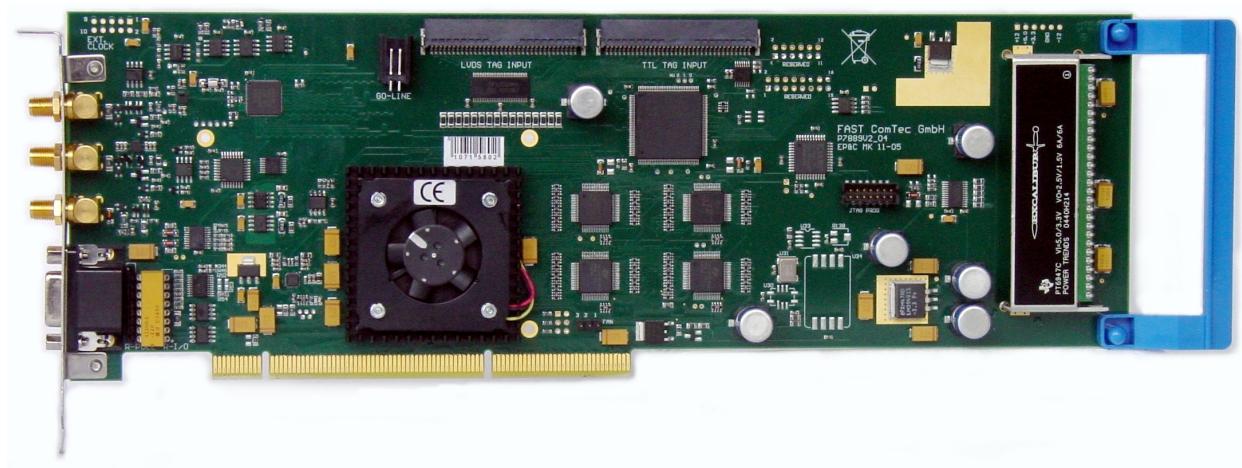


P7889

100 ps / 10 GHz Time-of-Flight / Multiscaler

User Manual

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Version 3.14, Januar 14, 2014

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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.

Important Information on Hardware Compatibility

The P788x Series Multiscalers are PCI Local Bus compliant devices. As such the board contains the configuration space register organization as defined by the PCI Local Bus Specification. Among the functions of the configuration registers is the storage of unique identification values for our devices as well as storage of base address size requirements for correct operation specific to each of our products.

The host computer that our products are installed in is responsible for reading and writing to/from the PCI configuration registers to enable proper operation. This functionality is referred to as 'Plug and Play' (PnP). As such, the host computer PnP BIOS must be capable of automatically identifying a PCI compliant device, determining the system resources required by the device, and assigning the necessary resources to the device. Failure of the host computer to execute any of these operations will prohibit the use of the P788x Series Multiscalers in such a host computer system.

It has been determined that systems that implement PnP BIOS, and contain only fully compliant PnP boards and drivers, operate properly. However, systems that do not have a PnP BIOS installed, or contain hardware or software drivers, which are not PnP compatible, may not successfully execute PnP initialization. This can render the P788x Series inoperable. It is beyond the ability of FAST ComTec's hardware or software to force a non-PnP system to operate P788x Series Multiscalers.

WARNINGS

Damage to the P7889 board, the computer or injury to yourself may result if power is applied during installation.

Static electricity discharges can severely damage the P7889. Use strict antistatic procedures during the installation of the board.

Take care to provide ample airflow around the P7889 board.

Take care not to exceed the maximum input values as described in the technical data.

The START and STOP inputs are ultra high speed, high sensitivity inputs and thus, susceptible to oscillation. Take care to apply low impedance ($\leq 50 \Omega$) source signals and well shielded, 50Ω cables.

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1. Introduction

The P7889 64Bit/66MHz/3.3V PCI board is one of the fastest commercially available multiple event time digitizers. It can be used as an ultra fast Multiscaler/TOF system in Time-of-Flight Mass-Spectrometry and time-resolved Single Photon Counting. The P7889 is capable of accepting one edge event (stop pulse) in every time bin. A genuine feature is the P7889's capability to detect rising and falling edges simultaneously. Thus, Time-over-Threshold (ToT) measurements can easily be accomplished. Burst/peak count rates of up to 10 GHz can be handled with no deadtime between timebins. The proprietary input logic securely prevents double counting.

The exceptionally dynamic range of up to 64 bit enables sweeps for an incredible 54 years with a time resolution of 100 ps. A crystal stabilized PLL oscillator assures a resolution of typically <400 ps FWHM at a full scale time range of 100 μ s (measured in the last time bin of 400,000 time bins and 30 minutes acquisition time). An optional available oven stabilized oscillator further improves long-term and temperature stability.

A two step FIFO¹ memory concept enables for ultra high event rate capability. Full 10 GHz bursts can be buffered for at least 6.5 μ s. The first 1024 deep multi event FIFO buffers incoming events at a maximum countrate of 10 GHz. A second 32k deep FIFO is filled at over 31 MHz and buffers the subsequent data transfer over the PCI bus. Data reduction is performed by recording interesting, i.e. inside a preselected time window arriving stop events only.

For experiments requiring repetitive sweeps the spectral data obtained from each sweep can be summed in the PC enabling extremely high sweep repetition rates. A presettable 32 bit sweep counter enables for exact normalization calculations.

The ultra fast discriminator inputs (± 1 V input voltage range) allow for a large range of START and STOP input signals.

Sixteen TAG inputs allow for a wide range of spectra routing, multi detector experiments, sequential acquisition etc.

An open-drain 'GO'-line (compatible to other products of FAST ComTec) allows for overall experiment synchronization.

Two software configurable SYNC outputs provide synchronization and triggering of external devices or experiment monitoring.

A versatile 8 bit digital I/O² port may further satisfy your experimental needs.

The P7889 is a fully digital design with "state-of-the-art" components offering excellent performance and reliability.

The high-performance hardware is matched by sophisticated software delivered with each P7889. MCDWIN - the MS-WINDOWS™ based operating software - provides a powerful graphical user interface for setup, data transfer and spectral data display.

Some of MCDWIN's features are high-resolution graphics displays with zoom, linear and logarithmic (auto)scaling, grids, ROIs³, Gaussian fit, calibration using diverse formulas and FWHM⁴ calculations. Macro generation using the powerful command language allows task oriented batch processing and self-running experiments.

A DLL (Dynamic Link Library) is available for operation in a Laboratory Automation environment.

¹ FIFO: First In, First Out

² I/O: Input / Output

³ ROI: Region Of Interest

⁴ FWHM: Full Width at Half Maximum

2. Installation Procedure

2.1. Hard- and Software Requirements

The P7889 requires a personal computer (with INTEL™ compatible processor) with an available 64 Bit / 3.3V PCI slot.

A Pentium II or higher processor and at least 64MB of memory are recommended.

A Microsoft WINDOWS 2000/XP or higher operating system must be installed.

2.2. Hardware Installation

Turn off the power to your computer system and remove the line cord. Discharge your body from any static electricity by touching a grounded surface – e.g. the metal surface of the power supply – before performing any further hardware procedure.

FAST ComTec assumes no liability for any damage, caused directly or indirectly, by improper installation of any components by unqualified service personnel. If you do not feel comfortable performing the installation, consult a qualified technician.

WARNING

Damage to the P7889 board, the computer or injury to yourself may result if power is applied during installation.

Static electricity discharges can severely damage the P7889. Use strict antistatic procedures during the installation of the board.

Open the cover of the computer case and insert the P7889 PCI board in an unused 64 Bit / 3.3V PCI slot. You might first have to remove the cover from the rear of the PCI expansion slot you selected. After the board is carefully seated in the PCI slot, make sure you fasten the board with a screw to the mounting bracket.

WARNING

Take care to provide ample airflow around the P7889 board.

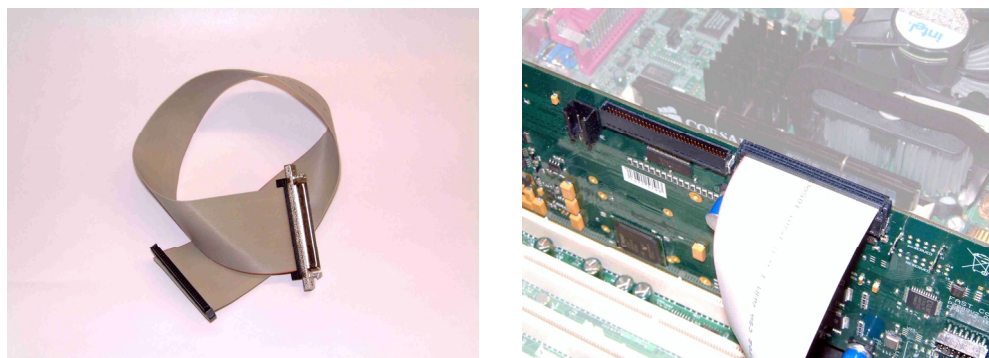


Figure 2.1: TAG input port connector

If you purchased the TAG-bits input option install the TAG input port connector now. Mount the housing bracket with the 68-pin SCSI-2 type connector in another available slot of your computer. On the P7889 PCI board Plug in the 68-pin socket connector (at the end of the ribbon cable) into the 68 pin four-walled header named TTL TAG INPUT or LVDS TAG INPUT respectively.

2.3. Software Installation

If you are using Windows ME, Windows 2000 or XP, the hardware manager will recognize the PCI card as a new hardware the first time after power on with the PCI card mounted, and will ask for a driver. Please insert then the installation disk and specify the WDMDRV directory on the installation medium as the driver location.

To install the P7889 software on your hard disk insert the P7889 installation disk and start the installation program by double clicking from the explorer

SETUP

A directory called C:\P7889 is created on the hard disk and all P7889 and MCDWIN files are transferred to this directory. Drive C: is taken as default drive and \P7889 as default directory. It is not mandatory that the P7889 operating software is located in this directory. You may specify another directory during the installation or may copy the files later to any other directory.

The Setup program has installed two shortcuts on the desktop, one icon is for Launch89.exe. Launch89.exe starts the P7889 Hardware Server program P7889.EXE in high priority, this is recommended when using DMA mode. The other icon starts directly the P7889.EXE in normal priority. The server program will automatically call the MCDWIN.EXE program when it is executed. The P7889 Server program controls the P7889 board but provides no graphics display capability by itself. By using the MCDWIN program, the user has complete control of the P7889 along with the MCDWIN display capabilities.

If you have more than one P7889 modules installed, edit the line devices=1 in the file P7889.INI and enter the number of modules. The frequency of the PLL in units of Hz has to be defined in the P7889.INI file by a line like pllfreq=10e9.

To run the P7889 software, simply double click on the "P7889 Server Program" icon. To close it, close the P7889 server in the Taskbar.

2.4. Getting Started with a basic measurement

To ease getting familiar with the use of the P7889 we will now setup a basic measurement. We use a simple TTL signal generator to supply START and STOP signals.

We want to measure the arrival time of multiple STOP events in a time window of 4 μ s that begins 10 μ s (delayed acquisition) after a START (Trigger) pulse. After a specific sweep a new start (trigger) should not be accepted for an additional 50 μ s (trigger hold off). The measurement should run for exactly 1,000,000 sweeps (scans, shots) until it ends. The resulting spectrum is suggested to look like a garden fence with peaks every 100 ns or 1000 time bins.

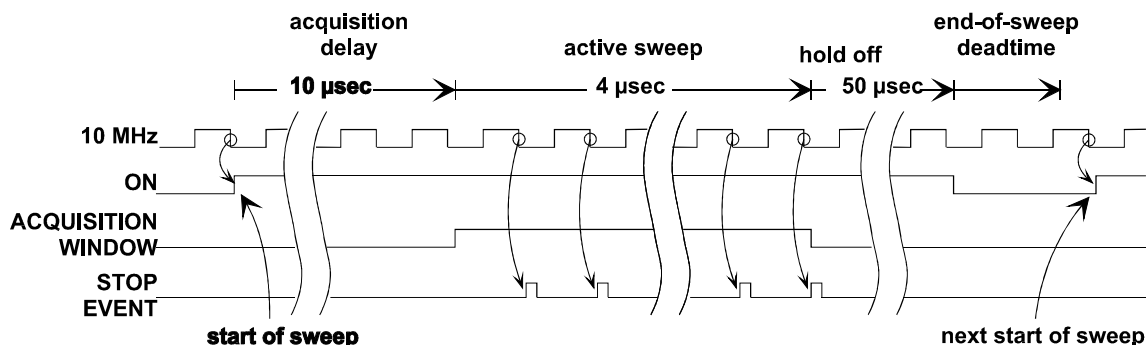


Figure 2.2: Basic measurement timing diagram

First let's setup up the wire connections to the board and then start the software to run the measurement.

2.4.1. Connecting the test signals

The generator should be able to drive two $50\ \Omega$ inputs to some hundred millivolts and should not exceed $1.7\ \text{V}$ as not to exceed the absolute maximum ratings of the inputs. For this, a $50\ \Omega$ power splitter divides the $10\ \text{MHz}$ TTL signal into two branches. The two output signals of the power splitter are connected to the START and STOP inputs on the PCI bracket (ref. Figure 2.4).

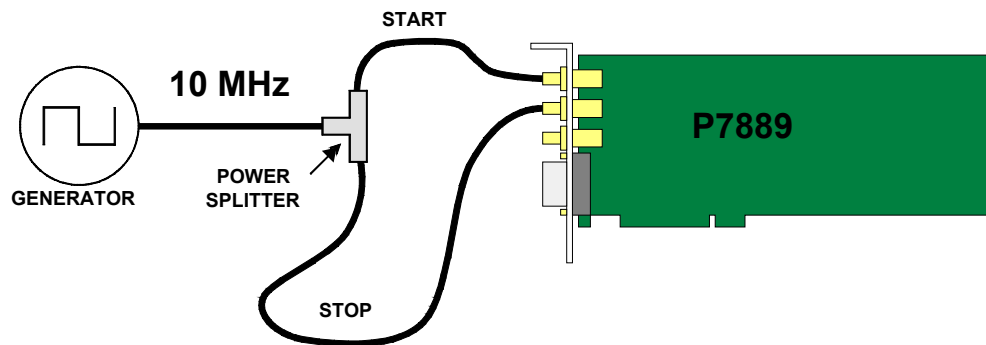


Figure 2.3: Basic measurement setup

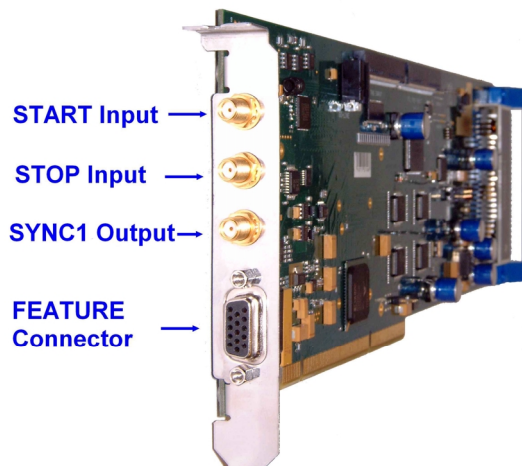


Figure 2.4: Bracket mounted signal connectors

2.4.2. Starting MCDWIN and setup for the measurement

Next step is to start the P7889 software by double clicking the corresponding icon. This will automatically start the MCDWIN program. On startup the P7889 Server is iconized and one does not have to worry about it since all hardware settings are also accessible from the MCDWIN program which actually is the graphical user interface and which will appear now on your screen (ref. Figure 2.5).

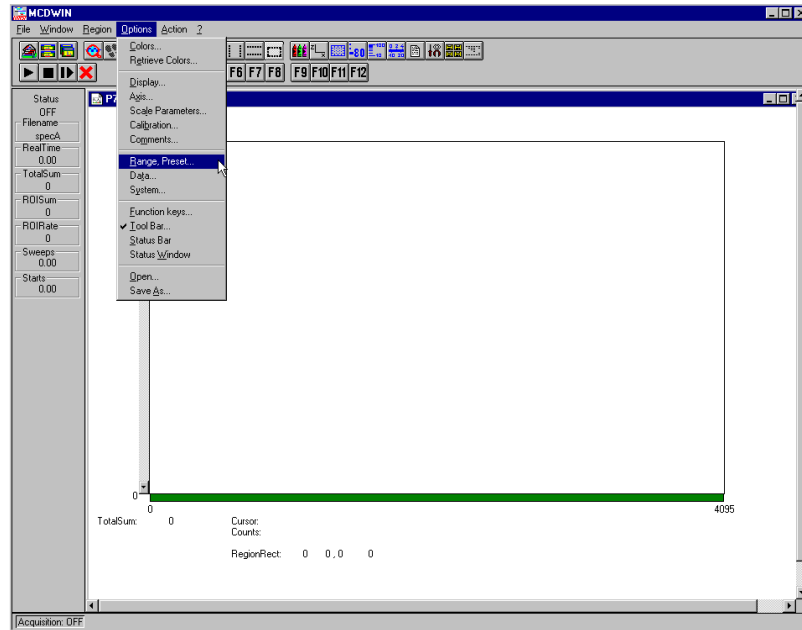


Figure 2.5: P7889 / MCDWIN startup window

Now we first have to setup the P7889. Click on Options – Range, Preset ... to find the P7889 Settings window pop up. Set the Range to 10,000 time bins (Binwidth = 1) which corresponds to the desired 1 μ s time range. Set the Acquisition Delay to 10,000 ns = 10 μ s and the Hold Off to 50,000 ns.

Enable the sweep preset and type in the number of sweeps as 1,000,000 (ref. Figure 2.6). Then click on Inputs to select the desired input threshold levels.

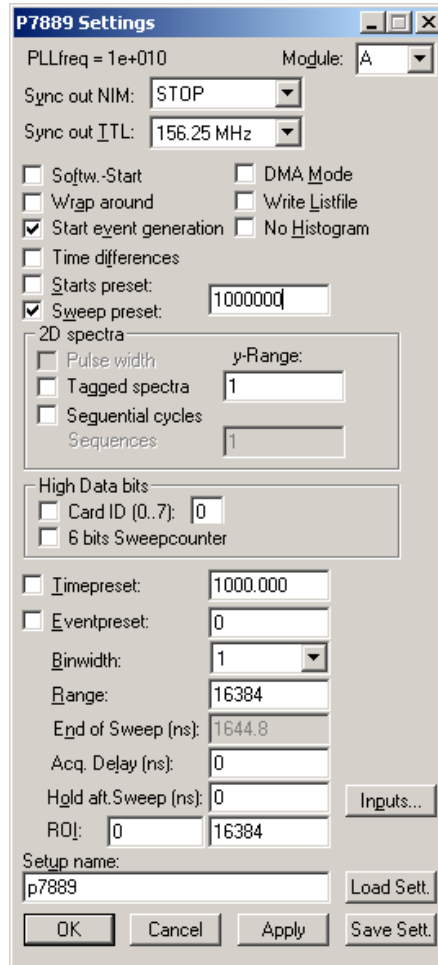


Figure 2.6: P7889 Settings window

Select the Start and Stop inputs and set them to 'Customized' and a voltage level corresponding to your signal amplitude (e.g. +0.5 V, ref. Figure 2.7). Now click OK to get back to the P7889 Settings window. Again click OK.

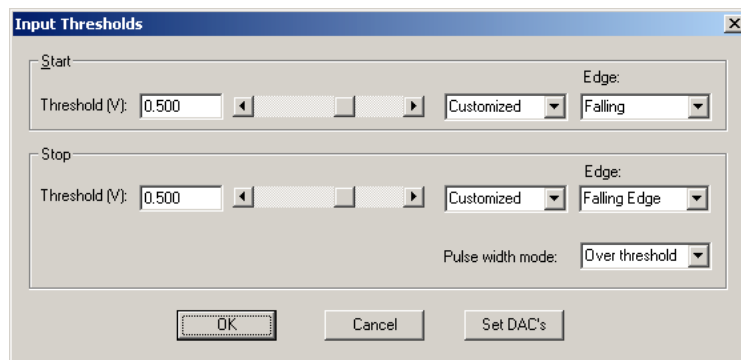


Figure 2.7: Input Threshold window

To verify the quality of the discriminated signals select START resp. STOP on the Fast NIM¹ SYNC output (ref. Figure 2.6) and connect the SYNC_1 output to an oscilloscope. Take care to

¹ NIM: Nuclear Instrument Modules. This is a standard for mechanical and electronic properties of such modules.

terminate the cable with 50 Ω . Now you can online watch the effect of changing the input thresholds.

Now lets change the display to have a grid and the axis numbered. Click on Options – Axis.... Enable the grid and the axis ticks (ref. Figure 2.8). Also enable 'Use Calibration' to see the x-axis in time units rather than channels. Then click OK.



Figure 2.8: Axis Parameter window

Now lets setup the scale calibration feature to see the actual time data in the spectrum. Click on Options – Calibration.... and make sure 'Use Calibration' is enabled (ref. Figure 2.9) and the calibration formula is set to $p_0 = 10,000$ (offset) and $p_1 = 0.1$ (time bin width) while the 'Unit' should be nsec.

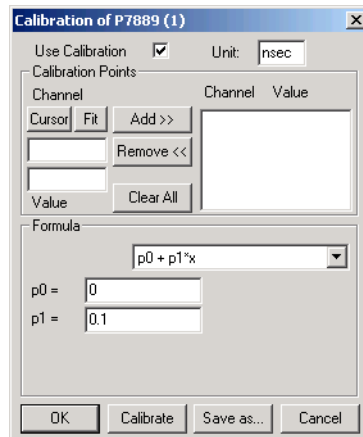


Figure 2.9: Calibration of P7889

The hardware is initialized properly now and also the display should appear as in Figure 2.10. To start the measurement now click on the Start button.

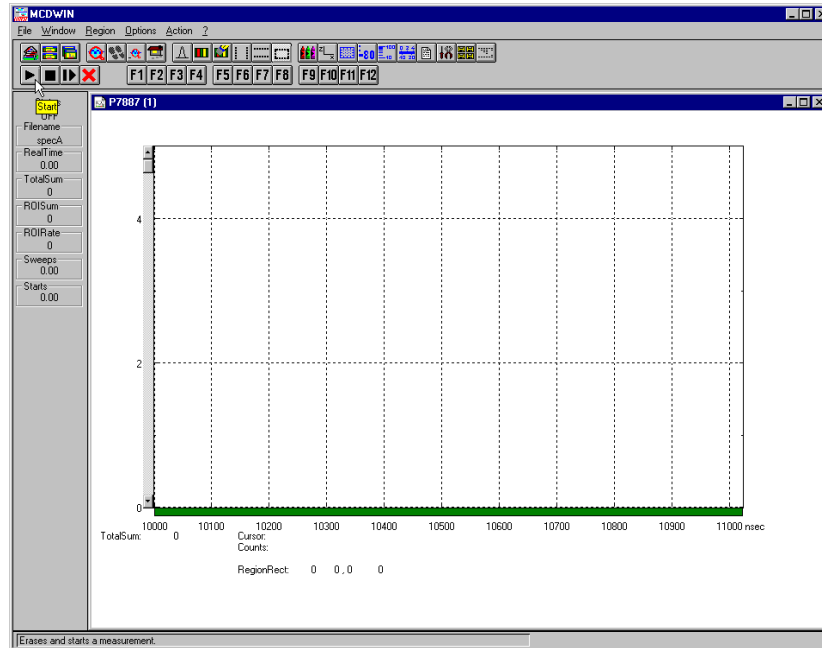


Figure 2.10: MCDWIN properly setup

The measurement will begin to run and ends when 1,000,000 sweeps are done. The resulting spectrum should look as in Figure 2.11. The peaks are separated by 1000 channels or 100 ns. The sweep counter shows that exactly 1,000,000 sweeps have been acquired.

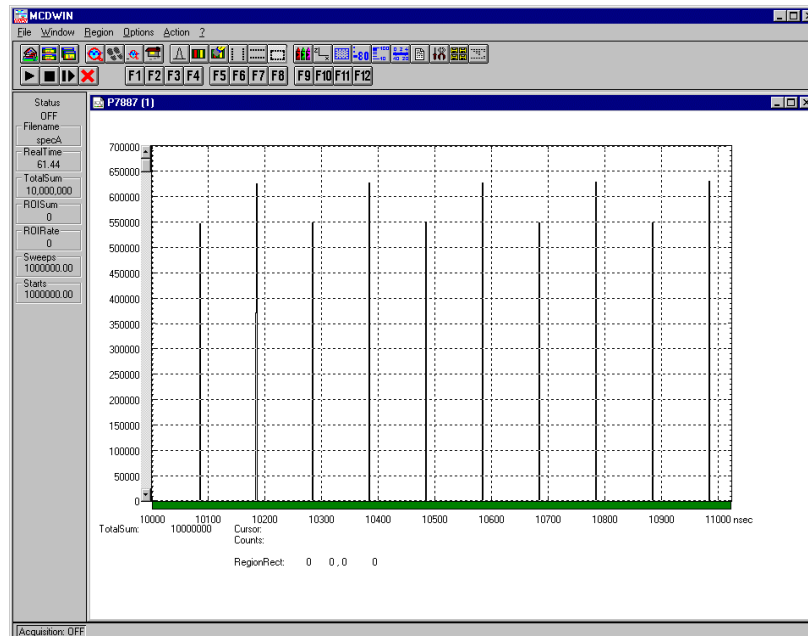


Figure 2.11: Resulting spectrum of the basic measurement

3. Hardware Description

3.1. Overview

The P7889 is a full size 64 Bit / 66 MHz / 3.3V PCI PC board with bus master capabilities. All settings are software selectable. No jumper, switch, etc. configurations are necessary. It is able to measure multiple events with a time resolution of 100 ps. The logic is able to accommodate an incredible burst edge rate of 10 GHz only limited by the analog STOP input bandwidth and sensitivity. No deadtime between the time bins and secure prevention of double counting is established by the sophisticated input logic circuitry. A unique feature is the P7889's capability to measure rising and falling edge events simultaneously. Thus, even Time-over-Threshold or pulse width measurements are easily accomplished.

The concept of a two step onboard FIFO with an ultra fast 1024 deep multi event FIFO and a second 32k deep FIFO allows for unprecedented burst and average count rates.

Additional features are two onboard discriminators. This enables the inputs to be adjusted for a large range of input signals.

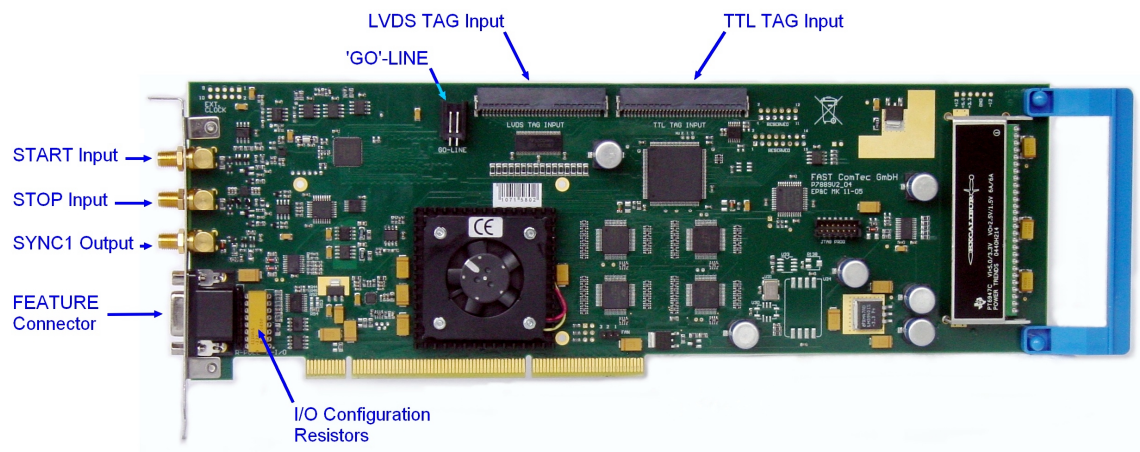


Figure 3.1: P7889 PCI board

Besides, two SYNC outputs with a large variety of output signal options (all software selectable) and the 'GO'-line (compatible to other FAST products) allow for easy synchronization or triggering of other measurement equipment.

Furthermore a versatile, user configurable 8 bit digital I/O port allows for a whole bunch of experimental control, monitor or whatsoever other tasks.

Moreover, the 16 bit TAG input allows for multi-detector configurations, sequential data acquisition etc.

3.2. START / STOP Inputs

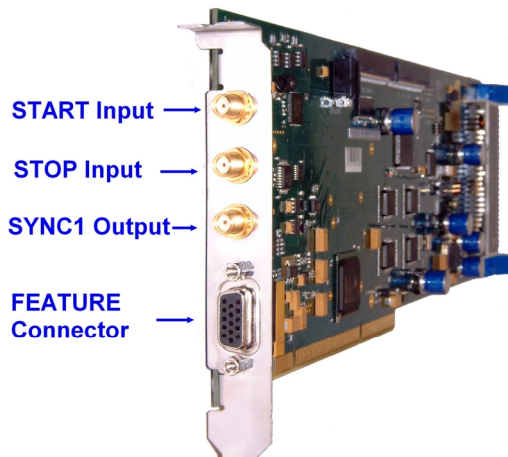


Figure 3.2: Connectors on the mounting bracket

The START (Trigger) and STOP (event) inputs are SMA types located on the mounting bracket (ref. Figure 3.2). The input impedance is $50\ \Omega$. The inputs are edge sensitive with software selectable rising or falling edge and additionally both edges for the STOP input. The threshold level is software tunable in a range of $\pm 2.0\text{ V}$.

WARNING

Take care not to exceed the maximum input values as described in the technical data (ref. chapter 8.2.1).

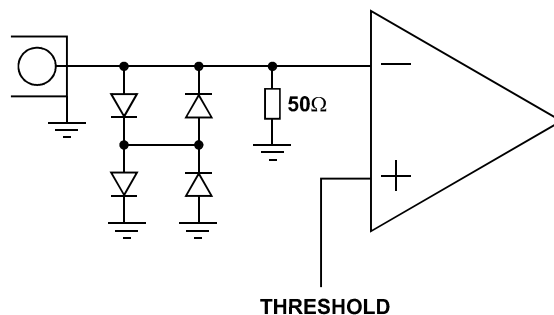


Figure 3.3: START / STOP input schematic

WARNING

The START and STOP inputs are ultra high speed, high sensitivity inputs and thus, susceptible to oscillation. Take care to apply low impedance ($\leq 50\ \Omega$) source signals and well shielded, $50\ \Omega$ cables.

The discriminator signals, as detected by the input circuitry, may be monitored online with an oscilloscope on the Fast-NIM SYNC_1 output. Thus, optimization of the threshold voltages was never as easy.

The high sensitivity of the START / STOP discriminators together with the monitoring feature on the SYNC outputs allow signal amplitudes even below 10 mV to be used (ref. Figure 3.4).

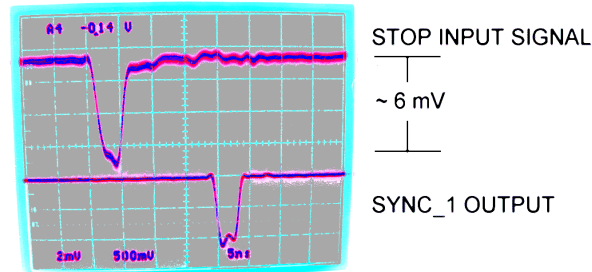


Figure 3.4: Trace of the STOP input sensitivity

3.3. SYNC / Monitor Outputs

The SYNC outputs provide a large variety of output signals for a lot of synchronizing, triggering, monitoring or whatever application. The selectable output signals are:

- **START:** Discriminated START input signal (available on SYNC_1 only)
- **STOP:** Discriminated STOP input signal (available on SYNC_1 only)
- **156.25 MHz** 10 GHz Sampling clock / 64
- **78.125 MHz** 10 GHz Sampling clock / 128
- **PCICLK** PCI bus clock
- **10 MHz** 10 MHz reference clock
- **INPUT_ON:** indicates a running sweep when logic '1'
- **WINDOW:** indicates the active measurement / acquisition time window
- **HOLD_OFF** Trigger hold off time window
- **COUNT[0]:** $6.4 \text{ ns} = 2^0 \times 6.4 \text{ ns}$ periodic timer signal active only while a sweep is running
- **COUNT[1]:** $12.8 \text{ ns} = 2^1 \times 6.4 \text{ ns}$ periodic timer signal active only while a sweep is running
- **COUNT[2]:** $25.6 \text{ ns} = 2^2 \times 6.4 \text{ ns}$ periodic timer signal active only while a sweep is running
- ...
- **COUNT[31]:** $13.74 \text{ s} = 2^{31} \times 6.4 \text{ ns}$ periodic timer signal active only while a sweep is running
- **SWEEP[0]:** bit 0 (LSB) of the sweep counter
- **SWEEP[1]:** bit 1 of the sweep counter
- **SWEEP[2]:** bit 2 of the sweep counter
- ...
- **SWEEP[31]:** bit 31 (MSB) of the sweep counter

All these signals may be output on the Fast-NIM SYNC_1 output on the mounting bracket and on the TTL SYNC_2 output on the FEATURE connector as well (START/STOP only on SYNC_1).

NOTE:

The initial states of the 'SWEEP' output bits depend on the preset value of the corresponding counter. The sweep counter is a 32 bit up-counter. In case of a preset it is set to ($FFFFFFF_{\text{hex}} - \text{'preset_value'}$) and runs until $FFFFFFF_{\text{hex}}$ is reached. When no preset is used the sweep counter is initially set to all zero.

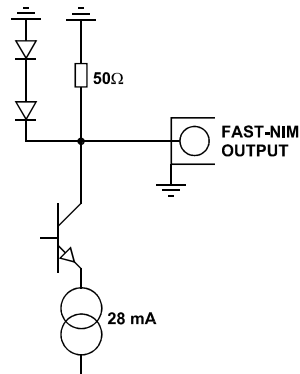


Figure 3.5: Fast-NIM SYNC_1 output schematic

The Fast-NIM SYNC output supplies standard Fast-NIM (0...-0.7 V / 14 mA) signals into a 50 Ω load. The output impedance also is 50 Ω. For Fast-NIM signals a logical 'TRUE' corresponds to a low voltage (-0.7 V), e.g. while a sweep is running 'ON' will result in -0.7 V (= 'TRUE') output.

3.4. TAG Inputs

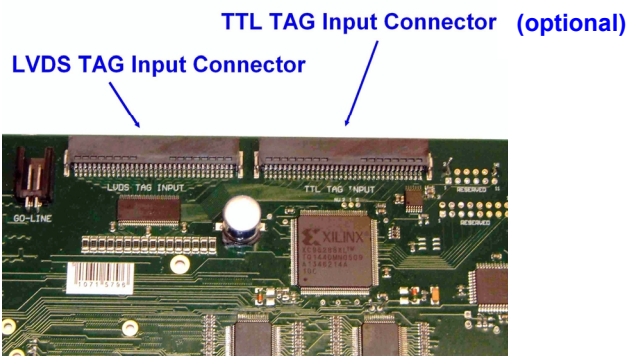


Figure 3.6: TAG input connector

A unique feature of the P7889 is a 16 bit TTL/LVDS TAG input with a time resolution of 6.4 ns.

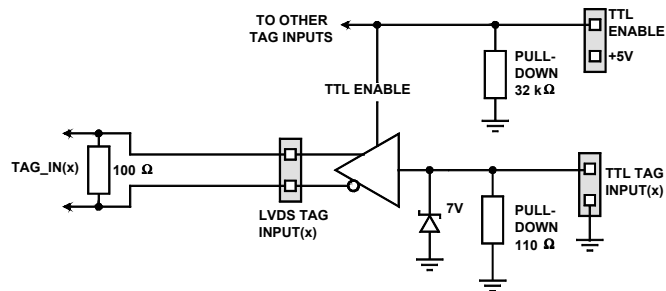


Figure 3.7: TAG input simplified schematic

As can be seen from the above figure the TTL_ENABLE input must be connected to +5V when the TTL TAG inputs are used. Otherwise - if the LVDS TAG input or no TAGs at all are used - TTL_ENABLE should be left unconnected.

A short between wires 34 and 68 on the TAG input cable would be sufficient for either case.

For a functional description of the TAG input refer chapter 4.2.4.

TTL TAG Input

GND - 1	●	35 - T0
GND - 2	●	36 - GND
T1 - 3	●	37 - GND
GND - 4	●	38 - GND
GND - 5	●	39 - T2
GND - 6	●	40 - GND
T3 - 7	●	41 - GND
GND - 8	●	42 - GND
GND - 9	●	43 - T4
GND - 10	●	44 - GND
T5 - 11	●	45 - GND
GND - 12	●	46 - GND
GND - 13	●	47 - T6
GND - 14	●	48 - GND
T7 - 15	●	49 - GND
GND - 16	●	50 - GND
GND - 17	●	51 - T8
GND - 18	●	52 - GND
T9 - 19	●	53 - GND
GND - 20	●	54 - GND
GND - 21	●	55 - T10
GND - 22	●	56 - GND
T11 - 23	●	57 - GND
GND - 24	●	58 - GND
GND - 25	●	59 - T12
GND - 26	●	60 - GND
T13 - 27	●	61 - GND
GND - 28	●	62 - GND
GND - 29	●	63 - T14
GND - 30	●	64 - GND
T15 - 31	●	65 - GND
GND - 32	●	66 - TCLK Out
GND - 33	●	67 - GND
+5V - 34	●	68 - TTL_ENABLE

LVDS TAG Input

T0_P - 1	●	35 - T0_N
GND - 2	●	36 - GND
T1_P - 3	●	37 - T1_N
GND - 4	●	38 - GND
T2_P - 5	●	39 - T2_N
GND - 6	●	40 - GND
T3_P - 7	●	41 - T3_N
GND - 8	●	42 - GND
T4_P - 9	●	43 - T4_N
GND - 10	●	44 - GND
T5_P - 11	●	45 - T5_N
GND - 12	●	46 - GND
T6_P - 13	●	47 - T6_N
GND - 14	●	48 - GND
T7_P - 15	●	49 - T7_N
GND - 16	●	50 - GND
T8_P - 17	●	51 - T8_N
GND - 18	●	52 - GND
T9_P - 19	●	53 - T9_N
GND - 20	●	54 - GND
T10_P - 21	●	55 - T10_N
GND - 22	●	56 - GND
T11_P - 23	●	57 - T11_N
GND - 24	●	58 - GND
T12_P - 25	●	59 - T12_N
GND - 26	●	60 - GND
T13_P - 27	●	61 - T13_N
GND - 28	●	62 - GND
T14_P - 29	●	63 - T14_N
GND - 30	●	64 - GND
T15_P - 31	●	65 - T15_N
GND - 32	●	66 - GND
TCLK_P Out - 33	●	67 - TCLK_N Out
+5V - 34	●	68 - +5V

Figure 3.8: TAG input connector pinning (TTL connector is optional)

(valid for card #124 and higher)

3.5. 'GO'-Line

The system-wide open-drain 'GO' line enables any connected device to enable and stop all participating measurement equipment simultaneously. This allows for easy synchronization of electronic devices previously often not possible.



Figure 3.9: 'GO'-line connector

The 'GO' line is a system-wide open-drain wired-AND signal that can start and stop a measurement. This line is also available on the Multi I/O port connector (ref Figure 3.11). The 'GO'-line may be enabled, disabled, set and reset by the software.

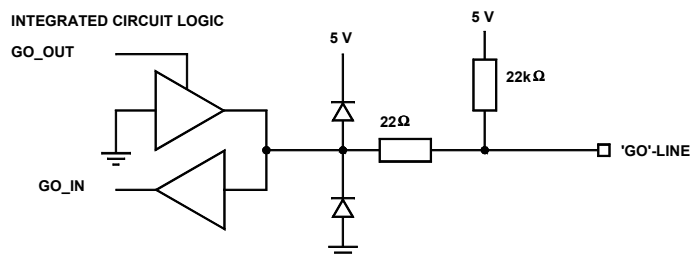


Figure 3.10: 'GO'-line logic circuit schematic

When watching of the 'GO'-line is enabled a low voltage will halt the measurement. When output to the 'GO'-line is enabled starting a measurement will release (high impedance output) the 'GO'-line whereas a halt of the measurement will pull down the 'GO'-line to a low state. Since it is an open drain output wired AND connection with other devices is possible.

3.6. FEATURE (Multi) I/O Connector

A very versatile 8 bit digital I/O port is implemented on the 15-pin high-density female D-SUB connector on the mounting bracket. Since the resistors are socket mounted (ref. Figure 3.12) they can be easily user configured in a most flexible way.

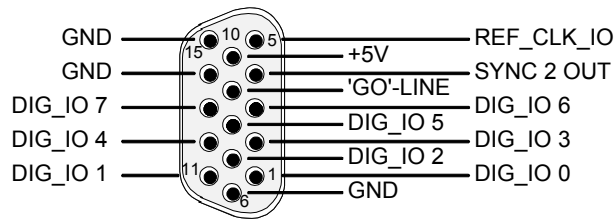


Figure 3.11: FEATURE (multi) I/O connector pinning

This I/O port is fully software controllable and each single (1-bit) port is individually configurable. It might be used for external alert signals, sample changer control, status inputs / outputs etc.

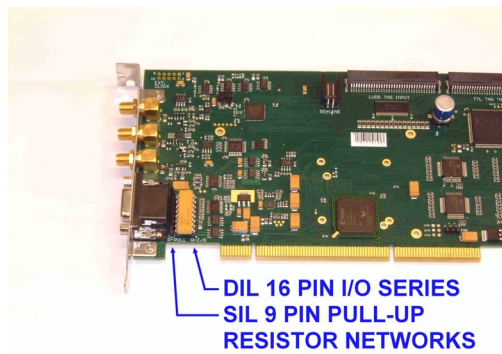


Figure 3.12: FEATURE (multi) I/O port connector

As can be seen from Figure 3.13 each bit of the digital I/O port might be configured as input only (tri-stated output) or open drain (pull-up) output with readback capability. Wired-OR/AND connections are also feasible (ref. chapter 0).

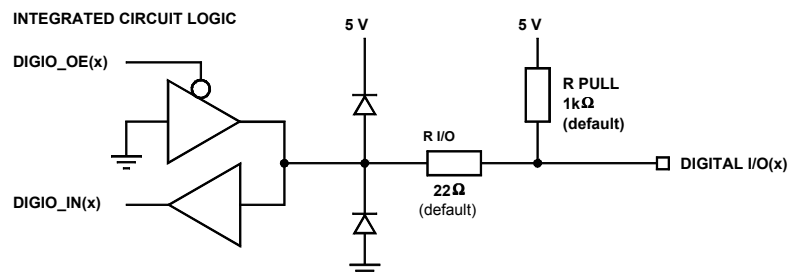


Figure 3.13: FEATURE (multi) I/O port schematic

3.7. Timebase

To derive the outstanding temperature and long-term stability the P7889 is equipped with an onboard crystal stabilized PLL (phase locked loop) 10 GHz synthesizer oscillator.

The reference is a 10 MHz clock. Either the internal (on-board) or an external reference is software selectable.

For highest stability requirements an optional oven stabilized crystal oscillator is available.

The ovenized option is particularly recommended for longer sweep ranges or long-term measurements. When figuring that a measurement at say 10 ms after the start has a dynamic range of 100 million channels a low timebase drift of only 1 ppm will result in a 100(!) channels drift at the end of the 10 ms range.

4. Functional Description

4.1. Introduction

The P7889 measures the arrival time of STOP input events relative to a previous START signal. The resolution or time bin width is 100 ps. The full dynamic range is 64 bit which results in the incredible maximum sweep time of over 58 years. 32 bits [6...37] of the timer are also accessible via the SYNC outputs (COUNT[0...31], ref. chapter 3.3). The measured data is transferred into the PC memory in list mode, i.e. as they are acquired.

4.2. Modes of Operation

4.2.1. Stop-After-Sweep Mode

This might be the most usual mode of operation. When the P7889 is armed it waits for a START input signal. When one occurs the sweep is started / triggered meaning the time starts to count. Now the arrival times of the STOP input signals relative to the start are acquired. A STOP event can be either a falling or rising edge or both. Since the type of edge is detected and marked in the datastream even Time-over-Threshold or pulse width measurements can be accomplished.

An acquisition delay time might be selected to accept only STOP signals that arrive after the selected delay.

When the selected measurement time range has elapsed the sweep and so the data acquisition ends. After a short (≤ 80 ns) end-of-sweep deadtime the P7889 is ready for a new start and begins a new sweep as soon as the next START signal arrives.

To reduce the overall average countrate a HOLD OFF might be selected that discards START signals until the selected hold off time has elapsed.

4.2.2. Sequential Mode

Like the stop-after-sweep mode but with a preselected number of sweeps. When the sweep preset is reached the FIFO is emptied, the corresponding spectrum closed and a new sequence with the same number of sweeps is started. Thus, the timely development of a histogrammed distribution may be watched.

4.2.3. Start Event Marker

For e.g. off-line or replay analysis of an experiment start markers may be inserted into the list mode data stream. This also enables to keep the full correlation of start and subsequent stop events. So one always knows what stop events belong to a special start event.

In this case care should be taken not to fill up the fast 1024 deep FIFO as this might lead to the loss of data integrity when a start event marker is missed due to a full FIFO. The detection of a filled FIFO is possible via an overflow flag in the decoded data.

For sequential mode it is better to enable Start Events and use "Starts Preset" than the hardware sweep counter, as the software can then count the number of sweeps and switch to the next memory part without stopping the acquisition (ref. chapter 5.1.4).

4.2.4. Tagged Spectra Acquisition

16 TAG inputs allow for sequenced spectra acquisition, multi detector configurations etc. The 16 TAGs are sampled synchronously to the STOP input with an uncertainty of 6.4 ns.

The TAG input signal should be stable 9 ns before til 3 ns after the corresponding stop input signal edge. For timing details please refer to the Appendix 8.2.5.

E.g. in a multi detector experiment it is feasible to measure which detector has fired and still maintain the incredible 100 ps binwidth. This allows also for ultra fast coincidence measurements with very little external logic required.

In case of using the TAG bits part of the upper 32 bits of the 64 bit time data word are replaced by the TAGs.

4.3. FIFO Concept

A two step FIFO concept is used to get the ultra high burst count rate of upto 10 GHz while also providing a large average or sustained event rate.

The detected stop events are fed into a 1024 deep, 6.4 ns wide ultra fast multiple event First-In-First-Out memory. A sophisticated input logic allows to buffer stop edges every 100 ps for at least 6.55 μ s which corresponds to a burst count rate of 10 GHz for a whole 64k spectrum (!). As a matter of fact each of the 1024 FIFO words contains a period of 6.4 ns regardless of the number of stop events. This data is then transferred to the second 32k deep FIFO memory at over 22.3 MHz. The depth of this second FIFO assures that high speed DMA data transfer over the PCI bus is feasible without easily losing data by a filled up FIFO.

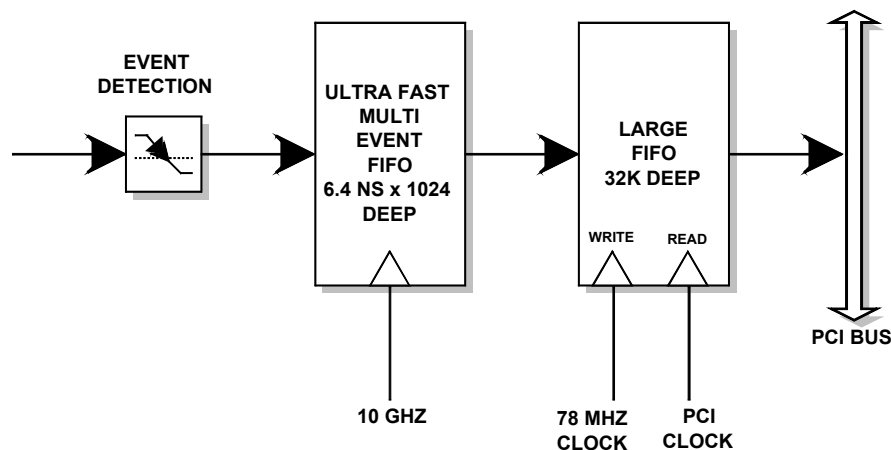


Figure 4.1: Two step FIFO concept for highest data throughput

When an experiment requires to be absolutely sure not to miss any single stop event the condition of an occasionally filled FIFO_1 is detectable via an overflow flag in the data stream. Thus, the experimental setup might be changed to prevent e.g. shadow effects or wrong normalization that might occur from such a situation. A filled-up FIFO_2 is no problem as long as the FIFO_1 is still not full as well. Thus, it is sufficient to watch for a FIFO_1 full condition only.

4.4. Measurement Time Window, Acquisition Delay and Trigger Hold Off

The time window in which stop events are acquired is programmable over a wide range. The begin (delay after the Start/Trigger) and end of the window is fully programmable. This enables to

detect even late events with large input count rates. This is due to the data reduction executed. The fact is that all data, that occur outside the selected time window, are discarded.

An acquisition delay, programmable in increments of 6.4 ns, begins data acquisition only when the selected time after the corresponding START signal has elapsed. Then data is sampled for the selected time range. All events occurring before the acquisition offset time has elapsed are discarded and do not contribute to the burst and average data rate.

The theoretical limit of the measurement window is 58.5 years $\cong 2^{64}$ time bins.

Example:

Average STOP data rate of 100 MHz. Interesting time window is 1 μ s at 1 ms after the START / TRIGGER signal:

In a time range of 1 ms the 100 MHz input rate would result in 100,000 STOP events which would cause data loss due to filled FIFOs. When programming an acquisition offset of 1 ms and a 1 μ s measurement time window the resulting number of events per sweep is only 100. Thus, no data loss at all will occur. And even with highest speed sweep repetition rates an average data rate of only some 1000 sweeps/sec x 100 events/sweep = 100,000 events/sec has to be stored.

Additionally a trigger hold off time, also programmable in increments of 6.4 ns, can be selected to further reduce the average datarate by accepting only a new start / trigger after this additional time has elapsed.

Example:

Average number of STOP events per sweep is 1,000. Say your computer allows an average transfer rate of 40 Mevents/s a maximum of 40MHz / 1000 = 40kHz sweep repetition rate can be accepted. With a sweep length of e.g. <5 μ s and start signals every 5 μ s the average datarate would be 200 MHz. A trigger hold off after every sweep of 20 μ s will reduce the startrate to 40 kHz and thus the average countrate to 40kHz x 1,000 = 40MHz.

4.5. Sweep Counter

A presettable 32 bit sweep counter is incremented at every start of a sweep. In fact the sweep counter counts the real start of a new sweep rather than the completion of sweeps. When the preset is enabled and the preselected number of sweeps have occurred further start of a sweep is disabled.

The individual bits may be output and watched on the SYNC outputs (ref. Chapter 3.3). They are particularly useful when some experiment should be periodically changed after a fixed number of sweeps.

5. Windows Server Program

P7889

The window of the P7889 server program is shown here. It enables the full control of the P7889 card to perform measurements and save data. This program has no own spectra display, 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.

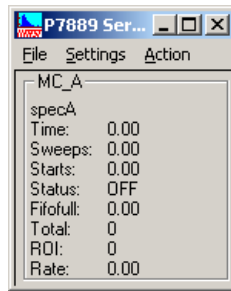


Figure 5.1: P7889 Server Window

5.1. Server functions

To start the software, just double click a shortcut icon linking to the server program. The server program performs a test whether the card works well on this computer, then starts MCDWIN and gets iconized. Usually you will control everything from MCDWIN, but it is possible to work with the server alone and independently from MCDWIN.

Note:

To go sure that no events are lost due to a full FIFO when working with MCDWIN and other applications, we strongly recommend that the P7889 server program runs in high priority at high counting rates if using DMA mode. This can be achieved by starting it with Launch89.EXE or by using the Windows task manager (use the ‚Processes‘ tab and right click the entry of P7889.EXE). Please note the remarks on DMA mode in section 5.1.4

5.1.1. Initialisation files

At program start the configuration files P7889.INI and P7889A.CFG are loaded. Up to 4 P7889 modules can be used. Specify the number of modules in the P7889.INI file with a line devices=n. You can also specify more than one module if you have only physical module. The software runs then for the not physical modules in demo mode and it is possible to load spectra and compare them in MCDWIN.

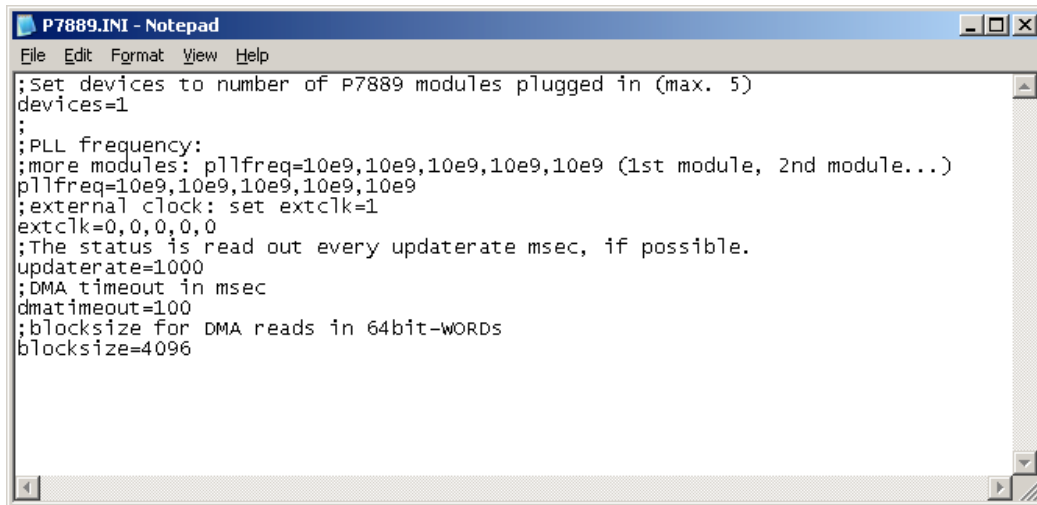


Figure 5.2: P7889 Ini File

The frequency of the PLL in units of Hz has to be defined in the P7889.INI file by a line like `pllfreq=10e9`. This is also a command of the control language. The frequency can be set in steps of 40 MHz. Other parameters that can be set only by editing the P7889.INI file are the `updatarate` in msec for the refresh of the status, and the `blocksize` parameter. The default value of 1024 is for moderate counting rates. For very high counting rates you may chose a value like 4096 or 8192.

The file P7889A.CFG (P7889B.CFG... for more modules) contains the default settings. It is not necessary to edit this file, it is saved automatically. Instead of this .CFG file any other setup file can be used if its name without the appendix 'A.CFG' is used as command line parameter (e.g. *P7889 TEST* to load TESTA.CFG).

5.1.2. Action menu

The server program normally is shown as an icon in the taskbar. After clicking the icon it is opened to show the status window. Using the „**Start**“ menu item from the action menu a measurement can be started. In the status window every second the acquired events, the counting rate and the time are shown. Clicking the „**Halt**“ menu item the measurement is stopped and via „**Continue**“ proceeded.

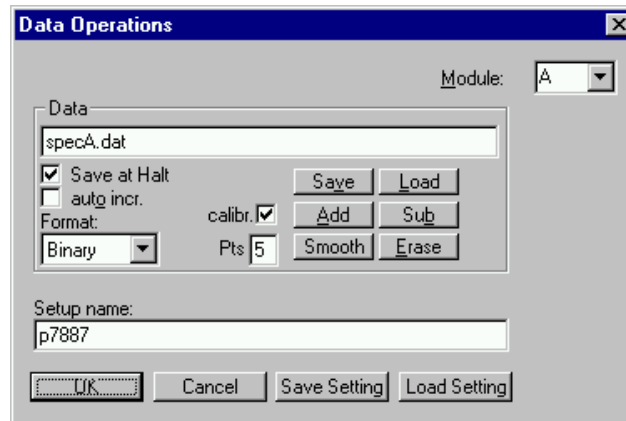


Figure 5.3: Data Operations dialog

5.1.3. File menu

The Data... item in the File menu opens the Data Operations dialog box. Mark the checkbox „**Save at Halt**“ to write a spectrum- and a configuration file at the stop of a measurement. The filename can be entered. If the checkbox „**auto incr.**“ is marked, 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 or binary (extension .ASC or .DAT). Click on „**Save**“ to write a data- and configuration file of the actual data with the specified name. By pressing „**Load**“ previously stored data can be loaded or a **control file** (extension .CTL) executed. With „**Add**“ or „**Sub**“ a stored spectrum can be added to or subtracted from the present data. Check the checkbox „**calib.**“ to enforce using a calibration and shift the data to be added according to the calibration. The „**Smooth**“ button performs a n-point smoothing of the spectrum data. The number of points to average can be set with the „**Pts**“ edit field between 2 and 21. „**Erase**“ clears the spectrum.

The menu item File – Replay... opens the Replay dialog.

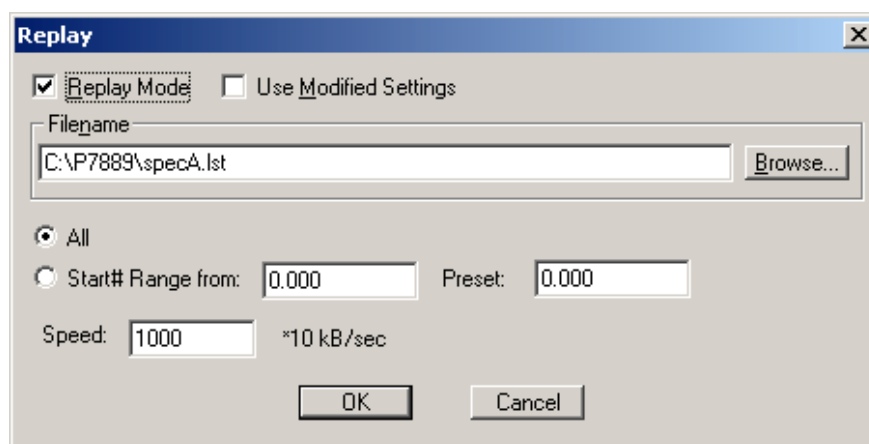


Figure 5.4: Replay Settings dialog

Enable **Replay Mode** using the checkbox and specify a **Filename** of a list file (extension .LST) or search one by pressing **Browse...** With the radio buttons it is possible either to choose the complete list file by selecting **All** or a selected **Start# Range**. Specify the sweep range by editing the respective edit fields **from:** and **Preset:** . The **Replay Speed** can be specified in units of 100 kB per sec. To **Use Modified Settings** enable the corresponding checkbox; otherwise the original settings are used. To start Replay press then Start in the Action menu or the corresponding MCDWIN toolbar icon.

The MCDWIN menu item in the file menu starts the MCDWIN program if it is not running.

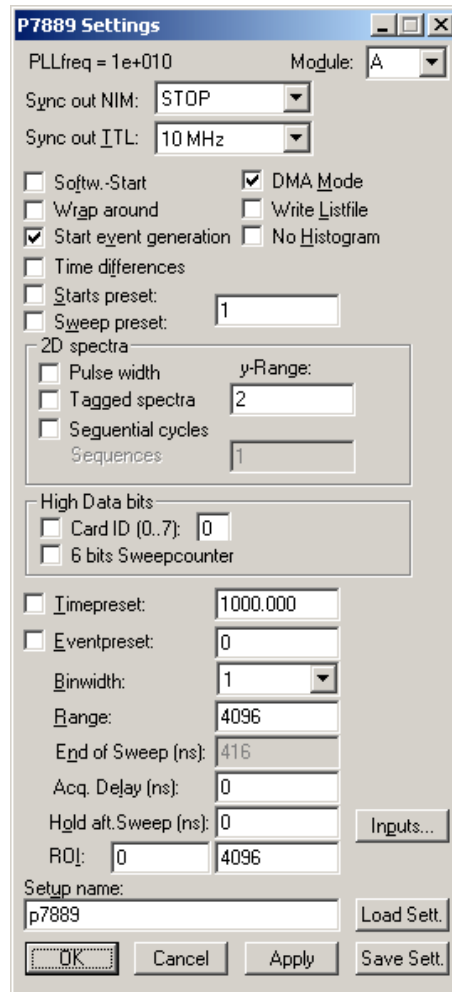


Figure 5.5: Settings dialog

5.1.4. Settings dialog

The Hardware... item in the Settings menu opens the P7889 Settings dialog box. The checkbox **DMA mode** sets the DMA mode for data transfer.

DMA mode is recommended for high counting rates above 300000 events per second. **For low counting rates please disable "DMA mode" in the settings.** Don't use then the shortcut on the desktop for starting the server in high priority. When not using DMA, the server should run in normal priority. **For very high counting rates of several million events / sec** edit the P7889.INI and set a blocksize of 32768, **start the server in high priority and use DMA mode.**

The mode of the measurement can be **Wrap around** if the corresponding checkbox is crossed, or Sweep mode. In Sweep mode usually via an external start signal a sweep is started, after completion the next sweep starts with the next start pulse. Wrap around mode means that the sweep is started once and runs until the acquisition is stopped by software. The time counter will count as long as possible (when using 62 bits for the time information up to 14.6 years) and in a list file the full time information for every stop event is written, but the channel pointer for the histogram wraps around and keeps counting along from zero. This mode can be used together with the sync out to synchronize the experiment. If **Softw. Start** is marked, no start signal is necessary. The time-counter for the spectra is masked corresponding to the chosen range. The signal for the synchronisation of the experiment can be obtained from one of the two Sync Out outputs.

Via the **Sync out** - combo boxes the Synchronisation / Monitor signals specified in chapter 3.3 can be selected.

An acquisition mode "**Time differences**" is implemented for analyzing pulse trails. In this mode the first stop event is used as a reference point and for following stop events the time difference to the reference is calculated. The displayed spectra is then a relative time distribution of stop events related to the reference point. Even wrap around mode works in this differential mode. The first stop event that falls out of the chosen time range after a reference event is taken as a new reference point.

If **Start event generation** is checked, a start event is inserted as a zero into the data stream and counted by the software. The measurement can be stopped automatically after a specified number of sweeps by checking **Starts preset** or **Sweep preset**. In the former case the start events are used, in the latter case the hardware sweep counter. If **DMA Mode** is checked, the data are acquired using DMA PCI bus master mode, otherwise by direct port control. The maximum possible data transfer rate is higher in DMA mode, but after a preset condition it takes some time to get out of the DMA read routine. A List file can be written by checking the corresponding checkbox **Write List file**. If **No Histogram** is checked, no histogramming is made.

A series of measurements can be acquired into separate memory parts by checking **Sequential cycles** and specifying the number of cycles. Each single measurement should be terminated by any of the preset conditions, the complete run stops after performing the specified number of cycles or is repeated accordingly if the specified number of **Sequences** is greater than 1.

Check **Tagged spectra** if you want to acquire up to 65536 separated spectra marked by tag bits as mentioned in chapters 3.4 and 4.2.4. (MCDWIN will show the spectra in a 2 dimensional view). Here is the scheme for the y- coordinate of a tagged 2D spectra:

y = 0 for no tag bit ON.

when using up to nmax = 18 tagged spectra:

y = nmax - n - 2 for tag bit n ON, n=0..15.

y = nmax-1 if more than 1 tag bit is on

When using more than 18 tagged spectra, y is the pattern of tag bits seen as a binary number. The numbering of the tag bits is reversed, i.e. tag [0] is the most significant bit of the tag pattern.

When using 6 sweep counter bits and less than 11 tag bits together, the first used tag bit is tag[6], not tag[0].

If the checkbox **Eventpreset** is marked, the measurement will be stopped after acquiring more events than specified in the corresponding edit field. The events are counted only if they are within the **ROI** limits, i.e. \geq the lower limit and $<$ the upper limit. It is not necessary that this ROI is within the spectra range. Another possibility is to acquire data for a given time via the **Time preset**. In the edit field **Range** the length of the spectrum can be entered. A **Bin width** of 1 means the highest time resolution. The Binwidth can be chosen in powers of 2 up to 16777216 times the elementary dwell time. If an **Acq. Delay** is specified, data are acquired in a sweep not before the specified time. **Hold after sweep** allows to wait a specified time after a sweep before the next sweep can be started.

The **Inputs...** button opens the Input Thresholds dialog box. Here you can specify the threshold level at the falling edge of the input signal. The combo box provides a choice between standard Fast NIM (-0.4 V) and customized, i.e. Voltage level set by hand between -2 .. +2 V (scroll bar or edit field). For the start and stop inputs the rising or falling edge of the input signal can be selected. For the stop input it is also possible to chose both edges. As the edge information is contained in bit 62 of the data (a 1 in that bit means rising edge) it is possible to distinguish stop events from rising and falling signals and it is possible to analyze the pulse width of the signals. Depending on the polarity of the stop signals there is a choice between **Over threshold** or **Under threshold** for the Pulse width analyzing.

To see the events from rising and falling signals separated, first set the STOP discrimination to 'Both edges', then click the checkbox for **Pulse width** in the settings dialog and set **y-Range** to **2** inside the box labeled "2D spectra". You will get a two dimensional spectra with an y-dimension of 2, for y=0 it contains the stop events from rising edges and for y=1 from falling edges. You can see here the separation time

between both edges. If you set then the y-Range to a value larger than the maximum pulse width in channels, you will get a 2-dimensional spectra with the time of the first edge as x coordinate and the pulse width as y coordinate.

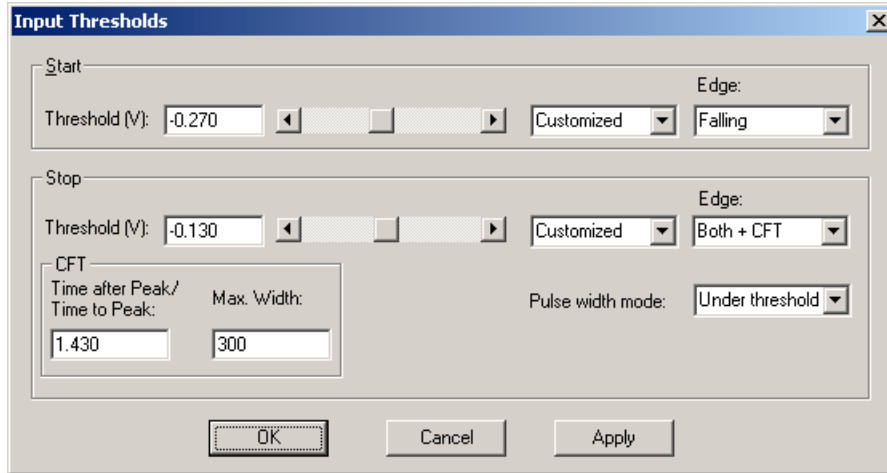


Figure 5.6: Input Thresholds dialog

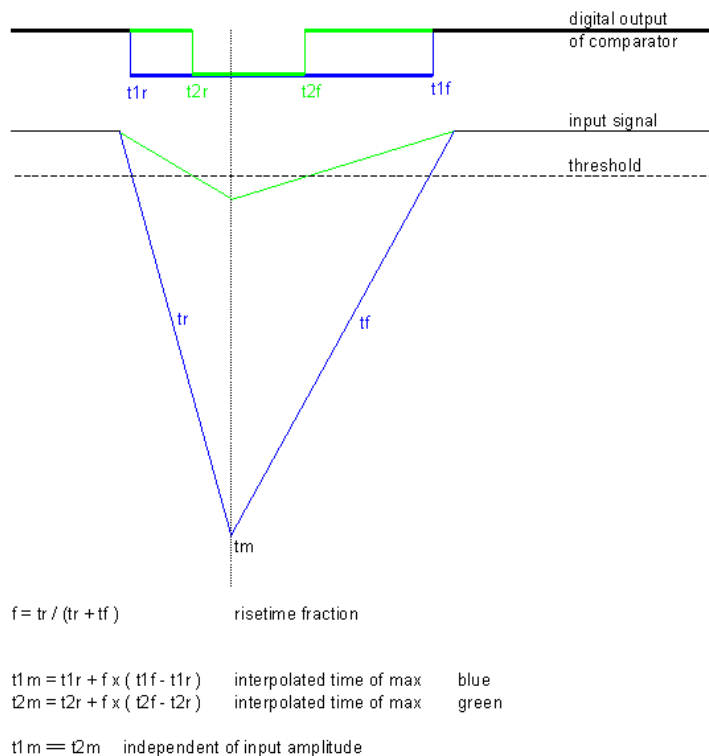


Figure 5.7: Principle of "Software CFT"

A well known method named "Constant Fraction Timing" (CFT) is used in electronic discriminators to get an enhanced time resolution for a trigger signal made from a detector signal. Due to the capability of detecting both edges of a peak a similar method can be used in the P7889 software too. By assuming that the shape of the signal does not depend on the amplitude, one can get a good estimation for the time of the peak by assuming that it is always at the same fraction of the time between both detected edges.

Select **Both + CFT** in the drop-down listbox for the edge detection, and enter a suited value for the fraction "**Time after Peak / Time to Peak**" i.e. time-after-peak divided by time-to-peak. For example enter 2 for a peak shaped like shown in Fig. 5.7, when the time after peak is twice the time to peak. A suited **Max. Width** for the pulse width in units of time bins must be entered, to reject spurious signals with too large width. Note that for using CFT again the "Pulse width mode" must be chosen accordingly as "Under threshold" for low going (negative) pulses or "Over threshold" for rising pulses. It is important that no data are lost, as both edges of a signal pulse must be detected.

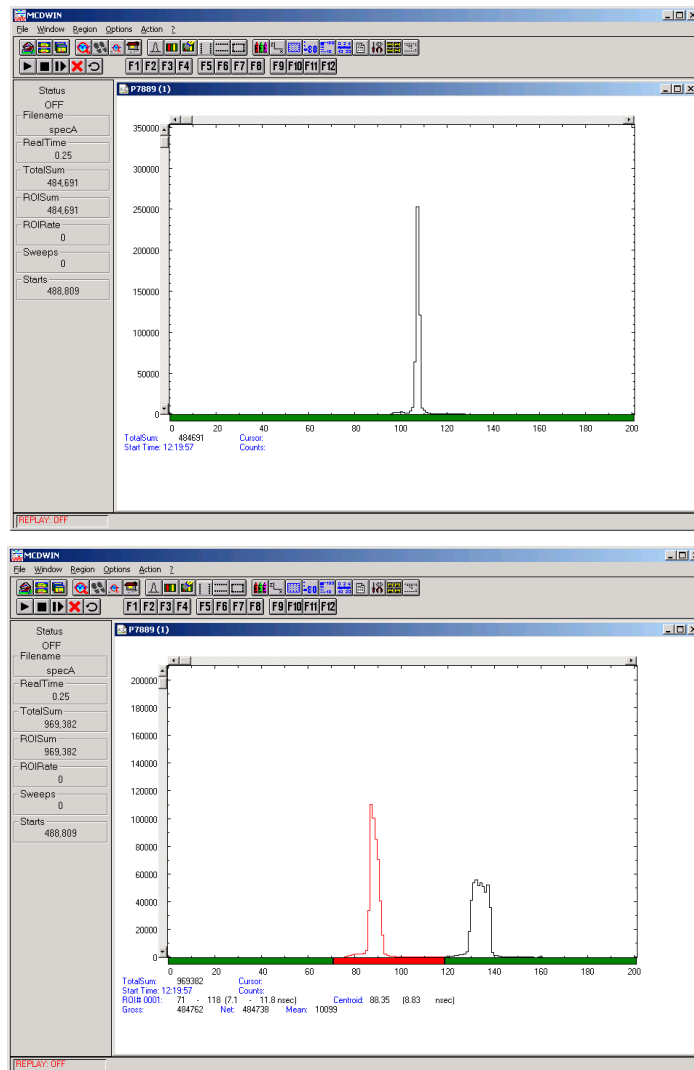


Figure 5.8: Example of Software CFT

The enhancement in resolution can be studied with the supplied sample list file TESTCFT.LST. Fig. 5.8 shows replay results of that file. Compare the result of replaying that file with original settings using CFT (upper picture) and using "Both Edges" (lower picture) instead of "Both + CFT". You may also test the "pulse width" capabilities of the software by replaying that list file.

5.1.5. System definition dialog

The „System...“ item in the settings menu opens the System Definition dialog box. If more than one P7889 modules are used, several cards can be combined to form one or up to 4 separate systems that can be started, stopped and erased by one command. In addition the use of the Digital Input / Output and the GO-Line can be defined: It can be used either to show the status of the MCA if the checkbox **Status Dig 0** (0..3 for more modules) is marked. At the respective pins +5 Volt are output if an acquisition is running and 0 V if not. The polarity can be inverted by checking **Invert**. Alternatively, it can be used for example with a sample changer by checking **Value inc. at Stop**. Here, the 8 bit value entered in the edit field (a number between 0 and 255) is output at the Dig I/O port. This value will always be incremented by 1 if the P7889 is stopped. The **Invert** checkbox allows to invert the logical level. See also the commands **pulse** and **waitpin** how to handshake a sample changer. The output mode of the Dig I/O ports is Open Drain.

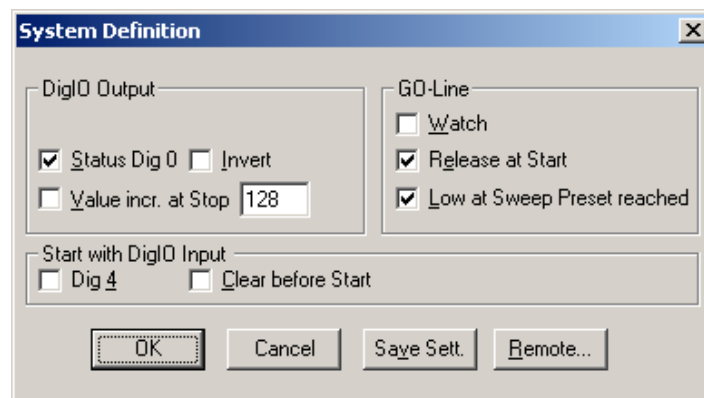


Figure 5.9: System Definition dialog box for a single P7889 card

It is also possible to use the digital input 4 as an external trigger for starting the system (more modules: Dig inputs 4..7 start systems 1..4) (**DESY control line**). If the corresponding checkbox is marked, a start command for the respective system will not immediately start the system. After the start command, the digital input will be permanently checked for its logical level. If the level changes from high to low, the data for the system is cleared and it will then be started. It will stop if the level returns to high (or vice versa if **Invert** is marked) and can again be restarted with the next level change. A stop command for the system will finish the digital input checking. By checking **Clear before Start** the spectra is cleared before the start. A stop command for the system will finish the digital input checking.

The Use of the GO-Line is controled via the 3 checkboxes **Watch**, **Release at Start**, and **Low at Sweep Preset reached**. The GO line gates directly the hardware. "Low at Sweep preset reached" means that the GO line is immediately pulled down when a sweep preset is reached.

If more than one P7889 card is used, the system definition dialog box comes up as shown in Figure 5.10. Here the several units can be combined to form up to 4 separate systems that can be started, stopped and erased by one command.

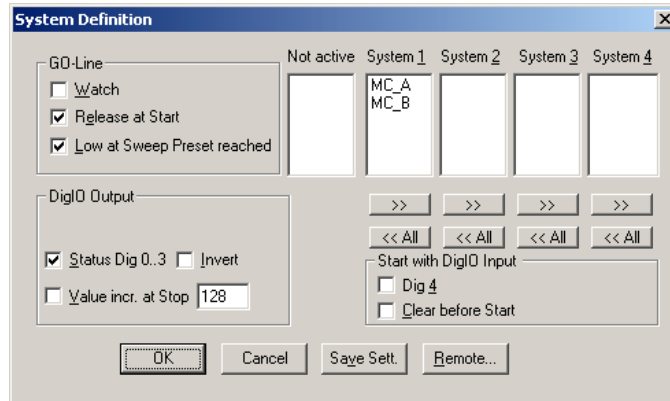


Figure 5.10: System Definition dialog box, two P7889 cards

In the shown setting a single system is formed. The two modules MC_A and MC_B are combined. 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.

OK accepts all settings and displays the value of P (the time counter preset value). **Cancel** rejects all changes. Pressing „**Save Settings**“ stores all settings in the file **P7889A.CFG** using the control language (see the following section)

This file is loaded at program start automatically and the parameters set. Together with each data file a header file with extension .889 is saved. This header also contains all settings and in addition some information like the date and time of the measurement and comments entered in the MCDWIN program.

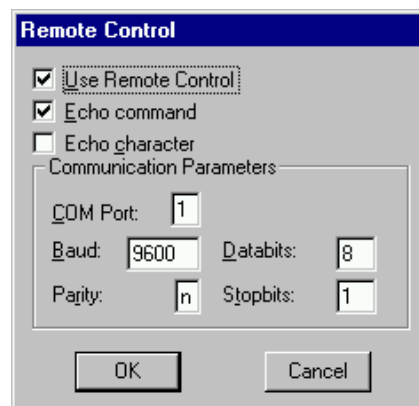


Figure 5.11: Remote control dialog

The **Remote...** button opens the Remote control dialog box. Here all settings can be made for the control of the P7889 server program via a serial port. If the Checkbox **Use Remote Control** is marked and the COMCTL.DLL is available (i.e. you have the **optional MCDLAN software**), the specified COM port will be used for accepting commands (see Control language). 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.

5.1.6. File formats

Spectra data is written into two separate files, one with extension .889 containing configuration data and one containing pure spectra data with an extension indicating the chosen format. The .889 file contains the settings in ASCII format using the control language described in section 5.2. Spectra data files with extension .asc contain in each line one decimal number in ASCII containing the corresponding count value in the histogram. Binary data files with extension .dat are written with 4 bytes per data value, as usual in the Intel world in reverse order i.e. the least significant byte comes first. Another ASCII file format is the x y format with extension .csv. It can be read for example with Excel and contains the channel number and content as two decimal numbers in ASCII per line separated by a TAB character.

A special ASCII format for 2D files, also with extension .asc can be read with the MPAWIN software for the FAST ComTec MPA/PC multiparameter system. It has got a small header starting with a line [DISPLAY] and ending with a line [DATA] and then only for each non zero data point a line containing 3 values separated by TAB characters, the x and y channel numbers and the channel content.

Listfiles have the extension .lst and start with a header containing the usual report and configuration data in ASCII as in the .889 files. The header ends with a line containing [DATA]. Then follows the data, depending on the format chosen for the data file either in ASCII or binary. In ASCII format one 64 bit number is written as two numbers per line, first the high double word in hex format and then the low double word in decimal notation. In binary format each stop event is written with 8 bytes, as usual in the Intel world in the reverse order, i.e. the least significant byte comes first.

The highest bits may contain tag bits (see chapter 3.4 and 4.2.4), a card id, or the 6 least significant bits of the sweep counter. The following table shows the possible data formats depending on these settings, together with the maximum possible sweep length. Bit 63 contains for all data formats a flag if the FIFO was full, and bit 62 is the edge information of the stop event, 1 means a rising edge. The remaining 62 bits allow a maximum sweep length of 14.6 years.

Tag bits	Card ID bits	Sweep counter	Time bits	Max. sweep length
-	-	-	62	14.623 y
-	3 (Bit[61:59]=cardID[2:0])	-	59	1.828 y
3 (Bit[61:59]=Tag[0:2])	-	-	59	1.828 y
9 (Bit[61:53]=Tag[0:8])	-	-	53	10.4 d
6 (Bit[58:53]=Tag[0:5])	3 (Bit[61:59]=cardID[2:0])	-	53	10.4 d
-	3 (Bit[61:59]=cardID[2:0])	6 (Bit[58:53]=Sweeps[5:0])	53	10.4 d
13 (Bit[61:49]=Tag[0:12])	-	-	49	15.6 h
10 (Bit[58:49]=Tag[0:9])	3 (Bit[61:59]=cardID[2:0])	-	49	15.6 h
4 (Bit[52:49]=Tag[9:12])	3 (Bit[61:59]=cardID[2:0])	6 (Bit[58:53]=Sweeps[5:0])	49	15.6 h
16 (Bit[61:46]=Tag[0:15])	-	-	46	117.3 min
13 (Bit[58:46]=Tag[0:12])	3 (Bit[61:59]=cardID[2:0])	-	46	117.3 min
7 (Bit[52:46]=Tag[9:15])	3 (Bit[61:59]=cardID[2:0])	6 (Bit[58:53]=Sweeps[5:0])	46	117.3 min
16 (Bit[58:43]=Tag[0:15])	3 (Bit[61:59]=cardID[2:0])	-	43	14.7 min
16 (Bit[61:46]=Tag[0:15])	-	6 (Bit[45:43]=Sweeps[2:0], Bit[42:40]=Sweeps[5:3])	40	110 sec
16 (Bit[58:43]=Tag[0:15])	3 (Bit[61:59]=cardID[2:0])	6 (Bit[42:37]=Sweeps[5:0])	37	13.74 sec

5.2. Control Language

A sequence of commands that is stored in a file with extension .CTL can be executed by the P7889 server program with the „**Load**“ command. A lot of these commands are used in the configuration file P7889A.CFG, also the header files with extension .889 contain such commands to set the parameters. Each command starts at the beginning of a new line with a typical keyword. Any further 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 chapter 5.3. The application name for opening the DDE connection with the standard P7889 server program P7889.EXE is P7889, the topic is 7889-. 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 TCP/IP networking installed 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 P7889A.CFG contains a complete list of commands for setting parameters. An example is:

```
digio=0           ; Use of digital I/O and GO-Line (hex):  
                  ; bit 0: status dig 0..3  
                  ; bit 1: Output digval and increment digval after stop  
                  ; bit 2: Invert polarity  
                  ; bit 3: Push-Pull output  
                  ; bit 4..7: Input pins 4..7 Trigger System 1..4  
                  ; bit 8: GOWATCH  
                  ; bit 9: GO High at Start  
                  ; bit 10: GO Low at Sweep preset reached  
                  ; bit 11: Clear before external triggered start  
  
digval=0         ; 8 bit digital I/O value for sample changer  
  
range=4096       ; sets histogram length  
  
fstchan=0        ; sets time offset = number of first channel / 64  
  
holdafter=0      ; sets hold after sweep in units of 64 basic dwelltimes  
  
sweepmode=280    ; (hex) sweepmode & 0xF: 0 = normal, 4=sequential  
                  ; bit 4: Softw. Start  
                  ; bit 5: DMA mode  
                  ; bit 6: Wrap around  
                  ; bit 7: Start event generation  
                  ; bit 8: Enable Tag bits
```

```

; bit (9,10): 0=rising, 1=falling, 2=both, 3=both+CFT
; bit 11: pulse width
; bit 12: 6 bits of Sweepcounter in Data
; bit 13: card ID in data

swpreset=1000      ; Sweep-Preset value
prena=0           ; Presets enabled (hex)
                    ; bit 0: real time preset enabled
                    ; bit 2: sweep preset enabled
                    ; bit 3: ROI preset enabled
                    ; bit 4: Starts preset enabled
syncout=0         ; sync out (hex): bit 0..7 NIM sync out, bit 8..15 TTL sync out
cycles=1          ; for sequential mode or number of tagged spectra
dac0=6700         ; (hex) LOWORD: START threshold
                    ; bit 16: edge
dac1=6700         ; (hex) LOWORD: STOP threshold,
                    ; bit 16: pulse width over threshold
bitshift=0        ; Bin width (0: 1, 1:2, 2:4, 3:8,...)
rtpreset=50       ; Time preset (seconds)
evpreset=100000000 ; ROI preset
autoinc=0         ; Enable Auto increment of filename
datname=dataspec2.asc ; Filename
savedata=0        ; bit 0: 1 if auto save after stop
                    ; bit 1: write list file
                    ; bit 2: list file only, no histogram
fmt=dat           ; Format (ASCII: asc, Binary: dat)
smoothpts=5       ; Number of points to average for a smooth operation
roimin=0          ; ROI lower limit (inclusive)
roimax=512        ; ROI upper limit (exclusive)
caluse=0          ; bit 0=1: Use calibration, higher bits: formula
calch0=0.00       ; First calibration point channel
calvl0=0.000000   ; First calibration point value
calch1=100.00     ; Second calibration point channel
calvl1=50.000000  ; Second calibration point value
caloff=0.000000   ; Calibration parameter: Offset
calfact=0.500000  ; Calibration parameter: Factor
calunit=nsec      ; Calibration unit

```

The following commands perform actions and therefore usually are not included in the P7889A.CFG file:

fpII=10e9	; Set PLL frequency (Hz)
fpII+=-0.04e9	; Change PLL frequency (Hz)
start	; Clears the data and starts a new acquisition. Further ; execution of the .CTL file is suspended until measurements ; 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 an acquisition if one is running.
halt2	; Stops acquisition of system 2 if running.
halt3	; Stops acquisition of system 3 if running.
halt4	; Stops acquisition of system 4 if running.
cont	; Continues an acquisition. If a Realtime preset is already ; reached, the time preset is prolonged 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 CFG file
MC_A	; Sets actual multichannel analyzer to MC_A for the rest of ; the controlfile.
MC_B ... MC_D	; Sets actual multichannel analyzer to MC_B ... MC_D for the ; rest of the controlfile.
savedat	; Saves data.
pushname	; pushes the actual filename on an internal stack that can hold 4 names.
popname	; pops the last filename from the internal stack.
load	; Loads data; the filename must be specified before with a ; command datname=...
add	; Adds data; 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	; Smooths the data in actual multichannel analyzer
eras	; Clears the histogram
eras2	; Clears the data of system 2.
eras3	; Clears the data of system 3.
eras4	; Clears the data of system 4.
sweep	; Starts a sweep by software
exit	; Exits the Server (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).
run controlfile	; Runs a sequence of commands stored in controlfile. This ; command cannot be nested, i.e. from the controlfile called a ; second run command cannot be executed.
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. 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.
oncycle command	; executes command after a cycle end in sequential mode. ; It is possible to enter up to 512 different such commands, ; each can be maximal 20 character long. The next in the ; series will be executed after the next cycle. When the last ; such entered command was executed the first one will be ; executed again after the next cycle.
oncycle off	; switches off the oncycle command executing.
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.
pulse 100	; Output a TTL pulse of 100 msec duration at dig 3 (pin 11)
waitpin 4000	; Waits 4000 ms for going the level at dig 7 (pin 13) going low. ; After a timeout a Message box warns and waits for pressing OK. ; Can be used for connecting a sample changer.
exec program	; Executes a Windows program or .PIF file. Example: ; exec notepad test.ctl opens the notepad editor and loads ; test.ctl.

deleteallrois	; Deletes all ROIs in the active Display of MCDWIN or the active multichannel analyzer if MCDWIN is not running.
deleteallrois MC_A	; Similar to the deleteallrois command, but using the argument allows to specify which spectrum should be treated independently of which child window is activated in MCDWIN
fitrois	; Makes a single peak Gaussian fit for all ROIs in the active Display of MCDWIN 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 fitroi 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 in the MCDWIN Region Edit dialog and uses the results 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, TCP/IP or DLL 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 multi channel analyzer
sendfile <i>filename</i>	; Sends the ASCII file named <i>filename</i> over the serial line.

The execution of a control file can be ended from the Server or MCDWIN with the Halt button.

5.3. Controlling the P7889 Windows Server via DDE

The P7889 program can be a server for 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 P7889 program are described together with a demo VI („Virtual Instrument“) for LabVIEW. It is not recommended to use the DDE protocol for LabVIEW, as also a DLL interface is available that is much faster. The following should be seen as a general description of the DDE conversation capabilities of the P7889 program.

5.3.1. Open Conversation

application: P7889

topic: 7889

Any application that wants to be a client of a DDE server, must open the conversation first by specifying an application and a topic name. The application name is P7889 and the topic is 7889.

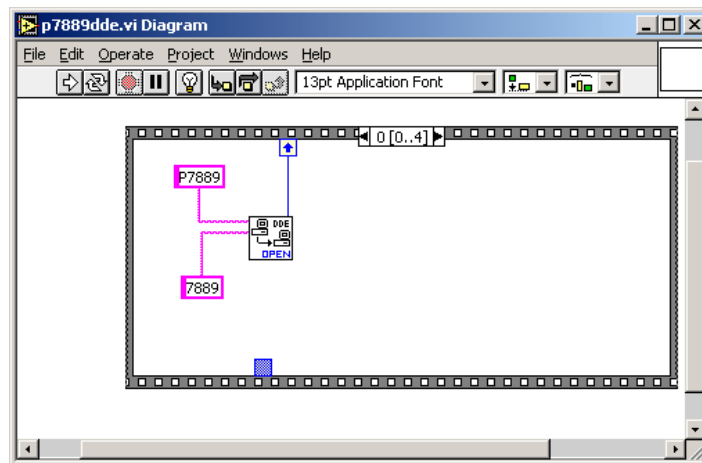


Figure 5.12: Opening the DDE conversation with the P7889 in LabVIEW

5.3.2. DDE Execute

The DDE Execute command can be used to perform any action of the P7889 program. Any of the Control command lines described in section 5.2 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 P7889 program then executes the command and, after finishing, it sends an Acknowledge message to the DDE client. This can be used to synchronize the actions in both applications.

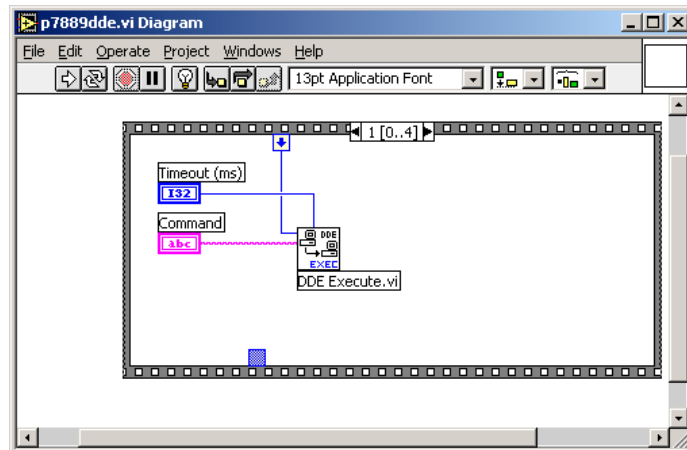


Figure 5.13: Executing a P7889 command from a LabVIEW application

5.3.3. 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 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.

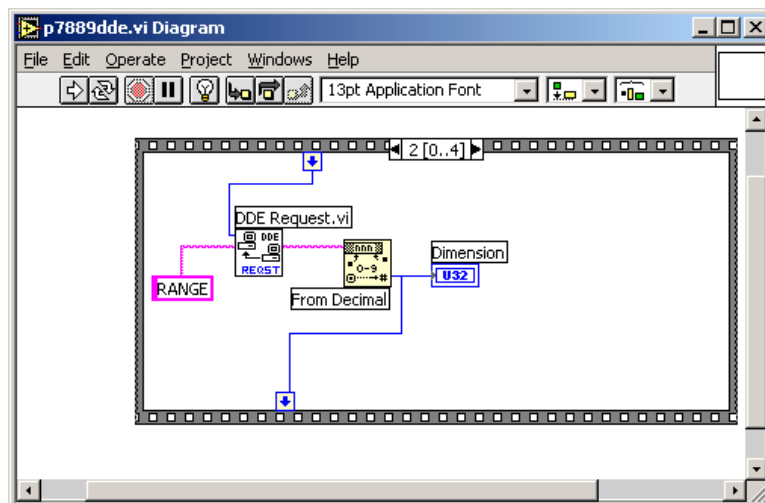


Figure 5.14: Getting the total number of data with LabVIEW

DATA

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

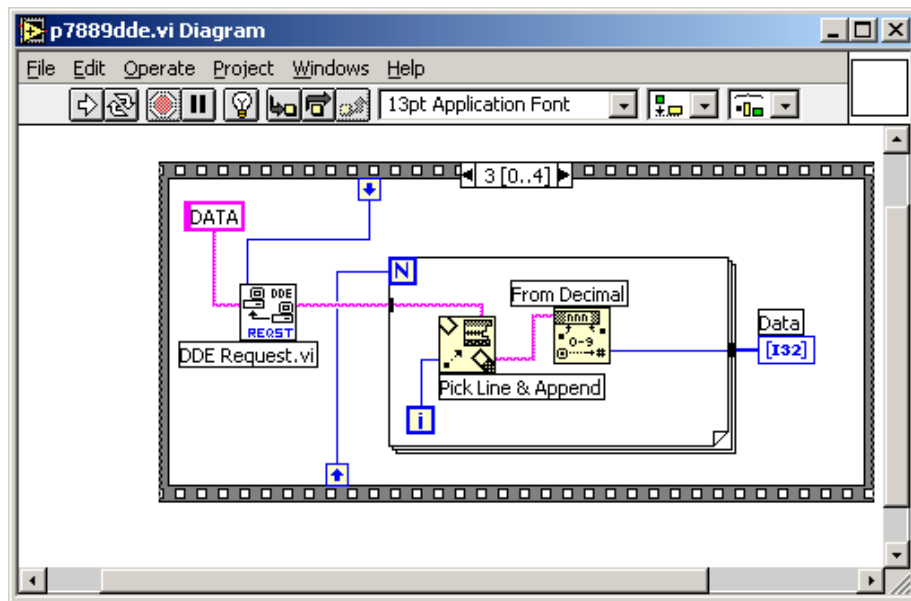


Figure 5.15: Getting the data with LabVIEW

5.3.4. Close Conversation

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

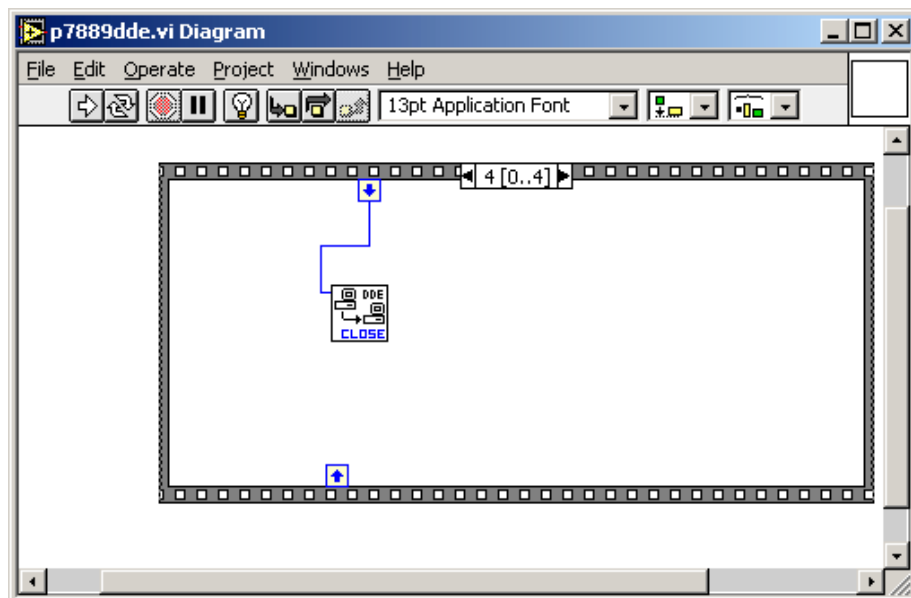


Figure 5.16: Closing the DDE communication in LabVIEW

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

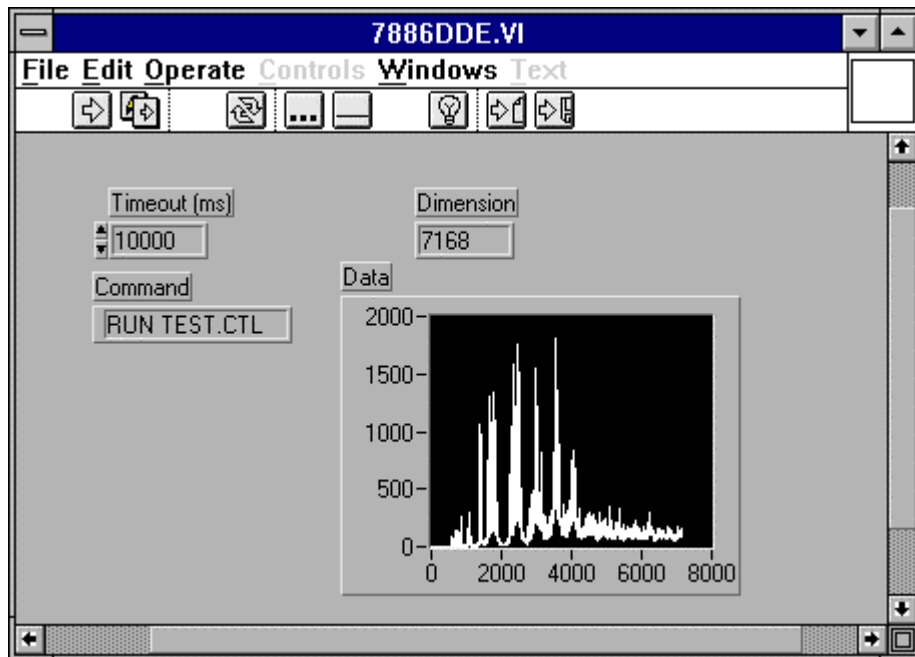


Figure 5.17: Control Panel of the demo VI for LabVIEW

5.3.5. DDE Conversation with GRAMS/386

The following file GRAMS889.CIF can be used to get the P7889 data into GRAMS/386 via DDE using the „Collect“ menu:

```
P7889 DDE Test
Query
P7889
7889
DATA

save

end
spc
1 second
```

5.4. Controlling the P7889 Windows Server via DLL

The P7889 server program provides access to all functions, parameters and data via a DLL („dynamic link library“). So the server can be completely controlled by the MCDWIN software that provides all necessary graphic displays.

In the following some parts of the header and definition files of the DP7889.DLL are listed, that may help an experienced programmer to use the DLL for own applications. The arguments „item, nDevice, nDisplay, nSystem“ are only for compatibility with other devices controlled by the MCDWIN software and must be zero.

NOTE:

The complete documented **sourcecode of the DLL** including fundamental VI's and an example VI for **LabVIEW** and an example **Visual Basic** and **C** program is available as an **option**.

```
typedef struct{
    int started;                // aquisition status: 1 if running, 0 else
    double runtime;            // running time in seconds
    double totalsum;           // total events
    double roisum;             // events within ROI
    double roirate;            // acquired ROI-events per second
    double ofls;               // fifo full;
    double sweeps;             // Number of sweeps
    double stevents;           // Start Events
    unsigned long maxval;      // Maximum value in spectrum
} ACQSTATUS;

typedef struct{
    unsigned long range;       // spectrum length
    long prena;                // bit 0: realtime preset enabled
                                // bit 1: single sweeps enabled
                                // bit 2: sweep preset enabled
                                // bit 3: ROI preset enabled
                                // bit 4: Starts preset enabled
    long cftfak;               // LOWORD: 256 * cft factor (t_after peak / t_to_peak)
                                // HIWORD: max pulse width for CFT
    unsigned long roimin;      // lower ROI limit
    unsigned long roimax;      // upper limit: roimin <= channel < roimax
    double eventpreset;        // ROI preset value
    double timepreset;         // time preset value
    long savedata;             // bit 0: 1 if auto save after stop
                                // bit 1: write listfile
                                // bit 2: listfile only, no histogram
    long fmt;                  // format type: 0 == ASCII, 1 == binary
    long autoinc;              // 1 if auto increment filename
    long cycles;               // for sequential mode
    long sweepmode;            // sweepmode & 0xF:
                                // 0 = normal, 4=sequential
                                // bit 4: Softw. Start
                                // bit 5: DMA mode
                                // bit 6: Wrap around
                                // bit 7: Start event generation
                                // bit 8: Enable tag bits
                                // bit (9,10): 0=rising, 1=falling,
                                // 2=both, 3=both+CFT
                                // bit 11: pulse width
                                // bit 12: 6 bits of Sweepcounter in Data
                                // bit 13: card ID in data
    long syncout;              // sync out; bit 0..5 NIM syncout,
                                // bit 6..12 TTL syncout
    long bitshift;             // Binwidth = 2 ^ (bitshift)
    long digval;               // digval=0..255 value for samplechanger
    long digio;                // Use of Dig I/O, GO Line:
```

```

// bit 0: status dig 0..3
// bit 1: Output digval and
// increment digval after stop
// bit 2: Invert polarity
// bit 3: Push-Pull output
// bit 4..7: Input pins 4..7
// Trigger System 1..4
// bit 8: GOWATCH
// bit 9: GO High at Start
// bit 10: GO Low at Stop
// bit 11: Clear before
// ext. triggered Start
long dac0; // LOWORD: DAC0 value (START)
long dac1; // bit 16: rising edge
// LOWORD: DAC1(STOP)
// bit 16: time under threshold
double swpreset; // sweep preset value
long nregions; // number of regions
long caluse; // bit 0 == 1 if calibration used,
// higher bits: formula
double fstchan; // first time channel * 32
long active; // 1 for module enabled in system 1
long 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
    HANDLE hs0;
    HANDLE hrg;
    HANDLE hcm;
    HANDLE hct;
} ACQDATA;

typedef struct {
    int nDevices; // Number of spectra = number of modules
    int nDisplays; // Number of active displays 0...nDevices
    int nSystems; // Number of systems 0...4
    int bRemote; // 1 if server controlled by MCDWIN
    unsigned int sys; // System definition word:
    // bit0=0, bit1=0: MCD#0 in system 1
    // bit0=1, bit1=0: MCD#0 in system 2
    // bit0=0, bit1=1: MCD#0 in system 3
    // bit0=1, bit1=1: MCD#0 in system 4
    // bit2=0, bit3=0: MCD#1 in system 1 ...
    // bit6=1, bit7=1: MCD#3 in system 4
} ACQDEF;

/** FUNCTION PROTOTYPES (do not change) */
BOOL APIENTRY DllMain(HANDLE hInst, DWORD ul_reason_being_called, LPVOID
lpReserved);
VOID APIENTRY StoreSettingData(ACQSETTING FAR *Setting, int nDisplay);
// Stores Settings into the DLL
int APIENTRY GetSettingData(ACQSETTING FAR *Setting, int nDisplay);
// Get Settings stored in the DLL
// Store System Definition into DLL
VOID APIENTRY StoreStatusData(ACQSTATUS FAR *Status, int nDisplay);
// Store the Status into the DLL
int APIENTRY GetStatusData(ACQSTATUS FAR *Status, int nDisplay);
// Get the Status
VOID APIENTRY Start(int nSystem); // Start
VOID APIENTRY Halt(int nSystem); // Halt

```



```

VOID APIENTRY Continue(int nSystem);          // Continue
VOID APIENTRY NewSetting(int nDevice);
// Indicate new Settings to Server
UINT APIENTRY ServExec(HWND ClientWnd);
// Execute the Server P7886.EXE
VOID APIENTRY StoreData(ACQDATA FAR *Data, int nDisplay);
// Stores Data pointers into the DLL
int APIENTRY GetData(ACQDATA FAR *Data, int nDisplay);
// Get Data pointers
long APIENTRY GetSpec(long i, int nDisplay);
// Get a spectrum value
VOID APIENTRY SaveSetting(void);              // Save Settings
int APIENTRY GetStatus(int nDevice);
// Request actual Status from Server
VOID APIENTRY Erase(int nSystem);             // Erase spectra
VOID APIENTRY SaveData(int nDevice);          // Saves data
VOID APIENTRY GetBlock(long FAR *hist, int start, int end, int step,
int nDisplay);
// Get a block of spectrum data
VOID APIENTRY StoreDefData(ACQDEF FAR *Def);
int APIENTRY GetDefData(ACQDEF FAR *Def);
// Get System Definition
VOID APIENTRY LoadData(int nDisplay);         // Loads data
VOID APIENTRY AddData(int nDisplay);          // Adds data
VOID APIENTRY SubData(int nDisplay);          // Subtracts data
VOID APIENTRY Smooth(int nDisplay);           // Smooth data
VOID APIENTRY NewData(void);                  // Indicate new ROI or string Data
VOID APIENTRY HardwareDlg(int item);
// Calls the Settings dialog box
VOID APIENTRY UnregisterClient(void);
// Clears remote mode from MCDWIN
VOID APIENTRY DestroyClient(void);            // Close MCDWIN
UINT APIENTRY ClientExec(HWND ServerWnd);
// Execute the Client MCDWIN.EXE
int APIENTRY LVGetDat(unsigned long HUGE *datp, int nDisplay);
// Copies the spectrum to an array
VOID APIENTRY RunCmd(int nDisplay, LPSTR Cmd);
// Executes command
int APIENTRY LVGetRoi(unsigned long FAR *roip, int nDisplay);
// Copies the ROI boundaries to an array
int APIENTRY LVGetCnt(double far *cntp, int nDisplay);
// Copies Cnt numbers to an array
int APIENTRY LVGetStr(char far *strp, int nDisplay);
// Copies strings to an array

EXPORTS
;      Functions in dp7889.c
      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
StoreExtSettingData	@35
GetExtSettingData	@36

6. MCDWIN Software

The window of the MCDWIN program is shown here. It enables the full control of the P7889 card via the server program to perform measurements, save data and to show the data online in several windows.

The server program P7889.EXE automatically starts MCDWIN. If you try to start MCDWIN in advance to the server, a message box warns that you should start the server first.

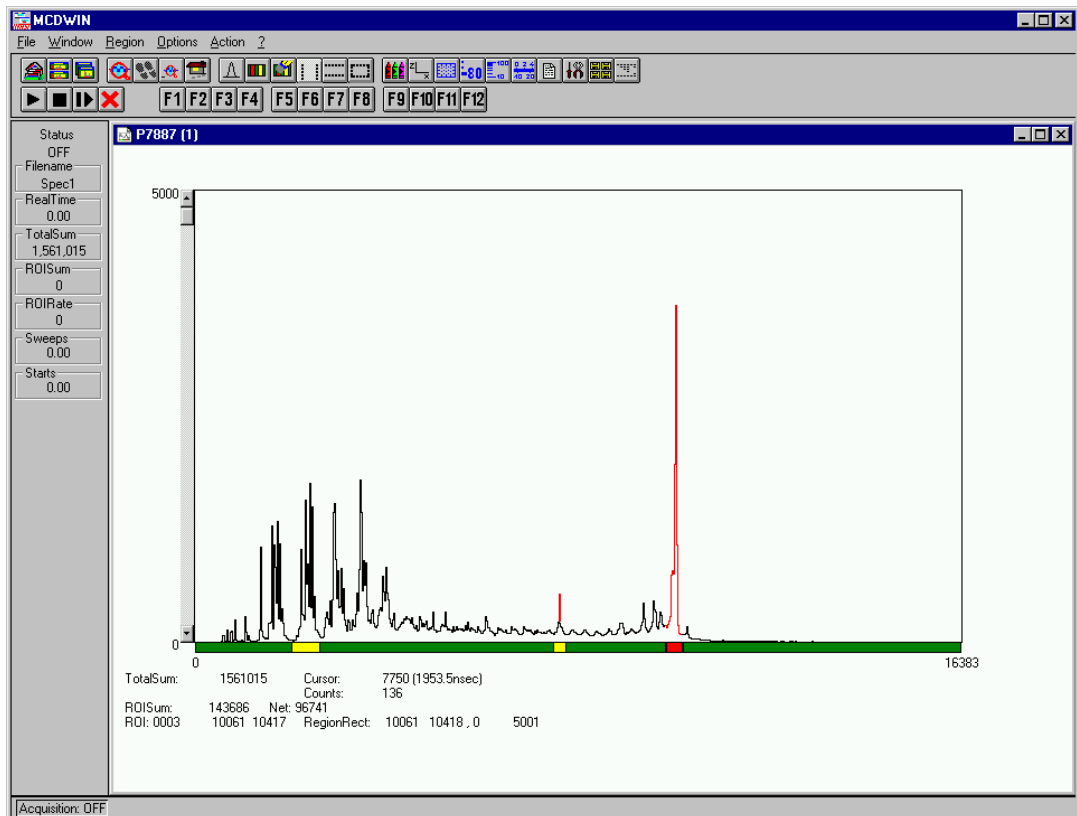


Figure 6.1: MCDWIN main window

A status window at the left side gives all information about the status of the P7889. A toolbar provides fast access to many used functions in the menu. A status bar at the bottom gives help about the meaning of the toolbar icons. A cursor appears when clicking the left mouse button inside the graphics area. To get rid of the cursor, make a double click with the right mouse button outside the graphics area. To define a region, press the right mouse button, and while keeping the button pressed, drag a rectangle. In zoomed state a scrollbar appears that allows to scroll through the spectrum.

MCDWIN has also viewing capabilities for two dimensional spectra. A single spectrum can be converted into a two dimensional one by specifying the x dimension in the display option dialog. It is possible to drag a rectangle and zoom into this rectangle. Rectangular ROIs can be set and the ROISum and Net ROISum is displayed. The Net Sum is calculated the same way like in the single view, by subtracting a linear interpolated background from the both outmost channels in x-direction. This Net sums are then summed up in y-direction. The ROI editing dialog is changed into a Rectangular Editing dialog for MAP and ISO displays. The Cursor can be moved in x and y direction using the mouse and the arrow keys, in ISO display only using the arrow keys.

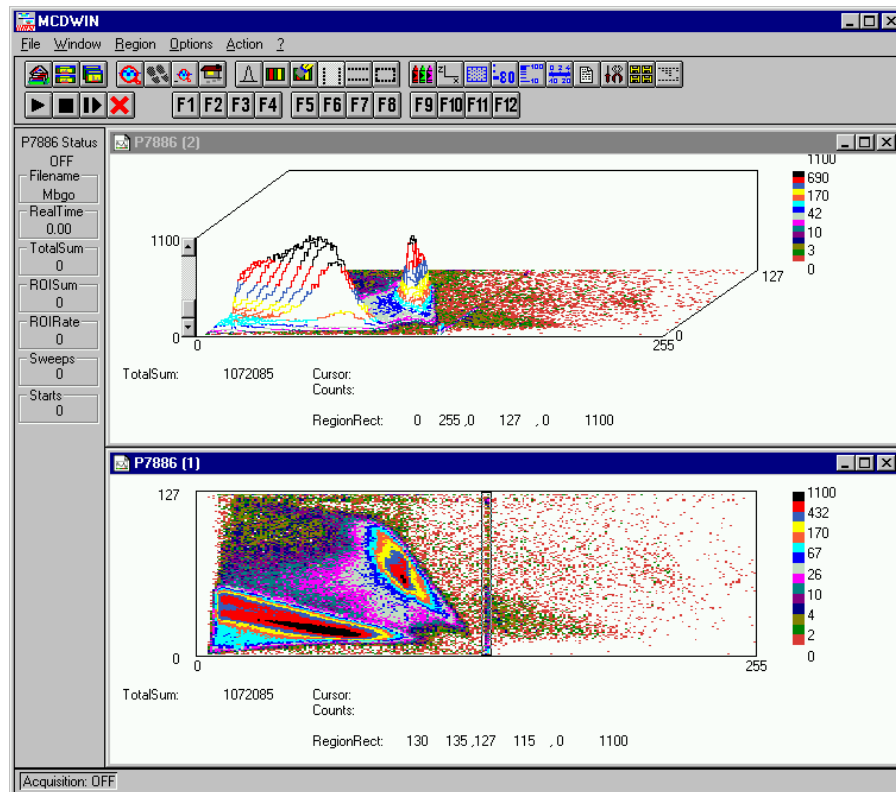


Figure 6.2: MCDWIN Map and Isometric display

A status window at the left side gives all information about the status of the P7889. A toolbar provides fast access to many used functions in the menu. A status bar at the bottom gives help about the meaning of the toolbar icons. A cursor appears when clicking the left mouse button inside the graphics area. The cursor can be moved using the arrow keys. To get rid of the cursor, make a double click with the right mouse button outside the graphics area. To define a region, press the right mouse button, and while keeping the button pressed, drag a rectangle. In 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.

6.1. File Menu

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

These menu items provide the usual functions for loading and saving data common to most Windows programs. When saving data, you have the choice between binary (.DAT) and ASCII (.ASC) format. When you load data, select a header file (extension .889). This file contains the information about the length and format of the data file, which is then automatically read.

It is also possible to load a file with extension .CTL containing commands which are then executed. With „Add“ the data is added to the present data. The data loaded from a file is corrected according to the calibration, if available.

Open New...



With the Open New menu item or the corresponding icon a new Display window will be created and shown as the active window.

Open All

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

Print...

The Print menu item opens the print dialog. It allows to arrange several pictures on a page into zones. The number of zones in vertical and horizontal direction can be specified. The Color can be black/white, RGB (colored) or Gray scale. RGB is recommended also for black laser printers. Some info lines containing date, filename and title can be added. For each page a temporary file PRINT1.WMF, PRINT2.WMF... will be created. This file is in Windows Metafile format and can be exported into some other Windows applications.

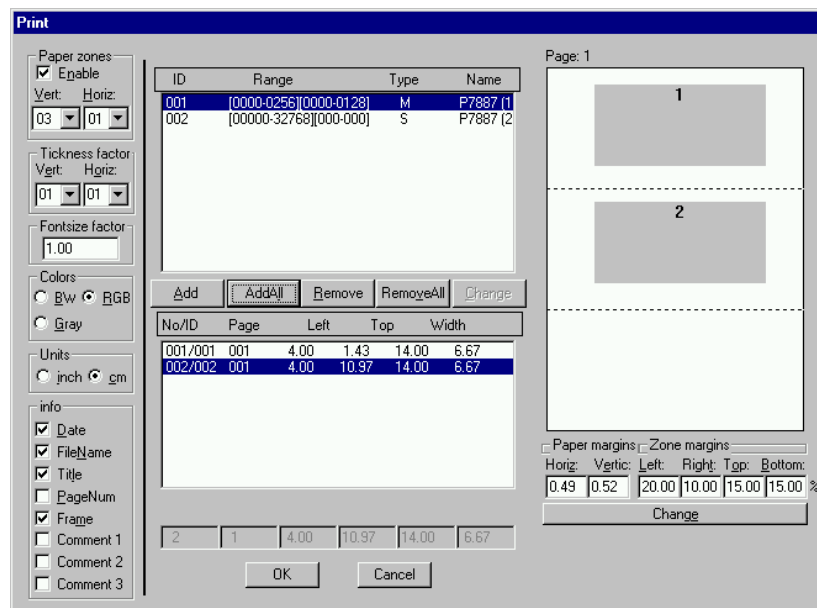


Figure 6.3: Print dialog box

NOTE:

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 9x 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.

6.2. 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 make the same size for all windows.

Cascade

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

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 and is displayed in front of all others.

6.3. Region Menu

The Region menu contains commands for Regions and ROIs (Regions of Interest). A Region can be marked in a display with the mouse using the right mouse button by dragging a rectangle over the area one is interested in. A ROI, i.e. an already defined region in a single spectra 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 Display Spectrum size.

Back

The Back menu item or clicking the corresponding icon restores the last zoom view. A successive Back command returns to the previous view.

Zoom Out

The Zoom Out menu item or clicking the corresponding icon reduces the actual zoom factor by 2, if applicable.

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 maximum height.

Y-Slice

Sets the Region shape to the rectangle with maximum 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 one, delete, change and activate an existing ROI. Also the peak values (e.g. energy, mass etc.) 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 can be written to a file with extension .CTL, which can be directly loaded into the server to restore the ROI list.

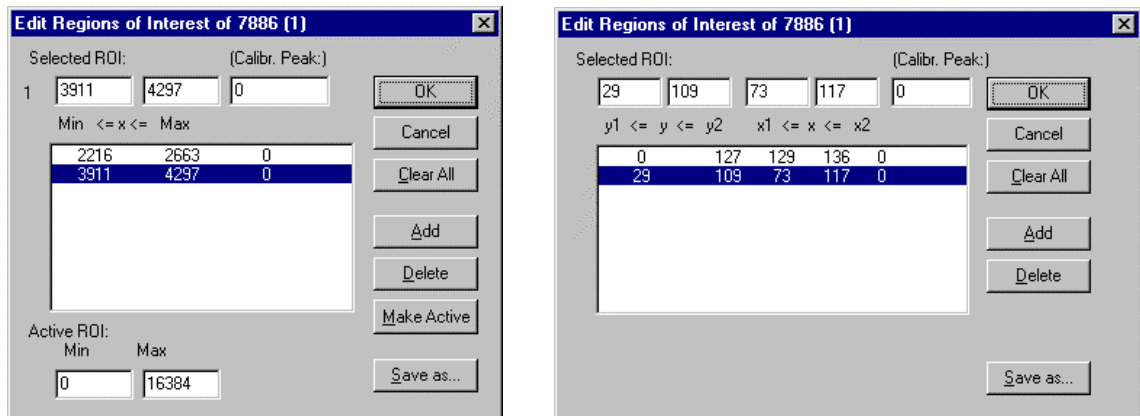


Figure 6.4: ROI Editing dialog box, left: Single spectra, right: 2D spectra

The selected ROI can be changed by clicking on it in the ROI list. In the MCDWIN spectrum display the total and net sum of the selected ROI is displayed.

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:

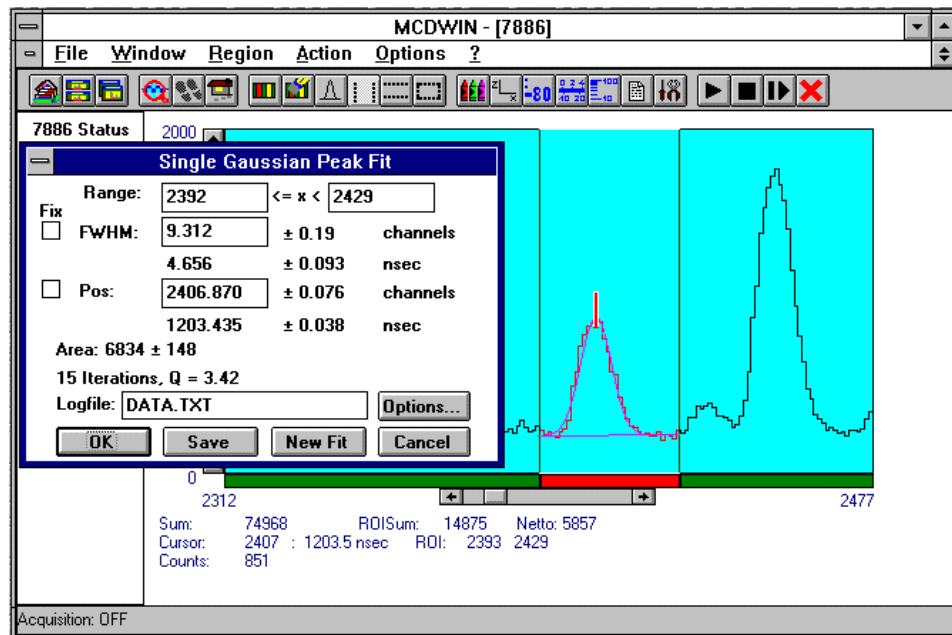


Figure 6.5: Single Gaussian Peak Fit

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 χ^2 . To take into account the systematic error of the lineshape, you may multiply the errors with the squareroot of Q. Click on **Save** to append a line containing the results to a **Logfile** with the specified name. **OK** closes the dialog

and the fitted function remains in the display - also if the display 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:

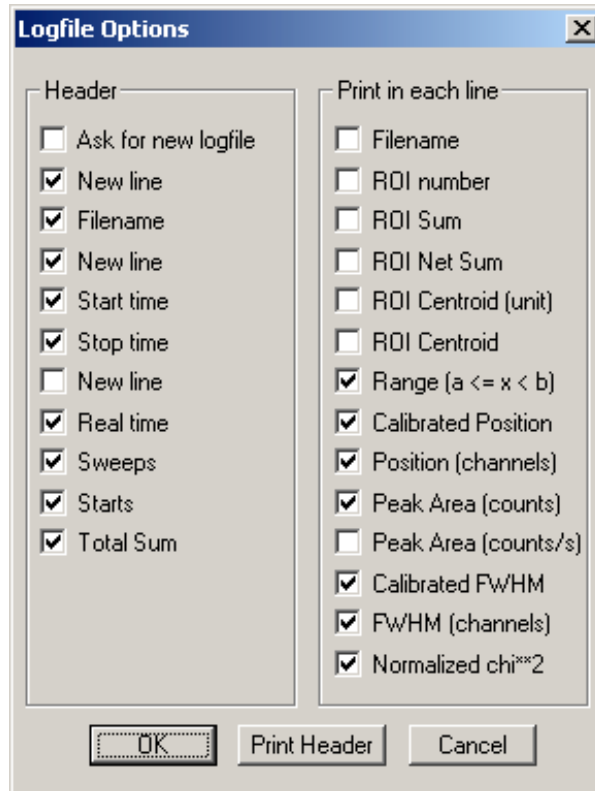


Figure 6.6: Log file Options for the Single Gaussian Peak Fit

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.

6.4. 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.

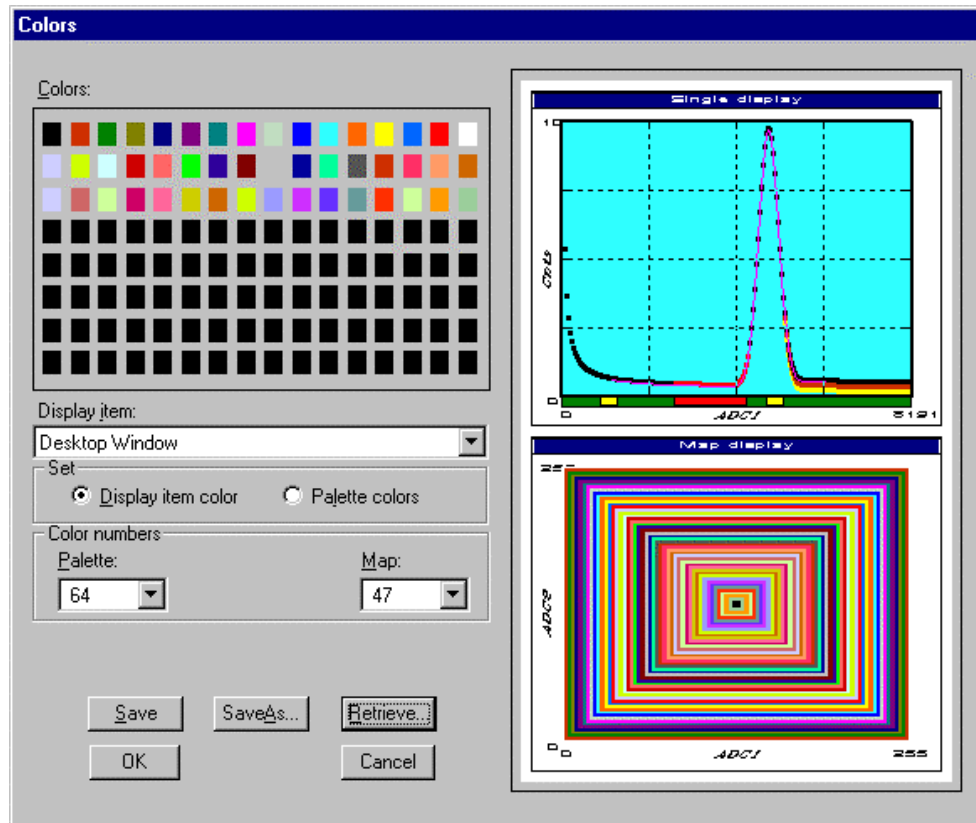


Figure 6.7: Colors dialog box

It changes the palette or Display element color depending on which mode is chosen. The current color and palette setup may be saved or a new one can be loaded.

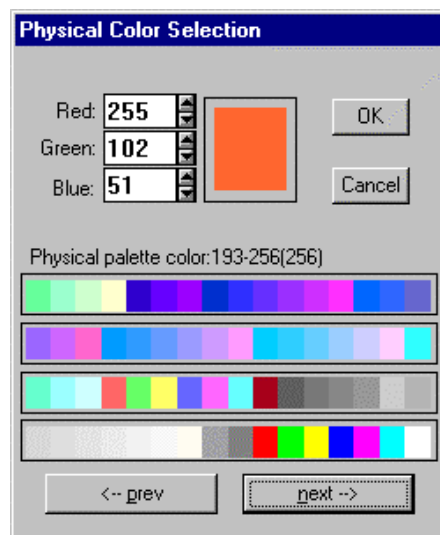


Figure 6.8: Color Palette dialog box

To change on of the colors, select "Palette colors" and click on one of the colors. In the Color Palette dialog box the RGB values can be edited or for a 256 color video driver one of the Physical palette colors can be chosen.

Display...

The Display menu item or the corresponding icon opens for single spectra the Single view dialog box.

Here the graphic display mode of single spectra can be chosen. The '**Type**' combo box gives a choice between dot, histogram, spline l and line. The '**Symbol**' combo box gives a choice between None, Circle, Triangle down, Triangle up, Cross, Snow-flake and Diamond. The symbols can be filled by checking **Fill**, error bars can be displayed by checking **Error Bar**.

'Dot' means that each spectra point is shown as a small rectangle or the specified symbol, the size can be adjusted with the **size** combo box. 'Histogram' is the usual display with horizontal and vertical lines, 'spline l' 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 „**All**“ data is displayed. But it can also explicitly specified by marking the checkboxes „**Max Pixel**“, „**Mean Pixel**“ or „**Min Pixel**“ which value in the pixel column 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 below this value then aren't taken into account for the mean value calculation.

It is possible to change to a two dimensional view of the spectrum by specifying the x Dimension and clicking the button ">> MAP".

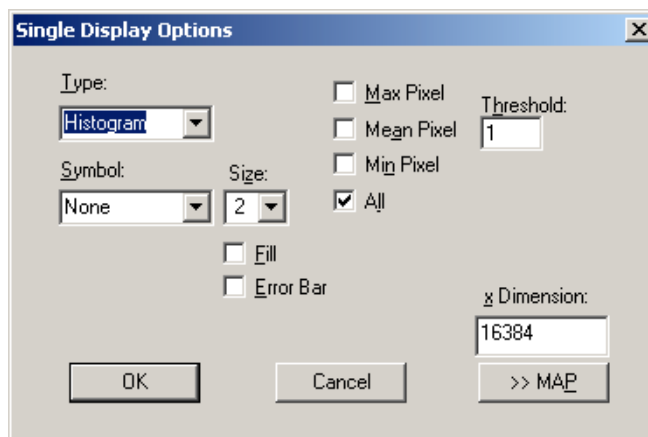


Figure 6.9: Single View dialog box

For MAP displays the Display Options dialog is changed and allows a choice between four Graphic types: **bitmap dot**, **vector dot**, **bitmap contour** and **vector contour**. Bitmap Dot is recommended as a standard, because it makes a good and fast display. Vector Contour paints colored contour lines. To calculate the lines takes a lot of time and causes the mouse pointer changing to an hourglass. But it gives very impressive colored pictures suited especially for presentation and when looking carefully at spectra details.

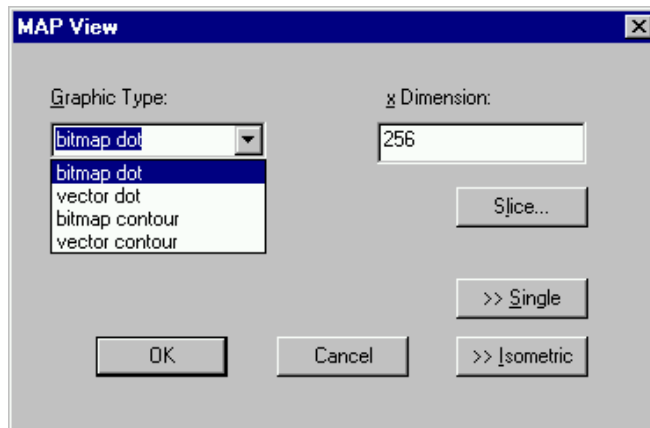


Figure 6.10: MAP View dialog box

Clicking the Slice button allows to create new single spectra displays, showing a slice in a 2D spectra. The Slice dialog box is displayed.

Select "x=const" or "y=const" for the slice direction, and the coordinate. Clicking the "create" button creates the new display window. In the title bar of the new window the name of the 2D spectra and the slice coordinate is shown.

The slice position can be changed using the scroll bar in the Slice dialog, or by entering the value in the edit field and pressing the button which is labeled "Set" after creation of the slice view.

The Slice dialog can be closed by clicking its close field. Created slice spectra displays remain visible and their coordinates can be changed later using the Slice dialog again. The position of the Slice dialog with respect to the MCDWIN main window can be saved in the MCDWIN.CNF file. Rectangular ROIs are visible in the slice spectra display and can be created here.



Figure 6.11: Slice dialog box

From the MAP View dialog it is possible to change to Single view by clicking ">> Single" or change to Isometric View by clicking ">> Isometric".

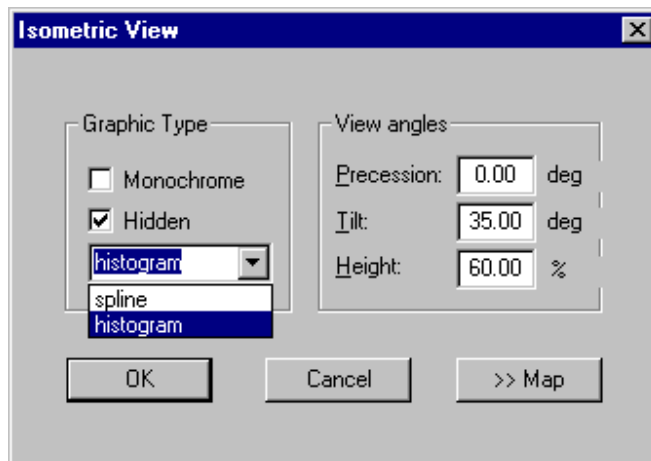


Figure 6.12: Isometric View dialog box

In isometric mode several single spectra are drawn behind each other. The **Precession** angle around the vertical axis can be chosen in multiples of 90 degrees. The **Tilt** angle is between the x and y axis and can be chosen between 15 and 89 degrees. The **Height** specifies the percentage of the z-axis length respective to the whole drawing, it can be entered between 0 and 99. With **hidden** it can be specified whether the hidden parts are not drawn. If "Monochrome" is checked, the spectra are painted monochrome, otherwise in color.

Axis...



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

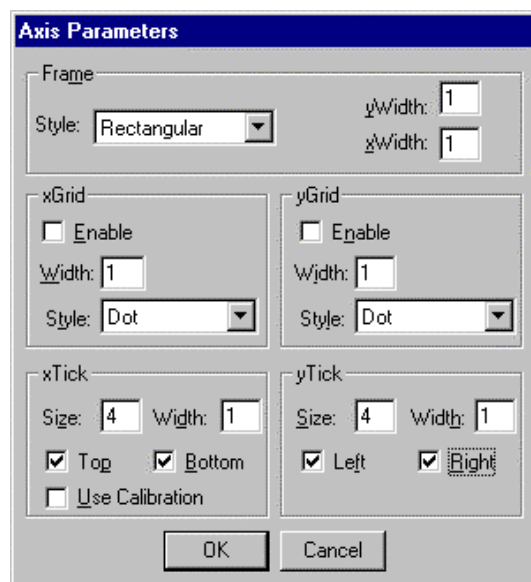


Figure 6.13: Axis Parameter dialog box

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.

Scaling...



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

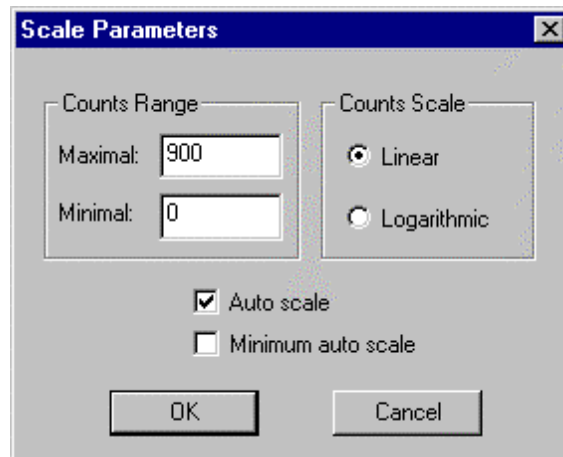


Figure 6.14: Scale Parameters dialog box

It allows to change the ranges and attributes of a Spectrum axis. By setting the Auto scaling mode, the MCDWIN will automatically recalculate the y-axe's maximum value for the visible Spectrum region only. To keep the same height of the visible region for a longer time, deselect the Auto scaling mode. 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



Chose between Linear or Logarithmic scaling. All options have effect only on the active Display.

Calibration...



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

The Calibration dialog box is titled "Calibration". It has a "Use Calibration" checkbox which is checked, and a "Unit" field set to "nsec".

Under "Calibration Points", there is a table with two columns: "Channel" and "Value".

Channel	Value
0.00	0
100.00	50
3168.00	1580
6234.00	3110
4075.00	2039

Buttons for "Cursor", "Fit", "Add >>", "Remove <<", and "Clear All" are present. The "Channel" and "Value" fields are currently empty.

Under "Formula", there is a dropdown menu showing the formula $p_0 + p_1 \cdot x + p_2 \cdot x^2 + p_3 \cdot x^3$.

The coefficients and their statistical errors are:

Coefficient	Value	Error
p0 =	0.776205	± 0.889
p1 =	0.483165	± 0.00454
p2 =	7.29987e-006	± 1.94e-006
p3 =	-7.69782e-010	± 1.98e-010

Buttons for "OK", "Calibrate", "Save as...", and "Cancel" are at the bottom.

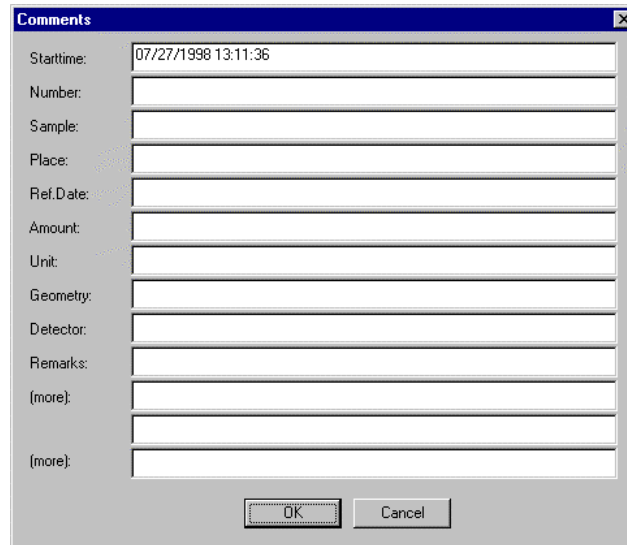
Figure 6.15: Calibration dialog box

Make a choice of several calibration formulas. Enter some cursor positions and the corresponding values (e.g. energy, mass etc.), click on Add and 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 enabled, the calibrated values are displayed together with the channel position of the cursor.

Comments...



Up to 13 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 automatically contains the time and date when a measurement was started. The titles of each line can be changed by editing the file COMMENT.TXT.



The image shows a 'Comments' dialog box with a blue title bar and a close button. It contains several text input fields for the following labels: Starttime (pre-filled with '07/27/1998 13:11:36'), Number, Sample, Place, Ref.Date, Amount, Unit, Geometry, Detector, Remarks, (more), and another (more). At the bottom are 'OK' and 'Cancel' buttons.

Figure 6.16: Comments dialog box

Range, Preset...



This dialog box allows to make all P7889 settings (ref. chapter 5.1.4).

P7889 Settings

PLLfreq = 1e+010 Module: A

Sync out NIM: STOP

Sync out ITL: 10 MHz

☐ Softw.-Start ☒ DMA Mode

☐ Wrap around ☐ Write Listfile

☒ Start event generation ☐ No Histogram

☐ Time differences

☐ Starts preset: 1

☐ Sweep preset: 1

2D spectra

☐ Pulse width y-Range: 2

☐ Tagged spectra

☐ Sequential cycles Sequences: 1

High Data bits

☐ Card ID (0..7): 0

☐ 6 bits Sweepcounter

☐ Timepreset: 1000.000

☐ Eventpreset: 0

Binwidth: 1

Range: 4096

End of Sweep (ns): 416

Acq. Delay (ns): 0

Hold aft. Sweep (ns): 0

ROI: 0 4096

Setup name: p7889

OK Cancel Apply Save Sett. Load Sett. Inputs...

Figure 6.17: P7889 Settings dialog box

Data...

The Data dialog box allows to perform all the P7889 data operations (ref. chapter 5.1.3).

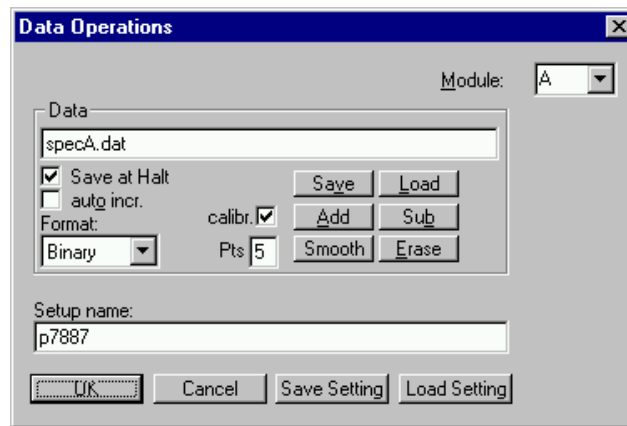


Figure 6.18: Data Operations dialog box

System...

The System Definition dialog box allows to make all the respective P7889 settings (See chapter 0).

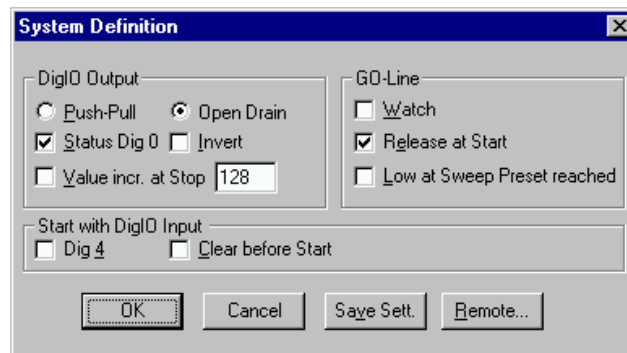


Figure 6.19: System Definition dialog box

Replay...

The menu item Options – Replay... opens the Replay settings dialog (ref. chapter 5.1.3).

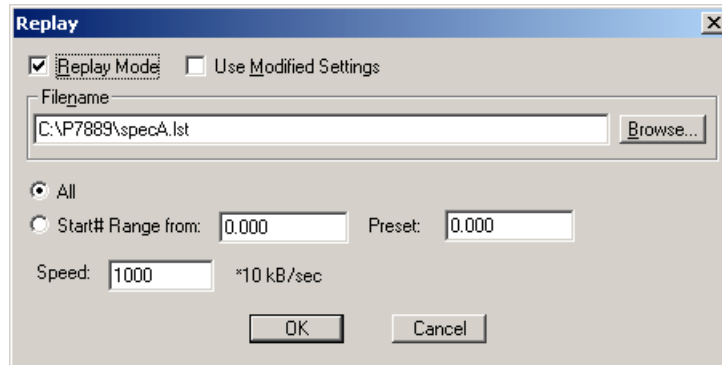


Figure 6.20: Replay dialog box

Tool Bar...

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

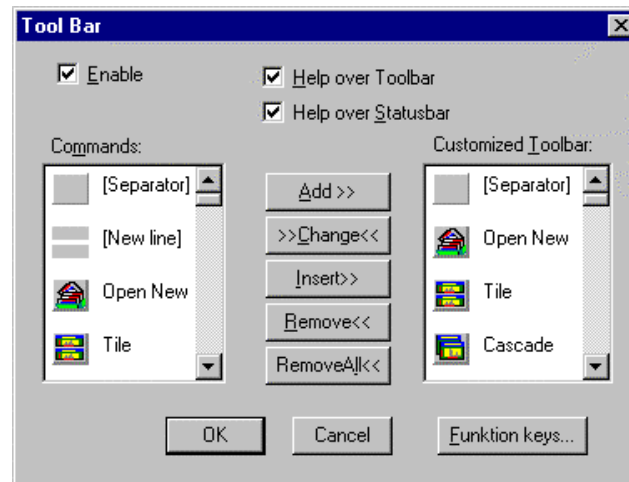


Figure 6.21: Tool Bar dialog box

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.

It is also possible to include icons for free programmable function keys F1...F12 into the Toolbar. The function keys can be programmed in the Function keys dialog. It can be accessed either by clicking the "Function keys..." button or directly from the options menu.

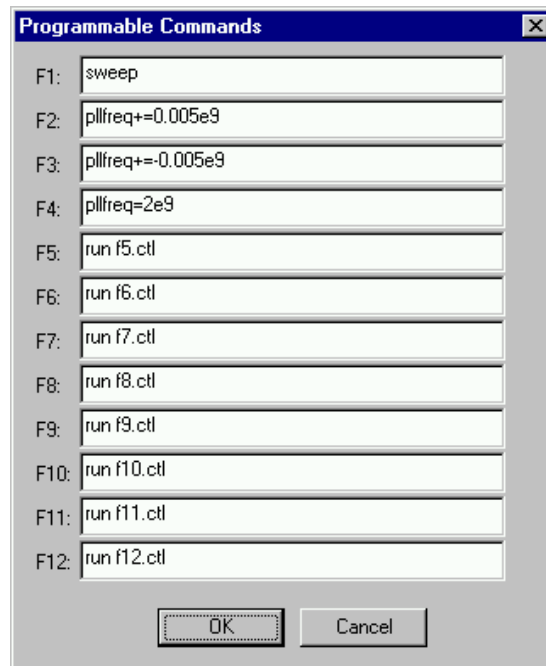


Figure 6.22: Function keys dialog box

The functions can be executed by clicking the corresponding icon in the toolbar or by the corresponding function key on the keyboard simultaneously with the CTRL key. The MCDWIN window must be the active on the desktop and have the focus.

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 checkmark shows if it is active or not. The Status bar usually shows if an acquisition is running. When the left mouse button is held down while the mouse cursor is on a toolbar icon, it displays a short help message what the toolbar icon does.

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

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

Save As...

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

Retrieve...

Loads a new configuration.

6.5. Action Menu

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

Start



The Start toolbar button erases the histogram 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 clears the histogram data.

7. Programming and Software Options

P7889

The P7889 can be controlled by user-written programs using the DLL software interface with example programs for Visual Basic, LabVIEW and C that is available as an option. Furthermore, LINUX software is available as an option containing a driver, library and console test program. A Windows software similar to the LINUX package that runs without the server using a stand-alone DLL is also available on demand for customers who own one of the two available library packages.

Auto-Correlation: an optional available expansion of the Server program allows to acquire data into a two dimensional array $M(i,j)$. The channel (i,j) is incremented when in a single sweep the channel i and $i+j$ has an event. The two dimensional MAP can be viewed in MCDWIN even during the acquisition. Use the display options and switch to MAP and later to ISOMETRIC.

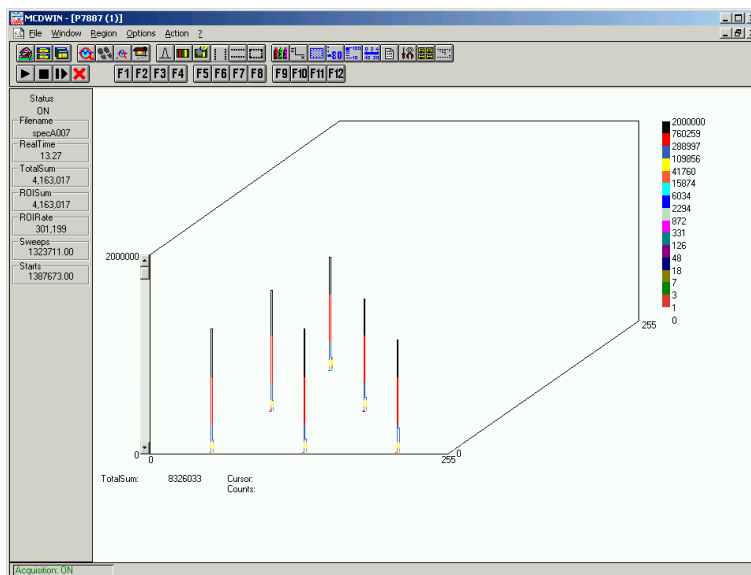


Figure 7.1: Autocorrelation software option

8. Appendix

8.1. Performance Characteristics

8.1.1. General

Resolution ¹ FWHM ² :	at 10 μ s \cong 100,000 chs over 60 min: typ. < 160 ps at 1 ms \cong 10,000,000 chs over 60 min: typ. < 180 ps
	Oven stabilized option: at 100 ms \cong 1,000,000,000 chs over 24 hours..... typ. < TBD
Dynamic range:	.....2^{64} x 100 ps = 58.5 a
Differential non-linearity:	.....<< \pm 1 %
Start / trigger delay:	..... typ. < 10 ns
Deadtime:	Start of sweep pipeline delay: 44.8 \pm 6.4 ns End of sweep: < 80 ns between time bins: none
Sweep repetition time:	..... \leq (Acq. Delay + Range + Hold Off + 132 ns)

8.1.2. Timebase

Reference oscillator:	Nominal frequency: 10.000 MHz Initial accuracy (25°C): $\leq \pm$ 50 ppm Frequency stability: in operating temperature range: $\leq \pm$ 100 ppm
Oven stabilized option:	Nominal frequency: 10.000 MHz Adjustment tolerance: $\leq \pm$ 0.25 ppm Frequency stability: in operating temperature range: $\leq \pm$ 0.03 ppm vs. Supply voltage change \pm 5 %: $\leq \pm$ 5.0 * 10 ⁻⁹ vs. Short term: $\leq \pm$ 1.0 * 10 ⁻¹⁰ /s Aging: $\leq \pm$ 2.0 * 10 ⁻⁹ /day 2.0 * 10 ⁻¹ /1 st year Warm-up time: \leq 1 min. @ 25°C \leq 2 min. @ 0°C
Synthesizer frequency:	Nominal: 10 GHz

¹ Input signal is a highly stable 10MHz Rubidium Frequency Standard sine wave signal in a laboratory surrounding

² Full width at half maximum. All FWHM data is derived from a gaussian fit.

8.1.3. Data Throughput

DMA data rate into PC ¹:	..... $22.3 \times 10^6 \text{ sec}^{-1}$ $\leq 51 \times 10^6 \text{ sec}^{-1}$
Burst STOP edge input rate:	..... 10 GHz
Max. burst length:	(initially empty 1024 deep FIFO_1)..... $\geq 6.55 \mu\text{s}$
FIFO_1-to-FIFO_2 rate:	..... $\geq 22.3 \text{ MHz}$ (at burst input rate)..... max. 51 MHz

8.2. Specification

8.2.1. Absolute Maximum Ratings

Input voltage:	any multi I/O port: -0.5 to + 5.5 V any TTL TAG input port: -0.5 to + 5.5 V any LVDS TAG input port: -0.5 to + 2.9 V any discriminator input: $\pm 1.7 \text{ V}$
DC current:	any multi I/O port..... $\pm 10 \text{ mA}$ any TTL TAG input port..... $\pm 40 \text{ mA}$ any LVDS TAG input port..... $\pm 20 \text{ mA}$ any discriminator input: $\pm 200 \text{ mA}$

8.2.2. Recommended Operating Conditions

Supply voltage:	(from PC power supply)..... +3.3V, +5 V, +12 V, -12 V
Temperature range:	..... 0 to 50°C
GO Line load:	..... min. 1 k Ω to +5.0V or min. 2 k Ω to GND

8.2.3. Power Requirements

Supply voltage:	..... $+3.3 \text{ V} \pm 0.16 \text{ V}$ $+5 \text{ V} \pm 0.25 \text{ V}$ $+12 \text{ V} \pm 0.6 \text{ V}$ $-12 \text{ V} \pm 0.6 \text{ V}$
Supply current:	+3.3 V: TBD +5 V: 2.2 A +12 V: 0.2 A -12 V: 0.25 A

8.2.4. Connectors

$\pm 1 \text{ V}$ Discriminator Inputs

Location: mounting bracket
-----------	------------------------

¹ depends largely on the computer used

Connector:	.....female SMA
Impedance:	..... 50 Ω
Input voltage range:	.....\pm 1.0 V
Threshold voltage:	(power-up default = 0.0 V) \pm 2.0 V in steps of 1 mV
Sensitivity:	.....typ. < 10 mVpp
Bandwidth STOP input:	(- 3dB) typ. > 3 GHz
Bandwidth START input:	(- 3dB) typ. > 1 GHz

Fast-NIM SYNC_1 Output

Location:	..... mounting bracket
Connector:	.....female SMA
Impedance:	..... 50 Ω
Output HIGH voltage:	(50 Ω load) typ. -0.0 V
Output LOW voltage:	(50 Ω load) typ. -0.8 V
Output short circuit current:	$V_{OUT} = GND$ typ. 28 mA

SYNC_2 Output

Location:	..... ref. FEATURE (multi) I/O port connector
Output HIGH voltage:	$I_{OutHIGH} = -24mA$ min. 2.4 V
Output LOW voltage:	$I_{OutLOW} = 48mA$ max. 0.45 V
Recommended current:	$V_{OUT} = LOW$ < 180 mA $V_{OUT} = HIGH$ < - 90 mA

Reference Clock I/O:

Location:	..... ref. FEATURE (multi) I/O port connector
Impedance:	.....(dc blocked) 50 Ω
Output HIGH voltage:	(50 Ω load) typ. 2.0 V
Output LOW voltage:	(50 Ω load) typ. 0.4 V
Input Amplitude:	(clipped sine or sine wave).....typ. 3.3 V _{pp} The clock I/O circuitry is widely adjustable to individual needs. Contact factory for details.

Digital I/O 0...7

Location:	..... ref. FEATURE (multi) I/O port connector
R PULL :	(default) 1.0 k Ω
R I/O:	(default) 22 Ω
Input HIGH voltage:	(at PIN _i , ref Figure 3.13.) ¹ min. 2.0 V
Input LOW voltage:	(at PIN _i) max. 0.8 V

¹ Note: input and output voltages are measured at the internal logic pads not at the external connectors. Thus, the corresponding pull and series resistors must be considered to get the external voltages

Output HIGH voltage: (at POUT_i) I_{OutHIGH} = -4.0mA min. 2.4 V
 Output LOW voltage: (at POUT_i) I_{OutLOW} = 8.0mA max. 0.4 V

GO-Line

Location: PCI board
 ref. multi I/O port connector
 Connector: 2 pin header on PCI board: LUMBERG 2,5 MSFW 2(MBX)
 suitable socket connector: LUMBERG 2,5 MBX 2
 Line Type : open drain / wired-AND
 Pull-up Resistor: 22kΩ to +5.0 V
 Input HIGH voltage: min. 2.0 V
 Input LOW voltage: max. 0.8 V
 Output LOW voltage: I_{Out LOW} = 8mA max. 0.4 V

TTL TAG Input 0...15

Location: ref. TTL TAG input port connector
 R PULL-DOWN : 110 Ω
 Input HIGH voltage: min. 2.0 V
 Input LOW voltage: max. 0.8 V
 Time resolution: 6.4 ns
 Sampling uncertainty: TAG to cor. STOP: ± 6.4 ns
 Pulse width: recommended: >12.8 ns

TTL TAG Clock Output

Location: ref. TTL TAG input port connector
 Output frequency: 156.25 MHz
 Output period: 6.4 ns
 Output HIGH voltage: I_{Out HIGH} = 128mA min. 2.0 V
 Output LOW voltage: I_{Out LOW} = 64mA max. 0.4 V
 Output HIGH current: max. -128 mA
 Output LOW current: max. 256 mA

LVDS TAG Input 0...15

Location: ref. LVDS TAG input port connector
 R Differential : 100 Ω
 detail of each input: 100 Ω to GND and 100 Ω to +2.5 V
 Input DIFFERENTIAL volt.: min. ±100 mV
 typ. ±350 mV
 Input Common-Mode volt.: (diff. ±350 mV) min. 0.2 V
 typ. 1.25 V
 max. 1.8 V
 Time resolution: 6.4 ns
 Sampling uncertainty: TAG to cor. STOP: ± 6.4 ns

Pulse width: recommended: >12.8 ns

TAG Clock Output

Location: ref. LVDS TAG input port connector

Output frequency: 156.25 MHz

Output period: 6.4 ns

Output DIFFERENTIAL volt.: $R_{Diff} = 100 \Omega$ min. 250 mV
 typ. 350 mV
 max. 400 mV

Output Common-Mode volt.: $R_{Diff} = 100 \Omega$ min. 1.125 V
 typ. 1.2 V
 max. 1.375 V

8.2.5. Tag Input Timing

TAG input signal with a save "0" recognition:

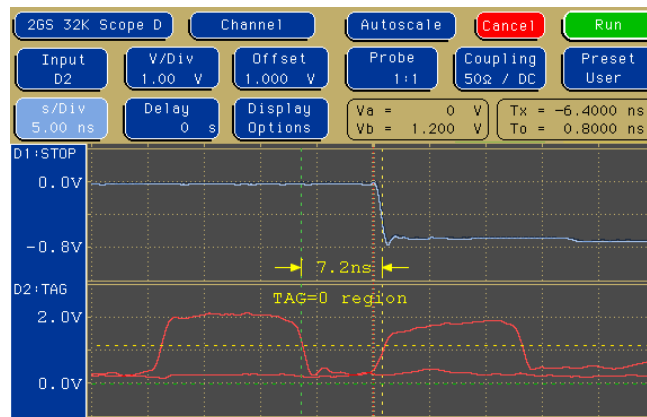


Figure 8.1: Save TAGs = 0 timing

TAG input signal with a save "1" recognition:

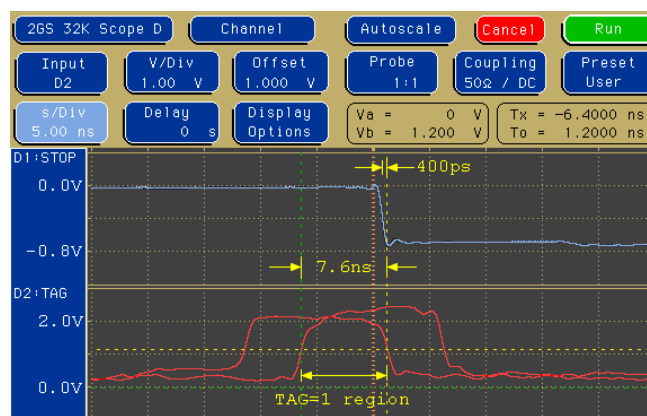


Figure 8.2: Save TAGs = 1 timing

TAG t_{SETUP} (rel. STOP): recommended: >9 ns

TAG t_{HOLD} (rel. STOP): recommended: >3 ns

TAG pulse width: recommended: >12 ns

8.2.6. Physical

PCI long board (ISA assembly, 64Bit, 3.3V)

Size: (incl. retainer) 341 x 107 mm

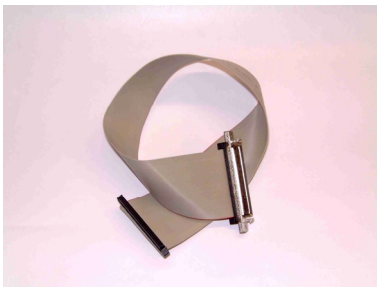
Weight: (board alone) \approx 220 g

8.3. Accessories

SMA – BNC adapter cables



TAG input port connector cable



8.4. Trouble Shooting

- System hangs on power-up: Take care that the board is well seated in the PCI connector. Push it towards the bracket to ensure proper connections.
- PCI device is not properly detected: Push the board in the PCI slot towards the bracket to ensure proper connections.
- Error message **"P7889 A not found or FAST7889 device driver not installed!"** at the first start of the software:
Maybe you did not install the device drivers. If Windows 2000/XP is installed with the P7889 board plugged in, a wrong device driver for a "general PCI communication device" may be installed. Check it using the Device manager, remove the wrong driver and install the correct driver from the WDMDRIV directory on the diskette.

- Personal Notes