FUNCTIONAL SPECIFICATION

MEDICIS GAS CONTROL SYSTEM

ABSTRACT:
As part of the MÉDICIS facility (CERN, Geneva), radioactive isotopes are produced and collected for medical research (e.g. cancer therapy) and then delivered to collaborators and university hospitals in the network. Radioactive material is produced (or introduced) in an apparatus called "target". One of the different types of these targets, called a "plasma target", requires an injection of gas inside the vacuum chamber to start a chemical reaction allowing the dissociation of the desired isotopes from the more complex base molecules. This is the most sophisticated feature of the gas system. Another functionality, more basic but just as useful, consists in injecting a mixture of noble gases, (He, Ne, Ar, Kr, Xe) in order to have ions of different masses for the calibration of the mass separator. One of the facility's technical devices is the gas injection system.

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1. SYSTEM DESCRIPTION

1.1 SCOPE

The MEDICIS facility aims at the production of innovative medical radioisotopes. Depending on the type of target (PLASMA type), an injection gas can be done with the Gas system. This adjunction of gas is used as a stable element, to manufacture isotopes and for the setting up of the machine.

This document describes the functionality of the MEDICIS control electronic gas system installed in the MEDICIS HV cage.

1.2 CONCERNED AREA

The MEDICIS facility is concentrated in building 179. The MEDICIS control gas system is located mainly in the HV room rack TY01. (179 R-029) (position 1). Only the CPU is in the lab 179 R-025 rack HY02 (position 2) and connected to the gas system via Scalance modules and the optical fibre. (see Fig.1).
1.3 GENERAL DESCRIPTION

The MEDICIS control gas system is designed to inject some particular gas using two ways injection. A spare way is foreseen if needed. (Fig.2). Four types of gas can be injected: (N2, SF6, CF4 and Mixt).

The maximum additional pressure of the two channels cannot exceed 2 bars. The first step is to inject the first gas with the desired pressure. Once the pressure reached then add the second desired pressure to the first one. The result will be entered as pressure to reach for the second channel. (the second gas).

The control system can be programmed depending on the gas type.

Several valve can be piloted (V1n, V2n, Venting valve, Bronkhorst delta-flow valves).

A vacuum pump can be switch ON/OFF.

A Pirani gauge and two pressure meter Bronkhorst can monitor the desired pressure.
2. GAS CONTROL SYSTEM DESCRIPTION

2.1 CONTROL HARDWARE

A dedicated rack (TY01), installed in the lab Medicis (building 179 R-029) (see FIG.1) are used to control the gas system, with a TCP/IP module for remote access by Ethernet connection from the lab and distributed on computers on site.

The racks is equipped with a Siemens PLC based on CPU S7 1500 (6ES7515-2AM01-0AB0) and the following additional modules:

- Deported ethernet modules IM155-5 PN HF (6ES7155-5AA00-0AC0). One used for the RS 232 modules and the second one for the other modules.
- RS 232 modules (x4) (6ES7541-1AD00—0AB0). Each module discusses with one Bronkhorst probe.
- Digital inputs module (6ES7521-1BH10-0AB0) to acquire the status of positioning switches used in V1n and V2n valves.
- Digital outputs relay module (6ES7522-5HF00-0AB0) to switch ON/OFF the vaccum pump.
- Digital outputs module (6ES7522-1BF00-0AB0) to control some electro valves (V1n, V2n.
- Analogical inputs module (6ES7531-7KF00-0AB0) to acquire two voltages (0 to 10V), picture of the pressure measured by the pressure meter Bronkhorst, to acquire the 4 to 20 mA signal, picture of the pressure into the gas system measured by the Pfeiffer gauge and to acquire the signal of four thermocouples not used in the gas system but monitored by itself.
- Analogical outputs module (6ES7532-5HF00-0AB0) to pilot voltage (between 0 to 10V), both flow meters Bronkhorst.
- Two optical fibber modules are used for the communication between the CPU and both deported modules.

2.2 ELECTRONIC EQUIPMENT

2.2.1 BRONKHORST PROBES SYSTEM

The gas system is mainly based on a couple of probes: The El press and Delta flow probes. One of each is use by channel. As we have two channels then we have totally two EL press and two Delta flow probes. It’s because we use four RS 232 modules. Each one is connected to one probe to program or monitor it.
2.2.1.1 DELTA FLOW PROBE
The EL-FLOW is designed to accurately measure and/or control gas flow rates in a fluidic system using the media and operating conditions (e.g. temperature, pressure) that were specified at ordering time.

The Delta flow probe is a mass flow meter. Its control valve is directly controlled by the El press probe.

2.2.1.2 EL PRESS PROBE
EL-PRESS™ probe is a pressure meter and controller equipped with a diaphragm type piezo-resistive pressure sensor and a digital printed circuit board and offer high accuracy, stability and reliability. The basic digital printed circuit board contains all of the general functions needed for measurement and control.

The El-Press probe control directly the mass flow meter Delta flow after receiving a setpoint value in voltage from the analogical output module.

2.2.2 VALVES USED FOR OPERATION
Three vacuum VAT valves are used in the gas system (Fig.3):
- V1n is used as input to permit to do the vacuum in the gas system.
- V2n is used as output to send the gas to the target.
- The venting valve is used to put the system at atmosphere.
2.2.3 VACUUM SYSTEM

The vacuum system includes all the previous probes and valves and a vacuum pump a Pfeiffer gauge and a manometer to read locally the pressure. (Fig.3).

2.2.3.1 VACUUM PUMP

The vacuum pump is used to do the vacuum inside the gas system and in the pipes until the target. Do relays are used to switch ON/OFF this device.

2.2.3.2 PFEIFFER GAUGE

The Pfeiffer gauge gives the pressure between the venting valve and the V1n input valve. The acquisition of the pressure is given by a Pfeiffer controller with a signal 4-20mA through the AI module. Locally you can read directly the pressure on the Pfeiffer controller.

2.2.3.3 MANOMETER

The manometer gives the pressure into the gas system. You can read locally the pressure on this device. This pressure will be the same given by the bronkhorst pressure meters.

2.3 REGULATION SYSTEM

In each channel, each mass flow meter is pilot by the flow meter and regulate by him. To improve precision of this, a part of the software is dedicated to do this in the FB_control.

3. SOFTWARE

3.1 ARTICULATION

The low-level software is mainly articulated in five parts:

- Communications between Mass flow meter, Pressure meter and the PLC
- Data Conversion (probes understand only ASCII)
- Programming of each mass flow meter.
- Programming of each pressure meter.
- Control and monitoring of the complete gas system.
3.2 GenIO Class

The data used for the GenIO class are listed below.

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<th>Type</th>
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<td>GENIOS - GenIO class 1</td>
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**4. GUI**

The operator GUI has been done under WINCC and you need the runtime on your machine to control the gas system.

A GenIO class has been done for expert intervention.
4.1 WINCC GUI

1. Monitoring and control of the channel.

2. Programming of the desired gas.

3. Control of the vacuum valves V1n and V2n.

4. Control of the vacuum venting valve.

5. Control of the vacuum pump.
4.2 EXPERT GUI
A.1 PRINCIPE