

SEMI F47
Voltage Sag Immunity Test Report
for
Power Supply TP960.481



Other devices covered by this report: TP960.484

SEMI F47 Test Report

Document Number	SEMI F47 Report TP960.481 LM1
PCTM Number	PCTM-74
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, Luka Mihic
Test Date	27.08.2024 - 28.08.2024
Description of Test Device	Built-in power supplies for DIN-Rail mounting
Devices under Evaluation	TP960.481 Input: 3AC 380-500V, Output: DC 48-56V, 24-20.6A, 960W
S/N of Devices	TP960.481: S/N: 29134977
Application Details	Input Voltage: 3-Phase AC 400V Input Frequency: 50 or 60Hz Output Load: 960W

PASS/FAIL Criteria

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:



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.

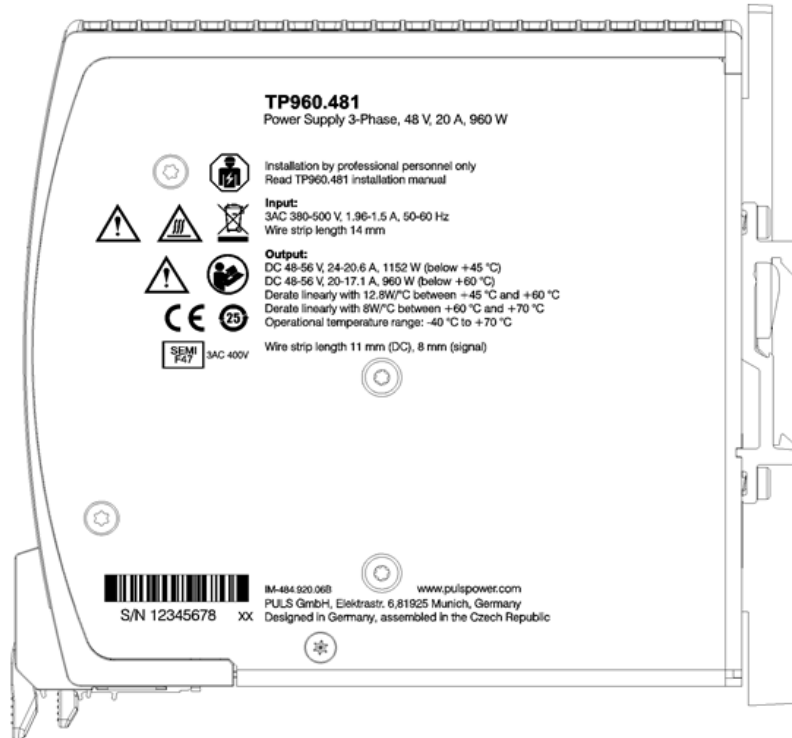
Approved

Harald Etlinger
Head of Product Compliance
PULS Vario GmbH, Vienna

Date of Approval

02.09.2024

Copy of marking plate



List of Test Equipment

Type	Model	Inventory number
AC Source	Kikusui PCR3000WE2	10388
el. Load	Chroma 63201 - 2.6kW	10109
Oscilloscope	LeCroy WS454	10129
Oscilloscope	LeCroy WS454	10179
Current Probe	LeCroy CP031	10280
Current Probe	LeCroy CP031	10267
Current Probe	LeCroy CP150	10288
Differential Probe	Testec Elektronik GmbH SI 9001	10264
Differential Probe	Testec Elektronik GmbH SI 9001	10259
Differential Probe	Testec Elektronik GmbH SI 9001	10336

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.

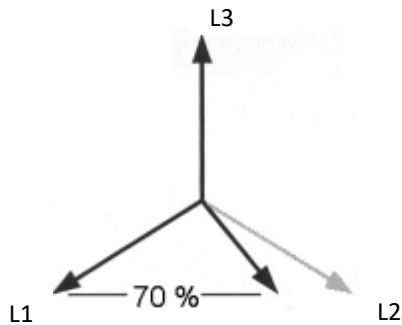
Test Specification for SEMI F47 compliance

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.

At three-phase systems, without neutral conductor, the sag is applied on one phase-to-phase pair.



Test Setup

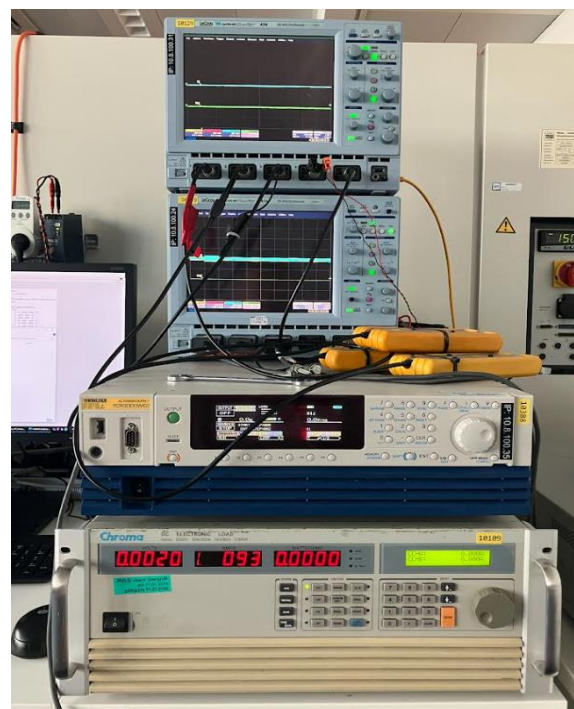
The unit under test in normal operating condition mounted in climate chamber.

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.

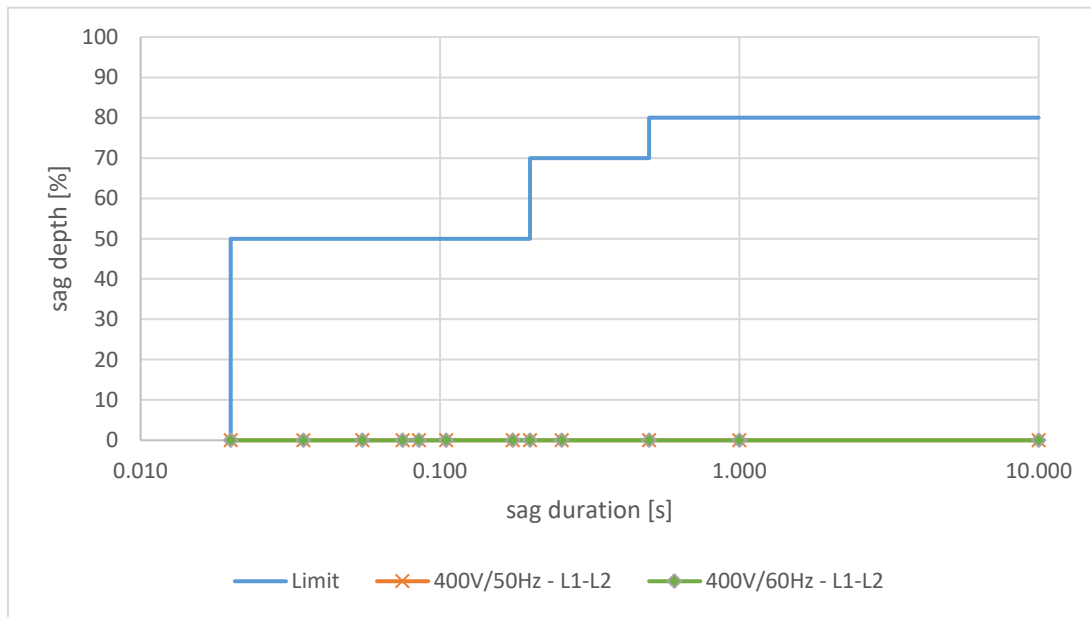
The output is connected to an active load. The output voltage is connected directly to the oscilloscope.

“DC-OK” signal is also measured with an oscilloscope.

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

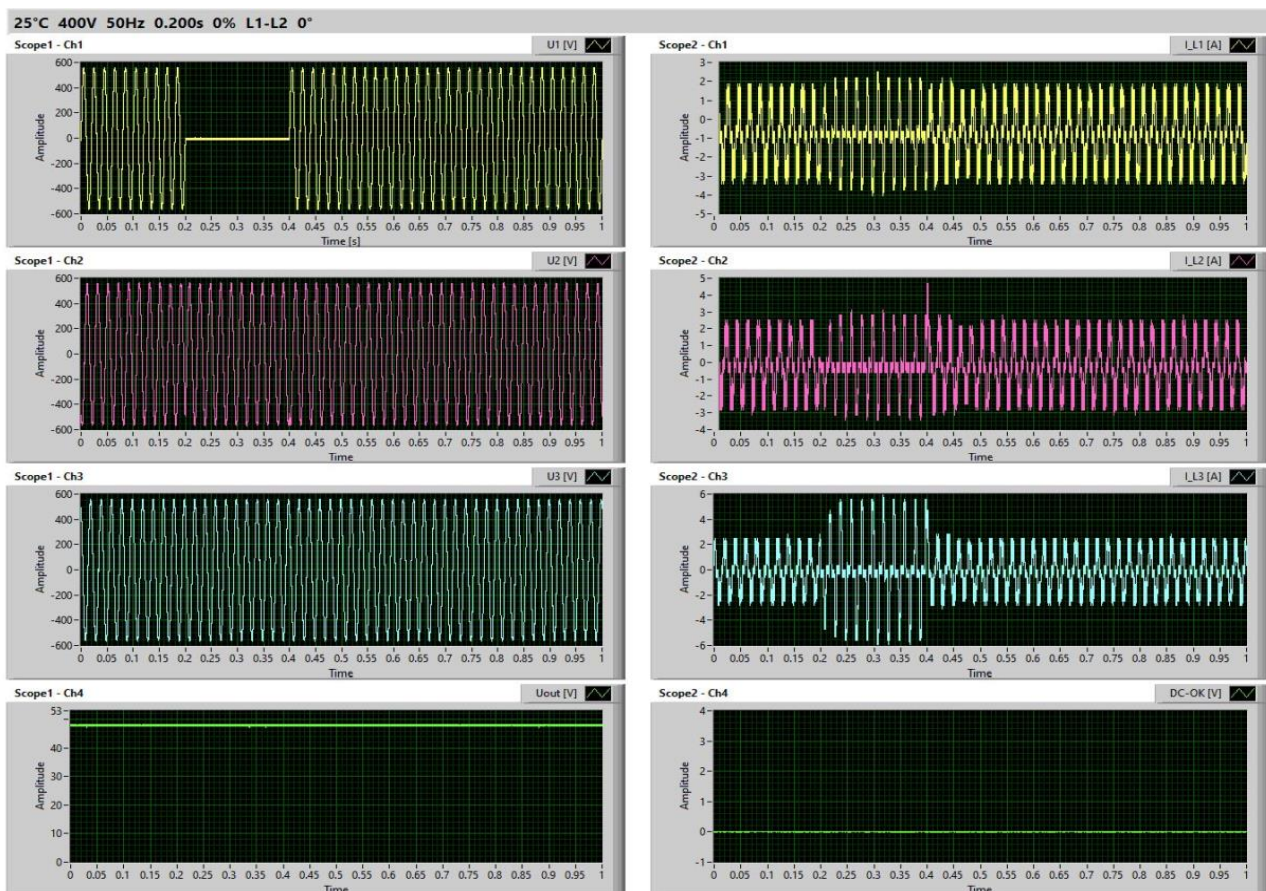


Voltage Sag Results

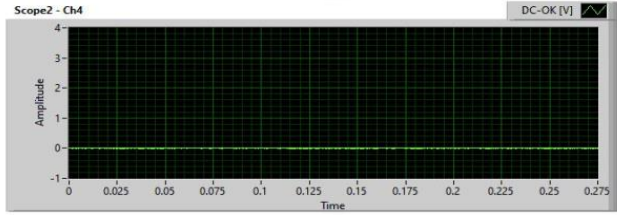
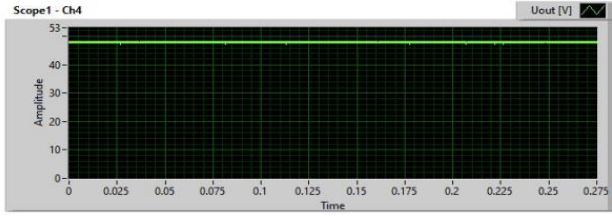
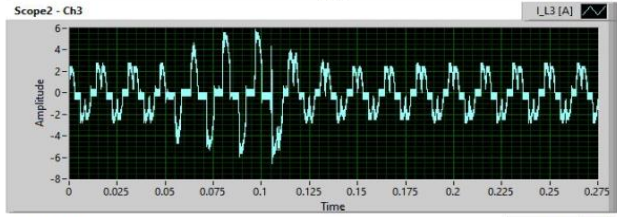
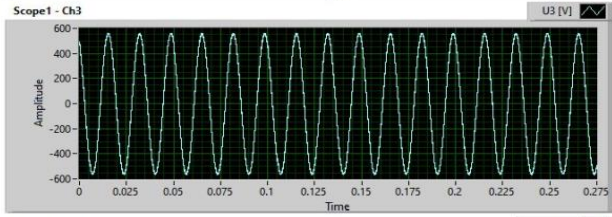
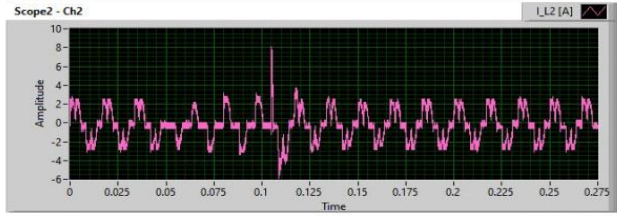
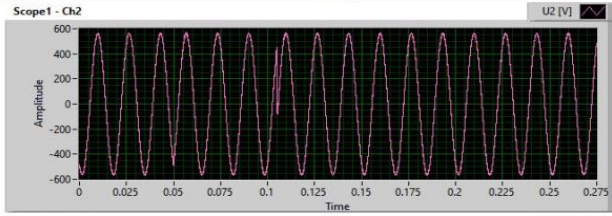
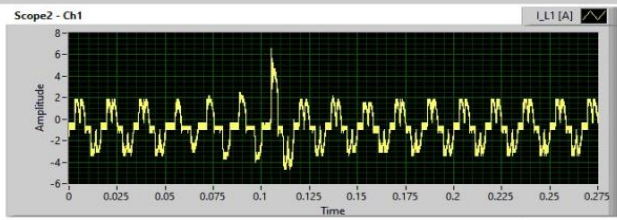
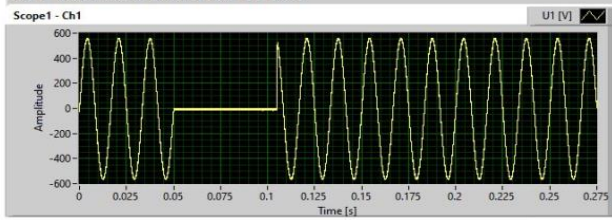


For all Sag times the voltage can be reduced to 0V without any influence on the output.

Input Voltages and Currents



25°C 400V 60Hz 0.055s 0% L1-L2 0°



Conducted Tests at 400V 50Hz

Input Voltage	400Vac	Output Voltage	48V
Input Frequency	50Hz	Output Current	20A
Sag	L1-L2	Ambient Temperature	25°C

Sag duration [s]	Voltage remaining		L1 - current [A]		L2 - current [A]		L3 - current [A]	
	[%]	[Vac]	max	min	max	min	max	min
0.020	0	0	3.4	-3.7	4.4	-3.4	5	-4.7
0.200	50	200	4.7	-6.2	4.4	-4.1	5.6	-5.6
0.500	70	280	4.4	-6.2	3.7	-4.1	5.6	-5.6
1	80	320	4.4	-6.2	4.1	-3.4	5.6	-5.6
10	80	320	4.4	-5.9	3.4	-3.4	5	-5

Informational measurements

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.020	0	0
0.035	0	0
0.055	0	0
0.075	0	0
0.085	0	0
0.105	0	0

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.175	0	0
0.200	0	0
0.255	0	0
0.500	0	0
1	0	0
10	0	0

Conducted Tests at 400V 60Hz

Input Voltage	400Vac	Output Voltage	48V
Input Frequency	60Hz	Output Current	20A
Sag	L1-L2	Ambient Temperature	25°C

Sag duration [s]	Voltage remaining		L1 - current [A]		L2 - current [A]		L3 - current [A]	
	[%]	[Vac]	max	min	max	min	max	min
0.016	0	0	3.4	-5.6	4.4	-3.7	4.7	-4.7
0.200	50	200	5	-6.6	4.4	-4.4	5.9	-5.9
0.500	70	280	4.7	-5.9	4.4	-4.4	5.6	-5.6
1	80	320	4.1	-5.6	4.1	-4.1	5	-5
10	80	320	4.1	-5.6	3.7	-3.7	5	-5.3

Informational measurements

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.016	0	0
0.035	0	0
0.055	0	0
0.075	0	0
0.085	0	0
0.105	0	0

Sag duration [s]	Voltage remaining	
	[%]	[Vac]
0.175	0	0
0.200	0	0
0.255	0	0
0.500	0	0
1	0	0
10	0	0

Inrush current measurements according 61000-4-11 at 400V 50Hz

Input Voltage	400Vac
Input Frequency	50Hz
Output Voltage	48V
Output Current	20A
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°: 25.9A

Measure peak input current when AC turned on at 270°: 28.4A

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°: 15.3A

Measure peak input current when AC turned on at 270°: 28.1A

Inrush current measurements according 61000-4-11 at 400V 60Hz

Input Voltage	400Vac
Input Frequency	60Hz
Output Voltage	48V
Output Current	20A
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°: 26.2A

Measure peak input current when AC turned on at 270°: 28.1A

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°: 15.6A

Measure peak input current when AC turned on at 270°: 28.1A

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 -40°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 48V vs. 56V:

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 48Vdc.

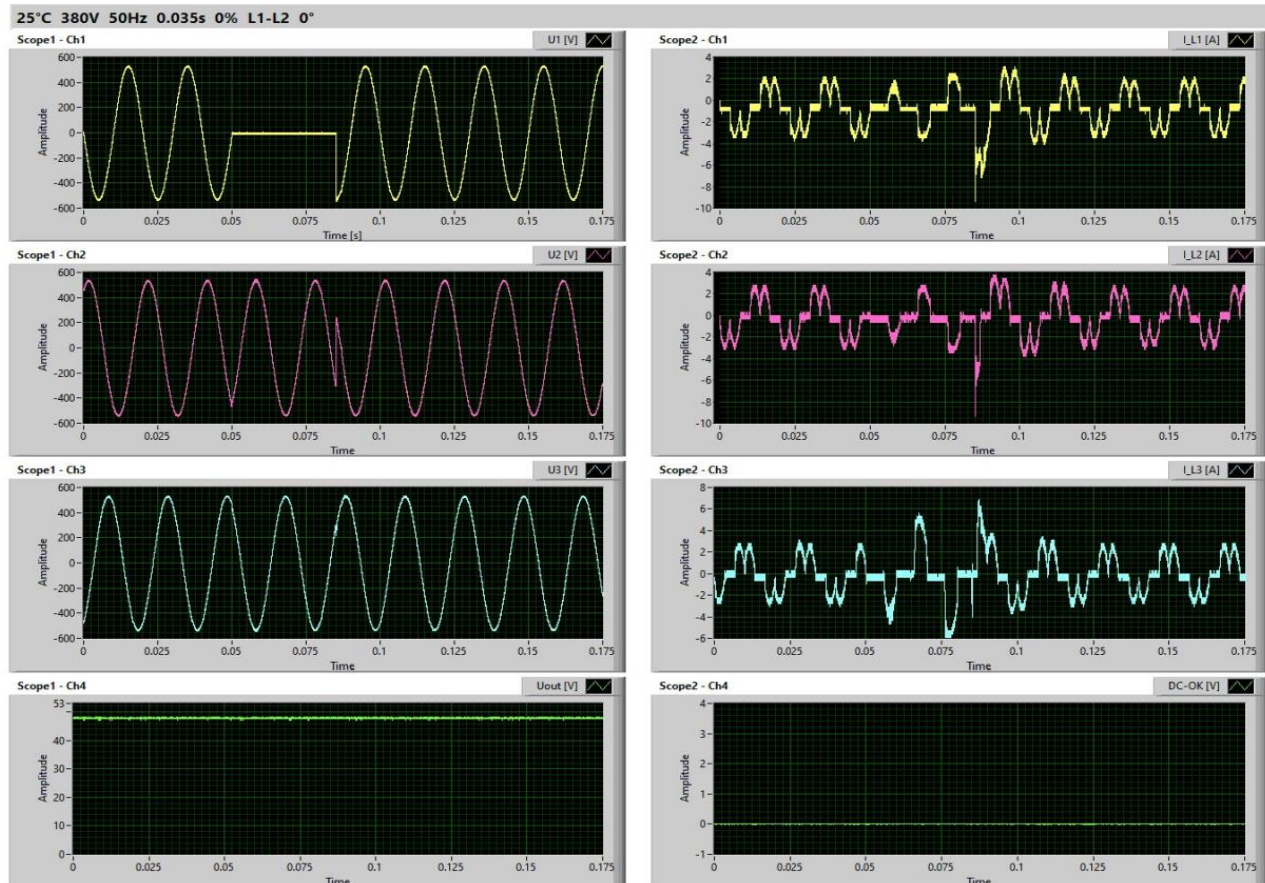
APPENDIX

Informational measurements at 380V

Input Voltage	380Vac	Output Voltage	48V
Input Frequency	50Hz	Output Current	20A
Sag	L1-L2	Ambient Temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining		L1 - current [A]		L2 - current [A]		L3 - current [A]	
	[%]	[Vac]	max	min	max	min	max	min
0.020	0	0	2.8	-4.1	5.0	-3.7	5.6	-4.4
0.035	0	0	3.1	-9.4	3.7	-9.4	6.9	-5.9
0.055	0	0	2.8	-9.4	4.1	-9.1	6.2	-6.2
0.075	0	0	2.8	-9.1	4.1	-8.7	6.2	-6.2
0.085	0	0	7.8	-4.1	8.7	-4.4	6.2	-6.6
0.105	0	0	7.8	-4.4	8.7	-4.4	6.9	-6.6
0.175	0	0	2.8	-8.7	4.1	-8.4	6.6	-6.9
0.200	0	0	3.1	-4.4	5.3	-4.1	7.2	-6.9
0.255	0	0	3.1	-9.1	4.4	-8.4	6.9	-7.2
0.500	0	0	3.1	-4.4	5.3	-4.1	7.2	-7.2
1	0	0	3.1	-4.7	5.3	-4.1	7.2	-7.5
10	0	0	3.1	-4.4	4.7	-4.1	6.9	-6.9



Informational measurements at 480V

Input Voltage	480Vac	Output Voltage	48V
Input Frequency	50Hz	Output Current	20A
Sag	L1-L2	Ambient Temperature	25°C

Informational measurements

Sag duration [s]	Voltage remaining		L1 - current [A]		L2 - current [A]		L3 - current [A]	
	[%]	[Vac]	max	min	max	min	max	min
0.020	0	0	3.1	-3.7	4.4	-3.1	4.4	-3.4
0.035	0	0	2.8	-16.6	4.1	-15.9	5.3	-5.0
0.055	0	0	2.2	-16.2	4.1	-15.6	5.3	-5.3
0.075	0	0	2.2	-15.9	4.1	-15.3	5.0	-5.0
0.085	0	0	14.4	-3.7	14.7	-4.4	5.0	-5.3
0.105	0	0	14.4	-3.7	14.7	-4.4	5.0	-5.3
0.175	0	0	2.2	-15.6	4.1	-14.4	5.0	-4.7
0.200	0	0	2.2	-3.7	4.1	-3.1	5.0	-5.0
0.255	0	0	2.2	-15.6	4.1	-14.4	4.7	-5.0
0.500	0	0	2.2	-3.7	4.4	-3.1	5.0	-5.0
1	0	0	2.2	-3.7	4.1	-3.1	4.7	-4.7
10	0	0	2.2	-3.7	3.4	-3.1	4.4	-4.4

