Time-Correlated Single Photon Counting Systems

PC Based Systems
Full Set of FLIM Cards with PCI Express Interface Available

December 2016 - Becker & Hickl have released a full set of PCI Express cards for TCSPC FLIM system. The set consists of one or two SPC-160pcie TCSPC / FLIM modules and a DCC-100pcie detector controller. For the bh DCS-120 scanners or for customer-specific galvanometer scanners a GVD-120pcie scan controller can be added to the system.

The system works with all the commonly used confocal and multiphoton laser scanning microscopes, and with the bh DCS-120 confocal and multiphoton systems. It records single and dual-channel FLIM, FCS, multi-wavelength FLIM, Z-stack FLIM, lateral mosaic FLIM, ultra-fast time-series FLIM and, for the DCS-120 system, simultaneous FLIM/PLIM.

Online FLIM is available up to an image rate of about 10 images per second. The system is using 64-bit data acquisition software. Images as large as 2048x2048 pixels and 256 time channels can be recorded. The electronic time resolution of the SPC-160pcie is 2.5 ps rms, the minimum time channel width is 813 fs.

Attached, for reference is the SPC-160 PCIE data sheet.
SPC-160 PCIE TCSPC/ FLIM Module

TCSPC / FLIM Module with PCI Express Interface

Input discriminator bandwidth 4 GHz
Sub-ps low-frequency timing wobble
Multi-detector / multi-wavelength capability
Photon distribution and parameter-tag modes
FLIM by bh Megapixel Technology
Mosaic FLIM mode
Multiscaler imaging mode
Parallel counter channel for FLIM intensities
Parallel operation of 2, 3 or 4 modules
Time channel width down to 813 fs
Electrical time resolution (Jitter) 2.5 ps rms
Laser repetition rates up to 150 MHz
Saturated count rate 12.5 MHz
TCSPC dead time 80 ns
Intensity-channel dead time <10 ns

Standard fluorescence lifetime experiments
Multi-wavelength lifetime experiments
Recording of transient fluorescence lifetime effects
Single-wavelength FLIM, multi-wavelength FLIM
Fast-acquisition FLIM, time-series FLIM
Mosaic FLIM, lateral, longitudinal, temporal mosaics
FLITS
Simultaneous PLIM and FLIM
Single and double-exponential FRET imaging
Recording of Ca²⁺ transients
fNIRS and NIRS experiments
Single-molecule spectroscopy
FCS, FCCS, Photon Counting Histograms
Anti-bunching experiments

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**SPC-160 PCIE TCSPC / FLIM Module**

### Photon Channel

- **Principle**: Constant Fraction Discriminator (CFD)
- **Discriminator Input Bandwidth**: 4 GHz
- **Optimal Input Voltage Range**: -30 mV to -500 mV
- **Min. Input Pulse Width**: 200 ps
- **Threshold**: 0 to -250 mV
- **Zero Cross Adjust**: -100 mV to +100 mV
- **Time Resolution (FWHM / RMS, electr.)**: 6.6 ps / 2.5 ps
- **Variance in time of IRF maximum**: <1 ps over 50 seconds
- **Optimum Input Voltage Range**: -30 mV to -500 mV
- **Min. Input Pulse Width**: 200 ps
- **Threshold**: 0 to -250 mV
- **Frequency Range**: 0 to 150 MHz
- **Frequency Divider**: 1-2-4

### Time-to-Amplitude Converters / ADCs

- **Principle**: Ramp Generator / Biased Amplifier
- **TAC Range**: 50 ns to 5 µs
- **Biased Amplifier Gain**: 1 to 15
- **Biased Amplifier Offset**: 0 to 50% of TAC Range
- **Time Range incl. Biased Amplifier**: 3.3 ns to 5 µs
- **min. Time / Channel**: 813 fs
- **ADC Principle**: 50 ns Flash ADC with Error Correction
- **Diff. Nonlinearity, electrical**: <0.5% rms, typ. <1% peak-peak

### Data Acquisition (Histogram Mode)

- **Method**: on-board multi-dimensional histogramming process
- **Dead Time**: 80 ns, independent of computer speed
- **Saturated Count Rate**: 12.5 MHz
- **Useful count rate**: 6.25 MHz
- **Channels / Pixel**: 4096, 1024, 256, 64, 16, 4, 1
- **max. Scanning Area**: 16x16, 64x64, 128 x 128, 256x256, 512x512
- **max. Counts / Time Channel**: 1024 x 1024, 2048 x 2048
- **Overflow Control**: none / stop / repeat and correct
- **Collection Time**: 0.1 us to 100,000 s
- **Display Interval Time**: 0.1 us to 100,000 s
- **Repeat Time**: 0.1 us to 100,000 s
- **Sequential Recording**: Programmable Hardware Sequencer, unlimited recording by memory swapping, in curve mode and scan mode
- **Curve Control (external Routing)**: 4 bit TTL
- **External event markers**: 4 bit TTL
- **Count Enable Control**: 1 bit TTL
- **Experiment Trigger**: TTL

### Data Acquisition (FIFO / Parameter-Tag Mode)

- **Method**: Parameter-tagging of individual photons and continuous writing to disk
- **Online display**: Decay function, FCS, Cross-FCS, PCH, MCS traces
- **FCS calculation**: Multi-tau algorithm, online calculation and online fit
- **Dead Time**: 80 ns
- **Saturated count rate**: 12.5 MHz
- **Sustained count rate (bus-transfer limited)**: 4.8 MHz
- **Output Data Format (ADC / Macrotime / Routing)**: 12 / 12 / 4
- **FIFO buffer Capacity (photons)**: 2 M
- **Macro Timer Resolution, internal clock**: 50ns, 12 bit, overflows marked by MTOF entry in data stream
- **Macro Timer Resolution, clock from SYNC input**: 10ns to 100ns, 12 bit, overflows marked by MTOF entry in data stream
- **Curvature (external Routing)**: 4 bit TTL
- **Count Enable Control**: 1 bit TTL
- **Experiment trigger**: TTL

### Data Acquisition, FIFO / Parameter-Tag Imaging Mode

- **Method**: Buildup of images from time- and wavelength tagged data
- **Online display**: up to 8 gated intensity images or up to 8 lifetime images via Frame Clock, Line Clock, and Pixel Clock pulses
- **TCSPC**: 80 ns, Intensity Channel: <10 ns
- **Detector / Wavelength Channels**: time channels / pixel
- **Image size in FIFO Imaging Mode**: 64 bit software, 64, 256, 1024, 4096, 4096
- **No. of pixels, 1 detector channel**: 1024 x 1024, 512 x 512, 256 x 256, 128 x 128, 128 x 128
- **No. of pixels, 16 detector channels (MW FLIM detector)**: 1024 x 1024, 512 x 512, 256 x 256, 128 x 128, 128 x 128

### Operation Environment

- **Computer System**: PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended
- **Bus Connectors**: PCI
- **Used PCI Slots**: 1
- **Total power Consumption**: approx. 12 W from +5V, 0.7 W from +12V
- **Dimensions**: 312 mm x 130 mm x 15 mm

### Related Products

- **SPC-160 TCSPC / FLIM modules**: DCS-120 confocal scanning FLIM systems, handbook on www.becker-hickl.com
- **SPC-150 and SPC-150N TCSPC modules**: HPM-100 GaAsP and GaAs hybrid detectors
- **Simple-Tau compact TCSPC systems**: PML-SPEC and MW-FLIM multi-wavelength detectors
- **FLIM systems for laser scanning microscopes**: GVD-120 scan controller
- **BDL-SMN picosecond diode lasers**: DBD-32 USB-controlled delay module

### Related Literature


Please see also www.becker-hickl.com, `Literature`, `Application notes`
Time-Correlated Single Photon Counting Module

Saturated Count Rate 10 MHz
Dead Time 100ns
Dual Memory Architecture: Readout during Measurement
Reversed Start/Stop: Repetition Rates up to 200 MHz
Electrical Time Resolution down to 8 ps FWHM / 5 ps rms
Channel Resolution down to 813 fs
Up to 4096 Time Channels / Curve
Measurement Times down to 0.1 ms
Instrument Software for Windows 2000 / NT / XP / VISTA
Direct Interfacing to most Detector Types
Single Decay Curve Mode
Oscilloscope Mode
Sequential Recording Mode
Spectrum Scan Mode with 8 Independent Time Windows
Continuous Flow Mode
FIFO / Time Tag Mode for FCS, FIDA, FILDA, BIFL

Covered by patents DE 43 39 784 and DE 43 39 787
Photon Channel
Principle
Constant Fraction Discriminator (CFD)
Time Resolution (FWHM / RMS, electr.)
8 ps / 5 ps
Opt. Input Voltage Range
- 50 mV to - 1 V
Min. Input Pulse Width
400 ps
Lower Threshold
- 20 mV to - 500 mV
Upper Threshold
- 100 mV to + 100 mV
Zero Cross Adjust
- 100 mV to + 100 mV

Synchronisation Channel
Principle
Constant Fraction Discriminator (CFD)
Opt. Input Voltage Range
- 50 mV to - 1 V
Min. Input Pulse Width
400 ps
Threshold
- 20 mV to -600 mV
Frequency Range
0 to 200 MHz
Frequency Divider
1-2-4
Zero Cross Adjust
- 100 mV to + 100 mV

Time-to-Amplitude Converter / ADC
Principle
Ramp Generator / Biased Amplifier
TAC Range
50 ns to 2 us
Biased Amplifier Gain
1 to 15
Biased Amplifier Offset
0 to 100% of TAC Range
Time Range incl. Biased Amplifier
3.3 ns to 2 us
ADC Principle
813 fs
Diff. Nonlinearity
40 ns Flash ADC with Error Correction
< 0.8% rms, typ. <2% peak-peak

Data Acquisition
Method
on-board 2-dimensional histogramming process
Dead Time
100 ns, independent of computer speed
max. Number of Curves in Memory
4096 1024 256 64
Number of Time Channels / Curve
64 256 1024 4096
max. Counts / Channel
2^{11-1}
Overflow Control
none / stop / repeat and correct
Collection Time
0.1 us to 10000 s
Display Interval Time
10 ms to 1000 s
Repeat Time
0.1 us to 1000 s
Curve Control (internal)
Programmable Hardware Sequencer
Count Enable Control
1 bit TTL
Experiment Trigger
TTL

Data Acquisition (FIFO / Time-Tag Mode)
Method
Time-tagging of individual photons and continuous writing to disk
Dead Time
100 ns
Output Data Format (ADC / Macrot ime / Routing)
12 / 12 / 3
FIFO buffer Capacity (photons)
128 k
Macro Timer Resolution, internal clock
50 ns, 12 bit
Macro Timer Resolution, clock from SYNC input
10 ns to 100 ns, 12 bit
Curve Control (external Routing)
3 bit TTL
Count Enable Control
1 bit TTL

Operation Environment
Computer System
PC Pentium
Bus Connectors
PCI
Used PCI Slots
1
Power Consumption
approx. 45 W at +5V, 2 W at +12V
Dimensions
225 mm x 115 mm x 25 mm

Related Products and Accessories
Detectors (MCPs, PMTs), multichannel detector heads, routing devices for multi-detector operation, detector controllers, detector / shutter assemblies, preamplifiers, PIN and avalanche photodiode modules, ps diode lasers with multiplexing capability. Also available: SPC-134, SPC-144, SPC-154, SPC-630, and SPC-830 time-correlated single photon counting modules, gated photon counters and multiscalers. Please call for individual data sheets and manuals.

Please see www.becker-hickl.com for free download of bh TCSPC handbook, device software and application literature.
General-Purpose Time-Correlated Single Photon Counting Module

Picosecond resolution
Ultra-high sensitivity
Multi-detector / multi-wavelength capability
High-speed on-board data acquisition
Photon distribution and time-tag modes
Unlimited sequential recording of curves or images
Time channel width down to 813 fs
Electrical time resolution (jitter) 6.6 ps fwhm / 2.5 ps rms
Reversed start/stop: Laser repetition rates up to 150 MHz
Saturated count rate 10 MHz
Total useful recorded count rate up to 5 MHz
Dead time 100 ns

Standard fluorescence lifetime experiments
Multi-wavelength lifetime experiments
Transient fluorescence lifetime effects
Fluorescence correlation
Anti-bunching experiments
Single-molecule spectroscopy

Covered by patents DE 43 39 784 and DE 43 39 787
Photon Channel (Start Input)
Principle: Constant Fraction Discriminator (CFD)
Time Resolution (Jitter, FWHM / RMS, electrical): 6.6 ps / 2.5 ps
Optimum Input Voltage Range: -30 mV to -1 V
Min. Input Pulse Width: 400 ps
Threshold: -20 mV to -500 mV
Zero Cross Adjust: -100 mV to + 100 mV

Synchronisation Channel (Stop Input)
Principle: Constant Fraction Discriminator (CFD)
Time Resolution (Jitter, FWHM / RMS, electrical): 6.6 ps / 2.5 ps
Optimum Input Voltage Range: -30 mV to -1 V
Min. Input Pulse Width: 400 ps
Threshold: 0 to 200 MHz
Frequency Range: 1-2-4
Threshold: 0 to 100%, programmable
Zero Cross Adjust: -100 mV to + 100 mV

Time-to-Amplitude Converter / ADC
Principle: Ramp Generator / Biased Amplifier
TAC Range: 0 to 200 ns
Biased Amplifier Gain: 1 to 15
Biased Amplifier Offset: 0 to 100% of TAC Range
max. Time / Channel: 3.3 ns to 5 us
ADC Principle: 40 ns Flash ADC with Error Correction
Diff. Nonlinearity: < 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)
Method: on-board 2-dimensional histogramming process
Online display: Decay curves (waveforms)
Dead Time: 100 ns, independent of computer speed
Saturated count rate: 10 MHz
Sustained count rate: 5 MHz
max. Number of Curves in Memory: 50 ns to 5 us
Number of Time Channels / Curve: 16 / 256
max. Counts / Channel: 2^4-1
Overflow Control: none / stop / repeat and correct
Collection Time: 0.1 us to 100,000 s
Display Interval Time: 0.1 us to 100,000 s
Repeat Time: 0.1 us to 100,000 s
max. Number of Decay / Waveform Recording: Programmable Hardware Sequencer
Curve Control (Internal sequencing): 4 bit, TTL
Curve Control (Routing): 1 bit, TTL
Count Enable Control: 4 bit, TTL
External event markers: TTL
Experiment trigger: TTL

Data Acquisition (FIFO / Time-Tag Mode)
Method: Time and wavelength tagging of individual photons and continuous writing to disk
Dead Time: 100 ns
Saturated count rate: typ. 4 MHz
Output Data Format (ADC / Macrotime / Routing): 12 / 12 / 4
FIFO buffer Capacity (photons): 2 M
Macro Timer Resolution, internal clock: 50ns, 12 bit, overflows marked by MTOF entry in data stream
Max. Time / Channel: 12 bit, overflows marked by MTOF entry in data stream
Curve Control (external Routing): 1 bit, TTL
Count Enable Control: TTL
Experiment trigger: TTL

Operation Environment
Computer System: PC Pentium, multi-core CPU recommended
Bus Connectors: PCI
Used PCI Slots: 1
Power Consumption: approx. 45 W at +5V, 2 W at +12V
Dimensions: 225 mm x 115 mm x 25 mm

Related Products
SPC-134 EM 4-channel TCSPC modules
SPC-150 TCSPC modules
SPC-154 4-channel TCSPC modules
SPC-830 TCSPC modules
Simple-Tau 130 compact TCSPC systems
Simple-Tau 150 compact TCSPC systems
Simple-Tau 134 compact 4-channel TCSPC systems
Simple-Tau 154 compact 4-channel TCSPC systems
Simple-Tau 830 TCSPC compact systems
DPC-230 16-channel ps photon correlator module
PM-100 cooled PMT modules
HMP-100 GaAsP and GaAs hybrid detectors
PML-SPEC and MW-FLIM multi-wavelength detectors
R3809U MCP PMTs, with HVM-100 power supply module
id-100 SPAD detector modules
DCC-100 detector controller
HRT-41, HRT-81, HRT-82 routing modules
A-PPi-D pulse inverters

Related Literature
GVD-100 scan controller

More than 15 years experience in multi-dimensional TCSPC. More than 700 TCSPC systems worldwide.
**TCSPC Module**

**SPC-150**

**TCSPC Module for Imaging Applications**

- Picosecond resolution
- Ultra-high sensitivity
- Multi-detector / multi-wavelength capability
- High-speed on-board data acquisition
- Photon distribution and time-tag modes
- Image acquisition by synchronisation with ext. scanner
- Unlimited sequential recording of curves or images
- Imaging in histogram mode and in time-tag mode
- Works at any scan rate of CLSMs or MPLSMs
- Time channel width down to 813 fs
- Electrical time resolution down to 8 ps fwhm / 4 ps rms
- Reversed start/stop: Laser repetition rates up to 150 MHz
- Saturated count rate 10 MHz
- Total useful recorded count rate up to 5 MHz
- Dead time 100 ns

- Multi-wavelength FLIM
- Double-exponential FLIM
- Fast-Acquisition FLIM
- Fast Sequential FLIM
- Single and double-exponential FRET imaging
- FCS, FCCS, FIDA, FILDA, BiFL
- FCS Imaging
- Transient fluorescence lifetime effects

Covered by patents DE 43 39 784 and DE 43 39 787
SPC-150

Photon Channel
Principle
Time Resolution (FWHM / RMS, electr.)
Optimal Input Voltage Range
Min. Input Pulse Width
Threshold
Zero Cross Adjust

Constant Fraction Discriminator (CFD)
8 ps / 5 ps
- 50 mV to - 1 V
400 ps
- 20 mV to - 500 mV

Synchronisation Channels
Principle
Optimal Input Voltage Range
Min. Input Pulse Width
Threshold
Frequency Range
Frequency Divider
Zero Cross Adjust

Constant Fraction Discriminator (CFD)
- 50 mV to - 1 V
400 ps
- 20 mV to -500 mV
0 to 200 MHz
1-2-4
-100 mV to + 100 mV

Time-to-Amplitude Converters / ADCs
Principle
TAC Range
Biased Amplifier Gain
Biased Amplifier Offset
Time Range incl. Biased Amplifier
min. Time / Channel
ADC Principle
Diff. Nonlinearity

Ramp Generator / Biased Amplifier
50 ns to 2 us
1 to 15
10 to 100 ns
3.3 ns to 2 us
813 fs
50 ns Flash ADC with Error Correction
< 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)
Method
Dead Time
Saturated Count Rate, per TCSPC channel / total
Useful count rate, per TCSPC channel / total
Channels / Pixel
max. Scanning Area per TCSPC channel
max. Counts / Time Channel
Overflow Control
Collection Time
Display Interval Time
Repeat Time
Sequential Recording
Synchronisation with Scanning
Count Enable Control
Experiment Trigger

on-board multi-dimensional histogramming process
100ns, independent of computer speed
10 MHz / 40 MHz
5 MHz / 20 MHz
16x16
64x64
128 x 128
256x256
512x512
1024x1024
2048x2048
2^i-1

Data Acquisition (FIFO / Time-Tag Mode)
Method
Online Display
Dead Time
Output Data Format (ADC / Macrotime / Routing)
Output Data Format for Scan Clock Markers (pxl, line, frame)
FIFO Buffer Capacity (photons and clock markers)
Macro Timer Resolution, internal clock
Macro Timer Resolution, clock from SYNC input
Curve Control (external Routing)
Count Enable Control

Time-tagging of individual photons, continuous writing to disk
Decay function, FCS, Cross-FCS, PCH, MCS traces
100 ns
12 bit ADC / 12 bit macro time / 4 bit routing
12 bit macro time / pxl, line, frame
2 M
25 ns, 12 bit
10 ns to 100 ns, 12 bit
4 bit TTL
1 bit TTL

Data Acquisition, FIFO / Time-Tag Imaging Mode
Method
Online Display
Synchronisation with scanner
Detector / Wavelength Channels
Time Channels / Pixel
max. Scan Area (one detector / wavelength channel)

Buildup of Images from Time-Tag data
Images of all wavelength channels
via Frame Clock, Line Clock, and Pixel Clock pulses
4096
1024
256
64
16
128 x 128
256x256
512x512
1024x1024
2048x2048

Operation Environment
Computer System
PC Pentium
PCI

Bus Connectors
Total power Consumption
Dimensions

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Product Literature
**SPC-150NTCSPC Module**

**Time-Correlated Single Photon Counting Imaging and FCS Module for Laser Scanning Microscopes**

- Improved version of SPC-150 TCSPC module
- Input discriminator bandwidth 4 GHz
- Reduced low-frequency timing wobble
- Multi-detector / multi-wavelength capability
- High-speed on-board data acquisition
- Photon distribution and parameter-tag modes
- Image acquisition by synchronisation with ext. scanner
- Imaging in histogram mode and in parameter-tag mode
- Megapixel image sizes
- Parallel operation of 2, 3 or 4 modules
- Works at any scan rate of CLSMs or MPLSMs
- Time channel width down to 813 fs
- Electrical time resolution (Jitter) 6.6 ps fwhm / 2.5 ps rms
- Reversed start/stop: Laser repetition rates up to 150 MHz
- Saturated count rate 10 MHz
- Total useful recorded count rate up to 5 MHz
- Dead time 100 ns

- Standard fluorescence lifetime experiments
- Multi-wavelength lifetime experiments
- Recording of transient fluorescence lifetime effects
- Fluorescence lifetime imaging (FLIM)
- Multi-wavelength FLIM
- Fast-Acquisition FLIM, fast Sequential FLIM
- Fluorescence lifetime-transient scanning (FLITS)
- Combined fluorescence and phosphorescence lifetime imaging (PLIM)
- Single-molecule spectroscopy
- Anti-bunching experiments

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Photon Channel

- Principle: Constant Fraction Discriminator (CFD)
- Discriminator Input Bandwidth: 4 GHz
- Time Resolution (FWHM / RMS, electr.): 6.6 ps / 2.5 ps
- Variance in time of IRF maximum: <1 ps over 50 seconds
- Optimum Input Voltage Range: -30 mV to -500 mV
- Min. Input Pulse Width: 200 ps
- Threshold: 0 to -250 mV
- Zero Cross Adjust: -100 mV to +100 mV

Synchronization Channels

- Principle: Constant Fraction Discriminator (CFD)
- Discriminator Input Bandwidth: 4 GHz
- Time Range incl. Biased Amplifier: 815 fs
- Optimal Input Voltage Range: -30 mV to -500 mV
- Min. Input Pulse Width: 200 ps
- Threshold: 0 to -250 mV
- Frequency Range: 0 to 150 MHz
- Frequency Divider: 1-2-4
- Zero Cross Adjust: -100 mV to +100 mV

Time-to-Amplitude Converters / ADCs

- Principle: Ramp Generator / Biased Amplifier
- TAC Range: 50 ns to 5 us
- Biased Amplifier Gain: 1 to 15
- Biased Amplifier Offset: 0 to 100% of TAC Range
- Time Range incl. Biased Amplifier: 3.3 ns to 5 us
- Min. Time / Channel: 813 fs
- Diff. Nonlinearity, electrical: < 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)

- Method: on-board multi-dimensional histogramming process
- Dead Time: 100ns, independent of computer speed
- FWHM: 5 MHz
- Channels / Pixel: 4096
- max. Scanning Area: 1024 x 1024
- Collection Time: 0.1 us to 100,000 s
- Display Interval Time: 0.1 us to 100,000 s
- Repeat Time: 0.1 us to 100,000 s
- Number of counts / Time Channel: 216-1
- Scanning pixel, line and frame clocks from scanning device
- Count Enable Control: 1 bit TTL
- Experiment Trigger: TTL

Data Acquisition (FIFO / Parameter-Tag Mode)

- Method: Parameter-tagging of individual photons and continuous writing to disk
- Decay function, FCS, Cross-FCS, PCH, MCS traces: Multi-tau algorithm, online calculation and online fit
- Dead Time: 100 ns
- Saturated count rate: 5 MHz
- Output Data Format (ADC / Macrotime / Routing): 12 / 12 / 4
- FIFO buffer Capacity (photons): 50ns, 12 bit, overflows marked by MTOF entry in data stream
- Max. Timer Resolution, internal clock: 4 bit TTL
- Max. Timer Resolution, clock from SYNC input: 4 bit TTL
- Curve Control (external Routing): 4 bit, TTL
- External event markers: 1 bit TTL
- Count Enable Control: TTL
- Experiment Trigger: TTL

Data Acquisition, FIFO / Parameter-Tag Imaging Mode

- Method: Buildup of images from time- and wavelength tagged data
- Image in FIFO Imaging Mode (64 bit software): up to 8 images in different time and wavelength windows
- Image size in FIFO Imaging Mode (64 bit software): via Frame Clock, Line Clock, and Pixel Clock pulses
- Detector / Wavelength Channels: 1 to 16
- time channels / pixel: 64
- 1 detector channel: 256
- 16 detector channels (MW FLIM detector): 1024 x 1024
- 1 detector channel: 4096 x 4096
- 16 detector channels (MW FLIM detector): 4096 x 1024 x 1024
- 1 detector channel: 2048 x 2048 x 1024 x 1024
- 16 detector channels (MW FLIM detector): 2048 x 2048 x 1024 x 1024
- Operation Environment
- Computer System: PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended
- Bus Connectors: 1
- Used PCI Slots: 1
- Total power Consumption: approx. 12 W from +5V, 0.7 W from +12V
- Dimensions: 240 mm x 130 mm x 15 mm

Related Products

- SPC-150 TCSPC modules
- HPM-100 GaAsP and GaAs hybrid detectors
- DCC-100 detector controller
- SPC-154 4-channel TCSPC modules
- PML-SPEC and MW-FLIM multi-wavelength detectors
- GVD-120 scan controller
- Simple-Tau compact TCSPC systems
- PMC-100 cooled PMT modules
- BDL-120 confocal scanning FLIM system
- FLIM systems for Zeiss LSM 510 and LSM 710 laser scanning microscopes
- Simple-Tau compact TCSPC systems
- id-100 SPAD detector modules
- DCS-120 confocal scanning FLIM system
- BDLSMN ps diode lasers

Related Literature

- Please see also www.becker-hickl.com, ‘Literature’, ‘Application notes’

More than 20 years experience in multi-dimensional TCSPC. More than 1500 TCSPC systems worldwide.
SPC-150NX TCSPC / FLIM Module


High-resolution version of SPC-150N TCSPC module
Improved resolution for ultra-fast detectors
Internal timing jitter 1.6 ps rms (3.5 ps fwhm)
Minimum time channel width 407 fs
Input discriminator bandwidth 4 GHz
Sub-ps low-frequency timing wobble
Photon distribution and parameter-tag modes
Multi-detector / multi-wavelength capability
FLIM by bh Megapixel Technology
Mosaic FLIM mode
Multiscaler imaging mode
Parallel operation of 2, 3 or 4 modules
Reversed start/stop: Laser repetition rates up to 150 MHz
Dead time 100 ns
Saturated count rate 10 MHz
Ultra-fast fluorescence lifetime experiments
Anti-bunching experiments
Multi-wavelength lifetime experiments
Recording of transient fluorescence lifetime effects
Single-wavelength FLIM, multi-wavelength FLIM
Fast-acquisition FLIM, time-series FLIM
Mosaic FLIM, lateral, longitudinal, temporal mosaics
FLITS
Simultaneous PLIM and FLIM
Double-exponential FRET imaging
Recording of Ca$^{2+}$ transients
fNIRS and NIRS experiments
Single-molecule spectroscopy
FCS, FCCS, PCH

More than 20 years experience in multi-dimensional TCSPC. More than 1500 TCSPC systems worldwide.
**SPC-150NX**

**TCSPC / FLIM Module**

### Photon Channel
**Principle**
- Constant Fraction Discriminator (CFD)
- Time Resolution (FWHM / RMS, electr.)
  - 3.3 ps / 1.6 ps
- Variance in time of IRF maximum
  - <1 ps over 50 seconds
- Optimum Input Voltage Range
  - - 30 mV to - 500 mV
- Min. Input Pulse Width
  - 200 ps
- Threshold
  - 0 to - 250 mV
- Zero Cross Adjust
  - - 100 mV to + 100 mV

### Synchronisation Channels
**Principle**
- Constant Fraction Discriminator (CFD)
- Discriminator Input Bandwidth
  - 4 GHz
- Optimal Input Voltage Range
  - - 30 mV to - 500 mV
- Min. Input Pulse Width
  - 200 ps
- Frequency Range
  - 0 to 150 MHz
- SYNC Frequency Divider
  - 1 - 2 - 4
- Zero Cross Adjust
  - - 100 mV to + 100 mV

### Time-to-Amplitude Converters / ADCs
**Principle**
- Ramp Generator / Biased Amplifier
- TAC Range
  - 25 ns to 2.5 us
- Biased Amplifier Gain
  - 1 to 10
- Biased Amplifier Offset
  - 0 to 50% of TAC Range
- Time Range incl. Biased Amplifier
  - 1.67 ns to 2.5 us
- ADC Principle
  - 50 ns Flash ADC with Error Correction

**Dead Time**
- 100 ns, independent of computer speed
- 10 MHz
- 5 MHz

**Useful count rate**
- 2^(-1)

**Overflow Control**
- none / stop / repeat and correct

**Collection Time**
- 0.1 us to 100,000 s

**Display Interval Time**
- 0.1 us to 100,000 s

**Repeat Time**
- 0.1 us to 100,000 s

**Sequential Recording**
- Programmable Hardware Sequencer, unlimited recording by memory swapping, in curve mode and scan mode

**Routing**
- pixel, line and frame clocks from scanning device
- 7 bit TTL

### Data Acquisition (Histogram Modes)
**Method**
- on-board multi-dimensional hardware histogramming process
- 100 ns, independent of computer speed
- 10 MHz
- 5 MHz

### Data Acquisition (FIFO / Parameter-Tag Mode)
**Method**
- Parameter-tagging of individual photons and continuous writing to disk
- Decay function, FCS, Cross-FCS, PCH, MCS traces

**Number of counts / time channel (counting depth)**
- unlimited

**Dead Time**
- 100 ns

**Saturated count rate**
- 10 MHz

**Max. count rate** (bus-transfer limited)
- typ. 4 MHz

**Macro Timer Resolution, internal clock**
- 50 ns, 12 bit, overflows marked by MTOF entry in data stream

**Macro Timer Resolution, clock from SYNC input**
- 10 ns to 100 ns, 12 bit, overflows marked by MTOF entry in data stream

**Routing**
- 4 bit TTL

### Data Acquisition, FIFO / Parameter-Tag Imaging Mode
**Method**
- Buildup of images from time- and wavelength tagged data
- up to 8 images in different time and wavelength windows
- via Frame Clock, Line Clock, and Pixel Clock pulses

**Detection Wavelength Channels**
- 1 to 16

**Image resolution, 64-bit SPCM software**
- 64 x 256

**No. of time channels**
- 1024 x 1024

**No. of pixels, 1 detector channel**
- 512 x 512

**No. of pixels, 16 detector channels**
- 128 x 128

### Operation Environment
**Computer System**
- PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended

**Bus Connectors**
- PCI

**Used PCI Slots**
- 1

**Total power Consumption**
- approx. 12 W from +5V, 0.7 W from +12V

**Dimensions**
- 240 mm x 130 mm x 15 mm

### Related Products
- SPC-150N TCSPC modules
- HPM-100 GaAsP and GaAs hybrid detectors
- DCC-100 detector controller
- Simple-Tau 150 compact TCSPC systems
- PML-SPEC and MW-FLIM multi-wavelength detectors
- BDS-9N diode lasers
- DCS-120 confocal scanning FLIM system
- iS-100 SPAD detector modules
- BDS-SM, -SMY, -MM picosecond diode lasers

### Related Literature
- World Record in TCSPC Time Resolution: Combination of bh SPC-150NX with SCONTHEL NBN Detector yields 17.8 ps FWHM

### International Sales Representatives

**US:**
- Boston Electronics Corp
  - tcspc@boselec.com
  - www.boselec.com

**UK:**
- Photonic Solutions PLC
  - sales@psplc.com
  - www.psplc.com

**Japan:**
- Tokyo Instruments Inc.
  - sales@tokyoinst.co.jp
  - www.tokyoinst.co.jp

**China:**
- DynaSense Photonics Co. Ltd.
  - info@dyna-sense.com
  - www.dyna-sense.com

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Aug. 2016
Time-Correlated Single Photon Counting Imaging and FCS Module for Laser Scanning Microscopes

- Input discriminator bandwidth 4 GHz
- Reduced low-frequency timing wobble
- Multi-detector / multi-wavelength capability
- Photon distribution and parameter-tag modes
- FLIM with galvanometer and resonance scanners
- FLIM in histogram mode and in parameter-tag mode
- Mosaic FLIM mode
- Multiscaler imaging mode
- Parallel Counter channel for FLIM intensities
- Megapixel image sizes
- Parallel operation of 2, 3 or 4 modules
- Time channel width down to 813 fs
- Electrical time resolution (Jitter) 2.5 ps rms
- Laser repetition rates up to 150 MHz
- Saturated count rate 12.5 MHz
- Total useful recorded count rate up to 6.25 MHz
- Dead time 80 ns

Standard fluorescence lifetime experiments
Multi-wavelength lifetime experiments
Fluorescence lifetime imaging (FLIM)
Multi-wavelength FLIM
Fast-Acquisition FLIM, fast Sequential FLIM
Fluorescence lifetime-transient scanning (FLITS)
Combined FLIM and PLIM
Single-molecule spectroscopy
Online FCS
Anti-bunching experiments
Photon Channel
Principle: Constant Fraction Discriminator (CFD)
Discriminator Input Bandwidth: 4 GHz
Time Resolution (FWHM / RMS, electr.): 6.6 ps / 2.5 ps
Variance in time of IRF maximum: <1 ps over 50 seconds
Optimum Input Voltage Range: -30 mV to -500 mV
Min. Input Pulse Width: 200 ps
Threshold: 0 to -250 mV
Zero Cross Adjust: -100 mV to +100 mV

Synchronisation Channels
Principle: Constant Fraction Discriminator (CFD)
Discriminator Input Bandwidth: 4 GHz
Optimal Input Voltage Range: -30 mV to -500 mV
Min. Input Pulse Width: 200 ps
Threshold: 0 to -250 mV
Frequency Range: 0 to 150 MHz
Frequency Divider: 1:2:4
Zero Cross Adjust: -100 mV to +100 mV

Time-to-Amplitude Converters / ADCs
Principle: Ramp Generator / Biased Amplifier
TAC Range: 50 ns to 5 us
Biased Amplifier Offset: 0 to 50% of TAC Range
Biased Amplifier Gain: 1 to 15
Biased Amplifier Offset: 0 to 100 mV
ADC Principle: Preamplifier with Error Correction
Diff. Nonlinearity, electrical: < 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)
Method: on-board multi-dimensional histogramming process
Dead Time: 0.1 us to 100,000 s
Channels / Pixel: 16x16
Overflow Control: none / stop / repeat and correct
Display Interval Time: 10 ns to 100 ns
Repetition Time: 10 ns to 100 ns
Synchronous with Scanning: Programmable Hardware Sequencer, unlimited recording by memory swapping, curve mode and scan mode
Count Enable Control: 1 bit TTL
Experiment Trigger: TTL

Data Acquisition (FIFO / Parameter-Tag Mode)
Method: Parameter-tagging of individual photons and continuous writing to disk
Dead Time: 100 ns
Channels / Pixel: 1 to 16
Overflow Control: none / stop / repeat and correct
Display Interval Time: 10 ns to 100 ns
Repetition Time: 10 ns to 100 ns
Macro Timer Resolution: 10 ns to 100 ns
Macro Timer Resolution, clock from SYNC input: 10 ns to 100 ns
Curve Control (external Routing): 4 bit TTL
External event markers: 4 bit, TTL
Count Enable Control: 1 bit TTL
Experiment trigger: TTL

Data Acquisition, FIFO / Parameter-Tag Imaging Mode
Method: Buildup of images from time- and wavelength tagged data
Channels / Pixel: 64, 256, 1024, 4096
 overflow data format (ADC / Memotribe / Routing): 12 / 12 / 4
FIFO buffer capacity (photons): 2 M
Dead Time: 50 ns, 12 bit, overflows marked by MTOF entry in data stream
Synchronous with Scanning: Programmable Hardware Sequencer, unlimited recording by memory swapping, curve mode and scan mode

Operation Environment
Computer System: PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended
Bus Connectors: PCI
Used PCI slots: 1
Total power Consumption: approx. 12 W from +5V, 0.7 W from +12V
Dimensions: 312 mm x 130 mm x 15 mm

Related Products
SPC-150 and SPC-150N TCSPC modules
SPC-154 and SPC-154N TCSPC modules
Simple-Tau compact TCSPC systems
FLIM systems for laser scanning microscopes
DCS-120 confocal scanning FLIM system

Related Literature
Please see also www.becker-hickl.com, ‘Literature’, ‘Application notes’

More than 20 years experience in multi-dimensional TCSPC. More than 1500 TCSPC systems worldwide.
SPC-160 PCIE TCSPC/ FLIM Module

TCSPC / FLIM Module with PCI Express Interface

- Input discriminator bandwidth 4 GHz
- Sub-ps low-frequency timing wobble
- Multi-detector / multi-wavelength capability
- Photon distribution and parameter-tag modes
- FLIM by bh Megapixel Technology
- Mosaic FLIM mode
- Multiscaler imaging mode
- Parallel counter channel for FLIM intensities
- Parallel operation of 2, 3 or 4 modules
- Time channel width down to 813 fs
- Electrical time resolution (Jitter) 2.5 ps rms
- Laser repetition rates up to 150 MHz
- Saturated count rate 12.5 MHz
- TCSPC dead time 80 ns
- Intensity-channel dead time <10 ns

Standard fluorescence lifetime experiments
Multi-wavelength lifetime experiments
Recording of transient fluorescence lifetime effects
Single-wavelength FLIM, multi-wavelength FLIM
Fast-acquisition FLIM, time-series FLIM
Mosaic FLIM, lateral, longitudinal, temporal mosaics
FLITS
Simultaneous PLIM and FLIM
Single and double-exponential FRET imaging
Recording of Ca²⁺ transients
fNIRS and NIRS experiments
Single-molecule spectroscopy
FCS, FCCS, Photon Counting Histograms
Anti-bunching experiments

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www.boselec.com

UK Representative:
Photonic Solutions PLC
sales@psplc.com
www.psplc.com

Japan:
Tokyo Instruments Inc.
sales@tokyoinst.co.jp
www.tokyoinst.co.jp

China:
DynaSense Photonics Co. Ltd.
info@dyna-sense.com
www.dyna-sense.com
### Photon Channel

<table>
<thead>
<tr>
<th>Principle</th>
<th>Constant Fraction Discriminator (CFD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discriminator Input Bandwidth</td>
<td>4 GHz</td>
</tr>
<tr>
<td>Optimal Input Voltage Range</td>
<td>-30 mV to -500 mV</td>
</tr>
<tr>
<td>Min. Input Pulse Width</td>
<td>200 ps</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>0 Hz to 150 MHz</td>
</tr>
<tr>
<td>Frequency Divider</td>
<td>1:2:4</td>
</tr>
<tr>
<td>Zero Cross Adjust</td>
<td>-100 mV to +100 mV</td>
</tr>
</tbody>
</table>

- Time Resolution (FWHM / RMS, electr.): 6.6 ps / 2.5 ps
- Variance in time of IRF maximum: <1 ps over 50 seconds
- Optimum Input Voltage Range: -30 mV to -500 mV
- Min. Input Pulse Width: 200 ps
- Threshold: 0 V to -250 mV
- Zero Cross Adjust: -100 mV to +100 mV

### Synchronisation Channels

<table>
<thead>
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<th>Principle</th>
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- Optimum Input Voltage Range: -30 mV to -500 mV
- Min. Input Pulse Width: 200 ps
- Threshold: 0 V to -250 mV
- Zero Cross Adjust: -100 mV to +100 mV

### Time-to-Amplitude Converters / ADCs

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<tr>
<th>Principle</th>
<th>Ramp Generator / Biased Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAC Range</td>
<td>50 ns to 5 us</td>
</tr>
<tr>
<td>Biased Amplifier Gain</td>
<td>1 to 15</td>
</tr>
<tr>
<td>Biased Amplifier Offset</td>
<td>0 to 50% of TAC Range</td>
</tr>
<tr>
<td>Time Range incl. Biased Amplifier</td>
<td>3.3 ns to 5 us</td>
</tr>
<tr>
<td>min. Time / Channel</td>
<td>813 fs</td>
</tr>
<tr>
<td>ADC Principle</td>
<td>Programmable Hardware Sequencer, unlimited recording by memory swapping, in curve mode and scan mode</td>
</tr>
<tr>
<td>Diff. Nonlinearity, electrical</td>
<td>&lt;0.5% rms, typ. &lt;1% peak-peak</td>
</tr>
</tbody>
</table>

### Data Acquisition (Histogram Mode)

- Method: on-board multi-dimensional histogramming process
- Dead Time: 80ns, independent of computer speed
- Minimum Counts / Time Channel: 813 fs
- ADC Principle: 50 ns Flash ADC with Error Correction
- FCS calculation: Multi-tau algorithm, online calculation and online fit
- Number of counts of decay / waveform recording: unlimited
- Decay function, FCS, Cross-FCS, PCH, MCS traces
- Dead Time: 80 ns
- saturated count rate: 12.5 MHz
- sustained count rate: 12.5 MHz
- Macro Timer Resolution, internal clock: 2 ns
- Macro Timer Resolution, clock from SYNC input: 50ns, 12 bit, overflows marked by MTOF entry in data stream
- Curve Control (external Routing): 4 bit TTL
- External event markers: 4 bit TTL
- Count Enable Control: 1 bit TTL
- Experiment Trigger: TTL

### Data Acquisition (FIFO / Parameter-Tag Mode)

- Method: Parameter-tagging of individual photons and continuous writing to disk
- Online display: Decay function, FCS, Cross-FCS, PCH, MCS traces
- FCS calculation: Multi-tau algorithm, online calculation and online fit
- Dead Time: 80 ns
- saturated count rate: 12.5 MHz
- sustained count rate (bus-transfer limited): typ. 4 MHz
- Output Data Format (ADC / Macrotime / Routing): 12 / 12 / 4
- FIFO buffer Capacity ( photons): 2 M
- Overflow Control: none / stop / repeat and correct
- Collection Time: 0.1 us to 100,000 s
- Display Interval Time: 0.1 us to 100,000 s
- Repeate Time: 0.1 us to 100,000 s
- Sequential Recording: Programmable Hardware Sequencer, unlimited recording by memory swapping, in curve mode and scan mode
- Count Enable Control: 1 bit TTL
- Experiment Trigger: TTL

### Data Acquisition, FIFO / Parameter-Tag Imaging Mode

- Method: Buildup of images from time- and wavelength tagged data
- Online display: up to 8 gated intensity images or up to 8 lifetime images
- Synchronisation with scanner: via Frame Clock, Line Clock, and Pixel Clock pulses
- Detection / Wavelength Channels: time channels / pixel: 64
- No. of pixels, 1 detector channel: 64 x 256 x 1024 x 4096 x 4096 x 4096 x 4096
- No. of pixels, 16 detector channels (MW FLIM detector): 1024 x 1024 x 512 x 512 x 256 x 256
- Image size in FIFO Imaging Mode (64 bit software): 1 to 16
- No. of pixels, 1 detector channel: 1024 x 1024 x 512 x 512 x 256 x 256
- Operation Environment: PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended
- PCI Connectors: PCI
- Dimensions: 312 mm x 130 mm x 15 mm

### Related Products

- SPC-150 and SPC-150N TCSPC modules: HPM-100 GaAsP and GaAs hybrid detectors, DCC-100 detector controller
- Simple-Tau compact TCSPC systems: PML-SPEC and MW-FLIM multi-wavelength detectors, GVD-120 scan controller
- FLIM systems for laser scanning microscopes: id-100, id-220, Si and InGaAs SPAD detector modules, DBL-50M picosecond diode lasers, handbook on www.becker-hickl.com

### Related Literature

- DCS-120 Confocal Scanning FLIM Systems, handbook on www.becker-hickl.com
- Please see also www.becker-hickl.com, ‘Literature’, ‘Application notes’

More than 20 years experience in multi-dimensional TCSPC. More than 1500 TCSPC systems worldwide.
High Resolution Time-Correlated Single Photon Counting Imaging and FCS Module for Laser Scanning Microscopes

- Complete picosecond imaging system on single PC board
- Picosecond resolution
- Ultra-high sensitivity
- Multi detector capability
- High-speed on-board data acquisition
- Works at any scanning speed of microscope
- High resolution picosecond lifetime imaging
- FRET imaging
- High-resolution steady state imaging
- Single-point time-lapse lifetime analysis
- Single-point FCS / lifetime data
- Time channel width down to 813 fs
- Image size up to 4096 x 4096 pixels
- Electrical time resolution down to 8 ps fwhm / 4 ps rms
- Reversed start/stop: Laser repetition rates up to 200 MHz
- Useful count rate up to 4 MHz - dead time 125 ns
- Active and passive scanning control
- Software versions for windows 95 / 98 / 2000 / NT

Covered by patents DE 43 39 784 A1 and DE 43 39 787
### Photon Channel
- **Principle:** Constant Fraction Discriminator
- **Time Resolution (FWHM / RMS, electr.):** 7 ps / 4 ps
- **Opt. Input Voltage Range:** - 50 mV to - 1 V
- **Min. Input Pulse Width:** 400 ps
- **Lower Threshold:** - 20 mV to - 500 mV
- **Zero Cross Adjust:** - 100 mV to + 100 mV

### Synchronisation Channel
- **Principle:** Constant Fraction Discriminator
- **Opt. Input Voltage Range:** - 50 mV to - 1 V
- **Min. Input Pulse Width:** 400 ps
- **Threshold:** 0 to 200 MHz
- **Frequency Divider:** 1-2-4-8-16
- **Zero Cross Adjust:** - 100 mV to + 100 mV

### Time-to-Amplitude Converter / ADC
- **Principle:** Ramp Generator / Biased Amplifier
- **TAC Range:** 50 ns to 2 us
- **Biased Amplifier Gain:** 1 to 15
- **Biased Amplifier Offset:** 0 to 100% of TAC Range
- **Time Range incl. Biased Amplifier:** 3.3 ns to 2 us
- **TAC Window Discriminator:** Any Window inside TAC Range
- **ADC Principle:** 50 ns 12 bit Flash ADC with Error Correction
- **Diff. Nonlinearity (dith width 1/8, 90% of TAC range):** < 0.5% rms, typically <1% peak-peak

### Data Acquisition, Histogram Modes
- **Method:** on-board 4-dimensional histogramming process over t, x, y, and detector channel number
- **Dead Time:** 125ns, independent of computer speed
- **Saturated Count Rate / Usefull Count Rate:** 8 MHz / 4 MHz
- **Number of Time Channels / Pixel:**
  - 1
  - 4
  - 16
  - 64
  - 256
  - 1024
  - 4096
- **Image Resolution (pixels), 1 Detector Channel:**
  - 4096 x 4096
  - 2048 x 2048
  - 1024 x 1024
  - 512 x 512
  - 256 x 256
  - 128 x 128
  - 64 x 64
  - 32 x 32
- **Image Resolution (pixels), 4 Detector Channels:**
  - 2048 x 2048
  - 1024 x 1024
  - 512 x 512
  - 256 x 256
  - 128 x 128
  - 64 x 64
  - 32 x 32
  - 16 x 16
- **Counts / Time Channel:**
  - $2^{31 - 1}$
  - $2^{30 - 1}$
- **Overflow Control:** none / stop / repeat and acquire
- **Collection Time (per curve or per pixel):** 100 ns to 1000 s
- **Display Interval Time:** 10ms to 1000 s
- **Repeat Time:** 0.1 ms to 1000 s
- **Curve Control (Internal Routing / Scan Sync In Mode):** up to 262,144 decay curves
- **Routting Control / Detector Channels:** 1 bit TTL / 16384
- **Count Enable Control:** 1 bit TTL
- **Control Signal Latch Delay:** 0 to 255 ns
- **Experiment Trigger:** TTL

### Data Acquisition, FIFO/BIFL Modes
- **Method:** Time-tagging of individual photons and continuous writing to disk
- **Macro Time Resolution:** 50 ns
- **ADC Resolution / No. of Time Channels:** 12 bit / 4096
- **Dead Time:** 150 ns
- **Output Data Format (ADC / Macrotime / Routing):**
  - 12 / 12 / 4
  - 8 million photons
- **FIFO buffer Capacity (photons):** 8 million photons

### Multi Module Systems
- Number of modules operable parallel: 4

### Operation Environment
- **Computer System:** PC Pentium
- **Bus Connector:** PCI
- **Power Consumption:** approx. 20 W at +5V, 0.7 W at +12V
- **Dimensions:** 312 mm x 122 mm x 28 mm

### Related Products and Accessories
- Detector Heads (MCPs, PMTs), Multichannel Detector Heads, Routing Devices for Multichannel Measurements, Step Motor Controllers, Preamplifiers, PIN and Avalanche Photodiode Modules, ps Diode Lasers, Adapter Cables for Scanning Microscopes. SPC-600/630 TCSPC modules for single molecule and correlation spectroscopy, SPC-700/730 for imaging and SPC-134 for optical tomography. Please download or call for individual data sheets. To control detectors and shutters please see DCC-100 detector controller.

Please visit our web site to download the manual, the device software and application notes.
DPC-230 16 Channel Photon Correlator

Photon correlation down to the ps range

- 16 LVTTL inputs for SPADs or 4 CFD inputs for PMTs
- Recording of absolute photon times
- Autocorrelation within 16 LVTTL or 4 CFD channels
- Cross-correlation between any pairs of LVTTL or CFD channels
- 3-channel TCSPC mode with 165 ps time channel width
- Multiscaler operation of 15 LVTTL or 3 CFD channels
- Single-slot PCI module
- Operating software for Windows 2000, NT and XP

Fluorescence correlation experiments down to the ps range
Antibunching experiments
Fluorescence correlation and antibunching from one experiment
Luminescence lifetime measurements
DPC-230 16 Channel Photon Correlator

LVTTL Inputs
No. of channels: 16
Input Voltage: LVTTL
Threshold: 1.4 V
Min. Input Pulse Width: 2 ns
Min. Pulse Distance: 5.5 ns
Connectors: MCX, on board

CFD Inputs
No. of channels: 4
Threshold: -20 mV to -500 mV
Zero Cross Adjust: -100 mV to +100 mV
Connectors: SMA, front panel

Experiment Trigger Input
Input Voltage: LVTTL
Threshold: 1.4 V

Data Acquisition, Correlation Mode
Method: Time-tag recording, absolute photon times
Correlation of photons: Multi tau or linear tau algorithm, online or offline
Auto-correlation: all channels
Cross-correlation: any pairs of channels
Time increment: 164.61 ps
Dead Time: < 10 ns
No of parallel channels: 16 LVTTL or 4 CFD channels
On-board FIFO Buffer size: 4 \times 10^6 photons
Readout: continuous readout during measurement
Sustained readout rate (typ., depends on computer): 7 \times 10^6 photons

Data Acquisition, TCSPC Mode
Method: Time-tag recording, reversed start-stop
Start (photon) channels: 3 CFD inputs
Dead Time: < 10 ns
Stop channel: 1 CFD input
Stop input rate: max 150 MHz
Stop frequency divider: 1 - 2 - 4
Time channel width: 164.61 ps
On-board FIFO Buffer size: 4 \times 10^6 photons
Readout: continuous readout during measurement
Sustained readout rate (typ., depends on computer): 7 \times 10^6 photons

Data Acquisition, Multiscaler Mode
Method: Time-tag recording, direct start-multistop
Start (reference) channel: 1 CFD input or 1 LVTTL input
Stop (photon) channels: 3 CFD inputs or 15 LVTTL inputs
Dead Time: < 10 ns
Time channel width: 164.61 ps
On-board FIFO Buffer size: 4 \times 10^6 photons
Readout: continuous readout during measurement
Sustained readout rate (typ., depends on computer): 7 \times 10^6 photons

Operation Environment
Computer System: Pentium PC
Recommended configuration: >1024 Mb RAM, >100 Gb HD
Bus Connector: PCI
Power Consumption: approx. 12 W from +5V
Dimensions: 312 mm x 124 mm x 20 mm

Related Products
SPC-830, SPC-630, SPC-134, SPC-144, SPC-154 TCSPC modules, MSA-1000 and MSA-300 multiscalers, DCC-100 Detector controller, BDL-375, -405, -440, -473 picosecond / CW diode lasers, id-100 SPAD modules, PMT detector modules, detector / shutter assemblies.

Please download or call for individual data sheets and manuals.
5ns Photon Counter / Multiscaler

Ultra-fast accumulation
High repetition rate
No dead time between sweeps
No dead time between channels
Fast on-board discriminators

Input pulse width down to 800 ps
Time / channel down to 5 ns
Count rate up to 100 MHz
Up to 512 k points / curve
Software for Windows 95 / 98 / 2000 / NT

The MSA-300 is a fast multiscaler for photon counting, time-of-flight measurements or other fast particle detection applications. By using a 128 bit memory structure a dead-time-free accumulation of subsequent sweeps is achieved. This makes the MSA-300 exceptionally useful for a wide variety of high-repetition rate signal recording applications.
**Specification**

- **Time per Channel**: min. 5 ns
- **Count Rate**: up to 100 MHz
- **No of Points / Curve**: up to 512 k
- **Overall Recording Length**: up to 2.62 ms
- **Accumulation (up to 256 events/point)**: Hardware, no dead time between recording cycles
- **Accumulation (> 256 events/point)**: Software
- **Count Input Impedance**: 50 Ω
- **Count Input Amplitude**: ±20 mV to ±1 V
- **Count Input Threshold**: 0 to ±200 mV, ± 8 bit resolution
- **Min.Count Input Pulse Width**: 800 ps
- **Trigger Input Impedance**: 50 Ω
- **Trigger Input Amplitude**: ±20 mV to ±1 V
- **Trigger Input Threshold**: 0 to ±1 V, ± 8 bit resolution
- **Min. Trigger Pulse Width**: 800 ps

**Data Readout**

- Typical readout rate (Pentium 166 MHz): 1 μs/point (C++, read 1 point and store into a data array)

**Luminescence Decay Measurements**

The sample is excited by laser pulses and the luminescence signal is detected by a PMT in the photon counting mode. Due to the deep memory a time scale from ns to ms can be covered in one measurement.

**Time-of-Flight Measurements**

Packages of ions are released by a pulsed source, sent through a drift tube and detected by an MCP. Due to the high accumulation speed of the MSA-300 very high repetition rates and short overall measurement times are achieved.

Accessories: PMTs, PMT detector heads with internal HV supply, preamplifiers, diode lasers, pulse generators for experiment control, step motor controllers. Please see individual data sheets.

Please visit our web site to download the manual, the device software and application notes.
PMS-400A

800 MHz Gated Photon Counter / Multiscaler

2 Counter Channels
800 MHz Count Rate, 32 bit Resolution
Direct Interfacing to most Detectors
Multiscaler Mode: Up to 64k Time Channels, min. 250ns / Channel
Gated Photon Counting: 1.5 ns min. Gate Pulse Width
Event Recording Mode: Up to 32 k Events

new 32 bit Accumulation Counter for ultra-fast Accumulation
On-Board Discriminators, Timing and Control Logics
new PCI Board with fast DMA (Bus Master),
Software for Windows 98, NT, 2k and XP, Parallel Operation of Several Modules Supported
Optical Transient Waveform Recording

The waveform of the light is measured with a resolution down to 250ns. Two signals can be recorded simultaneously. Applicable to luminescence decay of inorganic samples, phosphorescence, delayed fluorescence, chemoluminescence, LIDAR.

New: The PMS-400A provides a 32 bit accumulation counter which enables accumulation with virtually no dead time between sweeps ( < 100 ns ).

Recording of Luminescence Spectra

The luminescence and the excitation light are recorded simultaneously. Corrected excitation spectra are obtained by calculating B/A.

Single Molecule Detection

Recording of photon bursts. If the count rate inside a programmed time interval exceeds a programmed value, the number of photons and the time of the event is stored.

Gated Detection

The gate is opened during the laser pulse only. Events outside the laser pulses are suppressed. Exceptionally low background count rate.

Gating off Scattering Pulses

The gate is closed during the laser pulses. Scattered photons during the laser pulses are suppressed, the luminescence photons outside the laser pulses are recorded.

Specification (Typical Values)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter Channels</td>
<td>2</td>
</tr>
<tr>
<td>Count Rate (Input Amplitude 50mV, peak-peak)</td>
<td>800 MHz</td>
</tr>
<tr>
<td>min. Count Pulse Width</td>
<td>800 ps</td>
</tr>
<tr>
<td>min. Gate Width (Input Amplitude 200mV, peak-peak)</td>
<td>1 ns</td>
</tr>
<tr>
<td>min Trigger Pulse Width</td>
<td>1 ns</td>
</tr>
<tr>
<td>Discriminator Threshold (Count Inputs)</td>
<td>-1 V to +1 V in steps of 4 mV</td>
</tr>
<tr>
<td>Discriminator Threshold (Gate Inputs)</td>
<td>-2 V to +2 V in steps of 16 mV</td>
</tr>
<tr>
<td>Discriminator Threshold (Trigger Input)</td>
<td>-2 V to +2 V in steps of 16 mV</td>
</tr>
<tr>
<td>Input Connectors</td>
<td>MCX, 50</td>
</tr>
<tr>
<td>Counter Width</td>
<td>32 bit</td>
</tr>
<tr>
<td>Accumulation Counter</td>
<td>32 bit</td>
</tr>
<tr>
<td>Dead time between sweeps</td>
<td>&lt; 100ns</td>
</tr>
<tr>
<td>No. of Time Bins</td>
<td>64 k for each counter channel</td>
</tr>
<tr>
<td>Time / Bin</td>
<td>250 ns to 100 000 s</td>
</tr>
<tr>
<td>Hardware Environment</td>
<td>Pentium PC</td>
</tr>
<tr>
<td>Software Environment</td>
<td>Windows 95, 98, 2000 or NT</td>
</tr>
<tr>
<td>Dimensions</td>
<td>180 mm x 108 mm x 15 mm</td>
</tr>
</tbody>
</table>
Simple-Tau 164  Table-Top TCSPC Systems

Four-channel single photon counting systems in lap-top format

Four fully parallel SPC-160 TCSPC Channels
Laptop computer with extension box
Coupled via fast bus extension interface
Four parallel SPC-160 TCSPC modules
Picosecond resolution
Time channel width down to 813 fs
Electronic IRF 8 ps FWHM
Unprecedented count rate
Unprecedented timing stability
Photon distribution and time-tag modes
Standard fluorescence decay recording
Fast triggered sequential recording
Unlimited sequential recording by memory swapping
FLIM in histogram and time-tag modes
Fast FLIM series in memory-swapping mode
Multi-spectral FLIM
FCS recording
Works under windows XP, Vista, 7, 8, 10

Covered by patents DE 43 39 784 and DE 43 39 787
Simple-Tau 164 Table-Top TCSPC Systems

Photon Channels
- Principle: Constant Fraction Discriminator (CFD)
  - Time Resolution (FWHM / RMS, electr.): 8 ps / 5 ps
  - Opt. Input Voltage Range: -50 mV to -1 V
  - Min. Input Pulse Width: 400 ps
  - Lower Threshold:
  - Upper Threshold:
  - Zero Cross Adjust

Synchronisation Channels
- Principle: Constant Fraction Discriminator (CFD)
  - Opt. Input Voltage Range: -50 mV to -1 V
  - Min. Input Pulse Width: 400 ps
  - Threshold:
  - Frequency Range:
  - Frequency Divider:
  - Zero Cross Adjust

Time-to-Amplitude Converters / ADCs
- Principle: Ramp Generator / Biased Amplifier
  - Time Range incl. Biased Amplifier:
  - Biased Amplifier Gain:
  - Biased Amplifier Offset:
  - Time Range incl. Biased Amplifier:
  - ADC Principle:
  - Diff. Nonlinearity

Data Acquisition (Histogram Modes)
- Method: on-board multi-dimensional histogramming process
  - Saturated Count Rate, per TCSPC channel / total: 100ns, independent of computer speed
  - Useful count rate, per TCSPC channel / total: 5 MHz / 20 MHz
  - Number of Time Channels / Pixel:
  - Image Resolution (pixels), Detector Channel:
  - max. Counts / Time Channel:
  - Overflow Control:
  - Collection Time:
  - Display Interval Time:
  - Repeat Time:
  - Sequential Recording:
  - Synchronisation with scanning:
  - Count Enable Control:
  - Experiment Trigger:

Data Acquisition (FIFO / Time-Tag Mode)
- Method: Time-tagging of individual photons and continuous writing to disk
  - Decay function, FCS, Cross-FCS, PCH, MCS traces, images
  - Output Data Format (ADC / Macrotime / Routing):
  - FIFO buffer Capacity (photons):
  - Macro Timer Resolution, internal clock:
  - Macro Timer Resolution, clock from SYNC input:
  - Curve Control (external Routing):
  - Count Enable Control:
  - Waveform recording:
  - No of counts per time channel:
  - Image Acquisition in time-tag mode:
  - FCS calculation:
  - online recording of pixel, lineand frame pulses, online build-up of images by software
  - Multi-tau algorithm, online calculation and online fit

Related Products and Accessories
SPC-130 through SPC-830 TCSPC boards, Simple-Tau 130, 140, 150, 152 systems, FLIM systems, MCPs, PMT modules, SPAD modules, multi-spectral detector assemblies, routing devices for multichannel TCSPC, preamplifiers, PIN and avalanche photodiode modules, ps diode lasers.

Please download the bh TCSPC Handbook from www.becker-hickl.com

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by Wolfgang Becker

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☐ I am thinking about using TCSPC in the future
☐ My interest is microscopy
☐ My interest is single molecule detection
☐ My interest is _________________________________________

Name: __________________________________________________________________

Company or Institution: ___________________________________________________

Address: __________________________________________________________________

Also available useful publications (check the box to request):

☐ TCSPC for Microscopy
☐ TCSPC Systems
☐ Photon Counting Detectors for TCSPC
☐ Picosecond Lasers for TCSPC