Test Report issued under the responsibility of

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TEST REPORT EN 50438 Requirements for the connection of micro-generators in parallel with public low-voltage distribution networks	
Report Reference No. ..... :	EFSH15081877-IE-03-L01
Tested by (name + signature)..... :	Daniel Li Daniel Li
Approved by (name + signature) ..... :	Teddy Wang
Date of issue ..... :	2015-12-10
Contents ..... :	32 pages
Testing Laboratory ..... :	Eurofins Producut Testing Service (Shanghai) Co., Ltd.
Address ..... :	No. 395 West Jiangchang Road, Zhabei District, Shanghai, China
Testing location / procedure..... :	TL ☒ SMT ☐ TMP ☐
Testing location / address ..... :	Same as above
Applicant's name..... :	Zhejiang Envertech Corporation Ltd.
Address ..... :	24th Floor, Jintong Mansion, Center of Headquarters, Huang tang Block Dong Cheng district Yongkang City, Zhejiang Province P.R.China
Test specification:	
Standard..... :	EN 50438:2013 with deviations according the national network and system protection for Netherlands.
Test procedure..... :	Test report
Non-standard test method..... :	N/A
Test Report Form/blank test report	
Test Report Form No. ..... :	TRF_EN_50438A

Test item description ..... :	PV Microinverter
Trade Mark ..... :	Envertech, SEEYES
Manufacturer..... :	Zhejiang Envertech Corporation Ltd. 24th Floor, Jintong Mansion, Center of Headquarters, Huang tang Block Dong Cheng district Yongkang City, Zhejiang Province P.R.China
Model/Type reference..... :	EVT248; EVT500
Rating……..:	EVT248: IP65, Class I Input: Max. 54VDC, MPPT voltage range 24-42V, Max. 9,5A;Isc PV:15A Output:230VAC, 50/60Hz, 248W, max.1,07A EVT500: IP65,Class I Input: Max. 54VDC, dual MPPT voltage range：24-42VDC; Isc PV:15A,max. 9,5A x 2; Output: 230VAC, 50/60Hz, 500W, max. 2,17A;

Test item particulars.....:	
Classification of installation and use .....:	Class I
Supply Connection.....:	Permanent connection
Protection against ingress of water.....:	IP65
Mass of equipment [kg].....:	EVT248: 1,4KG; EVT500: 2,4KG
Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement .....:	P(Pass)
- test object does not meet the requirement .....:	F(Fail)
Testing.....:	
Date of receipt of test item.....:	2015-10-22
Date (s) of performance of tests.....:	2015-10-22 to 2015-12-10

General remarks:

The test results presented in this report relate only to the object tested.

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

"(see Enclosure #)" 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.

Determination of the test result includes consideration of measurement uncertainty from the test equipment and methods.

The test results presented in this report relate only to the item tested. The results indicate that the specimen complies with standard" EN 50438:2013".

Factory:

Factory 1:
Zhejiang Envertech Corporation Ltd.
Huang tang Block Dong Cheng District Yongkang City Zhejiang Province, P.R.China
Factory 2:
Zhejiang Envertech Corporation Ltd.
Gushan Industrial Area, Yongkang, Zhejiang Province, P.R.China

General product information:

The Product was tested to the standard EN 50438:2013 with the Netherlands parameter settings.

The grid type inverters type EVT248 and EVT500 are single-phase solar-power inverters. They are responsible for converting the direct current generated by photovoltaic panels into single phase 230V, 50 Hz alternative current for deliver into the electrical power distribution grid. The inverter only operates when it is connected to the electrical utility grid and cannot operate as a stand-alone unit or in case of AC grid disruption.

The inverter was tested on a 16A branch circuit. The safety of the unit relies on the branch circuit of building installation. If used on a branch circuit greater than this, additional testing may be necessary. The unit is

approved for TN mains connections and IEC 60664 overvoltage category III.

The equipment has been evaluated for use in a Pollution Degree III (reduction to pollution degree II because of enclosure IP 65.) and overvoltage category III environment and a maximum altitude of 2000m according to IEC 62109-1. The unit is specified for outdoor and indoor (unconditioned) use.

The input and output are protected by Varistors to Earth. The units are providing EMC filtering at the input and output toward mains. The Micro-inverter does provide galvanic separation from input to output (trans- fomer). The output is switched off redundant by the high power switching bridge.

The PV Micro-inverter provides two independent CPUs (Main CPU: U1, Slave CPU: U2), the main CPU control the fly back circuit, change the DC current to half sine wave and detect the internal temperature. The slave CPU control the H bridge, overturns the half sine wave to 50Hz sine wave and monitor the AC current, and AC voltage in parallel with frequency.

All CPUs monitor signals and analyze the data of the voltage and frequency along with resistors in serial which are connected directly to line/neutral respectively.

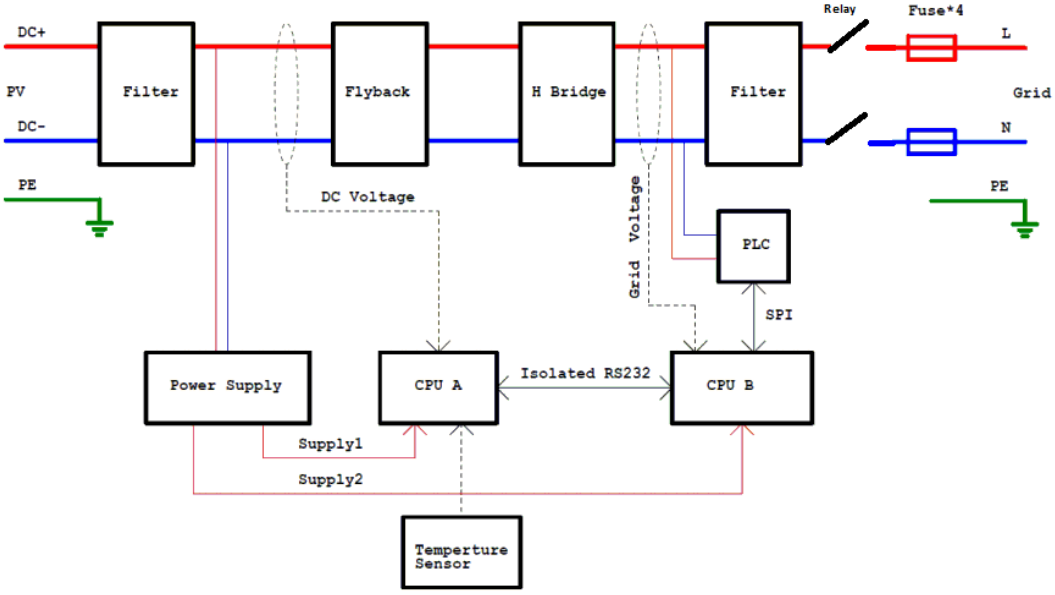
The PV Micro-inverter and systems are restricted for use in closed electrical operating areas.

Besides this at national level further requirements might be defined.

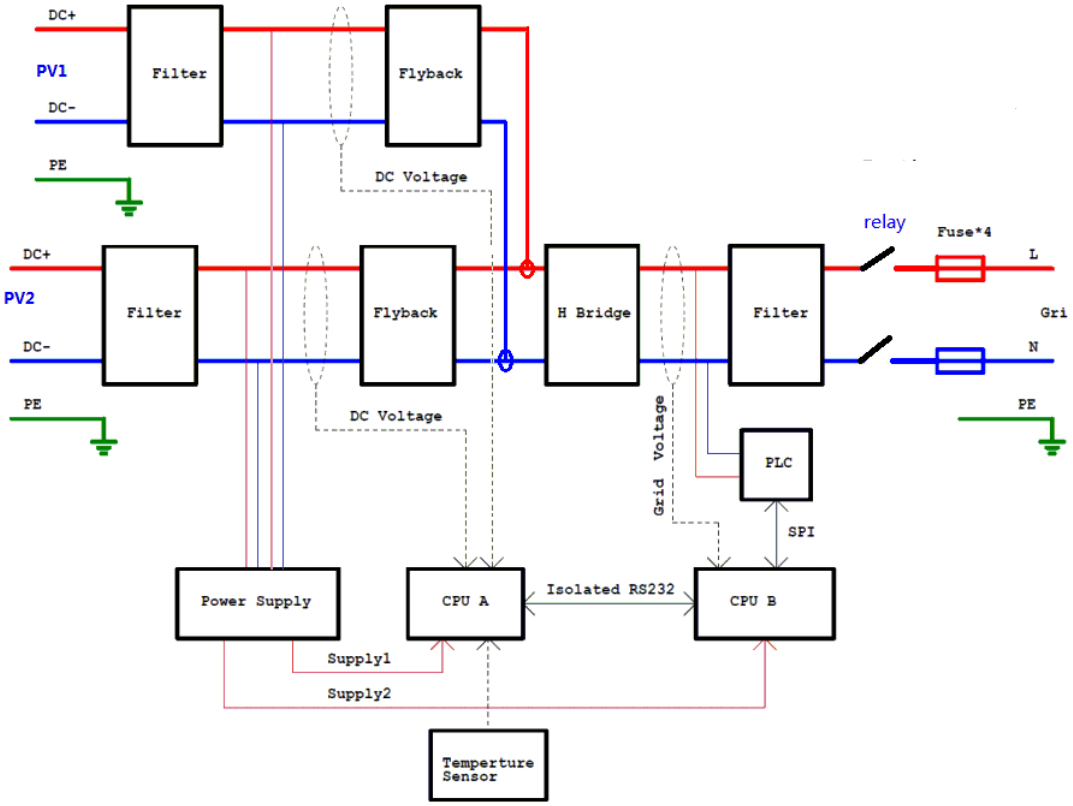
The PV Micro-inverte should be set in factory according to the settings for the place of installation.

Block diagrams

Model: EVT248



Model: EVT500



The product was tested on:
hardware version: V1.00
software version: V1.00

Copy of marking plate:

Rating label:

PV Microinverter		Model: EVT248	
Recommended maximum input power:	300W	Rated output power:	248W
Operating range:	18V ~ 54V	Nominal voltage:	230V
Peak power tracking range:	24V ~ 42V	Maximum output current:	1.07A
Maximum input DC voltage:	54V	Nominal frequency:	50Hz/60Hz
Maximum input current:	9.5A	Power factor:	>0.99
Maximum DC short circuit current:	15A	Maximum units per branch:	15
Enclosure rating:	IP65	Protective class:	I
Operating temperature range:	-40°C ~ +65°C	Overvoltage category:	III[Mains],II[PV]

SEEYES
Zhejiang Envertech Corporation LTD.
VDE AR-N 4105,VDE0126-1-1,G83/2,
AS4777,EN50438,EN62109
24 Floor Jintong Mansion,Center of Headquarters,Huangtang
Block,Dong cheng district,Yongkang City,Zhejiang Province,P.R China.
www.envertec.com

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PV Microinverter		Model: EVT500	
Recommended maximum input power:	300Wx2	Rated output power:	500W
Operating range:	18V ~ 54V	Nominal voltage:	230V
Peak power tracking range:	24V ~ 42V	Maximum output current:	2.17A
Maximum input DC voltage:	54V	Nominal frequency:	50Hz/60Hz
Maximum input current:	9.5Ax2	Power factor:	>0.99
Maximum DC short circuit current:	15A	Maximum units per branch:	8
Enclosure rating:	IP65	Protective class:	I
Operating temperature range:	-40°C ~ +65°C	Overvoltage category:	III[Mains],II[PV]

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Peak power tracking range:	24V ~ 42V	Maximum output current:	2.17A
Maximum input DC voltage:	54V	Nominal frequency:	50Hz/60Hz
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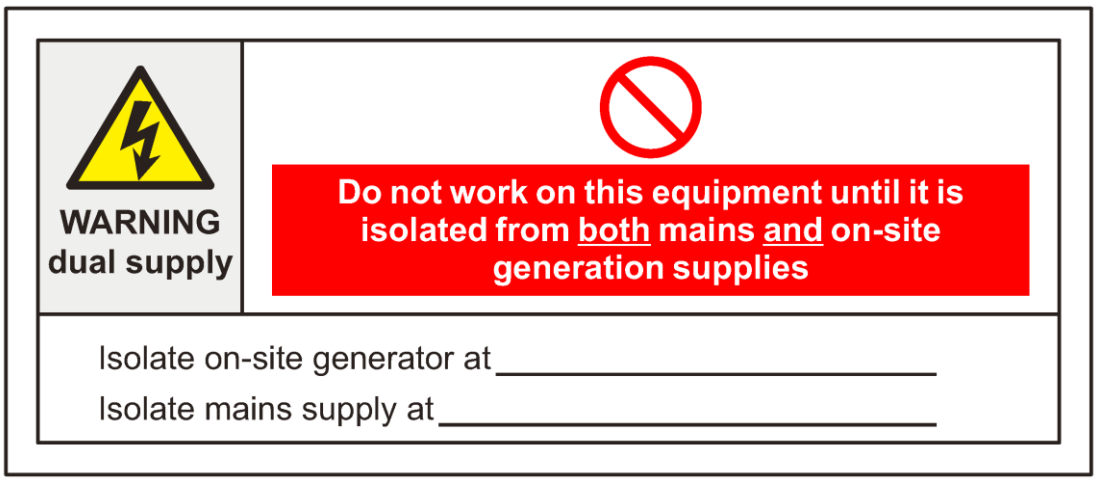
Caution label:



EN 50438:2013			
Clause	Requirement - Test	Result - Remark	Verdict
4	**CONNECTION REQUIREMENTS**		
4.1	The electrical installation		P
4.1.1	Low voltage electrical installations shall comply with national and local regulation. In case of any hardware malfunctioning, disconnection is required.	The installation shall be in compliance with HD 384 series and national and local regulation.	P
4.1.2	Over-current protection	The manufacturer recommends an over-current protection device in the manual	P
4.1.3	Earthing		P
4.2	Normal operating range		P
4.2.1	General		P
4.2.2	Continuous voltage operation range	See table 4.2.2	P
4.2.3	Continuous frequency operation range	See table 4.2.3	P
4.2.4	Response to under-frequencies	See table 4.2.4	P
4.2.5	Power response to over-frequency	See table 4.2.5	P
4.3	Reactive power capability		N/A
4.3.1	Inverter based micro-generator		N/A
4.3.2	Directly coupled micro-generator with no inverter		N/A
4.4	Reactive power control modes		N/A
4.4.1	General		N/A
4.4.2	Fix control mode cos φ fix		N/A
4.4.3	Voltage related control mode Q(U)		N/A
4.4.4	Power related control mode cos φ (P)		N/A
4.5	Voltage control by active power		N/A
4.6	Interface protection		P
4.6.1	General		P
4.6.1.1	Introduction		P
4.6.1.2	Response to protection operation		P
4.6.1.3	Place of the interface protection		P
4.6.1.4	Changing settings of the interface protection		P
4.6.1.5	Combined protection device for multiple generators		N/A
4.6.2	Interface protection settings		N/A
4.6.3	Requirements regarding single fault tolerance of interface protection system	See table 4.6.3	P
4.7	Connection and starting to generate electrical power		P
4.7.1	General		P

EN 50438:2013			
Clause	Requirement - Test	Result - Remark	Verdict
4.7.2	Automatic reconnection after tripping	See table 4.7.2	P
4.7.3	Starting to generate electrical power	See table 4.7.3	P
4.7.4	Synchronisation		P
4.8	Power quality		P
4.8.1	General	See table 4.8.1 See EMC report: EFSH15081877-IE-12-E01	P
4.8.2	DC injection		N/A
	The generating unit shall not inject a direct current.		N/A
5	Operation and safety of the micro-generator		P
5.1	General		P
5.2	Safety		N/A
5.3	Information plate		P
5.4	Labelling		P
5.5	Maintenance and routine testing		P
6	Commissioning		P
Annex A	Interface protection settings, national deviations		
	If no specific national settings for the Interface Protection are supplied in Annex A, the default settings in 4.2.2, Table 2 are applicable.		N/A
	AT – Austria		N/A
	BE – Belgium		N/A
	CH – Switzerland		N/A
	LV – Latvia		N/A
	CY – Cyprus		N/A
	CZ – Czech Republic		N/A
	DE – Germany		N/A
	DK – Denmark		N/A
	ES – Spain		N/A
	FI – Finland		N/A
	FR – France		N/A
	GB – United Kingdom		N/A
	IE – Ireland		N/A
	IT – Italy		N/A
	NL – The Netherlands		P
	NO – Norway		N/A

EN 50438:2013			
Clause	Requirement - Test	Result - Remark	Verdict
	PL – Poland		N/A
	SE – Sweden		N/A
	SI – Slovenia		N/A
Annex B	Loss of Mains and overall system security		Info
Annex C	Example notification sheets		Info
Annex D	Compliance type testing		P
Annex E	Example test results sheet		P
Annex F	Commissioning		Info.
Annex G	Countries allowing extension of the scope > 16 A		N/A

4.2.2 4.2.3	Operating Range Model: EVT248			P
Test sequence	**Voltage(V)**	**Frequency(Hz)**	**Output power(W)**	**Primary power Source(W)**
Test 1	195,5	47,5	248,0	259,5
Test 2	253,0	51,5	248,0	259,3

4.2.2 4.2.3	Operating Range Model: EVT500			P
Test sequence	**Voltage(V)**	**Frequency(Hz)**	**Output power(W)**	**Primary power Source(W)**
Test 1	195,5	47,5	490,0	256,2/255,5
Test 2	253,0	51,5	490,0	256,5/255,3

4.2.2	Power factor Model: EVT248			P
	210V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
20% of nominal active power	0,989	0,982	0,972	
50% of nominal active power	0,997	0,997	0,997	
75% of nominal active power	0,998	0,997	0,997	
100% of nominal active power	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	

4.2.2	Power factor Model: EVT500			P
	210V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
20% of nominal active power	0,989	0,988	0,982	
50% of nominal active power	0,997	0,997	0,996	
75% of nominal active power	0,998	0,998	0,998	
100% of nominal active power	0,999	0,999	0,999	
Limit	>0,95	>0,95	>0,95	

4.2.4	Active power at under-frequency Model: EVT248		P
Test sequence	**Output Power(W)**	**Frequency(Hz)**	**Primary power Source(W)**
Test a)	248,0	50,0	259,3
Test b)	248,0	49,5	259,4
Test c)	248,0	47,6	259,5

4.2.4	Active power at under-frequency Model: EVT500		P
Test sequence	**Output Power(W)**	**Frequency(Hz)**	**Primary power Source(W)**
Test a)	490,0	50,0	256,2/255,5
Test b)	490,0	49,5	256,5/255,2
Test c)	490,0	47,6	256,7/255,1

4.2.5	Power response to over-frequency Model: EVT248			P
Test sequence at power level >80%	**Output Power(W)**	**Frequency(Hz)**	**Primary power Source(W)**	**Power Gradient (%)**
Step a)	247,2	50,00	257,4	-
Step b)	231,2	50,25	242,0	0,78
Step c)	188,1	50,70	197,2	0,59
Step d)	146,3	51,15	153,6	0,76
Step e)	185,1	50,70	194,0	1,59
Step f)	232,0	50,25	243,2	1,31
Step g)	247,0	50,00	259,2	-

4.2.5	Power response to over-frequency Model: EVT248			P
Test sequence at power level 40%-60%	**Output Power(W)**	**Frequency(Hz)**	**Primary power Source(W)**	**Power gradient**
Step a)	124,3	50,00	135,1	-
Step b)	110,1	50,25	120,3	2,74
Step c)	94,1	50,70	103,4	1,40
Step d)	73,3	51,15	81,8	1,52
Step e)	90,7	50,70	99,7	0,22
Step f)	112,1	50,25	121,9	1,84

Step g)	247,0	50,00	259,3	-

4.2.5	Power response to over-frequency Model: EVT500			P
Test sequence at power level >80%	**Output Power(W)**	**Frequency(Hz)**	**Primary power Source(W)**	**Power Gradient (%)**
Step a)	460,5	50,00	239,5/239,1	-
Step b)	459,1	50,25	238,8/238,5	0,20
Step c)	374,2	50,70	195,4/195,0	0,11
Step d)	291,1	51,15	152,8/152,3	0,28
Step e)	366,2	50,70	191,1/190,7	0,33
Step f)	459,1	50,25	239,1/238,8	0,15
Step g)	497,0	50,00	258,6/258,4	-

4.2.5	Power response to over-frequency Model: EVT500			P
Test sequence at power level 40%-60%	**Output Power(W)**	**Frequency(Hz)**	**Primary power Source(W)**	**Power gradient**
Step a)	249,1	50,00	131,1/129,7	-
Step b)	226,5	50,25	119,7/119,2	0,26
Step c)	185,7	50,70	98,1/97,5	0,21
Step d)	144,1	51,15	76,7/76,1	0,55
Step e)	181,5	50,70	96,3/95,9	0,27
Step f)	228,7	50,25	120,5/119,8	0,31
Step g)	498,0	50,00	258,7/258,3	-

4.4	Reactive power output capability	N/A
Plot of P over Q of all measured points		

Test sequence start of generation	Output power	Set reactive power	Measured reactive power	Tolerance

4.6.2	Interface protection settings – Over / under voltage	P

Model: EVT248

Test Condition:			Output power: 124,0 W Frequency: 50+/-0,2Hz U_N=230Vac			
Phase	**Limit:**	**Trip value [V]:**	**Voltage step:**	**Reconnection time [s]**	**Disconnection time [ms]:**	**Limit [s]:**
L-N	80% of Un 184,0V	186,2V	230V to 181V	66,0 s	1814 ms	**2s**
			230V to 181V		1811 ms	
			230V to 181V		1811 ms	
			230V to 181V		1813 ms	
			230V to 181V		1817 ms	
	110% of Un 253,0V	252,4V	230V to 257V	66,0 s	1810 ms	**2s**
			230V to 257V		1818 ms	
			230V to 257V		1810 ms	
			230V to 257V		1815 ms	
			230V to 257V		1814 ms	

Model: EVT500

Test Condition:			Output power: 248,0 W Frequency: 50+/-0,2Hz U_N=230Vac			
Phase	**Limit:**	**Trip value [V]:**	**Voltage step:**	**Reconnection time [s]**	**Disconnection time [ms]:**	**Limit [s]:**
L-N	80% of Un	186,2V	230V to 181V	66,0 s	1814 ms	**2s**
			230V to 181V		1811 ms	

	184,0V		230V to 181V		1811 ms	
			230V to 181V		1813 ms	
			230V to 181V		1817 ms	
	110% of Un 253,0V	252,4V	230V to 257V	66,0 s	1810 ms	**2s**
			230V to 257V		1818 ms	
			230V to 257V		1810 ms	
			230V to 257V		1815 ms	
			230V to 257V		1814 ms	
Note: Lower and upper threshold voltage shall not fall or rise below or above 2,3V of the trip value itself. The measurement shall take place at nominal frequency and any power.						

4.6.2	**Interface protection settings – Over / under frequency**				**P**			
Model: EVT248								
Test conditions:	Output power: 124,0 W							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		~80%U_N	U_N	~110%U_N		~80%U_N	U_N	~110%U_N
Limit	48,0Hz	2000ms	2000ms	2000ms	51,0Hz	2000ms	2000ms	2000ms
Trip value[Hz]		48,02	48,02	48,02		50,96	50,96	50,96
Disconnection time (ms)	48,5Hz to 47,5Hz	1810,0	1805,0	1807,0	50,5Hz to 51,5Hz	1685,0	1673,0	1698,0
		1812,0	1803,0	1813,0		1675,0	1674,0	1677,0
		1821,0	1813,0	1807,0		1682,0	1689,0	1676,0
		1807,0	1809,0	1803,0		1681,0	1674,0	1679,0
		1805,0	1802,0	1811,0		1682,0	1673,0	1678,0
Reconnection time:	>= 20s	66,0 s			>= 20s	66,0 s		
Model: EVT500								
Test conditions:	Output power: 248,0 W							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		~80%U_N	U_N	~110%U_N		~80%U_N	U_N	~110%U_N
Limit	48,0Hz	2000ms	2000ms	2000ms	51,0Hz	2000ms	2000ms	2000ms
Trip value[Hz]		48,02	48,02	48,02		50,96	50,96	50,96
Disconnection time (ms)	48,5Hz to 47,5Hz	1811,0	1809,0	1807,0	50,5Hz to 51,5Hz	1677,0	1672,0	1674,0
		1805,0	1804,0	1801,0		1671,0	1675,0	1672,0
		1813,0	1810,0	1805,0		1675,0	1672,0	1679,0
		1807,0	1812,0	1802,0		1680,0	1675,0	1677,0

		1805,0	1811,0	1803,0		1671,0	1665,0	1668,0
Reconnection time:	>= 20s	66,0 s			>= 20s	66,0 s		

Note:
It was measured at a continuous change of frequency of 1Hz/s at lower, nominal and upper U_N and arbitary output power. The trip value was determined manually by reducing the frequency in 10mHz steps. When the trip value is known (e.g. 48,02Hz), the ac-source is programmed to run from e.g. 48,50Hz to 47,50Hz with 1Hz/s. The disconnection time is calculated by the measured time minus the 480ms from 48,50Hz to 48,02Hz.

4.6.2	**TABLE: Islanding protection**						**P**
P_{EUT}	Reactive load (5 of Ql)	P_{AC} (% of nominal)	Q_{AC} (% of nominal	Run on time (ms)	P_{EUT} (W)	Actual Qf	Remarks
Model: EVT248							
Disconnection limit		2s					
100	100	0	0	1010,0	247,0	0,996	Test A at BL
66	66	0	0	675,0	162,0	0,986	Test B at BL
33	33	0	0	370,0	82,0	0,982	Test C at BL
100	100	-5	-5	112,0	237,0	0,992	Test A at IB
100	100	-5	0	108,0	237,0	0,997	Test A at IB
100	100	-5	+5	116,0	237,0	0,995	Test A at IB
100	100	0	-5	201,0	247,0	0,995	Test A at IB
100	100	0	+5	205,0	247,0	0,995	Test A at IB
100	100	+5	-5	324,0	258,0	0,994	Test A at IB
100	100	+5	0	307,0	258,0	0,994	Test A at IB
100	100	+5	+5	158,0	258,0	0,995	Test A at IB
66	66	0	-5	265,0	162,0	0,988	Test B at IB
66	66	0	-4	256,0	163,0	0,989	Test B at IB
66	66	0	-3	411,0	162,0	0,989	Test B at IB
66	66	0	-2	386,0	162,0	0,989	Test B at IB
66	66	0	-1	442,0	162,0	0,989	Test B at IB
66	66	0	1	385,0	162,0	0,987	Test B at IB
66	66	0	2	249,0	162,0	0,988	Test B at IB
66	66	0	3	279,0	162,0	0,991	Test B at IB
66	66	0	4	136,0	162,0	0,989	Test B at IB
66	66	0	5	134,0	162,0	0,987	Test B at IB
33	33	0	-5	193,0	82,0	0,960	Test C at IB
33	33	0	-4	221,0	83,0	0,964	Test C at IB
33	33	0	-3	215,0	83,0	0,954	Test C at IB
33	33	0	-2	217,0	83,0	0,966	Test C at IB
33	33	0	-1	209,0	83,0	0,975	Test C at IB
33	33	0	1	366,0	83,0	0,971	Test C at IB
33	33	0	2	358,0	83,0	0,968	Test C at IB
33	33	0	3	390,0	83,0	0,965	Test C at IB
33	33	0	4	375,0	83,0	0,966	Test C at IB
33	33	0	5	364,0	83,0	0,967	Test C at IB
Model: EVT500							
Disconnection limit		2s					
100	100	0	0	752,0	495,0	0,998	Test A at BL
66	66	0	0	652,0	325,0	0,996	Test B at BL
33	33	0	0	390,0	167,0	0,988	Test C at BL
100	100	-5	-5	152,0	478,0	0,995	Test A at IB
100	100	-5	0	158,0	478,0	0,994	Test A at IB

100	100	-5	+5	166,0	478,0	0,997	Test A at IB
100	100	0	-5	233,0	495,0	0,997	Test A at IB
100	100	0	+5	235,0	495,0	0,997	Test A at IB
100	100	+5	-5	341,0	518,0	0,996	Test A at IB
100	100	+5	0	367,0	518,0	0,997	Test A at IB
100	100	+5	+5	325,0	518,0	0,997	Test A at IB
66	66	0	-5	267,0	325,0	0,982	Test B at IB
66	66	0	-4	243,0	325,0	0,983	Test B at IB
66	66	0	-3	375,0	325,0	0,981	Test B at IB
66	66	0	-2	355,0	325,0	0,981	Test B at IB
66	66	0	-1	438,0	325,0	0,982	Test B at IB
66	66	0	1	413,0	325,0	0,981	Test B at IB
66	66	0	2	354,0	325,0	0,982	Test B at IB
66	66	0	3	261,0	325,0	0,981	Test B at IB
66	66	0	4	177,0	325,0	0,982	Test B at IB
66	66	0	5	201,0	325,0	0,982	Test B at IB
33	33	0	-5	205,0	166,0	0,960	Test C at IB
33	33	0	-4	233,0	166,0	0,974	Test C at IB
33	33	0	-3	208,0	166,0	0,964	Test C at IB
33	33	0	-2	206,0	166,0	0,966	Test C at IB
33	33	0	-1	212,0	166,0	0,975	Test C at IB
33	33	0	1	335,0	166,0	0,981	Test C at IB
33	33	0	2	291,0	166,0	0,968	Test C at IB
33	33	0	3	305,0	166,0	0,965	Test C at IB
33	33	0	4	334,0	166,0	0,962	Test C at IB
33	33	0	5	354,0	166,0	0,967	Test C at IB

supplementary information:
This anti-islanding test is in accordance with test setup and procedure by EN62116

RLC is adjusted flowing to grid to not more than +/-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.
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, 75 % of range =X + 0,75 × (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.
P_{EUT} procedure:
Condition A:
EUT output power P_{EUT} = Maximum5)
EUT input voltage 6) = >75% of rated input voltage range
Condition B:
EUT output power PEUT = 50 % – 66 % of maximum
EUT input voltage 5) = 50 % of rated input voltage range, ±10 %
Condition C:
EUT output power PEUT = 25 % – 33 % 5) of maximum
EUT input voltage 6) = <20 % of rated input voltage range

4.6.3	Short-circuit current at micro-generator terminals	N/A

Short-circuit applied to micro-generator at normal running condition
0 - 2,0 s plot

4.6.3	Short-circuit current parameters Model: EVT248					P
Parameter	**Symbol**	**Value 1**	**Value 2**	**Value 3**	**Value 4**	**Value 5**
Peak short-circuit current	i_p	8,900A	7,680A	8,280A	9,200A	9,300A
Initial value of aperiodic component	A	1,270A	1,130A	1,090A	1,070A	1,070A
Initial symmetrical short-circuit current	I_k	3,560A	3,070A	3,120A	3,680A	3,710A
Decaying (aperiodic) component of short-circuit current	i_{DC}	0,105A	0,102A	0,106A	0,105A	0,106A
Reactance/Resistance ratio of source	x/R	2,5	2,5	2,5	2,5	2,5

4.6.3	Short-circuit current parameters Model: EVT500					P
Parameter	**Symbol**	**Value 1**	**Value 2**	**Value 3**	**Value 4**	**Value 5**
Peak short-circuit current	i_p	15,400A	15,100A	14,800A	14,700A	14,700A
Initial value of aperiodic component	A	2,200A	2,180A	2,110A	2,120A	2,180A
Initial symmetrical short-circuit current	I_k	6,050A	6,040A	5,920A	5,880A	5,890A
Decaying (aperiodic) component of short-circuit current	i_{DC}	0,095A	0,094A	0,094A	0,075A	0,052A
Reactance/Resistance ratio of source	x/R	2,5	2,5	2,5	2,5	2,5

4.6.3	**Response to protection operation - fault condition tests**							P
component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
Model: EVT248								
R103 Gird voltage sampling Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R106 Gird voltage sampling Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R103 Gird voltage sampling Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R106 Gird voltage sampling Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C67 Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R29 Communication interrupt Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C55 Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R33 DC input voltage monitoring Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R189 DC input voltage monitoring Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R164 Gird voltage monitoring Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R165 Gird voltage monitoring Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.

RT1 Temperature monitoring Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
RT2 Temperture monitoring Defect	Short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R20 Communication circuit Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R22 Communication circuit Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R24 Communication circuit Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R62 Communication circuit Defect	Open circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C58 Loss of control	VDC short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C55 Loss of control	VDC_G short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C57 Loss of control	+3.3V short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C58 Loss of control	+3.3V_G short circuit	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
Relay fault defect Pole1	short circuit before start-up	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit does not start up and not feed in power to the grid. No damage, no hazard.
Relay fault defect Pole1	K2 short circuit before start-up	230V 1,08A	36V 7,1A	10min	F2, F3 2A	230V 0A	36V 0A	Unit does not start up and not feed in power to the grid. No damage, no hazard.
Model: EVT500								

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
R103 Gird voltage sampling Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R106 Gird voltage sampling Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R103 Gird voltage sampling Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R106 Gird voltage sampling Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C67 Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R29 Communication interrupt Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C55 Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R33 DC input voltage monitoring Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R189 DC input voltage monitoring Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R164 Gird voltage monitoring Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R165 Gird voltage monitoring Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
RT1 Temperature monitoring Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.

RT2 Temperture monitoring Defect	Short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R20 Communication circuit Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R22 Communication circuit Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R24 Communication circuit Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
R62 Communication circuit Defect	Open circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C58 Loss of control	VDC short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C55 Loss of control	VDC_G short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C57 Loss of control	+3.3V short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
C58 Loss of control	+3.3V_G short circuit	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit disconnected form the grid immediately, no reconnection. No damage, no hazards.
Relay fault defect Pole1	short circuit before start-up	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit does not start up and not feed in power to the grid. No damage, no hazard.
Relay fault defect Pole1	K2 short circuit before start-up	230V 2,16A	36V 7,1Ax2	10min	F2, F3 2A	230V 0A	36V 0A	Unit does not start up and not feed in power to the grid. No damage, no hazard.

4.7.2	Automatic reconnection after tripping Model: EVT248			P
Test sequence after trip	**connection**	**connection allowed**	**Primary power Source(W)**	**Power gradient after connection(%)**
Step a)	No	No	254,8	-
Step b)	74s	Yes	254,8	-
Step c)	No	No	254,8	-
Step d)	74s	Yes	254,8	-
Step e)	No	No	254,8	-
Step f)	73s	Yes	254,8	-
Step g)	No	No	254,8	-
Step h)	74s	Yes	254,8	8,5%

4.7.2	Automatic reconnection after tripping Model: EVT500			P
Test sequence after trip	**connection**	**connection allowed**	**Primary power Source(W)**	**Power gradient after connection(%)**
Step a)	No	No	258,6/258,4	-
Step b)	74s	Yes	258,6/258,4	-
Step c)	No	No	258,6/258,4	-
Step d)	74s	Yes	258,6/258,4	-
Step e)	No	No	258,6/258,4	-
Step f)	73s	Yes	258,6/258,4	-
Step g)	No	No	258,6/258,4	-
Step h)	74s	Yes	258,6/258,4	8,7%

4.7.3	Starting to generate electrical power Model: EVT248			P
Test sequence after trip	**connection**	**connection allowed**	**Primary power Source(W)**	**Power gradient after connection(%)**
Step a)	No	No	254,8	-
Step b)	74s	Yes	254,8	-
Step c)	No	No	254,8	-

Step d)	74s	Yes	254,8	-
Step e)	No	No	254,8	-
Step f)	73s	Yes	254,8	-
Step g)	No	No	254,8	-
Step h)	74s	Yes	254,8	8,5%

4.7.3	**Starting to generate electrical power** **Model: EVT500**			**P**
Test sequence after trip	**connection**	**connection allowed**	**Primary power Source(W)**	**Power gradient after connection(%)**
Step a)	No	No	258,6/258,4	-
Step b)	74s	Yes	258,6/258,4	-
Step c)	No	No	258,6/258,4	-
Step d)	74s	Yes	258,6/258,4	-
Step e)	No	No	258,6/258,4	-
Step f)	73s	Yes	258,6/258,4	-
Step g)	No	No	258,6/258,4	-
Step h)	74s	Yes	258,6/258,4	8,5%

4.8.1	**Harmonic current emission** **Model: EVT248**										**P**
	Maximum permissible harmonic current as per EN 61000-3-2, Class A										
	Odd harmonics							Even harmonics			
Limit	3rd	5th	7th	9th	11th	13th	15th-n-39th Odd harmonics	2nd	4th	6th	8th-n-40th Even harmonics
Harmonic	2,30	1,14	0,77	0,40	0,33	0,21	0,15 (15/n)	1,08	0,43	0,30	0,23 (8/n)
Test value [A]:	0,011	0,005	0,003	0,004	0,004	0,005	0,005	0,002	0,001	0,001	0,001

4.8.1	Harmonic current emission Model: EVT500										P
	Maximum permissible harmonic current as per EN 61000-3-2, Class A										
	Odd harmonics							Even harmonics			
Limit	3rd	5th	7th	9th	11th	13th	15th-n-39th Odd harmonics	2nd	4th	6th	8th-n-40th Even harmonics
Harmonic	2,30	1,14	0,77	0,40	0,33	0,21	0,15 (15/n)	1,08	0,43	0,30	0,23 (8/n)
Test value [A]:	0,009	0,004	0,003	0,003	0,003	0,004	0,005	0,002	0,001	0,001	0,001

4.8.1	Voltage fluctuation and flicker				P
Model: EVT248					
Test conditions:	Maximum permissible flicker and voltage fluctuation as per EN 61000-3-3				
Limit	P_{st}	P_{lt}	d(t) – 500ms	d_c	d_{max}
	1,0	0,65	3,3%	3,3%	4%
Test value:	0,08	0,09	0,34%	0,34%	0,34%

4.8.1	Voltage fluctuation and flicker				P
Model: EVT500					
Test conditions:	Maximum permissible flicker and voltage fluctuation as per EN 61000-3-3				
Limit	P_{st}	P_{lt}	d(t) – 500ms	d_c	d_{max}
	1,0	0,65	3,3%	3,3%	4%
Test value:	0,08	0,09	0,33%	0,33%	0,33%

4.8.2	DC injection			N/A
Test level power	20%	50%	75%	100%
Recorded value				
As % of rated AC current				
Limit	0,5%	0,5%	0,5%	0,5%

Note:
1. This test is only relevant for inverter-based systems without output transformers.
2. The DC component shall be measured under steady-state conditions for the following power levels: 20 %, 50 %, 75 %, and 100 % of nominal power with a tolerance of ± 5 % of nominal power and as far as adjustable for the tested micro-generator.

Appendix 1:
Photos

EVT 248--Enclosure-Front1

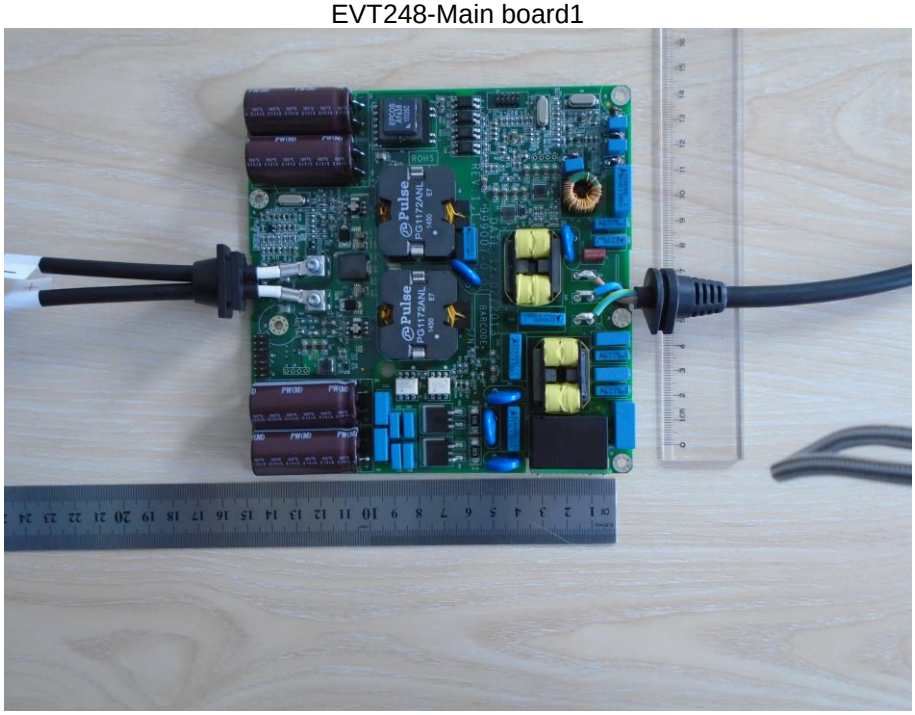
EVT248--Enclosure-Front2

EVT248-Enclosure-Rear1

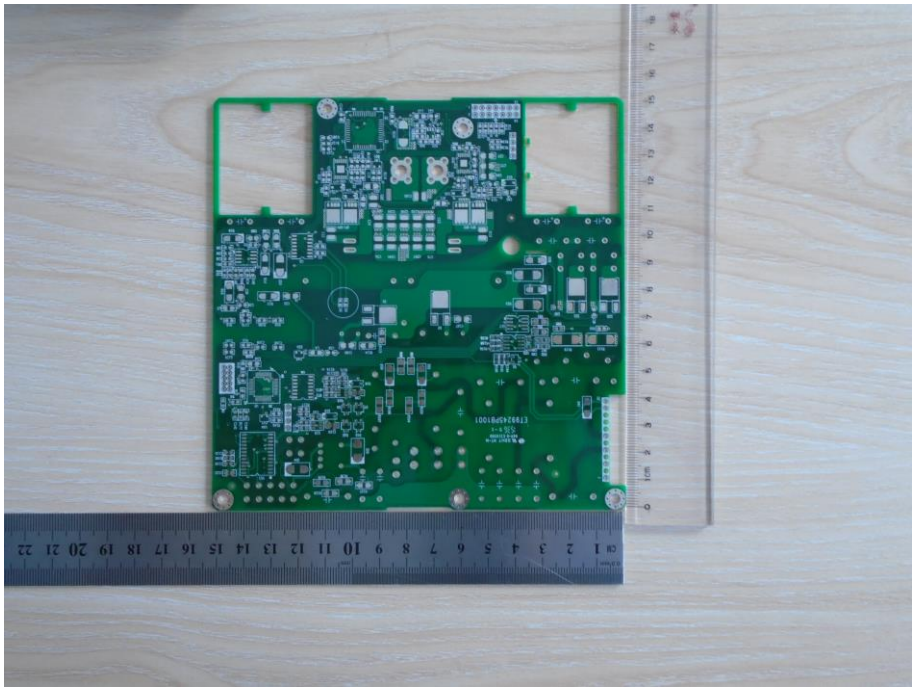
EVT248-Enclosure-Rear2

EVT248-Enclosure-Internal

EVT248-Main board1



EVT248-Main board2



EVT500-Enclosure-Front1

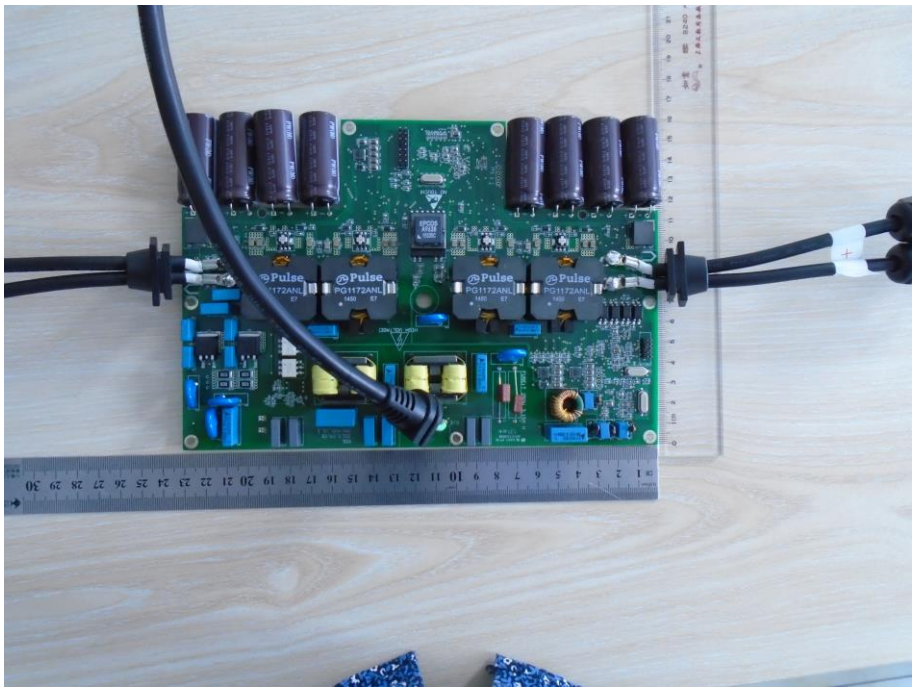
EVT500-Enclosure-Front2

EVT500-Enclosure-Rear

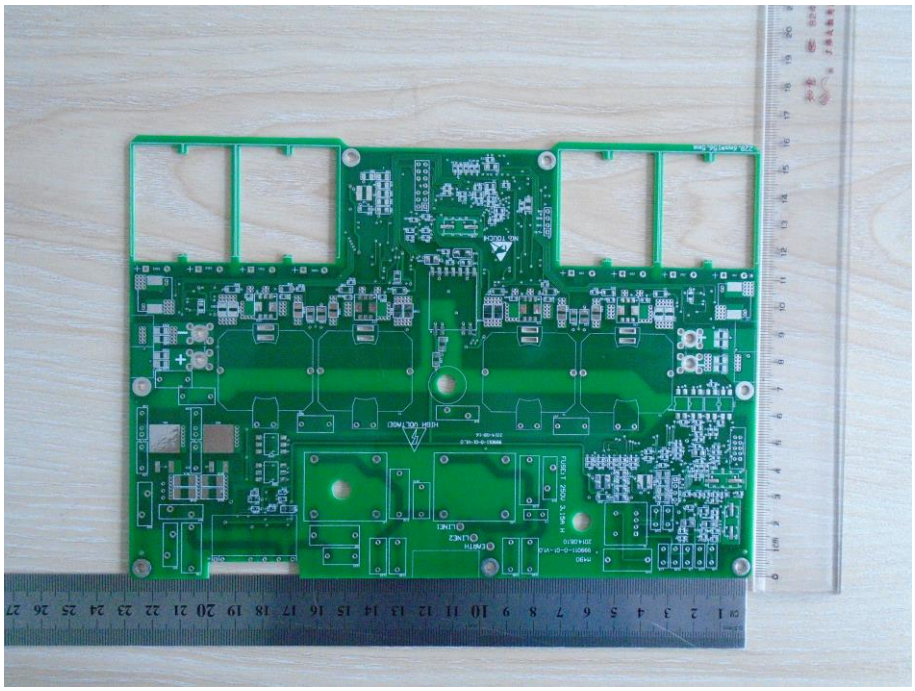
EVT500-Enclosure-Rear2

EVT500-Enclosure-Internal

EVT500-Main board1



EVT500-Main board2



********** End of Report**********