SPECTRUM
SYSTEMENTWICKLUNG MICROELECTRONIC GMBH

MX.46xx - four channel 16 bit high-speed A/D

- **PXI 3U / CompactPCI 3U format**
- **Fastest 16 bit A/D converter board**
- **Models with 200 kS/s, 500 kS/s, 1 MS/s or 3 MS/s**
- **Simultaneously sampling on all channels**
- **Separate ADC and amplifier per channel**
- **8 input ranges: ±50 mV up to ±10 V**
- **Programmable input offset of ±5 V**
- **complete on-board calibration**
- **True differential / single-ended selectable**
- **Up to 64 MSample (128 MByte) on-board memory**
- **FIFO mode**
- **Window/pulsewidth/re-arm/spike trigger**
- **Synchronization possible**

Product range overview

Model	1 channel	2 channels	4 channels
MX.4620	200 kS/s	200 kS/s	
MX.4621	200 kS/s	200 kS/s	200 kS/s
MX.4630	500 kS/s	500 kS/s	
MX.4631	500 kS/s	500 kS/s	500 kS/s
MX.4640	1 MS/s	1 MS/s	
MX.4641	1 MS/s	1 MS/s	1 MS/s
MX.4650	3 MS/s	3 MS/s	
MX.4651	3 MS/s	3 MS/s	3 MS/s

Software/Drivers

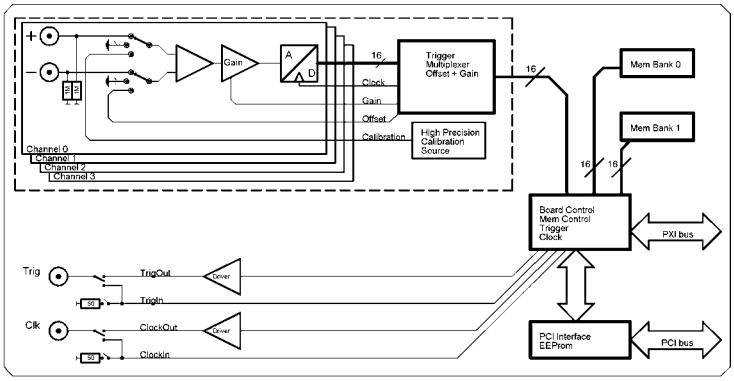
A large number of drivers and examples are delivered with the board or are available as an option:

- Windows 98/ME/NT/2000/XP/Vista/7 drivers
- Linux 32bit and 64bit drivers
- SBench 5.x for Windows
- SBench 6.x Base version for Windows and Linux
- Visual C++/Borland C++ Builder examples
- Borland Delphi examples
- Microsoft Visual Basic examples
- Microsoft Excel examples
- LabWindows/CVI examples
- FlexPro support with SBench
- LabVIEW - drivers (as option)
- DASYLab - drivers (as option)
- MATLAB - drivers (as option)
- Agilent VEE - drivers (as option)

General Information

The MX.46xx for the first time offers 16 bit resolution synchronously on four channels at very high sampling rates. Every channel has its own amplifier and A/D converter. This eliminates the problems known from multiplexed systems like phase error between the channels or high crosstalk. Every input channel can be offset and gain calibrated by software using a high-precision onboard calibration source.
The user will easily find a matching solution from the eight offered models. These versions are working with sampling rates of 200 kS/s, 500 kS/s, 1 MS/s or 3 MS/s. The boards can also be updated to a multi-channel system using PXI backplane signals.

Hardware block diagram



Software programmable parameters

Sampling rate	1 kS/s to max sampling rate, external clock, ref clock, PXI clock
Input range	±50 mV, ±100 mV, ±250 mV, ±500 mV, ±1 V, ±2 V, ±5 V, ±10 V
Input Offset (single-ended)	programmable to ±5 V in steps of 1 mV, not exceeding ±10 V input
Input type	Single-ended, true differential
Clock mode	internal PLL, internal quartz, external, external divided, external reference clock, PXI reference clock
Clock impedance	50 Ohm / high impedance (> 4 kOhm)
Trigger impedance	50 Ohm / high impedance (> 4 kOhm)
Trigger mode	Channel, External, Software, Auto, Window, Pulse, Spike, PXI Line[5..0], PXI Startrigger
Trigger level resolution	14 bit
Trigger edge	rising edge, falling edge or both edges
Trigger pulsewidth	1 to 255 samples in steps of 1 sample
Memory depth	32 up to installed memory in steps of 32
Posttrigger	32 up to 128 M in steps of 32
Multiple Recording segmentsize	32 up to installed memory / 2 in steps of 32

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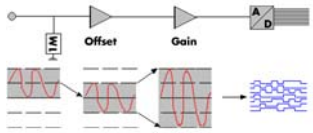
Possibilities and options

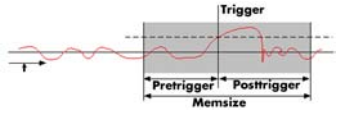
PXI bus
The PXI bus (PCI eXtension for instrumentation) offers a variety of additional normed possibilities for synchronising different components in one system. It is posible to connect several Spectrum cards with each other as well as to connect a Spectrum card with cards of other manufacturers.

PXI reference clock
The card is able to use the 10 MHz reference clock that is supplied by the PXI system. Enabled by software the PXI reference clock is feeded in the on-board PLL. This feature allows the cards to run with a fixed phase relation.

PXI trigger
The Spectrum cards support star trigger as well as the PXI trigger bus. using a simple software commend one or more trigger lines can be used as trigger source. This feature allows the easy setup of OR connected triggers from different cards.

Input Amplifier


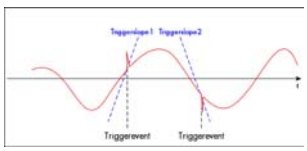
The analog inputs can be adapted to real world signals using a wide variety of settings that are individual for each channel. By using software commands one can select a matching input range and the signal offset can be compensated.

Ring buffer mode


The ring buffer mode is the standard mode of all oscilloscope boards. Data is written in a ring memory of the board until a trigger event is detected. After the event the posttrigger values are recorded. Because of this continuously recording into a ring buffer there are also samples prior to the trigger event visible: Pretrigger = Memsize - Posttrigger.

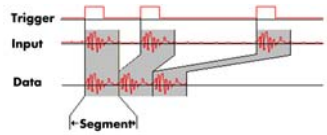
FIFO mode
The FIFO mode is designed for continuous data transfer between measurement board and PC memory (up to 100 MB /s) or hard disk (up to 50 MB/s). The control of the data stream is done automatically by the driver on interrupt request.

Channel trigger
The data acquisition boards offer a wide variety of trigger modes. Besides the standard signal checking for level and edge as known from oscilloscopes it's also possible to define a window trigger. All trigger modes can be combined with the pulsewidth trigger. This makes it possible to trigger on signal errors like too long or too short pulses.

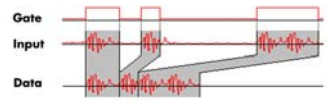
Spike trigger

When using the spike trigger mode, the difference between two samples is checked whether being higher than the programmed limit or not. This can be useful to trigger e.g. on noise coming from a power supply.

External trigger I/O
All boards can be triggered using an external TTL signal. It's possible to use positive or negative edge also in combination with a programmable pulse width. An internally recognised trigger event can - when activated by software - be routed to the trigger connector to start external instruments.

Pulse width
Defines the minimum or maximum width that a trigger pulse must have to generate a trigger event. Pulse width can be combined with channel trigger, pattern trigger and external trigger.

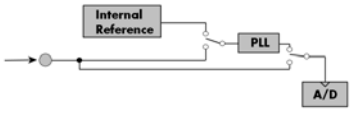
Multiple Recording


The Multiple Recording option allows the recording of several trigger events without restarting the hardware. With this option very fast repetition rates can be achieved. The on-board memory is divided in several segments of same size. Each of them is filled with data if a trigger event occurs.

Gated Sampling


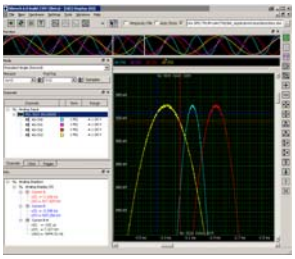
The Gated Sampling option allows data recording controlled by an external gate signal. Data is only recorded if the gate signal has a programmed level.

External clock I/O
Using a dedicated connector a sampling clock can be fed in from an external system. It's also possible to output the internally used sampling clock to synchronise external equipment to this clock.

Reference clock


The option to use a precise external reference clock (normally 10 MHz) is necessary to synchronize the board for high-quality measurements with external equipment (like a signal source). It's also possible to enhance the quality of the sampling clock in this way. The driver automatically generates the requested sampling clock from the fed in reference clock.

Differential inputs
With a simple software command the inputs can individually be switched from single-ended (in relation to ground) to differential, without loosing any inputs. When the inputs are used in differential mode the A/D converter measures the difference between two lines with relation to system ground.

SBench 6

A base licence of SBench 6 the easy-to-use graphical operating software for the Spectrum cards is included in the delivery. Using the base license ist is possible to test the card and to show acquired data. There are also some basic measurement functions included in the base license. The card comes with a demo license for the professional version giving the user the oportunity to test the features of the professional version with the new hardware. Existing customers have the oportunity to request a demo license for the professional version at Spectrum. The professional version contains several new measurement functions, FFT, import and exporr (including MATLAB and ASCII) as well as the streaming modes. The data streaming modes allow to continuously acquire data to hard disk. SBench 6 has been optimized to handle data files of several GByte. More details on SBench 6 are found in the dedicated SBench 6 data shett. The version 6 is running under Windows as well as under Linux (KDE and GNOME). A test version of SBench 6 is freely available in the internet. This test version will also operate with demo cards and can be tested as Professional version without any hardware installed.

Technical Data

Analog Inputs

Resolution	16 bit (±32000 values)
Inputs	True differential / single-ended
Differential non linearity (DNL)	464x: ±2 LSB, all others ±1 LSB (ADC)
Integral non linearity (INL)	465x: ±2 LSB, all others ±1 LSB (ADC)
Offset error (full speed)	≤ 1 LSB (after calibration)
Gain error (full speed)	≤ 0.1% (after calibration)
Programmable input offset	±5 V for single-ended ranges < ±10 V
Crosstalk: all ranges 100 kHz signal	≤ -110 dB on adjacent channels, 50 ohm term.
Analog Input impedance	1 MOhm against GND
Over voltage protection	±30 V all ranges (activated card)
CMRR for ±50 mV to ±500 mV	> 70 dB
CMRR for ±1 V to ±10 V	> 46 dB
Connector (analog)	MMCX female
Connector (trigger/clock)	3 mm SMB male

Power consumption (max speed)	**3,3 V**	**5 V**	**-12 V**	**+12 V**	**Total**
MX.46x0 (8 MS memory)	1.0 A	0.9 A	-	-	7.8 W
MX.46x1 (8 MS memory)	1.2 A	1.4 A	-	-	11.0 W
MX.4651 (64 MS memory),max power	1.6 A	1.4 A	-	-	12.3 W

Trigger input:Standard TTL level	Low: -0.5 > level < 0.8 V High: 2.0 V > level < 5.5 V Trigger pulse must be valid ≥ 2 clock periods.
Trigger output	Standard TTL, capable of driving 50 Ohm. Low < 0.4 V (@ 20 mA, max 64 mA) High > 2.4 V (@ -20 mA, max -48 mA) One positive edge after the first internal trigger

Ext. clock: delay to internal clock	42 ns ± 2 ns

Trigger

Multi: Trigger to 1st sample delay	fixed
Multi: Recovery time	< 20 samples
ext. Trigger accuracy	1 Sample
int. Trigger accuracy	1 Sample
input signal with 50 ohm termination	max 5 V rms
Trigger output delay	1 Sample

Environmental and Physical details

Dimension	160 mm x 100 mm (Standard 3U)
Width (standard board)	1 slot
Warm up time	10 minutes
Operating temperature	0°C - 50°C
Storage temperature	-10°C - 70°C
Humidity	10% to 90%
MTBF	80000 hours

Certifications and Compliances

EMC Immunity	Compliant with CE Mark
EMC Emission	Compliant with CE Mark

Clock input: Standard TTL level	Low: -0.5 V > level < 0.8 V High: 2.0 V > level < 5.5 V Rising edge. Duty cycle: 50% ± 5%
Clock output	Standard TTL, capable of driving 50 Ohm Low < 0.4 V (@ 20 mA, max 64 mA) High > 2.4 V (@ -20 mA, max -48 mA)

Dynamic Parameters

	MX.4620	MX.4621	MX.4630	MX.4631	MX.4640	MX.4641	MX.4650	MX.4651
Min internal clock	1 kS/s		1 kS/s		1 kS/s		1 kS/s	
Max internal clock	200 kS/s		500 kS/s		1 MS/s		3 MS/s	
Min external clock (special clock mode)	DC (DC)		DC (DC)		1 kS/s (DC)		1 kS/s (DC)	
Max external clock (special clock mode)	200 kS/s (200 kS/S)		500 kS/s (500 kS/s)		1 MS/s (800 kS/s)		3 MS/s (2 MS/s)	
-3 dB bandwidth	>100 kHz		>250 kHz		>500 kHz		>1.5 MHz	
Zero noise level (Range ≥ ±500 mV)	< 0.8 LSB rms		< 0.9 LSB rms		< 1.1 LSB rms		< 3.0 LSB rms	
Zero noise level (Range < ±500 mV)	< 8 uV rms		< 10 uV rms		< 17 uV rms		< 30 uV rms	
Test - sampling rate	200 kS/s		500 kS/s		1 MS/s		3 MS/s	
Test signal frequency	10 kHz		10 kHz		10 kHz		10 kHz	
SNR (typ)	91.8 dB	91.5 dB	91.2 dB	91.0 dB	91.0 dB	90.7 dB	84.0 dB	82.5 dB
THD (typ)	-102.0 dB	-101.7 dB	-101.8 dB	-101.6 dB	-101.5 dB	-100.8 dB	-94.5 dB	-90.1 dB
SFDR (typ), excl. harm.	112.0 dB	111.5 dB	112.0 dB	111.5 dB	112.0 dB	111.2 dB	107.0 dB	105.5 dB
ENOB (based on SNR)	15.0 bit	14.9 bit	14.9 bit	14.8 bit	14.8 bit	14.7 bit	13.6 bit	13.4 bit
ENOB (based on SINAD)	14.9 bit	14.8 bit	14.8 bit	14.7 bit	14.7 bit	14.6 bit	13.5 bit	13.3 bit

Dynamic parameters are measured at ±5 V input range (if no other range is stated) and 1 MOhm termination with the sampling rate specified in the table. Measured parameters are averaged 20 times to get typical values. Test signal is a pure sine wave of the specified frequency with > 99% amplitude. SNR and RMS noise parameters may differ depending on the quality of the used PC. SNR = Signal to Noise Ratio, THD = Total Harmonic Distortion, SFDR = Spurious Free Dynamic Range, SINAD = Signal Noise and Distortion, ENOB = Effective Number of Bits. For a detailed description please see application note 002.

Order Information

Versions

Order no.	Standard mem	1 channel	2 channels	4 channels
MX.4620	8 MSample	200 kS/s	200 kS/s	
MX.4621	8 MSample	200 kS/s	200 kS/s	200 kS/s
MX.4630	8 MSample	500 kS/s	500 kS/s	
MX.4631	8 MSample	500 kS/s	500 kS/s	500 kS/s
MX.4640	8 MSample	1 MS/s	1 MS/s	
MX.4641	8 MSample	1 MS/s	1 MS/s	1 MS/s
MX.4650	8 MSample	3 MS/s	3 MS/s	
MX.4651	8 MSample	3 MS/s	3 MS/s	3 MS/s

Memory

Order no.	Option
MX.4xxx-16M	Memory upgrade to 16 MSample (32 MB) of total memory
MX.4xxx-32M	Memory upgrade to 32 MSample (64 MB) of total memory
MX.4xxx-64M	Memory upgrade to 64 MSample (128 MB) of total memory
MX.4xxx-up	Additional fee for later memory upgrade

Options

Order no.	Option
MX.4xxx-mr	Option Multiple Recording
MX.4xxx-gs	Option Gated Sampling

Cables

Order no.	Option
Cab-1m-9m-80	Adapter cable MMCX male to BNC male, 80 cm (for analog inputs)
Cab-1m-9f-80	Adapter cable MMCX male to BNC female, 80 cm (for analog inputs)
Cab-1m-9m-200	Adapter cable MMCX male to BNC male, 200 cm (for analog inputs)
Cab-1m-9f-200	Adapter cable MMCX male to BNC female, 200 cm (for analog inputs)
Cab-1m-9f-5	Adapter cable MMCX male to BNC female, 5 cm (short cable especially for oscilloscope probes)
Cab-3f-9m-80	Adapter cable SMB female to BNC male, 80 cm (for clock and trigger I/O)
Cab-3f-9f-80	Adapter cable SMB female to BNC female, 80 cm (for clock and trigger I/O)
Cab-3f-3f-80	Adapter cable SMB female to SMB female, 80 cm (for clock and trigger I/O)
Cab-3f-9m-200	Adapter cable SMB female to BNC male, 200 cm (for clock and trigger I/O)
Cab-3f-9f-200	Adapter cable SMB female to BNC female, 200 cm (for clock and trigger I/O)
Cab-3f-3f-200	Adapter cable SMB female to SMB female, 200 cm (for clock and trigger I/O)

Drivers

Order no.	Option
MATLAB	MATLAB driver for all MI/MC/MX/PCI cards
MX.46xx-lv	LabVIEW driver for all MX.46xx cards
MX.46xx-dl	DASYLab driver for all MX.46xx cards
MX.46xx-vee	Agilent VEE driver for all MX.46xx cards

Technical changes and printing errors possible