Certificate of compliance

Applicant: **Delta Electronics, Inc.**
39, Sec. 2, Huandong Road,
Shanhua Dist., Tainan City, 74144,
Taiwan

Product: **Grid-tied photovoltaic (PV) inverter**

Model: **RPI-H3**

Use in accordance with regulations:

Automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G83/2 for photovoltaic systems with a single-phase parallel coupling via an inverter in the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter. This serves as a replacement for the disconnection device with isolating function that can access the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G83/2:2012
Recommendations for the Connection of Type Tested Small-scale Embedded Generators (Up to 16A per Phase) in Parallel with Low-Voltage Distribution Systems

DIN V VDE V 0126-1-1:2006-02 (Functional safety)
Automatic disconnection device between a generator and the public low-voltage grid

At the time of issue of this certificate the safety concept of an aforementioned representative product corresponds to the valid safety specifications for the specified use in accordance with regulations.

Report number: **PVUK121220C20-G83/2**
Certificate number: **U15-0121**
Date of issue: **2015-04-21**

Certification body

Dieter Zitzmann

DAkkS Deutsche Akkreditierungsstelle D-ZE-12024-01-01

Certification body of Bureau Veritas Consumer Products Services Germany GmbH
Accredited according to EN 45011 - ISO / IEC Guide 65

Appendix 4 Type Verification Test Report

Extract from test report according the Engineering Recommendation G83/2 **Nr. PVUK121220C20**

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G83/2.	
Manufacturer / applicant:	Delta Electronics, Inc. 39, Sec. 2, Huandong Road, Shanhua Dist., Tainan City, 74144, Taiwan
SSEG Type	Grid-tied photovoltaic inverter
Rated values	RPI-H3
Maximum rated capacity	3000 W
Rated voltage	230V
Firmware version	DSP 2,00 RED 2,00
Measurement period:	2013-03-12 to 2013-04-30

Description of the structure of the power generation unit (Figure 1):

The power generation unit is equipped with a PV and line-side EMC filter. The power generation unit has no galvanic isolation between DC input and AC output. Output switch-off is performed with single-fault tolerance based on two series-connected relays in line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

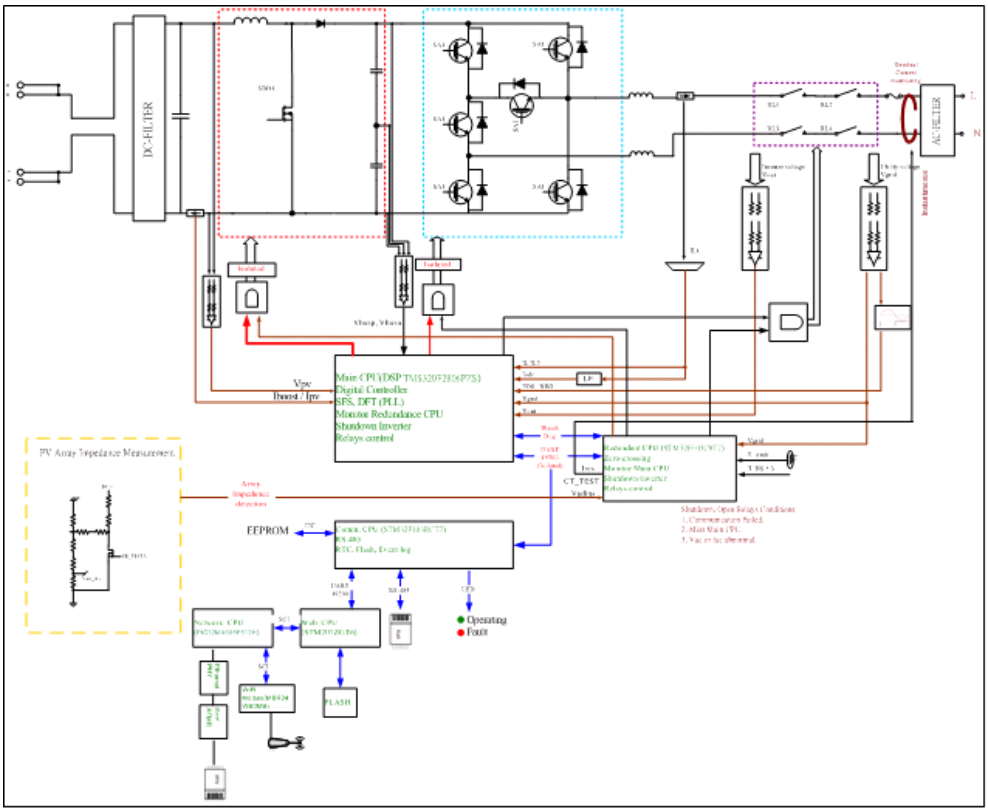

Figure 1 – Schematic structure of the power generation unit

The above stated Small Scale Embedded Generators (SSEGs) are tested according the requirements in the Engineering Recommendation G83/2. Any modification that affects the stated tests must be named by the manufacturer/supplier of the product to ensure that the product meets all requirements of the Engineering Recommendation G83/2.

Appendix 4 Type Verification Test Report

Extract from test report according the Engineering Recommendation G83/2 **Nr. PVUK121220C20**

Protection. Voltage tests.
The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.2

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	200,1V	2,5s	200V	2,61s	204,1V / 3,5s	No Trip
U/V stage 2	184V	0,5s	185V	0,72s	188V / 2,48s	No Trip
					180V / 0,48s	No Trip
O/V stage 1	262,2V	1,0s	261V	1,41s	258,2V 2,0s	No Trip
O/V stage 2	273,7V	0,5s	272V	0,72s	269,7V 0,98s	No Trip
					277,7V 0,48s	No Trip

Note for Voltage tests the Voltage required to trip is the setting ±3,45V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Protection. Frequency tests.
The requirement is specified in section 5.3.1, test procedure in Annex A or B 1.3.3

Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20s	47,55Hz	20,4s	47,7Hz / 25s	No Trip
U/F stage 2	47Hz	0,5s	47,05Hz	0,94s	47,2Hz / 19,98s	No Trip
					46,8Hz / 0,48s	No Trip
O/F stage 1	51,5Hz	90s	51,45Hz	90,4s	51,3Hz / 95s	No Trip
O/F stage 2	52Hz	0,5s	51,95Hz	0,92s	51,8Hz / 89,98s	No Trip
					52,2Hz / 0,48s	No Trip

Note for Frequency Trip tests the Frequency required to trip is the setting ±0,1Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No-trip tests” need to be carried out at the setting ±0,2Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

Appendix 4 Type Verification Test Report

Extract from test report according the Engineering Recommendation G83/2 **Nr. PVUK121220C20**

Protection. Loss of Mains.
The requirement is specified in section 5.3.2, test procedure in Annex A or B 1.3.4

Note as an alternative, inverters can be tested to BS EN 62116. The following sub set of tests should be recorded in the following table.

Balancing load on islanded network	33% of -5% Q Test 22	66% of -5% Q Test 12	100% of -5% P Test 5	33% of +5% Q Test 31	66% of +5% Q Test 21	100% of +5% P Test 10
Trip time. Ph1 fuse removed	301 ms	119 ms	142 ms	169 ms	89 ms	79 ms

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.

Indicate additional shut down time included in above results. (Integrated interface switch)	Type of switching equipment 1: Song Chuan Type 110 Series with 15ms Type of switching equipment 2: Song Chuan Type 110 Series with 15ms

Protection. Re-connection timer.
The requirement is specified in section 5.3.4 Automatic Reconnection, test procedure in Annex A or B 1.3.5

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

Voltage	
Time delay setting	**Measured delay**
20s	248s
Frequency	
Time delay setting	**Measured delay**
20s	192s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 196,1V	At 47,4Hz	At 51,6Hz
Confirmation that the SSEG does not re-connect.	Confirmed	Confirmed	Confirmed	Confirmed

Protection. Frequency change, Stability test.
The requirement is specified in section 5.3.3, test procedure in Annex A or B 1.3.6

	Start Frequency	**Change**	**End Frequency**	**Confirm no trip**
Positive Vector Shift	49,5Hz	+9 degrees		No Trip
Negative Vector Shift	50,5Hz	- 9 degrees		No Trip
Positive Frequency drift	49,5Hz	+0,19Hz/sec	51,5Hz	No Trip
Negative Frequency drift	50,5Hz	-0,19Hz/sec	47,5Hz	No Trip

Appendix 4 Type Verification Test Report

Extract from test report according the Engineering Recommendation G83/2 **Nr. PVUK121220C20**

Power Quality. Harmonics.
The requirement is specified in section 5.4.1, test procedure in Annex A or B 1.4.1

SSEG rating per phase (rpp)					NV=MV*3,68/rpp	
	At 45-55% of rated ouput 1,58kW		100% of rated output 3,03kW			
Harmonic	Measured Value (MV) in Amps	Normalised Value (NV) in Amps	Measured Value (MV) in Amps	Normalised Value (NV) in Amps	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0,0587	0,0479	0,0746	0,0613	1,080	
3rd	0,0889	0,0725	0,1119	0,0920	2,300	
4th	0,0357	0,0291	0,0437	0,0359	0,430	
5th	0,0515	0,0420	0,0635	0,0522	1,140	
6th	0,0262	0,0214	0,0297	0,0244	0,300	
7th	0,0313	0,0255	0,0328	0,0270	0,770	
8th	0,0219	0,0178	0,0240	0,0197	0,230	
9th	0,0261	0,0213	0,0274	0,0225	0,400	
10th	0,0183	0,0149	0,0204	0,0168	0,184	
11th	0,0231	0,0188	0,0240	0,0197	0,330	
12th	0,0190	0,0155	0,0198	0,0163	0,153	
13th	0,0217	0,0177	0,0228	0,0187	0,210	
14th	0,0189	0,0154	0,0196	0,0161	0,131	
15th	0,0207	0,0169	0,0209	0,0172	0,150	
16th	0,0190	0,0155	0,0197	0,0162	0,115	
17th	0,0194	0,0158	0,0203	0,0167	0,132	
18th	0,0199	0,0162	0,0207	0,0170	0,102	
19th	0,0249	0,0203	0,0291	0,0239	0,118	
20th	0,0209	0,0171	0,0217	0,0178	0,092	
21th	0,0269	0,0219	0,0291	0,0239	0,107	0,160
22th	0,0202	0,0164	0,0220	0,0181	0,084	
23th	0,0312	0,0255	0,0385	0,0316	0,098	0,147
24th	0,0203	0,0165	0,0221	0,0182	0,077	
25th	0,0296	0,0241	0,0335	0,0275	0,090	0,135
26th	0,0181	0,0147	0,0201	0,0165	0,071	
27th	0,0291	0,0237	0,0351	0,0289	0,083	0,124
28th	0,0146	0,0119	0,0167	0,0137	0,066	
29th	0,0231	0,0189	0,0264	0,0217	0,078	0,117
30th	0,0120	0,0098	0,0133	0,0109	0,061	
31th	0,0189	0,0154	0,0221	0,0182	0,073	0,109
32th	0,0101	0,0082	0,0105	0,0086	0,058	
33th	0,0146	0,0119	0,0175	0,0144	0,068	0,102
34th	0,0092	0,0075	0,0095	0,0078	0,054	
35th	0,0145	0,0119	0,0160	0,0132	0,064	0,096
36th	0,0078	0,0064	0,0084	0,0069	0,051	
37th	0,0124	0,0101	0,0151	0,0124	0,061	0,091
38th	0,0071	0,0058	0,0081	0,0067	0,048	
39th	0,0114	0,0093	0,0136	0,0112	0,058	0,087
40th	0,0063	0,0052	0,0078	0,0064	0,046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

Appendix 4 Type Verification Test Report

Extract from test report according the Engineering Recommendation G83/2 **Nr. PVUK121220C20**

Power Quality. Power factor.
The requirement is specified in section 5.6, test procedure in Annex A or B 1.4.2

	216,2V	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.
Measured value	0,9989	0,9991	0,9993	
Limit	>0,95	>0,95	>0,95	

Power Quality. Voltage fluctuation and Flicker.
The requirement is specified in section 5.4.2, test procedure in Annex A or B 1.4.3

	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Normalised to standard impedance and 3.68kW for multiple units	0,003%	0,0006%	0,00%	0,00232%	0,00%	0,00%	0,128	0,128
Limits set under BS EN 61000-3-3	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Power Quality. DC injection.
The requirement is specified in section 5.5, test procedure in Annex A or B 1.4.4

Test level power	10%	55%	100%
Recorded value of phase 1	1,04mA	2,51mA	3,23mA
As % of rated AC current phase 1	0,01%	0,02%	0,02%
Limit	0,25%	0,25%	0,25%

Fault level Contribution.
The requirement is specified in section 5.7, test procedure in Annex A or B 1.4.6

For a directly coupled SSEG			For a Inverter SSEG		
Parameter	**Symbol**	**Value**	**Time after fault**	**Volts**	**Amps**
Peak Short Circuit current	I_p	N/A	20ms	145,8V	10,87A
Initial Value of aperiodic current	A	N/A	100ms	86,4V	4,82A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	75,9V	3,27A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	70,3V	2,31A
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to trip**	0,73	In seconds

For rotating machines and linear piston machines the test should produce a 0s – 2s plot of the short circuit current as seen at the Generating Unit terminals.

* Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.

Appendix 4 Type Verification Test Report	
Extract from test report according the Engineering Recommendation G83/2	**Nr. PVUK121220C20**

Self Monitoring – Solid state switching. **The requirement is specified in section 5.3.1, No specified test requirements.**	**N/A**
It has been verified that in the event of the solid state switching device failing to disconnect the SSEG, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.	
Note. Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open.	