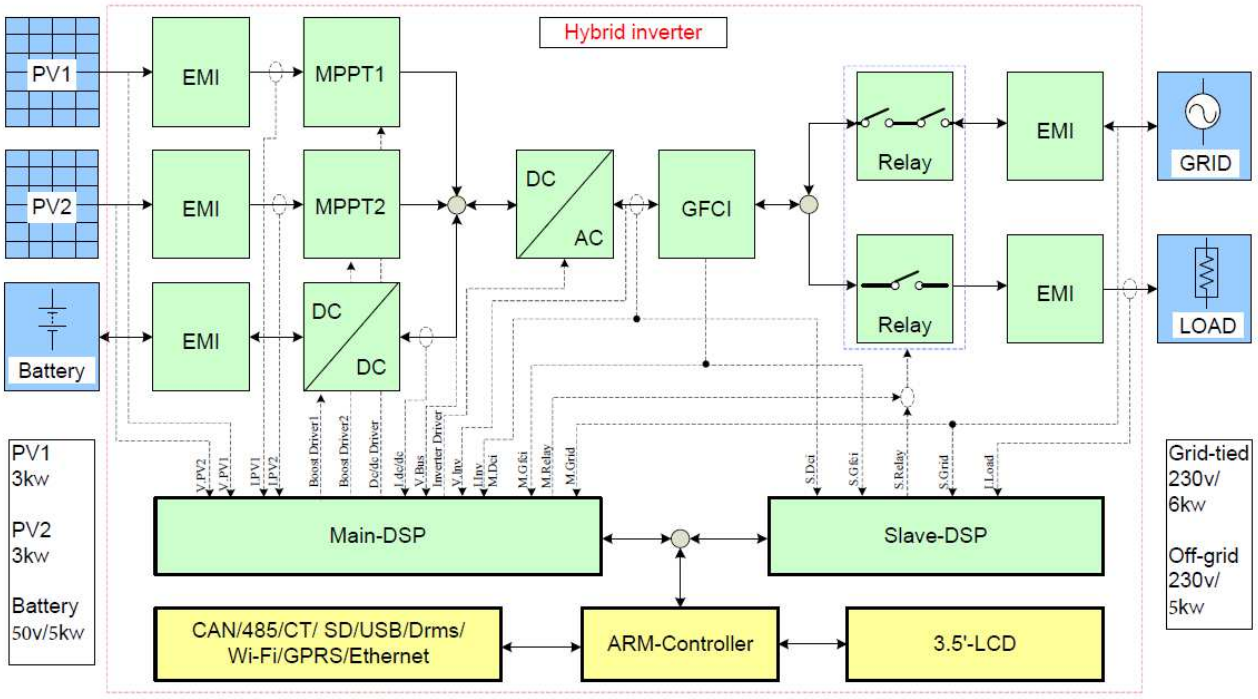


Figure 1 – Block diagram

The internal control is redundant built. It consists of Main MCU(U4) and slave MCU(U43).

The Main MCU(U4) can control the relays, measures voltage, and frequency, AC current with injected DC, insulation resistance and residual current, In addition it tests the array insulation resistance and the RCMU circuit before each start up.

The slave MCU (U43) is using for controlling the relays, measuring the voltage， frequency, inject a dc AC current, the residual current, and communicating with the master MCU (U4). And if the communicating with the master MCU, the slave MCU will disconnect the relays.

The unit provides two relays in series on Line and Neutral 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 start up. Both controllers Main MCU(U4), Slave MCU(U43) can open the relays.

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: V001
Software: 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.

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7	**Requirements for Type Testing Power Generating Modules**		
A.7.1	**Power Park Module Requirements**		
A.7.1.1	**Certification & Type Testing Generating Unit Requirements**		
A.7.1.2	Type Verification Functional Testing of the Interface Protection		**P**
A.7.1.2.1	Disconnection times		**P**
A.7.1.2.2	Over / Under Voltage	see Table A.7.1.2.2	**P**
A.7.1.2.3	Over / Under Frequency	see Table A.7.1.2.3	**P**
A.7.1.2.4	Loss of Mains Protection	see Table A.7.1.2.4	**P**
A.7.1.2.5	Re-connection	see Table A.7.1.2.5	**P**
A.7.1.2.6	Frequency Drift and Step Change Stability test	see Table A.7.1.2.6	**P**
A.7.1.3	Limited Frequency Sensitive Mode – Over (LFSM-O)	see Table A.7.1.3	**P**
A.7.1.4.1	Harmonics	see Table A.7.1.4.1	**P**
A.7.1.4.2	Power Factor	see Table A.7.1.4.1	**P**
A.7.1.4.3	Voltage Flicker	see Table A.7.1.4.3	**P**
A.7.1.4.4	DC Injection	see Table A.7.1.4.4	**P**
A.7.1.5	Short Circuit Current Contribution	see Table A.7.1.5	**P**
A.7.1.6	Self-Monitoring - Solid State Disconnection		**N/A**
A.7.2.3	Power Output with Falling Frequency	see Table A.7.2.3	**P**

G99-1 Type A Test Results:

A.7.1.2 Type Verification Functional Testing of the Interface Protection Functional safety - fault condition tests according DIN V VDE V 0126-1-1								P
	ambient temperature [°C] :			24°C				
	model/type of power supply :			AC: 61512 DC: 62150H-1000s				
	manufacturer of power supply :			Chroma				
	rated markings of power supply :			AC: 0-300V, 6kVA DC: 0-1000V,15A				

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
Relay RL4	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Relay RL1	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Relay RL2	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Relay RL5	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Rectifier bridge BR1	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated immediately, disconnected with grid. No damage, no hazards.
Q23 pin G-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.
Q17 pin G-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.
Q18 pin G-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.
Q16 pin G-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.

RCM/LP1 pin GND-Vout	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID05:GFCI fault”. No damage,no hazards.
Monitoring voltage defect R203	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code “GridUVP”. No damage. No hazards.
Monitoring voltage defect R219	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code “GridUVP”. No damage. No hazards.
U1 pin 485-1TX 485-1RX	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. 4851 Communication failure. No damage. No hazards.
U1 pin 485-2TX 485-2RX	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. 4852 Communication failure. No damage. No hazards.
U1 pin ARMToDSP ARMFromDSP-TX	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. SCI Communication failure. No damage. No hazards.
U1 pin M_CAN_RX M_CAN_TX	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. CAN Communication failure. No damage. No hazards.
U1,+3.3V.S	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. SCI Communication failure. No damage. No hazards.
PV voltage monitoring R283	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. No damage. No hazards
PV voltage monitoring R277	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. No damage. No hazards
L to N(Grid)	Reversed	230V 15,5A	520V 11,8A	10Min.	--	230V 15,5A	520V 11,8A	EUT operationed normally. No damage, no hazards.
C324	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. L2 ,L7,breakdown, no hazards.
EC2	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. EC2 damage, no hazards.
EC3	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. EC3 damage, no hazards.
Q61 pin D-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. No damage. No hazards
Q16 pin D-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code “ID81” (SwBatOCP). No damage, no hazards.

Q17 pin D-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
Q18 pin D-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
Q19 pin D-S	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
D13	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID69.PVOVP. No damage, no hazards.
R28	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID69.PVOVP. No damage, no hazards.
R68	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
R32	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
R71	Open	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
Q27	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
Q9 pin G-C-E	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q9,Q13 damaged, no hazards
Q8 pin G-C-E	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q8,Q14 damaged, no hazards
Q7 pin G-C	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q7 damaged, no hazards
Q12 pin G-C	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q12 damaged, no hazards

Q1 pin G-S-D	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q1,Q2,Q3 damaged, no hazards
Q2 pin G-S-D	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q1,Q2,Q3,Q6 damaged, no hazards
R531	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
R602	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
R611	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
R620	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
EC25	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
EC27	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC16	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC17	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC29	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC31	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.

EC18	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC19	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC24	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC26	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC20	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC21	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC28	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC30	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC22	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC23	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC32	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " SCI Communication failure". No damage, no hazards.

U4 pin M_LINRX M_LINTX	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. M_LINRX Communication failure No damaged. No hazards
INSYN,TX1 ,INSYN,RX 1	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. Error code"ID47(ParallelFault) No damaged. No hazards.
INSYN,TX1 ,INSYN,RX 1	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. Error code"ID47(ParallelFault) No damaged. No hazards.
C384	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code "ID81(SwBatOCP) . No damaged. No hazards.
EC6	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
EC9	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
EC11	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
U58	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
C463	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"GFCI fault" No damaged. No hazards
C105	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"CT current fault" No damaged. No hazards.
C130	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code" OverTempDerating" No damaged. No hazards.
C107	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"HwLLCBusOCP" No damaged. No hazards.
C120	Short	230V 15,5A	520V 11,8A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"HwLLCBusOCP" No damaged. No hazards.

The errors in the control circuit simulate that the safety is even ensured during single fault.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

The test results refer to the test report "PVTR200917N016" issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2021.01.20.

Operating Range		**P**
Setting values	Over-voltage [V]:	253,0
	Under-voltage [V]:	195,5
	Over-frequency [Hz]:	52,00
	Under-frequency [Hz]:	47,00

- Test 1: U = 195,5 V; f = 47,0 Hz; P = 1,00 Sn; cosφ = 1; at least 20 s
- Test 2: U = 195,5 V; f = 47,5 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 3: U = 253,0 V; f = 51,5 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 4: U = 253,0 V; f = 52,0 Hz; P = 1,00 Sn; cosφ = 1; at least 15 mins
- Test 5: U = 230,0 V; f = 50,0 to 50,5 Hz;RoCoF=1Hz/s; P = 1,00 Sn; cosφ = 1

Test sequence	Voltage [V]	Frequency [Hz]	Output power [W]	Cos φ [1]
Test 1	195,64	47,00	5422	0,993
Test 2	195,39	47,50	4531	0,994
Test 3	253,32	51,50	5982	0,997
Test 4	253,62	52,00	5980	0,996
Test5	230,59	50,50	5990	0,999

Note:

During the tests the interface protection was disabled.

Operation at reduced power is allowed during test 1 and test 2, equal to the maximum power that can be supplied on reaching the maximum output current limit (P ≥ 0,85 Sn).

During the sequence of test 3 and test 4, automatic adjustment to reduce power in the case of over-frequency was disabled.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

A.7.1.2.2 Over / Under Voltage

Table 10.1 Settingd for long term parallel Operation

P

Test: L to N

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	184,0V (0,8 pu)	2,5s	183,9V	2,520s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V (1,14 pu)	1,0s	260,9V	1,013s	258,2V / 5,0s	No trip
O/V stage 2	273,7V (1,19 pu)	0,5s	273,9V	0,512s	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

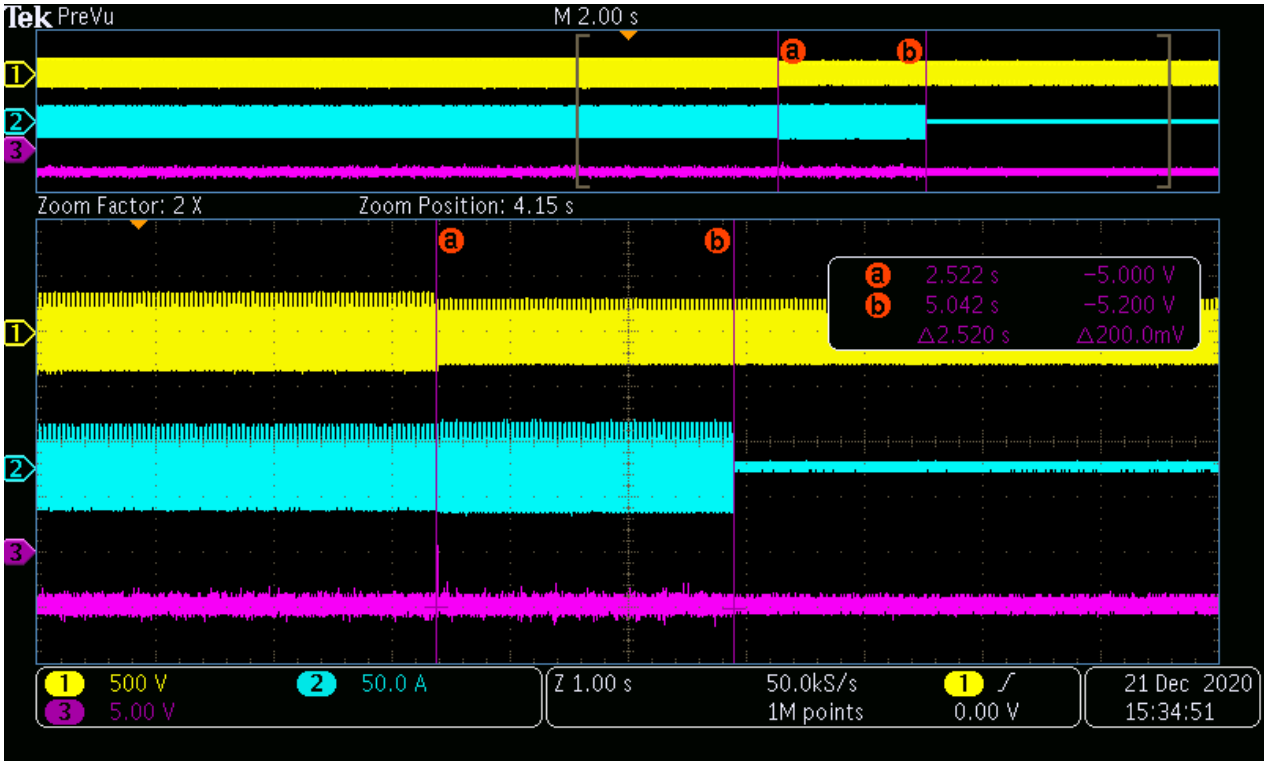
Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0.5 s.

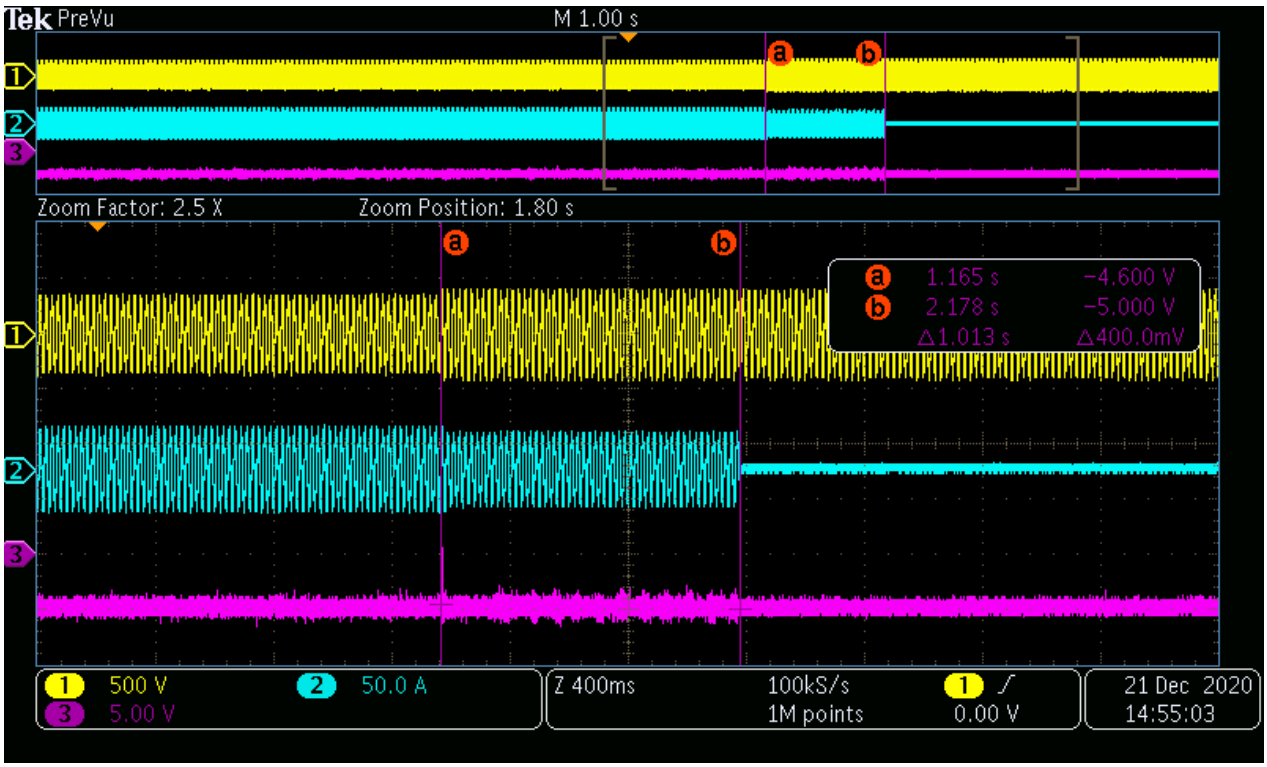
The Voltage required to trip is the setting ±3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

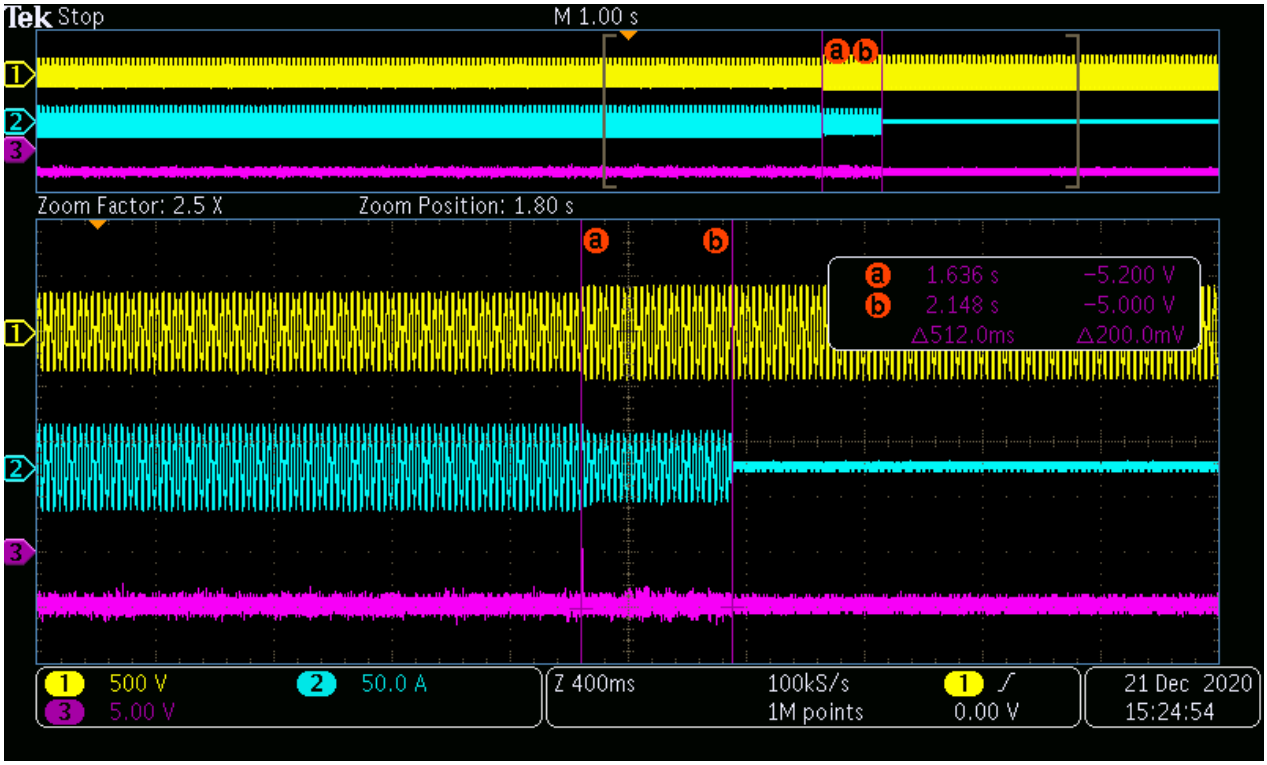
U/V


Tek PreVu
M 2.00 s
Zoom Factor: 2 X
Zoom Position: 4.15 s
a 2.522 s −5.000 V
b 5.042 s −5.200 V
Δ2.520 s Δ200.0mV
1 500 V
3 5.00 V
2 50.0 A
Z 1.00 s
50.0kS/s
1M points
1 0.00 V
21 Dec 2020
15:34:51

O/V stage 1


Tek PreVu
M 1.00 s
Zoom Factor: 2.5 X
Zoom Position: 1.80 s
a 1.165 s −4.600 V
b 2.178 s −5.000 V
Δ1.013 s Δ400.0mV
1 500 V
3 5.00 V
2 50.0 A
Z 400ms
100kS/s
1M points
1 0.00 V
21 Dec 2020
14:55:03

O/V stage 2


Tek Stop
M 1.00 s
Zoom Factor: 2.5 X
Zoom Position: 1.80 s
a 1.636 s -5.200 V
b 2.148 s -5.000 V
Δ512.0ms Δ200.0mV
1 500 V
3 5.00 V
2 50.0 A
Z 400ms
100kS/s
1M points
1 ⎍
0.00 V
21 Dec 2020
15:24:54

A.7.1.2.3 Over / Under Frequency						P
Test:						
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20,0s	47,50	20,030s	47,7Hz / 30s	No trip
U/F stage 2	47,0Hz	0,5s	47,00	0,515s	47,2Hz / 19,5s	No trip
					46,8 Hz / 0,45s	No trip
O/F	52,0Hz	0,5s	52,00Hz	0,515s	51,8Hz / 120s	No trip
					52,2 Hz / 0,45s	No trip

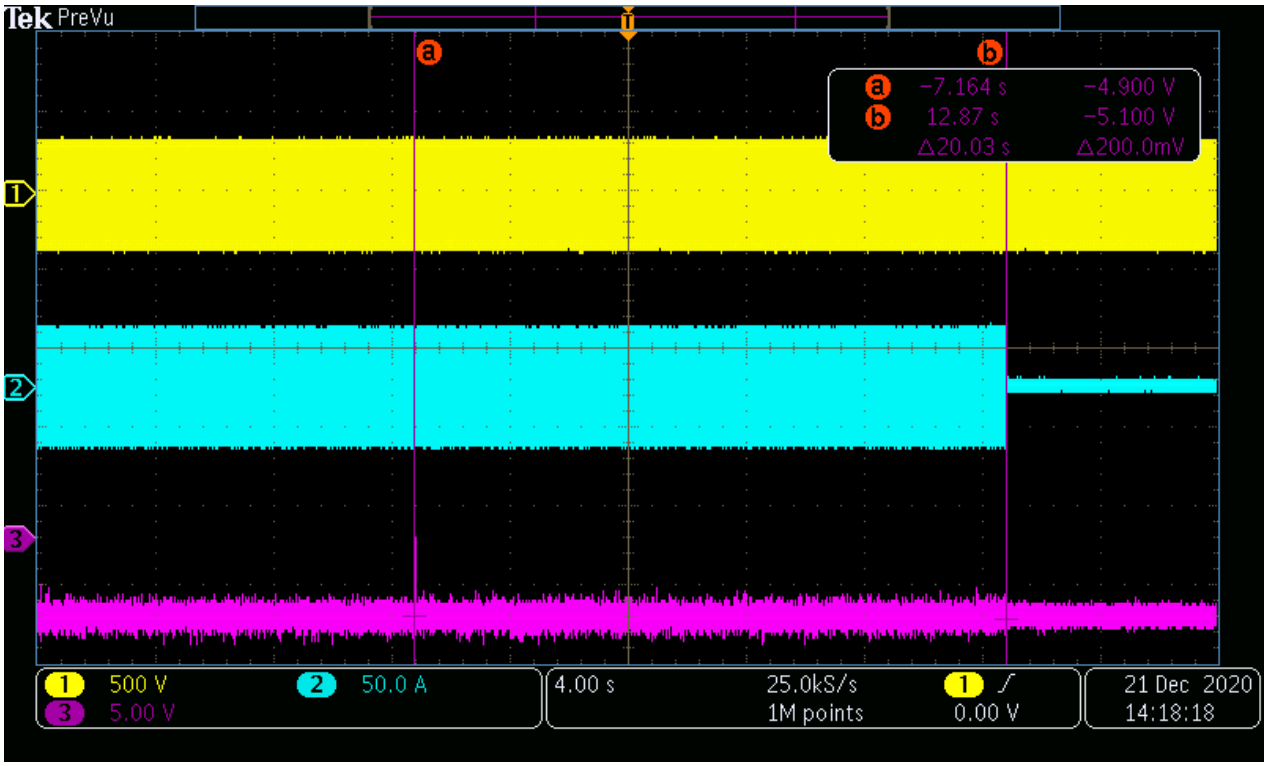
Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0.5 s.

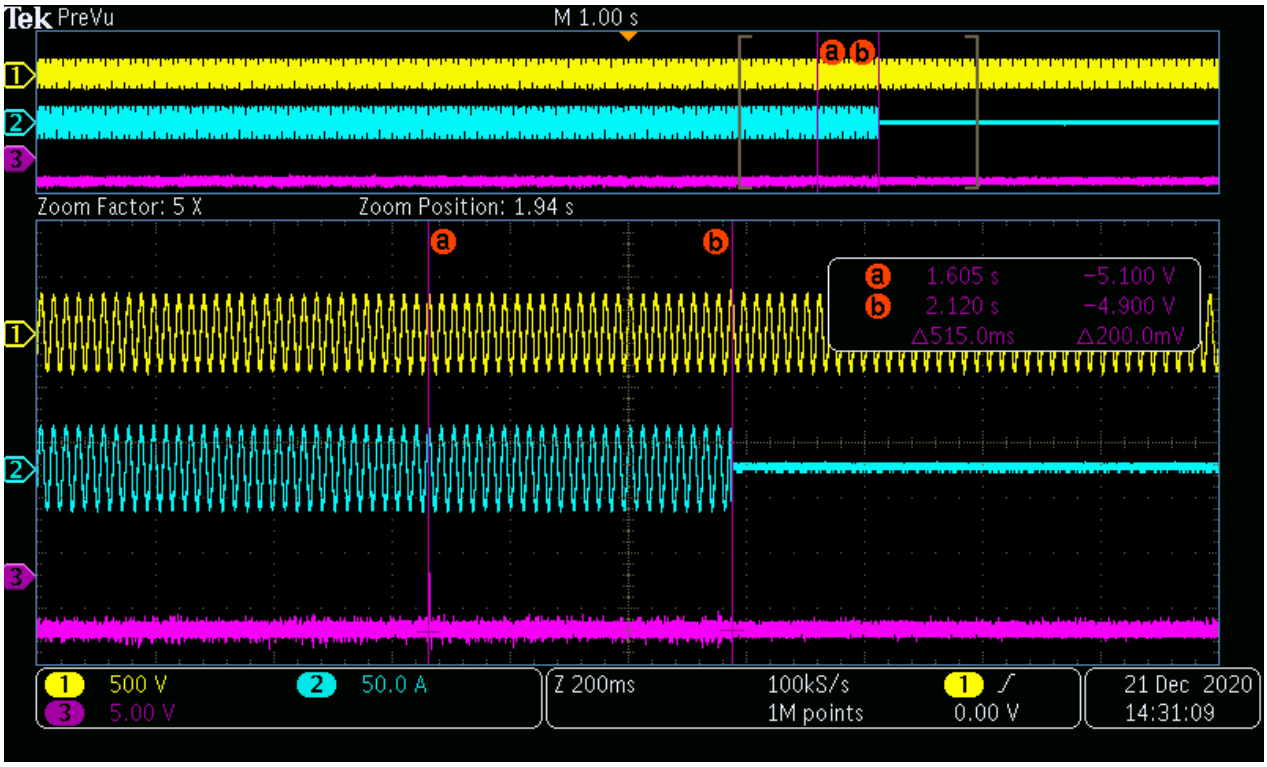
For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No trip tests” need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

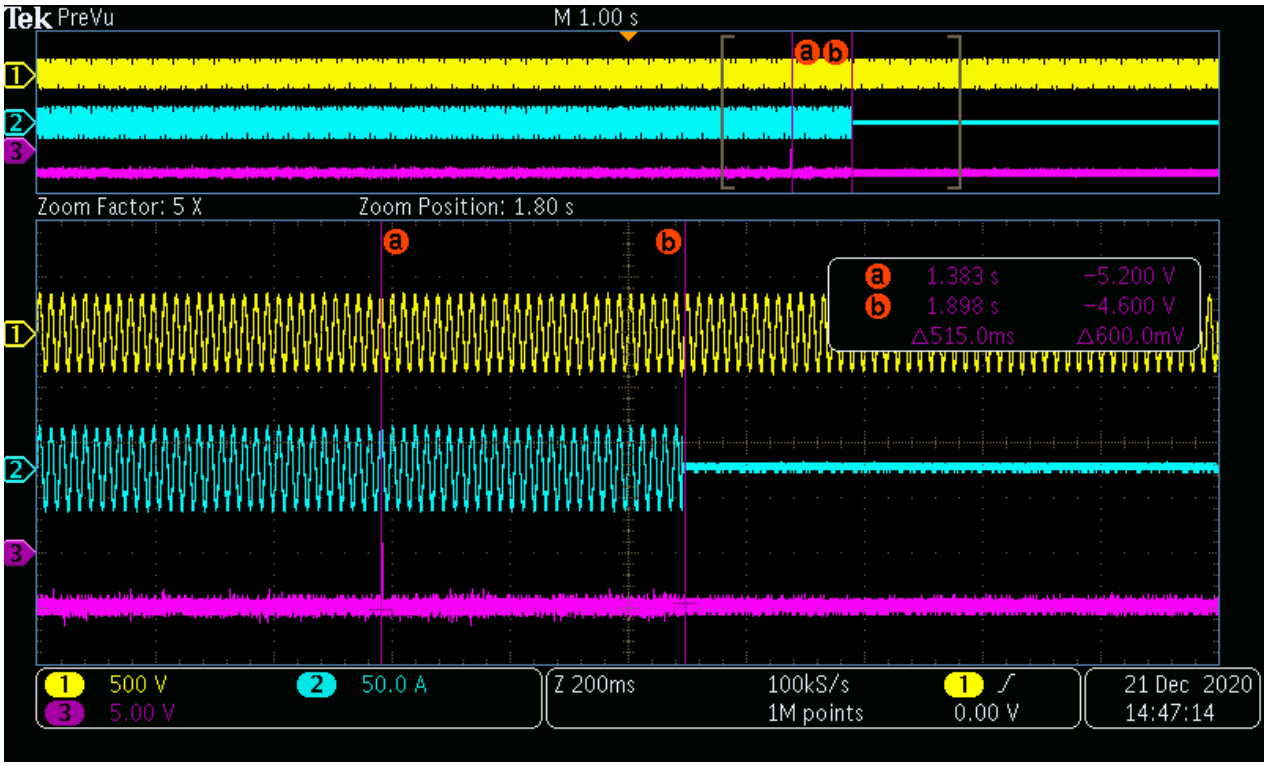
U/F stage 1



U/F stage 2



O/F


Tek PreVu
M 1.00 s
Zoom Factor: 5 X
Zoom Position: 1.80 s
a 1.383 s -5.200 V
b 1.898 s -4.600 V
Δ515.0ms Δ600.0mV
1 500 V
3 5.00 V
2 50.0 A
Z 200ms
100kS/s
1M points
1 0.00 V
21 Dec 2020
14:47:14

A.7.1.2.4 Loss of mains protection according BS EN 62116

The requirement is specified in section 10.2, test procedure in Annex A.2.2.4
Load imbalance (real, reactive load) for test condition A (EUT ouput = 100%)

P

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
1	100	100	0	0	6003	441	1,000	**225**	Test A at BL
2	100	100	-5	-5	6003	441	1,026	**208**	Test A at IB
3	100	100	-5	0	6003	441	1,053	216	Test A at IB
4	100	100	-5	+5	6003	441	1,079	206	Test A at IB
5	100	100	0	-5	6003	441	0,975	207	Test A at IB
6	100	100	0	+5	6003	441	1,025	210	Test A at IB
7	100	100	+5	-5	6003	441	0,928	148	Test A at IB
8	100	100	+5	0	6003	441	0,952	208	Test A at IB
9	100	100	+5	+5	6003	441	0,976	200	Test A at IB

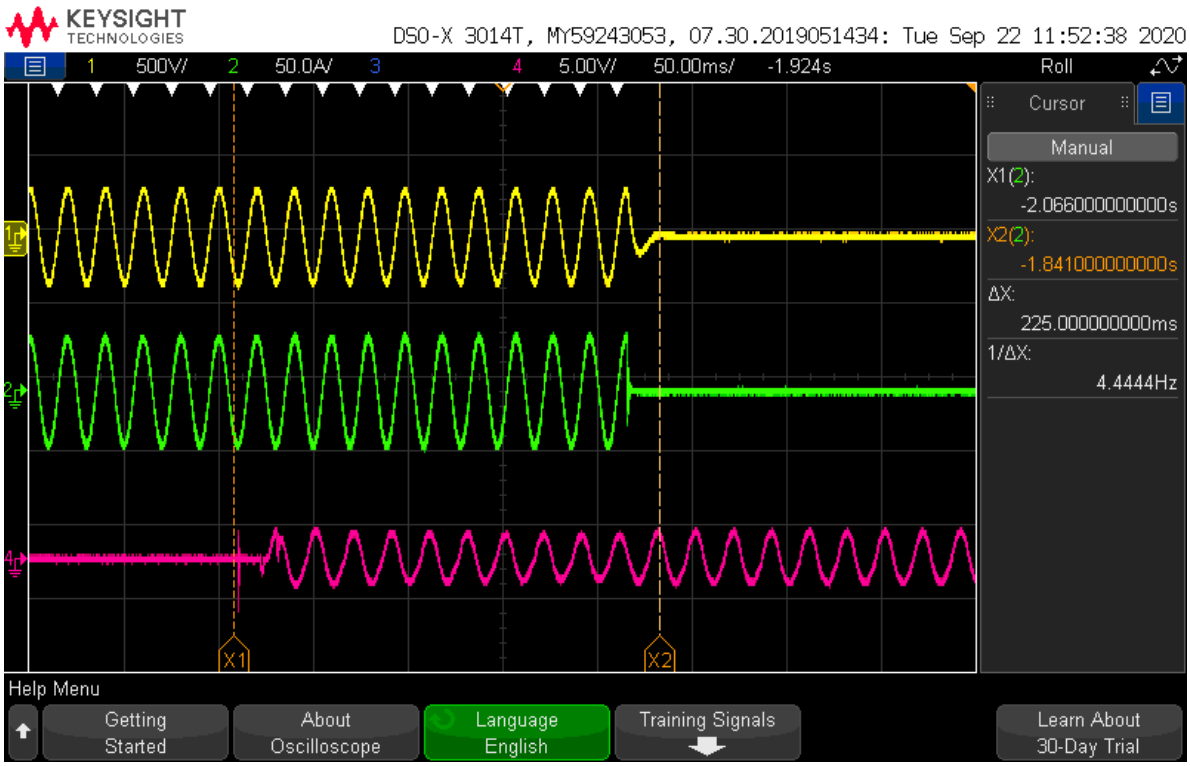
Parameter at 0%	L= 28,05mH	R= 8,81Ω	C= 361,21µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20 ms

Note:
Note for technologies which have a substantial shut down time this can be added to the 0.5 seconds in establishing that the trip occurred in less than 0.5s. Maximum shut down time could therefore be up to 1.0 seconds for these technologies.
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) BL: Balance condition, IB: Imbalance condition.
Condition A:
EUT output power PEUT = Maximum 5)
EUT input voltage 6) = >90% of rated input voltage range
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,9 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load and 100% nominal power



A.7.1.2.4 Loss of mains protection according BS EN 62116

P

The requirement is specified in section 10.2, test procedure in Annex A.2.2.4
Load imbalance (real, reactive load) for test condition A (EUT output = 50 % – 66 %)

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
11	66	66	0	-5	4000	280	0,975	149	Test B at IB
10	66	66	0	-4	4000	280	0,980	222	Test B at IB
9	66	66	0	-3	4000	280	0,985	200	Test B at IB
8	66	66	0	-2	4000	280	0,990	199	Test B at IB
7	66	66	0	-1	4000	280	0,995	201	Test B at IB
1	66	66	0	0	4000	280	1,000	232	Test B at BL
2	66	66	0	1	4000	280	1,005	**217**	Test B at IB
3	66	66	0	2	4000	280	1,010	203	Test B at IB
4	66	66	0	3	4000	280	1,015	213	Test B at IB
5	66	66	0	4	4000	280	1,020	215	Test B at IB
6	66	66	0	5	4000	280	1,025	154	Test B at IB

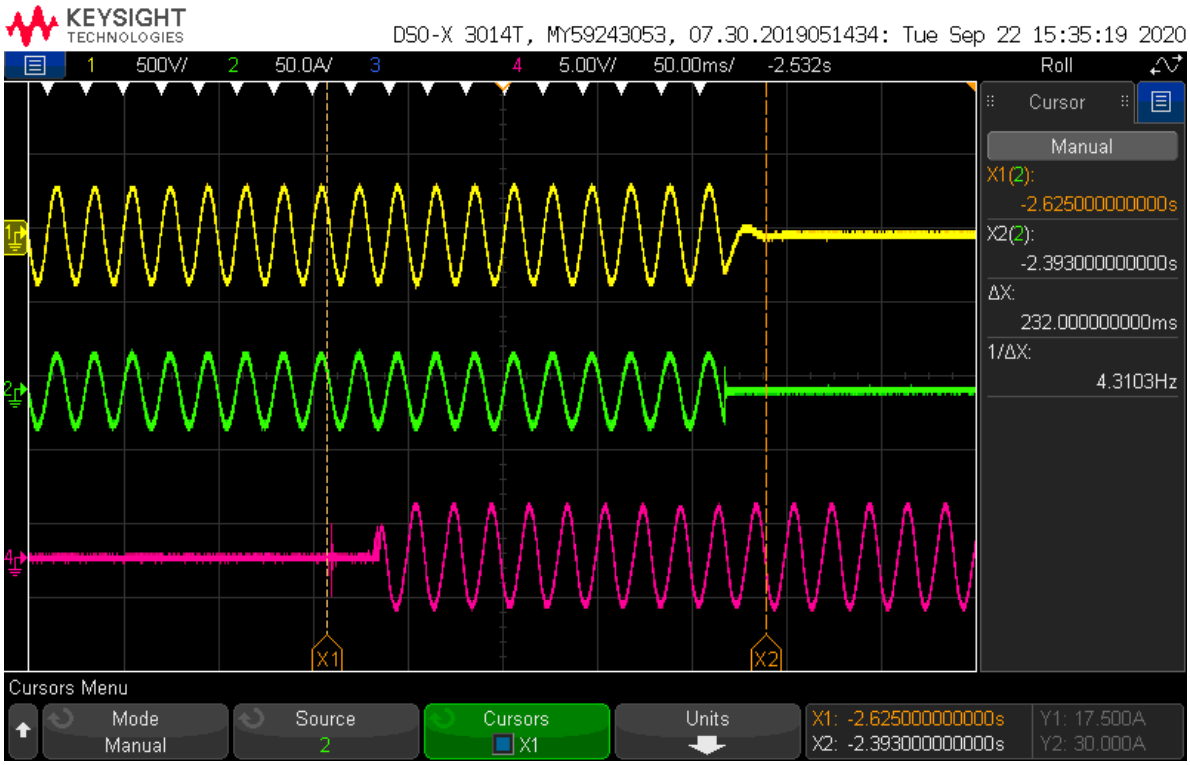
Parameter at 0%	L= 42,10 mH	R= 13,23Ω	C= 240,69µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20 ms

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) BL: Balance condition, IB: Imbalance condition.
Condition B:
EUT output power PEUT = 50 % – 66 % of maximum
EUT input voltage 5) = 50 % of rated input voltage range, ±10 %
5) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,5 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load and 66% nominal power



A.7.1.2.4 Loss of mains protection according BS EN 62116

P

The requirement is specified in section 10.2, test procedure in Annex A.2.2.4
Load imbalance (real, reactive load) for test condition A (EUT output = 25 % – 33 %)

Test conditions	Frequency: 50+/-0,1Hz U_N=230+/-3Vac Distortion factor of chokes < 2% Quality =1
Disconnection limit	0,5s

No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [W per phase]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks 4)
11	33	33	0	-5	1993	129	0.973	114	Test B at IB
10	33	33	0	-4	1993	129	0.978	195	Test B at IB
9	33	33	0	-3	1993	129	0.983	130	Test B at IB
8	33	33	0	-2	1993	129	0.988	216	Test B at IB
7	33	33	0	-1	1993	129	0.993	209	Test B at IB
1	33	33	0	0	1993	129	0.998	221	Test B at BL
2	33	33	0	1	1993	129	1.003	**214**	Test B at IB
3	33	33	0	2	1993	129	1.008	211	Test B at IB
4	33	33	0	3	1993	129	1.013	138	Test B at IB
5	33	33	0	4	1993	129	1.018	208	Test B at IB
6	33	33	0	5	1993	129	1.023	129	Test B at IB

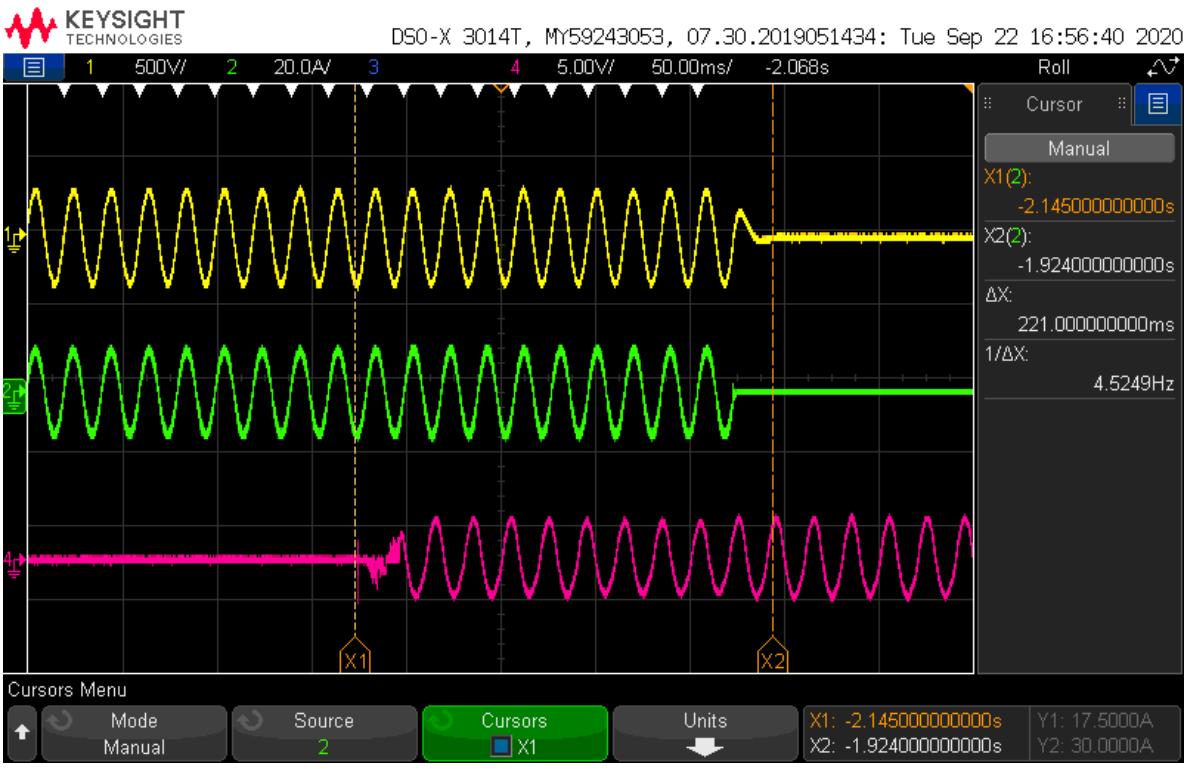
Parameter at 0%	L= 84,66mH	R= 26,54Ω	C= 119,68µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20 ms

Note:
RLC is adjusted to min. +/-1% of the inverter rated output power
1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
4) BL: Balance condition, IB: Imbalance condition.
Condition C:
EUT output power PEUT = 25 % – 33 % 5) of maximum
EUT input voltage 6) = <10 % of rated input voltage range
5) Or minimum allowable EUT output level if greater than 33 %.
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 90 % of range =X + 0,1 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 1 reactive load and 33% nominal power



A.7.1.2.5 Reconnection	P

Test:

Test should prove that the reconnection sequence starts after a minimum delay of 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 1.

Under Voltage	
Time delay setting	Measured delay
20s	63s
Over Voltage	
Time delay setting	Measured delay
20s	64s
Under Frequency	
Time delay setting	Measured delay
20s	63s
Over Frequency	
Time delay setting	Measured delay
20s	62s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 180,0V	At 47,4Hz	At 52,1Hz
Confirmation that the SSEG does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

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

A.7.1.2.6 Frequency Drift and Step Change Stability test	P

Test:

	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49,0Hz	+50 degrees		No trip
Negative Vector Shift	50,0Hz	-50 degrees		No trip
Positive Frequency drift	49,0Hz	+0,95Hz/sec	51,0Hz	No trip
Negative Frequency drift	51,0Hz	-0,95Hz/sec	49,0Hz	No trip

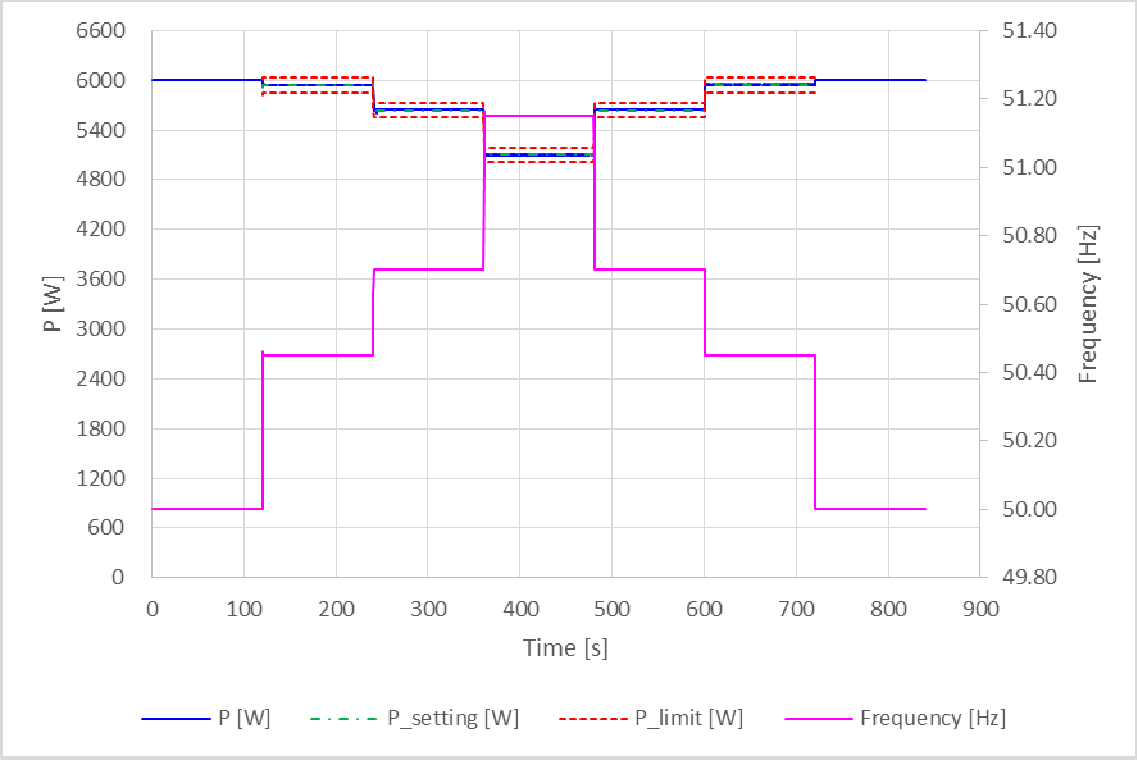
Note:
Manufacturers considering new designs should allow for the RoCoF where stability is required to be increased to, up to 2Hz per second, as proposed in the new European network codes, which are expected to come into force over the period 2014/2015. Under these conditions RoCoF will cease to be an effective loss of mains protection and is unlikely to be permitted in future revisions of this document.

For the step change test the SSEG should be operated with a measureable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 seconds to complete the test. The SSEG should not trip during this test.

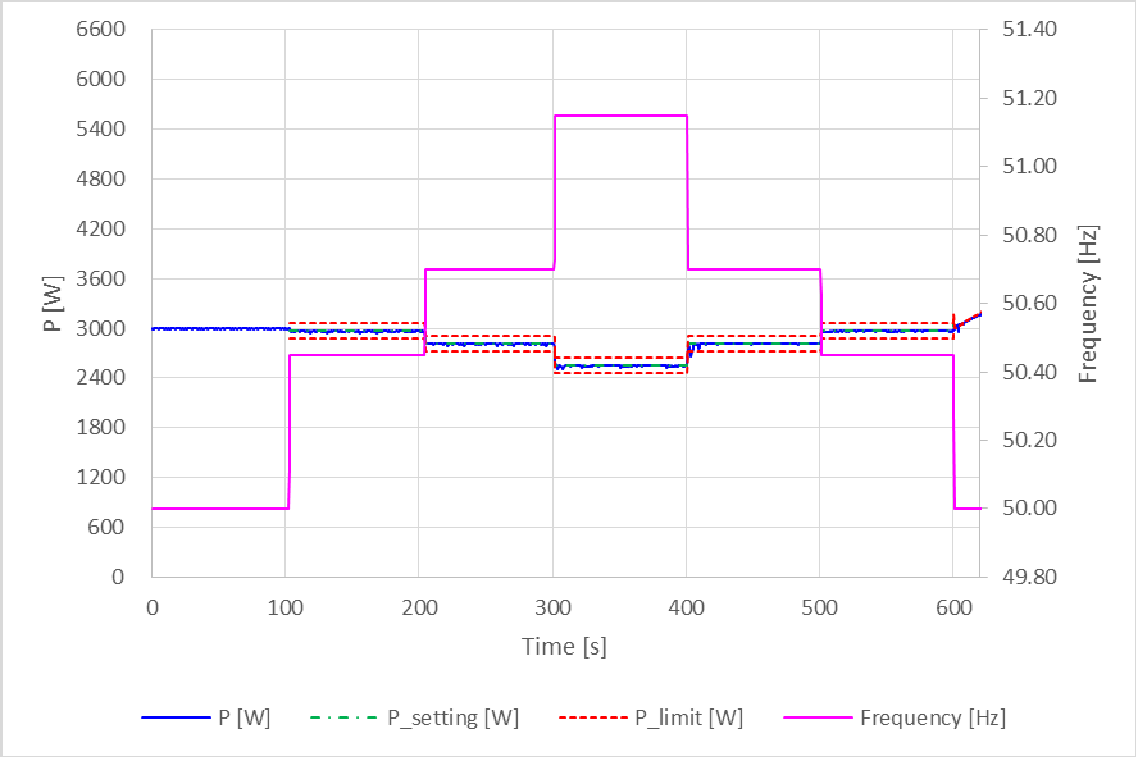
For frequency drift tests the SSEG should be operated with a measureable output at the start frequency and then the frequency changed in a ramp function at 0,95Hz per second to the end frequency. On reaching the end frequency it should be maintained for a period of at least10 seconds. The SSEG should not trip during this test.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

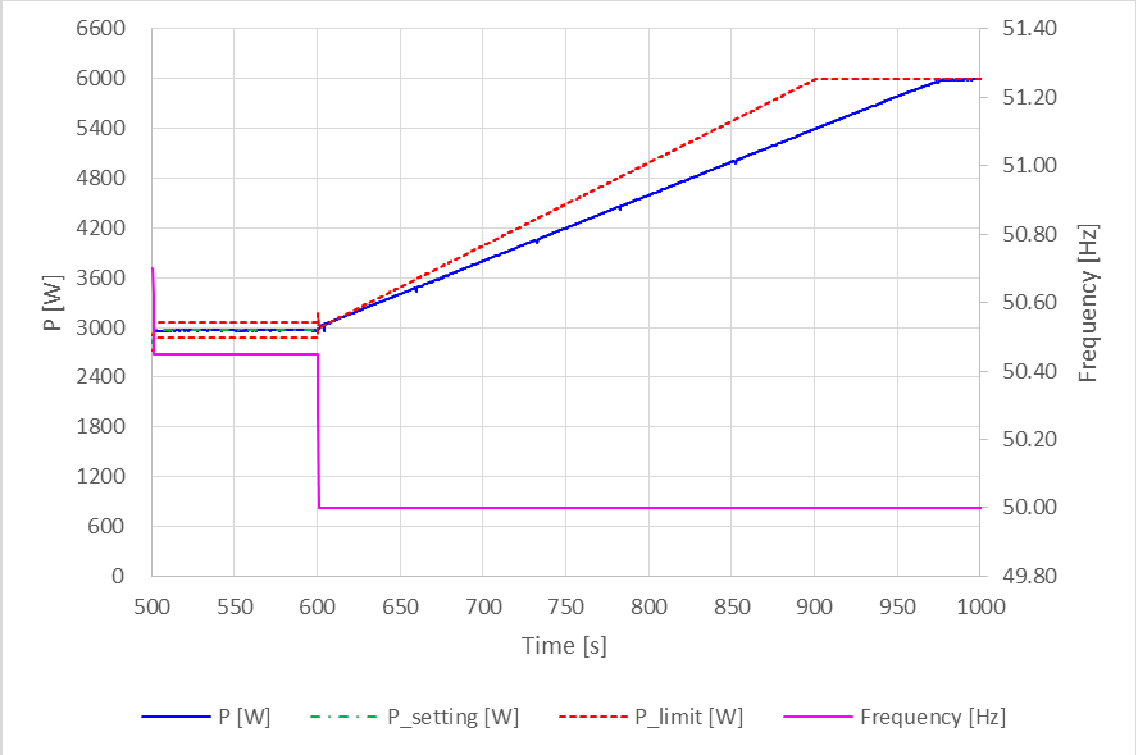
A.7.1.3 Power response to over-frequency							P
Test: HYD 6000-EP							
1-min mean value [Hz]:	a) 50,00	b) 50,45	c) 50,70	d) 51,15	e) 50,70	f) 50,45	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P_M [W]:	N/A	5940	5640	5100	5640	5940	N/A
P_{E60} [W]:	6007	5947	5649	5100	5650	5948	6007
$\Delta P_{E60}/P_M$ [%]:	N/A	0,190	0,244	0,000	0,271	0,217	N/A
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
P_M [W]:	N/A	2970	2820	2550	2820	2970	N/A
P_{E60} [W]:	2994	2962	2814	2548	2815	2964	2994
$\Delta P_{E60}/P_M$ [%]:	N/A	-0,217	-0,163	-0,054	-0,136	-0,163	N/A
Limit $\Delta P/P_{1min}$:	2,5 % of P_M						
Graph of Measurement 1.: Active power output > 80% P_n							



Graph of Measurement 2.:Active power output 40% and 60% after freezing > 80% P_n



Graph of power gradient:



Test:

The test is conducted for two powers. First, the test must start at a power > 80% P_n ("Measurement 1"), and in a second test, for a power between 40% to 60% P_n ("Measurement 2"). In the second test, after freezing of the P_M, the available active power output must be increased to a value > 80% P_n, and after the network frequency of 50,4 Hz is fallen below, the rise of the active power gradient must be recorded.

Point g) must be held until the micro-generator is again feeding in with the active power output available.

Assessment criterion:

For f = 50,4 Hz, the value of the P_M active power currently being generated is "frozen".

a) For adjustable micro-generators when:

1) the active power reduces between measuring points b) and f) given above with the set gradient P_M per Hz for a increasing frequency (or rises for a frequency decreasing again).

2) the maximum active power gradient occurring in point is less than the configured maximum active power per minute

3) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from P_n by more than ± 10%.

4) the settling time is equal or below 2 s with an intentional delay set to zero

b) For partly adjustable micro-generators

1) when they behave as in a) within their adjustment range, and

2) when, outside the adjustable range, the power fed in on leaving the adjustment range remains constant until shutdown. Shutdown must be no later than at 51,5 Hz.

The droop values should between 8,52% and 12,82%.

Note:

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: HYD 3000-EP

Generating Unit rating per phase (rpp)	3,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 1,512 kW		100% of rated output 3,011 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1th	6,564	--	13,052	--	--
2th	0,004	0,061	0,004	0,031	1
3th	0,144	2,194	0,149	1,142	4
4th	0,002	0,030	0,002	0,015	1
5th	0,073	1,112	0,074	0,567	4
6th	0,002	0,030	0,002	0,015	1
7th	0,044	0,670	0,040	0,306	4
8th	0,002	0,030	0,002	0,015	1
9th	0,024	0,366	0,024	0,184	4
10th	0,002	0,030	0,002	0,015	0,5
11th	0,015	0,229	0,016	0,123	2
12th	0,002	0,030	0,002	0,015	0,5
13th	0,012	0,183	0,014	0,107	2
14th	0,001	0,015	0,002	0,015	0,5
15th	0,008	0,122	0,013	0,100	2
16th	0,001	0,015	0,001	0,008	0,5
17th	0,007	0,107	0,013	0,100	1,5
18th	0,001	0,015	0,001	0,008	0,5
19th	0,006	0,091	0,012	0,092	1,5
20th	0,001	0,015	0,001	0,008	0,5
21th	0,006	0,091	0,012	0,092	1,5
22th	0,001	0,015	0,001	0,008	0,5
23th	0,006	0,091	0,011	0,084	0,6
24th	0,001	0,015	0,001	0,008	0,5
25th	0,006	0,091	0,010	0,077	0,6
26th	0,001	0,015	0,001	0,008	0,5
27th	0,006	0,091	0,010	0,077	0,6
28th	0,001	0,015	0,001	0,008	0,5
29th	0,006	0,091	0,008	0,061	0,6
30th	0,001	0,015	0,001	0,008	0,5
31th	0,006	0,091	0,008	0,061	0,6
32th	0,001	0,015	0,001	0,008	0,5
33th	0,006	0,091	0,008	0,061	0,6
34th	0,001	0,015	0,001	0,008	--
35th	0,005	0,076	0,007	0,054	--
36th	0,001	0,015	0,001	0,008	--
37th	0,005	0,076	0,007	0,054	--
38th	0,001	0,015	0,001	0,008	--
39th	0,005	0,076	0,007	0,054	--
40th	0,001	0,015	0,001	0,008	--
41th	0,004	0,061	0,006	0,046	--
42th	0,001	0,015	0,001	0,008	--
43th	0,004	0,061	0,005	0,038	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
44th	0,001	0,015	0,001	0,008	--
45th	0,004	0,061	0,006	0,046	--
46th	0,001	0,015	0,001	0,008	--
47th	0,003	0,046	0,005	0,038	--
48th	0,001	0,015	0,001	0,008	--
49th	0,003	0,046	0,005	0,038	--
50th	0,005	0,076	0,005	0,038	--
THD_[%]	--	2,620	--	1,367	23
PWHD_[%}	--	1,970	--	1,514	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: HYD 3680-EP

Generating Unit rating per phase (rpp)	3,68kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 1,852 kW		100% of rated output 3,683 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1nd	8,037	--	15,955	--	--
2nd	0,004	0,050	0,004	0,025	1
3rd	0,146	1,817	0,158	0,990	4
4th	0,002	0,025	0,003	0,019	1
5th	0,073	0,908	0,085	0,533	4
6th	0,002	0,025	0,002	0,013	1
7th	0,042	0,523	0,051	0,320	4
8th	0,002	0,025	0,002	0,013	1
9th	0,025	0,311	0,035	0,219	4
10th	0,002	0,025	0,002	0,013	0,5
11th	0,015	0,187	0,024	0,150	2
12th	0,002	0,025	0,002	0,013	0,5
13th	0,009	0,112	0,018	0,113	2
14th	0,002	0,025	0,002	0,013	0,5
15th	0,007	0,087	0,014	0,088	2
16th	0,001	0,012	0,001	0,006	0,5
17th	0,007	0,087	0,013	0,081	1,5
18th	0,001	0,012	0,001	0,006	0,5
19th	0,006	0,075	0,012	0,075	1,5
20th	0,001	0,012	0,001	0,006	0,5
21th	0,006	0,075	0,011	0,069	1,5
22th	0,001	0,012	0,001	0,006	0,5
23th	0,007	0,087	0,011	0,069	0,6
24th	0,001	0,012	0,001	0,006	0,5
25th	0,007	0,087	0,010	0,063	0,6
26th	0,001	0,012	0,001	0,006	0,5
27th	0,007	0,087	0,009	0,056	0,6
28th	0,001	0,012	0,001	0,006	0,5
29th	0,006	0,075	0,008	0,050	0,6
30th	0,001	0,012	0,001	0,006	0,5
31th	0,007	0,087	0,008	0,050	0,6
32th	0,001	0,012	0,001	0,006	0,5
33th	0,006	0,075	0,007	0,044	0,6
34th	0,001	0,012	0,001	0,006	--
35th	0,006	0,075	0,007	0,044	--
36th	0,001	0,012	0,001	0,006	--
37th	0,005	0,062	0,007	0,044	--
38th	0,001	0,012	0,001	0,006	--
39th	0,005	0,062	0,007	0,044	--
40th	0,001	0,012	0,001	0,006	--
41th	0,004	0,050	0,006	0,038	--
42th	0,001	0,012	0,001	0,006	--
43th	0,004	0,050	0,005	0,031	--
44th	0,001	0,012	0,001	0,006	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,004	0,050	0,006	0,038	--
46th	0,001	0,012	0,001	0,006	--
47th	0,004	0,050	0,005	0,031	--
48th	0,001	0,012	0,002	0,013	--
49th	0,003	0,037	0,005	0,031	--
50th	0,005	0,062	0,005	0,031	--
THD_[%]	--	2,156	--	1,228	23
PWHD_[%]	--	1,701	--	1,221	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: HYD 4000-EP

Generating Unit rating per phase (rpp)	4,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,020 kW		100% of rated output 4,013 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1nd	8,762	--	17,380	--	--
2nd	0,004	0,046	0,004	0,023	1
3rd	0,145	1,655	0,172	0,990	4
4th	0,002	0,023	0,003	0,017	1
5th	0,074	0,845	0,098	0,564	4
6th	0,002	0,023	0,002	0,012	1
7th	0,042	0,479	0,062	0,357	4
8th	0,002	0,023	0,002	0,012	1
9th	0,024	0,274	0,041	0,236	4
10th	0,002	0,023	0,002	0,012	0,5
11th	0,015	0,171	0,025	0,144	2
12th	0,002	0,023	0,002	0,012	0,5
13th	0,010	0,114	0,016	0,092	2
14th	0,002	0,023	0,002	0,012	0,5
15th	0,007	0,080	0,013	0,075	2
16th	0,001	0,011	0,001	0,006	0,5
17th	0,007	0,080	0,013	0,075	1,5
18th	0,001	0,011	0,001	0,006	0,5
19th	0,007	0,080	0,013	0,075	1,5
20th	0,001	0,011	0,001	0,006	0,5
21th	0,007	0,080	0,012	0,069	1,5
22th	0,001	0,011	0,001	0,006	0,5
23th	0,007	0,080	0,010	0,058	0,6
24th	0,001	0,011	0,001	0,006	0,5
25th	0,007	0,080	0,009	0,052	0,6
26th	0,001	0,011	0,001	0,006	0,5
27th	0,007	0,080	0,008	0,046	0,6
28th	0,001	0,011	0,001	0,006	0,5
29th	0,007	0,080	0,008	0,046	0,6
30th	0,001	0,011	0,001	0,006	0,5
31th	0,007	0,080	0,007	0,040	0,6
32th	0,001	0,011	0,001	0,006	0,5
33th	0,006	0,068	0,007	0,040	0,6
34th	0,001	0,011	0,001	0,006	--
35th	0,006	0,068	0,006	0,035	--
36th	0,001	0,011	0,001	0,006	--
37th	0,005	0,057	0,006	0,035	--
38th	0,001	0,011	0,001	0,006	--
39th	0,005	0,057	0,006	0,035	--
40th	0,001	0,011	0,001	0,006	--
41th	0,005	0,057	0,005	0,029	--
42th	0,001	0,011	0,001	0,006	--
43th	0,004	0,046	0,005	0,029	--
44th	0,001	0,011	0,001	0,006	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,004	0,046	0,006	0,035	--
46th	0,001	0,011	0,001	0,006	--
47th	0,004	0,046	0,004	0,023	--
48th	0,001	0,011	0,002	0,012	--
49th	0,004	0,046	0,005	0,029	--
50th	0,005	0,057	0,005	0,029	--
THD_[%]	--	1,974	--	1,248	23
PWHD_[%]	--	1,626	--	1,072	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: HYD 4600-EP

Generating Unit rating per phase (rpp)	4,6kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,317 kW		100% of rated output 4,596 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1nd	10,054	--	19,899	--	--
2nd	0,004	0,040	0,006	0,030	1
3rd	0,148	1,472	0,207	1,040	4
4th	0,002	0,020	0,003	0,015	1
5th	0,073	0,726	0,129	0,648	4
6th	0,002	0,020	0,002	0,010	1
7th	0,042	0,418	0,081	0,407	4
8th	0,002	0,020	0,002	0,010	1
9th	0,024	0,239	0,048	0,241	4
10th	0,002	0,020	0,002	0,010	0,5
11th	0,014	0,139	0,023	0,116	2
12th	0,002	0,020	0,002	0,010	0,5
13th	0,011	0,109	0,013	0,065	2
14th	0,001	0,010	0,002	0,010	0,5
15th	0,008	0,080	0,014	0,070	2
16th	0,001	0,010	0,002	0,010	0,5
17th	0,008	0,080	0,015	0,075	1,5
18th	0,001	0,010	0,002	0,010	0,5
19th	0,008	0,080	0,012	0,060	1,5
20th	0,001	0,010	0,001	0,005	0,5
21th	0,008	0,080	0,009	0,045	1,5
22th	0,001	0,010	0,001	0,005	0,5
23th	0,008	0,080	0,008	0,040	0,6
24th	0,001	0,010	0,001	0,005	0,5
25th	0,008	0,080	0,008	0,040	0,6
26th	0,001	0,010	0,001	0,005	0,5
27th	0,008	0,080	0,007	0,035	0,6
28th	0,001	0,010	0,001	0,005	0,5
29th	0,007	0,070	0,007	0,035	0,6
30th	0,001	0,010	0,001	0,005	0,5
31th	0,008	0,080	0,006	0,030	0,6
32th	0,001	0,010	0,001	0,005	0,5
33th	0,007	0,070	0,005	0,025	0,6
34th	0,001	0,010	0,001	0,005	--
35th	0,006	0,060	0,005	0,025	--
36th	0,001	0,010	0,001	0,005	--
37th	0,006	0,060	0,004	0,020	--
38th	0,001	0,010	0,001	0,005	--
39th	0,006	0,060	0,004	0,020	--
40th	0,001	0,010	0,001	0,005	--
41th	0,005	0,050	0,003	0,015	--
42th	0,001	0,010	0,001	0,005	--
43th	0,005	0,050	0,003	0,015	--
44th	0,001	0,010	0,001	0,005	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,005	0,050	0,004	0,020	--
46th	0,001	0,010	0,001	0,005	--
47th	0,004	0,040	0,003	0,015	--
48th	0,001	0,010	0,002	0,010	--
49th	0,004	0,040	0,003	0,015	--
50th	0,005	0,050	0,006	0,030	--
THD_[%]	--	1,746	--	1,331	23
PWHD_[%]	--	1,581	--	0,807	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: HYD 5000-EP

Generating Unit rating per phase (rpp)	5,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 2,533 kW		100% of rated output 5,018 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1nd	10,984	--	21,719	--	--
2nd	0,004	0,036	0,006	0,028	1
3rd	0,148	1,347	0,237	1,091	4
4th	0,002	0,018	0,003	0,014	1
5th	0,074	0,674	0,153	0,704	4
6th	0,002	0,018	0,002	0,009	1
7th	0,040	0,364	0,093	0,428	4
8th	0,002	0,018	0,002	0,009	1
9th	0,023	0,209	0,051	0,235	4
10th	0,002	0,018	0,002	0,009	0,5
11th	0,015	0,137	0,020	0,092	2,0
12th	0,002	0,018	0,002	0,009	0,5
13th	0,011	0,100	0,014	0,064	2
14th	0,002	0,018	0,002	0,009	0,5
15th	0,009	0,082	0,016	0,074	2
16th	0,001	0,009	0,002	0,009	0,5
17th	0,010	0,091	0,015	0,069	1,5
18th	0,001	0,009	0,002	0,009	0,5
19th	0,009	0,082	0,010	0,046	1,5
20th	0,001	0,009	0,001	0,005	0,5
21th	0,009	0,082	0,007	0,032	1,5
22th	0,001	0,009	0,002	0,009	0,5
23th	0,009	0,082	0,009	0,041	0,6
24th	0,001	0,009	0,001	0,005	0,5
25th	0,009	0,082	0,008	0,037	0,6
26th	0,001	0,009	0,002	0,009	0,5
27th	0,009	0,082	0,007	0,032	0,6
28th	0,001	0,009	0,001	0,005	0,5
29th	0,008	0,073	0,006	0,028	0,6
30th	0,001	0,009	0,002	0,009	0,5
31th	0,008	0,073	0,005	0,023	0,6
32th	0,001	0,009	0,001	0,005	0,5
33th	0,007	0,064	0,004	0,018	0,6
34th	0,001	0,009	0,001	0,005	--
35th	0,007	0,064	0,005	0,023	--
36th	0,001	0,009	0,001	0,005	--
37th	0,006	0,055	0,004	0,018	--
38th	0,001	0,009	0,002	0,009	--
39th	0,006	0,055	0,004	0,018	--
40th	0,001	0,009	0,001	0,005	--
41th	0,005	0,046	0,003	0,014	--
42th	0,001	0,009	0,002	0,009	--
43th	0,005	0,046	0,003	0,014	--
44th	0,001	0,009	0,001	0,005	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,005	0,046	0,004	0,018	--
46th	0,001	0,009	0,001	0,005	--
47th	0,005	0,046	0,003	0,014	--
48th	0,001	0,009	0,002	0,009	--
49th	0,004	0,036	0,003	0,014	--
50th	0,005	0,046	0,006	0,028	--
THD_[%]	--	1,601	--	1,400	23
PWHD_[%]	--	1,560	--	0,732	23

A.7.1.4.1 Harmonic Current Emissions	P

Generating Unit tested to BS EN 61000-3-12

Test result: HYD 6000-EP

Generating Unit rating per phase (rpp)	6,0kW	Harmonic %

	At 100%% of rated output				
Harmonic	At 45-55% of rated ouput 3,038 kW		100% of rated output 6,005 kW		Limit in BS EN61000-3-12 in [%]
	Measured Value (MV) in Amps	Measured Value (MV) in %	Measured Value (MV) in Amps	Measured Value (MV) in %	
1nd	13,168	--	25,969	--	--
2nd	0,006	0,046	0,006	0,023	1
3rd	0,151	1,147	0,320	1,232	4
4th	0,002	0,015	0,003	0,012	1
5th	0,074	0,562	0,210	0,809	4
6th	0,002	0,015	0,003	0,012	1
7th	0,041	0,311	0,119	0,458	4
8th	0,002	0,015	0,002	0,008	1
9th	0,024	0,182	0,056	0,216	4
10th	0,002	0,015	0,002	0,008	0,5
11th	0,017	0,129	0,016	0,062	2
12th	0,002	0,015	0,002	0,008	0,5
13th	0,014	0,106	0,022	0,085	2
14th	0,002	0,015	0,002	0,008	0,5
15th	0,013	0,099	0,021	0,081	2
16th	0,002	0,015	0,002	0,008	0,5
17th	0,013	0,099	0,014	0,054	1,5
18th	0,001	0,008	0,002	0,008	0,5
19th	0,012	0,091	0,007	0,027	1,5
20th	0,001	0,008	0,002	0,008	0,5
21th	0,012	0,091	0,009	0,035	1,5
22th	0,001	0,008	0,002	0,008	0,5
23th	0,011	0,084	0,009	0,035	0,6
24th	0,001	0,008	0,002	0,008	0,5
25th	0,010	0,076	0,006	0,023	0,6
26th	0,001	0,008	0,002	0,008	0,5
27th	0,010	0,076	0,004	0,015	0,6
28th	0,001	0,008	0,002	0,008	0,5
29th	0,008	0,061	0,004	0,015	0,6
30th	0,001	0,008	0,003	0,012	0,5
31th	0,008	0,061	0,004	0,015	0,6
32th	0,001	0,008	0,002	0,008	0,5
33th	0,007	0,053	0,003	0,012	0,6
34th	0,001	0,008	0,001	0,004	--
35th	0,007	0,053	0,003	0,012	--
36th	0,001	0,008	0,002	0,008	--
37th	0,007	0,053	0,002	0,008	--
38th	0,001	0,008	0,001	0,004	--
39th	0,007	0,053	0,002	0,008	--
40th	0,001	0,008	0,001	0,004	--
41th	0,006	0,046	0,002	0,008	--
42th	0,001	0,008	0,001	0,004	--
43th	0,005	0,038	0,002	0,008	--
44th	0,001	0,008	0,001	0,004	--

A.7.1.4.1 Harmonic Current Emissions					P
Generating Unit tested to BS EN 61000-3-12					
45th	0,006	0,046	0,002	0,008	--
46th	0,001	0,008	0,001	0,004	--
47th	0,005	0,038	0,002	0,008	--
48th	0,001	0,008	0,003	0,012	--
49th	0,005	0,038	0,002	0,008	--
50th	0,005	0,038	0,008	0,031	--
THD_[%]	--	1,370	--	1,568	23
PWHD_[%]	--	1,494	--	0,597	23

Note:
The tests should be based on the limits of the EN 61000-3-12 for more than 16A.

The tests had been performed on the HYD 6000-EP are valid for the HYD 5500-EP since it is same as in hardware and just power derated by software.

A.7.1.4.2 Power factor				P
Test:				
HYD 3000-EP				
Output power	216,2 V	230 V	253,20 V	
20%	0,982	0,977	0,964	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
50%	0,997	0,997	0,995	
75%	0,999	0,999	0,998	
100%	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	
HYD 6000-EP				
Output power	216,2 V	230 V	253,20 V	
20%	0,996	0,995	0,992	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
50%	0,999	0,999	0,999	
75%	0,999	0,999	0,999	
100%	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	

Note:
The power factor capability of the SSEG shall conform to EN 50438. When operating at Registered Capacity the SSEGshall operate at apower factor within the range 0.95 lagging to 0.95 leading relative to the voltage waveform unless otherwise agreed with the DNO eg for power factor improvement.

The test set up shall be such that the Inverter supplies full load to the DNO's Distribution System via the power factor (pf) meter and the variac as shown below in figure A5. The Inverter pf should be within the limits given in 5.6, for three test voltages 230 V –6%, 230V and 230 V +10%.

The tests had been performed on the HYD 6000-EP and HYD 3000-EP are valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

A.7.1.4.3 Voltage Flicker — P

HYD 3000-EP

	Phase	Starting			Stopping			Running	
		d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	L1	0,228	0,034	--	0,235	0,037	--	0,176	0,175
Normalised to standard impedance	L1	0,228	0,034	--	0,235	0,037	--	0,176	0,175
Normalised to required maximum impedance	L1	0,228	0,034	--	0,235	0,037	--	0,176	0,175
Limits set under BS EN 61000-3-11		4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Test impedance**	R	0,400	Ω	Xl	0,25	Ω
	Z	0,472	Ω			
Standard impedance**	R	0,400	Ω	Xl	0,25	Ω
	Z	0,472	Ω			
Maximum Impedance**	R	0,400	Ω	Xl	0,25	Ω
	Z	0,472	Ω			

HYD 6000-EP

	Phase	Starting			Stopping			Running	
		d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	L1	0,217	0,046	--	0,233	0,034	--	0,168	0,166
Normalised to standard impedance	L1	0,217	0,046	--	0,233	0,034	--	0,168	0,166
Normalised to required maximum impedance	L1	0,217	0,046	--	0,233	0,034	--	0,168	0,166
Limits set under BS EN 61000-3-11		4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Test impedance**	R	0,400	Ω	Xl	0,25	Ω
	Z	0,472	Ω			
Standard impedance**	R	0,400	Ω	Xl	0,25	Ω
	Z	0,472	Ω			
Maximum Impedance**	R	0,400	Ω	Xl	0,25	Ω
	Z	0,472	Ω			

A.7.1.4.3 Voltage Flicker	P

Note:
* Applies to three phase and split single phase Generating Units

^ Applies to single phase Generating Units and Generating Units using two phases on a three phase system

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation ouput is 0,98 or above.

Normalised value = Measured value*reference source resistance/measured source resistance at test point.

Single phase unit reference source resistance is 0,4Ω

Two phase units in a three phase system reference source resistance 0,4Ω

Two phase units in a split phase system reference source resistance is 0,24Ω

Three phase units reference source resistance is 0,24Ω

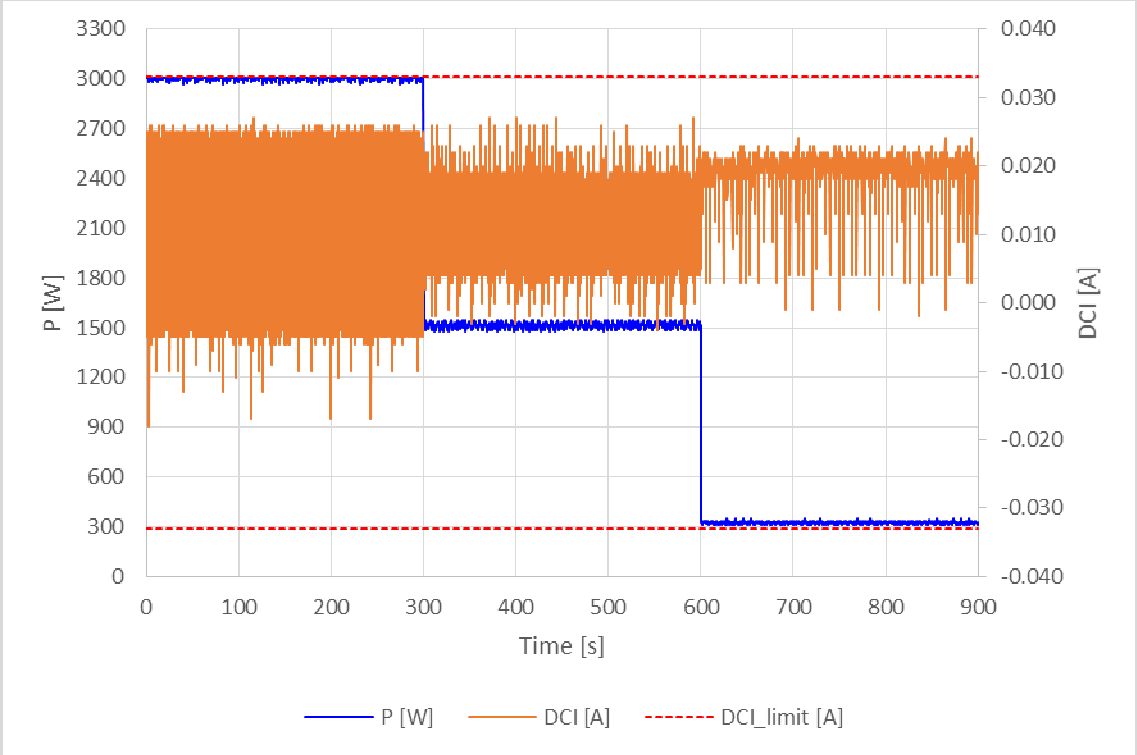
Where the power factor of the output is under 0,98 then the Xl to R ratio of the test impedance should be close to that of the Standard impedance.

The stopping test should be a trip from full load operation.

The tests had been performed on the HYD 6000-EP and HYD 3000-EP are valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

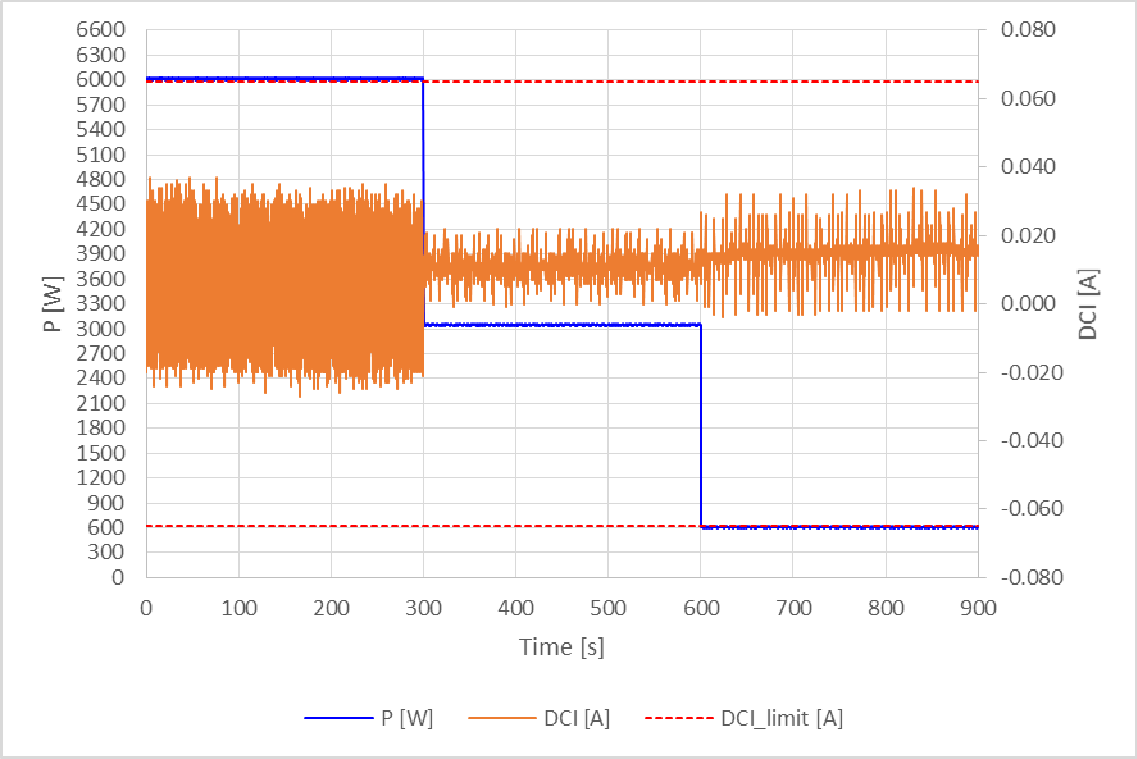
A.7.1.4.4 DC injection			P
HYD 3000-EP			
Test level power	10%	55%	100%
Abs, Max, DC (mA)	24,0	27,0	27,0
As % of rated AC current	0,18	0,21	0,21
Abs, Ave, DC (mA)	19,5	11,5	12,5
As % of rated AC current	0,15	0,09	0,10
Limit	24,0	27,0	27,0
HYD 6000-EP			
Test level power	10%	55%	100%
Abs, Max, DC (mA)	34,0	22,0	37,0
As % of rated AC current	0,13	0,08	0,14
Abs, Ave, DC (mA)	15,1	11,1	13,0
As % of rated AC current	0,06	0,04	0,05
Limit	0,25%	0,25%	0,25%

Graphs for HYD 3000-EP



A.7.1.4.4 DC injection	P

Graphs: HYD 6000-EP



Note:
The level of DC injection from the Inverter-connected PV generator in to the DNO's Distribution System shall not exceed the levels specified in 5.5 when measured during operation at three levels, 20%, 50%, 75% and 100% of rating with a tolerance of plus or minus 5%.

The tests had been performed on the HYD 6000-EP and HYD 3000-EP are valid for the HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

A.7.1.5 Short Circuit Current Contribution for Inverters	P

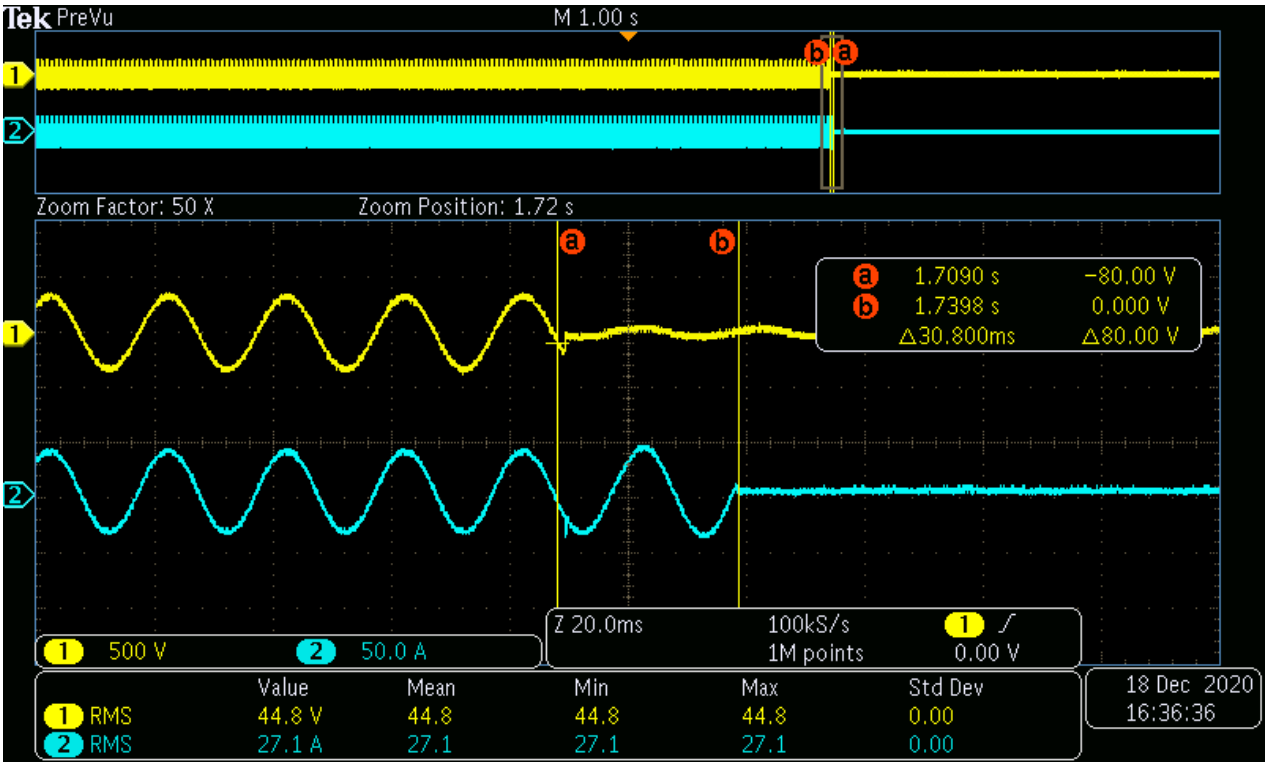
L to N

For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	49,2V	27,5A
Initial Value of aperiodic current	A	N/A	100ms	35,1V	15,1A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	32,6V	9,64A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	N/A	N/A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,031s	In seconds

Note:
The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report (Appendix 4) including the time taken for the Inverter to trip.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

Graphs

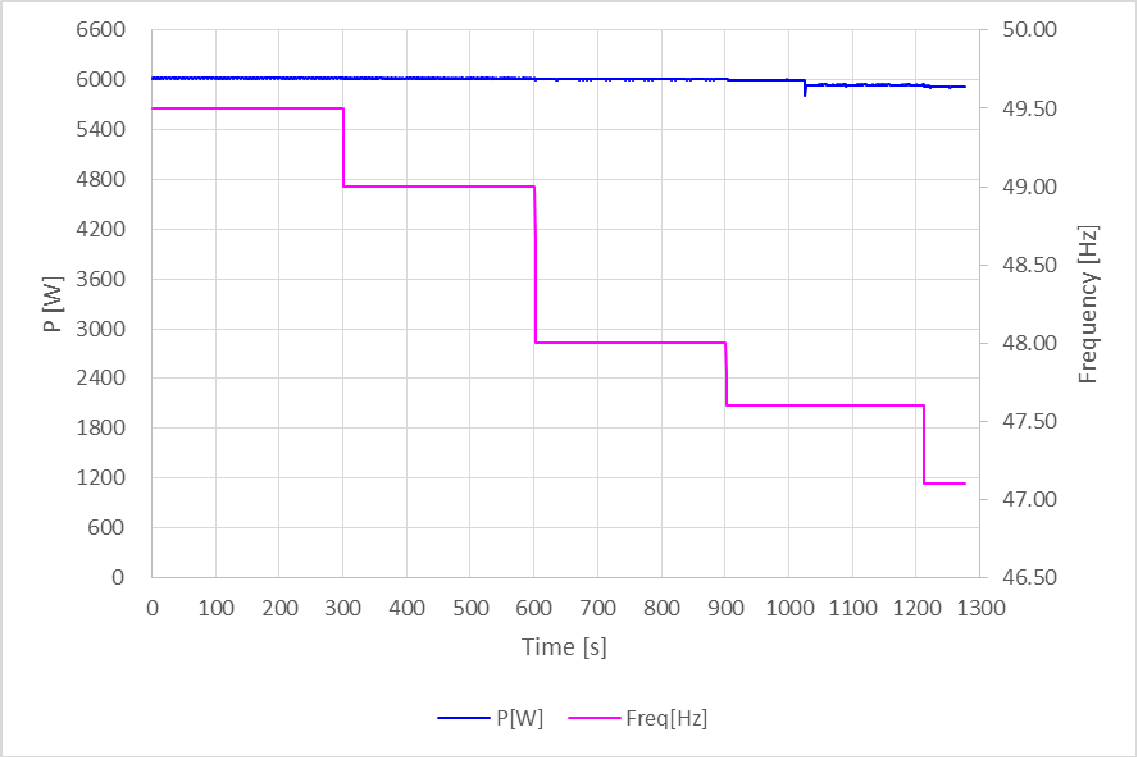


A.7.1.6 Self Monitoring – Solid state Disconnection.	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the SSEG, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
Note: Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open (Functional safety of the internal automatic disconnection device according to VDE 0126-1-1).	

Wiring fuctional tests: If required by para 15.2.1.	N/A
Confirm that the relevant test schedule is attached (test to be undertaken at time of commissioning)	N/A

Logic Interface (Input port)	P
Confirm that an input port is provided and can be used to shut down the module.	Yes

A.7.2.3 Power Output with Falling Frequency	P

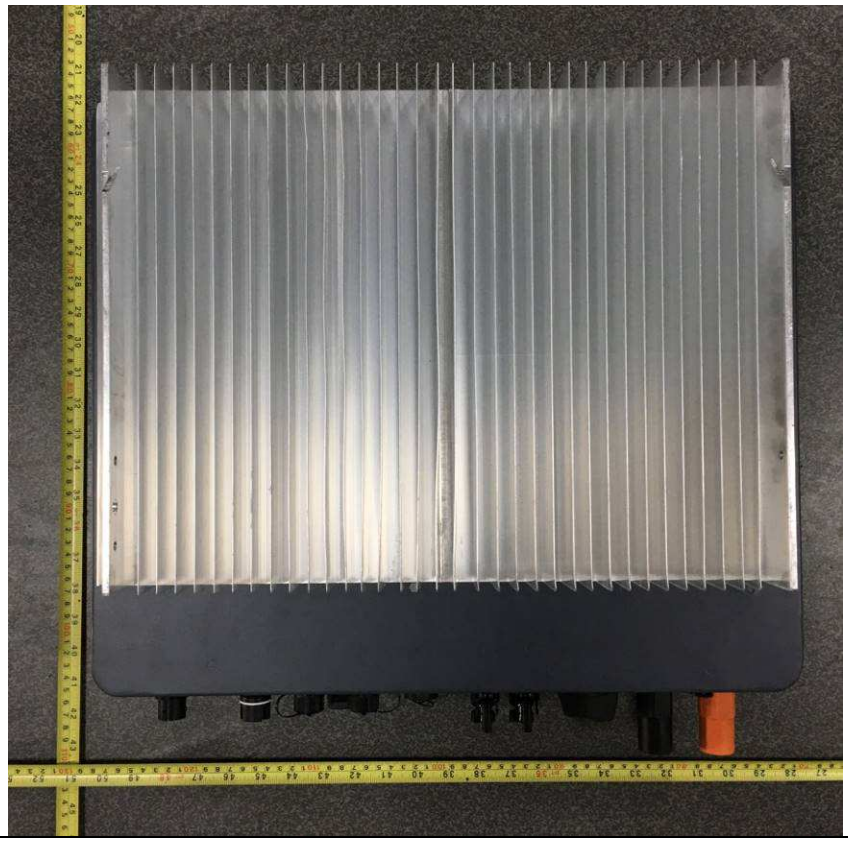


Criteria:
The frequency should then be set to 49,5 Hz for 5 minutes. The output should remain at 100% of Registered Capacity.
The frequency should then be set to 49,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 99% of Registered Capacity.
The frequency should then be set to 48,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 97% of Registered Capacity.
The frequency should then be set to 47,6 Hz and once the output has stabilised, held at this frequency for 5 minutes. The Active Power output must not be below 96.2% of Registered Capacity.
The frequency should then be set to 47,1 Hz and held at this frequency for 20 s. The Active Power output must not be below 95.0% of Registered Capacity and the Synchronous Power Generating Module must not trip in less than the 20s of the test.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

Annex No. 1

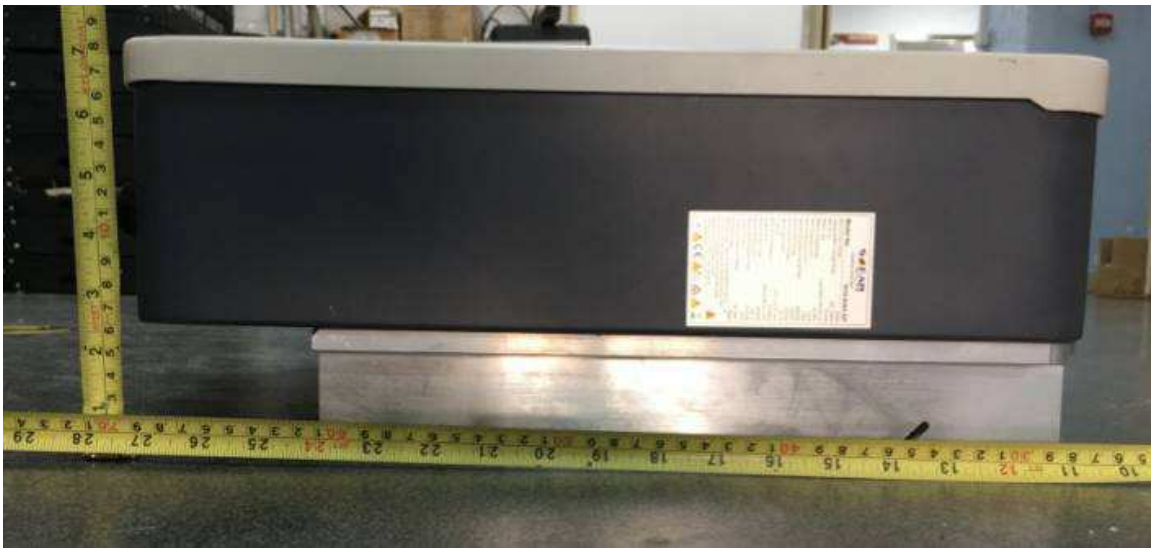
Pictures of the unit

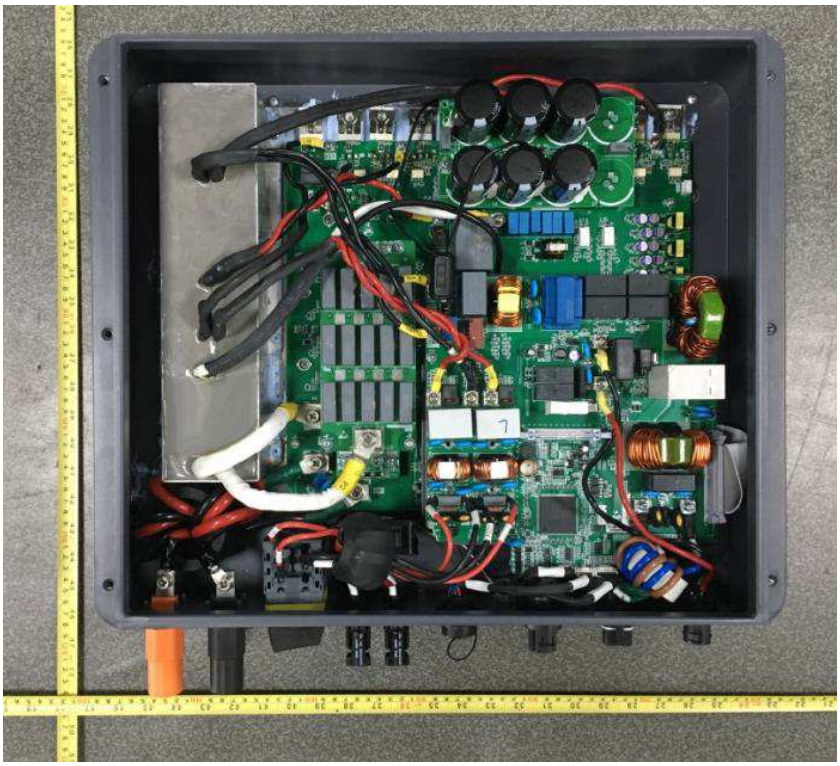
EUT Photo
General view – 1 of Front 
General view – 1 of Rear 

EUT Photo

General view – 1 of Bottom

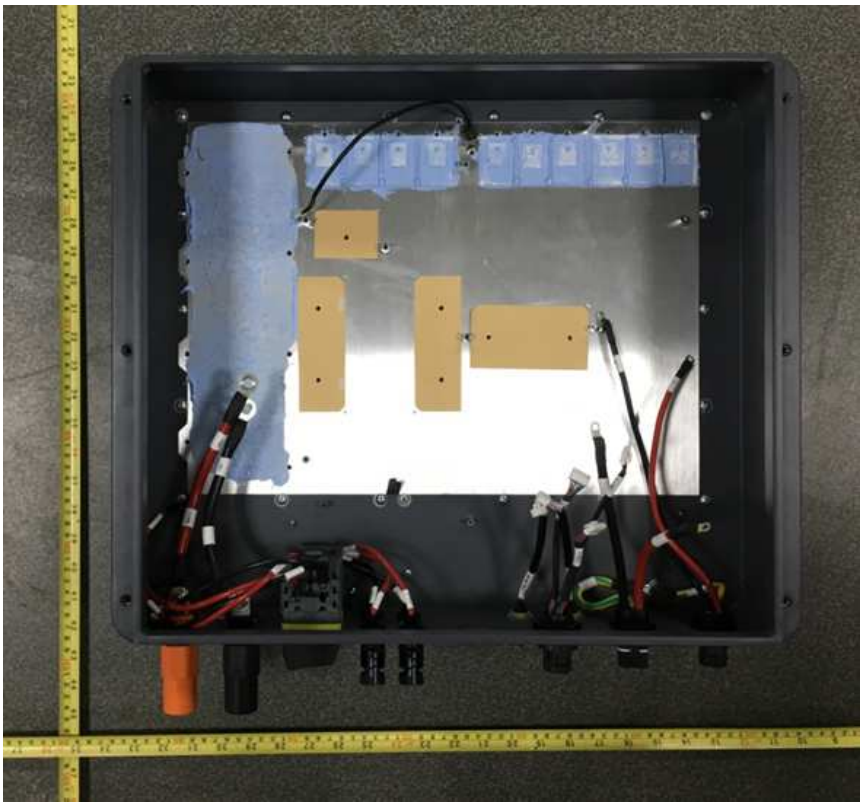
General view – 1 of Side



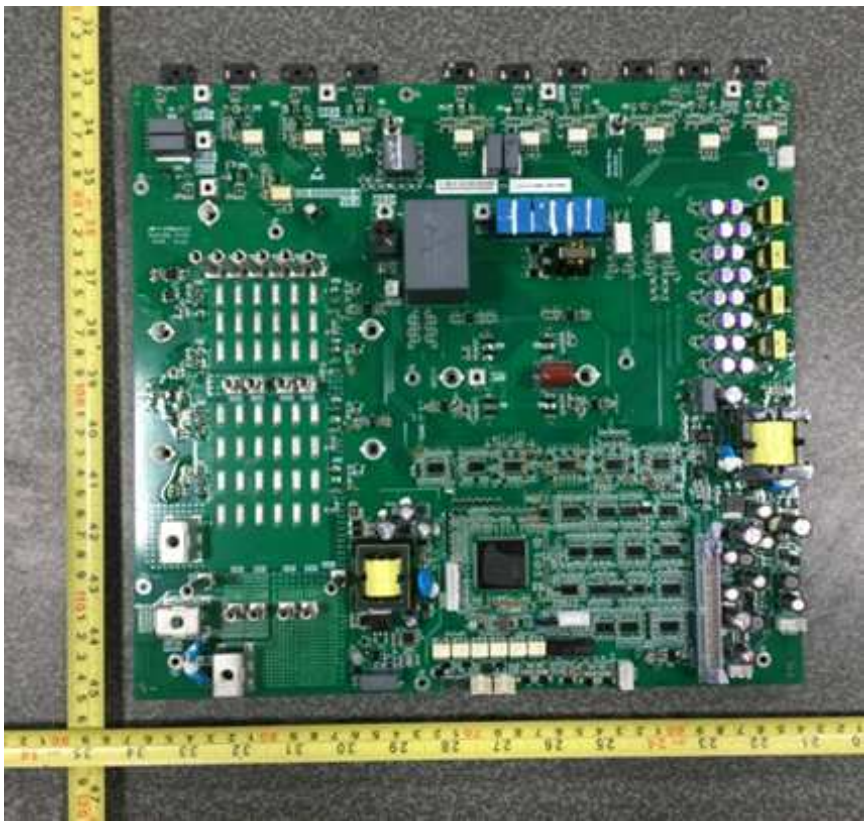
EUT Photo
Internal view – 1 **(**HYD 4600-EP, HYD 5000-EP, HYD 5500-EP,HYD 6000-EP) 
Internal view – 2 (HYD 3000-EP, HYD 3680-EP, HYD 4000-EP)


EUT Photo

Internal view - 3

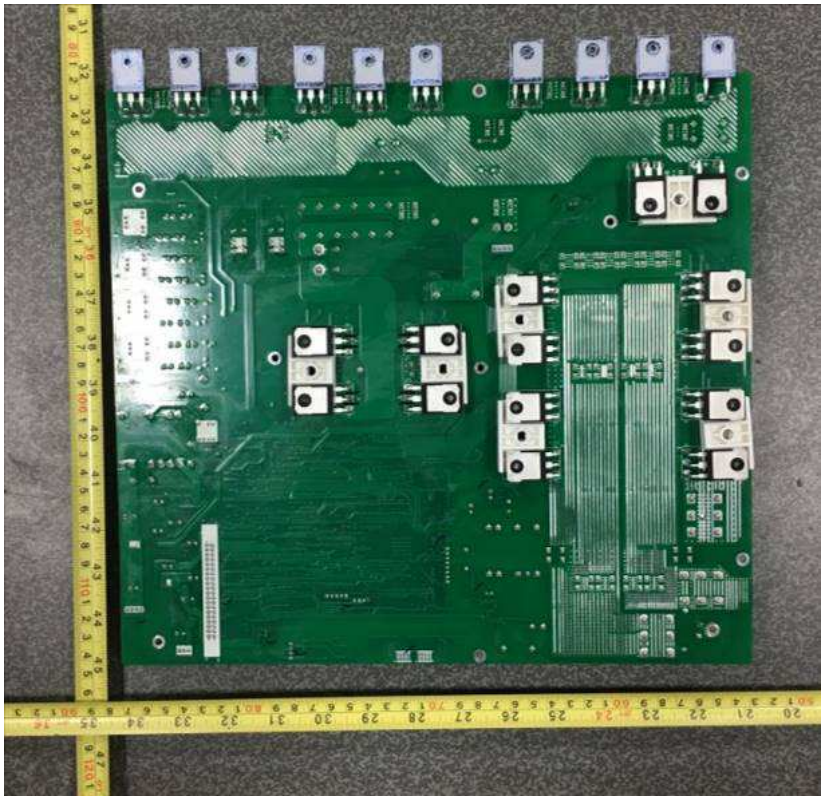


General view – 1 of Power board

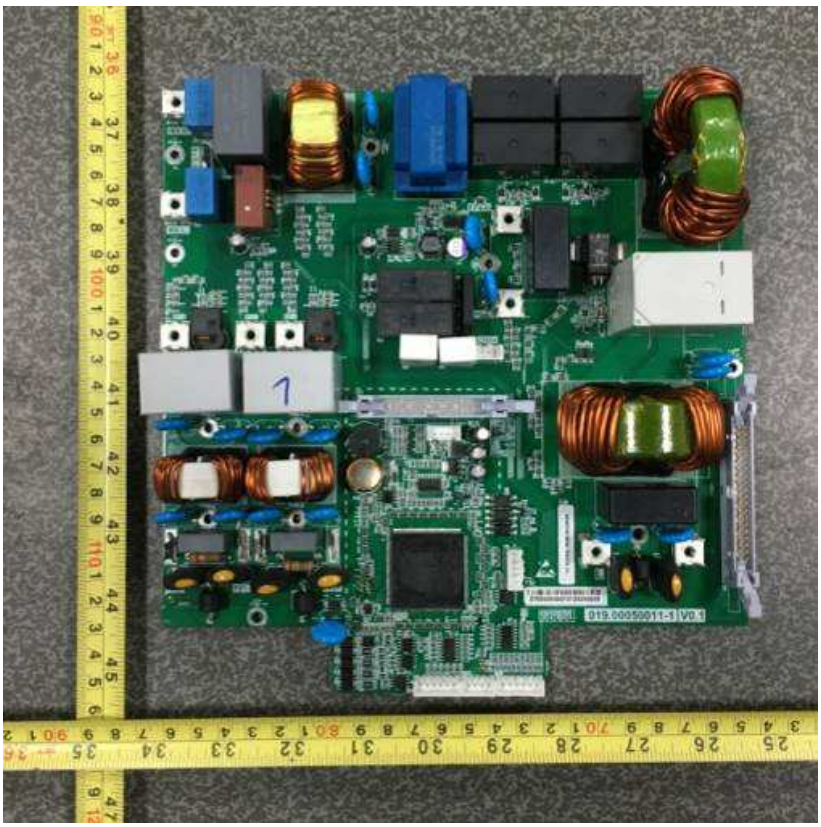


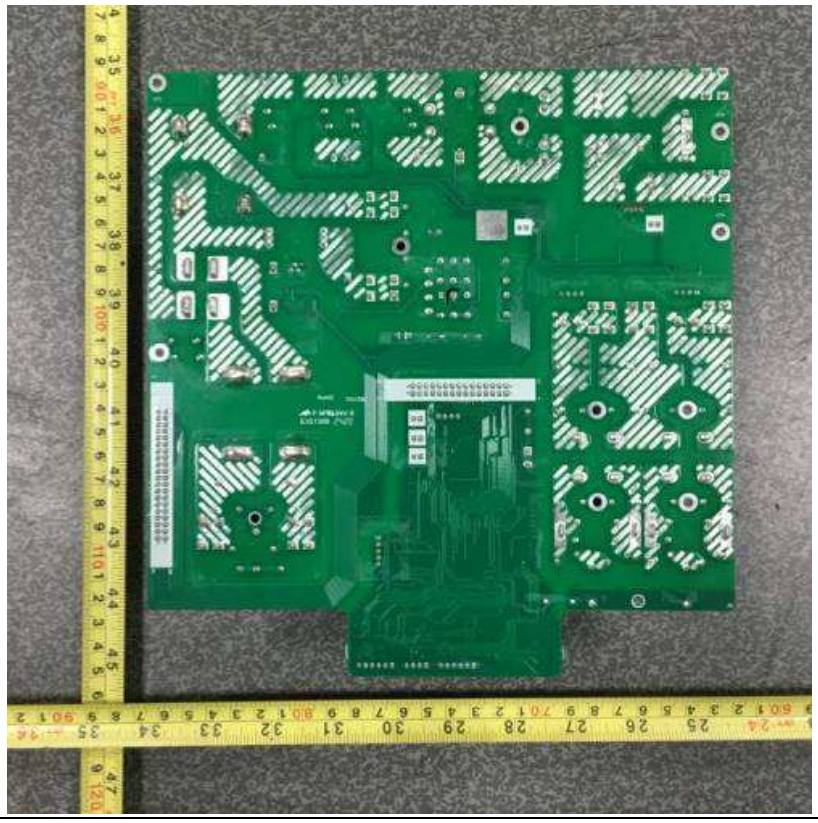
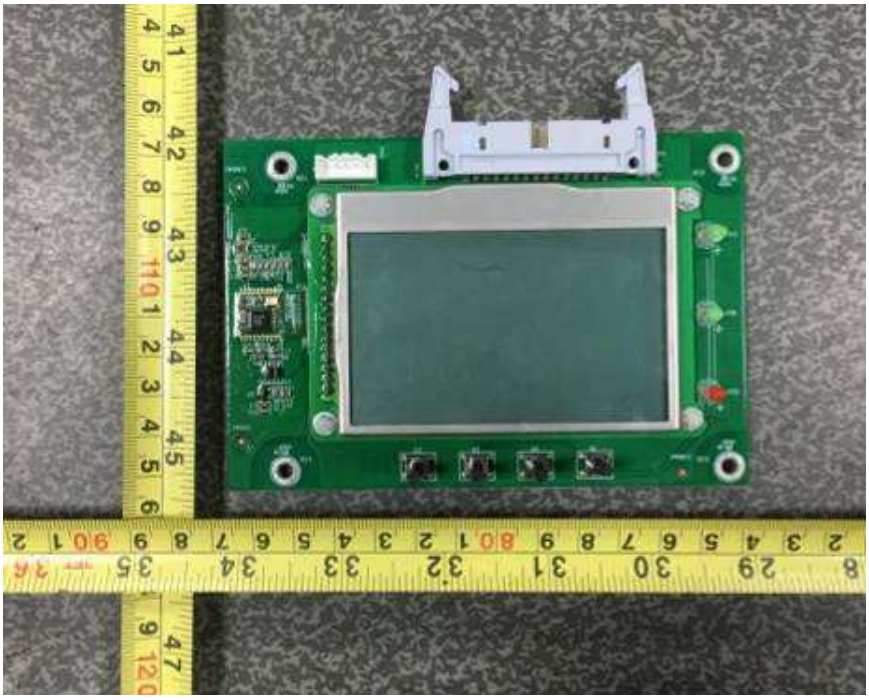
EUT Photo

General view – 2 of Power board



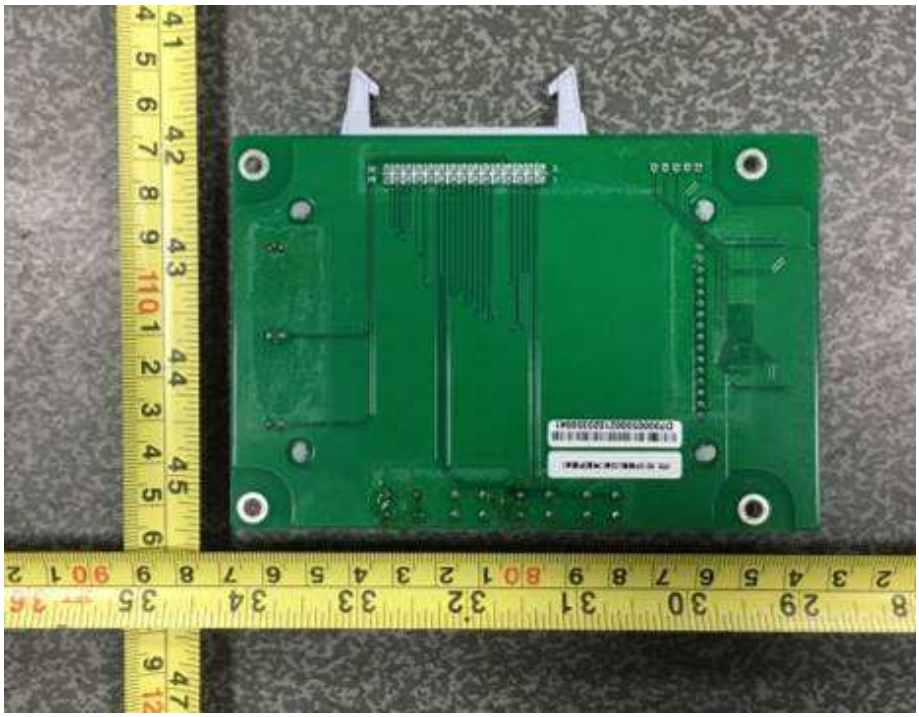
General view – 1 of Output board



EUT Photo
General view – 2 of Output board 
General view – 1 of LCD panel 

EUT Photo

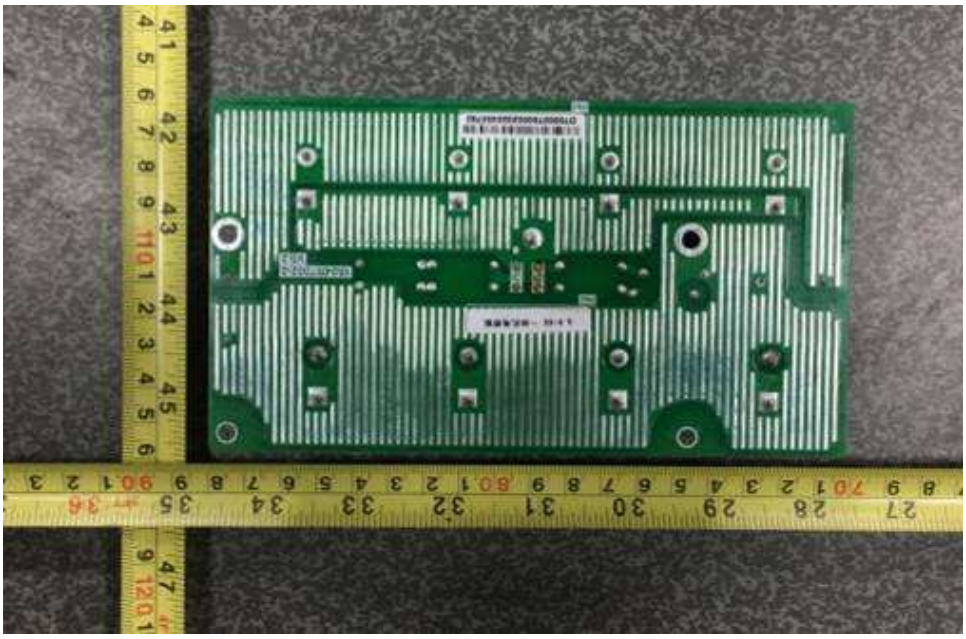
General view – 2 of LCD panel



General view - 1 of BUS board

EUT Photo

General view - 2 of BUS board



General view of Grouding point

Annex No. 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 2021-01-08

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