

Certificate G83/2.

SSEG manufacturer/supplier declaration

Manufacturer	N.V. Nederlandsche Apparatenfabriek "Nedap"
Address	Parallelweg 2, 7141 DC Groenlo, The Netherlands
Test house details	Bureau Veritas Consumer Products Services Germany GmbH
Test house address	Businesspark A96, 86842 Türkheim, Germany

Product type reference	PR50S / PR50SB / PR50SBi	PR37S / PR37SB / PR37SBi	PR30S / PR30SB
Max. AC power	5000W	3680W	3000W
Nominal AC power	5000W	3680W	3000W
Grid connection	Single phase	Single phase	Single phase

I certify on behalf of the company named above as a manufacturer/supplier of Small Scale Embedded Generators, that all products manufactured/supplied by the company with the above SSEG Type reference number will be manufactured and tested to ensure that they perform as stated in this Type Verification Test Report, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of G83/2.

Test Summary (for details see attached test report)

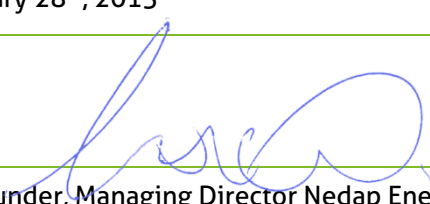
Power Quality

- » Harmonic current emissions as per BS EN 61000-3-2
- » Voltage fluctuations and flicker as per BS EN 61000-3-3
- » DC injection
- » Power factor

Protection

- » Frequency test
- » Voltage test
- » Loss of mains test
- » Frequency change test, stability test
- » Reconnection timer

Fault level contribution

Drawn up in	Groenlo, The Netherlands
Date	January 28 th , 2015
	
Name and position	W. Klunder, Managing Director Nedap Energy Systems

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G83/2 - Appendix 4 - Type Verification Test Report.

All tests were performed on model PR30S provided with software version 6.0.0. unless stated otherwise. Tests on models PR30S and PR50S were considered representative for all PowerRouter models as listed under "Product type reference"

Power Quality. Harmonics. The requirement is specified in section 5.4.1, test procedure in Annex A or B 1.4.1						
Model PR30S						
SSEG rating per phase (rpp)			3	kW	NV=MV*3.68/rpp	
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	Normalised Value (NV) in Amps	Measured Value (MV) in Amps	Normalised Value (NV) in Amps		
2nd	0.049	0.060	0.050	0.061	1.080	
3rd	0.059	0.072	0.063	0.078	2.300	
4th	0.016	0.019	0.009	0.011	0.430	
5th	0.076	0.093	0.100	0.123	1.140	
6th	0.007	0.008	0.006	0.008	0.300	
7th	0.041	0.050	0.078	0.096	0.770	
8th	0.004	0.005	0.005	0.006	0.230	
9th	0.026	0.032	0.051	0.062	0.400	
10th	0.004	0.005	0.005	0.006	0.184	
11th	0.022	0.027	0.035	0.043	0.330	
12th	0.004	0.005	0.005	0.006	0.153	
13th	0.018	0.023	0.030	0.037	0.210	
14th	0.004	0.005	0.004	0.005	0.131	
15th	0.013	0.015	0.021	0.026	0.150	
16th	0.003	0.004	0.003	0.004	0.115	
17th	0.009	0.011	0.018	0.022	0.132	
18th	0.003	0.004	0.003	0.004	0.102	
19th	0.006	0.007	0.013	0.016	0.118	
20th	0.002	0.003	0.003	0.003	0.092	
21th	0.005	0.006	0.012	0.015	0.107	0.160
22th	0.002	0.003	0.003	0.003	0.084	
23th	0.004	0.005	0.010	0.012	0.098	0.147
24th	0.002	0.003	0.003	0.003	0.077	
25th	0.003	0.003	0.009	0.011	0.090	0.135
26th	0.002	0.003	0.002	0.003	0.071	
27th	0.002	0.002	0.007	0.009	0.083	0.124
28th	0.002	0.002	0.002	0.002	0.066	
29th	0.002	0.003	0.008	0.009	0.078	0.117
30th	0.002	0.002	0.002	0.002	0.061	
31th	0.002	0.003	0.006	0.008	0.073	0.109
32th	0.002	0.002	0.002	0.002	0.058	
33th	0.003	0.003	0.006	0.007	0.068	0.102
34th	0.002	0.002	0.002	0.002	0.054	
35th	0.003	0.003	0.006	0.007	0.064	0.096
36th	0.002	0.002	0.002	0.002	0.051	
37th	0.003	0.003	0.004	0.005	0.061	0.091
38th	0.002	0.002	0.002	0.002	0.048	
39th	0.003	0.004	0.005	0.006	0.058	0.087
40th	0.001	0.002	0.001	0.002	0.046	

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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.

N/A

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

Model PR50S

SSEG rating per phase (rpp)		5	kW		NV=MV*3.68/rpp	
Harmonic	At 45-55% of rated output		100% of rated output			
	Measured Value (MV) in Amps	Normalised Value (NV) in Amps	Measured Value (MV) in Amps	Normalised Value (NV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.049	0.060	0.050	0.061	1.080	
3	0.059	0.072	0.063	0.078	2.300	
4	0.016	0.019	0.009	0.011	0.430	
5	0.076	0.093	0.100	0.123	1.140	
6	0.007	0.008	0.006	0.008	0.300	
7	0.041	0.050	0.078	0.096	0.770	
8	0.004	0.005	0.005	0.006	0.230	
9	0.026	0.032	0.051	0.062	0.400	
10	0.004	0.005	0.005	0.006	0.184	
11	0.022	0.027	0.035	0.043	0.330	
12	0.004	0.005	0.005	0.006	0.153	
13	0.018	0.023	0.030	0.037	0.210	
14	0.004	0.005	0.004	0.005	0.131	
15	0.013	0.015	0.021	0.026	0.150	
16	0.003	0.004	0.003	0.004	0.115	
17	0.009	0.011	0.018	0.022	0.132	
18	0.003	0.004	0.003	0.004	0.102	
19	0.006	0.007	0.013	0.016	0.118	
20	0.002	0.003	0.003	0.003	0.092	
21	0.005	0.006	0.012	0.015	0.107	0.160
22	0.002	0.003	0.003	0.003	0.084	
23	0.004	0.005	0.010	0.012	0.098	0.147
24	0.002	0.003	0.003	0.003	0.077	
25	0.003	0.003	0.009	0.011	0.090	0.135
26	0.002	0.003	0.002	0.003	0.071	
27	0.002	0.002	0.007	0.009	0.083	0.124
28	0.002	0.002	0.002	0.002	0.066	
29	0.002	0.003	0.008	0.009	0.078	0.117
30	0.002	0.002	0.002	0.002	0.061	
31	0.002	0.003	0.006	0.008	0.073	0.109
32	0.002	0.002	0.002	0.002	0.058	
33	0.003	0.003	0.006	0.007	0.068	0.102
34	0.002	0.002	0.002	0.002	0.054	
35	0.003	0.003	0.006	0.007	0.064	0.096
36	0.002	0.002	0.002	0.002	0.051	
37	0.003	0.003	0.004	0.005	0.061	0.091

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38	0.002	0.002	0.002	0.002	0.048	
39	0.003	0.004	0.005	0.006	0.058	0.087
40	0.001	0.002	0.001	0.002	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.						
N.A.						

Power Quality. Voltage fluctuations and Flicker. The requirement is specified in section 5.4.2, test procedure in Annex A or B 1.4.3								
Model PR30S								
	Starting		Stopping			Running		
	d _{max}	d _c	d _(t)	d _{max}	d _{c-}	d _(t)	P _{st}	P _{tt} 2 hours
Measured Values	0.27%	2.68%	0.00%	0.27%	2.68%	0.00%	0.07	0.07
Normalised to standard impedance and 3.68kW for multiple units	0.33%	3.28%	0.00%	0.33%	3.28%	0.00%	0.09	0.09
Limits set under BS EN 61000-3-2	4%	3.3%	3.3% 500ms	4%	3.3%	3.3% 500ms	1.0	0.65

Power Quality. Voltage fluctuations and Flicker. The requirement is specified in section 5.4.2, test procedure in Annex A or B 1.4.3								
Model PR50S								
	Starting		Stopping			Running		
	d _{max}	d _c	d _(t)	d _{max}	d _{c-}	d _(t)	P _{st}	P _{tt} 2 hours
Measured Values	0.33%	3.30%	0.00%	0.33%	3.30%	0.00%	0.09	0.09
Normalised to standard impedance and 3.68kW for multiple units	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Limits set under BS EN 61000-3-2	4%	3.3%	3.3% 500ms	4%	3.3%	3.3% 500ms	1.0	0.65
Test start date	2014-05-27		Test end date	2014-06-03				
Test location	See test house details							

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Power quality. DC injection. The requirement is specified in section 5.5, test procedure in Annex A or B 1.4.4				
Model PR30S				
Test power level	10%	55%	100%	
Recorded value	28.82mA	28.60mA	27.29mA	
as % of rated AC current	0.22%	0.22%	0.21%	
Limit	0.25%	0.25%	0.25%	
Model PR50S				
Test power level	10%	55%	100%	
Recorded value	1.24mA	13.96mA	8.71mA	
as % of rated AC current	0.01%	0.06%	0.04%	
Limit	0.25%	0.25%	0.25%	

Power Quality. Power factor. The requirement is specified in section 5.6, test procedure in Annex A or B 1.4.2				
Model PR30S				
	216.2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.
Measured value	0.999	0.999	0.999	
Limit	>0.95	>0.95	>0.95	
Model PR50S				
	216.2V	230V	253V	Measured at three voltage levels and at full output. Voltage to be maintained within $\pm 1.5\%$ of the stated level during the test.
Measured value	0.999	0.999	0.999	
Limit	>0.95	>0.95	>0.95	

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 tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5Hz	20s	47.51Hz	20.01s	47.7Hz 25s	No trip.
U/F stage 2	47Hz	0.5s	47.01Hz	0.515s	47.2Hz 19.98s	No trip.
					46.8Hz 0.48s	No trip.
O/F stage 1	51.5Hz	90s	51.49Hz	90.05s	51.3Hz 95s	No trip.
O/F stage 2	52Hz	0.5s	51.99Hz	0.508s	51.8Hz 89.98s	No trip.
					52.2Hz 0.48s	No trip.

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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 tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V stage 1	200.1V	2.5s	202.0V	2.514s	204.1V 3.5s	No trip.
U/V stage 2	184V	0.5s	186.0V	0.504s	188V 2.48s	No trip.
					180V 0.48s	No trip.
O/V stage 1	262.2V	1.0s	260.0V	1.01s	258.2V 2.0s	No trip.
O/V stage 2	273.7V	0.5s	272.4V	0.503s	269.7V 0.98s	No trip.
					277.7V 0.48s	No trip.

Note for Voltage tests the Voltage required to trip is the setting $\pm 3.45V$. 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 $\pm 4V$ and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

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Protection. Loss of Mains test. The requirement is specified in section 5.3.2, test procedure in Annex A or B 1.3.4						
To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of SSEG output	95% of SSEG output	95% of SSEG output	105% of SSEG output	105% of SSEG output	105% of SSEG output
Trip time. Limit is 0.5 seconds	N.A	N.A	N.A	N.A	N.A	N.A
For Multi-phase SSEGs confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of SSEG output	95% of SSEG output	95% of SSEG output	105% of SSEG output	105% of SSEG output	105% of SSEG output
Trip time. Ph1 fuse removed	N.A	N.A	N.A	N.A	N.A	N.A
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of SSEG output	95% of SSEG output	95% of SSEG output	105% of SSEG output	105% of SSEG output	105% of SSEG output
Trip time. Ph2 fuse removed	N.A	N.A	N.A	N.A	N.A	N.A
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of SSEG output	95% of SSEG output	95% of SSEG output	105% of SSEG output	105% of SSEG output	105% of SSEG output
Trip time. Ph3 fuse removed	N.A	N.A	N.A	N.A	N.A	N.A
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.					-ms	
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.						
Model PR30S						
Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5s*	464ms	321ms	657ms	379ms	303ms	492ms
Model PR50S						
Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5s*	336ms	320ms	737ms	379ms	320ms	446ms
Note: 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.						

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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.

Protection. Re-connection timer. The requirement is specified in section 5.3.4, 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.					
Time delay setting	Measured delay	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.		No reconnection	No reconnection	No reconnection	No reconnection

Fault level contribution. The requirement is specified in section 5.7, test procedure in Annex A or B 1.4.6					
Model PR30S					
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	77.32	37.51
Initial Value of aperiodic current	A	N/A	100ms	72.55	16.79
Initial symmetrical short-circuit current*	I_k	N/A	250ms	71.73	10.63
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	71.47	7.53
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0.018	In seconds

Model PR50S					
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	83.19	37.61
Initial Value of aperiodic current	A	N/A	100ms	73.31	16.83
Initial symmetrical short-circuit current*	I_k	N/A	250ms	71.66	10.65
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	71.07	7.54
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0.018	In seconds
Note: The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report including the time taken for the Inverter to trip.					

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TEST REPORT

TEST RESULTS

Self-Monitoring solid state switching The requirement is specified in section 5.3.1, No specified test requirements.	Yes/or NA
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.	N/A

Additional comments
N/A