MCD-2E

Dual Input Multiscaler / Multichannel Analyzer

User Manual

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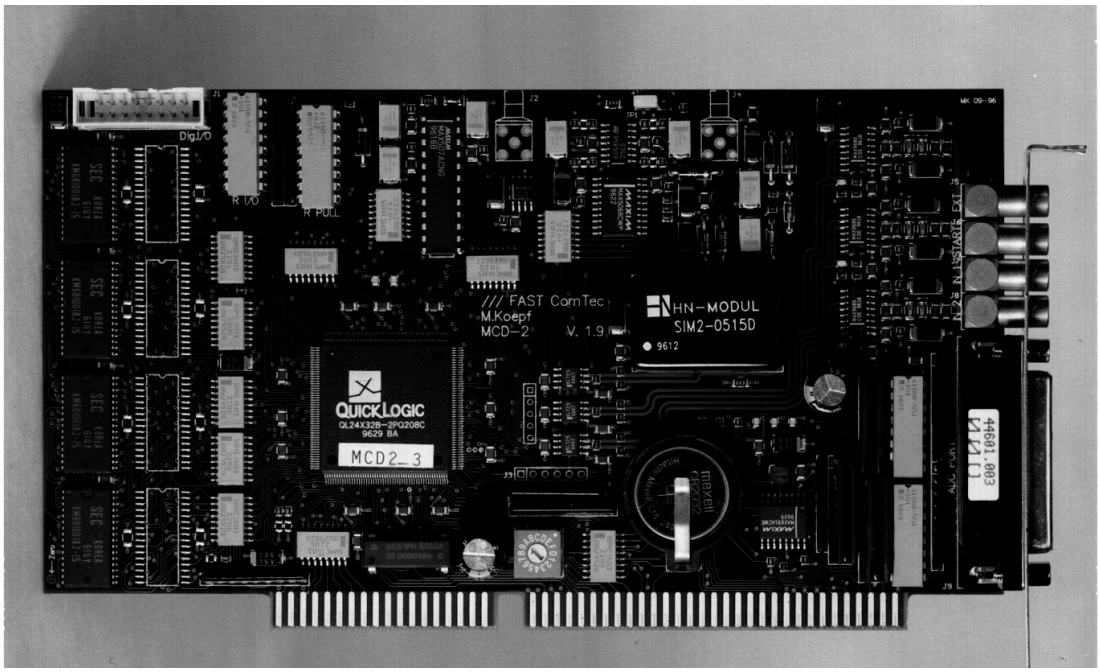

Version 2.7, July 9, 2003

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The information in this manual describes the hardware and the software as accurately as possible, but is subject to change without notice.

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1. Introduction

The MCD-2E is an advanced Multichannel Analyzer / Two-Input Multiscaler on a $^{2}/_{3}$ length PC-card. The design incorporates more features and functions than any other MCA in its price range.

An "add-one" cycle time of 2 µs can accommodate event count rates of up to 500,000 events/s in PHA[1] mode. The actual throughput of the system will almost only be determined by the pulse shape of the detector and the dead times of the amplifier and ADC. For many types of detectors this will enable loss free counting.

Multiscaling in the MCD-2E is far advanced and offers improved precision by signal averaging. The two counting inputs allow to acquire - for example - two Mössbauer spectra at a time from a single Mössbauer drive. This is a very economical solution requiring just one Mössbauer system. The short dwell times starting at 1 µs make the MCD-2E ideal for many types of spectrometers and LIDAR applications where high burst count rates of more than 150 MHz and continuous count rates of 60 MHz are also required.

The large 128k x 32 bit onboard battery backed data memory and the high integrated logic enable to accumulate data 100% in the background thus freeing the computer for other applications. Even a hardware reset of the computer does not affect data acquisition.

IMPORTANT NOTE:
The backup battery is continuously discharged at a slow rate while the power is off. Therefore the battery should be installed only when important experiments are to be started - where data loss due to power failure must be surely prevented.

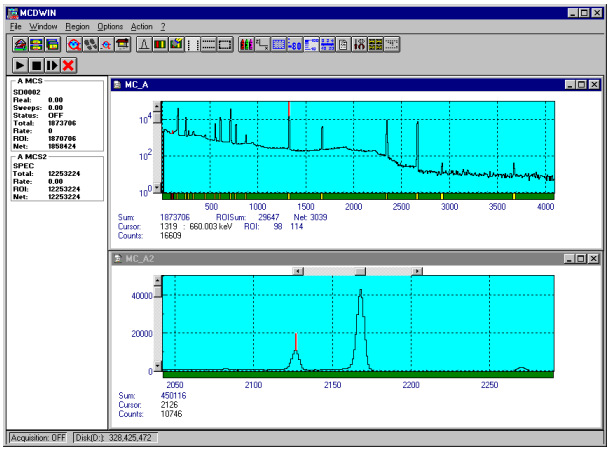
In addition to the high performance of the hardware the sophisticated WINDOWS based control and analysis software MCDWIN ensures quick learning and easy usage.

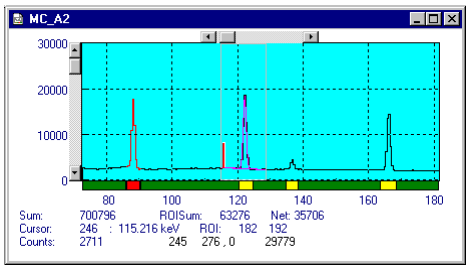
Some of MCDWIN's features are high resolution graphics displays with zoom, linear and logarithmic (auto)scaling, grids, ROIs[2], Gaussian fit, calibration using diverse formulas. and FWHM[3] calculations. Macro generation using the powerfull command language allows task oriented batch processing and selfrunning experiments. An IAEA compatible software interface allows to directly use such analysis packages as GANAAS, QXAS, POSFIT or others.

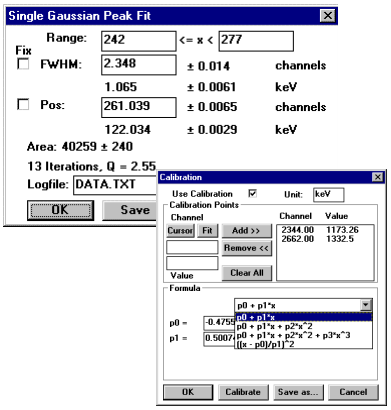
[1] PHA: Pulse Height Analysis

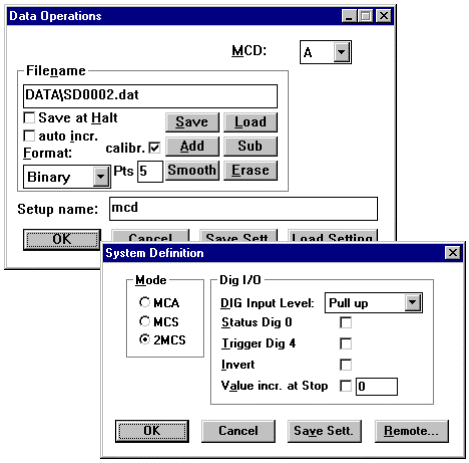
[2] ROI: Region Of Interest

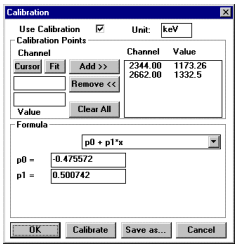
[3] FWHM: Full Width at Half Maximum


MCDWIN
File Window Region Options Action ?
MC_A
MC_A2
Acquisition: OFF
Disk(D:): 328,425,472


MC_A2
30000
20000
10000
0
80 100 120 140 160 180
Sum: 700796 ROISum: 63276 Net: 35706
Cursor: 246 : 115.216 keV ROI: 182 192
Counts: 2711 245 276 , 0 29779


Single Gaussian Peak Fit
Range: 242 <= x < 277
Fix
FWHM: 2.348 ± 0.014 channels
1.065 ± 0.0061 keV
Pos: 261.039 ± 0.0065 channels
122.034 ± 0.0029 keV
Area: 40259 ± 240
13 Iterations, Q = 2.55
Logfile: DATA.TXT
OK
Save
Calibration
Use Calibration
Unit: keV
Calibration Points
Channel Value
Cursor Fit Add >> 2344.00 1173.26
Remove << 2662.00 1332.5
Clear All
Formula
p0 + p1*x
p0 = -0.4755
p1 = 0.5007
OK Calibrate Save as... Cancel


Data Operations
MCD: A
Filename
DATA\SD0002.dat
Save at Halt
auto incr.
Format:
calibr.
Save Load
Add Sub
Binary
Pts 5
Smooth Erase
Setup name: mcd
OK
Cancel Save Sett. Load Setting
System Definition
Mode
MCA
MCS
2MCS
Dig I/O
DIG Input Level: Pull up
Status Dig 0
Trigger Dig 4
Invert
Value incr. at Stop 0
OK Cancel Save Sett. Remote...


Calibration
Use Calibration
Unit: keV
Calibration Points
Channel Value
Cursor Fit Add >> 2344.00 1173.26
Remove << 2662.00 1332.5
Clear All
Formula
p0 + p1*x
p0 = -0.475572
p1 = 0.500742
OK Calibrate Save as... Cancel

2. Installation Procedure

2.1. Hard- and Software Requirements

The MCD-2E requires an IBM AT or compatible computer with a 386, 486, Pentium or higher processor and an available 16 bit slot. Several MCD-2E cards might be installed in your computer if you have enough available slots.

A PC with Microsoft Windows 3.1, Windows 95 or Windows NT installed is required for use of the supplied control and analysis software MCDWIN.

2.2. Hardware Installation

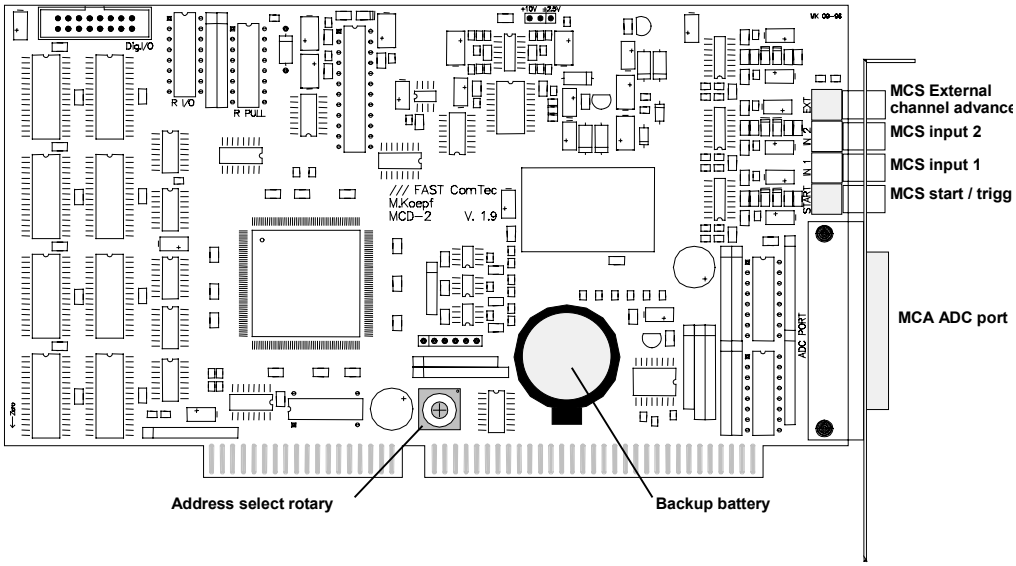


Figure 2.1: MCD-2E PC card

First you should locate an unused address in the I/O[4] address space of your computer. The MCD-2E has a small rotary switch (ref. Figure 2.1) that determines the base I/O address of the card. The MCD-2E occupies 12 I/O addresses starting at this base address. The supported base addresses and corresponding switch settings are:

Switch	Base Address [hex]	Switch	Base Address [hex]	Switch	Base Address [hex]	Switch	Base Address [hex]
0	200	4	240	8	300	C	340
1	210	5	250	9	310	D	350
2	220	6	260	A	320	E	360
3	230	7	270	B	330	F	370

Figure 2.2: Table of the base I/O addresses

The factory setting is 320_{hex} - an address commonly not used by other devices.

4 I/O: Input / Output

2.3. Software Installation

To install the MCD-2E software on your hard disk insert the MCD-2E disk into drive A. Log to drive A: by clicking from the explorer and if you are using any 32 bit Windows (9x, NT, 2000, ME, XP) start the installation program by double clicking the SETUP.EXE. If you are using Windows 3.x change to the WIN3X directory and double click the INSTALL.BAT there.

A directory called C:\MCD2E is created on the hard disk and all MCD-2E and MCDWIN files are transferred to this directory. Drive C: is taken as default drive and the MCD-2E working directory as default directory. It is not mandatory that the 7882 operating software is located in C:\ MCD-2E. You may specify another directory to the setup program or you may copy the files to any other directory after the installation is completed.

For Windows NT/2000/XP it is necessary that you install the device driver FASTMCD.SYS from the WINNT\DRIVER directory. If not already done by the SETUP program, run INSTALL.BAT from this directory and restart the system.

The installation program installs an icon on the desktop for MCD2.EXE. MCD2.EXE is the MCD-2E Hardware Server program. This program will automatically call the MCDWIN.EXE program when it is executed. The MCD2 Server program controls the MCD-2E board but provides no graphics display capability by itself. By using the MCDWIN program, the user has complete control of the MCD-2E along with the MCDWIN display capabilities.

To start the software from the WINDOWS 3.x program manager install icons for MCDWIN.EXE (graphical display and analysis) and MCD2.EXE (server to control the hardware) in the WINDOWS program manager using the File - New... menu item (ref. Figure 2.3 and your WINDOWS manual).

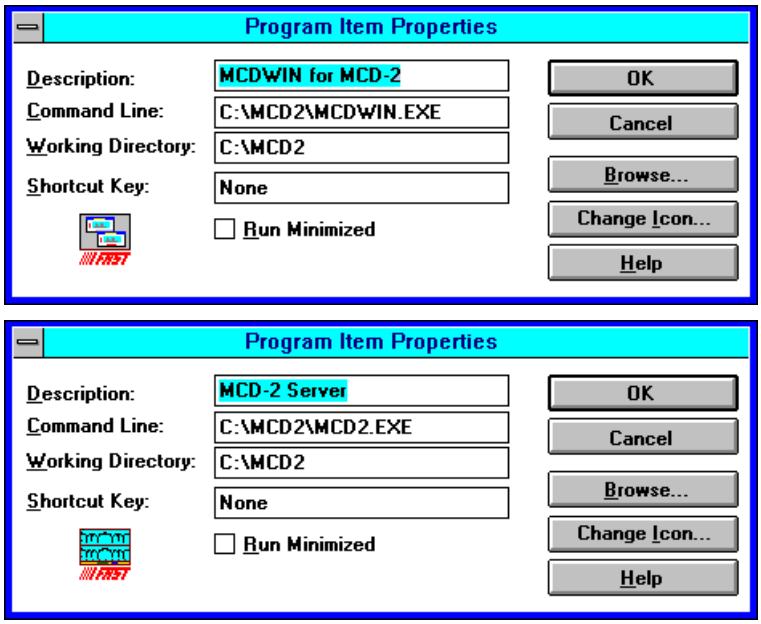


Figure 2.3: WINDOWS 3.x program item properties

Under Windows 95 or NT you may use the Explorer to find the icons of MCDWIN.EXE and MCD2.EXE (look in C:\MCD2E_95 or C:\MCD2E_NT respectively) and drag them onto the Desktop keeping the right mouse button pressed.

2.4. Setup a basic MCS measurement

This chapter shows how to setup a basic measurement using a two output TTL frequency generator that might be available in most labs. One output is used to generate the Start/Trigger signal and the other one as count signal connected to Count Input 1.

The MCD-2E is configured as single MCS[5], 1 µs dwell time, range 1024, complete sweeps and internal clock. In our example the available TTL signal generator had a 125 Hz (connected to Start/Trigger) and a 12.5 kHz / 80 µs (connected to MCS Input 1) output. With the 50 Ω internal termination of the MCD-2E inputs the resulting pulse height was only 1.5 V thus an input threshold level of 700 mV was chosen (ref. Figure 2.4).

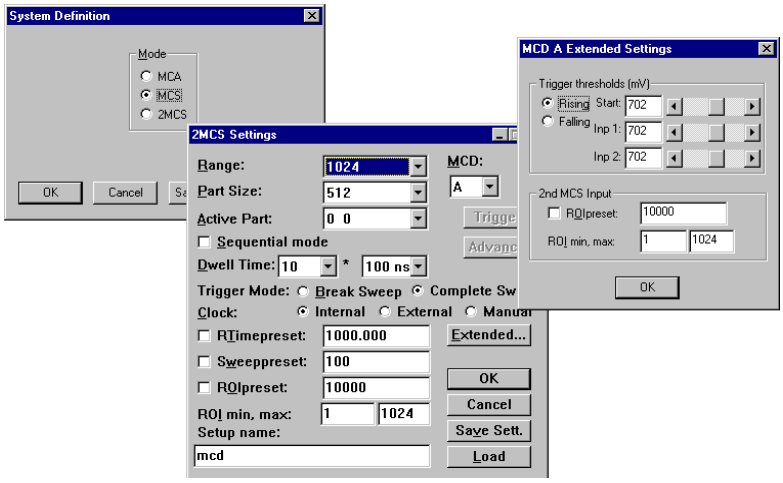


Figure 2.4: Setup for a basic measurement

The obtained spectrum is shown in Figure 2.5. With the 1 µs dwell time and the 12.5 kHz / 80 µs pulse repetition there are counts in every 80th channel.

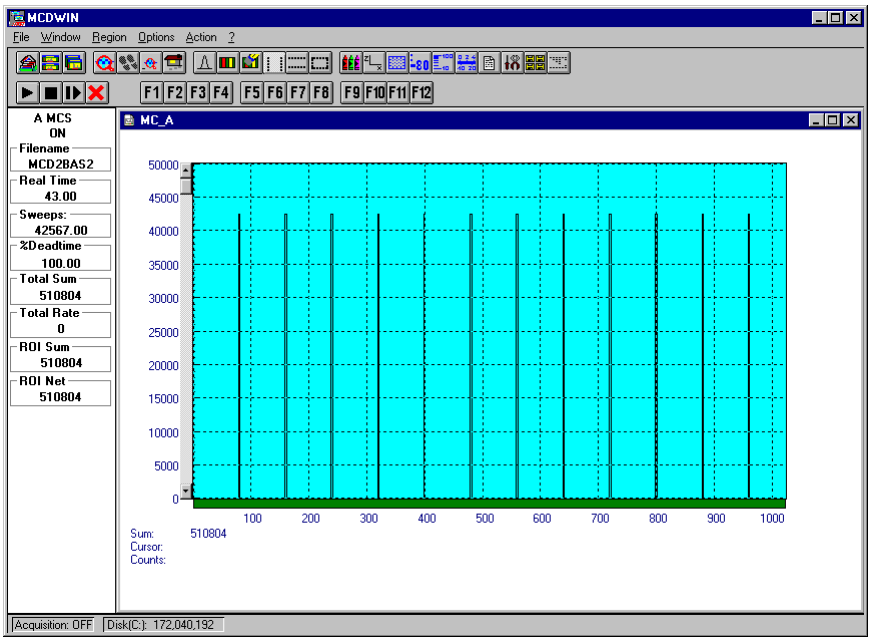


Figure 2.5: Basic spectrum from a 12.5kHz TTL generator

[5] MCS: Multi Channel Scaling

If there is only one single signal available connect only the Count Input 1 and use a manual trigger. Since the triggers will be asynchronously to the input pulses the spectrum will look like noise after some sweeps (ref. Figure 2.6). To ease the use of the manual trigger configure the function key F1 as manual Trigger button (refer the MCDWIN menu Options - Function Keys and the online help on "Options - Tool Bar..." and "Use the control language"). The control language command is "SWEEP".

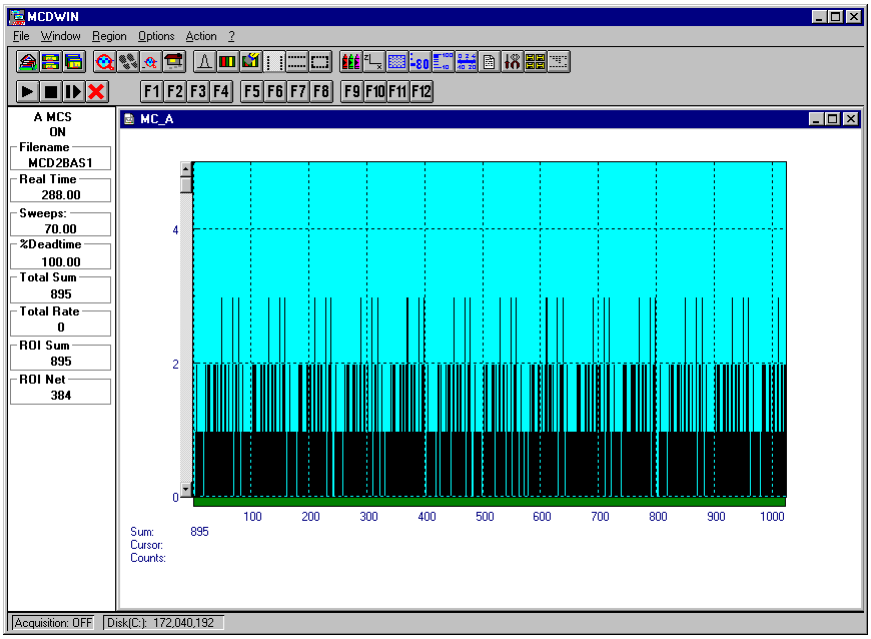


Figure 2.6: Manual triggered spectrum

3. Hardware Description

3.1. Overview

The MCD-2E is an advanced Multichannel Analyzer / Two-Input Multiscaler on a $^{2}/_{3}$ length PC-card. All settings of the hardware are software configurable even the threshold levels of the Trigger and Count inputs.

For experiments where data loss due to power failure must be surely prevented a backup battery for the onboard data memory is provided. Due to the 100% background operation capability even a hardware reset of the computer does not affect data acquisition.

3.2. Multichannel Analyzer Section

3.2.1. ADC Interface

The MCA / ADC input port supports up to 16 bit (64k) ADCs, TOFs etc. Since all control signal polarities are software selectable any known ADC, TOF etc. might be connected.

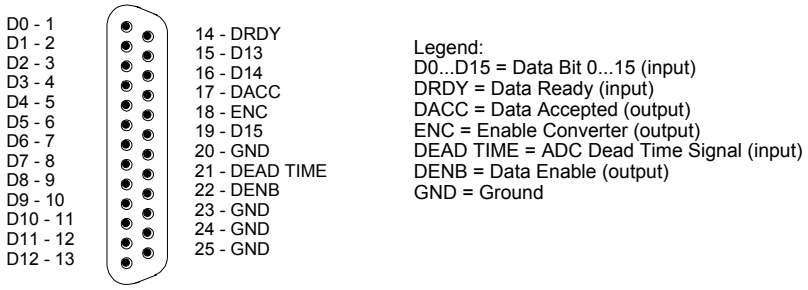


Figure 3.1: MCA / ADC port connector

3.2.2. Live and True Timer

Two timers are implemented featuring live and true time measurement with a resolution of 10 ms.

Each of the timers is presetable in a range of 10 ms to more than 11930 hours (the software supports steps of 1 s).

3.3. Multiscaler Section

3.3.1. Trigger/Start, Count 1 & 2 Inputs

All these inputs are terminated with 50 Ω to ground. The input range is ±5 V for all inputs. The threshold levels of the input discriminators are individually programmable via three onboard 8 bit DACs also in the range of ±5 V. The slope of the trigger input is programmable. The count inputs are falling edge sensitive.

3.3.2. Dwell Timer

The dwell time counter is software programmable in steps of

$$N \times 10^{M} \times 1\ \mu s$$

where N = 1...16 and M = 0...7. Thus dwell times from 1 µs up to 160 s are supported.

Also an external channel advance input is provided accepting TTL signals.

For test purposes a software / manual channel advance is also applicable.

3.3.3. Sweep Counter

The presetable sweep counter is incremented on each start of a new sweep.

NOTE:
A sweep counter preset is not applicable in instant retrigger mode.

3.4. Backup Battery

The backup battery insures that during a power failure the accumulated data is not lost. However the battery is slowly discharged during a power off state of the computer. Thus one should only install the battery when important experiments are to be done.

IMPORTANT NOTE:
The backup battery is continuously discharged at a slow rate while the power is off. Therefore the battery should be installed only when important experiments are to be started - where data loss due to power failure must be surely prevented.

4. Windows Server Program

The window of the MCD-2E server program MCD2.EXE is shown here. It enables the full control of the MCD-2E to perform measurements and save data. This program has no own graphic capabilities, but it provides - via a DLL („dynamic link library“) - access to all functions, parameters and data. The server can be completely controlled from the MCDWIN software that provides all necessary graphic displays.

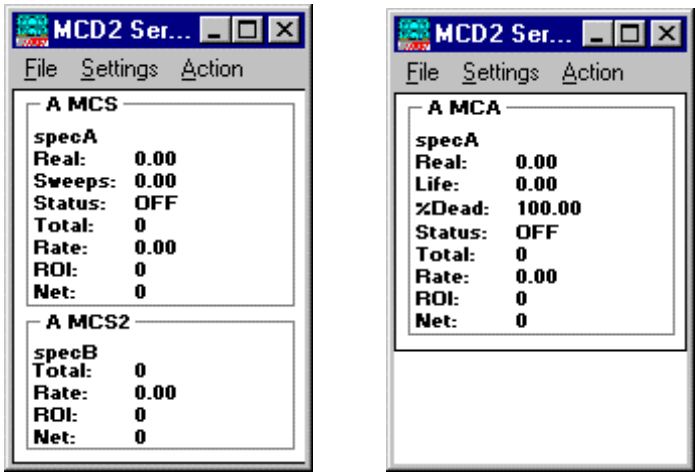


Figure 4.1: Status display in dual MCS mode (left) or MCA mode (right)

At program start the configuration files MCD2.INI (contains - for example - the I/O port base address in a format base=320 and the ADC port handshake signal polarities; see Figure 4.2) and MCDA.INF are loaded. Instead of this MCDA.INF file any other setup file can be used if its name - excluding the appendix ‘A.INF’ - is used as command line parameter (e.g. MCD2 TEST to load TESTA.INF) . The server program is normally shown as an icon. After a double click it is opened to show a status window.

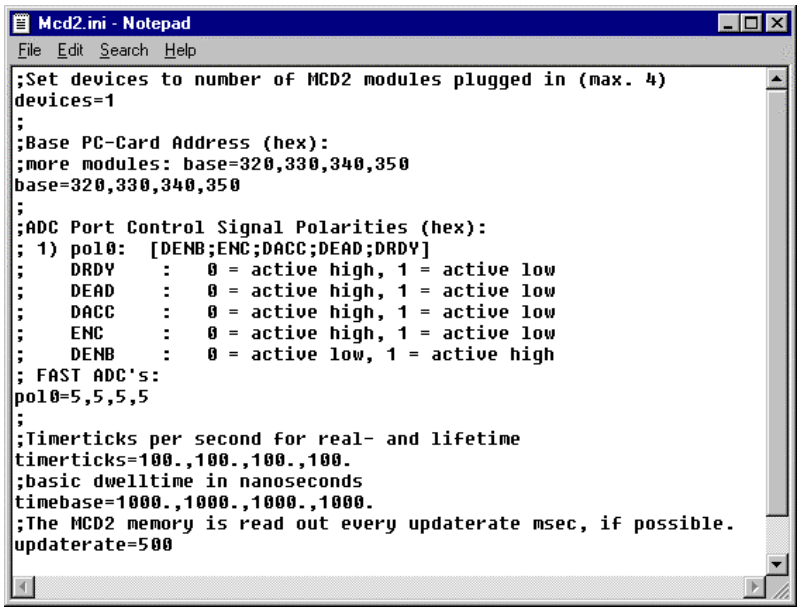


Figure 4.2: Sample MCD2.INI file

In the following the several dialogs are described in detail:

Clicking in the File menu on the Data... item opens the Data Operations dialog box.

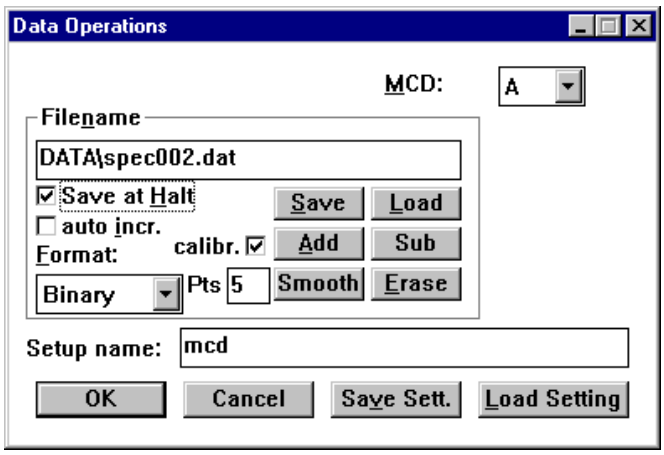


Figure 4.3: Data Operations dialog box

This dialog allows to edit the data settings. Mark the checkbox „**Save at Halt**“ to store a spectrum- and a configuration file at the end of a measurement. The filename can be entered. If the checkbox **auto incr.** is checked, a 3-digit number is appended to the filename that is automatically incremented with each saving. The format of the data file can be ASCII (extension .ASC), binary (.DAT), GANAAS (.SPE) or Dual Binary (.DA2), i.e. both spectra in dual MCS mode in a single data file. The buttons **Save**, **Load**, and **Erase** perform the respective operation. With **Add** and **Sub** a spectrum can be added or subtracted from the present data. The Checkbox **calibr.** is checked if a calibration is used and the data is then adjusted according to the calibration. The **Smooth** button performs an n-point smoothing of the data. The number of points to average can be set with the **Pts** edit field between 3 and 21.

Clicking in the Settings menu on MCD... item opens the MCD-2E Settings dialog box. Here depending on the mode of operation (MCS or MCA/PHA) parameters like presets, range parameters, dwell time, etc. for the MCD-2E card can be set.

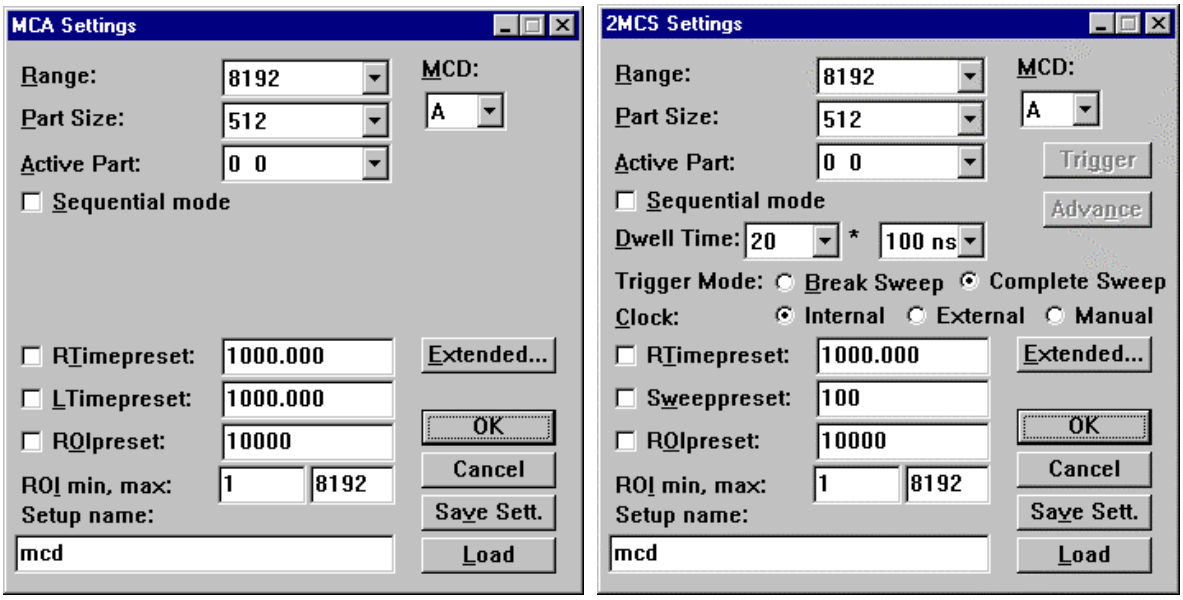


Figure 4.4: MCD-2E Settings dialog box

In the edit field „**Range**“ the size of the spectrum can be chosen between 256 and 128k. If the checkbox „**ROIpreset**“ is marked, the measurement will be stopped after the events specified in the corresponding edit field have been reached. The events are counted only if they are within the „**ROI**“ limits, i.e. >= the lower limit and < the upper limit. Another possibility is to acquire data in MCA mode for a given real time via the „**RTimepreset**“ or a given live time via the „**LTimepreset**“., or in MCS mode for a specified amount of sweeps via a „**sweep preset**“. A

measurement will be stopped if the corresponding checkbox is marked. The MCD-2E has a rather large memory and it is possible to acquire several spectra into separate parts of the memory. The start point of the spectrum in the memory can be defined using the „**Active Part**“ drop down listbox, the size of the corresponding memory part with the „**Part Size**“. If „**Sequential mode**“ is checked, the label of the „Active Part“ listbox changes to „**Last active part**“. It is then possible to perform a sequential measurement. In this mode it is permanently checked whether the card has stopped due to a preset reached, the active part is incremented and the measurement immediately restarted in the next active memory part. In this mode the range should be equal to the part size and one of the two preset checkboxes for real time and live time or sweeps should be checked.

Extended opens the extended settings dialog box that allows to configure the MCS input thresholds, and the second MCS input ROI.

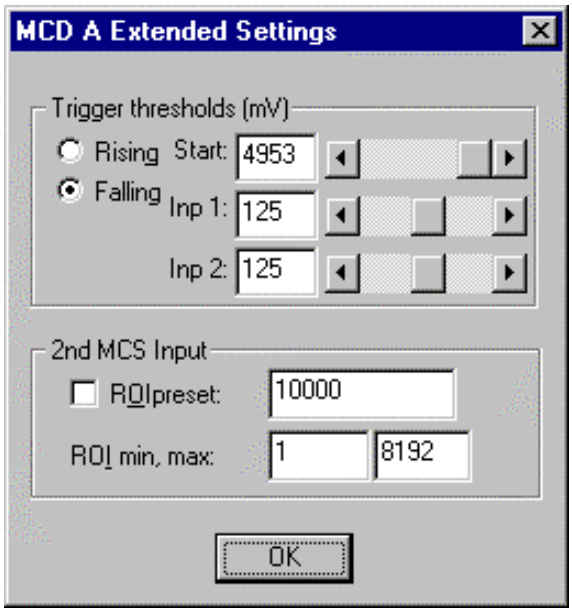


Figure 4.5: Extended Settings dialog box

The „System...“ item in the settings menu opens the System Definition dialog box. Here the configuration of the MCD-2E as a MCA for PHA (Pulse Height Analysis of pulses analyzed via an ADC connected at the 25-pin Sub-D connector), MCS or dual input MCS is made.

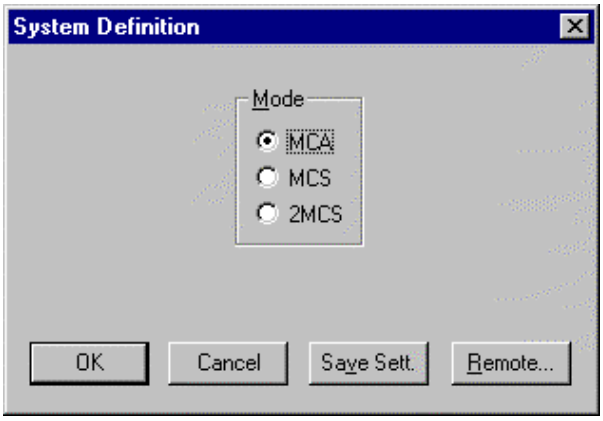


Figure 4.6: System Definition dialog box for a single MCD-2E card

If more than one MCD-2E card is used, the system definition dialog box comes up as shown in Figure 4.7. Here the several units can be combined to form up to 4 separate systems that can be started, stopped and erased by one command.

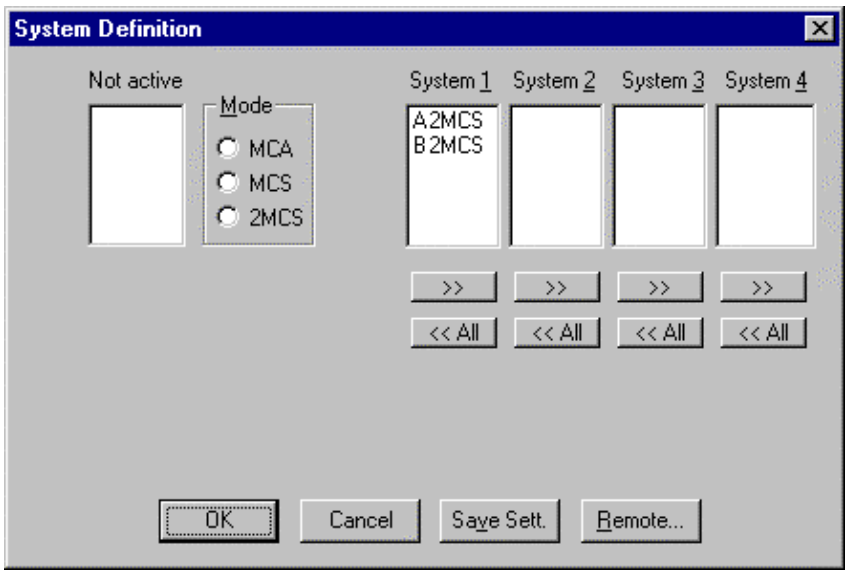


Figure 4.7: System Definition dialog box, two MCD-2E cards

In the shown setting a single system is formed. The two MCD-2Es A and B are combined, both operate in pulse height analysis mode. System 1 can be started, stopped, erased, and continued with the respective commands in the Action 1 menu. It is also possible for example to form two independent systems 1 and 2: Click on the button labeled **<<All** below the list box „System1“ to remove all units from system 1. They are then shown in the „Not active“ list box. Then select unit A and click on the button labeled **>>** below the „System 1“ list box to include it into system 1 and perform the respective action for unit B and System 2. To switch between MCA and MCS mode, the unit must be selected in the „not active“ box and then click on the **MCA** or **MCS** or **MCS2** radio button in the box labeled **Mode**.

Click **OK to** accept all settings. **Cancel** cancels all changes. Clicking „**Save Settings**“ stores all settings in the file **MCDA.INF** in a form:

```
wndwidth=154
wndheight=251
sysdef=0
roi2preset=10000
roi2min=1
roi2max=8192
mcsmode=0
rdacuse=0       ; fix, 12bit, 1 stepsize
rdac=0
qdac=0
thrstart=125
pol1=0
thr1=125
thr2=125
syncsrc=0
diguse=0
digval=0
range=8192
rtpreset=1000
prena=0         ; Preset enable
ltpreset=1000
swpreset=100
roipreset=10000
roimin=1
roimax=8192
mempart=0       ; active:0 size:256
dwelltime=0     ; 2 * 10^2 ns
```

autoinc=0
datname=specA.asc
savedata=0
fmt=asc
smoothpts=5

This file is automatically loaded at the start of the program and the parameters are set. Together with each data file a header file with extension .MCD is saved. This header also contains all settings and in addition some information like the date and time of the measurement, comments and calibration parameters entered in the MCDWIN program.

The „**Remote mode...**“ item in the settings menu or the „**Remote“** button in the System Definition dialog box opens the Remote Control dialog box. Here all settings can be made for the control of the MCD2 server program via a serial port.

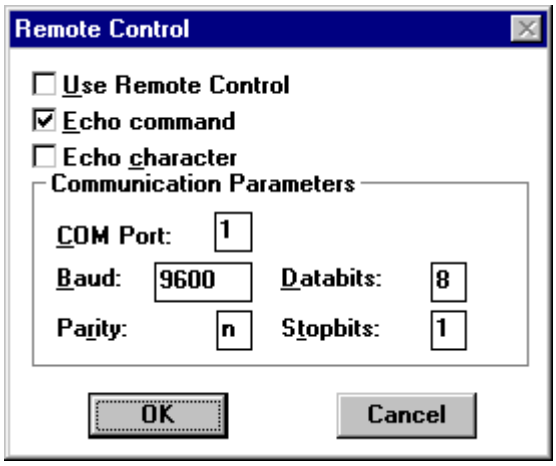


Figure 4.8: Remote Control dialog box

If the Checkbox „Use Remote Control“ is marked and the COMCTL.DLL is available, the specified COM port will be used for accepting commands. If „Echo command“ is marked, the input line will be echoed after the newline character was sent. „Echo character“, on the other hand, immediately echoes each character. The possible commands and their syntax are listed in the following section.

4.1. Control Language

A sequence of commands that are stored in a file with extension .CTL can be executed by the MCD-2E server program or MCDWIN with the „Load “ command. Also the configuration files MCDx.INF or the header files with extension .MCD contain such commands to set the parameters. Each command starts at the beginning of a new line with a typical keyword, the case is ignored. Any other characters in a line may contain a value or a comment.

Following methods are available to execute commands:

- Load the command file using the Load command in the file menu.
- Enable remote mode in the server and send commands via the serial connection. The COMCTL.DLL is necessary which is part of the optional available MCDLAN software.
- Open a DDE connection and send the commands via DDE as described in section 4.2. The application name for opening the DDE connection with the standard MCD-2E server program MCD2.EXE is MCD2, the topic is MCD2-. Implemented are the DDE Execute to perform any command, and the DDE Request with items RANGE and DATA.
- Send the commands over a TCP/IP net using a remote shell and the optional available MCDLAN software. It is necessary to have a TCP/IP Winsock installed like the Trumpet winsockets and that the remote shell daemon program MCWNET is running. See the readme file on the installation disk.

- Send the commands via the DLL interface from LabVIEW, a Visual Basic program or any other application (software including the complete source code of the DLL and examples optional available).
- From your own Windows application, register a Windows message and then send the command as can be seen in the DLL source code.

The file MCDA.INF contains a complete list of commands for setting parameters; an example is:

wndwidth=284	; Sets width of server window
wndheight=308	; Sets height of server window
sysdef=0 (hex)	; Sets system definition word (hexadecimal). Bits 0 and 1 are ; reserved for unit A, bits 2 and 3 for unit B and so on until bits 15 and ; 16 for unit H. the bit pattern 00 means the respective unit belongs to ; System 1, 01 System 2, 10 Sytem 3 and 11 System 4.
roi2preset=10000	; ROIpreset value in 2nd MCS channel
roi2min=1	; ROI in 2nd MCS channel lower limit (inclusive)
roi2max=4096	; ROI in 2nd MCS channel upper limit (exclusive)
mcsmode=0	; bit 0: 1=1 channel MCS mode ; bit 1: 1=2 channel MCS mode ; bit 2: 1=Retrigger mode, i.e. the next signal ; breaks the current sweep and starts a new sweep.
rdacuse=1 (hex)	; bit 0: Ramp DAC enable ; bit 1: Ramp DAC increment enable (0=fixed mode) ; bit 2..3: Ramp DAC resolution ; 00 : 12 bit, 01: 11 bit, 10: 10 bit, 11: 9 bit
rdac=0	; Ramp DAC output value
qdac=0	; bit 0..7: Quad DAC 3 output value (8 bit) ; bit 8: qdac enable
thrstart=-580	; trigger level for start input in units of 1 mV, i.e. -580 means -580 mV
pol1=0	; 0=trigger start input on rising edge, 1=falling edge
thr1=-580	; trigger level for input 1 in units of mV (always falling edge)
thr2=-580	; trigger level for input 2 in units of mV (always falling edge)
syncsrc=1	; bit 0..1: sync output source ; 00: 1 kHz, 01: Sweep Start, ; 10: End of Sweep, 11: End of time bin
diguse=0 (hex)	; Usage of DIG I/O (only 1. device stored): ; bit 0: DIG I/O pins 0-3 output status of MCD's ; bit 1: Invert Polarity ; bit 2..5: Input pins 4..7 Trigger System 1..4 ; bit 6: Output digval and increment digval after stop ; bit 7: Input Mode: =0 Resistive, =1 Tristate ; bit 8: Input Mode: =0 Pull up, =1 Pull down
digval=0	; DIG I/O Output value (only 1. device stored)
range=4096	; Sets histogram length
rtpreset=1000	; Realtimepreset value (seconds)
prena=0 (hex)	; bit 0: realtime preset enabled ; bit 1: lifetime preset enabled ; bit 2: sweep preset enabled ; bit 3: ROI preset enabled ; bit 4: 2nd MCS input: ROI preset enabled

ltpreset=1000	; Lifetime preset value (seconds)
ltprena=0	; Lifetime preset enable
swpreset=1000	; Sweep preset value
roipreset=10000	; ROI preset value
roimin=1	; ROI lower limit (inclusive)
roimax=4096	; ROI upper limit (exclusive)
mempart=0 (hex)	; bit 0..7: number of active part ; bit 8..10: partsize 0:512, 1:1024,...,7:64k
dwelltime=1 (hex)	; Dwell time = (N+1) x 10^M x time base (125 ns) ; bit 0..3: N ; bit 4..7: M ; M=8: Extern channel advance
autoinc=0	; Enable Auto increment of filename
datname=SPECA.dat	; Filename
datname2=SPECB.dat	; Filename of 2nd MCS channel
savedata=0	; Save at Halt
fmt=dat	; Format (ASCII: asc, Binary: dat, GANAAS: spe, Dual Binary: da2)
smoothpts=5	; Number of points to average for a smooth operation

A data header file with extension .MCD contains a subset of above parameters and some additional information typical for the special measurement. An example is the file CALIB2.MCD:

```
REPORT-FILE from 11/03/86 08:00:00 written 09/12/96 19:39:00
                        ; the first time is when the measurement was started,
                        ; the 2nd when the data file was written
realtime=4788           ; real time in seconds
lifetime=4788           ; life time in seconds
TOTALSUM=0              ; total sum of counts
ROISUM=0                ; sum of counts in ROI
NETTOSUM=0              ; sum in ROI with background subtracted
cmline0=11/03/86 08:00:00      ; comment lines: the first line always contains the start time
cmline1=*****CALIBRATION SPECTRA
cmline2=Cd109, Co57, Ce139, Sn113, Hg203, Sr85, Cs137, Co60
range=4096              ; subset of parameters as in a MCDx.INF file...
rtpreset=1000
prena=0                 ; Preset enable
ltpreset=1000
swpreset=100
roipreset=10000
roimin=0
roimax=4096
mempart=0               ; active:0 size:512
dwelltime=0             ; 125 * 10^0 ns
autoinc=0
datname=CALIB2.spe
savedata=0
fmt=spe
smoothpts=5             ; last parameter like in a .INF file
caloff=3.671330         ; calibration parameters: caloff = 0. coefficient
calfact=0.453466        ; 1. coefficient
calfact2=-1.37019e-007 ; 2. coefficient
calfact3=5.369e-011     ; 3. coefficient
calunit=keV             ; calibration unit
caluse=3                ; bit 0: Use calibration
                        ; bit 1..2 calibration formula:
                        ; 00=linear (caluse=1), 01=quadratic (caluse=3), 10=cubic (caluse=5)
calch00=186.07          ; calibration points: 0. channel
calvl00=88.034000       ;        0. value
calch01=261.05          ;        1. channel
calvl01=122.061000      ;        1. value...
calch02=357.86
calvl02=165.854000
calch03=607.56
```

```
calvl03=279.197000
calch04=855.83
calvl04=391.688000
calch05=1451.72
calvl05=661.660000
calch06=2932.93
calvl06=1332.500000
calch07=2581.25
calvl07=1173.240000
roi=182 192          ; ROIs set in MCDWIN...
roi=257 268
roi=289 298
roi=352 364
roi=551 559
roi=601 615
roi=849 864
roi=1121 1134
roi=1443 1463
roi=1777 1801
roi=1961 1988
roi=2909 2925
roi=2924 2943
roi=4036 4055
roi=2573 2590
```

The following commands perform actions and therefore usually are not included in a MCDx.INF file:

```
start        ; Clears the data and starts a new acquisition for system 1. Further
             ; execution of the .CTL file is suspended until any acquisition stops
             ; due to a preset.
start2       ; Clears and starts system 2. Further execution suspended (see start).
start3       ; Clears and starts system 3. Further execution suspended (see start).
start4       ; Clears and starts system 4. Further execution suspended (see start).
halt         ; Stops acquisition of system 1 if one is running.
halt2        ; Stops acquisition of system 2 if one is running.
halt3        ; Stops acquisition of system 3 if one is running.
halt4        ; Stops acquisition of system 4 if one is running.
cont         ; Continues acquisition of system 1. If a time preset is already
             ; reached, the time preset is prolongated by the value which was valid
             ; when the „start“ command was executed. Further execution of the ;.CTL
             file is suspended (see start).
cont2        ; Continues acquisition of system 2 (see cont).
cont3        ; Continues acquisition of system 3 (see cont).
```

cont4	; Continues acquisition of system 4 (see cont).
savecnf	; Writes the settings into MCDA.INF (,MCDB.INF,...)
MC_A	; Sets actual multichannel analyzer to MC_A for the rest of the ; control file.
MC_B	; Sets actual multichannel analyzer to MC_B for the rest of the ; control file.
MC_C	; Sets actual multichannel analyzer to MC_C for the rest of the ; control file.
MC_D	; Sets actual multichannel analyzer to MC_D for the rest of the ; control file.
savedat	; Saves data of actual multichannel analyzer. An existing file is ; overwritten.
load	; Loads data of actual multichannel analyzer; the filename must be ; specified before with a command datname=...
add	; Adds data to actual multichannel analyzer; the filename must be ; specified before with a command datname=...
sub	; Subtracts data from actual multichannel analyzer; the filename must ; be specified before with a command datname=...
smooth	; Smoothes the data in actual multichannel analyzer
eras	; Clears the data of system 1.
eras2	; Clears the data of system 2.
eras3	; Clears the data of system 3.
eras4	; Clears the data of system 4.
exit	; Exits the MCD2 (and MCDWIN) programs
alert Message	; Displays a Messagebox containing Message and an OK button that ; must be pressed before execution can continue.
waitinfo 5000 Message	; Displays a Messagebox containing Message, an OK and an END ; button. After the specified time (5000 msec) the Messagebox ; vanishes and execution continues. OK continues immediately, END ; escapes execution.
beep *	; Makes a beep. The character '*' may be replaced with '?', '!' or left ; empty. The corresponding sound is defined in the WIN.INI file in the ; [sounds] section.
delay 4000	; Waits specified time (4000 msec = 4 sec).
pulse 100	; Outputs a pulse of 100 ms duration at dig 3 (pin 11).
waitpin 4000	; Waits 4000 ms for going the level low at dig 7 (pin13). ; After a timeout a Message box warns and waits for pressing OK. ; Can be used for connecting a sample changer.
sweep	; Starts a Sweep (Software-Trigger).
run controlfile	; Runs a sequence of commands stored in control file. This command ; cannot be nested, i.e. it is not possible to execute a run command ; from the control file called.
onstart command	; The command is executed always after a start action when the ; acquisition is already running. The command can be any valid ; command, also 'run controlfile' is possible.
onstart off	; Switches off the 'onstart' feature. Also a manual Stop command ; switches it off.

onstop command	; The command is executed always after a stop caused by a preset ; reached or trigger. This can be used to program measure cycles. For ; example the command 'onstop start' makes a loop of this kind.
onstop off	; Switches off the 'onstop' feature. Also a manual Stop command ; switches it off.
lastrun=5	; Defines the file count for the last run in a measure cycle. After a file ; with this count or greater was saved with autoinc on, instead of the ; 'onstop command' the 'onlast command' is executed.
numruns=5	; Defines the file count for the last run in a measure cycle. The last ; count is the present one plus the numruns number.After a file with ; this count was saved with autoinc on, instead of the 'onstop ; command' the 'onlast command' is executed.
onlast command	; The command is executed after a stop caused by a preset reached ; or trigger instead of the 'onstop command', when the last file count is ; reached with autoinc on. This can be used to finish programmed ; measure cycles.
onlast off	; Switches off the 'onlast' feature. Also a manual Stop command ; switches it off.
exec program	; Executes a Windows program or .PIF file. ; Example: exec notepad test.ctl ; opens the notepad editor and loads test.ctl.
fitrois	; Makes a single peak Gaussian fit for all ROIs and dumps the result ; into a logfile. This is performed by the MCDWIN program and ; therefore can be made only if this application is running.
fitrois MC_A	; Similar to the fitrois command, but using the argument allows to ; specify which spectrum should be evaluated independently of ; which child window is activated in MCDWIN.
autocal	; Makes a single peak Gaussian fit for all ROIs in the active Display of ; MCDWIN, for which a peak value was entered and uses the result for ; a calibration. This is performed by the MCDWIN program and ; therefore can be made only if this application is running.
autocal MC_A	; Similar to the autocal command, but using the argument allows to ; specify which spectrum should be evaluated independently of ; which child window is activated in MCDWIN.

The following commands make sense only when using the serial line or TCP/IP control:

MC_A?	; Sends the status of MC_A via the serial port and make MC_A ; actual.
MC_B?	; Sends the status of MC_B via the serial port and make MC_B ; actual.
MC_C?	; Sends the status of MC_C via the serial port and make MC_C ; actual.
MC_D?	; Sends the status of MC_D via the serial port and make MC_D ; actual.
?	; Send the status of the actual multichannel analyzer
sendfile filename	; Sends the ASCII file with name ‘filename’ via the serial line.

The execution of a control file can be finished from the Server or MCDWIN with any Halt command.

4.2. Controlling the MCD-2E Windows Server via DDE

The MCD2 program can be a server for a DDE (Dynamic Data Exchange). Many Windows software packages can use the DDE standard protocols to communicate with other Windows programs, for example GRAMS, FAMOS or LabVIEW. In the following the DDE capabilities of the MCD program are described together with a demo VI („Virtual Instrument“) for LabVIEW. It is not recommended to use the DDE protocol for LabVIEW, as a DLL interface is (optionally) available which works much faster. The following should be seen as a general description of the DDE conversation capabilities of the MCD2 program.

4.2.1. Open Conversation

application: MCD2
topic: MCD2-

Any application that wants to be a client of a DDE server, must first open the conversation by specifying an application and a topic name. The application name is MCD2 and the topic is MCD2-.

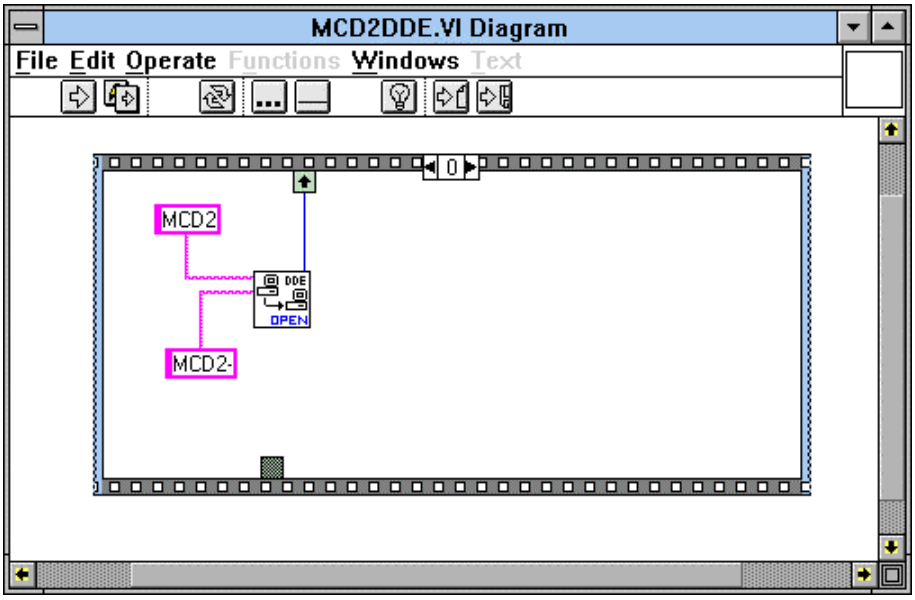


Figure 4.9: Opening the DDE conversation with the MCD2 server in LabVIEW

4.2.2. DDE Execute

The DDE Execute command can be used to perform any action of the MCD2 program. Any of the Control command lines described in chapter 4.1 can be used. For example a sequence of control commands saved in a file TEST.CTL can be executed by specifying the command:

```
RUN TEST.CTL
```

The MCD2 program then executes the command and, after finishing, it sends an Acknowledge message to the DDE client. This can be used for synchronizing the actions in both applications.

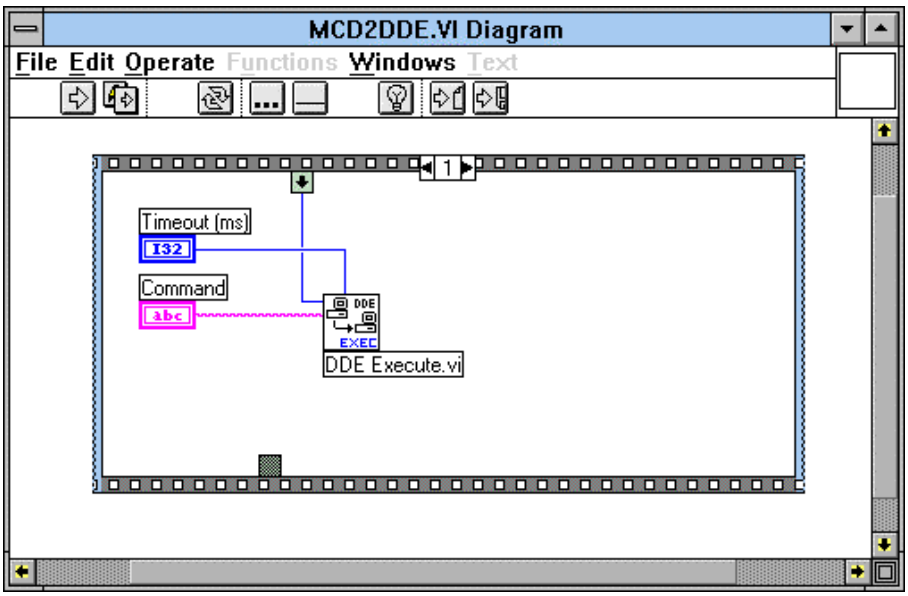


Figure 4.10: Executing a MCD2 command from a LabVIEW application

4.2.3. DDE Request

The DDE Request is a message exchange to obtain the value of a specified item. Only two items are defined for DDE request up to now: RANGE and DATA. The value is obtained as an ASCII string, i.e. it must be converted by the client to get the numbers. All other parameters concerning the MCD2 Setup can be obtained by the client application by reading and evaluating the configuration file.

RANGE

The RANGE item can be used to obtain the total number of data in the actual multichannel analyzer. The desired multichannel analyzer can be selected before by a command MC_A, ..., MC_D.

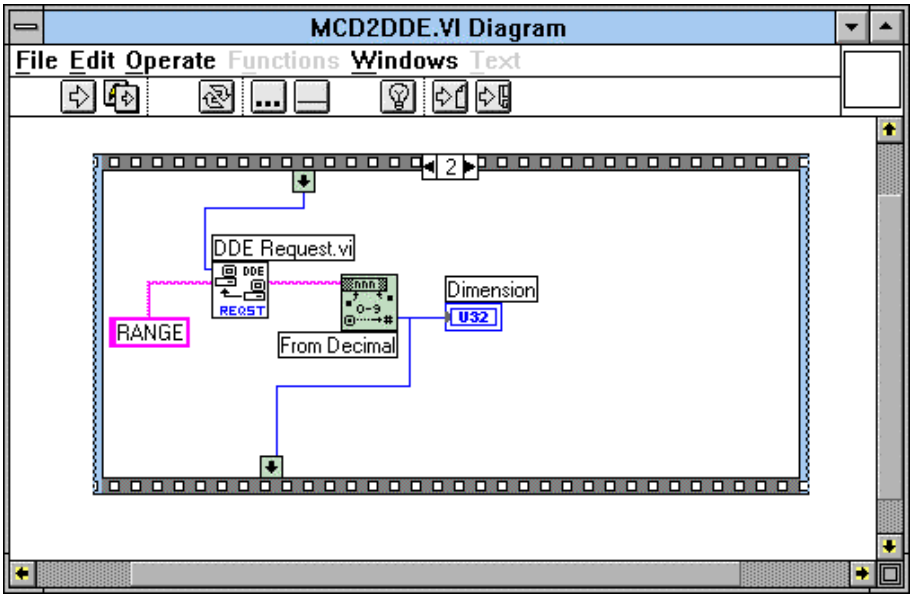


Figure 4.11: Getting the total number of data with LabVIEW

DATA

With the DATA item the data are obtained. The value of this item is a multiline string that contains in each line a decimal number as an ASCII string.

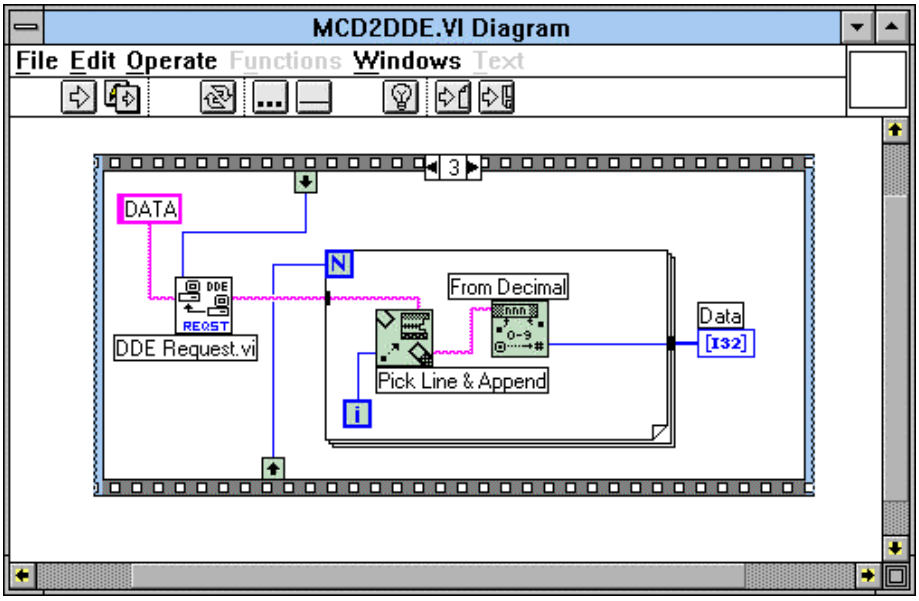


Figure 4.12: Getting the data with LabVIEW

4.2.4. Close Conversation

After finishing the DDE communication with the MCD2 program, it must be closed.

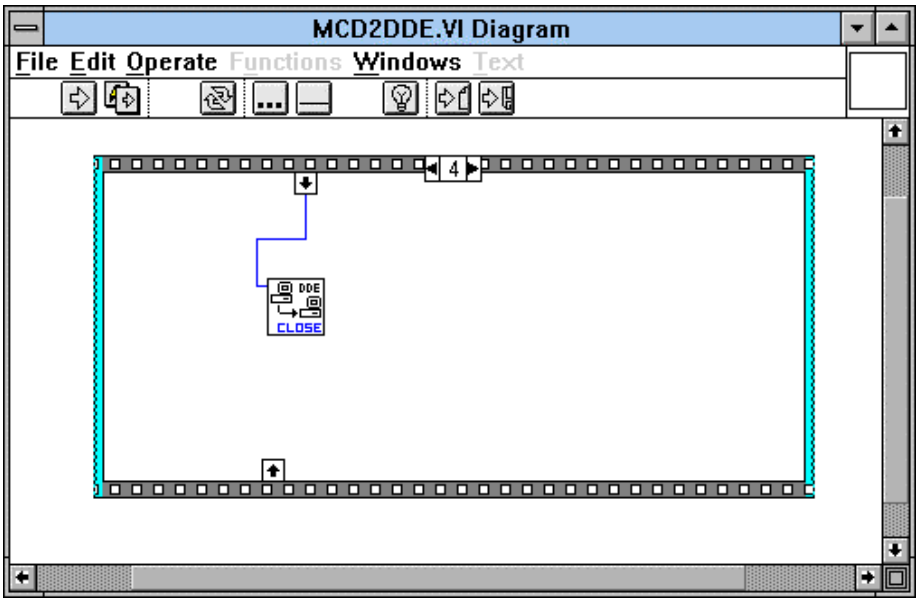


Figure 4.13: Closing the DDE communication in LabVIEW

The following figure shows the „Panel“ of the described VI for LabVIEW.

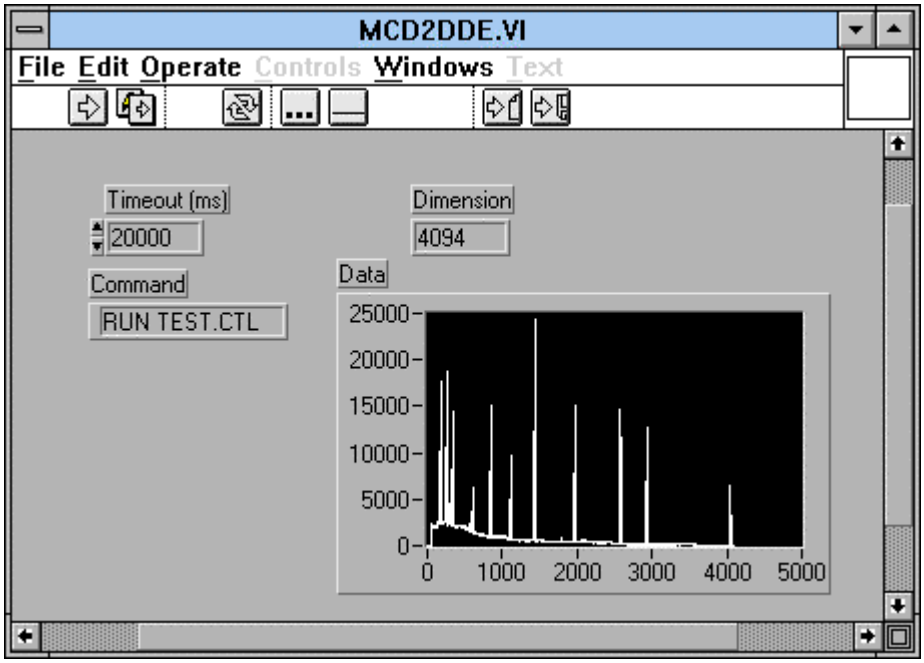


Figure 4.14: Control Panel of the demo VI for LabVIEW

4.3. Controlling the MCD-2E Windows Server via DLL

The MCD2 server program provides - via a DLL („dynamic link library“) - access to all functions, parameters and data. So the server can be completely controlled from the MCDWIN software that provides all necessary graphic displays.

In the following some parts of the header and definition files of the DMCD2.DLL are listed, that may help an experienced programmer to use the DLL for own written applications. Please note that the complete documented source code of the DLL including fundamental VI's and an example VI for LabVIEW and example program in Visual Basic is available as an option.

```
typedef struct{
  int started;          // acquisition status: 1 if running, 0 else
  double realtime;      // real time in seconds
  double totalsum;      // total events
  double roisum;        // events within ROI
  double totalrate;     // acquired events per second
  double nettosum;      // ROI sum with background subtracted
  double livetime;      // Lifetime in seconds
  double deadtime;      // Dead time in percent
  unsigned long maxval; // Maximum value in spectrum
} ACQSTATUS;

typedef struct{
  long range;           // spectrum length
  int prena;            // bit 0: real time preset enabled
                        // bit 1: lifetime preset enabled
                        // bit 2: sweep preset enabled
                        // bit 3: ROI preset enabled
                        // bit 4: 2nd MCS Input: ROI preset enabled
  int qdac;             // bit 0..7: Quad DAC 3 output value (8 bit)
                        // bit 8: qdac enable
  long roimin;          // lower ROI limit
  long roimax;          // upper limit: roimin <= channel < roimax
  double roipreset;     // ROI preset value
  double rtpreset;      // time preset value
  int savedata;         // 1 if auto save after stop
  int fmt;              // format type: 0 == ASCII, 1 == binary
  int autoinc;          // 1 if auto increment filename
  int diguse;           // Usage of DIG I/O only Setting[0] stored
                        // bit 0:  DIG I/O pins 0-3 output status of
                        //         MCD's
                        // bit 1:  Invert Polarity
                        // bit 2..5: Input pins 4..7 Trigger System 1..4
                        // bit 6: Output digval and increment
                        //         digval after stop
                        // bit 7:  Input Mode: =0 Resistive, =1 Tristate
                        // bit 8:  Input Mode: =0 Pullup, =1 Pulldown
  int digval ;          // DIG I/O Output value only Setting[0] stored
  int rdac;             // Ramp DAC output value (12 bits)
  int mempart;          // bit 0..7: number of active part
                        // bit 8..10: partsize 0:512, 1:1024,...,6:64k
  int dwelltime;        // Dwelltime=(N+1) x 10^M x timebase (125ns)
                        // bit 0..3: N
                        // bit 4..7: M
                        // M=8: Extern channel advance
  int rdacuse;          // bit 0: rdac enable
                        // bit 1: ramp increment enable
                        // bit 2..3: rdac width
                        //   00: 12bit, 01: 11bit, 10: 10 bit, 11: 9bit
                        // bit 4..8: Divider for ramp increment -1
  int mcsmode;          // bit 0: =1: 1 channel MCS-mode
                        // bit 1: =1: 2 channel MCS-mode
                        // bit 2: =1: Retrigger mode
  int syncsrc;          // bit 0..1: sync output source
                        //   00: 1kHz, 01: Sweep Start,
                        //   10: End of Sweep, 11: End of time bin
  double ltpreset;      // lifetime preset value
  int nregions;         // number of regions
```

```
  int caluse;           // bit0: 1 if calibration used,
                        // higher bits: formula
  double swpreset;      // Sweep preset
  int active;           // system number 1..4 if active, 0 if not active
  int calpoints;        // number of calibration points
} ACQSETTING;

typedef struct{
  unsigned long huge *s0;          // pointer to spectrum
  unsigned long far *region;       // pointer to regions
  unsigned char far *comment0;     // pointer to strings
  double far *cnt;                 // pointer to counters
} ACQDATA;

typedef struct {
  int nDevices;          // Number of devices: always 4
  int nDisplays;         // Number of displays (active MCA's): 0...4
  int nSystems;          // Number of systems
  int bRemote;           // 1 if server controled by MCDWIN
  int sys;               // System definition word
} ACQDEF;

/*** FUNCTION PROTOTYPES (do not change) ***/
int  FAR PASCAL LibMain(HANDLE, WORD, WORD, LPSTR);
VOID FAR PASCAL StoreSettingData(ACQSETTING FAR *Setting, int nDisplay);
                                        // Stores Settings into the DLL
int FAR PASCAL GetSettingData(ACQSETTING FAR *Setting, int nDisplay);
                                        // Get Settings stored in the DLL
VOID FAR PASCAL StoreStatusData(ACQSTATUS FAR *Status, int nDisplay);
                                        // Store the Status into the DLL
int FAR PASCAL GetStatusData(ACQSTATUS FAR *Status, int nDisplay);
                                        // Get the Status
VOID FAR PASCAL Start(int nSystem);         // Start
VOID FAR PASCAL Halt(int nSystem);          // Halt
VOID FAR PASCAL Continue(int nSystem);      // Continue
VOID FAR PASCAL NewSetting(int nDisplay);
                                    // Indicate new Settings to Server
UINT FAR PASCAL ServExec(HWND ClientWnd);
                                    // Execute the Server WMCD.EXE
VOID FAR PASCAL StoreData(ACQDATA FAR *Data, int nDisplay);
                                    // Stores Data pointers into the DLL
int FAR PASCAL GetData(ACQDATA FAR *Data, int nDisplay);
                                        // Get Data pointers
long FAR PASCAL GetSpec(long i, int nDisplay);
                                        // Get a spectrum value
VOID FAR PASCAL SaveSetting(void);          // Save Settings
int FAR PASCAL GetStatus(int nDisplay);
                                    // Request actual Status from Server
VOID FAR PASCAL Erase(int nSystem);         // Erase spectrum
VOID FAR PASCAL SaveData(int nDisplay);      // Saves data
VOID FAR PASCAL GetBlock(long FAR *hist, int start, int end, int step,
  int nDisplay);                    // Get a block of spectrum data
VOID FAR PASCAL StoreDefData(ACQDEF FAR *Def);
                                    // Store System Definition into DLL
int FAR PASCAL GetDefData(ACQDEF FAR *Def);
                                   // Get System Definition
VOID FAR PASCAL LoadData(int nDisplay);      // Loads data
VOID FAR PASCAL NewData(void);     // Indicate new ROI or string Data
VOID FAR PASCAL HardwareDlg(int item);
                                // item=0: Calls the Settings dialog
                                // 1: data dialog, 2: system dialog
VOID FAR PASCAL UnregisterClient(void);
                                  // Clears remote mode from MCDWIN
VOID FAR PASCAL DestroyClient(void);        // Close MCDWIN
UINT FAR PASCAL ClientExec(HWND ServerWnd);
                                  // Execute the Client MCDWIN.EXE
int FAR PASCAL LVGetDat(unsigned long huge *datp, int nDisplay);
                                 // Copies the spectrum to an array
VOID FAR PASCAL RunCmd(int nDisplay, LPSTR Cmd);
                                        // Executes command
VOID FAR PASCAL AddData(int nDisplay);       // Adds data
```

```
VOID FAR PASCAL SubData(int nDisplay);      // Subtracts data
VOID FAR PASCAL Smooth(int nDisplay);       // Smooth data
int FAR PASCAL LVGetRoi(unsigned long far *roip, int nDisplay);
                                // Copies the ROI boundaries to an array
int FAR PASCAL LVGetCnt(double far *cntp, int nDisplay);
                                // Copies Cnt numbers to an array
int FAR PASCAL LVGetStr(char far *strp, int nDisplay);
                                // Copies strings to an array

EXPORTS
      WEP               @1 RESIDENTNAME
        StoreSettingData        @2
        GetSettingData          @3
        StoreStatusData         @4
        GetStatusData           @5
        Start                   @6
        Halt                    @7
        Continue                @8
        NewSetting              @9
        ServExec                @10
        StoreData               @11
        GetData                 @12
        GetSpec                 @13
        SaveSetting             @14
        GetStatus               @15
        Erase                   @16
        SaveData                @17
        GetBlock                @18
        StoreDefData            @19
        GetDefData              @20
        LoadData                @21
        NewData                 @22
        HardwareDlg             @23
        UnregisterClient        @24
        DestroyClient           @25
        ClientExec              @26
        LVGetDat                @27
        RunCmd                  @28
        AddData                 @29
        LVGetRoi                @30
        LVGetCnt                @31
        LVGetStr                @32
        SubData                 @33
        Smooth                  @34
```

5. MCDWIN Program

The window of the MCDWIN program is shown here. It enables the full control of the MCD-2 card via the server program to perform measurements and save data, and shows the data on-line in several windows.

The server program MCD2.EXE automatically starts MCDWIN. If you try to start MCDWIN before the server is started, a message box warns that you should start the server first.

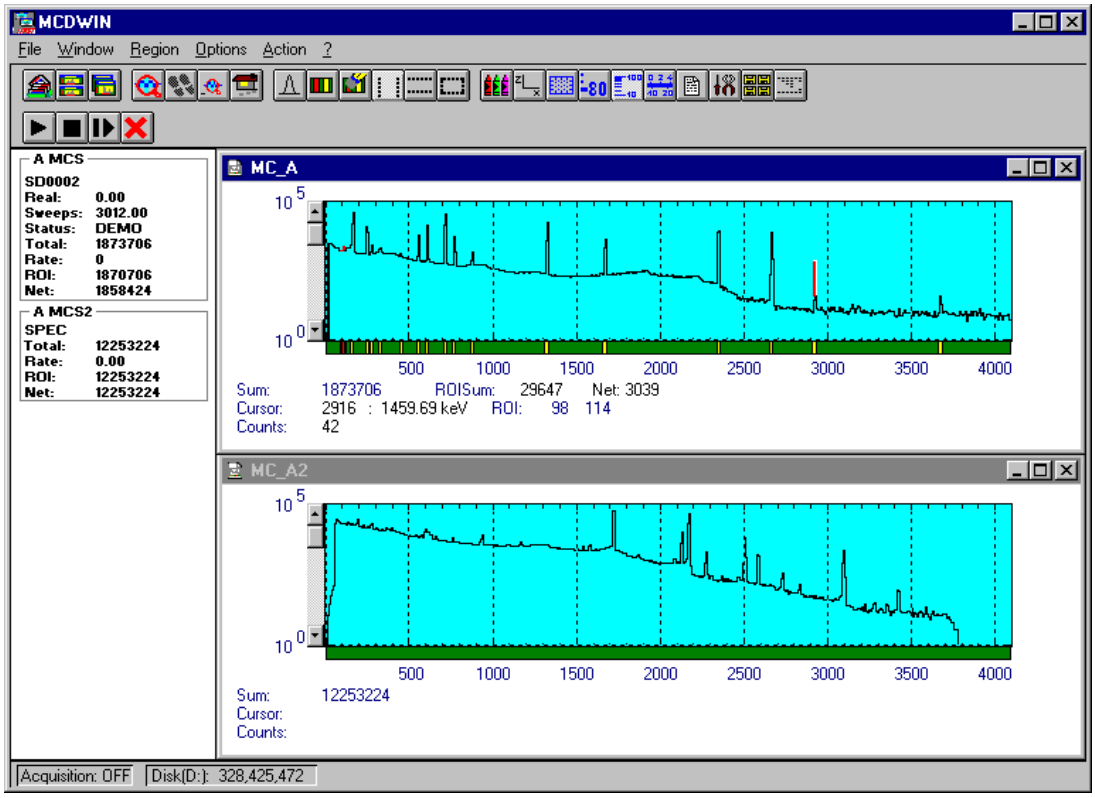


Figure 5.1: MCDWIN main window

A status window at the left side gives all information about the status of the MCD-2. A toolbar provides fast access to many used functions in the menu. A status bar at the bottom indicates the meaning of the toolbar icons. A cursor appears when clicking the left mouse button inside the graphic area. To clear the cursor, move the cursor outside the spectrum display and double click with the right mouse button. To define a region, press the right mouse button, and while keeping the button pressed, drag a rectangle. In the zoomed state a scrollbar appears that allows to scroll through the spectrum.

In the following the several menu functions are described together with the corresponding toolbar icons.

5.1. File Menu

Load...,Add..., Save, Save As...

These menu items provide the usual functions for loading and saving data into the MCA selected by the active window. When saving data, you have the choice between binary (.DAT), ASCII (.ASC), GANAAS (.SPE) and DUALBIN (.DA2) format. When you load data, select a header file (extension .MCD). This file contains the information about the size and format of the data file, which is then automatically read. With „**Add**“ the data is added to the present data. The data read from a file is shifted according to the calibration, if it is available.

New Display...

With the Open New menu item or the corresponding icon a new Display window can be created and shown as the active window. In the „**Open New Display**“ dialog box the MCA for the new display can be selected.

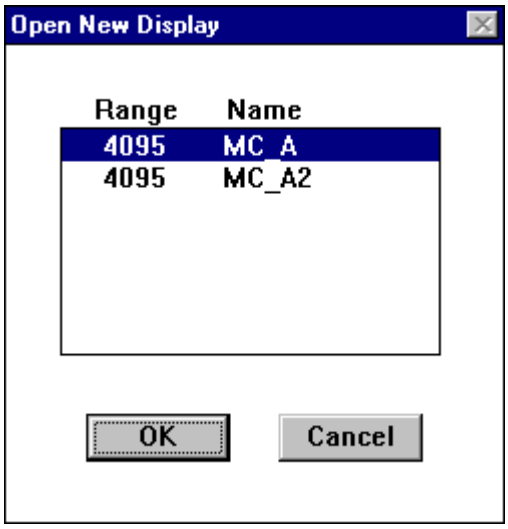


Figure 5.2: File New Display dialog box

Open All

By selecting the Open All menu item, all available Displays are shown. The windows of the last opened Display becomes active.

Print...

The Print menu item prints a Display to the printer. Only the visible part of the spectra will be printed. The size and position of the graphic on paper can be adjusted in a dialog box.

If printing takes a long time and disk activity is high, please note the following: The picture for the printing is first built in the memory, but it may need quite a lot of memory if the printer resolution is high and therefore Windows makes intense virtual memory swapping to disk if for example only 8 MB RAM are available. Therefore it is recommended: never use a 600 dpi printer driver for the printout of spectra. For example for an HP Laser 4, install the PCL driver and use 300 dpi. The PCL driver is also much more effective than a Postscript driver, printing is much faster. With 600 dpi, the maximum figure size is indeed limited to about 12 cm x 7 cm (Windows cannot handle on an easy way bitmaps larger than 16 MB).

Setup Printer...

The Setup Printer menu item allows to configure the printer.

Exit

The Exit menu item exits the MCDWIN.

5.2. Window Menu

The Window menu allows to arrange the Display windows.

Tile

With the Tile menu item or clicking the corresponding icon, all opened and displayed MCDWIN Display windows are arranged over the full MCDWIN client area trying to allocate the same size for each window.

Cascade

The Cascade menu item or respective icon arranges all windows in a cascade display.

Arrange Icons

By the Arrange Icons menu item, the minimized MCDWIN Display windows are arranged in a series at the bottom of the MCDWIN client area.

Close All

By selecting the Close All menu item, all Display windows are closed.

Window list

At the end of the Window menu, all created Display windows are listed with their names, the current active window is checked. By selecting any of the names, this window becomes the active window and is displayed in front of all the others.

5.3. Region Menu

The Region menu contains commands for Regions and ROIs (Regions of Interest). A Region can be defined by marking it in a display, with the mouse using the right mouse button and dragging a rectangle over the area one is interested in. A ROI, i.e. an already defined region in a single spectrum can be shown zoomed by double-clicking with the left mouse button on the corresponding colored area in the bar at the bottom of the spectra display. A single mouse click with the left button on the corresponding colored area makes this to the active ROI and lets the counts contained in this ROI be displayed in the information lines of the respective window.

Zoom

The Zoom item or respective icon enlarges a Region to the maximum Spectrum Display size.

Back

The Back menu item or clicking the corresponding icon restores the last zoom view. Each time a Back command is clicked the view is stepped back one step.

Zoom Out

The Zoom Out menu item or clicking the corresponding icon enlarges the actual zoom view by a factor 2, if possible.

Home

Clicking the Home menu item or the corresponding icon restores a Display to the basic configuration.

Shape

Selecting the Shape menu item opens a submenu with the items Rectangle, X-Slice, Y-Slice, and Polygon to choose the ROI shape.

Rectangle

Sets the region shape to a rectangle with arbitrary dimensions. To enter the rectangular region, press the right mouse button, drag a rectangle, and release the button to define the region.

X-Slice

Sets the Region shape to the rectangle with maximal height.

Y-Slice

Sets the Region shape to the rectangle with maximal width.

Create

The Create menu item creates a new ROI from the current marked Region.

Delete

By selecting the Delete menu item or the respective icon, the current active ROI is deleted and the previously defined ROI is activated.

Edit...

With the Edit item, a dialog box is opened which allows to edit the ROI list, i.e. create a new or delete, change and activate an existing ROI. Also the peak values for an automatic calibration can be entered here. A ROI can be edited and added to the list. It can also be made to the „Active ROI“, that is the special ROI that is used by the server program to calculate the events within this ROI and look for an event preset. The ROI list can be cleared and it can be written into a file with extension .CTL, which can be directly loaded into the server to restore the ROI list.

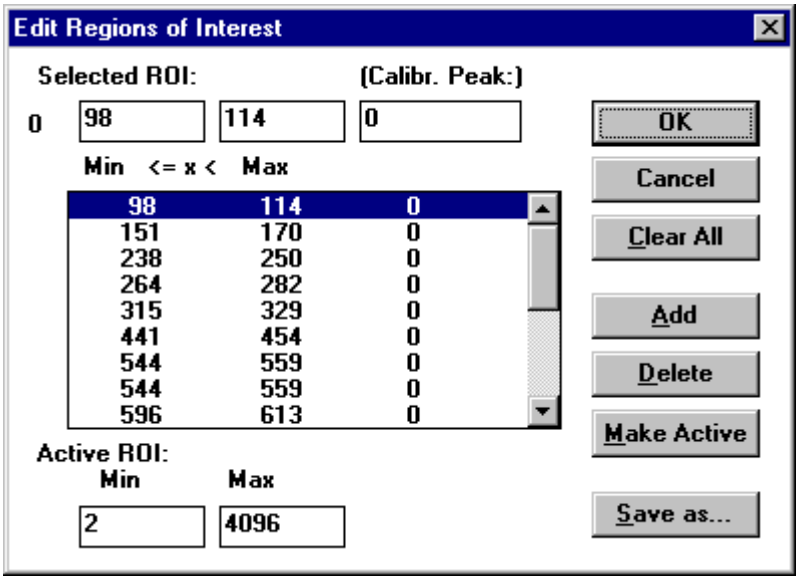


Figure 5.3: ROI Editing dialog box

Fit...

By selecting the Fit... menu item or the respective icon, A single Gaussian peak fit with linear background is performed for the currently marked region. The fitted curve is displayed and a dialog box shows the results:

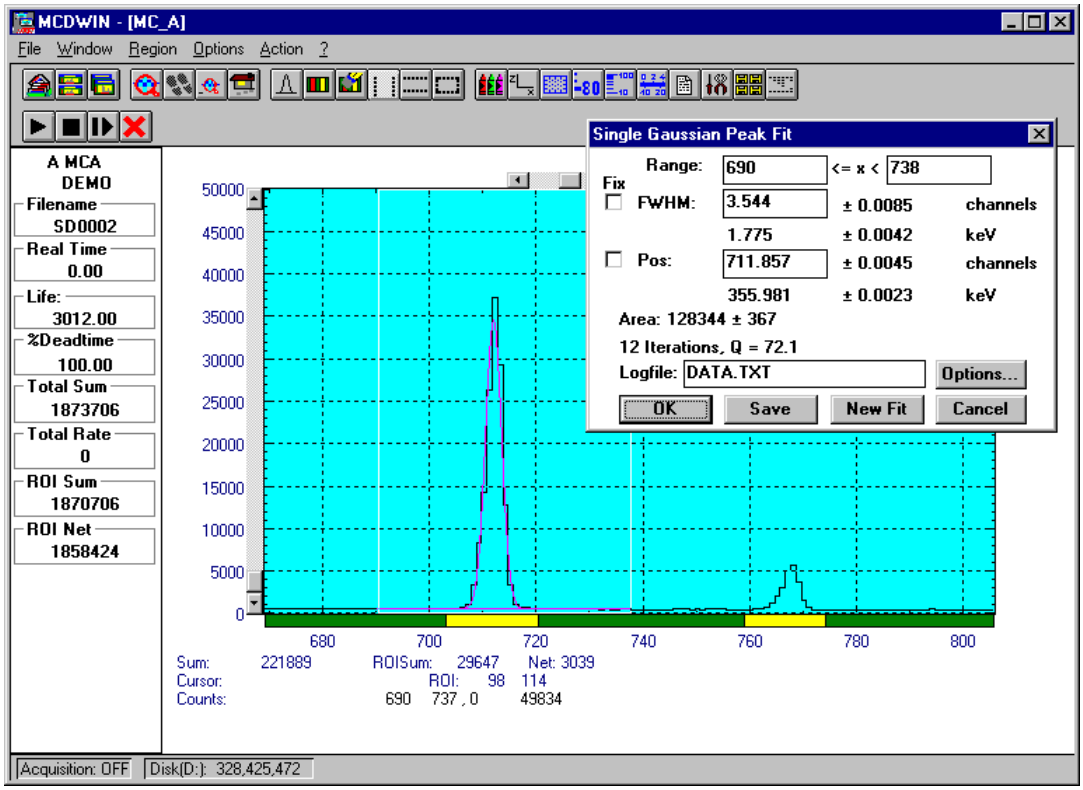


Figure 5.4: Single Gaussian Peak Fit

The full width at half maximum FWHM and Position of the Gaussian can be changed and a New Fit can be performed, they even can be fixed to the entered value by marking the respective

checkbox. The Position and FWHM are displayed in channels and also in calibrated units, if a calibration is available. The area of the Gaussian is also shown. For all values also the standard deviations are given. The value of Q is the normalized chi**2. To take into account the systematic error of the line shape, you may multiply the errors with the square root of Q. Click on Save to append a line containing the results to a Logfile with the specified name. OK closes the dialog and lets the fitted function in the display also if it is refreshed, whereas after Cancel the curve no longer will be shown in a refreshed display. Options... opens a new dialog box to define the information in the logfile:

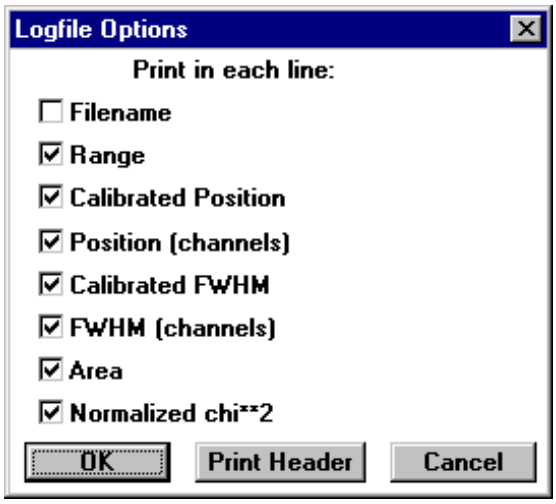


Figure 5.5: Log file Options for the Single Gaussian Peak Fit

The several quantities are written in standard text format with Tabs as separators and a Newline character at the end of each line, so the file can be read with standard calculation programs like EXCEL. Click on Print Header to write a header line.

Fit ROIs

With the Fit ROIs item, for all ROIs a Single Gaussian Peak Fit is performed and the results are dumped into the logfile.

Auto Calib

Makes a Gauss fit for all ROIs in the active Display for which a peak value was entered, and performs a calibration using the fit results.

5.4. Options Menu

The Options Menu contains commands for changing display properties like scale, colors etc., hardware settings, calibration and comments.

Colors...

The Colors menu item or respective icon opens the Colors dialog box. It changes the palette or Display element color depending on which mode is chosen. The current color and palette set-up may be saved or a new one can be loaded.

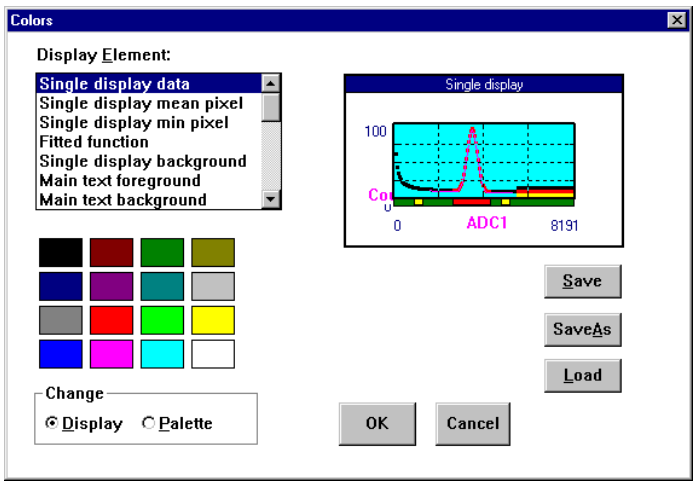


Figure 5.6: Colors dialog box

Display...

The Display menu item or the corresponding icon opens the Display Options dialog box.

Here the graphic display mode of single spectra can be chosen. The 'type' combo box gives a choice between **dot**, **histogram**, **spline I** and **line**.

'Dot' means that each spectra point is shown as a small rectangle, the size of this rectangle can be adjusted with the **size** combo box. 'Histogram' is the usual display with horizontal and vertical lines, 'spline I' means linear interpolation between the points, and 'line' means vertical lines from the ground to each spectra point.

If the displayed spectra range contains more channels as pixel columns are available in the video graphic display, usually only the maximum value of the channels falling into that pixel columns is displayed. But it can also explicitly specified by marking the checkboxes „**Max Pixel**“, „**Mean Pixel**“ or „**Min Pixel**“ which value will be displayed. It is also possible to display all three possible values in different colors that can be chosen in the colors dialog. For the „Mean Pixel“ a Threshold value can be entered; channel contents that are below this value are then not taken into account for the mean value calculation.

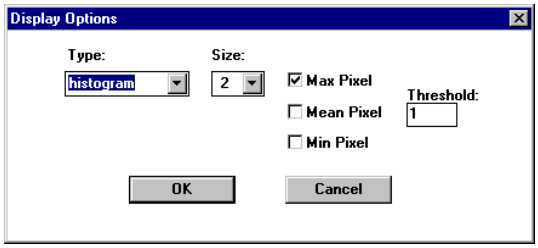


Figure 5.7: Display Options dialog box

Axis...

By the Axis... menu item or the respective icon, the Axis Parameters dialog box is opened.

It provides many choices for the axis of a display. The frame can be rectangular or L-shape, the frame thickness can be adjusted (xWidth, yWidth). A grid for x and y can be enabled, the style can be chosen between Solid, Dash, DashDot and DashDotDot. Ticks on each of the four frame borders can be enabled, the tick length and thickness can be chosen. The style of the axis labeling depends on enabled ticks at the bottom respective left side: If no ticks are enabled there, only the lowest and highest values are displayed at the axis, otherwise the ticks are labeled.

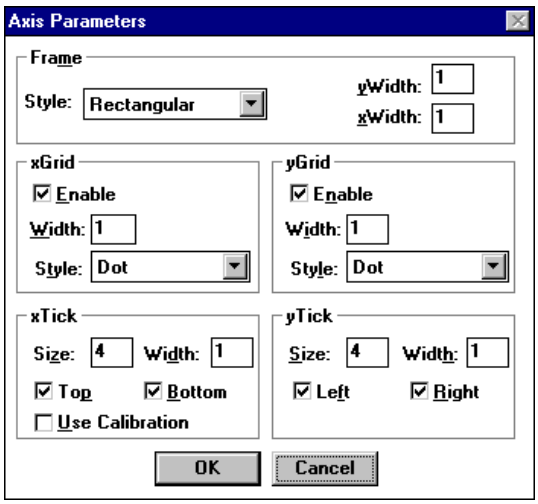


Figure 5.8: Axis Parameter dialog box

Scaling...

The Scaling menu item or the corresponding icon opens the Scale Parameters dialog box.

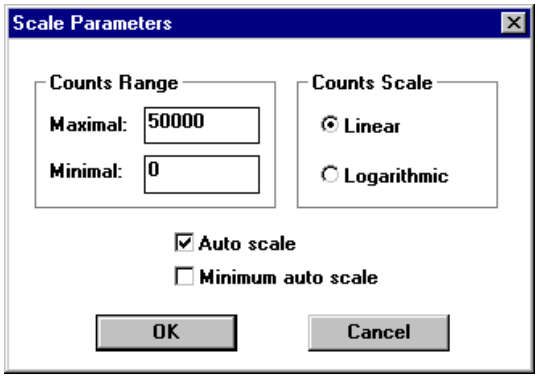


Figure 5.9: :Scale Parameters dialog box

It allows to change the ranges and attributes of a Spectrum axis. By setting the Auto scaling mode, the MCDWIN will automatically recalculate the maximum y axes of the visible Spectrum region only. To keep the same height of the visible region for a longer time, set the Auto scaling mode off. Then with the scroll bar thumb one can quickly change the visible region scale, otherwise the scale will be changed automatically. The Minimum auto scale mode helps to display weak structures on a large background.

Lin / Log scale

For a Lin scale all data intervals have the same size. With Log scale the intervals will be small for small y values and large for large y values. All options have effect only on the active Display.

Calibration...

Using the Calibration menu item or the corresponding icon opens the Calibration dialog box.

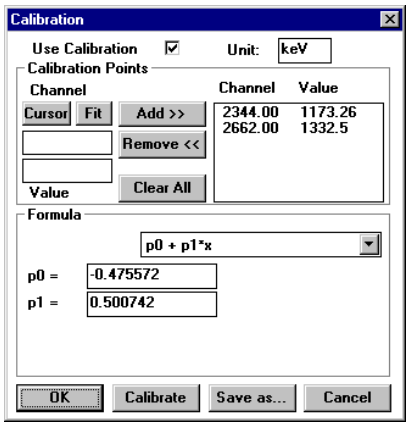


Figure 5.10: Calibration dialog box

Make a choice of several calibration formulas. Enter some cursor positions and the corresponding values, click on Add, then on Calibrate. The obtained coefficients can be inspected together with the statistical error, or they can be changed and entered by hand. If 'use calibration' is on, the calibrated values are displayed together with the channel position of the cursor.

Comments...

Up to eleven comment lines with each 60 characters can be entered using the Comments dialog box. The content of these lines is saved in the data header file. The first line contains automatically the time and date when a measurement was started. The titles of each line can be changed by editing the file COMMENT.TXT.

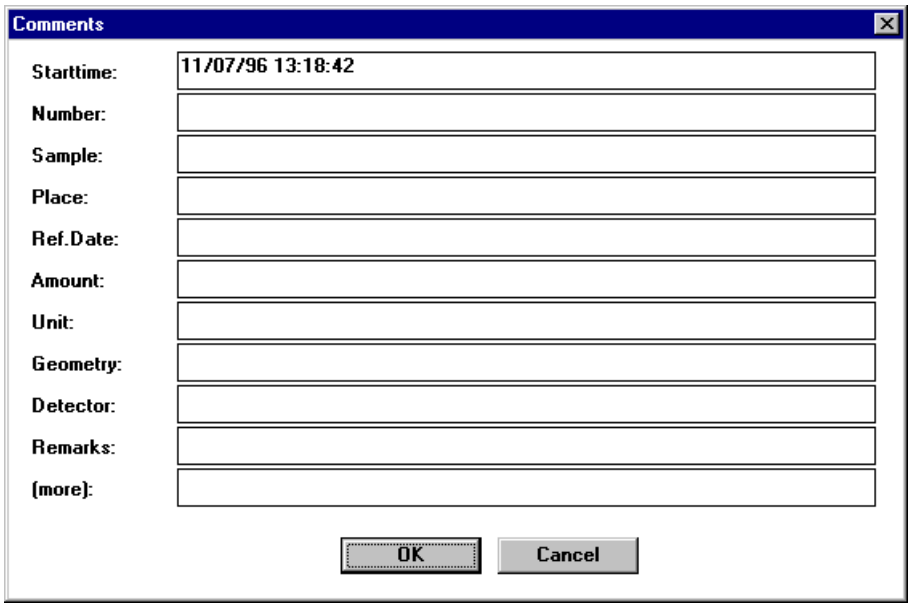


Figure 5.11: Comments dialog box

Range, Preset...

The Range, Preset dialog box allows to make all the respective MCD-2 settings (See MCD-2 Server documentation).

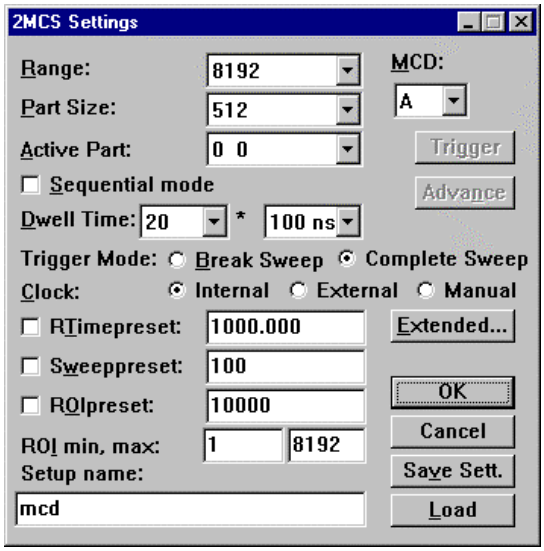


Figure 5.12: Settings dialog box

Via the button **Extended** the Extended Settings dialog box opens. There the MCS input thresholds, the analog outputs, the Sync output source and the 2nd MCS input ROI are configured.

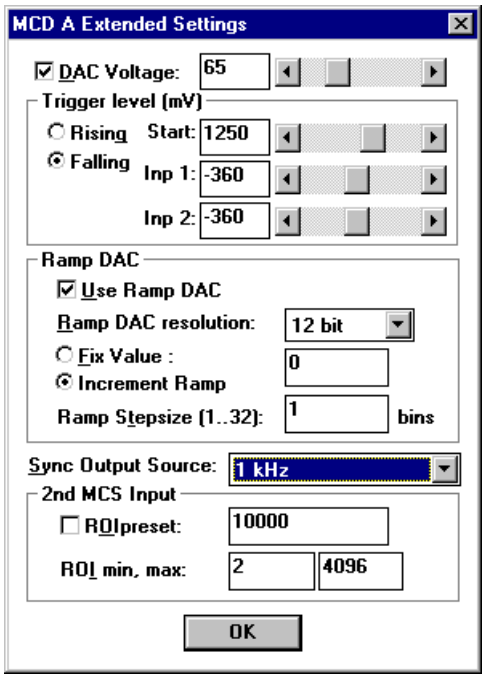


Figure 5.13: Extended Settings dialog box

Data...

The Data dialog box allows to make all the respective MCD-2 settings (See MCD-2 Server documentation).

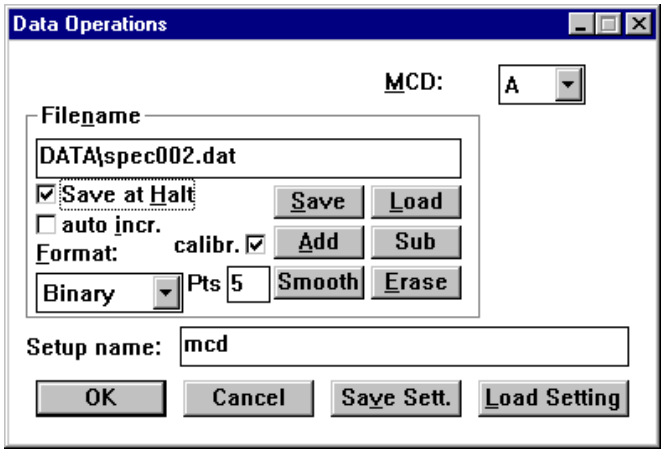


Figure 5.14: Data Operations dialog box

System...

The System Definition dialog box allows to make all the respective MCD-2 settings (See MCD-2 Server documentation).

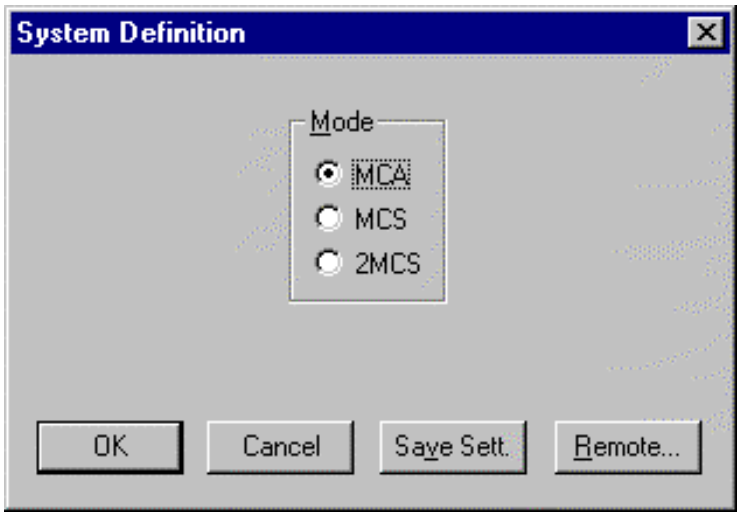
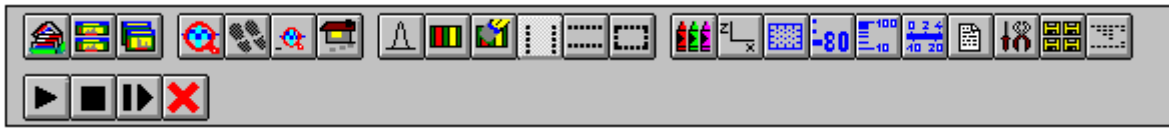


Figure 5.15: System Definition dialog box

Tool Bar...



Selecting the Tool Bar Menu item opens the Tool Bar Dialog Box. It allows to arrange the icons in the Tool Bar.

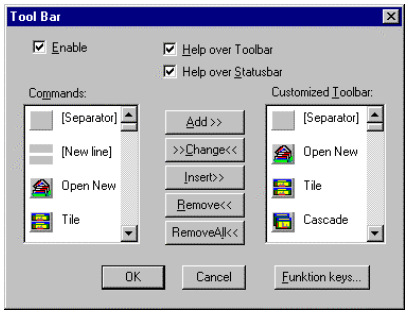


Figure 5.16: Tool Bar dialog box

If it is enabled, an array of icons in the MCDWIN Menu is shown. Clicking the left mouse button with the cursor positioned on an icon, the user can perform a corresponding MCDWIN Menu command very quick.

Status bar

With this menu item the Status bar at the bottom of the MCDWIN main window can be switched on or off. A corresponding check mark shows if it is active or not. The Status bar usually shows if an acquisition is active. When the left mouse button is pressed while the mouse cursor is within a toolbar icon, it displays a short help message what the meaning of the toolbar icon is.

Status window

The same way it is possible to hide or show the status window at the left side of the MCDWIN main window.

Save

Saves all parameters defined in the Options menu to the MCDWIN.CNF config file.

Save As...

Saves all parameters defined in the Options menu to a user defined config file.

Retrieve...

Loads a new configuration.

5.5. Action Menu

The Action Menu or corresponding toolbar icons contain the commands to start, stop, continue and erase a measurement. If more than one systems are formed, also more actions menus are available, otherwise they are grayed.

Start

The Start toolbar button erases the data and starts a new measurement.

Halt

The Halt toolbar button stops a measurement.

Continue

The Continue toolbar button continues a measurement.

Erase

The Erase toolbar button erases the data.

6. MCD-2E Programming

6.1. Register Specification

The MCD-2E is controlled via input and output from/to some I/O port registers. The base address is defined by the rotary switch setting (ref. chapter Hardware Installation; default: 320_{hex}).

Address BASE +	Width [bits]	Write Operation	Read Operation
0	16	CONTROL	CONTROL
1	8	ADC PORT CONTROL	ADC PORT CONTROL
2	16	SPEC CONTROL	SPEC CONTROL
3	8	OFFSET	OFFSET
4	16	OUT CONTROL	OUT CONTROL
5	8	DAC CONTROL	DAC CONTROL
6	16	RWA COUNTER	not used
8	16	LOWER DATA WORD	LOWER DATA WORD
10	16	HIGHER DATA WORD	HIGHER DATA WORD
11	8	QUAD DAC	not used

Figure 6.1: Register Overview

CONTROL Register
Base + 0

The CONTROL register is accessed by a 16 bit output or input at base address + 0. The bits in the CONTROL register are defined and used as follows:

Bit	Default @reset	Name (Write)	Name (Read)	Meaning
0	1	RESET	ARES	Reset state of the MCD-2E card
1	0	ABORT	ABORT	Abort a running MCS sweep
2	0	MCS	MCS	MCS mode enable
3	0	PHA	PHA	PHA mode enable
4	0	WRITE	WMODRDY	Write: Write-to-memory enable Read: Write-to-memory mode ready
5	0	SPRE	SPRE	Sweep preset enable (MCS)
6	0	RPRE	RPRE	Real time preset enable (PHA)
7	0	LPRE	LPRE	Live time preset enable (PHA)
8	0	ARM	ARM	MCD-2E arm
9	0	STRG	ON	Write: Software trigger (not registered) Read: MCS sweep running
10	0	ENRT	ENRT	Retrigger mode enable (MCS)
11	1	/EN2	/EN2	Input 2 enable (MCS, act. low)
12	0	SADV	DAV	Write: Software channel advance (MCS) Read: Data valid (read / write memory)
13	0	ENC	ENC	Enable converter (PHA)
14	0	DENB	DENB	Data enable (PHA)
15	[1] 0	PCLR	DIS	Write: Preset clear (not registered) Read: MCD-2E disabled by preset reached (clears ARM & ENC)

Figure 6.2: Control Register

The main modes are Multiscaling (MCS), Multichannel / Pulse Height Analysis (PHA) and Write-to-RAM (WRITE / WMODRDY).

To enable MCS or PHA mode the procedure is:

- set WRITE = 0
- wait until WMODRDY = 0
- set MCS or PHA = 1

ADC PORT CONTROL Register
Base + 1

The ADC PORT CONTROL register is accessed by an 8 bit output or input at base address + 1. The bits in the ADC PORT CONTROL register are defined and used as follows:

Bit	Default @reset	Name	Meaning	
0	1	POL 0	Polarity DRDY:	0 = act. high; 1 = act. low
1	0	POL 1	Polarity DEAD:	0 = act. high; 1 = act. low
2	1	POL 2	Polarity DACC:	0 = act. high; 1 = act. low
3	0	POL 3	Polarity ENC:	0 = act. high; 1 = act. low
4	0	POL 4	Polarity START:	0 = rising; 1 = falling edge
5	0	*reserved*		
6	0	*reserved*		
7	0	*reserved*		

Figure 6.3: ADC PORT CONTROL Register

SPEC CONTROL Register
Base + 2

The SPEC CONTROL register is accessed by a 16 bit output or input at base address + 2. The bits written to the SPEC CONTROL register are defined and used as follows: (when reading, N and M are exchanged)

Bit	Default @reset	Name	Meaning
0 1 2 3	0	N(0:3)	Dwell Time = (N+1) x 10^M x 4 x 1/CLK N = 0...15
4 5 6 7	0	M(0:3)	M = 0...7 8 = select external channel advance 9 = select software channel advance
8 9 10 11	0	RG(0:3)	Range select: 0 = 256 ; 1 = 512 ; 2 = 1k ; 3 = 2k ; 4 = 4k ; 5 = 8k ; 6 = 16k ; 7 = 32k ; 8 = 64k ; 9 = 128k
12 13	0	OSC(0:1)	Onboard crystal oscillator select: 0 = 32 MHz ; 1 = 40 MHz ; 2 = 25 MHz ; 3 = 20 MHz (==> CLK)
14 15	#	VER(0:1)	Version Number

Figure 6.4: SPEC CONTROL Register

OFFSET Register
Base + 3

The OFFSET register is accessed by an 8 bit output or input at base address + 3. The bits in the OFFSET register are defined and used as follows:

Bit	Default @reset	Name	Meaning
0	0	OFFS 0	Spectrum offset = + 512
1	0	OFFS 1	Spectrum offset = + 1k
2	0	OFFS 2	Spectrum offset = + 2k
3	0	OFFS 3	Spectrum offset = + 4k
4	0	OFFS 4	Spectrum offset = + 8k
5	0	OFFS 5	Spectrum offset = + 16k
6	0	OFFS 6	Spectrum offset = + 32k
7	0	OFFS 7	Spectrum offset = + 64k

Figure 6.5: OFFSET Register

OUT CONTROL Register
Base + 4

The OUT CONTROL register is accessed by an 16 bit output or input at base address + 4. The bits in the OUT CONTROL register are defined and used as follows:

Bit	Default @reset	Name	Meaning
0 ... 11	0	DAP(0:11)	12 bit DAC fixed mode output voltage or lower voltage limit in X-ramp mode
12 13	0	DSEL(0:1)	Effective DAC resolution in X-ramp mode: 0 = 12 bit ; 1 = 11 bit ; 2 = 10 bit ; 3 = 9 bit
14 15	0	SSEL(0:1)	Sync output source select: 0 = 1 kHz ; 1 = Start-of-sweep ; 2 = End-of-sweep ; 3 = End-of-timebin

Figure 6.6: OUT CONTROL Register

DAC CONTROL Register
Base + 5

The DAC CONTROL register is accessed by an 8 bit output or input at base address + 5. The bits in the DAC CONTROL register are defined and used as follows:

Bit	Default @reset	Name	Meaning
0 1 2 3 4	31	DACT(0:4)	Divider ratio of End-of-time-bin (EOT) to the X-ramp output generator = $[(0...31)_{dec} + 1]$: In X-ramp mode the 12 bit DAC output is controlled by a counter that is incremented by EOT / (DACT + 1)
5	0	ramp	enable X-ramp mode of the 12 bit DAC
6 7	3	DADR(0:1)	Quad 8 bit DAC select: 0 = Trigger ; 1 = Count 1 ; 2 = Count 2 ; 3 = 8 bit analog output

Figure 6.7: DAC CONTROL Register

The X-ramp output is generated by a 12 bit counter that is incremented by EOT / (DACT + 1). The effective used depth of the counter is defined by DSEL (in any case the most significant bits are used). At EOS (End-of-sweep) the counter is reset to DAP (ref. OUT CONTROL register).

QUAD DAC Register
Base + 11

To write data to one of the four 8 bit DACs first select the appropriate address (DADR) then write the data to base + 11 - QUAD DAC register. The QUAD DAC controls the threshold levels of TRIGGER/START, COUNT 1 & 2 and the 8 bit analog output voltage. Note that this register has no readback capability.

RWA COUNTER
Base + 6

The first RAM address for read or write operations from or to the memory is specified by a 16 bit output of bits 1...16 of the 17 bit RAM address space. Bit 0 (least significant bit) is set to 0. The RWA COUNTER - Read/Write Address Counter - is then automatically incremented on every consecutive read or write operation.

LOWER DATA WORD
Base + 8

The LOWER DATA WORD - 16 bit - of the 32 bit RAM data is accessed via this port address.

HIGHER DATA WORD
Base + 10

The HIGHER DATA WORD - 16 bit - of the 32 bit RAM data is accessed via this port address.

IMPORTANT NOTE:
First the lower, then the higher word must be read or written.

To **write data** into the RAM the procedure is as follows:

- set MCS, PHA, ARM, ENC = 0 and /EN2 = 1
- set WRITE = 1
- wait for WMODRDY = 1 --> WriteModeReady

- wait for DAV = 0
- load the RWA COUNTER
- wait for DAV = 0 --> MCD-2E signals that it is waiting for valid data
- first write the LOWER then the HIGHER DATA WORD
- repeat the last step until finished

To **read data** from the memory the following procedure must be performed:

- MCS or PHA = 1 and WRITE = 0 is mandatory
- wait for DAV = 1
- load the RWA COUNTER
- wait for DAV = 1 --> MCD-2E signals that valid data is present in the output register
- first read the LOWER then the HIGHER DATA WORD
- repeat the last two steps until finished

6.2. The Subroutines for controlling the MCD-2E

In the following the low level subroutines used by the MCD2 server program (MCD2.EXE) for controlling the MCD-2E are listed and commented. The program language used is C

(Microsoft C; for use with Turbo-C replace:

```
outp   with    outportb     (writes a byte to an I/O port)
outpw  with    outport      (writes a 16 bit word to an I/O port)
inp    with    inportb      (reads a byte from an I/O port)
inpw   with    inport).     (reads a 16 bit word from an I/O port)
```

Variables and constants, if not clear from the context, are discussed when they appear first time. The following functions are listed to illustrate the hardware programming, but do not form a complete executable program. Note that not all variables and functions are declared, if they are not necessary to understand the hardware programming. Standard Microsoft C or Windows functions like fopen, lstrcpy, MessageBox and so on are not documented.

The complete source code of the DLL DMCD2.DLL that controls the hardware via the server program MCD2.EXE including example programs for Visual Basic and LabVIEW is available as an option.

cardinit

The cardinit routine defines the base address, initializes the MCD-2E and performs a basic test whether it is present and OK. It returns TRUE if a MCD-2E is present and working, otherwise FALSE.

```
int cardinit()
{
  int nDev, demo=0, ibit=1, running=0, ret;
  long i;
  FILE *f;
  char buf[80];

  for (nDev=0; nDev<devices; nDev++) {
    if (!demomod[nDev]) {
      creg = inpw(base[nDev]);  // read control register
      if ((creg & 0x01) ||      // ares==1, power on status
          !(creg & (BITARM | BITENC))) {
                                // arm==enc==0, not running
        Status[nDev].started = OFF;
        Status[nDev+devices].started = OFF; // 2nd input spect
        ret=cardreset(nDev);
        if (ret != 1) {       // reset card and set parameters
          demomod[nDev] = 1;
        }
      }
      else {                  // a measurement is running!
        cardget(nDev);        // get card settings
      }
      if (!readmem(nDev,0,256)) {  // check whether card
        demomod[nDev]=1;            // memory can be read
      }
      if (Status[nDev].started) running=1;
    }
    if (demomod[nDev]) {
      Status[nDev].started = 6;       // Status: DEMO
      Status[nDev+devices].started = 6;
      demo |= ibit;
    }
    ibit <<= 1;
  }
  if (running) {
    if (f = fopen("MCD2.STS", "r+t")) {
      freadstr(f,buf,80);
      for (i=0; i<devices; i++) {
        fscanf(f,"%lu %lu", rtimoff+i, ltimoff+i);
        if (Status[i].started)
          lstrcpy((LPSTR)Data[i].comment0, (LPSTR)buf);
```

```
            }
            fclose(f);
          }
        }
        for (nDev=0; nDev<devices; nDev++) {
          for (i=0; i<memrange[nDev]; i+=256)
            readmem(nDev,i,256);
          if (Setting[nDev].mcsmode & 0x02) {
            int nDev1 = nDev + devices;
            for (i=0; i<memrange[nDev]; i+=256)
              readmem(nDev1,i,256);
          }
        }
        return demo;
      }
```

Variable	Meaning
base[4]	unsigned integer array specifying the i/o port base addresses of the MCD-2E cards.
creg	control register
memrange[8]	long array containing offset + histogram length of the spectra.
Status[8]	an array of structures describing the Status of each MCA (see section 4.3):
Setting[8]	an array of structures describing the settings of each MCA (see section 4.3):
devices	number of installed MCD-2E cards (1..4)

Constants	Meaning

```
#define BITARES    0x01
#define BITABORT   0x02
#define BITENOWS   0x02
#define BITMCS     0x04
#define BITPHA     0x08
#define BITWRITE   0x10
#define BITWMODRDY 0x10
#define BITSPRE    0x20
#define BITRPRE    0x40
#define BITLPRE    0x80
#define BITARM     0x100
#define BITON      0x200
#define BITSTRG    0x200
#define BITENRT    0x400
#define BITEN2     0x800
#define BITDAV     0x1000
#define BITSADV    0x1000
#define BITENC     0x2000
#define BITDENB    0x4000
#define BITDIS     0x8000
#define BITPCLR    0x8000
#define MASK       0x6DFC
```

cardreset

The cardreset routine resets the MCD-2E.

```
int cardreset(int nDev)
{
  creg = inpw(base[nDev]);
  creg |= BITARES;
  outpw(base[nDev],creg);                // Reset...
  creg = inpw(base[nDev]);
  if (!creg & BITARES) return -1;  // ares must be ON now
  if (creg & 0x77FE) {             // these bits must be zero
    creg &= MASK;
    outpw(base[nDev],creg);        // ares=0  back to regular state
    return -2;
```

```
  }
  creg &= MASK;
  outpw(base[nDev],creg);          // ares=0  back to regular state
  creg = inpw(base[nDev]);
  if (creg & BITARES) return -3;   // must be OFF now
  cardset(nDev);
  return (TRUE);
}
```

cardset

The cardset routine initializes the MCD-2E parameters.

```
void cardset(int nDev)
{
  int w=0,v,dacctl;
  int baseadr = base[nDev];
  long r=256L;

  v = (pol0[nDev] & 0x0F) | ((pol1[nDev] & 0x01)<<4);
  outp(baseadr+1,v);           // Set polarities
  for (v=0; v<16; v++) {
    if (r==Setting[nDev].range) break;
    r <<= 1;
  }
  v <<= 8;
  v |= (Setting[nDev].dwelltime & 0xFF);
  v |= oszselect[nDev];        // Oscillator select
  outpw(baseadr+2,v);          // Set dwell time and range
  w = (int)(memstart[nDev] >> 9);
  outp(baseadr+3,w);           // memory offset
  v = inp(baseadr + 5);     // read dac control
  v &= 0x3F;
  dacctl = v;               // select dac0
  outp(baseadr+5, dacctl);
  w = ((thrstart[nDev] * 32)/125 + 128);
  if (w > 255) w = 255; if (w < 0) w = 0;
  outp(baseadr+11, w);      // set start threshold
  dacctl = v | 0x40;        // select dac1
  outp(baseadr+5, dacctl);
  w = ((thr1[nDev] * 32)/125 + 128);
  if (w > 255) w = 255; if (w < 0) w = 0;
  outp(baseadr+11, w);      // set inp1 threshold
  dacctl = v | 0x80;        // select dac2
  outp(baseadr+5, dacctl);
  w = ((thr2[nDev] * 32)/125 + 128);
  if (w > 255) w = 255; if (w < 0) w = 0;
  outp(baseadr+11, w);     // set inp2 threshold
  dacctl |= 0xC0;           // select dac3
  outp(baseadr+5, dacctl);

  creg = inpw(baseadr) & MASK;

  if (!(Setting[nDev].mcsmode & 0x03)) { // MCA mode
    if (Setting[nDev].prena & 0x01) creg |= BITRPRE; // real time preset
    else creg &= (0xFFFF ^ BITRPRE);
    if (Setting[nDev].prena & 0x02) creg |= BITLPRE; // life time preset
    else creg &= (0xFFFF ^ BITLPRE);
  }
  else creg &= 0xFF3F;
  if (Setting[nDev].prena & 0x04) creg |= BITSPRE;   // Sweep preset
  else creg &= (0xFFFF ^ BITSPRE);
  if (!(Setting[nDev].mcsmode & 0x03)) {  // MCA mode
    if (pol0[nDev] & 0x10)                // denb=1
      creg &= (0xFFFF ^ BITDENB);
    else
      creg |= BITDENB;
  }
  outpw(baseadr,creg);                  // Set Preset Bits
}
```

readmem

The readmem routine reads a block of channels.

```
int readmem(int nDev, long knum, int amount)   // reads amount channels
{                                              // starting from knum
  int i,j,base8,base10,baseadr;
  unsigned int num;
  unsigned long val;
  unsigned *pw;
  int nDev0 = nDev;
  if (!Setting[nDev].active) return TRUE;
  if (nDev >= devices) nDev0 -= devices;

  if (demomod[nDev0]) return FALSE;
  pw = (unsigned *)(&val);
  baseadr = base[nDev0];
  if (!prepareread(nDev0, baseadr)) return FALSE;
  num = (unsigned int)(knum >> 1);
  if (nDev >= devices) num |= 0x8000;
  outpw(baseadr+6, num);
  base8=baseadr+8;
  base10=baseadr+10;
  for (j=0; j<amount; j++) {
    //  if (!waitdav(baseadr)) return FALSE;
    pw[0] = inpw(base8);
    pw[1] = inpw(base10);
    Data[nDev].s0[knum++] = val;
  }
  return TRUE;
}

int prepareread(int nDev0, int baseadr) // prepare for reading
{
  int i;
  creg = inpw(baseadr);
  if (creg & BITWMODRDY) {              // wmodrdy != 0 ?
    creg &= 0x6DEE;
    outpw(baseadr, creg);               // set write=0
    for (i=0; i<MAXLOOP; i++) {
      creg = inpw(baseadr);
      if (!(creg & BITWMODRDY)) break;  // wmodrdy == 0 ?
    }
    if (i==MAXLOOP) return FALSE;
  }
  if (!(creg & BITDAV)) {               // dav != 1?
    creg &= 0x6DE0;
  if (Setting[nDev0].mcsmode && 0x11) creg |= BITMCS;
    else creg |= BITPHA;
    outpw(baseadr, creg);               // set mca or mcs mode
  }
  return TRUE;
}

int waitdav(int baseadr)               // wait for data vailid
{
  int i;
  for (i=0; i<MAXLOOP; i++) {
    creg = inpw(baseadr);
    if (creg & BITDAV) break;         // dav == 1 ?
  }
  if (i==MAXLOOP) return FALSE;
  return TRUE;
}
```

Variable	Meaning
Data	An array of structures containing the pointers to the data of each MCA (see section 4.3).

writemem

The writemem routine writes a block of channels.

```
int writemem(int nDev, long knum, int amount)
{
  int i, j, base8, base10;
  unsigned int num;
  int nDev0 = nDev;
  int baseadr;
  unsigned int huge *pt;

  if (nDev >= devices) nDev0 -= devices;
  if (demomod[nDev0]) return TRUE;
  baseadr = base[nDev0];
  if (!preparewrite(baseadr)) return FALSE;
  num = (unsigned int)(knum >> 1);
  if (nDev >= devices) num |= 0x8000;
  outpwt(baseadr+6, num);
  base8=baseadr+8;
  base10=baseadr+10;
  pt = (unsigned huge *)(&Data[nDev].s0[knum]);
  for (j=0; j<amount; j++) {
    outpw(base8, *pt++);
    outpw(base10, *pt++);
  }
  return TRUE;
}

int preparewrite(int baseadr)    // prepare for writing
{
  int i;
  creg = inpw(baseadr);
                                  // wmodrdy==0 or dav==1?
    creg &= 0x48E2;
    creg |= BITEN2;
    outpw(baseadr, creg);    // set mcs, pha, arm, enc, enrt=0 and en2=1
    outpw(baseadr+6, 0);     // address counter must be set to clear dav
    creg |= BITWRITE;
    outpw(baseadr, creg);          // set write=1
    for (i=0; i<MAXLOOP; i++) {
      creg = inpw(baseadr);
      if ((creg & BITWMODRDY) && !(creg & BITDAV)) break;
                                  // wmodrdy==1 && dav==0?
    }
    if (i==MAXLOOP) return FALSE;

  return TRUE;
}
```

clearspec

The clearspec routine clears an MCA.

```
void clearspec(int nDev)
{
  long i;
  int oldstate;
  int nDev0=nDev;

  if (nDev >= devices) nDev0 -= devices;
  oldstate = Status[nDev0].started;
  if (oldstate & 0x01) MCA_Stop(nDev0);

  for (i=memstart[nDev0]; i<memrange[nDev0]; i++) Data[nDev].s0[i]=0L;
  Status[nDev].totalsum=0.;
  Status[nDev].totalrate=0.;
  Status[nDev].roisum=0.;
```

```
  Status[nDev].nettosum=0.;
  oldevents[nDev]=0.;
  Status[nDev].realtime=0.;
  Status[nDev].livetime=0.;
  Data[nDev].cnt[CN_TOTALSUM]=0.;
  Data[nDev].cnt[CN_TOTALRATE]=0.;
  Data[nDev].cnt[CN_ROISUM]=0.;
  Data[nDev].cnt[CN_NETTOSUM]=0.;
  Data[nDev].cnt[CN_REALTIME]=0.;
  Data[nDev].cnt[CN_LIVETIME]=0.;
  if (!demomod[nDev0]) {
    for (i=memstart[nDev0]; i<memrange[nDev0]; i+=256) {
      writemem(nDev,i,256);
    }
  }
  rtimoff[nDev0] = 0L;
  ltimoff[nDev0] = 0L;
  writetimers(nDev);
  if (oldstate & 0x01) MCA_Continue(nDev0);
  else ShowStatus(nDev);
}
```

Variable Meaning

memstart[8] memory offset, where the active spectrum starts.

MCA_Newtime, MCA_Newsweeps

The MCA_Newtime routine sets the timers, MCA_Newsweeps the sweepcounter.

```
void MCA_Newsweeps(int nDev, unsigned long sweeps)
{
  Data[nDev].s0[memstart[nDev]] = (unsigned long)sweeps;
  writemem(nDev, memstart[nDev], 1);
}

void MCA_Newtime(int nDev, unsigned long rtim, unsigned long ltim)
{
  int i, j, base8, base10;
  unsigned int num;
  int baseadr;
  unsigned int *pt;
  unsigned int val0, val1;

  if (demomod[nDev]) return;
  baseadr = base[nDev];
  if (!preparewrite(baseadr)) return;
  num = (unsigned int)(memstart[nDev] >> 9) | 0xFF00;
  outpw(baseadr+6, num);
  base8=baseadr+8;
  base10=baseadr+10;
  pt = (unsigned int *)(&rtim);
  val0 = *pt++;
  val1 = *pt++;
  outpw(base8, val0);
  outpw(base10, val1);
  pt = (unsigned int *)(&ltim);
  outpw(base8, *pt++);
  outpw(base10, *pt++);
  return;
}
```

MCA_Gettime, MCA_Getsweeps

The MCA_Gettime routine reads the timers, MCA_Getsweeps the sweepcounter.

```
unsigned long MCA_Getsweeps(int nDev)
{
  readmem(nDev, memstart[nDev], 1);
  return Data[nDev].s0[memstart[nDev]];
```

```
}

void MCA_Gettime(int nDev, unsigned long *rtim, unsigned long *ltim)
{
  unsigned long val;
  unsigned *pw;
  unsigned int num;
  int i, base8, base10, baseadr;
  if (!Setting[nDev].active) return;
  if (demomod[nDev]) return;
  baseadr = base[nDev];
  if (!prepareread(nDev, baseadr)) return;
  pw = (unsigned *)(&val);
  num = (unsigned int)(memstart[nDev] >> 9) | 0xFF00;
  outpw(baseadr+6, num);
  base8=baseadr+8;
  base10=baseadr+10;
     if (!waitdav(baseadr)) return;
  pw[0] = inpw(base8);
  pw[1] = inpw(base10);
  *rtim = val;
     if (!waitdav(baseadr)) return;
  pw[0] = inpw(base8);
  pw[1] = inpw(base10);
  *ltim = val;
}
```

setpreset

The setpreset routine sets real- life time and sweep presets.

```
long rtim0, ltim0;
int setpreset(int nDev)
{
  int ret, nDev0=nDev;
  if (nDev0 >= devices) nDev0 -= devices;
  if (!(Setting[nDev0].mcsmode & 0x03)) {
    MCA_Gettime(nDev0, &rtim0, &ltim0);
    if (Setting[nDev0].prena & 0x01) {
      if(rtim0 < Setting[nDev0].rtpreset * dtimerticks[nDev0]) {
        rtimoff[nDev0] = (long)(Setting[nDev0].rtpreset *
            dtimerticks[nDev0]);
        rtim0 -= rtimoff[nDev0];
      }
      else {
        if (!ctlrunning) {
          ret = MessageBox(hwndMCD,
            "Realtime Preset reached! \nNew measurement without clear?",
            szAppName, MB_YESNO);
          if (ret==IDNO) return 1;
        }
        rtimoff[nDev0] = rtim0 + (long)(Setting[nDev0].rtpreset *
            dtimerticks[nDev0]);
        rtim0 = - (long)(Setting[nDev0].rtpreset * dtimerticks[nDev0]);
      }
    }
    else rtimoff[nDev0] = 0L;
    if (Setting[nDev0].prena & 0x02) {
      if(ltim0 < Setting[nDev0].ltpreset * dtimerticks[nDev0]) {
        ltimoff[nDev0] = (long)(Setting[nDev0].ltpreset *
            dtimerticks[nDev0]);
        ltim0 -= ltimoff[nDev0];
      }
      else {
        if (!ctlrunning) {
          ret = MessageBox(hwndMCD,
            "Lifetime Preset reached! \nNew measurement without clear?",
```

```
            szAppName, MB_YESNO);
          if (ret==IDNO) return 1;
        }
        ltimoff[nDev0] = ltim0 + (long)(Setting[nDev0].ltpreset *
            dtimerticks[nDev0]);
        ltim0 = - (long)(Setting[nDev0].ltpreset * dtimerticks[nDev0]);
      }
    }
    else ltimoff[nDev0] = 0L;
    MCA_Newtime(nDev0, rtim0, ltim0);
  }
  else {
    ltim0 = MCA_Getsweeps(nDev0);
    if (Setting[nDev0].prena & 0x04) {
      if(ltim0 < Setting[nDev0].swpreset) {
        ltimoff[nDev0] = (long)(Setting[nDev0].swpreset+1);
        ltim0 -= ltimoff[nDev0];
      }
      else {
        if (!ctlrunning) {
          ret = MessageBox(hwndMCD,
            "Sweep Preset reached! \nNew measurement without clear?",
            szAppName, MB_YESNO);
          if (ret==IDNO) return 1;
        }
        ltimoff[nDev0] = ltim0 + (long)(Setting[nDev0].swpreset+1);
        ltim0 = - (long)(Setting[nDev0].swpreset+1);
      }
    }
    else ltimoff[nDev0] = 0L;
    MCA_Newsweeps(nDev0, ltim0);
    if ((Setting[nDev0].prena & 0x01) &&
      (Status[nDev0].realtime >= Setting[nDev0].rtpreset)) {
      if (!ctlrunning) {
        ret = MessageBox(hwndMCD,
          "Realtime Preset reached! \nNew measurement without clear?",
          szAppName, MB_YESNO);
        if (ret==IDNO) return 1;
      }
      rtime0[nDev0] = 0.;
      Status[nDev0].realtime = 0.;
      Data[nDev0].cnt[CN_REALTIME] = Status[nDev0].realtime;
      if (Setting[nDev0].mcsmode & 0x02) {
        int nDev1 = nDev0 + devices;
        Status[nDev1].realtime = 0.;
        Data[nDev1].cnt[CN_REALTIME] = Status[nDev1].realtime;
      }
    }
  }
  return 0;
}
```

MCA_Start

The MCA_Start routine starts an acquisition.

```
void MCA_Start(int nDev)
{
  time_t    tnow;
  struct tm *tmnow;
  char buf[80];
  time(&tnow);
  tmnow = localtime(&tnow);
  wsprintf(buf, "%.2d/%.2d/%.2d %.2d:%.2d:%.2d ",
      tmnow->tm_mon+1, tmnow->tm_mday, tmnow->tm_year, tmnow->tm_hour,
      tmnow->tm_min, tmnow->tm_sec);
  lstrcpy((LPSTR)Data[nDev].comment0, (LPSTR)buf);
  if (Setting[nDev].mcsmode & 0x02)
    lstrcpy((LPSTR)Data[nDev+devices].comment0, (LPSTR)buf);
  cardreset(nDev);
```

```
  //cardset(nDev);
  MCA_Continue(nDev);
}

void MCA_Continue(int nDev0)
{
  int baseadr = base[nDev0];
  int nDev1 = nDev0;
  if (demomod[nDev0]) return;
  setpreset(nDev0);
  prepareread(nDev0, baseadr);  // set write=0, chose mcs or pha mode
  if (Setting[nDev0].mcsmode & 0x02) {  // 2 inputs mcsmode
    creg &= 0x01EE;                     // denb=0, enc=0, en2=0,
                                         // write=0, enrt=0
    if (Setting[nDev0].mcsmode & 0x04)  // retrigger mode
      creg |= BITENRT;                  // enrt=1
    creg |= BITARM;                     // arm=1
    nDev1 += devices;
  }
  else if (Setting[nDev0].mcsmode & 0x01) {  // 1 input mcsmode
    creg &= 0x0D6E;                     // denb=0, enc=0, write=0
    if (Setting[nDev0].mcsmode & 0x04)  // retrigger mode
      creg |= BITENRT;                  // enrt=1
    creg |= 0x0900;                     // arm=1, en2=1
  }
  else {                                // pha mode
    creg &= 0x2CE2;                     // denb=0, arm=0, write=0
    if (pol0[nDev0] & 0x10)
      creg |= BITDENB;                  // denb=1
    creg |= (BITENC | BITPHA);          // enc=1
  }
  outpw(baseadr, creg);
  startclock[nDev0] = clock();
  Status[nDev0].started = ON;
  Status[nDev1].started = ON;
  dumpsts();
  (*lpStoreStatusData)(&Status[nDev0],nDev0); //store status data in DLL
  if (Setting[nDev0].mcsmode & 0x02)
    (*lpStoreStatusData)(&Status[nDev1],nDev1);
}

void NEAR dumpsts()
{
  int i;
  FILE *f;

  f = fopen("MCD2.STS", "w+t");
  fprintf(f,"%s\n", Data[0].comment0);
  for (i=0; i<devices; i++)
    fprintf(f,"%lu %lu\n",rtimoff[i], ltimoff[i]);
  fclose(f);
}
```

MCA_Stop

The MCA_Stop finishes an acquisition.

```
void MCA_Stop(int nDev)
{
  int nDev0 = nDev;
  if (nDev >= devices) nDev0 -= devices;
  MCA_Halt(nDev0);
  ShowStatus(nDev0);
  if (Setting[nDev0].mcsmode & 0x02) ShowStatus(nDev0+devices);
  if ((Setting[nDev0].mcsmode & 0x03) && (Status[nDev0].started & 0x01))
  {
    if (IDNO == MessageBox(hwndMCD,
          "Sweep still running! \nAbort Sweep?",
          szAppName, MB_YESNO)) return;
    abortsweep(nDev0); ShowStatus(nDev0);
```

```
  }
}

void MCA_Halt(int nDev0)
{
  int baseadr = base[nDev0];
  if (demomod[nDev0]) {
    return;
  }
  creg = inpw(baseadr);
  creg &= 0xCCEE;                // enc=0, arm=0, write=0
  if (!(Setting[nDev0].mcsmode & 0x03)) {
    if (pol0[nDev0] & 0x10)      // denb=1
      creg &= (0xFFFF ^ BITDENB);
    else
      creg |= BITDENB;
  }
  outpw(baseadr, creg);  // set (evt. pclr=1), enc=0, arm=0, write=0
}

void abortsweep(int nDev)
{
  if (demomod[nDev]) return;
  creg = inpw(base[nDev]);
  creg &= 0x6EFC;             // (MASK & 0xFEFF); arm=0
  creg |= BITABORT;           // abort = 1
  outpw(base[nDev], creg);
  for (i=0; i<450; i++) {
    creg = inpw(base[nDev]);
    if (creg & BITON) waitmsec(100); // wait 100 msec if still running
    else break;
  }
  creg &= 0x6EFC;             // abort = 0
  outpw(base[nDev], creg);
  setioreg(nDev);
}
```

makesweep, makeadvance

The makesweep starts a software sweep, makeadvance advances a new time bin.

```
void makesweep(int nDev)
{
  if (demomod[nDev]) return;
  creg = inpw(base[nDev]);
  creg &= MASK;
  creg |= BITSTRG;           // strg = 1
  outpw(base[nDev], creg);
}

void makeadvance(int nDev)
{
  if (demomod[nDev]) return;
  creg = inpw(base[nDev]);
  creg &= MASK;
  creg |= BITSADV;           // sadv = 1
  outpw(base[nDev], creg);
}
```

7. Appendix

7.1. Absolute maximum ratings

Input voltage (Trigger, Count 1 & 2): ..... -5.3 to +5.3 V
Input voltage (all other digital I/O lines): ..... -0.5 to +5.5 V

7.2. Connectors

7.2.1. MCS Inputs

Trigger Input

Connector type:	LEMOSA Series 00 NIM-CAMAC
Input voltage range:	± 5 V
Input threshold range:	± 5 V
Input threshold step size:	39 mV
Input comparator bandwidth:	(20mV overdrive voltage) 600 MHz
Input slew rate requirement:	min. 0.5 V/µs
Input impedance:	50 Ω
Slope:	programmable falling or rising edge

Count 1 & 2 Inputs

Connector type:	LEMOSA Series 00 NIM-CAMAC
Input voltage range:	± 5 V
Input threshold range:	± 5 V
Input threshold step size:	39 mV
Input comparator bandwidth:	(20mV overdrive voltage) 600 MHz
Input slew rate requirement:	min. 0.5 V/µs
Input impedance:	50 Ω

External Channel Advance

Connector type:	LEMOSA Series 00 NIM-CAMAC
Input voltage range:	TTL
Input impedance:	4.7 kΩ pull-up

7.2.2. MCA / ADC port

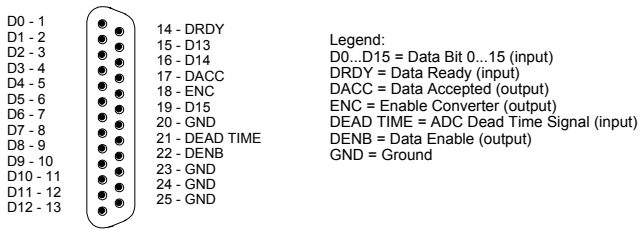


Figure 7.1: ADC Port Connector

Connector	25 pin female D-SUB
Low amplitude	≤ 0.5 V
High amplitude	≥ 4.5 V
Maximum rating	- 0.5 to + 5.5 V
Input impedance	10 kΩ pull-up
Output impedance	100 Ω

D0...15 - Active low data input signals

DRDY - Data Ready input signal indicating that valid data are present at the ADC port. The polarity is software selectable.

DACC - Data Accepted output signal. The polarity is software selectable.

DEAD TIME - Dead Time input signal. The polarity is software selectable.

ENC - Enable Converter output signal to arm the connected ADC, TOF, etc. The polarity is software selectable.

DENB - Output signal to enable a tri-state data output driver of the ADC, TOF, etc. The polarity is software selectable.

7.3. Performance

7.3.1. General

Memory:	128k x 32 bit
Basic Operating Modes:	Multiscaling Pulse Height / Multichannel Analysis
Spectra Ranges:	256, 512, 1k, 2k, 4k, 8k, 16k, 32k, 64, or 128k
Spectra Offset:	512 to 130560 (= 128k - 512) programmable in steps of 512
Temperature Range:	0 - 50°C

7.3.2. PHA / MCA Mode

PHA / MCA Input Rate:	max. 4 * 10^6 events / s
"Add-one" Cycle Time:	2 µs
Live / True Timer Resolution:	10 ms
Timer Preset Range:	10 ms to >11930 h

7.3.3. MCS Mode

Dwell Time Modes:	internal, external, manual
Internal Dwell Time:	1 MCS input channel min. 1 µs 2 MCS input channels min. 2 µs max. 160 s step size: N x 10^M x 1 µs N = 1 to 16; M = 0 to 7
External Channel Advance:	rising edge sensitive
Pulse Width External Clock:	min. 500 ns synchronized to the internal oscillator clock
Count Rate Capability:	COUNT 1 & 2: falling edge sensitive 60 MHz (>150 MHz burst)
Pulse Width COUNT IN 1&2:	TBD
Pulse Width TRIGGER IN:	TBD
Interchannel Dead Time:	< ± 0.5 ns
End of Sweep Dead Time:	1 MCS input channel 750 ns 2 MCS input channels 1750 ns Retrigger mode no additional dead time
Trigger Delay:	Complete sweep mode 1375 ns Retrigger mode 4375 ns
Trigger Uncertainty:	± 125 ns
Trigger Modes:	complete sweeps, instant retrigger, manual
Sweep Preset Range:	2 to 2^{32}

All technical data are for ±5 V power supply, FAST NIM input pulses and a 4 MHz system clock.

7.4. Power Requirements

Computer Power Supply	..... + 5 V / ±0.25V
	..... - 5 V / ±0.25V @ 150mA
Battery	..... 3 V Lithium type
	Data retention current consumption ..... typ. 7.5 mA

7.5. Physical

Size	$^{2}/_{3}$ length ISA bus PC-card, ... ≈ 218 x 135 mm
Weight	..... ≈ TBD