

Certificate

Applicant: **Victron Energy B.V.**
De Paal 35
1351 JG Almere-Haven
The Netherlands

Product: **Inverter with integrated automatic disconnection device
between a generator and the public low-voltage grid**

Model:	Multiplus			
	12/3000/120-16	12/3000/120-50	24/3000/70-16	24/3000/70-50
	48/3000/35-16		48/3000/35-50	
Rating:	2,4kW; 3,0kVA			
Model:	Multiplus		Quattro	
	24/5000/120-100		24/5000/120-100/100	
	48/5000/70-50	48/5000/70-100	48/5000/70-100/100	48/5000/70-100/100-S
Rating:	4,5kW; 5,0kVA			
Model:	Quattro			
	48/8000/110-100/100	48/10000/140-100/100	48/15000/200-100/100	
Rating:	6,4kW; 8,0kVA		8,0kW; 10,0kVA	
				12,0kW; 15,0kVA

Intended use:

An automatic disconnection device with single-phase mains surveillance in accordance with Engineering Recommendation G59/3 for generators with a single-phase parallel coupling via an inverter to the public mains supply. The automatic disconnection device is an integral part of the aforementioned inverter.

Applied standards and guidelines:

Engineering Recommendation G59/3-1 Issue 3, Amendment 1 – August 2014

Recommendations for the connection of generating plant to the distribution systems of licensed distribution network operators

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

The above mentioned inverters are also in compliance with the standard, if installed in parallel and three-phase configurations up to 16A per phase. For configurations above 16A per phase the DNO must be consulted.

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Certification Department



Power Quality. Harmonics.

Generating Unit tested to BS EN 61000-3-12

Quattro 48/15000/200-100/100

Generating Unit rating per phase (rpp)			10	kVA	Harmonics % = Measured Value (Amps) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of rated output		100% of rated output		Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	1 phase	3 phase
2	0,33	0,172	0,261	0,115	8%	8%
3	4,98	2,598	1,137	0,501	21,6%	Not stated
4	0,12	0,063	0,115	0,051	4%	4%
5	0,5	0,261	0,569	0,251	10,7%	10,7%
6	0,15	0,078	0,110	0,048	2,67%	2,67%
7	1	0,522	0,313	0,138	7,2%	7,2%
8	0,22	0,115	0,151	0,067	2%	2%
9	0,5	0,261	0,209	0,092	3,8%	Not stated
10	0,13	0,068	0,073	0,032	1,6%	1,6%
11	0,15	0,078	0,110	0,048	3,1%	3,1%
12	0,05	0,026	0,026	0,012	1,33%	1,33%
13	0,62	0,323	0,083	0,037	2%	2%
THD	-	5,781	-	5,270	23%	13%
PWHD	-	3,293	-	2,481	23%	22%

Quattro 48/10000/140-100/100

Generating Unit rating per phase (rpp)			10	kVA	Harmonics % = Measured Value (Amps) x 23/rating per phase (kVA)	
Harmonic	At 45-55% of rated output		100% of rated output		Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	1 phase	3 phase
2	0,31	0,70	0,33	0,76	8%	8%
3	1,88	4,32	2,74	6,30	21,6%	Not stated
4	0,13	0,30	0,13	0,30	4%	4%
5	0,45	1,03	0,51	1,18	10,7%	10,7%
6	0,13	0,30	0,11	0,26	2,67%	2,67%
7	0,22	0,50	0,30	0,69	7,2%	7,2%
8	0,11	0,26	0,11	0,26	2%	2%
9	0,12	0,28	0,16	0,38	3,8%	Not stated
10	0,06	0,13	0,07	0,15	1,6%	1,6%
11	0,05	0,11	0,11	0,26	3,1%	3,1%
12	0,03	0,07	0,03	0,07	1,33%	1,33%
13	0,05	0,10	0,08	0,18	2%	2%
THD	-	11,96	-	8,68	23%	13%
PWHD	-	3,20	-	1,96	23%	22%

Multiplus 24/5000/120-100

Generating Unit rating per phase (rpp)		5	kVA	Harmonics % = Measured Value (Amps) x 23/rating per phase (kVA)		
Harmonic	At 45-55% of rated output		100% of rated output		Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps	%	Measured Value (MV) in Amps	%	1 phase	3 phase
2	0,04	0,22	0,11	0,54	8%	8%
3	0,86	4,41	1,81	9,23	21,6%	Not stated
4	0,01	0,07	0,05	0,27	4%	4%
5	0,51	2,61	0,20	1,02	10,7%	10,7%
6	0,01	0,07	0,04	0,21	2,67%	2,67%
7	0,06	0,29	0,18	0,92	7,2%	7,2%
8	0,03	0,13	0,07	0,35	2%	2%
9	0,07	0,36	0,12	0,63	3,8%	Not stated
10	0,02	0,08	0,03	0,17	1,6%	1,6%
11	0,03	0,16	0,07	0,37	3,1%	3,1%
12	0,01	0,03	0,01	0,05	1,33%	1,33%
13	0,05	0,26	0,05	0,26	2%	2%
THD	-	10,38	-	9,58	23%	13%
PWHD	-	3,28	-	2,43	23%	22%

Generating Unit tested to BS EN 61000-3-2

Multiplus 24/3000/70-50

Generating Unit rating per phase (rpp)		2,4	kW		
Harmonic	At 45-55% of rated output	100% of rated output		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
	Measured Value (MV) in Amps	Measured Value (MV) in Amps			
2	0,04	0,05		1,080	
3	0,58	0,52		2,300	
4	0,03	0,03		0,430	
5	0,17	0,16		1,140	
6	0,02	0,02		0,300	
7	0,08	0,05		0,770	
8	0,02	0,02		0,230	
9	0,05	0,05		0,400	
10	0,01	0,02		0,184	
11	0,03	0,04		0,330	
12	0,00	0,00		0,153	
13	0,02	0,03		0,210	
14	0,00	0,00		0,131	
15	0,01	0,03		0,150	
16	0,00	0,00		0,115	
17	0,00	0,02		0,132	
18	0,00	0,00		0,102	
19	0,01	0,01		0,118	
20	0,00	0,00		0,092	
21	0,01	0,01		0,107	0,160
22	0,00	0,00		0,084	
23	0,01	0,02		0,098	0,147
24	0,00	0,00		0,077	
25	0,01	0,01		0,090	0,135
26	0,00	0,00		0,071	
27	0,00	0,01		0,083	0,124
28	0,00	0,00		0,066	
29	0,00	0,01		0,078	0,117
30	0,00	0,00		0,061	
31	0,01	0,00		0,073	0,109
32	0,00	0,00		0,058	
33	0,01	0,00		0,068	0,102
34	0,00	0,00		0,054	
35	0,00	0,00		0,064	0,096
36	0,00	0,00		0,051	
37	0,00	0,00		0,061	0,091
38	0,00	0,00		0,048	
39	0,00	0,01		0,058	0,087
40	0,00	0,00		0,046	

Power Quality. Voltage fluctuations and flicker
Quattro 48/15000/200-100/100

	Starting			Stopping from full load			Running	
	d _{max}	d _c	d _(t)	d _{max}	d _c	d _(t)	P _{st}	P _{It} 2 hours
Measured Values at test impedance	-1,87	-1,05	0	1,30	1,23	0	0,40	0,40
Normalised to standard impedance	-15,86	-8,88	0	11,07	10,41	0	3,38	3,37
Normalised to required maximum impedance	-1,34	-0,75	0	0,94	0,88	0	0,29	0,29
Limits set under BS EN 61000-3-11	4%	3,3%	3,3%	4%	3,3%	3,3%	1,0	0,65

Quattro 48/10000/140-100/100

	Starting			Stopping from full load			Running	
	d _{max}	d _c	d _(t)	d _{max}	d _c	d _(t)	P _{st}	P _{It} 2 hours
Measured Values at test impedance	6,12	5,91	0	6,10	5,90	0	1,37	1,35
Normalised to standard impedance	6,12	5,91	0	6,10	5,90	0	1,37	1,35
Normalised to required maximum impedance	2,04	1,97	0	2,04	1,97	0	0,46	0,45
Limits set under BS EN 61000-3-11	4%	3,3%	3,3%	4%	3,3%	3,3%	1,0	0,65

Multiplus 24/5000/120-100

	Starting			Stopping from full load			Running	
	d _{max}	d _c	d _(t)	d _{max}	d _c	d _(t)	P _{st}	P _{It} 2 hours
Measured Values at test impedance	-2,79	-2,70	0	3,98	3,83***	0	0,58	0,50
Normalised to standard impedance	-2,79	-2,70	0	3,98	3,83***	0	0,58	0,50
Normalised to required maximum impedance	-2,40	-2,33	0	3,43	3,30	0	0,50	0,43
Limits set under BS EN 61000-3-11	4%	3,3%	3,3%	4%	3,3%	3,3%	1,0	0,65

Multiplus 24/3000/70-50

	Starting			Stopping from full load			Running	
	d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{It} 2 hours
Measured Values at test impedance	0,311	0,150	0,311	1,509	0,036	1,509	0,018	0,018
Normalised to standard impedance	0,311	0,150	0,311	1,509	0,036	1,509	0,018	0,018
Normalised to required maximum impedance	N/A							
Limits set under BS EN 61000-3-11	4%	3,3%	3,3%	4%	3,3%	3,3%	1,0	0,65
Test impedance	R	0,24	Ω	XI	0,15	Ω		
Standard impedance	R	0,24* 0,4**	Ω	XI	0,15* 0,25**	Ω		
Maximum impedance	R	N/A	Ω	XI	N/A	Ω		

*Applies to three phase and split single phase generating units

**Applies to single phase generating units and generating units using two phases on a three phase system.

***The dc is above the limit since the current goes through the normalized impedance. The required maximum supply impedance is 0,35 Ω

Power Quality. Power factor.

	216,2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within + or - 1,5% of the stated level during test.
Measured Value	0,997	0,998	0,995	
Limit	>0,95	>0,95	>0,95	

Protection. Frequency tests

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20,0s	47,50Hz	20,20s	47,7Hz 25s	No trip
U/F stage 2	47,0Hz	0,5s	47,00Hz	0,610s	47,2Hz 19,98s	No trip
					46,8Hz 0,48s	No trip
O/F stage 1	51,5Hz	90,0s	51,53Hz	90,20s	51,3Hz 95s	No trip
O/F stage 2	52,0Hz	0,5s	52,03Hz	0,595s	51,8Hz 89,98s	No trip
					52,2Hz 0,48s	No trip

Protection. Voltage tests

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	200,1V	2,5s	200,1V	2,555s	204,1V 3,5s	No trip
U/V stage 2	184,0V	0,5s	184,0V	0,574s	188,0V 2,48s	No trip
					180,0V 0,48s	No trip
O/V stage 1	262,2V	1,0s	262,3V	1,080s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	273,8V	0,600	269,7V 0,98s	No trip
					277,7V 0,48s	No trip

a) Protection. Loss of Mains test and single phase test

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.

Test power and imbalance	33% P -5% Q	66% P -5% Q	100% P -5% Q	33% P +5% Q	66% P +5% Q	100% P +5% Q
Trip time. Limit is 0.5s	102ms	152ms	142ms	144ms	216ms	178ms

Single phase test for multi phase **Generating Units**. Confirm that when generating in parallel with a network operating at around 50Hz with no network disturbance, that the removal of a single phase connection to the **Generating Unit**, with the remaining phases connected causes a disconnection of the generating unit within a maximum of 1s.

Ph 1 removed	Confirm trip	Ph 2 removed	Confirm trip	Ph 3 removed	Confirm trip

b) 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

c) Protection. Re-connection timer.

Time delay settings (s)	Measured delay (s)	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 10.5.7.1			
20s	22,7s	At 266,2V	At 196,1V	At 47,4Hz	At 51,6Hz
Confirmation that the Generating Unit does not re-connect		No re-connection	No re-connection	No re-connection	No re-connection

d) Fault Level contribution.

For machines with electro-magnetic output			For inverter output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	-	20ms	46,07 V	8,69 A
Initial Value of aperiodic current	A	-	100ms	27,48 V	0,02 A
Initial symmetrical short-circuit current	I_k	-	250ms	27,43 V	0,02 A
Decaying (aperiodic) component of short-circuit current	i_{DC}	-	500ms	27,41 V	0,02 A
Reactance/Resistance Ratio of source	X/R	-	Time to trip	31,27 ms	In seconds