

UG electronics FM Crate

Test report n.1

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1 Introduction

This document describes preliminary results of the space acceptance test of one of the electronics crates of the AMS02 experiment, the crate controller of the gas circuit for the sub detector called TRD (*Transition Radiation Detector*): the UG crate.

A general description of the AMS02 experiment can be found in the following site: <http://ams.cern.ch/AMS> .

The *UG crate* construction and test is responsibility of INFN Roma who made the projects and the tests of the Engineering Models and of the QM2 version. The AMS02 TRD Gas circuit will be equipped with one such crate. The Space Acceptance tests of this crate is performed on the Flight Model (FM) according to the procedure described by the guidelines specified in <http://ams.cern.ch/AMS/electronics/SubD/qa/> where most of the reference documents can be found.

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2 FM UG test configuration

Hardware

The material entered the TV chamber is the UG and the UGPD crate, the latter supplying the power by DC-DC converters, while all the other hardware needed to test the UG crate functionality, 28VDC power supplies, computers etc., resided outside the vacuum chamber.

The UG Crate

G&A Engineering built the mechanical crate, following the drawings provided by *Carlo Gavazzi Space* (CGS). Fig.1 shows a photo of the crate.

The boards

The crate is equipped with a total of 8 boards of 4 different kinds, plus a backplane to which the boards are connected. The boards are:

- 2 UGSCM
- 2 UGBS
- 2 UGBC
- 2 UGFV

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Figure 1 – UG crate

Except for the UGSCM, which is provided by the AMS electronics team, all the other boards have been projected, engineered and tested by INFN Roma. For the Space Acceptance tests, 2 FM boards per type were built. The complete crate with all modules went through the thermal stress test and vibration test having commercial power supplies providing the needed voltages.

The UGPD Crate

The UGPD crate was built by CSIST Taiwan and was available only for the TVT test. The 28V power supply needed by the UGPD crate was supplied by an external power supply.

Ancillary hardware

The acceptance test is performed while testing full functionality of the UG crate. For this reason, a Test Station (UGTS), with a set of 6 boards simulating the input/output operations of TRD gas circuit, is connected to the UG crate. The connection scheme is sketched in fig.2.

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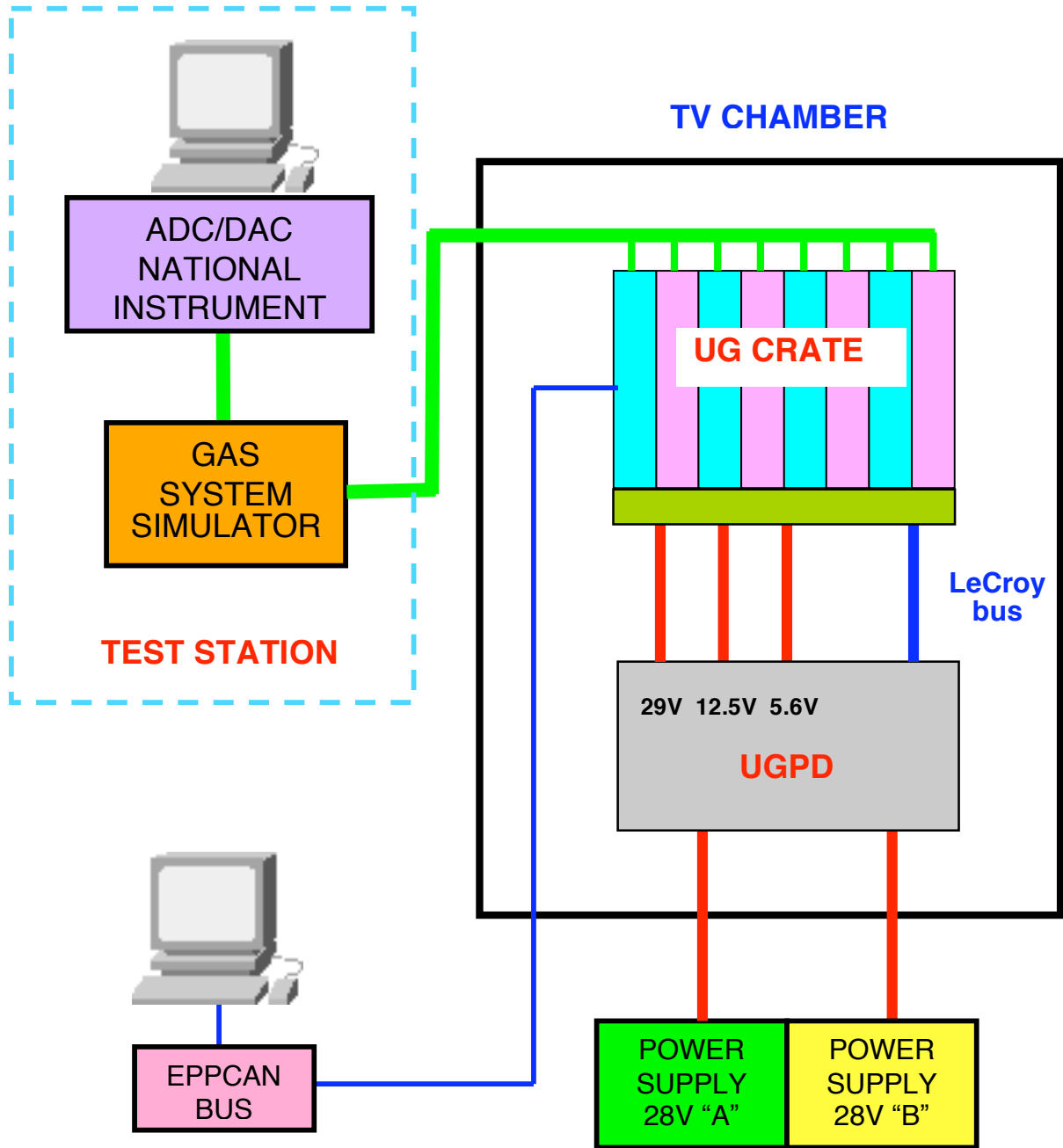


Figure 2 - Schematics of UG electronics test set-up

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The connection between UG crate and the test station UGTS is done through thermal-vacuum flanges (DNC200) equipped with TV qualified feed-throughs DB 37 pin connectors (ITT CANNON socket housing D37 way cod. DCA37S-A197-F0 + ITT CANNON crimp socket cod. 3307636010). The cables inside the chamber are RAYCHEM cod. 44A0111-20-9.

3 Test preliminary results

Following the directions reported in the document <http://ams.cern.ch/AMS/electronics/SubD/qa/>, the test was performed in two steps:

1. **ESS** (Environmental Stress Screening): a test in air, in a thermal chamber and on the vibration table. Commercial power supplies provided the supply voltages.
2. **TVT** (Termo-Vacuum Test): a test in vacuum. The UG was equipped with the UGPD. Lecroy cable and power cables were connected between the UGPD and the UG. Lecroy cable was shielded and the shield was connected to the UGPD. Power cables, 5.6V, 12.5V, 29V, were not shielded. Each crate had its own interface plate and both plates were bolted on the same “cold plate” of the vacuum chamber.

The test temperature profile followed strictly the prescribed cycle

This report describes briefly the experienced behavior of the LeCroy commands to the internal modules of the UG crates.

1. The UG FM electronics passed the ESS test without any failure at high temperature (+50 °C) and at low temperature (-20 °C). All LeCroy commands acted correctly on modules UGBS, UGBC and UGFV, hot and cold. In the TV chamber, at ambient temperature ($\approx +20$ °C), modules UGBS and UGBC, *hot* and *cold*, did not reply to the LeCroy commands. The message on the screen command panel is: “*Command executed OK, but....*”, i.e. the CAN communication was ok, but the LeCroy command failed for whatsoever reason. The failure was intermittent with a rate of $\approx 1/10$ of failures, slightly larger in *cold* modules.
2. Exercising the temperature cycle, at + 50 °C the failure rate was lower, $\approx 1/20$, instead at -20 °C the rate was almost $\approx 1/3$.
3. Since the cabling for the TV test contained the unused wires for the external power supplies, the floating wires were grounded outside the vacuum chamber and shielded with aluminum foil. The failure rate at +50 °C almost disappears, while at -20 °C was still persistent at about 1/5.
4. The failure was so evident that no exact counting of commands was necessary. No failure

4 Test results in Rome lab

1. After the TV test ended, we brought all equipment to our lab in Rome and we proceeded to perform functionality test with a simpler set-up supplying only 5.6V from the UGPD and with LeCroy cable connected between the UGPD and the UG crate. We observed the same failure behavior with a rate of $\approx 1/20$.
2. Disconnecting the LeCroy cable, the failure disappears.

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3. Connecting the Lecroy cable and disconnecting the mechanical ground from the electrical ground in the UG-FM crate, we did not observed any failure.
4. With a commercial power supply of 5.6V, we did not observed any failure.
5. We checked the connection of electrical ground and mechanical ground inside the UGPD to confirm the presence of the zero ohm resistor in S9011AUG board.
6. As countercheck of the failure behavior, we performed a functionality test of the UG electronics placing the crate in a thermal chamber and lowering the temperature to -20 °C. Commercial 5.6V power supply was connected to the UG-FM crate. No failure was observed.

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4 Conclusions

The zero ohm resistor possibly is responsible of a ground loop introducing noise in the system. Disconnecting the LeCroy cable between UG and UGPD, the noise disappears and we do not observe any command failure. Removal of the connection between mechanical ground and electrical ground at UG crate side has the same effect. Removing the zero ohm resistor may have the same effect.

Appendix A – Step by step procedure for TVT test

1. PRELIMINARY TEST

- a. The electronics is switched on and a **functionality test** is performed. Communication is via EPPCAN bus. The operation sequence, together with temperatures, pressures, status flags that are read out during the test, are stored in a pc together with the output from the Test Station.
 - i. UGSCM A and B are initialized;
 - ii. all valves controlled by UGBS (V1a, V2a, V3a, V4a, V10a, V20a, V1b, V2b, V3b, V4b, V10b, V20b, Sp1, Sp2) are enabled and opened for 5 s one at a time, and status is read, then disabled;
 - iii. all pressure sensors controlled by UGBS (P1a, P2a, P1b, P2b, Pk1c, Pk2c, Pk1d) are read out;
 - iv. all heaters controlled by UGBS (H1, H2, H3, H4, H5) are enabled and started for 1 minute, then disabled, one at a time;
 - v. operations ii to iv are repeated 4 times: [UGSCM-A + UGBS-A], [UGSCM-A + UGBS-B], [UGSCM-B + UGBS-A], [UGSCM-B + UGBS-B];
 - vi. all power supplies (29V, 12V, 5V, 8.5V) controlled by UGBC are enabled, and the status is read out;
 - vii. all valves controlled by UGBC (V6a, V18a, V6b, V18b, V6a&V18a, V6b&V18b) are enabled and opened for 5 s one at a time, and status is read, then disabled;
 - viii. all pressure sensors controlled by UGBC (P3, P4) are read out;
 - ix. all circulation pumps controlled by UGBC (CP1, CP2) are enabled at H speed, started and stopped after 5 s, then enabled at F speed, started and stopped after 5 s then disabled, one at a time;
 - x. all UGBC serial ports (RS232_1, RS232_2, RS232_3, RS232_4) are enabled and the status is read, then disabled;
 - xi. all power supplies (29V, 12V, 5V, 8.5V) controlled by UGBC are disabled;
 - xii. operations vi to xi are repeated 4 times: [UGSCM-A + UGBC-A], [UGSCM-A + UGBC-B], [UGSCM-B + UGBC-A], [UGSCM-B + UGBC-B];
 - xiii. all power supplies controlled by UGFV (12VPS, 12VJV, 21V, MUX) are enabled;

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- xiv. modules 1 to 4 are selected one at a time, and for each module, valves V1 to V5 are opened then closed after 5 s;
 - xv. multiplexers 1 to 4 are selected one at a time, and for each multiplexer all pressure sensors (P1, P2, P3, P4, P5) are read out;
 - xvi. all power supplies controlled by UGFV (12VPS, 12VFV, 21V, MUX) are disabled;
 - xvii. operations xiii to xvi are repeated 4 times: [UGSCM-A + UGFV-A], [UGSCM-A + UGFV-B], [UGSCM-B + UGFV-A], [UGSCM-B + UGFV-B].
- b. The time needed to perform these tests is of the order of 15 minutes.

*NB: These operations are repeated each time a **functionality test** is required.*

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