MC.46xx - 8 channel 16 bit high-speed A/D

- **CompactPCI 6U format**
- **2, 4 or 8 channels with 16 bit resolution per card**
- **Versions with 200 kS/s up to 3 MS/s**
- **Simultaneously sampling on all channels**
- **Software selectable single-ended or differential inputs**
- **Separate ADC and amplifier per channel**
- **complete on-board calibration**
- **8 input ranges: ±50 mV up to ±10 V**
- **Up to 256 MSample (512 MByte) on-board memory**
- **Sustained streaming mode up to 100 MB/s**
- **Window, pulse width, OR/AND trigger**
- **Programmable input offset of ±5 V**
- **Synchronization option available for up to 16 cards**

Product range overview

Model	1 channel	2 channels	4 channels	8 channels
MC.4620	200 kS/s	200 kS/s		
MC.4621	200 kS/s	200 kS/s	200 kS/s	
MC.4622	200 kS/s	200 kS/s	200 kS/s	200 kS/s
MC.4630	500 kS/s	500 kS/s		
MC.4631	500 kS/s	500 kS/s	500 kS/s	
MC.4632	500 kS/s	500 kS/s	500 kS/s	500 kS/s
MC.4640	1 MS/s	1 MS/s		
MC.4641	1 MS/s	1 MS/s	1 MS/s	
MC.4642	1 MS/s	1 MS/s	1 MS/s	1 MS/s
MC.4650	3 MS/s	3 MS/s		
MC.4651	3 MS/s	3 MS/s	3 MS/s	
MC.4652	3 MS/s	3 MS/s	3 MS/s	3 MS/s

Software/Drivers

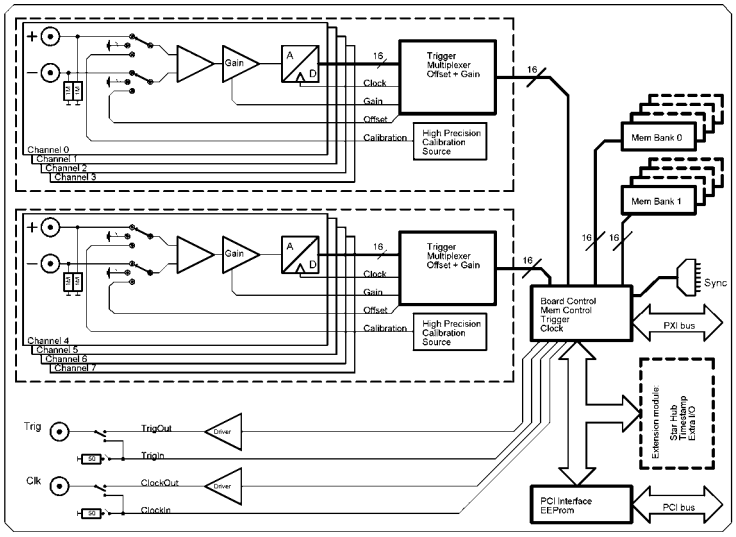
A large number of drivers and examples are delivered with the board:

- 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 MC.46xx for the first time offers 16 bit resolution synchronously on all channels at 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 using the software. The user will find easily a matching solution from the 12 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 have two, four or eight channels and can also be updated to a multi-channel system using the internal synchronization bus.

Hardware block diagram

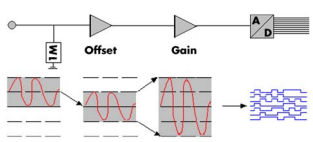


Software programmable parameters

Sampling rate	1 kS/s to max sampling rate, external clock, ref 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
Clock impedance	50 Ohm / high impedance (> 4 kOhm)
Trigger impedance	50 Ohm / high impedance (> 4 kOhm)
Trigger mode	Channel, External, Software, Auto, Window, Pulse
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

Input Amplifier

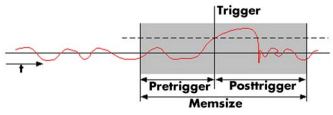


The analog inputs can be adapted to real world signals using a wide variety of settings that are individual for each channel. By using software commands one can select a matching input range and the signal offset can be compensated.

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.

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.

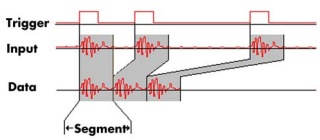
External trigger I/O

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

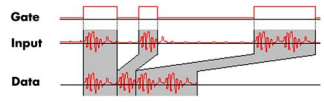
Defines the minimum or maximum width that a trigger pulse must have to generate a trigger event. Pulse width can be combined with channel trigger, pattern trigger and external trigger.

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

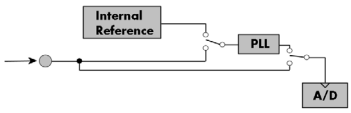


The Gated Sampling mode allows data recording controlled by an external gate signal. Data is only recorded if the gate signal has a programmed level.

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.

Cascading

The cascading option synchronises up to 4 Spectrum boards internally. It's the easiest way to build up a multi channel system. There is a phase delay between two boards of about 500 pico seconds when this synchronisation option is used.

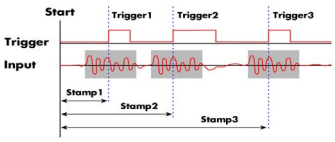
Star-Hub

The star-hub is an additional module allowing the phase stable synchronisation of up to 16 boards. Independent of the number of boards there is no phase delay between all channels. The star hub distributes trigger and clock information between all boards. As a result all connected boards are running with the same clock and the same trigger.

Extra I/O

The Extra I/O module adds 24 additional digital I/O lines and 4 analog outputs on an extra connector. These additional lines are independent from the standard function and can be controlled asynchronously. There is also an internal version available with 16 digital I/Os and 4 analog outputs that can be used directly at the rear board connector.

Timestamp

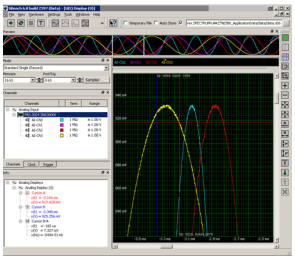


The timestamp function writes the time positions of the trigger events in an extra memory. The timestamps are relative to the start of recording, a defined zero time, externally synchronized to a radio clock, an IRIG-B a GPS receiver. Using the external synchronization gives a precise time relation for acquisitions of systems on different locations.

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 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.

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Technical Data

Analog Inputs	
Resolution	16 bit (±32000 values)
Inputs	True differential / single-ended
Differential non linearity (DNL)	465x: ±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 type (standard analog)	MMCX female
Connector type (standard trigger/clock)	3 mm SMB male

Environmental and Physical details					
Dimension	160 mm x 233 mm (Standard 6U)				
Width (standard board)	1 slot				
Width (with star hub)	2 slots				
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				
Power consumption (max speed)	**3,3 V**	**5 V**	**-12 V**	**+12 V**	**Total**
MC.46x0 (32 MS memory)	0.5 A	0.9 A	n.u.	n.u.	6.2 W
MC.46x1 (32 MS memory)	0.7 A	1.4 A	n.u.	n.u.	9.3 W
MC.46x2 (32 MS memory)	0.8 A	2.4 A	n.u.	n.u.	14.6 W
MC.4652 (256 MS memory),max power	2.4 A	2.4 A	n.u.	n.u.	19.9 W

Clock	
Internal clock range (PLL mode)	1 kS/s to max (see table below)
Internal clock accuracy	≤ 50 ppm
Internal clock setup granularity	≤1% of range (10M, 1M, 100k, 10k, ...)
Reference clock: external clock range	≥ 1.0 MHz and ≤ 125.0 MHz
External clock: delay to internal clock	42 ns ± 2 ns
External clock type	3.3V LVTTL compatible (5V tolerant)
External clock input levels	Low ≤ 0.8 V, High ≥ 2.0 V
External clock input duty cycle	45% - 55%
External clock input sampling edge	Rising edge
External clock input maximum voltage	-0,5 V up to + 5.5V
External clock output levels	Low ≤ 0.4 V, High ≥ 2.4 V, TTL compat.
External clock output drive strength	Low ≤ 0.8 V, High ≥ 2.0 V, ≥ 2 clocks

Trigger	
Multi: Trigger to 1st sample delay	fixed
Multi: Recovery time	< 20 samples
Internal/External trigger accuracy	1 Sample
External trigger type	3.3V LVTTL compatible (5V tolerant)
External trigger input	Low ≤ 0.8 V, High ≥ 2.0 V, ≥ 2 clocks
External trigger maximum voltage	-0.5 V up to +5.5 V
External trigger output drive strength	Low: 64 mA, High: -48 mA
External trigger output levels	Low ≤ 0.4 V, High ≥ 2.4 V, TTL compat.
Trigger output delay	1 Sample

Certifications and Compliances	
EMC Immunity	Compliant with CE Mark
EMC Emission	Compliant with CE Mark

Dynamic Parameters

	MC.4620	MC.4621 MC.4622	MC.4630	MC.4631 MC.4632	MC.4640	MC.4641 MC.4642	MC.4650	MC.4651 MC.4652
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	8 channels
MC.4620	32 MSample	200 kS/s	200 kS/s		
MC.4621	32 MSample	200 kS/s	200 kS/s	200 kS/s	
MC.4622	32 MSample	200 kS/s	200 kS/s	200 kS/s	200 kS/s
MC.4630	32 MSample	500 kS/s	500 kS/s		
MC.4631	32 MSample	500 kS/s	500 kS/s	500 kS/s	
MC.4632	32 MSample	500 kS/s	500 kS/s	500 kS/s	500 kS/s
MC.4640	32 MSample	1 MS/s	1 MS/s		
MC.4641	32 MSample	1 MS/s	1 MS/s	1 MS/s	
MC.4642	32 MSample	1 MS/s	1 MS/s	1 MS/s	1 MS/s
MC.4650	32 MSample	3 MS/s	3 MS/s		
MC.4651	32 MSample	3 MS/s	3 MS/s	3 MS/s	
MC.4652	32 MSample	3 MS/s	3 MS/s	3 MS/s	3 MS/s

Memory

Order no.	Option
MC.4xxx-64M	Memory upgrade to 64 MSample (128 MB) of total memory
MC.4xxx-128M	Memory upgrade to 128 MSample (256 MB) of total memory
MC.4xxx-256M	Memory upgrade to 256 MSample (512 MB) of total memory
MC.4xxx-up	Additional fee for later memory upgrade

Options

Order no.	Option
MC.4xxx-cs	Option Cascading: Synchronization of up to 4 cards (one option needed per system)
MC.4xxx-smod (1)	Option Star-Hub:Synchronization of up to 16 cards (one option needed per system)
MC.4xxx-time (1)	Option Timestamp: Recording of trigger timestamps in an extra memory
MC.xxxx-xmf (1)	Option Extra I/O with external connector, 24 digital I/O + 4 analog outputs. Including one cable Cab-d40-idc-100.

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.

(1) : Just one of the options can be installed on a card at a time.
(2) : Third party product with warranty differing from our export conditions. No volume rebate possible.

Technical changes and printing errors possible