

Electronics for InGaAs Arrays: Modular Components for NIR Spectroscopy

A number of modules is available supporting linear multiplexed InGaAs arrays from several manufacturers. These include standard InGaAs sensitive in the wavelength range between 900nm and 1700nm and extended InGaAs sensitive up to 2500nm maximum.

In addition, the electronics modules can be used to operate Spectral Sensors types PGS-NIR manufactured by Carl Zeiss, based on InGaAs arrays

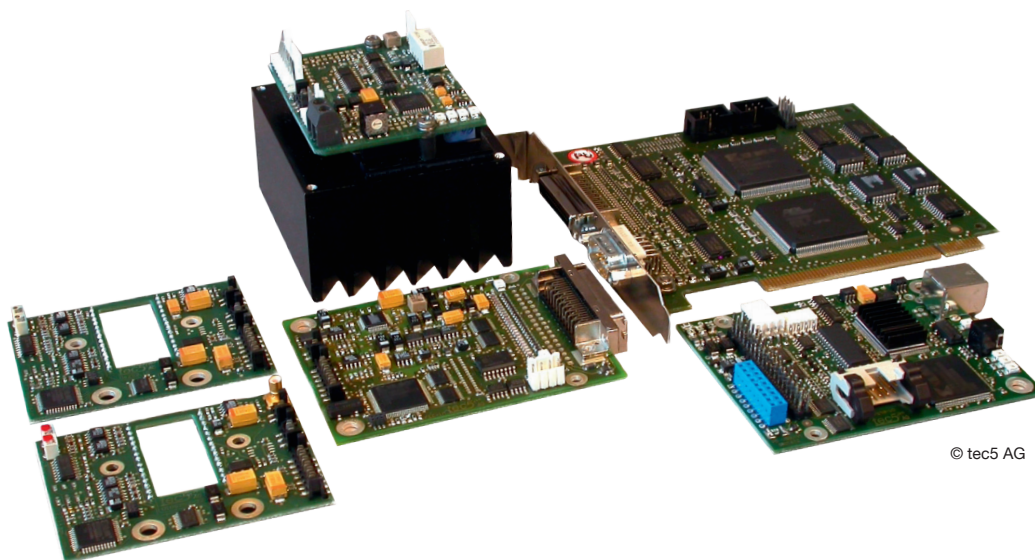
supported. In most cases, the detector arrays are Peltier-cooled for low noise operation and reduced dark current. For this purpose, a suitable temperature controller electronics is available from tec5. Data are passed to follow-on processing by various interfaces, e.g. PCI, USB or Ethernet for a standard PC or by a parallel interface to a customer micro-computer'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

- Humidity
- Protein content
- Layer thickness
- Organics concentration



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Figure 1: Electronics modules for InGaAs arrays

Characteristics

- 128, 256 and 512 pixel arrays supported
- Carl Zeiss PGS-NIR sensors supported
- 15 or 16 bit A/D conversion
- Fast readout operation allowing acquisition rates of up to 1000 spectra per second
- Cooling module for 1..3 stage Peltier elements
- Available PC interfaces
 - USB
 - Ethernet
 - PCI
 - Other (contact tec5)
- Embedded applications and data pre-processing options
- Customization available

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, drawn in blue in figure 2, are supplied from the PC's internal power supply. Only the DC supply voltage required for Peltier cooling has to be provided externally.

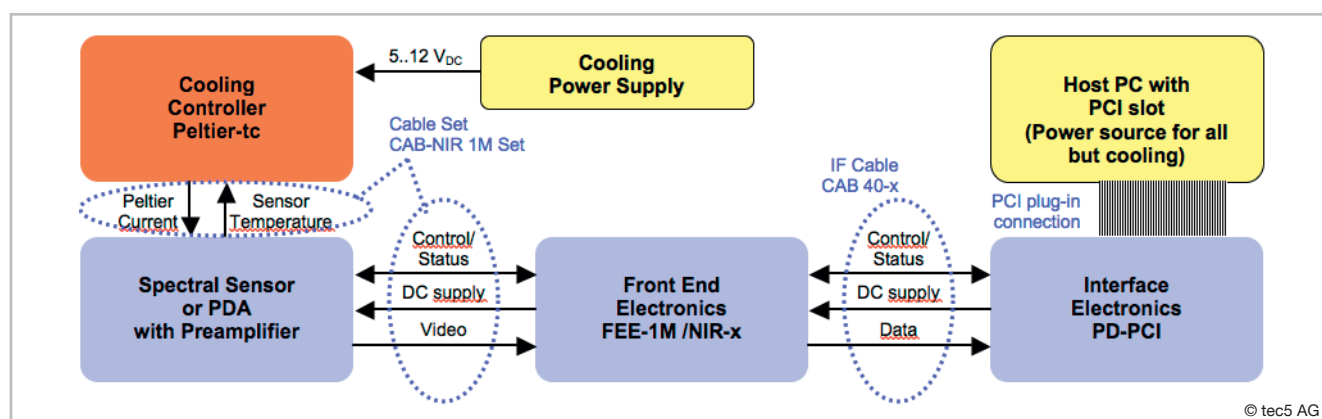


Figure 2: Block diagram of PCI-based electronics

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.

All electronics boards are designed for integration into a customer's housing.

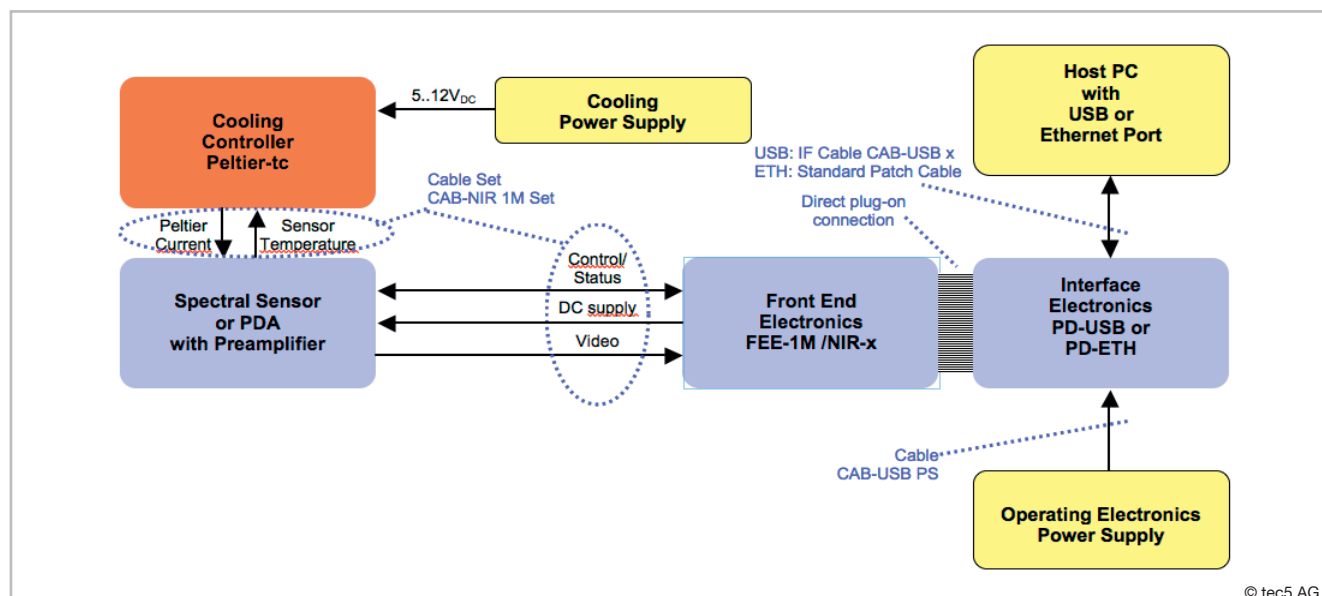


Figure 3: Block diagram of USB- / Ethernet- based electronics

Electronics Modules

Sensor Preamplifiers

For each array type supported, a dedicated preamplifier module is available, where the sensor array can be directly plugged onto this board. The electronics contains circuitry which should be located in close proximity to the detector array.

Available sensor preamplifier modules

- **DZA-VVIR-LD** for Sensors Unlimited InGaAs array types SUxxx-LD and SUxxx-LX with RT or T1 pinout.
- **DZA-VVIR-HM** for Hamamatsu InGaAs array types G9211-G9214 and G9205-G9208.

For each of the arrays mentioned, compatible types may be available and can be possibly operated with one of the preamplifiers. Additional arrays can be supported by modifications of the sensor board. In case of any uncertainty, please contact tec5 to assure compatibility.

For cooled operation of the InGaAs array, appropriate heatsinking has to be considered to remove thermal power dissipated by the detector array and by the Peltier element. A rectangular clearance in the sensor circuit board allows to attach a heat conductor to the bottom of the photodetector array for this purpose.

If a Carl Zeiss spectral sensor type PGS is used, heat-sinking is provided with the module.

Cooling Controller

The electronics module Peltier-tc is a universal cooling controller unit, which has been specifically designed to operate cooled photodiode arrays. Containing a linear PI-type control circuit, possible interactions and cross-talk to the weak optical signal are minimized. Depending on the system configuration, a temperature stability of better than 0.1 K can be achieved.

All important parameters for control loop operation are selectable on the board. For known temperature sensor and Peltier element parameters, factory preconfiguration of the module is possible. In addition, the electronics board allows to connect heatsink thermistors or remote switches to shut down cooling in cases of failure. Relay contacts are available allowing to disrupt the power supply of attached electronics (e.g. the sensor preamplifier) if the sensor temperature is out of its control limit.

The module offers a maximum cooling current of 3 A with adjustable current limit. It is supplied by a DC voltage in

the range between 5 V and 12 V. For specifications and configuration details please refer to the technical data sheet of the module.

Front End Electronics

Featuring 16 bit A/D conversion, the FEE-1M supports all tec5 sensor preamplifier modules for InGaAs arrays. Sensor readout is performed at a rate of 500 or 1000 kpixels per second, allowing to read up to more than a thousand full spectra per second.

Matching different types of interface electronics and diode arrays or sensors, various board versions of the FEE-1M are available from tec5. Please refer to the configuration details below or to the FEE-1M technical data sheet for additional information concerning the FEE-1M board versions.

Available Front End Electronics

- **FEE-1M /NIR-2** for Sensors Unlimited InGaAs Arrays and Carl Zeiss PGS1.7-512 Spectral Sensors
- **FEE-1M /NIR-4** for Hamamatsu InGaAs Arrays and Carl Zeiss PGS1.7-256, PGS2.0 and PGS2.2 Spectral Sensors

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.

Operating Carl Zeiss PGS Spectral Sensors

If ordered as OEM spectral sensor, the PGS-NIR series manufactured by Carl Zeiss is supplied with sensor pre-amplifier electronics manufactured by tec5. For operation, a tec5 Front End and Interface Electronics and a cooling controller are required.



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Software

For configurations based on Interface Electronics manufactured by tec5, drivers for Windows 2000, XP, Vista and Windows 7 are supplied. The free AdminTool 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.

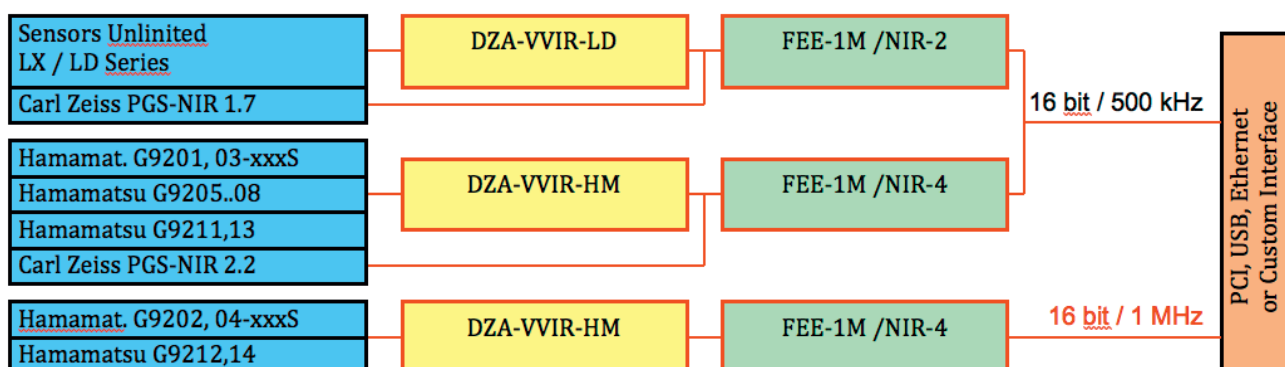
MultiSpec® Pro Lite

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	Cooling ¹	Cable Assy
SU LX or LD Sensors Unlimited	DZA-VVIR-LD 11-0106253-00	FEE-1M /NIR-2 EMB 11-0106107-31	PD-USB01V2 /STD 11-0106015-00 or PD-ETH01V1 /STD 11-0106020-00	PELTIER-tc 11-0106550-01 one stage types*	CAB-NIR 1M Set 11-1501004-13
G9201, G9203-xxxS G9205...G9208 G9211, G9213 Hamamatsu	DZA-VVIR-HM /256 11-0106252-00	FEE-1M /NIR-4 EMB 11-0106107-41		PELTIER-tc 11-0106550-02 two-stage types*	
G9202, G9204-xxxS G9212, G9214 Hamamatsu	DZA-VVIR-HM /512 11-0106252-01	FEE-1M /NIR-4 EMB 11-0106107-41		or customized*	
PGS-NIR 1.7 Carl Zeiss	Included in sensor	FEE-1M /NIR-2 EMB 11-0106107-31		PELTIER-tc 11-0106550-01	
PGS-NIR 2.2 Carl Zeiss	Included in sensor	FEE-1M /NIR-4 EMB 11-0106107-41		PELTIER-tc 11-0106550-02	
PGS-NIR 1.7-256 Carl Zeiss	Included in sensor	FEE-1M /NIR-4 EMB 11-0106107-41		PELTIER-tc 11-0106550-01	
PGS-NIR 2.0 Carl Zeiss	Included in sensor	FEE-1M /NIR-4 EMB 11-0106107-41		PELTIER-tc 11-0106550-02	
Optional for all 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 / Additional DC power supply required for cooling.					
¹5VDC supply recommended for all Hamamatsu sensors. Check PELTIER-tc data sheet for details.					
*Cooling of sensors: compatibility must be checked with the Peltier element and thermistor specifications of the detector array.					
PCI Configurations					
Sensor Type	Preamplifier	Front End	Interface	Cooling ¹	Cable Assy
SU LX or LD Sensors Unlimited	DZA-VVIR-LD 11-0106253-00	FEE-1M /NIR-2 STD 11-0106107-30	PD-PCI01V1 /52 11-0106012-30	PELTIER-tc 11-0106550-01 one stage types*	CAB-NIR 1M Set 11-1501004-13
G9201, G9203-xxxS G9205...G9208 G9211, G9213 Hamamatsu	DZA-VVIR-HM /256 11-0106252-00	FEE-1M /NIR-4 STD 11-0106107-40		PELTIER-tc 11-0106550-02 two-stage types*	
G9202, G9204-xxxS G9212, G9214 Hamamatsu	DZA-VVIR-HM /512 11-0106252-01	FEE-1M /NIR-4 STD 11-0106107-40		or customized*	
PGS-NIR 1.7 Carl Zeiss	Included in sensor	FEE-1M /NIR-2 STD 11-0106107-31		PELTIER-tc 11-0106550-01	
PGS-NIR 2.2 Carl Zeiss	Included in sensor	FEE-1M /NIR-4 STD 11-0106107-40		PELTIER-tc 11-0106550-02	
PGS-NIR 1.7-256 Carl Zeiss	Included in sensor	FEE-1M /NIR-4 STD 11-0106107-40		PELTIER-tc 11-0106550-01	
PGS-NIR 2.0 Carl Zeiss	Included in sensor	FEE-1M /NIR-4 STD 11-0106107-40		PELTIER-tc 11-0106550-02	
For all PCI configurations: PCI interconnection cable CAB40-2, 11-1501005-00 or CAB40-5, 11-1501005-01. Additional DC power supply required for cooling.					
¹5VDC supply recommended for all Hamamatsu sensors. Check PELTIER-tc data sheet for details.					
*Cooling of sensors: compatibility must be checked with the Peltier element and thermistor specifications of the detector array.					

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