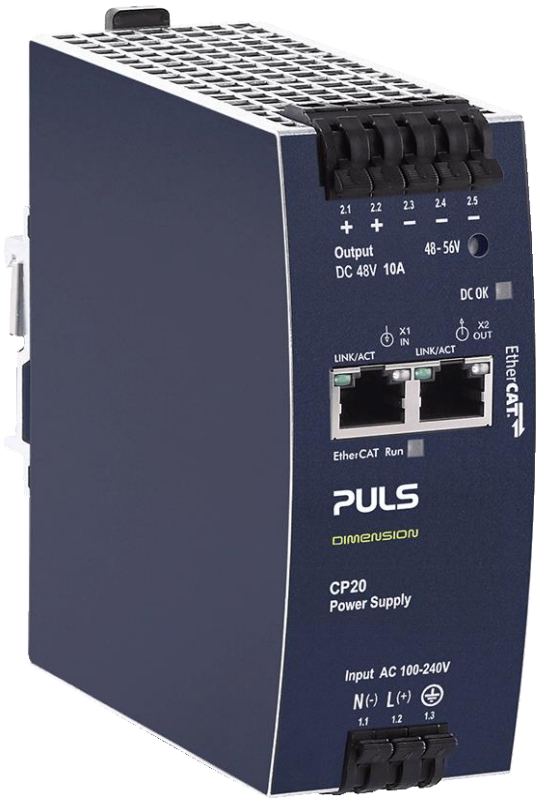
SEMI F47
Voltage Sag Immunity Test Report
for
Power Supply CP20.481-ETC

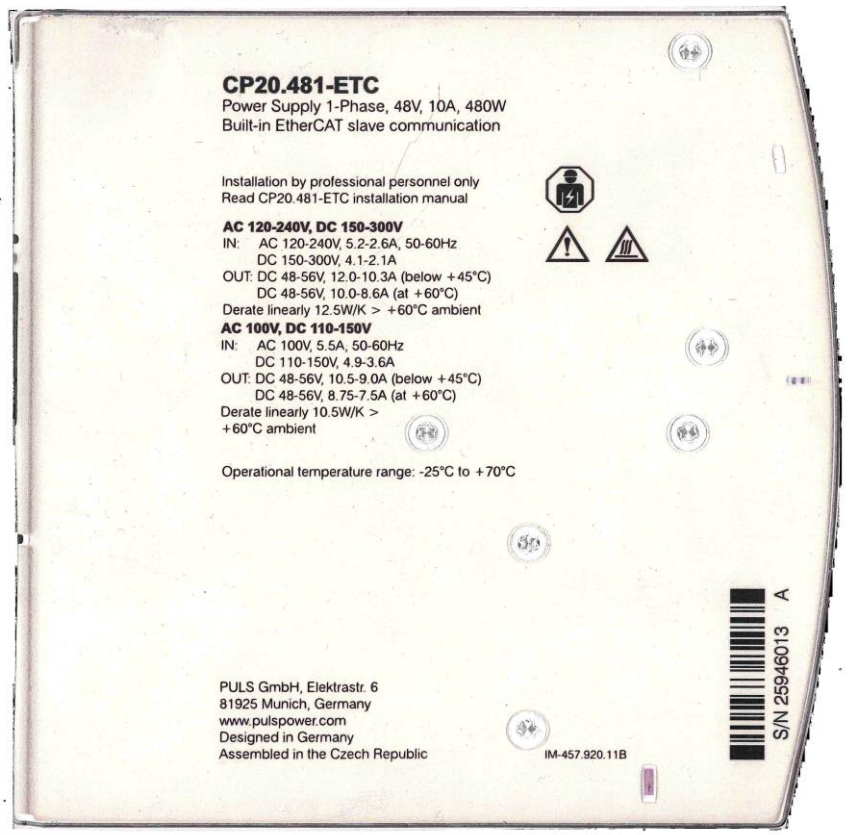


SEMI F47 Test Report

Document number	CP20.481-ETC Semi F47 Rev1 TR1
PCTM number	PCTM-27 (3)
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	Thomas Ramel, Daniel Schwayer
Test Date	30.08.2023
Description of Test Device:	Built-in power supplies for DIN-Rail mounting
Devices under Evaluation:	CP20.481-ETC Power Supply 1-Phase, 48V, 10A, 480W
S/N of Devices:	CP20.481-ETC: S/N: 25945900 A
Application Details:	Input voltage: 1-Phase AC 208V Input frequency: 50 or 60Hz Output load: 480W

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
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:  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 Sr. Qualification Eng. PULS Vario GmbH, Vienna
Date of Approval	**01.09.2023**

Copy of marking plate:



List of Test Equipment

Type	Model	Inventory number
Test generator:	Kikusui PCR3000WE2	10372
Load:	Chroma 63201 - 2.6kW	10054
Oscilloscope:	LeCroy WS454	10129
Oscilloscope:	LeCroy WS454	10127
Diffential probe.	LeCroy AP031	10259
Current Probe:	LeCroy CP150	10280
Communication Interface:	EtherCAT Testdevice	(MUC) 800.20 [2]

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 deliver minimum 32.7A.

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

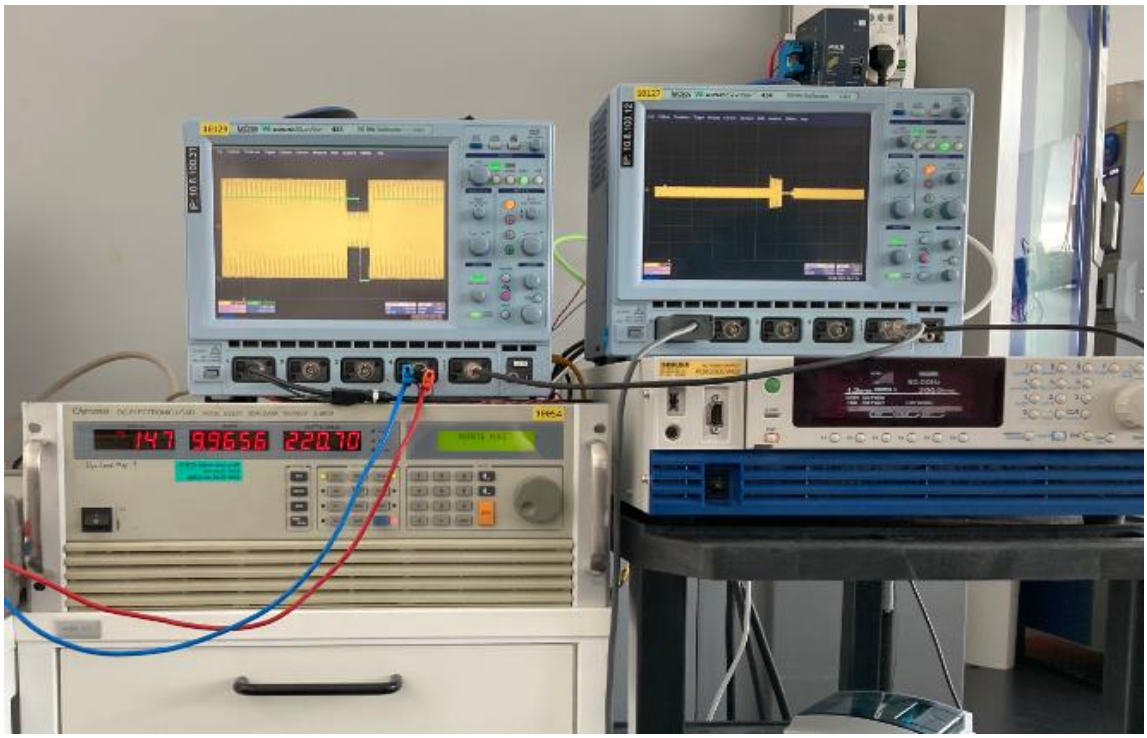
#1 Sag depth is expressed in percent of remaining nominal voltage. For example, during a 70% voltage sag on a 200 volt nominal system, the voltage is reduced during the sag to 140 volts and not 60 volts.

Test Setup

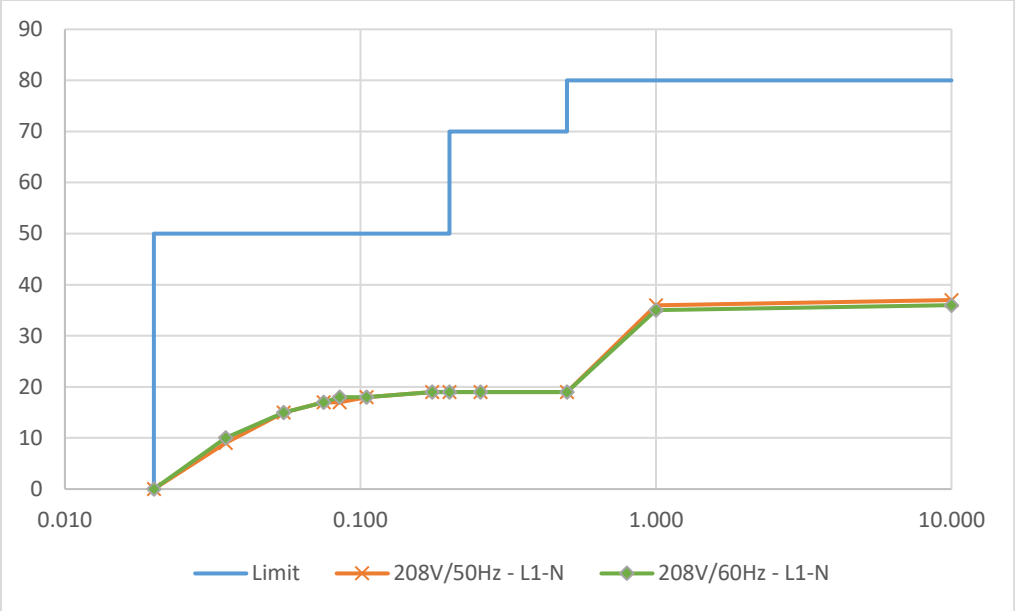
The unit under test in normal operating condition mounted in climate chamber.
The input is connected to an AC Source. The input voltage is measured with a 100:1 differential probe and the input current is measured with current probes. These probes are connected to oscilloscopes.

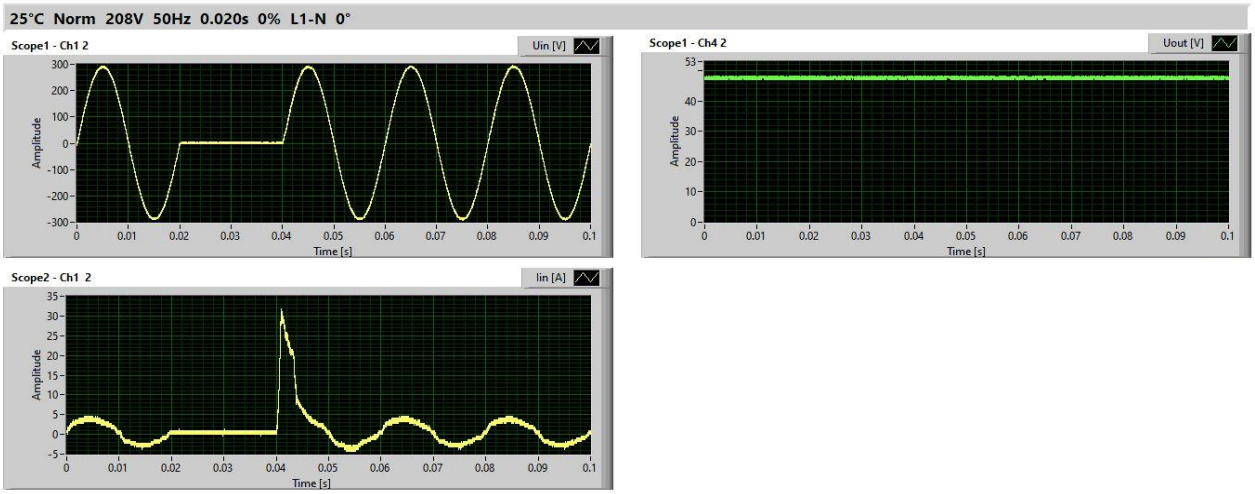
The output is connected to an active load. The output voltage is connected directly to the oscilloscope.
Input and output voltages are measured with oscilloscope #1 and input currents with oscilloscope #2.

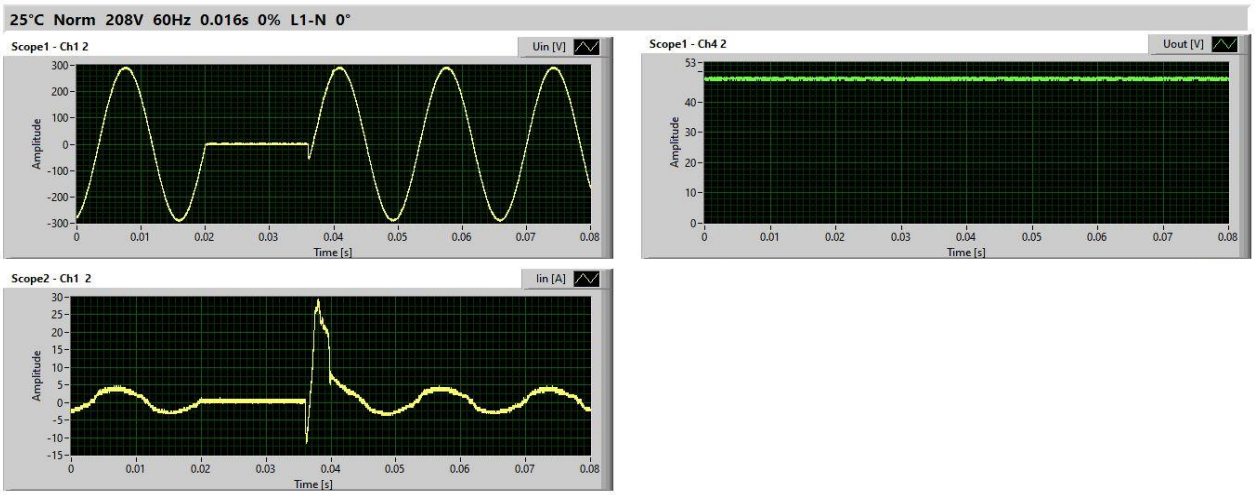
Active EtherCAT communication is simulated with the "EtherCAT Testdevice 800.20 [2]" during the tests.



Voltage Sag Results







Conducted Tests at 208V 50Hz

Input voltage	208Vac
Input Frequency	50Hz
Output voltage	48V
Output current	10A
Ambient temperature	25°C

Sag duration [s]	Voltage remaining [%]	Positive peak current	Negative peak current
0.020	0	31.9	-4.2
0.200	50	12.2	-8.4
0.500	70	7	-5.6
1	80	5.6	-4.7
10	80	5.6	-4.7

Informational measurements

Sag duration [s]	Voltage remaining [%]
0.020	0
0.035	9
0.055	15
0.075	17
0.085	17
0.105	18

Sag duration [s]	Voltage remaining [%]
0.175	19
0.200	19
0.255	19
0.500	19
1	36
10	37

Conducted Tests at 208V 60Hz

Input voltage	208Vac
Input Frequency	60Hz
Output voltage	48V
Output current	10A
Ambient temperature	25°C

Sag duration [s]	Voltage remaining [%]	Positive peak current	Negative peak current
0.016	0	29.5	-11.7
0.200	50	12.7	-8
0.500	70	7.5	-5.6
1	80	5.6	-4.7
10	80	5.6	-4.7

Informational measurements

Sag duration [s]	Voltage remaining [%]
0.016	0
0.035	10
0.055	15
0.075	17
0.085	18
0.105	18

Sag duration [s]	Voltage remaining [%]
0.175	19
0.200	19
0.255	19
0.500	19
1	35
10	36

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

Input voltage	208Vac
Input Frequency	50Hz
Output voltage	48V
Output current	10A
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°: 7
Measure peak input current when AC turned on at 270°: 6.6
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°: 6.6
Measure peak input current when AC turned on at 270°: 6.1

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

Input voltage	208Vac
Input Frequency	60Hz
Output voltage	48V
Output current	10A
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°: 7.5
Measure peak input current when AC turned on at 270°: 6.6
on again.
Measure peak input current when AC turned on at 90°: 7.5
Measure peak input current when AC turned on at 270°: 7.5

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 depend 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.

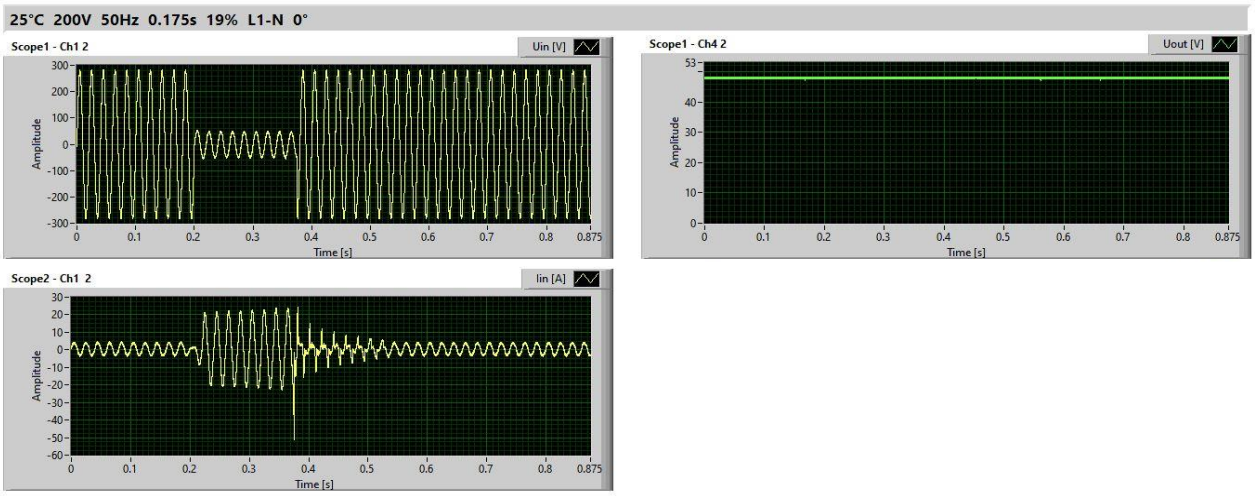
APPENDIX

Informational measurements at 200V

Input voltage	200Vac
Input Frequency	50Hz
Output voltage	48V
Output current	10A
Ambient temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining [%]	Positive peak current [A]	Negative peak current [A]
0.020	0	32.3	-4.7
0.035	9	25.8	-47.3
0.055	16	24.4	-49.2
0.075	18	22	-50.6
0.085	18	50.2	-21.6
0.105	19	48.7	-21.6
0.175	19	24.4	-51.1
0.200	19	37	-23.4
0.255	20	23.9	-48.7
0.500	20	37.5	-22
1	37	19.2	-11.2
10	38	18.3	-10.8

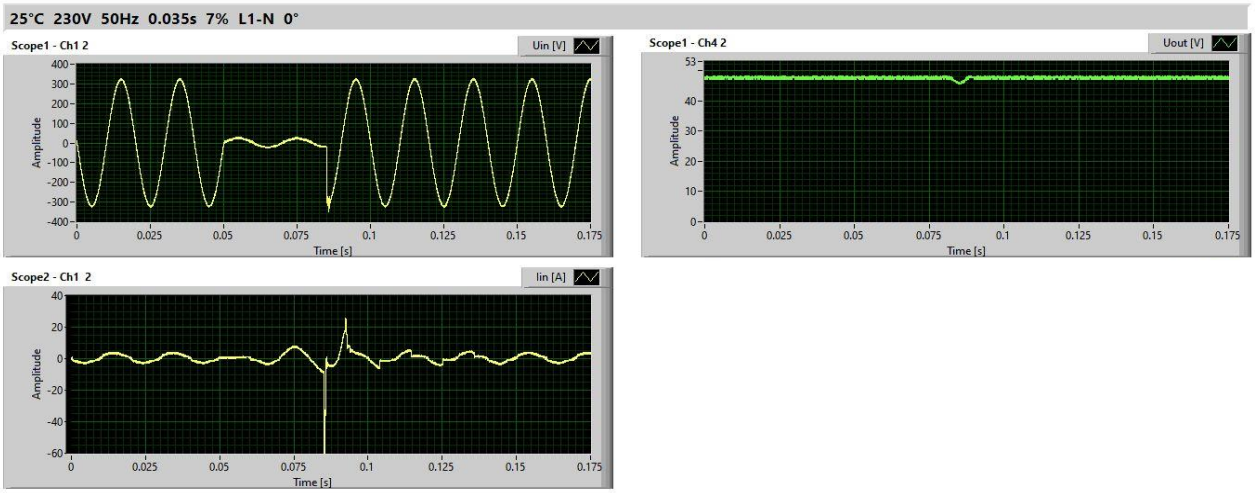


Informational measurements at 230V

Input voltage	230Vac
Input Frequency	50Hz
Output voltage	48V
Output current	10A
Ambient temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining [%]	Positive peak current [A]	Negative peak current [A]
0.020	0	31.4	-3.7
0.035	7	25.8	-60
0.055	14	27.2	-60
0.075	15	28.1	-60
0.085	16	56.7	-23.9
0.105	16	56.7	-24.8
0.175	17	23.4	-55.8
0.200	17	33.7	-22.5
0.255	17	23.9	-50.2
0.500	17	38.4	-23
1	32	22	-11.7
10	33	23.4	-11.2



Informational measurements at 100V

Input voltage	100Vac
Input Frequency	50Hz
Output voltage	48V
Output current	10A
Ambient temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining [%]	Positive peak current [A]	Negative peak current [A]
0.000	0	0	0
0.020	0	30.5	-11.7
0.020	0	30.5	-11.7
0.035	20	29.5	-40.3
0.055	30	30	-40.8
0.075	35	29.5	-38.9
0.085	35	40.3	-28.6
0.105	36	41.7	-28.6
0.175	38	29.5	-39.4
0.200	38	31.9	-23.9
0	50	23	-18.3
0	39	29.5	-37