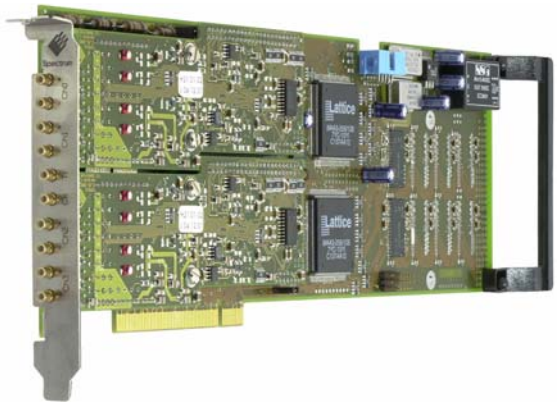
SPECTRUM
SYSTEMENTWICKLUNG MICROELECTRONIC GMBH

MI.45xx - 4 channel 16 bit high-speed A/D

- **StandardPCI format**
- **Fastest 16 bit A/D converter board**
- **Models with 200 kS/s, 500 kS/s or 1 MS/s on 2 or 4 channels**
- **Simultaneous sampling on all channels**
- **4 input ranges: ±1 V up to ± 10 V**
- **Differential / single-ended selectable**
- **Up to 256 MSample memory**
- **FIFO mode**
- **Window and pulsewidth trigger**
- **Input offset up to ±100%**
- **Synchronization possible**
- **Windows program SBench included**



Product range overview

Model	1 channel	2 channels	4 channels
MI.4520	200 kS/s	200 kS/s	
MI.4521	200 kS/s	200 kS/s	200 kS/s
MI.4530	500 kS/S	500 kS/s	
MI.4531	500 kS/s	500 kS/s	500 kS/s
MI.4540	1 MS/s	1 MS/s	
MI.4541	1 MS/s	1 MS/s	1 MS/s

Software/Drivers

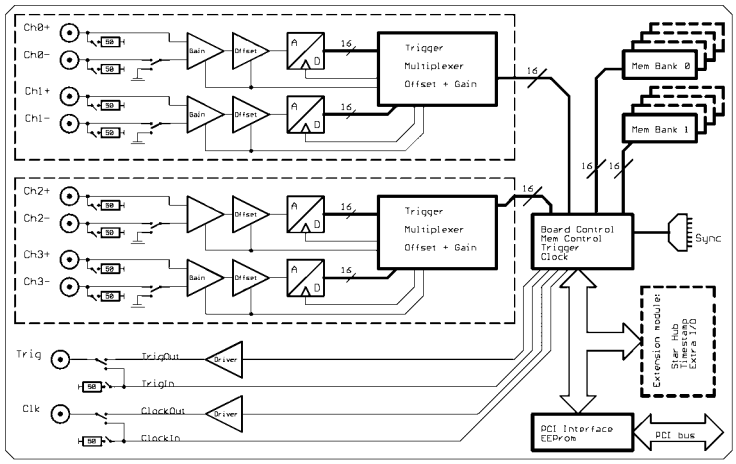
A large number of drivers and examples are delivered with the board or are available as an option:

- Windows NT/2000 32 bit drivers
- Windows XP/Vista/7 32 and 64 bit drivers
- 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 examples
- Microsoft Excel examples
- LabWindows/CVI examples
- LabVIEW - drivers (as option)
- DASYLab - drivers (as option)
- MATLAB - drivers (as option)
- Agilent VEE - drivers (as option)

General Information

The MI.45xx for the first time offers full 16 bit resolution synchronously on all channels at very high samplerates. 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 could be offset calibrated using the software. The user will easily find a matching solution from the six offered models. These versions are working with samplerates of 200 kS/s, 500 kS/s or 1 MS/s. The boards have two or four channels and could also be updated to a multichannel system using the internal synchronization bus.

Hardware block diagram



Software programmable parameters

Samplerate	1 kS/s to max samplerate, external clock, ref clock
Input Range	±1 V, ±2 V, ±5 V, ±10 V
Input impedance	50 Ohm / 1 MOhm
Input type	Single-ended, differential
Input Offset	±100% in steps of 1%
Clock mode	internal PLL, int.quartz, external, ext. divided, ext. reference clock
Clock impedance	50 Ohm / 1 MOhm
Trigger impedance	50 Ohm / 1 MOhm
Trigger mode	Channel, External, Software, Auto, Windows, Pulse
Trigger level	1/2048 to 2047/2048 of input range
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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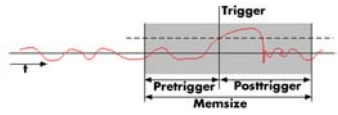
Possibilities and options

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.

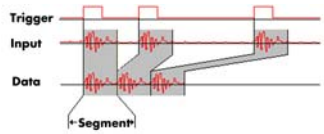
External trigger I/O

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

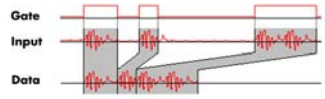
Defines the minimum or maximum width that a trigger pulse must have to generate a trigger event. Pulse width can be combined with channel trigger, pattern trigger and external trigger.

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

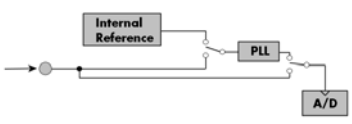


The Gated Sampling option allows data recording controlled by an external gate signal. Data is only recorded if the gate signal has a programmed level.

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.

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.

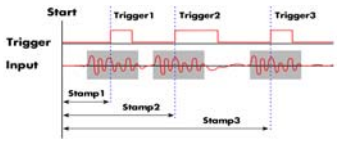
Star-Hub

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 option 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 synchronised to a radio clock, or a GPS receiver. With this option acquisitions of systems on different locations can be set in a precise time relation.

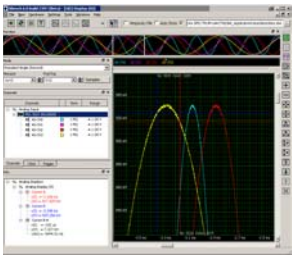
Input impedance

All inputs could individually be switched by software between 50 Ohm and 1 MOhm input impedance. If using fast signals and high sampling rates or have 50 Ohm cable impedance the use of the 50 Ohm termination is recommended to minimise noise and signal reflections. If using weak signal sources or standard probes the use of the 1 MOhm termination is helpful.

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

Resolution	16 bit	Dimension	312 mm x 107 mm
Differential linearity error	< 1 LSB (ADC)	Width (Standard board)	1 full size slot
Integral linearity error	< 2.5 LSB (ADC)	Width (with star hub option)	2 full size slots
Multi: Trigger to 1st sample delay	fixed	Connector	3 mm SMB male
Multi: Recovery time	< 20 samples	Inputs	Differential / Single Ended
ext. Trigger accuracy	1 Sample	Input impedance	50 Ohm / 1 MOhm || 25 pF
int. Trigger accuracy	1 Sample	Overvoltage protection (all ranges)	±40 V
input signal with 50 ohm termination	max 5 V rms	Warm up time	10 minutes
Trigger output delay	1 Sample	Operating temperature	0°C - 50°C
Offset error	< 1 LSB, adjustable by user	Storage temperature	-10°C - 70°C
Gain error	< 1%	Humidity	10% to 90%
Noise @ full speed, 50 ohm termination	< 2.5 LSB rms	Power consumption -12 V	max 100 mA (1.2 Watt)
Crosstalk @ 20 kHz	< -95 dB	Power consumption +12 V	max 100 mA (1.2 Watt)
Ext. clock: delay to internal clock	42 ns ± 2 ns	Power consumption 5 V @ full speed	max 1.8 A (9 Watt)
Max common mode voltage	±8 V (differntial inputs)	Power consumption 5 V @ power down	max 1.4 A (7 Watt)
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.	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%
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 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)

	MI.4520 MI.4521	MI.4530 MI.4531	MI.4540 MI.4541
Min internal clock	1 kS/s	1 kS/s	1 kS/s
Max internal clock	200 kS/s	500 kS/s	1 MS/s
Min external clock	DC	DC	1 kS/s
Max external clock	200 kS/s	500 kS/s	1 MS/s
-3 dB bandwidth	>100 kHz	>250 kHz	>500 kHz

Dynamic Parameters

	MI.4520 MI.4521	MI.4530 MI.4531	MI.4540 MI.4541
Test - Samplerate	200 kS/s	500 kS/s	1 MS/s
Testsignal frequency			
SNR (typ)			
THD (typ)			
SFDR (typ), incl harm.			
SINAD (typ)			
ENOB (based on SINAD)			

Dynamic parameters are measured at ± 1 V input range (if no other range is stated) and 50 Ohm termination with the samplerate 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

Order No	Description	Order No	Description
MI4520	MI.4520 with 8 MSample memory and drivers/SBench 5.x	MI4xxx-16M	Option: 16 MSample memory instead of 8 MSample standard mem
MI4521	MI.4521 with 8 MSample memory and drivers/SBench 5.x	MI4xxx-32M	Option: 32 MSample memory instead of 8 MSample standard mem
MI4530	MI.4530 with 8 MSample memory and drivers/SBench 5.x	MI4xxx-64M	Option: 64 MSample memory instead of 8 MSample standard mem
MI4531	MI.4531 with 8 MSample memory and drivers/SBench 5.x	MI4xxx-128M	Option: 128 MSample memory instead of 8 MSample standard mem
MI4540	MI.4540 with 8 MSample memory and drivers/SBench 5.x	MI4xxx-256M	Option: 256 MSample memory instead of 8 MSample standard mem
MI4541	MI.4541 with 8 MSample memory and drivers/SBench 5.x	MI4xxx-up	Additional handling costs for later memory upgrade
MI4xxx-smod	Star Hub: Synchronisation of 2 - 16 boards, one option per system	MI4xxx-mr	Option Multiple Recording: Memory segmentation
MIxxxx.xio	Extra I/O, internal connector: 16 DI/O, 4 Analog out	MI4xxx-gs	Option Gated Sampling: Gate signal controls acquisition
MI4xxx-time	Timestamp option: Extra memory for trigger time	MI4xxx-cs	Synchronisation of 2 - 4 boards, one option per system
MIxxxx-xmf	Extra I/O, external connector: 24 DI/O, 4 Analog out, incl. cable		
Cab-3f-9m-80	Adapter cable: SMB female to BNC male 80 cm	MI45xx-dl	DASYLab driver for MI.45xx series
Cab-3f-9m-200	Adapter cable: SMB female to BNC male 200 cm	MI45xx-hp	VEE driver for MI.45xx series
Cab-3f-9f-80	Adapter cable: SMB female to BNC female 80 cm	MI45xx-lv	LabVIEW driver for MI.45xx series
Cab-3f-9f-200	Adapter cable: SMB female to BNC female 200 cm	MATLAB	MATLAB driver for all MI.xxxx, MC.xxxx and MX.xxxx series.

Technical changes and printing errors possible