MC.60xx - 14 bit 125 MS/s Arbitrary Waveform Generator

- **CompactPCI 6U format**
- **Fast 14 bit arbitrary waveform generator**
- **Models with 20 MS/s, 60 MS/s or 125 MS/s**
- **1, 2 or 4 channel versions**
- **Simultaneous sampling on all channels**
- **Output up to ± 3 V in 50 Ohm**
- **Amplifier option available for ±10 V**
- **Offset and amplitude programmable**
- **3 software selectable filters**
- **Up to 256 MSample memory**
- **FIFO mode**
- **Synchronization possible**
- **Bank Switching mode**

Product range overview

Model	1 channel	2 channels	4 channels
MC.6011	20 MS/s	20 MS/s	
MC.6012	20 MS/s	20 MS/s	20 MS/s
MC.6021	60 MS/s	60 MS/s	
MC.6022	60 MS/s	60 MS/s	60 MS/s
MC.6030	125 MS/s		
MC.6031	125 MS/s	125 MS/s	
MC.6033	125 MS/s	60 MS/s	
MC.6034	125 MS/s	125 MS/s	60 MS/s

Software/Drivers

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

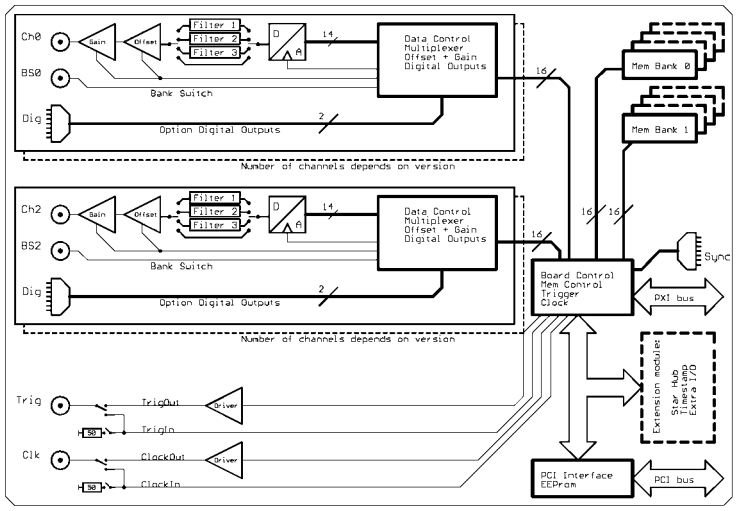
- Windows NT/2000 32 bit drivers
- Windows XP/Vista/7/8/10, 32 and 64 bit driver
- Linux 32bit and 64bit drivers
- SBench 6.x Base version for Windows and Linux
- Microsoft Visual C++ examples
- Borland Delphi examples
- Microsoft Visual Basic & Excel examples
- Python examples
- LabWindows/CVI examples
- 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.60xx series offer 8 different versions of arbitrary waveform generators for the CompactPCI bus. With these boards it is possible to generate free definable waveforms on several channels synchronously. There are up to four channels on one board with a maximum sampling rate of 125 MS/s. The internal standard Sync-bus allows the setup of synchronous multi channel systems with higher channel numbers. It is also possible to combine the arbitrary waveform generator with other boards of the MC product family like analogue or digital acquisition boards.

With the up to 256 MSample large on-board memory long waveforms can be generated even with high sampling rates. The memory can also be used as a FIFO buffer to make continuously data transfer from PC memory or hard disk.

Hardware block diagram



Software programmable parameters

sampling rate	1 kS/s to max sampling rate, external clock, ref clock
Output amplitude	±100 mV up to ±3 V in 1 mV steps (Amp option: ±333 mV up to ±10 V)
Output offset	±3 V selectable in 1 mV steps (Amp otpion: ±10 V in 3 mV steps)
Filters	no filter or one of 3 different filters as defined in technical data section
Mode	Singleshot, Continuous, Standard, Bank Switching
Clock mode	internal PLL, int.quartz, external, ext. divided, ext. reference clock
Clock impedance	50 Ohm / high impedance (> 4 kOhm)
Trigger impedance	50 Ohm / high impedance (> 4 kOhm)
Trigger mode	External, Software
Memory depth	32 up to installed memory in steps of 32
Posttrigger	32 up to 128 M in steps of 32
Output amplitude	±100 mV up to ±3 V in 1 mV steps
Multiple Replay segmentsize	32 up to installed memory / 2 in steps of 32

Possibilities and options

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.

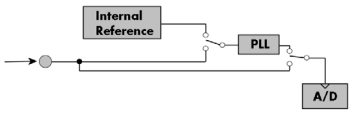
External trigger I/O

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.

External clock I/O

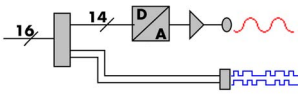
Using a dedicated connector a sampling clock can be fed in from an external system. It's also possible to output the internally used sampling clock to synchronise external equipment to this clock.

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.

Digital marker outputs



This option outputs additional synchronous digital channels phase-stable with the analog data. When this option is installed there are 2 additional digital outputs for every analog D/A channel. The digital data is stored in the upper two bits of the 16 bit data word.

Bank Switching

In bank switching mode two different signals of the same length are written in the on-board memory. Controlled by an external bank signal that is individually available for every channel one of the signals is selected for output. The user can define whether the signal should switch immediately or whether the complete signal should be generated up to the end.

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.

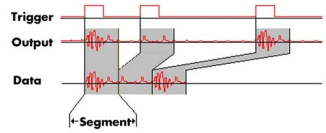
Star-Hub

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

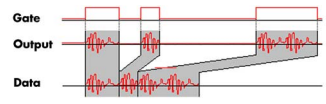
The Extra I/O module adds 24 additional digital I/O lines and 4 analog outputs on an extra connector. These additional lines are independent from the standard function and can be controlled asynchronously. There is also an internal version available with 16 digital I/Os and 4 analog outputs that can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

Multiple Replay



The Multiple Replay mode allows the fast output generation on several trigger events without restarting the hardware. With this option very fast repetition rates can be achieved. The on-board memory is divided into several segments of the same size. Each segment can contain different data which will then be played with the occurrence of each trigger event.

Gated Replay



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

Singleshot output

When singleshot output is activated the data of the on-board memory is played exactly one time. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

Continuous output

When continuous output is activated the data of the on-board memory is replayed continuously until a stop command is executed. As trigger source one can use the external TTL trigger or the software trigger.

±10 V Amplifier

The amplifier board allows the output of ±10 V on up to four channels without software modification. The standard outputs of the card are amplified by factor 3.33. The amplifier which has 30 MHz bandwidth has an output impedance of 50 Ohm. This allows ±10 V with high impedance termination or ±5 V with 50 ohm termination.

Technical Data

Resolution (MC.60xx)	14 bit	Dimension	160 mm x 233 mm (Standard 6U)
Integral linearity (DAC)	± 1.5 LSB typ.	Width (Standard)	1 slot (6U)
Differential linearity (DAC)	± 1.0 LSB typ.	Width (with digital outputs)	2 slots (6U)
Output resistance	< 1 Ohm	Width (with star hub option)	2 slots (6U)
Minimum output load	35 Ohm (not short circuit protected)	Width of Amplifier option	1 slot (3U)
Max output swing in 50 Ohm	± 3 V (offset + amplitude)	Analogue connector	3 mm SMB male
Max slew rate (no filter)	> 0.9 V/ns	Digital connector	40 pol half pitch (Hirose FX2 series)
Multi: Trigger to 1st sample delay	fixed	Digital Outputs delay to analog sample	0 samples (due to internal correction)
Multi: Recovery time	< 20 samples	Digital Outputs voltage and current	Low ≤ 0.4 V, High ≥ 3.8 V, max. ± 8 mA
Ext. clock: delay to internal clock	42 ns ± 2 ns	Warm up time	10 minutes
Output to trigger out delay 1 channel	< 5 MS/s: -5 samples, > 5 MS/s: -21 samples	Operating temperature	0°C to 50°C
Output to trigger out delay 2 channels	< 5 MS/s: -3.5 samples, > 5 MS/s: -12 sampl.	Storage temperature	-10°C to 70°C
Crosstalk @ 1 MHz signal ±3 V	< -80 dB	Humidity	10% to 90%
Output accuracy	< 1%	MTBF	100000 hours
Min internal clock	1 kS/s	Offset stepsize	< 2 mV
Min external clock	DC	Amplitude stepsize	< 1 mV
Bank input:Standard TTL level	Low: -0.5 > level < 0.8 V High: 2.0 V > level < 5.5 V	Power consumption 3.3 V @ full speed	max. 1.51 A (5.0Watt)
		Power consumption 5 V @ full speed	max. 1.53 A (7.7 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)

±10 V Amplifier Card Options

Bandwidth	30 MHz
Max. input voltage	±3 V
Output impedance	50 Ω
Fixed Amplification	x 3.3
Max. Output Voltage (into high impedance load)	±10 V
Max. Output Voltage (into 50 Ohm load)	±5 V
Analog ground to PC system ground impedance	10 kΩ (with ground jumper unplugged), 0 Ω (when ground jumper is plugged)
Gain Error	≤ ±1 %
Offset Error	≤ ±50 mV

PXI Version MX.6xxxx-1Amp/2Amp/4Amp

Interface	PXI 32 Bit 33 MHz (power connection only)
Dimension (PCB without SMB connectors)	3U (160 mm x 100 mm)
Power Consumption 3.3 V	0.0 A
Power Consumption 5.0 V	-1Amp and -2Amp: 2.5 A, -4Amp: 5.0 A

Clock and Filter

	MC.6011 MC.6012	MC.6021 MC.6022	MC.6030 MC.6033	MC.6031 MC.6034
max internal clock	20 MS/s	60 MS/s	125 MS/s	125 MS/s
max external clock	20 MS/s	60 MS/s	125 MS/s	125 MS/s
-3 dB bandwidth no filter	> 10 MHz	> 30 MHz	> 60 MHz	> 60 MHz
Filter 3: Characteristics	4th order Butterworth		5th order Butterworth	
Filter 3: -3 dB bandwidth	5 MHz (typ. 5.4 MHz)	10 MHz (typ. 11.4 MHz)	25 MHz (typ. 26.5 MHz)	25 MHz (typ. 26.5 MHz)
Filter 2: Characteristics	4th order Butterworth		4th order Butterworth	
Filter 2: -3 dB bandwidth	1 MHz (typ. 1.2 MHz)	2 MHz (typ. 2.4 MHz)	5 MHz (typ. 5.8 MHz)	5 MHz (typ. 5.8 MHz)
Filter 1: Characteristics	4th order Butterworth		4th order Butterworth	
Filter 1: -3 dB bandwidth	100 kHz (typ. 96 kHz)	200 kHz (typ. 200 kHz)	500 kHz (typ. 495 kHz)	500 kHz (typ. 495 kHz)

Dynamic Parameters

	MC.6011 MC.6012	MC.6011 MC.6012	MC.6011 MC.6012	MC.6021 MC.6022	MC.6021 MC.6022	MC.6030 MC.6031 MC.6033 MC.6034	MC.6030 MC.6031 MC.6033 MC.6034	MC.6030 MC.6031 MC.6033 MC.6034	MC.6030 MC.6031 MC.6033 MC.6034
Test - Samplerate	20 MS/s	20 MS/s	20 MS/s	60 MS/s	60 MS/s	62.5 MS/s	62.5 MS/s	125 MS/s	125 MS/s
Output Frequency	80 kHz	800 kHz	4 MHz	170 kHz	1.7 MHz	400 kHz	4 MHz	400 kHz	4 MHz
Output Level	±2 V	±2 V	±2 V	±2 V	±2 V	±2 V	±2 V	±2 V	±2 V
Used Filter	100 kHz	1 MHz	5 MHz	200 kHz	2 MHz	500 kHz	5 MHz	500 kHz	5 MHz
SNR (typ)	> 61.5 dB	> 60.2 dB	> 54.5 dB	> 61.5 dB	> 59.5 dB	> 61.2 dB	> 54.5 dB	> 60.2 dB	> 55.0 dB
THD (typ)	< -70.4 dB	< -67.5 dB	< -45.0 dB	< -72.7 dB	< -62.5 dB	< -71.5 dB	< -55.6 dB	< -71.5 dB	< -56.0 dB
SFDR (typ), excl harm.	> 85.5 dB	> 72.0 dB	> 60.0 dB	> 81.5 dB	> 68.5 dB	> 81.5 dB	> 65.5 dB	> 71.0 dB	> 66.0 dB

Dynamic parameters are measured at the given output level and 50 Ohm termination with a high resolution data acquisition card and are calculated from the spectrum. The sample rate that is selected is the maximum possible one. All available channels are activated for the tests. SNR and SFDR figures may differ depending on the quality of the used PC. SNR = Signal to Noise Ratio, THD = Total Harmonic Distortion, SFDR = Spurious Free Dynamic Range

Order information

The card is delivered with 32 MSample on-board memory and supports standard replay (single-shot, loop, single restart), FIFO replay (streaming), Multiple Replay and Gated Replay. 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.

Versions

Order no.	1 channel	2 channels	4 channels
MC.6011	20 MS/s	20 MS/s	
MC.6012	20 MS/s	20 MS/s	20 MS/s
MC.6021	60 MS/s	60 MS/s	
MC.6022	60 MS/s	60 MS/s	60 MS/s
MC.6030	125 MS/s		
MC.6031	125 MS/s	125 MS/s	
MC.6033	125 MS/s	60 MS/s	
MC.6034	125 MS/s	125 MS/s	60 MS/s

Memory

Order no.	Option
MC.60xx-64M	Memory upgrade to 64 MSample (128 MB) of total memory
MC.60xx-128M	Memory upgrade to 128 MSample (256 MB) of total memory
MC.60xx-256M	Memory upgrade to 256 MSample (512 MB) of total memory
MC.6xxx-up	Additional fee for later memory upgrade

Options

Order no.	Option
MC.6xxx-cs	Option Cascading: Synchronization of up to 4 cards (one option needed per system)
MC.60xx-dig	Additional synchronous digital outputs (2 per analog channel) including Cab-d40-idc-100
MC.6xxx-smod (1)	Option Star-Hub:Synchronization of up to 16 cards (one option needed per system)
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.
MC.6xxx-1Amp	±10 V output amplifier card with 1 channel including 15 cm SMB to SMB connection cable
MC.6xxx-2Amp	±10 V output amplifier card with 2 channels including 15 cm SMB to SMB connection cables
MC.6xxx-4Amp	±10 V output amplifier card with 4 channels including 15 cm SMB to SMB connection cables

Cables

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

		to 2x20 pole IDC	to 40 pole FX2			
Digital signals (option)	100 cm	Cab-d40-idc-100	Cab-d40-d40-100			

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