ECAL Low Voltage System

EE WORKSHOP
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Introduction

Following an article on: **Power Supply Design and Distribution by Kim Fowler**
(http://www.kepco.com/fowler.htm)

Important points in a power system:

- power source and condition
- needs and constraints of the system
- types of converters
- distribution method

Buy vs. build:

“This usually is not even a question – buy the power supply”

Needs and Constraints of the System

- Very low noise and ripple → original specification:

3.0 mV RMS; 30 mV p-p (BW: 100 kHz – 100 MHz)

- Protection of the VFE/FE electronics in case of a power system failure
- VFE/FE electronics are in a radiation environment
- magnetic field and radiation levels in the cavern
- Significant distance between the power source and the load (min. 27 m)
- Minimal power losses in the system
- Minimal costs
- European Standards and Regulations
- TIS regulations:
    - Electrical Safety Code C1
    - Voltage Domains according to IEC, IS33
    - Fire Prevention for Cables, Cable Trays and Conduits, IS48, IS23
    - Dangers due to Electricity, IS28
    - …

Needs and Constraints of the System

Voltages (V) and currents (mA) of active components:

Chip	+5 V ana	-2 V ana	+5 V dig	+2.5 V dig
FPPA	76.48	74.28	46.18	
ADC	109		10	
Fenix 1				120
Fenix 2				120
GOL				120
Control				140

25 channels	+5 V ana	-2 V ana	+5 V dig	+2.5 V dig
I / A	4.64	1.86	1.40	1.10
P / W	30.14	6.50	9.13	4.40

Udrop LVR	1.5	
total power	**50.2**	Watt
power / ch	**2.0**	Watt

Super Module	+5 V ana	-2 V ana	+5 V dig	+2.5 V dig	Sum
I / A	315.32	126.28	95.51	74.80	611.90
P / W	2049.55	441.97	620.79	299.20	3411.51

New idea of LV distribution

1) Low Voltage Regulators combined with a switch power units of 25 channels and hence a group of regulators can be supplied from a single source:

- **This reduces the cost of the Power supplies**
- **This should reduce the cost of the cables as the number of wires required is reduced**

Consequences:

- **Need a radiation hard regulator with switching capabilities and integrated protection with a very high reliability**
- **Need large cross section cables inside the detector**
- **Need to control the regulators**

2) Supply a high voltage to the detector and convert it on the magnet to a low voltage:

- **This should reduce the cost of the cables significantly**

LVR

1) **Sharp regulators → not recommended in applications with very high reliability demands (see the data sheet)**

2) **RD49 regulators from ST microelectronics**
   - **Maximum current 3A → need 2 for +5 V analog in parallel (problem?)**
   - **Low dropout voltage 1.5 Volt at 3A → not really low → significant additional power loss close to the load**
   - **Remote sensing: no real 4 wire remote sensing → Regulators should be as close to the load, I.e. integrated into the detector, hence they are unaccessible for repair → reliability ???**
   - **Control? Voltage and Current measurements?**
   - **Negative regulator for –2V analog require an additional positive supply voltage to operate: This voltage should not disappear as long as the inhibit signal is active as this could damage the regulator (problem?)**
   - **Space and location in the detector? Additional print? On the FE board?**
   - **Cooling connection?**
   - **Connectors and Fan/Out**
   - **Filter Capacitors → OSCON**

LVPS

What concerns the distribution inside the detector the choice of the LVPS and their location are not important it could be:

- A 400Hz/1kHz supply system with transformers + rectifiers as converters on the magnet?
- Linear or Switching mode supply in the counting house + cables?
- AC/DC or DC/DC converters at the magnet?

Questions:

- **What do this supplies if the load changes significantly (50%) is the same power delivered to load or less (50%)?**
- **Do we need to regulate the output voltage of the converters at the magnet / input voltage to the regulators to keep them in the operation limits / to minimize the power loss inside the detector?**
- **How are the converters at the magnet controlled and maintained?**
- **What are the costs of different solutions including development, test, installation and maintenance**
- **…**