INTELLECTUAL CRATE-CONTROLLER K167

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Abstract

This paper describes hardware and software of ICC-controller K167, developed for modernization of Kurchatov synchrotron radiation source (KSRS) automated control system (ACS). K167 is based on SBC-computer of miniMODUL167 type, programmable logical integrated circuit CPLD XC95288XL and being controlled by RTX-166Full V4.0 RTOS. Controllers K167 are installed into 12 crates and connected to the LAN server of ACS (automated control system) through CAN-bus. They control synchrotron radiation source with CAMAC devices developed in the Institute of Nuclear Physics SB RAS.

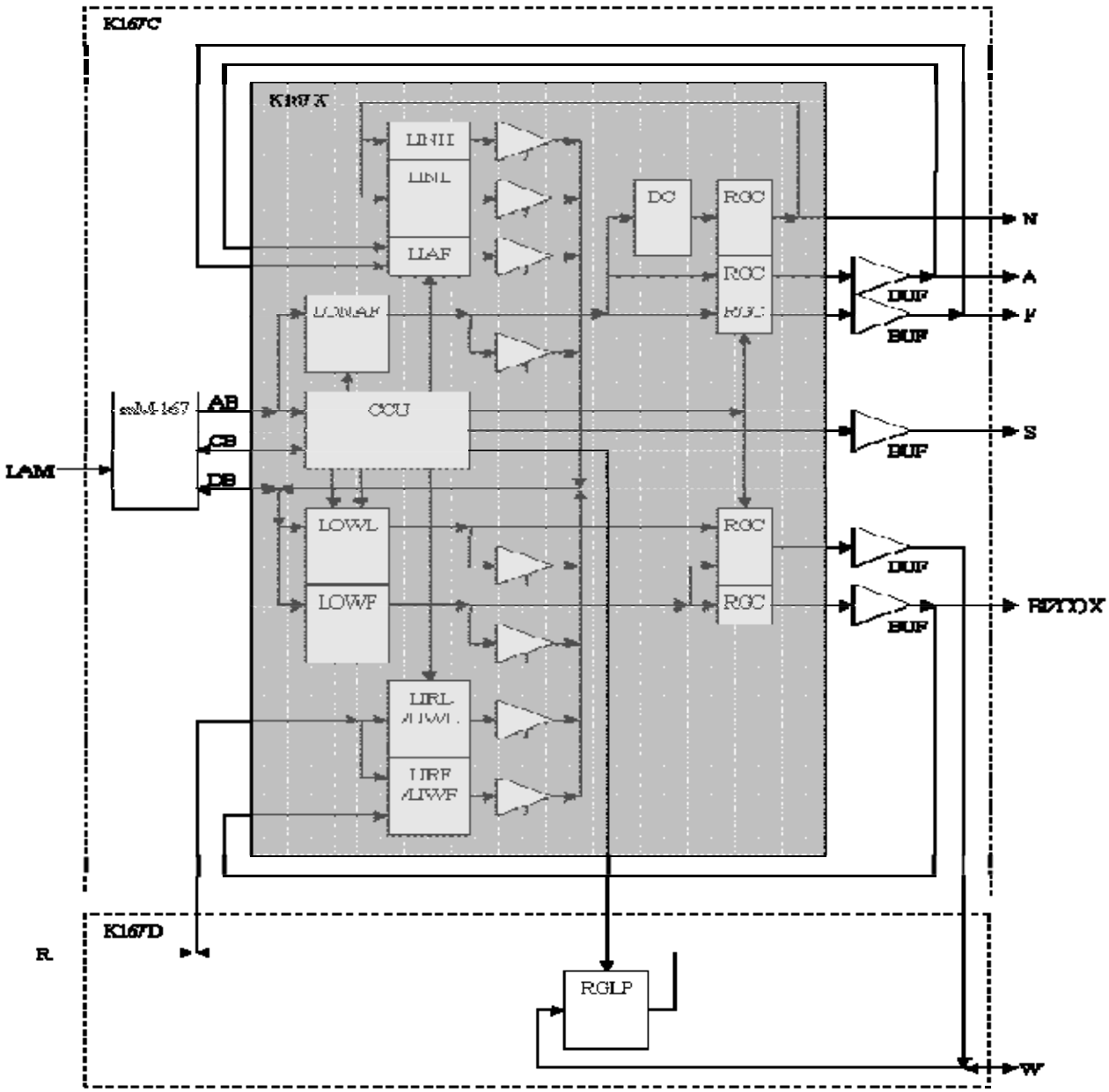

Figure 1: Structure of K167 controller.

STRUCTURE OF K167 CONTROLLER

Controller K167X is connected to the processor bus of miniMODUL167. It contains three groups of registers (see Fig. 1):

- Input registers LONAF and LOWF that set value on the address bus of the miniMODUL167 for creating signals I, Z, C, N, A, F and registering signals X, Q of CAMAC bus. Register LOWL sets 16 lower order bits of recording bus W.
- Registers RGG that set signal state on CAMAC bus based on the information from the input registers (LONAF, LOWF, LOWL).
- Registers LIRF/LIWF and LIRL/LIWL are receiving data during the read and set cycles of X, Q signals state. LINH, LINL, LIAF and external register RGLP are there mostly for the diagnostic purposes. They set states of N, A, F, W signals.
- CCU unit of the controller controls: recording of information from miniMODUL167 into the input registers; transferring of information from the input registers to the registers of CAMAC line; setting of CAMAC cycles with issuing of strobes S1 and S2.

WORKING WITH K167 CONTROLLER

Access to the K167 ports is implemented through 32-Kbyte address block in the 256 Kbyte memory segment of miniMODUL167 defined in the configuration registers ADDRSEL2 and BUSCON2. Table 1 contains the map of the addresses 08000h≤A≤083FFh in the 256-Kbytes memory segment. For addressing N, A, F on the CAMAC bus AB[14] – AB[1] bits of the miniMODUL167 address bus are used. High-order byte of the LOWF register is used for outputting I, Z, C, Q, X signals in the CAMAC bus cycles. Signal B is being set automatically by the controller.

On the start of the recording cycle in the CAMAC bus (N>0, F16=1, F8=0) data for recording through buses W and values of I, Z, C, Q, X signals are taken from the input registers LOWL and LOWF. In the cycle of making controlling signals and commands (N>0, F16=1, F8=1) only the high-order byte of the LOWF register is used.

States of the N, A, F, B, I, Z, C, Q, X, R, W signals of the CAMAC crate's bus are being recorded via strobe S1 in the corresponding registers: LINH, LINL, LIAF, LIRF/LIWF, LIRL/LIWL, RGLP, which values could be read through the ports LINH, LINL, LIAF, LIRF, LIRL, LIWF, LIWL. For improving performance of the K167, CCU unit creates a queue of commands in the input registers and CAMAC bus registers. Thus the following events could happen simultaneously: operation executing on the CAMAC bus, input registers containing information for the next operation and miniMODUL167 bus waiting for the end of input-output operation.

Read operations on MiniMODUL167 bus referring to the registers that set signal states on the CAMAC bus should wait for all the commands in the queue to be completed. In worst case scenario such operations may take as long as 2.5 microseconds. All other operations could take 100 nanoseconds if the registers are available and up to 1 microseconds if the registers are not available.

Thus the maximum data transfer speed that intellectual crate-controller K167 provides on the crate CAMAC bus is 3 Mbytes/sec.

Table 1: Ports of K167X

Port	Address Bus	Bus Oper	Data Bus															
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LIRL	08000 h	RD	RI 16	RI 15	RI 14	RI 13	RI 12	RI 11	RI 10	RI 9	RI 8	RI 7	RI 6	RI 5	RI 4	RI 3	RI 2	RI 1
LIRF	08010 h	RD	0	0	BI	II	ZI	CI	QI	XI	RI 24	RI 23	RI 22	RI 21	RI 20	RI 19	RI 18	RI 17
LIWL	08040 h	RD	WI 16	WI 15	WI 14	WI 13	WI 12	WI 11	WI 10	WI 9	WI 8	WI 7	WI 6	WI 5	WI 4	WI 3	WI 2	WI 1
LIWF	08050 h	RD	0	0	BI	II	ZI	CI	QI	XI	WI 24	WI 23	WI 22	WI 21	WI 20	WI 19	WI 18	WI 17
LOWL	08060 h	RD& WR	WO 16	WO 15	WO 14	WO 13	WO 12	WO 11	WO 10	WO 9	WO 8	WO 7	WO 6	WO 5	WO 4	WO 3	WO 2	WO 1
LOWF	08070 h	RD& WR	0	0	IE	IO	ZO	CO	QO	XO	WO 24	WO 23	WO 22	WO 21	WO 20	WO 19	WO 18	WO 17
LIAF	08080 h	RD	0	0	0	0	0	0	AI 8	AI 4	AI 2	AI 1	FI 16	FI 8	FI 4	FI 2	FI 1	0
LONAF	080A0 h	RD	0	NO 16	NO 8	NO 4	NO 2	NO 1	AO 8	AO 4	AO 2	AO 1	FO 16	FO 8	FO 4	FO 2	FO 1	0
LINL	080C0 h	RD	NI 16	NI 15	NI 14	NI 13	NI 12	NI 11	NI 10	NI 9	NI 8	NI 7	NI 6	NI 5	NI 4	NI 3	NI 2	NI 1
LINH	080D0 h	RD	0	0	0	0	0	0	0	0	0	NI 23	NI 22	NI 21	NI 20	NI 19	NI 18	NI 17

K167 SOFTWARE

Automated control system has 3-tiers structure. The lower level is the executable programs in the K167 controllers. Those programs provide real-time control of the CAMAC hardware using OS Keil RTX-166 Full V4.0 RTOS. K167 controllers are connected to a SQL server through the CAN bus. This is the middle tier of the ACS. SQL server has a Phytec PCAN-PCI card that being controlled by PCAN-Evaluation. This program developed by Keil works in the so-called Windows Kernel mode and is responsible for the interface between CAN application running on the server and executable programs in the K167 controllers.

Parameters of the logical control channels are stored in the MS SQL server tables. On the upper level of the ACS there are SQL server client applications. Those are Windows XP applications for the Pentium4 PCs.

K167 uses real-time OS ARTX-166 for C16x kernel and STMicroelectronics ST10 family of the Infineon microcontrollers. It allows simultaneous processing of multiple tasks on one CPU. It also allows to control a certain operation in real-time and for a given period of time. File system ARTX-166 allows creating, saving, reading and modifying files stored in the flash memory of the K167 controllers.

Today K167 controllers installed into the 12 CAMAC crates and controlled by the computers ACS allow to control: large and small storage devices of the synchrotron, input-output system and vacuum system of KSRS [3-4].

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