National Institute of Solar Energy

(Formerly known as Solar Energy Centre)

(An autonomous Institute of Ministry of New & Renewable Energy)

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2014-2015

TEST REPORT ON

SINUSOIDAL PUMP CONTROLLER with MPPT (SPCM) - 5 HP

Sample ID No. : **14/2014/Controller**
Model : **iACQUA-280/5**
Sl. No. : **001/11/14**
Manufactured by: **KISAN SOLAR**
Submitted by : **KISAN SOLAR**
A/2, ATULYA BHAVAN, NEXT TO C.E.R.C, S.G. HIGHWAY
THALTEJ, AHMEDABAD-380054, GUJRAT, INDIA

NOTE

This is a test report on measurements carried out on the Solar Pump Controller for solar water pumping applications (sample Id no. 14/2014/Controller) submitted at National Institute of Solar Energy (NISE). The Solar Pump Controller is tested as per the user specifications. The data reported in this TEST REPORT is valid at the time and under the stipulated conditions of measurement. The test results reported are applicable to this Solar Pump Controller only and do not apply to other PCUs even though declared to be identical. The data contents in this report do not constitute a qualification test certificate. NISE does not accept any liability for any consequences including commercial or otherwise arising out of the utilization of the information contained in this report.

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Kanaiyalal Mithileshkumar

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S.No.	Test performed as per NMRE Specifications	Claims of Manufacturer	NISE's Observations	Remarks
1.	**Input voltage**	300-375V		Maximum Voc allowed at inverter input is 385Vdc
	Inverter Minimum rated voltage		300	
	Inverter Nominal voltage		340	
	Maximum Input voltage		375	
2.	Ripple and Distortion	-	Tested with PV Array Simulator	Given in Tables on page no. 3
3.	Insulation Resistance test	-	800MΩ @ 1000V applied for 1 minutes	
4.	Output Voltage (Sine wave)	Three Phase, 280V AC pure Sine wave	Sine wave	Given in annexure -1
5.	Inductive load	-	Tested with ansons 5 H.P. Pump	
6.	Low irradiation mode protection	Provided	Observed	Satisfactory
7.	Dry run protection	Provided	Observed	Satisfactory
8.	Reverse polarity protection	Provided	Observed	Satisfactory
9.	Short Ckt protection	Provided	Observed	Satisfactory
10.	Open Ckt Protection	Provided	Observed	Satisfactory
11.	Data logging	Provided	NT	NT
12.	**Efficiency Tests of the Controller at Nominal Voltage (340V) and motor's Duty Point @51mtr head**			
	At 25%of input power	**To be measured**	92.2%	
	At 50%of input power		94.2%	
	At 75%of input power		94.8%	
	At 100%of input power		94.9%	
13.	**Average MPPT tracking efficiency (%) @ duty point of motor**		99.9%	
14.	**Rated Output efficiency**	**To be measured**	94.9%	
15.	**Max. PV energy to water Efficiency (%)**	45 meter	47.2%	
		51 meter	47.0%	
16.	**Output voltage THD at rated Ppv**	**To be measured**	1.76%	
17.	**Crest factor at rated Ppv**	**To be measured**	1.45 for V/1.57 for I	

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Table No. 1: Efficiency test of solar pump controller at nominal parameters (340V) and various heads					
Head	**S.No.**	1	2	3	4
	Load (%)	**25**	**50**	**75**	**100**
	DC Input Power (W)	983.8	1949.91	2923.72	3909.32
	Output Voltage R.M.S. Line-Line (V)	166.45	194.43	243.29	273.21
	Frequency(Hz)	31.8	37.6	43.3	49.3
	Output power(W)	910.51	1841.92	2774.08	3712.99
35	**Output power factor**	0.54	0.74	0.80	0.84
Meter	**Output V_{THD} (%)- V1/V2**	-	-	1.86/1.52	1.93/1.56
	Output I_{THD} (%) - I1/I2	-	-	3.11/3.04	2.97/3.01
	Pump Controller Output Efficiency (%)	92.5	94.4	94.8	94.9
	Max. PV Energy to Water Efficiency (%)	33.6			
	Average MPPT tracking Efficiency (%)	99.91			
	DC Input Power (W)	976.83	1949.17	2925.11	3900.58
	Output Voltage R.M.S	166.24	202.28	242.84	270.82
	Frequency(Hz)	31.6	39.0	43.4	48.9
	Output power(W)	906.84	1842.25	2777.93	3708.94
45	**Output power factor**	0.543	0.721	0.80	0.838
Meter	**Output V_{THD} (%)- V1/V2**	-	-	1.878/1.541	1.939/1.582
	Output I_{THD} (%) - I1/I2	-	-	3.14/3.071	2.95/2.986
	Pump Controller Output Efficiency (%)	92.8	94.5	94.9	95.0
	Max. PV Energy to Water Efficiency (%)	47.2			
	Average MPPT tracking Efficiency (%)	99.95			
	DC Input Power (W)	976.64	1950.14	2930.07	3899.7
	Output Voltage R.M.S	173.23	210.74	246.98	269.21
	Frequency(Hz)	32.5	40.4	44.0	48.8
	Output power(W)	901.18	1837.39	2779.57	3703.43
51	**Output power factor**	0.518	0.704	0.796	0.838
Meter	**Output V_{THD} (%)- V1/V2**	-	7.24/7.48	1.88/1.53	1.94/1.58
	Output I_{THD} (%) - I1/I2	-	7.97/8.17	3.21/3.13	2.949/2.98
	Pump Controller Output Efficiency (%)	92.2	94.2	94.8	94.9
	Max. PV Energy to Water Efficiency (%)	47.0			
	Average MPPT tracking efficiency (%)	99.93			
	DC Input Power (W)	-	1950.53	2925.46	3900.31
	Output Voltage R.M.S	-	217.48	239.87	271.40
	Frequency(Hz)		41.8	44.6	49.0
	Output power(W)	-	1836.3	2774.81	3704.71
55	**Output power factor**	-	0.692	0.79	0.837
Meter	**Output V_{THD} (%)- V1/V2**	- -	5.76/3.405	1.887/1.528	1.945/1.587
	Output I_{THD} (%) - I1/I2	- -	5.92/4.93	3.28/3.19	2.979/3.012
	Pump Controller Output Efficiency (%)	-	94.1	94.8	94.9
	Max. PV Energy to Water Efficiency (%)	45.7			
	Average MPPT tracking efficiency (%)	99.94			
	DC Input Power (W)	-	1950.84	2925.61	3899.22
	Output Voltage R.M.S	-	226.90	247.50	269.83
	Frequency(Hz)		43.4	47.8	50.5
	Output power(W)	-	1832.92	2771.89	3704.85
70	**Output power factor**	-	0.67	0.77	0.831
Meter	**Output V_{THD} (%)- V1/V2**	-	1.799/1.643	1.904/1.510	1.96/1.567
	Output I_{THD} (%) - I1/I2	-	4.171/4.141	3.676/3.592	3.193/3.183
	Pump Controller Output Efficiency (%)	-	93.9	94.7	95.0
	Max. PV Energy to Water Efficiency (%)	40.4			
	Average MPPT tracking efficiency (%)	99.95			

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Table No. 2: Performance over specified voltage range and at various heads				
Head	**S.No.**	**1**	**2**	**5**
35 Meter	**Voltage Range**	**Minimum**	**Nominal**	**Maximum**
	Input voltage (V)	300	340	375
	Threshold P_{PV} for start of water discharge (W)*	-	1157	-
	Threshold P_{PV} for stop of water discharge (W)*	-	988.9	-
	Average MPPT tracking efficiency (%)	99.94	99.91	99.92
45 Meter	**Voltage Range**	**Minimum**	**Nominal**	**Maximum**
	Input voltage (V)	300	340	375
	Threshold P_{PV} for start of water discharge (W)*	-	1421.9	-
	Threshold P_{PV} for stop of water discharge (W)*	-	1138.5	-
	Average MPPT tracking efficiency (%)	99.92	99.95	99.89
51 Meter	**Voltage Range**	**Minimum**	**Nominal**	**Maximum**
	Input voltage (V)	300	340	375
	Threshold P_{PV} for start of water discharge (W)*	-	1510.6	-
	Threshold P_{PV} for stop of water discharge (W)*	-	1311.2	-
	Average MPPT tracking efficiency (%)	99.94	99.93	99.92
55 Meter	**Voltage Range**	**Minimum**	**Nominal**	**Maximum**
	Input voltage (V)	300	340	375
	Threshold P_{PV} for start of water discharge (W)*	-	1919.3	-
	Threshold P_{PV} for stop of water discharge (W)*	-	1546.74	-
	Average MPPT tracking efficiency (%)	99.94	99.94	99.90
70 Meter	**Voltage Range**	**Minimum**	**Nominal**	**Maximum**
	Input voltage (V)	300	340	375
	Threshold P_{PV} for start of water discharge (W)*	-	2342.4	-
	Threshold P_{PV} for stop of water discharge (W)*	-	2118.0	-
	Average MPPT tracking efficiency (%)	99.95	99.95	99.92

* P_{PV} – photovoltaic power

* NT – NOT Tested.

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Note:

1. The pump controller is tested using PV array simulator Ametek Make, Model No. ETS600X and the load is 5 Hp submersible pump of Anson Make, Model No. XRF B35 5-6.

2. It is observed that MPPT of Sinusoidal Pump Controller with MPPT (SPCM) is operating at >99.5%, which is remarkable and the performance of the pump with this controller is found to be optimum under the given conditions.

3. The PV array to water efficiency of the system using this controller is about 47% at 45 and 51 meter heads.

4. The crest factor of the SPCM is 1.45, which indicates the wave form is a good sine wave.

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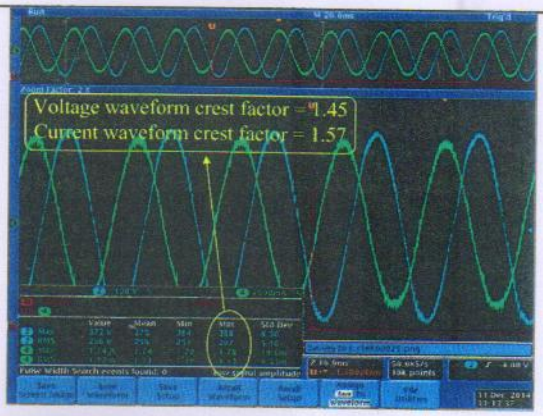
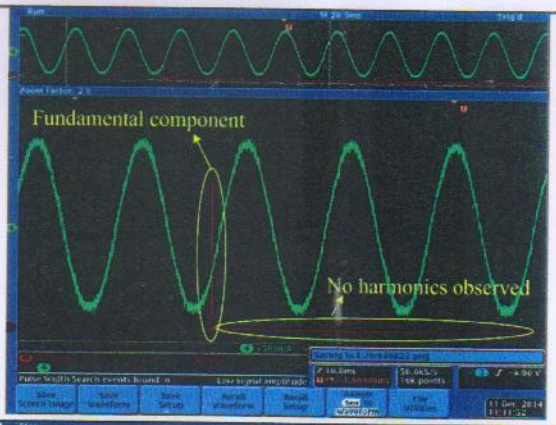
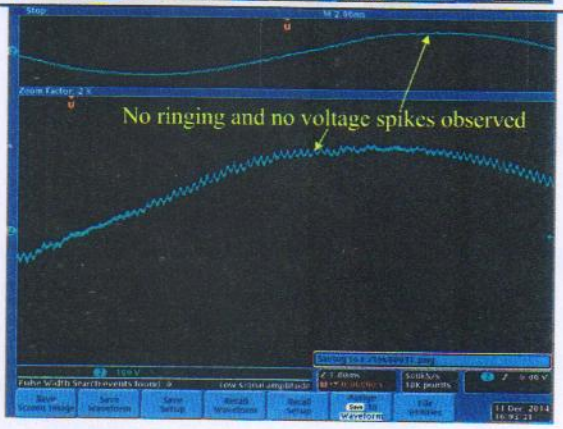
Table No. 3: Instantaneous voltage performance for long motor cable			
S. No.	Description	Waveform recorded	Remark
1	Instantaneous line voltage at PCU terminals		Satisfactory. Crest factors for voltage waveform = 1.45 And current waveform = 1.57
2	Instantaneous line voltage at motor terminals with 60 meter length of motor cable		THD is less than 1.8% and No voltage spikes observed
3	Instantaneous line voltage at motor terminals with 60 meter length of motor cable (Zoomed version)		No ringing observed

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