Automotive
Energy & Power Analysis
Aerospace & Defense
Transportation
General Test & Measurement

DEWE-ORION-0424-200

Technical reference manual

TÜV BAYERN UM-System EN ISO 14001 zertifiziert Landesges. Österreich

TÜV CERT ISO 9001

ISO9001

Test & Measurement Solutions

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DEWETRON

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Indicates hazardous voltages.

WARNING	*Calls attention to a procedure, practice, or condition that could cause bodily injury or death.*

CAUTION	*Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.*

WARNINGS

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. DEWETRON Elektronische Messgeraete Ges.m.b.H. assumes no liability for the customer’s failure to comply with these requirements.

All accessories shown in this document are available as option and will not be shipped as standard parts.

Safety instructions for all DEWETRON DAQ boards

- The DEWETRON data acquisition boards may only be installed by experts.
- Read your manual before operating the board.
- Observe local laws when using the board.
- DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.
- DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to a DEWETRON sales and service office for service and repair to ensure that safety features are maintained.
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- Don’t use higher supply voltage than specified!
- Use only original plugs and cables for harnessing.
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- Using the board for medical applications only at owner’s risk

General System Information

Environmental Considerations

Information about the environmental impact of the product.

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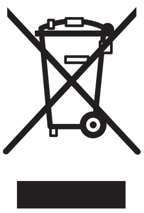
System and Components Recycling

Production of this components required the extraction and use of natural resources. The substances contained in the system could be harmful to your health and to the environment if the system is improperly handled at it's end of life! Please recycle this product in an appropriate way to avoid an unnecessary pollution of the environment and to keep natural resources.



This symbol indicates that this system complies with the European Union’s requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). Please find further informations about recycling on the DEWETRON web site www.dewetron.com

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive. This product is known to contain lead.

1 Introduction

1.1 Key features

- 4 simultaneous sampled channels
- 204.8 kS/s per channel
- 24-bit resolution
- Anti-aliasing filter
- High dynamic range 108 dB
- 4 input ranges (from ±0.1 V to ±10 V)
- Voltage or ICP® mode (4 mA or 8 mA source)
- Input coupling DC or AC (0.15 Hz or 3.4 Hz)
- Input configuration differential or single-ended
- TEDS (IEEE 1451) sensor support
- Direct support of ICP® sensors
- 32-bit counter/encoder with programmable trigger levels

1.2 How to use the manual

- In Chapter one you find an overview about the card-types and possibilities of configurations.
- Chapter two explains how to install the card and connect the sensors.
- The ADC conversion and the counter-functions are described in chapter three.
- All specifications are listed in chapter four.

1.3 Overview

The DEWE-ORION-0424-200 combines high resolution (24-bit) with high speed (204.8 kS/s per channel) and high accuracy (typically 0.002 dB inter channel gain mismatch). In addition each channel has an anti-aliasing filter which is automatically set to the half of the sample frequency. This can be reached with an internal oversampling of the ADC of up to 256 times. That means if the sample frequency is set to 50 kHz, the ADC converts data with 12.8 MHz! Due to the multiple board synchronisation features it is possible to install up to 8 DEWE-ORION-0424-200 boards in one system working absolutely synchronous.

The analog input range can be set independently to 0.1 V, 0.5 V, 2 V and 10 V. A highpass filter with 0.15 Hz or 3.4 Hz, a DC current source with 4 mA or 8 mA as well as TEDS sensor support is on board. The advanced counter input has adjustable trigger levels from 0 to 40 V (with 100 V over voltage protection) with settable AC/DC coupling. The measurement can be started with an external trigger input.

Model	Analog input channels	Max. sampling rate / channel	Digital input channels	Digital I/O	Ext. Clock	Ext. Trigger	Counter Encoder TTL	Counter Encoder ADJ	CAN
DEWE-ORION-0424-200	4	204.8 kS/s	-	-	-	1	-	1	-

1.4 Requirements for using the DEWE-ORION-0424-200

To install and use the DEWE-ORION-0424-200 device you need:

- PC with one free PCI slot
- WINDOWS 2000 or XP operating system
- DEWE-ORION-0424-200 board
- DEWE-ORION-0424-200 Technical Reference Manual
  (shipped with the board or available on www.dewetron.com or ftp.dewetron.com)
- Device driver (shipped with the board)

Recommended options (not shipped with the board):

- Signal connection (e.g. BNC connector box ORION-CB16-BNC)
- DEWESoft 6.6.3 (or higher) or other application software

1.5 Unpacking

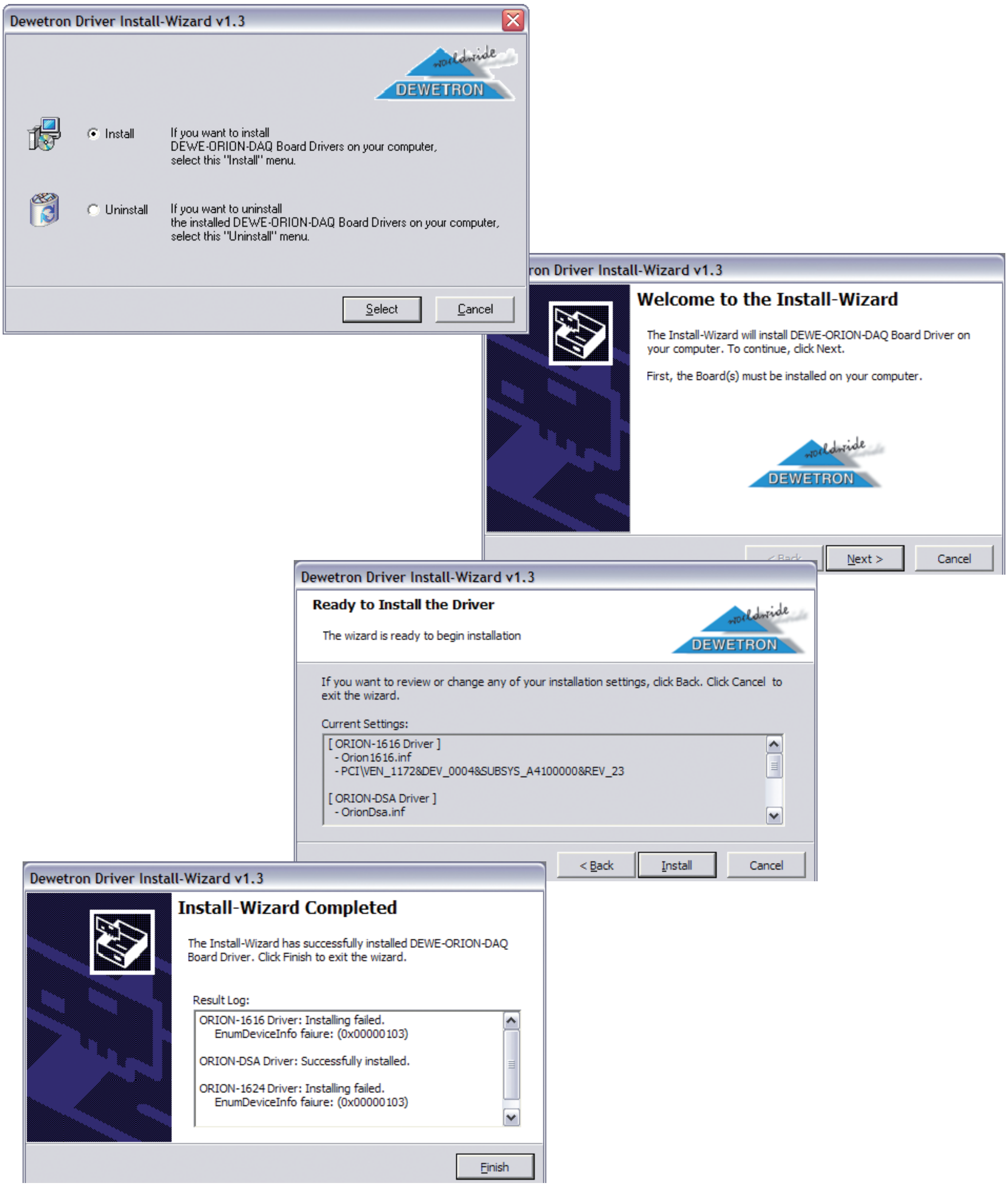
Transport and store the DEWE-ORION-0424-200 in the antistatic plastic package (ESD packaging), where it was originally packed in. Otherwise the device may be damaged by electrostatic discharge. The unpacking and the mounting in your computer should be done in an electrostatic protected area. Don’t touch the exposed pins of the connectors! Inspect the device for loose components or other sign of damage before mounting it. Don’t install a damaged device into your computer.

2 Using DEWE-ORION-0424-200

2.1 Hardware installation

Shut down your computer and remove power. Install the board into your computer in correspondence with the instructions in your PC manual. When you have finished the hardware installation and boot up your computer, the operating system will alert that it found a new hardware. Cancel the windows hardware-driver wizard.

Insert the DEWE-System DVD shipped together with the board into your DVD drive (for example D:\) and start the following executable file: D:\Install\Drivers\6_DaqBoards\Dewetron\OrionDAQ\OrionSetup.exe. After the installation you have to reboot the system.

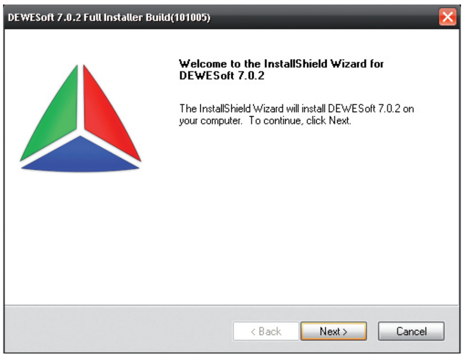


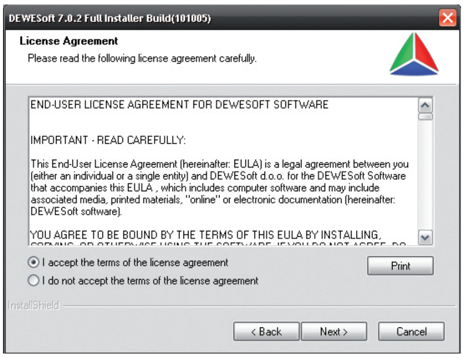
2.2 Software installation

2.2.1 DEWESoft installation

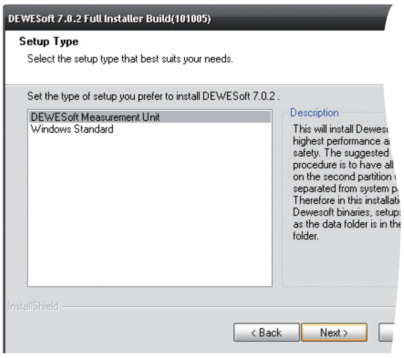
If the installation software doesn't start when you insert the DEWE-System DVD into the computer, start it manually by clicking on the ***ShelExec.exe*** file on the DVD or navigate to *"HTML"* and start the ***index.html***. Follow the instructions of the installer.

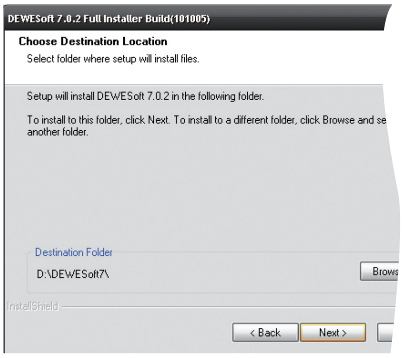
The install shield wizard will simplify the installing procedure.

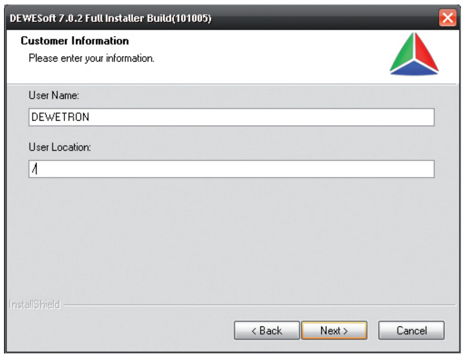




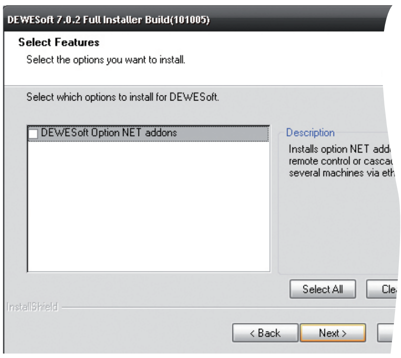
Select the needed options you want to install and enter your information.

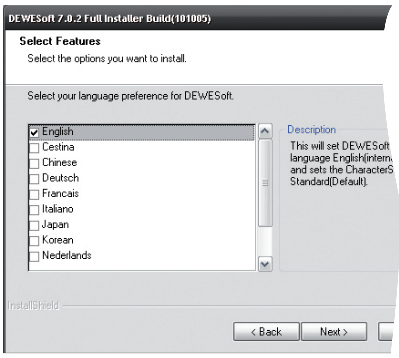


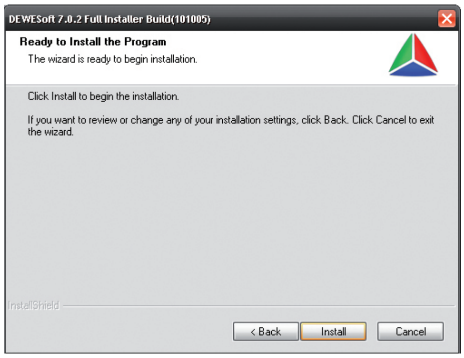


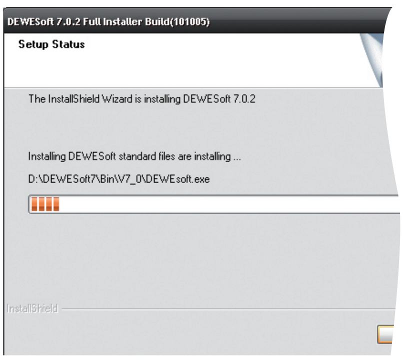


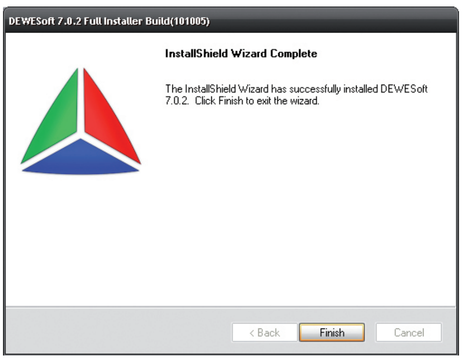
Select the features you want to install and start the installation.









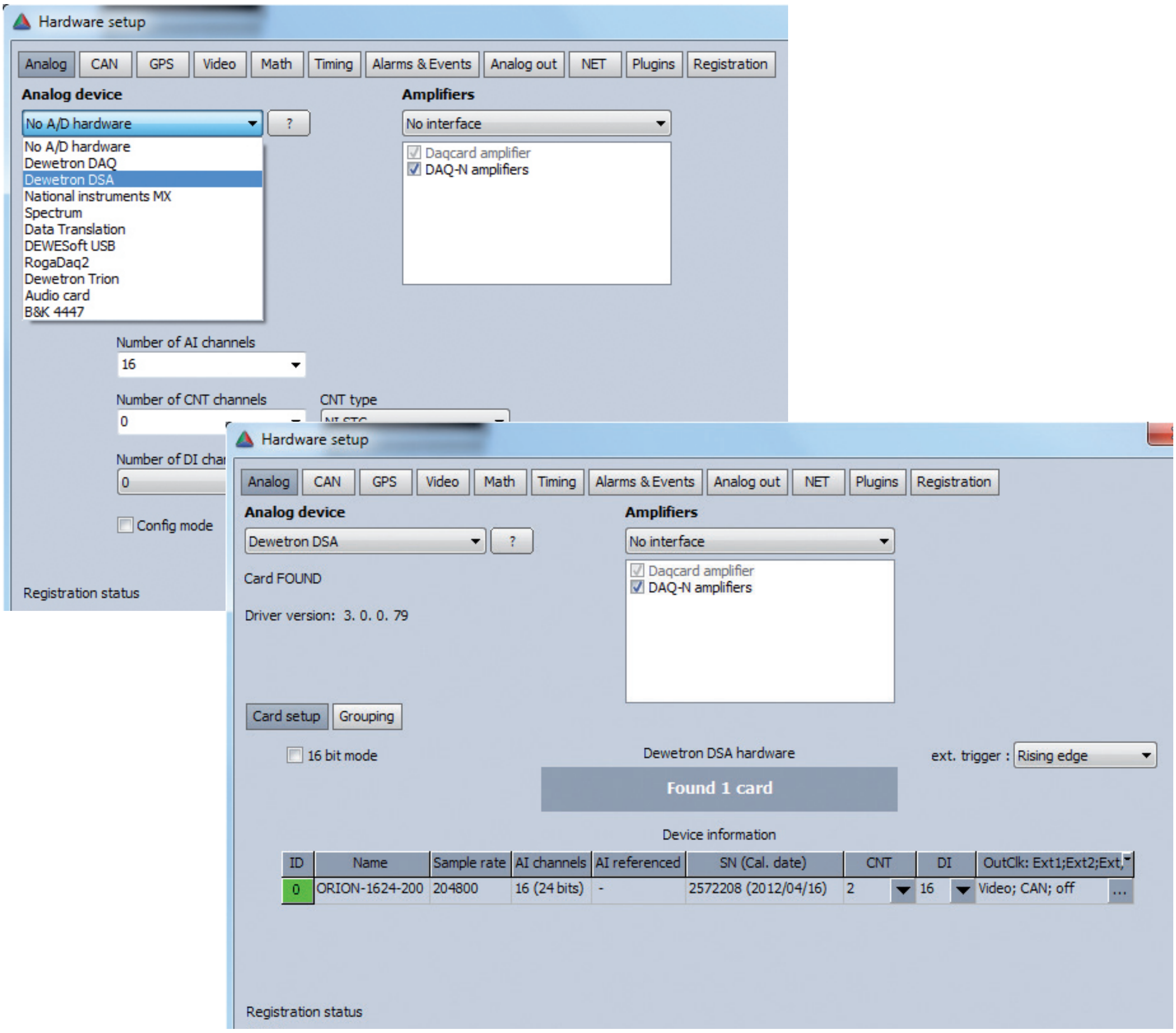


DEWE-ORION-0424-200

Now DEWESoft is installed on your computer. The software creates some directories on your harddisk.

You can start the software in the Windows start menu or use the icon created on your desktop. For more information about the DEWESoft installation please refer to the *DEWESoft Software Users Manual*.

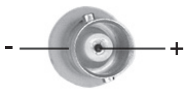
To modify the hardware settings, select System - Hardware setup in the menu. Select ***DEWETRON DSA*** as analog device.



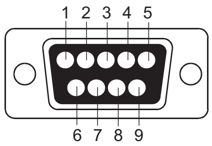
2.3 Connecting signals

2.3.1 Signal input

The four BNCs are used for connecting the analog input.



The 9-pin male SUB-D connector is prepared for the counter and the trigger input connection.

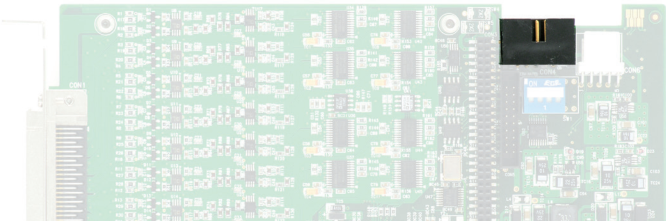


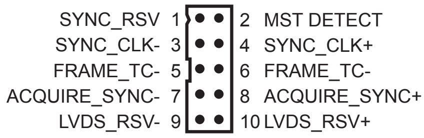
Pin assignment:

1.) CNT In-
2.) EXT_Trigger
3.) GND
4.) +5 V
5.) GND
6.) DI 0
7.) DI 1
8.) DI 2
9.) DI 3

2.3.2 Internal synchronisation connector

For multiple device operation the DEWE-ORION-0424-200 is equipped with an additional synchronization connector. Pin assignment of the on-board 10-pin Synch-connector:





10-pin connector male

2.4 Analog signals

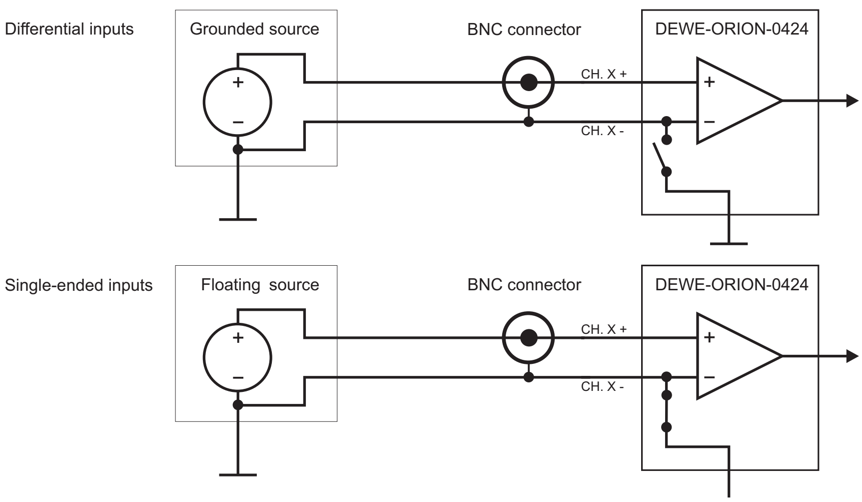
All 4 channels of the DEWE-ORION-0424-200 are fully differential inputs with 1 MOhm differential input resistance and each input with 60 pF to GND. But the inputs are setable via software to single-ended inputs where the minus input will be switched to GND. Then also two highpass filters with 0.15 and 3.4 Hz corner frequency are selectable. The input voltage range is selectable in 4 ranges with 0.1 V, 0.5 V, 2V and 10V. Because of the differential input structure, the difference of the input (Channel xx (+) - Channel xx (-)) will be shown as the result of the measurement. Although the input is protected for input voltages up to ±30 V, the common voltage range of each input is limited to ±10.5 V. If the input voltage exceeds this range, the result is not valid even when the difference input voltage is lower than 10 V. These voltage ranges will be clipped and introduced as large errors that can be easily identified in the frequency spectrum.

Examples:

V(+) = +10 V, V(-) = +5 V, voltage difference = 5 V, result is valid

V(+) = +15 V, V(-) = +10 V, voltage difference = 5 V, result is not valid (V+ will be clipped at +10.5 V!)

The differential input is ideal for grounded signal sources because the ground loop between signal source and input is eliminated automatically. When measuring floating input sources (batteries or isolated thermocouples) it is necessary to select the single-ended input structure by software.



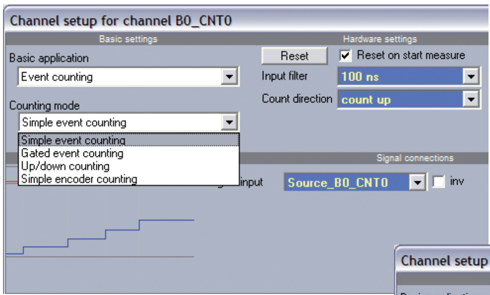
2.5 Counter

2.5.1 General functionality

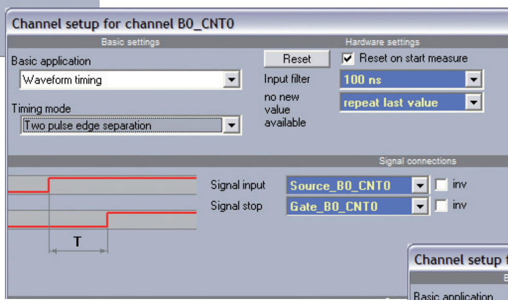
The DEWE-ORION-0424-200 is also suited with a synchronous 32-bit advanced counter. The flexible signal routing allows easy signal connection and the usage of the same input pin for all counter input functions. In addition to the basic counter function like simple event counting, up/down counting and gated event counting also period time, pulse width, two-edge separation, frequency and all encoder measurements are supported.

2.5.1.1 DEWESoft settings

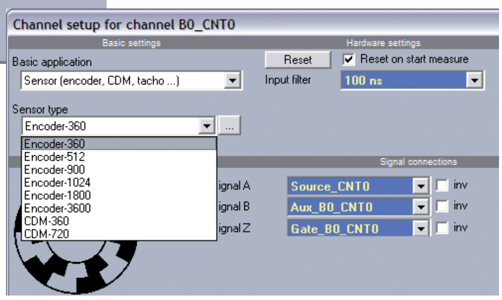
In Dewesoft there are three basically functions implemented:



Event counting



Waveform timing



Sensor

2.5.2 Counter structure

Figure 3 on the next page shows the principal of a counter block. Every counter channel consists basically of a main counter and a sub counter.

The main counter consists of 4 inputs. The input “Armed” is needed for starting and triggering the counter. The basic input of a counter is the source pin. The default usage of this input is event counting. In addition to the gated counting mode the “GATE” input is also the standard input for period measurement. The AUX input is for special functions like up/down counting or encoder measurement.

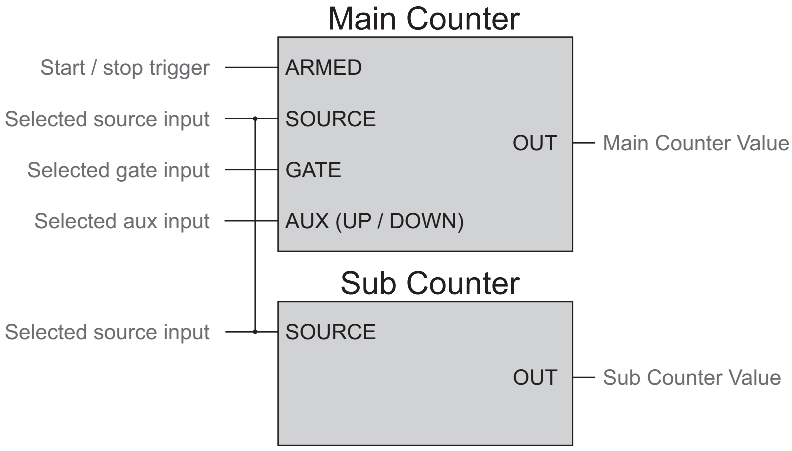


Figure 3: Counter functions

The sub counter is automatically switched on in the background if the measurement result needs principal two counters. For example measuring the duty cycle of an input signal needs the information of the period time and the pulse width for the calculation. Also for precise measurement the frequency of a signal synchronized to analog samples two counters are needed.

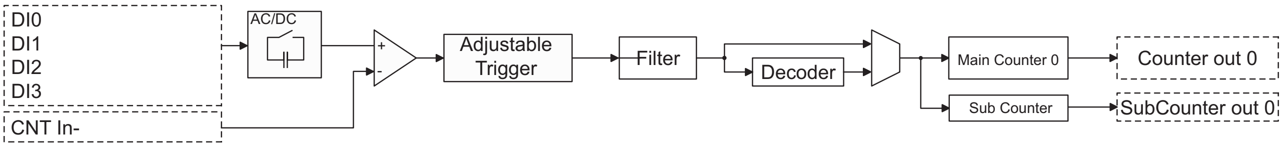
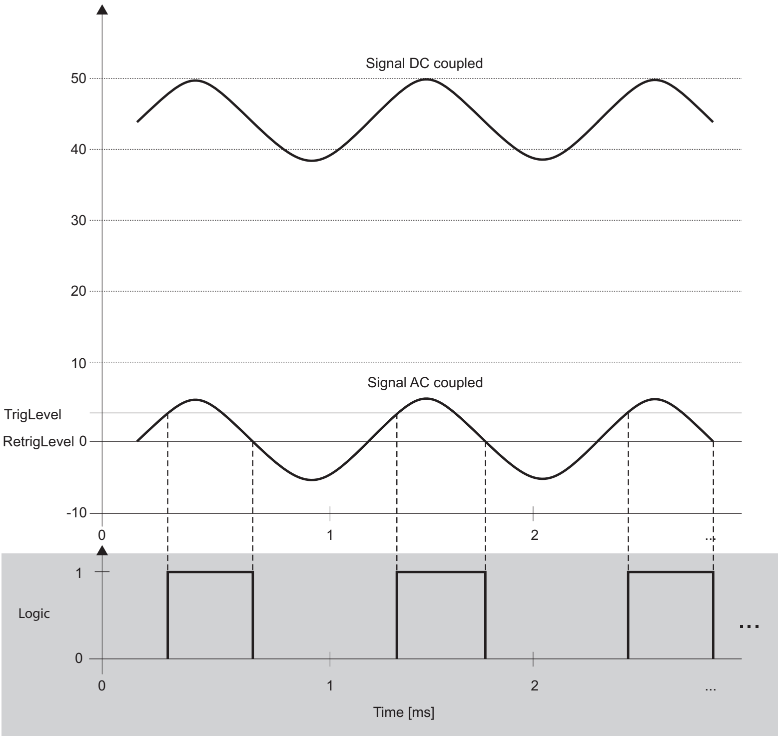


Figure 4: Basic counter organization

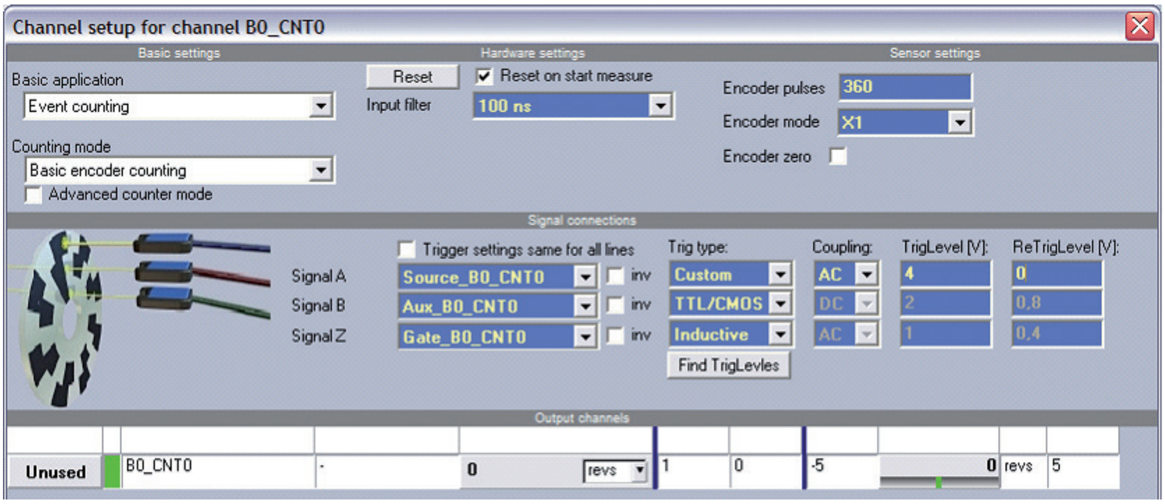
The DEWE-ORION-0424-200 provides high voltage differential inputs protected up to 100 Vpeak with a common minus input for each counter input signal. Furthermore a programmable trigger and re-trigger level of each input, from 0 to 40 V and a software selectable AC/DC coupling with 1 Hz cut off frequency, is included. All the counter functions are triggered with the rising edge of the input signal. If falling edge trigger is required the inputs can be simple inverted by software settings. To remove glitches at the input a digital filter between 100 nsec and 5 µsec within 7 steps in the filter block can be selected. The following block selects if the encoder mode is used or not.

With the adjustable counter it is possible to set the trigger level and the retrigger level between 0 and 40 V with a resolution of 40 mV. If the input signal exceeds the value of the trigger level the logical value will be "HIGH" and if the input signal falls below the retrigger level the logical value is "LOW". As an additional feature the input can be also set to AC coupling for removing the DC component of the input signal.

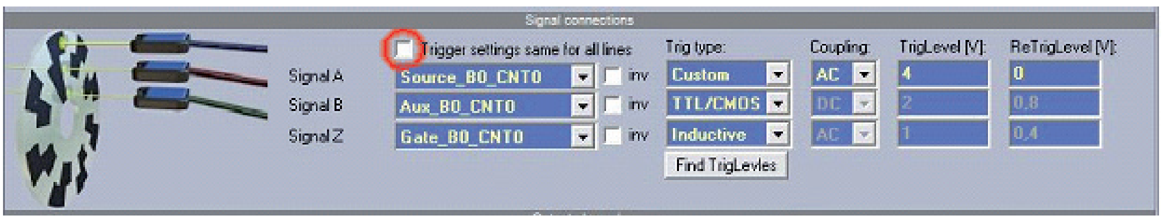
The diagram on the next page illustrates the functionality of the settable trigger levels.



The levels can be set for each input independent like shown on this page. Some common used levels are predefined (like TTL, inductive pick-up sensors…). Selecting “Custom” as the trigger type. All parameters are free definable.



If the sensor signal is not known, an automatic algorithm for finding the trigger levels is implemented. A sensor like the shown encoder has usually for all outputs the same signal level. Enabling “trigger settings same for all lines” sets automatically the same level to all used inputs.



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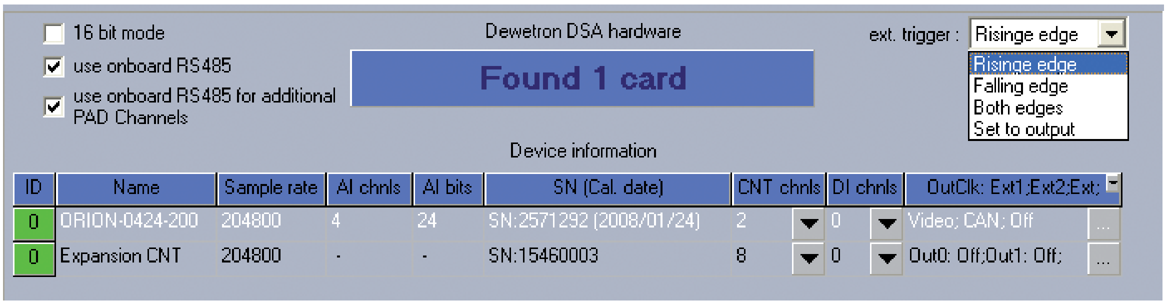
2.6 Trigger

The DEWE-ORION-0424-200 allows external triggering for start of the acquisition using the pin EXT_Trigger. The default detection for the trigger signal is the rising edge but can be configured to falling or both edge (change of input signal) detection. Changing the direction to output, the start of acquisition can be indicated.



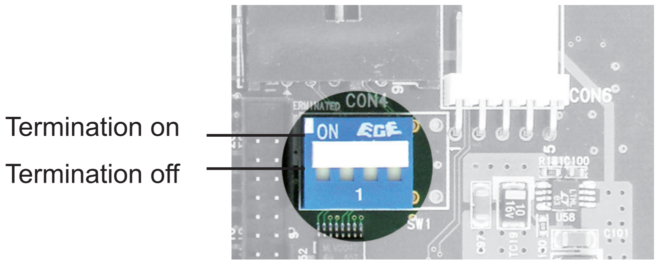
2.7 Synchronizing multiple devices

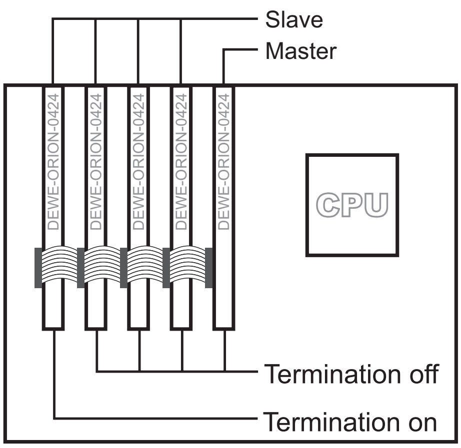
2.7.1 Internal synchronisation

For multiple device operation the DEWE-ORION-0424-200 is equipped with an additional synchronization connector. A standard 10-pin connector with 1.27 mm flat ribbon cable is available for easy connection between the boards. To reduce electromagnetic influences because of the very high frequency at this synchronization bus, IEEE 1394 compatible LVDS (low voltage difference signals) are used.

The LVDS interface is current-based. Therefore the last board has to be terminated. This can be done with a switch, positioned directly below the sync connector.

If you use only one DEWE-ORION-0424-200 in your system, the board has to be terminated.



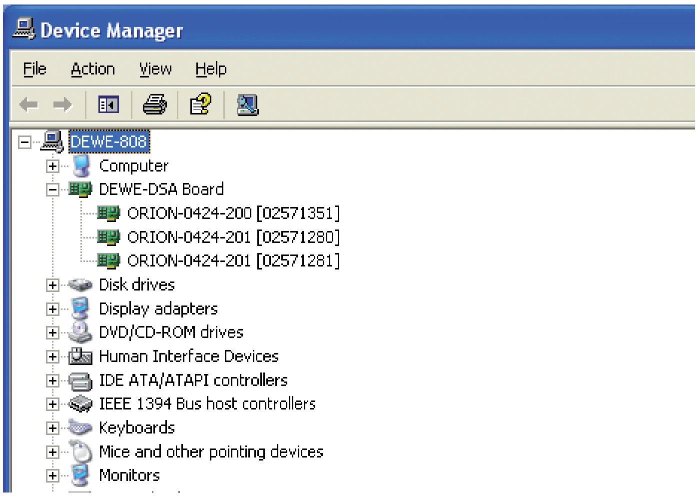


2.7.2 Defining the board order

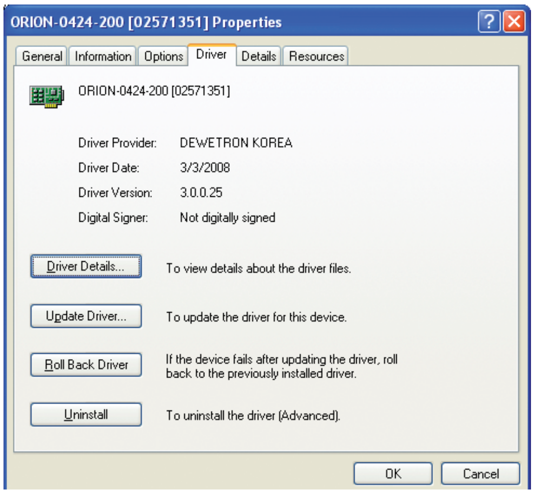
In multiple boards application the location of each single board has to be known. This is required to get the correct channel mapping at the application software. The PCI bus structure does not allow a guaranteed board allocation. However, the whole PCI-bus in a PC system is organized in bus and device numbers. The combination of both numbers is unique inside a PCI-bus based system.

By default the DEWE-ORION-0424-200 device driver orders the board beginning with the lowest PCI-bus No. and lowest device number to increasing device No. and PCI-bus No ...

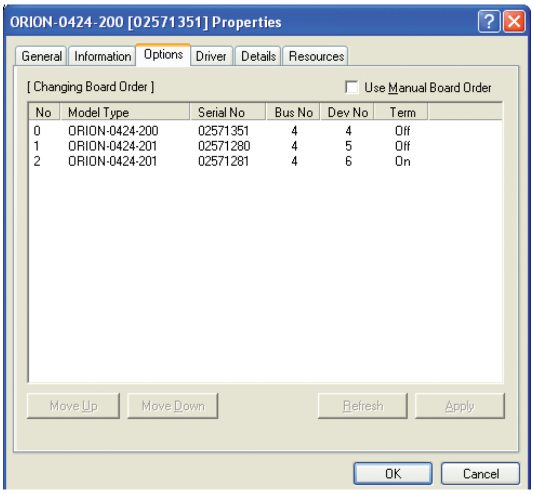
If the system configuration needs to be changed, please modify the settings shown in the next screens. Get this window at Start > Settings > Control Panel > System > Hardware > Device Manager



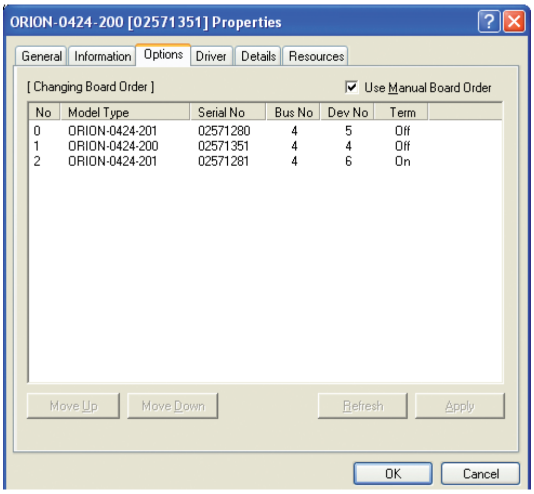
Device manager



Click on "driver details" to get the next screen



Info screen



ORION cards in manual sorted order

The order can be changed by clicking on the name of the board and moving it with the move up/down buttons. Please note that the settings are taken only after clicking the button <Apply>. A click on the <Refresh> button shows the actual settings.

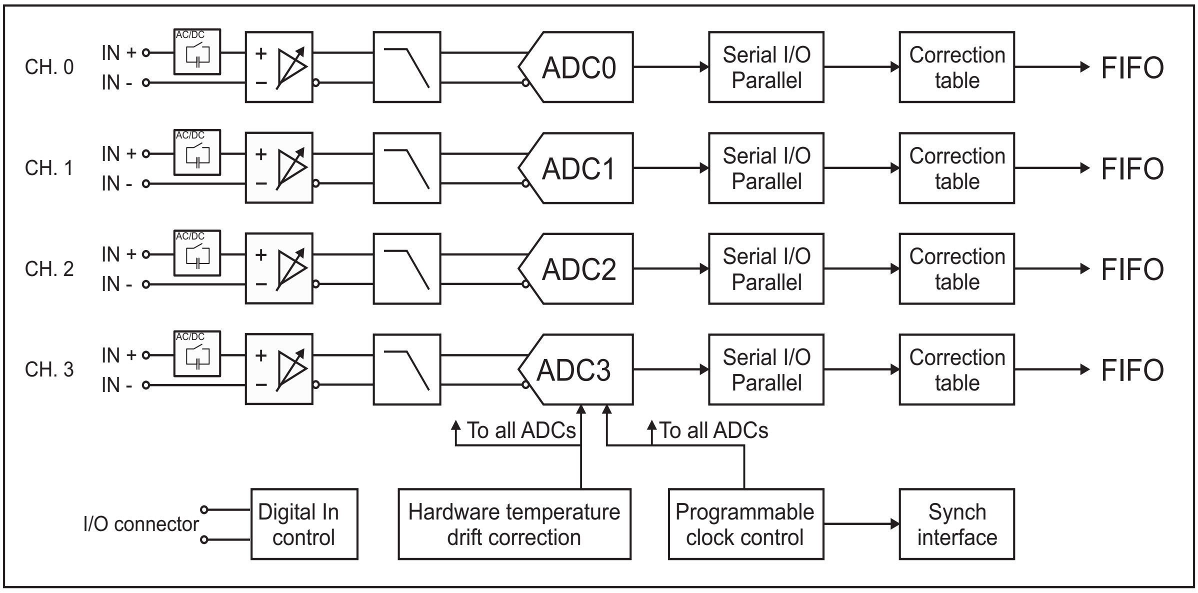
Notes

2.8 Theory of operation

2.8.1 Analog Input

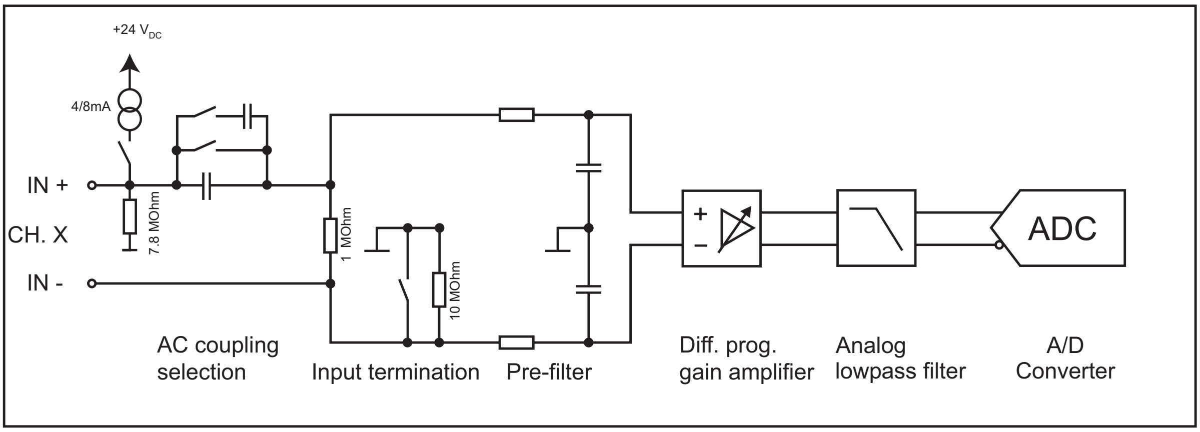
2.8.1.1 Functional overview

The analog function block diagram below shows the signal processing of the DEWE-ORION-0824-200.

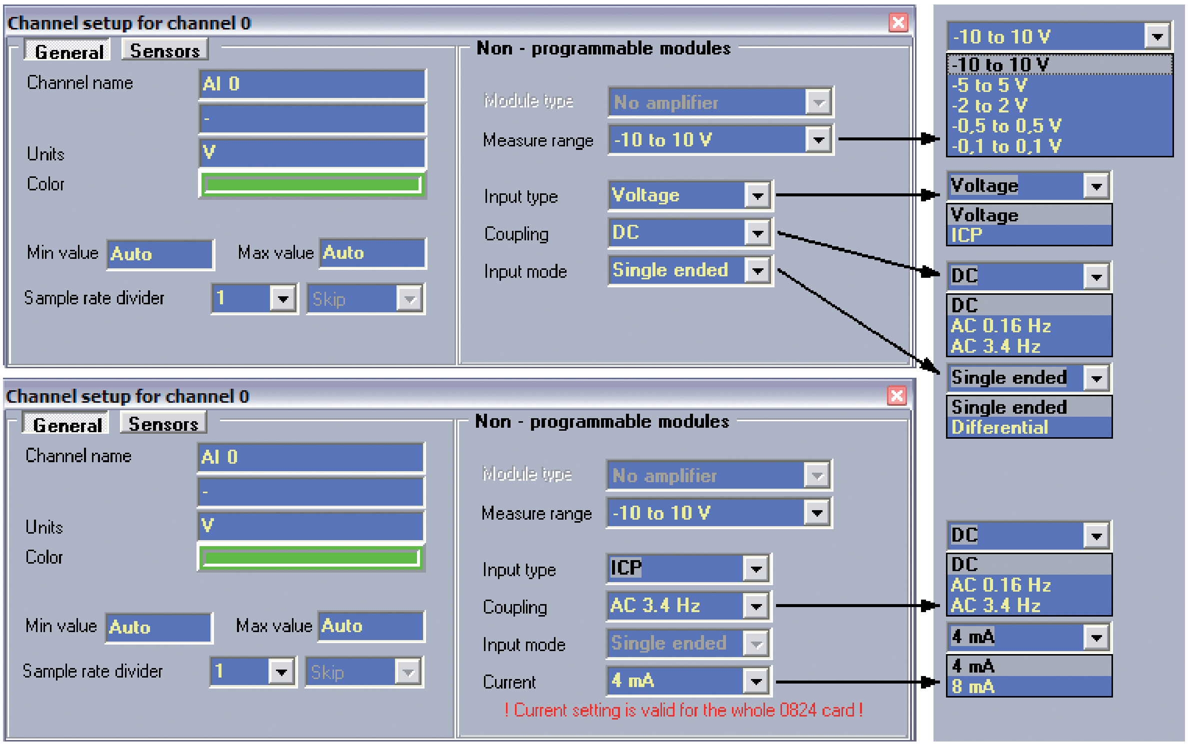


2.8.1.2 Analog input configuration

Block diagram for one of the 4 identical DEWE-ORION-0424-200 analog inputs.



The high input impedance (10 MOhm ground referenced) has no distortion influence to the measured signals. 24-bit resolution and software-programmable rates up to 204.8 kS/s allow high performance data acquisition.



Amplifier setup in DEWESoft

2.8.1.3 Analog to digital conversion

The DEWE-ORION-0424-200 uses 4 delta-sigma A/D converters. If you sample with a data rate of 102.4 kS/s, the ADC actually samples the input signal with 13.1072 MS/s (multiply the data rate with 128) and produces 1-bit samples which are applied to the digital filter. The filter expands the data to 24-bits and rejects signal parts greater than 51.2 kHz (Nyquist frequency). It also re-samples the data to the more conventional rate of 102.4 kS/s.

A 1-bit quantizer introduces many quantization errors to the signal. The 1-bit, 13.1072 MS/s from the ADC carry all information to produce 24-bit samples at 102.4 kS/s. The delta-sigma ADC converts from high speed to high resolution by adding much random noise to the signal. In this way the resulting quantization noise is restricted to frequencies above 100 kHz. This noise is not correlated with the useful signal and is rejected by the digital filter.

2.8.1.4 Anti-alias filter

ADCs can only represent signals of a limited bandwidth. The maximum frequency you can represent is the half of the sampling rate. This maximum frequency is also called Nyquist frequency. The bandwidth between 0 Hz and the Nyquist frequency is called Nyquist bandwidth. Signals exceeding this frequency range can not be converted correctly by the sampler.

For example, the sample rate is 1000 S/s, the Nyquist frequency is 500 Hz. If the input signal is a 375 Hz sine wave, the resulting samples represent a 375 Hz sine wave. If a 625 Hz sine wave is sampled, the resulting samples represent a 375 Hz sine wave too. This happens because signals exceeds the Nyquist frequency (500 Hz). The represented frequency of the sine wave is the absolute value of the difference between the input frequency and the closest integer multiple of the sampling rate (in this case 1000 Hz).

Some examples:

Input sine wave 2280 Hz, sampling frequency 1000 Hz: 2280 - 2 * 1000 = 280 Hz

Input sine wave 3890 Hz, sampling frequency 1000 Hz: 4 * 1000 - 3890 = 110 Hz

When the sampler modulates frequencies out of the Nyquist bandwidth back to the 0 to 500 Hz baseband it is called aliasing. Signals which are not pure sine wave can have many components (harmonics) above the Nyquist frequency. These harmonics are erroneously aliased back to the baseband, added to parts of the accurately sampled signal and produces a distorted data set. To block frequencies out of the Nyquist bandwidth, a lowpass filter is applied to the signal before it reaches the sampler.

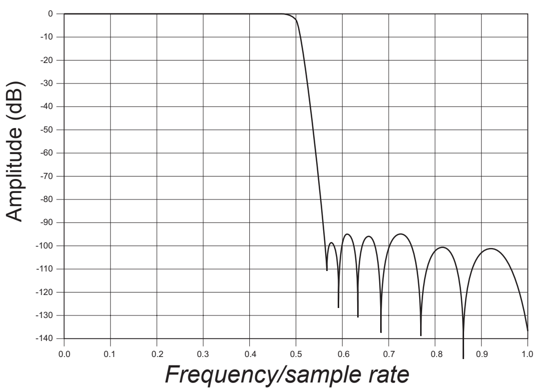
Each input channel has its two pole anti-alias lowpass filter with a cutoff frequency of about 250 kHz. The very high cutoff frequency allows an extremely flat frequency response in the bandwidth of interest and a small phase error. The analog filter precedes the analog sampler. The analog sampler operates at 256 times the selected sample rate for rates below 51.2 kS/s, 128 times for rates between 51.2 kS/s and 102.4 kS/s. For rates over 102.4 kS/s the oversampling is 64 times. That means, the ADC operates at 13.1072 MS/s if you select a sample rate of 102.4 kS/s (128 * 102.4 kS/s).

The 1-bit oversampled data is passed to a digital anti-aliasing filter. This filter has no phase error and an extremely flat frequency response. It also has an extremely sharp roll-off near the cutoff frequency (0.38 to 0.494 times the sample rate) and the rejection above 0.5465 times the sample rate is greater than 92 dB. The output stage of the digital filter resamples higher frequencies to 24-bit samples.

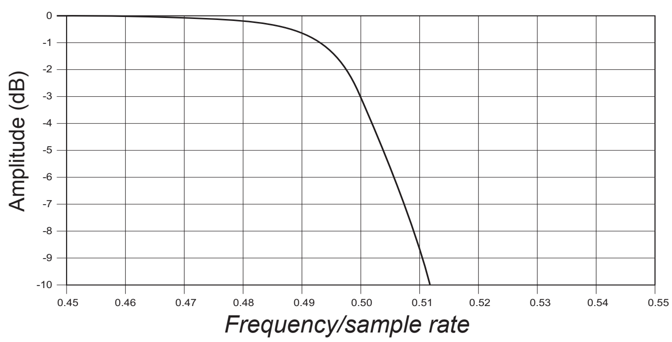
The digital filter passes only signal components within the Nyquist bandwidth or within the Nyquist bandwidth at 64, 128 or 256 times (depending on sampling rate) the sample rate and multiples of it. The analog filter rejects most noise near these multiples. The following diagrams show the frequency response of the input circuitry.

Sample rate 1 kS/s to 51.2 kS/s

Input frequency response

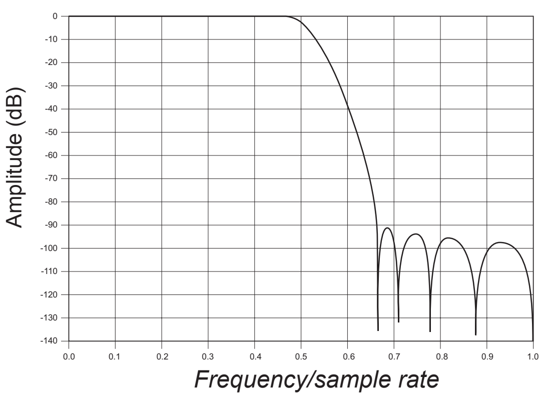


Input frequency response near the cutoff

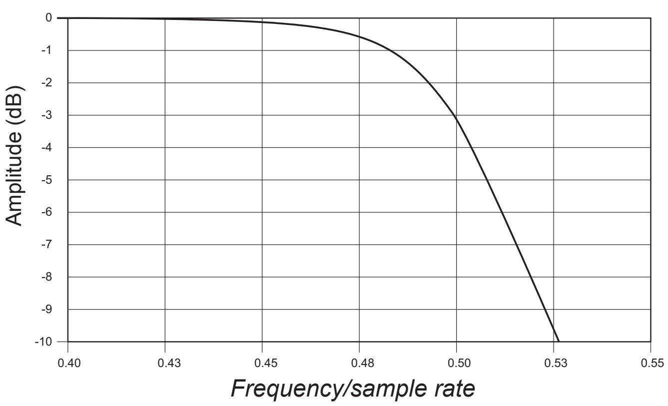


Sample rate 51.2 kS/s to 102.4 kS/s

Input frequency response

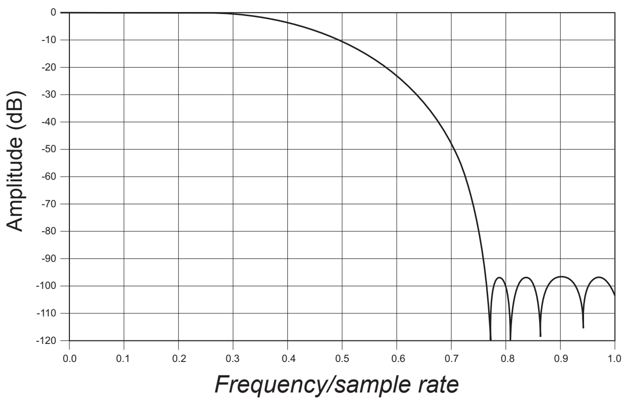


Input frequency response near the cutoff

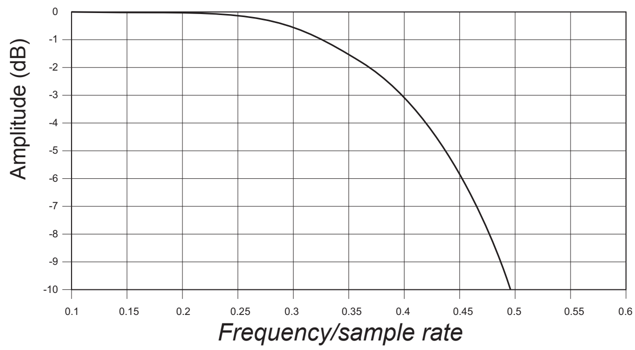


Sample rate 102.4 kS/s to 200 kS/s

Input frequency response



Input frequency response near the cutoff



The ADC samples at 64, 128 or 256 times the data rate (depending on the adjusted sample rate). Frequency components above one half of the oversampling rate (> 32, 64 or 128) can alias. Most of this frequency range is rejected by the digital filter. The filter can not reject components that lie close (±Nyquist bandwidth) to integer multiples of the oversampling rate because it can not differentiate these components from components between 0 Hz and the Nyquist frequency. That means, if the sample rate is 10 kS/s and a signal component is between 2.555 and 2.565 MHz (256 x 10 kHz ±Nyquist bandwidth), this signal will be aliased into the passband region and is not rejected by the digital filter. The analog filter removes these components before they get to the digital filter and the sampler.

The frequency response of the analog filter is fixed. The filter is optimized to produce high-frequency alias rejection and to have a flat in-band frequency response. It is a second order filter with a slow roll-off that rejects aliases at lower sample rates not so good. But the filter has very good alias rejection at higher sample rates.

If aliasing is caused by a clipped or overranged waveform, (exceeding the voltage range of the ADC) it can not be rejected with any filter. The ADC assumes the closest value to the actual value of the signal in its digital range when the signal is clipping. The result of clipping is also a sudden change in the signal slope and results in corrupt digital data with high-frequency energy. This energy is spread over the complete frequency spectrum and is aliased back into the baseband. Do not allow the signal to exceed the input range to avoid this.

2.8.1.5 Sample clock selection

Due to the nature of delta sigma converters they have to overclock the ADC to reach the high accuracy specification. The overclocking rate varies with the sample rate:

256 for 1kS/s <= 51.2 kS/s

128 for 1kS/s < fs <= 102.4 kS/s

128 for 102.4 kS/s < fs <= 204.8 kS/s

That means at 50 kS/s the delta sigma converter is clocked with 12.8 Mhz (50 kHz * 256).

To set nearly each frequency a low jitter programmable PLL (phase locked loop) circuit is used for generating the clocking frequency. PLL gives the best solution for variable frequency setting with small steps between the frequency. But still not every frequency is possible to set. The formula below gives you an idea how the frequency can be set to get different sample rates:

$$\frac{12.8\ \text{MHz}}{Q} \cdot P \cdot \frac{1}{N} \cdot \frac{1}{OC}$$

where Q is limited from 2 to 51; P is limited from 8 to 1600 and N is limited from 1 to 127. OC for fs 1kS/s <= 51.2 kS/s equals 1024 and for higher sample rates it is fixed to 256. Also the product of 12.8 MHz/Q * P has to be in the range of 100 to 400 MHz for stable operation. The factors Q, P and N are integer values and automatically set the best performance values. The table below give a rough idea about the sample rate resolution at different sample rates.

Sample rate	Resolution [ppm]	Resolution [Hz]
1kS/sec	40	0,04 Hz
10kS/sec	70	0,7 Hz
50kS/sec	400	20 Hz
100kS/sec	400	40 Hz
200kS/sec	400	80 Hz

The exact value of the sample is read back (and displayed in DEWESoft) for knowing the exact sample rate.

The factors Q, P and N are integer values and automatically set the best performance values. The exact value of the sample is read back (and displayed in DEWESoft) for knowing the exact sample rate.

All channels have to be acquired with the same saple rate. It is not possible to set different sample rates to some channels.

2.8.1.6 Output data format

Due to the nature of the PCI Bus, each channel is transferred as a 32-bit value, although the converter output is only a 24-bit value. Multiple channel applications with high sample rates may limit the maximum sample rate. A 128 channel system with 100 kS/s will give a total output data stream of 51.2 MByte/sec.

ADC-data (24-bit)

23 16	15 8	7 0

MSB LSB

Transferred data (32-bit) filled with “0”

23 16	15 8	7 0	0 0 0 0 0 0 0 0

MS LSB

To reduce this high amount of data by half, a 16-bit mode is implemented. This 16-bit mode will only transfer 16 bits per ADC. Due to the selection of most significant 16 bits of the 24-bit ADC value, it is also possible to define the interesting array of bits which should be transferred. That means you have a kind of programmable range, using this packed mode.

ADC-data (24-bit)

23 16	15 8	7 0

MSB LSB

Transferred data (32-bit)

23 16	15 8	23 16	15 8

MSB Channel 0 Channel 1 LSB

Input range ±10 V with 0.3 mV resolution

Transferred data (32-bit)

21 14	13 6	21 14	13 6

MSB Channel 0 Channel 1 LSB

Input range ±2.5 V with 0.076 mV resolution

2.8.1.7 Calibration

Your DEWE-ORION-0424-200 is shipped with a calibration certificate. Typically a recalibration is required every year. The calibration constants are stored in the on-board EEPROM. The calibration can only be done with an optional available calibration kit. You are also able to send the DEWE-ORION-0424-200 back to DEWETRON for recalibration.

2.9 Counter input

2.9.1 Counter applications

As mentioned above each counter block is equipped with three inputs. With this three inputs the following applications can be done:

- Event Counting
- Gated Event Counting
- Up/Down Counter
- Frequency Measurement
- Period Time Measurement
- Pulse Width Measurement
- Two Pulse Edge Separation
- Quadrature Encoder (X1, X2, X4, A-Up/B-Down)

2.9.1.1 Event Counting

In Event Counting the counter counts the number of pulses that occur on counter source. At every sample clock the counter value is read without disturbing the counting process.

Figure 12 shows an example of event counting where the counter counts eight events on *Counter Source*. *Synchronized Value* is the value read by the DEWE-ORION-0424-200 board at *Sample Clock* (encircled numbers in the figure, e.g. ①, ②).

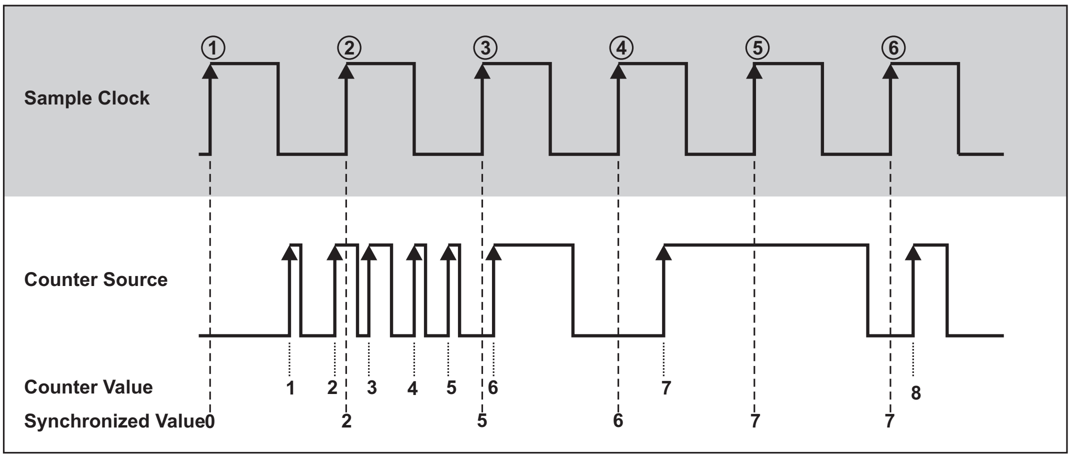
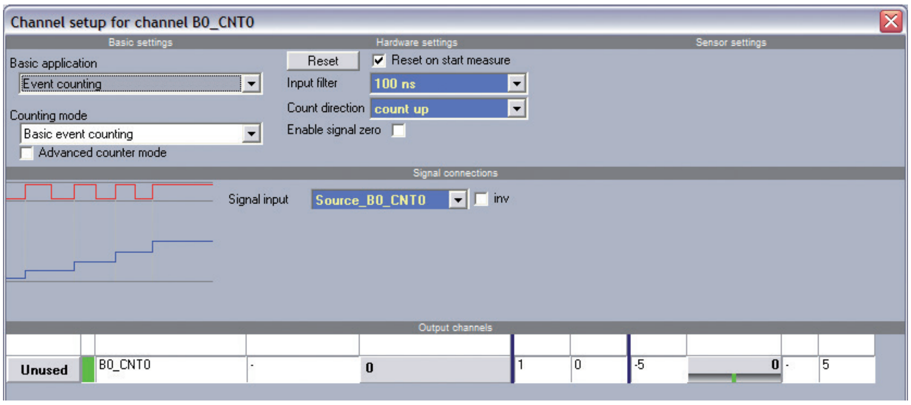


Figure 12: Event Counting

If counting at falling edges is necessary, the input signal has to be inverted. This can be done directly on the ORION-EXP-CNT8 by selecting inverted input.



2.9.1.2 Gated Event Counting

Gated Event Counting is similar to Event Counting except that the counting process is gated. When *Counter Gate* is active, the counter counts pulses which occur on counter source. When *Counter Gate* is inactive the counter retains the current count value. At every *Sample Clock* the value is read.

Figure 13 shows an example of Gated Event Counting where the counter counts three events on *Counter Source*. At ① and ② the counter value is zero, because the gate signal is inactive. At sample clock ③, ④ and ⑤ the actual counter value is read out. At ⑥ the same value as at ⑤ is typed out.

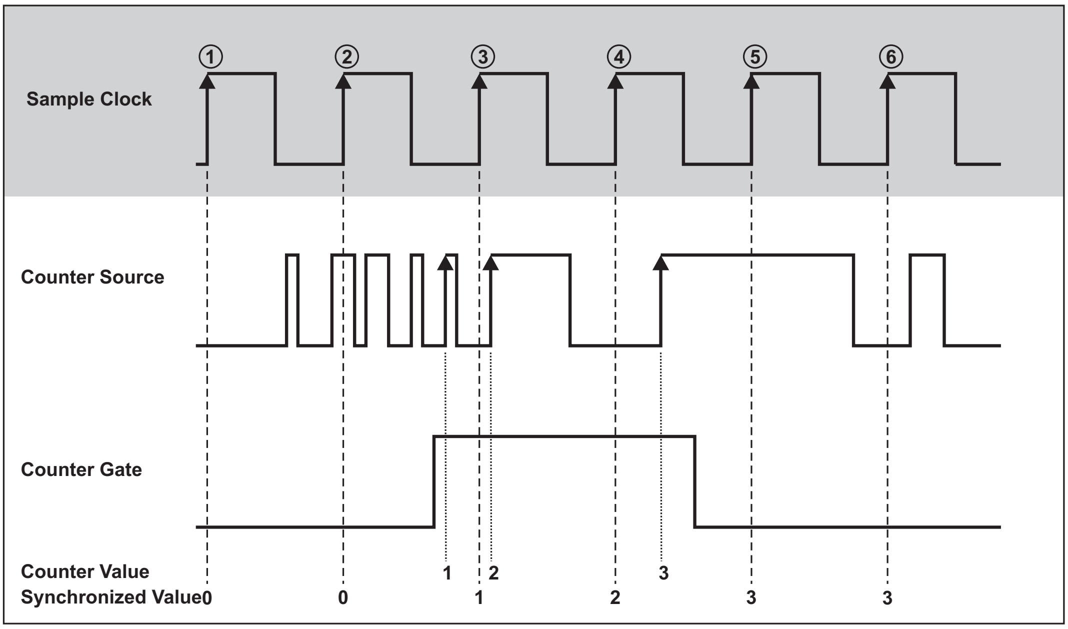
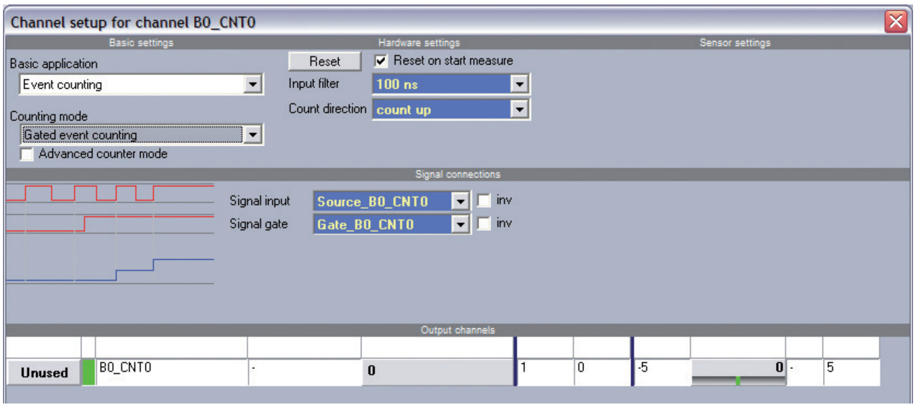


Figure 13: Gated Event Counting

It is also possible, as in Event Counting, to invert the input signals.



2.9.1.3 Up/Down Counter

The Up/Down Counter counts the rising edges on *Counter Source*. The direction of the counting depends on the signal state on *Counter Aux*. If *Counter Aux* is active (high level), the counter is increasing the counter value; if *Counter Aux* is inactive (low level), the counter is decreasing the counter value.

Figure 14 shows Up/Down counting.

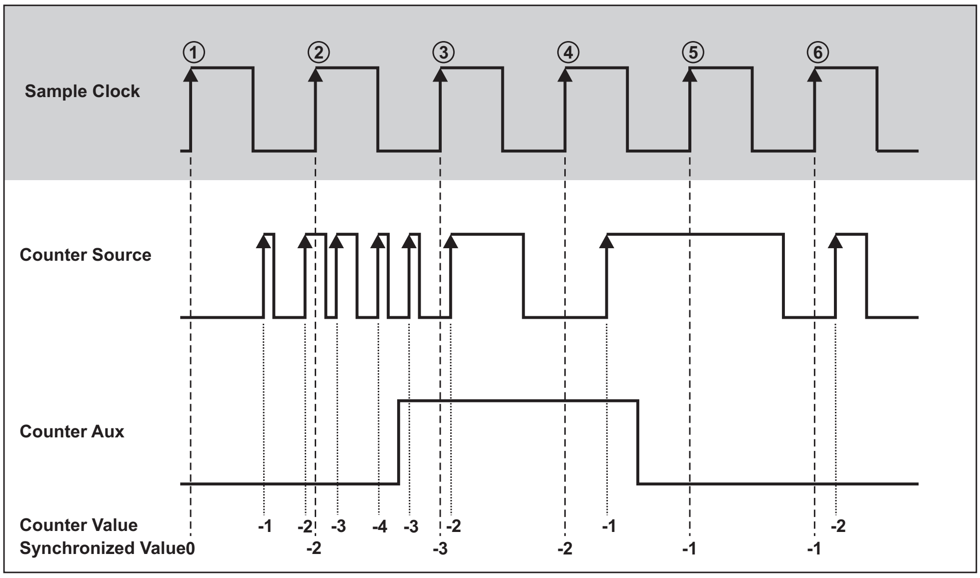
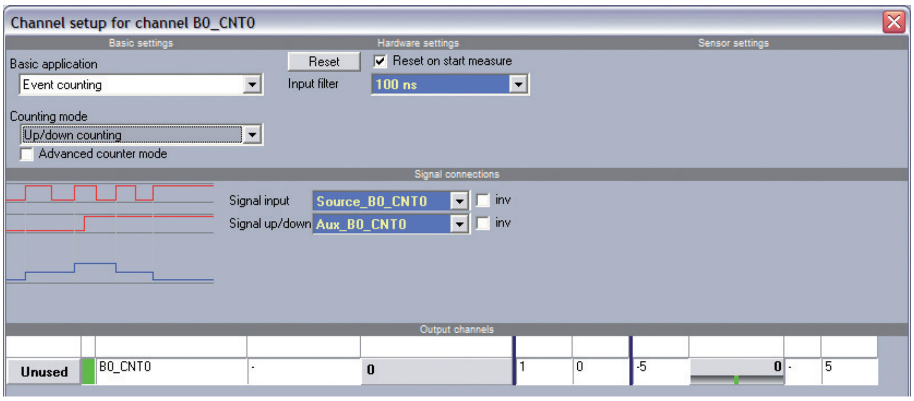


Figure 14: Up/Down Counter



2.9.1.4 Period Time Measurement

In Period Time Measurement the counter uses the internal time base to measure the period time of the signal present on *Counter Source*. The counter counts the rising edges of the internal time base which occurs between two rising edges on *Counter Source*. At the completion of the period interval the counter value is stored in a register and the counter starts counting from zero. At every *Sample Clock* (①, ②, …, ⑥) the register value is read out.

Figure 15 shows a Period Time Measurement.

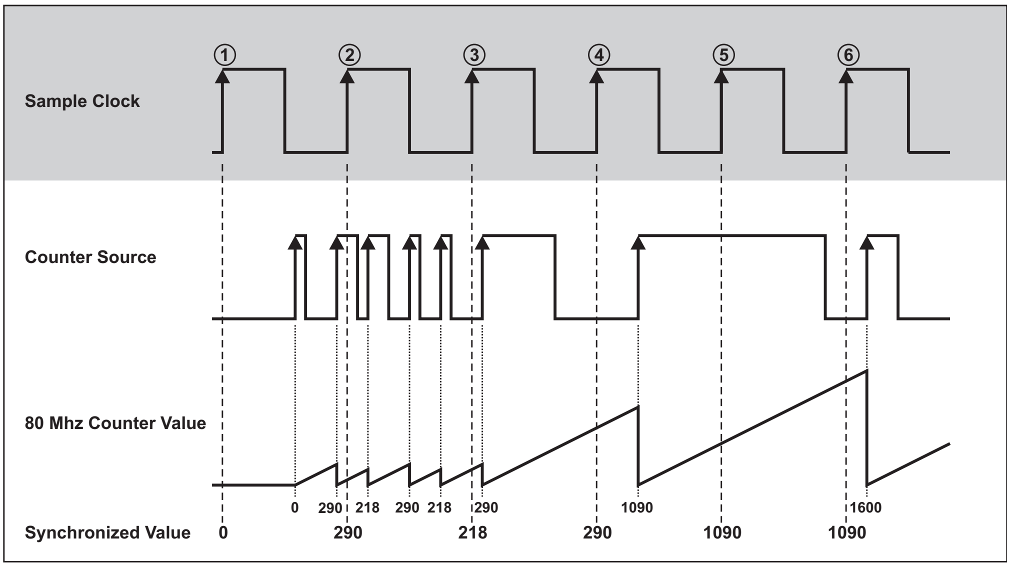
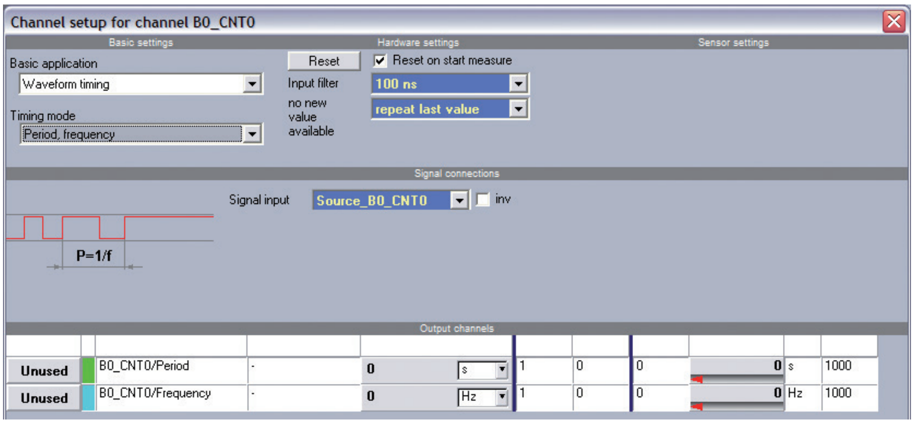


Figure 15: Period Time Measurement



2.9.1.5 Pulse Width Measurement

In Pulse Width Measurement the counter uses the internal time base to measure the pulse width of the signal present on *Counter Source*. The counter counts the rising edges of the internal time base after a rising edge occurs on counter source. At the falling edge on *Counter Source* the counter value is stored in a register and the counter is set to zero. With the next rising edge on *Counter Source* the counter starts counting again. At every *Sample Clock* (①, ②, …, ⑥) the register value is read out.

Figure 16 shows a pulse width measurement.

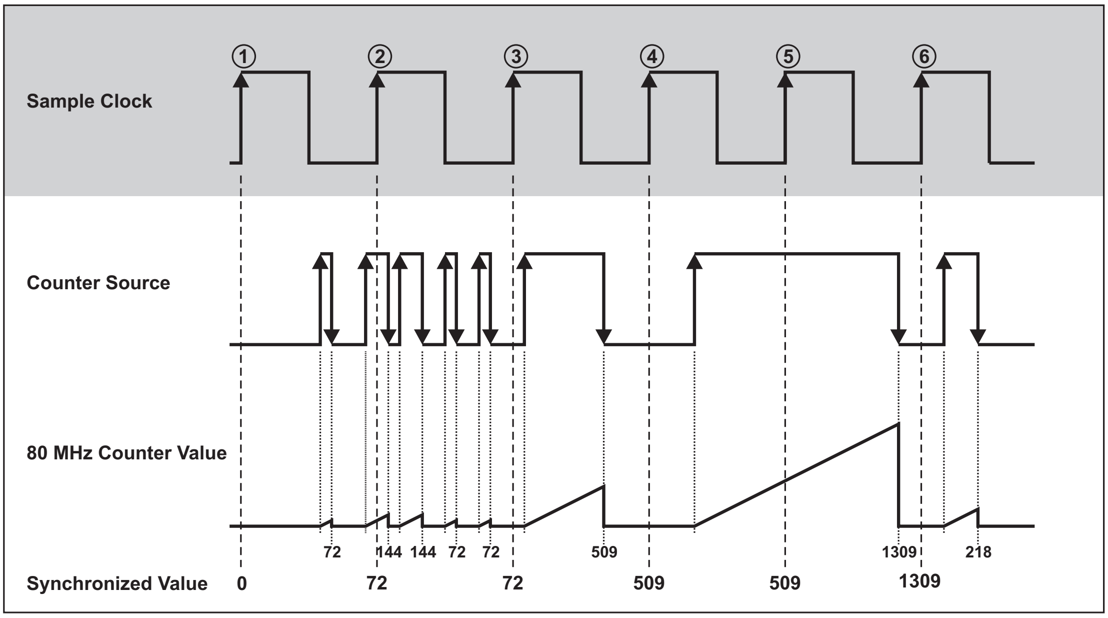
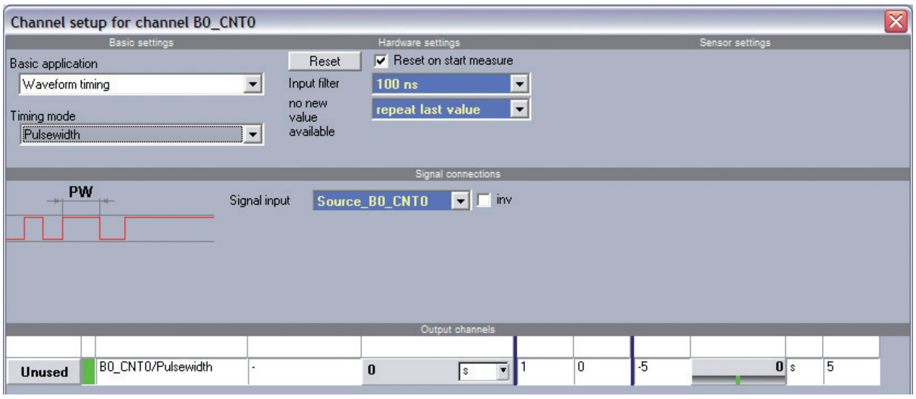


Figure 16: Pulse Width Measurement

For measuring the low time of the signal, the input signal has to be inverted on the ORION-EXP-CNT6.



2.9.1.6 Two Pulse Edge Separation Measurement

The two pulse edge separation measurement is similar to the pulse width measurement, except that there are two input signals: *Counter Start* and *Counter Stop*. After a rising edge has occurred on *Counter Start* the counter counts rising edges of the internal time base. Additional edges on signal start are ignored. After a rising edge has occurred on *Counter Stop* the counter stops counting and the value is stored in a register. At the next rising edge on *Counter Start* the counter starts counting from zero again. At every *Sample Clock* (①, ②, …, ⑥) the register value is read out.

Figure 17 shows an example of Two Pulse Edge Separation Measurement.

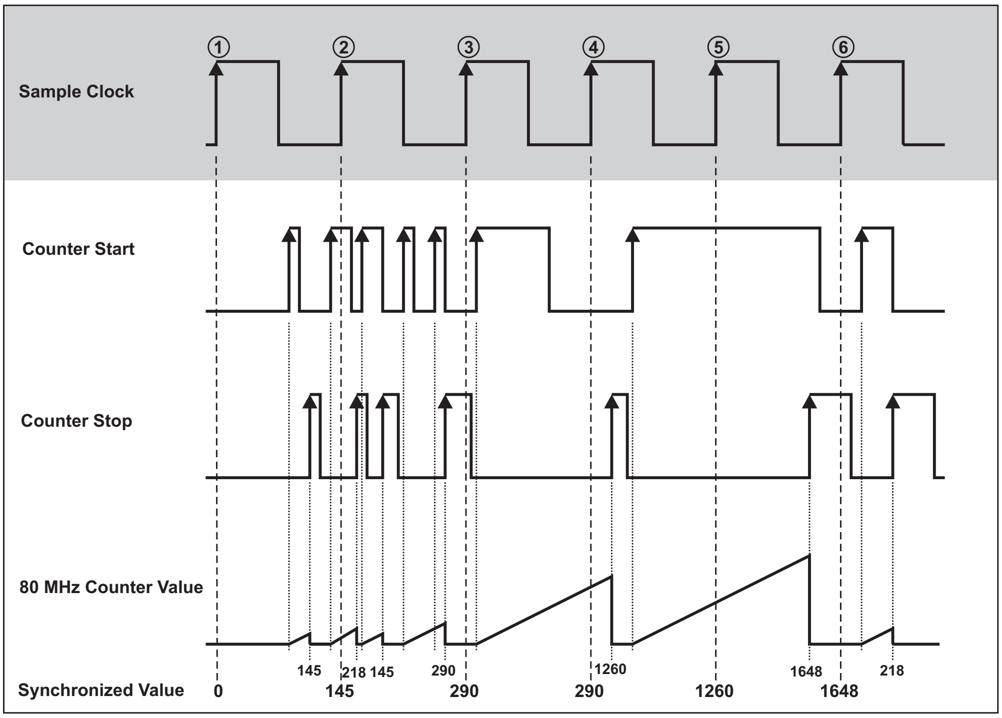
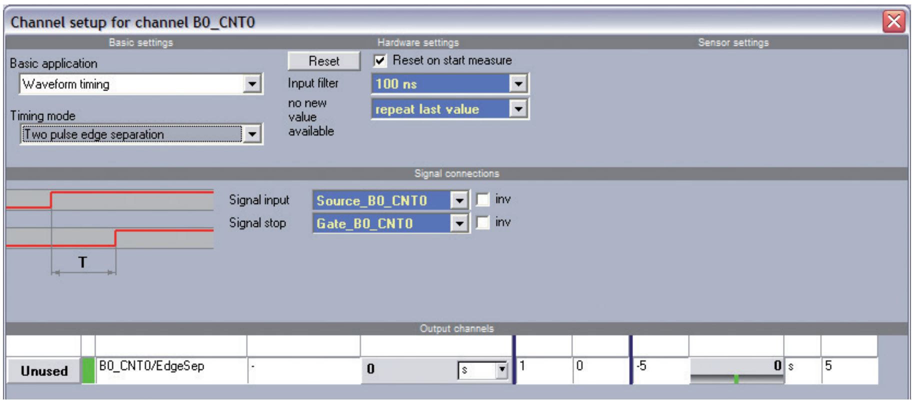


Figure 17: Two Pulse Edge Separation Measurement

If the input signals are inverted the counter takes the falling edges for counting.



2.9.1.7 Motion Encoder

Motion encoders have usually three channels: channel A, B and Z. Channel A and channel B are providing the square signals for the counter, and have a phase shift of 90°. With this phase shift the decoder is able to recognize the rotation direction of the motion encoder. The third channel types out one pulse at a certain position at each revolution. This pulse is used to set the counter to zero. The amount of counts per cycle at a given motion encoder depends on the type of decoding: X1, X2, X4. All three types are provided by the ORION-EXP-CNT8-TTL/ADJ. Some motion encoders have two outputs, which are working in a different way. Either channel A or channel B providing the square signal, depending on the direction of the rotation. Also this type is supplied by the ORION-EXP-CNT8-TTL/ADJ.

2.9.1.8 Quadrature Encoder

In the first case X1 decoding is explained. When *Input A* leads *Input B* in a quadrature cycle, the counter increments on rising edges of *Input A*. When *Input B* leads *Input A* in a quadrature cycle, the counter decrements on the falling edges of *Input A*. At every *Sample Clock* (①, ②, …, ⑨) the counter value is read out.

Figure 18 shows the resulting increments and decrements for X1 encoding.

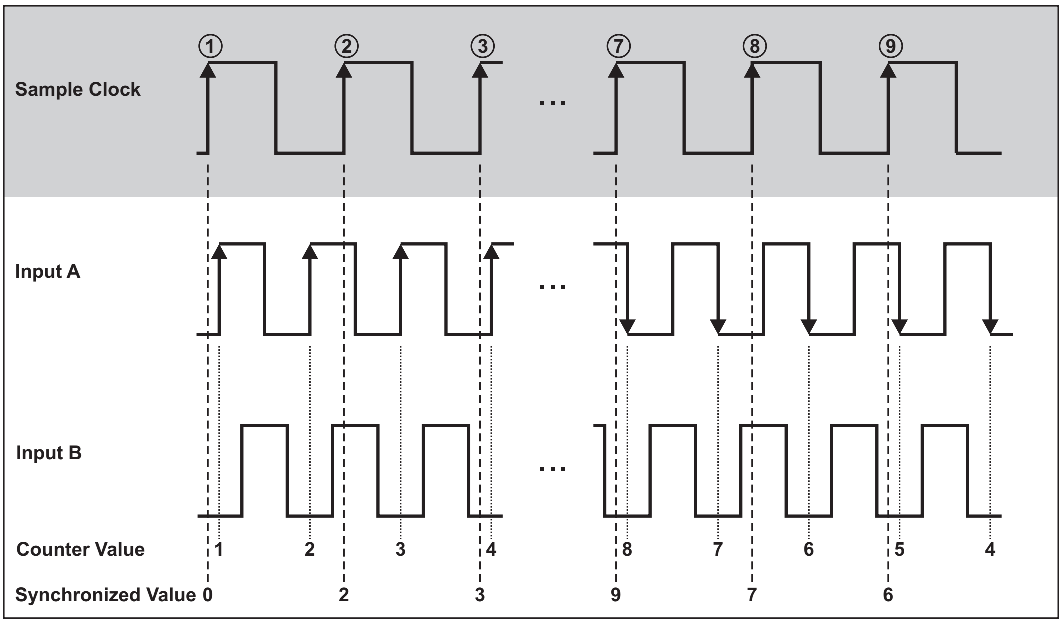


Figure 18: Quadrature Encoder X1 Mode

For X2 encoding the rising edges and the falling edges of *Input A* are used to increment or decrement. The counter increments if *Input A* leads *Input B* and decrements if *Input B* leads *Input A*. This is shown in Figure 19.

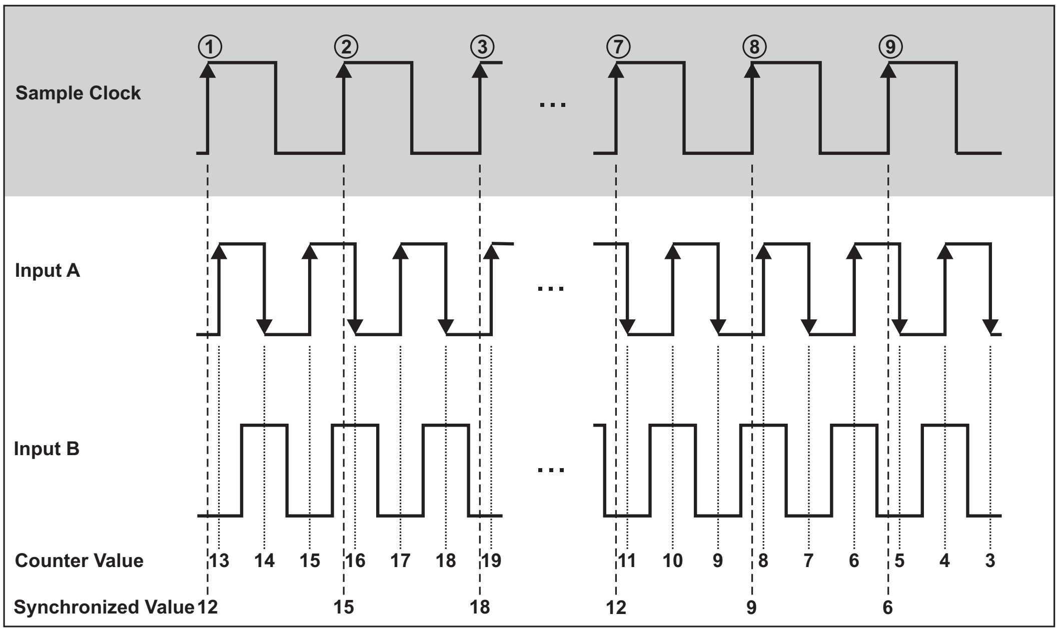


Figure 19: Quadrature Encoder X2 Mode

Similarly, the counter increments or decrements on each edge of *Input A* and *Input B* for X4 decoding. The condition for increment and decrement is the same as for X1 and X2.

Figure 20 shows the results for X4 encoding.

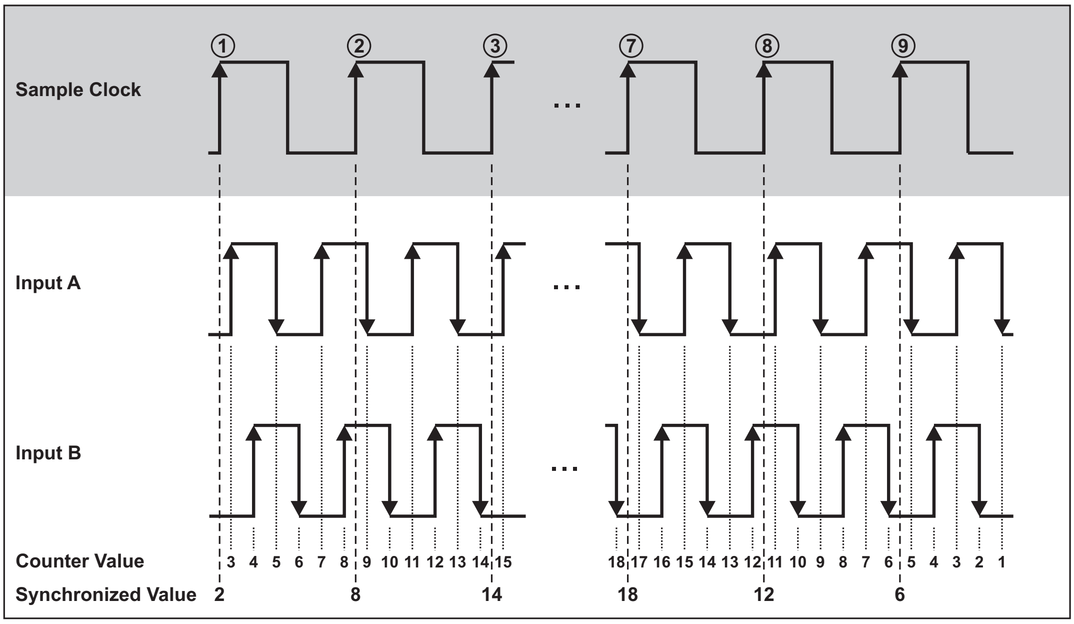


Figure 20: Quadrature Encoder X4 Mode

The third channel *Input Z*, which is also referred as the index channel, causes the counter to be reloaded with zero in a specific phase of the quadrature cycle.

Figure 21 shows the results for X1 encoding with input Z.

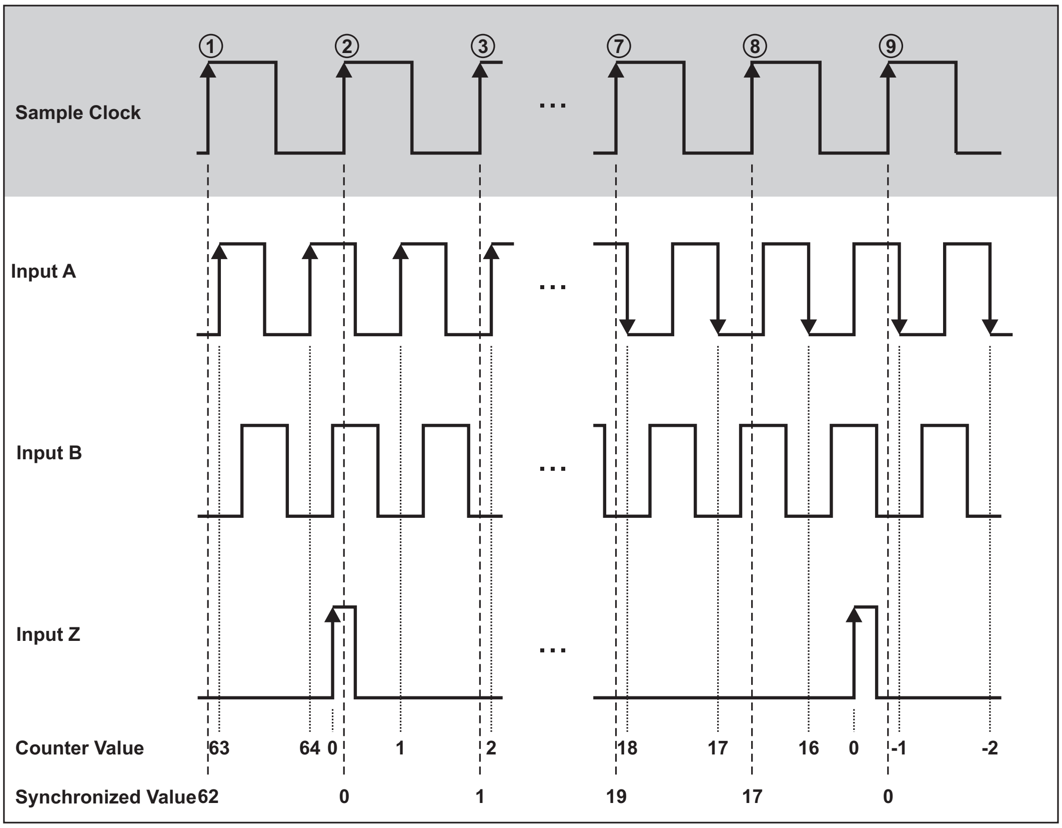
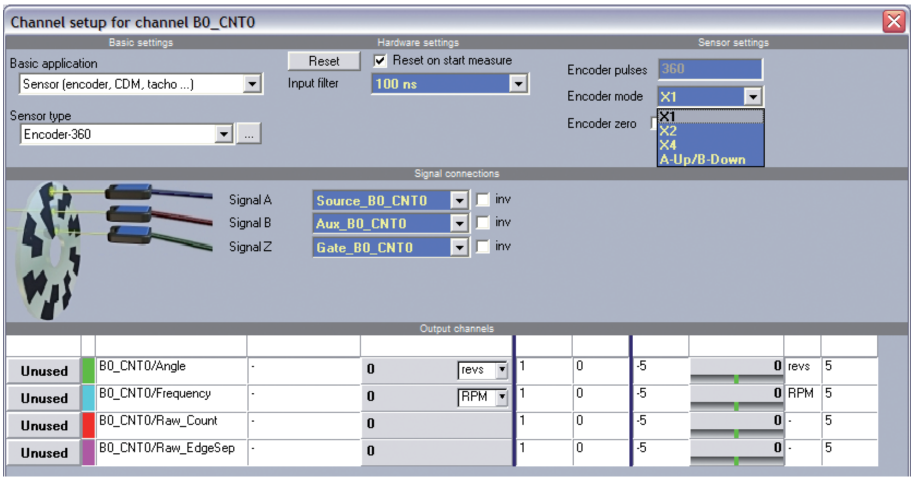


Figure 21: Quadrature Encoder with channel Z



2.9.1.9 A-Up/B-Down Encoder

The A-Up/B-Down Encoder supports two inputs, A and B. A pulse on *Input A* increments the counter on its rising edges. A pulse on *Input B* decrements the counter on its rising edges. At every *Sample Clock* (①, ②, …, ⑨) the counter value is read out.

This situation is shown in Figure 22.

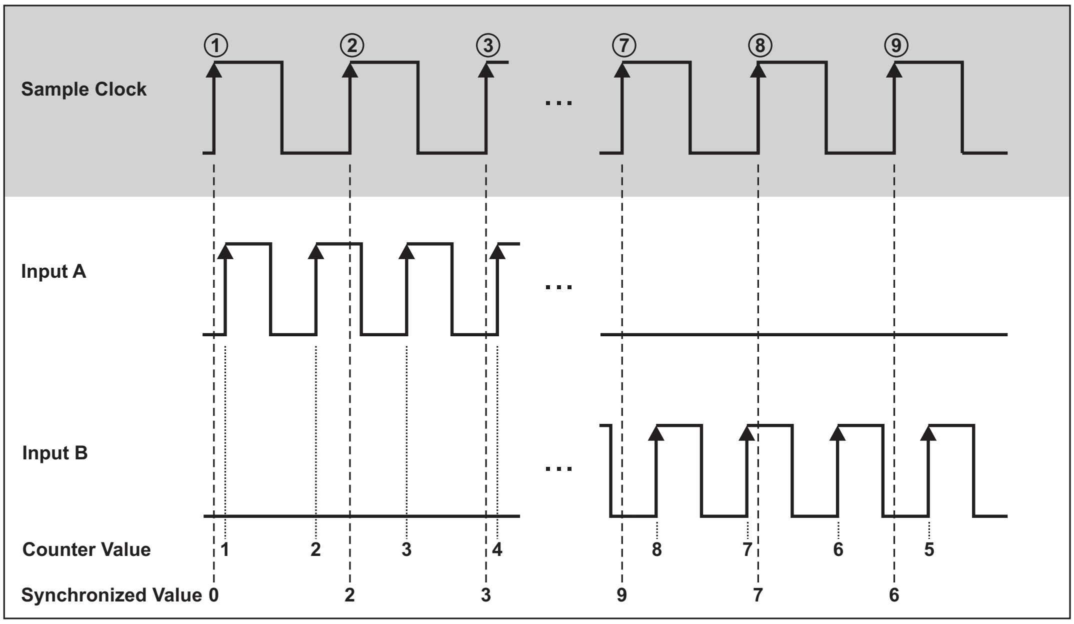
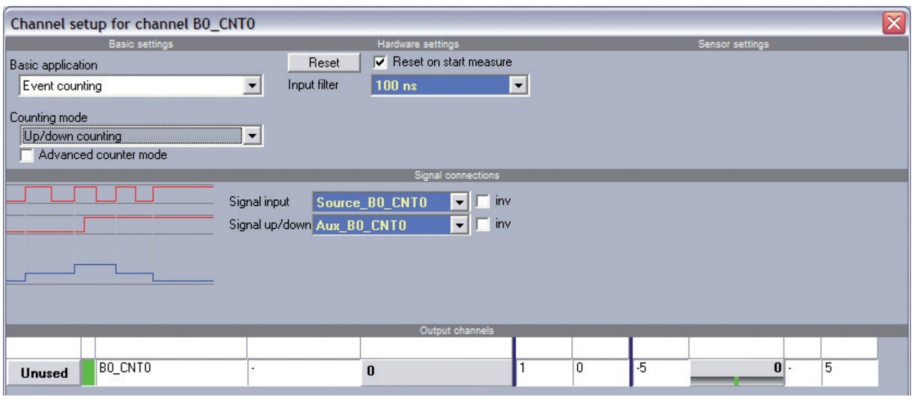


Figure 22: A-Up/B-Down Encoder



2.9.1.10 Frequency Measurement

In general it is possible to take the inverse of a period measurement to get the frequency of the input signal. If the period time measurement is done an inaccuracy of counted internal time base cycles of ±1 cycle appears, because the counted cycles of the internal time base depends on the phase of the input signal with respect to the internal time base. For long period times, and therewith low frequencies, the measurement error is negligible. At high frequencies, and therewith short period times, few cycles are counted. In this case the error of ±1 cycle becomes significant.

Input Frequency	Number of internal time base cycles	Measurement error of -1 cycle	Measurement error of +1 cycle	Calculated frequency with error of -1 cycle	Calculated frequency with error of +1 cycle
40 kHz	2000	1999	2001	39,98 kHz	40,02 kHz
10 MHz	8	7	9	8,75 MHz	11,25 MHz

Accuracy at period time measurement

For higher precision result a combination of main and sub counter is used internally for getting higher precision at the frequency measurement. The main counter is running on event counting (or encoder mode). The sub counter measures the time between the sample clock and the input event. The sub counter measures exactly the time of the input event with a resolution of 12.5 nsec relative to the sample clock. At every rising edge on *Counter Source* the counter value of the sub counter is stored in a register. At every *Sample Clock* (①, ②, …, ⑥) the values of both counters are read out.

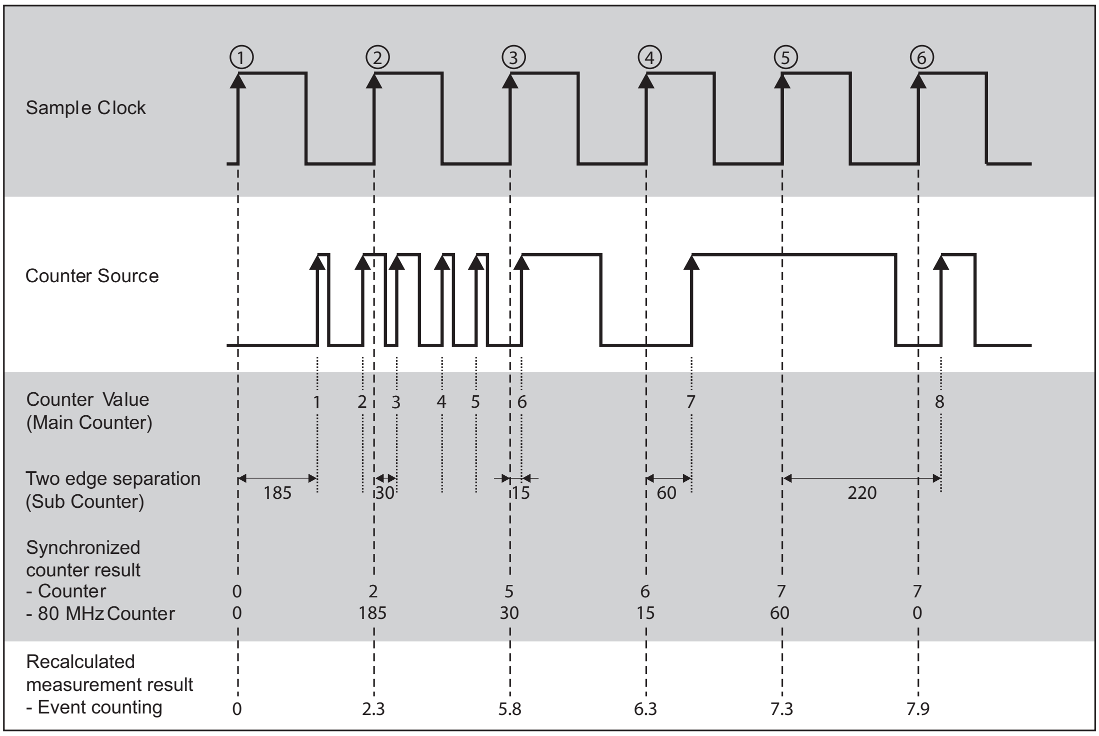


Figure 23: Frequency Measurement

The basic formular for calculating the frequency reads as follows:

$$f = f_{TB} \bullet \frac{EventCnt_n - EventCnt_{n-1}}{\frac{f_{TB}}{SampRate} + EdgeVal_n - EdgeVal_{n-1}}$$

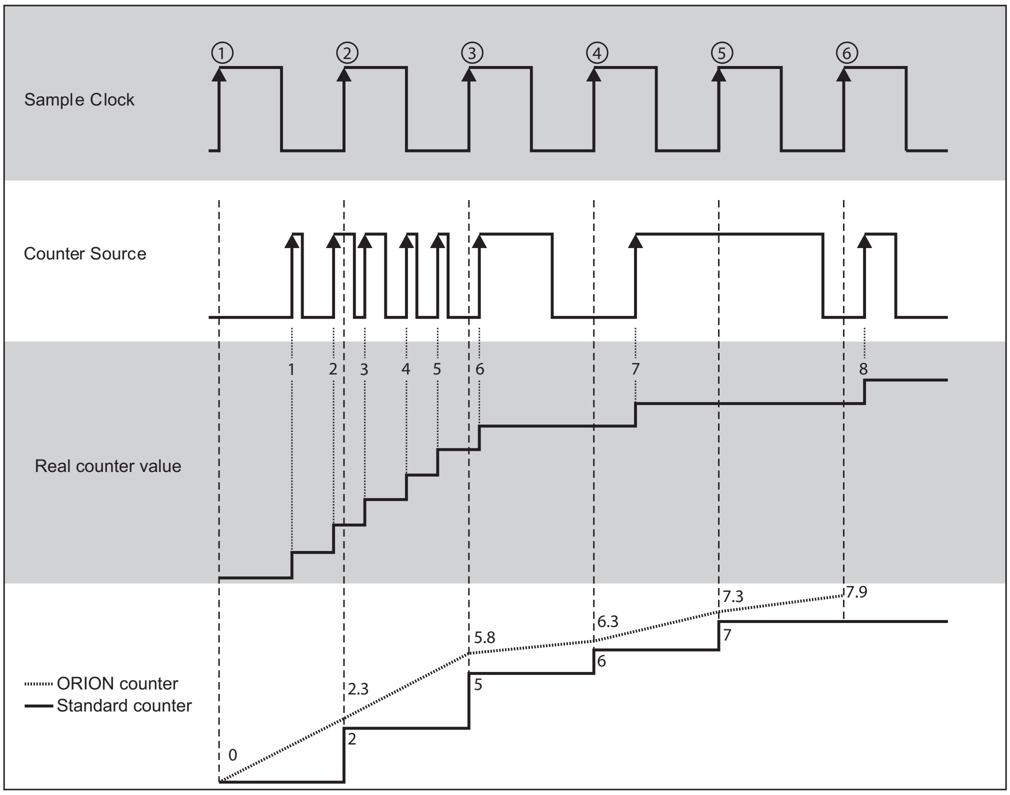
f = calculated frequency
f_{TB} = Internal timebase (80 Mhz)
$EventCnt_n$ = Event counter result of actual sample
$EventCnt_{n-1}$ = Event counter result of previous sample
SampRate = Acquisition rate
$EdgeVal_n$ = Measurement result from edge separation measurement of actual sample
$EdgeVal_{n-1}$ = Measurement result from edge separation measurement of previous sample

As an example the frequency is described on sample point 3. The acquisition rate is assumed with 80 kS/sec.

$$f = 80 \bullet 10^6 \bullet \frac{5-2}{\frac{80 \bullet 10^6}{80 \bullet 10^3} + 80 - 160} = 206.869 \text{ kHz}$$

With the measurement concept shown above not only the frequency can be calculated in a precise way. Also the event counter result can be shown in fractions because the exact time when the event occurs at the input is known. The event counting result is recalculated with interpolation to the exact sample point like shown in the diagram above.

Below, the difference of the measurement result is shown. While a standard counter input shows the value up to one sample delayed, the counter input of the ORION calculates the counter result at the exact sample point.



For low frequency input signals the frequency also can be obtained by measure the period time and take its inverse without more inaccuracy.

2.9.2 Miscellaneous counter functions

2.9.2.1 Filters

Each counter and digital input has a digital filter, which can be set to various gate times. If the gate time is set to “Off”, no filter is on the input signal.

The filter circuit samples the input signal on each rising edge of the internal time base. If the input signal maintains his state for at least the gate time, the new state is propagated. As an effect the signal transition is shifted by the gate time.

Figure 24 demonstrates the function of the filter.

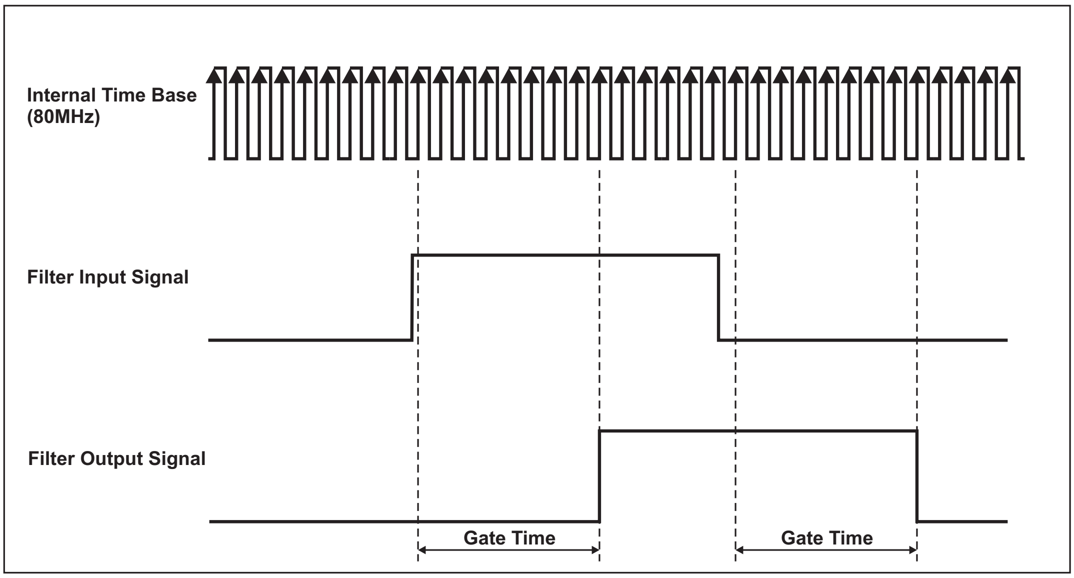


Figure 24: Filters

The intent of the filter is to eliminate unstable states, e.g. glitches, chatter, …, which may appear on the input signal, as shown in Figure 25.

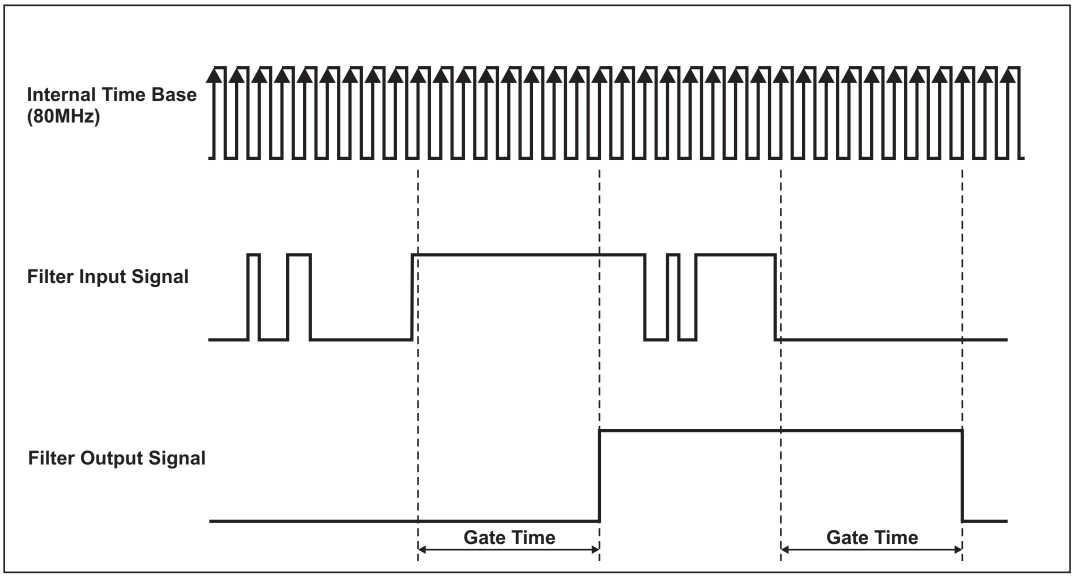


Figure 25: Input signal with chatter

It can be chosen between eight filter settings: Off, 100 ns, 200 ns, 500 ns, 1 µs, 2 µs, 4 µs and 5 µs. Two examples of filter settings are described.

The 100 ns filter will pass all pulse widths (high and low) that are 100 ns or longer. It will block all pulse widths that are 75 ns or shorter. The 5 µs filter will pass all pulse widths (high and low) that are 5 µs or longer and will block all pulse widths that are 4.975 µs or shorter.

The internal sampling clock (time base) is 80 MHz, so the period time amounts 12.5 ns. Pulse widths between gate time minus two internal time base period times may or may not pass, depending on the phase of the input signal with respect to the internal time base.

Properties of all filter settings:

Filter settings	Pulse width to pass	Pulse width to be blocked
100 ns	100 ns	75 ns
200 ns	200 ns	175 ns
500 ns	500 ns	475 ns
1 µs	1 µs	975 ns
2 µs	2µs	1.975 µs
4 µs	4 µs	3.975 µs
5 µs	5 µs	4.975 µs
Off	-	-

Filter Gate Times

2.9.2.2 Reset on start measure

Usually all counters are reset at the start of data acquisition, i.e. the counter value is set to zero at the start of data acquisition. In some applications this is not required. An angle encoder for example is adjusted to the physical zero position at the beginning of a test procedure. By resetting the counter at every start of the measurement this adjustment get lost. Without this reset the counter is also active if the acquisition is interrupted between the test cycles. As a result the counter types out the absolute angle position at the measurement output all the time.

2.9.2.3 Count Direction

As default setting the count direction is in up-counting mode. Every rising edge at the input will increase the counter value. The DEWE-ORION-0424-200 supports also down counting without the need of an additional input like in the up/down counting mode.

2.9.2.4 No new value available

Especially in every kind of input period time measurement mode (also pulse width or two pulse edge separation measurement) there may be new information between two samples. Also measuring the line frequency of about 50 Hz with a sample rate of 10 kSamples/sec means, that only after every 200th measurement new input frequency information is available. Another example is the measurement on rotating machines if the sensor output frequency is lower than the sample rate. Depending on the application the DEWE-ORION-0424-200 can choose between two different output data settings:

- Repeat last value: last measured cycle time is taken until a new measured cycle time is available.
- Make zero value: as soon as no input information is available the output is set to Zero.

DEWE-ORION-0424-200

3 Specifications

3.1 Analog input

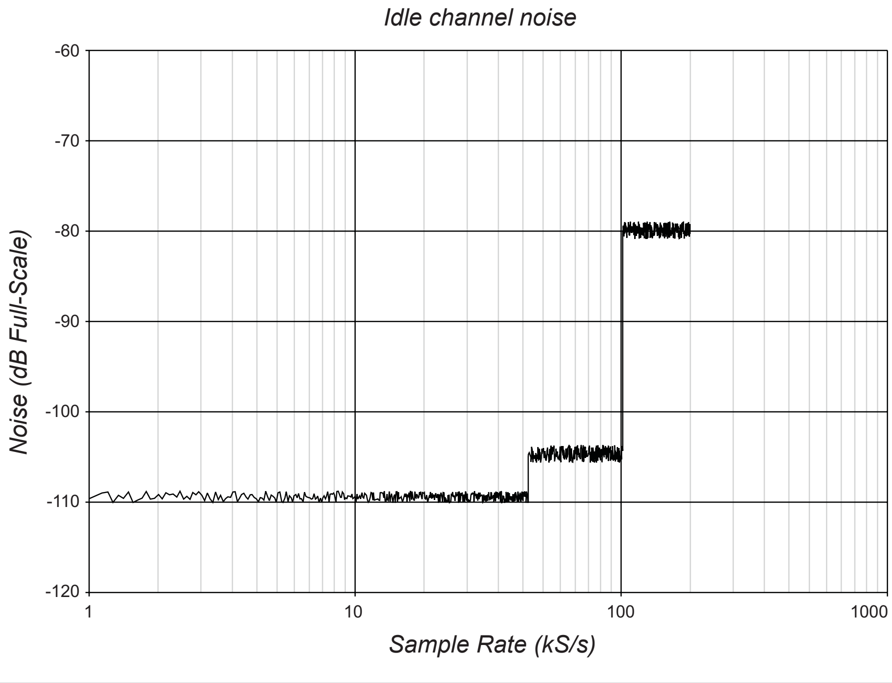
Analog input	
Channel characteristics	
Number of channels	4, simultaneously sampled
Input configuration	Symmetric, differential or single ended
Resolution	24-bit, nominal
Type of ADC	Delta-sigma
Sampling rate	204.8 kS/s per channel
Data throughput	1.6 MS/s
Oversampling, for sample rate (fs)	
Frequency accuracy	±35 ppm
1 kS/s $\leq f_s \leq$ 51.2 kS/s	256 f_s
51.2 kS/s $< f_s \leq$ 102.4 kS/s	128 f_s
102.4 kS/s $< f_s \leq$ 204.8 kS/s	64 f_s
Input signal range	±10 V, ±2 V, ±0.5 V, ±0.1 V peak
FIFO buffer size	4096 samples
Data transfers	DMA
Transfer characteristics	
DC accuracy	% of reading / % of range
Range ±10 V	±0.05 % / ± 0.01 %
±2 V	±0.05 % / ± 0.012 %
±0.5 V	±0.05 % / ± 0.02 %
±0.1 V	±0.05 % / ± 0.06 %
Gain drift	±15 ppm/K
Amplifier characteristics	
Input impedance (ground referenced)	
Positive input to negative input	1 MΩ each with 60 pF to GND
Positive input to GND	7.8 MΩ in parallel with 60 pF
Negative input to GND	10 MΩ in parallel with 60 pF
Overvoltage protection	
Positive input	±30 V
Negative input	±30 V
Common mode rejection (CMR)	
Range	±10 V / ±2 V / ±0.5V / ±0.1 V
f_{in} < 1 kHz	> 60 dB, typ. / > 74 dB, typ. / > 86 dB, typ. / > 100 dB, typ.
Flatness digital filter	
1 kS/s $\leq f_s \leq$ 51.2 kS/s	-0.035 dB to +0.01 dB, DC to 0.475 f_s
51.2 kS/s $< f_s \leq$ 102.4 kS/s	-0.035 dB to +0.01 dB, DC to 0.45 f_s
102.4 kS/s $< f_s \leq$ 204.8 kS/s	-0.035 dB to +0.01 dB, DC to 0.246 f_s
-3 dB Bandwidth digital filter	
1 kS/s $\leq f_s \leq$ 51.2 kS/s	0.494 f_s
51.2 kS/s $< f_s \leq$ 102.4 kS/s	0.49 f_s
102.4 kS/s $< f_s \leq$ 204.8 kS/s	0.38 f_s
Analog bandwidth	
Range	±10 V / ±2 V / ±0.5V / ±0.1 V
-1 dB Bandwidth	225 kHz / 225 kHz / 200 kHz / 80 kHz
-3 dB Bandwidth	360 kHz / 360 kHz / 320 kHz / 150 kHz
Maximum working voltage	
Channel-to-ground, channel-to-channel	10 V, installation category I
Max. working voltage refers to the signal voltage plus common-mode voltage.	

Dynamic characteristics				
Alias-free bandwidth (passband)				
1 kS/s ≤ f_s ≤ 51.2 kS/s	DC (0 Hz) to 0.42 f_s			
51.2 kS/s < f_s ≤ 102.4 kS/s	DC (0 Hz) to 0.32 f_s			
102.4 kS/s < f_s ≤ 200 kS/s	DC (0 Hz) to 0.22 f_s			
Alias rejection				
1 kS/s ≤ f_s ≤ 51.2 kS/s	-95 dB			
51.2 kS/s < f_s ≤ 102.4 kS/s	-92 dB			
102.4 kS/s < f_s ≤ 200 kS/s	-97 dB			
Signal to noise				
Range	±10 V	±2 V	±0.5 V	±0.1 V
1 kS/s ≤ f_s ≤ 51.2 kS/s	108 dB	107 dB	104 dB	93 dB
51.2 kS/s < f_s ≤ 102.4 kS/s	105 dB	104 dB	101 dB	90 dB
102.4 kS/s < f_s ≤ 200 kS/s	78 dB	78 dB	78 dB	78 dB
Spurious free dynamic range				
Range	±10 V	±2 V	±0.5 V	±0.1 V
1kS to 51.2 kS/s	140 dB	140 dB	138 dB	125 dB
51.2kS to 102.4 kS/s	137 dB	133 dB	132 dB	122 dB
102.4kS to 200 kS/s	103 dB*	103 dB*	103 dB**	103 dB***
THD (1kS/s <= f_s <= 102.4 kS/s)				
Range	±10 V	±2 V	±0.5 V	±0.1 V
0 dB_{FS} input	< -92 dB	< -96 dB	< -96 dB	< -88 dB
-20 dB_{FS} input	< -100 dB	< - 97 dB	< - 88 dB	< - 78 dB
-60 dB_{FS} input	< -60 dB	< -60 dB	< -60 dB	< -55 dB
Crosstalk (channel separation)				
f_{in} 0 to 10 kHz	120 dB			
f_{in} 10 to 50 kHz	105 dB			
Typical Interchannel gain mismatch	±0.002 dB			
Typical filter delay through ADC				
1 kS/s ≤ f_s ≤ 51.2 kS/s	12 / f_s			
51.2 kS/s < f_s ≤ 102.4 kS/s	9 / f_s			
102.4 kS/s < f_s ≤ 200 kS/s	5 / f_s			
Inter channel phase mismatch	0.02° * f_{in} (kHz) + 0.08°			

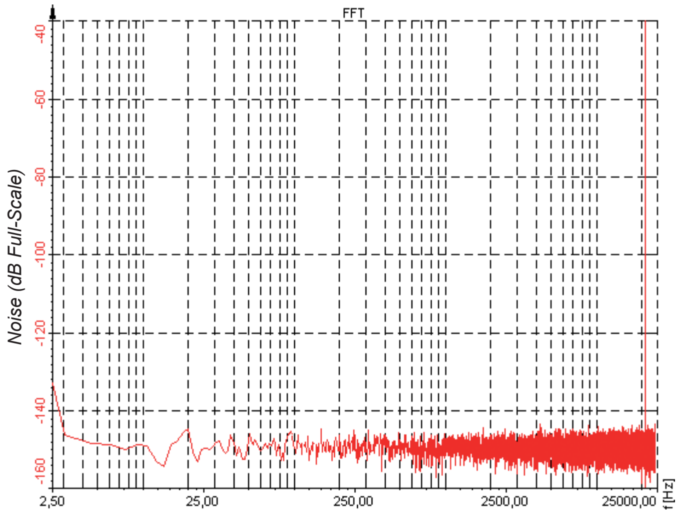
* 133 dB below 0.22*f_s

** 132 dB below 0.22*f_s

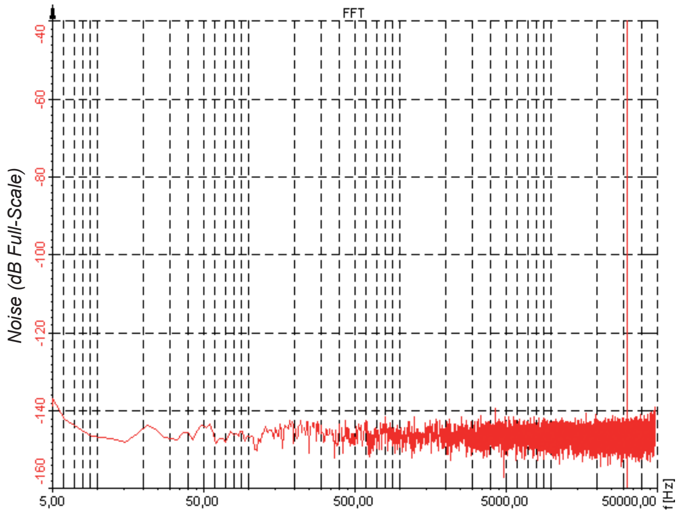
*** 119 dB below 0.22*f_s



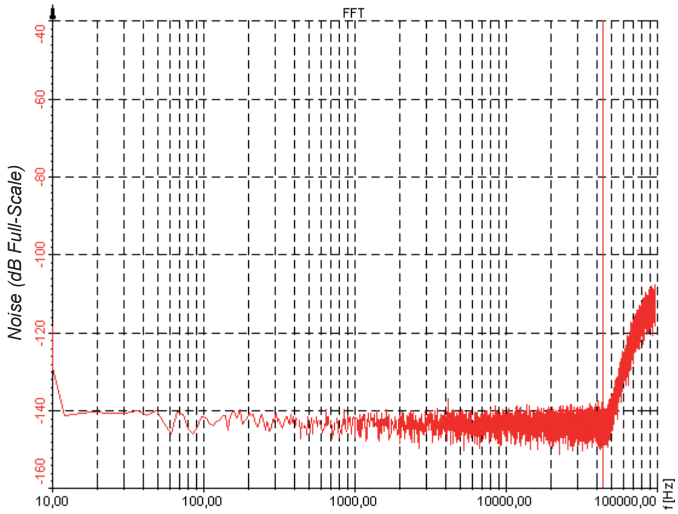
Spectral noise - Idle input - 10 V range - 10 averages 16k lines @ 50 kHz sampling rate



Spectral noise - Idle input - 10 averages 16k lines @ 100 kHz sampling rate



Spectral noise - Idle input - 10 averages 16k lines @ 200 kHz sampling rate



3.2 Digital and Counter input

Counter input	
Counter resolution	32-bit
Counter time base	80 MHz
Time base accuracy	35 ppm
Maximum input frequency	40 MHz
Input signal characteristic	
Adjustable Counter	
Compatibility	Adjustable trigger levels
Configuration	Symmetric differential
Input coupling	DC / AC (1Hz)
Input impedance (ground referenced)	1 MOhm / 5 pF
Bandwith (-3dB)	5 MHz
Trigger adjustment range	0 to 40 V
Trigger resolution	40 mV
Trigger level accuracy	±100 mV ±1% of trigger level
Common voltage range	-35 to 50V
Common mode rejection ratio	>40 dB
Overvoltage protection	±100 V continuous
Max. DC level @AC coupling	±50 V continuous
Input signal characteristic Trigger	
Compatibility	TTL Schmitt trigger
Configuration	Pull-up with 100 kOhm
Input low level	-0.7 V to 2 V
Input high level	3 V to 5 V
Input low current	< -50 µA
Input high current	< 10 µA
Input capacitance	< 5 pF
Overvoltage protection	-1 to 6 V

3.3 Power requirements

Orion Type	I_{12V} [mA]	I_{5V} [mA]	$I_{3.3V}$ [mA]	$P_{tot.}$ [Watt]
Orion-0424-200	150	680	---	7.8

This table does not include the current taken from the I/O connectors like CAN or analog input.

3.4 General Specifications

General Specifications	
Environmental	
Operating temperature	0 to 50 °C
Storage temperature	-20 to 70 °C
Relative humidity	10 to 90%, non condensing
Maximum altitude	2000 m
Pollution degree (indoor use only)	2
Physical	
Dimensions (not including connectors)	17.5 x 10.7 cm (6.9 x 4.2 in.)
Analog input connector	BNC
Counter input connector	SUB-D 9-pin male

Notes

CE-Certificate of conformity

Manufacturer: **DEWETRON Elektronische Messgeraete Ges.m.b.H.**

Address: **Parkring 4**
A-8074 Graz-Grambach Austria

Tel.: +43 316 3070 0
Fax: +43 316 3070 90
e-mail: sales@dewetron.com
http://www.dewetron.com

Name of product: **DEWE-ORION-0424-200**

Kind of product: *A/D board*

The product meets the regulations of the following EC-directives:

73/23/EEC
"Directive on the approximation of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits amended by the directive 93/68/EEC"

89/336/EEC
"Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility amended by the directives 91/263/EEC, 92/31/EEC, 93/68/EEC and 93/97/EEC

The accordance is proved by the observance of the following standards:

LV	**Safety**	IEC/EN 61010-1:1992/93 IEC/EN 61010-2-031	IEC 61010-1:1992/300 V CATIII Pol. D. 2 IEC 1010-2-031
EMC	**Emissions**	EN 61000-6-4	EN 55011 Class B
EMC	**Immunity**	EN 61000-6-2	Group standard

Graz, April 28, 2010
Place / Date of the CE-marking

Dipl.-Ing. Roland Jeutter / Managing director

Notes