Electronic Instrumentation for Nuclear, Astroparticle Physics and Industrial Electronics.

Model DCB209A.

8 channels charge sensitive preamplifier.

Operation Manual.

WARRANTY

NAICAM S.R.L. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment from headquarter in Italy.

NAICAM SRL warrants the following items for one year from the date of shipment: probes, cables, and documentation of specified equipment.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local NAICAM SRL representative, or contact NAICAM SRL headquarters in Italy. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without NAICAM SRL express written consent, or misuse of any product or part.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES.

NAICAM srl, NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE EVEN IF NAICAM SRL, HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAM- AGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

Front view.

Back View.

1. GENERAL DESCRIPTION.

1.1. DESCRIPTION.

The function of a preamplifier is to extract the signal from the detector without significantly degrading and receive maximum the signal to noise ratio. Usually, the preamplifier is located as close as possible to the detector, and the input circuits are designed to match the characteristics of the detector.

Different types of detectors produce moderately large signals at their outputs, and this relaxes the restrictions on the noise contribution from the preamplifier. Detectors that typically include in this category are photodiodes, photomultiplier tubes (PMT), scintillation detectors (different scintillator mounted on a PMT), micro channel plate PMTs, micro channel plates and Si multipliers. For such detectors, a wideband amplifier with a low input impedance can be used directly at the detector output to generate short, fast rising pulses for timing or counting purposes.

Some detectors produce very small output signals, it is essential that the input stage of the preamplifier contribute little noise. The requirement for low noise and stable sensitivity with these detectors is met by using a charge sensitive preamplifier with an FET (Field-Effect Transistor) input stage. For silicon particle detectors and proportional counters, the entire preamplifier usually is operated at room temperature. However, the excellent resolution of the cooled germanium and silicon.

NAICAM manufactures a preamplifier to fit your detector, your application, and your budget. The applications information and selection guides will help you to choose the optimum preamplifier for your task. The DCB209 series **preamplifier** is a low noise charge sensitive preamplifier with fixed gain values. The preamplifier is optimized for high input capacitance (up to 1000pF). The module has bias input up to 3 kV and protection circuit to avoid breakdown of the input of the preamplifier circuit.

1.2. CHARGE-SENSITIVE PREAMPLIFIER.

DCB209 series preamplifiers are preferred for most energy spectroscopy applications. The signal from a semiconductor detector or ion chamber is a current pulse and the waveform of signal is depending on the type of detector and its size. For most applications the parameters of interest are the quantity of charge and the time of occurrence of an event.

The current pulse integrates the charge on the feedback capacitor, its gain is not sensitive to a change in detector capacitance and the rise time of the output pulse is equal to the detector current pulse width.

The output voltage from the preamplifier has an amplitude Vout, and a decay time constant τf, given respectively by

$V_{out} = Q_d / C_f$ where Qd is the charge released by the detector,
Cf is the feedback capacitor (0.1 to 30 pF),
Rf is the feedback resistor.

Rf is a noise source and in direct-coupled system, is made as large as possible consistent

with the signal energy-rate product and the detector leakage current. The

preamplifier package is kept small to permit mounting it as close as practical to the detector, thus reducing input capacitance caused by cabling and decreasing microphonic noise, ground loops, and radio frequency pickup, all of which are sources of noise for the charge-sensitive preamplifier.
The gain of preamplifier can be expressed in mV/fC, but usually a sensitivity is generally expressed in mV per MeV of energy deposited in a given detector material. The charge released by the detector is a function of the photon or particle energy and the detector material, and is given by

$$Qd = (E * e)/ \varepsilon;$$

where E is the energy in eV of the incident radiation, e is the charge of an electron (1.6 X 10–19 coulomb), and ε is the amount of energy required to produce an electron-hole pair in the detector. Approximate values for ε for various detectors are given in Table 1. The output voltage produced by a charge-sensitive preamplifier is

$$Vo = (E*e)/Cf* \varepsilon;$$

Table 1.

Detector	ε (eV)
Silicon	3.62 (300° K)* to 3.71 (77° K)
Germanium	2.96 (77° K)
Proportional Counters	
Argon	26.4
Methane	29.2

1.3. FUNCTIONAL BLOCK DIAGRAM.

On the figure 1 the simplified circuit of the DCB209 is shown. The module has High Voltage bias SHV connector, Output and Test LEMO connector. Input power (DSUB9 male connector) through captive power cable from NAICAM spectrometric Amplifier, Model DCB100 portable power supply or other linear power supply[1].

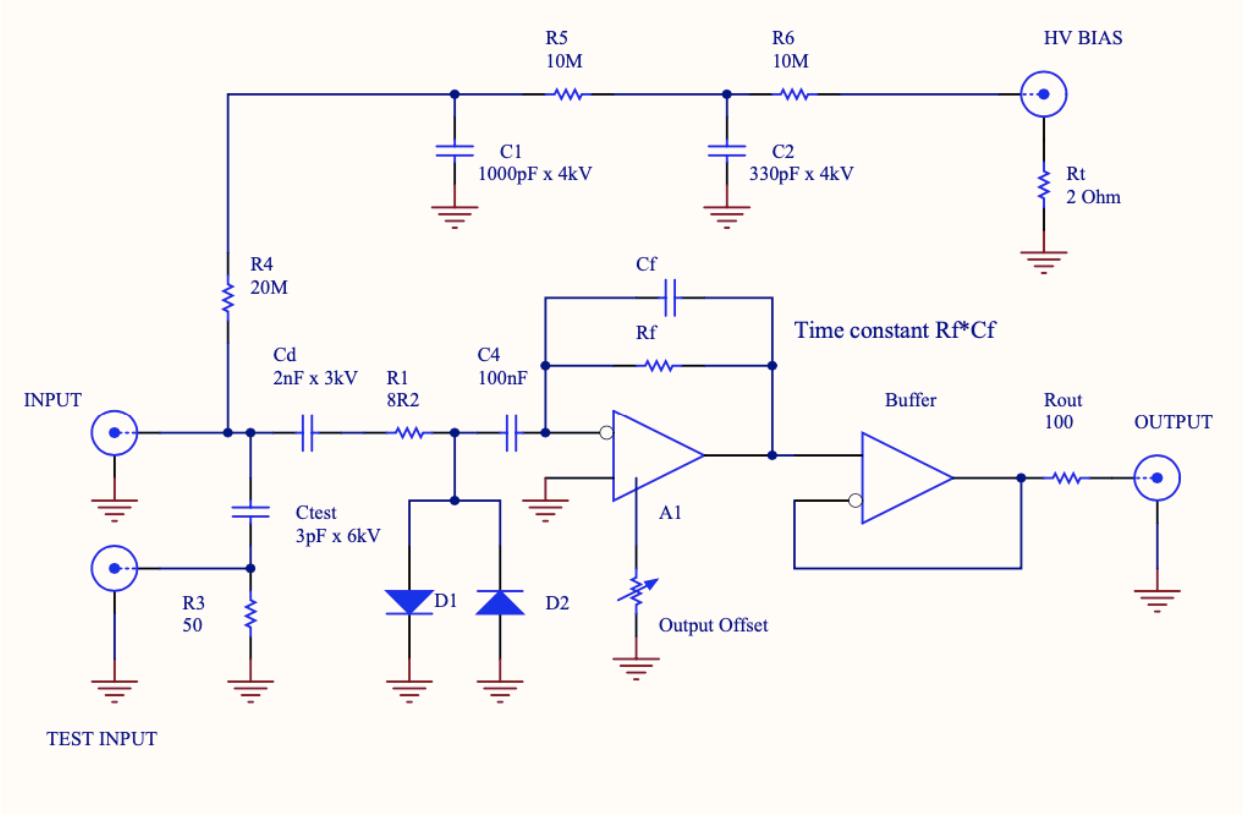

Figure 1. Simplified schematic of the model DCB209.

Test Pulse.

To calibrate the preamplifier the equivalent charge must be injected through test LEMO 00 connector. The amplitude of the pulse Vtest determine the injected charge by formula

Qt = Vtest*3 pF.

[1] don't use pulse generator with switching power supply.

Spectrometric chain with DCB209 preamplifiers.

The model should be used with a shaping amplifiers, such as NAICAM NCB215, NCB226 and DCB215. Figure 2 shows typical amplifier usage preamplifier and

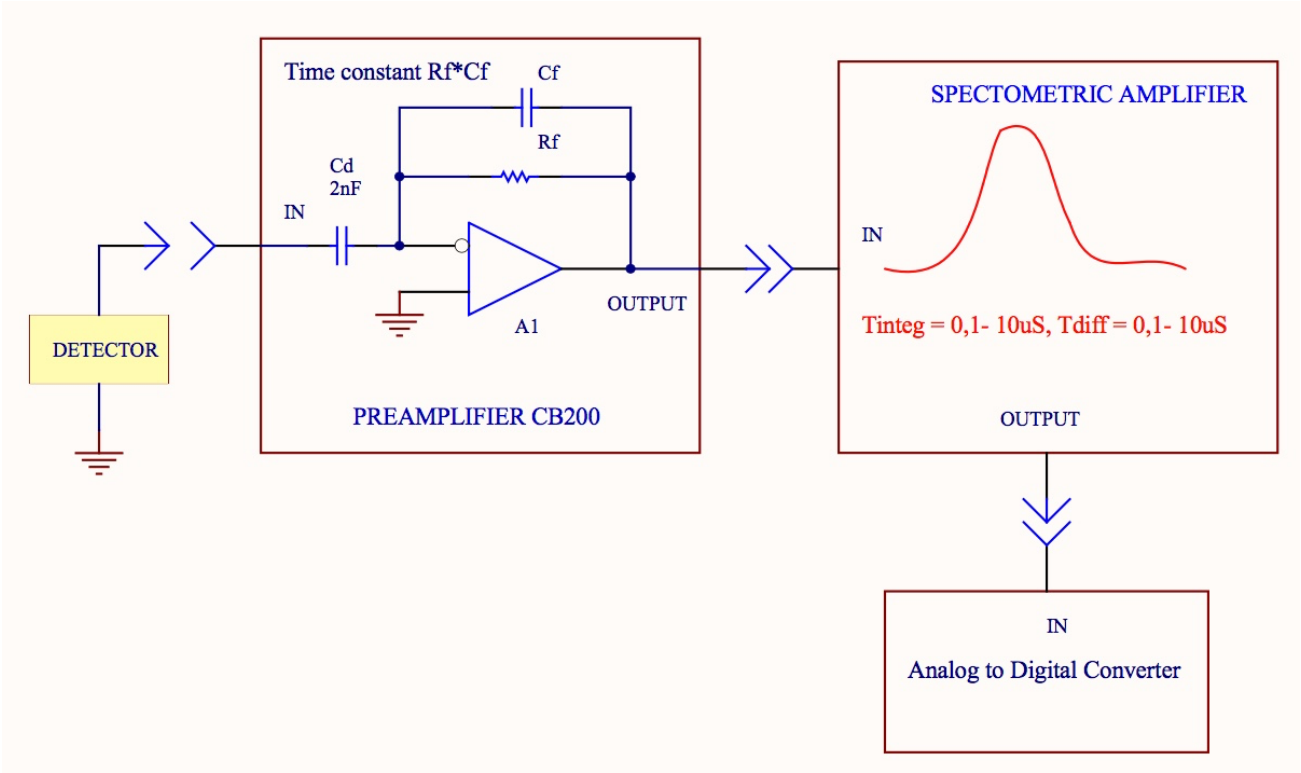

Figure 2. Typical set up with the module DCB209.

spectrometric amplifier.

The preamplifier noise has determined signal to noise resolution. Using the spectrometric amplifier, the lows value of this parameters can be richened. The shaping time of amplifier determines the time resolution of the timing system and common gain of spectrometric channel. The amplifier is important components in a pulse processing system for applications in counting, timing, or pulse amplitude (energy) spectroscopy. Normally, it is the amplifier that provides the pulse-shaping controls
needed to optimize the performance of the analog electronics. In the module DCB209 can be mounted from 4 up to 8 channels.

Input and Bias connectors can be SHV or BNC type connectors. Maximum applied bias to SHV connector 3 kV. If used BNC connector the maximum bias voltage is 500 VDC.

Output resistance of preamplifier is 100 Ohm and output signal can be terminated from 50 Ohm up to 1 Mega Ohm. Optional version channel circuit is preamplifier with output driver that increase the gain. The gain of channel can be fixed up to 10. This parameter usually defined by customer. Default version module has not

additional output driver.

Noise of preamplifier.

Noise in charge-sensitive preamplifiers is generally controlled by four components: the input field effect transistor (FET), the total capacitance at the input (Cf, the detector capacitance, etc.), the resistance connected to the input, and input leakage currents from the detector and FET. Figure 3 is a graph showing the noise versus external capacitance for a typical preamplifier. It is desirable to keep the external capacitance at a minimum to obtain the best timing resolution, as well as the

best energy resolution.

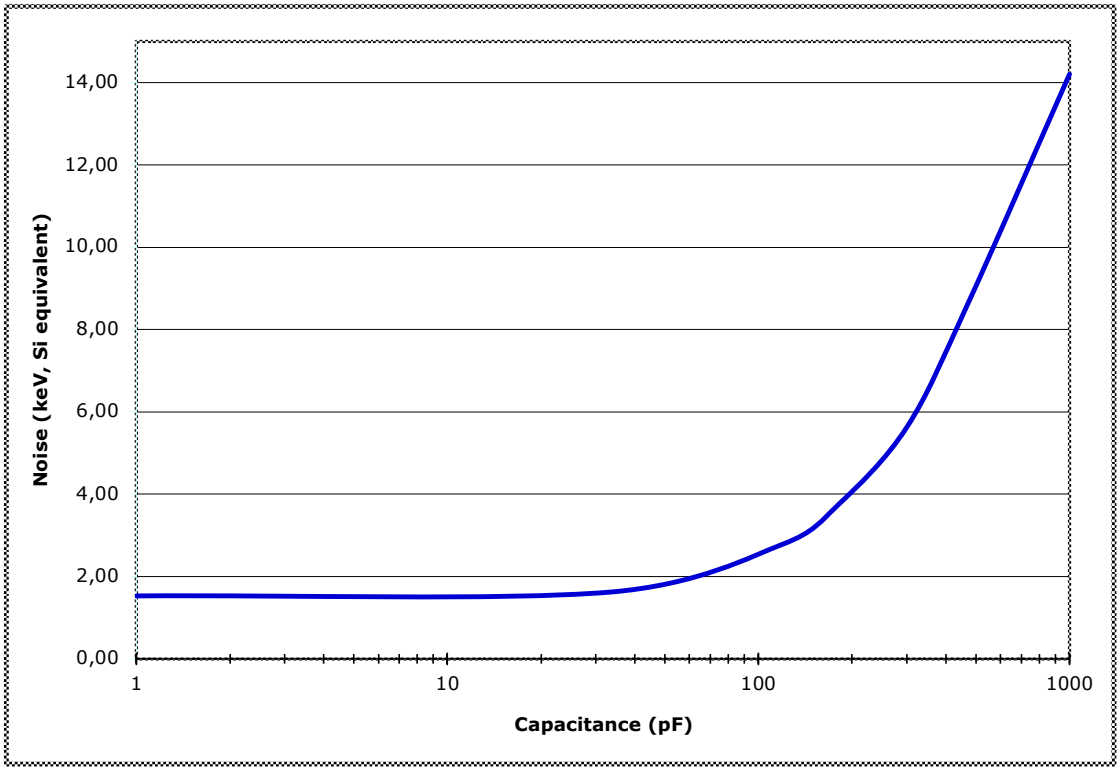

Fig.3. Typical noise as function of input capacitance measured with spectrometric amplifier (2 us Integration and 2 us Differential constants).

2. TECHNICAL SPECIFICATIONS.

2.1 PERFORMANCE.

The series DCB209 has four models (table 2). All modules have fixed gain, energy range and can be used in different applications.

Table 2.

Model	Charge sensitivity	Max. Noise	Energy range
	GAIN (Si Equivalent 3,62)	Noise RMS[2] (keV/(Si) (Cin=0 pF)	Range Energy
DCB209A	40-45 mV/MeV	<1.5 keV	0-200 MeV
DCB209A2	20-25 mV/MeV	<1.5 keV	0-400 MeV
DCB209A3	12-15mV/MeV	<1,9 keV	0-600 MeV
DCB209A7	5,5 mV/MeV	<1,9 keV	0-1200 MeV

The D**CB209A module has** 8 channels low noise charge sensitive preamplifiers with fixed gain. Fast timing and small size make this preamplifier excellent module for small, charged particle detectors or laboratory measurements. The preamplifier is optimized for high input capacitance (up to 1000pF). The module has bias input (up to 3 KV) and protection circuit to avoid breakdown of the input of the preamplifier circuit.

General default values in Si equivalent ratio for DCB209A version:

Model	Charge sensitivity (Si Equivalent)	Max. Noise (Si equiv.)	
		Cin = 0pF	Cin = 200pF
DCB209A	Fixed 45 mV/MeV	<2,3 keV (FWHM)	<4,3 keV(FWHM)

[2] Noise value is measured with 2 us integration and 2 us differential constants.

Decay time	**DCB209A** **DCB209A2** **DCB209A3** **DCB209A7**	100 us 50 us 150 us 200us
Dynamic input capacitance:	up to 1000 pF	
Noise/Input capacitance ratio:	**DCB209A** **DCB209A2** **DCB209A3** **DCB209A7**	9 e-/pF 10 e-/pF 12 e-/pF 14 e-/pF
Integral nonlinearity:	0,03 % (without termination)	
Dynamic output range:	+/- 6 V (without termination). +/-3 V (with 100 Ohms termination).	
Temperature stability:	+/- 100 ppm/C.	
Rise time	Less than 12 ns (Cin = 0pF, 50 Ohm output termination).	
Open loop gain:	30,000	
HV Bias resistor	50 MOhm[3]	
Output resistors:	100 Ohm	
Test Capacitance:	3 pF (+/-3%).	
Output Offset	Less than 100 mV	

[3] 8 Low pass filters are integrated in module. The components of low pass filters are coated by special high resistive transparent gel.

2.2 INPUT/OUTPUT CONNECTIONS AND SIGNAL CHARACTERISTIC.

INPUT	Accepts positive or negative charge signal. Input has SHV/BNC connector.
BIAS	High Voltage can be applied through SHV up to 3 kV. BNC version is optional. The serial resistance between input and bias connectors is 40 Megohms.
TEST	Each channel has individual test input connector (LEMO type). Test capacitance is 3,0 pF +/- 3 %.
POWER	DSUB 9 pin connector.
OUTPUT	Output negative or positive linear pulse. The output connectors are LEMO type connectors.
CASE GROUND	One point connected to front panel screw.

SHV Connectors.

Input bias SHV connector is isolated from frame by plastics rings. Input ground and module ground are separated by small value resistor. All channels connected to Bias connector though low frequency pass filter.

2.3 POWER REQUIREMENTS

The best solution is alimentation from a NIM standard power supply or special low noise linear power supply.

Power supply voltage (V)	Current (mA)
+12	110,0
-12	100,0

Power supply DSUB 9 pins out:

Pin number	
3	NC
5	NC
4	+12 Volt
9	-12 Volt
1	Ground
2	NC

Cable length 3 m (different length should be specified in order).

2.4. DIMENSION AND WEIGHT

Box dimensions :160x165x52 mm

Weight: 1150 gr. (box without cables)

For More information on NAICAM products and applications contact your local NAICAM representative:

Europe: NAICAM s.r.l., Via Aosta 14, Padova, 35142, Italy.
Telephone: +39.049.2050437. Fax: +39.049.2050437
E-mail: info@naicam-tech.com.
Website: www.naicam-tech.com.