



**REALTIME CENTROIDDING PROCESSOR
for the
NEUTRON-HANDMONITOR**

Operating Instructions

THE ND&M REALTIME CENTROIDING PROCESSOR FOR THE HAND-HELD NEUTRON MONITOR (HANDMONITOR)

The ND&M Realtime Centroiding Processor is a 16-bit ISA card (PC/AT card) that analyzes video frames from a CCD camera for scintillation lightspots and determines their centers of gravity in realtime.

Usually the Realtime Centroiding Processor is used together with the ND&M Neutron Monitor (Handmonitor) and the ND&M Readout Unit, but it can also be operated standalone together with any kind of CCIR video camera that allows external synchronisation.

The operating principle of the Realtime Centroiding Processor is as follows:

1. The CCD camera (see fig.1) views the screen of the ND&M Neutron Handmonitor. The video signal of this camera is digitized by an 8 bit analog-to-digital converter. The camera is synchronized by a genlock generator on the Realtime Centroiding Processor to ensure a pixel-synchronous digitization of the video signal.
2. Each digitized video frame runs through a twodimensional convolver where the frames are correlated with idealized model distributions of scintillation light spots. This filtering suppresses background noise and prepares the frames with the scintillation light spots in them for processing in the next stage.
3. In the next stage the filtered frames are scanned by an array of 8 comparators. Each pixel in a frame is compared with its neighbours to determine the brightest pixel in each light spot. If one of these pixels is found, the comparator array delivers the x- and y-coordinates of this pixel together with its brightness value.
4. The x- and y-coordinates and the brightness values are stored in a FIFO buffer to allow asynchronous operation of the Realtime Centroiding Processor and the host PC. The PC has to determine the filling level of this FIFO from time to time. At a certain level, the FIFO has to be read out to make room for new coordinates. The read data is then further processed by appropriate software, e.g. for online display or mass storage.

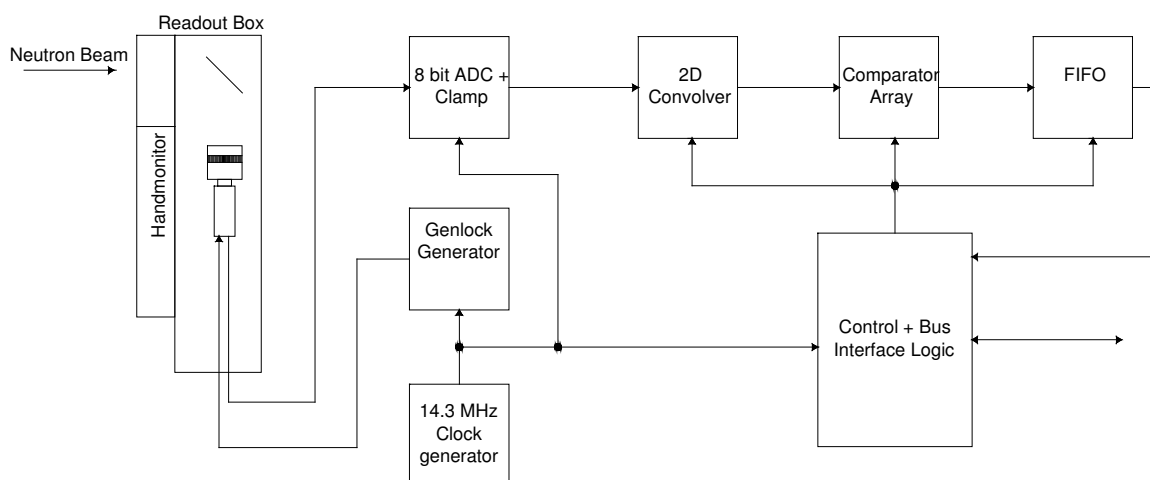


Fig 1 Block diagram of a RCP detector system

CAUTIONARY NOTES

Please refer to the cautionary notes for the Handmonitor before operating the Realtime Centroiding Processor, the Readout Unit and the Handmonitor.

WARRANTY CONDITIONS

The warranty period is 6 months after delivery date. ND&M warrants that it will either repair or replace this product if it proves to be defective in design, material, or workmanship in the course of its normal use. If two consecutive repair attempts fail, the general warranty conditions given by law apply.

Please refer also to the warranty conditions for the Handmonitor.

OPERATING INSTRUCTIONS

- Before inserting the Realtime Centroiding Processor in your PC, please check the jumper settings for selecting the base address of the board. Refer to fig. 1 for determining the correct settings.

Note: The default setting for the base address is 240 (hexadecimal). Do not change this setting unless you encounter a bus conflict with some other board in your PC. We chose this address because it showed a very low probability of interfering with other cards.

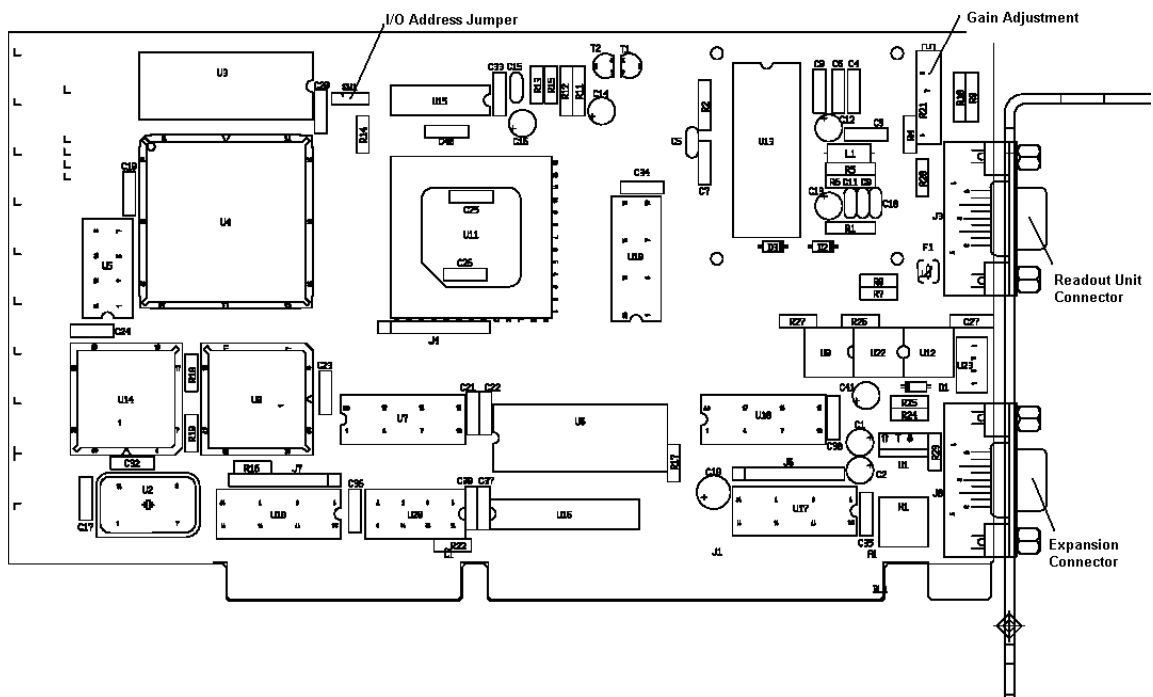


Fig 2: RCP board and location of the jumpers, adjustment potentiometer and connectors

The Realtime Centroiding Processor uses 8 consecutive addresses in the I/O space of your PC and no interrupts or DMA channels. Please check also that you really insert the Realtime Centroiding Processor in a 16-bit slot. It won't work in an 8-bit slot. We encourage the user to optimize the ISA bus timing via BIOS setup (I/O wait states, I/O clock speed, I/O recovery etc.), but correct operation can only be guaranteed for IEEE P996 conformity of the bus signals.

- Mount the Handmonitor on the Readout Unit (please refer to the manual of the Readout Unit if you have problems).
- Make sure that the Handmonitor is switched off. Start with a gain setting of '2' on the Handmonitor (For scintillators with low light output use gain setting '3').
- Connect the Readout Unit to the inserted Realtime Centroiding Processor via the supplied special video cable. Secure the cable with the fastening screws on the connectors.
- Switch on your PC if you haven't done so already. Hot-plugging of the Readout Unit should usually be no problem unless you have an exceptionally weak power supply in your PC.
- Turn on the power switch on the Readout Unit. The power indicator LED on the Readout Unit should be on now.
- Install the software on the supplied CD.

ADJUSTING THE DETECTOR SYSTEM

This section applies if you are doubtful about the current settings of your detection system or if you use a non-standard scintillator with different light output from the NE426 scintillator.

In case you use the standard NE426 scintillator, we recommend that you don't change the factory setting of the ADC gain trim pot.

Change any gain setting trim pots at the Realtime Centroiding Processor or at the CCD camera only if you are absolutely sure about what you are doing!

- Proper gain setting is important for:
 1. Best signal-to-noise ratio.
 2. Highest dynamic range.
 3. Lowest nonlinearities.
 4. Highest spatial resolution.

The Realtime Centroiding Processor needs scintillation signals that are well above noise in each frame. The standard neutron scintillator NE426 fulfills this requirement, though at the expense of a relatively broad pulse height spectrum.

- There are 6 different adjustment locations that determine the overall gain of the detection system:
 1. The gain setting of the Handmonitor (1-2-3).
 2. The aperture setting of the lens.
 3. The gain setting of the CCD camera (see fig. 4).
 4. The gain setting of the analog-to-digital converter on the Realtime Centroiding Processor (-4.5...10 dB, see fig. 3).
 5. The chosen filter coefficients of the twodimensional convolver.
 6. The digital gain setting of the scaler function of the twodimensional convolver.

It is recommended that the user only uses settings 1., 5. or 6. to adjust the overall gain and leaves 2., 3. and 4. at their preset value. See also the RCP-software manual for setting the gain.

1. GAIN SETTING OF THE HANDMONITOR

The required gain setting of the Handmonitor depends on the light output of the scintillator. For the standard NE426 scintillator, we recommend a gain setting of '2' at the Handmonitor.

Keep in mind that high gains of the image intensifier always run the risk of saturating the image intensifier, leading to a decrease of the linearity of the detector. This saturation further leads to a lower spatial resolution because of the broadening of the scintillation events.

2. LENS APERTURE

The aperture of the lens should be opened as much as possible to collect as much scintillation light as possible on the CCD. This ensures a high signal-to-noise ratio of the video signal. Therefore, the lens aperture is fixed to $f=1.3$ or $f=1.4$ (depending on your type of lens).

3. CCD CAMERA GAIN SETTING

The default gain setting of the CCD camera is set to give a signal-to-noise ratio that allows digitization with true 8 bits, i.e. more than 48 dB. Change this setting only if you want to use a scintillator with low light output, and if the maximum gain setting of '3' at the Handmonitor does not give bright enough scintillation light spots for operating with the default setting of the CCD gain. Refer to the supplement *CCD Camera Setup* before opening the CCD camera!

4. ADC GAIN

The gain adjustment of the A/D converter should ensure that the video signal from the CCD camera covers the whole range of the ADC without saturating it (see fig.4). You can control this by looking at the brightness values of the detected scintillation light spots with the 'RCP.EXE' program. The trim pot for adjusting the gain of the A/D-converter is accessible from outside of your computer (see fig. 3).

5. FILTER COEFFICIENTS

The filter coefficients of the twodimensional convolver are freely programmable. The 'RCP.EXE' program lets you choose between different sets of coefficients (see 'RCP.EXE' manual) and you can also insert your own sets of coefficients. The range of each coefficient goes from -64 to +63 (6 bits + sign). If you set the coefficients such that the sum of all coefficients times the setting of DGAIN gives approximately 2000, then you will get the right levels.

6. DIGITAL GAIN SETTING (DGAIN)

The last programmable stage that affects the overall gain of the signal chain is a digital multiplier that multiplies the result of the convolution operation with a number between 1 and 15. This setting is called DGAIN in the 'RCP.EXE' program. The result of this multiplication is shifted 4 bits to the right. The comparator array that follows gets only the bits from b10...b18. The sign bit is not used because meaningful coefficients give only positive convolution results. Thus the range of brightness values that enters the comparator is:

$$\text{comparator input} = \text{convolution result} \times \text{DGAIN} / 16 / 128.$$

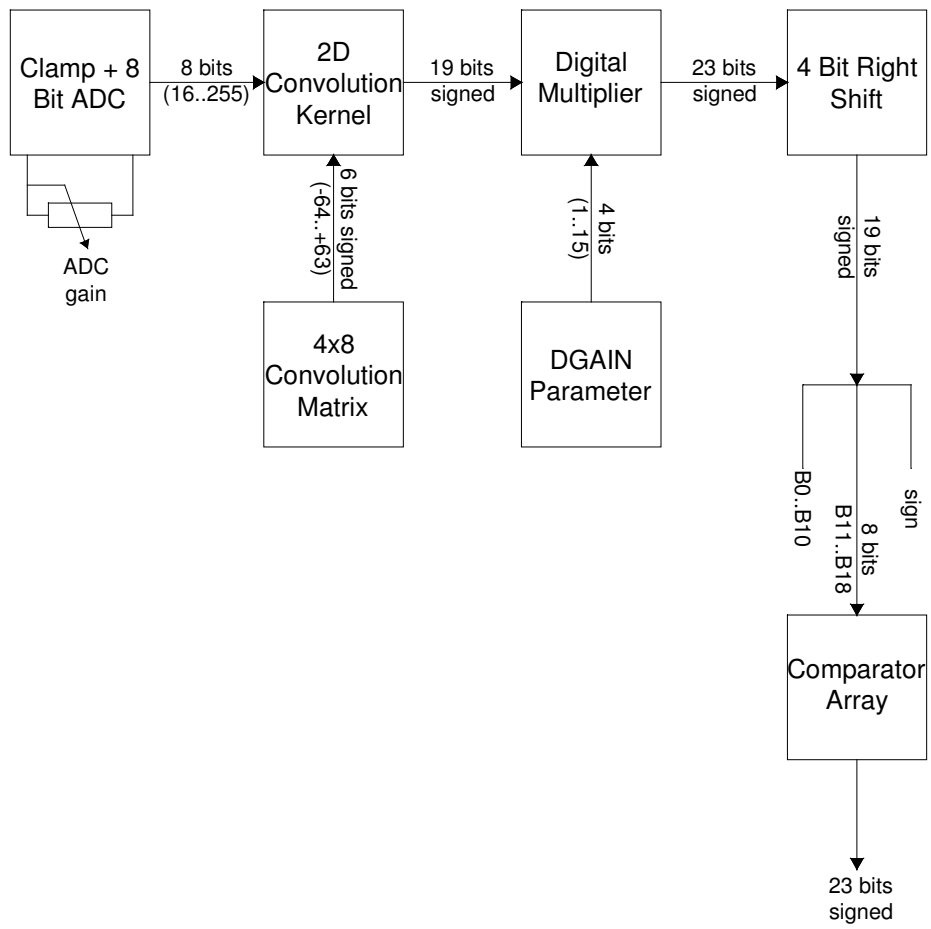


Fig 3: Gain affecting stages of the RCP

SUPPLEMENT: CCD CAMERA SETUP

In normal operation, the settings of the camera do not need to be changed. If you have certain applications that absolutely require changes in the standard settings, we give here a short description how to modify the camera setup. Please refer also to the manual of the Hitachi KP-M1 camera for the following section.

External Controls:

- Remove the 6 screws that hold the cover of the Readout Unit and look at the panel at the rear side of the CCD camera (see fig.5).

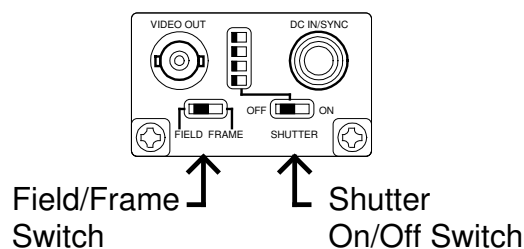


Fig 4 Panel of the CCD camera inside the Readout Unit

- The 'field/frame' switch should be set to the 'field' position (Users of the Realtime Centroiding Processor should set this switch to the 'field' position to avoid double-counting of neutrons due to the overlapping of frames in the 'frame' mode. 'Frame' mode, on the other side, gives a higher resolution and higher sensitivity. Overlapping frames are no subject for the Accumulating Framegrabber, because here the frames are summed up anyway.)
- The 'shutter' switch should be set to the 'off' position (unless you have a special application that makes use of the shutter, of course).
- Don't care for the shutter speed select switch, it is ignored when the shutter is switched off.

Internal Controls:

Changing the internal settings of the CCD camera should only be done by qualified personnel and requires great care to avoid damage!

- Opening the CCD camera reveals the video board that can be seen in fig. 6. The CCD gain can be adjusted with RV301, the automatic gain control can be switched on with SW301 and the gamma characteristic can be changed with switch SW302. Please note the default settings before changing anything!

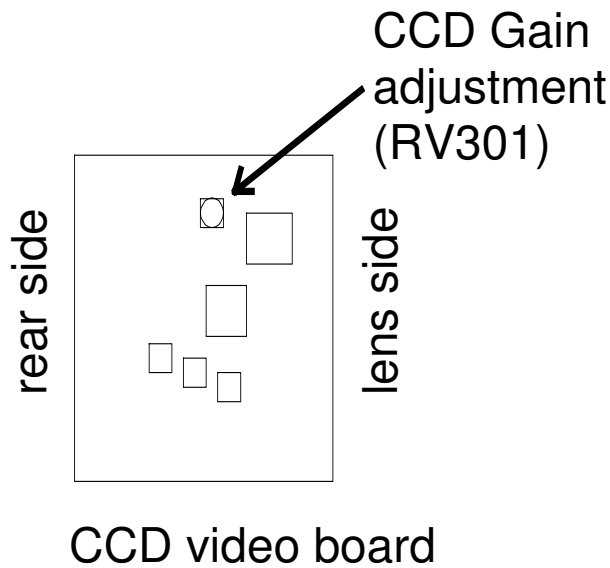


Fig 5 Gain adjustment potentiometer inside the CCD camera of the Readout Unit

GATE INPUT

The Gate input for starting/stopping of the measurement via an external TTL signal or optocoupler input is accessible through a LEMO connector below the DB9 connector for the Readout Unit (see fig.7). The input is active low, i.e. measurement starts when this input goes low and stops when it goes high. The 'external gate' flag must be enabled in the 'RCP.EXE' program.

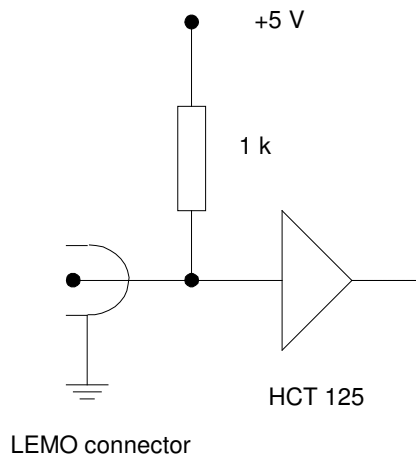


Fig 6 Gate input, internal connection

TECHNICAL SPECIFICATIONS

ADC resolution:	8 bits
# of digitized pixels:	512 x 512
Pixel clock:	14.318 MHz
Signal system:	CCIR system
Horizontal scan frequency:	15625 Hz
Vertical scan frequency:	50 Hz
Arithmetic operations:	1 0030 980 960 operations/sec*
Video input:	1.0 V p-p, 75 Ohms, unbalanced
Sync output:	1 V p-p, negative
Board type:	16 bit, ISA
operating conditions:	20..40 °C, 0..40 % rel. humidity

Ser. No.:
