SEMI F47
Voltage Sag Immunity Test Report
for
Power Supply SP960.241-S

SEMI F47 Test Report

Document Number	SP960.241-S Semi F47 Rev1 MM1
PCTM Number	PCTM-70
Standards	**SEMI F47-0706** (July 2006) SPECIFICATION FOR SEMICONDUCTOR PROCESSING EQUIPMENT - Voltage Sag Immunity Compliance Tests **IEC 61000-4-11** 2004 +A1:2017 Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase
Applicant	PULS GmbH Elektrastraße 6 81925 Munich, Germany
Test Laboratory	PULS Vario GmbH Kranichberggasse 6 1120 Vienna, Austria
Test Engineer	Milan Maksimovic
Test Date	11.07.2024 - 12.07.2024
Description of Test Device	Built-in power supplies for DIN-Rail mounting
Devices under Evaluation	SP960.241-S Input: AC 100-240V, Output: DC 24-28V, 40A, 960W
S/N of Devices	SP960.241-S: S/N: 29 122 934
Application Details	Input voltage: 1-Phase AC 230V Input frequency: 50 or 60Hz Output load: 960W

PASS/FAIL Criterions	In accordance with paragraph 7.8.2 a) of SEMI F47-0706 The output voltage is not allowed to deviated more than 5% of the initial value DC OK contact is not allowed to trigger during and after the test
Test Result	**PASS** The test device passed all essential SEMI F47-0706 tests according to the defined application details without any limitations and is qualified to bear the following approval mark: SEMI F47 Since DC power supplies, as covered in this test report, are only components of a semiconductor processing equipment, the tests of the SEMI F47 standard were conducted with selected rated characteristics of the DC power supply. The system integrator of the final semiconductor processing equipment needs to judge if the results of this test report are compatible with the SEMI F47 requirements of his system or if test data under other operating conditions are additionally required. The system integrator also needs to judge if the results of the inrush current peaks are compatible with the selected external fuses for input protection. The system integrator also needs to be aware about aging effects. It is expected that the ride through time can be reduced by 15% at end of the specified lifetime expectancy. A SEMI F47 certificate is not intended for this type of component, however the product fulfils the general requirements and can be marked with the following symbol.
Approved	Harald Etlinger Head of Product Compliance PULS Vario GmbH, Vienna
Date of Approval	**16.07.2024**

List of Test Equipment

Type	Model	Inventory number
Test generator	Chroma 6560	10009
el. Load	el. Load Chroma 63201	10109
Oscilloscope	LeCroy WS454	10129
Oscilloscope	LeCroy WS424	10179
Diffential Probe	Lecroy AP031	10254
Current Probe	LeCroy CP150	10280

The test equipment complies with the requirements of IEC 61000-4-11.

The peak current capability of the test generator was evaluated according Annex A of IEC 61000-4-11 and is able to

Test Specification for SEMI F47 compliance

Voltage Sag Immunity according to the following table:

Sag depth#1	**Duration**	**Duration at 50 Hz**	**Duration at 60 Hz**
50%	200ms	10 cycles	12 cycles
70%	500ms	25 cycles	30 cycles
80%	1000ms	50 cycles	60 cycles

volt nominal system, the voltage is reduced during the sag to 140 volts and not 60 volts.

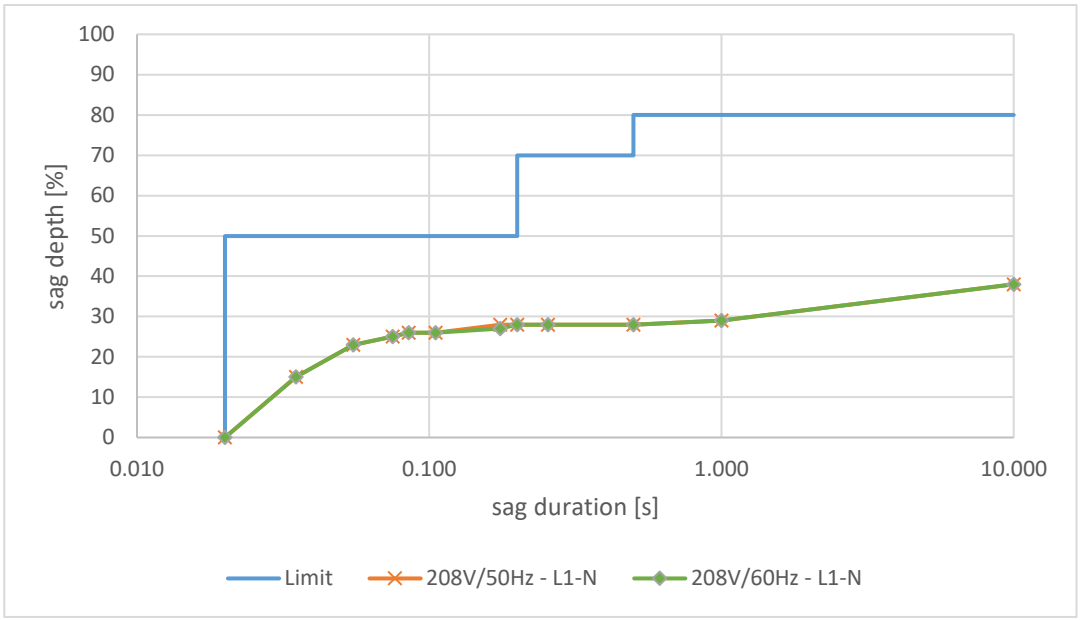
Test Setup

The unit under test in normal operating condition mounted in climate chamber.
The input is connected to an AC Source. The input voltage is measured with a 100:1 differential probe and the input current is measured with current probes. These probes are connected to oscilloscopes.

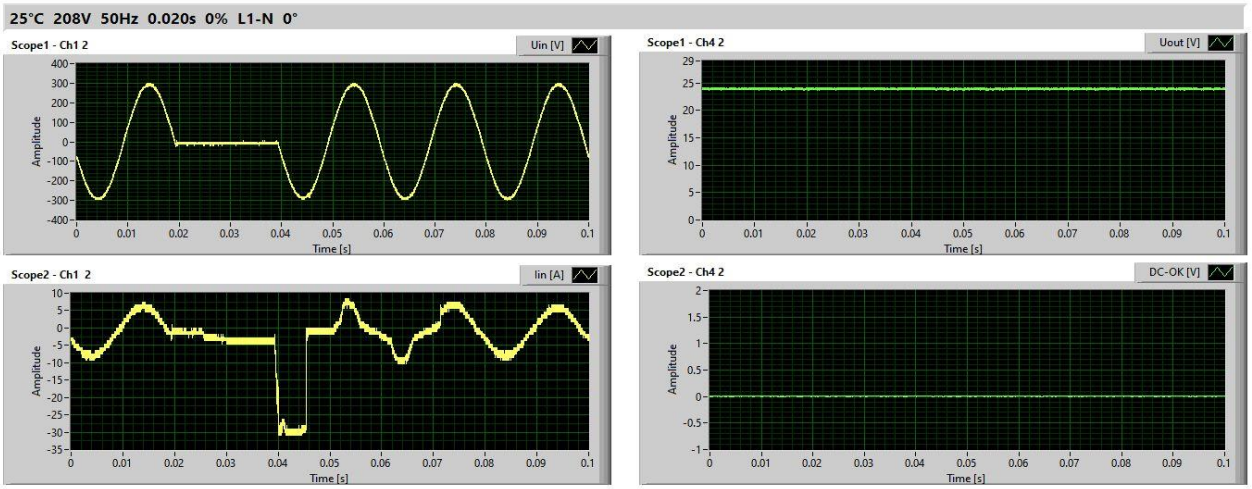
The output is connected to an active load. The output voltage is connected directly to the oscilloscope.
"DC-OK" signal is also measured with an oscilloscope.

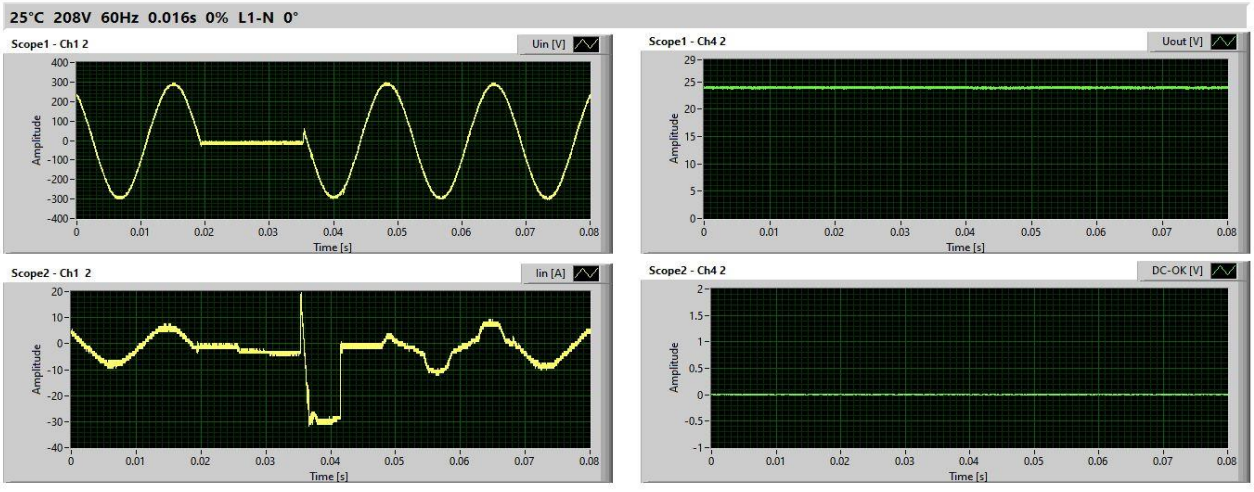
Input and output voltages are measured with oscilloscope #1 and input currents with oscilloscope #2.

Voltage Sag Results



Input Voltage and Current





Conducted Tests at 208V 50Hz

Input Voltage	208Vac	Output Voltage	24V
Input Frequency	50Hz	Output Current	40A
Sag	L-N	Ambient Temperature	25°C

Sag duration [s]	Voltage remaining		Input current [A]	
	[%]	[Vac]	max	min
0.020	0	0	8.4	-32.8
0.200	50	104	15.9	-25.3
0.500	70	145.6	11.3	-15
1	80	166.4	9.4	-12.2
10	80	166.4	9.4	-11.3

Informational measurements

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.020	0	0
0.035	15	31.2
0.055	23	47.84
0.075	25	52
0.085	26	54.08
0.105	26	54.08

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.175	28	58.24
0.200	28	58.24
0.255	28	58.24
0.500	28	58.24
1	29	60.32
10	38	79.04

Conducted Tests at 208V 60Hz

Input Voltage	208Vac	Output Voltage	24V
Input Frequency	60Hz	Output Current	40A
Sag	L-N	Ambient Temperature	25°C

Sag duration [s]	Voltage remaining		Input current [A]	
	[%]	[Vac]	max	min
0.016	0	0	18.8	-31.9
0.200	50	104	15.9	-25.3
0.500	70	145.6	11.3	-15
1	80	166.4	9.4	-12.2
10	80	166.4	9.4	-12.2

Informational measurements

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.016	0	0
0.035	15	31.2
0.055	23	47.84
0.075	25	52
0.085	26	54.08
0.105	26	54.08

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.175	27	56.16
0.200	28	58.24
0.255	28	58.24
0.500	28	58.24
1	29	60.32
10	38	79.04

Inrush current measurements according 61000-4-11 at 208V 50Hz

Input Voltage	208Vac
Input Frequency	50Hz
Output Voltage	24V
Output Current	40A
Ambient Temperature	25°C

Peak input current measurements on unit under test:

First two measurements turn off input power for EUT for 5 minutes and then

Measure peak input current when AC turned on at 90°: 9,4A

Measure peak input current when AC turned on at 270°: 10,3A

Next two measurements turn on the input power for EUT for at least 1 minute then turn off input power for 5s and on again.

Measure peak input current when AC turned on at 90°: 9,4A

Measure peak input current when AC turned on at 270°: 9,4A

Inrush current measurements according 61000-4-11 at 208V 60Hz

Input Voltage	208Vac
Input Frequency	60Hz
Output Voltage	24V
Output Current	40A
Ambient Temperature	25°C

Peak input current measurements on unit under test:

First two measurements turn off input power for EUT for 5 minutes and then

Measure peak input current when AC turned on at 90°: 9,4A

Measure peak input current when AC turned on at 270°: 9,4A

Next two measurements turn on the input power for EUT for at least 1 minute then turn off input power for 5s and on again.

Measure peak input current when AC turned on at 90°: 9,4A

Measure peak input current when AC turned on at 270°: 9,4A

Operating conditions and their influence in test results:

a) Ambient temperature:
Control measurements show that the ambient temperature has only a minor influence in the ride-through time test results.
Depending on the used topology to reduce the input inrush current, the ambient temperature can have a major influence in the arising peak current after the sag test. Therefore, tests were performed at ambient temperatures of 25°C and +60°C.
It is assumed that semiconductor processing equipment is never used at lower temperatures than +25°C. Although the power supply itself is specified down to -25°C, a test at such low temperatures is not performed.

b) Mains frequency 50Hz vs. 60Hz:
Control measurements show that 50Hz testing is more critical than 60Hz testing.
Therefore, unless otherwise noted, all tests were performed with a mains frequency of 50Hz.

c) Output voltage 24V vs. 28V:
The ride-through time depends on the stored energy in the input capacitors and the amount of output power. The output voltage is not essential as long as the output power is constant.
The adjusted output voltage has no influence in input currents peaks after input voltage sags.
Therefore, unless otherwise noted, all tests were performed with an output voltage of 24Vdc.

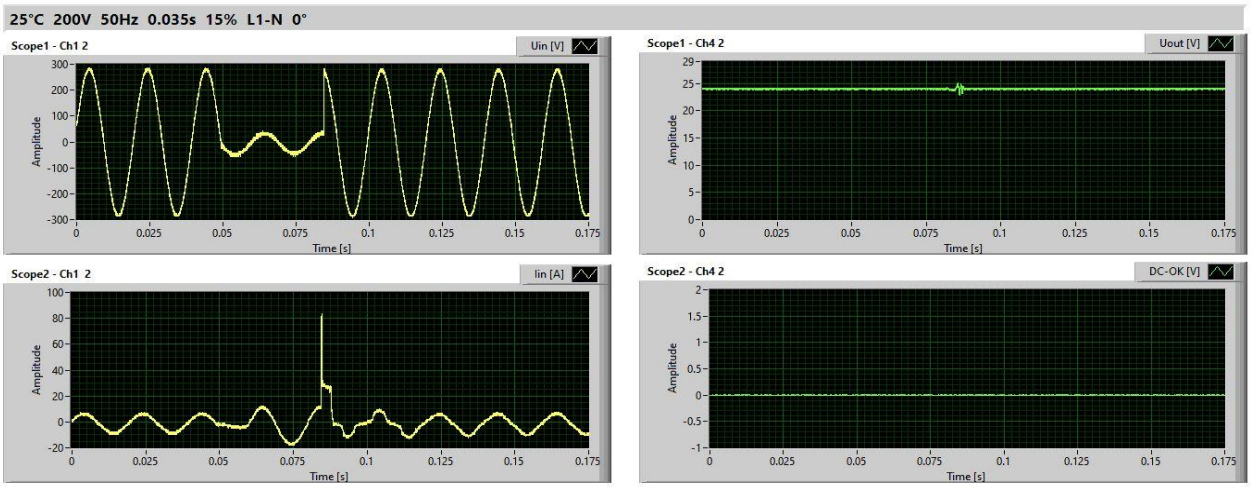
APPENDIX

Informational measurements at 200V

Input Voltage	200Vac	Output Voltage	24V
Input Frequency	50Hz	Output Current	40A
Sag	L-N	Ambient Temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining		Input current [A]	
	[%]	[Vac]	max	min
0.020	0	0	8.4	-32.8
0.035	15	30	83.4	-17.8
0.055	23	46	82.5	-25.3
0.075	26	52	75.9	-28.1
0.085	27	54	24.4	-75.9
0.105	27	54	24.4	-82.5
0.175	29	58	58.1	-30
0.200	29	58	27.2	-30.9
0.255	29	58	58.1	-30
0.500	29	58	27.2	-31.9
1	30	60	28.1	-30.9
10	40	80	17.8	-30



Informational measurements at 230V

Input Voltage	230Vac	Output Voltage	24V
Input Frequency	50Hz	Output Current	40A
Sag	L-N	Ambient Temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining		Input current [A]	
	[%]	[Vac]	max	min
0.020	0	0	9.4	-31.9
0.035	14	32.2	89.1	-19.7
0.055	21	48.3	88.1	-26.3
0.075	23	52.9	88.1	-29.1
0.085	23	52.9	23.4	-90
0.105	24	55.2	25.3	-90.9
0.175	25	57.5	83.4	-30
0.200	25	57.5	26.3	-30.9
0.255	25	57.5	84.4	-30
0.500	26	59.8	28.1	-30.9
1	26	59.8	28.1	-30
10	34	78.2	18.8	-30