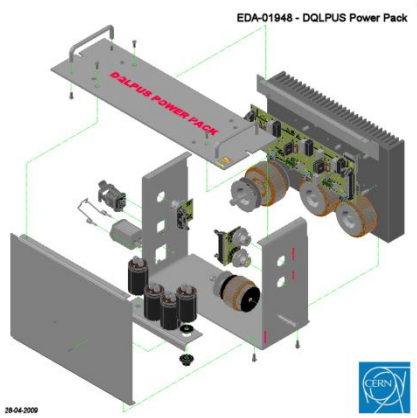
L.V. Power for the iQPS (nDYPB) Local Protection Systems

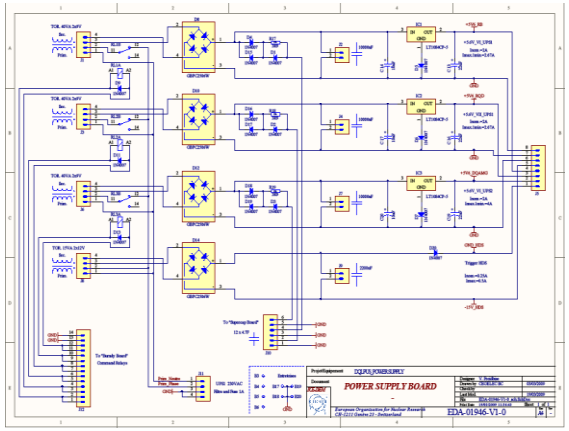
On behalf of the EE-section

FROM THE PAST:

Historical facts:

- **So far, only the nQPS crate (DQLPU-S) and the DQHDS quench heater powering system have profited from the available redundancy offered by the two UPS tunnel power networks.**
  - **Implementation made during the Enhanced QPS Project in 2009 through introduction of two, identical L.V. power systems per Local Protection Unit (dipole 'B') – the so-called 'Power Packs' (DQLPUS).**
  - **The two 'PowerPacks' of each nQPS detection crate are powered from UPS1 (F3) and UPS2 (F4) respectively.**
    Specification: 45 W total output, 3x5.6 V, -15 V, linear regulation. 872 units installed in the LHC machine. incl. power-cycle possibility.
  - **At the same occasion the powering of the 4 / 2 quench heater power supplies was made redundant:**
    - **#1 and #3 from UPS1, #2 and #4 from UPS2 for dipoles**
    - **#1 from UPS1 and #2 from UPS2 for quadrupoles.**





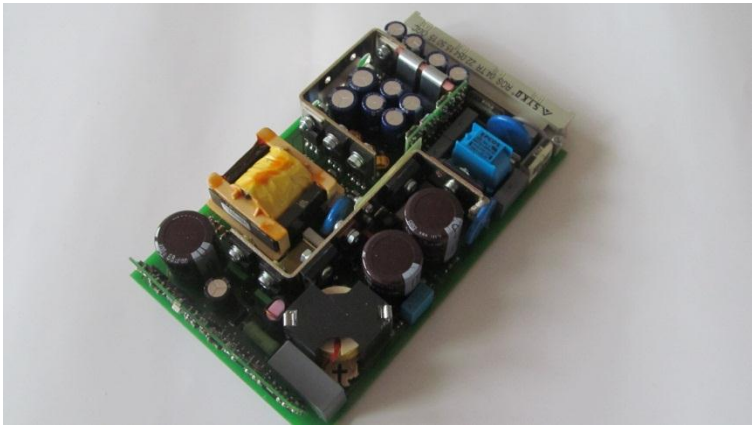
- **Powering redundancy for the iQPS quench detectors was originally considered but not retained as option due to cuts in spending at the moment of design (2003 – 2004) driven by budgetary limitations.**

- **Consequently, the powering of the iQPS has always been based on a single power source: The industrial, tri-volt supply from 'Syko' DE, now powered from one of the UPS lines.**
  - 50 W, 5.4 V, +/- 15 V commercial supply of switch-mode technology, non-resonant, with partly radiation-hardened design (e.g. voltage overrating of Mosfets in output stage).

  → **one tri-volt supply per DQLPU-B, two tri-volt supplies per DQLPU-Q (QF and QD independently).**

- **The powering of the iQPS of dipoles and quads was not upgraded at the occasion of the nQPS introduction (nor later).**
  - There was no changes to the iQPS powering at that time
  - The symmetric quench detector (DQQDS) will, to a large extend, also cover asymmetric quenches
  - The QF/QD time constants have been lowered
  - There was no resources for changing the iQPS powering scheme at that time

- **The 'Syko' pwrs.**



AT PRESENT:

- **Decision to upgrade the iQPS powering scheme for full UPS redundancy during LS1 is closely related to three circumstances:**

1) **Operation of the 2016 commercial supplies in the LHC main circuits has not been completely flawless.**
   A weak point appeared during commissioning in 2007 with spurious CB openings on line F3.
   With 17 cases experienced during 2010 and 2011 operation caused by fast current transients the correlation with the Syko supplies became suspect.
   Was confirmed in 2012 after swapping F3 and F4: only one single case of F3 release detected.
   F3: ultrafast breaker tripping at ~30A, 2ms, F4 standard breaker tripping at ~70A, 10 ms

Conclusion: The measured (rare) surge currents most probably have their origin in the Syko power sources. If not replaced by other power supplies any UPS-redundant powering scheme would then require replacement of the 1700 F3 circuit breakers.

2) **The foreseen upgrade of the Local Quench Protection units and the associated planned improvement of the quench heater discharge supervision for the dipole chains will impose new powering requirements which are not compatible with the Syko power sources.**

3) **As the DQLPU and the Interface Modules (Crawford) are being redesigned and remade, the opportunity to introduce two fully redundant, new, linear power supplies, for remote reset and compatible with the new power requirements, became evident.**

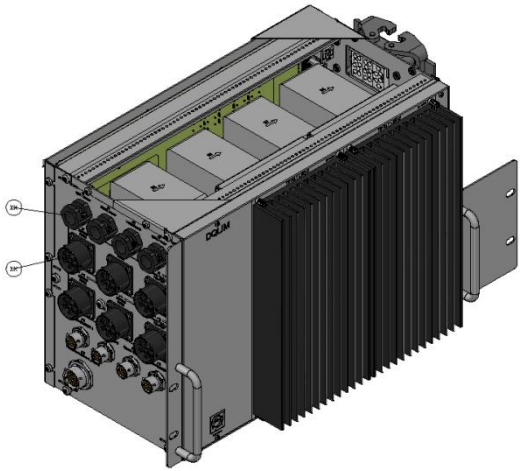
Further remarks:

- **It is NOT foreseen to perform any upgrades, during LS1, on the DQLPU detection crates or the Interface Module (Crawford) of the quadrupole protection units. There will not be any replacement of the two L.V. Power supplies.**

  However, the DQLPU crate is already foreseen for receiving two power supplies per circuit (QF and QD) operating in parallel BUT POWERED FROM THE SAME INPUT (UPS) NETWORK.

  By the replacement of the power sources in the 1232 dipole racks we free an equivalent number of 'SYKO supplies which we intend to insert into the DQLPUQ's for source doubling.

- **The design of the nCrawford Interface module has been completed. It is forseen for housing the two, new, redundant power supplies presently being designed and procured by MPE.**



Requirements and design fundamentals for the new DQLPUR:

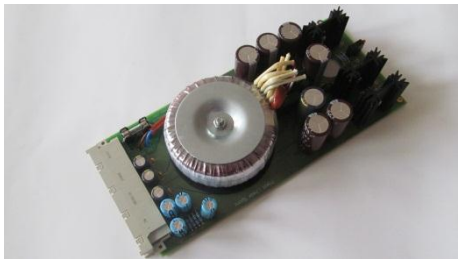
- **POWER RATINGS:** **data mainly from R. Denz**

System	5.6 V floating	+15 V floating	-15 V floating	5.6 V ref to ground	+15 V ref to ground	-15 V ref to ground	Comment
DQQDL Board A	100	50	50	-	-	-	
DQQDL Board B	100	50	50	-	-	-	
DQAMC	-	-	-	250	100	100	
DQHSU fast	-	-	-	250	40	20	
DQHSU slow	-	-	-	-	-	-	
DQCSU	-	-	-	250	20	10	
Spare 1	-	-	-	250	50	50	
Spare 2	-	-	-	250	50	50	
Trfo bias	-	-	-	200	-	-	Maybe not needed
TOTAL	200 mA	100 mA	100 mA	1450 mA	260 mA	230 mA	
With margin	**500 mA**	**250 mA**	**250 mA**	**2000 mA**	**500 mA**	**500 mA**	

THE PRESENT:

- **Design and prototype work on the new 7-output power supplies began in March/April 2012**

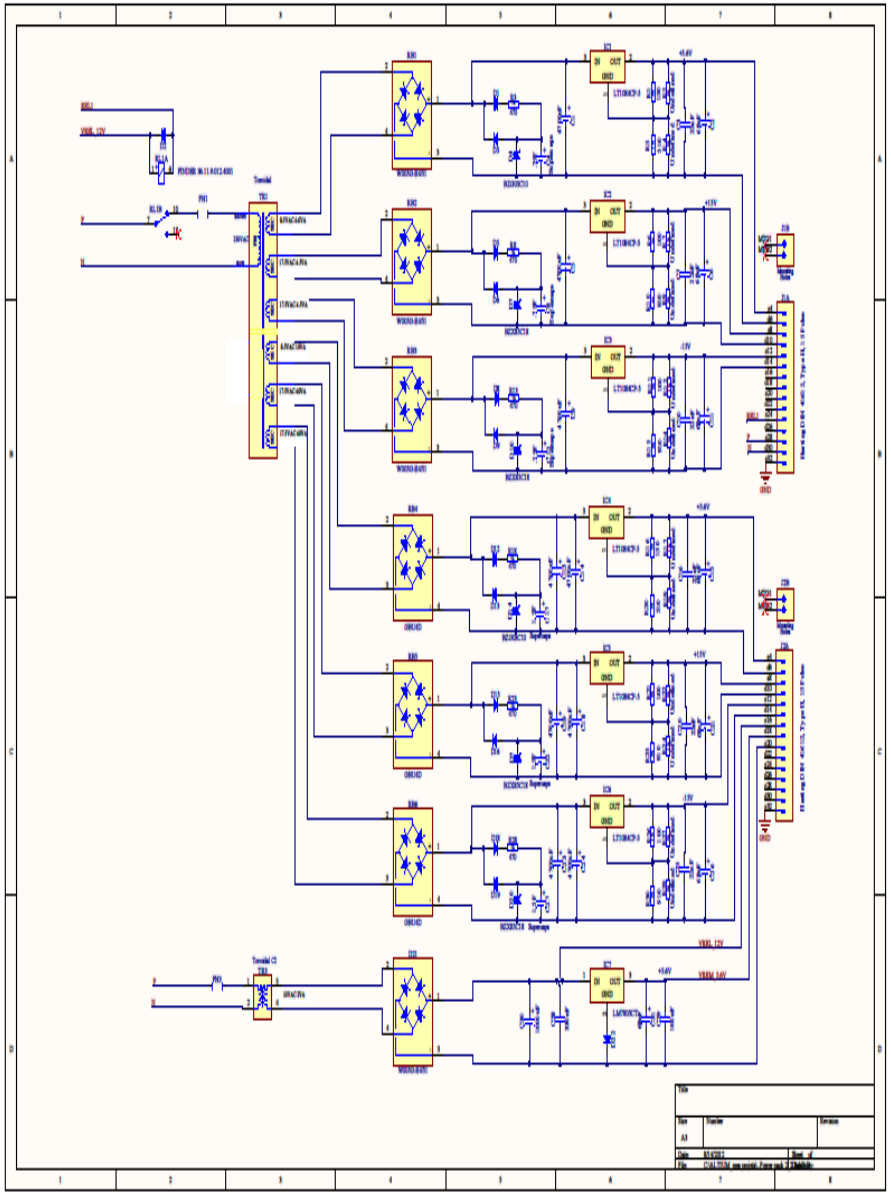
- **A large number of components, features and design details were taken over from**
  - **the nQPS PowerPacks for which the operational experience has been very successful (one problem in more than two years of operation – many installed in areas with non-negligible radiation level)**
  - **the small series (50 pcs) of linear tri-volt supplies designed and build by QPS in 2011 for replacement of failing 'Sykos'.**



- **The principal features are:**
  - **> 90% of generated heat losses dissipated to the outside of cubicle through principal heat sink (radiator)**
  - **All loss affected components mounted directly on the heat sink**
  - **Toroidal, multi-secondary transformer with electro-static screens. For efficient clamping on radiator. With thermal switch on primary winding.**
  - **Simple and robust design through use of standard linear voltage regulators with built-in overload protection (current limitation).**
  - **Voltage hold-up on low-voltage side – use of super-capacitors.**
  - **PCB-mounted, standard H15 connectors**

More details in talk of Joaquim.

Circuit Topology:



THE PRESENT (contd.):

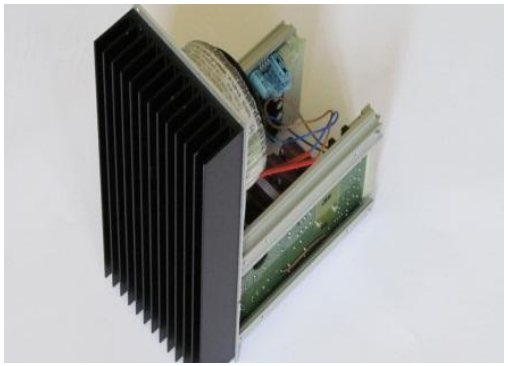
- **Overall rating: total output power 38 W -with installed apparent power of 51 VA.**
- **A seventh, separate output provides a non-interrupted, 12 VDC, 100 mA non-regulated floating source for use in the external power cycling unit.**

More details in talk of Joaquim.

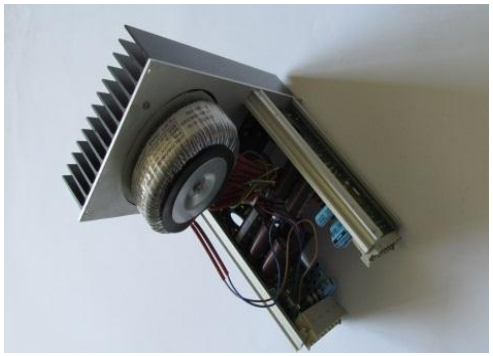
- **Two consecutive prototypes have been produced and tested by MPE/EE.**
- **A third (and probably last) prototype is in production – joint EE and EM task**

Test results in talk of Stephen.

Pictures of second prototype:



Front view



Top view before closing cubicle

PRESENT & FUTURE:

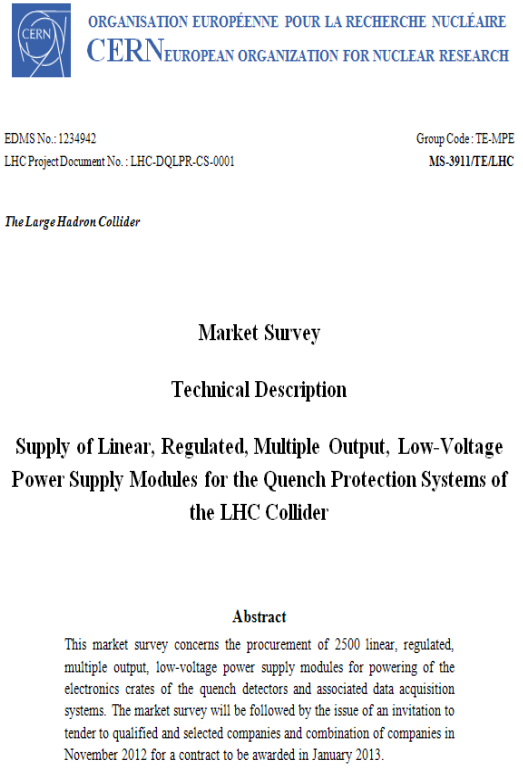
In parallel: Market Survey launched end of October - with closing date of 4 December (next week).

Time frame:

Technical Specification ready: 10 December 2012 (KDP)
Launch of Tender: 17 December using result of MS (I. Lobmaier)
Closing date: 28 January 2013 (I. Lobmaier)
Placing of the order: 11 February 2013
20 pre-series delivered to CERN: 17 May 2013 (14 weeks)
1st batch of 310 units: 21 June 2013 (20 weeks)
2nd batch of 310 units: 19 July 2013 (24 weeks)
3rd batch of 310 units: 8 August 2013 (28 weeks)
4th batch of 310 units: 27 September 2013 (35 weeks)
5th batch of 310 units: 25 October 2013 (39 weeks)
6th batch of 310 units: 22 November 2013 (43 weeks)
7th batch of 310 units: 20 December 2013 (47 weeks)
8th and last batch of 310 units: 31 January 2014 (53 weeks)

Available for contract follow-up and factory test participation:
J. Mourao, S. Pemberton, M. Favre and KDP.

Note: To remain within the limit of the Finance Committee (750 kCHF) MPE/EE shall free-issue to the contractor the power transformers and the heat sinks.



ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

EDMS No.: 1234942 Group Code: TE-MPE
LHC Project Document No.: LHC-DQLPR-CS-0001 MS-3911/TE/LHC

The Large Hadron Collider

Market Survey

Technical Description

Supply of Linear, Regulated, Multiple Output, Low-Voltage Power Supply Modules for the Quench Protection Systems of the LHC Collider

Abstract

This market survey concerns the procurement of 2500 linear, regulated, multiple output, low-voltage power supply modules for powering of the electronics crates of the quench detectors and associated data acquisition systems. The market survey will be followed by the issue of an invitation to tender to qualified and selected companies and combination of companies in November 2012 for a contract to be awarded in January 2013.

TEST SYSTEMS:

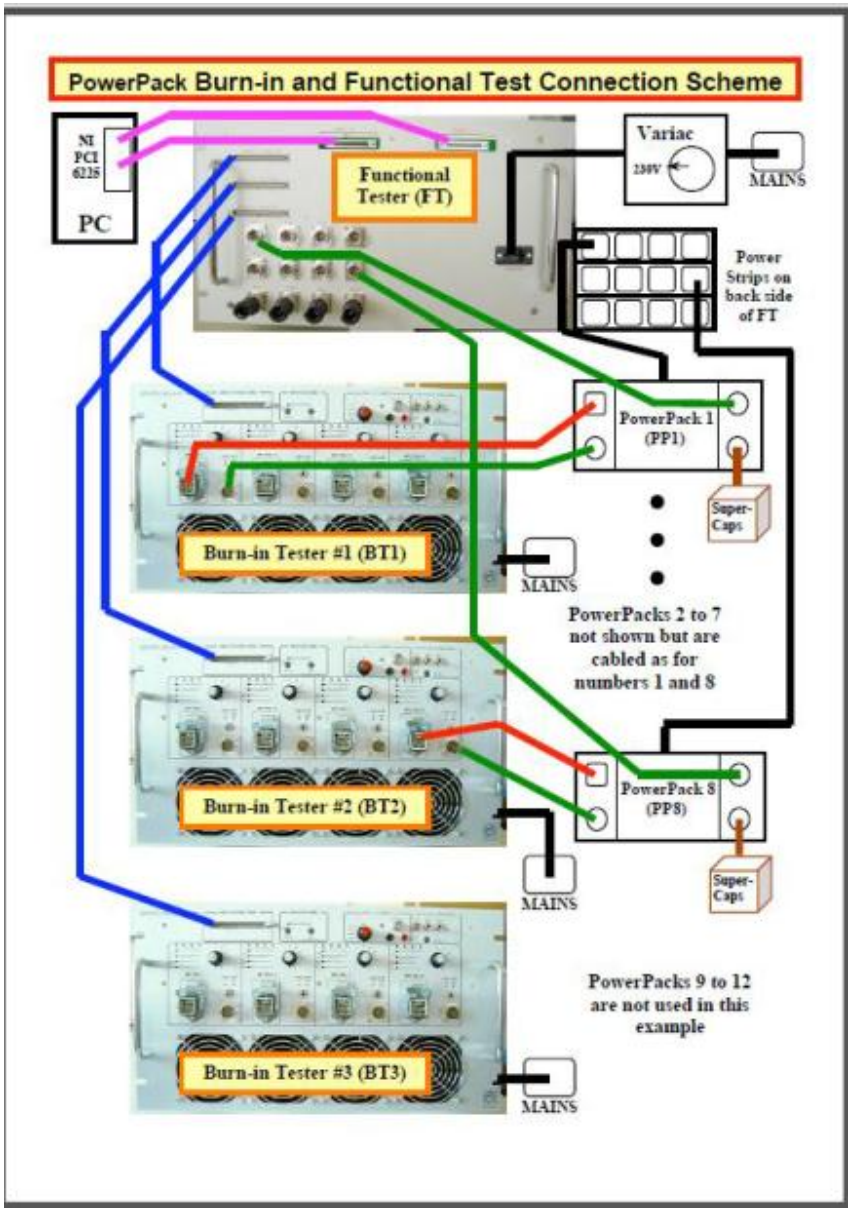
Functional testers and Burn-in testers can be recovered from the nQPS PowerPack project.
At least 8 burn-in testers and 2 functional testers are available.
Only 2 DQLPURs can be tested simultaneously from one burn-in tester .

With each set of one functional tester and three burn-in testers 6 DQLPURs can be tested simultaneously .

With two such test assemblies and a burn-in of 12 hours the capacity is largely enough to prepare 310 power supplies every 4 weeks.

Modifications to the test software is required. Zinur will instruct two BE/OP volunteers (H. Genoud and R. Zuikerbuik).

More details in the talk of Zinur.



The End
Thank you