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GAS SYSTEM COTROLLER FOR RPC

GAS SYSTEM CONTROLLER FOR RPC

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ABSTRACT

An electronic controller for the gas supply of Resistive Plate Counters is presented in this paper. This device is operative in the μ-spectrometer of experiment E771[1] at Fermilab.

1. INTRODUCTIO

The RPCs are thin gap gas chambers operating in streamer mode in a very high uniform electric field (40 kV/cm)[2]. They are filled with a mixture of argon, butane and freon. Since their performances depend strongly on the gas composition, one must control continuously the mixture to insure high stability and precision. Furthermore, it is necessary to switch off the high voltage (~8000 V on each chamber) in case of a pressure drops in the gas mixture. In the E771 spectrometer, the gas mixture is controlled by three mass flow meters[3] (one for each gas), the signals of which are sent to an electrically-controlled valve in order to regulate the gas flow of the corresponding gas into the RPCs.

These voltage signals are used also to monitor the gas pressure, to switch off the high voltages and to set an alarm whenever one of the three gas bottles is getting empty (Fig.1.).

In normal operation conditions, the RPC Gas System Controller (RGSC) checks these signals and can, accordingly, stop the mixture flow, send a kill signal to the high voltage power supply and trigger an alarm buzzer, whenever at least one of the signals drops below a set threshold.

2. PACKAGING

The RGSC is a double-width NIM module containing 16 integrated circuits. Physical dimensions of the module are those of the NIM specifications. In Fig.2., the schematic diagram is shown.

2.1. MODULE PINOUT (BACK CONNECTIONS)

P1
(INPUT)
(9 Pins D-size connector). Input connector for the signals produced by the mass flow meters. The input impedance is 10 kΩ;

J1
(VALVE)
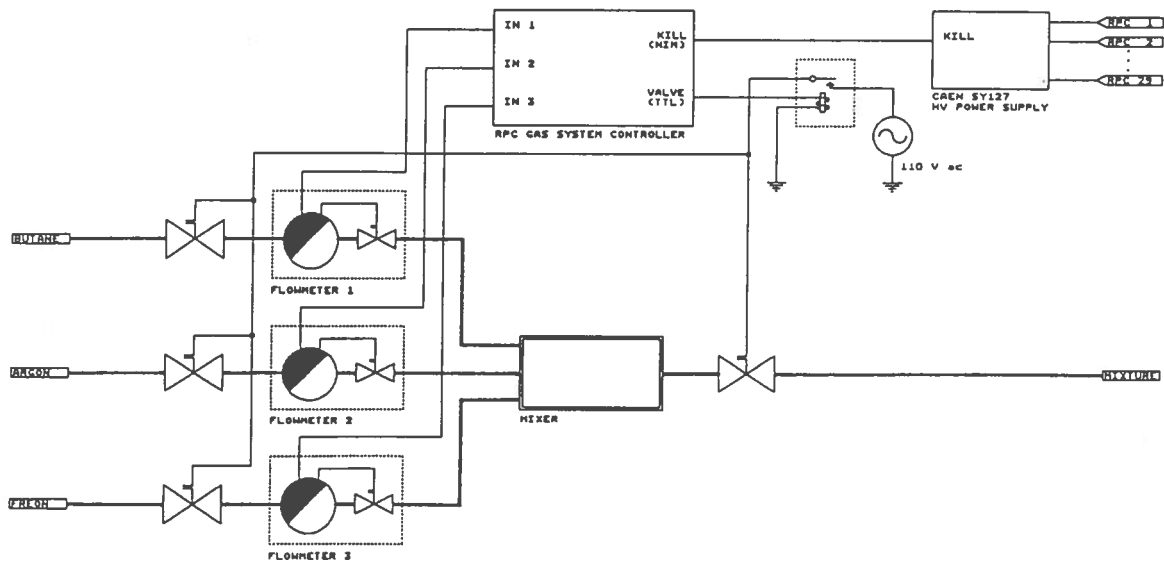(NIM LEMO). Output to the valve commands. It's a TTL single ended output;

Fig.1.- RPC Gas System (detail).

| J2 (KILL) | (NIM LEMO). Output for the high voltage power supply. It's a NIM standard signal with 50 Ω output impedance. |

2.2. FRONT PANEL

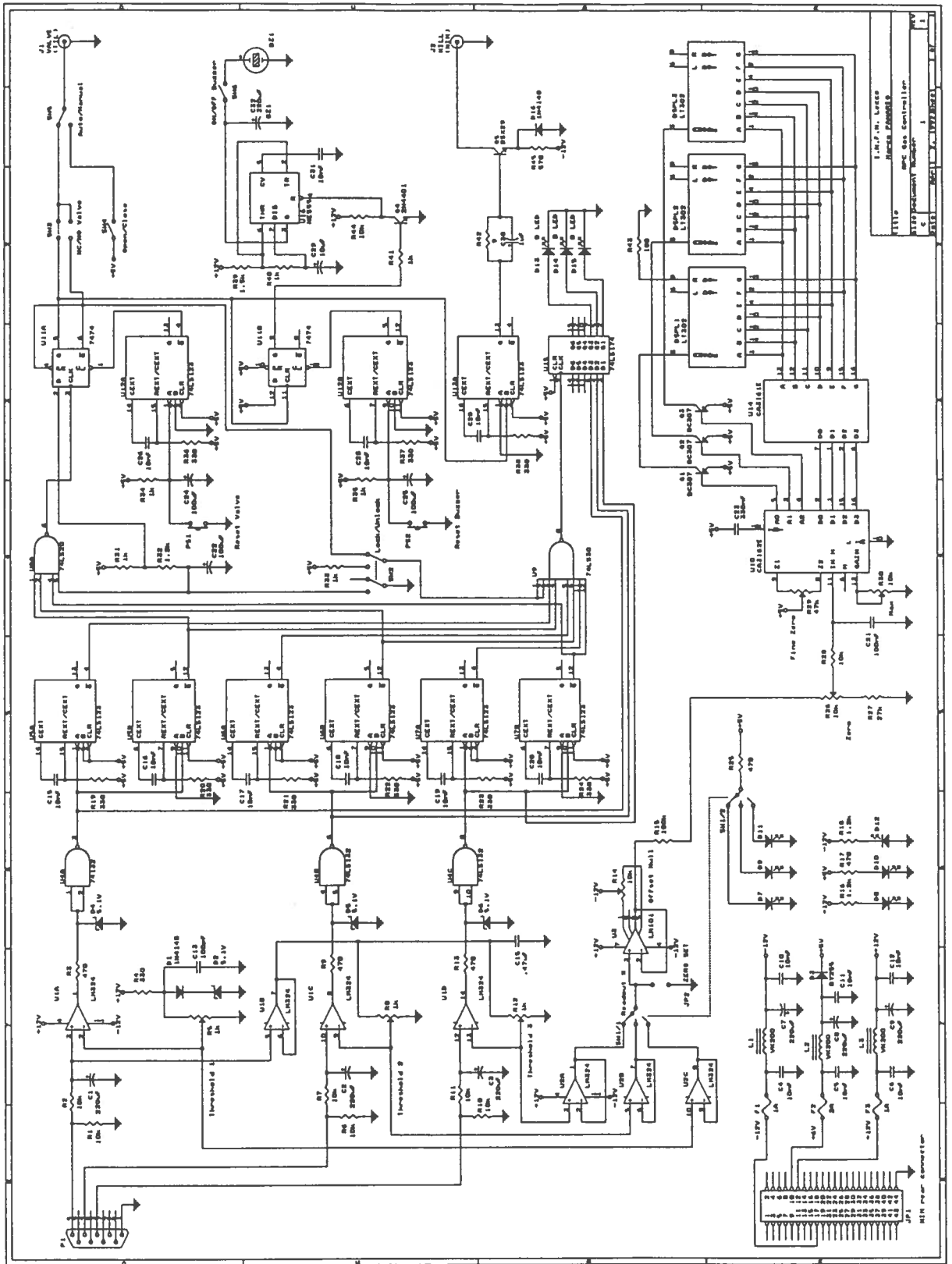| +5, +12, -12 (D10, 8, 12)	Power supply monitors;
Readout% (DSPL1, 2, 3)	Fractional value of the minimum flow to produce an alarm condition;
Lock/Unlock (SW2)	Enables or disables the alarms. In the unlock position, when the alarm condition is on, the corresponding LED blinks and stops blinking when the alarm goes off. In the lock position, when an alarm condition occurs, the LED starts blinking, the output (J1) is set to 0 V, a 100 ns wide pulse on the KILL output (J2) is generated and the alarm buzzer starts. The alarm condition is kept on hold even after the cause of the alarm disappears;
Display switch (SW1)	Selects the display of the threshold values;
Trimpot (R5, 8, 12)	Variable resistors to adjust the threshold values;
Channel LEDs (D7, 9, 11)	The LED on indicates the channel number the threshold value of which is shown;
Alarm LEDs (D13, 14, 15)	The LED blinking indicates the channel where the alarm condition occurs;
Manual/Auto (SW5)	Enables or disables the manual operation on the VALVE output. In the Manual position, the voltage on this output is controlled by the Open/Close switch. In the Auto position and when the Lock/Unlock switch is on the Lock position, an alarm condition causes the voltage on this output to drop to 0 V;
Open/Close (SW4)	Forces the VALVE output to 0 V or 5 V in manual operation;
Reset Valve (PS1)	Resets the status on the VALVE output after an alarm condition (force 5 V on the VALVE output);
Reset Buzzer (PS2)	Stops the alarm buzzer.

Fig.2. - *Gas System controller for RPC.*

3. DESCRIPTION AND OPERATION

The U1A, U1C and U1D operational amplifiers compare the voltages coming from the mass flow meters to the thresholds set by the R5, R8 and R12 trimmers. Reference for the first channel (Master) is created by a 5.1 V zener diode (D2) and reference for the others (Servers) is the Master channel voltage buffered by U1B. Every input is grounded with a 10 kΩ resistor to match the mass flow meters output resistance. A 100 μF capacitor on each comparator input prevents an accidental voltage drops occurring in short times to trigger the corresponding comparator.

The transition at the output of a comparator normally high, triggers a high level on the corresponding Schmitt trigger (U4) output. This transition generates a low level, 3 μs width, on the corresponding monostable (U5B, U6B, U7B) output. A falling edge sensible monostable (U5A, U6A, U7A) is connected on the same Schmitt trigger output. Thus, a high level pulse on pin 8 of U9 is generated, for every slow transition at the input of the controller.

This pulse enables the status transfer from the inputs to the outputs of the U15 latch so that the corresponding blinking LED indicates the input of the controller status.

When the switch SW2 is in the lock position, a high to low transition on the output of U5B, U6B or U7B, triggers the U11A bistable. In this manner the level on pin 6 of U11A falls down and masks the other signals on the NAND U9 inputs. Therefore the status shown by the LEDs D13, D14 and D15 is frozen. In the Auto position of SW5, the status of the output of U11A is sent to the VALVE output to drive an electrovalve through a solid state relay. By pressing the PS1 pushbutton, a low level pulse clears the U11A bistable and restores the status preceding the alarm generation.

The transition on pin 5 of U11A is sent to the U13A monostable to generate a 100 μs wide NIM pulse on the KILL output. The same transition causes the U11B output status to change, so the reset condition is removed from U16 and BZ1 start buzzing. By pressing the PS2 pushbutton, a pulse from U12B clears U11B and the buzzer stops.

The threshold levels set by R5, R8 and R12 are applied through the U2 buffers to U3 where the offset is removed. The output voltage is sent to the U10 4 bits analog to digital converter via a voltage divider; U14 decodes the output of U10 and drives three 7 segment LED displays (DSPL1, DSPL2, DSPL3).

REFERENCES

1. B. Cox et al., P771, Fermilab, May 1986; L. Antoniazzi et al., NIM **A307** (1991) 312;

2. R. Santonico and R. Cardarelli, NIM **187** (1981); R. Cardarelli et al., NIM **A263** (1988) 20;

3. BRONKHORST HIGH-TECH B.V., RUURLO-HOLLAND; Series F-100 Gas flow meters.