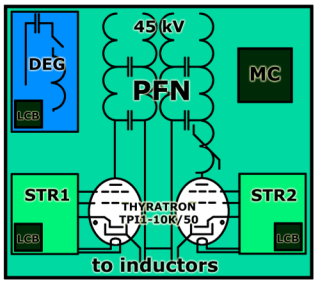
LIA-2 POWER SUPPLY CONTROL SYSTEM

A. Panov, P. Bak, D. Bolkhovityanov
Budker Institute of Nuclear Physics, Russia

LIA-2 BASIC PARAMETERS

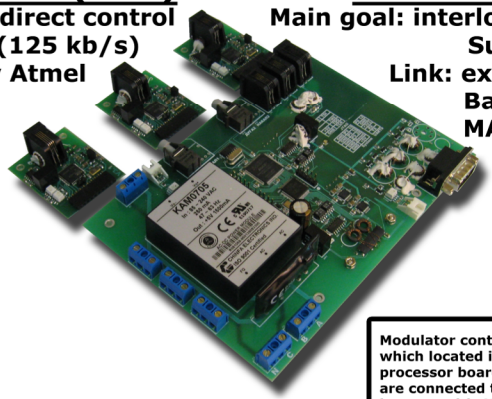
Maximum electron beam energy	2.0 MeV
Maximum electron beam current	2.0 kA
Number of pulses in the burst	2
Cathode heater DC power	2.5 kW
Time interval between pulses in the burst	2 - 10 us
Pulse duration, flat top ±4%	200 ns
Maximum repetition rate	0.1 Hz
Min. beam spot size FWHM on the target	1.5 mm

HARDWARE



Local Control Board (LCB)

Main goal: sub-devices direct control
Link: internal CAN-bus (125 kb/s)
Base: 80C51 T89C51 by Atmel
Input/Output:
2 channels 10-bit ADC
2 channels 8-bit DAC
2 TTL input/output
1 CAN channel
Total LCB: 144



Modulator Controller (MC)

Main goal: interlocks gathering/processing.
Sub-devices indirect control.
Link: external CAN-bus (125 kb/s)
Base: ARM7 LPC2119 by NXP
MAX3000 EPM3128 by Altera
Input/Output:
5 inputs for fast interlocks
3 synchronization pulses
2 CAN channels
4 PS outputs
Total MC: 48

Pulsed HV power supply system consists of 48 identical double pulse modulators, two charging units (one for each pulse) and coaxial feeding lines (20 cables for one modulator). Each modulator feeds two inductors in parallel and includes two Pulse Forming Networks (PFN), two cold cathode thyratrons TPI 1-10K/50 with a switched current 10 kA and working voltage 50 kV, two thyratron starters and a degausser. Two starters (STR1/2) and degausser (DEG) are driven by Local Control Boards (LCB). In addition, each modulator is equipped by the controller (MC).

Modulator controller receive requests from CX-server which located in cPCI crate equipped with x86-compatible processor board running Linux. Modulator controllers are connected to cPCI crate via external CAN-bus and interact with CX-server via extended KOZAK standard.

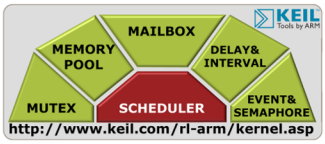
SOFTWARE

The modulator controller works under control of a Real-Time Operating System (RTOS) Keil RTX.
The Keil RTX is a royalty-free, deterministic RTOS designed for ARM and Cortex-M devices.
It allows creating programs that simultaneously perform multiple functions and helps create applications which are better structured and more easily maintained.

Features

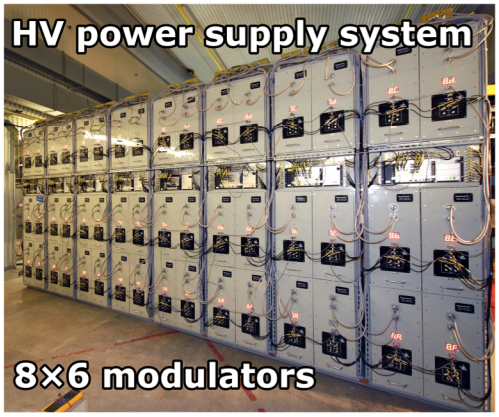
- Royalty-free, deterministic RTOS with source code
- Flexible Scheduling: round-robin, pre-emptive,collaborative
- High-Speed real-time operation with low interrupt latency
- Small footprint for resource constrained systems
- Unlimited number of tasks each with 254 priority levels
- Unlimited number of mailboxes, semaphores, mutex, timers
- Support for multithreading and thread-safe operation
- Kernel aware debug support in MDK-ARM
- Dialog-based setup using µVision Configuration Wizard

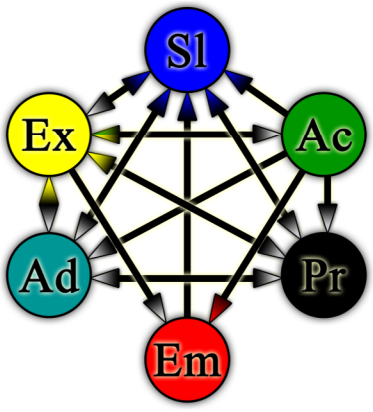
RTX Real-Time Operating System



Current RTOS settings

Main clock	60 MHz
System clock	1 kHz
Round-Robin task switching	
Number of concurrent running tasks	20
Task stack size	200 bytes





Modulator modes

Each modulator can be in one of six modes. Essentially one mode differs from another by Mask of Admissible Commands (MAC) which is used at the request reception.

Sleep (Sl)
Initial mode. All internal sub-devices are switched off. In this mode operator can write minor settings. Final interlock is active.

Experiment (Ex)
Basic mode. All internal sub-devices are switched on. In this mode operator can write minor/major settings. Final interlock is managed by current enabled internal interlocks.

Action (Ac)
Main shot mode. In this mode operator cannot change any settings. After main shot modulator change mode to Experiment by itself

Adjustment (Ad)
Mode for calibration of measured signals and other auxiliary procedures. Final interlock is active.

Programming (Pr)
Mode for firmware download to the microcontroller. Final interlock is active.

Emergency (Em)
In this mode all internal sub-devices are switched off, interlocks are hold and final interlock is active. Operator should change mode to Sleep for exit from this mode or reset microcontroller.

Transition reasons

- Button or power reset
- Watchdog timer reset
- Main shot
- Enabled interlock
- Command