

Proposed Controller for the Readout of the Temperature and Humidity Digital Sensors Sensirion SHT85 Envisioned for the RICH Detector

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In this note, National Instruments’ (NI) CompactRIO 9627 controller is proposed for the readout of the Sensirion SHT85 integrated temperature and humidity digital sensors for the RICH detector.

For its readout, the proposed SHT85 [1] requires a digital controller that must be directly compatible with the RICH detector’s hardware interlock system [2], support the programming and readout of at least 32 SHT85 sensors, and have multiple communication interfaces.

The NI CompactRIO 9627 (sbRIO-9627)—a reconfigurable, single-board computer designed for original equipment manufacturers who require a high performing and reliable, single-board controller—was selected.

Figure 1 shows the block diagram for the sbRIO-9627; Table 1 lists its specifications.

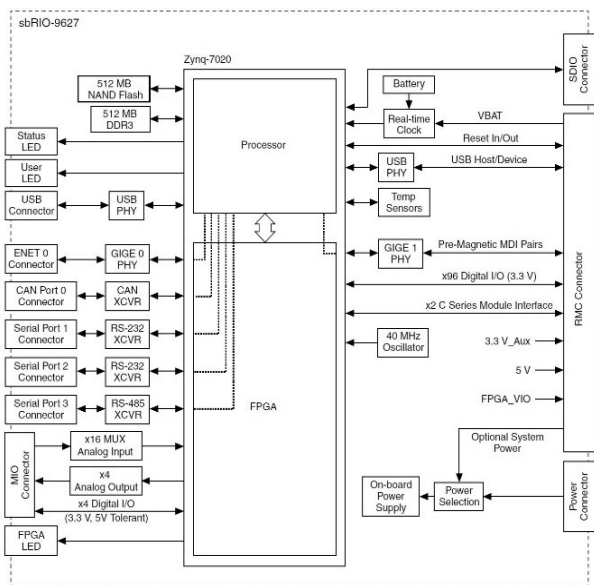


FIG. 1. Block diagram for the sbRIO-9627 [3].

On a single PCB, sbRIO-9627 combines an ARM processor, an FPGA, Linux real-time operating system, built-in input/output interfaces, and a RIO mezzanine card (RMC) connector for connecting digital signals directly to the FPGA. The ARM processor and FPGA is integrated into an industrial grade Xilinx-7020 Zynq All-Programmable System on Chip.

As required, the sbRIO-9627 has multiple communication interfaces available for connectivity with the rest of the interlock system and user interfaces. The on-board communication interfaces include Ethernet, RS-232, RS-485, USB, and CAN. The on-board SD card slot is used by the interlock system to store configuration files read during rebooting.

The sbRIO-9627’s RMC connector provides direct con-

nection to 96 FPGA digital I/O pins, which support up to 48 SHT85 sensors per controller, more than the mandated 32 sensors per sector of the RICH detector.

Bi-directional data transfer between the FPGA and the SHT85’s digital interface is supported by a two-wire communication bus, Fig. 2.

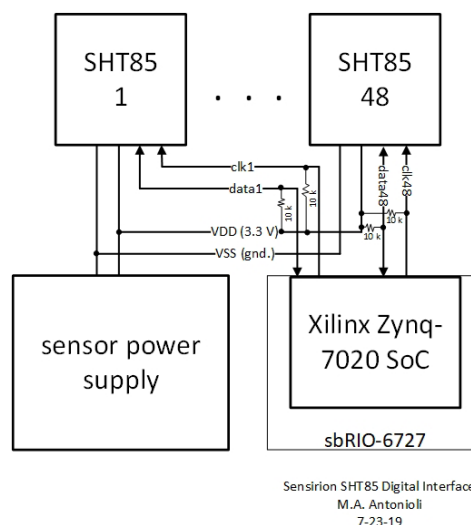


FIG. 2. Block diagram for the sbRIO-9627.

In addition to the communication interfaces and FPGA digital I/O pins, the sbRIO-9627 has 16 single-ended analog input channels and four analog output channels for interfacing with additional instrumentation. The controller also has three sensors to measure the on-board operating temperature.

In conclusion, sbRIO-9627 has the same type of architecture and development software as the RICH hardware interlock system, which uses NI cRIO 9035 FPGA-based controllers with an integrated EPICS interface and is programmed with LabVIEW; hence, sbRIO-9627 will seamlessly integrate into the hardware interlock system as one cohesive design.

[1] P. Bonneau, et al. *Proposed Integrated Temperature and Humidity Digital Sensor for the RICH Detector*, DSG Note 2019-12, 2019.
 [2] M. A. Antonioli, et al. *Proposal for RICH Hardware Interlock System*, DSG Note 2017-01, 2017.
 [3] National Instruments. (2017). *NI sbRIO-9627: User Manual*. Retrieved from <http://www.ni.com/pdf/manuals/375466b.pdf>.

Parameter	Specification
Processor	667 MHz dual-core ARM Cortex-A9 (SoC)
FPGA	Xilinx Zynq-7020 (SoC) with 85,000 logic cells, 106,400 flip-flops, 16 DMA channels
Memory	nonvolatile memory: 512 MB; volatile memory (DRAM): 512 MB
Real time operating system	Linux RTOS (32 bit)
Operating temperature range	-40°C to 85°C local ambient
No. of on-board temperature sensors	3
Power requirements	9–30 VDC supply range; up to 29 W max
Communication interfaces (no. of ports)	Ethernet (1), RS-232 (2), RS-485 (1), USB (1), SD Card Slot (1), CAN (1)
No. of digital I/O signals (RMC connector)	96 DIO (3.3 V)
No. of digital I/O signals (IDC connector)	4 DIO (3.3 V)
No. of analog input channels	16 single-ended or 8 differential
ADC resolution	16 bits
Input analog ranges	± 10 V, ± 5 V, ± 2 V, ± 1 V
No. of analog output channels	4
DAC resolution	16 bits
Output analog range	± 10 V
Application software	LabVIEW, LabVIEW real-time module, LabVIEW FPGA module
Driver software	NI CompactRIO device drivers

TABLE I. Specifications of sbRIO-9627.