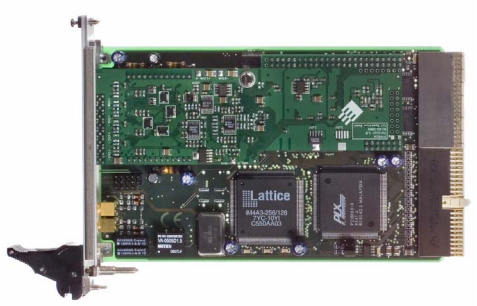
MX.46xx - four channel 16 bit high-speed A/D

- **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 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

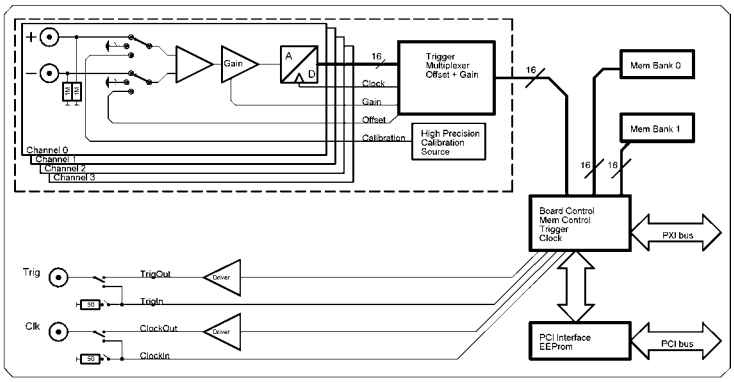
A large number of drivers and examples are delivered with the board:

- Windows NT/2000 32 bit drivers
- Windows XP/Vista/7/8/10, 32 and 64 bit driver
- Linux 32bit and 64bit drivers
- SBench 6.x Base version for Windows and Linux
- Visual C++/Borland C++ Builder examples
- Borland Delphi examples
- Microsoft Visual Basic & Excel examples
- Python examples
- LabWindows/CVI examples
- LabVIEW - drivers and examples
- MATLAB - drivers and examples
- Other 3rd party drivers (e.g. VEE,DASYLab) are partly available upon request

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, 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

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.

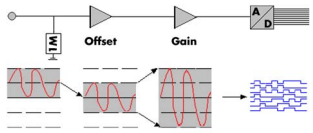
PXI reference clock

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

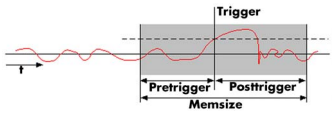
The Spectrum cards support star trigger as well as the PXI trigger bus. using a simple software commend one or more trigger lines can be used as trigger source. This feature allows the easy setup of OR connected triggers from different cards.

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 instruments. Digitized data is continuously written into a ring memory until a trigger event is detected. After the trigger, post-trigger samples are recorded and pre-trigger samples can also be stored. The number of pre-trigger samples available simply equals the total ring memory size minus the number of post trigger samples.

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.

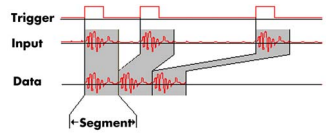
External trigger I/O

All instruments 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

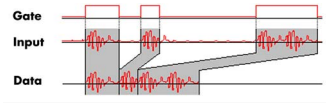
Defines the minimum or maximum width that a trigger pulse must have to generate a trigger event. Pulse width can be combined with channel trigger, pattern trigger and external trigger.

Multiple Recording



The Multiple Recording mode 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

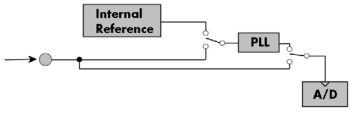


The Gated Sampling mode allows data recording controlled by an external gate signal. Data is only recorded if the gate signal has a programmed level.

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

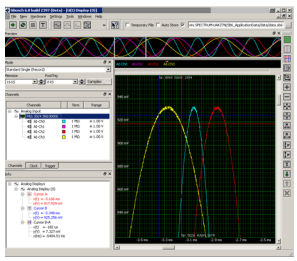
Differential inputs

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.

Automatic on-board calibration

All of the channels are calibrated in factory before the board is shipped. To compensate for different variations like PC power supply, temperature and aging, the software driver provides routines for an automatic onboard offset and gain calibration of all input ranges. All the cards contain a high precision on-board calibration reference.

SBench 6



A base license of SBench 6, the easy-to-use graphical operating software for Spectrum cards, is included in the delivery. The base license makes it is possible to test the card, display acquired data and make some basic measurements. It's a valuable tool for checking the card's performance and assisting with the unit's initial setup. The cards also come with a demo license for the SBench 6 professional version. This license gives the user the opportunity to test the additional features of the professional version with their hardware. The professional version contains several advanced measurement functions, such as FFTs and X/Y display, import and export utilities as well as support for all acquisition modes including data streaming. Data streaming allows the cards to continuously acquire data and transfer it directly to the PC RAM or hard disk. SBench 6 has been optimized to handle data files of several

GBytes. SBench 6 runs under Windows as well as Linux (KDE, GNOME and Unity) operating systems. A test version of SBench 6 can be downloaded directly over the internet and can run the professional version in a simulation mode without any hardware installed. Existing customers can also request a demo license for the professional version from Spectrum. More details on SBench 6 can be found in the SBench 6 data sheet.

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)	≤ 0.1% (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 (32 MS memory)	1.0 A	0.9 A	-	-	7.8 W
MX.46x1 (32 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

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 to 50°C
Storage temperature	-10°C to 70°C
Humidity	10% to 90%
MTBF	80000 hours
Certifications and Compliances	
EMC Immunity	Compliant with CE Mark
EMC Emission	Compliant with CE Mark

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
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

The card is delivered with 32 MSample on-board memory and supports standard mode (Scope) and FIFO mode (streaming). Operating system drivers for Windows/Linux 32 bit and 64 bit, examples for C/C++, LabVIEW (Windows), MATLAB (Windows), LabWindows/CVI, Delphi, Visual Basic, Python and a Base license of the oscilloscope software SBench 6 are included. Drivers for other 3rd party products like VEE or DASYLab may be available on request.

Adapter cables are not included. Please order separately!

Versions

Order no.	Standard mem	1 channel	2 channels	4 channels
MX.4620	32 MSample	200 kS/s	200 kS/s	
MX.4621	32 MSample	200 kS/s	200 kS/s	200 kS/s
MX.4630	32 MSample	500 kS/s	500 kS/s	
MX.4631	32 MSample	500 kS/s	500 kS/s	500 kS/s
MX.4640	32 MSample	1 MS/s	1 MS/s	
MX.4641	32 MSample	1 MS/s	1 MS/s	1 MS/s
MX.4650	32 MSample	3 MS/s	3 MS/s	
MX.4651	32 MSample	3 MS/s	3 MS/s	3 MS/s

Memory

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

Cables

		Order no.				
for Connections	Length	to BNC male	to BNC female	to SMA male	to SMA female	to SMB female
Analog Inputs	80 cm	Cab-1m-9m-80	Cab-1m-9f-80	Cab-1m-3mA-80	Cab-1m-3fA-80	Cab-1m-3f-80
Analog Inputs	200 cm	Cab-1m-9m-200	Cab-1m-9f-200	Cab-1m-3mA-200	Cab-1m-3fA-200	Cab-1m-3f-200
Probes (short)	5 cm		Cab-1m-9f-5			
Trigger/Clock I/O	80 cm	Cab-3f-9m-80	Cab-3f-9f-80	Cab-3f-3mA-80	Cab-3f-3fA-80	Cab-3f-3f-80
Trigger/Clock I/O	200 cm	Cab-3f-9m-200	Cab-3f-9f-200	Cab-3f-3mA-200	Cab-3f-3fA-200	Cab-3f-3f-200

Software SBench6

Order no.	
SBench6	Base version included in delivery. Supports standard mode for one card.
SBench6-Pro	Professional version for one card: FIFO mode, export/import, calculation functions
SBench6-Multi	Option multiple cards: Needs SBench6-Pro. Handles multiple synchronized cards in one system.
Volume Licenses	Please ask Spectrum for details.

Technical changes and printing errors possible