

The Nanoammeter is a rack-mounting, 2U-high box, intended for monitoring the anode and dynode currents in any one of a group of 12 Supercrystals (SCs) in the CMS Electromagnetic Calorimeter Endcaps (CMS-EE).

The device can be mounted between the two HV distribution crates feeding a single Dee, so that the Redel connectors will not have to be moved very far.

This user guide is in four parts: (1) Front panel description; (2) Rear panel description; (3) Internal circuit description; (4) Method of use.

(1) Front panel description – see figure 1



Figure 1 Front panel of Nanoammeter

The front panel has two rotary switches, two moving-coil current meters, two Lemo sockets, and an indicator light.

The two rotary switches are:

(a: on the left) a 12-position switch to select anode and dynode current readings for one of the 12 SCs fed through the Redel bundle under test.

(b: on the right) a four-position switch to select the range of current to be measured. The ranges are: [A] 10 A full scale, [B] 1 A, [C] 100nA, [D] 10nA. The ranges for anode and dynode are selected together.

The two centre-zero meters are (a: on the left) Anode current, and (b: on the right) Dynode current. The convention is that a positive current flows from the power supply to the SC, a negative current flows back from the SC.

The two Lemo connectors provide analogue signals corresponding to the anode and dynode currents. The range changes with the position of the range switch. In all cases, full-scale on the meter corresponds to 100 mV at the output socket.

The indicator is a red LED to show when the mains is connected and the device is powered.

(2) Rear panel description – see figure 2



Figure 2 Rear panel of Nanoammeter

The rear panel has a mains connector, two SHV connectors and a 51-way Redel connector. The mains connector is an IEC socket for 230V ac mains. The SHV connectors are Anode HV in, and Dynode HV in. They are fed from the CAEN power supply, usually from the two ‘Test’ channels. The Redel connector is for the output HVs to the 12 SCs.

(3) Internal circuit description – see figure 3

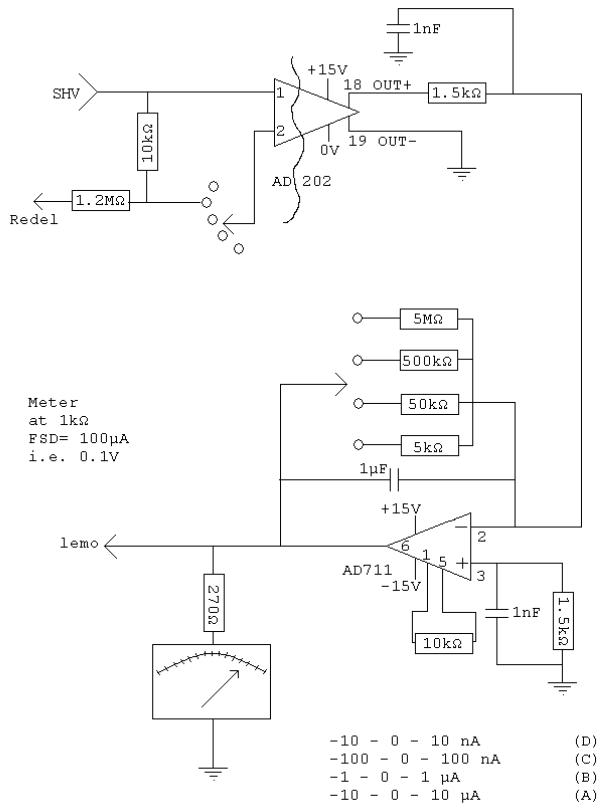


Figure 3 Circuit diagram of Nanoammeter (NB there are two identical circuits, one for the anode & one for the dynode.)

The current is measured by monitoring the potential developed across a 10kohm resistor in series with the SC under test. One end of this resistor is at the input HV, the other end is only a little below this potential. Each of the 12 10k resistors can be switched in turn to the inputs of an isolating op-amp (AD202), which provides an output close to ground potential. This is then fed to a second op-amp, whose gain is set by switching one of four feedback resistors, for the four ranges (A-D, as above.) The output of this second op-amp is taken to the meter (impedance 720 ohms) via a 270 ohm resistor, so that 100 mV corresponds to full-scale on the meter. The output is also taken to the corresponding Lemo connector.

NB On the most sensitive range, the op-amp can develop an offset voltage, so there is a 10kohm variable resistor to adjust this offset.

(4) Method of use

The nanoammeter is placed near to the HV distribution crates for the Dee to be tested, usually by mounting it in the rack, in-between the appropriate HV crates. It is connected to the 230Vac mains, and the Anode and Dynode HV inputs (SHV) are connected to the 'Test' outputs on the CAEN supply. The Redel bundle containing the SC(s) to be measured is disconnected from the distribution crate, and plugged in to the back of the nanoammeter.

It is advisable to record the 'offset' current for both anode and dynode before the CAEN HV is turned on. If this offset is too large, it is possible to remove the top of the nanoammeter and adjust the trim resistors (the one nearest the front of the box is for the dynode, the one at the rear is for the anode.) The offset current will need to be subtracted from subsequent readings taken with HV on. Notice that the offset can drift over time, so it is advisable to re-measure it at intervals.

When the anode and dynode HV are both on, the left switch can be used to select each of the 12 SCs in turn. The anode and dynode currents can be read, taking care to select an appropriate sensitivity range for the meter each time. If the meter is set to a range which gives more than 100mV output (ie the meter pointer is off-scale), then the gain of the op-amp is unreliable, and the range needs to be switched to a less sensitive one.

Safety considerations:

In normal use, there are no safety concerns. However, the safety features of the normal EE distribution crates are not implemented in the nanoammeter, so features like overcurrent and overvoltage will be handled by the CAEN crate instead. It is advisable to turn off the HV and let the voltage decay away to zero before unplugging the Redel cable from the rear, otherwise a charge will remain in the cables, which although not dangerous, can be a surprise if discharged through your fingers.

Please send any comments to <vjs@cern.ch>