



**BUREAU
VERITAS**

Certificate of compliance

Applicant: SMA Solar Technology AG
Sonnenallee 1
34266 Niestetal
Germany

Product: Grid-tied photovoltaic (PV) inverter

Model: STP 60-10 / MLX 60

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.

The STP 60-10 / MLX 60 is rated > 50kW (3 phase) or 17kW (1 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: 14TH0075-G59/3

Certificate number: U15-0071

Date of issue: 2015-02-27

Certification body

Dieter Zitzmann



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. 14TH0075

Type Approval and declaration of compliance with the requirements of Engineering Recommendation G59/3.	
Manufacturer / applicant:	SMA Solar Technology AG Sonnenallee 1 34266 Niestetal Germany
Generating Unit technology	Grid-tied photovoltaic inverter
Rated values	STP 60-10 / MLX 60
Maximum rated capacity	60 kW
Rated voltage	230 / 240 V
Firmware version	1.40

Measurement period: 2014-09-15 to 2014-09-16

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 with two series-connected relays in line. This enables a safe disconnection of the power generation unit from the network in case of error.

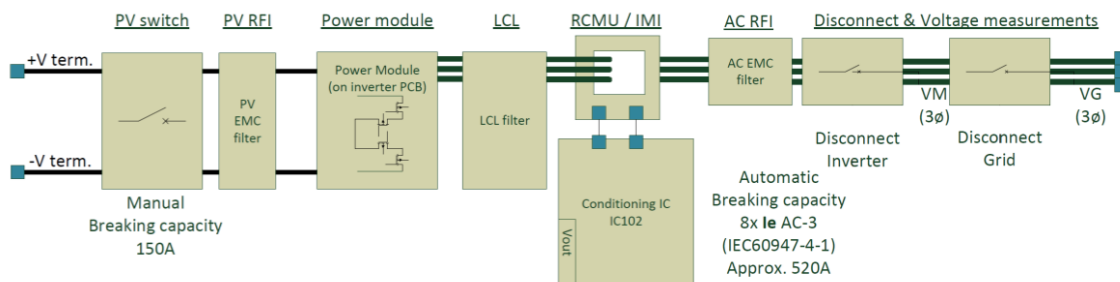


Figure 1 – Schematic structure of the power generation unit

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. 14TH0075

Protection. Voltage tests.						
STP 60-10 / MLX 60 Phase 1 at 230V						
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	200,5V	2,51s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	184,3V	0,55s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	263,6V	1,04s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	275,6V	0,55s	269,7V 0,98s	No trip
					277,7V 0,48s	No trip

Protection. Voltage tests.						
STP 60-10 / MLX 60 Phase 2 at 230V						
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	200,6V	2,56s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	184,5V	0,55s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	263,9V	1,05s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	275,7V	0,55s	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. 14TH0075

Protection. Voltage tests.						
STP 60-10 / MLX 60 Phase 3 at 230V						
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	200,4V	2,54s	204,1V / 3,5s	No trip
U/V stage 2	184V	0,5s	184,6V	0,55s	188V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	262,2V	1,0s	263,5V	1,05s	258,2V 2,0s	No trip
O/V stage 2	273,7V	0,5s	275,6V	0,56s	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.						

Protection. Voltage tests.						
STP 60-10 / MLX 60 Phase 1 at 240V						
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	208,5V	2,62s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	192,5V	0,55s	196V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	274,7V	1,05s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	286,7V	0,55s	281,6V 0,98s	No trip
					289,5V 0,48s	No trip

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. 14TH0075

Protection. Voltage tests.						
STP 60-10 / MLX 60 Phase 2 at 240V						
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	209,8V	2,62s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	192,6V	0,55s	196V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	274,7V	1,06s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	286,7V	0,54s	281,6V 0,98s	No trip
					289,5V 0,48s	No trip

Protection. Voltage tests.						
STP 60-10 / MLX 60 Phase 3 at 240V						
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	208,6V	2,63s	212,8V / 3,5s	No trip
U/V stage 2	192V	0,5s	192,5V	0,55s	196V / 2,48s	No trip
					180V / 0,48s	No trip
O/V stage 1	273,6V	1,0s	274,6V	1,06s	269,6V 2,0s	No trip
O/V stage 2	285,6V	0,5s	286,6V	0,54s	281,6V 0,98s	No trip
					289,5V 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.

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

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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	47,49Hz	20,03s	47,7Hz / 25s	No trip
U/F stage 2	47Hz	0,5s	47,00Hz	0,55s	47,2Hz / 19,98s	No trip
					46,8Hz / 0,48s	No trip
O/F stage 1	51,5Hz	90s	51,00Hz	90,00s	51,3Hz / 95s	No trip
O/F stage 2	52Hz	0,5s	52,00Hz	0,54	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 $\pm 0,1$ Hz. In order to measure the time delay a larger deviation than the minimum required to operate the protection can be used. The "No-trip tests" need to be carried out at the setting $\pm 0,2$ Hz 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. 14TH0075

Protection. Loss of Mains.								
Ramp in range 49,50 – 50,50Hz	Pickup ($\pm 0,005 \text{ Hz}^{-1}$)				Time Delay RoCoF= $\pm 0,05 \text{ Hz/s}$ above setting			
Setting 0,125/0,20 Hz^{-1}	Lower Limit	Measured Value	Upper Limit	Result	Test condition	Measured Value	Upper Limit	Result
Increasing Frequency	0,120 0,195	0,203	0,130 0,205	P	0,175 Hz^{-1} 0,25 Hz^{-1}	0,477	<0,5s	P
Reducing Frequency	0,120 0,195	0,1965	0,130 0,205	P	0,175 Hz^{-1} 0,25 Hz^{-1}	0,466	<0,5s	P

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				
Time delay setting		Measured delay		
20s		21,2s		
Frequency				
Time delay setting		Measured delay		
20s		27,1s		
at 230V				
	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
at 240V				
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 277,7V	At 204,6V	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. 14TH0075

Power Quality. Harmonics.						
Phase 1						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 10,04kW		100% of rated output 19,90kW			
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	0,171	0,199	0,242	0,281	8%	8%
3rd	0,193	0,223	0,084	0,097	21,6%	N/A
4th	0,070	0,081	0,053	0,062	4%	4%
5th	0,155	0,180	0,049	0,057	10,7%	10,7%
6th	0,040	0,047	0,033	0,039	2,67%	2,67%
7th	0,049	0,057	0,052	0,060	7,2%	7,2%
8th	0,030	0,035	0,025	0,028	2%	2%
9th	0,053	0,061	0,031	0,036	3,8%	N/A
10th	0,028	0,033	0,025	0,029	1,6%	1,6%
11th	0,098	0,113	0,159	0,185	3,1%	3,1%
12th	0,024	0,027	0,019	0,022	1,33%	1,33%
13th	0,101	0,118	0,166	0,192	2%	2%
14th	0,014	0,016	0,014	0,017	N/A	N/A
15th	0,013	0,016	0,012	0,014	N/A	N/A
16th	0,013	0,015	0,013	0,015	N/A	N/A
17th	0,127	0,147	0,155	0,179	N/A	N/A
18th	0,008	0,009	0,009	0,011	N/A	N/A
19th	0,097	0,112	0,113	0,131	N/A	N/A
20th	0,007	0,008	0,009	0,011	N/A	N/A
21th	0,009	0,011	0,010	0,012	N/A	N/A
22th	0,006	0,007	0,008	0,009	N/A	N/A
23th	0,074	0,086	0,062	0,072	N/A	N/A
24th	0,008	0,010	0,010	0,011	N/A	N/A
25th	0,073	0,084	0,064	0,074	N/A	N/A
26th	0,008	0,009	0,009	0,010	N/A	N/A
27th	0,033	0,039	0,033	0,039	N/A	N/A
28th	0,006	0,007	0,007	0,008	N/A	N/A
29th	0,041	0,048	0,037	0,043	N/A	N/A
30th	0,006	0,007	0,006	0,007	N/A	N/A
31th	0,034	0,040	0,032	0,037	N/A	N/A
32th	0,007	0,008	0,006	0,007	N/A	N/A
33th	0,008	0,009	0,006	0,007	N/A	N/A
34th	0,006	0,007	0,005	0,006	N/A	N/A
35th	0,019	0,022	0,014	0,017	N/A	N/A
36th	0,016	0,019	0,012	0,014	N/A	N/A
37th	0,015	0,018	0,011	0,013	N/A	N/A
38th	0,013	0,015	0,010	0,011	N/A	N/A
39th	0,007	0,008	0,005	0,006	N/A	N/A
40th	0,008	0,009	0,005	0,006	N/A	N/A
THD ₄₀	0,47%		0,98%		23%	13%
PWHD	0,0012%		0,0062%		23%	22%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. 14TH0075

Power Quality. Harmonics.						
Phase 2						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 10,03kW		100% of rated output 19,93kW			
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	0,234	0,271	0,238	0,276	8%	8%
3rd	0,073	0,084	0,129	0,149	21,6%	N/A
4th	0,058	0,068	0,071	0,082	4%	4%
5th	0,034	0,040	0,074	0,086	10,7%	10,7%
6th	0,031	0,036	0,035	0,041	2,67%	2,67%
7th	0,045	0,052	0,029	0,033	7,2%	7,2%
8th	0,022	0,025	0,025	0,029	2%	2%
9th	0,022	0,026	0,059	0,068	3,8%	N/A
10th	0,025	0,029	0,030	0,034	1,6%	1,6%
11th	0,153	0,177	0,100	0,115	3,1%	3,1%
12th	0,022	0,025	0,024	0,028	1,33%	1,33%
13th	0,164	0,189	0,096	0,111	2%	2%
14th	0,017	0,019	0,016	0,019	N/A	N/A
15th	0,012	0,013	0,016	0,018	N/A	N/A
16th	0,012	0,014	0,012	0,014	N/A	N/A
17th	0,154	0,178	0,128	0,148	N/A	N/A
18th	0,011	0,013	0,009	0,011	N/A	N/A
19th	0,117	0,135	0,095	0,110	N/A	N/A
20th	0,009	0,010	0,007	0,008	N/A	N/A
21th	0,009	0,011	0,009	0,010	N/A	N/A
22th	0,009	0,010	0,007	0,008	N/A	N/A
23th	0,058	0,067	0,073	0,085	N/A	N/A
24th	0,010	0,012	0,010	0,011	N/A	N/A
25th	0,064	0,074	0,071	0,082	N/A	N/A
26th	0,009	0,011	0,008	0,009	N/A	N/A
27th	0,033	0,039	0,032	0,037	N/A	N/A
28th	0,006	0,007	0,006	0,007	N/A	N/A
29th	0,035	0,040	0,040	0,046	N/A	N/A
30th	0,006	0,006	0,006	0,007	N/A	N/A
31th	0,032	0,037	0,033	0,039	N/A	N/A
32th	0,007	0,008	0,007	0,009	N/A	N/A
33th	0,007	0,008	0,008	0,009	N/A	N/A
34th	0,007	0,008	0,009	0,010	N/A	N/A
35th	0,013	0,016	0,019	0,022	N/A	N/A
36th	0,013	0,015	0,017	0,020	N/A	N/A
37th	0,012	0,014	0,014	0,017	N/A	N/A
38th	0,009	0,011	0,012	0,014	N/A	N/A
39th	0,004	0,004	0,006	0,007	N/A	N/A
40th	0,003	0,004	0,004	0,004	N/A	N/A
THD ₄₀	0,45%		0,95%		23%	13%
PWHD	0,0012%		0,006%		23%	22%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. 14TH0075

Power Quality. Harmonics.						
Phase 3						
Generating Unit tested to BS EN 61000-3-12						
Generating Unit rating per phase (rpp)						
	At 45-55% of rated output 10,06kW		100% of rated output 19,95kW			
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	0,171	0,197	0,108	0,125	8%	8%
3rd	0,068	0,079	0,096	0,111	21,6%	N/A
4th	0,055	0,064	0,071	0,082	4%	4%
5th	0,038	0,044	0,129	0,149	10,7%	10,7%
6th	0,031	0,035	0,033	0,039	2,67%	2,67%
7th	0,042	0,049	0,036	0,041	7,2%	7,2%
8th	0,022	0,025	0,027	0,031	2%	2%
9th	0,026	0,030	0,042	0,049	3,8%	N/A
10th	0,024	0,028	0,029	0,034	1,6%	1,6%
11th	0,153	0,177	0,094	0,108	3,1%	3,1%
12th	0,021	0,024	0,024	0,027	1,33%	1,33%
13th	0,164	0,190	0,099	0,115	2%	2%
14th	0,015	0,017	0,015	0,018	N/A	N/A
15th	0,011	0,013	0,014	0,016	N/A	N/A
16th	0,012	0,014	0,013	0,015	N/A	N/A
17th	0,159	0,184	0,133	0,153	N/A	N/A
18th	0,011	0,012	0,009	0,011	N/A	N/A
19th	0,115	0,132	0,095	0,109	N/A	N/A
20th	0,008	0,009	0,008	0,009	N/A	N/A
21th	0,010	0,011	0,010	0,012	N/A	N/A
22th	0,009	0,010	0,007	0,008	N/A	N/A
23th	0,062	0,072	0,078	0,090	N/A	N/A
24th	0,010	0,011	0,009	0,010	N/A	N/A
25th	0,061	0,071	0,071	0,082	N/A	N/A
26th	0,008	0,010	0,009	0,011	N/A	N/A
27th	0,033	0,038	0,034	0,039	N/A	N/A
28th	0,006	0,007	0,006	0,007	N/A	N/A
29th	0,038	0,044	0,043	0,050	N/A	N/A
30th	0,006	0,007	0,006	0,007	N/A	N/A
31th	0,031	0,035	0,033	0,038	N/A	N/A
32th	0,006	0,007	0,007	0,008	N/A	N/A
33th	0,006	0,007	0,007	0,008	N/A	N/A
34th	0,007	0,008	0,007	0,008	N/A	N/A
35th	0,016	0,018	0,020	0,023	N/A	N/A
36th	0,013	0,015	0,017	0,019	N/A	N/A
37th	0,011	0,013	0,016	0,018	N/A	N/A
38th	0,010	0,011	0,012	0,014	N/A	N/A
39th	0,003	0,004	0,004	0,004	N/A	N/A
40th	0,003	0,004	0,005	0,006	N/A	N/A
THD ₄₀	0,39%		0,87%		23%	13%
PWHD	0,0012%		0,006%		23%	22%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. 14TH0075

Power Quality. Power factor.				
Voltage	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	1,000	1,000	1,000	
Limit	>0,95	>0,95	>0,95	
Voltage	225,6V	240V	264V	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	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
Normalised to standard impedance	3,3%	3,3%	0%	3,3%	3,3%	0%	0,0856	0,0856
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65
Maximum impedance	R	0,074	Ω	XI	0,046	Ω		

Power Quality. DC injection.			
Phase 1			
Test level power	10%	55%	100%
Recorded value	37,20mA	51,46mA	57,04mA
As % of rated AC current	0,05%	0,06%	0,07%
Limit	0,25%	0,25%	0,25%
Phase 2			
Test level power	10%	55%	100%
Recorded value	41,03mA	47,52 mA	65,17 mA
As % of rated AC current	0,05%	0,06%	0,08%
Limit	0,25%	0,25%	0,25%
Phase 3			
Test level power	10%	55%	100%
Recorded value	39,75 mA	46,77 mA	58,69 mA
As % of rated AC current	0,05%	0,06%	0,07%
Limit	0,25%	0,25%	0,25%

Appendix 13.1 Type Testing a Generating Unit

Extract from test report according the Engineering Recommendation G59/3

Nr. 14TH0075

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	37,65V	43,60A
Initial Value of aperiodic current	A	N/A	100ms	24,66V	19,50A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	22,07V	12,33A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	21,13V	8,72A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	4,9	In milliseconds

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.	N/A
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.	