NIM standard multi-function monitoring and control module

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A NIM standard multi-function module has been developed for monitoring output voltage and the load current of the CAEN made NIM based High voltage power supply unit as well as the ultra-violet lamp current from Oriel made power supply unit. An ECL based digital circuit has also been included in this module to control the high voltage power supply output, based on certain external conditions.

1 CAEN High voltage power supply

CAEN made model N-126 is a general purpose high voltage power supply housed in a one-unit wide NIM module. It can deliver 0 to 3000 volts for a maximum load current of 5 mA. It provides two ports for monitoring of output voltage and current, designated VMON and IMON respectively. The conversion ratios for the purpose of monitoring are -1V/1kV for voltage and -1V/1mA for current.

In one of the operating modes called KILL, the module stops supplying power to the load and the output voltage is quickly brought to zero regardless of the ramp-down value. The mode is activated by either the KILL pushbotton or by the NIM TRUE pulse at the KILL input.

2 Oriel UV lamp power supply

Oriel made model 6061 power supply is a stand alone unit which provides at its output, a high voltage (1200-1500V) to *break down* calibration lamps and then a low current to sustain the discharge through the lamp. It can be operated in AC or DC modes. When in AC mode, the current is reversed every 30mS. In the DC+ or DC- modes, the current is true DC and hence the light output of the lamp has very little ripple.

In either of the operating modes, the lamp current can be monitored using the output jacks on the rear of the unit which provide a DC output voltage proportional to the lamp current. The conversion ratio for the purpose of monitoring is 10mV/1mA.

3 Monitoring and control module

This single-width NIM standard multi-function module has been designed for monitoring output voltage and the load current of the CAEN made NIM based high voltage power supply unit as well as the ultra-violet lamp current from Oriel made power supply unit. An ECL based digital circuit section has also been included in this module to control the high voltage power supply output, based on certain external conditions.

While the control section comprises of a stand alone circuit, the monitor section depends on an external peak sensing type ADC, such as LeCroy model 2259B CAMAC based unit for analog to digital conversion. A software triggered pulser scheme has been implemented (details in Appendix) to generate Gate input for this ADC. The monitoring and control module uses $\pm$6volts d.c supply which is drawn from the NIM back panel. -5.2V supply required for ECL section is generated on-board.

3.1 Motivation for design of the module

This module has been designed for a specific purpose of using with the Cosmic Ray test setup for scintillation counters. In this setup, a CAEN high voltage power supply unit is being used to power the phototubes of the counters under test. This module will be used to monitor the output voltage and the load current of the power supply during test runs, so that stability of the system is ensured.

It is dangerous to expose the phototubes to ambient light when they are powered on with high voltage. Since the scintillation counters (and hence the phototubes) are housed in a light tight box during testing, the controlling section of this module is designed to KILL the output power from the supply as soon as one of the latches used to open the light tight box are disengaged.

An apparatus primarily used for scanning Wave Length Shifting (blue to green) fibers has been developed by the Group[1]. It uses Orial made model 6035 Hg(Ar) ultra violet pencil type spectral lamp for exciting the fibers under test. The lamp is powered by Oriel's model 6061 power supply. An additional monitoring channel has also been included in the module to monitor the lamp current of the power supply (and hence the light intensity of the UV lamp), the purpose of which is to ensure short as well as long term stability of the scanning apparatus.

3.2 Practical considerations in the monitoring section

The peak sensing type ADC modules which are normally used to digitise the DC signals work only on negative polarity signals with a maximum input voltage of under two volts. It offers an input impedance of 50Ω to the input signals.

Since in general, the instruments provide the monitoring signals across high output impedances, feeding these signals directly into the ADC is not possible, as they will get loaded. In addition, there may also be a need for scaling the dynamic ranges of monitoring signals to fit into those supported by the ADC. So, the requirements of the conditioning circuits for the monitor signals are then to offer high input impedance, to provide signal scaling, to maintain the right polarity of the signal and to drive the signal into 50Ω loads. Circuits for all three monitoring channels have been designed keeping these requirements in mind.

3.3 Monitoring CAEN high voltage power supply

Two identical circuits are used to monitor output voltage and load current of the power supply. Each of these three stage circuits consists of an LM318 based inverting attenuator (of gain $\frac{1}{2}$!), an LM318 based inverter and a 50Ω driver stage built by ganging four opamps of LM324. While the first stage was required to make the monitoring possible for the entire range of output voltage as well as to offer high input impedance, the inverter was necessary to generate the right signal polarity for the ADC. It may be noted here that the power supply provides monitoring signals of negative polarity irrespective of the polarity of output voltage. Lemo00 connectors are provided on the front panel of the module for input and output. Refer Fig. 1a and 1b for complete schematics of these circuits.

3.4 Controlling CAEN high voltage power supply

Control circuit for the power supply is essentially built around an ECL IC MC10104, which implements quad 2-input AND gates. The circuit can take four external inputs through a D-type front panel connector. Output of this stage is passed through an ECL-NIM converter built using another ECL gate MC10216 and a few other components. The *KILL* output is terminated on a front panel Lemo00 connector. The input lines are pulled-up using termination resistors in the module so that they may be easily interfaced to the external inputs. Refer to Fig. 1d-f for complete schematic of the circuit.

3.5 Monitoring Oriel UV lamp power supply

The monitoring signal of the UV lamp power supply is of positive polarity irrespective of its mode of operation (AC, DC+ or DC-). Since the maximum load current the supply can deliver is 20mA, the maximum amplitude of monitoring signal is 200mV. Current monitoring circuit for the UV lamp power supply consists of an LM318 based inverting amplifier (of gain 4) and a 50Ω driver stage built by ganging four opamps of LM324. The first stage was required to improve the resolution of the monitoring as well as to offer high input impedance. Lemo00 connectors are provided on the front panel of the module for input and output. Refer Fig. 1c for complete schematic of the circuit.

4 Calibration and test results

Extensive tests and calibration runs are taken on the module, the monitoring channels in particular. Various test programs have been developed for this purpose. These tests serve the dual purpose of testing the performance of the module as well as to determine the constants for the purpose of calculation of the monitored parameter on-line.

4.1 Calibration for output voltage of the high voltage supply

Voltage monitoring output port VMON on the CAEN high voltage power supply is connected to the first channel of the monitoring section of the module. The output of this channel is connected to the LeCroy peak sensing ADC. The software triggered pulser is used to generate Gate input for this ADC. ADC bins are recorded for different values of the output voltage of the supply, which are varied using the front panel potentiometer. Dial readings given by the power supply unit are also noted down for all the data points. Fig. 3 shows the plot of the dial voltage versus ADC bins. When the data is fit in the useful region of operation by straight line, the following equation is obtained:

$adc\_bins = 0.4895 * dial\_voltage - 101.6$, or

$dial\_voltage = \frac{adc\_bins+101.6}{0.4895}$ in Volts.

When test runs are taken after these constants are incorporated into the test program, excellent agreement has been observed between the dial readings of the power supply unit and those readout by the program from the monitoring module.

4.2 Calibration for load current of the high voltage supply

Current monitoring output port IMON on the CAEN high voltage power supply is connected to the second channel of the monitoring section of the module. Following similar procedure described in the previous section, ADC bins are recorded for different values of the load current of the supply, which are set by connecting different loads to the power supply. Dial readings given by the power supply unit are also noted down for all the data points. Fig. 4 shows the plot of the dial load current versus ADC bins. When the data is fit in the useful region of operation by straight line, the following equation is obtained:

$adc\_bins = 0.5498 * dial\_current - 105.6$, or

$dial\_current = \frac{adc\_bins + 105.6}{0.5498}$ in micro amperes.

When test runs are taken after these constants are incorporated into the test program, excellent agreement has been observed between the dial readings of the power supply unit and those readout by the program from the monitoring module.

4.3 Calibration for UV lamp current from the power supply

Current monitoring output port on the rear panel of the the UV lamp power supply is connected to the third channel of the monitoring section of the module. Following similar procedure described in the previous section, ADC bins are recorded for different values of the lamp current of the supply, which are varied using the front panel potentiometer. Monitoring signal on the rear panel port, which is given interms of voltage is also noted down for all the data points using a volt meter. Fig. 5 shows the plot of this voltage (with conversion ratio of 10mV per 1mA of lamp current) versus ADC bins. When the data is fit in the useful region of operation by straight line, the following equation is obtained:

$adc\_bins = 4.518 * monitor\_voltage - 132.6$, or

$lamp\_current = \frac{adc\_bins + 132.6}{45.18}$ in milli amperes.

When test runs are taken after these constants are incorporated into the test program, excellent agreement has been observed between the values read by the voltmeter at the monitoring port of the power supply and those readout by the program from the monitoring module.

5 Applications and operating instructions

As mentioned already in Section 3.1, this module has been designed with a specific purpose of using with the Cosmic Ray test setup for scintillation counters. It may be used to monitor the output voltage and the load current of the high voltage power supply during test runs. A flag may be included in the configuration file, opting the monitoring by SCINTEST[2]. The SCINTEST can monitor the voltage and current at the time of automatic backup and store the data in a separate data file.

The following scheme may be implemented to remove the high voltage to the phototubes instantly when the door of the light tight box is opened without disabling the high voltage from the power supply. The required inputs from the box may be brought in by connecting ground line to one end of the latches and the input lines to the other. When the box is closed by engaging all these latches, the module produces a NIM output that enables the high voltage power supply. When one of the latches is disengaged, suggesting the user's intention to open the box, the module generates the NIM signal to KILL the high voltage output from the supply, thus preventing the phototubes from any damage due to excess light while they were powered on.

Again, as mentioned above, a need for monitoring the UV lamp current was felt while designing the optical fiber scanner. A simple scheme to implement this is to read the monitor data along with the photodiode data for each sample at a specified position of the UV source on the fibers. The data may be saved in an additional column along with data corresponding to the test fibers. The analysis program then can be made to identify this data as different from the fiber data.

In addition to the specific applications for which the module has been designed, it can also be used in similar situations, or in applications which require minor modifications to module.

6 Conclusions

The NIM based multi-function suppoting three d.c monitoring channels as well as a control functional block has been designed and tested. The monitoring channels have shown good linearity and precision. The control section has been found to function reliably.

A Appendix

Modifications are made to the Trigger Control Unit (TCU)[3] in order to implement a CAMAC based software triggerable NIM pulser. This appendix describes these changes and gives the operating instructions for the same.

A.1 Motivation

A multi-fibre testing apparatus is currently being designed by our group for CMS related R & D work. In this setup, UV light is shown to the fibres under test and the light generated by the fibres is readout from the fibres by a Photodiode as D.C charge. In order to read this charge by a charge ADC, a constant width GATE is required. The same may also be used with peak sensing type ADC as well in cases where the front-end generated GATE is not available.

A.2 Modifications to TCU

CAMAC based software triggerable NIM pulser could be implemented by some simple changes in the TCU module. A few of the unused gates on the card were put to use and a few changes are made to the gates which are already being used. A new output from the CAMAC function decoder (74LS154) is pickedup. This line corresponds to a CAMAC reserved function, F(15) on this card. A new gate of 74S11 is made use off and changes made to 74S10 gate inputs in order to include this new function for generating CAMAC X signal.

The decoder output is also used to trigger a monoshot (74LS123). The $\bar{Q}$ output of the monoshot is passed through a TTL-NIM converter stage to produce a NIM level signal.

A.3 Operating instructions

The NIM pulser output is available from the front-panel LEMO connector, located just above the Trigger mark LED bank. Actually, the veto output which was earlier available on this connector apart from two more above this one, has been replaced by the pulser signal. Width of the NIM pulse may be varied from about 100-400 nSec with the help of a 20KOhm trim pot which is accessable from the front-panel, located below the LED bank.

Typically, a pulse is generated by software by issueing a CAMAC function, F(15) on the station address, N of the TCU. Sub-address, A and the variable for transferring data to and from the module are ignored by the function. The only response generated on the CAMAC bus for this function is the Command Accepted, X signal.

References

1. Optical fiber scanning apparatus, B.S.Acharya *et al*, Technical notes, Under Preparation.

2. SCINTEST: On-line data acquisition software for the scintillation counter test system, B Satyanarayana, Technical notes, 1994.

3. CAMAC based Trigger Control Unit, B Satyanarayana, Technical note, 1993.