Certificate of compliance

Applicant: **Delta Electronics, Inc.**
39, Section 2, Huandong Road, Shanhua Township,
Tainan Country, 74144,
Taiwan

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

Model: **RPI M50A_xxx***
Remark: In the inverter name 'x' can be any number 0 to 9 or letter A to Z or blank

Use in accordance with regulations:

Automatic disconnection device with three-phase mains surveillance in accordance with Engineering Recommendation G59/3 for photovoltaic systems with a three-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 G59/3:2013
Recommendation for the Connection of Generating Plant to the Distribution Systems of licensed Distribution Network Operators.

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

The RPI M50A_xxx* are rated >16A per phase and >50kW (3 phase). The default values for "Small Power Stations" on the low-voltage grid were verified.

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: **PVUK140613C04A-G59/3**
Certificate number: **U14-0663**
Date of issue: **2014-12-11**

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 13.1 Type Testing a Generating Unit	
Extract from test report according the Engineering Recommendation G59/3	**Nr. PVUK140613C04A**

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G59/3.	
Manufacturer / applicant:	**Delta Electronics, Inc.** **39, Section 2, Huandong Road, Shanhua Township,** **Tainan Country, 74144,** **Taiwan**
Generating Unit technology	**Grid-tied photovoltaic inverter**
Rated values	**RPI M50A_xxx***
Maximum rated capacity	**55,0 kW**
Rated voltage	**230V**
Firmware version	**DSP: 1.24, 1.30, 1.40, 1.50, 1.60** **RED: 1.10, 1.20, 1.30, 1.40** **COMM: 1.08, 1.20, 1.50, 1.80, 2.20**
Measurement period:	**2014-06-16 to 2014-12-09**

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.

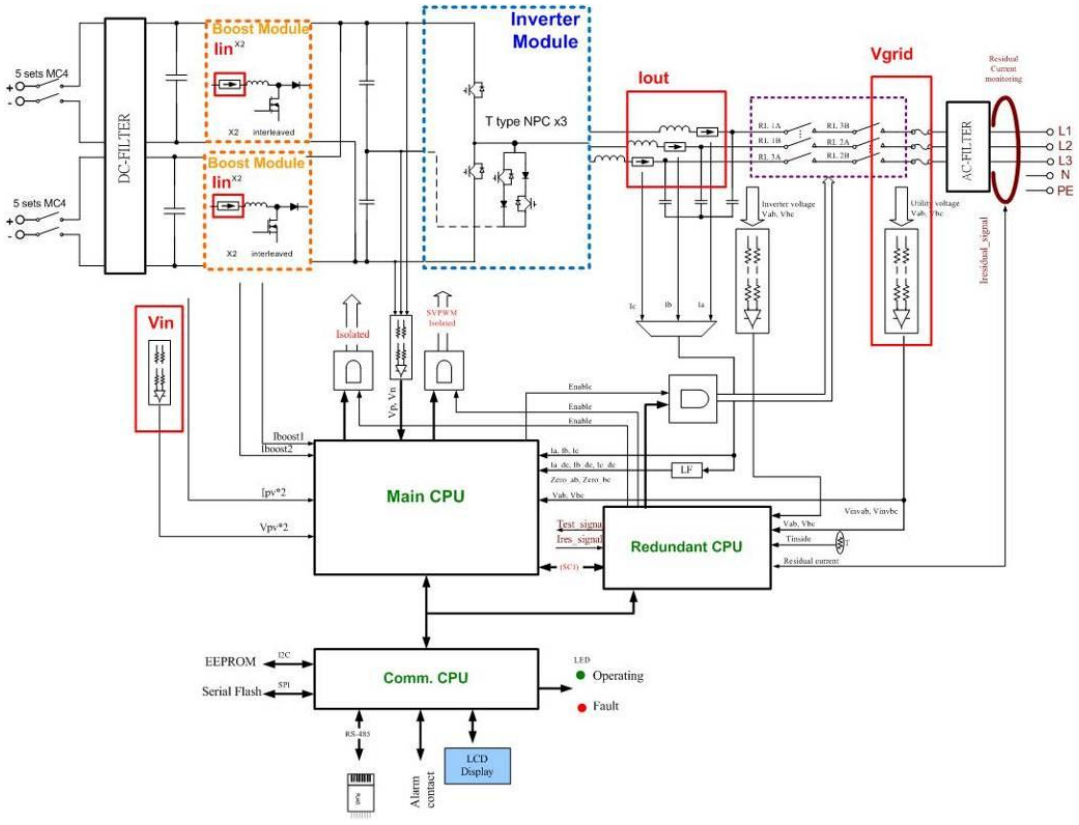

Figure 1 – Schematic structure of the power generation unit

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G59/3. 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 G59/3.

Appendix 13.1 Type Testing a Generating Unit	
Extract from test report according the Engineering Recommendation G59/3	**Nr. PVUK140613C04A**

Protection. Voltage tests.						
Phase 1(230V grid setting)						
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	200,1V	2,511s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	183,8V	0,514s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	263,3V	1,014s	258.2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	274,4V	0,516s	269,7V 0,98s	No trip
					277,7V 0,48s	No trip

Protection. Voltage tests.						
Phase 2 (230V grid setting)						
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	199,8V	2,509s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	183,2V	0,517s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	263,6V	1,005s	258.2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	274,8V	0,513s	269,7V 0,98s	No trip
					277,7V 0,48s	No trip

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3 **Nr. PVUK140613C04A**

Protection. Voltage tests.						
Phase 3 (230V grid setting)						
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	199,2V	2,509s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	183,0V	0,532s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	263,8V	1,019s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	274,6V	0,518s	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. Voltage tests.						
Phase 1 (240V grid setting)						
Function	**Setting**		**Trip test**		**No trip test**	
	Voltage	**Time delay**	**Voltage**	**Time delay**	**Voltage / time**	**Confirm no trip**
U/V stage 1	208,8V	2,5s	208,7V	2,515s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	192,1V	0,507s	196V / 2,48s	No trip
					188V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	273,5V	1,042s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	285,6V	0,512s	281,6V 0,98s	No trip
					289,6V 0,48s	No trip

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3 **Nr. PVUK140613C04A**

Protection. Voltage tests.						
Phase 2 (240V grid setting)						
Function	**Setting**		**Trip test**		**No trip test**	
	Voltage	**Time delay**	**Voltage**	**Time delay**	**Voltage / time**	**Confirm no trip**
U/V stage 1	208,8V	2,5s	208,8V	2,519s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	192,0V	0,509s	196V / 2,48s	No trip
					188V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	273,6V	1,056s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	285,5V	0,516s	281,6V 0,98s	No trip
					289,6V 0,48s	No trip

Protection. Voltage tests.						
Phase 3 (240V grid setting)						
Function	**Setting**		**Trip test**		**No trip test**	
	Voltage	**Time delay**	**Voltage**	**Time delay**	**Voltage / time**	**Confirm no trip**
U/V stage 1	208,8V	2,5s	208,7V	2,512s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	192,1V	0,523s	196V / 2,48s	No trip
					188V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	273,6V	1,049s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	285,5V	0,511s	281,6V 0,98s	No trip
					289,6V 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.

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3 **Nr. PVUK140613C04A**

Protection. Frequency tests.						
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	47,50Hz	20,074s	47,7Hz / 25s	No trip
U/F stage 2	47Hz	0,5s	47,00Hz	0,531s	47,2Hz / 19,98s	No trip
					46,8Hz / 0,48s	No trip
O/F stage 1	51,5Hz	90s	51,50Hz	90,105s	51,3Hz / 95s	No trip
O/F stage 2	52Hz	0,5s	52,00Hz	0,542s	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.						

Protection. Loss of Mains.						
BS EN 62116						
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	336ms	367ms	172ms	328ms	405ms	186ms
Trip time. Ph2 fuse removed	336ms	367ms	172ms	328ms	405ms	186ms
Trip time. Ph3 fuse removed	336ms	367ms	172ms	328ms	405ms	186ms
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: Relay Song Chuan 511H-P-1AH-F-C with 30ms Type of switching equipment 2: Relay Song Chuan 511H-P-1AH-F-C with 30ms		
Note. All relays are direct coupled and open directly by receiving the islanding signal from the controller.						

Appendix 13.1 Type Testing a Generating Unit	
Extract from test report according the Engineering Recommendation G59/3	**Nr. PVUK140613C04A**

Protection. Re-connection timer.	
Test should prove that the reconnection sequence starts in no less than 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 10.5.7.1.	
Voltage (230V grid setting)	
Time delay setting	**Measured delay**
20s	39s
Voltage (240V grid setting)	
Time delay setting	**Measured delay**
20s	38s
Frequency	
Time delay setting	**Measured delay**
20s	40s

230V grid setting				
	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 Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

240V grid setting				
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 277,6V	At 204,8V	At 47,4Hz	At 51,6Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Protection. Frequency change, Stability test.				
	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 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3 **Nr. PVUK140613C04A**

Power Quality. Harmonics.						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated ouput 25kW		**100% of rated output 55kW**			
Harmonic	**Measured Value (MV) in Amps**	**Measured Value (MV) in %**	**Measured Value (MV) in Amps**	**Measured Value (MV) in %**	**Limit in BS EN61000-3-12 in %**	
					1 phase	**3 phase**
2nd	0,190	0,523	0,133	0,167	8%	8%
3rd	0,078	0,215	0,194	0,244	21,6%	N/A
4th	0,132	0,364	0,055	0,069	4%	4%
5th	0,277	0,764	0,324	0,407	10,7%	10,7%
6th	0,219	0,604	0,030	0,038	2,67%	2,67%
7th	0,360	0,991	0,345	0,433	7,2%	7,2%
8th	0,128	0,354	0,030	0,038	2%	2%
9th	0,037	0,102	0,073	0,092	3,8%	N/A
10th	0,074	0,203	0,040	0,050	1,6%	1,6%
11th	0,856	2,360	0,301	0,377	3,1%	3,1%
12th	0,078	0,214	0,020	0,025	1,33%	1,33%
13th	0,662	1,823	0,291	0,366	2%	2%
14th	0,042	0,116	0,030	0,038	N/A	N/A
15th	0,018	0,050	0,030	0,038	N/A	N/A
16th	0,043	0,117	0,020	0,025	N/A	N/A
17th	0,140	0,385	0,090	0,113	N/A	N/A
18th	0,059	0,161	0,010	0,013	N/A	N/A
19th	0,179	0,494	0,110	0,138	N/A	N/A
20th	0,026	0,070	0,010	0,013	N/A	N/A
21th	0,009	0,025	0,010	0,013	N/A	N/A
22th	0,008	0,022	0,010	0,013	N/A	N/A
23th	0,048	0,132	0,080	0,101	N/A	N/A
24th	0,011	0,031	0,020	0,025	N/A	N/A
25th	0,053	0,146	0,080	0,101	N/A	N/A
26th	0,009	0,025	0,010	0,013	N/A	N/A
27th	0,007	0,018	0,010	0,013	N/A	N/A
28th	0,008	0,022	0,010	0,013	N/A	N/A
29th	0,033	0,092	0,070	0,088	N/A	N/A
30th	0,021	0,057	0,010	0,013	N/A	N/A
31th	0,065	0,179	0,060	0,075	N/A	N/A
32th	0,024	0,066	0,010	0,013	N/A	N/A
33th	0,017	0,048	0,010	0,013	N/A	N/A
34th	0,010	0,028	0,010	0,013	N/A	N/A
35th	0,073	0,202	0,050	0,063	N/A	N/A
36th	0,024	0,067	0,010	0,013	N/A	N/A
37th	0,035	0,096	0,050	0,063	N/A	N/A
38th	0,009	0,025	0,010	0,013	N/A	N/A
39th	0,009	0,025	0,010	0,013	N/A	N/A
40th	0,013	0,036	0,009	0,011	N/A	N/A
THD_{40}	3,486%		0,864%		23%	13%
PWHD	3,882%		1,375%		23%	22%

Appendix 13.1 Type Testing a Generating Unit	
Extract from test report according the Engineering Recommendation G59/3	**Nr. PVUK140613C04A**

Power Quality. Power factor.				
230V grid setting				
	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	0,998	0,999	0,998	
Limit	>0,95	>0,95	>0,95	
240V grid setting				
	225,6V	240V	264V	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	0,998	0,999	0,998	
Limit	>0,95	>0,95	>0,95	

Power Quality. Voltage fluctuation and Flicker.								
	Starting			**Stopping**			**Running**	
	dmax	**dc**	**d(t)**	**dmax**	**dc**	**d(t)**	**Pst**	**Plt 2 hours**
Measured values at test impedance	0,67%	0,05%	0,0%	0,67%	0,05%	0,0%	0,83	0,46
Normalised to standard impedance	0,67%	0,05%	0,0%	0,67%	0,05%	0,0%	0,83	0,46
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65
Test impedance	R	0,24* 0,4^	Ω	Xl	0,15* 0,25	Ω		
Standard impedance	R	0,24* 0,4^	Ω	Xl	0,15* 0,25^	Ω		

Appendix 13.1 Type Testing a Generating Unit	
Extract from test report according the Engineering Recommendation G59/3	**Nr. PVUK140613C04A**

Power Quality. DC injection.			
Test level power	10%	55%	100%
Recorded value phase 1	13mA	19mA	30mA
As % of rated AC current phase 1	0,02%	0,02%	0,04%
Limit	0,25%	0,25%	0,25%
Recorded value phase 2	107mA	22mA	30mA
As % of rated AC current phase 2	0,13%	0,03%	0,04%
Limit	0,25%	0,25%	0,25%
Recorded value phase 3	17mA	37mA	40mA
As % of rated AC current phase 2	0,02%	0,05%	0,05%
Limit	0,25%	0,25%	0,25%

Fault level Contribution.					
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	27,04	28,05
Initial Value of aperiodic current	A	N/A	100ms	27,06	N/A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	27,06	N/A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	27,06	N/A
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to trip**	0,074s	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.					

Self Monitoring – Solid state switching.	**N/A**
It has been verified that in the event of the solid state switching device failing to disconnect the Generating Unit, 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.	