MCS8A: 2-8 input 80 ps Multistop TDC with USB 3.0, Multiscaler, TOF

Time range up to 8.3 days

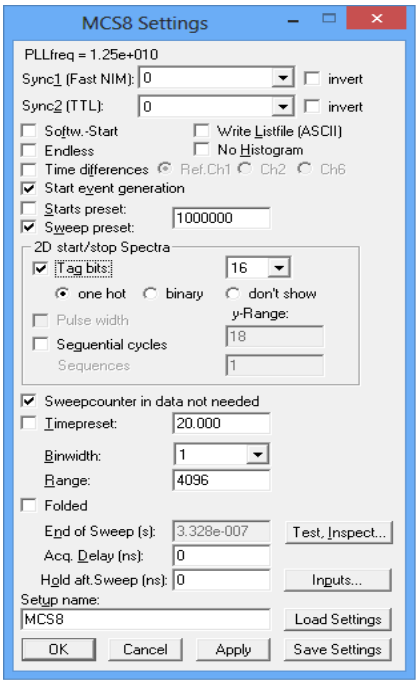
Versions available with up to 8 input channels

In operation the sweep is started by a usersupplied start (trigger) pulse. Then subsequent events detected at the stop inputs are recorded, each in a specific time bin corresponding to the time of arrival relative to the start pulse. Peak (burst) input rates of up to 12.5 Gbit/s, the FIFO can be filled with 300 MHz total count rate.

The MCS8A is a 2-8 input multiple-event time digitizer. It detects the time of the incidence of the stop signals (rising, falling or both edges) relative to the start signal with 80 ps time resolution.

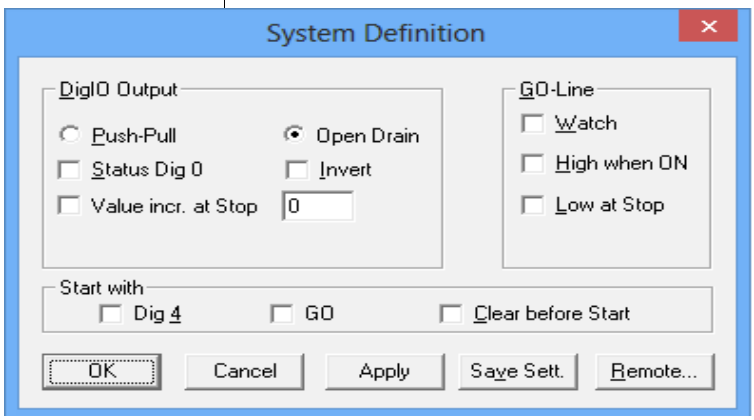
Description:

The Model MCS8A is a 80 ps per time bin, multiple-event time digitizer (TDC) with zero dead time. It can be used in ultra-fast Multi-scaler/ TOF systems, in Time-of-Flight mass spectrometry and time resolved single ion or photon counting. Pulse-width evaluation with 80 ps precision enables the user to calculate the area, the pulse height of the detector pulse but also if multiple events have occured – multiple events have a broader pulse width than single pulses. In operation the sweep is started by a user supplied start (trigger) pulse either at the START or STOP1 input. When using the START input there is a 5 ns trigger delay before Stop events can be recorded. Then subsequent events detected at the stop inputs are recorded, each in a specific time bin corresponding to the time of arrival relative to the start pulse. Compared to non-multi-hit devices, the MCS8A can evaluate stop events at a rate of 12.5 GHz state changes/sec, in the pulse width mode at 6.25 GHz. The USB 3.0 interface enables a permanent throughput of 240 MB/s. The MCS8A has been optimized for the best possible pulse pair resolving while providing state-of-the-art time resolution available in digital designs. Nine built-in discriminators can be adjusted for a wide range of signal levels. The single sweep time range enables the user to take data of up to 8.3 days (53 bit setting) or 6 min (42 bit setting with 16 TAG bits enabled), with a time resolution of 80 ps. An oven-stabilized clock is optional, an external clock input enables using high stability external clock sources such as a GPS or rubidium disciplined oscillator. The FIFO memory buffers enable the MCS8A to continuously transfer data with approx. 240 MB/second. Selection of data width per event of 32 bit or 64 bit allows for optimized FIFO and USB bandwidth usage. For experiments requiring repetitive sweeps the spectral data obtained from each sweep can be summed in the PC enabling very high sweep repetition rates. In endless / wrap around mode sweep repetitions with zero end-of-sweep dead time can be accommodated. The MCS8A is designed with "state-of-the-art" components which offer excellent performance and reliability. A sophisticated WINDOWS-based software is delivered with each MCS8A - providing a powerful graphical user interface for setup, data transfer and spectral data display. Using Wine it is possible to run the Windows software on LINUX systems.



Performance

Number of Time Bins: 128 to 2^{53} selectable in steps of 64. Transfer of acquired data in List- Mode to RAM or Hard-Disk.
Time range per shot: Up to a total 2^{53} x 80 ps = 8.3 days (less with TAG- and Status-words - ref. last page)
Memory: 4k x 2.56 ns fast FIFO, capable of recording at least 10.5 µsec at full burst rate, plus a 1, 2 or 4 GB USB-interface FIFO.
Time Resolution: 58 ps FWHM, typical mass line resolution after Gauss-fit measured at a distance of 10 µs after a trigger
Min. Pulse Width (pos. or neg.): 80 ps
Pulse Width resolution: 80 ps



Max. Input counting rate: 12.5 Gbit/s (400mV input amplitude) (12.5 G state changes/ sec.)
Bin-width: 80 ps, independent of selected range.
Deadtime: No deadtime between time bins. End-of-sweep Deadtime: 100ns or 0 in wraparound mode
Count Rate: The burst count rate to the FIFO can be recorded with no loss of stop pulses for at least 10.5 µsec, 300 MHz permanent count rate in sum on all inputs until the large FIFO is full, average continuous data throughput is up to 240 MB/ sec to the computer memory.
No Double Counting! No loss of counts! prevented by the proprietary input logic used. Differential linearity <<+/-1%
Data Reduction: by recording stop-events only (no "0" events as recorded by transient digitizers) significantly increases the sweep repetition rate capabilities. Selection of 32 or 64 bits/event for optimum FIFO and USB bandwidth usage.
Operating Modes: Continuous, end-after sweep, sequential (by software), time interval, pulse width and time over/below threshold
Sweep Counter: hardware sweep counter (48 bit) with programmable preset. Optional Start-of-Sweep marker insertion in the list mode data stream

Features

- Exceptionally high count rate Time Spectrometry System with 80 ps time resolution
- 8 STOP input channels
- 1 START/TRIGGER input
- Time range from nanoseconds to 8.3 days with 80 ps time resolution (53 bit dynamic range)
- Stop pulses are evaluated either for rising, falling edge or both at 12.5 GHz. This allows to obtain data on pulse-width with 80 ps precision
- Minimum time between rising and falling edge is 80 ps
- Maximum burst rates up to 12.5 GHz
- 300 MHz sum rate on all inputs
- High data transfer rate to PC by USB 3.0
- Six operating modes: Stop after sweep, sequential, multi start recording, pulse width (TOT - time over threshold and TUT - time below threshold) and time interval.
- Fully digital design, no software corrections required
- Start- and Stop-Inputs via built-in –2…+3V discriminators (-1...+1.5V threshold level adjustable in steps of 1mV)
- No dead time between time bins, No missed events, No double counting
- On-board 4k x 2.56ns fast FIFO on each input for ultra fast data acquisition. Secondary 1GB FIFO (2 or 4GB opt.) to buffer list-mode or on-line histogramming data transfer into the PC
- On-line sweep summing
- Two versatile, software configurable Sync outputs for triggering of external devices (FAST NIM, TTL)
- Tag inputs (16) with 2.56 ns time resolution (i.e. for sequential data acquisition, multi-detector configurations, etc.
- Presettable 48 bit sweep counter; programmable acquisition delay, programmable number of time bins and programmable trigger hold-off after sweep
- User configurable "GO"-line for experiment synchronisation (compatible with other FAST ComTec devices)
- 8-bit digital I/O port
- Optional six 200 MHz counters for monitoring

Specifications

FRONT PANEL:
Start / Stop Inputs: 9 x SMA-connector , Zin = 50 Ohm, -2V...+3V max. input range, +/-2V max. relative to threshold, rising and falling edge sensitive, threshold -1V...+1.5V programmable in 1 mV steps
Sync output 1: SMA-connector, outputs FAST NIM (CML) pulses (neg.: 0V -> -0.7V), Z = 50 Ohm backterminated, user selectable signals
REAR PANEL:
Feature connector: 15-pin D-SUB HD (female), 8-bit user configurable digital I/O port (TTL compatible), GO-line, Sync output 2, +5V power (fused)
TAG Inputs: 37- pin D-SUB (female), 16-bit TTL, TAG Clk out (2.56 ns periode), impedance 50 Ohms. 5.12 ns time resolution. , +5V power (fused)
Reference clock: BNC connector, I/O, TTL compatible, output 10 MHz, input 5...100 MHz, input: AC- coupled
Power connector: 2.1 x 5.5 mm DC connector (center positive)
REFERENCE CLOCK:
optional 10 MHz ovenized crystal oscillator, frequency stability: 0.03 ppm @ 0°C to +50°C
Power requirements: 12V DC / 1.3A
Operating Temperature Range: 0°C to +50°C
Physical: aluminum case, 275mm x 260mm x 48mm, 1.8 kg
Shipping case: 440mm x 350mm x 170mm, 5.5 kg

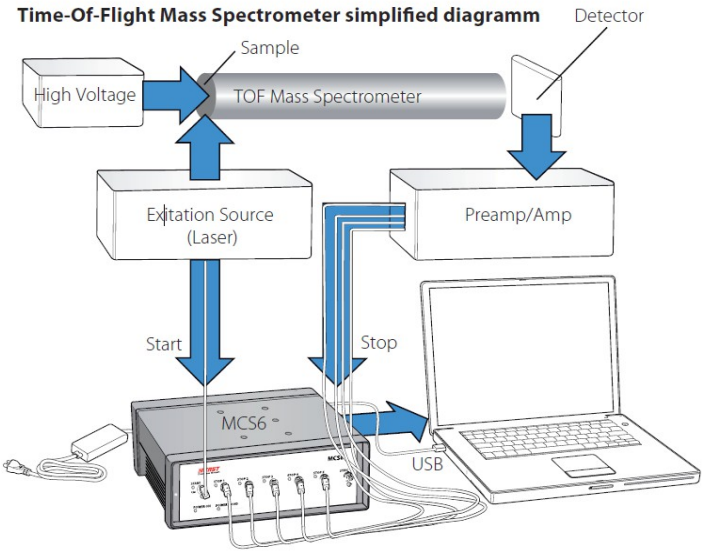
Accessories: Input cable: RG316 (PTFE), 2m, SMA + BNC connector (9 x)
• External power supply: IN: 90 - 264 V AC Out: 12 V DC
• Operating software on CD
• Handbook
Hardware options:
• FIFO memory increased to 4 GByte (from 1 or 2 GByte) for longer time buffering of data to be transferred to the computer (order number MCS8F4)
Software:
The MPANT Windows software for the MCS8A consists of a hardware-dependent server program with DLL and a general graphics program that controls the hardware via the DLL. List file recording can be done simultaneously with histogramming. A replay function for evaluation of list files is included. The spectra data can be saved into a single data file using different formats like binary and ASCII, single spectra can be extracted. Handling of 2D histograms enable sequential acquisition of seperated sweeps into rows of 2D histograms as well as spectra marked by tag bits or a 2D view of pulse width versus time. Even coincidence acquisition of dualparameter histograms is possible, for example for using position dependent detectors. MACRO commands enable automatic execution of scripts for acquisition and evaluation.
Software options:
• DLL and VI's for LabVIEW, C , Visual Basic - see separate datasheet.

Examples of time range settings

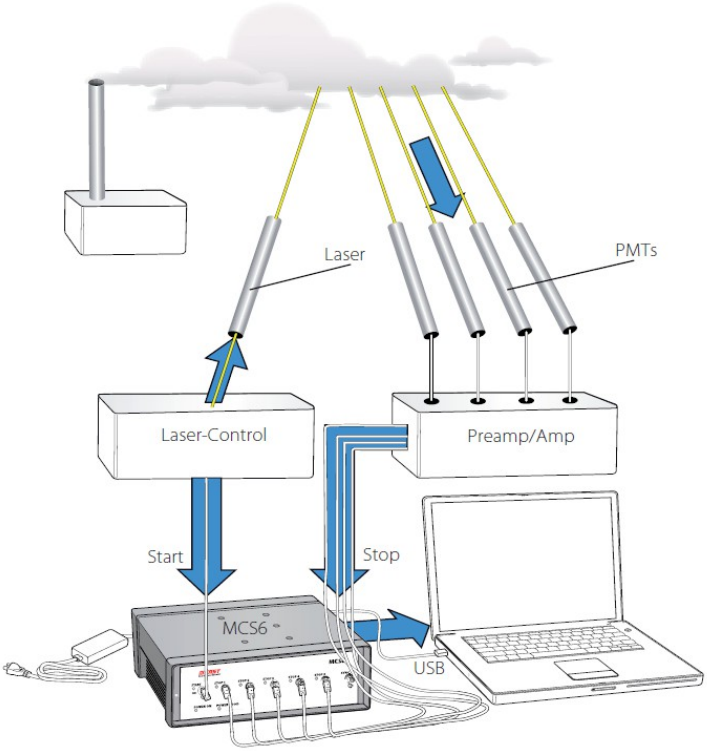
time bits	tag bits	Sweep counter	Max. Sweep length	Data word length
53	5	0	8.34 d	64 bit
42	16	0	352 s	64 bit
38	0	20	22 s	64 bit
30	8	20	0,086 s	64 bit
22	16	20	335,5 µs	64 bit
16	16	26	5,24 µs	64 bit
26	0	0	5,37 ms	32 bit
16	0	10	5,24 µs	32 bit

Typical Applications

Time-Of-Flight Mass Spectrometer simplified diagramm



A Simplified Diagram of a LIDAR Setup

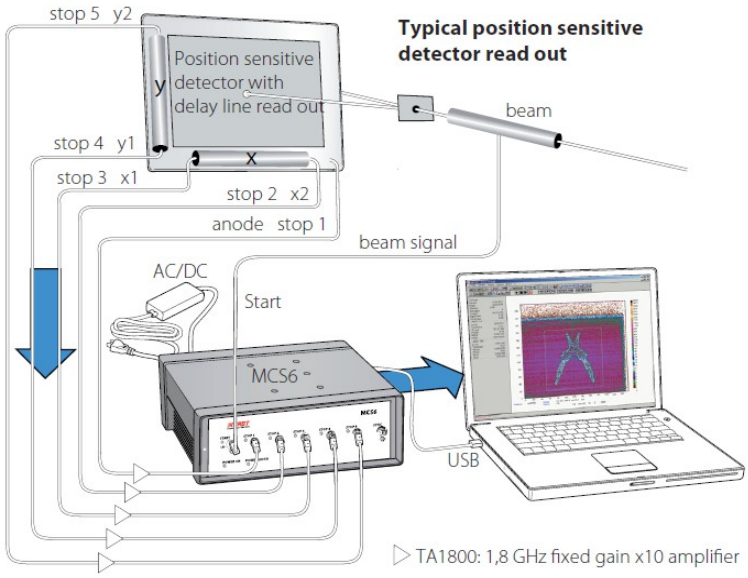


Time-of-Flight Spectrometry
This application is specifically suited to the capabilities of the MCS8A. Because the MCS8A has been optimized for the best pulse-pair resolving
time while providing excellent time resolution one can easily record mass lines that are very closely spaced. Because of the multistop capability of the MCS8A stop events in all mass lines can be recorded during a single shot - something practically impossible with analog-type instrumentation.

LIDAR
The beam of a pulsed LASER is aimed at an object from as close as a plume of a smoke stack to as far as a cloud or the exhaust vapor of a Jet engine flying at high altitudes.
The reflected beam is detected, for example with a PMT and the photons are counted as stop pulses by the MCS6A. Responses from repeated shots from the LASER are summed to improve the statistical precision.
The time range of the MCS6A from 12.8 ns to 20 days can be used to measure objects from close range up to distances far exceeding the useful range of a LIDAR System. The spatial resolution is 1.5 cm - uniformly over the entire selected range.

Typical applications are:
- TOF Time-of-Flight Spectrometry with exceptional dynamic-range and time resolution
- Position Sensitive Detectors (delay line type: start, 2 x 2 delay signals, time / anode)
- Multi-scaling with very high burst count rates
- Pulse width evaluation with 100 ps precision
- Static TOF SIMS secondary electron Massspectrometry - used for example in analyzing molecules from biological samples
- Quantum Cryptography research
- Laser-induced fluorescence spectroscopy in biological samples
- Laser-induced photo-electron spectrometry to analyze the electronic state of gas and solid state samples
- Single photon / single molecule counting
- Multi-level measurements e.g.for mass spectroscopy with very strong (pile up) lines by pairing input channels
- LIDAR (1.5 cm spatial resolution)
- Eight - channel ultra high speed and huge memory logic analyzer. Evaluation of logic circuits / search for spurious signals
- „Area measurement" in high energy physics by width measurement of pulses with constant shape
- Multiparameter / correlation / coincidence measurements

Typical Applications



Position sensitive detector read out
This application is specifically suited to the capabilities of the MCS8A. Because the MCS8A has been optimized for the best pulse-pair resolving time while providing excellent time resolution one can easily record highest countrates.
Because of the multi-stop capability of the MCS8A stop events in all overlapping signals can be recorded - something practically impossible with analog-type instrumentation.

Order Information

Model	Description	Order
MCS8AGOLD	8 input 12.5 GHz Multiscaler, 80 ps, 4GB Fifo, USB 3.0, DLL, TAG + COUNT	MCS8AGOLD
MCS8AxT0	x input, x=2..8, 12.5 GHz Multiscaler 80 ps, 2GB, USB 3.0, field upgrade	MCS8AxT0
MCS8AxT1	x input, x=2..8, 10 GHz Multiscaler, 100 ps, 2GB, USB 3.0, field upgrade	MCS8AxT1
MCS8AxT2	x input, x=2..8, 10 GHz Multiscaler, 200 ps, 2GB, USB 3.0, field upgrade	MCS8AxT2
MCS8AxT4	x input, x=2..8, 10 GHz Multiscaler, 400 ps, 2GB, USB 3.0, field upgrade	MCS8AxT4
MCS8AxT8	x input, x=2..8, 10 GHz Multiscaler, 800 ps, 2GB, USB 3.0, field upgrade	MCS8AxT8
MCS8DxTy	x input, x=2..8, y=0,1,2,4,8 (80..800 ps), 1GB Fifo, no TAG, no oven	MCS8DxTy
MCS8OVX	oven controlled ref.oscillator (higher stability) for “D” models (included in all “A”)	MCS8OVX
MCS8UP	Additional cost for in-field upgrade	MCS8UP
MCS8TAG	16it TAG input option (included in all “A” models)	MCS8TAG
MCS8FIFO2	FIFO expansion 1 GB → 2 GB (included in all “A” models)	MCS8FIFO2
MCS8FIFO4	FIFO expansion to 4 GB	MCS8FIFO4
MCS8COUNT	6 x 200 MHz counter (48 bit)	MCS8COUNT
MCS8DLL	DLL for LabVIEW/“C“/Visual Basic (32 + 64 bit) for MCS8	MCS8DLL
MPA4-C1	TAG / Counter Cable, converts D-SUB 37 to 18 separate BNC cables, 1.5m	MCS8C1
MPA4-C2	TAG / Counter Cable, converts D-SUB 37 to 18 separate LEMO cables, 1.5m	MCS8C2
MCS8-40ps	Option 40 ps resolution, 4x ext. Splitter, channel pairing, 1 start, 3 stop inputs	MCS840P