

Electronics for NMOS Arrays: Modular Components for UV-VIS Spectroscopy

Linear silicon photodiode arrays based on NMOS technology offer excellent dynamic performance for applications in UV-VIS spectroscopy. A range of electronics modules is available from tec5, supporting series S3901 – S3904 and S8380 – S8381 arrays manufactured by Hamamatsu and equivalent types. In addition, the electronics modules can be

used to operate Spectral Sensors types MMS and MCS manufactured by Carl Zeiss, based on the NMOS arrays supported.

Data are passed to follow-on processing by various interfaces, e.g. PCI, USB or Ethernet for a standard PC or by a parallel interface to a customer microcomputer's digital I/O.

Key Features

- High precision and high dynamic range
- Fast readout with 15 or 16 bit A/D conversion
- Various PC interfaces supported

Application areas

- Light source emission
- Absorbance, color
- Layer thickness
- Concentration in fluids

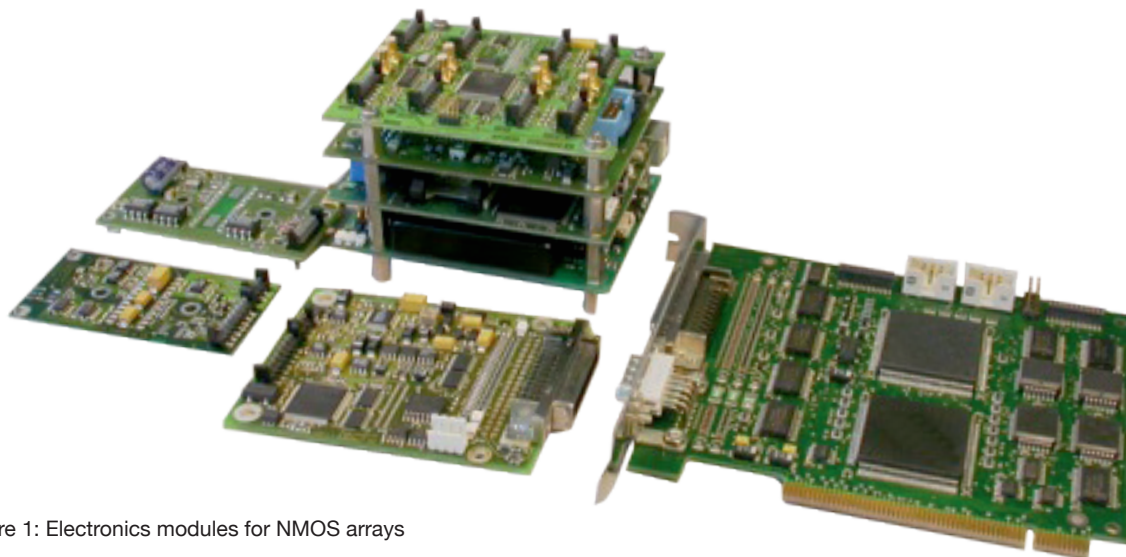


Figure 1: Electronics modules for NMOS arrays

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Characteristics

- 128, 256, 512 and 1024 pixel arrays supported
- Carl Zeiss MMS and MCS sensors supported
- 15 or 16 bit A/D conversion
- Fast readout operation allowing acquisition rates of up to 1000 spectra per second
- High dynamic range version for lowest noise available
- Available PC interfaces
 - USB
 - Ethernet
 - PCI
 - Other (contact tec5)
- Embedded applications and data pre-processing options
- Customization available
- Multiplexing options

Electronics Block Diagrams

Several electronics modules are used with the arrays or spectral sensors according to the block diagrams shown in figures 2 and 3. The function of each of the blocks is described in detail below.

PCI-based Configuration

A dedicated interface electronics board is plugged into a PC with PCI slot. The other boards and the sensor

are designed for being included into a customer's housing, connected to the PC by a 40-pin interface cable available in standard lengths of 2 m or 5 m.

All signal electronics modules are supplied from the PC's internal power supply.

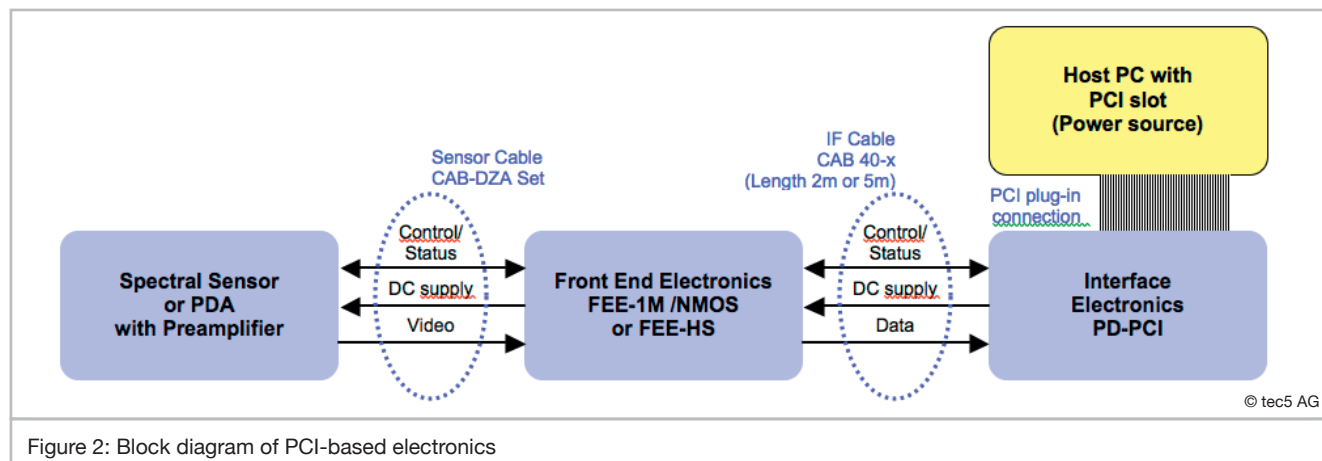


Figure 2: Block diagram of PCI-based electronics

USB- / Ethernet based Configuration

The USB- / Ethernet- based interface electronics with the Front End Electronics is supplied externally by an additional power supply (self-powered). The electronics is connected to the PC by a standard USB or Ethernet interconnection cable according to the block diagram shown in figure 3. The electronics is compatible to standards USB 1.1, 2.0 and 3.0 for PD-USB01 or Ethernet 802.3 10,

100 and 1000Base-T for PD-ETH01. We recommend to use a Hi-Speed USB 2.0 port or an Ethernet 802.3 100Base-T or faster interconnection for best performance.

For high speed versions FEE-1M, Hi-Speed USB communication or 100Base-T Ethernet is mandatory. All electronics boards are designed for integration into a customer's housing.

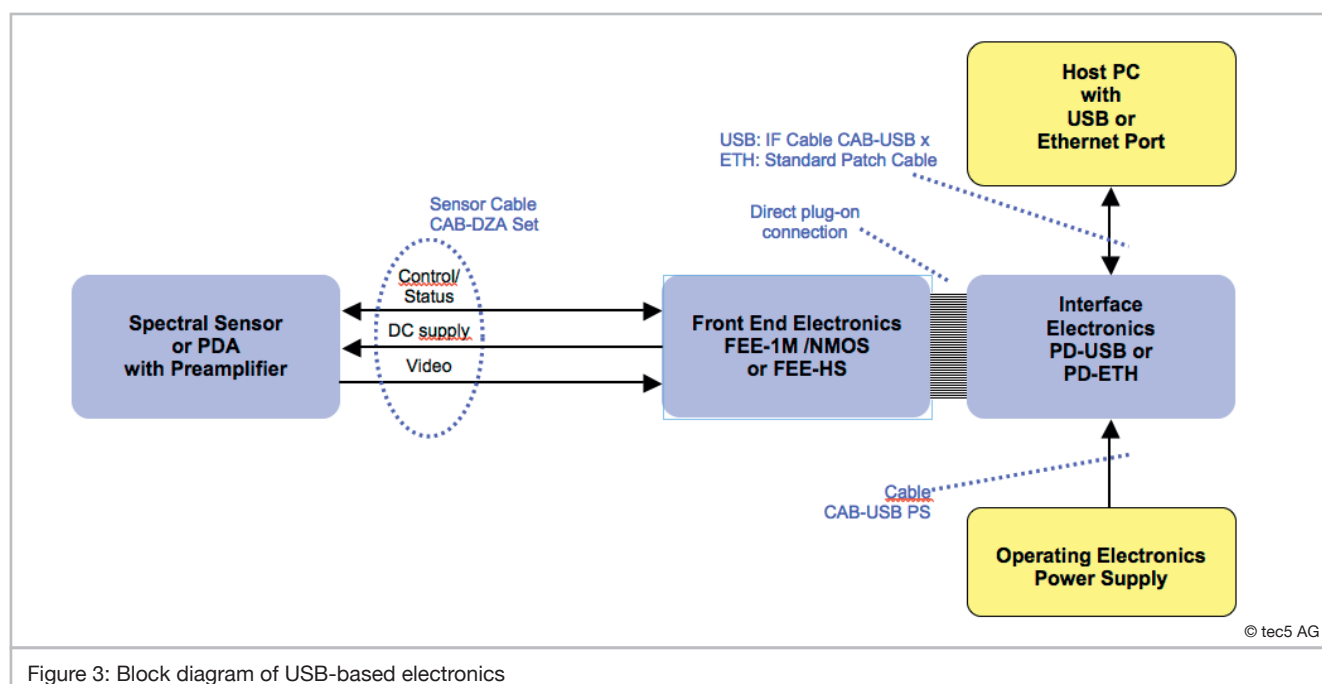


Figure 3: Block diagram of USB-based electronics

Electronics Modules

Sensor Preamplifiers

The photodiode array is plugged into the socket on the pre-amplifier printed circuit board, containing circuitry which should be located in close proximity to the detector array.

Available Preamplifier Boards

- **DZA-S3901-4** for Hamamatsu S3901 to S3904 type photodiode arrays, for 187.5 kpixel per second readout rate, compatible to Carl Zeiss MCS spectral sensors, allows electronic multiplexing.
- **DZA-S3901-4 1M /0x** for Hamamatsu S3901 to S3904 type photodiode arrays, for 1 Mpixel per second read out rate (high-speed readout); compatible to Carl Zeiss MCS spectral sensors.
- **DZA-S3901-4 1M /D0x** for Hamamatsu S3901 to S3904 type photodiode arrays, for 100 kpixel per second readout rate (high-dynamic range readout), compatible to Carl Zeiss MCS spectral sensors.
- **DZA-MMS 1M** for Carl Zeiss MMS spectral sensors, for 1 Mpixel per second readout rate (high-speed readout).

Front End Electronics

Featuring 16 bit A/D conversion, the FEE-1M supports all tec5 1M-type sensor preamplifier modules for NMOS photodiode arrays. Sensor readout is performed at a rate of either 1000 or 100 kpixels per second. The high-speed configuration allows to read more than a thousand full spectra per second. The 100 kpixels per second readout in high dynamic range configuration results in lowest noise operation. Both FEE-1M configurations can be used with Carl Zeiss MCS spectral sensors.

The FEE-HS reads Carl Zeiss MMS or MCS spectral sensors at a readout rate of 187.5 kpixels per second, resulting in a total readout time of less than 1.5 ms for the spectral sensor. In MMS-based configurations, the internal preamplifier of the spectral sensor is used. Optionally, an electronic multiplexer can be used with the FEE-HS to operate up to eight sensors with a single FEE and interface board.

Available Front End Electronics

- **FEE-1M /NMOS-1** for Hamamatsu S390x Arrays and Carl Zeiss NMOS type Spectral Sensors with tec5 preamplifier DZA-S3901-4 1M or DZA-MMS 1M
- **FEE-HS** for Hamamatsu S390x Arrays and Carl Zeiss NMOS type Spectral Sensors with DZA-S3901-4 or MMS preamplifier and optional electronic multiplexer

Interface Electronics

Depending on the preferred type of connection to the host PC, a PCI plug-in interface, a USB- or an Ethernet interface may be used. Other alternatives for interfacing are available, please contact tec5 for details.

The Interface Electronics modules retrieve digitized data from the Front End and forward the data to a host PC. The circuitry contains the readout scan cycle control logic with precise integration timing and hardware sequencing of all functions with real-time requirements. A FIFO buffer memory is used to assure consistent data transfer to the computer's main memory. The interface modules offer peripheral control and synchronization with digital I/O lines, e.g. flash trigger output, external trigger input and general purpose digital I/O lines.

Available Interface Electronics

- **PD-ETH01** for Ethernet networks
- **PD-USB01** for USB connection
- **PD-PCI01** for PCI bus connection

Embedded Solutions

Data processing and evaluation can be partly or completely performed in compact electronics. This reduces data traffic and host processing requirements. In addition, stand-alone solutions may be provided, in which no host PC is required for regular operation.

Allowing averaging, linearization, dark correction and region-of-interest (ROI) selection during data acquisition in real-time, the standard product PD-ETH01 /DP can be effectively used for in-line applications with high speed requirements.

Our hardware and software building blocks are a powerful platform for developing customized solutions for embedded applications. Please contact us to discuss the possibilities suited to your requirements.

Electronics with Data PreProcessing

- **PD-ETH01 /DP** with FPGA realtime data preprocessing for Ethernet networks.

Electronic Multiplexer

In configurations based on the Frontend Electronics FEE-HS, electronic multiplexers may be used to connect up to eight Spectral Sensors or photodiode arrays with their preamplifiers to a single readout electronics. This allows to perform multi-sensor measurements in sequential or simultaneous modes. These configurations are particularly useful for all types of high-precision process analysis, in which a reference channel has to be observed simultaneously. To achieve negligible time delay between two channels, the reference (e.g. monitoring the light source)

and sample channel measurements are interwoven: variations of the light source or other temperature effects can be effectively compensated.

Available Electronic Multiplexers

- **MUX-4P** two channels in simultaneous or four channels in sequential operation
- **MUX-8a** up to eight channels in sequential or simultaneous mode

Operating Carl Zeiss MMS and MCS Spectral Sensors

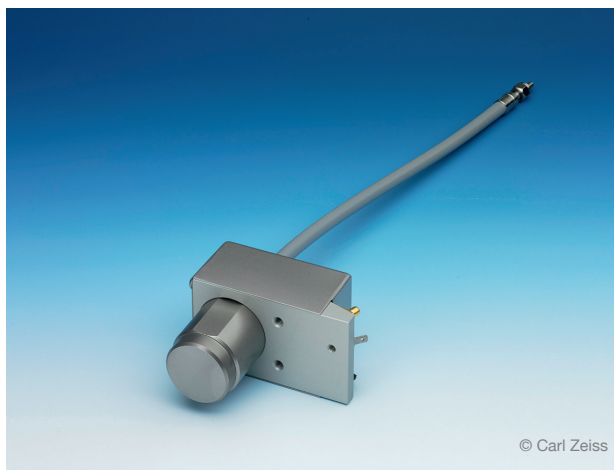
For operation of a standard Carl Zeiss MMS module, a FEE-HS and one of the tec5 interface boards are required. This standard configuration results in 15 bit A/D conversion and readout time below 1.5 ms.

For high speed applications, an MMS module without preamplifier can be used with DZA-MMS 1M and FEE-1M /NMOS-1 to achieve a readout time below 0.3 ms (256 pixel). For NMOS based MCS- or MCS-flex-type spectral sensors manufactured by Carl Zeiss, either a high speed or high dynamic range configuration may be selected, both based on preamplifier DZA-S7030-4 1M

and FEE 1M Front End Electronics with one of the tec5 interface boards.

Details for each standard configuration are contained in the dedicated section below. Other configurations may be available for special requirements, please contact us for more information if required.

Configurations based on FEE-HS can be used with an optional electronic multiplexer to operate up to eight Spectral Sensors.



Software

For configurations based on Interface Electronics manufactured by tec5, drivers for Windows 2000, XP, Vista and Windows 7 are supplied. The free Admin-Tool program can be used for verifying hardware operation and simple data acquisition. In addition, various application programs and software development kits are available from tec5. Please contact us if you intend to use alternative operating systems or for custom software development.

Software Development Kits

- SDK for the function library SDACQ32MP.DLL supporting C/C++, Visual Basic and Delphi programming languages
- SDK for the function library SDPROC32.DLL with ready-to-use dialogs for data acquisition, configuration and parameter setting
- LabVIEW function library (VIs) for programming in a LabVIEW development environment

MultiSpec® Pro

Multi-purpose modular spectroscopy software package with various data acquisition modes, data display, processing and output options, designed for process applications. It runs all current tec5 operating electronics and spectrometer systems. The basic version can be upgraded by a number of optional add-on modules, e.g. for color measurement, chemometric prediction (compatible to The Unscrambler, GRAMS, SensoLogic) as well as for process communication to cover numerous applications. Trial licenses available.

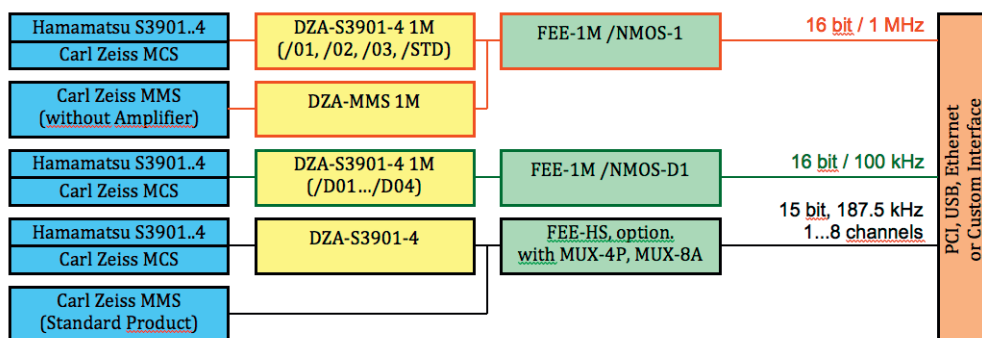
MultiSpec® Pro Lite

In cases especially requiring data acquisition, display and export functionality, a lite version of the MultiSpec Pro software package is offered. Trial licenses available.

Configuration Details

For each sensor supported, the basic hardware configuration is shown in figure 4. The tables below

contain detailed ordering information for the most popular sensors and interfaces.



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Figure 4: Configurations overview

USB / Ethernet Configurations						
Sensor Type	Preamplifier		Front End	Interface	Cable Assy	Remark
S3901 Hamamatsu	DZA-S3901-4 1M /01	11-0106205-01	FEE-1M /NMOS-1 EMB 11-0106107-21	PD-USB01V2 /STD 11-0106015-00 or PD-ETH01V1 /STD 11-0106020-00	CAB-NMOS 1M Set 11-1501004-14	High Speed Configuration
S3902 Hamamatsu	DZA-S3901-4 1M /02	11-0106205-02				
S3903 Hamamatsu	DZA-S3901-4 1M /03	11-0106205-03				
S3904 Hamamatsu	DZA-S3901-4 1M /STD 11-0106205-00					
Carl Zeiss MCS						
Carl Zeiss MMS (without amplifier)	DZA-MMS 1M	11-0106206-01			CAB-MICA 18-14-4 M-1501027-00	
S3901 Hamamatsu	DZA-S3901-4 1M /D01	11-0106205-11	FEE-1M /NMOS- D1 EMB 11-0106107-51		CAB-NMOS 1M Set 11-1501004-14	High Dynamic Range Configuration
S3902 Hamamatsu	DZA-S3901-4 1M /D02	11-0106205-12				
S3903 Hamamatsu	DZA-S3901-4 1M /D03	11-0106205-13				
S3904 Hamamatsu	DZA-S3901-4 1M /D04 11-0106205-10					
Carl Zeiss MCS						
Carl Zeiss MCS	DZA-S3901-4	11-0106200-00	FEE-HS /EMB 11-0106101-12		CAB-DZA Set 11-1501004-00	Option: MUX 4P or MUX 8A
Carl Zeiss MCS	Included in sensor					
Optional for USB configurations: USB cable CAB-USB 2, 11-1501007-00 or CAB-USB 5, 11-1501007-01. DC power supply for signal chain NT-USB, 11-0302001-01.						

USB / Ethernet Configurations						
Sensor Type	Preamplifier		Front End	Interface	Cable Assy	Remark
S3901 Hamamatsu	DZA-S3901-4 1M/01	11-0106205-01	FEE-1M /NMOS-1 STD 11-0106107-20	PD-PCI01V1 /52 11-0106012-30	CAB-NMOS 1M Set 11-1501004-14	High Speed Configuration
S3902 Hamamatsu	DZA-S3901-4 1M/02	11-0106205-02				
S3903 Hamamatsu	DZA-S3901-4 1M/03	11-0106205-03				
S3904 Hamamatsu	DZA-S3901-4 1M/STD 11-0106205-00					
Carl Zeiss MCS						
Carl Zeiss MMS (without amplifier)	DZA-MMS 1M					
S3901 Hamamatsu	DZA-S3901-4 1M/D01	11-0106205-11	FEE-1M /NMOS-D1 STD 11-0106107-50		CAB-NMOS 1M Set 11-1501004-14	High Dynamic Range Configuration
S3902 Hamamatsu	DZA-S3901-4 1M/D02	11-0106205-12				
S3903 Hamamatsu	DZA-S3901-4 1M/D03	11-0106205-13				
S3904 Hamamatsu	DZA-S3901-4 1M /D04 11-0106205-10					
Carl Zeiss MCS						
Carl Zeiss MCS	DZA-S3901-4	11-0106200-00	FEE-HS /STD 11-0106101-11		CAB-DZA Set 11-1501004-00	Option: MUX 4P or MUX 8A
Carl Zeiss MCS	Included in sensor					
For all PCI configurations: PCI interconnection cable CAB40-2, 11-1501005-00 or CAB40-5, 11-1501005-01.						

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