Prüfbericht-Nr.: *Test Report No.*:	50131287 001	**Auftrags-Nr.:** *Order No.*:	154302874	Seite 1 von 57 *Page 1 of 57*
Kunden-Referenz-Nr.: *Client Reference No.*:	616910	**Auftragsdatum:** *Order date*:	Jan., 08, 2018	
Auftraggeber: *Client*:	**Ningbo Ginlong technologies Co., Ltd.** No.57 Jintong Road, Binhai, (seafront) industrial Park, Xiangshan, Ningbo, zhejiang, 315712, P.R. China			
Prüfgegenstand: *Test item*:	Grid-connected PV Inverter			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	Solis-40K, Solis-50K, Solis-50K-HV, Solis-60K-HV			
Auftrags-Inhalt: *Order content*:	AK Certification			
Prüfgrundlage: *Test specification*:	NRS 097-2-1: 2017			

Wareneingangsdatum: *Date of receipt*:	Jan., 23, 2018
Prüfmuster-Nr.: *Test sample No.*:	A000680680-002
Prüfzeitraum: *Testing period*:	26.01.2018 – 27.07.2018
Ort der Prüfung: *Place of testing*:	TÜV Rheinland (Shanghai) Co.,Ltd.
Prüflaboratorium: *Testing laboratory*:	TÜV Rheinland (Shanghai) Co.,Ltd.
Prüfergebnis*: *Test result**:	Pass

geprüft von / *tested by*:			**kontrolliert von** / *reviewed by*:		
30.07.2018	John Dai / PE	John Dai	30.07.2018	Billy Chen / Reviewer	Billy Chen
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*:
N/A

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

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NRS 097-2-1
GRID INTERCONNECTION OF EMBEDDED GENERATION
PART 2: SMALL-SCALE EMBEDDED GENERATION
– Section 1: Utility interface

Report Reference No. .....:	50131287 001
Tested by (name + signature) .....:	See cove page .....
Approved by (name + signature)....:	See cove page .....
Date of issue.....:	See cove page
Testing Laboratory.....:	**TÜV Rheinland (Shanghai) Co., Ltd.**
Address .....:	No. 177, Lane 777 West Guangzhong Road, Jingan District, Shanghai, P.R.China
Testing location/ procedure .....:	CBTL☐ TMP☐ WMT☐ SMT☐ RMT☐ CCATL ☒
Testing location/ address .....:	**TÜV Rheinland (Shanghai) Co., Ltd.** No. 177, Lane 777 West Guangzhong Road, Jingan District, Shanghai, P.R.China
Applicant's name .....:	**Ningbo Ginlong technologies Co., Ltd.**
Address .....:	No.57 Jintong Road, Binhai, (seafront) industrial Park, Xiangshan, Ningbo, zhejiang, 315712, P.R. China
Test specification:	
Standard .....:	NRS 097-2-1: 2017
Test procedure .....:	AK
Non-standard test method……..:	N/A
Test Report Form No.....:	MS-0025008-appendix 2
Test Report Form(s) Originator .....:	TÜV Rheinland Group
Master TRF.....:	2017-05

Test item description .....:	Grid-connected PV Inverter
Trade Mark .....:	solis
Manufacturer .....:	Same as the applicant
Model/Type reference .....:	Solis-40K, Solis-50K, Solis-50K-HV, Solis-60K-HV
Ratings .....:	See copy of marking plate for details

Equipment mobility:	☐ movable ☐ hand-held ☐ stationary ☒ fixed
Connection to the mains:	☐ pluggable equipment ☐ direct plug-in ☒ permanent connection ☐ for building-in
Operating condition:	☒ continuous ☐ short-time ☐ intermittent
Over voltage category Mains:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Tested for IT power systems :	☐ Yes ☒ No
IT testing, phase-phase voltage (V) :	N/A
Class of equipment :	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg):	63
Pollution degree	☐ PD 1 ☐ PD 2 ☒ PD 3
IP protection class :	IP65

Possible test case verdicts:	
- test case does not apply to the test object..... :	N/A
- test object does meet the requirement..... :	Pass (P)
- test object does not meet the requirement..... :	Fail (F)

Testing:	
Date of receipt of test items:	See cover page
Date(s) of performance of tests:	See cover page

General remarks

” The test result presented in this report relate only to the object(s) tested.

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

"(see remark #)" refers to remark appended to the report.
"(see Annex #)" refers to an annex appended to the report.

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

Attachement:

This report also includes attached photo documentation 16 pages.

Summary of testing:

All the test were performed on the Solis-60K and valid for other models.

Tests performed (name of test and test clause)

Clause(s)		Test(s)
☒	4.1	Utility compatibility
☒	4.1.5.1	Flicker
☒	4.1.5.3	Voltage change
☐	4.1.6.1	Apparent power unblance
☒	4.1.6.2	Voltage unblance
☒	4.1.7	Commutation notches
☒	4.1.8	DC injection
☒	4.1.10	Harmonics and waveform distortion
☒	4.1.11.2	Power factor for sub-categories A1 and A2
☒	4.1.11.4	Power factor for sub-categories A3
☒	4.1.11.9	Power factor characteristics curve for sub-categories A3
☒	4.2	Safety protection and controls
☒	4.2.2.3.2	Over/under voltage
☒	4.2.2.3.3	Over/under frequency
☒	4.2.2.3.3	Active power under over frequency
☒	4.2.2.4	Prevention of islanding (IEC 62116)
☒	4.2.2.5	DC current injection
☒	4.2.4	Utility Response to recovery
☒	5.2.1	Tolerance to sudden voltage drops and peaks for A3 (RPP Grid Code) & LVRT test

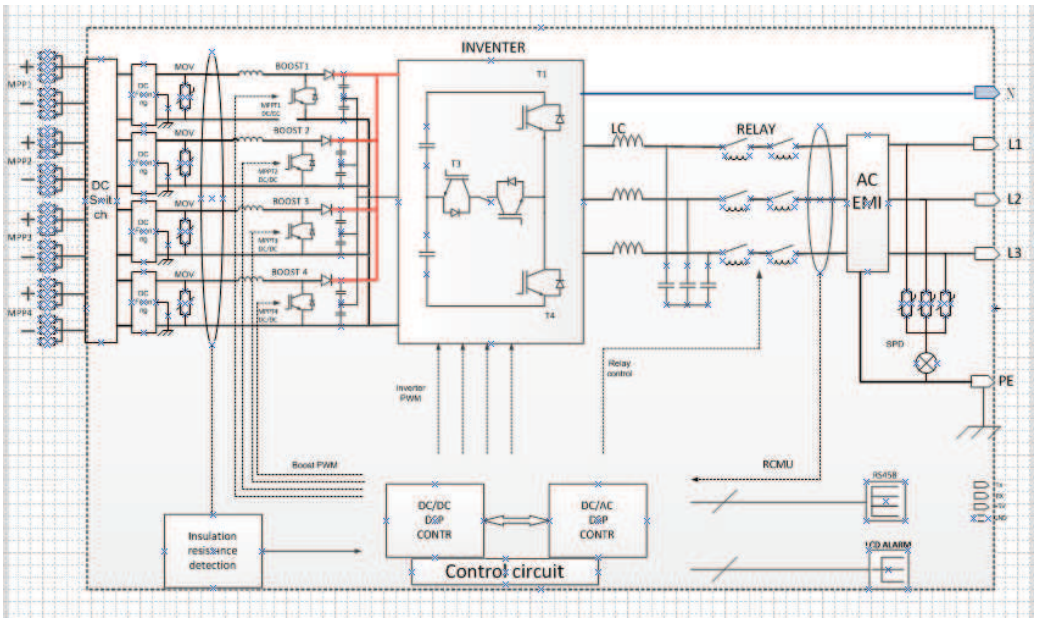
Testing location:

All tests as described in Test Case and Measurement Sections were performed at the laboratory described on page 2.

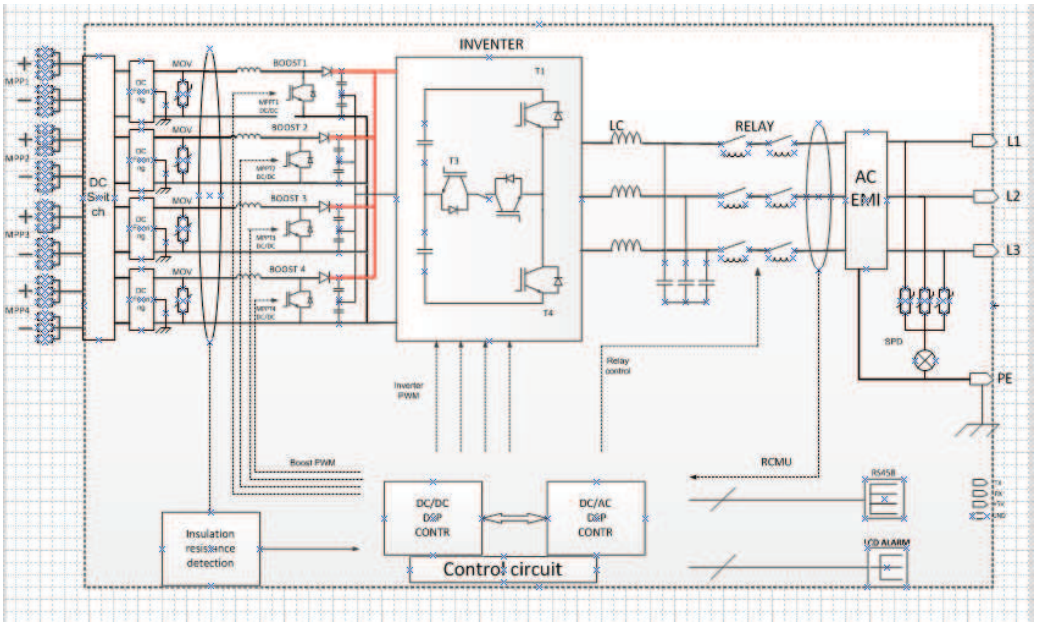
Description of the test item:

The PCEs under test models Solis-40K, Solis-50K, Solis-50K-HV, Solis-60K-HV are three-phase grid connected inverter for solar power generation. The Grid-connected PV Inverter utilize the advanced power conversion technology IGBT to convert the DC power normally from the photovoltaic array to stable three-phase AC power and then feed the power to the utility grid.

Block diagram:



Solis-50K



Solis-60K-HV

The protection device makes up of two in series in each line and netural between inverter and gird. Inverter and back-up load communicative coupled AC relays so that the equipment could be effectively separated from utitlity even any one of relays short circuited or works abnormally.

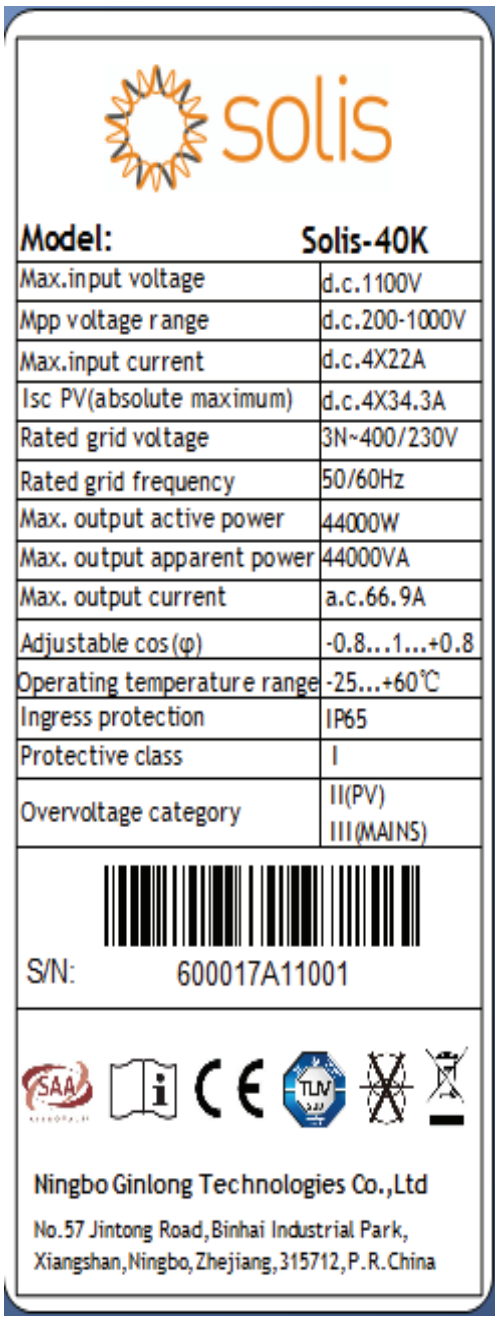
Model list:

MODELS LIST		Solis-40K	Solis-50K	Solis-50K-HV	Solis-60K-HV
PV INPUT	V_{MAX} PV [Vdc]	1100	1100	1100	1100
	I_{SC} PV [A]	22.0/22.0/ 22.0/22.0A	28.5/28.5/ 28.5/28.5A	22.0/22.0/ 22.0/22.0A	28.5/28.5/ 28.5/28.5A
	MPP Voltage Range V_{MPP} [Vdc]	200-1000V	200-1000V	200-1000V	200-1000V
	Max. Input Current I_{MAX} [A] (A/B) (each MPPT)	34.3A	44.5A	34.3A	44.5A
	MPP Full Power Voltage Range [Vdc]	454-850V	439-850V	568-850V	526-850V
	Backfeed Current [A]	0	0	0	0
	Overvoltage Category (OVC)	II	II	II	II
AC OUTPUT	Rated Output Voltage Ur [Vac]	3/N/PE 400	3/N/PE 400	3/N/PE 480	3/N/PE 480
	Normal Operating Voltage Range Un[Vac]	304-460 U_{AVG}≥1.1Ur (<10min)	304-460 U_{AVG}≥1.1Ur (<10min)	384-576 U_{AVG}≥1.1Ur (<10min)	384-576 U_{AVG}≥1.1Ur (<10min)
	Rated Output Frequency F_{NETZ} [Hz]	50	50	50	50
	Normal Operating Frequency Range Fn [Hz]	47-52Hz or 57-62Hz	47-52Hz or 57-62Hz	47-52Hz or 57-62Hz	47-52Hz or 57-62Hz
	Operating Frequency Adjustable Range Fn [Hz]	45-55	45-55	45-55	45-55
	Rated Output Power P_E [kW]	40	50	50	60
	Max. Output Power P_{Emax} [kW]	44	55	55	66
	Max. Apparent power S_{Emax} [VA]	44000	55000	55000	66000
	PGS S_{Emax} [kVA]	No limit	No limit	No limit	No limit

	Rated Output Current Ir [A]	60.8	76.0	60.2	72.2
	Max. Output Current Imax [A]	66.9	83.3	66.2	80
	Power Factor cosφ [λ]	0.8under-excited - 0.8over-excited			
	Efficiency max. η_{max}	98.8%	98.8%	99.0%	99.0%
	Standby Power Consumption [W]	<10W	<10W	<10W	<10W
	Night Power Consumption [W]	<1W	<1W	<1W	<1W
	THD [V / I] (100% full power)	<3%	<3%	<3%	<3%
	Acoustic Noise [dB]	<50	<50	<50	<50
	Overvoltage Category (OVC)	III			
PV & GRID CONNECTION	Array Insulation Resistance Detection [Ω]	200k (> V_{MAX} PV/30mA)			
	The accuracy of resistance measurement [%/Ω]	1%			
	Continuous residual current threshold value [mA]	120 (I_{LIMIT}: 300)			
	Sudden residual current threshold value [mA]	22 (I_{LIMIT}: 30) / 50 (I_{LIMIT}: 60) / 120 (I_{LIMIT}: 150)			
	Sudden residual current trip time [ms]	160 (T_{LIMIT}: 300) / 120 (T_{LIMIT}: 150) / 30 (T_{LIMIT}: 40)			
	Voltage threshold value [V]	U_{MIN}: 320 (U_{LIMITU}: 320), U_{MAX}: 460 (U_{LIMITO}: 460) for 20-30k models U_{MIN}: 384 (U_{LIMITU}: 384), U_{MAX}: 550(U_{LIMITO}: 550) for 36 and 40 HV models			
	The accuracy of voltage measurement[%/V]	Min (2.3 / 4.0 Vrms, 1%)			
	Voltage trip time [ms]	U_{MIN}: 160 (T_{LIMIT}: 200), U_{MAX}: 160 (T_{LIMIT}: 200), $U_{AVG \geq 110\%Ur}$: <10 min (T_{LIMIT}: 10 min)			

	Frequency threshold value [Hz]	F_{MIN}: 47.5 (F_{LIMITU}: 47.5), F_{MAX}: 51.5 (F_{LIMITO}: 51.5)			
	The accuracy of frequency measurement [%/Hz]	Min (0.01Hz, 0.1%)			
	Frequency trip time [ms]	F_{MIN}: 100 (T_{LIMIT}: 200), F_{MAX}: 100 (T_{LIMIT}: 200)			
	Active anti-islanding trip time [s]	<5.0 (T_{LIMIT}: 5)			
	DC Injection Current normal value [mA]	< 20			
	DC Injection Current threshold value [mA]	1000 (I_{LIMIT}: 1000)			
	DC Injection current trip time [ms]	100 (T_{LIMIT}: 200)			
	Reconnection Voltage [V]	U_{MIN}: 340 (U_{LIMITU}: 340), U_{MAX}: 440 (U_{LIMITO}: 440) for 20-30k models U_{MIN}: 0 (U_{LIMITU}: 340), U_{MAX}: 440 (U_{LIMITO}: 440) for 36-40k HV models			
	Reconnection Frequency [Hz]	F_{MIN}: 47.5 (F_{LIMITU}: 47.5), F_{MAX}: 50.05 (F_{LIMITO}: 50.05)			
	Reconnection Time [s]	60 (T_{LIMIT} > 60)			
CONSTRUCTION	Type of inverter	Non-insulated			
	Type of NS Protection	Integrated			
	Separated by	Transformerless			
	MPPT strings	8	12	8	12
	MPPT tracking	4			
	Protective Class	I			
	Enclosure Protection (IP)	IP65			
	Operating Temperature Range [ºC]	-25 to 60			
	Pollution degree (PD)	PD 2(inside), PD3(outside)			
	Altitude [m]	2000			
	Weight [kg]	61	63	61	63
	Firmware version	1D			

Copy of marking plate:



solis

Model:	Solis-40K
Max.input voltage	d.c.1100V
Mpp voltage range	d.c.200-1000V
Max.input current	d.c.4X22A
Isc PV(absolute maximum)	d.c.4X34.3A
Rated grid voltage	3N~400/230V
Rated grid frequency	50/60Hz
Max. output active power	44000W
Max. output apparent power	44000VA
Max. output current	a.c.66.9A
Adjustable cos(φ)	-0.8...1...+0.8
Operating temperature range	-25...+60℃
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV) III(MAINS)

S/N: 600017A11001

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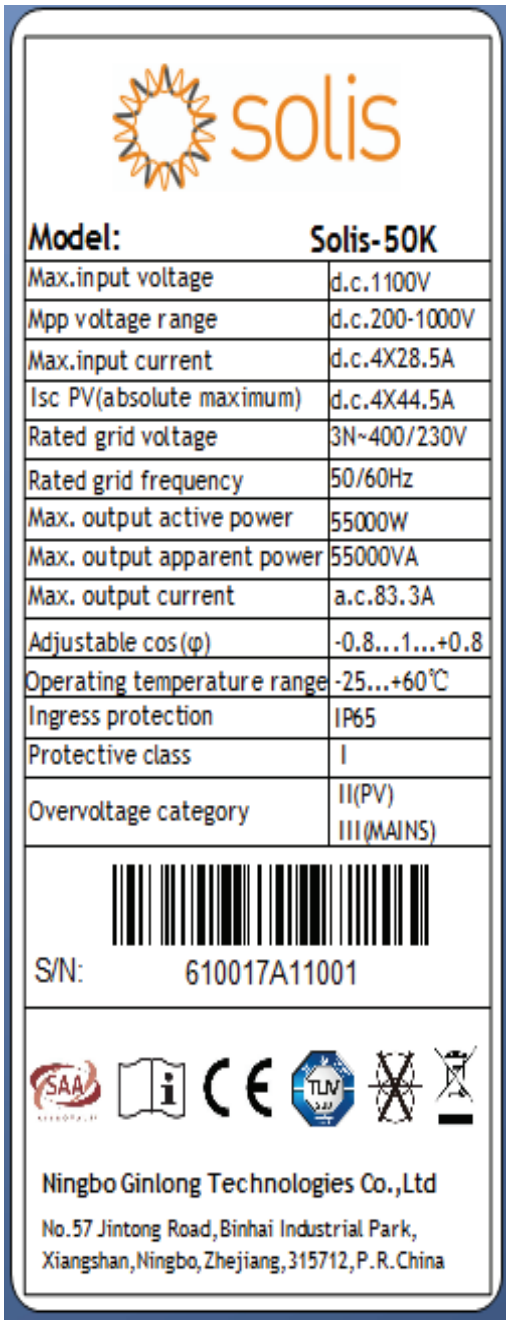

solis

Model:	Solis-50K
Max.input voltage	d.c.1100V
Mpp voltage range	d.c.200-1000V
Max.input current	d.c.4X28.5A
Isc PV(absolute maximum)	d.c.4X44.5A
Rated grid voltage	3N~400/230V
Rated grid frequency	50/60Hz
Max. output active power	55000W
Max. output apparent power	55000VA
Max. output current	a.c.83.3A
Adjustable cos(φ)	-0.8...1...+0.8
Operating temperature range	-25...+60℃
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV) III(MAINS)

S/N: 610017A11001

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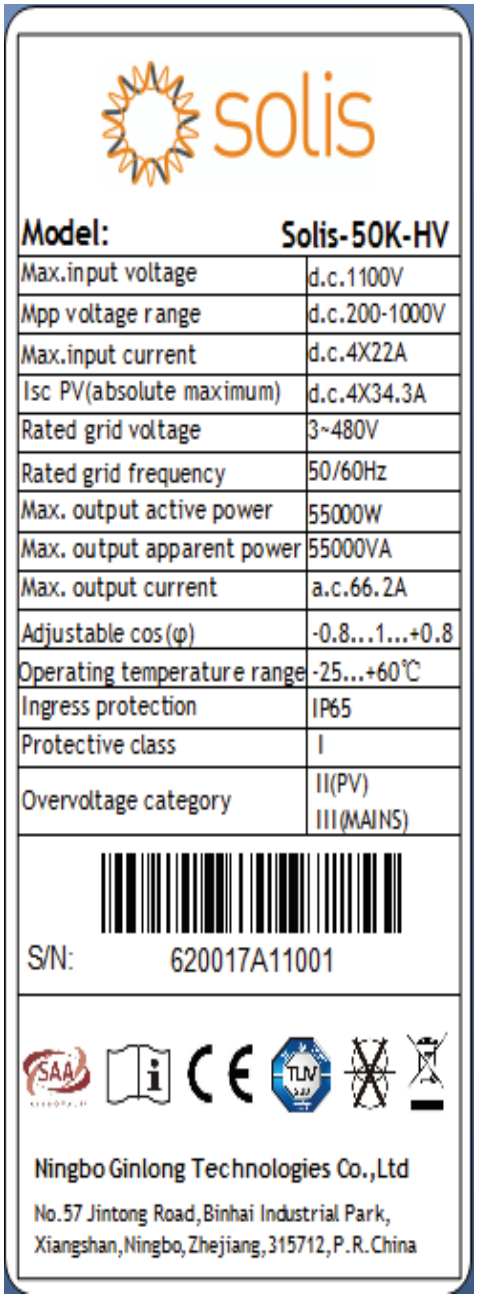

solis

Model:	Solis-50K-HV
Max.input voltage	d.c.1100V
Mpp voltage range	d.c.200-1000V
Max.input current	d.c.4X22A
Isc PV(absolute maximum)	d.c.4X34.3A
Rated grid voltage	3~480V
Rated grid frequency	50/60Hz
Max. output active power	55000W
Max. output apparent power	55000VA
Max. output current	a.c.66.2A
Adjustable cos(φ)	-0.8...1...+0.8
Operating temperature range	-25...+60℃
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV) III(MAINS)

S/N: 620017A11001

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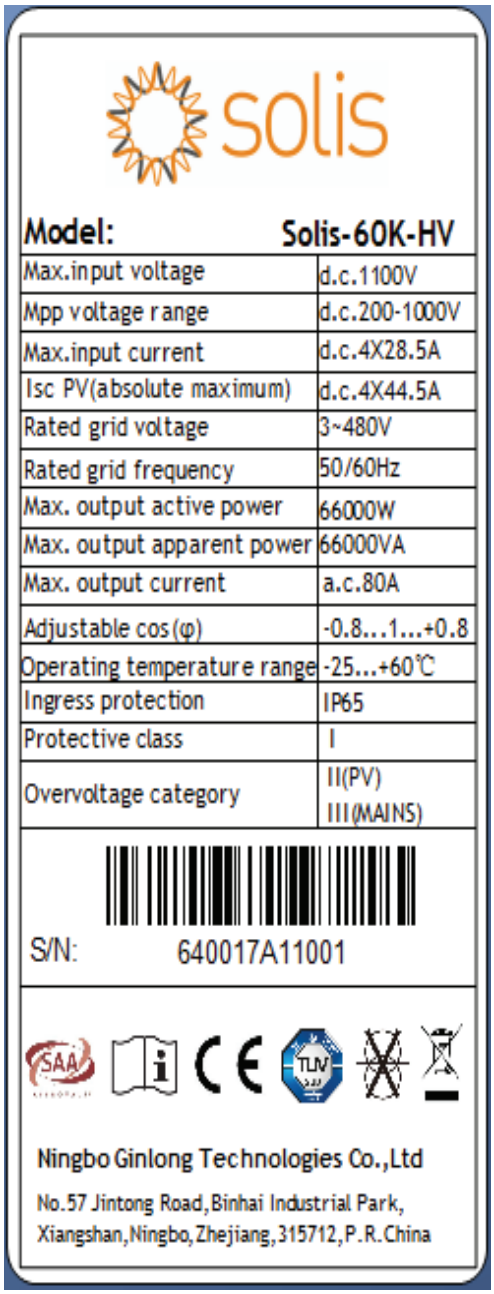

solis

Model:	Solis-60K-HV
Max.input voltage	d.c.1100V
Mpp voltage range	d.c.200-1000V
Max.input current	d.c.4X28.5A
Isc PV(absolute maximum)	d.c.4X44.5A
Rated grid voltage	3~480V
Rated grid frequency	50/60Hz
Max. output active power	66000W
Max. output apparent power	66000VA
Max. output current	a.c.80A
Adjustable cos(φ)	-0.8...1...+0.8
Operating temperature range	-25...+60℃
Ingress protection	IP65
Protective class	I
Overvoltage category	II(PV) III(MAINS)

S/N: 640017A11001

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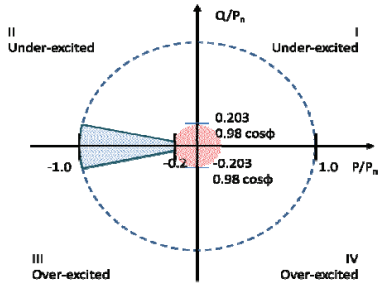
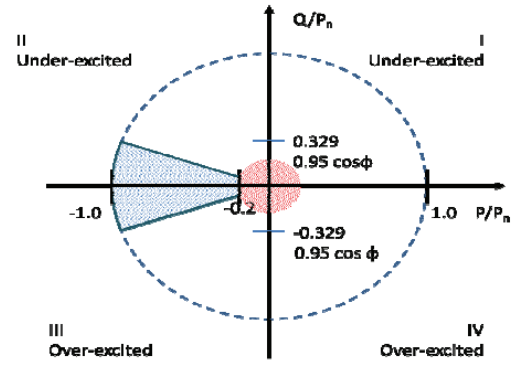
NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

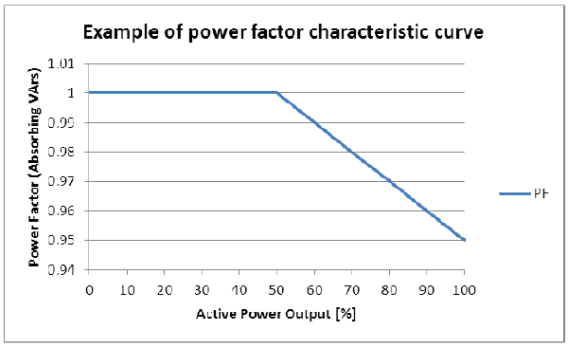
4.1	**Utility compatibility**		**P**
4.1.1	**General**		**P**
4.1.1.1	This clause describes the technical issues and the responsibilities related to interconnecting an embedded generator to a utility network.		**P**
4.1.1.2	The quality of power provided by the embedded generator in the case of the on-site a.c. loads and the 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-ofbounds conditions. The embedded generator is required to sense the deviation and might need to disconnect from the utility network.		**P**
4.1.1.3	All power quality parameters (voltage, flicker, frequency and harmonics) shall be measured at the POC, unless otherwise specified (see annex A).	See appended table at the end of report for detailed test.	**P**
4.1.1.4	The embedded generator's a.c. voltage, current and frequency shall be compatible with the utility at the POC.		**P**
4.1.1.5	The embedded generator shall be type approved, unless otherwise agreed upon with the utility (see annex A).		**P**
4.1.1.6	The maximum size of the embedded generator is limited to the rating of the supply point on the premises.	Shall be evaluated in final installation.	**N/A**
4.1.1.7	The utility will approve the size of the embedded generator and will decide on the connection point and conditions. In some cases it may be required to create a separate supply point.	Three-phase inverter.	**P**
4.1.1.8	Embedded generators larger than 13,8 kVA shall be of the balanced three-phase type unless only a single-phase network supply is available, in which case NRS 097-2-3 recommendations can be applied based on the NMD. NOTE 1 This value refers to the maximum export potential of the generation device/system. NOTE 2 In the case of long feeder spurs the maximum desired capacity of the EG might require approval by the utility and might result in the requirement for a three-phase connection for smaller units.	Three-phase inverter.	**P**
4.1.1.9	A customer with a multiphase connection shall split the embedded generator in a balanced manner over all phases if the EG is larger than 4,6 kVA. NOTE Balancing phases in a multiphase embedded generator is deemed desirable.	Three phase balance inverter. The max unbalance power is 42W.	**P**
4.1.1.10	Embedded generators or generator systems larger than 100 kVA may have additional requirements, for example, they must be able to receive communication signals for ceasing generation/disconnection from the utility supply, if the utility requires such. Communication facilities	Considered	**P**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

	shall be provided to utility at no charge for integration with SCADA or other system when required. See Annex G (G.1). NOTE The RPP Grid Code requires category A3 units to be able to interface with the utility in order to receive stop and start signals.		
4.1.1.11	In line with the current Renewable Power Plant Grid Code, embedded generators smaller than 1000 kVA connected to low-voltage form part of Category A generators, with the following subcategories: a) Category A1: 0 – 13,8 kVA; b) Category A2: 13,8 kVA – 100 kVA; c) Category A3: 100 kVA – 1 MVA.	Category A2/A3	**P**
4.1.1.12	In accordance with SANS 10142-1, all generators shall be wired permanently.	Considered	**P**
4.1.1.13	Any UPS/generating device that operates in parallel with the grid may only connect to the grid when it complies fully with the requirements of this part of NRS 097. This includes UPS configurations with or without EG.	Considered	**P**
4.1.1.14	Standby-generators are covered by SANS 10142-1.	Considered	**P**
4.1.1.15	All generators larger than 100 kVA will be controllable, i.e. be able to control the active output power dependent on network conditions/abnormal conditions. This includes several smaller units that totals more than 100 kVA at a single POC.	Considered the parallel operation.	**P**
4.1.1.16	Maximum DC Voltage may not exceed 1000V. This is the voltage on the DC side of the inverter, for example when no load is taken and maximum source energy is provided, e.g. peak solar radiation occurs on the solar panels.	Maximum DC voltage 1100Vdc	**P**
4.1.2	**Normal voltage operating range**	See appended table	**P**
4.1.3	**Reference source impedance and short-circuit levels (fault levels)**		**P**
4.1.4	**General QOS requirements**		**P**
4.1.5	**Flicker and voltage changes**	See appended table	**P**
4.1.6	**Voltage unbalance**	See appended table	**P**
4.1.7	**Commutation notches**	See appended table	**P**
4.1.8	**DC injection**	See appended table	**P**
4.1.9	**Normal frequency operating range**	See appended table	**P**
4.1.10	**Harmonics and waveform distortion**	See appended table	**P**
4.1.11	**Power factor**		**P**
4.1.11.1	Irrespective of the number of phases to which an embedded generator is connected, it shall comply with the power factor requirements in accordance with 4.1.11.2 to 4.1.11.12 on each phase for system normal conditions when the output power exceeds 20 % of rated active power:		**P**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict
4.1.11.2	For static power converter embedded generators and synchronous embedded generators of sub-categories A1 and A2, the power factor shall remain above 0,98 as shown in Figure 1. The embedded generator shall operate anywhere in the shaded area of figure 1.  NOTE At the time of publication, this is in contradiction with the RPP Grid Code.	See appended table	**P**
4.1.11.3	For asynchronous embedded generators of sub-categories A1 and A2, which cannot control the power factor over any range, the power factor shall reach the shaded area of figure 1 within 60 s. The power factor shall remain above 0,98 as shown in figure 1. The embedded generator shall operate anywhere in the shaded area. NOTE At the time of publication, this is in contradiction with the RPP Grid Code.		**N/A**
4.1.11.4	For static power converter embedded generators and synchronous embedded generators of sub-category A3, the power factor shall remain above 0,95 as shown in Figure 2. The embedded generator shall operate anywhere in the shaded area of Figure 2.  	Considered the parallel operation.	**P**
4.1.11.5	For asynchronous embedded generators of sub-category A3, which cannot control the power factor over any range, the power factor shall reach the shaded area of Figure 2 within 60 s. The power factor shall remain above 0,95 as shown in Figure 2. The embedded generator shall operate anywhere in the shaded area.		**P**
4.1.11.6	Where the EG is capable of controlling the power factor at the POC, the EG should improve the power factor at the POC towards unity.		**P**

NRS 097-2-1			
Clause	Requirement – Test	Result – Remark	Verdict

4.1.11.7	Unless otherwise agreed with the utility, the standard power factor setting shall be unity for the full power output range.		**P**
4.1.11.8	The maximum tolerance on the reactive power setting is 5 % of the rated active power.		**N/A**
4.1.11.9	For embedded generators of sub-category A3, the power factor shall be settable to operate according to a characteristic curve provided by the utility, if required by the utility, within the range 0,95 leading and 0,95 lagging; An example of a standard characteristic curve is shown in figure 3. 	Considered the parallel operation.	**P**
4.1.11.10	These limits apply, unless otherwise agreed upon with the utility (see annex A).		**P**
4.1.11.11	Equipment for reactive power compensation shall either: a) be connected or disconnected with the embedded generator, or b) operated via automatic control equipment for disconnection when not required.		**P**
4.1.11.12	The requirement for and type of detuning for reactive power compensation devices will be agreed upon by the owner of the generator and utility.	Confirmed	**P**
4.1.12	**Synchronization**		**P**
4.1.13	**Electromagnetic compatibility (EMC)**	Refer to EMC report.	**P**
4.1.14	**Mains signalling (e.g. PLC and ripple control)**	External use PLC will be used, shall be re-evaluated in final installation.	**N/A**

4.2	**Safety and protection**		**P**
4.2.1	**General**		**P**
4.2.2	**Safety disconnect from utility network**		**P**
4.2.2.1	General		**P**
4.2.2.1.1	All SSEG shall comply with the safety requirements in accordance with SANS/IEC 62109-1 and IEC 62109-2. NOTE In principle, IEC 62109 documents only apply to PV inverters. However, other SSEG shall prove compliance to these safety requirements to the satisfaction of the utility.	Refer to IEC 62109-1 and IEC 62109-2 reports.	**P**
4.2.2.1.2	The embedded generator shall automatically and safely disconnect from the grid in the event of an abnormal condition.		**P**

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Clause	Requirement – Test	Result – Remark	Verdict
4.2.2.2	**Disconnection device (previously disconnection switching unit)**		**P**
4.2.2.2.1	The embedded generator shall be equipped with a disconnection device, which separates the embedded generator from the grid due to abnormal conditions. The disconnection unit may be integrated into one of the components of the embedded generator (for example the PV utility. interconnected inverter) or may be an independent device installed between the embedded generator and the utility interface.	PV inverter provided two relays in series used in each line and neutral as disconnection devices.	**P**
4.2.2.2.2	The disconnection switching unit shall be able to operate under all operating conditions of the utility network.	Simulated fault test has been performed, see appended table.	**P**
4.2.2.2.3	A failure within the disconnection switching unit shall lead to disconnection and indication of the failure condition.	Refer to IEC 62109-1 and IEC 62109-2 reports.	**P**
4.2.2.2.4	A single failure within the disconnection switching unit shall not lead to failure to disconnect. Failures with one common cause shall be taken into account and addressed through adequate redundancy.	Refer to IEC 62109-1 and IEC 62109-2 reports.	**P**
4.2.2.2.5	The disconnection device shall disconnect the generator from the network by means of two series connected robust automated load disconnect switches.	PV inverter provided two relays in series used in each line and neutral as disconnection devices.	**P**
4.2.2.2.6	Both switches shall be electromechanical switches.	Relays with suitable rating provided.	**P**
4.2.2.2.7	Each electromechanical switch shall disconnect the embedded generator on the neutral and the live wire(s). NOTE The switching unit need not disconnect its sensing circuits.	Considered.	**P**
4.2.2.2.8	All rotating generating units, e.g. synchronous or asynchronous generating units shall have adequate redundancy in accordance with 4.2.2.2.5.	PV inverter	**N/A**
4.2.2.2.9	A static power converter without simple separation shall make use of two series connected electromechanical disconnection switches.	PV inverter provided two relays in series used in each line and neutral as disconnection devices.	**P**
4.2.2.2.10	The current breaking capacity of each disconnecting switch shall be appropriately sized for the application. In cases where the disconnecting device is an electromechanical switching device such as a contractor, this requires suitable coordination with the upstream short circuit protection device (circuit breaker).	Considered.	**P**
4.2.2.2.11	Any programmable parameters of the disconnection switching unit shall be protected from interference by third-parties, i.e. password protected or access physically sealed.	Considered.	**P**
4.2.2.2.12	In order to allow customers to supply their own load in isolated operation (islanded)	Considered.	**P**

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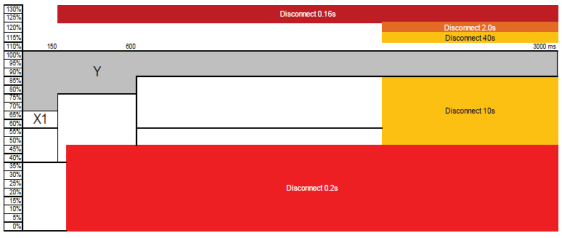
Clause	Requirement – Test	Result – Remark	Verdict

	where this is feasible and required, the disconnection device may be incorporated upstream of part of or all of a customers' loads, provided that none of the network disconnection requirements in this document are violated.		
4.2.2.2.13	All EG installations larger than 30 kVA shall have a central disconnection device.	The models more than 30kVA have a central disconnection device.	**P**
4.2.2.2.14	The network and system grid protection voltage and frequency relay for the central disconnection device will be type-tested and certified on its own (stand-alone tested). All clauses of 4.2.2, except 4.2.2.4 (anti-islanding) apply.		**P**
4.2.2.3	**Overvoltage, undervoltage and frequency**		**P**
4.2.2.3.1	**General**		**P**
	The values in 4.2.2.3 relate to SSEG in sub-categories A1 and A2. These are kept from a historical perspective. The Grid Code requirements will override values and requirements in this category. Sub-category A3 generators shall disconnect from the network according to the RPP Grid Code for all abnormal conditions as well as stay connected in accordance with the voltage ride-through requirements of the RPP Grid Code.	See appended table. Considered the parallel operation.	**P**
4.2.2.3.2	**Overvoltage and undervoltage**		**P**
	The embedded generator in sub-category A1 and A2 shall cease to energize the utility distribution system should the network voltage deviate outside the conditions specified in table 2. The following conditions shall be met, with voltages in r.m.s. and measured at the POC.	See appended table	**P**
4.2.2.3.3	**Overfrequency and underfrequency**		**P**
	This requirement is in line with the RPP Grid Code (version 2.8) and applies to all EG in category A.	See appended table.	**P**

1	2
Voltage range (at point of connection)	**Maximum trip time** S
V < 50 %	0,2 s
50 % ≤ V < 85 %	10 s
85 % ≤ V ≤ 110 %	Continuous operation
110 % < V < 115 %	40 s
115% ≤ V < 120%	2 s
120 % ≤ V	0,16 s
NOTE If multi-voltage control settings are not possible, the more stringent trip time should be implemented, e.g. 2 s between 110% and 120% of voltage.	



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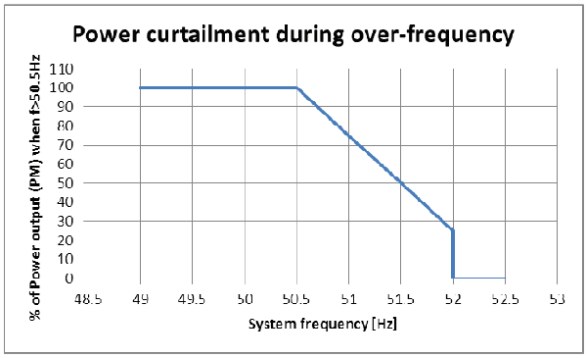
Clause	Requirement – Test	Result – Remark	Verdict

4.2.2.3.3.1	Relaxation for non-controllable generators		**P**
	Non-controllable generators may disconnect randomly within the frequency range 50.5 Hz to 52 Hz. The disconnect frequency for non-controllable generators will each be set at a random value by the manufacturer, with the option of changing this to a utility provided setting. The random disconnect frequency shall be selected so that all generators from any specific manufacturer will disconnect uniformly over the range with 0,1 Hz increments. When the utility frequency is more than the non-controllable generator over-frequency setpoint for longer than 4 seconds, the non-controllable generator shall cease to energise the utility line within 0,5 s. 	See appended table.	**P**
4.2.2.4	**Prevention of islanding**		**P**
4.2.2.4.1	A utility distribution network can become de-energized for several reasons: for example, a substation breaker that opens due to a fault condition or the distribution network might be switched off for maintenance purposes. Should the load and (embedded) generation within an isolated network be closely matched, then the voltage and frequency limits may not be triggered. If the embedded generator control system only made use of passive voltage and frequency out-of-bounds detection, this would result in an unintentional island that could continue beyond the allowed time limits.	See appended table.	**P**
4.2.2.4.2	In order to detect an islanding condition, the embedded generator shall make use of at least one active islanding detection method. An active islanding detection method intentionally varies an output parameter and monitors the response or it attempts to cause an abnormal condition at the utility interface to trigger an out-of-bounds condition. If the utility supply is available, the attempt to vary an output parameter or cause an abnormal condition will fail and no response will be detected. However, if the utility supply network is de-energized, there will be a response	See appended table.	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
	to the change which can be detected. This signals an island condition to the embedded generator upon detection of which the embedded generator shall cease to energize the utility network within a specific time period.		
4.2.2.4.3	Active islanding shall be detected in all cases where the EG interfaces with the utility network.		**P**
4.2.2.4.4	An islanding condition shall cause the embedded generator to cease to energize the utility network within 2 s, irrespective of connected loads or other embedded generators. The embedded generator employing active islanding detection shall comply with the requirements of IEC 62116 (ed.1). NOTE Prevention of islanding measures is only considered on the embedded generator side, i.e. no utility installed anti-islanding measures are considered.	See appended table.	**P**
4.2.2.4.5	All rotating generators shall use a minimum of two islanding detection methods (e.g. rate-of-change-of-frequency and voltage vector shift detection due to the dead bands (slow detection) of islands in both methods). NOTE It is possible for a condition to exist, where a mains-excited generator becomes self-excited due to capacitance of the network (either cable capacitance or power factor correction). Under such conditions, the mains-excited generator will not disconnect from an island, hence effective islanding detection is required for all rotating generators.	Not rotating generator	**N/A**
4.2.2.4.6	Passive methods of islanding detection shall not be the sole method to detect an island condition. When used, passive methods of islanding detection shall be done by three-phase voltage detection and shall be verified by an AC voltage source.	Considered	**P**
4.2.2.4.7	The embedded generator shall physically disconnect from the utility network in accordance with the requirements in 4.2.2.2.	Two series connected relays used as the disconnection device in both line and neutral	**P**
4.2.2.5	**DC current injection**		**P**
	The embedded generator shall not inject d.c. current greater than 0,5 % of the rated a.c. output current into the utility interface under any operating condition, measured over a 1-minute interval. The EG shall cease to energize the utility network within 500 ms if this threshold is exceeded.	See appended table.	**P**
4.2.3	**Emergency personnel safety**		**N/A**
	No requirements for emergency personnel safety (e.g. fire brigade) existed at the time of publication. It is expected that such issues will be dealt with in other documents, e.g. OHS Act, SANS 10142-1.		**N/A**
4.2.4	**Response to utility recovery**		**P**

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Clause	Requirement – Test	Result – Remark	Verdict
4.2.4.1	The embedded generator shall ensure synchronisation before re-energizing at all times in accordance with 4.1.12.		**P**
4.2.4.2	After a voltage or frequency out-of-range condition that has caused the embedded generator to cease energizing the utility network, the generator shall not re-energize the utility network until the utility service voltage and frequency have remained within the specified ranges for a continuous and uninterrupted period of 60 s. The reconnection shall commence as follows:	See appended table.	**P**
4.2.4.2.1	Non-controllable generators may connect randomly within the 1 minute to 10 minute period after voltage and frequency recovery (period includes the 60 s to confirm recovery). The delay for non-controllable generators will each be set at a random value by the manufacturer, with the option of changing this to a utility provided setting. The random value shall be selected so that no more than 2 % of generators from any specific manufacturer will reconnect within 10s of each other.	Considered	**P**
4.2.4.2.2	Controllable generators may reconnect immediately after the 60 s delay confirming recovery of the system voltage and frequency at a maximum rate of 10 % of rated power per minute, i.e. full power output will only be reached after 10 minutes. This ramp rate may be modified at the request of the utility or in consultation with the utility.	Not controllable generator.	**N/A**
4.2.5	**Isolation**		**P**
4.2.5.1	In line with SANS 10142-1 (as amended), each energy source should have its own, appropriately rated, isolation device.	Isolation device is not integral part of the unit. The installation instructions specify a isolation device for the final installation. This shall be re-evaluated in final installation.	**P**
4.2.5.2	It is expected that isolation requirements will be dealt with in more detail in future in e.g. SANS 10142-1/3. Such requirements shall supersede 4.2.5.	Requirement specified in the installation instruction, shall be re-evaluated in final installation	**P**
4.2.5.3	The embedded generator shall provide a means of isolating from the utility interface in order to allow for safe maintenance of the EG. The disconnection device shall be a double pole for a single-phase EG, a three-pole for a three-phase delta-connected EG, and a four-pole for a three phase star-connected EG. The grid supply side shall be wired as the source.	The installation instructions specify a isolation device for the final installation. This shall be re-evaluated in final installation.	**P**
4.2.5.4	The breaking capacity of the isolation circuit-breaker closest to the point of utility connection shall be rated appropriately for the installation point in accordance with SANS 60947-2. This disconnection device does not need to be	The installation instructions specify a isolation device for the final installation. This shall be re-evaluated in final installation.	**P**

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Clause	Requirement – Test	Result – Remark	Verdict
	accessible to the utility.		
4.2.5.5	For dedicated supplies, a means shall be provided of isolating from the point of supply in order to allow for safe maintenance of the utility network. The disconnection device shall be a double pole for a single-phase EG, a three-pole for a three-phase delta-connected EG, and a four-pole for a three-phase star-connected EG.	The installation instructions specify a isolation device for the final installation. This shall be re-evaluated in final installation.	**P**
4.2.6	**Earthing**		**P**
4.2.6.1	The electrical installation shall be earthed in accordance with SANS 10142-1. The earthing requirements for different embedded generation configurations in conjunction with the customer network are described in annex B for the most common earthing systems	Requirement specified in the installation instruction, shall be re-evaluated in final installation.	**N/A**
4.2.6.2	Installations with utility-interconnected inverters without simple separation shall make use of earth leakage protection which are able to respond to d.c. fault currents including smooth d.c. fault currents (i.e. without zero crossings) according to IEC 62109-2 unless the inverter can exclude the occurrence of d.c. earth fault currents on any phase, neutral or earth connection through its circuit design1). This function may be internal or external to the inverter.	Refer to IEC 62109-2 report.	**P**
4.2.6.3	Where an electrical installation includes a PV power supply system without at least simple separation between the AC side and the DC side, an integrated RCD function shall be present to provide fault protection by automatic disconnection of supply shall be type B according to IEC/TR 60755, amendment 2. Where the PV inverter by construction is not able to feed DC fault currents into the electrical installation, an RCD of type B according to IEC/TR 60755 amendment 2 is not required.	Requirement specified in the installation instruction, shall be re-evaluated in final installation.	**P**
4.2.7	**Short-circuit protection**		**P**
4.2.7.1	The embedded generator shall have suitably rated short-circuit protection at the connection to the AC mains in accordance with SANS 10142-1 and 3.	Requirement for using circuit breaker specified in the installation instruction, shall be re-evaluated in final installation	**P**
4.2.7.2	The short-circuit characteristics for the SSEG shall be supplied to the utility.	See instruction manual	**P**
4.2.8	**Maximum short-circuit contribution**		**P**
	Embedded generators have the potential to increase the fault level of the network to which it is connected. In order to limit the fault level changes in low voltage networks and allow coordination of fault levels with the utility, no generator will exceed the following fault level contribution: a) for synchronous generators: 8 times the rated current; b) for asynchronous generators: 6 times the rated	1 times of the rated current for PV inverter.	**P**

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Clause	Requirement – Test	Result – Remark	Verdict

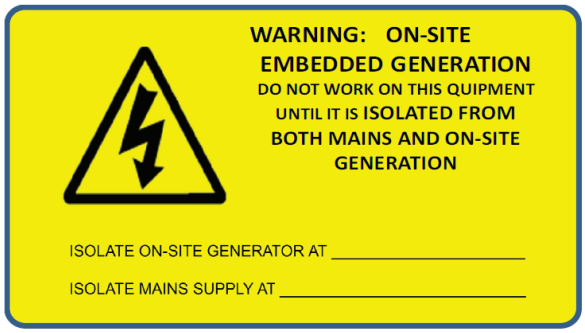
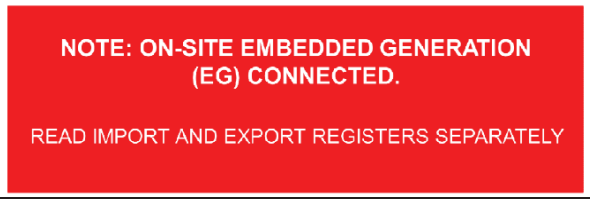
	current; and c) for generators with inverters: 1 times the rated current.		
4.2.9	**Labelling**		**P**
4.2.9.1	A label on the distribution board of the premises where the embedded generator is connected, shall state: "ON-SITE EMBEDDED GENERATION (EG) CONNECTED. THE EG IS FITTED WITH AN AUTOMATIC DISCONNECTION SWITCH WHICH DISCONNECTS THE EG IN THE CASE OF UTILITY NETWORK DE-ENERGIZATION."  	Requirement specified in the installation instruction, shall be re-evaluated in final installation.	**P**
4.2.9.2	The label shall be permanent, coloured red, and with white lettering of height at least 8 mm.		**P**
4.2.9.3	The label shall comply to requirements of SABS 1186-1.		**P**
4.2.9.4	The absence of emergency shutdown capabilities will be indicated on signage in accordance with 4.2.2.  	Requirement specified in the installation instruction, shall be re-evaluated in final installation.	**P**
4.2.10	Robustness requirements		**P**
	According to 4.2.2.1 all SSEG shall comply with safety requirements in accordance to SANS/IEC 62109-1 and IEC 62109-2.	Refer to IEC 62109-1 and IEC 62109-2 reports.	**P**
4.3	**Metering**	Shall be re-evaluated in final installation.	**N/A**
Annex A	**Notes to purchase**		**--**
Annex B	**Earthing system**	Shall be re-evaluated in final installation.	**N/A**

Table 4.1.5	Voltage fluctuations and flicker		P
Reference Impedance used:	L=0.15+0.15j, N=0.1+0.1j		
Pst (Limits: 0.35)			
Interval	Phase A	Phase B	Phase C
1	0.09	0.07	0.07
2	0.09	0.07	0.07
3	0.10	0.07	0.08
4	0.12	0.08	0.10
5	0.13	0.08	0.11
6	0.12	0.08	0.11
7	0.12	0.08	0.10
8	0.14	0.09	0.12
9	0.12	0.08	0.11
10	0.10	0.07	0.08
11	0.10	0.08	0.08
12	0.10	0.08	0.08
P_{lt} =	0.11	0.08	0.10

TABLE 4.1.5.3	Rapid voltage change	P
Mains voltage: 230V		
Switching actions		Ki
Marking operation without default (to primary energy carrier)		0.5
Marking operation at reference conditions(of primary energy carrier)		1.0
Breaking operation at nominal power		1.0
Worst case value of all switching operations Ki max		1.0

Table 4.1.7	Commutation notches		P
Test condition	Commutation notches current [A]		
Between 25% P_{Emax} and 35% P_{Emax}	1.2	1.1	1.2
Between 65% P_{Emax} and 75% P_{Emax}	1.2	1.3	1.1
> 90 P_{Emax}	1.5	1.4	1.4

TABLE 4.1.8	DC injection			P
Rated output current [A]	Measured value [mA]			Limit [mA]
	Phase A	Phase B	Phase C	
100% output				
73.0	196	131	91	360
75% output				
54.7	105	67	42	360
50% output				
36.7	83	43	28	360
25% output				
18.2	119	58	23	360
10% output				
7.3	65	22	31	360
Injected DC current exceeded 1% rated current [A]	Turn off time measured [ms]			Limit [ms]
	Phase A	Phase B	Phase C	
0.73	180	184	180	500
Remark:				

4.1.10 Harmonics and waveform distortion(phase A)						P
Harmonics	100%Pn	Limits		Harmonics	100%Pn	Limits
Order	I[%]	I[%]		Frequency [Hz]	I[%]	I[%]
2	0.449	1		75	0.054	0.1
3	0.168	4		125	0.068	0.1
4	0.342	1		175	0.034	0.1
5	1.832	4		225	0.032	0.1
6	0.057	1		275	0.057	0.1
7	1.634	4		325	0.034	0.1
8	0.202	1		375	0.020	0.1
9	0.046	4		425	0.046	0.1
10	0.177	1		475	0.017	0.1
11	0.712	2		525	0.012	0.1
12	0.056	0.5		575	0.056	0.25
13	0.516	2		625	0.060	0.25
14	0.146	0.5		675	0.146	0.25
15	0.041	2		725	0.041	0.25
16	0.136	0.5		775	0.136	0.25
17	0.270	1.5		825	0.070	0.25
18	0.045	0.38		875	0.045	0.19
19	0.281	1.5		925	0.081	0.19

20	0.104	0.38		975	0.104	0.19
21	0.114	1.5		1025	0.114	0.19
22	0.105	0.38		1075	0.105	0.19
23	0.124	0.6		1125	0.124	0.19
24	0.040	0.38		1175	0.040	0.08
25	0.096	0.6		1225	0.031	0.08
26	0.060	0.15		1275	0.060	0.08
27	0.027	0.6		1325	0.027	0.08
28	0.058	0.15		1375	0.058	0.08
29	0.060	0.6		1425	0.060	0.08
30	0.021	0.15		1475	0.021	0.08
31	0.077	0.6		1525	0.017	0.08
32	0.055	0.15		1575	0.055	0.08
33	0.022	0.6		1625	0.022	0.08
34	0.045	0.15		1675	0.045	0.08
35	0.057	0.3		1725	0.057	0.08
36	0.020	0.08		1775	0.010	0.03
37	0.028	0.3		1825	0.018	0.03
38	0.027	0.08		1875	0.017	0.03
39	0.027	0.3		1925	0.007	0.03
40	0.024	0.08		1975	0.024	0.03
42	0.017	0.08		--		--
43	0.041	0.3		--		--
50	0.019	0.08		--		--
THD	2.749	5				
4.1.10 Harmonics and waveform distortion (**phase B**)						P
Harmonics	100%Pn	Limits		Harmonics	100%Pn	Limits
Order	I[%]	I[%]		Frequency [Hz]	I[%]	I[%]
2	0.683	1		75	0.078	0.1
3	0.303	4		125	0.033	0.1
4	0.419	1		175	0.041	0.1
5	1.742	4		225	0.042	0.1
6	0.107	1		275	0.071	0.1
7	1.719	4		325	0.019	0.1
8	0.239	1		375	0.039	0.1
9	0.045	4		425	0.045	0.1
10	0.196	1		475	0.016	0.1
11	0.679	2		525	0.039	0.1
12	0.088	0.5		575	0.088	0.25
13	0.551	2		625	0.051	0.25
14	0.126	0.5		675	0.126	0.25
15	0.046	2		725	0.046	0.25
16	0.158	0.5		775	0.158	0.25
17	0.262	1.5		825	0.062	0.25
18	0.036	0.38		875	0.036	0.19

19	0.258	1.5		925	0.058	0.19
20	0.083	0.38		975	0.083	0.19
21	0.098	1.5		1025	0.098	0.19
22	0.094	0.38		1075	0.094	0.19
23	0.129	0.6		1125	0.129	0.19
24	0.044	0.38		1175	0.044	0.08
25	0.107	0.6		1225	0.046	0.08
26	0.077	0.15		1275	0.037	0.08
27	0.027	0.6		1325	0.027	0.08
28	0.066	0.15		1375	0.035	0.08
29	0.069	0.6		1425	0.069	0.08
30	0.023	0.15		1475	0.023	0.08
31	0.083	0.6		1525	0.013	0.08
32	0.043	0.15		1575	0.043	0.08
33	0.020	0.6		1625	0.020	0.08
34	0.051	0.15		1675	0.051	0.08
35	0.056	0.3		1725	0.056	0.08
36	0.027	0.08		1775	0.017	0.03
37	0.042	0.3		1825	0.012	0.03
38	0.028	0.08		1875	0.018	0.03
39	0.042	0.3		1925	0.012	0.03
40	0.030	0.08		1975	0.020	0.03
42	0.018	0.08		--		--
43	0.049	0.3		--		--
50	0.014	0.08		--		--
THD	2.818	5				
4.1.10 Harmonics and waveform distortion (**phase C**)						P
Harmonics	100%Pn	Limits		Harmonics	100%Pn	Limits
Order	I[%]	I[%]		Frequency [Hz]	I[%]	I[%]
2	0.365	1		75	0.066	0.1
3	0.235	4		125	0.035	0.1
4	0.471	1		175	0.047	0.1
5	1.882	4		225	0.082	0.1
6	0.147	1		275	0.047	0.1
7	1.705	4		325	0.070	0.1
8	0.304	1		375	0.031	0.1
9	0.067	4		425	0.067	0.1
10	0.247	1		475	0.047	0.1
11	0.700	2		525	0.027	0.1
12	0.138	0.5		575	0.138	0.25
13	0.525	2		625	0.025	0.25
14	0.195	0.5		675	0.155	0.25
15	0.077	2		725	0.077	0.25
16	0.161	0.5		775	0.161	0.25
17	0.263	1.5		825	0.063	0.25

18	0.070	0.38		875	0.070	0.19
19	0.283	1.5		925	0.083	0.19
20	0.115	0.38		975	0.115	0.19
21	0.103	1.5		1025	0.103	0.19
22	0.080	0.38		1075	0.080	0.19
23	0.141	0.6		1125	0.101	0.19
24	0.076	0.38		1175	0.036	0.08
25	0.101	0.6		1225	0.027	0.08
26	0.053	0.15		1275	0.053	0.08
27	0.040	0.6		1325	0.040	0.08
28	0.065	0.15		1375	0.065	0.08
29	0.074	0.6		1425	0.057	0.08
30	0.032	0.15		1475	0.032	0.08
31	0.084	0.6		1525	0.014	0.08
32	0.046	0.15		1575	0.046	0.08
33	0.027	0.6		1625	0.027	0.08
34	0.055	0.15		1675	0.055	0.08
35	0.062	0.3		1725	0.062	0.08
36	0.033	0.08		1775	0.011	0.03
37	0.039	0.3		1825	0.019	0.03
38	0.026	0.08		1875	0.006	0.03
39	0.048	0.3		1925	0.008	0.03
40	0.026	0.08		1975	0.016	0.03
42	0.021	0.08		--	--	--
43	0.048	0.3		--	--	--
50	0.018	0.08		--	--	--
THD	2.867	5				

TABLE4.1.11.2	Power factor for generators of sub-categories A1 and A2					P
P/Pn (%)	DC input Voltage(V)	DC input current (A)	Output voltage (V)	Output current (A)	Power factor	Limit
10%	742.52	9.09	A:276.64	A:7.52	A: 0.999	--
			B:276.80	B:7.54	B: 0.999	
			C:276.58	C:7.48	C: 0.999	
25%	742.80	22.09	A:276.67	A:18.87	A: 0.999	0.98
			B:276.82	B:18.90	B: 0.999	
			C:276.60	C:18.86	C: 0.999	
50%	744.48	43.26	A:276.70	A:37.35	A: 0.999	0.98
			B:276.83	B:37.43	B: 0.999	
			C:276.66	C:37.37	C: 0.999	
75%	745.03	64.09	A:276.74	A:55.45	A: 0.999	0.98
			B:276.85	B:55.59	B: 0.999	
			C:276.71	C:55.50	C: 0.999	
100%	745.67	84.54	A:276.77	A:73.12	A: 0.999	0.98
			B:276.87	B:73.24	B: 0.999	
			C:276.75	C:73.20	C: 0.999	
Remark:						

4.1.11.4	TABLE: Power Factor for generators of sub-categories A3								P
No.	Test condition			Measurement					
	P/Pn	U/Un	cos ϕ	U_{L1} [V]	U_{L2} [V]	U_{L3} [V]	P [kW]	Q [kVar]	cos ϕ
1	50%	91%	0.95 under-excited	252.09	252.27	252.30	29.965	-10.329	0.945
2	50%	100%	0.95 under-excited	277.12	277.24	277.25	30.033	-10.307	0.946
3	50%	109%	0.95 under-excited	301.62	301.73	301.72	30.000	-10.346	0.945
4	$P_{Emax0.9)}$	91%	0.95 under-excited	252.32	252.50	252.54	59.879	-20.232	0.947
5	$P_{Emax0.9)}$	100%	0.95 under-excited	277.29	277.45	277.47	60.095	-20.242	0.948
6	$P_{Emax0.9)}$	109%	0.95 under-excited	301.78	301.98	302.00	60.100	-20.242	0.94
7	50%	100%	0.96 under-excited	277.03	277.26	277.28	30.035	-9.072	0.957
8	50%	100%	0.97 under-excited	277.00	277.30	277.29	30.045	-7.626	0.969
9	50%	100%	0.98 under-excited	277.04	277.29	277.29	30.059	-1.583	0.982
10	50%	100%	0.99 under-excited	277.05	277.29	277.26	30.100	-4.004	0.991
11	50%	100%	1.00	277.04	277.32	277.26	30.079	1.798	0.998
12	50%	100%	0.99 over-excited	277.08	277.32	277.24	30.079	4.986	0.987
13	50%	100%	0.98 over-excited	277.12	277.27	277.28	30.077	6.373	0.978
14	50%	100%	0.97 over-excited	277.15	277.23	277.29	30.072	7.549	0.970
15	50%	100%	0.96 over-excited	277.15	277.22	277.30	30.067	8.635	0.961

16	50%	91%	0.95 over-excited	252.18	252.26	252.32	29.990	9.575	0.953
17	50%	100%	0.95 over-excited	277.15	277.22	277.29	30.042	9.619	0.952
18	50%	109%	0.95 over-excited	301.66	301.74	301.80	30.024	9.624	0.952
19	$P_{Emax0.9)}$	91%	0.95 over-excited	252.47	252.53	252.57	60.016	19.595	0.951
20	$P_{Emax0.9)}$	100%	0.95 over-excited	277.41	277.48	277.53	60.187	19.693	0.950
21	$P_{Emax0.9)}$	109%	0.95 over-excited	301.92	301.98	302.02	60.200	19.724	0.950
Remark: Each point stay for 30s. $P_{Emax0.9)}$ means the possible maximum active power under 0.95 displacement factor condition.									

4.1.11.9	**TABLE: Power factor characteristics curve for sub-categories A3**					**P**
P/Pn [%]	P	Q	S	cos ϕ	Δ cos ϕ	Limitation
20	4029.0	379.1	4046.9	0.996	0.004	1
30	6010.6	452.0	6029.6	0.997	0.003	1
40	8022.6	544.8	8042.0	0.998	0.002	1
50	10010.0	608.5	10028.7	0.998	0.002	1
60	12002.8	1282.4	12071.5	0.994	0.004	0.99
70	14008.0	-2661.8	14258.9	0.982	0.002	0.98
80	15994.9	-3997.0	16487.3	0.970	0.000	0.97
90	18005.2	-5358.2	18786.0	0.958	0.002	0.96
100	20029.5	-6764.1	21141.1	0.947	0.003	0.95

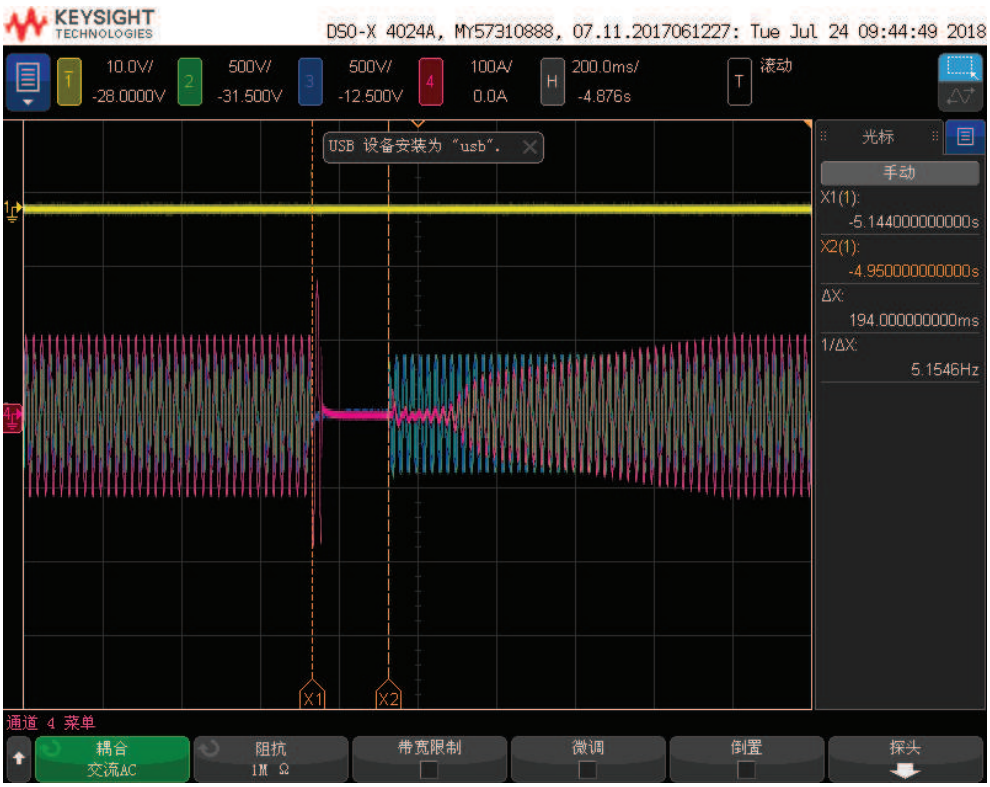
5.2.1 of RPP Grid Code	Tolerance to sudden voltage drops and peaks-CAT A3

Summary of tests

Test no.	Remaining voltage	Type	Output power level		K factor	Test number
			P requirement	Required duration [ms]		
1	2%	Three-phase short circuit	$P \geq 0,9P_n$	194	--	1.1.1
			$0,1P_n \leq P \leq 0,3P_n$		--	1.1.2
		Two-phase short circuit	$P \geq 0,9P_n$		--	1.2.1
			$0,1P_n \leq P \leq 0,3P_n$		--	1.2.2
		Single-phase short circuit	$P \geq 0,9P_n$		--	1.3.1
			$0,1P_n \leq P \leq 0,3P_n$		--	1.3.2
2	25%	Three-phase short circuit	$P \geq 0,9P_n$	694	--	2.1.1
			$0,1P_n \leq P \leq 0,3P_n$		--	2.1.2
		Two-phase short circuit	$P \geq 0,9P_n$		--	2.2.1
			$0,1P_n \leq P \leq 0,3P_n$		--	2.2.2
		Single-phase short circuit	$P \geq 0,9P_n$		--	2.3.1
			$0,1P_n \leq P \leq 0,3P_n$		--	2.3.2
3	55%	Three-phase short circuit	$P \geq 0,9P_n$	1347	--	3.1.1
			$0,1P_n \leq P \leq 0,3P_n$		--	3.1.2
		Two-phase short circuit	$P \geq 0,9P_n$		--	3.2.1
			$0,1P_n \leq P \leq 0,3P_n$		--	3.2.2
		Single-phase short circuit	$P \geq 0,9P_n$		--	3.3.1
			$0,1P_n \leq P \leq 0,3P_n$		--	3.3.2
4	86%	Three-phase short circuit	$P \geq 0,9P_n$	20000	--	3.1.1
			$0,1P_n \leq P \leq 0,3P_n$		--	4.1.2
		Two-phase short circuit	$P \geq 0,9P_n$		--	4.2.1
			$0,1P_n \leq P \leq 0,3P_n$		--	4.2.2
		Single-phase short circuit	$P \geq 0,9P_n$		--	4.3.1
			$0,1P_n \leq P \leq 0,3P_n$		--	4.3.2

Note: L1: channel 1; L2: channel 2; L3: channel 3; I1: channel 4.

Test 1.2.1/1.2.2:
phase L1: 0 degree, 2%; phase L2: 269.3degree, 87%;phase L3: 90.7degree, 87%
Test 2.2.1/2.2.2:
phase L1: 0 degree, 25%; phase L2: 261.8degree, 88%;phase L3: 98.2degree, 88%
Test 3.2.1/3.2.2:
phase L1: 0 degree, 55%; phase L2: 252.4degree, 91%;phase L3: 107.6degree, 91%
Test 4.2.1/4.2.2:
phase L1: 0 degree, 86%; phase L2: 243.6degree, 97%;phase L3: 116.4degree, 97%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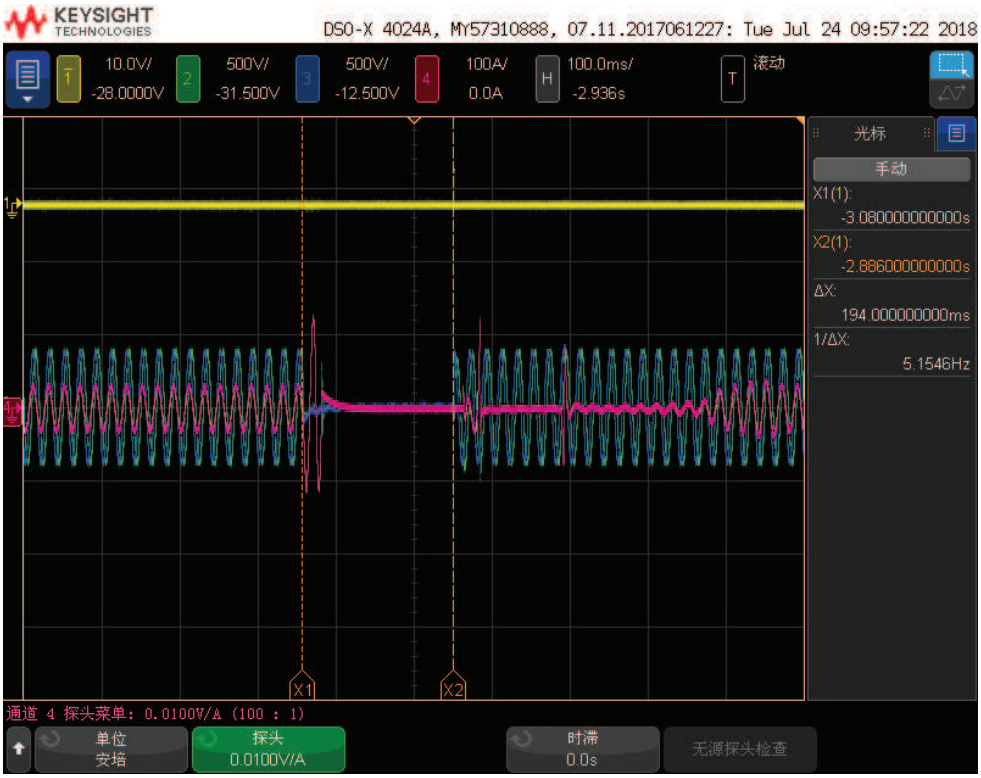
10.0V/ -28.0000V
500V/ -31.500V
500V/ -12.500V
100A/ 0.0A
200.0ms/ -4.876s
滚动
USB 设备安装为 "usb".
光标
手动
X1(1):
-5.144000000000s
X2(1):
-4.950000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
通道 4 菜单
耦合 交流AC
阻抗 1M Ω
带宽限制
微调
倒置
探头

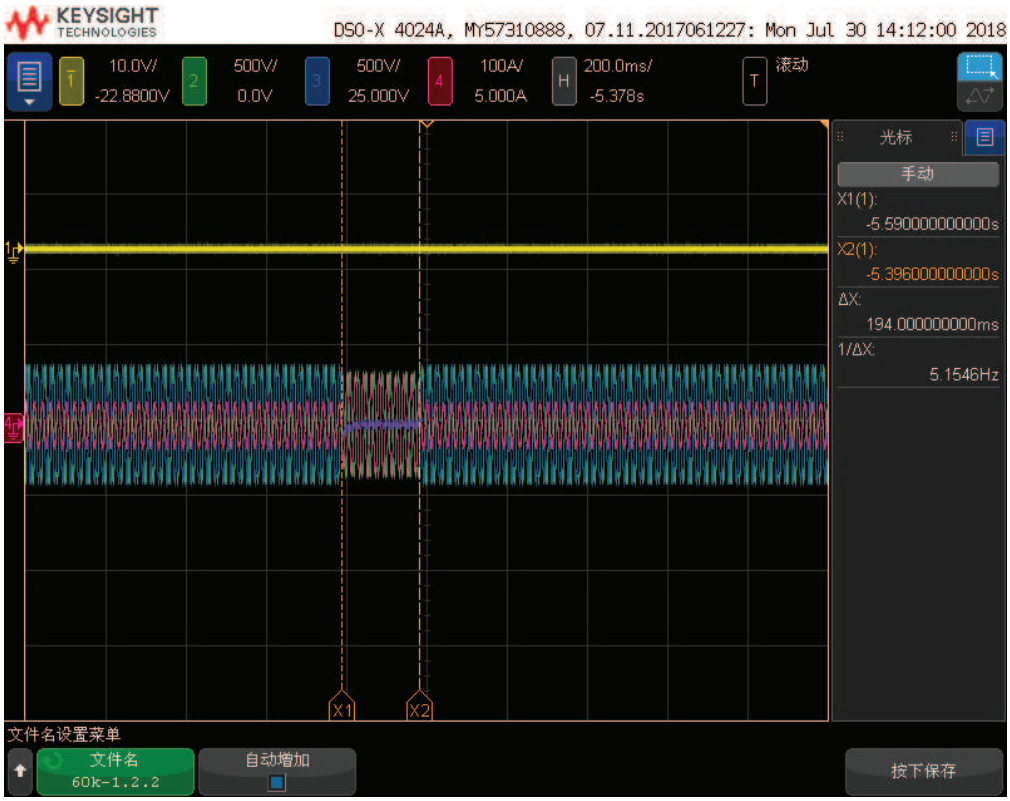
1.1.1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 09:57:22 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -12.500V
100A/ 0.0A
100.0ms/ -2.936s
滚动
光标
手动
X1(1):
-3.080000000000s
X2(1):
-2.886000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
通道 4 探头菜单: 0.0100V/A (100 : 1)
单位 安培
探头 0.0100V/A
时滞 0.0s
无源探头检查

1.1.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:00:14 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -12.500V
100A/ 0.0A
800.0ms/ -5.780s
滚动
光标
手动
X1(1):
-9.160000000000s
X2(1):
-8.966000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
通道 4 探头菜单: 0.00660V/A (152 : 1)
单位
安培
探头
0.00660V/A
时滞
0.0s
无源探头检查

1.2.1


KEYSIGHT TECHNOLOGIES
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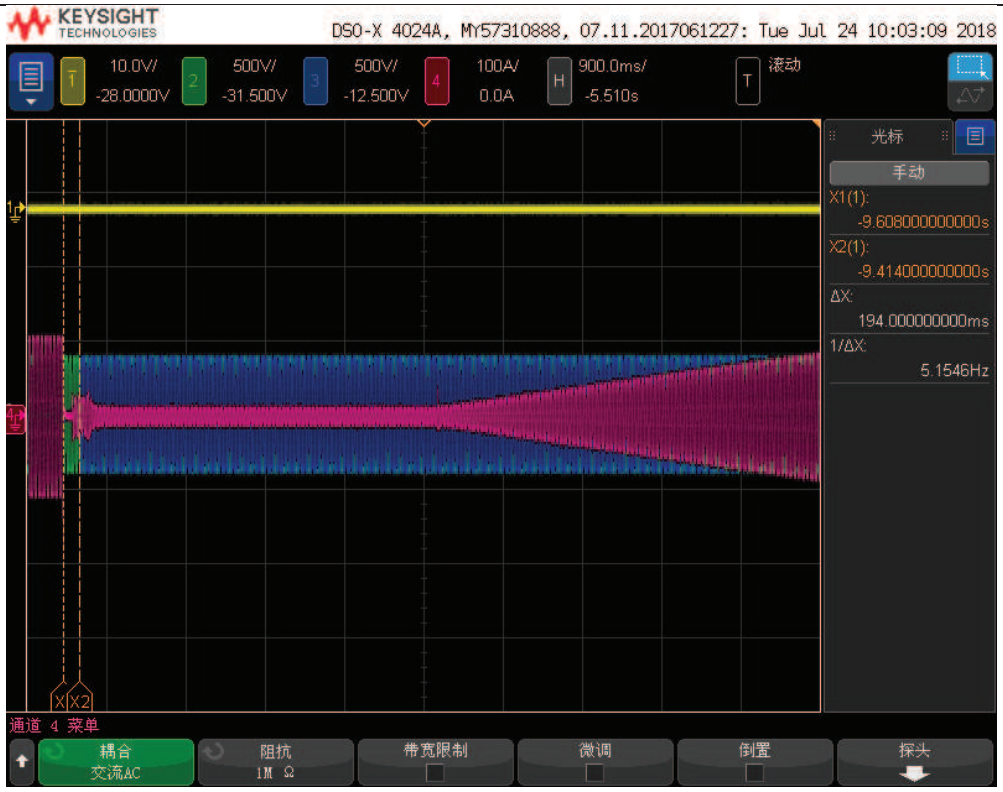
500V/ 0.0V
500V/ 25.000V
100A/ 5.000A
200.0ms/ -5.378s
滚动
光标
手动
X1(1):
-5.590000000000s
X2(1):
-5.396000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
文件名设置菜单
文件名
60k-1.2.2
自动增加
按下保存

1.2.2


KEYSIGHT TECHNOLOGIES
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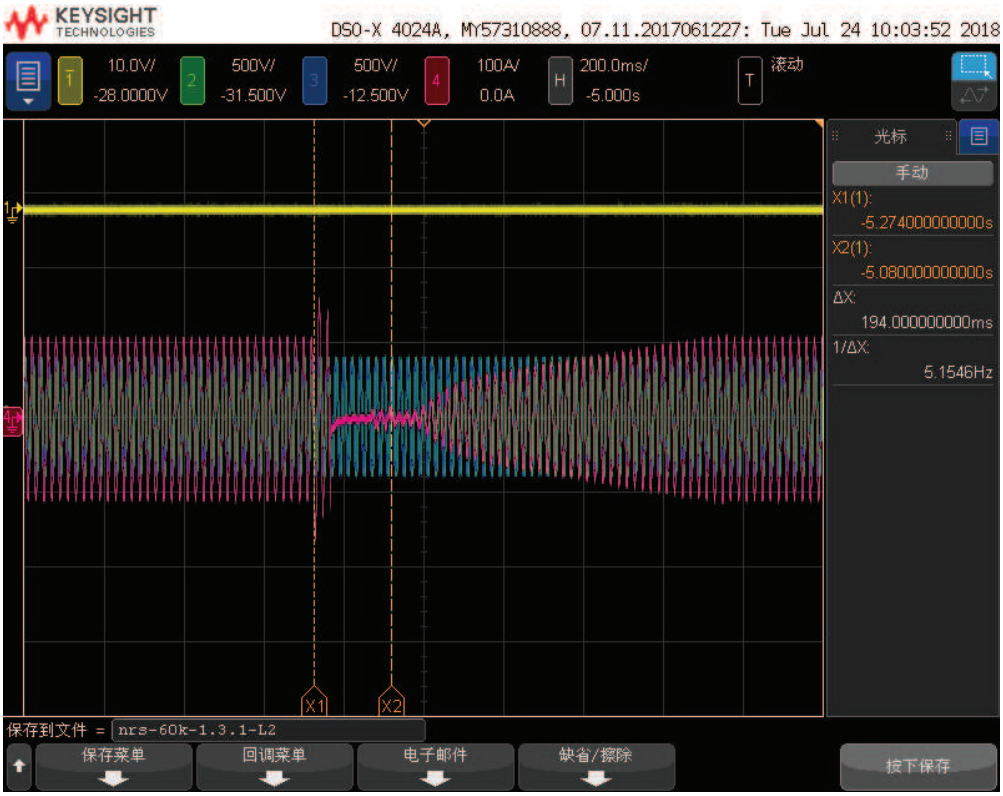
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
900.0ms/
-5.510s
滚动
光标
手动
X1(1):
-9.608000000000s
X2(1):
-9.414000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

1.3.1-L1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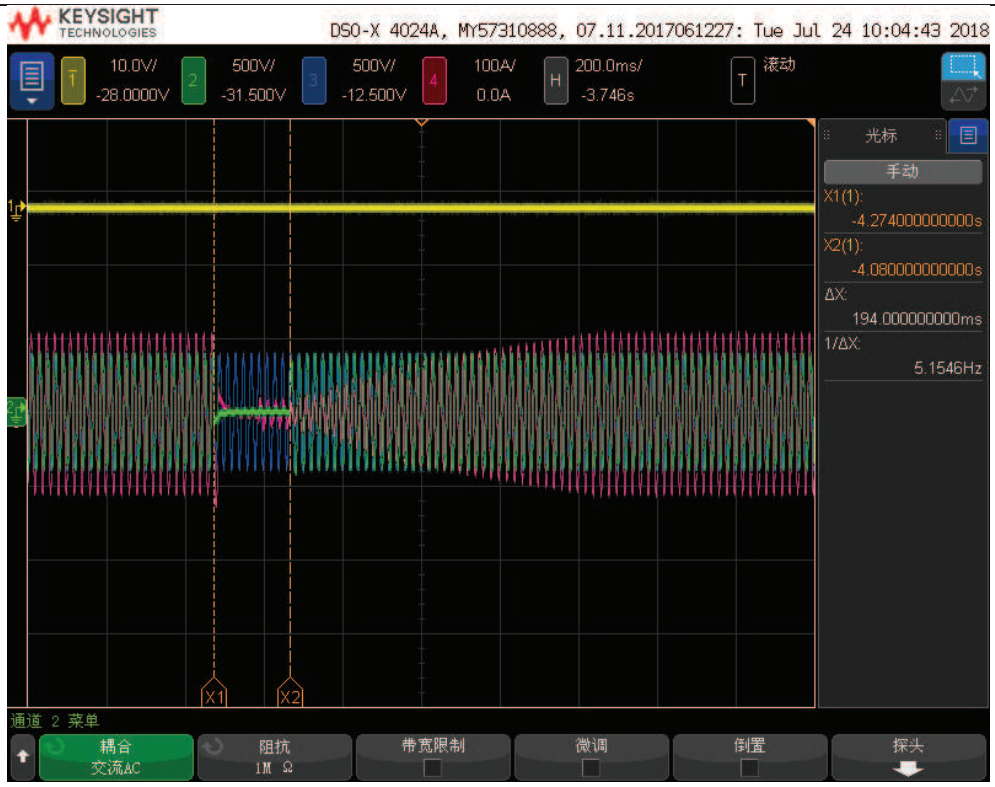
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-5.000s
滚动
光标
手动
X1(1):
-5.274000000000s
X2(1):
-5.080000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
保存到文件 = nrs-60k-1.3.1-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

1.3.1-L2


KEYSIGHT TECHNOLOGIES
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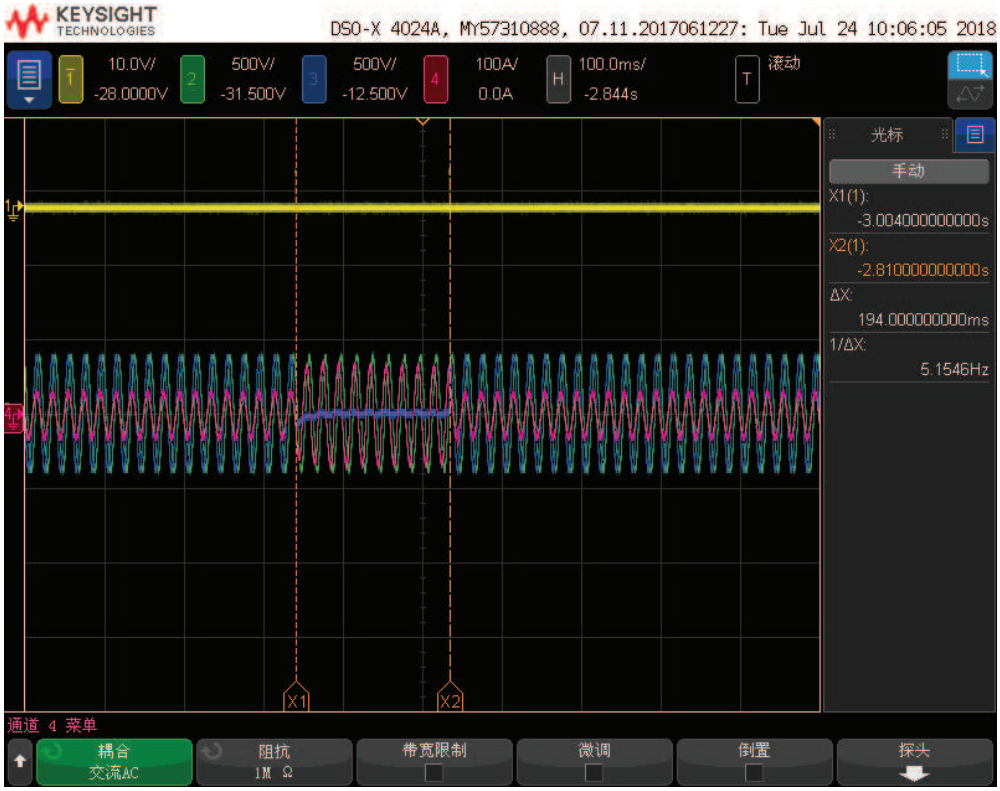
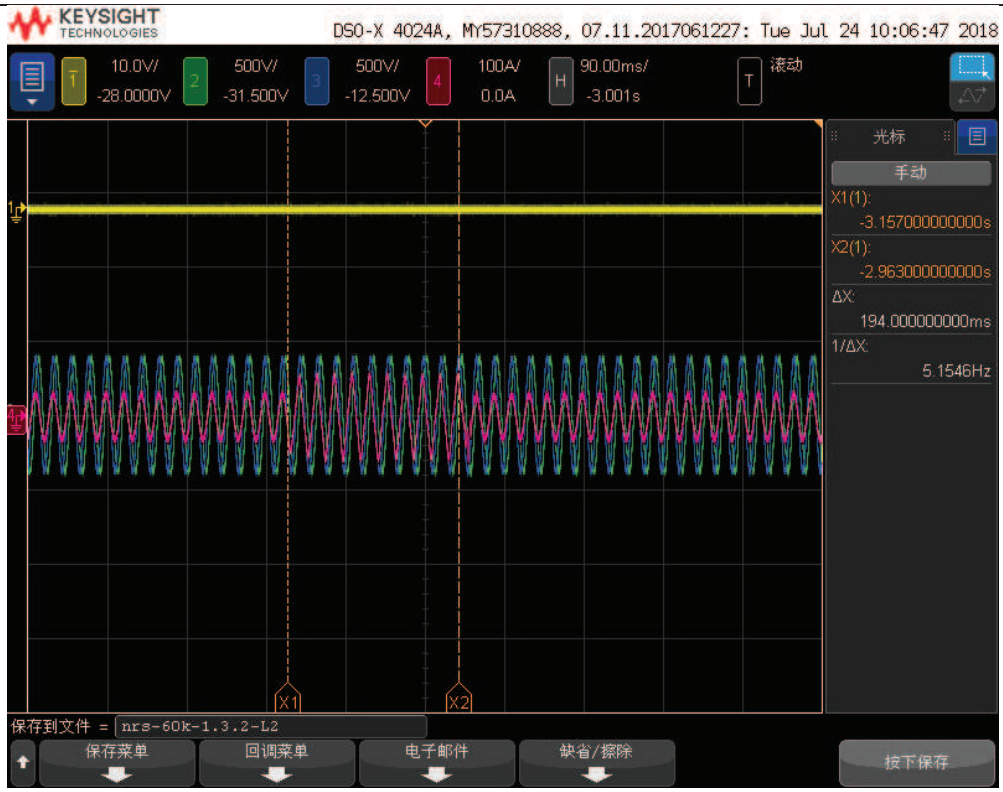
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-3.746s
滚动
光标
手动
X1(1):
-4.274000000000s
X2(1):
-4.080000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
X1
X2
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

1.3.1-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:06:05 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
100.0ms/
-2.844s
滚动
光标
手动
X1(1):
-3.004000000000s
X2(1):
-2.810000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
X1
X2
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

1.3.2-L1


KEYSIGHT TECHNOLOGIES
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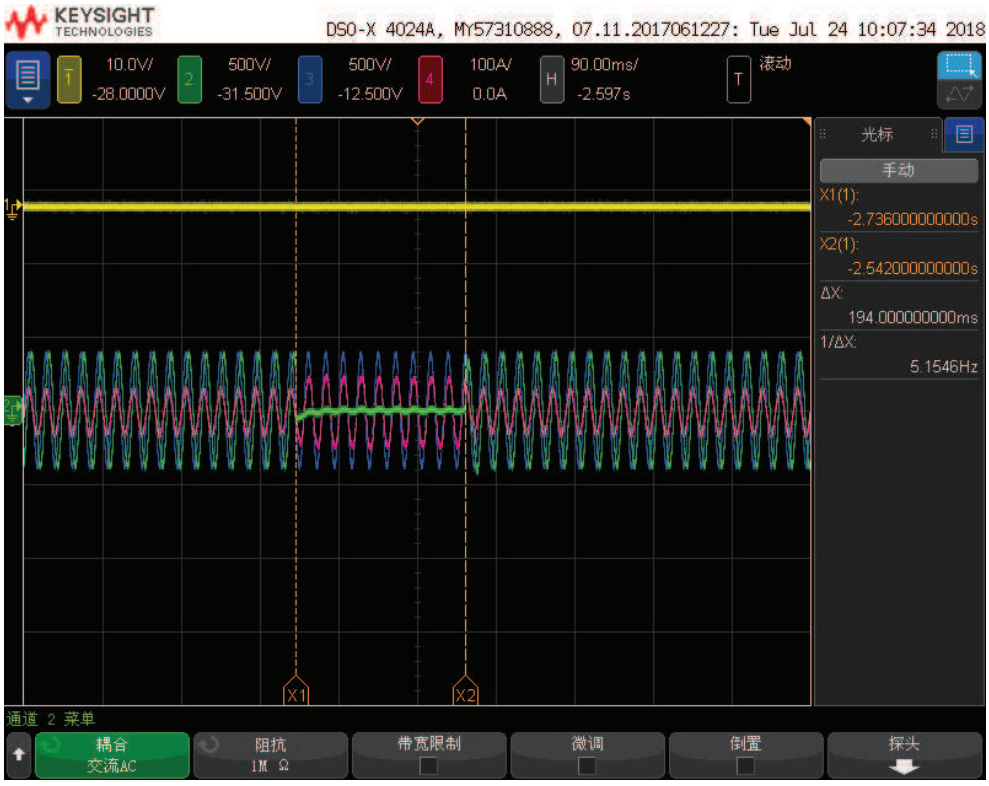
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
90.00ms/
-3.001s
滚动
光标
手动
X1(1):
-3.157000000000s
X2(1):
-2.963000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
保存到文件 = nrs-60k-1.3.2-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

1.3.2-L2


KEYSIGHT TECHNOLOGIES
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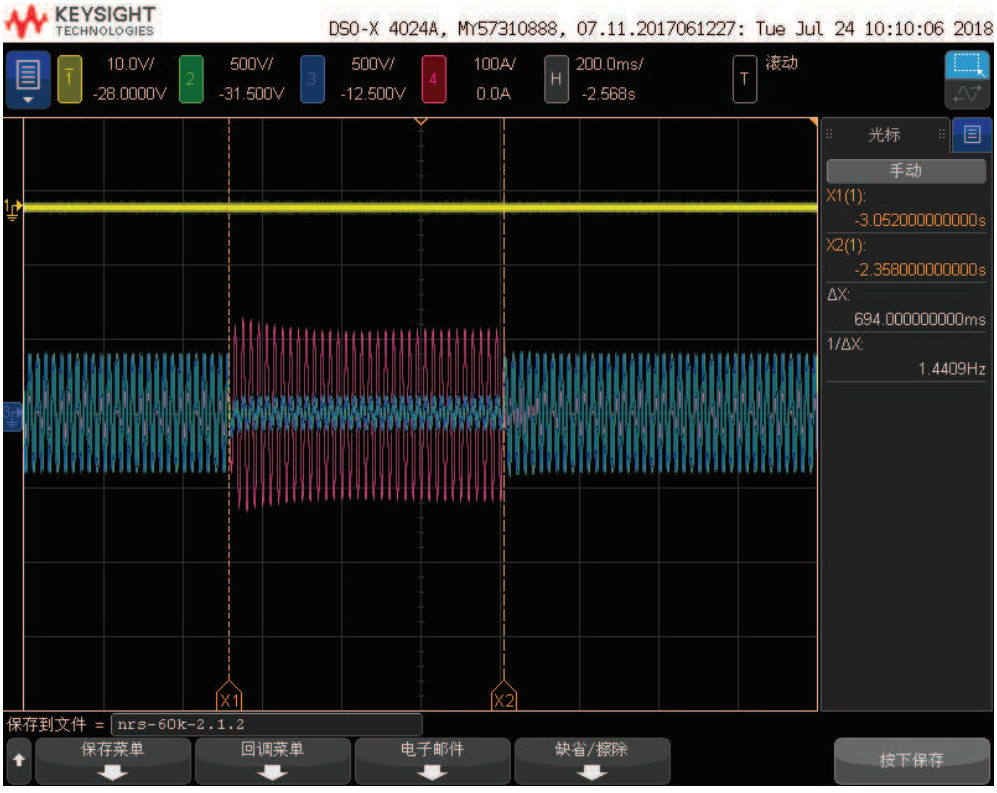
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
90.00ms/
-2.597s
滚动
光标
手动
X1(1):
-2.736000000000s
X2(1):
-2.542000000000s
ΔX:
194.000000000ms
1/ΔX:
5.1546Hz
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

1.3.2-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:09:29 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-2.500s
滚动
光标
手动
X1(1):
-2.936000000000s
X2(1):
-2.242000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
X1
X2
保存到文件 = nrs-60k-2.1.1
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

2.1.1


KEYSIGHT TECHNOLOGIES
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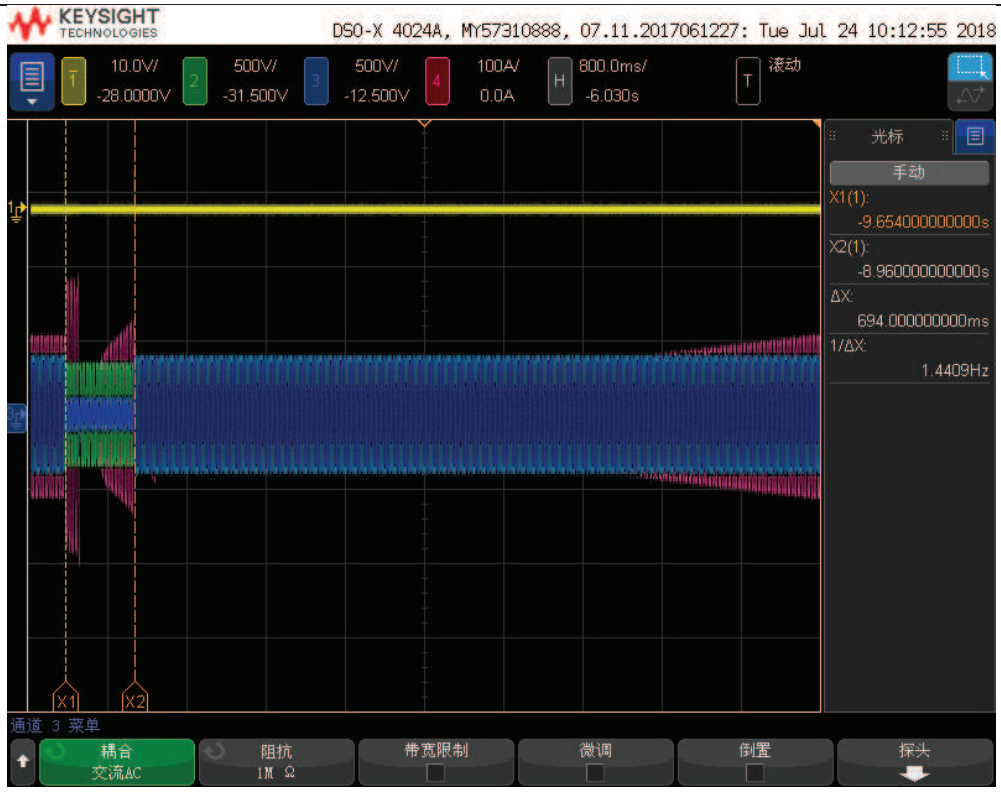
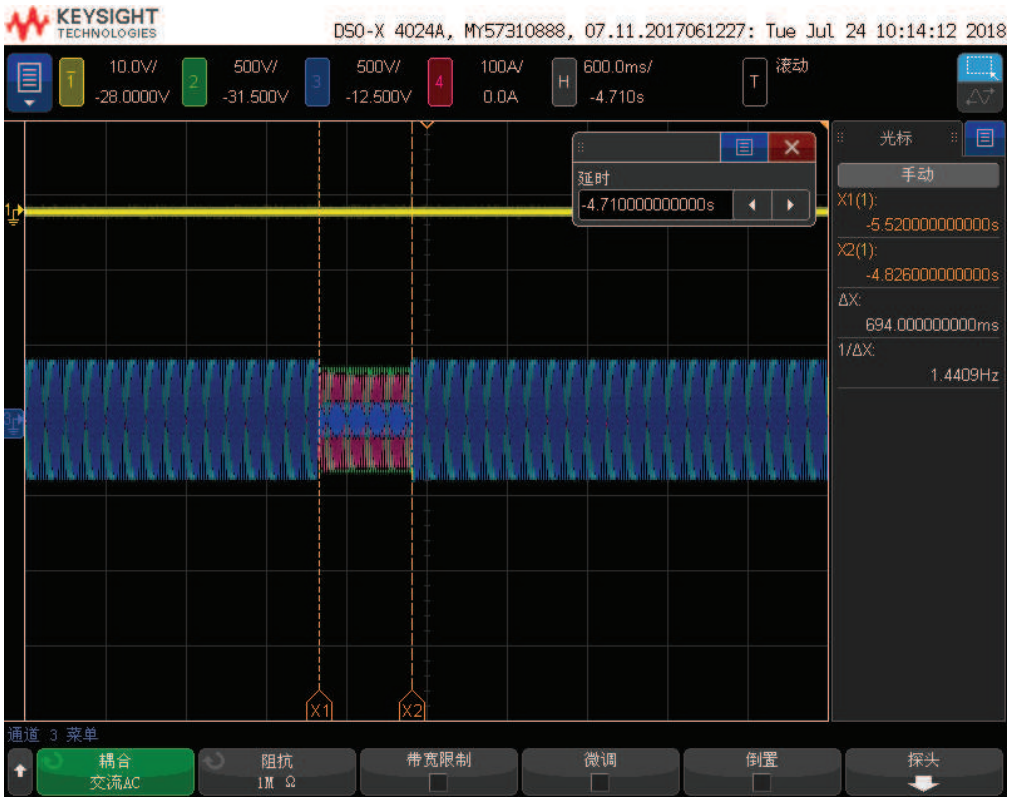
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-2.568s
滚动
光标
手动
X1(1):
-3.052000000000s
X2(1):
-2.358000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
X1
X2
保存到文件 = nrs-60k-2.1.2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

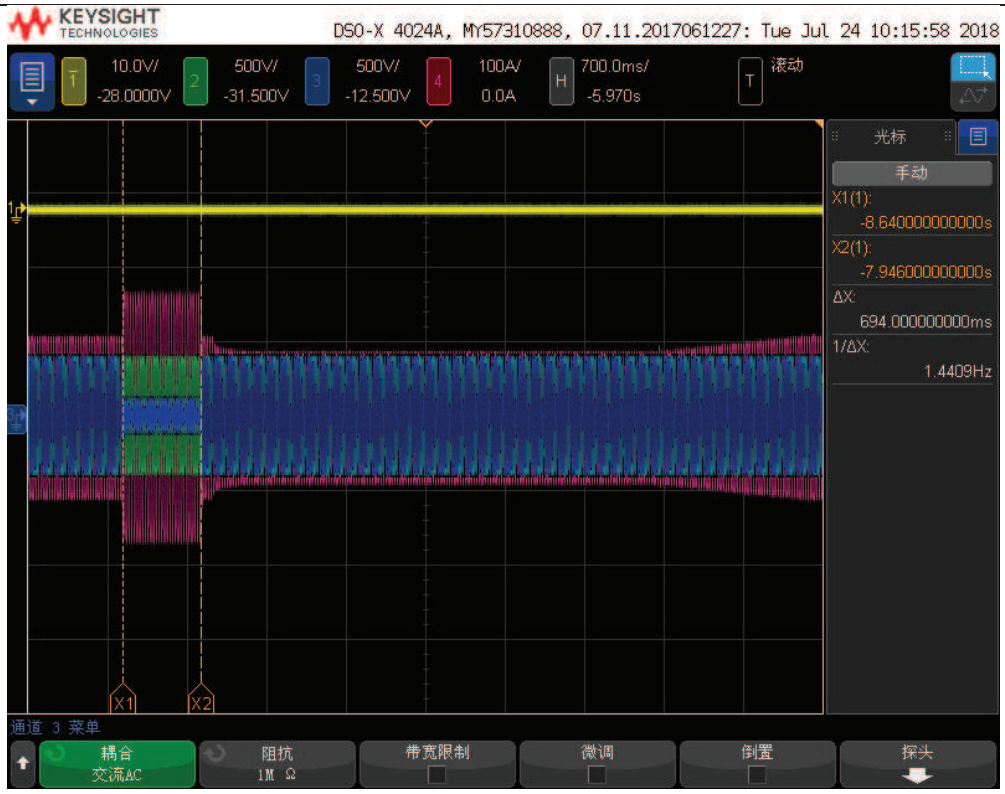
2.1.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:12:55 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
800.0ms/
-6.030s
滚动
光标
手动
X1(1):
-9.654000000000s
X2(1):
-8.960000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
X1
X2
通道 3 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

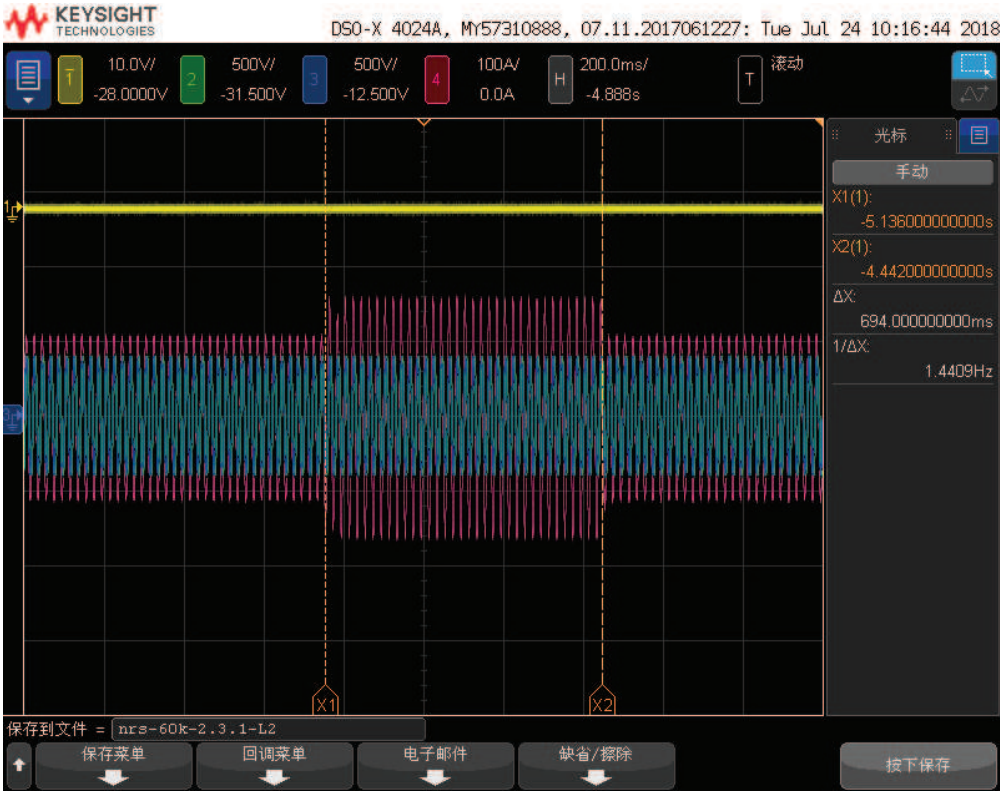
2.2.1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:14:12 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
600.0ms/
-4.710s
滚动
延时
-4.710000000000s
光标
手动
X1(1):
-5.520000000000s
X2(1):
-4.826000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
X1
X2
通道 3 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

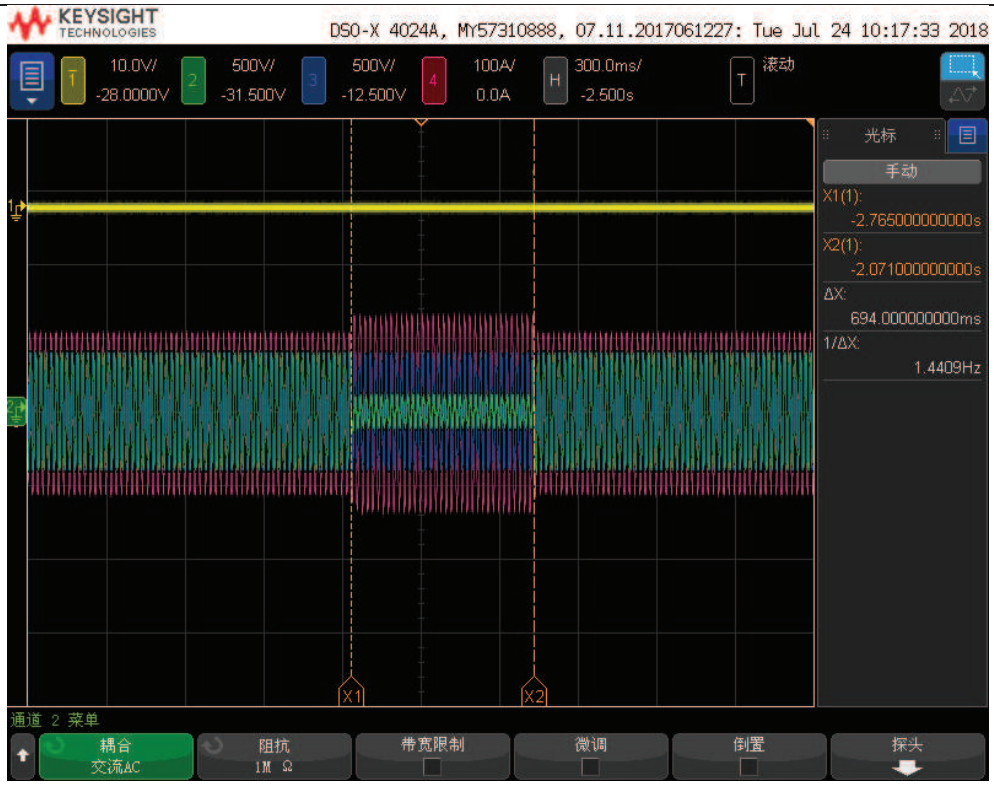
2.2.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:15:58 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -12.500V
100A/ 0.0A
700.0ms/ -5.970s
滚动
光标
手动
X1(1): -8.640000000000s
X2(1): -7.946000000000s
ΔX: 694.000000000ms
1/ΔX: 1.4409Hz
通道 3 菜单
耦合 交流AC
阻抗 1M Ω
带宽限制
微调
倒置
探头

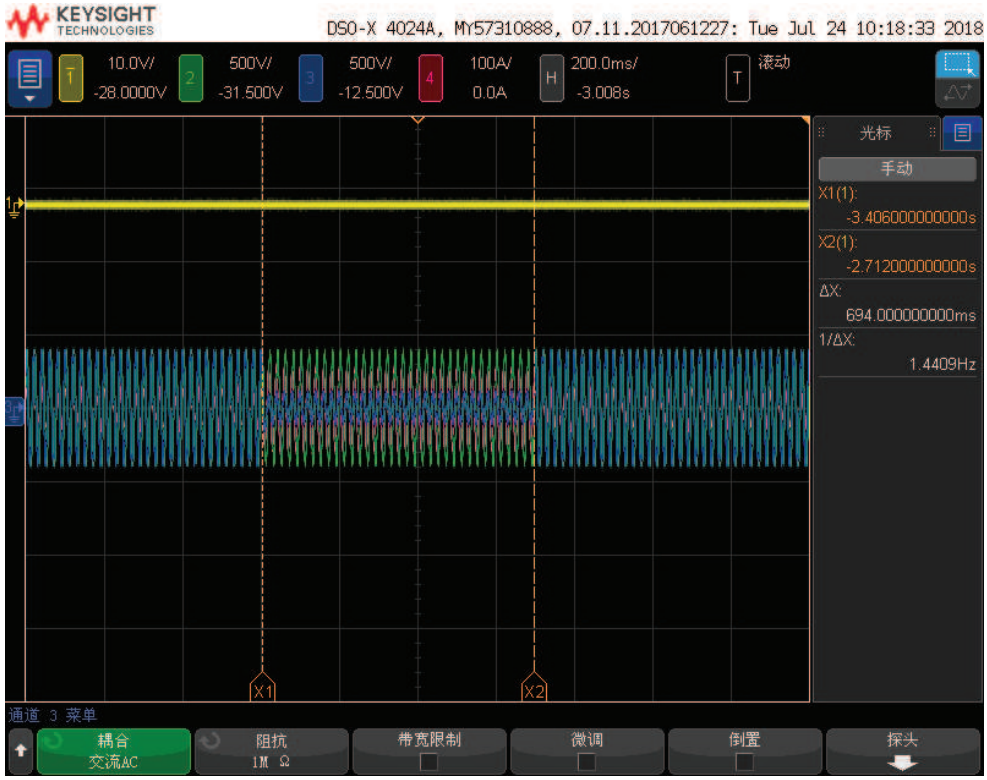
2.3.1-L1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:16:44 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -12.500V
100A/ 0.0A
200.0ms/ -4.888s
滚动
光标
手动
X1(1): -5.136000000000s
X2(1): -4.442000000000s
ΔX: 694.000000000ms
1/ΔX: 1.4409Hz
保存到文件 = nrs-60k-2.3.1-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

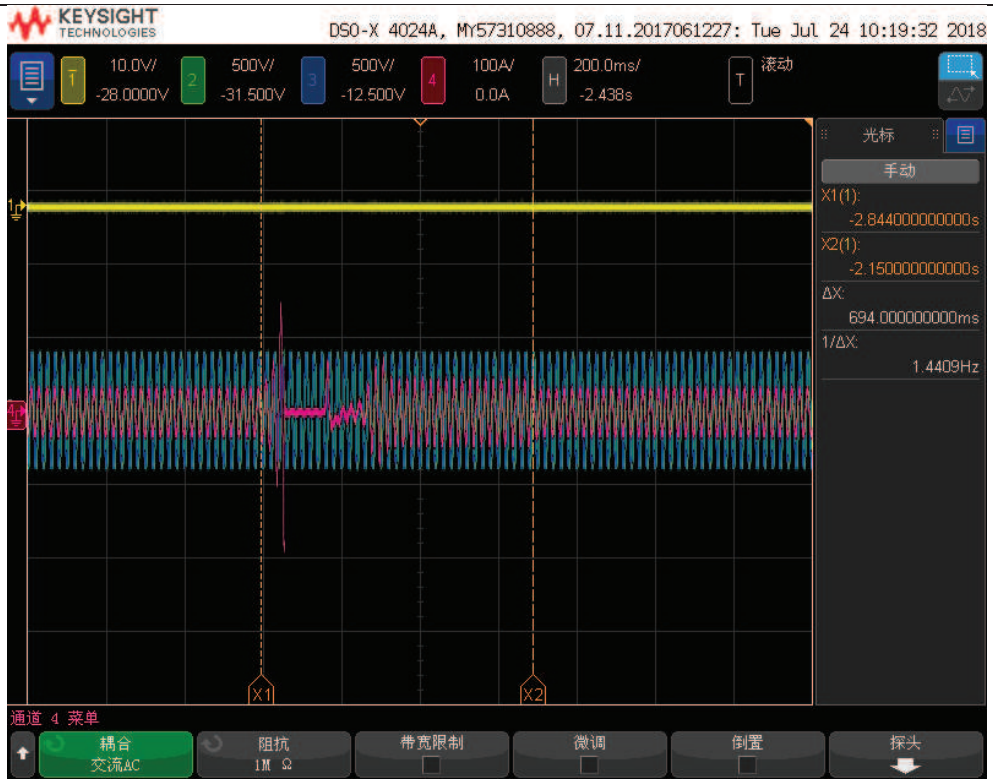
2.3.1-L2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:17:33 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
300.0ms/
-2.500s
滚动
光标
手动
X1(1):
-2.765000000000s
X2(1):
-2.071000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

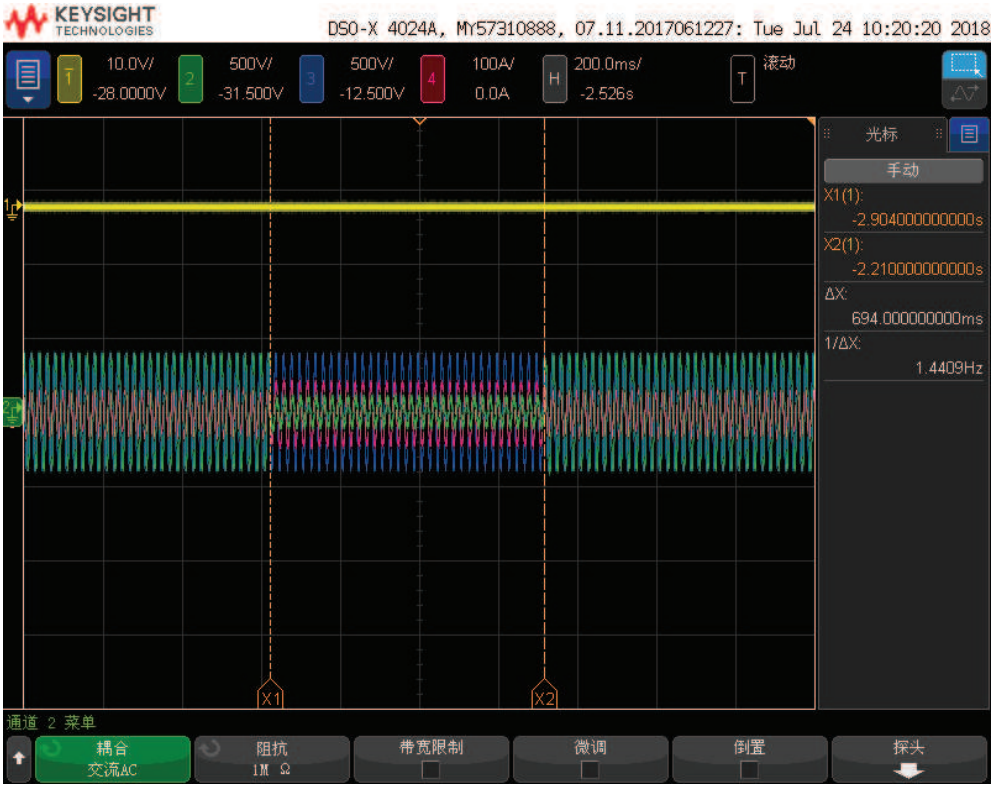
2.3.1-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:18:33 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-3.008s
滚动
光标
手动
X1(1):
-3.406000000000s
X2(1):
-2.712000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
通道 3 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

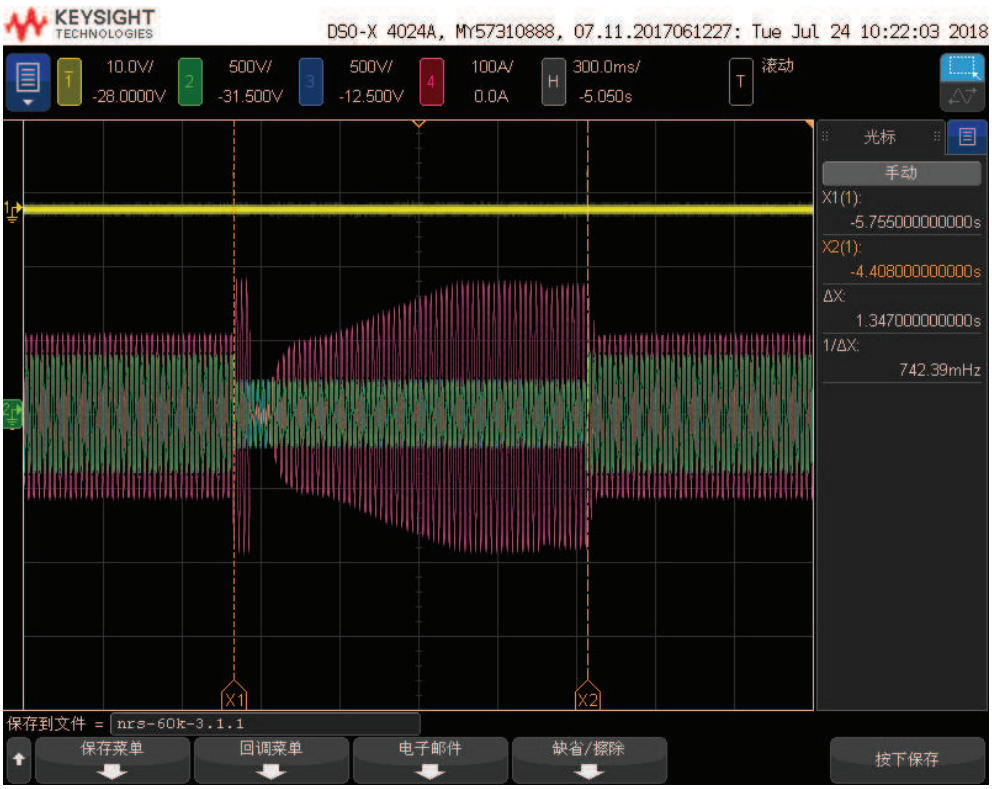
2.3.2-L1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:19:32 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-2.438s
滚动
光标
手动
X1(1):
-2.8440000000000s
X2(1):
-2.1500000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
X1
X2
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

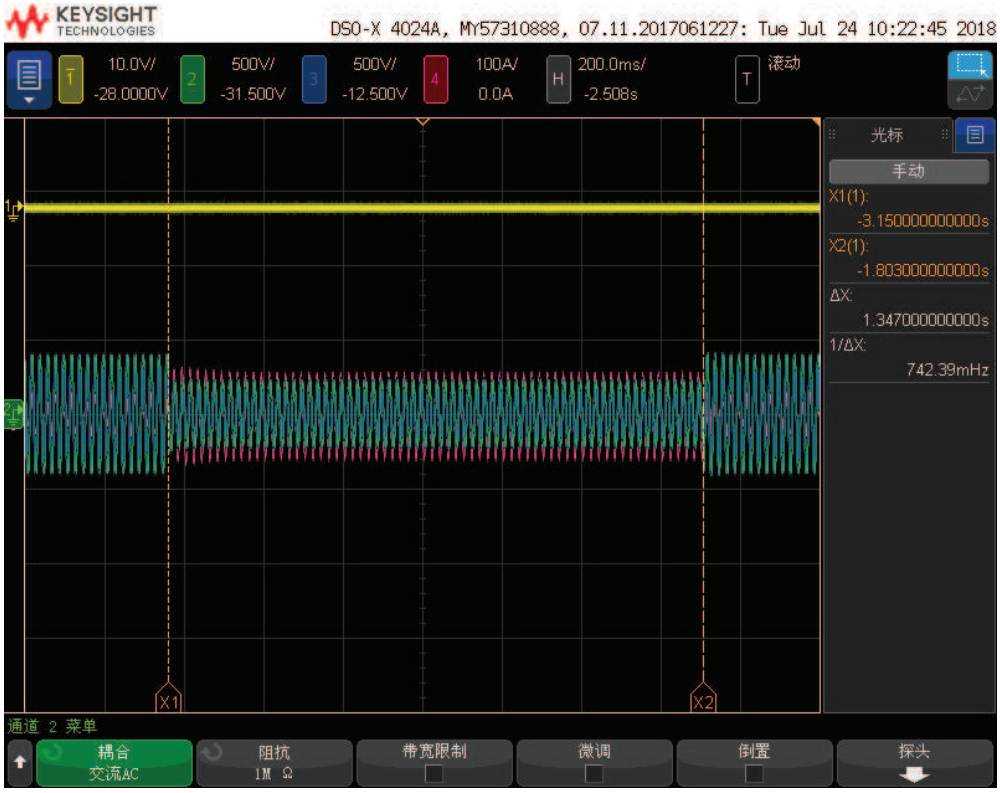
2.3.2-L2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:20:20 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-2.526s
滚动
光标
手动
X1(1):
-2.9040000000000s
X2(1):
-2.2100000000000s
ΔX:
694.000000000ms
1/ΔX:
1.4409Hz
X1
X2
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

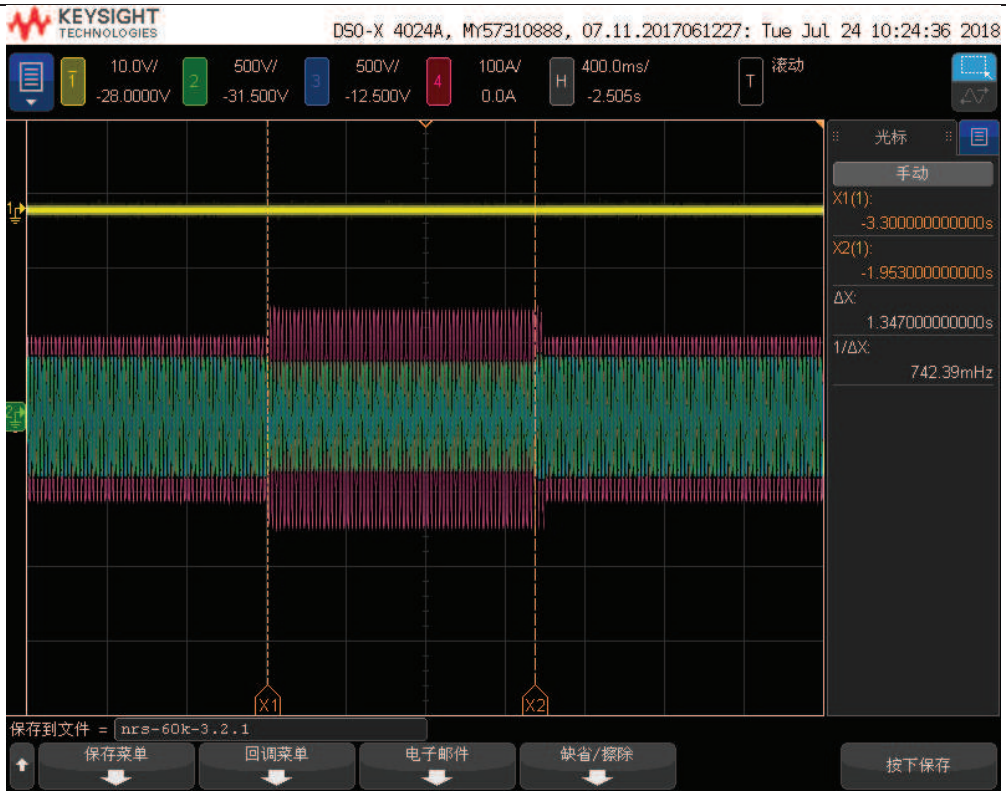
2.3.2-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:22:03 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
300.0ms/
-5.050s
滚动
光标
手动
X1(1):
-5.755000000000s
X2(1):
-4.408000000000s
ΔX:
1.347000000000s
1/ΔX:
742.39mHz
X1
X2
保存到文件 = nrs-60k-3.1.1
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

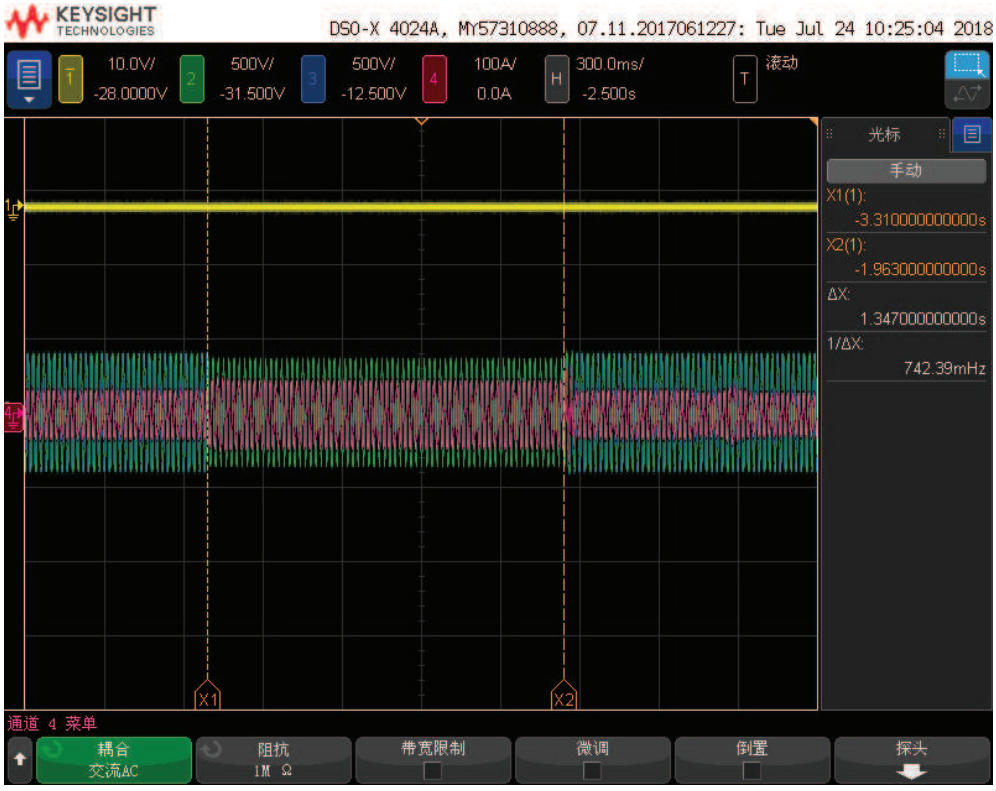
3.1.1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:22:45 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
200.0ms/
-2.508s
滚动
光标
手动
X1(1):
-3.150000000000s
X2(1):
-1.803000000000s
ΔX:
1.347000000000s
1/ΔX:
742.39mHz
X1
X2
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

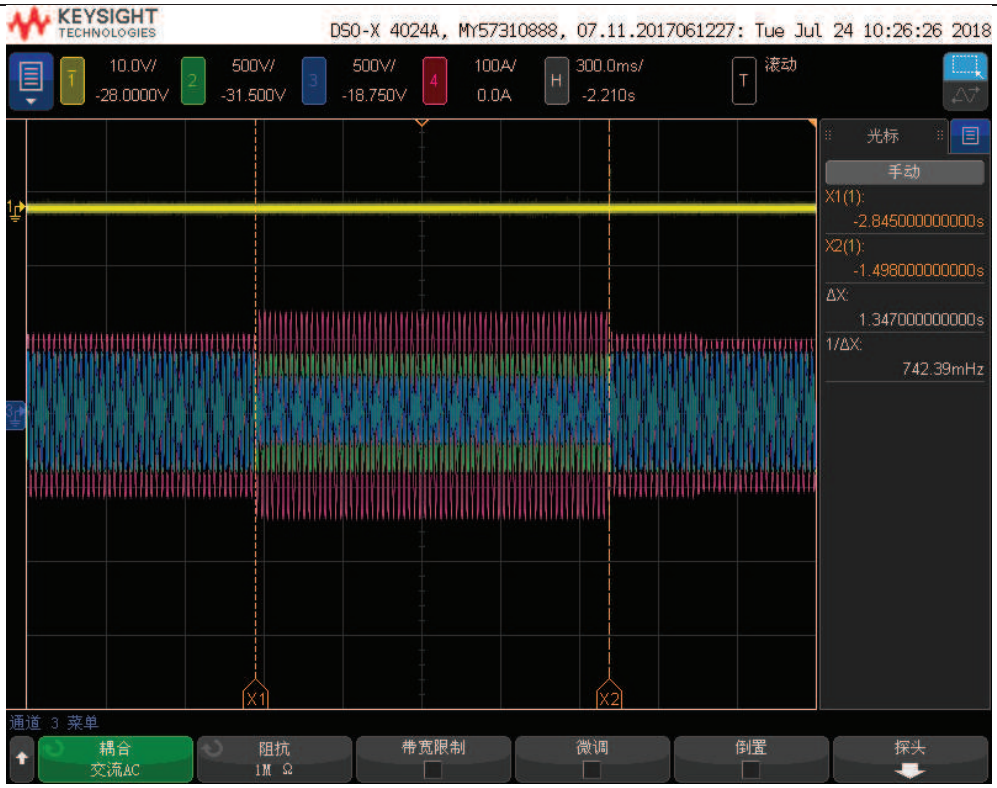
3.1.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:24:36 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
400.0ms/
-2.505s
滚动
光标
手动
X1(1):
-3.300000000000s
X2(1):
-1.953000000000s
ΔX:
1.347000000000s
1/ΔX:
742.39mHz
X1
X2
保存到文件 = nrs-60k-3.2.1
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

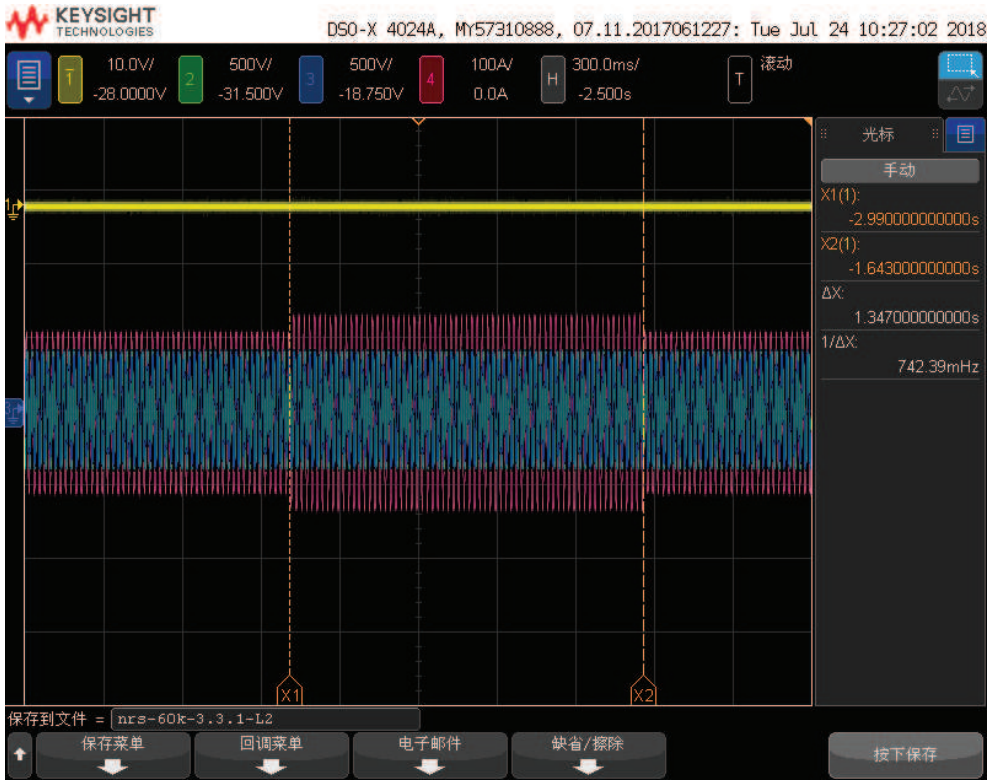
3.2.1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:25:04 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-12.500V
100A/
0.0A
300.0ms/
-2.500s
滚动
光标
手动
X1(1):
-3.310000000000s
X2(1):
-1.963000000000s
ΔX:
1.347000000000s
1/ΔX:
742.39mHz
X1
X2
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

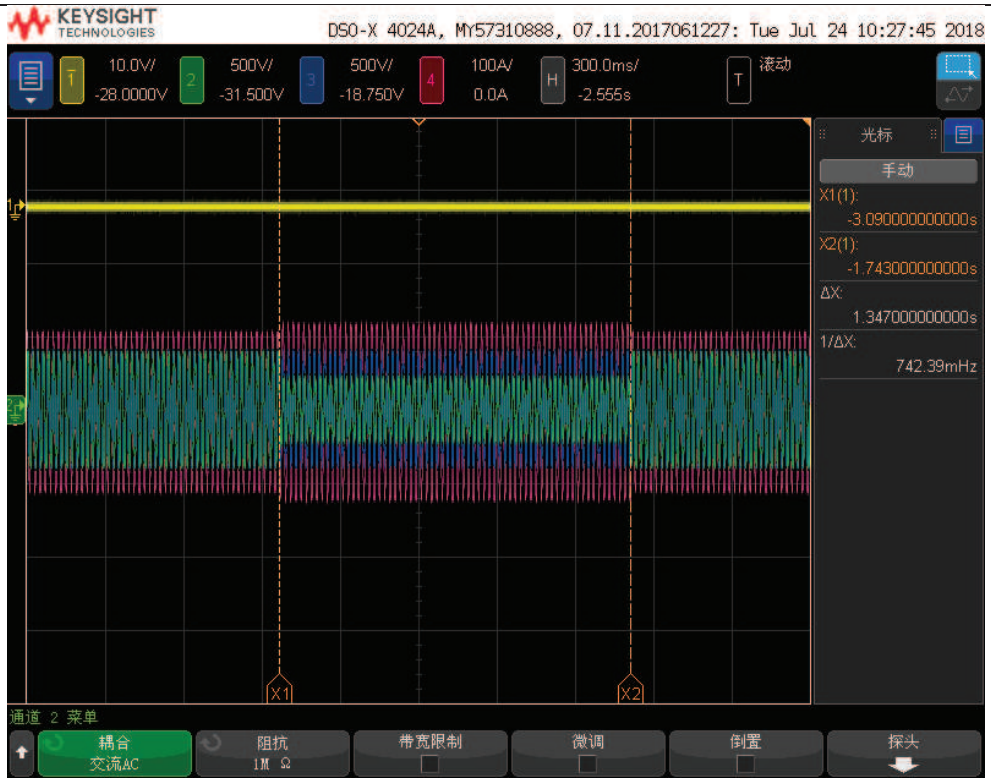
3.2.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:26:26 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -18.750V
100A/ 0.0A
300.0ms/ -2.210s
滚动
光标
手动
X1(1): -2.8450000000000s
X2(1): -1.4980000000000s
ΔX: 1.3470000000000s
1/ΔX: 742.39mHz
通道 3 菜单
耦合 交流AC
阻抗 1M Ω
带宽限制
微调
倒置
探头

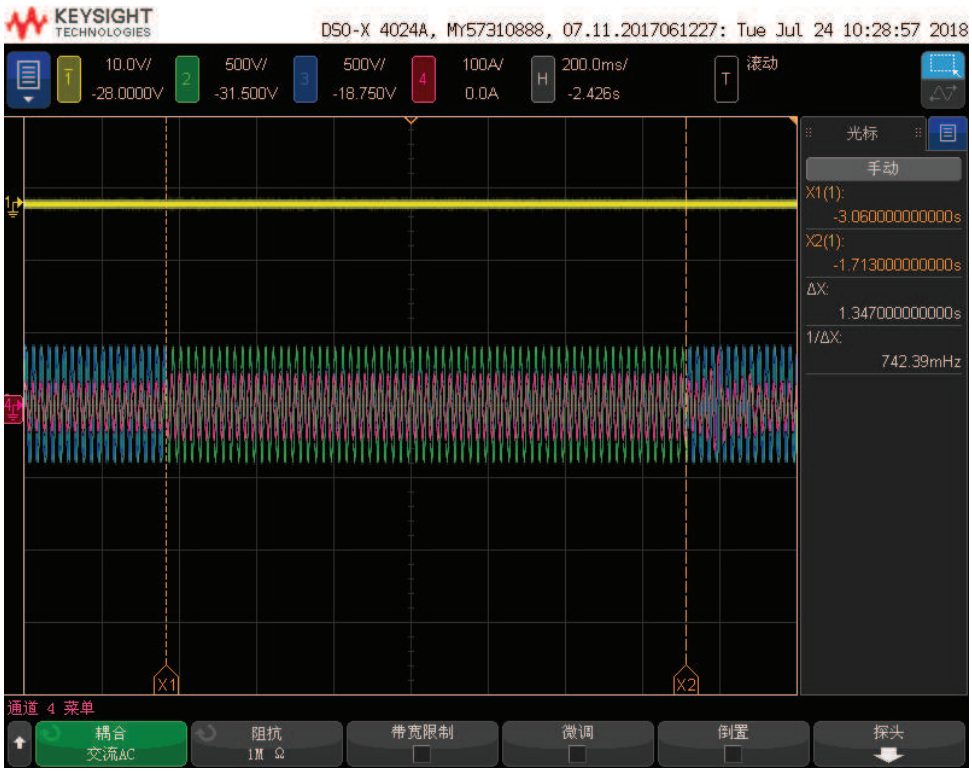
3.3.1-L1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:27:02 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -18.750V
100A/ 0.0A
300.0ms/ -2.500s
滚动
光标
手动
X1(1): -2.9900000000000s
X2(1): -1.6430000000000s
ΔX: 1.3470000000000s
1/ΔX: 742.39mHz
保存到文件 = nrs-60k-3.3.1-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

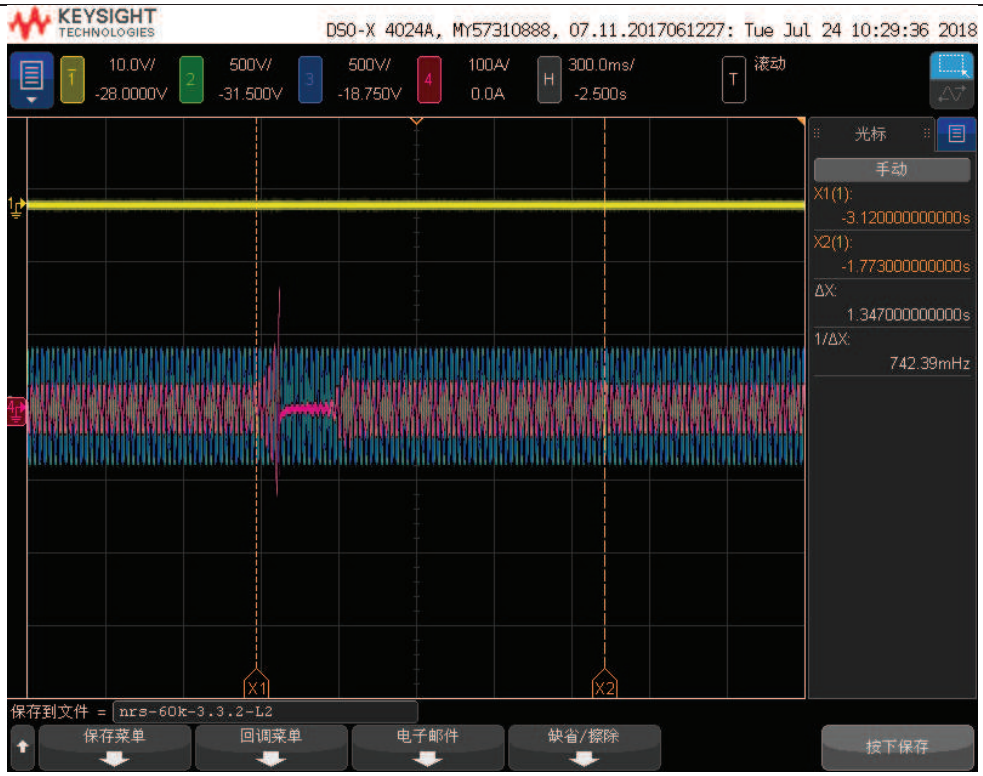
3.3.1-L2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:27:45 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
300.0ms/
-2.555s
滚动
光标
手动
X1(1):
-3.090000000000s
X2(1):
-1.743000000000s
ΔX:
1.347000000000s
1/ΔX:
742.39mHz
X1
X2
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

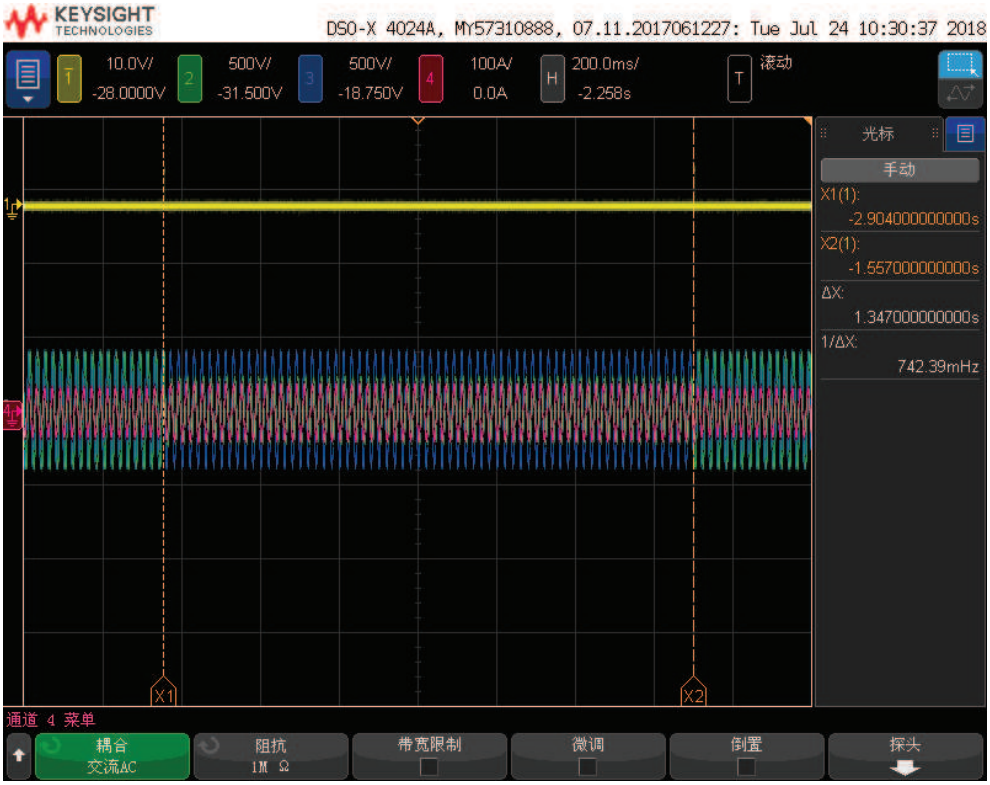
3.3.1-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:28:57 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
200.0ms/
-2.426s
滚动
光标
手动
X1(1):
-3.060000000000s
X2(1):
-1.713000000000s
ΔX:
1.347000000000s
1/ΔX:
742.39mHz
X1
X2
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

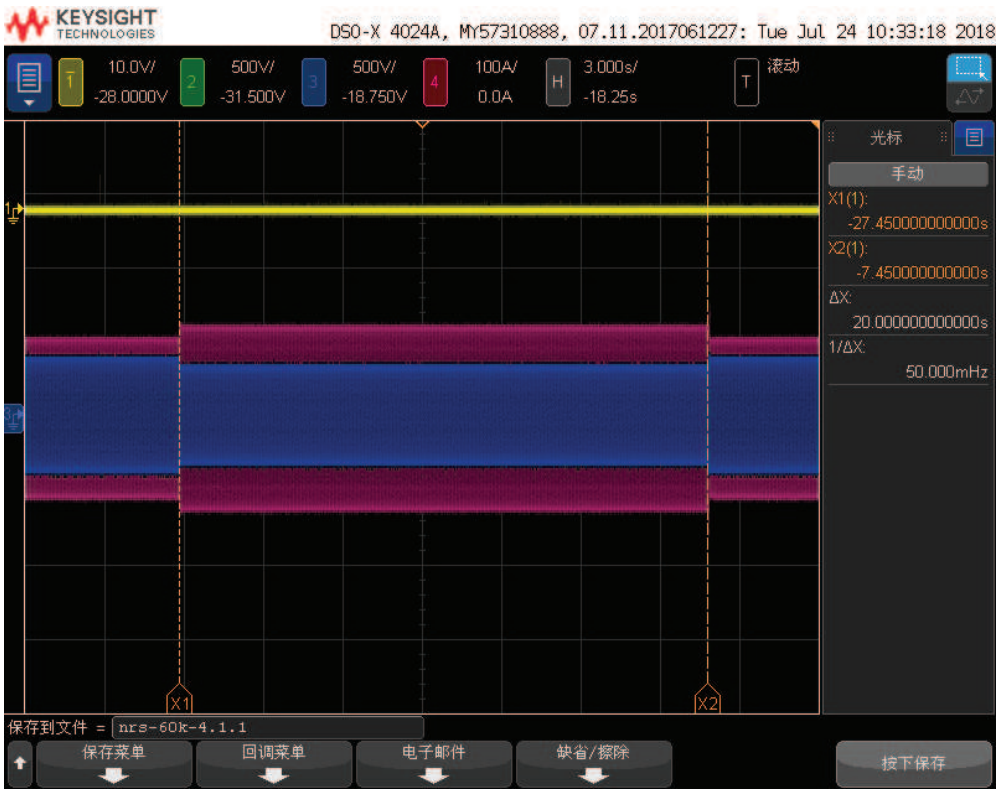
3.3.2-L1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:29:36 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -18.750V
100A/ 0.0A
300.0ms/ -2.500s
滚动
光标
手动
X1(1): -3.120000000000s
X2(1): -1.773000000000s
ΔX: 1.347000000000s
1/ΔX: 742.39mHz
保存到文件 = nrs-60k-3.3.2-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

3.3.2-L2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:30:37 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -18.750V
100A/ 0.0A
200.0ms/ -2.258s
滚动
光标
手动
X1(1): -2.904000000000s
X2(1): -1.557000000000s
ΔX: 1.347000000000s
1/ΔX: 742.39mHz
通道 4 菜单
耦合 交流AC
阻抗 1M Ω
带宽限制
微调
倒置
探头

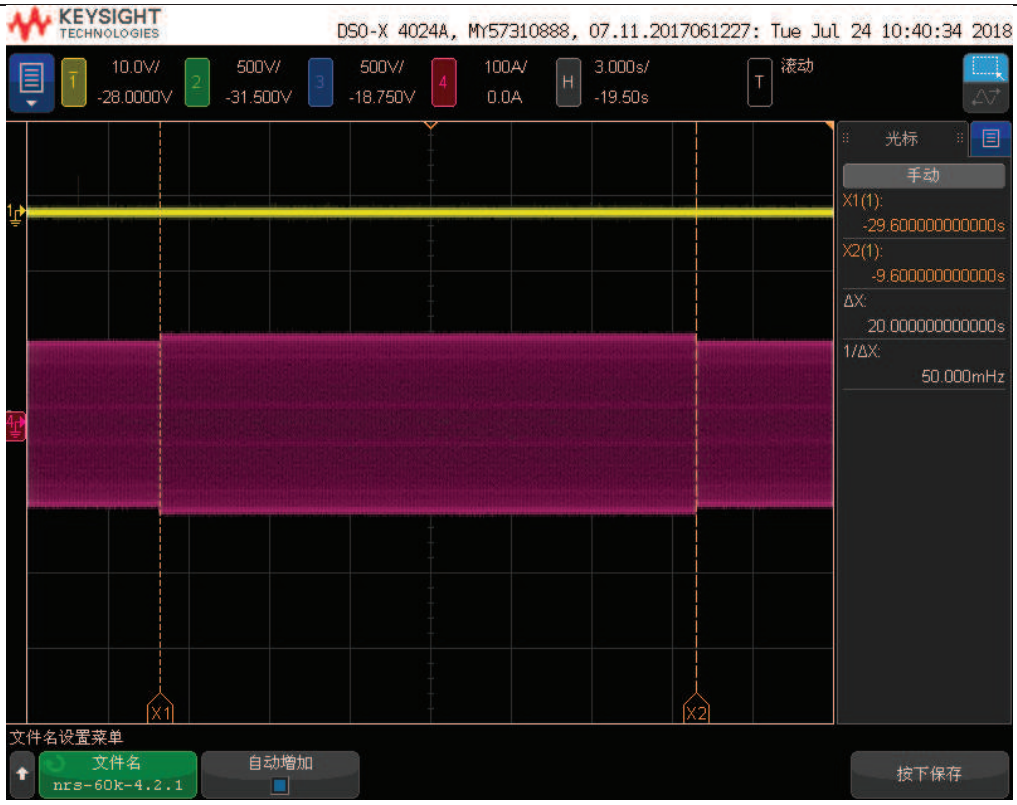
3.3.2-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:33:18 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-18.25s
滚动
光标
手动
X1(1):
-27.450000000000s
X2(1):
-7.450000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
保存到文件 = nrs-60k-4.1.1
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

4.1.1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:34:22 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-20.00s
滚动
光标
手动
X1(1):
-30.850000000000s
X2(1):
-10.850000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

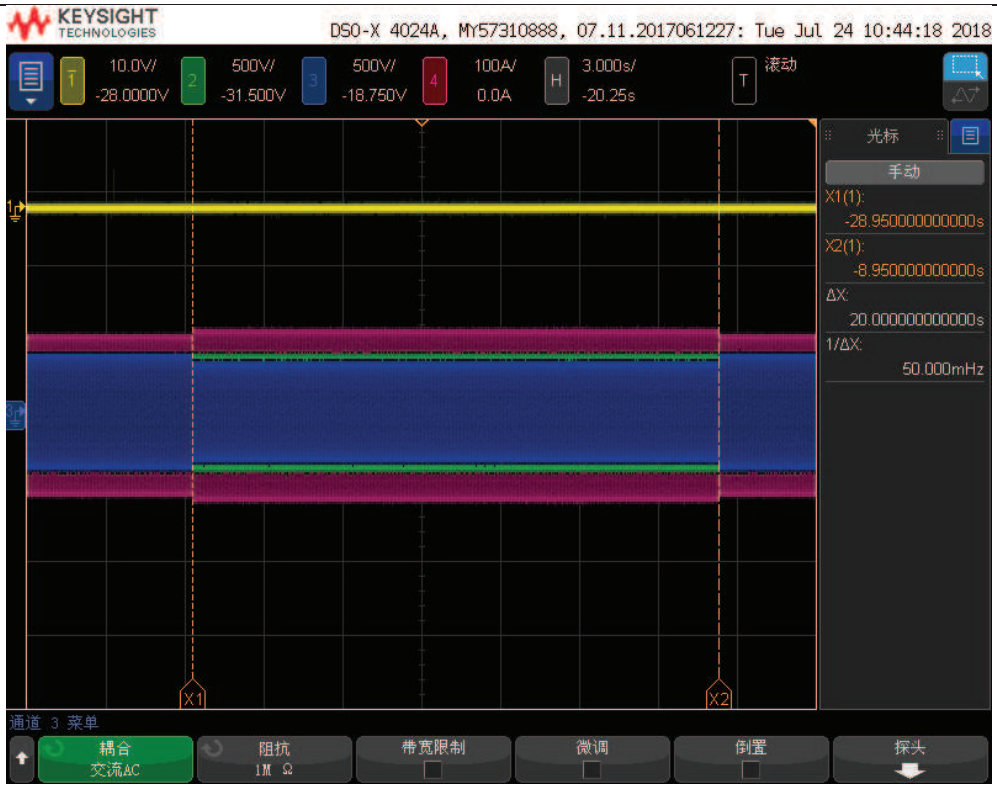
4.1.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:40:34 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-19.50s
滚动
光标
手动
X1(1):
-29.600000000000s
X2(1):
-9.600000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
文件名设置菜单
文件名
nrs-60k-4.2.1
自动增加
按下保存

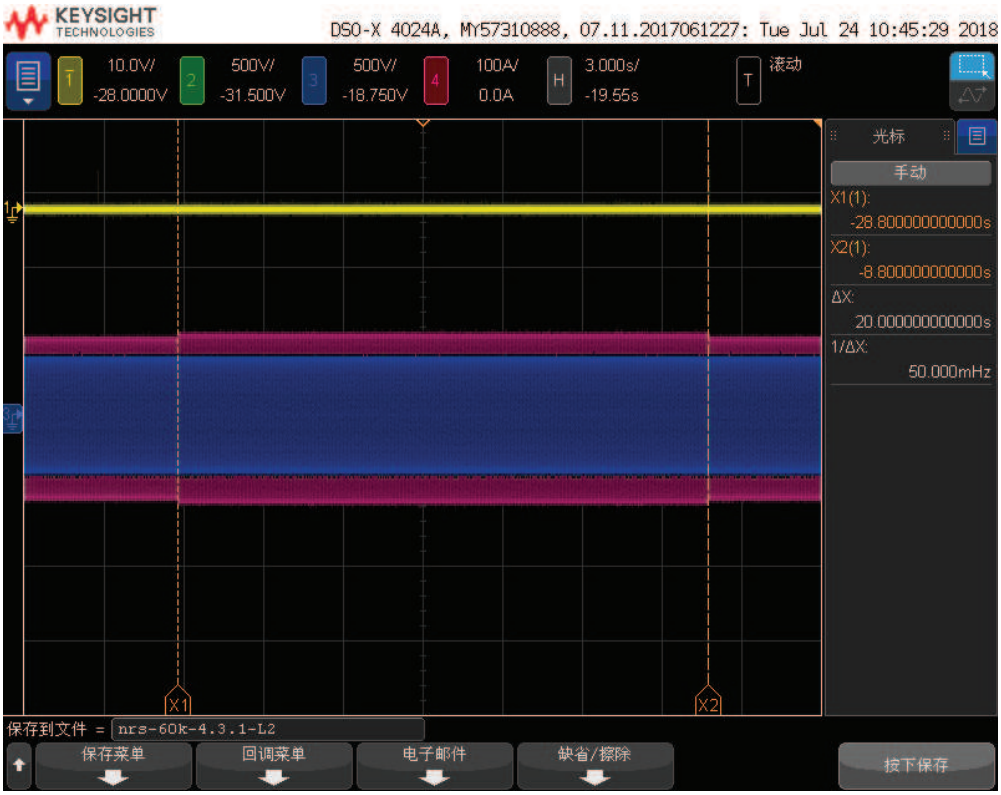
4.2.1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:41:58 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-20.00s
滚动
光标
手动
X1(1):
-29.900000000000s
X2(1):
-9.900000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
保存到文件 = nrs-60k-4.2.2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

4.2.2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:44:18 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-20.25s
滚动
光标
手动
X1(1):
-28.950000000000s
X2(1):
-8.950000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
通道 3 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

4.3.1-L1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:45:29 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-19.55s
滚动
光标
手动
X1(1):
-28.800000000000s
X2(1):
-8.800000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
保存到文件 = nrs-60k-4.3.1-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

4.3.1-L2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:49:12 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -18.750V
100A/ 0.0A
3.000s/ -22.45s
滚动
光标
手动
X1(1):
-31.950000000000s
X2(1):
-11.950000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
通道 2 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

4.3.1-L3


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:50:34 2018
10.0V/ -28.0000V
500V/ -31.500V
500V/ -18.750V
100A/ 0.0A
3.000s/ -17.80s
滚动
光标
手动
X1(1):
-29.400000000000s
X2(1):
-9.400000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

4.3.2-L1


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:52:59 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-19.35s
滚动
光标
手动
X1(1):
-29.050000000000s
X2(1):
-9.050000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
X1
X2
保存到文件 = nrs-60k-4.3.2-L2
保存菜单
回调菜单
电子邮件
缺省/擦除
按下保存

4.3.2-L2


KEYSIGHT TECHNOLOGIES
DSO-X 4024A, MY57310888, 07.11.2017061227: Tue Jul 24 10:55:13 2018
10.0V/
-28.0000V
500V/
-31.500V
500V/
-18.750V
100A/
0.0A
3.000s/
-22.20s
滚动
光标
手动
X1(1):
-33.000000000000s
X2(1):
-13.000000000000s
ΔX:
20.000000000000s
1/ΔX:
50.000mHz
X1
X2
通道 4 菜单
耦合
交流AC
阻抗
1M Ω
带宽限制
微调
倒置
探头

4.3.2-L3

4.2.2.3.2	Table: Overvoltage and under-voltage/ Voltage-ride-through (the test performed on the model Solis-50K)				P
Target value U	Trip value (V)	Trip value limit	Trip time(s)	Limit(s)	Remark
For phase A/ B/ C（400V）					
U<50%Ur	112.8	49%Ur≤U<50%	0.15	≤0.2	Trip vlaue : 112.7V to 115V
50 %Ur ≤ U < 85 %Ur	193.0	84%Ur≤U<85%	8.58	0.6 to 10	Trip vlaue : 193.2V to 195.5V
85 %Ur ≤ U ≤ 110 % Ur	--	--	--	--	Continuous operation
110 % Ur < U < 115 % Ur	254.9	110%Ur<U≤111%	38.03	≤40	Trip vlaue : 253V to 255.3V
115 %Ur ≤ U < 120%Ur	266.8	115%Ur≤U≤116%	0.145	≤2	Trip vlaue : 264.5V to 266.8V
120%Ur ≤ U	277.9	120%Ur≤U≤121%	0.15	≤0.16	Trip vlaue : 276V to 278.3V

4.2.2.3.2	Table: Overvoltage and under-voltage/ Voltage-ride-through				P
Target value U	Trip value (V)	Trip value limit	Trip time(s)	Limit(s)	Remark
For phase A/ B/ C（480V）					
U<50%Ur	137.2	49%Ur≤U<50%	0.14	≤0.2	
50 %Ur ≤ U < 85 %Ur	231.8	84%Ur≤U<85%	8.03	0.6 to 10	
85 %Ur ≤ U ≤ 110 % Ur	--	--	--	--	
110 % Ur < U < 115 % Ur	305.3	110%Ur<U≤111%	38.04	≤40	
115 %Ur ≤ U < 120%Ur	319.6	115%Ur≤U≤116%	0.153	≤2	
120%Ur ≤ U	333.2	120%Ur≤U≤121%	0.143	≤0.16	

4.2.2.3.3	Over-frequency and under-frequency	P

Target value F	Trip value (Hz)	Trip value limits (Hz)	Trip time(s)	Limit (s)	Remark
F< 47 Hz	46.975	46.95 ≤ F< 47	0.1655	≤0.2	
47≤ F≤ 50.5Hz	--	--	--	--	Normal operation
F> 52Hz	52.039	52 <F≤ 52.05	4.31	4 to 4.5	

Step #	Set output power [%]	frequency [Hz] [± 10 mHz]	Expected power value [W]	Actual power values [W]	Limit	Graph point
1	100	47.50	60000	60583	± 2.5% Pn	t1
2	100	50.40	60000	60668		t2
3	100	50.55	58500	58932		t3
4	100	51.00	45000	45337		t4
5	100	51.50	30000	30352		t5
6	100	50.11	60000	60318		t6
7	100	50.00	60000	60462	Pn	t7

Note:
50.5Hz: 100%P_M
52.0 Hz: 25%P_M
When the utility frequency exceeds 50.5 Hz. the active power available at the time shall be stored as the maximum power value P_M; this value P_M shall not be exceeded until the frequency has stabilized below 50.5 Hz for at least 4 seconds.

4.2.2.4	`TABLE: Prevention of islanding (IEC 62116)	P

Power 100%

Conditions	P_W [w]	Q_L [VA]	Q_C [VA]	Q_f	Trip time [ms]	Limitation [ms]
R: 90% L / C: 110%	L1: 18112	L1: 22073	L1: 22063	1.20	580	2000
	L2: 18170	L2: 22061	L2: 22083	1.21		
	L3: 18195	L3: 22041	L3: 22043	1.20		
R: 90% L / C: 105%	L1: 18130	L1: 21064	L1: 21093	1.15	540	2000
	L2: 18148	L2: 21040	L2: 21093	1.16		
	L3: 18178	L3: 21054	L3: 21073	1.16		
R: 90% L / C: 100%	L1: 18098	L1: 20068	L1: 20062	1.10	540	2000
	L2: 18140	L2: 20054	L2: 20076	1.11		
	L3: 18237	L3: 20020	L3: 20078	1.10		
R: 90% L / C: 95%	L1: 18096	L1: 19029	L1: 19082	1.06	460	2000
	L2: 18184	L2: 19041	L2: 19054	1.05		
	L3: 18215	L3: 19055	L3: 19044	1.05		
R: 90% L / C: 90%	L1: 18146	L1: 18049	L1: 18057	1.00	580	2000
	L2: 18132	L2: 18055	L2: 18035	1.01		
	L3: 18231	L3: 18077	L3: 18087	1.00		
R: 95% L / C: 110%	L1: 19165	L1: 22077	L1: 22073	1.16	280	2000
	L2: 19193	L2: 22031	L2: 22043	1.15		
	L3: 19208	L3: 22077	L3: 22049	1.15		
R: 95% L / C: 90%	L1: 19129	L1: 18037	L1: 18045	0.95	480	2000
	L2: 19135	L2: 18023	L2: 18071	0.95		
	L3: 19193	L3: 18045	L3: 18085	0.94		
R: 100% L / C: 110%	L1: 20104	L1: 22035	L1: 22059	1.10	600	2000
	L2: 20144	L2: 22065	L2: 22071	1.10		
	L3: 20205	L3: 22055	L3: 22071	1.10		
R: 95% L / C: 105%	L1: 19129	L1: 21074	L1: 21049	1.11	600	2000
	L2: 19147	L2: 21029	L2: 21071	1.10		
	L3: 19220	L3: 21025	L3: 21075	1.10		
R: 95% L / C: 100%	L1: 19101	L1: 20038	L1: 20048	1.05	530	2000
	L2: 19200	L2: 20078	L2: 20084	1.05		
	L3: 19240	L3: 20036	L3: 20088	1.04		
R: 95% L / C: 95%	L1: 19107	L1: 19037	L1: 19086	1.00	570	2000
	L2: 19147	L2: 19079	L2: 19074	1.00		
	L3: 19214	L3: 19061	L3: 19086	1.00		
R: 100%	L1: 20142	L1: 21021	L1: 21079	1.05	600	

L / C: 105%	L2: 20146	L2: 21046	L2: 21089	1.05		2000
	L3: 20231	L3: 21054	L3: 21039	1.04		
R: 100% L / C: 100%	L1: 20152	L1: 20052	L1: 20080	1.00	400	2000
	L2: 20150	L2: 20080	L2: 20052	1.00		
	L3: 20211	L3: 20034	L3: 20038	0.99		
R: 100% L / C: 95%	L1: 20138	L1: 19049	L1: 19070	0.95	720	2000
	L2: 20196	L2: 19039	L2: 19074	0.95		
	L3: 20188	L3: 19018	L3: 19080	0.95		
R: 105% L / C: 105%	L1: 21109	L1: 21074	L1: 21073	1.00	440	2000
	L2: 21201	L2: 21050	L2: 21091	1.00		
	L3: 21240	L3: 21036	L3: 21069	0.99		
R: 105% L / C: 100%	L1: 21129	L1: 20064	L1: 20042	0.95	520	2000
	L2: 21212	L2: 20048	L2: 20044	0.95		
	L3: 21276	L3: 20066	L3: 20038	0.95		
R: 105% L / C: 95%	L1: 21109	L1: 19063	L1: 19060	0.91	300	2000
	L2: 21210	L2: 19035	L2: 19032	0.90		
	L3: 21240	L3: 19041	L3: 19060	0.90		
R: 100% L / C: 90%	L1: 20144	L1: 18037	L1: 18029	0.90	560	2000
	L2: 20166	L2: 18029	L2: 18033	0.90		
	L3: 20225	L3: 18055	L3: 18049	0.90		
R: 105% L / C: 110%	L1: 21109	L1: 22071	L1: 22091	1.05	530	2000
	L2: 21185	L2: 22071	L2: 22039	1.05		
	L3: 21210	L3: 22059	L3: 22039	1.04		
R: 105% L / C: 90%	L1: 21167	L1: 18047	L1: 18029	0.86	370	2000
	L2: 21181	L2: 18073	L2: 18049	0.86		
	L3: 21206	L3: 18077	L3: 18055	0.86		
R: 110% L / C: 110%	L1: 22154	L1: 22079	L1: 22075	1.00	540	2000
	L2: 22164	L2: 22043	L2: 22087	1.00		
	L3: 22245	L3: 22071	L3: 22095	1.00		
R: 110% L / C: 105%	L1: 22156	L1: 21025	L1: 21039	0.95	380	2000
	L2: 22186	L2: 21042	L2: 21053	0.95		
	L3: 22249	L3: 21060	L3: 21071	0.95		

R: 110% L / C: 100%	L1: 22126 L2: 22202 L3: 22213	L1: 20030 L2: 20060 L3: 20034	L1: 20052 L2: 20050 L3: 20034	0.90 0.91 0.90	560	2000
R: 110% L / C: 95%	L1: 22144 L2: 22223 L3: 22208	L1: 19071 L2: 19075 L3: 19045	L1: 19070 L2: 19036 L3: 19034	0.86 0.85 0.86	510	2000
R: 110% L / C: 90%	L1: 22158 L2: 22178 L3: 22267	L1: 18077 L2: 18051 L3: 18061	L1: 18079 L2: 18037 L3: 18055	0.81 0.82 0.81	550	2000
Power 66%						
Conditions	P_W [w]	Q_L [VA]	Q_C [VA]	Q_f	Trip time [ms]	Limitation [ms]
R: 100% L / C: 95%	L1: 13274 L2: 13308 L3: 13373	L1: 12571 L2: 12591 L3: 12547	L1: 12560 L2: 12552 L3: 12582	0.95 0.95 0.94	560	2000
R: 100% L / C: 96%	L1: 13302 L2: 13316 L3: 13367	L1: 12681 L2: 12687 L3: 12705	L1: 12698 L2: 12720 L3: 12732	0.96 0.96 0.95	580	2000
R: 100% L / C: 97%	L1: 13274 L2: 13342 L3: 13340	L1: 12843 L2: 12863 L3: 12835	L1: 12834 L2: 12840 L3: 12874	0.97 0.97 0.97	640	2000
R: 100% L / C: 98%	L1: 13278 L2: 13316 L3: 13340	L1: 12945 L2: 12955 L3: 12955	L1: 12990 L2: 12950 L3: 12950	0.98 0.98 0.97	580	2000
R: 100% L / C: 99%	L1: 13294 L2: 13330 L3: 13356	L1: 13104 L2: 13108 L3: 13128	L1: 13081 L2: 13133 L3: 13093	0.99 0.99 0.99	560	2000
R: 100% L / C: 100%	L1: 13258 L2: 13340 L3: 13320	L1: 13264 L2: 13262 L3: 13252	L1: 13265 L2: 13221 L3: 13243	1.00 1.00 1.00	600	2000
R: 100% L / C: 101%	L1: 13332 L2: 13300 L3: 13318	L1: 13346 L2: 13390 L3: 13350	L1: 13379 L2: 13399 L3: 13363	1.00 1.01 1.01	460	2000
R: 100% L / C: 102%	L1: 13272 L2: 13360 L3: 13350	L1: 13478 L2: 13518 L3: 13508	L1: 13537 L2: 13499 L3: 13535	1.02 1.02 1.02	560	2000
R: 100% L / C: 103%	L1: 13328 L2: 13360	L1: 13642 L2: 13614	L1: 13667 L2: 13623	1.03 1.02	490	2000

	L3: 13332	L3: 13614	L3: 13615	1.02		
R: 100% L / C: 104%	L1: 13330	L1: 13753	L1: 13793	1.04	560	2000
	L2: 13290	L2: 13739	L2: 13759	1.04		
	L3: 13344	L3: 13739	L3: 13781	1.03		
R: 100% L / C: 105%	L1: 13256	L1: 13899	L1: 13913	1.05	580	2000
	L2: 13286	L2: 13903	L2: 13891	1.05		
	L3: 13336	L3: 13899	L3: 13919	1.05		
Power 33%						
Conditions	P_W [w]	Q_L [VA]	Q_C [VA]	Q_f	Trip time [ms]	Limitation [ms]
R: 100% L / C: 95%	L1: 6637	L1: 6275	L1: 6271	0.95	330	2000
	L2: 6677	L2: 6303	L2: 6295	0.95		
	L3: 6653	L3: 6263	L3: 6323	0.94		
R: 100% L / C: 96%	L1: 6643	L1: 6386	L1: 6379	0.96	340	2000
	L2: 6699	L2: 6358	L2: 6341	0.95		
	L3: 6715	L3: 6358	L3: 6345	0.95		
R: 100% L / C: 97%	L1: 6677	L1: 6434	L1: 6425	0.97	330	2000
	L2: 6663	L2: 6424	L2: 6453	0.97		
	L3: 6659	L3: 6428	L3: 6423	0.97		
R: 100% L / C: 98%	L1: 6655	L1: 6480	L1: 6525	0.98	650	2000
	L2: 6677	L2: 6482	L2: 6519	0.97		
	L3: 6665	L3: 6522	L3: 6467	0.98		
R: 100% L / C: 99%	L1: 6679	L1: 6540	L1: 6581	0.98	690	2000
	L2: 6659	L2: 6584	L2: 6531	0.99		
	L3: 6693	L3: 6556	L3: 6585	0.98		
R: 100% L / C: 100%	L1: 6675	L1: 6632	L1: 6613	1.00	760	2000
	L2: 6669	L2: 6608	L2: 6639	0.99		
	L3: 6711	L3: 6606	L3: 6621	0.99		
R: 100% L / C: 101%	L1: 6683	L1: 6718	L1: 6669	1.01	620	2000
	L2: 6645	L2: 6686	L2: 6683	1.01		
	L3: 6705	L3: 6682	L3: 6679	1.00		
R: 100% L / C: 102%	L1: 6693	L1: 6756	L1: 6737	1.01	290	2000
	L2: 6697	L2: 6732	L2: 6737	1.01		
	L3: 6669	L3: 6756	L3: 6783	1.02		
R: 100% L / C: 103%	L1: 6671	L1: 6824	L1: 6805	1.03	480	2000
	L2: 6667	L2: 6820	L2: 6845	1.03		
	L3: 6715	L3: 6850	L3: 6831	1.02		
R: 100%	L1: 6671	L1: 6900	L1: 6877	1.04	510	

L / C: 104%	L2:	6653	L2:	6918	L2:	6905	1.04		2000
	L3:	6725	L3:	6884	L3:	6871	1.03		
R: 100% L / C: 105%	L1:	6669	L1:	6966	L1:	6939	1.05	440	
	L2:	6659	L2:	6954	L2:	6933	1.05		2000
	L3:	6709	L3:	6972	L3:	6983	1.04		

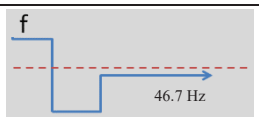
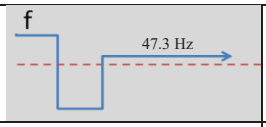
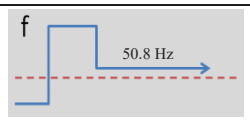
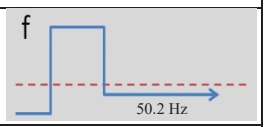
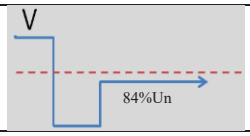
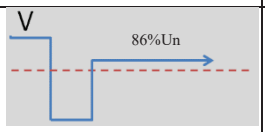
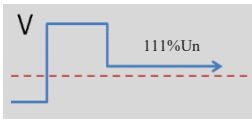
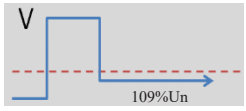
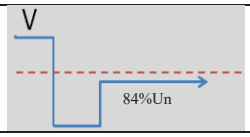
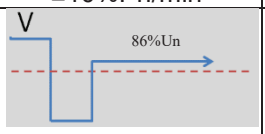
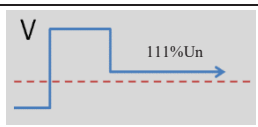
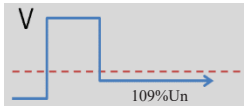
Remark:

Single phase test for multi phase **Generating Units**. Confirm that when generating in parallel with a network operating at around 50Hz with no network disturbance. that the removal of a single phase connection to the **Generating Unit**. with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.

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.

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 + 0.9 × (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.

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 + 0.9 × (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.

4.2.4.2.2	TABLE: Response to utility recovery			P
Conditions-Frequency				
Connection	☐ Yes/ ☒ No	☒ Yes/ ☐ No	☒ Yes/ ☐ No	☒ Yes/ ☐ No
Time [s]	N/A	67.8s	N/A	70.4s
Limits	Not connected	>60 s	Not connected	>60 s
Power rate	N/A	9.95%	N/A	9.89%
Limits	N/A	≤10%Pn/min	N/A	≤10%Pn/min
Conditions-Voltage（400V）				
Connection	☐ Yes/ ☒ No	☒ Yes/ ☐ No	☐ Yes/ ☒ No	☒ Yes/ ☐ No
Time [s]	N/A	68.8	N/A	61.9s
Limits	Not connected	>60 s	Not connected	>60 s
Power rate	N/A	9.93%	N/A	9.98%
Limits	N/A	≤10%Pn/min	N/A	≤10%Pn/min
Conditions-Voltage（480V）				
Connection	☐ Yes/ ☒ No	☒ Yes/ ☐ No	☐ Yes/ ☒ No	☒ Yes/ ☐ No
Time [s]	N/A	73.6s	N/A	88.4s
Limits	Not connected	>60 s	Not connected	>60 s
Power rate	N/A	9.91%	N/A	9.88%
Limits	N/A	≤10%Pn/min	N/A	≤10%Pn/min
Note:				

The end of report