# SEMI F47
# Voltage Sag Immunity Test Report
# for
# Power Supply QS10.241


**Other devices covered by this report:**

| | |
|---|---|
| **QS10.241-ww** | Standard units |

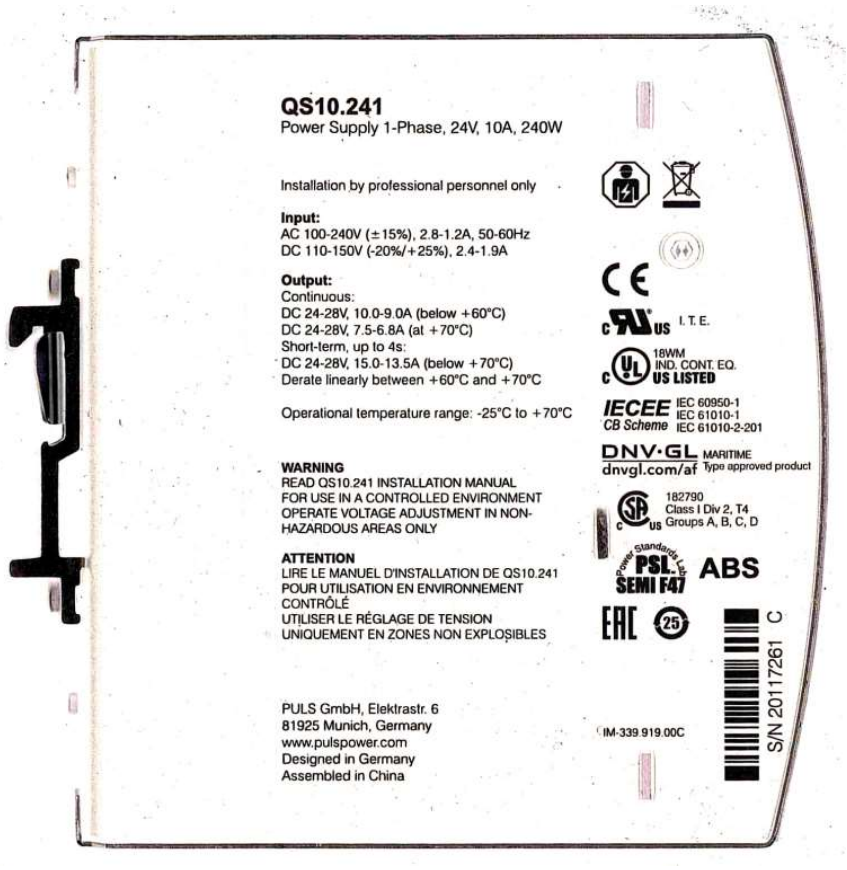
| | | |
|---|---|---|
| **ww:** | blank | Standard unit |
| | C1 | Version with conformal coated pc-boards |
| | 75 | Same as QS10.241 but with assembled wall mount bracket |
| | A1 | Version with conformal coated pc-boards and ATEX/IECEx approval |
| | D1 | Version with enhanced DC-Input range |

# SEMI F47 Test Report

| | |
|---|---|
| **Document Number** | QS10.241 Semi F47 Rev2 TR1 |
| **Approval Order Number** | LAB 20-806 |
| **Standards** | **SEMI F47-0706** (July 2006)<br>SPECIFICATION FOR SEMICONDUCTOR PROCESSING EQUIPMENT - Voltage Sag Immunity Compliance Tests<br><br>**IEC 61000-4-11** 2004 +A1:2017<br>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<br>Elektrastraße 6<br>81925 Munich, Germany |
| **Test Laboratory** | PULS Vario GmbH<br>Kranichberggasse 6<br>1120 Vienna, Austria |
| **Test Engineer** | Thomas Ramel |
| **Test Date** | 23.06.2020 - 04.08.2020 |
| **Description of Test Device** | Built-in power supplies for DIN-Rail mounting |
| **Devices under Evaluation** | QS10.241<br>Input: AC 100-240V, Output: DC 24-28V, 10A |
| **S/N of Devices** | QS10.241: S/N: 20117261 C |
| **Application Details** | Input voltage: 1-Phase AC 120V, 208V<br>Input frequency: 50 or 60Hz<br>Output load: 240W |

| | |
|---|---|
| **PASS/FAIL Criterions:** | In accordance with paragraph 7.8.2 a) of SEMI F47-0706<br>The output voltage is not allowed to deviated more than 5% of the initial value<br>DC OK contact is not allowed to trigger during and after the test |
| **Test Result:** | **PASS**<br>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:<br>  <br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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<br>Sr. Qualification Eng.<br>PULS Vario GmbH, Vienna |
| **Date of Approval** | **04.08.2020** |

**Copy of marking plate:**




**List of Test Equipment**

| Type | Model | Inventory number |
|---|---|---|
| Test generator | Kikusui PCR3000WE2 | 10381 |
| el. Load | el. Load Chroma 63201 | 10046 |
| Oscilloscope | LeCroy WS454 | 10130 |
| Oscilloscope | LeCroy WS424 | 10127 |
| Diffential Probe | Lecroy | 10246 |
| Current Probe | LeCroy CP30 | 10378 |

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 |

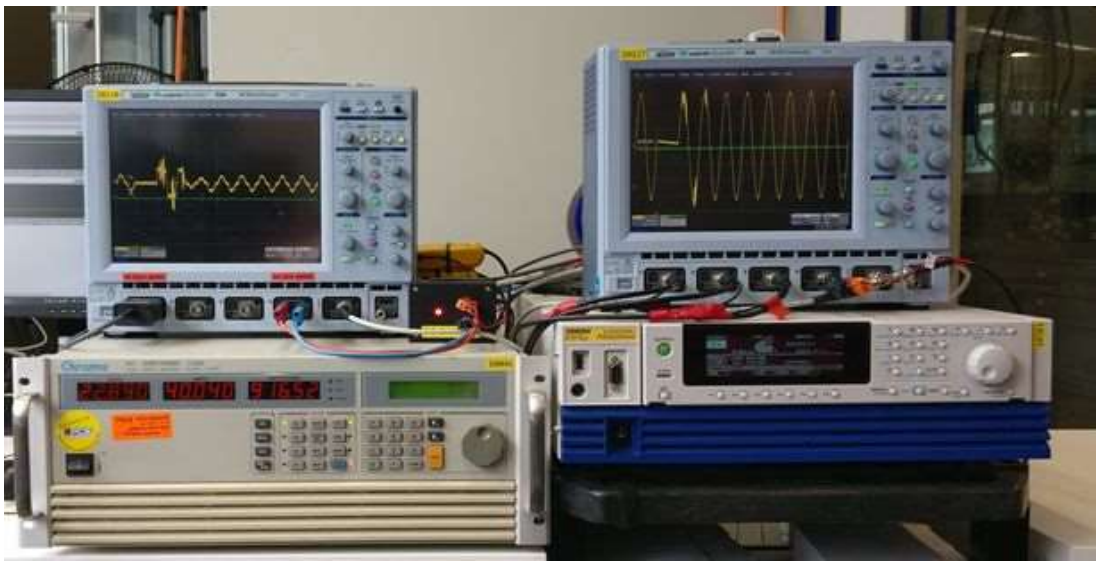
#1 Sag depth is expressed in percent of remaining nominal voltage. For example, during a 70% voltage sag on a 200 volt nominal system, the voltage is reduced during the sag to 140 volts and not 60 volts.

**Test Setup**

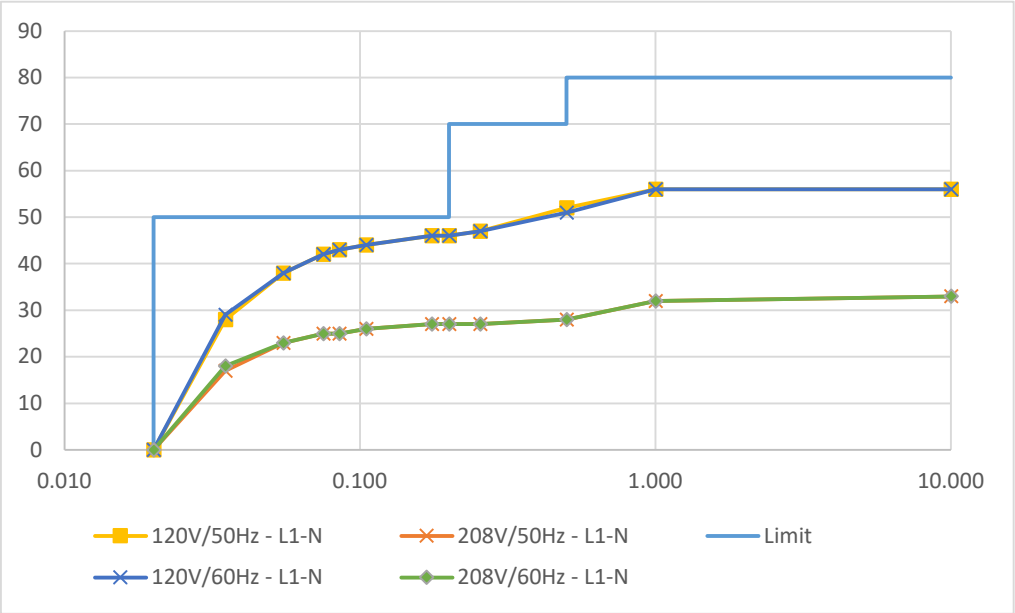
The unit under test in normal operating condition mounted in climate chamber.
The input is connected to an AC Source. The input voltage is measured with a 100:1 differential probe and the input current is measured with current probes. These probes are connected to oscilloscopes.

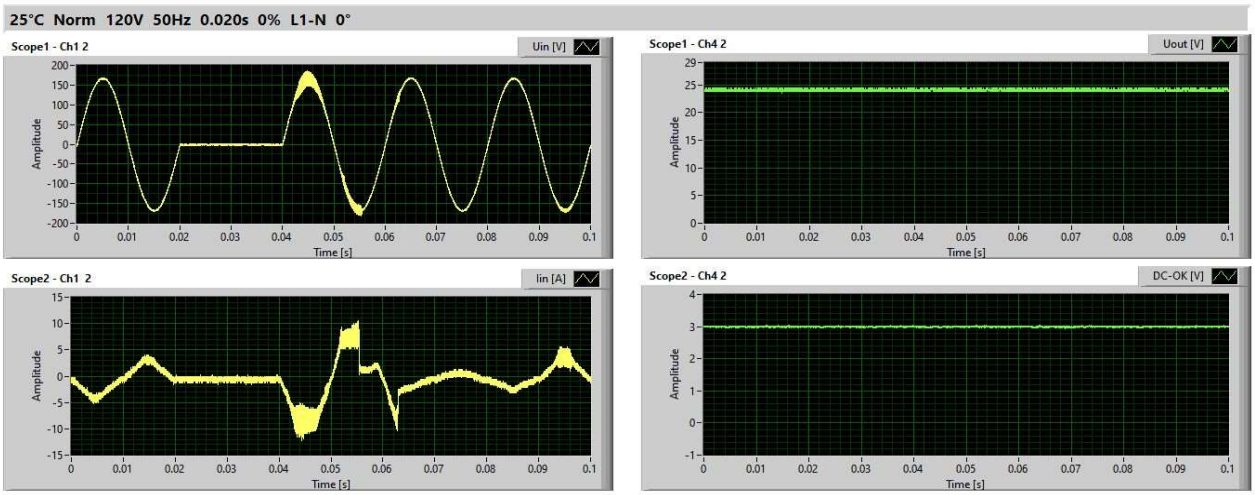
The output is connected to an active load. The output voltage is connected directly to the oscilloscope.
"DC-OK" signal is also measured with an oscilloscope.

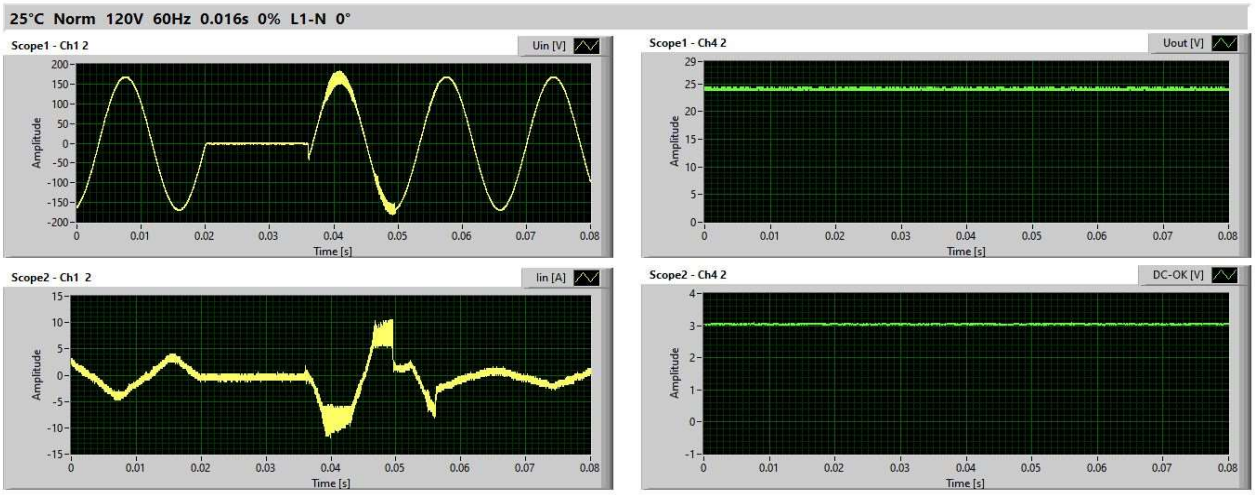
Input and output voltages are measured with oscilloscope #1 and input currents with oscilloscope #2.

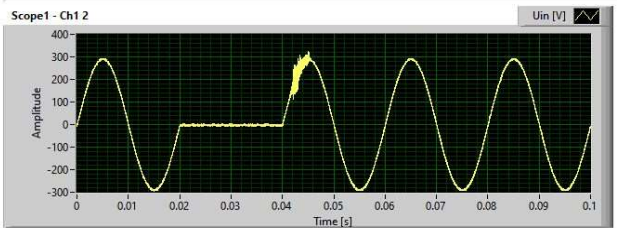
## Voltage Sag Results

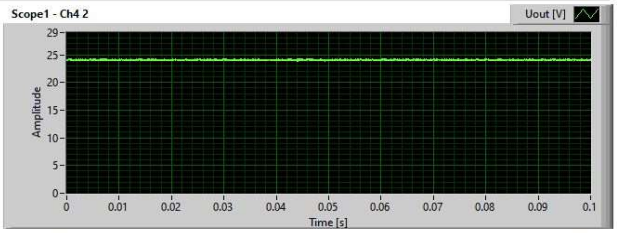


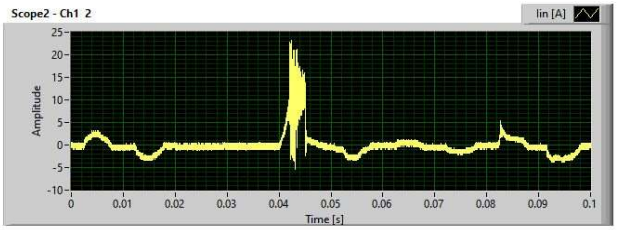



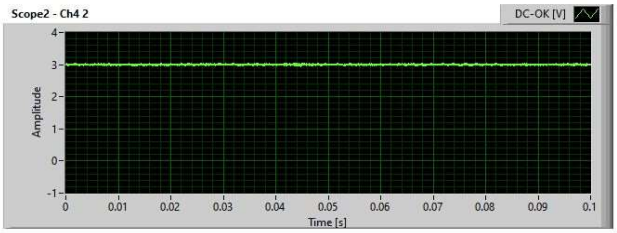



**25°C Norm 208V 50Hz 0.020s 0% L1-N 0°**

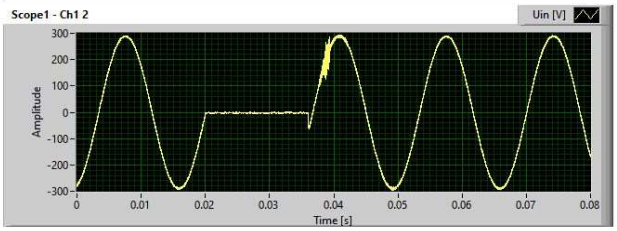


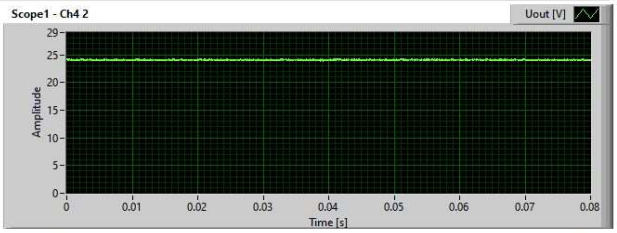



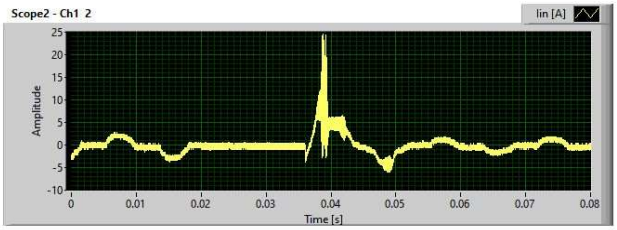



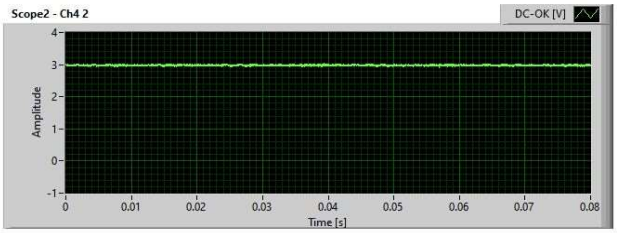




**25°C Norm 208V 60Hz 0.016s 0% L1-N 0°**



**Conducted Tests at 120V 50Hz**

| | |
|---|---|
| Input Voltage | 120Vac |
| Input Frequency | 50Hz |
| Output Voltage | 24V |
| Output Current | 10A |
| Ambient Temperature | 25°C |

| Sag duration [s] | Voltage remaining [%] | Pos. peak current [A] | Neg. peak current [A] |
|---|---|---|---|
| 0.020 | 0 | 10.6 | -12.2 |
| 0.200 | 50 | 9.4 | -10.9 |
| 0.500 | 70 | 6.6 | -8.4 |
| 1 | 80 | 5.6 | -6.9 |
| 10 | 80 | 5.6 | -6.6 |

Informational measurements

| Sag duration [s] | Voltage remaining [%] | Sag duration [s] | Voltage remaining [%] |
|---|---|---|---|
| 0.020 | 0 | 0.175 | 46 |
| 0.035 | 28 | 0.200 | 46 |
| 0.055 | 38 | 0.255 | 47 |
| 0.075 | 42 | 0.500 | 52 |
| 0.085 | 43 | 1 | 56 |
| 0.105 | 44 | 10 | 56 |

**Conducted Tests at 120V 60Hz**

| | |
|---|---|
| Input Voltage | 120Vac |
| Input Frequency | 60Hz |
| Output Voltage | 24V |
| Output Current | 10A |
| Ambient Temperature | 25°C |

| Sag duration [s] | Voltage remaining [%] | Pos. peak current [A] | Neg. peak current [A] |
|---|---|---|---|
| 0.016 | 0 | 10.6 | -11.9 |
| 0.200 | 50 | 9.7 | -10.6 |
| 0.500 | 70 | 6.9 | -8.4 |
| 1 | 80 | 5.6 | -7.2 |
| 10 | 80 | 5.6 | -6.6 |

Informational measurements

| Sag duration [s] | Voltage remaining [%] | Sag duration [s] | Voltage remaining [%] |
|---|---|---|---|
| 0.016 | 0 | 0.175 | 46 |
| 0.035 | 29 | 0.200 | 46 |
| 0.055 | 38 | 0.255 | 47 |
| 0.075 | 42 | 0.500 | 51 |
| 0.085 | 43 | 1 | 56 |
| 0.105 | 44 | 10 | 56 |

**Conducted Tests at 208V 50Hz**

| | |
|---|---|
| Input Voltage | 208Vac |
| Input Frequency | 50Hz |
| Output Voltage | 24V |
| Output Current | 10A |
| Ambient Temperature | 25°C |

| Sag duration [s] | Voltage remaining [%] | Pos. peak current [A] | Neg. peak current [A] |
|---|---|---|---|
| 0.020 | 0 | 23.1 | -5.3 |
| 0.200 | 50 | 9.7 | -10 |
| 0.500 | 70 | 7.2 | -5.3 |
| 1 | 80 | 5.3 | -4.4 |
| 10 | 80 | 5 | -3.7 |

Informational measurements

| Sag duration [s] | Voltage remaining [%] | Sag duration [s] | Voltage remaining [%] |
|---|---|---|---|
| 0.020 | 0 | 0.175 | 27 |
| 0.035 | 17 | 0.200 | 27 |
| 0.055 | 23 | 0.255 | 27 |
| 0.075 | 25 | 0.500 | 28 |
| 0.085 | 25 | 1 | 32 |
| 0.105 | 26 | 10 | 33 |

**Conducted Tests at 208V 60Hz**

| | |
|---|---|
| Input Voltage | 208Vac |
| Input Frequency | 60Hz |
| Output Voltage | 24V |
| Output Current | 10A |
| Ambient Temperature | 25°C |

| Sag duration [s] | Voltage remaining [%] | Pos. peak current [A] | Neg. peak current [A] |
|---|---|---|---|
| 0.016 | 0 | 24.7 | -5.9 |
| 0.200 | 50 | 9.4 | -9.7 |
| 0.500 | 70 | 6.9 | -6.6 |
| 1 | 80 | 5 | -4.4 |
| 10 | 80 | 5 | -4.4 |

Informational measurements

| Sag duration [s] | Voltage remaining [%] | Sag duration [s] | Voltage remaining [%] |
|---|---|---|---|
| 0.016 | 0 | 0.175 | 27 |
| 0.035 | 18 | 0.200 | 27 |
| 0.055 | 23 | 0.255 | 27 |
| 0.075 | 25 | 0.500 | 28 |
| 0.085 | 25 | 1 | 32 |
| 0.105 | 26 | 10 | 33 |

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

| | |
|---|---|
| Input Voltage | 208Vac |
| Input Frequency | 50Hz |
| Output Voltage | 24V |
| 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°: 4.1A
Measure peak input current when AC turned on at 270°: 4.1A
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°: 4.1A
Measure peak input current when AC turned on at 270°: 3.7A

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

| | |
|---|---|
| Input Voltage | 208Vac |
| Input Frequency | 60Hz |
| Output Voltage | 24V |
| 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°: 4.7A
Measure peak input current when AC turned on at 270°: 5.6A
on again.
Measure peak input current when AC turned on at 90°: 4.1A
Measure peak input current when AC turned on at 270°: 5A

**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.

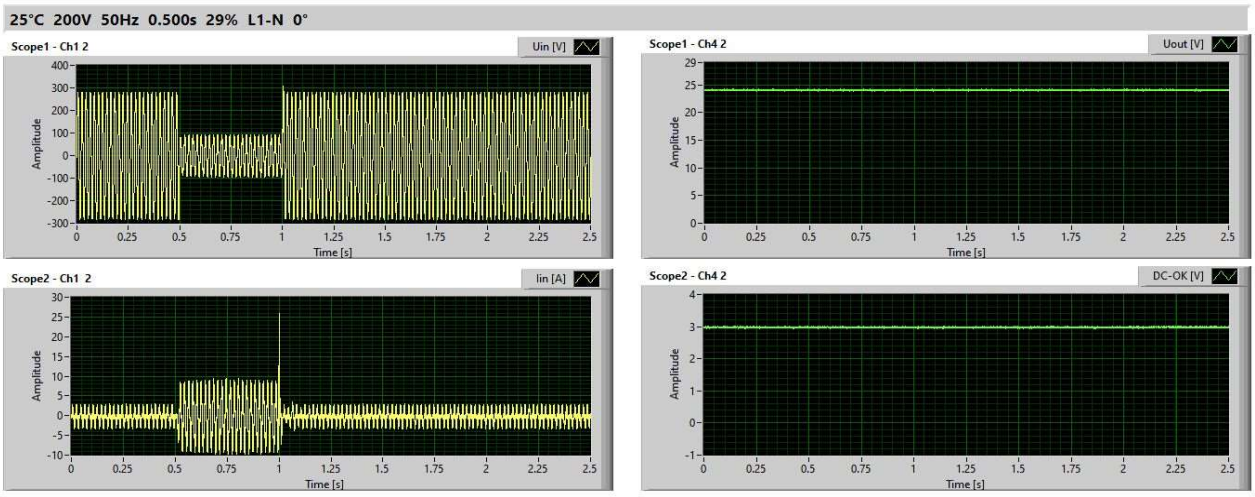
**APPENDIX**

**Informational measurements at 200V**

| | |
|---|---|
| Input Voltage | 200Vac |
| Input Frequency | 50Hz |
| Output Voltage | 24V |
| 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 | 24.1 | -6.2 |
| 0.035 | 18 | 23.1 | -25 |
| 0.055 | 24 | 17.2 | -25.6 |
| 0.075 | 26 | 10.9 | -25.3 |
| 0.085 | 26 | 25.3 | -15.6 |
| 0.105 | 27 | 24.7 | -11.2 |
| 0.175 | 28 | 9.7 | -24.4 |
| 0.200 | 28 | 23.1 | -10.3 |
| 0.255 | 28 | 11.6 | -23.4 |
| 0.500 | 29 | 25.9 | -9.7 |
| 1 | 33 | 18.1 | -10.9 |
| 10 | 34 | 9.7 | -9.4 |



**Informational measurements at 230V**

| | |
|---|---|
| Input Voltage | 230Vac |
| Input Frequency | 50Hz |
| Output Voltage | 24V |
| 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 | 23.1 | -5.9 |
| 0.035 | 16 | 11.2 | -27.2 |
| 0.055 | 21 | 10.9 | -30 |
| 0.075 | 23 | 10 | -26.2 |
| 0.085 | 23 | 25.3 | -10.3 |
| 0.105 | 23 | 31.9 | -11.2 |
| 0.175 | 24 | 10.3 | -29.7 |
| 0.200 | 24 | 21.2 | -10.3 |
| 0.255 | 25 | 9.4 | -23.7 |
| 0.500 | 25 | 22.8 | -10 |
| 1 | 28 | 18.4 | -10.3 |
| 10 | 30 | 10.3 | -9.4 |