Tilecal Bulk LVPS 200VDC Conducted Emissions Test Report

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System: TESLA power supply delivering 200VDC 3.5KW.
Contact: Georges.Blanchot [Georges.Blanchot@cern.ch]

1. Scope of the test.

To measure the conducted emissions on the output interconnection cables of a TESLA bulk power supply used by Tilecal to feed the front-end Dc to Dc converters.

The Liquid Argon calorimeter suffers from EMI couplings at 17 MHz that degrades the performance of their system. The EMI is known to appear when the Tilecal power supplies are turned on. The purpose of the test is to conclude if the power supply system of Tilecal is at the origin of the EMI couplings.

2. Limits

The conducted emission limits as applied in ATLAS are obtained from the voltage limits established in the CISPR11 IEC standard and assuming a standard load of 50 ohms. They are specified as maximum admissible common mode current from the tested interconnect cables (shields included), under nominal operating conditions (Table 1). The maximum peak detection method is used.

Range	9 kHz to 500 kHz	500 kHz to 100 MHz
Limit	45 dBµA	39 dBµA

Table 1: ATLAS EMI Emissions Limits

3. Test setup and instruments

The setup (Figure 1) is composed by a TESLA system, in one of the bulk power racks of Tilecal. The power supply feeds the DC/DC converters, but those remain OFF as long as the start signal isn't sent. The measurement is made in three steps:

1. All the Tilecal power back end is OFF.
2. One TESLA channel is switched on, the 200VDC output is enabled.
3. Many TESLA channels are switched on, and the 200VDC outputs are enabled.

It must be noted that the DC/DC converters are never turned on during the test. Therefore the observations are exclusively attributed to the emissions of the bulk power supply from TESLA.

The measurement of common mode currents is made on the corresponding output cable including the shield in its original installation.

The EMI emissions are measured with a calibrated current probe from ETS-Lindgren, model 91550-1L, and an EMI receiver, model ESPI3 from Rohde and Schwarz. For shielded cables, the EMI emissions are measured including the shield in the probe window.

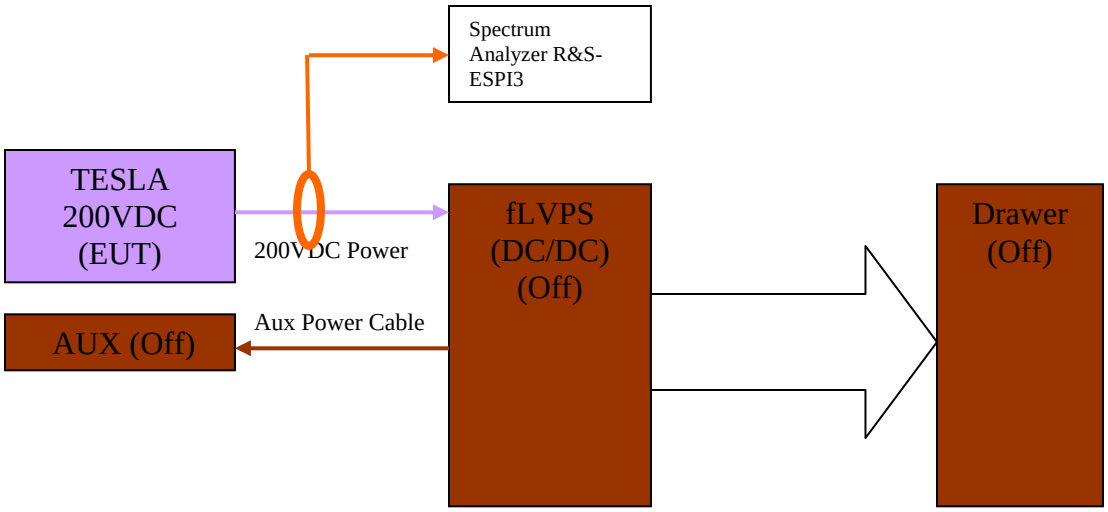

Figure 1: Test setup; only one of the three outputs of the TESLA power supply is exercised; the measurement is made on the 200VDC output.

4. Common Mode Current on the 200V Power Link

Three measurements (Figure 2) were made on the same output cable:

- Green curve (3): All the power back end is turned off, the 200V is no delivered.
- Black curve (2): All the power back-end is turned on, many of the 200V outputs are enabled.
- Blue curve(1): Only the channel under test is turned on, only the 200V output is enabled.

Discussion.

When the bulk power supplies are turned off, the 17 MHz interference disappears entirely. When the power back end is turned on, the 17 MHz is visible on all the 200V output cables but also on the high voltage cables, and to less extent to other cables that belong to Tilecal.

The noise emissions on the tested output are very similar when only the channel under test is enabled or when more are enabled. Therefore, the noise emissions are produced by the channel under test.

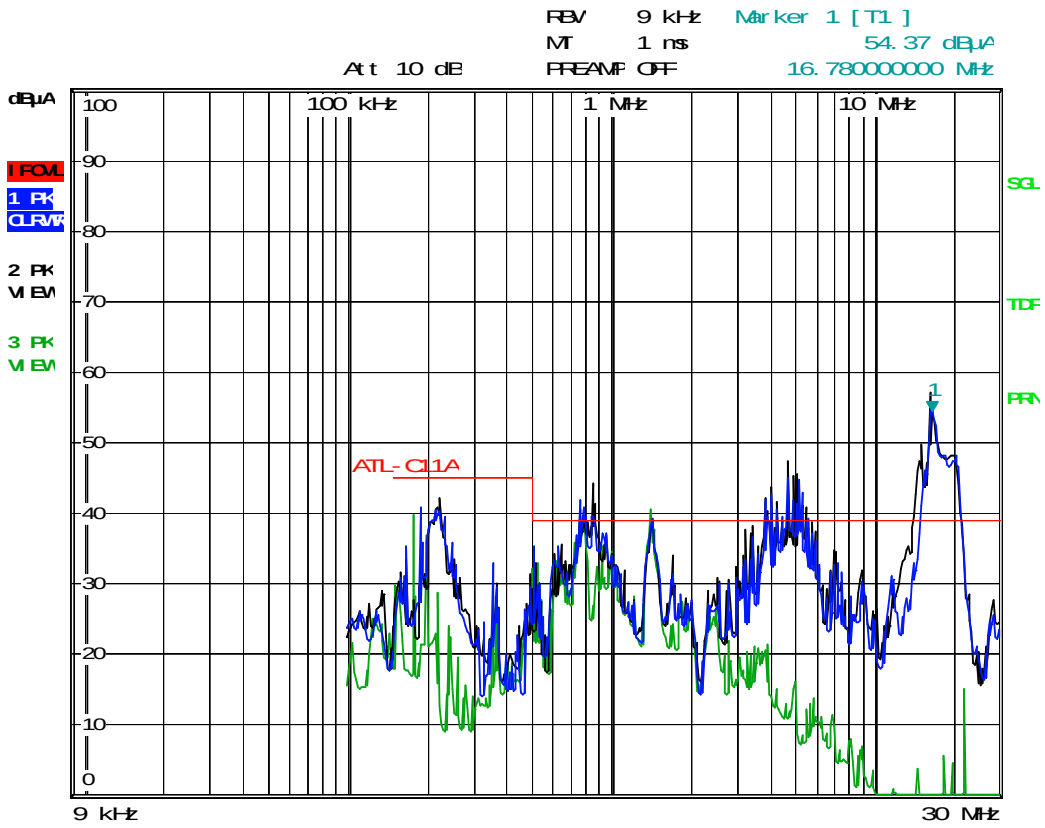

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Figure 2: conducted emissions on the output under test.

5. Conclusion

The measurement is conclusive to identify the bulk LVPS as the source of EMI at 17 MHz.

The 200VDC power cables of Tilecal (64 cables) are routed together with the Liquid Argon 280VDC power cables (55 cables). Both cables are shielded, but they share a common cable tray over distances of 60 meters (barrel) and almost 100 meter (endcaps). The Liquid Argon calorimeter appears more susceptible to the coupling of EMI in the endcaps, which is consistent with the longer coupling path.

It is recommended to first add selected ferrites on all the 200VDC output cable in order to reduce the EMI emissions at 17 MHz down to levels compatible with the ATLAS limits.

It is recommended that Tilecal and the Liquid Argon calorimeters check the proper grounding of the cable shields, which must be connected on both ends to prevent the inductive coupling that is taking place inside the common cable tray.