ND&M

Neutron Detectors and more ...

**ACCUMULATING FRAMEGRABBER
for the
NEUTRON-HANDMONITOR**

Operating Instructions

THE ND&M ACCUMULATING FRAMEGRABBER FOR THE HAND-HELD NEUTRON MONITOR (HANDMONITOR)

The ND&M Accumulating Framegrabber is a 16-bit ISA card (PC/AT card) that captures up to 256 video frames from a CCD camera and sums them up.
Each video frame is discriminated before it gets summed up.

Usually the Accumulating Framegrabber 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.

In principle there a two ways of detecting neutrons with the Accumulating Framegrabber:

1. Summing up of frames without discrimination.
   This mode allows the integration of the light distribution on the intensifier screen of the Handmonitor of up to 10.24 secs per readout period.
   In this mode, the Handmonitor runs as an integrating detector for neutrons, theoretically without any limits on maximum neutron flux (please refer to the warranty conditions and cautionary notes for the Handmonitor before operating it in high fluxes), but with relatively low dynamic range and low position resolution (dependent on the type of scintillator your Handmonitor is equipped with).
   For special applications, e.g. the detection of low energy X-rays with customer-specific versions of the Handmonitor, where a single quanta does not give enough light to be well separated from the noise floor of the image intensifier and CCD camera, this mode is the mode of choice.

2. Summing up of frames with discriminator set to a level well above noise.
   Setting the discriminator to a level well above noise allows you to strip off the noise components of the image intensifier and CCD camera before summing up the frames. This mode allows the summing of frames, where only few bright spots (i.e. scintillation events) are present in each frame, without drowning them in the accumulated noise due to long integration times.
   After readout of the accumulated frames, the positions of the bright spots can be determined very accurately by appropriate algorithms.
   The prerequisite for this operating mode is that the spots in the accumulated frame do not overlap. For an integration time of 10.24 secs (corresponding to 256 frames) and a maximum allowed deviation from linear response of 1%, this leads to a maximum count rate of approximately 30 neutrons per second, homogeneously distributed over the detector area.
   Shorter integration times allow higher count rates, but at the expense of higher dead times of the detection system due to the more frequent readout periods.

CAUTIONARY NOTES

Please refer to the cautionary notes for the Handmonitor before operating the Accumulating Framegrabber, the Readout Unit and the Handmonitor.

WARRANTY CONDITIONS

The warranty period is 6 months after delivery date. Credit (prorata replacement) upon failure within 6 months.
Please refer also to the warranty conditions for the Handmonitor.

OPERATING INSTRUCTIONS

• Before inserting the Accumulating Framegrabber 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.

The Accumulating Framegrabber uses only 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
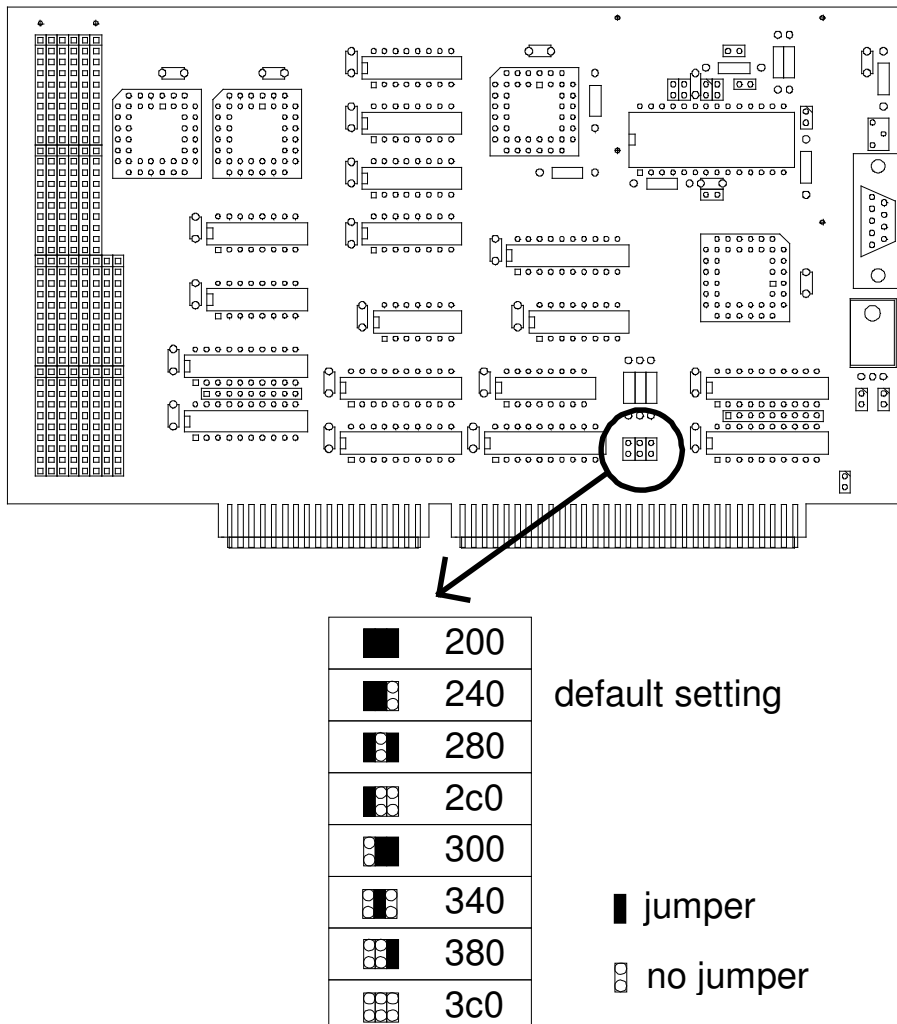

■ 200	
■ 240	default setting
■ 280	
■ 2c0	
■ 300	
■ 340	▌ jumper
■ 380	
■ 3c0	▯ no jumper

Fig. 1: Location of the base address selection jumpers

Accumulating Framegrabber in a 16-bit slot. It won´t work in an 8bit slot.

- 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 Accumulating Framegrabber 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.

- Try out the software on the supplied disks.

- To adjust the focus of the CCD camera carefully turn the focus ring on the lens. For this, open the camera housing first with the 3 screws on each side. Check your adjustment with the program ´AFG.EXE´ or with a TV monitor connected to the Readout Unit. Please check afterwards that the aperture setting wasn´t changed. The aperture should always be set to ´open´ (i.e. f=1.3 or f=1.4, depending on lens type).
  If you are in doubt, please contact us!

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.2).
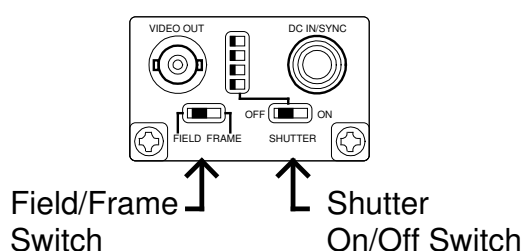

Fig. 2: Panel of the CCD camera inside the Readout Unit

- The ´field/frame´ switch should be set to the ´frame´ 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. 3. 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!

CCD Gain
adjustment
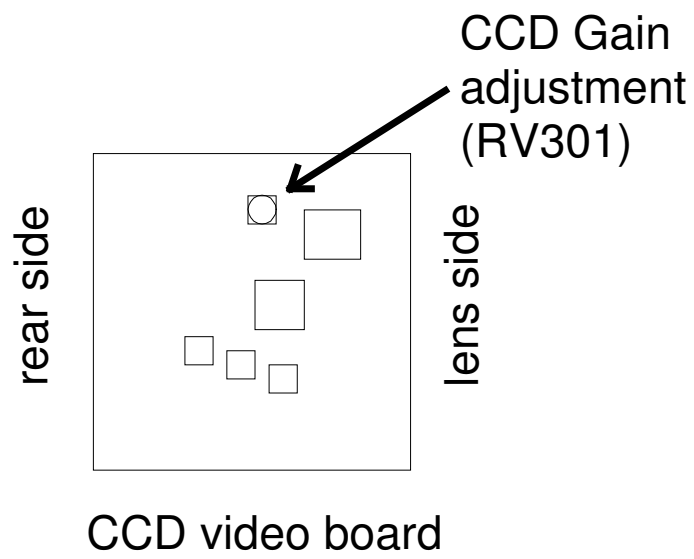(RV301)

rear side

lens side

CCD video board

Fig. 3: Gain adjustment potentiometer inside the CCD camera of the Readout Unit

FINE-ADJUSTMENT PROCEDURES:

This section applies only 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 standard scintillator.

- There are 4 different adjustment locations that determine the overall gain of the detection system:

  1. The gain setting of the Handmonitor.
  2. The aperture setting of the lens.
  3. The gain setting of the CCD camera (see fig. 3).
  4. The gain setting of the analog-to-digital converter on the Accumulating Framegrabber (see fig. 4).

- Keep in mind that you should optimize for:

  1. Best signal-to-noise ratio.
  2. Highest dynamic range.
  3. Lowest nonlinearities.
  4. Highest spatial resolution.

I. If you are primarily using the Accumulating Framegrabber without discrimination and without further determining the locations of the scintillation events, consider the following:
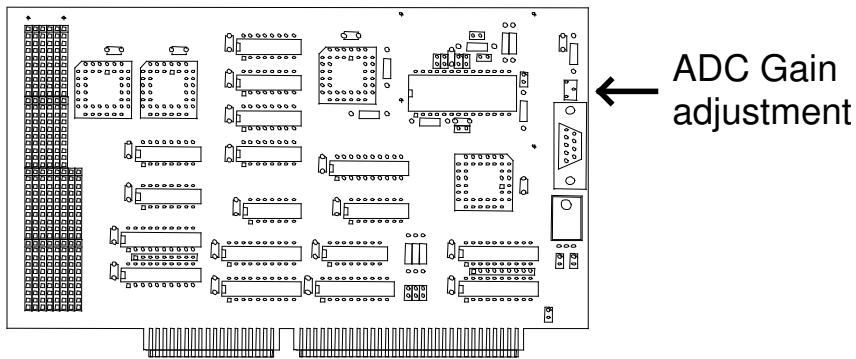

Fig. 4: Location of the ADC gain adjustment potentiometer

That means that you should use a high gain on the image intensifier, because the signal-to noise-ratio of the image intensifier is only weakly dependent on the gain. The aperture of the lens should be large (i.e. you should use a low f-number). To adjust the gain of the

CCD and ADC, you should first try to crank up the gain of the ADC, because this avoids opening the CCD camera. If this still isn´t enough, turn back the gain of the ADC to its former setting (which means that full range of the ADC corresponds to a 1 V p-p video signal) and then crank up the gain of the CCD until you get enough signal.

Keep in mind that high gains of the image intensifier always run the risk of saturating the image intensifier, leading to a drastic decrease of the linearity of the detector. This saruration further leads to a lower spatial resolution because of the broadening of the scintillation events on the intensifier screen when operating in the saturated region. Depending on your experimental requirements you may then have to use a lower gain of the intensifier and a higher gain of the CCD camera, at the expense of a somewhat higher noise level.

II. If you are using the system mainly with discriminator and further data processing for determination of the locations of the scintillation events, consider the following:

Using the technique of discrimination and further processing of the data needs scintillation signals that are well above noise in each frame. The standard neutron scintillator NE426 fulfills this requirement.

Use the standard gain setting of the CCD (as it was set when it was delivered), open the aperture of the lens (set it to f=1.3 or f=1.4, depending on lens type), turn the ADC adjustment potentiometer to the center position and try a gain setting of ´2´ on the Handmonitor.

Expose the detector to a low neutron flux (some thousand neutrons per second, evenly spread on the whole detector area), using the software that came with the Accumulating Framegrabber (´afg.exe´ : please refer to the manual for this software). Use a ´Frames´ parameter of zero. Now you should see several dozens of neutrons per image. Choose an appropriate color palette. Set the offset to the lowest possible value and the intensity scaling to 1. Now change the gain of the ADC until a few percent of the neutrons reach the saturation value.

HARDWARE DESCRIPTION

The block diagram of the Accumulating Framegrabber can be seen in fig. 5. There are essentially 3 blocks that are accessible by the user: the discriminator, the frame counter and the FiFo.
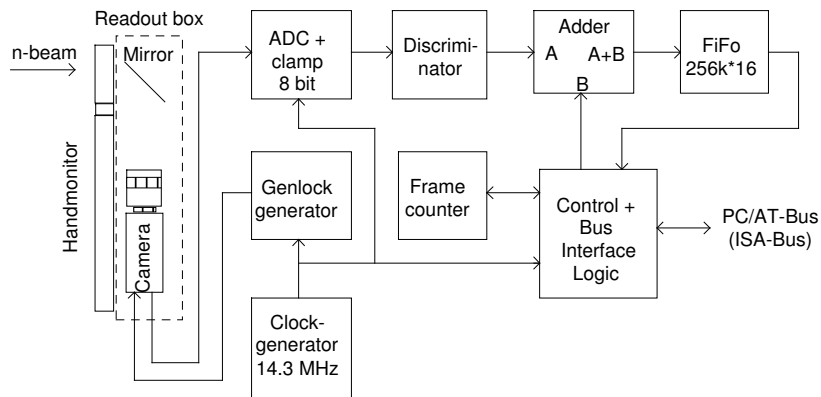
Fig. 5: Block diagram of the Accumulating Framegrabber

For a demonstration of the workings of the Accumulating Framegrabber, let us look at a simple demonstration program that reads in the frame buffer and shows it on the video screen:

```
/* AFGTEST.C:
   This program reads the ND&M Accumulating Framegrabber
   and displays the frame buffer on a 1024*768 pixel screen.
   Compile this program with GNU C 2.6.0 with the
   command: "gcc afgtest.c -o afgtest -O3 -lgrx -lpc" and run it
   with: "go32 afgtest"
*/

#include <grx.h>
#include <time.h>

void getframe(void);
void erasefifo(void);

/* Frames per integration period = 2^(FRAMEXP+1) */

#define FRAMEXP 0

#define FGRW 0x240
#define FGINT 0x242
#define FGRES 0x244
#define FGTHR 0x246

#define VBASE 0xd0000000L

int mx, my;

main()
{
  int i;

  GrSetMode(GR_width_height_color_graphics,
            1024,768,256);                    /* Set graphics mode */

  for(i=0;i<255;i++)
    GrSetColor(i,i,i,i);                      /* Set palette */

  while(!kbhit()) {                           /* Read in AFG until key pressed */

    inportw(FGRW);
    inportw(FGRW);
    outportw(FGRW,0);
    outportw(FGRW,0);                         /* Make sure that the FiFo is */
                                              /* resetable */
```

```
    outportw(FGRES,0);                              /* Reset the FiFo */

    erasefifo();                                    /* Erase the FiFo */

    getframe();                                     /* Read in FiFo and display it */

  }

  GrSetMode(GR_default_text);                       /* Restore old graphics mode */

}


void getframe()
{
  unsigned short i, j;
  static unsigned short iline[512];
  char *p;

  p=(char *)VBASE;                                  /* Set base address of SVGA card */

  outportw(FGTHR,0);                                     /* Set discriminator level */

  outportw(FGINT, FRAMEXP);                         /* Set number of frames and */
                                                    /* start integration period */

  while(!(inportw(FGINT) & 1)) ;                    /* Wait until bit 0 of AFGINT */
                                                    /* goes to 1 ... */
  while(inportw(FGINT) & 1) ;                       /* ... and to zero again: */
                                                    /* Now the integration is over */
  for(j=0;j<160;j++)
    outportw(FGRW, 0);
    inportw(FGRW);
    inportw(FGRW);
    inportw(FGRES);                                 /* Make sure that the Fifo captures */
                                                    /* also the last data words */

  for(j=0;j<256;j++) {                              /* Read in the even lines */
    inportsw(FGRW, iline, 512);
    for(i=0;i<512;i++)
      *(p++)=(unsigned char)(iline[i] >> (FRAMEXP+1) );
      p+=1536;
  }

  p=(char *)VBASE + 1024;

  for(j=0;j<256;j++) {                              /* Read in the odd lines */
    inportsw(FGRW, iline, 512);
    for(i=0;i<512;i++)
      *(p++)=(unsigned char)(iline[i] >> (FRAMEXP+1) );
      p+=1536;
  }

}                                                   /* That´s it */

void erasefifo()
{
      int i;
      unsigned short buf[512];

      for(i=0;i<512;i++)                            /* Load a buffer for faster output */
          buf[i]=0;
      for(i=0;i<513;i++)
          outportsw(FGRW, buf, 512);                /* Write out buffer to Fifo */

}
```

From the program listing you can see that there are 4 addresses that are relevant for programming (a base address of 240 (hexadecimal) is assumed here):

FGRW (240):

An I/O read instruction on this address gets a new 16-bit data value from the FiFo. Use only 16-bit accesses to read from this port. The internal read address pointer inside the FiFo is automatically incremented, so you can make use of the very efficient string I/O instructions of the 80386 and higher (REP INSW). The contents of the FiFo remain stored, so you can read them as many times as you want.

An I/O write instruction stores data in the FiFo. The internal write address pointer inside the FiFo is automatically incremented, so you can make use of the efficient string I/O instructions of the 80386 and higher (REP OUTSW).

FGINT (242):

A write on this address loads the frame counter with the lower 3 bits of the data word and starts an integration period. The integration time can thus have 8 different values:

0	=	2 x 40 ms	=	80 ms
1	=	4 x 40 ms	=	160 ms
2	=	8 x 40 ms	=	320 ms
3	=	16 x 40 ms	=	640 ms
4	=	32 x 40 ms	=	1280 ms
5	=	64 x 40 ms	=	2560 ms
6	=	128 x 40 ms	=	5120 ms
7	=	256 x 40 ms	=	10240 ms

A read on this address retrieves the status of the Accumulating Framegrabber in bit 0 of the data word. Right after writing to FGINT, this bit 0 goes to zero. Shortly after this, the bit 0 goes to zero, thus indicating the begin of the integration time. At the end of the integration time, bit 0 goes to zero again.

FGRES (244):

A write to this address resets the write address pointer of the FiFo, a read on this address resets the read address pointer of the FiFo. Between two consecutive reset commands there should be a minimum of 2 read or write commands, respectively.

FGTHR (246):

A write to this address sets the discriminator threshold. The allowed values range from 0 to 255.

CONNECTOR PIN ASSIGNMENT

Connector Type: 9-pin SUB-D

PIN #	Function
1	GND Handmonitor
2	GND Camera
3	reserved
4	+12V Camera
5	+12V Handmonitor
6	Sync out
7	Video in
8,9	reserved

TECHNICAL SPECIFICATIONS

ADC resolution:	8 bits
# of digitized pixels:	512 x 512
Pixel clock:	14.318 MHz
Frame Buffer:	512 kByte
Discriminator:	8 bits, programmable
Signal system:	CCIR system
Horizontal scan frequency:	15625 Hz
Vertical scan frequency:	50 Hz
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.:   _____