intreXis®
POWER SUPPLIES

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White Paper Insulation Test

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1 INDEX

2 INTRODUCTION

This document describes the correct way to perform the insulation type test with a high voltage and the problems that can occur if some rules are disregarded.

3 REQUIREMENTS ACCORDING EN 50155

In the paragraph safety, the standard EN50155 defines:

10.1 General
Equipment shall be designed, constructed and installed (as relevant to the contract), in full accordance with the current National Safety legislation of the country or countries of use, as defined by the user.

In most cases, the safety legislation is covered by the standard EN/IEC 60950-1 and IEC 62368-1.

Regarding the insulation, the standard EN50155 defines:

12.2.9 Insulation test
The aim of this test is to ensure that the mounting of components, their metal connections and casings, and the routing of wiring and printed board tracks, are not located too close to surrounding metal parts or fixings.

4 INSULATION TEST ACCORDING EN 60950 / IEC 62368-1

Some important details are defined in the standards EN/IEC 60950-1 / IEC 62368-1 regarding the insulation test:

To avoid damage to components or insulations that are not involved in the test, ICs or the like, may be disconnected and equipotential bonding may be used.

For equipment incorporating basic insulation and supplementary insulation in parallel with reinforced insulation, care is taken that the voltage applied to the reinforced insulation does not overstress basic insulation or supplementary insulation.

Where capacitors are in parallel with the insulation under test (for example, radio-frequency filter capacitors) and the capacitors can affect the test results, DC test voltages shall be used.

The first two statements allow removing components in order to avoid overstressing them.
The third statement recommends performing the insulation test with a DC-voltage. If a DC-voltage is used, the voltage must be equal to the peak voltage of the prescribed a.c. test voltage.

5 INSULATION SYSTEM OF A POWER SUPPLY

The insulation system of a power supply is as follows:

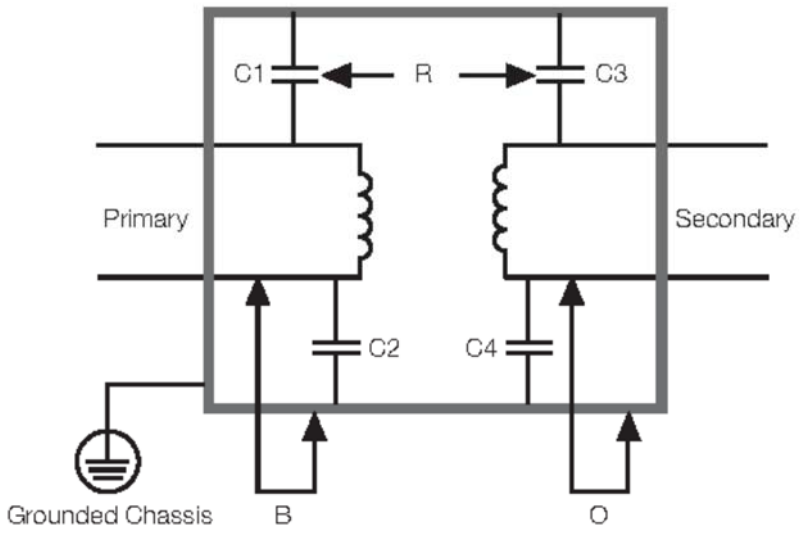

Figure 1

- R – Location of Reinforced Insulation
- B – Location of Basic Insulation
- O – Location of Operational or Basic Insulation

Between Primary and Secondary, reinforced insulation is required.
Between Primary and Chassis Ground, basic insulation is required.
Between Secondary and Chassis Ground, operational or basic insulation is required.

Typical values for the required insulation voltages are:

INUSLATION PATH	INSULATION VOLTAGE AC	INSULATION VOLTAGE DC
primary to secondary	3000 VAC	4243 VDC
primary to earth (chassis)	1500 VAC	2121 VDC
secondary to earth (chassis)	500 VAC	707 VDC

6 PROBLEMS CAUSED BY THE INSULATION TEST WITH HIGH VOLTAGE

The insulation test causes following problems (please refer to Figure 1 above):

1) If an AC-testvoltage is used, an AC-current is flowing through the capacitors C1 – C4, depending on where the voltage is applied:
   Iac = Vac / Xcapacitor
   Xcapacitor = 1 / (2π*50Hz*C)
   The insulation measuring equipment interprets these AC-currents as a failure or breakdown of the insulation. Furthermore, the high AC-currents can overheat and damage the capacitors.

   Workaround: Use only DC-testvoltage, as recommended by the standards. To avoid excessive charging/discharging currents in the capacitors C1 – C4, the ramp-up and ramp-down time (0V to DC-Testvoltage) should be set to 5 seconds.

2) The insulation test between primary and secondary will overstress the other insulation paths, for following reasons:
   a. The creepage and clearance distances are reduced for basic or operational paths compared to the reinforced requirement.
   b. The voltage requirements for the filter capacitors C1 – C2 and C3 – C4 are reduced compared to the reinforced requirement.
   c. The capacitors C1 – C2 and C3 – C4 form a capacitive voltage divider when a voltage is applied between primary to secondary. Depending on the capacitor-values, a single capacitor can experience any voltage between 0 and the maximum testvoltage.

   Therefore, false failures will occur and possibly damage some filter-capacitors and the power supply.

   Workaround: Disassemble all filter capacitors to earth, please contact intreXis AG for advice.

In most of our power-supplies, we have only two parts which cross the isolation between primary and secondary (reinforced insulation):
- Transformer for power conversion.
- Optocoupler for regulation.

Each transformer is tested in our production with the required reinforced insulation voltage. The optocoupler reinforced insulation voltage is guaranteed by the manufacturer and approved by the safety agencies. We use only optocouplers, which have a higher insulation voltage than required.

7 HOW TO PERFORM THE INSULATION TEST WITH HIGH VOLTAGE CORRECTLY

7.1 TYPE TEST

For the type test, the filter-capacitors (C1 – C4, see figure above) must be removed, according to EN 61287-1:2014.
The test voltage shall be applied by gradually increasing the voltage amplitude to the test voltage (recommended ramp-up and ramp-down time = 5 seconds) and maintained at the specified level for 1 minute.
intreXis AG has already performed a type test for all converters.

7.2 ROUTINE TEST

For the routine test, the filter capacitors cannot be removed. To avoid capacitor-failures as described above, the approval agencies allow a reduced test-voltage.

For the routine test according to EN 50124-1:2017 between Input – Output and Input – Chassis, intreXis AG recommends the following procedure:
Connect Output to Chassis, apply a test-voltage of 2125 VDC or 1500 VAC with trigger threshold ≥ 30 mA, The test voltage shall be applied by gradually increasing the voltage amplitude to the test voltage (recommended ramp-up and ramp-down time = 5 seconds) and maintained at the specified level for 10 seconds.