Standalone, battery powered radiation monitors for accelerator electronics

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Abstract:
Based on the principle of the RADMON on line radiation monitoring system for the LHC, a new type of low cost, battery powered radiation monitors has been designed that do not need any external cabling. This type of radiation monitors integrates radiation levels as a function of time up to a maximum of 220 days. The radiation data and the elapsed time are stored in triplicate registers that are independently powered for a maximum period of 600 days (3 years operation of the Large Hadron Collider). The associated USB interface and labview software can be operated on any PC. For portability, small battery powered miniPCs have been chosen making the complete system ideally suited for integrated radiation measurements around the CERN accelerators during short access or in shutdown periods.

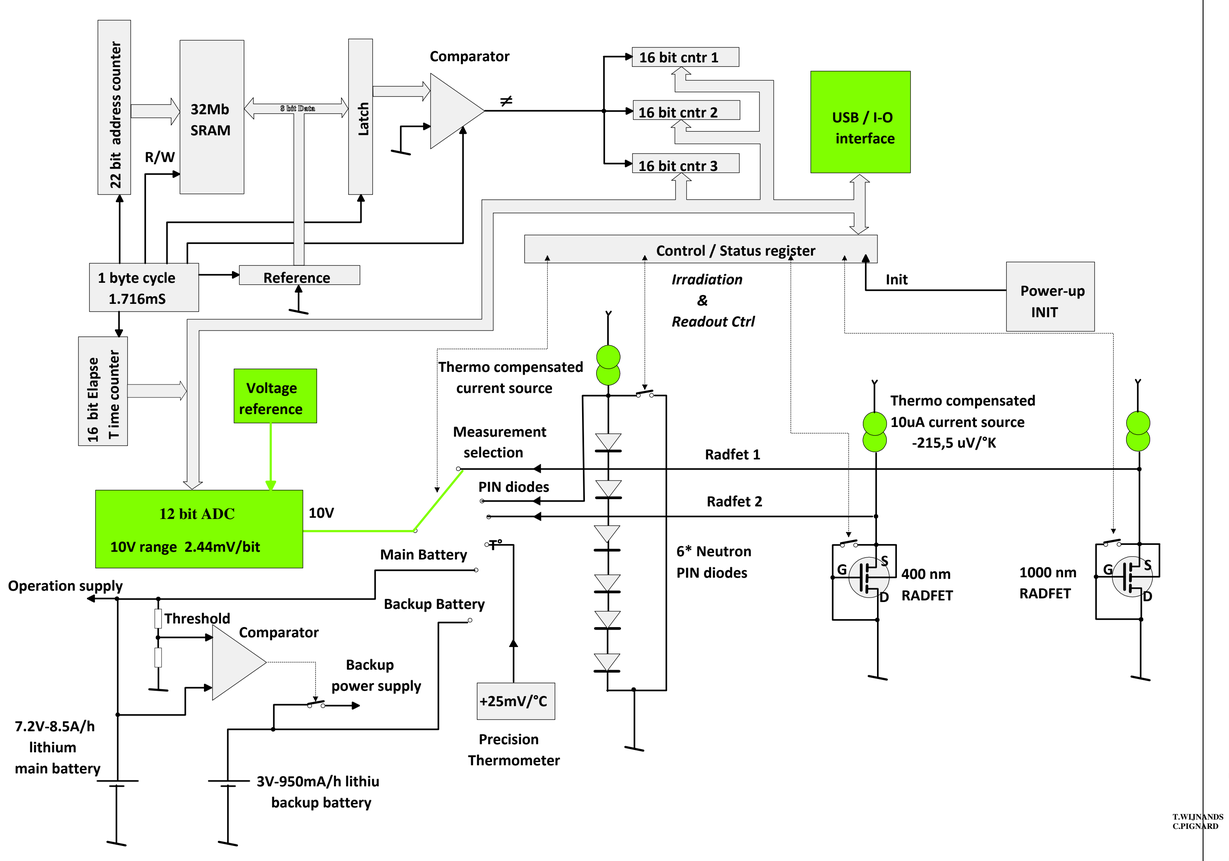
Operation Mode

Radiation Data

Three types of radiation sensors provide measurements of the total ionising dose (TID) and the particle fluences (1 MeV equivalent and high energy hadrons). During operation, the 2 Radfets and 6 PIN diodes (1 MeV n) are in short circuit mode and do not consume any on board power. The 32 Mb of SRAM memory is continuously scanned and used to measure the high energy neutron fluence. The elapsed time (clock cycles) and the number of radiation induced logic transitions from “0” to “1” are stored in triplicated registers.
For readout a signal cable and USB interface have to be attached. The raw on board data is transferred to the portable PC, corrected for temperature variations and then finally stored in an Excel worksheet. In the office, synchronisation with a global database takes place.

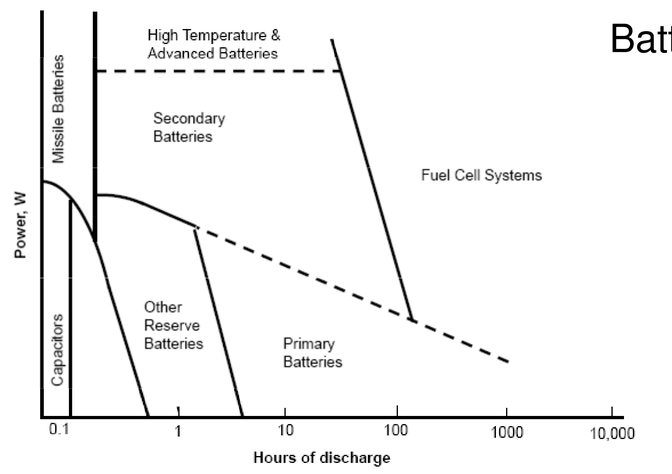
Readout

Operating principle

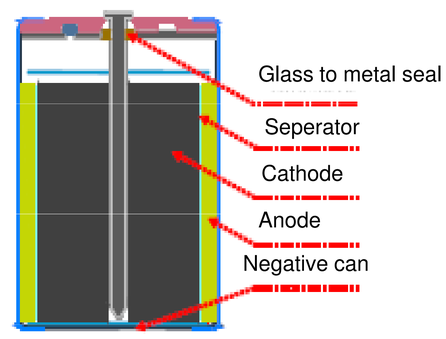


Components in green are not exposed to radiation and are located in the remote readout unit. Connectivity to a PC is via the USB interface.

Performance Envelope of Electrochemical Power Sources



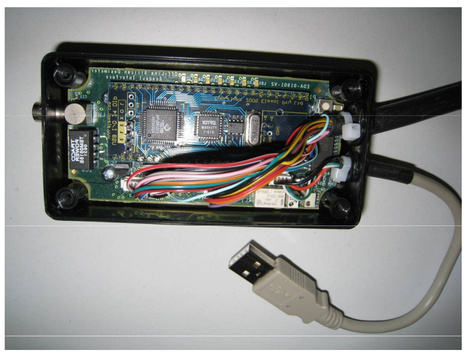
Battery Construction



Bobbin type

Llithium thionyl chloride batteries have been used successfully for various space missions (Mars pathfinder Rover, Deep impact mission, Galileo). They provide the highest energy density Li is the anode material while the cathode is made of liquid thionyl chloride ($SOCL_2$). First radiation test have shown unchanged performance up to 500 Gy total dose (60Co source) using a constant charge. The neutron response is still to be investigated.

USB readout module



The USB interface module connects the radiation monitor to any desktop or portable PC. The module is not exposed to radiation so cumulative damage to the ADC or to the current sources is not an issue. The module is powered via the USB port of the portable PC, saving on board power.

Performance data

High sensitivity mode :

Memory refreshment time	2 hours (32 Mb memory)
Power consumption	
during operation	12 mW
storage	330 μW
Max operation time	220 days
Max data storage time	595 days

Low sensitivity mode :

Memory refreshment time	2 hours (32 Mb memory)
Power consumption	
during operation	17 mW
storage	330 μW
Max operation time	148 days
Max data storage time	523 days

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Device Assembly