

**RogaDAQ16**  
**USB2.0**  
**Series**



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## 1 Imprint

ROGA-Instruments

Manual : RogaDAQ16 *Series*  
Date : 4/25/2007

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## 2 Introduction

### 2.1 RogaDAQ16 USB-Series

The intelligent data acquisition system RogaDAQ16 series offers a maximum of flexibility. Excellent availability, very high processing speeds, and easy configurability by its user's are the outstanding features of the RogaDAQ16. Furthermore RogaDAQ16 offers integrated counters and is able to work with pulse width modulation. It is possible to customize the RogaDAQ16 to individual needs. The RogaDAQ16 not only offers a wide variety of functionality it also offers online mathematics. This is the base for a wide range of different applications:

- Very fast control systems
- Fast control of test systems
- Controlling counter readings, pulse widths/frequencies
- Simultaneous measuring and outputting of signals
- Online mathematics
- Wave form generators

RogaDAQ16 is equipped with an USB 2.0-interface. With full downward compatibility this version offers 40 times of the USB1.1 data rate. Additionally to its stand alone capability this portable measurement center offers hot plug functionality so it is possible to connect it during runtime and have it immediately ready to run.

- No Configuration Conflicts  
RogaDAQ16 is configured after connecting it to the PC system and is ready to run immediately.
- High bandwidths with USB2.0 while fully downward compatible to USB1.1.

RogaDAQ16 allows simultaneous measuring and outputting of data with up to three independent sequential control systems. Each sequence has associated its own channel list. So not only a time synchronized measuring is possible but also a time synchronized output of analog and digital data and the output of counter readings. Furthermore RogaDAQ16 offers a lot of different trigger modes which allow starting of sequences depending on various signals.

- Up to three simultaneous sequences
- Programmable channel lists
  - Analog inputs
  - Digital inputs
  - Counters
  - Analog outputs
  - Digital outputs
- Single processing: Measuring a single predefined input value is possible
- Block processing: with and without **flexible** signaling
- Numerous triggers
  - External clock
  - External, digital trigger
  - Edge-/level triggering
  - Gradient triggered start

- Online mathematics: FFT, FIR – Filter (Finite Impulse Response), IIR-Filter (Infinite Impulse Response)
- Output
  - Single output
  - continuous output
  - repetitive output

## 2.2 Signal Description

RogaDAQ16 offers a wide range of available inputs and outputs. They differ in data width, data rate, and functionality.

### 2.2.1 Analog Inputs:

Analog data acquisition serves to measure analog voltages. It is possible to measure single ended and dual ended. In the first mode the voltage is measured relative to ground. This mode allows measuring voltages only. Dual ended measuring means to measure between two input terminals. The negative terminal should be connected with a resistor to the ground of the RogaDAQ16 which serves to associate to a referential potential. This mode allows to measure voltages and, aided by a shunt, also currents. Dual ended measuring cuts the number of available inputs in half because each channel has associated two input terminals.

The inputs are available with a resolution of 16 bits (65535 quantifying steps)

The most actual version of RogaDAQ16 works jumper less. It offers a completely software based configuration. Furthermore there are numerous options associated to the channels. In example it is possible to set the channel gain individually (1x, 2x, 4, 8x & + 20 dB) as well to set the inputs to bipolar (+/-) or unipolar (0. +). The channels offer also individually settable oversampling and threshold controlling for triggering.

Example:

Gain 1x = 10 Volt	+ 20 dB = 1 Volt
Gain 2x = 5 Volt	+ 20 dB = 0.5 Volt
Gain 4x = 2.5 Volt	+ 20 dB = 0.25 Volt
Gain 8x = 1.25 Volt	+ 20 dB = 0.125 Volt

### 2.2.2 Analog Outputs:

The analog outputs deliver a voltage. The voltage is kept as long as a new value is applied. After switching on RogaDAQ16 all voltages are set to zero volts. The outputs can be configured by software. There are no jumpers to set.

The DACs can be toggled between unipolar (0..+) and bipolar (+/-) to distribute the resolution to the intended spectrum.

The outputs can be operated with resolutions of 12 bits (4096 quantifying steps) and 16 bits (65535 quantifying steps).

### 2.2.3 Digital Inputs/Outputs:

RogaDAQ16 offers 16 inputs/outputs. The terminals can be set to input or output by software. The configuration is set individually for each bit. Any digital bits can handle voltages up to low voltage TTL level (5V max).

## 2.2.4 Counters:

The counters count digital pulses (low voltage level) and process them automatically. It is possible to count pulses and measure times and phase differences. All counters are fully software configured. The counters offer the acquisition modes described in the following. The modes may vary depending on the purchased options.

### 2.2.4.1 Counting Pulses:

Counting pulses up to 24 bit values (16.777.215) and a maximum frequency of approx. 10 MHz. It is possible to set an initial value. The counter can be used in up or in down mode.

### 2.2.4.2 Measuring Frequencies:

The method of „measuring frequencies by “counting in a time window“ depends on the definition of the frequency (number of oscillations or periods per second). After starting the measurement a clock generator keeps open the „time window“ for a certain period of time. The time window can be set in 1000, 100, 10 and in 1 millisecond(s). Within the time window the number of pulses of the frequency signal to determine is counted. The number of pulses can be read directly as frequency value shown in Hz and can be used for the display. The highest resolution is available within the one second range because it is counted exactly to 1 Hz. Indeed a new result can be displayed once a second because the time window is one second long.

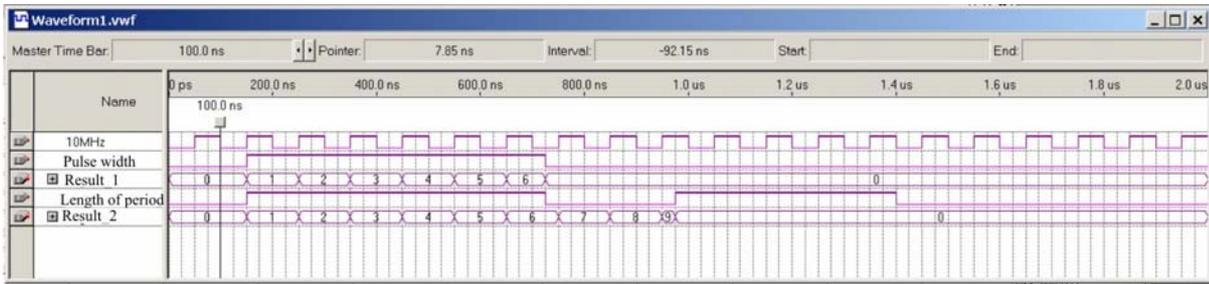
The display shows the following with an input frequency of 12563 Hz depending on the setting of the reference frequency:

Resolution	Display
1 Hz	12563 Hz
10 Hz	12560 Hz
100 Hz	12600 Hz
1000 Hz	13000 Hz

### 2.2.4.3 Measuring the Period Length:

To measure the length of a period a time window is compared with the length of the period of the signal to determine and the numbers of pulses within this window are counted. The counting pulses are generated by a 10 MHz clock oscillator. This is the equivalent of a counter resolution of 100ns.

The measuring of the length of the period is to prefer for high precision or very fast frequency measures because for each period a new reciprocal value of the frequency is available. If an input frequency of 1 kHz is fed into the counter the display shows 10000 which means  $10000 * 100\text{ns}$ . Other than the frequency measurement the counter reading without a signal, in example if a pulse generator is not turned on any more, is not refreshed because the second reference pulse is missing. The calculation into rotations per second or into a frequency will not lead to a zero value in the display; instead the last value is displayed. This is caused by technical details because a zero frequency means the length of the period had to be infinite – a value that is limited by the properties of the real hardware.



#### 2.2.4.4 Measuring the Pulse Width (Pulse/Pause Ratio):

Measuring the pulse width is used to determine pulse width modulated signals. Depending on the selected mode the positive or the negative part of the signal is processed. If two counters are used to measure the pulse width, and one of them is programmed to be triggered by the negative and the other one by the positive edge of the input signal, the summed up result will show the period length. If the input signals are stopped the last measured value becomes available.

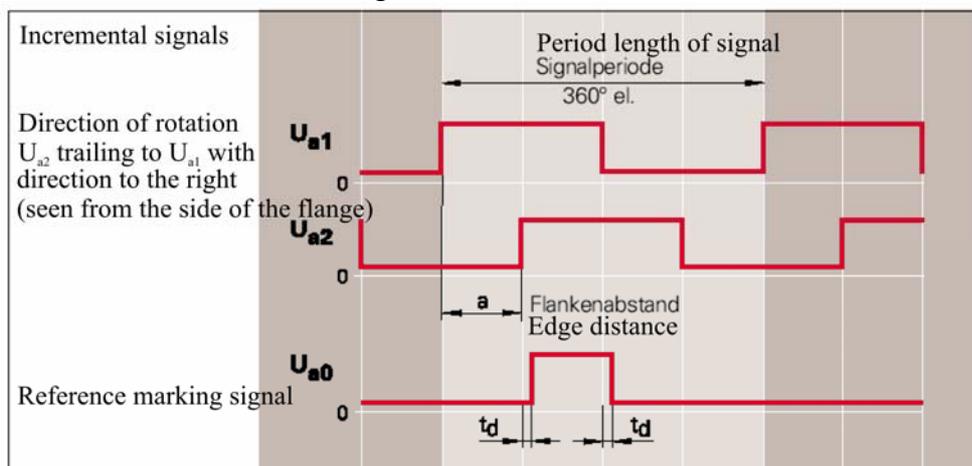
#### 2.2.4.5 Incremental Counter:

Measuring with an incremental encoder means two signals of the encoder are measured and the direction of counting will be detected by the phase difference and the direction information.

The counters can count 24 bits and offer a programmable interpolation (1x, 2x, 4x) which allow to interpolate the signal. The maximum input frequency at the input of the counters is 20 MHz. An edge configurable zero position detection is also available which can be switched off and which makes it possible to reset the counter to zero over an additional digital input.

Additionally to the incremental values there are time stamps available. These time stamps are equal to the period length of the last pulse. With a resolution of 100 ns the maximum readable frequency of the counters ranges is between 1 kHz and 100 kHz. Caused by the interpolation a higher resolution of the encoder signals become available. Up to 4x interpolation resulting in 4 times higher resolution is supported.

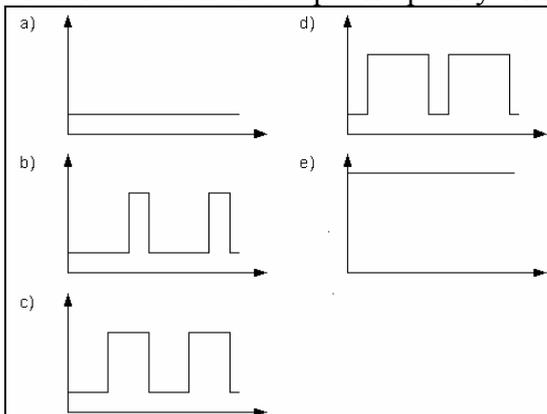
The time stamp of the incremental encoder shows a zero reading after the maximum time interval within the time stamp was valid. This zero value signals the idle mode of the encoder.



### 2.2.5 Pulse Width Modulation/Frequency Modulation:

RogaDAQ16 offers digital frequency outputs which allow modulating continuously pulse width and frequency. These outputs may be used in example to control proportional valves.

To achieve a fully continuous output signal without any distortions during reproduction a new frequency or pulse relation output is set only after the last one is fully completed. In this way it is possible to change pulse width faster than the output frequency without causing any distortions by switching.



Pulse width signal with a) 0%, b) 25%, c) 50%, d) 75% and e) 100%

### 2.3 Drivers and Applications

RogaDAQ16 and its software are developed modular and are based on common sources.

According to a layer model only the lowest hardware specific layer is different. Any methods based upon them are identical.

This design makes actualization of drivers much easier and guaranties high levels of quality while offering its user's well known dialogs and interfaces.

The RogaDAQ16 package includes optimized drivers for Windows 2000/XP and high quality drivers for standard applications. If needed the RogaDAQ16 can be integrated into existent software systems.

- Standard Applications
  - DIAdem
  - DASyLab
  - LabView
  - EdasWin
  - EVA Pro
  - RogaREC
- Operating System
  - Windows XP & Vista (W2k partially supported only)
- Individual Software Solutions
  - Easy to use programming interface

### 2.4 Extended Customizing

Besides the basic functionality RogaDAQ16 can be customized to the special needs of its users. This is not only possible as far as the software configuration is concerned. It also applies to the hardware configuration.

- **Customizing Software**  
With a minimum of programming effort it is possible to meet individual needs above the standard functionality like this could be in example for a sine wave analysis in energy generation. To program the signal processor with assembler or C several library functions are available. Programming can be carried out by the user or the manufacturer.
- **Customizing Hardware**  
It is also possible to fit the individual needs concerning the counters and the digital input or output of the pulse width modulation. The number and the resolution of reference frequencies or event driven control can be customized as well. Any customization of this type can carried out at the manufacturer only.

### **3 Standard Measurement Software Solutions**

To support common software solutions like DIAdem, DASyLab, LabView, EVApro and EdasWin RogaDAQ16 is shipped with free-of-charge drivers. The included CDs represent the actual state at the time of the delivery.

#### **3.1 RogaDAQ16 and DIAdem**

To use RogaDAQ16 with DIAdem a perfected driver based on the GPI interface is available. It allows fast access to the basic functionality and any of the options as well. The driver is configured completely in DIAdem which offers the best possible comfort and optimized integration into the DIAdem user interface.

#### **3.2 RogaDAQ16 and DASyLab**

DASyLab drivers are not used over the existing driver interface but as special modules aided by the so called extension interface. This allows measuring with up to four RogaDAQ16. Furthermore the driver interface is kept free for other drivers. This allows the system to be used to its maximum. DASyLab offers an easy user interface with hierarchically grouped submenus. The most common settings can be seen at a glance and the user is able to configure any other settings manually.

#### **3.3 RogaDAQ16 and LabView**

The graphical measure and programming software LabView of National Instruments is supported by some simple and some complex virtual instruments (VI's). They allow easy integration of RogaDAQ16 series in any measuring tasks. The whole functionality can be controlled by the available VI's.

#### **3.4**

The program EVApro of Bedo Elektronik GmbH allows programming and carrying out measuring tasks. Any further processing of the measured data is carried out in EVApro. The description of the measuring task is made in a text editor.

#### **4 Technical Information:**

The RogaDAQ16 series is designed around a signal processor. These processors control usually all processes of the RogaDAQ16. In parallel to the signal processors automatic measuring is realized with an FPGA which allows measuring with maximum sample rates directly processed by hardware. A 512 Kbytes Flash EEPROM allows stand alone operation without any host. RogaDAQ16 can boot out of the EEPROM, configure itself, and carry out later on the tasks which were programmed before. The DSP runs with 384 Kbytes of fast SRAM which can be used for data or the program. In this memory are stored the measurement sequences and the online processing of measured data is processed. Communication between host and RogaDAQ16 is achieved with bulk transfer over the fast USB 2.0 interface. USB 2.0 guarantees continuous data rates.

The architecture of the system makes high performance data acquisition available with operating systems like Windows 2000/XP . Any latency caused by the operating systems is compensated by the extremely high functionality of the RogaDAQ16. With local buffers and its high speed bus system it is possible to decouple the measuring process from the computing power of the main computer. The online processing of the RogaDAQ16 makes real time measurements available even with non real time operating systems like Windows.

## 5 Hardware/Software Installation

### 5.1 First Time Installation of RogaDAQ16

To operate the RogaDAQ16 series normally there are no jumpers to set. Because RogaDAQ16 supports hot plugging no special measures have to be taken. After the first time installation of a single USB driver routine RogaDAQ16 is ready to run.

### 5.2 Handling of RogaDAQ16

**Important:**

**To avoid erroneous measuring and severe damages to your equipment please follow the following global advices.**

- Integrated circuits in common and especially CMOS devices input and output circuitry is very sensitive against high voltages. The maximum values can easily be exceeded as in example with static discharging of the human body. Because of this CMOS devices can be destroyed by touching analog inputs, devices or conductive paths.
- Avoid any contact to substances which are subject to develop static electricity like plastics, vinyl, styropor, woolen or synthetic sweaters and the like.
- Touch optional cards and the like on their borders only.
- While switched on, a maximum voltage of  $\pm 13.5$  Volts (voltage resistant multiplexers:  $\pm 40$  Volts) should not exceeded under any circumstances. The maximum voltage value for digital inputs and inputs of counters is 5 Volts.
- Switched off the maximum voltage for any kind of input are  $\pm 1$  volts while voltage resistant multiplexers can withstand up to  $\pm 40V$ .
- Analog outputs and as analog outputs defined bits are not allowed to connect to any voltage. Furthermore it is not allowed to source/sink more current as specified because this can lead to severe damages to the devices.

**5.3 Installing *RogaDAQ16***

**5.4 Configuring the RogaDAQ16 for Single Ended or Dual Ended Mode**

## **5.5 Installing the System Drivers**

To run with 32 bit Windows drivers are necessary which support the access to the RogaDAQ16. Because of the USB bus structure for the RogaDAQ16 there is only one driver necessary.

After plugging in the RogaDAQ16 the assistant for installing new devices appears. Insert the provided CD into the CDROM drive and let the assistant search for the respective driver. After the driver was found Windows XP shows the message that the driver is not digitally signed. Please click on the button Install Driver and use this driver.

After the installation the driver is available system wide. It is not necessary to restart the system. RogaDAQ16 is shown now under USB devices → RogaDAQ16.

### **Important!**

**Please make sure to install the latest USB 2.0 drivers!**

After changing the USB port RogaDAQ16 is recognized as a new device and is newly installed. Windows XP stores the last version of the driver for each port. If you are going to actualize the driver you have to achieve this for all existent ports.

## **6 Connecting the Signals to Measure**

### **6.1 Miscellaneous Information**

Generally it has to be taken into consideration that the signals should not be fed to a switched off device. RogaDAQ16 withstands a voltage of up to  $\pm 40V$  regardless of the state switched on or off.

The digital signals are not permitted to be applied if the device is switched off.

After switching on the signals of all analog outputs are reset to zero. The digital pins are configured as inputs with no voltage applied. The PWM output is inactive. During the starting process a short voltage pulse at the analog outputs can occur, if the standard voltage range is set. Connected systems have to be configured in a way that this pulse may not cause any negative effects.

In the single ended mode the analog inputs are measured relative to ground. The common single ended inputs are usable for voltage measurements only. Any of these inputs relate to the same reference ground against which the voltage is measured. Any of the inputs are independent. Please ensure that the ground terminals are connected to the ground terminal of the measuring signal ground. All of the analog inputs are available.

In the dual ended mode the difference between two terminals is measured. The inputs can be used for voltage and current measurement. If current is measured the shunt resistor  $R$  and the voltmeter  $V$  are a measuring unit (equivalent to an ammeter). The shunt resistor has to have a certain exactly known resistance. If the dual ended inputs are connected it has to be taken into consideration that the voltage measurement is achieved parallel to the circuitry while the current measurement is a sequential one. If a dual ended input has to be connected both terminals of the input have to be connected.

The ground has to be connected to the ground of the signal source and a resistor has to be in the negative terminal against ground to ensure a reference potential.

#### **6.1.1 RogaDAQ16 USB**

Feeding of the signals is achieved over different sockets.

The BNC sockets are connected to an encoder or a signal source on one side and the other one is connected to the channel in question. The digital inputs are connected with the screwable terminals on the back panel. For dual ended measurements the jumpers on the board under the BNC sockets have to be configured respectively. After this is carried out the dual ended inputs are available at the channels 0 .. 7, where the BNC signal carries the positive and the negative part.

The screw able Phoenix type terminal version is connected respectively. To use the dual ended mode please connect the negative route (K8-K15) with a  $5\text{ k}\Omega$  resistor to the ground of the RogaDAQ16. Connecting the digital signals is similar to the BNC version. Aided by flat ribbon cables the signals are fed. In this way customer specific kinds of connections can be realized easily.

## 7 Pin Positions

### 7.1 RogaDAQ16 Phoenix Terminal

Analog inputs/outputs of P7 Phoenix socket K0-15

D-Sub Pin	Signal name	Function
GND	GND	Ground
K0	K0 +K0	Analog input 0
K1	K1 +K1	Analog input 1
K2	K2 +K2	Analog input 2
K3	K3 +K3	Analog input 3
K4	K4 +K4	Analog input 4
K5	K5 +K5	Analog input 5
K6	K6 +K6	Analog input 6
K7	K7 +K7	Analog input 7
K8	K8 -K0	Analog input 8
K9	K9 -K1 Ue. Diff.	Analog input 9
K10	K10 -K2	Analog input 10
K11	K11 -K3	Analog input 11
K12	K12 -K4	Analog input 12
K13	K13 -K5	Analog input 13
K14	K14 -K6	Analog input 14
K15	K15 -K7	Analog input 15
GND	GND	Ground
GND	GND	Ground
DA0	DA0	<i>Analog output 1</i>
DA1	DA1	<i>Analog output 2</i>
DA2	DA2	<i>Analog output 3</i>
DA3	DA3	<i>Analog output 4</i>
GND	GND	Ground

## 7.2 P1 RogaDAQ16 Digital Inputs/Outputs

Phoenix and BNC version

Signal name	Function	Signal name	Function
GND	Ground	GND	Ground
A 1	Digital input/output 0	B 1	Digital input/output 8
A 2	Digital input/output 1	B 2	Digital input/output 9
A 3	Digital input/output 2	B 3	Digital input/output 10
A 4	Digital input/output 3	B 4	Digital input/output 11
A 5	Digital input/output 4	B 5	Digital input/output 12
A 6	Digital input/output 5	B 6	Digital input/output 13
A 7	Digital input/output 6	B 7	Digital input/output 14
A 8	Digital input/output 7	B 8	Digital input/output 15 SSI DATA
GND	Ground	GND	Ground
GND	Ground	GND	Ground
C 5	Digital input/output 20 Incremental/PH90	C 1	Digital input/output 16 SSI CLK
C 6	Digital input/output 21 Incremental/PH0	C 2	Digital input/output 17 Counter Sync
C 7	Digital input/output 22 Timer 1	C 3	Digital input/output 18 Synchronisation Master / Slave
C 8	Digital input/output 23 PWM 0	C 4	Digital input/output 19 Incremental/zero position
TRG	Trigger	TMR	Timer 0
GND	Ground	GND	Ground

## 7.3 CountPeri4

Pin name	Signal name	Function
C 1	Z1	Counter input 1
C 2	Z2	Counter input 2
C 3	Z3	Counter input 3
C 4	Z4	Counter input 4
GND	GND	Digital ground
GND	GND	Digital ground
Tri.	Trigger	Synchronization Slave

#### 7.4 CountInkr4

C 1	PHI0(0)	Counter input 0 pulse
C 2	PHI90(0)	Counter input 0 direction
C 3	PHI0(1)	Counter input 1 pulse
C 4	PHI90(1)	Counter input 1 direction
C 5	PHI0(2)	Counter input 2 pulse
C 6	PHI90(2)	Counter input 2 direction
C 7	PHI0(3)	Counter input 3 pulse
C 8	PHI90(3)	Counter input 3 direction
B 1	REF (0)	Reference pin 0
B 2	REF (1)	Reference pin 1
B 3	REF (2)	Reference pin 2
B 4	REF (3)	Reference pin 3
Tri.	Trigger	Synchronisation Slave
GND	GND	Digital ground
GND	GND	Digital ground

#### 7.5 CountInkr6

Pin name	Signal name	Function
C 1	PHI0(0)	Counter input 0 pulse
C 2	PHI90(0)	Counter input 0 direction
C 3	PHI0(1)	Counter input 1 pulse
C 4	PHI90(1)	Counter input 1 direction
C 5	PHI0(2)	Counter input 2 pulse
C 6	PHI90(2)	Counter input 2 direction
C 7	PHI0(3)	Counter input 3 pulse
C 8	PHI90(3)	Counter input 3 direction
A 1	PHI0(4)	Counter input 4 pulse
A 2	PHI90(4)	Counter input 4 direction
A 3	PHI0(5)	Counter input 5 pulse
A 4	PHI90(5)	Counter input 5 direction
B 1	REF (0)	Reference pin 0
B 2	REF (1)	Reference pin 1
B 3	REF (2)	Reference pin 2
B 4	REF (3)	Reference pin 3
B 5	REF (4)	Reference pin 4
B 6	REF (5)	Reference pin 5
Tri.	Trigger	Synchronisation slave
GND	GND	Digital ground

## 7.6 Count8

Pin name	Signal name	Function
C 1	Z0	Counter input 0
C 2	Z1	Counter input 1
C 3	Z2	Counter input 2
C 4	Z3	Counter input 3
C 5	Z4	Counter input 4
C 6	Z5	Counter input 5
C 7	Z6	Counter input 6
C 8	Z7	Counter input 7
A 1	PA 0	Digital input/output 0
A 2	PA 1	Digital input/output 1
A 3	PA 2	Digital input/output 2
A 4	PA 3	Digital input/output 3
A 5	PA 4	Digital input/output 4
A 6	PA 5	Digital input/output 5
A 7	PA 6	Digital input/output 6
A 8	PA 7	Digital input/output 7
B 1	PB 0	Digital input/output 8
B 2	PB 1	Digital input/output 9
B 3	PB 2	Digital input/output 10
B 4	PB 3	Digital input/output 11
B 5	PB 4	Digital input/output 12
B 6	PB 5	Digital input/output 13
B 7	PB 6	Digital input/output 14
B 8	PB 7	Digital input/output 15
Tri.	Trigger	Synchronization slave
GND	GND	Digital ground

## 7.7 CountPwm8

Pin name	Signal name	Function
C 1	Z0	PWM output 0
C 2	Z1	PWM output 1
C 3	Z2	PWM output 2
C 4	Z3	PWM output 3
C 5	Z4	PWM output 4
C 6	Z5	PWM output 5
C 7	Z6	PWM output 6
C 8	Z7	PWM output 7
TIN0	TIN0	Timer input
GND	GND	Digital ground

## 7.8 Count8 Up/Down

D-Sub Pin	Signal name	Function
C 1	Z0 up	Counter input 0
C 2	Z0 down	Counter input 0
C 3	Z1 up	Counter input 1
C 4	Z1 down	Counter input 1
C 5	Z2 up	Counter input 2
C 6	Z2 down	Counter input 2
C 7	Z3 up	Counter input 3
C 8	Z3/ down	Counter input 3
A 1	PA 0	Digital input/output 0
A 2	PA 1	Digital input/output 1
A 3	PA 2	Digital input/output 2
A 4	PA 3	Digital input/output 3
A 5	PA 4	Digital input/output 4
A 6	PA 5	Digital input/output 5
A 7	PA 6	Digital input/output 6
A 8	PA 7	Digital input/output 7
B 1	Z 4 up	Counter input 4
B 2	Z 4 down	Counter input 4
B 3	Z 5 up	Counter input 5
B 4	Z 5 down	Counter input 5
B 5	Z 6 up	Counter input 6
B 6	Z 6 down	Counter input 6
B 7	Z 7 up	Counter input 7
B 8	Z 7 down	Counter input 7
49	GND	Digital ground

Tri.	Trigger	Synchronisation slave
50	GND	Digital ground

## 8 Synchronization of several RogaDAQ16

More than one RogaDAQ16 can be synchronized over the digital input C3. Please ensure to connect the digital ground of the systems together.

## 9 Installation of Software

### 9.1 Installation of the Drivers of the DIAdem Versions 6, 7, 8, and 9.x

#### 9.1.1 Driver Properties and Performance

Types of Measurements:

- Standard measurement with hardware and software clock
- Disk measurement
- High speed measurement
- Edge triggered window measurement (each of the measurements) external triggering with hardware clock for high speed and disk measurements
- wave form generator (function generator)
- Analog and digital PWM (pulse width measurement)
- Measuring digital, counter, and analog signals at the same
- Wave form generator: output of sine wave, triangle, square, pulse, saw tooth, white noise, and files.
- Online scaling of measured data
- Online filter: IIR und FIR
- Online FFT (Fast Fourier Transformation)
- Oversampling
- Online PID control
- Online digital control

#### 9.1.2 Installation

The driver for the RogaDAQ16 series can be used for any DIAdem version starting with release 6.0. It supports the whole functionality of the RogaDAQ16 series and has to be installed once only even when using more than one in parallel.

Insert the provided driver CD into your CDROM or DVD drive. Thereafter a selection program starts automatically if auto run is activated. If the program does not run automatically it has to be run with My Computer.

After the starting screen has appeared click on the Install button to install or click on Cancel to terminate the program.

After you selected Install a text box appears containing further hints and information about the last optimizations made. Please read this carefully and continue with Next. The Cancel button is used to go back to the starting screen.

Next a window opens which is used to select an appropriate directory for installation. In this directory has to be installed a 32 bit version of the DIAdem software. Otherwise it is not possible to install the drivers. The existence of the mentioned installation can be approved by the existence of a file named DIADEM.EXE within the directory. The default directory is C:\DIADEM. If you like to use another directory please specify.

After you typed in the name of the directory a dialog box asks if you really like to use this directory. Please confirm with Yes or return to the prior window with No. If you selected a directory without an DIAdem installation instead of the dialog box, an error message appears and the installation program is terminated. Please check if the directory name was typed in correctly and the DIAdem installation in this directory was completed. If both conditions are true please contact GfS Aachen or ROGA-Instruments.  
Network based installation:

If DIAdem has to be installed over a network the RogaDAQ16 driver has to be copied into the server's directory. DIAdem runs with the option /s <path>. <path> is a path to the place where the files are stored. If the directory is correct and you confirm it with Yes the copying starts. After the copying process you are asked if the DLL shall be registered automatically. If your DIAdem installation was a first time installation you should confirm the automatic registering with Yes. If there is an older version of the driver you should select No. Otherwise the driver is loaded more than once.

Now a window appears which tells you the installation is finished. DIAdem is ready to run.

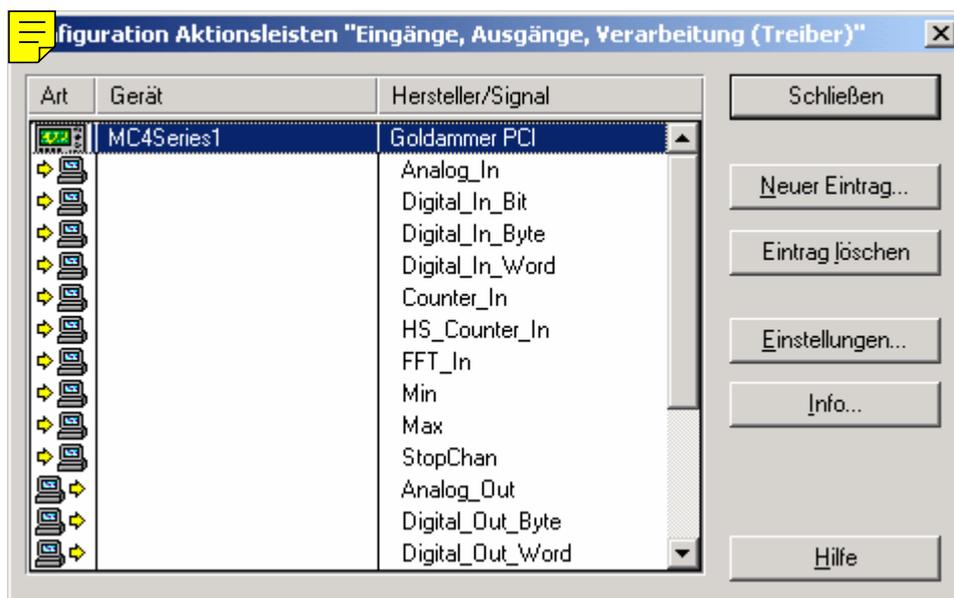
Important: *If using Windows NT it is necessary to have administrator rights for the first time installation. Otherwise the driver cannot be registered.*

### 9.1.3 Registering the driver in DIAdem

To use the RogaDAQ16 driver in DIAdem you have to register it. Please select DIAdem DAC followed by the menu option „Settings → „Einzelnwertverarbeitung (Single Value)“ → „Treiber konfigurieren (Configure Driver)“

The existent RogaDAQ16's can be configured there.

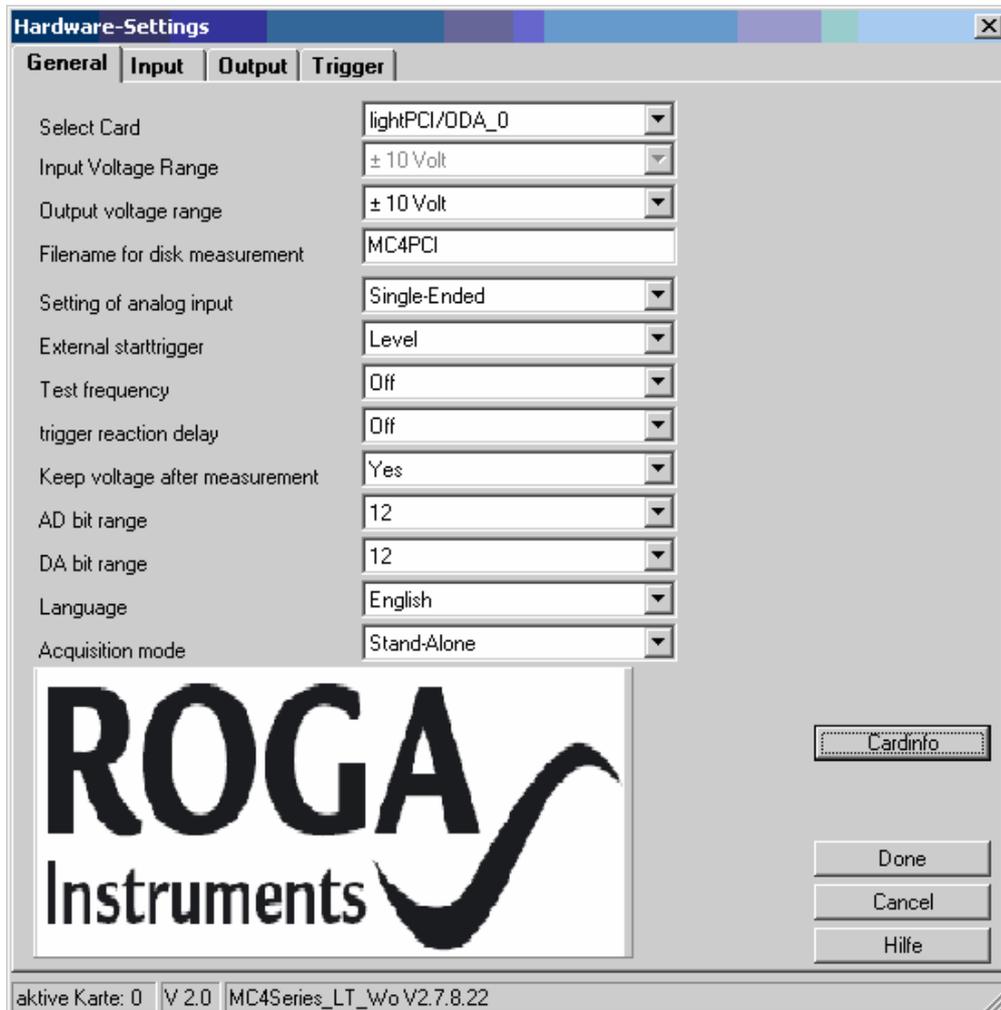
Please select „DAC“ as manufacturer followed by the entry “RogaDAQ16”. When registering the driver all important configurations have been made. Now you are able to run up to four RogaDAQ16 in parallel.



Switching between the RogaDAQ16's is carried out in the dialog box of the measuring blocks where each of the blocks can be associated to one of the available RogaDAQ16's.

The term *High* stands for high speed measurement. Data is stored very fast in the memory of the computer. Because of this kind of measurement is extremely fast. The term *disk* has the meaning the acquired data are stored on the disk directly. All other proceedings are DAC kernel measurements. DIAdem® controls this type of measuring. This kind of measurement is slower than the other ones so the potential of the RogaDAQ16 is not used to the possible extent. The file type for any of these proceedings is *.dac*.

Under „Input Driver“ you will find the settings of the respective RogaDAQ16



If you open an input block followed by the option devices you will get an overview of the device specific features which can be configured. You can set which RogaDAQ16 has to be used for measurement if there are more than one and you can configure some more details.

Filename for disk measurement to disk is the name of the .DAT file which contains the measured data after ending the measurement. If the file already exists if starting a new measure cycle, a message appears which warns and overwrites it.

With Setting of analog input you can switch between dual ended and single ended inputs.

The edge of the External Start trigger describes the signal that has to be fed over the trigger input terminal by an externally triggered measurement to start the process. You can select a rising (low to high) or a falling (high to low) edge.

Furthermore it is possible to generate a Test frequency with RogaDAQ16. You can select Off, Internal or External.

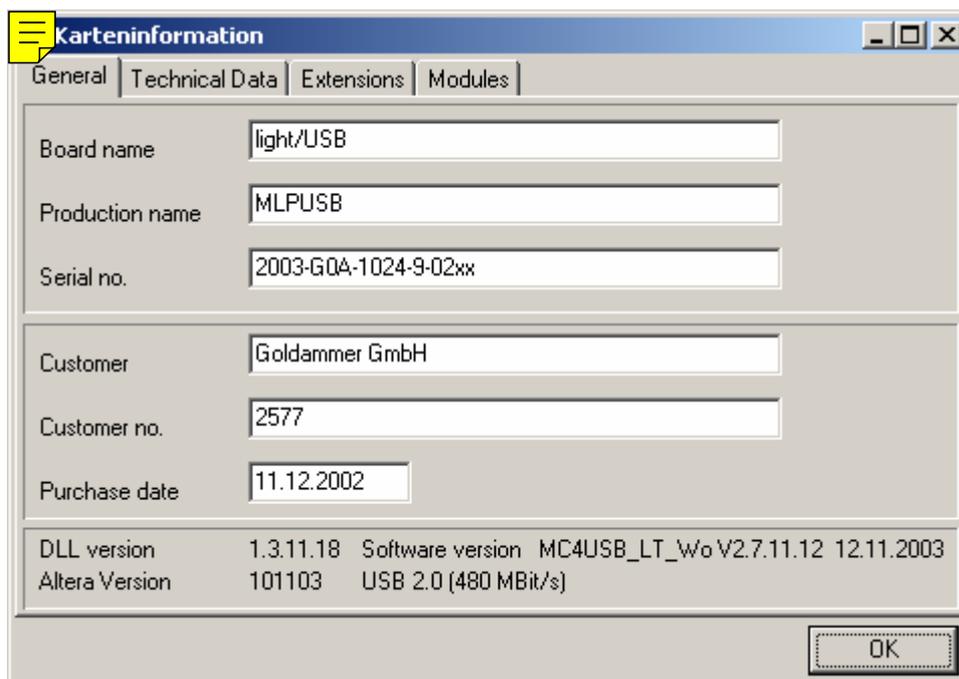
If internal is selected the test signal is fed directly to the first counter. Externally the signal is available at the TTL port PC7. The frequency of the test signal is 100 Hz for the RogaDAQ16.

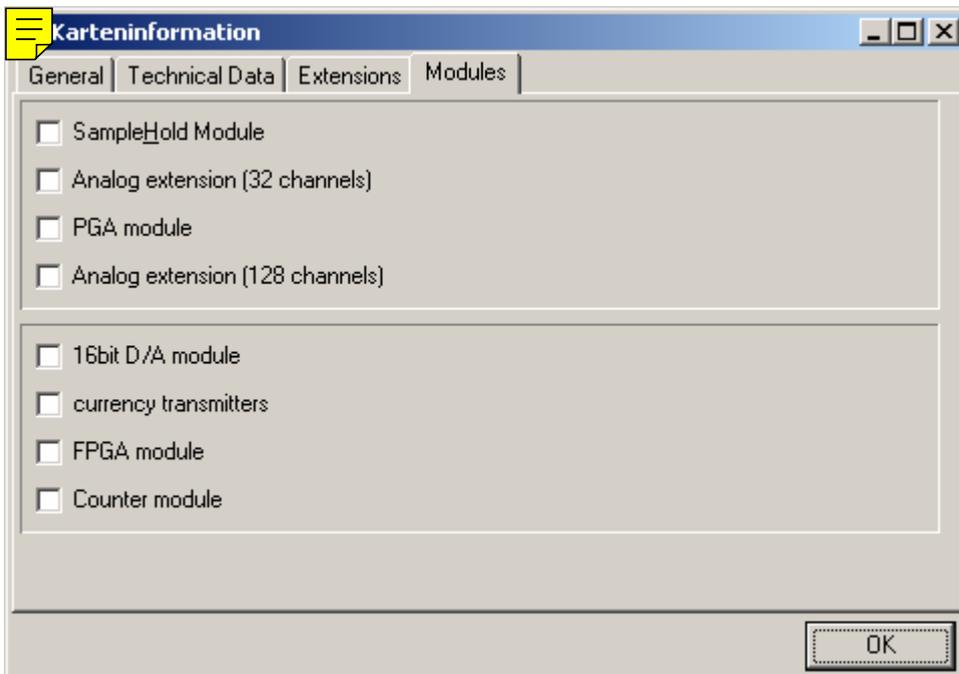
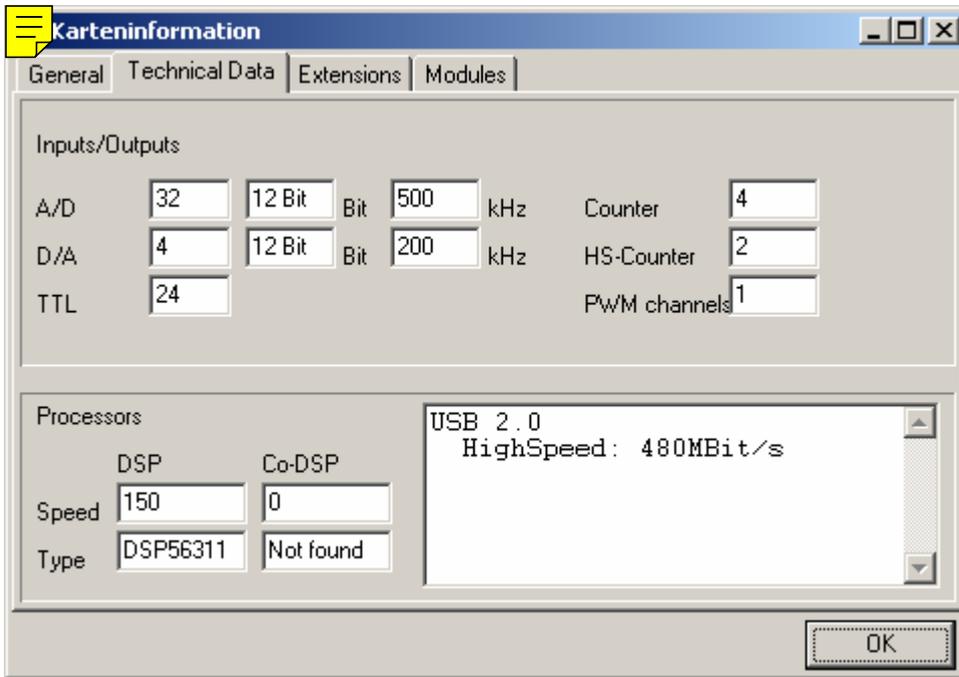
The trigger reaction delay defines the sensitivity of the trigger input. If there are significant EMG distortions in the surrounding which may cause erroneous triggering you can specify the time interval in which a trigger signal has to be applied continuously to be recognized as a valid trigger signal.

Furthermore there is the possibility to change the language of the hardware related dialogs. This affects the specific dialogs only. The language selection of DIAdem is not affected.

To get a better overview at the bottom of the dialog a small information bar shows the actual active RogaDAQ16 and the release number of the program running on the digital signal processor. Because you are able to switch without limitation between RogaDAQ16s you are better informed about the RogaDAQ16 you are measuring actually.

The available settings may change if another RogaDAQ16 is selected. Because not all types of the RogaDAQ16 series offer the same settings for a counter card without analog inputs the configuration options single ended and dual ended are disabled.

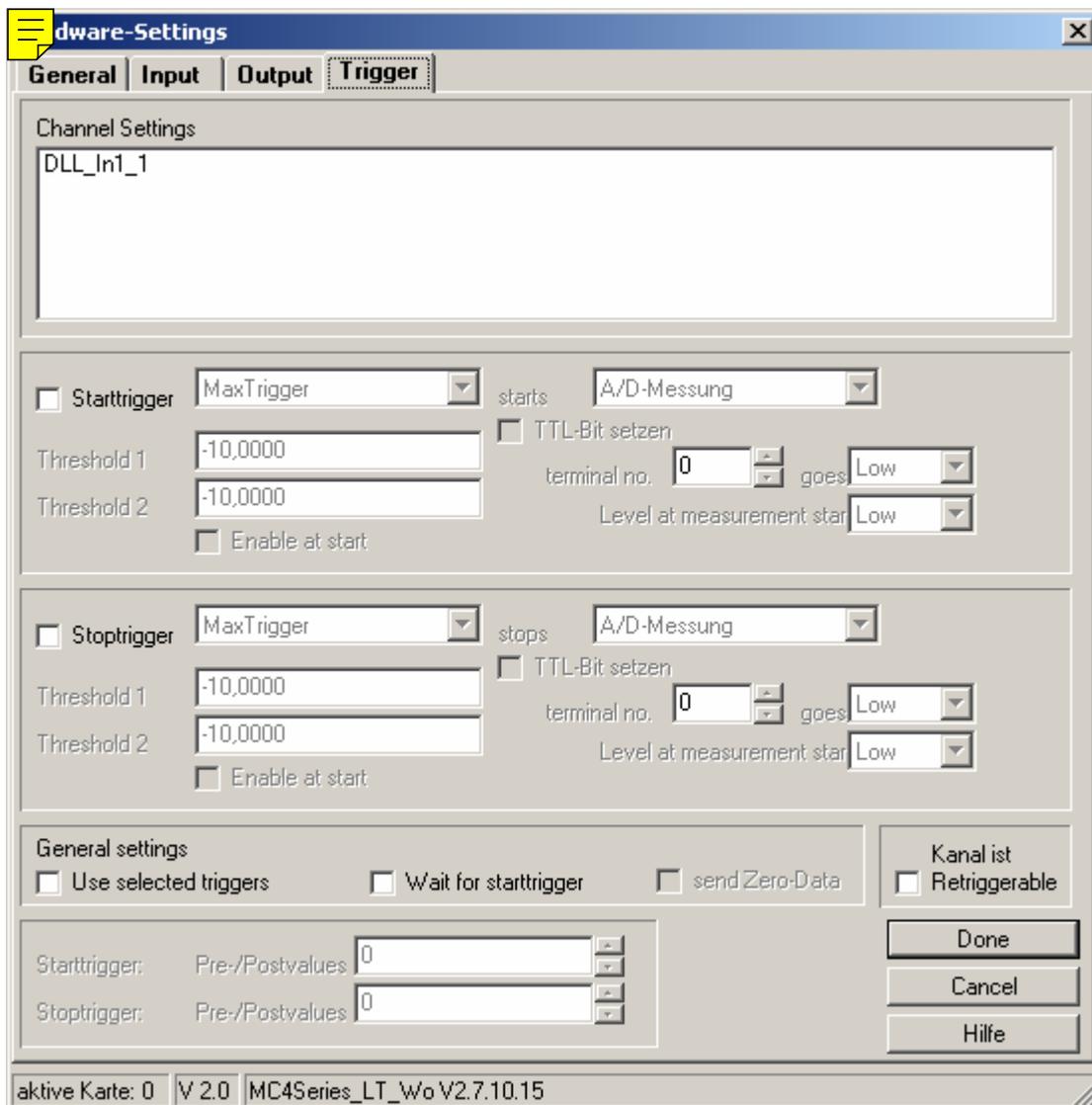




If you click on „Card info“ a new summary about the actual RogaDAQ16 is shown.  
If the system contains more than one RogaDAQ16 the actually selected RogaDAQ16 is shown.

Within this summary the personal data and the technical ones can be read as they are stored. There is also a list of all hardware and software expansion options which are installed. And you can get information about the modules.

Hardware Settings now has a new register card named Trigger.



These triggers are start and stop conditions which are controlled by the RogaDAQ16. The triggers are available with the measuring modes high speed, hardware clock, and disk measurement.

The triggers are transmitted to the DSP as conditions which were checked after starting a measurement. Because the trigger mechanism is controlled by the DSP the delay between the occurrence of a trigger event and the start or stop of a measurement goes to zero.

Additionally it is possible to set any TTL output to high or low if a trigger event occurs. To set an output to low it has to be set to high before. Otherwise it is impossible to recognize the change. Furthermore the starting condition for the measurement can be set.

Important: If the option „set TTL Bit“ is used the quadruple block of the TTL outputs (PA0..3, PA4..7) is switched to output and therefore cannot be used as input.

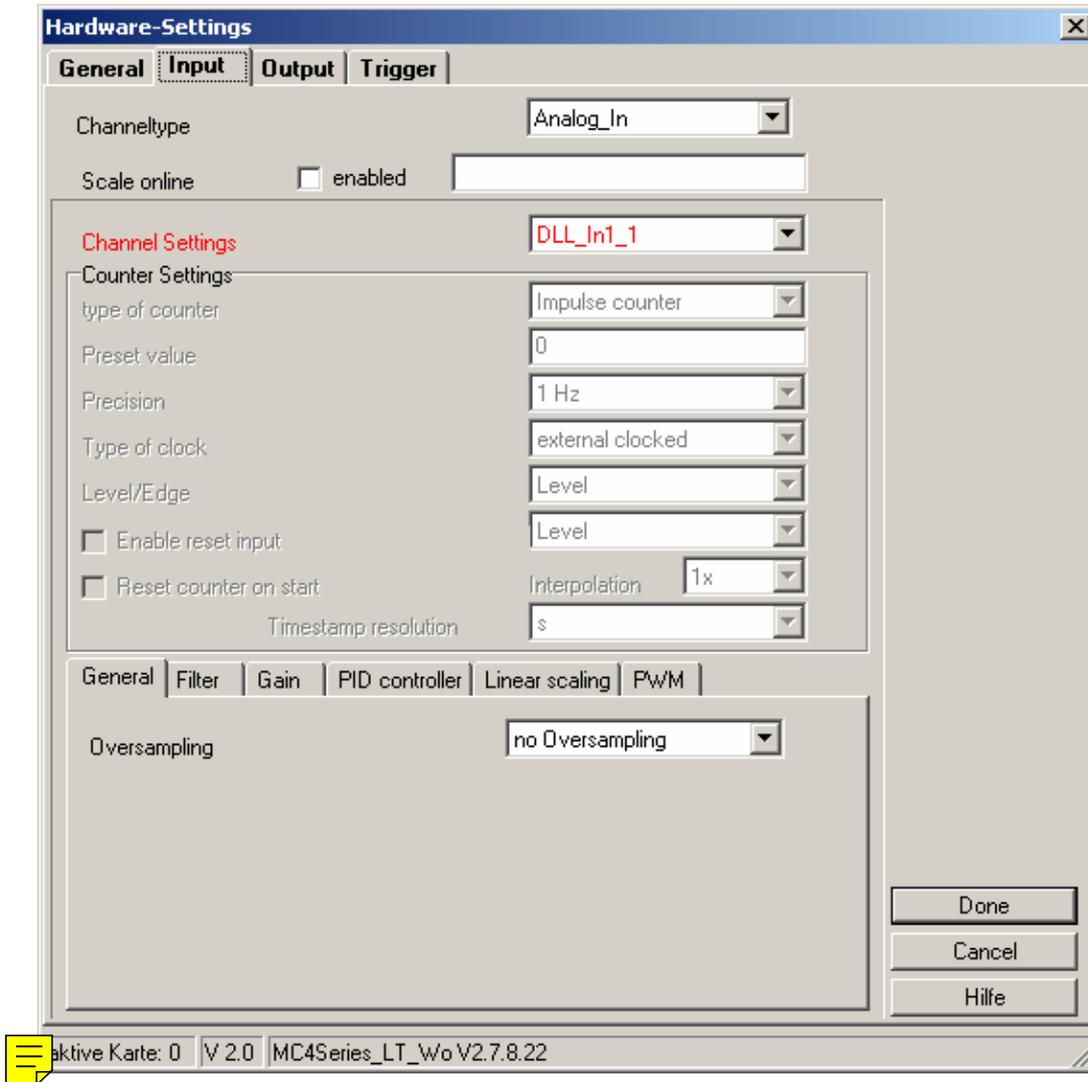
The channels defined in the input block are shown in the upper part. If you select one of these channels in the right area the channel specific settings are shown. The general settings are global in the meaning they are applied to all channels.

The option „Use selected triggers“ allows activate/deactivate all of the triggers without losing the set trigger conditions. This makes it possible to measure the signal without triggering to determine signal borders or other options without the necessity to change the circuit diagram.

The RogaDAQ16 stores the measured values in a circular organized buffer and check in the background if the trigger conditions are valid. If a trigger condition becomes true the full size of the circular buffer can be used to store the pre trigger values. Post trigger signals are acquired like the measured values. There is no limit caused by the RogaDAQ16.

If there are questions left click on the button Help. The online help function is run and an explanation according to the settings in question can be found.

This window appears if an input block is opened:



This window allows setting the type of measurement for the input signal and the detail configuration of the measurement. The possible settings are shown as default values and can be selected.

### 9.1.3.1 Oversampling

RogaDAQ16 series make it possible to set for each of the channels an oversampling which is used to reduce the distortion of the measured signal. There is 2x, 4x, 8x, and 16x oversampling available. By request other oversampling rates can be implemented.

The RogaDAQ16 series allows to set different oversampling values for each of the channels.

The oversampling runs autonomously on the processor of the RogaDAQ16. It does not depend on the load of the processor of the computer. So DIAdem gets passed the averaged values only. Access to the original oversampling values is not possible.

Because RogaDAQ16 is limited to a maximum upper sample rate the “shown” sample rate is reduced with rising oversampling. If you use 10 channels with 1 kHz and 8x oversampling the effective averaged sample rate results in 80 kHz. This has to be taken in consideration to avoid buffer overruns which results in losses of measured data. Oversampling can be used in the modes hardware clock, high speed, and disk measurement.

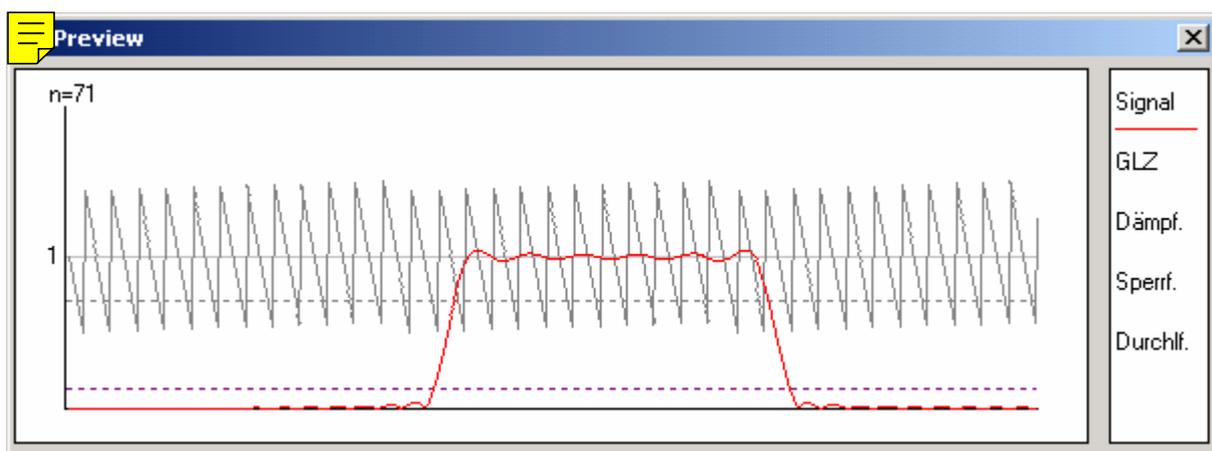
The possible shown settings vary depending on the input signal and the kind of installed hard- and software expansions.

### 9.1.3.2 Online Filter

Because of the extremely fast signal processor which is used for all RogaDAQ16's it is possible to do many mathematical calculations with the DSP and to influence the measured signal.

Furthermore many filter mechanisms are implemented yet or are under development. For example this are high band, low band, band pass and many other filters which can be used in real time applications without rising the load of the processor. By request customized filters can be implemented. For details and actual information's please contact the distributor.

With the dynamic calculation of coefficients it is possible to adapt to nearly any characteristic of the filter. The following picture shows an example for a possible filter curve. For more information according this item please read chapter 9.



### 9.1.3.3 Filter Coprocessor

The second processor of RogaDAQ16 is equipped with an integrated filter coprocessor (EFCOP) including an own buffer which reduces the processor load and guaranties optimal performance. The

coprocessor is able to handle nearly any kind of filter like FIR and IIR filters. The main processor only serves to carry out the transmission of data from and to the coprocessor.

#### **9.1.3.4 Online PID Controller**

The mathematic power of the signal processor permits also a real time PID control without intervention of the PC system.

A PID control is implemented in the single value driver. For this purpose an ADC input block and a DAC output block are connected together. The set value is set statically in the user interface. After starting the measurement the ADC input measures continuously the actual value using the set frequency and passes it to the PID program on the DSP. This program calculates the manipulated variable and outputs it over the DAC output.

A second variable PID control is implemented in the packet driver. The packet driver allows setting of the number of inputs and outputs in any of the blocks in the circuit diagram as desired. Such a kind of PID block contains two inputs (set value and manipulated variable) and an output (manipulated variable) which carries out the upper functions.

#### **9.1.3.5 Online FFT**

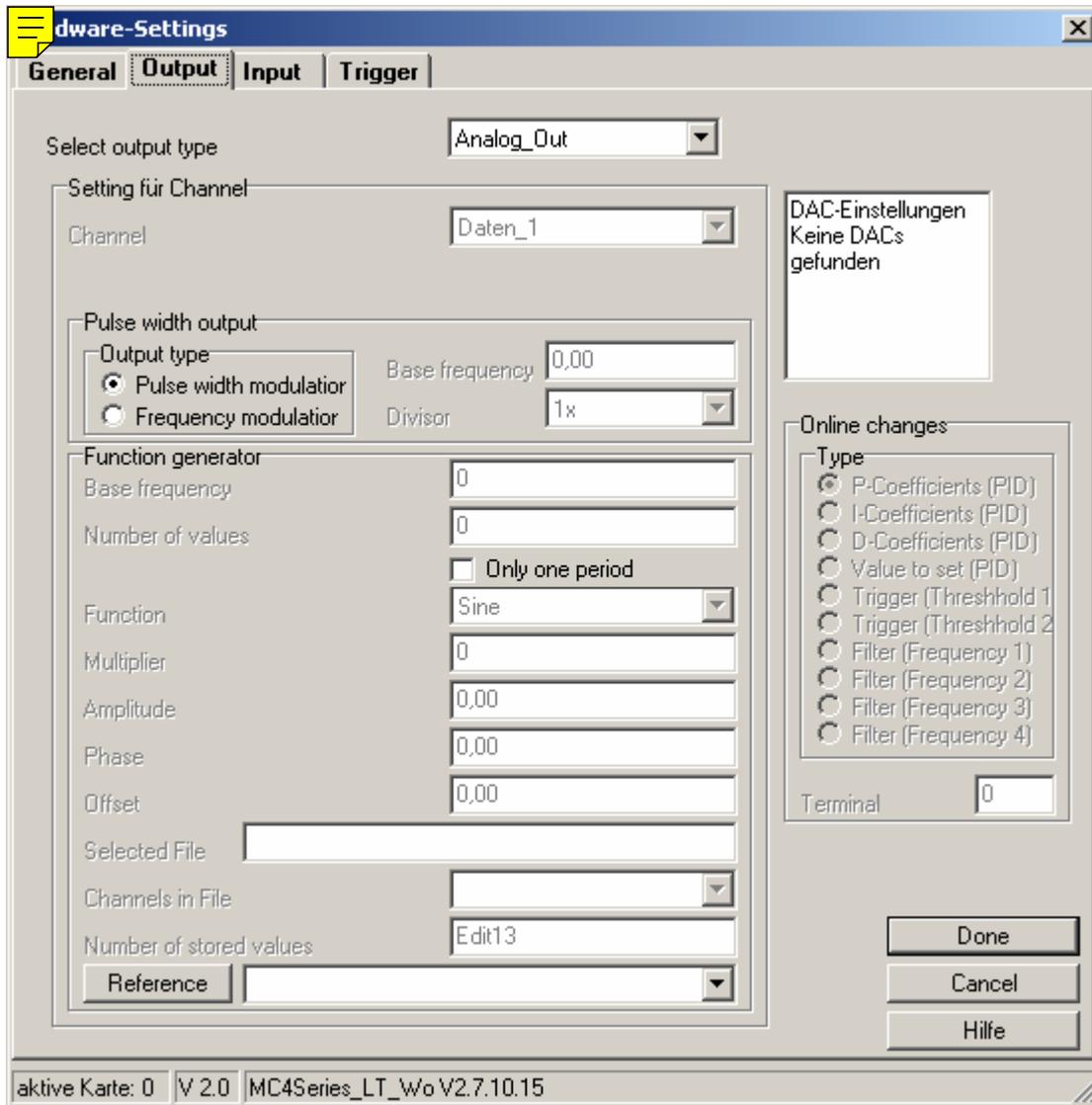
Online FFT serves as a fast Fourier transformation which runs in real time on the DSP. Data passed to DIAdem with a selected FFT contain already the calculated frequency spectrum according to the set parameters.

#### **9.1.3.6 Miscellaneous Online Functions**

By request we can realize special mathematical functions in form of a DSP program which is executed in real time on the signal processor. Because this programs run without changing the load of the processor of the PC system they are the ideal choice for time critical or very fast measure and control applications.

Please contact the manufacturer if you need customized drivers.

This window is shown after opening an output block:



In this window similar to the input signals type and description of the output signal can be set. With the selected output mode the available configuration fields are enabled so you can make the detail settings for any kind of measurement.

Furthermore in the right section a small sub window is shown which serves to display the output range of the analog outputs in question.

- The available settings depend on the kind of the selected output method and on the installed hardware and software expansions.

#### Filename

Type in the name of the file in which the measured values shall be stored during a measurement to disk. Please select the name very carefully. ALREADY EXISTING FILES ARE SUBJECT TO BE OVERWRITTEN.

#### Analog Output Channel 0-3

This serves to set the voltage range for the output channels. Please select among two options:

0-10	Volt
±10	Volt

All four outputs are set to the desired range. Default is 0V-10V. Switching over the voltage ranges is achieved by software.

DACs of RogaDAQ16 are kept together in groups of four in example 0..3, 4..7, 8.. 11, ... All of these quadruple groups can be defined nearly synchronously which means four DAC outputs are defined together.

#### 9.1.3.7 Trigger

Window/Edge triggering (for any kinds of measurements) See Trigger Conditions

External triggering (High Speed and Disk Measurement)

The trigger event is valid if bit D0 of the digital input A changes from low (0) to high (1). The external trigger signal is connected to pin 45 of socket P1. The triggering edge is set either to positive or to negative.

#### 9.1.3.8 Trigger Conditions

RogaDAQ16 supports start and stop trigger which are processed with the digital signal processor of the RogaDAQ16. Therefore it is possible to implement it in all kinds of measurements with the exception of a single value processing software clock.

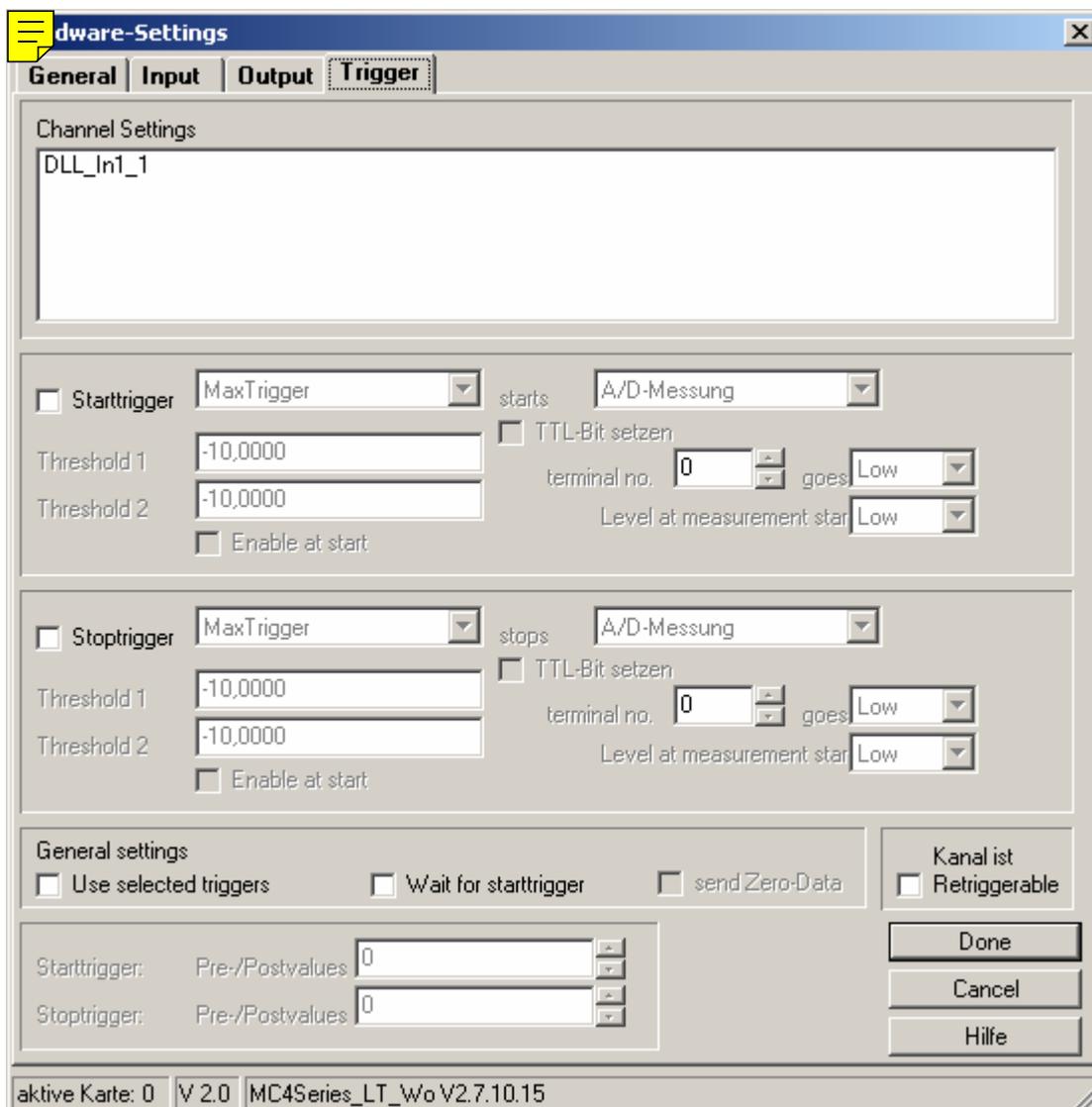
These triggers work independent of the speed of your PC system so maximum performance is available without rising the load of the PC processor.

The register card Trigger contains all settings necessary for this purpose.

In the left part all channels are listed which are set in DIAdem. These channels are associated to the channel and terminal relations of the input block

### 9.1.3.9 Start and Stop Trigger

The settings for the trigger conditions associated to a channel can be made here. Start and stop triggers are individually set for each of the channels. It is possible to define up to two different start and stop trigger for each channel which are combined with a **boolean** AND respectively OR operation. If two triggers are connected with an OR operation the resulting condition is valid if one of them is valid. The result of AND operation connected triggers is valid only if both conditions are valid at the same time. Start and stop triggers can be activated/deactivated individually (start trigger activated) respectively (stop trigger activated).



Additionally global rules may be applied.

These rules include the setting of any digital output on the RogaDAQ16. This output is set in the menu „TTL-Bit  en“. To use both edges (High→Low and Low→ High) it is possible to set the condition at start measurement for example a high level.

If the TTL bits for start and stop trigger are connected to the same output the starting condition for the stop trigger is deactivated and the start trigger is adapted. If the TTL outputs are set different it is possible to set different start conditions of the TTL ports as well.

#### Start and Stop Trigger

Combinations of start and stop signaling are possible with the TTL ports. In example:

Both signaling to bit 0

Starting condition Low

Start trigger: Rising edge

Stop trigger: Falling edge

For settings like the bit 0 of the TTL output A is set to low as long as the starting trigger condition becomes true. If the stop condition of the trigger becomes valid the output is set to low again.

This can be used to realize test systems or emergency stop systems.

#### Pretrigger

For the whole measurement pre- and post trigger values can be defined.

The pretrigger values of the start trigger are the number of measured data sets which were measured immediately before the trigger event. This makes it possible to get data measured before the actual trigger event.

#### Posttrigger

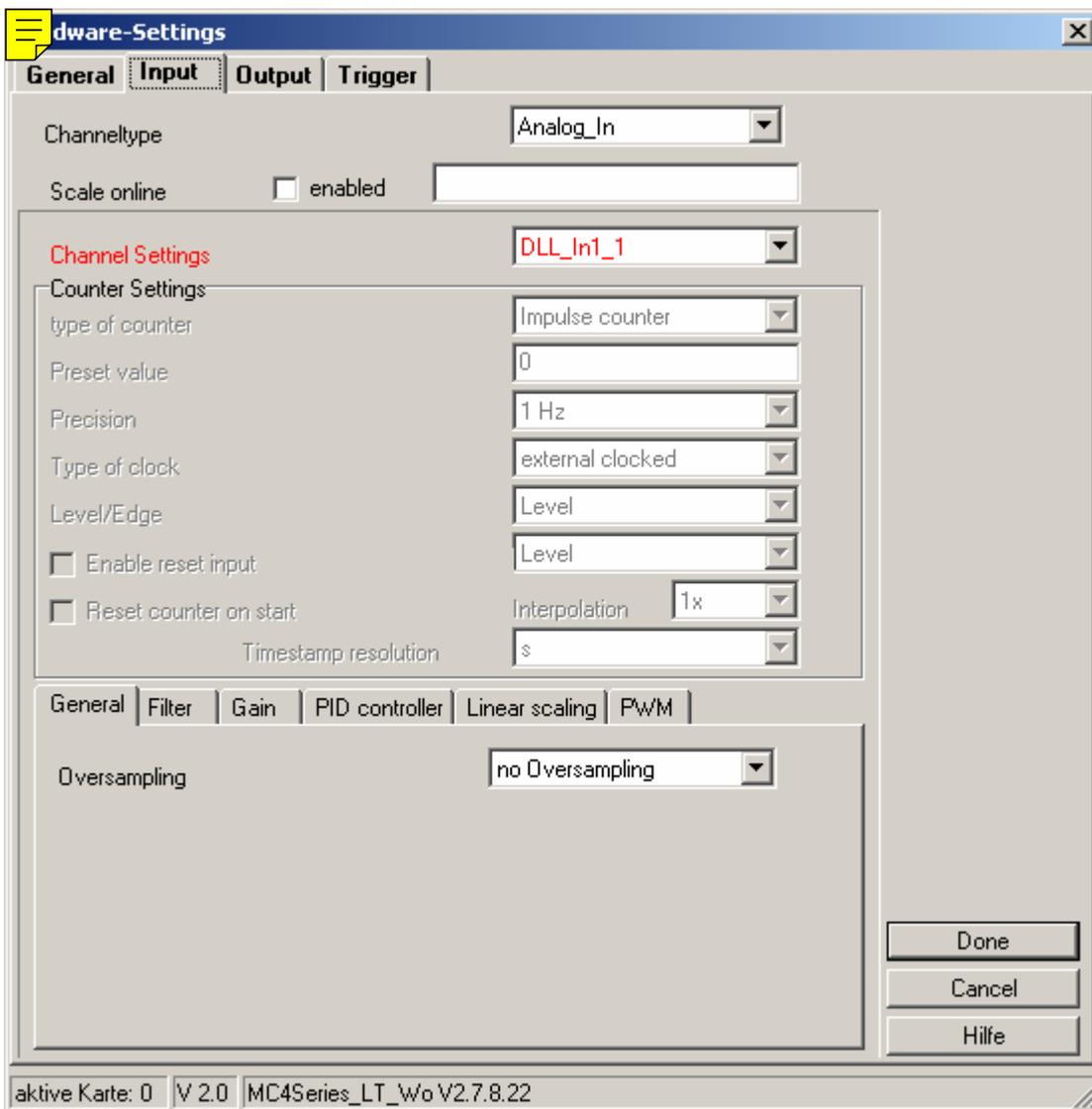
The posttrigger values for the stop trigger are the equivalent of the measured data sets which were measured after the stop trigger event. This allows to react on a certain stop trigger and to measure the signals after this event has occurred.

The pretrigger values for the stop triggers and the post trigger values for the start triggers define the number of values which were dropped after a respective event. Momentarily they are not implemented. If you select a new channel in the left part of the window the settings of this channel are displayed. The global settings are shown on the lower side. They are applied to any channel and can only be changed for all channels in common. These global settings include the settings for TTL bits, the start conditions of the digital outputs, and the pre- and post trigger values.

### 9.1.3.10 External Clock of the ADC conversion

The minimum period length of the external clock (pin P1, pin P8) has to be similar to CMOS TTL circuits 15 ns.

It can be programmed if the conversion is started by a rising or a falling edge. For each trigger pulse the whole number of activated channels are measured.



### 9.1.3.11 Counters

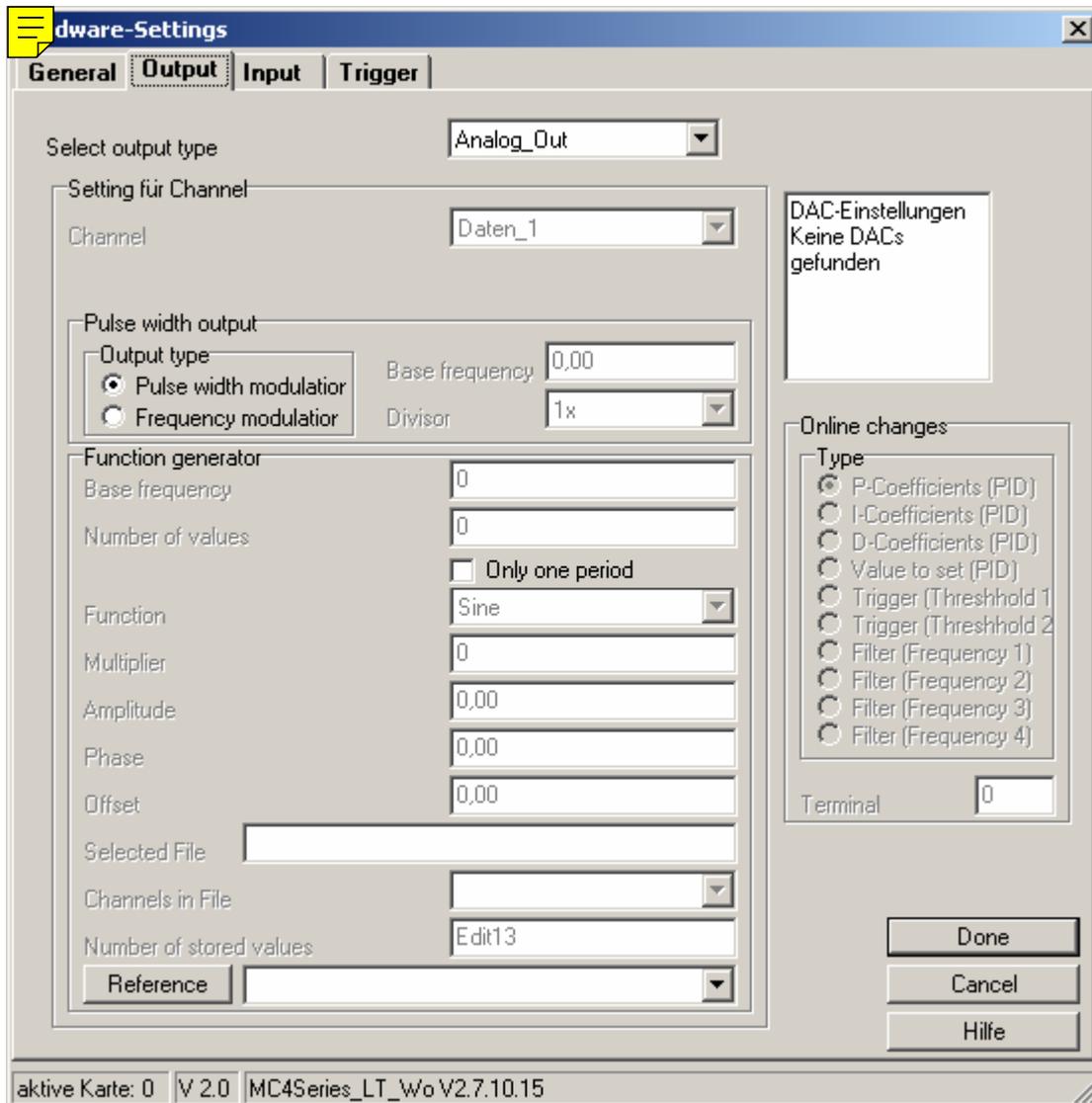
For counting frequencies all four modes of the timer are supported. Furthermore it can be set if and when the timer has to be reset. With a value written to an output the counter can be preset by the user.

### 9.1.3.12 Frequency

This mode allows to measure frequencies, period lengths and pulse widths. The desired unit can be set by the user (kHz, Hz, Sec, ms etc.). If the respective reference frequency is set measurements in the range

from 1 Hz up to the maximum counter frequency of 10 MHz can be measured. The counter is connected via pin 24 of the socket.

### 9.1.3.13 Wave Form Generator



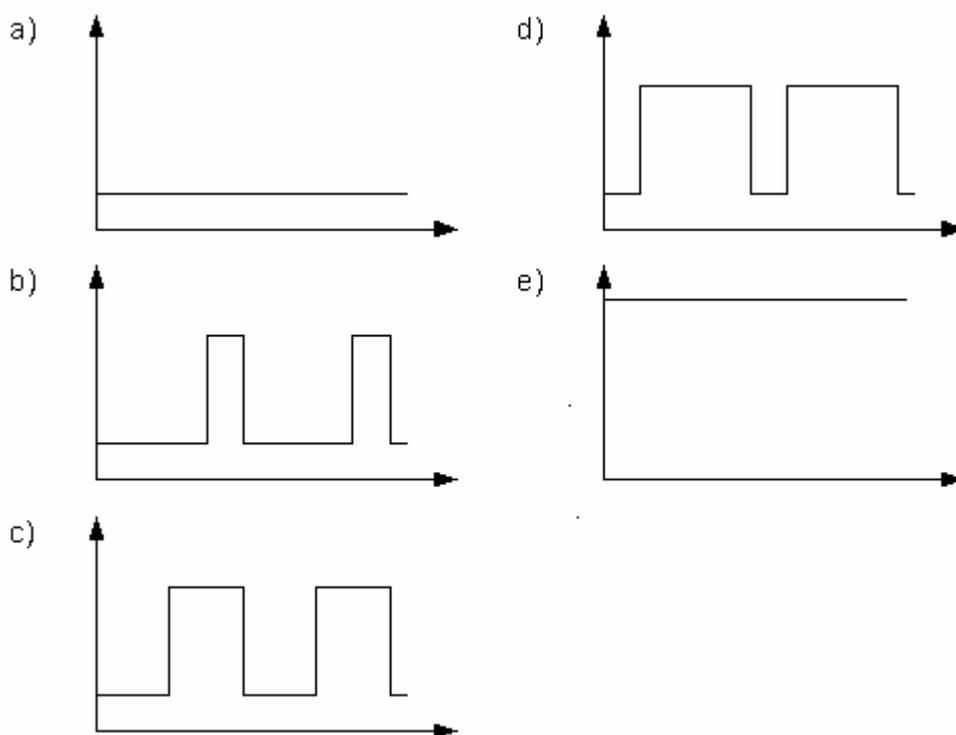
As an option RogaDAQ16 offers a wave form generator. Aided by this generator it is possible to output several kinds of signals over different outputs.

By default sine wave, triangle, square, pulse, saw tooth, and white noise are available as wave forms. In the near future an analog pulse width output will become available for the wave form generator. Furthermore it is possible to reproduce signals periodically measured which allow the generation of nearly any desired wave form.

**This kind of reproduction of wave forms works independent of a measuring process in the background. Therefore it is possible to measure analog and digital signals and to make counter readings. Even outputting of analog and digital controlled voltages to free terminals is possible during the reproduction of wave forms.**

### 9.1.3.14 Pulse Width Modulation (PWM)

PWM modulates the pulse width of a square wave signal with constant period width. The pulse width is set as percentage of the period length related to a 50%/50% related pulse width (duty cycle). If a value of -100 is set the PWM output is low all the time. A value of zero (0) leads to a symmetric high/low relation while a value of 100 keeps the output at high level all the time.



Pulse width signal with a) 0%, b) 25%, c) 50%, d) 75%, and e) 100%

### 9.1.3.15 Frequency Modulation (FM)

With frequency modulation the period length of a square wave signal is modulated. The pulse/pause relation is kept constant. The little most period length is equivalent to the maximum frequency and vice versa.

### 9.1.3.16 Structure of the Online Scaling Files

Online scaling files are pure text files (ASCII) which are divided into 32 columns and 4097 rows including numbers (32 bit floating point numbers. The columns are separated with tabs (#9), while the lines are terminated with carriage return/line feed (#13#10). The example file “demo.txt“ is provided.

**Important:** The first line of the files only serves for purposes of numbering; it does **not** influence the scaling functionality.

The easiest way to edit/create these files is an Excel sheet with a table including the numbering in the first line followed by the scaling values.

Please use text format (OS/2 or MS-DOS \*.txt) if the file is saved. The validity of the file content can be checked with the provided program testtxt.exe. This program loads the .txt file into a table where you can check your settings.

**Important:** The value at position 0/1 is equivalent to the voltage value which is output to channel 0V - 10V in the given example while a value of 0/4096 leads to an output voltage of +10V over channel 0. A maximum of 32 channels can be scaled at once. The order of the channels is similar to the order of the screwed terminals. In DIAdem the channels can be measured in any order and the linearization is achieved in a fixed relationship to the screwed terminal.

### 9.1.4 Auto Sequences in DIAdem

The DIAdem driver for the RogaDAQ16 series supports auto sequences to change single parameters of the measurements interactively or aided by automatic processes. More details to auto sequences you may find in the DIAdem online help.

Any of the parameters supported by the ROGADAQ16 driver are listed in the following. It has to be taken into consideration that any of the variables need at least one parameter which specifies the RogaDAQ16 in question. The numbering scheme starts with 1 while the order is identical to the order in the dialog box of DIAdem.

Channel specific parameters need at least a second parameter which is used to select the desired channel. The numbering scheme starts also with 1.

In example:

Switching over from single ended measuring mode to dual ended mode for the third RogaDAQ16 is done with:

```
MeasMode(3) := 1;
```

The number in brackets specifies the RogaDAQ16 in question and the new value is set to 1.

Activating 4x oversampling for the second RogaDAQ16 in the third channel:

```
Oversampling(2,3) := 2;
```

The first parameter selects the RogaDAQ16 (2) while the second one chooses the desired channel (3).

The new value is set to two.

#### Important

The numbering scheme for RogaDAQ16 and the channels always start with 1 while parameters always start with zero (0). The number to set is identical to the one in the input boxes of the dialog field.

Oversampling offers five entries in the dialog. They are associated as shown in the following:

Dialog entry:	Parameter to set
No Oversampling	0
2x Oversampling	1
4x Oversampling	2
8x Oversampling	3
16x Oversampling	4

Because the available entries are subject to be changed by new releases or revision changes please read the latest information on this subject in the online help of the driver.

#### 9.1.4.1 Parameters of DIAdem:

Global Variables	1. Parameter: RogaDAQ16
InputRange	set the input voltage range of the RogaDAQ16
MeasMode	switches from single ended to dual ended mode
ExtTrigger	set the triggering edge of the external trigger
HoldVolt	specifies if after ending the measurement all voltages are set to zero or if the last value is hold

Input variables	1. Parameter: RogaDAQ16 2. Parameter: Channel
Oversampling	sets a new value for oversampling for the selected RogaDAQ16 and the selected channel
OnlineCalc	set online signal processing to a new value
Countermode	set a new counting mode for counters
CounterEdge	determines the edge of the specified counter input
CounterPreset	sets a new preset value for the selected counter channel (pulse measurements only)
CounterRslt	sets the resolution of the selected counter channel (frequency measurements only)
OnlineScale	specifies if the selected RogaDAQ16 has to use online scaling
OnlineScaleFile	determines the file out of which the data for online scaling have to be loaded
Output Variables	1. Parameter: RogaDAQ16 2. Parameter: Channel
Wave Form Generator:	
FuncGen_Function	sets a new output function for the specified channel
FuncGen_Ampl	sets a new amplitude for the specified channel
FunkGen_Offset	sets a new offset for the specified channel
FunkGen_Phase	sets a new phase for the desired channel
FunkGen_Multipl	sets a new multiplier for the selected channel
FunkGen_BaseFreq	sets the base frequency for output of the wave form generator for the selected RogaDAQ16
FuncGen_NoV	sets the number of sampling points for the selected RogaDAQ16
Pulse Width Output	
PWM_Out_BaseFreq	sets a new base frequency for pulse width output
Global Trigger Variables	1. Parameter: RogaDAQ16
EnableTrigger	This variable allows to activate/deactivate any set triggers at once. This allows in example to examine the measured signal before the actual measurement without reconfiguring of the circuit diagram. Possible values: 0 deactivated, 1 activated.
Trig1PrePost	sets the pre-/post trigger values for the start trigger. Because of the internal buffer structure values between -2048 and 2048 can be used.
Trig2PrePost	sets the pre-/post trigger values for the stop trigger. Because of the internal buffer structure values between -2048 and 2048 (samples) can be used.
Retrigger	If a measurement has to be retriggerable start and stop triggers have to be set. The stop trigger enables the start trigger if its condition becomes true. So if the next trigger event allows to measure further data. If this function is not activated no data is measured after a true stop trigger condition. Possible values are: 0= not retriggerable, 1= retriggerable.

Start Trigger Variables	1. Parameter: RogaDAQ16 2. Parameter: Channel
EnableTrig1	This variable is used to activate/deactivate the start trigger. Possible values: 0 deactivated, 1 activated.
SetTrig1Type	sets the trigger type. Possible values depend on the driver version. The numbering scheme of the trigger type is identical to the user interface and starts with zero (0) (number – 1)
SetTrig1Value1	configures the threshold of the start trigger. The valid range is -10.0 up to 10.0. It is interpreted as a voltage range.
SetTrig1Value2	configures the threshold of the second start trigger. The valid range is -10.0 up to 10.0. It is interpreted as a voltage range. The second threshold is used only if a respective trigger type is used (in example a window trigger).
Trig1FromStart	This specifies if the trigger is activated at the beginning of the measurement or if it has to be activated later. If the trigger is not activated at start the stop trigger is activated earliest if the condition of the start trigger becomes true. Possible values are 0=deactivated, 1=activated.
SetTrig1Meas	specifies if a measurement has to be run. The value is the equivalent of the entry in the dialog box.
SetTrig1Bit	With this variable the signaling of the trigger can be controlled over digital inputs. If this value is set to zero the signaling is deactivated. With a value of 1 it is activated.
Trig1BitChannel	This variable specifies the digital output over which the selected channel is signaled. The maximum number depends on the RogaDAQ16 used
Trig1BitLevel	To achieve signaling a defined condition is necessary. Set the output condition which has to be used (0=low 1=high)
Trig1BitStartLvl	To ensure a correct signaling it can be necessary to define a start condition which is set at the beginning of the measurement. Overwriting of the digital outputs during the measurement is possible at any time (0=low 1=high).
Stop Trigger Variables	1. Parameter: RogaDAQ16 2. Parameter: Channel
EnableTrig2	With this variable the start trigger is activated/deactivated. Possible values are 0=deactivated, 1=activated.
SetTrig2Type	Here the type of trigger is specified. The possible values depend on the respective version of the driver. The numbering scheme of the trigger type is similar to the one in the user interface and it starts with 0 (number – 1).
SetTrig2Value1	This specifies the threshold of the start trigger. The valid range is spread from -10.0 up to 10.0. It is interpreted as a voltage.
SetTrig2Value2	Here the second threshold of the start trigger is specified. The valid range is spread from -10.0 up to 10.0. It is interpreted as a voltage. The second threshold value is used only with respective types of trigger (in example a window trigger)
Trig2FromStart	This specifies if the trigger is activated at the beginning of the measurement or if it has to be activated later. If the trigger is not activated at start the stop trigger is activated earliest if the condition of the start trigger becomes true. Possible values are 0=deactivated, 1=activated.
SetTrig2Meas	specifies if a measurement has to be run. The value is the equivalent of the entry in the dialog box.

SetTrig2Bit	With this variable the signaling of the trigger can be controlled over digital inputs. If this value is set to zero the signaling is deactivated. With a value of 1 it is activated.
Trig2BitChannel	This variable specifies the digital output over which the selected channel is signaled. The maximum number depends on the RogaDAQ16 used.
Trig2BitLevel	To achieve signaling a defined condition is necessary. Set the output condition which has to be used (0=low 1=high)
Trig2BitStartLvl	To ensure a correct signaling it can be necessary to define a start condition which is set at the beginning of the measurement. Overwriting of the digital outputs during the measurement is possible at any time (0=low 1=high).
SetAnalogOut	writes a certain value to a DAC channel SetAnalogOut(RogaDAQ16,Channel,Volt) Parameters: Number of the desired RogaDAQ16 starting with 0 (LONG) Channel: Number of the desired channel starting with 0 (LONG) Volt: desired voltage (DOUBLE)
SetDigitalOut	sets a digital output to the desired level SetDigitalOut(RogaDAQ16,Channel,Level) Parameters: RogaDAQ16: Number of the desired RogaDAQ16 starting with 0 (LONG) Channel: Number of the desired channel starting with 0 (LONG) Level: level to output, 0=LOW, 1=HIGH (LONG)
SetPWMOut	Starts PWM outputwidth predefined values SetPWMOut(RogaDAQ16,Channel,BaseFreq,Ratio) RogaDAQ16: Number of the desired RogaDAQ16 starting with 0 (LONG) channel: Number of the desired channel starting with 0 (LONG) BaseFreq: frequency to output (LONG) Ratio: Value between -100 .. +100 which defines the relation between pulse and pause
CalibrateDA	Starts calibrating of the DAC converters CalibrateDA(RogaDAQ16,DACHannel,ADchannel) RogaDAQ16: Number of the desired channel starting with 0 (LONG) DACHannel: DAC channel to calibrate ADchannel: ADC channel to calibrate

## 9.2 DASyLab

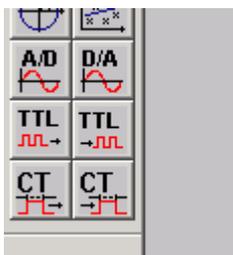
### 9.2.1 Installation

Installation of the driver for DASyLab is carried out with the provided installation program „SETUP.EXE“. For this installation procedure all necessary files have to be copied into the directory of DASyLab.

It is important to have administrator rights for the first time start under Windows NT/2000 and Windows XP because the driver has to be registered in Windows. If you have no administrator rights please consult your system administrator.

The driver is no acquisition driver but it is integrated as an additional interface. Therefore proprietary block definitions are provided which have to be used instead of the existent ADC and DAC blocks. The advantage of this additional driver is that you can measure with up to four RogaDAQ16 at the same time. Furthermore an additional measuring hardware can be integrated and used also at the same time.

The additional DLL generates a menu called „RogaDAQ16“ respectively „RogaDAQ16“ within the DASyLab menu. In this menu you can select the desired blocks. Alternatively you can reconfigure the module bar with the desired icons. To avoid conflicts or mix ups with other acquisition systems any of the blocks are marked with a T in front of their names. So the analog acquisition can be found under Analog In.



Now you can use the driver in the known way. During the first time start of a driver block all RogaDAQ16's existing in the system are loaded automatically.

To keep the circuit diagrams configurable offline, nearly any options can be activated in the user interface. Error messages appear only at starting time if an invalid screwed terminal or a non-existent option is tried to be used.

Depending on the type of block after double clicking a signal specific dialog box is opened which allow to specify the settings for the RogaDAQ16.

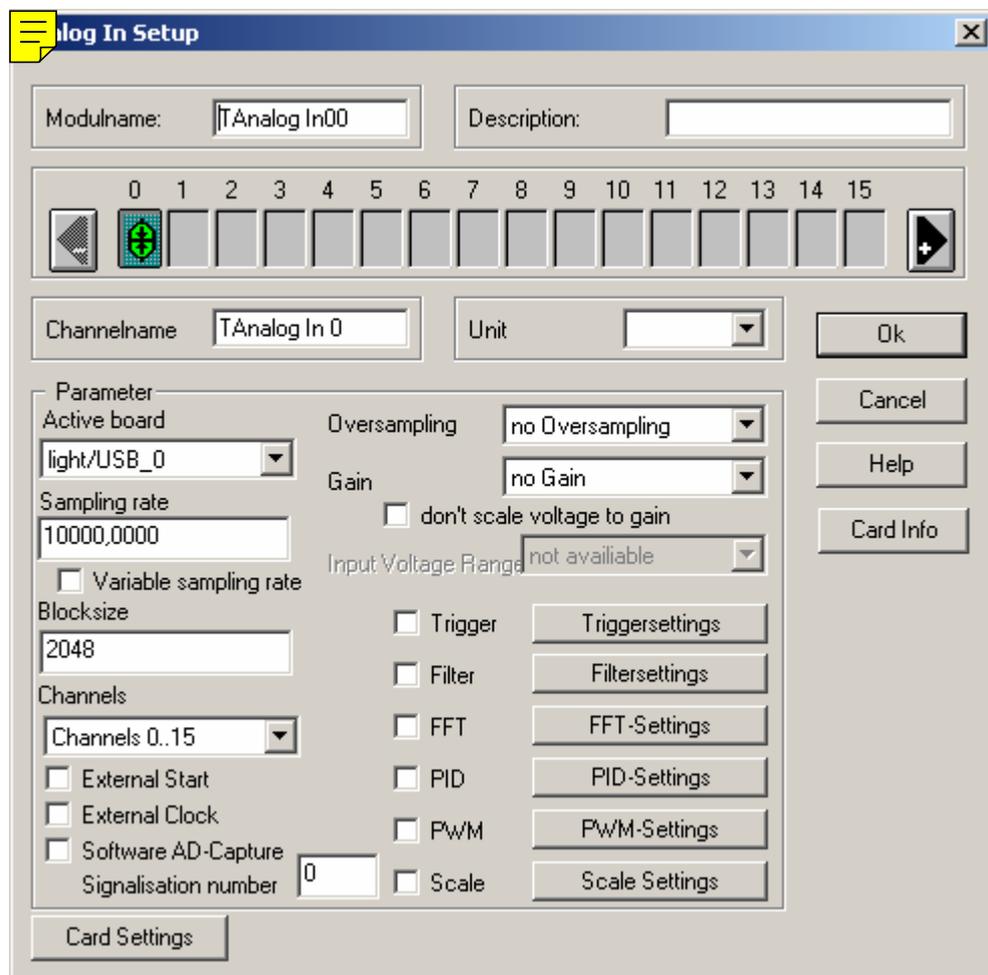
In example for analog measuring the sample rates, block size and online functions like oversampling, trigger, filter, or FFT calculation can be activated or configured.

The switching between RogaDAQ16s is done within the block and it is valid only within the block.

Because of limitations of DASyLab, where each block can consist of a maximum of 16 channels, for some signals like digital inputs or outputs or analog inputs the channel range of the block can be selected to cover more than 16 channels. A channel setting of 16..32 projects the set channels and parameters to the appropriate higher channels. The sample rates are taken from the block which was called first, because different sample rates per type of signal on one RogaDAQ16 are not possible.

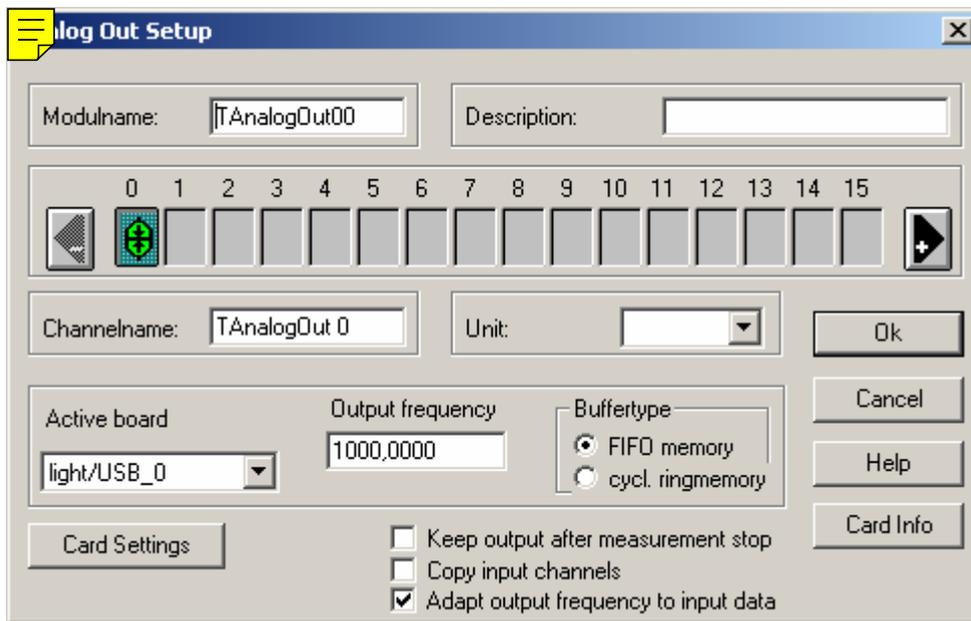
### 9.2.2 Dialog Window

#### Analog Acquisition:

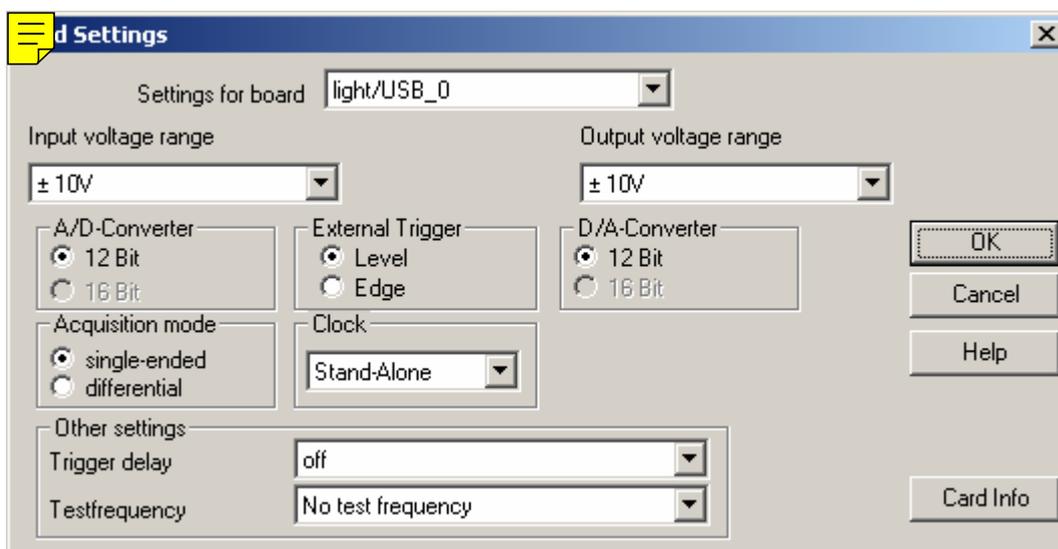


In some cases the synchronization is done with the parameters predefined for the default interface. If analog output is controlled of a generator it is necessary to set the output rate to a value identical to the global one of which the generator receives its time information. Otherwise no continuous output is possible.

With analog output it is possible to synchronize the block size with the fed frequency of the prior block. To do this, activate the option in the block „Adapt output frequency to input data“.

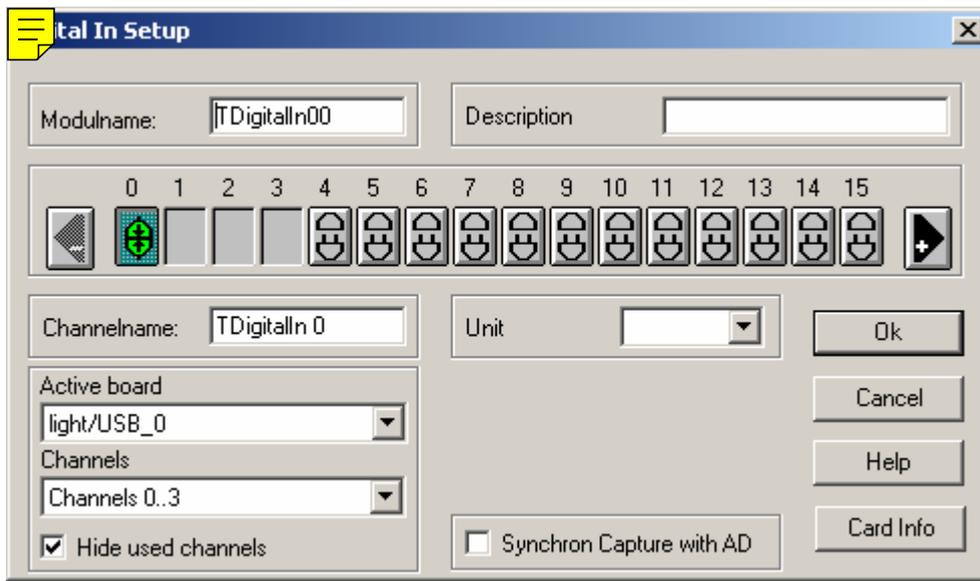


The most important global settings of the RogaDAQ16 can be configured for the respective blocks by clicking on „Card Settings“. Please note that only the data relevant to the respective output will be applied. For AnalogIn blocks the output voltage range is not changed.



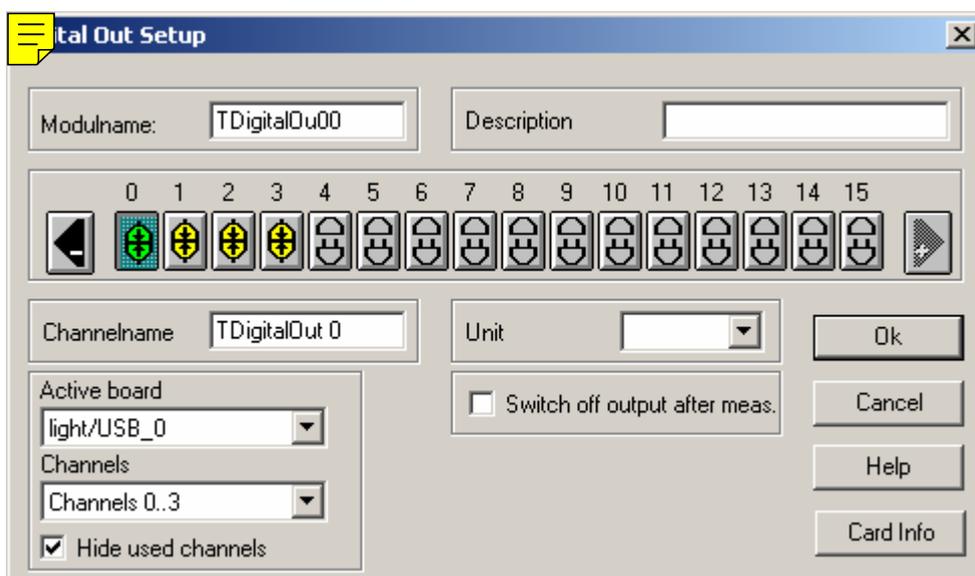
### Synchronous Digital Acquisition

DASYLab drivers support the synchronous digital acquisition for multi function cards. This means that digital channels are put into the list of analog channels and are treated identically. Therefore they are run with the same clock so it is possible to have an exact time oriented association between analog and digitally measured values. Furthermore exact and quite fast sample rates are possible.



### Pulse Width and Frequency Modulation

The pulse width and the frequency modulation both use input values in the range of -100 to 100. For PWM a negative value of -100 is the equivalent of a permanent low level while a value of 100 leads to a permanent high level. The value zero defines a 50% to 50% relation between high and low level. For frequency modulation the pulse width relation is set in the range 0% to 100% and directly used as output frequency of the input of the block.

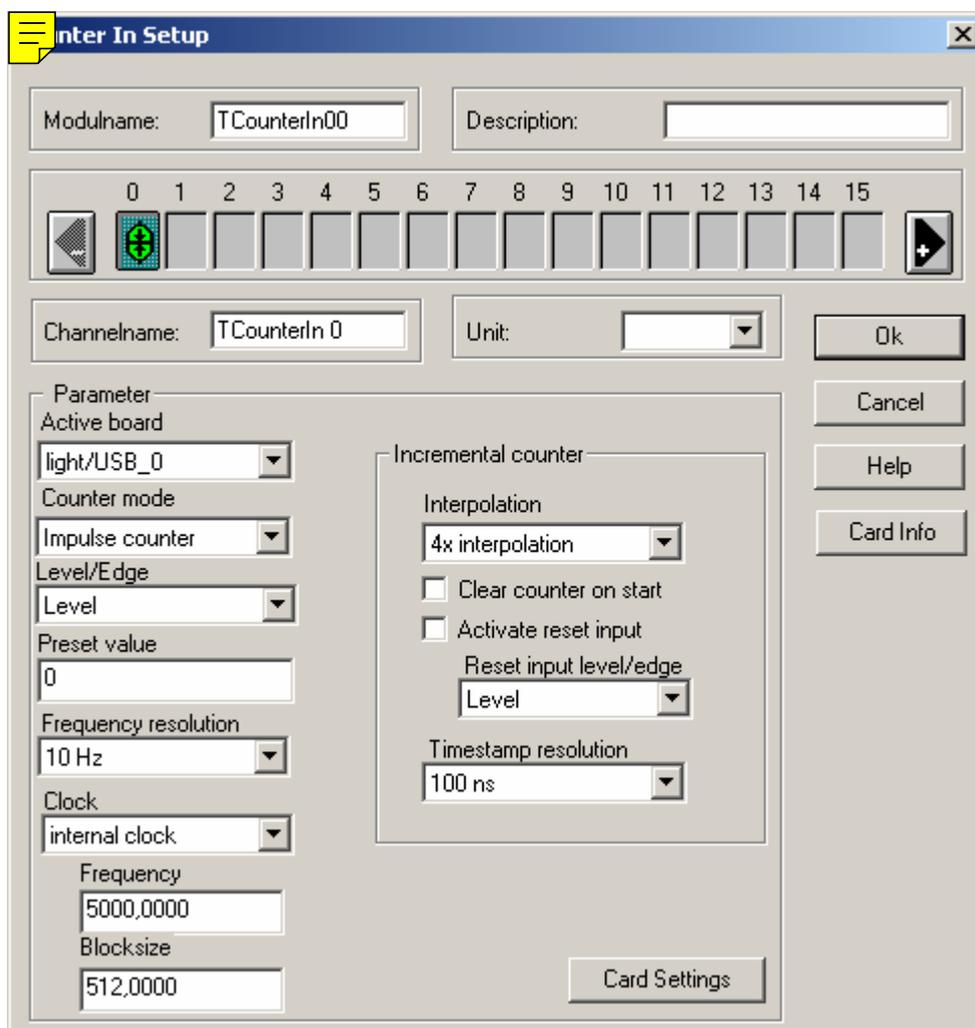


### Measuring with Counters

Measurements made with counters can be synchronously or asynchronously. Depending on the options in the RogaDAQ16 it is switched between the types of measurement.

The parameters are distinguished depending on the type of the RogaDAQ16.

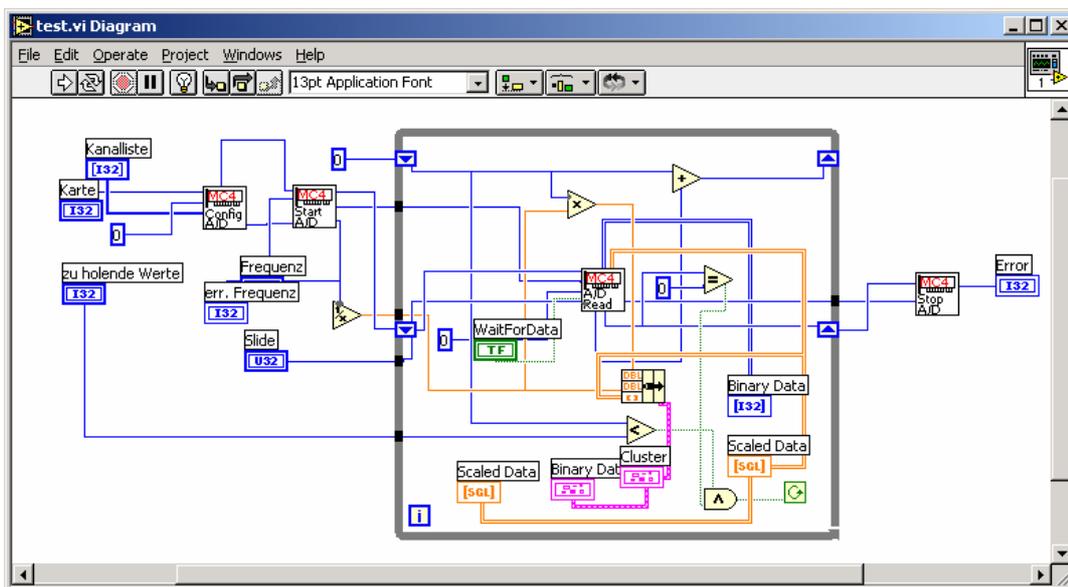
The set measuring edge, clock type, block size, and frequency are valid for the whole counter while any other settings are specific to the individual counter. Preset values are used only for a single pulse counter while the frequency resolution is taken over for frequency measuring, and incremental encoders with reset, interpolation and so on are configured. Counters for measuring period length and pulse width cannot be configured.

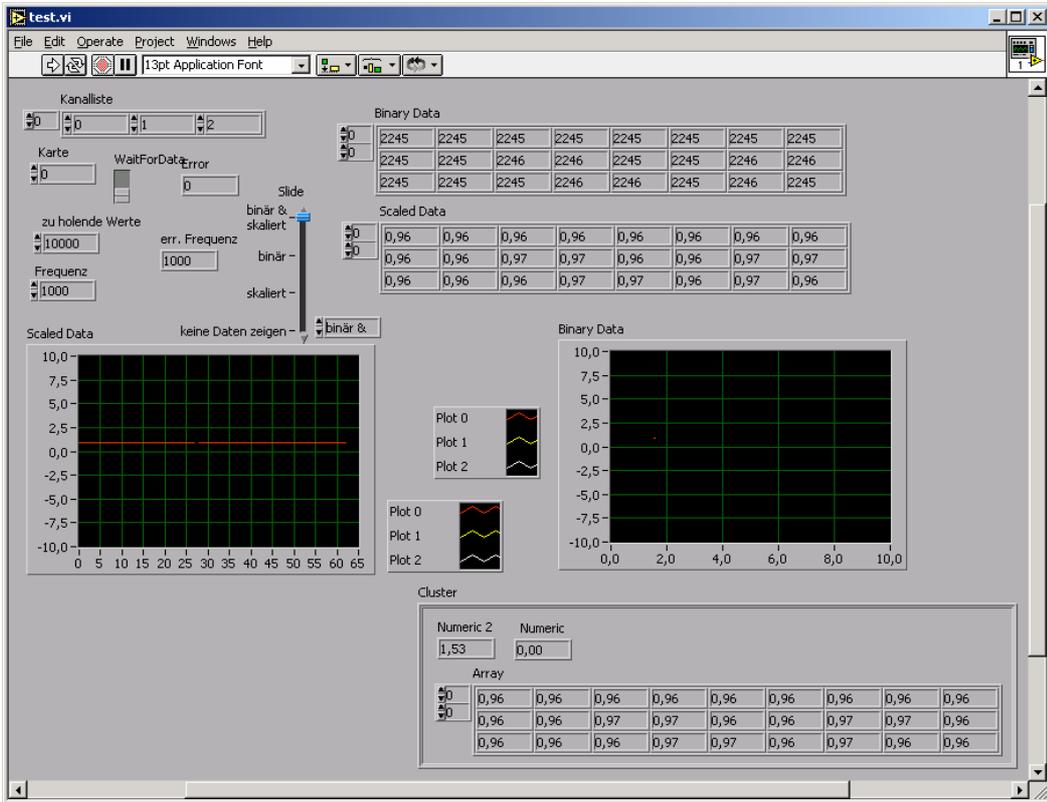


### 9.3 RogaDAQ16 Series and LabView

For the RogaDAQ16 series virtual instruments (VI's) are available which allow easy integration of RogaDAQ16 in measurement systems run with LabView. Only 32 bit operating systems are supported.

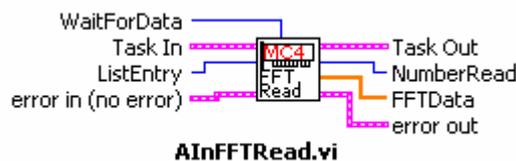
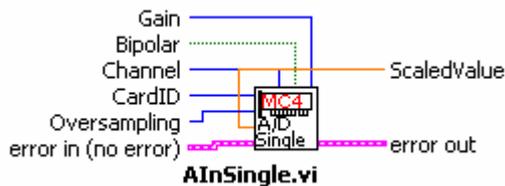
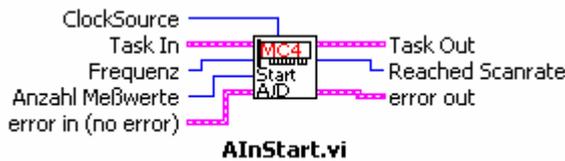
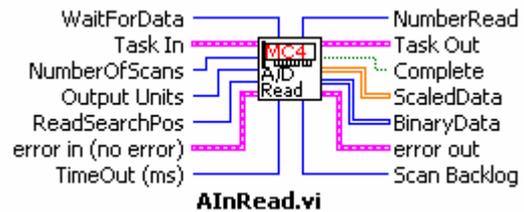
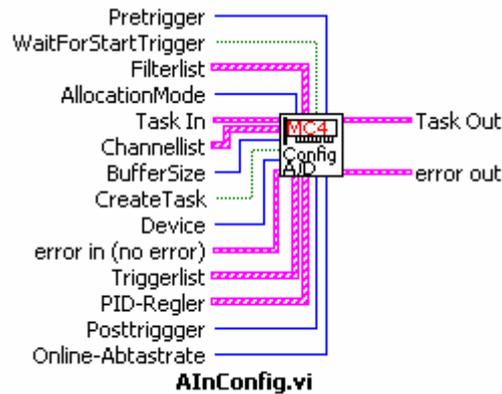
Because there are no standard drivers for LabView and the programming of the functionality is done graphically by the user there is no general description for the installation process or the use of the driver. Please consult the provided CD for actual VI's and the respective descriptions.



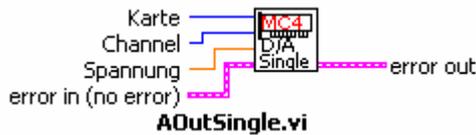
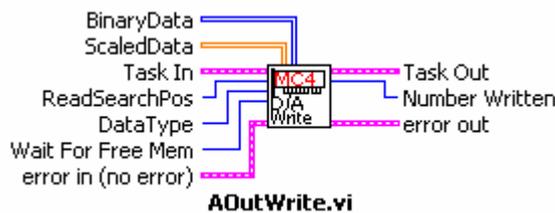
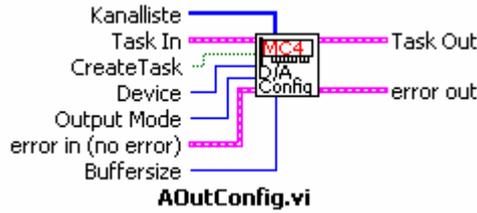


A listing of the VI's available at the time of printing of this manual you will find in the following:

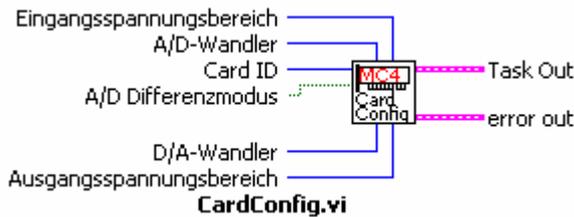
**Analog Acquisition:**



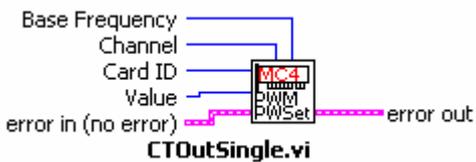
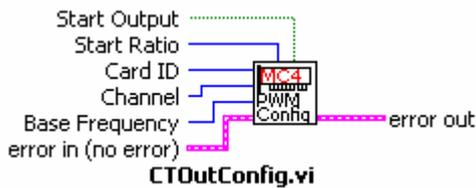
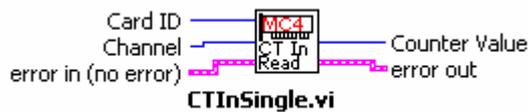
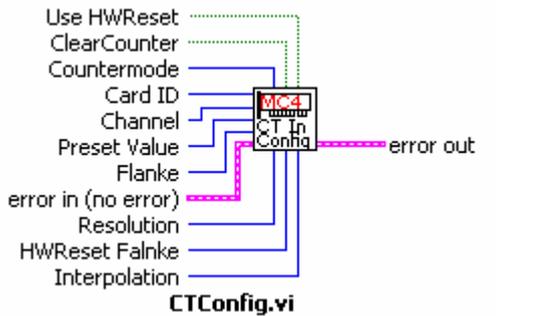
Analogue Output:



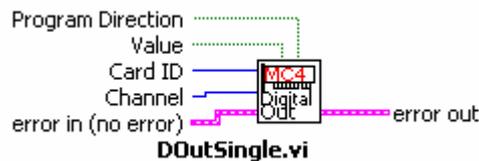
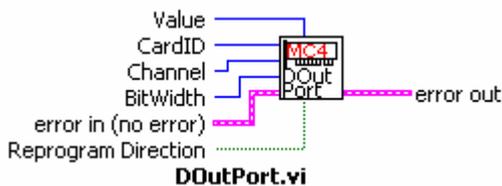
RogaDAQ16 Configuration and information



## Counter based Acquisition and Pulse Width/Frequency Output



## Digital Input/Output



Any VI is an equivalent of certain encapsulated functions which can be used to program measurement cards with LabView. Please see the examples provided with the driver.

## 10 Digital Filters

### 10.1 The Real Time Concept of RogaDAQ16

The intelligent measuring system RogaDAQ16 reduces the processing load of the PC during acquisition and reproduction of signals. This also includes a real time processing of signals. This real time processing is integrated into our drivers and therefore it is easy to activate and configure it. Each channel is processed individually.

Measured signals can be filtered in real time on the RogaDAQ16. The filtering can make it necessary to separate the measured signal from distorting noise. To achieve this the measured signals were fed into a filter algorithm. The determination of the coefficients is realized with a program library which is integrated in our drivers which support the most common products like DIAdem, DASyLab, and LabView. Therefore additional programs are not necessary. Users only have to specify the conditions for the filter characteristics. Any other activities are carried out by our drivers.

### 10.2 Sampling Theorem or Rules for the Sampling of Time Signals

For the sampling and processing of sampled signals with digital systems some prerequisites apply. These are:

1. The bandwidth of the signals has to be limited. Above a certain border frequency any frequencies have to be zero.
2. The sampling frequency has to be in minimum twice as fast as the highest border frequency of the measured signal.

These rules are named the sampling theorem of SHANNON. If it is not met and the sampling frequency is not twice the border frequency of a signal partial frequencies appear which are not really part of the original signal. The effect is called aliasing. It is made out of the mirroring of frequencies above the border frequency into a frequency band under the border frequency. The border frequency is called Nyquist frequency.

### 10.3 How Digital Filters Work

Sampled signals are normally mixed of a useful signal (which contains information) and noise. The noise can consist of signals of other frequencies or it is white noise which is overlaid.

In most of the cases the amplitude of the noise is very small compared to the signal itself so it has not to be taken into consideration. If this is not the case it is possible that the noise covers the useful signal and the information included in the useful signal cannot be retrieved.

If the noise can be removed from the sampled signal the information of the useful signal is available. For this purpose very often active filters are used. These filters use the fact that mostly the noise is of higher frequency than the useful signal. They filter the useful signal out of the sampled signal and suppress any other frequencies.

The filtering of a signal needs under certain circumstances lots of computing power. To reduce the load of the PC arising out of filtering sampled signals, RogaDAQ16 filters the signal on itself and passes the already filtered signal to the PC.

In the last part of the chapter performance measurements are shown. They show the possible number of coefficients of FIR filters in dependence to the number of channels and the accumulated sample rate.

#### 10.4 Types of Filters

There are four standard types of selective filters:

##### Low Pass

High frequencies are suppressed, low frequencies remain unchanged.

##### Low Pass

low frequencies are suppressed, high frequencies remain unchanged.

##### Band Pass

Frequencies within a certain range remain unchanged, any others are suppressed.

##### Band Stop

Frequencies within a certain range are suppressed while any others remain unchanged.

There are also multi band filters which apply several passes with stop and pass through characteristics which are not discussed here.

What type of filter has to be used and how stop and pass ranges have to be distributed over a frequency response is specified with coefficients and therefore they are independent of the used calculation algorithm. The coefficients have to be determined for any of the filter algorithms in a specific way. They cannot be applied to other algorithms. Filter algorithms are called filter structures also.

The most common structures for filters are recursive (IIR) and nonrecursive (FIR) filters. Both types are supported by RogaDAQ16.

#### 10.5 The Tolerance Scheme

The tolerance scheme is a basic part of the filter design. In this scheme all information is inserted which is needed to design a filter. The necessary parameters are:

Border frequencies	define the width of the transmission range beginning with pass through into the stop range. Depending on the type of filter it can be a different number. For each edge of the filter a pair of border frequencies has to be defined. Therefore: Low and high passes need 2 border frequencies while band passes and band stops have to work with four.
Block absorption	Minimum absorption value for frequencies in the range to suppress
Pass absorption	Maximum value for absorption of frequencies in the pass through range

Sometimes allowed ripple is given. Ripple can be calculated to absorption values and vice versa.

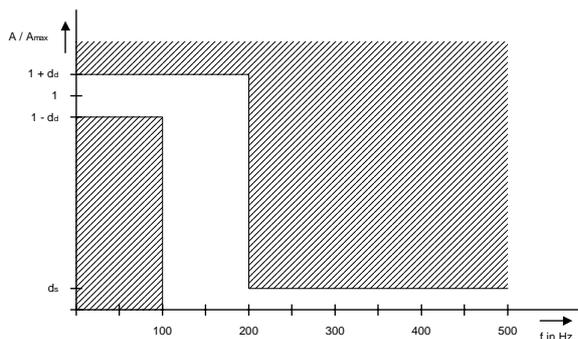
The width of the transmission range and the specified absorption define the order of the filter. The smaller the transmission range and the bigger the Block absorption the higher the order of the filter and the bigger the calculation processes necessary for the filter.

The tolerance scheme can be presented in several different ways. In most of the cases the absorptions are shown.

Picture 10.2 shows a tolerance scheme for which the absorptions are shown. In Picture 10.1 the allowed ripple is displayed. To settle the requirements of the tolerance scheme the frequency response of the filter is not allowed to cross the hatched areas. In this case the tolerance scheme could not be applied any longer. To reduce the order of the filter sometimes it can be necessary to decide if minor violations of the upper rule should not be tolerated.

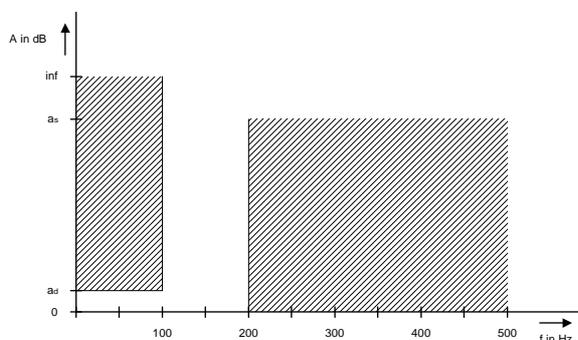
Tolerance scheme of a low pass with the following specifications:

- Sample frequency: 1000 Hz
- Lower border frequency: 100 Hz
- Upper border frequency: 200 Hz
- Allowed ripple in the pass through range:  $d_d$
- Allowed ripple in the absorption range:  $d_s$



Picture 10.1: Tolerance scheme with frequencies and allowed ripple

Instead of the ripple the following picture shows a tolerance scheme including absorption values. In this case important also: The hatched areas are not allowed to be crossed by the frequency response of the filter.



Picture 10.2: Tolerance scheme with frequencies and allowed absorption

## 10.6 Recursive Filters (IIR Filter)

Recursive filters are a type of filter for which the output signal of the filter is fed back into the input of the filter. The name is English and has the meaning „infinite impulse response“. By feeding back the order of the filter can be reduced. Of course the normally nonlinear phase is a disadvantage.

The design of IIR filters can be reduced to the design of a traditional analog filter. Therefore it is possible to determine the order of the filter which is necessary to fulfill the requirements of the tolerance scheme. The design of a high pass filter can be reduced also to the design of a low pass filter. Therefore only a low pass filter has to be determined. Other types of filters (low pass, high pass, band pass, band stop) have to be calculated by so called frequency transformations based on the prototype of a low pass filter. There is no need to set limits for the coefficients. This is a great advantage compared to FIR filters.

The group delay of the filter determines the length of the delay of the frequency ranges between input and output. IIR filters mostly have variable group delays, in the meaning there is a change of the phase of the frequency range at the output. Therefore the signal at the output is altered. This is the case also if the filter has not changed the amplitude of frequency ranges.

### 10.6.1 Butterworth

Linear frequency response in the pass through and stop ranges, therefore no complete use of the tolerance scheme. The filter order is relatively high. There is no significant change of the group delays over the frequency response.

### 10.6.2 Chebycheff 1

Linear frequency response in the stop range only and ripple in the pass through range. The tolerance scheme is better used in the pass trough range. Therefore the order of the filter is less than the one of Butterworth filters. The group delays are changed slightly over the frequency response.

### 10.6.3 Chebycheff 2

Linear frequency response in the pass through range only and ripple in the stop range. The tolerance scheme is used to its full content in the stop. Any other characteristics like Chebycheff1.

### 10.6.4 Cauer

Ripple in stop and in pass through range, therefore full use of the tolerance scheme. The order of the filter is less than Chebycheff1/2. The group delays are changed significantly over the frequency response.

### 10.6.5 Bessel

The tolerance scheme is used very badly so the order of the filter is a lot higher than for any other types of filters. The group delays are nearly constant over the whole frequency response.

## 10.7 Nonrecursive Filters (FIR-Filter)

Nonrecursive filters are filters where the output signal is not fed back to the input. Their name is English and means “finite impulse response”. These types of filters are stable under any conditions. With this type of filter it is possible to realize linear phase and therefore constant group delays. This advantage over the IIR filters is compensated by a higher order of the filter.

The design of FIR filters cannot be reduced to an analog design. And it is not possible to determine the order of the filter which is necessary to settle the requirements of the tolerance scheme. This leads to trial and fail processing with recursive steps for the whole design. For any single process step the order of the filter is raised and tested if it fulfills the tolerance scheme. If this is the case the recursion is terminated. There are no known transformations by which a low pass can be converted to any other type like a high pass. Any design has to be processed anew.

### 10.7.1 Design Process

The **RogaDAQ16** driver supports several different design processes to carry out the calculations for FIR filters. Any of the calculation processes can determine

low passes, high passes, band passes, and band stops.

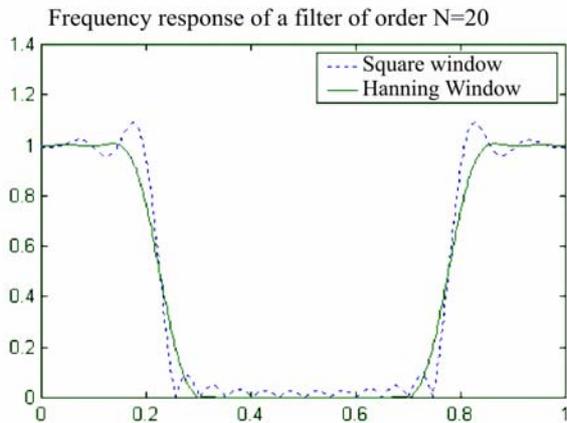
Because the order of a FIR filter cannot be calculated with a basic type of calculation an additional function is implemented which determines the order which is able to fulfill the necessities of the tolerance scheme. This may take some time because there is a recursion used until the usable order is determined.

### 10.7.2 Window Method

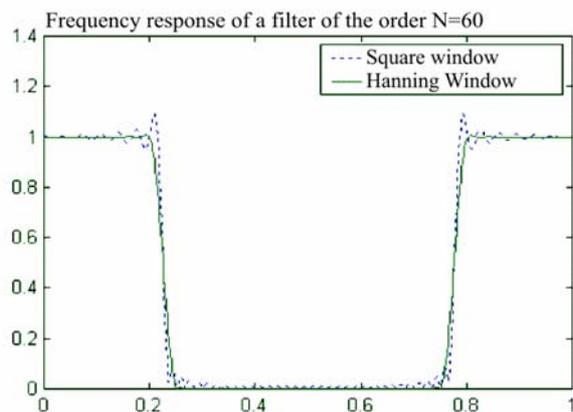
With the window method a pulse response is calculated. Functions are used which allow to calculate the coefficients directly. But in this way a linear phase can be realized only.

The calculated pulse response is limited for its length. If it is cut off it is called a square window limitation. This leads to oscillations at the edges of the filter. These oscillations drop down with the distance to the edges. Raising of the order of the filter does not reduce the amplitudes of the oscillations. Using another window function which does not cut off the pulse response but develops the coefficients at the borders to zero, reduces the oscillations significantly. But this leads to less steeper edges also. In picture 10.7.5 the function graphs of some window functions are shown.

The following pictures show frequency responses of filters with different orders. As you can see rising of the order does not lead to make the oscillations disappear but they are concentrated in a smaller range around the edge. The Hanning window reduces the oscillations significantly but the steepness of the edge is reduced.



Picture 10.3: Frequency response of a filter of 20<sup>th</sup> order designed with the window method. It can be seen easily the ripple caused by using a square window. The Hanning window reduces the ripple but reduces the steepness of the edge also.



Picture 10.4: Frequency response of a filter of 60<sup>th</sup> order designed with the window method. The steepness of the edge rises but the ripple is not reduced.

### 10.7.3 Frequency Sampling

Frequency sampling generates out of frequency and phase response a pulse response if aided by the inverse FFT. The advantage is that any frequency and pulse responses can be realized. The arithmetic effort is mostly determined by the FFT processing. The order of the filter is not significant.

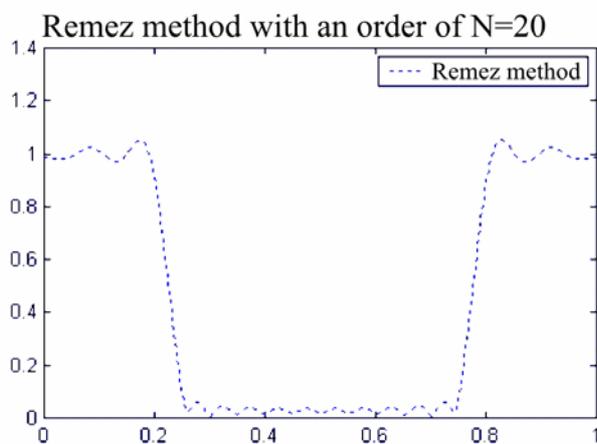
The coefficients calculated here is just an approximation of the real pulse response. The precision can be raised by the rising number of the FFT points. But the time necessary for the calculations increases significantly.

The problem of oscillations at the edges of the filter is existent to. By using window functions the oscillations amplitude can be reduced but the steepness of the edges is reduced.

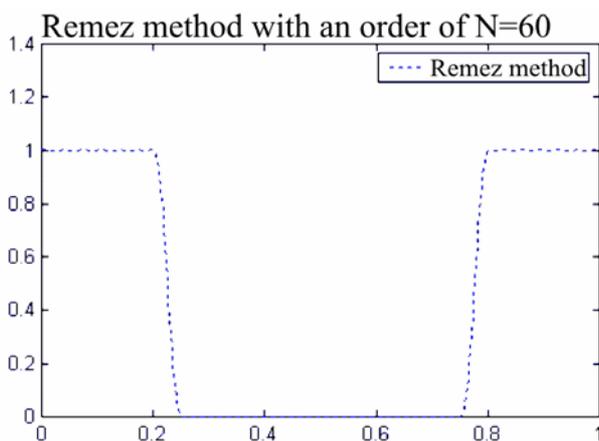
### 10.7.4 Remez Method

The Remez method generates filter coefficients which are known as „equi-ripple-filters“. Another name is „optimized FIR filter“. Filters designed according to this method are optimized in the meaning that the requirements of the tolerance scheme are fulfilled perfectly for the pass through and the band stop ranges. Because of this in the pass through and in the band stop ranges a ripple is generated (similar to the Tschebycheff3 IIR filter). Furthermore these filters need often lower orders of their order compared to the filter designs discussed above what is sufficient to fulfill the tolerance scheme.

The major disadvantage is the relatively high need for calculation time though this design offers very high flexibility.



Picture 10.5: Frequency response of a filter with a 20<sup>th</sup> order designed according to the Remez method.



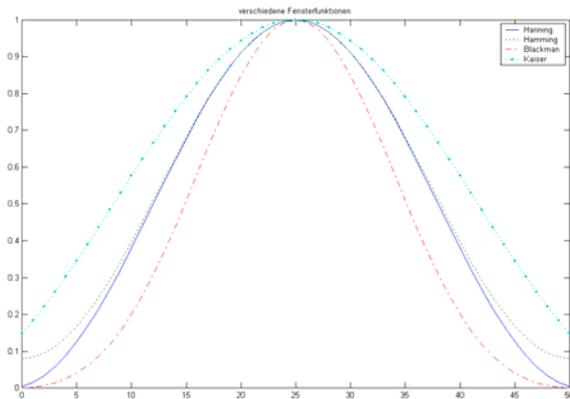
Picture 10.6: Frequency response of a filter with a 60<sup>th</sup> order designed according to the Remez method.

For the Remez method there is no need for a window function because with rising orders the ripple decreases.

### 10.7.5 Window Function

This design method generates a window function only and passes it to the calling routine. The number of coefficients of the window function is the passed order plus one. There are more than 200 window functions known. Most of the commonly used are offered by the RogaDAQ16 driver.

The following picture shows several window functions.



Picture 10.7: Graphs of some window functions

### 10.8 Comparing IIR and FIR Filters

An immediate comparison between IIR and FIR filters is not possible. The user has to decide depending on the task and the specific conditions which type of filter can be used.

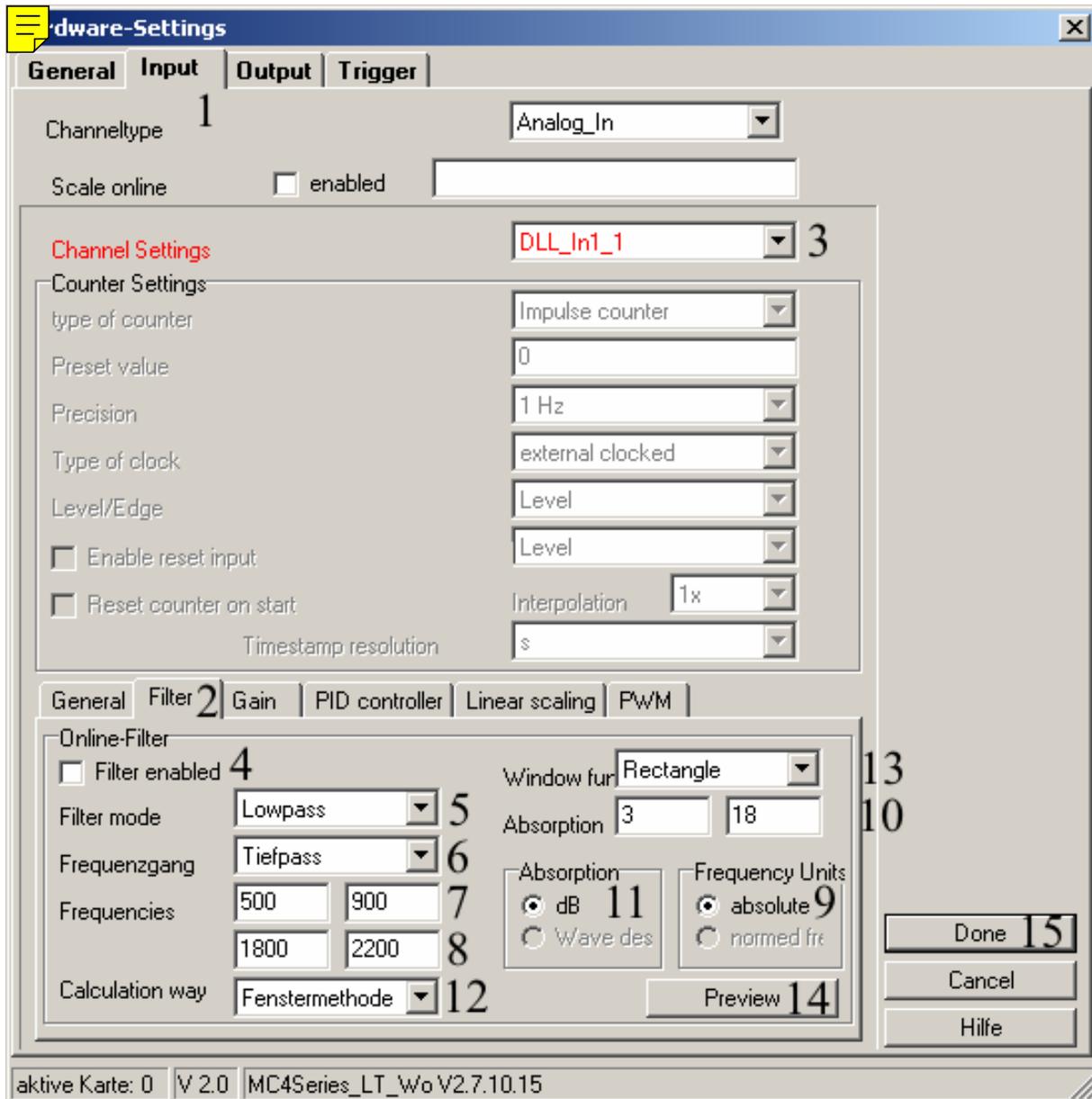
To decide, advantages and disadvantages have to be weighted.

The following table is intended to make the decision easier:

FIR Filter		IIR Filter	
Advantages	Disadvantages	Advantages	Disadvantages
Stable operation			Stable operation not under any conditions, necessity to check stability
constant (linear) group delay			variable (nonlinear) group delay
Output signal is not altered			Output signal is altered
	Finite pulse response therefore oscillations at discontinuities	Infinite pulse response therefore no oscillations at discontinuities	
	Higher order necessary for fulfilling the tolerance scheme as compared to IIR	Lower order to fulfill tolerance scheme as compared to FIR	
	Big group delays and big calculation efforts	Less group delays and less calculation efforts	

Table 10.1: Comparing advantages and disadvantages of FIR and IIR filters

## 10.9 Settings for Digital Filters in DIAdem



Picture

10.8: Filter Dialog box in DIAdem

To activate and configure filters you have to click on „Device..“. The dialog box which then appears contains the possible settings seen in the upper part.

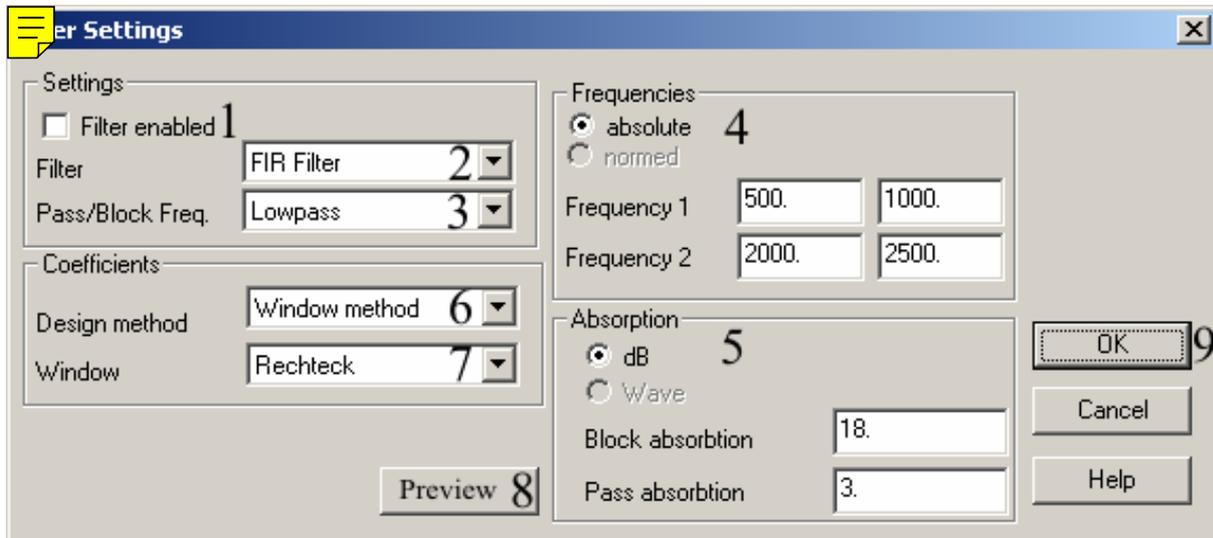
1. At this tab the inputs are configured.
2. Here are the settings for the filters of a channel located which is selected under (3). The settings on this page can be configured individually for each of the channels.
3. This is used to select the channel to be configured. After configuring the channel the next can be selected immediately.

4. Here you can specify for the channel selected under (3) if the sampled values of this channel have to undergo a filtering process.
5. Selection of the filter structure (recursive IIR or no recursive FIR filter). The structure selected here has influence to the meaning and the entries of other input fields.
6. Specifying of the filter type. Possible settings: Low pass, high pass, band pass, band stop
7. Border frequencies of the 1st edge of the filter. To the left the lower, to the right the upper border frequency of the edge.  
The entries are necessary for high and low passes. For this types the second edge is ignored.
8. Border frequencies of the second filter edge. To the left the lower, to the right the upper border frequency of the edge.  
These entries are necessary for band pass and band stop only.
9. Frequencies can be input in absolute (in Hz) or in standardized form. Standardized frequencies offer the advantage that the sampling rate has not to be taken into consideration. Absolute frequency values can be converted to standardized ones if the sampling rate is known. The sample frequency is taken over of the block clock while configuring “absolute” frequencies.
10. The values for absorption in the pass through and the stop range can be input here. To the left you will find the pass through absorption, to the right the block absorption. The value of the Block absorption has to be bigger than the one for the pass trough absorption.
11. Absorptions can be specified as allowed ripple (wave) also. The conversion is achieved internally. Here it has to be specified if the input value has to be interpreted as absorption or as ripple .
12. Here the type of acquisition is specified. At this place it has to be distinguished which filter structure was selected under (5). Advantages, disadvantages and special features are discussed above.  

FIR-Filter	window method, frequency sampling, Remez method, window function
IIR-Filter	Butterworth, Tschebyscheff 1, Tschebyscheff 2, Cauer
13. This field serves to select the window function which has to be used to validate the coefficients to minimize the ripple at the edges of the filter. This option is available for FIR filters only.
14. Clicking on this field opens a window in which frequency response and group delays of the filter are displayed. So the user can see the properties of the defined filter at a glance.
15. If any parameters are set for any of the channels the configuration window can be closed here.

### 10.10 Settings for Digital Filters and DASyLab

With DASyLab digital filters are supported with the Expansion Toolkit only.



Picture 10.9: Input mask for filters with DASyLab

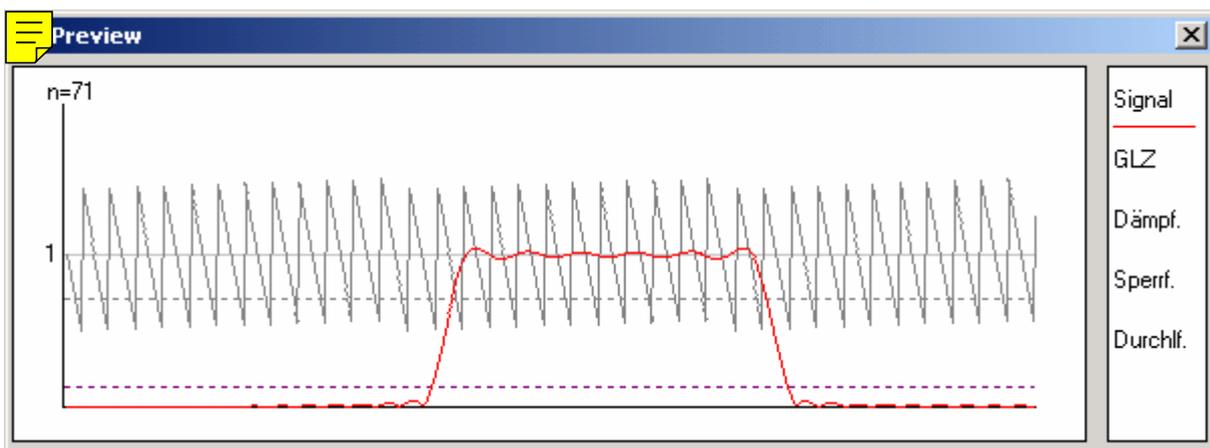
This dialog box is opened by clicking on the field „Filter Settings“ within the configuration dialog of the selected block.

1. Here you can specify for the selected channel if the sampled values of this channel have to be filtered.
2. Selection of filter structures (recursive IIR or nonrecursive FIR filter). The structure selected here has influence to the meaning and the entries of other input fields.
3. Specifying of the filter type. Possible settings: Low pass, high pass, band pass, band stop.
4. Frequencies can be input in absolute (in Hz) or in standardized form. Standardized frequencies offer the advantage that the sampling rate has not to be taken into consideration. Absolute frequency values can be converted to standardized ones if the sampling rate is known. The sample frequency is taken over of the block clock while configuring “absolute” frequencies. Here the border frequencies for the 1<sup>st</sup> and the 2<sup>nd</sup> edge of the filter are input.  
To the left the lower, to the right the upper border frequency of the edge is specified.  
The entries are necessary for high and low passes only. For these types the second edge is ignored. For band passes and band stops it is necessary to specify the values of the 2nd edge also.
5. Absorptions can be specified as allowed ripple (wave) also. The conversion is achieved internally. Here it has to be specified if the input value has to be interpreted as absorption or as ripple. The values for absorption in the pass through and the stop range can be input here. The value of the block absorption has to be bigger than the one for the pass through absorption.

6. Specify here the used designing process. It has to be distinguished here what kind of filter structure was selected under (5). Advantages, disadvantages and special features are discussed above.
 

FIR-Filter	window method, frequency sampling, Remez method, window function
IIR-Filter	Butterworth, Tschebyscheff 1, Tschebyscheff 2, Cauer
7. This field serves to select the window function which has to be used to validate the coefficients to minimize the ripple at the edges of the filter.  
This option is available for FIR filters only.
8. Clicking on this field opens a window in which frequency response and group delays of the filter are displayed. So the user can see the properties of the defined filter at a glance.
9. If any parameters are set for any of the channels the configuration window can be closed here.

The drivers of the commonly used measuring programs offer previews for the signals so the filter coefficients can be displayed graphically:



### 10.11 Performance Data of FIR Filters

Number of coefficients at constant averaged sample rate

No. channels	Sample Freq.	Averaged Sample Rt	Border freq.		Width in %	Absorptions		Order per ch.	Coefficients			Ratio no./channel		
			Freq1	Freq2		Ad	As		per ch.	Total	30 / 10	30 / 20	20 / 10	
1	30000	30000	4000	4049	0,16	3	22	600	601	601	0,3157	0,6583		
2	15000	30000	2000	2049	0,33	3	37	620	621	1242	0,3176	0,6509		
4	7500	30000	2000	2020	0,27	3	31	603	604	2416	0,3146	0,6474		
10	3000	30000	500	510	0,33	3	37	608	609	6090	0,3117	0,6692		

1	10000	10000	1000	1011	0,11	3	38	1903	1904	1904	3,1681			2,0854
2	5000	10000	500	505	0,10	3	36	1954	1955	3910	3,1481			2,0493
4	2500	10000	250	253	0,12	3	41	1919	1920	7680	3,1788			2,0579
10	1000	10000	125	126	0,10	3	36	1953	1954	19540	3,2085			2,1473

1	20000	20000	2000	2022	0,11	3	38	912	913	913		1,5191	0,4795
2	10000	20000	1000	1011	0,11	3	23	953	954	1908		1,5362	0,4880
4	5000	20000	500	506	0,12	3	24	932	933	3732		1,5447	0,4859
10	2000	20000	200	202	0,10	3	21	909	910	9100		1,4943	0,4657

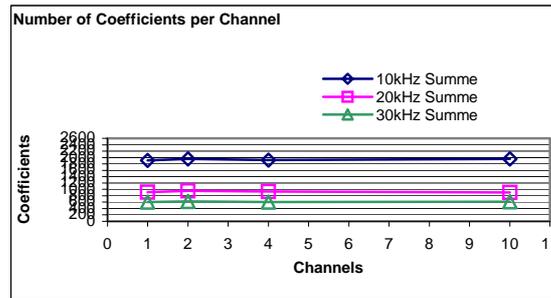
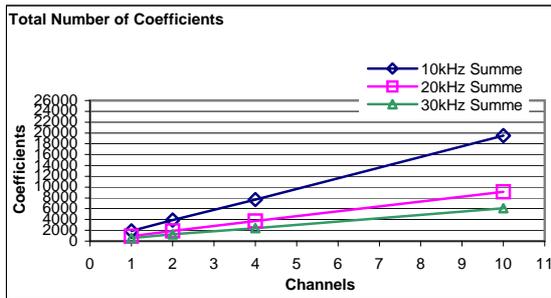


Table 10.2: Comparing the possible number of coefficients with the accumulated sampling rate

## 11 Technical Data of RogaDAQ16 USB

### 11.1 Signal Processor Type RogaDAQ16

Motorola	DSP56311GW150 with internal filtering coprocessor
Clock frequency	150 MHz
Cycle time	7.5 ns, 255 MIPS
RAM	DSP56311 1.5MByte
Flash memory	512KByte

### 11.2 Analog Inputs

Converter type	AD7665AST
Number of inputs	16
Resolution	16 Bit
Input voltage ranges	$\pm 0.125V, \pm 1.25V, \pm 2.5V, \pm 5V, \pm 10V$ 0-0.125V, 0-1.25V, 0-2.5V, 0-5V, 0-10V
Gain	1/2/4/8 & + 20 dB
ADC sample rate	500 kHz single channel, 400 kHz multichannel
Precision of system	0.009% = 1,8mV 0.0025% = 0,5mV 16x oversampling
ADC conversion time	2 $\mu$ s
Impedance of input	1 G $\Omega$ , 30 pF
Maximum input voltage in operation	$\pm 35 V$
Maximum input current non operating	$\pm 35 V$
Bias current	$\pm 40 nA$
Non linearity	$\pm 3$ LSB 16x oversampling $\pm 1,5$
Digitalization error	$\pm 3$ LSB 16x oversampling $\pm 1,5$
Quantification error	$< \pm 1$ LSB
Range error	adjustable
Zero error	adjustable
ADC bias drift	$\pm 7$ ppm / $^{\circ}C$
Monotonicity	$\pm 1.5$ LSB

### 11.3 Analog Outputs: DAC Converter DAC7734)

Number of outputs	4
Resolution	16 bits
Outputs voltage ranges	0-10V, ±10 V
DAC sample rate	200 kHz (4 channels)
Output current	±5 mA
Output impedance	0.2 Ω
Non linearity	< ±3 LSB
Range error	< ±0.1 %, typ.
Zero error	< ±0.1 %, typ.
Settling time up to 0.012 % FSR	5 μs, 20V step
Slew rate	10 V / μs
Zero drift	±5 ppm / °C, typ.
Range drift	±5 ppm / °C, typ.
Monotonicity	guaranteed

### 11.4 Timer

Component	ACEX
Number of counters	1 (2)
Counter modes	Event counting, Frequency measurement (Frequency resolution 1/10/100/1000Hz) Pulse width and period length measurement resolution 100ns
Measuring with an incremental encoder 1x,2.4x Interpolation w. zero position detection	Resolution 24 Bit time stamp 16 Bit
SSI Interface	programmable 8 to 24 Bit
Logic High Input Voltage	2.2 V
Logic Low Input Voltage	0.8 V
Logic Input Current	±10 μA
Logic High Output Voltage	2.4 V min.
Logic Low Output Voltage	0.4 V max.
Logic High Output Current	-15 mA max.
Logic Low Output Current	24 mA max.
External input frequency	10 MHz max.
Resolution 24 Bit	programmable

### 11.5 Digital Inputs/Outputs

Number of inputs	24 (switchable in four bit groups) switchable bit by bit
Logic Family	LVC MOS
Logic Sense	High
Logic High Input Voltage	2.0 V
Logic Low Input Voltage	0.8 V
Logic High Input Current	0.5 $\mu$ A
Logic Low Input Current	0.1 $\mu$ A
Logic High Output Voltage	3.1 V min.
Logic Low Output Voltage	0.1 V max.
Logic High Output Current	-2.5 mA
Logic Low Output Current	2.5 mA
Termination	None
Throughput	20 MHz
Maximum input voltage in operation	+5 V

### 11.6 External Trigger and Counter

Input mode	Logic High
Logic Family	CMOS
Maximum input voltage in operation	+5 V
Logic High Input Voltage	2.5 V
Logic Low Input Voltage	0.8 V
Logic High Input Current	1 mA
Logic Low Input Current	-0.1 $\mu$ A
Min. Pulse Width High	100 ns
Min. Pulse Width Low	100 ns
Max. Pulse Width	to $\infty$

### 11.7 PWM Output

Number of PWM outputs	1
Logic Family	LVC MOS
Logic High Output Voltage	3.1 V min.
Logic Low Output Voltage	0.1 V max.
Logic High Output Current	-2.5 mA
Logic Low Output Current	2.5 mA
Frequency range	2Hz –2500 kHz adjustable in 100ns steps

### 11.8 Miscellaneous

Power supply	+5 V; 1500 mA max. as conversion via USB, 100V – 230VAC/ 5V DC adapter
Weight	app. 2 kg
Operating temperature range	0 to 70° C
Connector	Phoenix MDSTB(digital), MSTBA(analog), BNC(analog)
Storage temperature range	-40 to 85° C
Humidity	95 %, non condensing
Dimensions	100 mm x 160 mm
Bus interface	USB 2.0, USB 1.2 compatible

## **12 CE Conformance and FCC Rules**

### CE

This device was tested and found to comply in practical operation with the protection requirements of council directives (89/336/EEG) relating to safety and electromagnetic compatibility according to the standards EN 55022, and EN61000-3.

### FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules.

### CE and FCC

These limits are designed to provide reasonable protection against interference in a residential area. This device generates and uses radio frequency energy and if not installed and used in accordance with the instructions, it may cause interference to radio or TV reception. If this unit does cause interference with TV or radio reception, you can try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the radio or TV receiver.
- Plug the equipment into a different wall outlet so that it is not on the same circuit as the radio or TV receiver.
- Consult the dealer or an experienced radio/TV technician for help.
- To ensure that the use of this product does not contribute to interference, and to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules, it is necessary to use shielded I/O cables.

### **Important**

The Federal Communications Commission points out expressively that changes or modifications to this equipment not expressly approved by the authority for compliance could void the user's authority to operate this equipment.

## **13 Disclaimer (Technical Changes)**

### **Important**

Any changes made to the software or the hardware of the device which are not approved with the written consent of „ROGA-Instruments“ will not only void the warranty. This can also void the user's authority to operate the device. ROGA-Instruments is not liable by any means according to consequences which may arise of such changes.

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