



ELECTRONICS TEST & DEVELOPMENT CENTRE - PUNE
 Standardisation Testing & Quality Certification Directorate
 Department of Electronics & Information Technology
 Ministry of Communication & Information Technology
Government of India
 Agriculture College Campus, Shivajinagar
 PUNE - 411 005

Test Report on:
**Solar Inverter/PCU
 3 Phase type**

Report No: OST-008 (2016-17) Date 28/10/2016 Page 1 of 15

1 Service Request No. OST-008 Date 07/10/2016

2 Service requested by Enertech UPS Pvt. Ltd.
 S.No. 399/1-2, Plot No. 5 Bhare,
 P.O. Ghotawde Pune-412115

2.1 Tested at : Enertech UPS Pvt. Ltd.
 S.No. 399/1-2, Plot No. 5 Bhare,
 P.O. Ghotawde Pune-412115

3. Item submitted on : 13/10/2016 4 Job completed on 14/10/2016

5 Description & Identification of item

Nomenclature	Sr. /ID No.	Type / Model	Make	Qty
Solar Inverter/PCU 3 Phase type Rating: 10 kW, 240VDC	201604028	SunMagic*	Enertech	01

6 Condition of item when received Satisfactory.

7. Test method used: OPT- 01, IEEE std 1547.1-2005, IEC62116:2014 & IEC 61727

8 Test specification of the item As per the customer's specifications given in the column "TEST", "CONDITION", "REQUIREMENT" on page no. 2 to 4 of this report.

9 Major equipments used in the test

Sr.	Name of the Equipment	Calibration Validity (dd-mm-yy)
01	*Digital Multimeter (Rishabh)	22/07/2017
02	*Clamp meter (kusam -meco-151130414)	27/06/2017
03	*Clamp meter (kusam -meco-161071220)	22/07/2017
04	*Digital Power Analyser (Fluke)	22/07/2017
05	*Digital storage Oscilloscope	15/02/2017

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**Solar Inverter/PCU
3 Phase type**

Report No: OST-008(16-17) Date: 28/10/2016 Page 2 of 15

10.0 : TEST SPECIFICATIONS / TEST RESULTS

Sr. No.	Test	Condition	Requirement	Observations
10.1	Performance Test	As per Table 1 of IEC62116:2014 & IEEE std 1547.1-2005 Test Load: (R, L, C) Switch S1 & S2 closed	Value to be recorded. Parameters: 1) Input DC voltage, Current, Power, 2) Output AC Voltage, Current at each phase, Power, Reactive Power, Voltage & Current waveform. 3) Run-on time, Stopping signal. 4) AC Utility Power Source: Active power, reactive Power, Current at each phase.	As per Table -A at page no. 5 of 15
10.2	Voltage & Frequency Trip Parameters (Utility based output trip setting)	As per Table 5 of IEC62116:2014 At over voltage: 115% of nominal voltage. At under Voltage: 85 % of nominal voltage. At over Frequency: 1.5 Hz above the nominal Frequency. At under Frequency: 1.5 Hz below the nominal Frequency.	As per table 5 of IEC62116:2014	Refer Table-B at page no. 6 of 15



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Report No:	OST-008(16-17)	Date	28/10/2016	Page	3	of	15
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10.0 : TEST SPECIFICATIONS / TEST RESULTS

Sr. No.	Test	Condition	Requirement	Observations
10.3	Run-on time	As per Table 5, 6, 7 & 9 of IEC62116:2014 & IEEE std 1547.1-2005 At 33 % ,66 % & maximum load	Value to be recorded. As per Table 5, 6, 7 & 9 of IEC62116:2014	Refer Table-C At page no. 7 of 15
10.4	Voltage and Frequency test	Clause 4.1 of IEC 61727	Should be compatible with the utility. Customer requirement: Voltage should be within 230 VAC±7 % Frequency should be with be within 50Hz ±0.5 %	Complied refer Table-D at page 9 of 15
10.5	Harmonics and Waveform distortion	Clause 4.1 of IEC 61727	Current harmonic distortion limits shall be as in Table-1 of IEC 61727,	Complied Current Total harmonic distortion: R-phase 2.9 % Y-Phase 1.2 % B-Phase 1.1% For harmonics refer Table E at page 9 of 15
10.6	Power factor test	Clause 4.7 of IEC 61727	>0.9	At 100 % load: 0.95 At 60 % load: 0.91
10.7	Personal safety and equipment protection test	Clause 5 of IEC 61727	-----	-----



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Test Report on:
Solar Inverter/PCU
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Report No: OST-008(16-17) Date 28/10/2016 Page 4 of 15

10.0 : TEST SPECIFICATIONS / TEST RESULTS

Sr. No.	Test	Condition	Requirement	Observations
10.7.1	Loss of utility voltage	Ref: IEC 61727, Clause 5.1	EUT should cease to energize the utility system in the specified time limit	Complied
10.7.2	Over/Under voltage	Ref: IEC 61727, Clause 5.2.1	Maximum trip time: < 2 sec	Refer Table B at page 6 of 15
10.7.3	Over/Under frequency	Ref: IEC 61727, Clause 5.2.2	Maximum trip time: < 2 sec	Refer Table B at page 6 of 15
10.8	Islanding protection	Ref: IEC 61727, Clause 5.2.2	Maximum trip time: < 2 sec	Complied At 100 % Balanced load condition trip time is 288 ms.
10.9	Response to Utility recovery	Ref: IEC 61727, Clause 5.4	Value to be measured	Utility condition: Under Voltage- 196 V Recovery time: 38 sec Over Voltage- 263 VAC Recovery time: 46sec
10.10	DC Injection test	Ref: IEC 61727, Clause 4.4	Shall not greater than 1 % of the rated inverter output current (15 A).	Complied.
10.11	Earthing (As per Customer specification)	Visual examination	Earth bar(6 earth stud) mounted on earth side of solar inverter.	Provided
10.12	Short circuit protection (As per Customer specification)	Short circuit at inverter output terminal without load.	EUT should trip & fault mimic should glow with buzzer	Complied
10.13	Isolation and switching (As per Customer specifaion)	Isolation Transformer at inverter stage	Visual examination	Provided



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Test Report on:

**Solar Inverter/PCU
3 Phase type**

Report No: OST-008(16-17) Date 28/10/2016 Page 5 of 15

Table-A
10.1 Performance Test

Parameter	Symbol	Value	Units
EUT DC input			
DC voltage	V_{DC}	232.7	V
DC current	I_{DC}	29.6	A
DC power	P_{DC}	6887.9	W
EUT AC output			
AC voltage	V_{EUT}	R-phase-229 Y-phase-236 B-phase-245	V
AC current	I_{EUT}	R-14.0A Y-12.7A B-5.3A	A
Active power	P_{EUT}	8.5kW	W
Reactive power	Q_{EUT}	3.2kVAr	VAr
Voltage waveform		Attached refer page no. 14 of 15	
Current waveform		Attached refer page no. 14 of 15	--
Run-on time	t_R	288ms at 100% load	s
Stopping signal	SS	Manual stopping	
Test load			
Resistive load current	I_R	R-phase-12.34A Y-phase-13.12A B-phase-13.42A	A
Inductive load current	I_L	R-phase-12.34A Y-phase-13.18A B-phase-13.39A	A
Capacitive load current	I_C	R-phase-12.25A Y-phase-12.88A B-phase-13.30A	A
AC(utility) power source			
Utility active power	P_{AC}	9.3kW	W
Utility reactive power	Q_{AC}	0.1 kVAr	VAr
Utility current	I_{AC}	R-13.3A Y-12.6A B-14.8A	A



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	Report No:	OST-008(16-17)	Date	28/10/2016	Page	6 of 15

Table-B

10.2 Voltage & Frequency Trip Parameters(Utility based output trip setting)

Parameter	Standard applicable	Magnitude		Trip time As per standard (seconds)	Observation (seconds)
		As per standard	Set		
Below under voltage	IEC 61727	$V < 0.5 * V_{nominal}$	----	0.1	Refer Note-1 below
Under voltage	IEC62116 & IEC 61727	85% of normal voltage	196V	2	156ms
Normal Operation	IEC 61727	$85 \% \leq V \leq 110 \%$	230 V	Continuous operation	Complied
Over voltage	IEC62116 & IEC 61727	115% of nominal voltage	265V	2	90.67ms
Above over voltage	IEC 61727	$110 \% < V < 135 \%$	---	0.05	Refer Note-2 below
Over frequency	IEC62116 & IEC 61727	1.5 Hz above Nominal Frequency	52.2Hz	1	129.3ms Refer Note-3 below
Under frequency	IEC62116 & IEC 61727	1.5 Hz below Nominal Frequency	48.1Hz	1	168.0ms Refer Note-3 below

Note-1: EUT trips at 196 VAC hence below this voltage test could not be conducted.

Note-2: EUT trips at 265 VAC hence above this voltage test could not be conducted.

Note-3: Due to limitation of facility test was conducted above $50 \text{ Hz} \pm 2 \text{ Hz}$.

		
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Test Report on:
Solar Inverter/PCU
3 Phase type

Report No: OST-008(16-17) Date: 28/10/2016 Page 7 of 15

Table-C
10.3 Run-on time

No.	PEUT _a (% of EUT rating)	Reactive load (% of Q ₁ in 6.1d1)	P _{ac} _b (% of nominal)	Q _{ac} _c (% of nominal)	Run on time (ms)	PEUT (kW)	Actual ϕ	f _{bc}	Remarks ^d
1	100	100	0	0	288.0	9.6	1.02	230.1	Test A at BL
2	66	66	0	0	288.0	6.6	1.01	242.4	Test B at BL
3	33	33	0	0	152.0	3.30	0.98	253.1	Test C at BL
4	100	100	-5	-5	285.3	8.6	1.13	220.1	Test A at IB
5	100	100	-5	0	258.7	9.6	1.27	218.3	Test A at IB
6	100	100	-5	+5	285.3	9.2	1.29	219.4	Test A at IB
7	100	100	0	-5	253.3	9.2	1.03	233.9	Test A at IB
8	100	100	0	+5	250.7	8.8	1.05	222.6	Test A at IB
9	100	100	+5	-5	256.0	10.02	0.97	225.8	Test A at IB
10	100	100	+5	0	285.3	9.4	0.99	226.8	Test A at IB
11	100	100	+5	+5	258.7	9.8	1.02	223.1	Test A at IB
12	66	66	0	-5	322.7	6.2	0.98	225.1	Test B at IB
13	66	66	0	-4	437.3	6.2	0.98	232.7	Test B at IB
14	66	66	0	-3	253.3	6.2	1.00	228.8	Test B at IB
15	66	66	0	-2	304.0	6.4	1.02	233.9	Test B at IB
16	66	66	0	-1	304.0	6.4	1.02	233.9	Test B at IB
17	66	66	0	1	282.7	6.2	1.01	228.5	Test B at IB



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Test Report on:
Solar Inverter/PCU
3 Phase type

Report No: OST-008(16-17) Date: 28/10/2016 Page 8 of 15

Table-C
10.3 Run-on time

No.	P_{EUT} (% of EUT rating)	Reactive load (% of C_L in 6.1d(1))	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual ϕ	I_{bc}	Remarks *
18	66	66	0	2	580.0	6.4	1.04	243.6	Test B at IB
19	66	66	0	3	580.0	6.4	1.04	243.6	Test B at IB
20	66	66	0	4	288.0	6.3	1.03	238.3	Test B at IB
21	66	66	0	5	266.7	6.2	1.03	237.1	Test C at IB
22	33	33	0	-5	202.1	3.30	0.98	254.2	Test C at IB
23	33	33	0	-4	168.0	3.28	0.98	254.5	Test C at IB
24	33	33	0	-3	232.0	3.30	0.99	254.8	Test C at IB
25	33	33	0	-2	208.0	3.30	0.99	255.7	Test C at IB
26	33	33	0	-1	248.1	3.30	0.99	255.4	Test C at IB
27	33	33	0	1	285.3	3.30	1.00	254.1	Test C at IB
28	33	33	0	2	253.3	3.30	1.00	259.1	Test C at IB
29	33	33	0	3	237.3	3.30	1.00	259.1	Test C at IB
30	33	33	0	4	288.0	3.30	1.01	259.5	Test C at IB
31	33	33	0	5	280.0	3.30	1.02	258.7	Test C at IB

* P_{EUT} : EUT output power.
 † P_{AC} : Active power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
 ‡ Q_{AC} : Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.
 § BI: balance condition, IB: imbalance condition.



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Test Report on:
Solar Inverter/PCU
3 Phase type

Report No: OST-008(16-17) Date 28/10/2016 Page 9 of 15

Table-D
10.4 Voltage and Frequency test

	R-Phase	Y-Phase	B-Phase
Current (A) Load (100%)	14.6	13.6	13.5
Voltage (VAC)	236	224	234
Frequency (Hz)	50.47	50.47	50.47

Table-E
10.5 Harmonics and Waveform distortion

	ODD Current harmonics					EVEN Current harmonics				
	Order	Limit (%)	Measurement (%)			Order	Limit (%)	Measurement (%)		
			R Phase	Y Phase	B Phase			R Phase	Y Phase	B Phase
1	3rd	<4%	2.0	1.7	0.4	2nd	<1%	0.1	0.1	0.2
2	5th	<4%	1.0	0.5	0.7	4th	<1%	0.0	0.1	0.2
3	7th	<4%	1.2	1.1	0.3	6th	<1%	0.0	0.1	0.1
4	9th	<4%	0.7	0.6	0.1	8th	<1%	0.0	0.0	0.3
5	11th	<2%	0.5	0.7	0.4	10th	<0.5%	0.0	0.0	0.2
6	13th	<2%	0.1	0.6	0.3	12th	<0.5%	0.0	0.0	0.2
7	15th	<2%	0.2	0.4	0.1	14th	<0.5%	0.0	0.0	0.2
8	17th	<1.5%	0.5	0.2	0.1	16th	<0.5%	0.0	0.0	0.2
9	19th	<1.5%	0.2	0.3	0.1	18th	<0.5%	0.0	0.0	0.2
10	21st	<1.5%	0.2	0.1	0.1	20th	<0.5%	0.0	0.0	0.1
11	23rd	<0.6%	0.2	0.3	0.1	22nd	<0.5%	0.0	0.0	0.2
12	25th	<0.6%	0.5	0.1	0.1	24th	<0.5%	0.0	0.0	0.1
13	27th	<0.6%	0.2	0.1	0.0	26th	<0.5%	0.0	0.0	0.2
14	29th	<0.6%	0.1	0.3	0.0	28th	<0.5%	0.0	0.0	0.1
15	31st	<0.6%	0.2	0.2	0.0	30th	<0.5%	0.0	0.0	0.2

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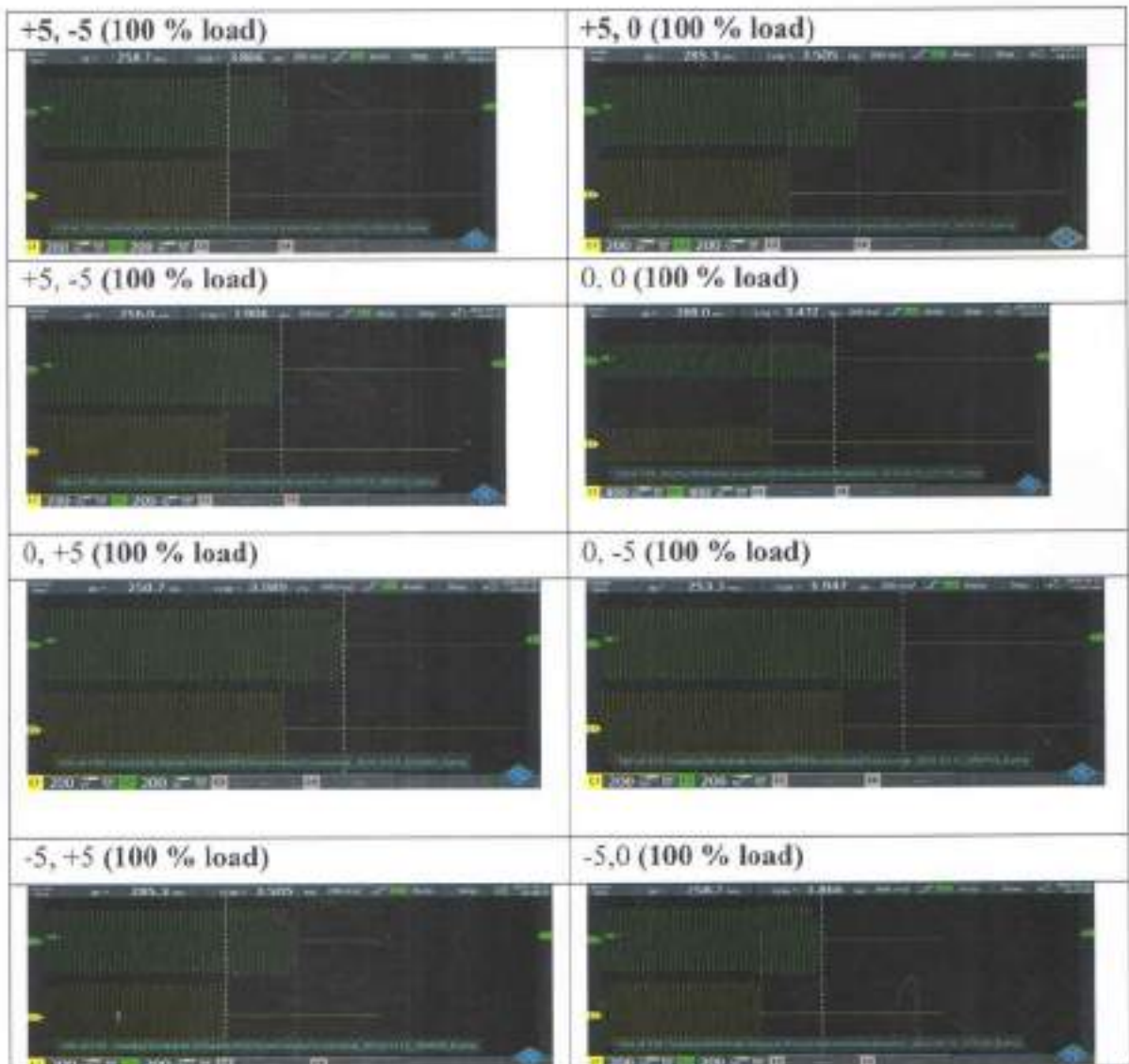
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Test Report on:
Solar Inverter/PCU
3 Phase type

Report No:	OST-008(16-17)	Date	28/10/2016	Page	10	of	15
------------	----------------	------	------------	------	----	----	----

Run on time test: % change in active load, reactive load from nominal output power



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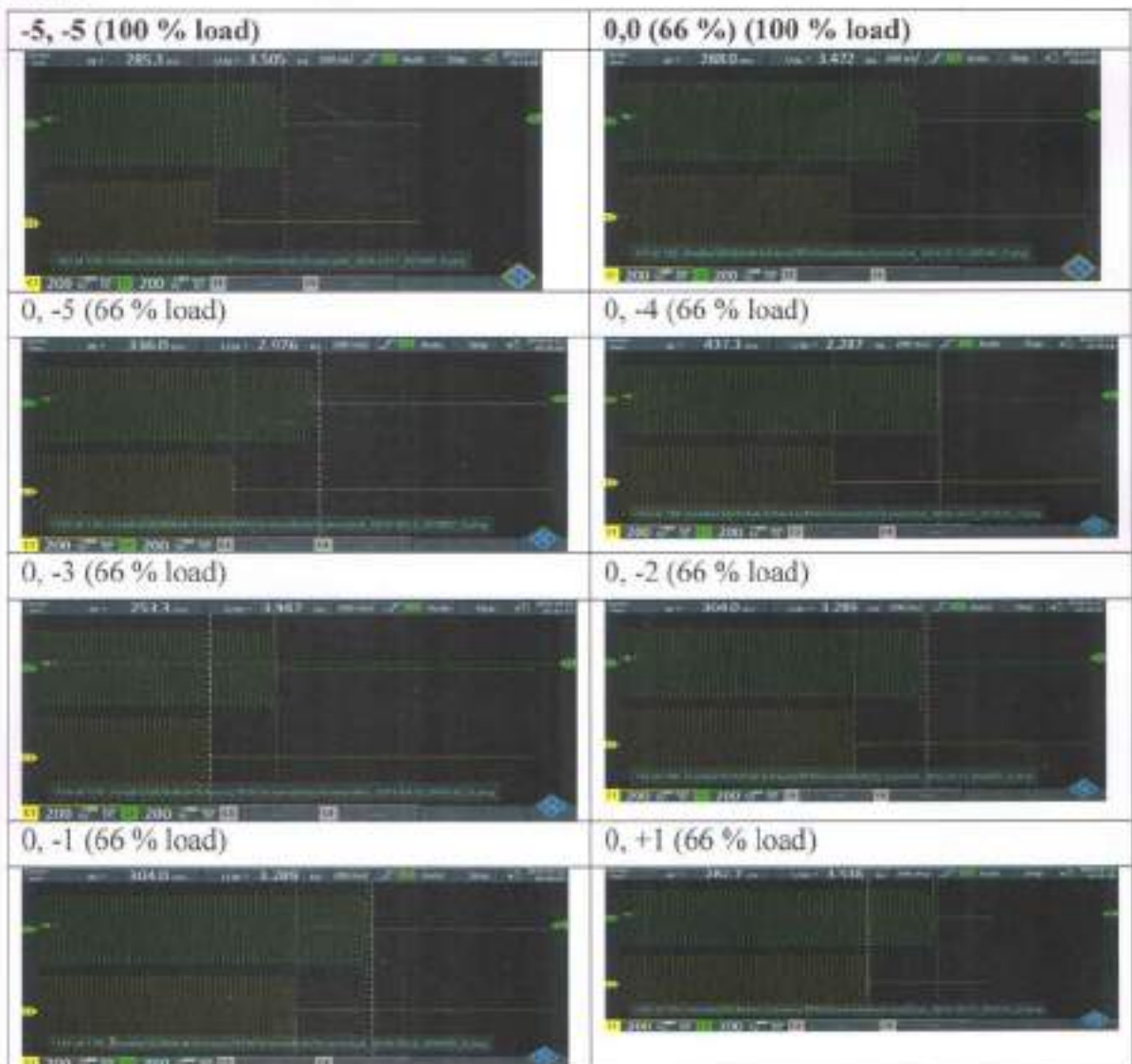


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 PUNE - 411 005

Test Report on:
Solar Inverter/PCU
3 Phase type

Report No:	OST-008(16-17)	Date	28/10/2016	Page	11	of	15
------------	----------------	------	------------	------	----	----	----

Run on time test: % change in active load, reactive load from nominal output power



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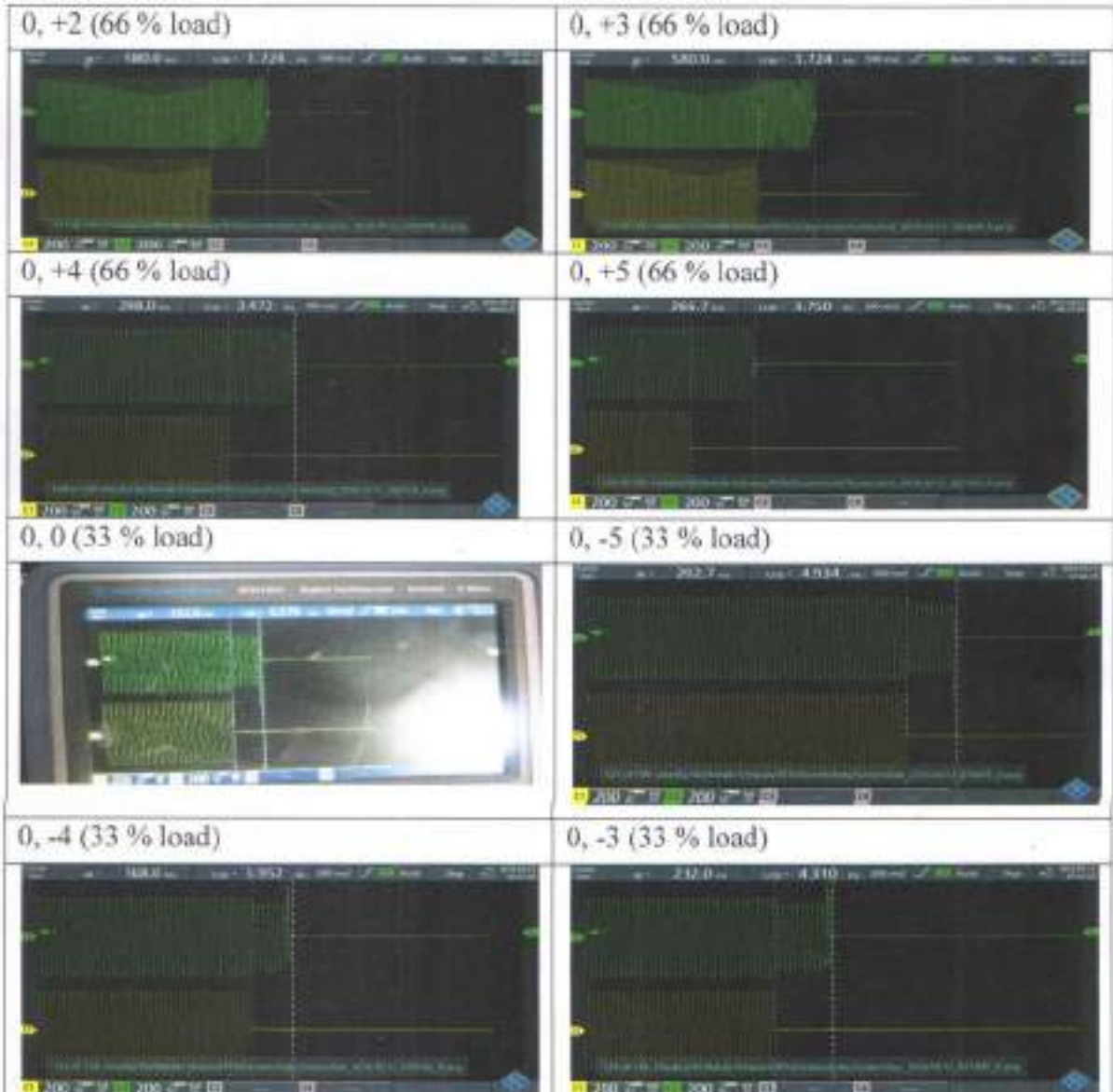


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PUNE - 411 005

Test Report on:
Solar Inverter/PCU
3 Phase type

Report No:	OST-008(16-17)	Date	28/10/2016	Page	12	of	15
------------	----------------	------	------------	------	----	----	----

Run on time test: % change in active load, reactive load from nominal output power



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Test Report on:
Solar Inverter/PCU
3 Phase type

Report No:	OST-008(16-17)	Date	28/10/2016	Page	13	of	15
------------	----------------	------	------------	------	----	----	----

Run on time test: % change in active load, reactive load from nominal output power

0, -2 (33 % load)	0, -1 (33 % load)
0, +1 (33 % load)	0, +2 (33 % load)
0, +3 (33 % load)	0, +4 (33 % load)
0, +5 (33 % load)	



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 PUNE - 411 005

Test Report on:
Solar Inverter/PCU
3 Phase type

Report No: OST-008(16-17) Date 28/10/2016 Page 14 of 15

10.1 EUT AC Output Waveform

Voltage wave form

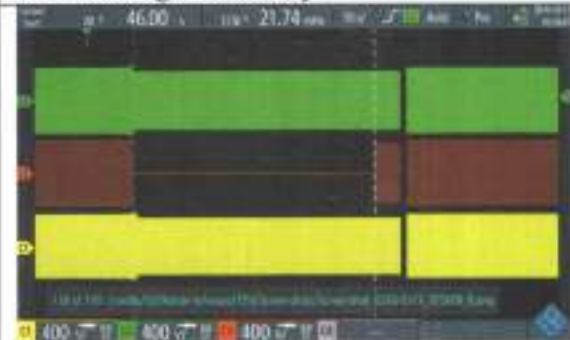


Current waveform

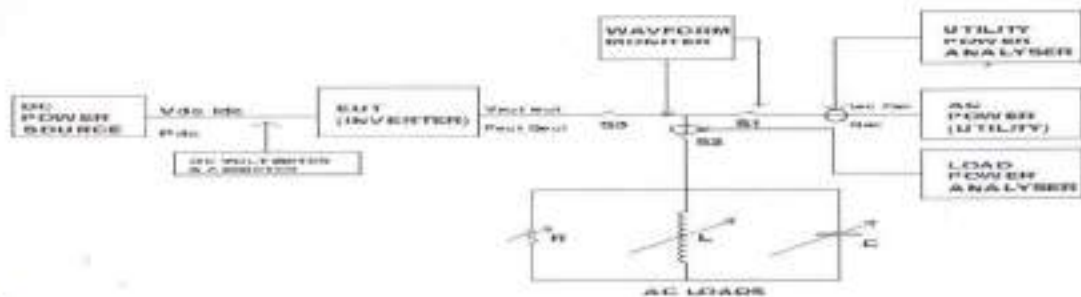
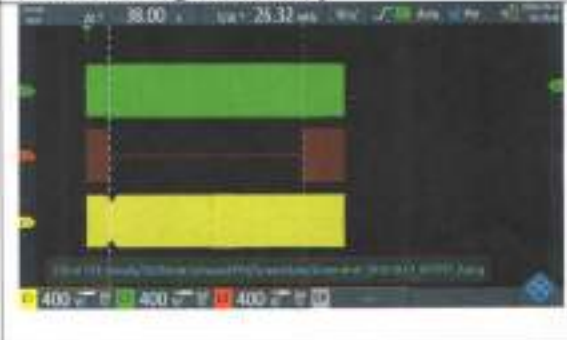


10.9 Response to utility recovery

Over Voltage Recovery



Under Voltage Recovery



BLOCK DIAGRAM OF ISLANDING MEASUREMENT SET UP



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 3 Phase type**

Report No:	OST-008(16-17)	Date	28/10/2016	Page	15	of	15
------------	----------------	------	------------	------	----	----	----

11.0 : Photo of UUT:

Photo of **Solar Inverter/PCU 3 Phase type**
 (Refer Page-1 for Description and Identification of item)



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 (Narendra Kumar)
 Scientist "D"
 Head Testing

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रविंद्र प्र. देशपांडे / R. P. DESHPANDE

इंजीनियर 'सी' / SCIENTIST 'C'

ई.टी.डी.सी.एन. / ETOC, PUNE.

सूचना प्रौद्योगिकी विभाग / DEPT. OF I.T.

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