Certificate of compliance

Applicant:	**Fronius International GmbH** **Günter Fronius Straße 1** **4600 Wels-Thalheim** **Austria**
Product:	**Photovoltaic (PV) inverter**
Model:	**Symo 10.0-3-M**

Use in accordance with regulations:

Automatic disconnection device with three-phase mains surveillance in accordance with Engineering Recommendation G98/1 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, which can be accessed the distribution network provider at any time.

Applied rules and standards:

Engineering Recommendation G98/1-4:2019
Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks

DIN V VDE V 0126-1-1:2006-02 (4.1 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:	**19TH0407-G98/1_0**	**Certification program:**	**NSOP-0032-DEU-ZE-V01**
Certificate number:	**U20-0470**	**Date of issue:**	**2020-06-19**

Certification body

Thomas Lammel

Certification body Bureau Veritas Consumer Products Services Germany GmbH accredited according to DIN EN ISO/IEC 17065

A partial representation of the certificate requires the written approval of Bureau Veritas Consumer Products Services Germany GmbH

Appendix C Type Test Verification Report	
Extract from test report according to the Engineering Recommendation G98/1	**Nr. 19TH0407-G98/1_0**

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G98/1.			
PGM Technology	Photovoltaic inverter		
Manufacturer	Fronius International GmbH		
Address	Günter Fronius Straße 1 4600 Wels-Thalheim Austria		
Tel	+43 7242 241-2330	**Fax:**	+43 7242 241-952330
Email	feichtinger.josef@fronius.com	**Website:**	www.fronius.com

Rated values	Symo10.0-3-M			
MPP DC voltage range [V]	270 - 800			
Input DC voltage range [V]	200 - 1000			
Input DC current [A]	27,0 / 16,5			
Output AC voltage [V]	3~NPE 220 / 230			
Output AC current [A]	14,5			
Output power [VA]	10000			

Firmware version	Beginning with V1.1.5.0
Measurement period:	2020-04-29 – 2020-05-08

Description of the structure of the power generation unit:

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 each line and neutral. This enables a safe disconnection of the power generation unit from the network in case of error.

The above stated Generating Units are tested according the requirements in the Engineering Recommendation G98/1. 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 G98/1.

Appendix C Type Test Verification Report	
Extract from test report according to the Engineering Recommendation G98/1	**Nr. 19TH0407-G98/1_0**

Operating Range.	
Test 1	Voltage = 85% of nominal (195,5 V) Frequency = 47,5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 2	Voltage = 110% of nominal (253 V) Frequency = 51,5 Hz Power Factor = 1 Period of test 90 minutes
Connection:	Always connected
Limit:	Always connected
Test 3	Voltage = 110% of nominal (253 V) Frequency = 52,0 Hz Power Factor = 1 Period of test 15 minutes
Connection:	Always connected
Limit:	Always connected

Protection. Voltage tests.						
Phase 1						
Function	**Setting**		**Trip test**		**No trip test**	
	Voltage [V]	**Time delay [s]**	**Voltage [V]**	**Time delay [s]**	**Voltage / time**	**Confirm no trip**
U/V	184	2,5	184,1	2,602	188V / 5s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,0	1,022	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	275,0	0,538	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

Appendix C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1 **Nr. 19TH0407-G98/1_0**

Protection. Voltage tests.

Phase 2

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184	2,5	184,3	2,589	188V / 5s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,0	1,022	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	275,0	0,538	269,7V 0,95s	No trip
					277,7V 0,45s	No trip

Protection. Voltage tests.

Phase 3

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184	2,5	184,4	2,587	188V / 5s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2	1,0	263,3	1,037	258,2V 5,0s	No trip
O/V stage 2	273,7	0,5	275,0	0,527	269,7V 0,95s	No trip
					277,7V 0,45s	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 C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1 **Nr. 19TH0407-G98/1_0**

Protection. Frequency tests.

Function	Setting		Trip test		No trip test	
	Frequency [Hz]	Time delay [s]	Frequency [Hz]	Time delay [s]	Frequency / time	Confirm no trip
U/F stage 1	47,5	20	47,50	20,07	47,7Hz / 30s	No trip
U/F stage 2	47	0,5	47,00	0,540	47,2Hz / 19,5s	No trip
					46,8Hz / 0,45s	No trip
O/F stage 2	52	0,5	52,00	0,540	51,8Hz / 120s	No trip
					52,2Hz / 0,45s	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.

Inverters tested according to 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 [s]	0,170	0,166	0,382	0,206	0,194	0,302
Trip time. Ph1 fuse removed [s]	0,170	0,166	0,382	0,206	0,194	0,302
Trip time. Ph1 fuse removed [s]	0,170	0,166	0,382	0,206	0,194	0,302

Note. Trip time limit is 0,5s.

Appendix C Type Test Verification Report	
Extract from test report according to the Engineering Recommendation G98/1	**Nr. 19TH0407-G98/1_0**

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 2.	
Over Voltage	
Time delay setting	**Measured delay**
20s	75s
Under Voltage	
Time delay setting	**Measured delay**
20s	80s
Over Frequency	
Time delay setting	**Measured delay**
20s	76s
Under Frequency	
Time delay setting	**Measured delay**
20s	57s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 180,0V	At 47,4Hz	At 52,1Hz
Confirmation that the Generating Unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Protection. Frequency change, Stability test.				
	Start Frequency [Hz]	**Change**	**Test Duration**	**Confirm no trip**
Positive Vector Shift	49,0	+50 degrees		No trip
Negative Vector Shift	50,0	-50 degrees		No trip
Positive Frequency drift	49,0 to 51,0	+0,95Hz/sec	2,1s	No trip
Negative Frequency drift	51,0 to 49,0	-0,95Hz/sec	2,1s	No trip

Appendix C Type Test Verification Report	
Extract from test report according to the Engineering Recommendation G98/1	**Nr. 19TH0407-G98/1_0**

Limited Frequency Sensitive Mode – Over Frequency							
1-min mean value [Hz]:	**a) 50,00**	**b) 50,45**	**c) 50,70**	**d) 51,15**	**e) 50,70**	**f) 50,45**	**g) 50,00**
1. Measurement a) to g): Active power output > 80% Pn							
Frequency [Hz]:	50,00	50,45	50,71	51,14	50,70	50,44	50,00
$P_{expected}$ [kW]:	N/A	10,04	9,78	9,34	9,78	10,04	N/A
$P_{measured}$ [kW]:	10,08	9,98	9,46	8,59	9,48	9,99	10,08
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% Pn							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	N/A	5,05	4,92	4,69	4,92	5,05	N/A
$P_{measured}$ [kW]:	5,07	5,02	4,77	4,32	4,77	5,02	5,58

Output Power with falling Frequency			
5-min mean value (each)	**a) 50 ± 0,01 Hz**	**b) - 0,4 to - 0,5 Hz**	**c) - 2,4 to - 2,5 Hz**
Frequency [Hz]:	50,00	49,50	47,60
Active power [W]:	9,99	9,98	9,98
ΔP/Pmax [%]:			0,2
Note. Electronic inverter no power reduction take place..			

Appendix C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1 **Nr. 19TH0407-G98/1_0**

Power Quality. Harmonics.

Symo10.0-3-M

Phase 1

SSEG rating per phase (rpp)						
	At 45-55% of rated output 1,68kW		100% of rated output 3,30kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0,017	0,120	0,018	0,127	1,080	
3rd	0,063	0,443	0,061	0,431	2,300	
4th	0,029	0,202	0,028	0,195	0,430	
5th	0,048	0,335	0,048	0,341	1,140	
6th	0,019	0,137	0,020	0,138	0,300	
7th	0,057	0,400	0,059	0,414	0,770	
8th	0,023	0,163	0,024	0,168	0,230	
9th	0,044	0,310	0,047	0,328	0,400	
10th	0,018	0,125	0,017	0,122	0,184	
11th	0,040	0,284	0,027	0,194	0,330	
12th	0,010	0,071	0,010	0,070	0,153	
13th	0,024	0,168	0,043	0,302	0,210	
14th	0,011	0,075	0,011	0,078	0,131	
15th	0,019	0,134	0,023	0,161	0,150	
16th	0,010	0,072	0,010	0,068	0,115	
17th	0,013	0,092	0,020	0,141	0,132	
18th	0,007	0,049	0,007	0,050	0,102	
19th	0,010	0,072	0,012	0,087	0,118	
20th	0,009	0,060	0,008	0,055	0,092	
21th	0,006	0,045	0,007	0,051	0,107	0,160
22th	0,009	0,065	0,009	0,063	0,084	
23th	0,006	0,044	0,006	0,044	0,098	0,147
24th	0,004	0,030	0,004	0,029	0,077	
25th	0,006	0,044	0,009	0,060	0,090	0,135
26th	0,008	0,054	0,008	0,053	0,071	
27th	0,007	0,052	0,007	0,049	0,083	0,124
28th	0,006	0,042	0,006	0,041	0,066	
29th	0,006	0,043	0,006	0,042	0,078	0,117
30th	0,005	0,036	0,005	0,032	0,061	
31th	0,007	0,053	0,006	0,040	0,073	0,109
32th	0,008	0,056	0,005	0,036	0,058	
33th	0,009	0,060	0,005	0,037	0,068	0,102
34th	0,010	0,068	0,007	0,047	0,054	
35th	0,008	0,057	0,006	0,044	0,064	0,096
36th	0,006	0,041	0,005	0,037	0,051	
37th	0,007	0,048	0,006	0,045	0,061	0,091
38th	0,007	0,052	0,009	0,063	0,048	
39th	0,005	0,033	0,009	0,064	0,058	0,087
40th	0,007	0,052	0,010	0,072	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 C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1 **Nr. 19TH0407-G98/1_0**

Power Quality. Harmonics.

Phase 2

SSEG rating per phase (rpp)						
	At 45-55% of rated output 1,70kW		100% of rated output 3,31kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0,040	0,280	0,040	0,283	1,080	
3rd	0,040	0,283	0,035	0,245	2,300	
4th	0,023	0,158	0,022	0,152	0,430	
5th	0,031	0,218	0,044	0,310	1,140	
6th	0,027	0,186	0,027	0,193	0,300	
7th	0,011	0,074	0,011	0,080	0,770	
8th	0,014	0,096	0,014	0,095	0,230	
9th	0,008	0,053	0,008	0,055	0,400	
10th	0,015	0,103	0,015	0,103	0,184	
11th	0,011	0,074	0,027	0,186	0,330	
12th	0,018	0,124	0,018	0,123	0,153	
13th	0,011	0,074	0,026	0,184	0,210	
14th	0,011	0,077	0,011	0,079	0,131	
15th	0,008	0,053	0,010	0,072	0,150	
16th	0,009	0,061	0,009	0,060	0,115	
17th	0,008	0,054	0,014	0,101	0,132	
18th	0,010	0,070	0,010	0,072	0,102	
19th	0,010	0,070	0,015	0,104	0,118	
20th	0,007	0,046	0,006	0,045	0,092	
21th	0,007	0,047	0,008	0,057	0,107	0,160
22th	0,006	0,041	0,006	0,039	0,084	
23th	0,006	0,041	0,007	0,052	0,098	0,147
24th	0,006	0,044	0,006	0,042	0,077	
25th	0,008	0,053	0,010	0,073	0,090	0,135
26th	0,006	0,040	0,006	0,039	0,071	
27th	0,004	0,025	0,004	0,027	0,083	0,124
28th	0,006	0,039	0,006	0,039	0,066	
29th	0,004	0,028	0,004	0,030	0,078	0,117
30th	0,007	0,048	0,007	0,049	0,061	
31th	0,004	0,028	0,004	0,028	0,073	0,109
32th	0,006	0,039	0,006	0,039	0,058	
33th	0,004	0,029	0,004	0,025	0,068	0,102
34th	0,005	0,035	0,005	0,032	0,054	
35th	0,005	0,036	0,007	0,046	0,064	0,096
36th	0,005	0,032	0,005	0,035	0,051	
37th	0,005	0,032	0,004	0,031	0,061	0,091
38th	0,005	0,034	0,005	0,037	0,048	
39th	0,005	0,037	0,007	0,049	0,058	0,087
40th	0,005	0,035	0,006	0,039	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 C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1 **Nr. 19TH0407-G98/1_0**

Power Quality. Harmonics.

Phase 3

SSEG rating per phase (rpp)						
	At 45-55% of rated output 1,68kW		100% of rated output 3,30kW			
Harmonic	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Measured Value (MV) in [A]	Measured Value (MV) in [%]	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2nd	0,042	0,293	0,042	0,297	1,080	
3rd	0,031	0,220	0,032	0,228	2,300	
4th	0,025	0,178	0,024	0,166	0,430	
5th	0,034	0,240	0,048	0,339	1,140	
6th	0,025	0,174	0,026	0,181	0,300	
7th	0,015	0,103	0,014	0,096	0,770	
8th	0,018	0,127	0,020	0,139	0,230	
9th	0,011	0,074	0,012	0,082	0,400	
10th	0,016	0,114	0,016	0,114	0,184	
11th	0,016	0,114	0,025	0,175	0,330	
12th	0,020	0,139	0,019	0,133	0,153	
13th	0,010	0,070	0,026	0,183	0,210	
14th	0,010	0,070	0,011	0,077	0,131	
15th	0,009	0,063	0,011	0,077	0,150	
16th	0,008	0,056	0,008	0,056	0,115	
17th	0,009	0,063	0,017	0,116	0,132	
18th	0,012	0,086	0,012	0,086	0,102	
19th	0,008	0,056	0,013	0,094	0,118	
20th	0,008	0,056	0,008	0,059	0,092	
21th	0,006	0,043	0,008	0,056	0,107	0,160
22th	0,007	0,046	0,006	0,045	0,084	
23th	0,007	0,048	0,009	0,060	0,098	0,147
24th	0,006	0,044	0,006	0,043	0,077	
25th	0,008	0,053	0,010	0,073	0,090	0,135
26th	0,005	0,035	0,005	0,036	0,071	
27th	0,006	0,041	0,006	0,041	0,083	0,124
28th	0,006	0,041	0,006	0,041	0,066	
29th	0,007	0,049	0,006	0,042	0,078	0,117
30th	0,008	0,055	0,007	0,051	0,061	
31th	0,006	0,044	0,004	0,032	0,073	0,109
32th	0,008	0,054	0,006	0,040	0,058	
33th	0,008	0,054	0,004	0,030	0,068	0,102
34th	0,008	0,056	0,005	0,035	0,054	
35th	0,009	0,060	0,007	0,053	0,064	0,096
36th	0,007	0,046	0,006	0,041	0,051	
37th	0,006	0,041	0,006	0,044	0,061	0,091
38th	0,006	0,045	0,008	0,058	0,048	
39th	0,005	0,035	0,009	0,064	0,058	0,087
40th	0,006	0,045	0,009	0,065	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 C Type Test Verification Report

Extract from test report according to the Engineering Recommendation G98/1 **Nr. 19TH0407-G98/1_0**

Power Quality. Power factor.

Output power	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.
20%	0,999	0,999	0,999	
50%	0,999	0,999	1,000	
75%	0,999	0,999	1,000	
100%	0,999	1,000	1,000	
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	1,640	1,650	0,0	1,640	1,650	0,0	0,339	0,339
Measured values at standard impedance	1,640	1,650	0,0	1,640	1,650	0,0	0,339	0,339
Values for maximum impedance	3,145	3,145	0,0	3,145	3,145	0,0	0,650	0,650
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	Ω	Xl	0,15	Ω
	Z	0,283	Ω			
Standard impedance	R	0,24	Ω	Xl	0,15	Ω
	Z	0,283	Ω			
Maximum impedance	R	0,460	Ω	Xl	0,288	Ω
	Zmax	0,543	Ω			

Appendix C Type Test Verification Report				
Extract from test report according to the Engineering Recommendation G98/1				**Nr. 19TH0407-G98/1_0**
Power Quality. DC injection.				
Phase1				
Test level power [%]	20	50	75	100
Recorded value [mA]	57	58	57	58
Recorded value [%]	0,20	0,20	0,20	0,20
Limit [%]	0,25	0,25	0,25	0,25
Phase2				
Test level power [%]	20	50	75	100
Recorded value [mA]	28	27	27	29
Recorded value [%]	0,10	0,09	0,09	0,10
Limit [%]	0,25	0,25	0,25	0,25
Phase3				
Test level power [%]	20	50	75	100
Recorded value [mA]	19	13	13	7
Recorded value [%]	0,07	0,04	0,04	0,02
Limit [%]	0,25	0,25	0,25	0,25
Note. DC-injection is tested at each phase of the inverter and a limit of 0,25% per phase was used as pass criteria.				

Fault level Contribution.					
For a directly coupled SSEG			**For a Inverter SSEG**		
Parameter	**Symbol**	**Value**	**Time after fault**	**Volts [V]**	**Amps [A]**
Peak Short Circuit current	I_p	N/A	20ms	230,9	14,6
Initial Value of aperiodic current	A	N/A	100ms	230,9	14,5
Initial symmetrical short-circuit current*	I_k	N/A	250ms	135,8	13,6
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	23,1	0,3
Reactance/Resistance Ratio of source*	X/R	N/A	**Time to Trip [s]**	2,589	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 (Functional safety of the internal automatic disconnection device according to VDE 0126-1-1).	

Appendix C Type Test Verification Report	
Extract from test report according to the Engineering Recommendation G98/1	**Nr. 19TH0407-G98/1_0**

Logic Interface (input port) Required by paragraph 11.1.3	P
Confirm that an input port is provided and can be used to shut down the module.	Yes