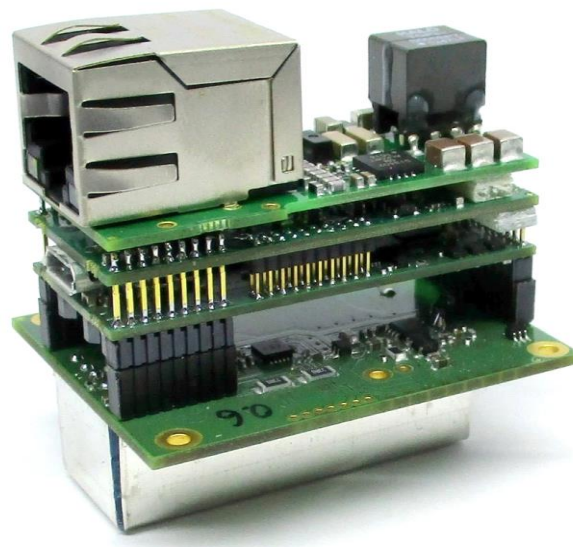# MCA527MICROE / E+

DIGITAL MULTI CHANNEL ANALYZER

EXTENDED DATASHEET/
ADD – ON GUIDE

Exclusion of liability

The GBS Elektronik GmbH is not liable for errors and does not guarantee the specific utility of the MCA527 software or firmware. The GBS Elektronik GmbH is not liable for indirect or subsequent damages due to errors of the MCA527 software or firmware.

The information in this manual has been carefully reviewed and is believed to be accurate and reliable. However, the GBS Elektronik GmbH assumes no liabilities for inaccuracies in this manual. This manual is subject to change without notice.

For software updates or problems exceeding the frame of this manual refer to:

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kontakt@gbs-elektronik.de

REVISION SHEET

Revision	Section / Figure / Entry	Correction
1.0	General	Initial Version
1.1	General	Minor changes
1.2	Chapter, Order codes, Layout Table 7: Module Specification	• Chapter "Charge Sensitive Amplifier for Photo-multiplier Tubes" modified • Chapter "USB-Ethernet and PoE Add-On Board" added • Chapter "USB-RS485 Add-On Board" added • Order codes added • First page modified • Document layout changed • Many changes
V19.03	USB-RS485 Add-On PCB Table Order codes Entire Document	• Layout change • Added RS485 possible configurations • Changed from 2k to 4k as standard version • Design changes
V20.01	Links to GBS website failed	• Links corrected
V20.09	General /Add-on PCB Order codes TTL Interface	• New structure, additional add- on PCBs, examples of Add- on combinations • Many changes with cross-references to the chapters • Added TTL-Interface for Cube527 devices

Table of Contents

1 Product Description

The MCA527microE is a very small ultra-low power multichannel analyzer module designed for direct integration into a detector housing. It is intended for use in NaI- and CdZnTe-detectors but it is also suitable for other applications such as neutron counters or CsI detectors. In conjunction with a preamplifier and a high voltage power supply it is possible to realize an ultra-compact spectrometer. The MCA527microE+ can operate with up to 16k channel resolution for HPGe detector purposes.

The module is powered by a single 5V power supply. In the idle mode it draws about 50mA, during a measurement it needs typical not more than 80mA. Because of its ultra-low power design, it is suitable for low power and battery powered operation.

Two basic interfaces are provided by the module for host communication, UART and RMII. The UART may be used for serial interfaces like USB, and RS232 while RMII enables 10/100 Ethernet communication. A large set of different interface and power supply lines makes it possible to attach additional functions, like GPS receivers, sensors, or microcontrollers. Please contact us if you need support or a firmware extension.

Because the MCA527microE is derived from the MCA527, it is fully firmware compatible with it. All existing application programs and programming libraries for the MCA527 product family can be used to operate the MCA527microE. The basic functions will always work well but for complete device support only the latest software versions should be used.
Please check our website for newest software versions and documents.
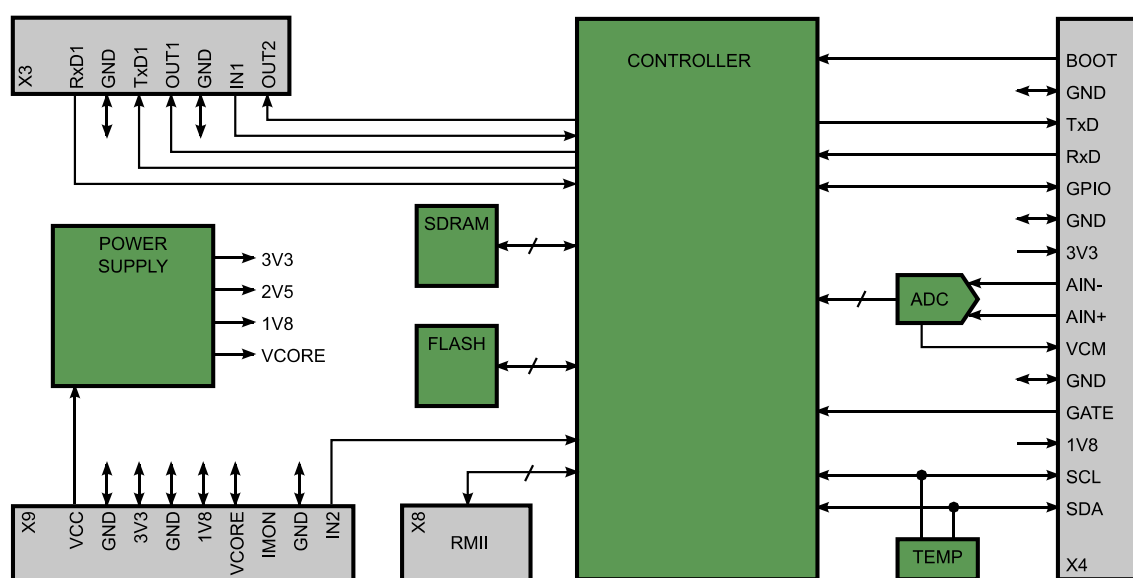
Figure 1 MCA527microE /microE+ Block Diagram

2   Absolute maximum Ratings

Parameter	Rating
Supply Voltage (V_{CC})	-0.3V to +5.5V
Digital Input Voltage (BOOT, RxD, RxD1, GPIO, IN1, IN2, RXD0, RXD1, RXER, CRSDV, MDIO)	-0.3V to (V_{1V8} +0.3V)
Digital Input Voltage GATE	-0.5V to +6.5V
Digital Input Voltage TWI (SDA, SDA_E, SCL, SCL_E)	-0.5V to +3.6V
Analog Input Voltage (AIN+, AIN-)	-0.3V to (V_{3V3} +0.3V)
Operating Temperature Range	0°C to +50°C
Storage Temperature Range	-40°C to +125°C

Table 1: Absolute Maximum Ratings

3   Connection Diagram

Figure 2: Connection Diagram (Top View)

3.1 Pinout Description

Table 2: X9 Pinout Description

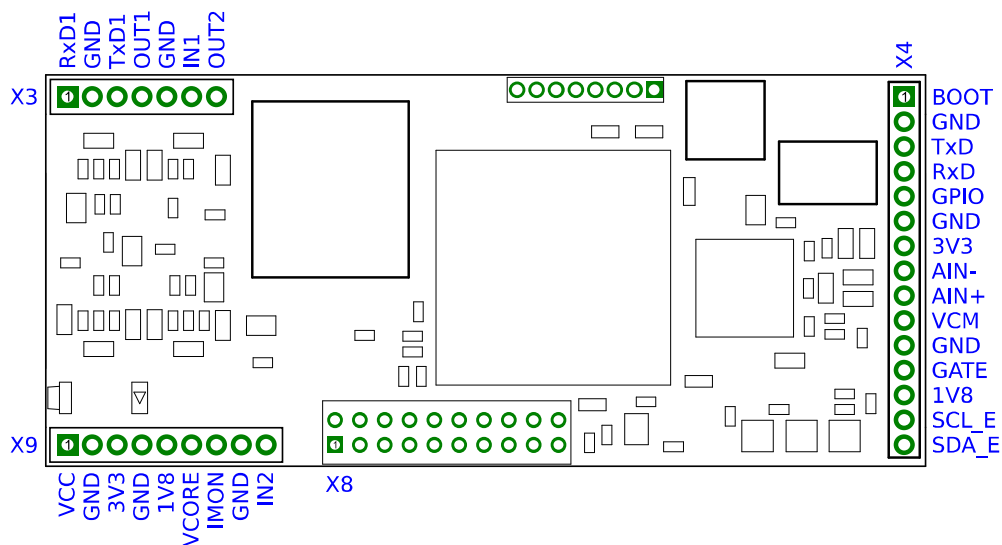| Name	Pin	Type	Description
VCC	1	In	**Supply Voltage:** 5.0V power supply input.
IMON	7	I/O	**Input Current Monitor:** Not used by the MCA527microE module, leave it unconnected.
IN2	9	In	**Digital Input2:** Digital input for extension port functionality.
VCORE	6	Supply	**Core Power Supply:** 1.0V output from integrated power supply.
1V8	5	Supply	**1.8V Power Supply:** 1.8V output from the integrated power supply. The pin is internally connected to 1V8 from X4.
3V3	3	Supply	**3.3V Power Supply:** 3.3V output from the integrated power supply. The pin is internally connected to 3V3 from X4.
GND	2, 4, 8	Supply	**Ground:** Ground supply pins.

Table 3: X3 Pinout Description

Name	Pin	Type	Description
RxD1	1	In	**UART Receiver:** The data input of the controller's host UART.
TxD1	3	Out	**UART Transmitter:** The data output of the controller's host UART.
OUT1	4	Out	**Digital Output1:** Digital output for extension port functionality.
IN1	6	In	**Digital Input1:** Digital input for extension port functionality.
OUT2	7	Out	**Digital Output2:** Digital output for extension port functionality.
GND	2, 5	Supply	**Ground:** Ground supply pins.

Table 4: X8 Pinout Description

Name	Pin	Type	Description
TXD0	1	Out	**TXD0:** RMII - The MAC transmits data to the transceiver using this signal.
TXD1	2	Out	**TXD1:** RMII - The MAC transmits data to the transceiver using this signal.
TXEN	5	Out	**TXEN:** RMII - Indicates that valid transmission data is present on TXD [1:0].
RESET	6	Out	**RESET:** System reset output
CLK	8	Out	**CLK:** RMII - 50MHz clock output to the PHY
RXER	9	In	**RXER:** RMII - This signal indicates that an error was detected somewhere in the frame presently being transferred from the transceiver.
RXD1	10	In	**RXD1:** RMII - Bit 1 of the two data bits that are sent by the transceiver on the receive path.

Name	Pin	Type	Description
CRSDV	13	In	**CRSDV:** RMII - This signal indicates that the receive medium is non-idle.
RXD0	14	In	**RXD0:** RMII - Bit 0 of the two data bits that are sent by the transceiver on the receive path.
MDC	15	Out	**MDC:** RMII serial management interface clock
MDIO	16	I/O	**MDIO:** RMII serial management interface data input/output
SDA	19	I/O	**Serial Data Line:** The data line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
SCL	20	I/O	**Serial Clock Line:** The clock line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
GND	3, 4, 7, 11, 12, 17, 18	Supply	**Ground:** Ground supply pins.

Table 5: X4 Pinout Description

Name	Pin	Type	Description
BOOT	1	In	**Boot Mode Control:** This pin is internally pulled up to 1.8V with 10kΩ. For normal operation, this pin must be tied to ground. If this pin is left floating or driven high during power-up, the controller boots into a special rescue mode for firmware programming.
TxD	3	Out	**UART Transmitter:** The data output of the controllers UART.
RxD	4	In	**UART Receiver:** The data input of the controllers UART.
GPIO	5	I/O	**General Purpose I/O:** Currently this pin has no function and should be left floating. It is reserved for future use.
AIN-	8	In	**Negative Differential Analog Input:** The output of the preamplifier must be connected to AIN+ and AIN-. The signal should swing ±0.5V around the common mode voltage V_{CM} (1.5V). In a single-ended configuration this pin should be driven at 1.5V.
AIN+	9	In	**Positive Differential Analog Input:** The output of the preamplifier must be connected to AIN+ and AIN-. The signal should swing ±0.5V around the common mode voltage V_{CM} (1.5V). In a single-ended configuration this pin should swing ±1.0V around AIN- (1.5V).
VCM	10	Out	**Common Mode Bias:** A 1.5V reference voltage is supplied to the preamplifier on this pin. It can be used to bias the preamplifier.
GATE	12	In	**Gate Signal:** If required, this Schmitt-trigger input can be used for gating. Otherwise this pin should be left floating. The input is pulled down with 5.1kΩ to ground.

Name	Pin	Type	Description
SCL_E	14	I/O	**External Serial Clock Line:** The decoupled (33Ω, 12pF) clock line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
SDA_E	15	I/O	**External Serial Data Line:** The decoupled (33Ω, 12pF) data line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
3V3	7	Supply	**3.3V Power Supply:** 3.3V output from the integrated power supply. The pin is internally connected to 3V3 from X3.
1V8	13	Supply	**1.8V Power Supply:** 1.8V output from the integrated power supply. The pin is internally connected to 1V8 from X3.
GND	2, 6, 11	Supply	**Ground:** Ground supply pins.

4 Electrical Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
V_{CC}	Supply Voltage		3.50		5.5	V
I_{CC}	Supply Current	$3.5V < V_{CC} < 5.5V$			500	mA
I_Q	Quiescent Current	$3.5V < V_{CC} < 5.5V$	50		100	mA
I_{Q_IDLE}	Supply Current Idle Mode	all outputs unloaded		50		mA
I_{Q_MEAS}	Supply Current Measurement	all outputs unloaded, input count rate 50kcps		65	80	mA
V_{3V3}	Output Voltage of 3.3V Regulator	$0mA < I_{3V3} < 250mA$	3.15	3.30	3.45	V
I_{3V3}	Output Current of 3.3V Regulator		0		250	mA
V_{1V8}	Output Voltage of 1.8V Regulator	$0mA < I_{1V8} < 150mA$	1.71	1.80	1.89	V
I_{1V8}	Output Current of 1.8V Regulator		0		150	mA
V_{CORE}	Output Voltage of Core Voltage Regulator	$0mA < I_{CORE} < 90mA$	0.95		1.05	V
I_{CORE}	Output Current of Core Voltage Regulator		0		90	mA
Digital Inputs and Outputs						
V_{IH}	High Level Input Voltage [1], [2]		1.10			V
V_{IL}	Low Level Input Voltage [1], [2]				0.60	V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IHTWI}	High Level Input Voltage TWI [4]		1.35			V
V_{ILTWI}	Low Level Input Voltage TWI [4]				0.51	V
V_{OH}	High Level Output Voltage [3]	I_{OH} = -0.5mA	1.35			V
V_{OL}	Low Level Output Voltage [3]	I_{OL} = 2mA			0.40	V
I_{IH}	High Level Input Current [1]	V_{IN} = 3.6V			10	µA
I_{IL}	Low Level Input Current [1]	V_{IN} = 0V			10	µA
C_{IN}	Input Capacitance [1]	f_{IN} = 1 MHz, $T_{AMBIENT}$ = 25°C		5	8	pF
C_{INTWI}	Input Capacitance TWI [4]	f_{IN} = 1 MHz, $T_{AMBIENT}$ = 25°C			15	pF
V_{T+}	Positive-going Threshold Voltage [5]		0.70	1.02	1.20	V
V_{T-}	Negative-going Threshold Voltage [5]		0.30	0.53	0.72	V
V_H	Hysteresis Voltage [5]		0.30	0.48	0.62	V
R_{IGATE}	GATE Input resistance [5]			5.1		kΩ
Analog Inputs and Outputs						
V_{IN}	Analog Input Range (AIN+ − AIN−)			±1		V
V_{INCM}	Analog Input Common Mode Voltage	Differential Input	1.0	1.5	1.9	V
		Single Ended Input	0.5	1.5	2.0	V
I_{IN}	Analog Input Leakage Current	0V < AIN+, AIN− < V_{3V3}	-1		1	µA
V_{CM}	Common Mode Bias	I_{OUT} = 0	1.475	1.500	1.525	V
Dynamic Characteristics						
f_{TWI}	TWI Bus Clock Frequency			100		kHz
BR	UART Baud Rate		110		3.0M	Baud
t_{GATEON}	Minimum GATE Pulse Width		500			ns

[1] Parameter value applies to all digital inputs and bidirectional pins, except BOOT, GATE, SCL, SCL_E, SDA, SDA_E
[2] Parameter value applies to input pin BOOT.
[3] Parameter value applies to all digital outputs and bidirectional pins
[4] Parameter value applies to SCL, SCL_E, SDA and SDA_E.
[5] Parameter value applies to GATE input.

5 Power Supply

When the supply voltage V_{CC} exceed its minimum value, the integrated power supply starts working and turns on V_{3V3}, V_{1V8} and V_{CORE} (in that order). If V_{CORE} is stable for a few milliseconds, reset is released, and the controller starts the boot process.

Through its pin headers X9 and X4 the MCA527microE is able to supply external circuits with V_{CORE}, V_{3V3} and V_{1V8}. The current rating for each voltage can be found in Electrical Characteristics. However, these limits are only the maximum currents an external circuit may draw from each output rail assumed all other rails are unloaded. The real limiting factor is the modules maximum input current I_{CC}. This limit should never be exceeded under all operating conditions.

6 Analog Frontend

The analog frontend consists of the two inputs AIN+ and AIN- and the reference output VCM. Both inputs are connected directly to the ADC which has a differential input stage. It is possible to drive the ADC with a differential or a single-ended amplifier. Referred to the ADC, SNR and DNL are the same for both versions but INL and harmonic distortion of the single-ended version are degraded. However, in most situations the single-ended driver should work well. Both versions must be configured that the signals baseline is at 10% of full scale for positive input signals and at 90% of full scale for negative input signals.
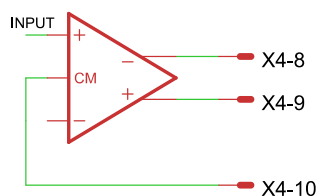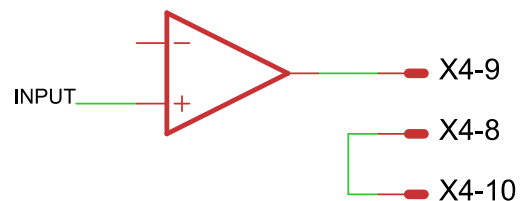

Figure 3: Differential ADC Driver
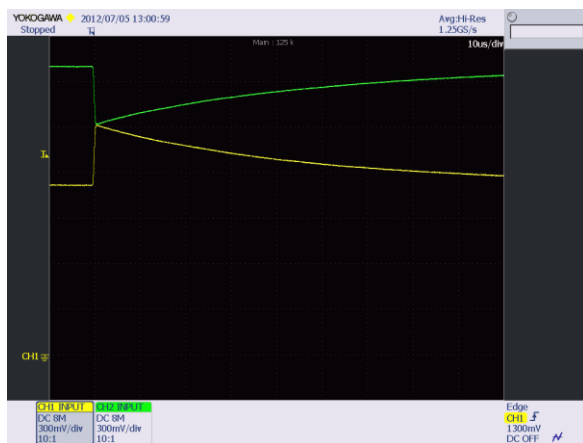

Figure 4: Single Ended Driver

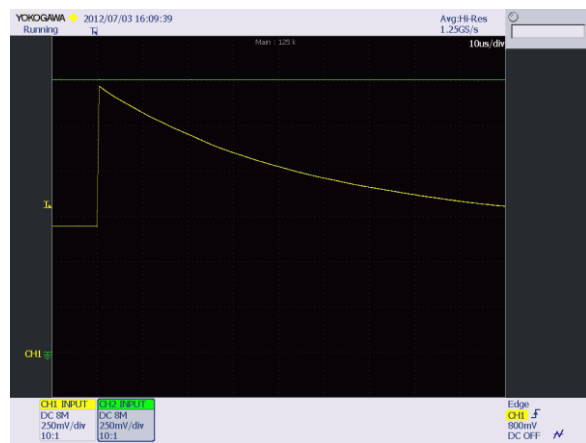*Figure 5: Signals of Differential Driver*
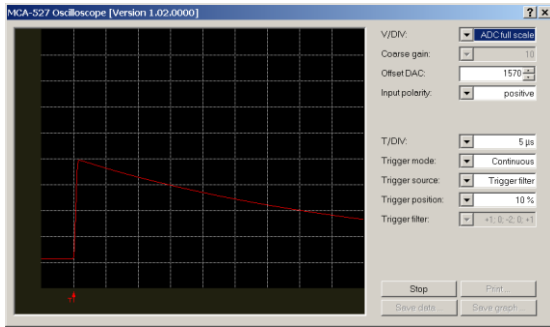

Figure 6: Signals of Single Ended ADC

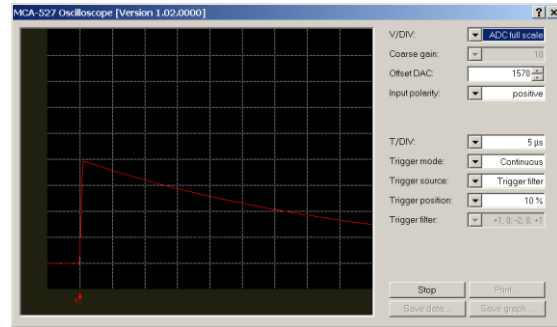Figure 7: ADC Output for Figure 4 Signals

Figure 8: ADC Output for Figure 5 Signals

Figure 3 shows a differential driver stage. The signals AIN+ and AIN- must swing around 1.5V (Figure 5). For that the reference voltage VCM may be used to bias the common mode input of the amplifier. When the previous stage has a single-ended output, the differential driver may be configured as single-ended to differential voltage converter.

A single-ended driver stage has two main advantages: It saves power and board space in most situations. Especially when a photomultiplier is used, only one operational amplifier is needed for pulse forming and ADC driving. Moreover, no additional noise is added to the signal by further operational amplifiers. In a single-ended configuration the signal AIN- should be driven at 1.5V. For that the reference voltage VCM may be used. The signal AIN+ may swing between 0.5V (0% FS) and 2.5V (100% FS).

The ADC output of Figure 5 and Figure 6 produces a peak at about 95% of the spectrums full scale when the fine gain is set to 1.

For best noise performance the bandwidth of the input signal must not be higher than 5MHz. It is recommended to use a low-pass filter directly before the ADC. The filters corner frequency should set to 3.3MHz, higher values will only increase the noise. The higher the filters attenuation for high frequencies, the lower the noise seen by the ADC.

7   Host Communication

The simplest way to establish host communication is to use the modules host UART. Currently four different baud rates are supported (38.4k, 115.2k, 307k, 3M), the baud rate is adjusted automatically. The interface may be used directly by a microcontroller using its TTL signals or through an additional transceiver for various standard serial interfaces like USB, RS232 or RS485.

For 10/100 Ethernet communication the RMII standard interface is provided on connector X8. Different extension boards with Ethernet PHY are available from GBS-Elektronik for an off-the-shelf solution. We recommend using this boards whenever possible. However, when no board fits to the requirements, customer specific solutions are possible. Please contact us for more information.

8   Boot Input

During power-up the controller of the MCA527microE checks the state of the BOOT pin. When it is driven low, the controller tries to start the standard firmware. After booting the state of this pin is meaningless. However, if for any reason the firmware does not start, it is possible to bring the controller in a special rescue mode where only firmware programming is possible. This is done by driving the BOOT pin high (or leaving it floating) during power-up. With the GBS Firmware Loader a new firmware may be loaded to the flash of the MCA527microE through the USB interface now.

This pin must be driven low for normal operation due to the internal pull-up resistor!

Because the pins status is only sampled one time at power-up, the pin may be also used as GPIO after booting. However, this feature is currently not implemented. Please contact us if you need an additional GPIO.

9   Gate Input

Just like the MCA527, the MCA527microE is also provided with a gate input. It is accessible at the GATE pin of X4. All features for gated measurements of the MCA527 are available for the MCA527microE, too, as there are:

- turning gating on or off
- changing the gate signal polarity
- delay time adjustment
- discard or sort mode

In discard mode, the event associated with the gate trigger is rejected and dead time is generated, in sort mode, this event is counted in a second spectrum. Sort mode is an option if doing stabilization with a LED-pulse on a NaI detector. Furthermore, the gate input may be used to trigger a measurement.

10 Two-Wire Interface

For communication with external circuits a two-wire interface is available on X4 and X8. The signals SDA_E and SCL_E are decoupled from SDA and SCL by a series resistor of 33Ω and a capacitor of 12pF to ground. Both signals SDA (SDA_E) and SCL (SCL_E) are pulled up with 2.2kΩ to V_{1V8}, therefore external pull-up resistors are only required, if the lines are loaded with large capacities. All addresses may be used for external devices, excepted addresses 0x92 and 0x94. Both addresses are reserved for temperature sensors of the type TMP102 or compatible, where 0x92 is the address of the internal temperature sensor and 0x94 is reserved for an optional external temperature sensor (maybe placed directly on the crystal). Currently the firmware supports only the two temperature sensors but firmware extensions for other devices, like microcontrollers or ADCs, are possible. Please contact us if your application requires extended functionality.

11 Extension Port Signals

Like the MCA527 the MCA527microE provides two digital outputs and two digital inputs for extension port functionality. The signals IN1, IN2, OUT1 and OUT2 are available on X3 and X9. They can be used for counting, PWM output or simple GPIO functionality.

Table 6: Extension Port Signals

Signal	Functionality
IN1	- general purpose input - slow software counter
IN2	- general purpose input - fast hardware counter
OUT1	- general purpose output
OUT2	- general purpose output - fast hardware PWM output for signal generation

11.1 Extension Port UART Interface

In addition to the two-wire interface, the MCA527microE provides a UART interface on X4, too. The two lines TxD and RxD are referred to V_{1V8}. The UART can be operated with various baud rates in the range of 110Baud to 3MBaud.

Currently two modes of UART operation are supported by the firmware, GPS receiver mode and transparent mode. In GPS receiver mode the controller records the data from an attached GPS receiver and the application software may evaluate this data. In transparent mode the controller passes the data received from the application program through the UART to the external device and vice versa. This mode is only available for programmers. Please refer to communication functions

- MMCA_SET_EXTENSION_PORT,
- MMCA_SET_EXTENSION_RS232,
- MMCA_WRITE_TO_EXTENSION,
- MMCA_READ_FROM_EXTENSION and
- MMCA_READ_FROM_EXTENSION_EX

of the Mca32com.dll library.

12 Module Specification

Table 7: Module Specification

Parameter	Value
Host Interface	- UART, 38.4kBd, 115.2kBd, 307kBd, 3MBd - RMII interface for 10/100 Ethernet
Power Supply	3.6V … 5.5V, 80mA typical
Power Consumption (typical)	250mW / 350mW (Idle / Measurement)
ADC	10MS/s, 14bit, ≤0.05% INL, TK50
Number of Channels	128, 256, 512, 1024, 2048, 4096[1],8192[1], 16384[1]
Shaping Time	0.1µs to 2µs (0.1µs to 25.5µs) [1], step 0.1µs
Flat Top Time	0µs to 15µs, step 0.1µs
Fine Gain Adjustment	0.5 to 6.5, step 0.0001
Trigger Threshold Adjustment	automatically / manually
Trigger Filter	Double and single [1] differential filtering
Pulse Pair Resolution	~400ns
Pile Up Rejection	yes
Throughput (0.2µs shaping time)	>100,000cps
Base Line Restorer	BLR with fixed/adjustable [1] averaging
Pole Zero Adjustment	Decay time down to 40µs can be compensated
Peak Stabilization Modes	standard mode, LED mode
Operation Modes	- PHA (Pulse Height Analysis) - MCS (Multichannel Scaling) - Sample Mode (Transient Record) - Oscilloscope Mode - Firmware Repeat Mode - Gate Mode (by time, by state) [1] - List Modes [2]
Special Features	- Integrated Temperature Sensor - various digital interfaces (TWI, UART, GPIO)
Operation Temperature Range	0°C – 50°C
Dimensions	45mm x 20mm x 5mm
Weight	5g

[1] Only available on MCA527microE+ version
[2] Optional available (option -LW)
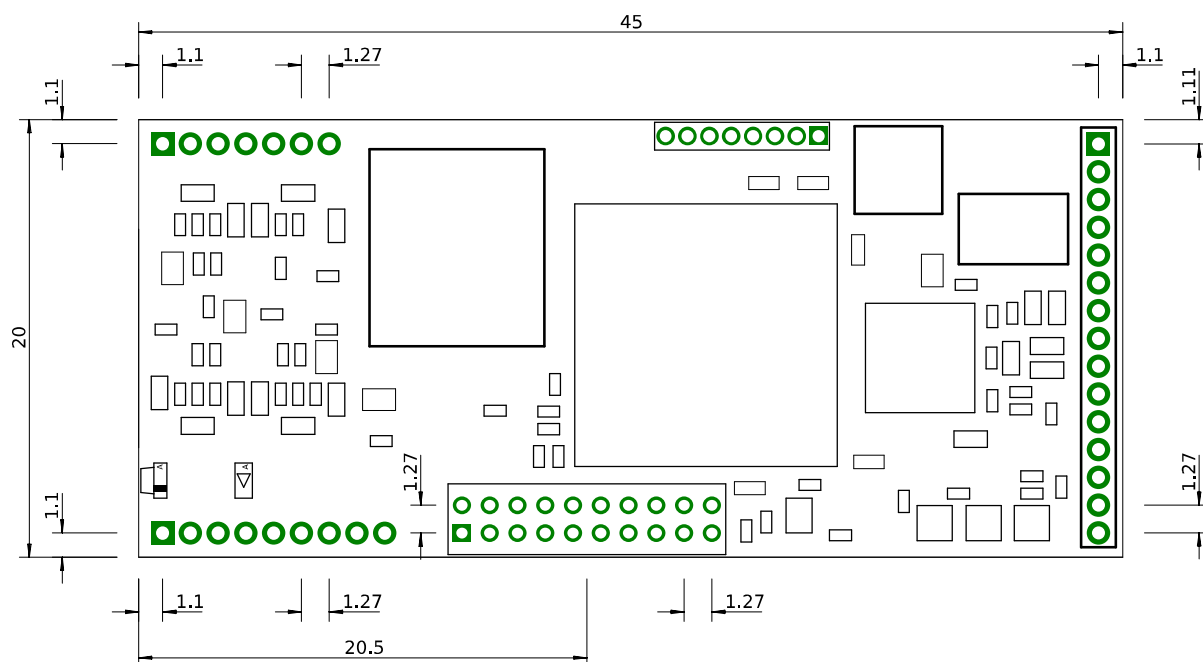
13 Outline Dimensions of MCA527 MicroE

Figure 9: Outline Dimensions (Top View, all Dimensions are in Millimeters)

14 Order Codes and options of the MCA527Micro E/E+

Order code	Description
A-GBS-MCA527MICRO-E	Standard version with 4k resolution
A-GBS-MCA527MICRO-E+	Extended version with 16k resolution
Options	Description
A-GBS-MCA527MICRO-E-FW485	Standard version with 4k resolution and RS485 bootloader
A-GBS-MCA527MICRO-E+-FW485	Extended version with 16k resolution and RS485 bootloader
A-GBS-MCA527MICRO-E+-LM	Extended version with 16k resolution, list mode option
A-GBS-MCA527MICRO-E+-FW485-LM	Extended version with 16k resolution and RS485 bootloader, list mode option

15 Add – on PCB for MCA527MicroE/E+

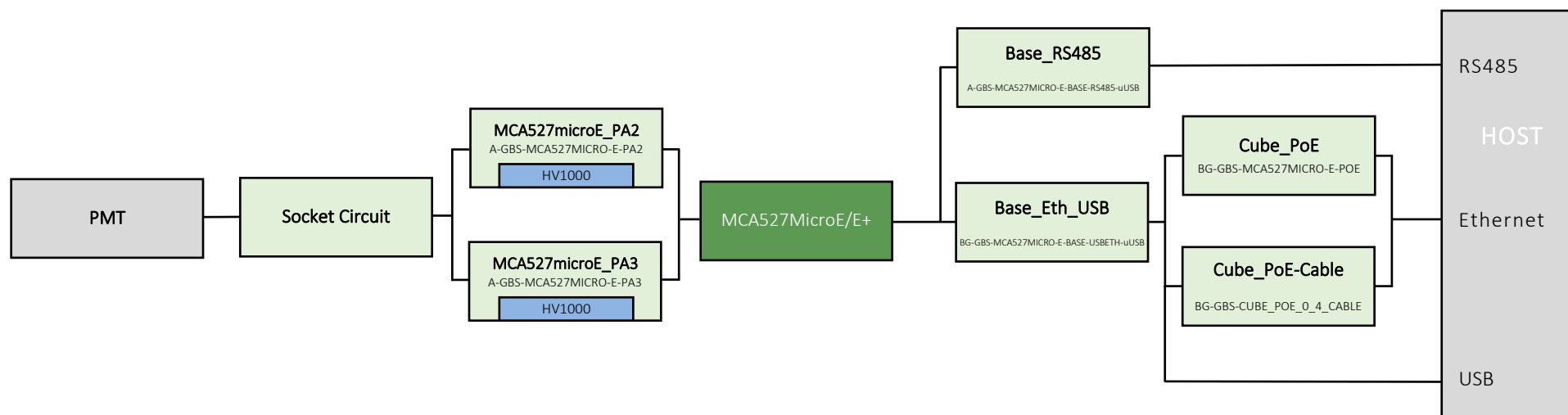### 15.1 Add - on overview for PMT purposes

Figure 10: Add - on PCB overview for PMT purposes

15.1.1 Charge sensitive Amplifier (PA2/PA3)

The PCBs providing a charge sensitive amplifier suitable for most PMT socket circuits and support for a HV1000 module. It requires a MCA527microE module.
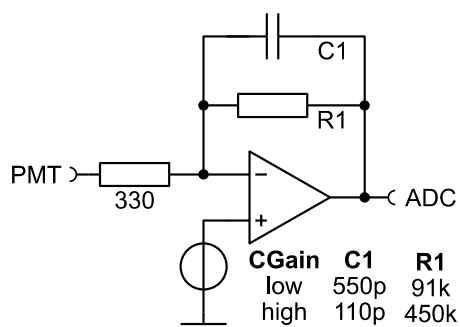

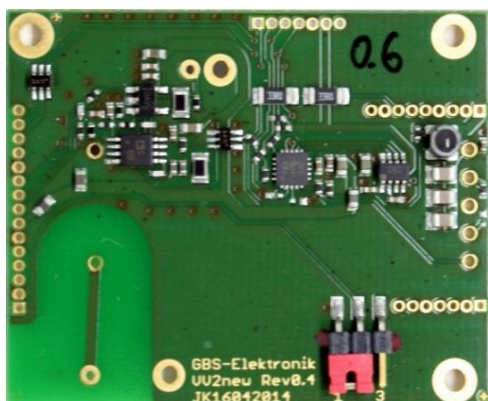*Figure 12: Principal Schematic of the PA*

Figure 13: Charge sensitive Amplifier PA2

Figure 14: Charge sensitive Amplifier PA3

Table 8: Technical Data of Charge Sensitive Amplifier

Parameter	Value
Sensitivity @ CGain=10 (low) Sensitivity @ CGain=50 (high)	~500pC Full Scale (Fine Gain = 1) ~100pC Full Scale (Fine Gain = 1)
Noise Level @ CGain=10 (low) Noise Level @ CGain=50 (high)	~0.1pC RMS typ. ~0.02pC RMS typ.
Rise Time	~200ns
Power Consumption (without HV supply)	~10mA @ 3.3V typ. ~1mA @ 1.8V typ.
Operating Temperature Range	0°C to 50°C
Size (L x W x H) (without DIL headers, HV module populated)	45mm x 36mm x 16mm (PA2) 45mm x 20mm x 16mm (PA3)
Weight (I ncluding HV module)	~25g
Connectors	1.27mm DIL sockets for MCA527microE, solder pads for input and bias supply

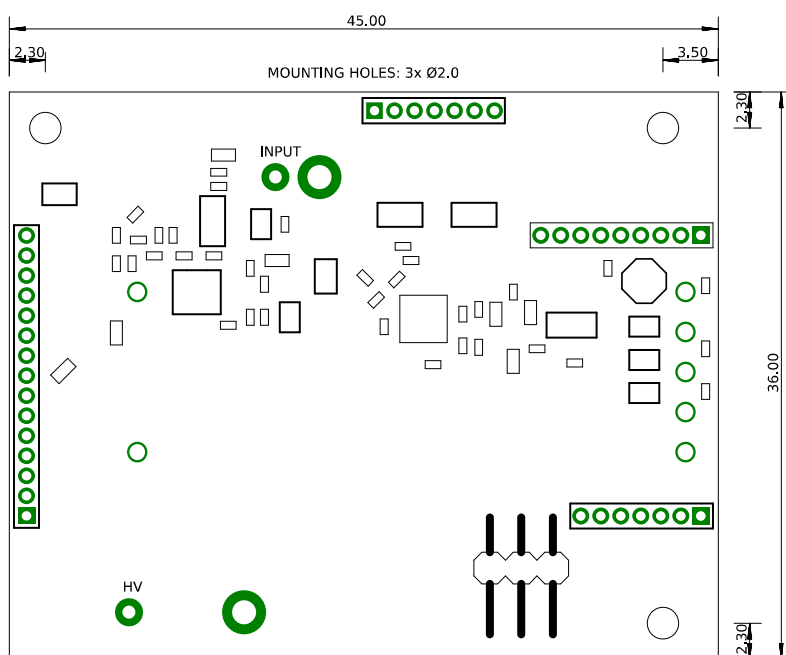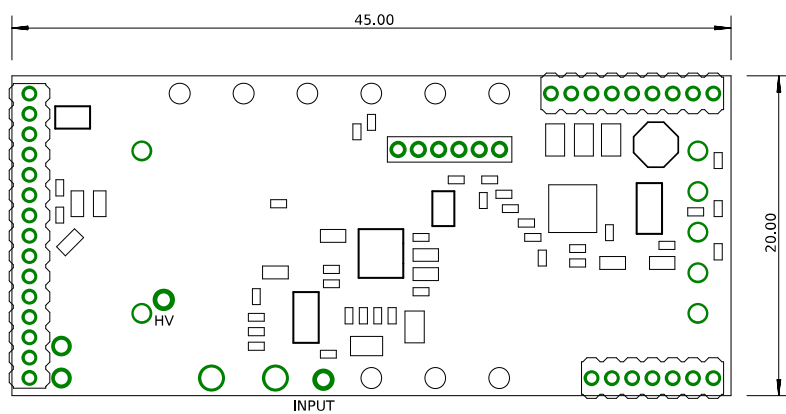*Figure 15: Outline Dimensions of Amplifier Board A-GBS-MCA527MICRO-E-PA2*

Figure 16: Outline Dimensions of Amplifier Board A-GBS-MCA527MICRO-E-PA3

15.1.2 USB-Ethernet Add-On Board

The USB-Ethernet add-on board consists an USB controller with UART interface and a 10/100 Ethernet Transceiver with RMII interface. Board size and connector arrangement is compatible to the MCA527microE. That makes it easy to build a space saving PCB stack.

The USB controller works always with a baud rate of 3MBaud. By default, the board is populated with a micro USB-B socket but it is also available with a standard USB-B socket. However, in this configuration the Ethernet interface is not available. In USB mode the device is powered by the USB hub.
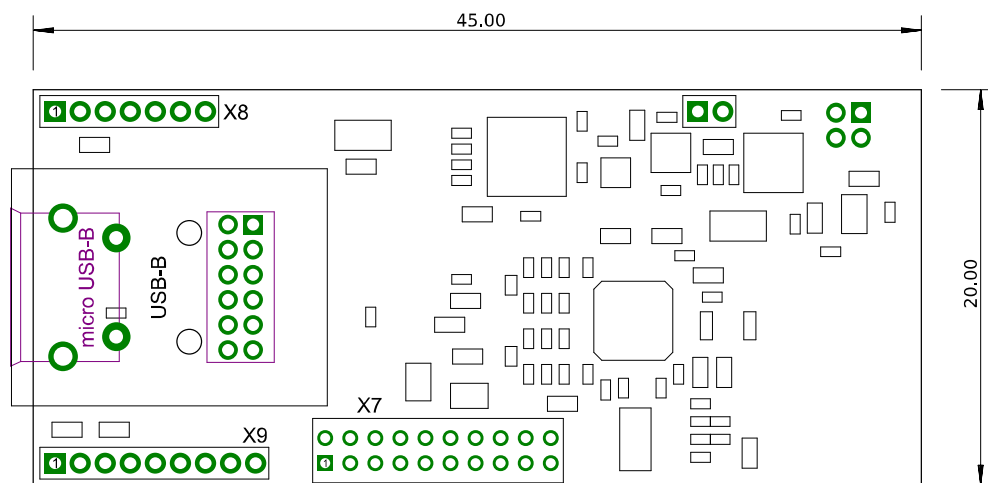

Figure 17: USB Ethernet Add-On Board Outline Dimensions

Table 9: X7 Pinout Description

Name	Pin	Type	Description
TXD0	1	In	**TXD0:** RMII - The MAC transmits data to the transceiver using this signal.
TXD1	2	In	**TXD1:** RMII - The MAC transmits data to the transceiver using this signal.
TXEN	5	In	**TXEN:** RMII - Indicates that valid transmission data is present on TXD [1:0].
RESET	6	In	**RESET:** Reset input for the Ethernet PHY.
CLK	8	In	**CLK:** RMII - 50MHz clock input for to the Ethernet PHY.
RXER	9	Out	**RXER:** RMII - This signal indicates that an error was detected somewhere in the frame presently being transferred from the transceiver.
RXD1	10	Out	**RXD1:** RMII - Bit 1 of the two data bits that are sent by the transceiver on the receive path.
CRSDV	13	Out	**CRSDV:** RMII - This signal indicates that the receive medium is non-idle.

Name	Pin	Type	Description
RXD0	14	Out	**RXD0:** RMII - Bit 0 of the two data bits that are sent by the transceiver on the receive path.
MDC	15	In	**MDC:** RMII serial management interface clock.
MDIO	16	I/O	**MDIO:** RMII serial management interface data input/output.
SDA	19	I/O	**Serial Data Line:** The data line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
SCL	20	I/O	**Serial Clock Line:** The clock line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
GND	3, 4, 7, 11, 12, 17, 18	Supply	**Ground:** Ground supply pins.

Table 10: X8 Pinout Description

Name	Pin	Type	Description
TxD	1	Out	**Serial Transmitter:** The serial data output to the MCA527microE. This pin delivers a 1.8V TTL signal derived from the USB receiver output.
RxD	3	In	**Serial Receiver:** The serial data input fed by the MCA527microE. This pin accepts 1.8V TTL signals and feeds the USB transmitter input.
	4, 6, 7	n.c.	Pins not connected.
GND	2, 5	Supply	**Ground:** Ground supply pins.

Table 11: X9 Pinout Description

Name	Pin	Type	Description
VOUT	1	Out	**Power Output:** Power output to external circuits (e.g. MCA527microE). Output voltage is 5V nominal, the maximum output current is 400mA.
3V3	3	Supply	**3.3V Power Supply:** Power input.
1V8	5	Supply	**1.8V Power Supply:** Power input.
	6, 9	n.c.	Pins not connected.
IMON	7	Out	**Current Monitor:** Output of system current monitor where system current I_{SYS} is the current at VOUT (X9-1). $V_{IMON}=3.3\Omega * I_{SYS}$
GND	2, 4,8	Supply	**Ground:** Ground supply pins.

15.1.3 PoE Add-On

For applications that require Ethernet communication, a second add-on board is necessary - the PoE add-on board. This board has a standard RJ45 jack for the Ethernet cable and an integrated Power-over-Ethernet DC/DC converter. In Ethernet mode the board may be powered by an USB wall adaptor, an USB high power hub or by Power-over-Ethernet (PoE). The Ethernet Transceiver has a RMII interface (Reduced Media Independent Interface) which is available on X7.
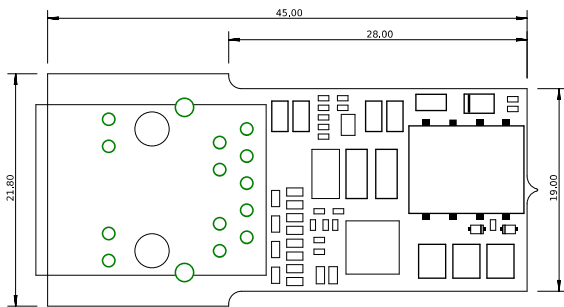
Figure 18: PoE Add-On Board Outline Dimensions

15.1.4 PoE Add-On cable

The PoE_cable PCB is equal the PoE Add-On in Chapter 15.2.3. It provides an Ethernet communication for a fixed cable variant. A DC/DC converter with 5V output and galvanic isolation is also provided.
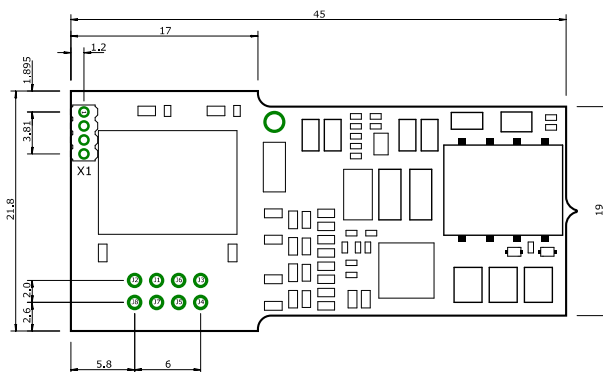
Figure 19 : PoE Add-On cable Board Outline Dimensions

15.1.5 HV1000 Module

A 0.5W HV module with up to 1000V output voltage. Both polarities are available.
It is suitable for A-GBS-MCA527MICRO-E-PA2 -and A-GBS-MCA527MICRO-E-PA3 board.

We kindly refer to the datasheet of the ISEG-hv company for the HV1000 module

15.1.6 USB-RS485 Add-On Board

Together with the USB-RS485 add-on board the MCA527microE becomes a spectrometer with RS485 and USB interface. The USB port is USB 1.1 compliant and works always at 3MBaud. The RS485 interface can be operated in half or full duplex mode. In half duplex mode the RS485 driver enable line (DE, X8-4) must be controlled by the MCA527microE while in full duplex mode it may be connected to a logic high level. Maximum data rate for RS485 is 3MBaud but for longer cables or bad interconnects the baud rate must be reduced by the user. In RS485 mode multiple MCA527microE may be operated on one physical bus. For that, all MCA527microE on the bus must be configured with the same baud rate. The serial number of the MCA527microE is used as address for communication.

 In USB mode the system is powered by the USB port. In RS485 mode the system may be powered by an USB wall adaptor or by an external supply voltage applied to VCC (*Figure18* X3-5). In both cases the VOUT terminal (*Figure18* X9-1) delivers a nominal voltage of 5V with up to 400mA that should be used to power the MCA527microE and other add-on boards like an amplifier board.

When the board is connected to an USB hub, the RS485 interface is automatically disabled. This avoids crosstalk from one interface to the other. To operate the USB-RS485 add-on board it is necessary to configure the MCA527microE properly. Please refer to the document "Description of the MCA527 RS485 Interface" available on our website for more details. Furthermore, it is necessary to order the MCA527microE with the correct bootloader firmware (order option -FW485).
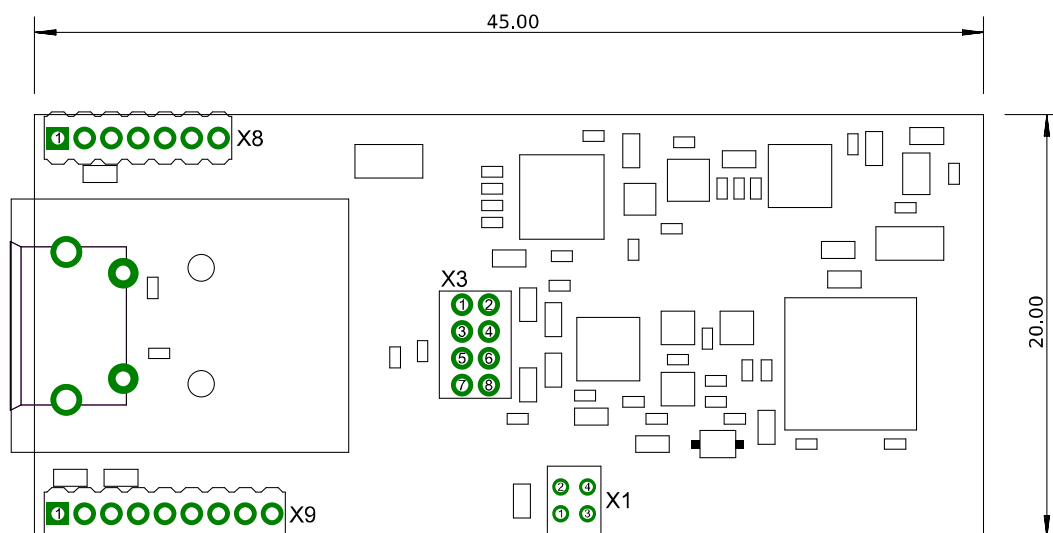

Figure 20: USB-RS485 Add-On Board Outline

Table 12: X1 Pinout Description

Name	Pin	Type	Description
SDA	3	I/O	**Serial Data Line:** The data line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
SCL	4	I/O	**Serial Clock Line:** The clock line of the systems two-wire interface (TWI). If not used, this pin should be left floating.
GND	1, 2	Supply	**Ground:** Ground supply pins.

Table 13: X3 Pinout Description

Name	Pin	Type	Description
TA	7	In/Out	**RS485:** Termination Resistor Line A
TY	1	In/Out	**RS485:** Termination Resistor Line Y
Y	2	Out	**RS485:** Noninverting Driver Output
Z	4	Out	**RS485:** Inverting Driver Output
B	8	In	**RS485:** Inverting Receiver Input
A	6	In	**RS485:** Noninverting Receiver Input
GND	3	Supply	**Ground:** Ground supply pin.
VCC	5	Supply	**Supply:** External Supply Voltage, 8V … 25V

Table 14: X8 Pinout Description

Name	Pin	Type	Description
TxD	1	Out	**Serial Transmitter:** The serial data output to the MCA527microE. This pin delivers a 1.8V TTL signal derived from the USB- or RS485 receiver output.
RxD	3	In	**Serial Receiver:** The serial data input fed by the MCA527microE. This pin accepts 1.8V TTL signals and feeds the USB- and RS485 transmitter input.
DE	4	In	**RS485 Driver Enable:** A logic high (1.8V TTL) enables the RS485 output driver.
	6, 7	n.c.	Pins not connected.
GND	2, 5	Supply	**Ground:** Ground supply pins.

Table 15: X9 Pinout Description

Name	Pin	Type	Description
VOUT	1	Out	**Power Output:** Power output to external circuits (e.g. MCA527microE). Output voltage is 5V nominal, the maximum output current is 400mA.
3V3	3	Supply	**3.3V Power Supply:** Power input.
1V8	5	Supply	**1.8V Power Supply:** Power input.

Name	Pin	Type	Description
	6	n.c.	Pin not connected.
IMON	7	Out	**Current Monitor:** Output of system current monitor where system current I_{SYS} is the sum of current at VOUT (X9-1) and the RS485 driver. $V_{IMON}=3.3\Omega * I_{SYS}$
IF_DET	9	Out	**Interface Detect:** A logic low indicates that a USB hub was detected, and the USB interface is active (RS485 disabled). Otherwise the RS485 interface is enabled. The pin delivers 1.8V TTL output levels.
GND	2, 4,8	Supply	**Ground:** Ground supply pins.

15.1.6.1   RS485 Configuration

The USB-RS485 Add-On Board interface can be operated in half- or full duplex mode. Power can be supplied either via a USB wall-adapter or via X3 DIL header pin5 (VCC) and pin3 (GND).
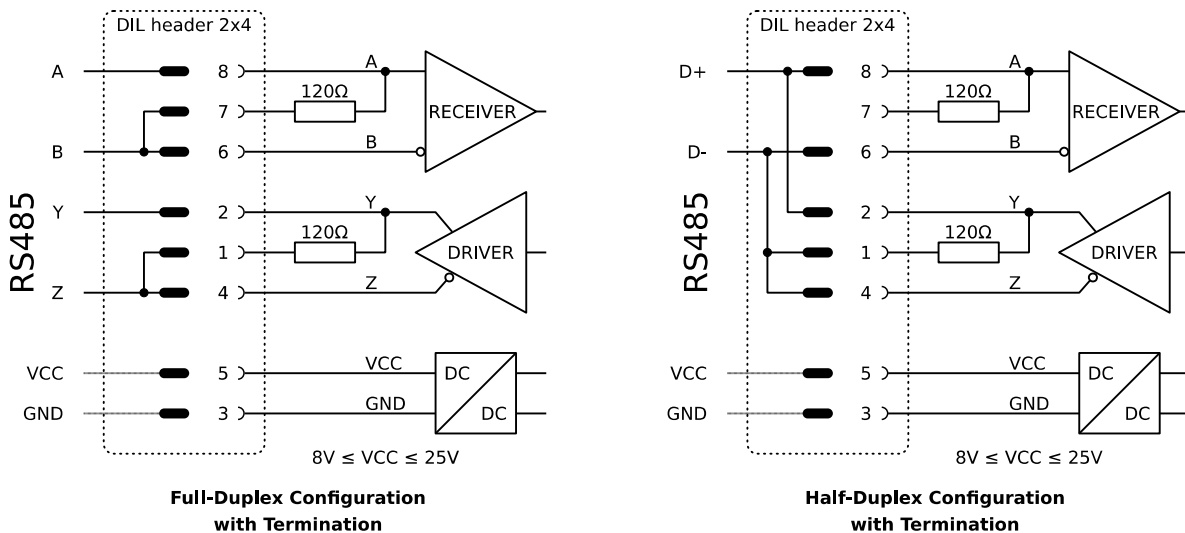
Figure 21: Wiring of possible combinations

15.1.7 Add – on Order Codes

Order code	Chapter - Description
A-GBS-MCA527MICRO-E-PA2	15.1.1 Charge sensitive Amplifier (PA2/PA3)
A-GBS-MCA527MICRO-E-PA3	15.1.1 Charge sensitive Amplifier (PA2/PA3)
BG-GBS-MCA527MICRO-E-BASE-USBETH-UUSB	15.1.2 USB-Ethernet Add-On Board
BG-GBS-MCA527MICRO-E-POE	15.1.3 PoE Add-On
BG-GBS-CUBE_POE_0_4_CABLE	15.1.3 PoE Add-On_cable
A-GBS-MCA527MICRO-HV1000	15.1.5 HV1000 Module
A-GBS-MCA527MICRO-E-BASE-RS485-UUSB	15.1.6 USB-RS485 Add-On Board

15.1.8 Example of an add-on combination

All add-on boards for the MCA527microE were designed to be compatible to each other.
So, it is possible to build board assemblies with different options and interfaces.
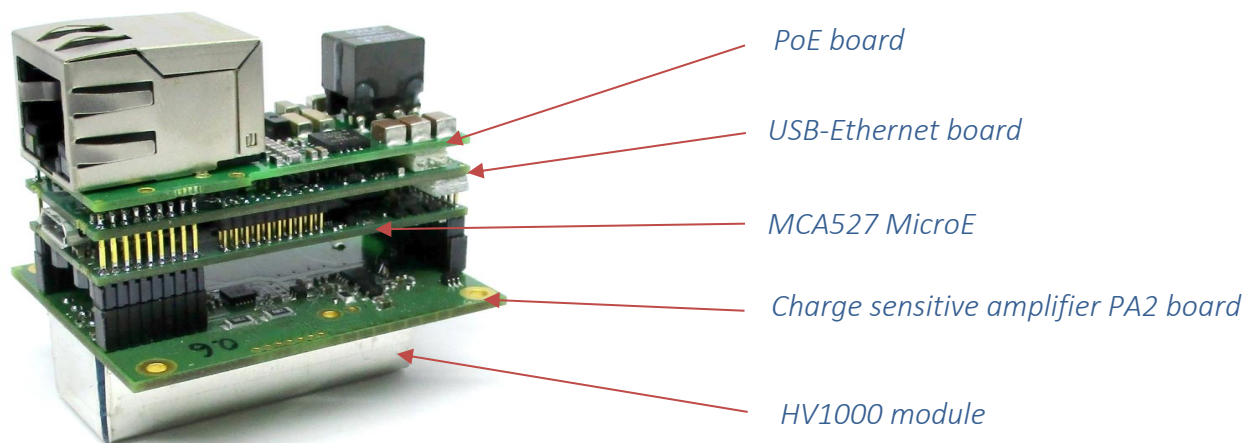
Figure 22: Together with a scintillation detector, this combination corresponds to a spectrometer with USB and Ethernet interfaces

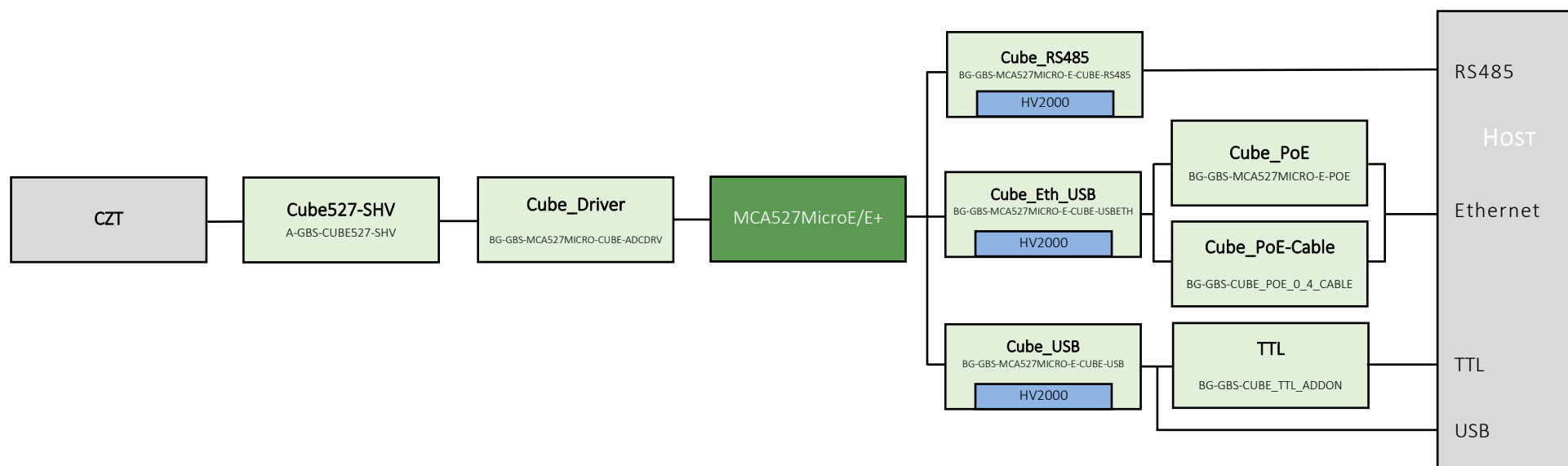## 15.2 Add - on PCB overview for CZT- /semiconductor detector purposes

Figure 23: Add - on PCB overview for CZT- /semiconductor detector purposes

15.2.1 Cube Driver

PCB to drive the ADC. Needed for all possible variants.
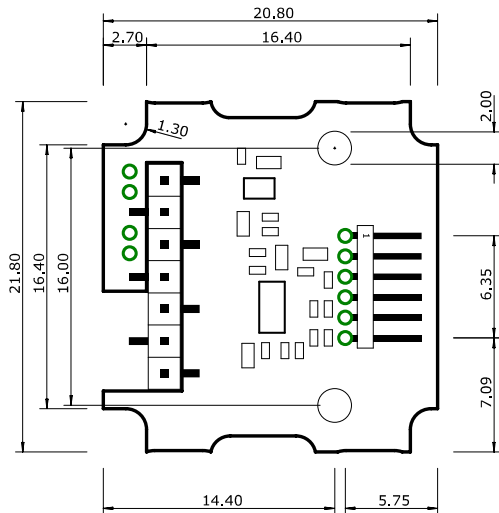

Figure 24: Cube Driver Add-On Board Outline

15.2.2 Cube_Eth USB

Together with the MCA527MicroE, the Cube_Eth USB PCB provides an USB Interface with USB-socket, two MMCX sockets for extension port signals, an 10/100 Ethernet transceiver, as well as the holder for a HV2000 module.
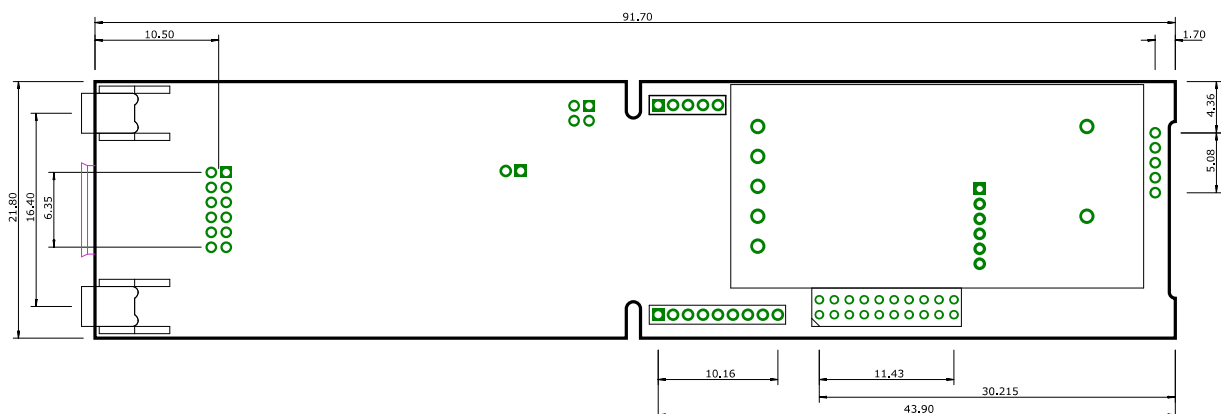
Figure 25: Cube Ethernet USB Add-On Board Outline

15.2.3 Cube PoE

Please see chapter *15.1.3*

15.2.4 Cube_PoE_Cable

Please see chapter *15.1.4*

15.2.5 Cube_USB

The PCB provides an USB interface with µUSB socket, two extension port signals and connections for a HV2000P module. It requires a MCA527microE.
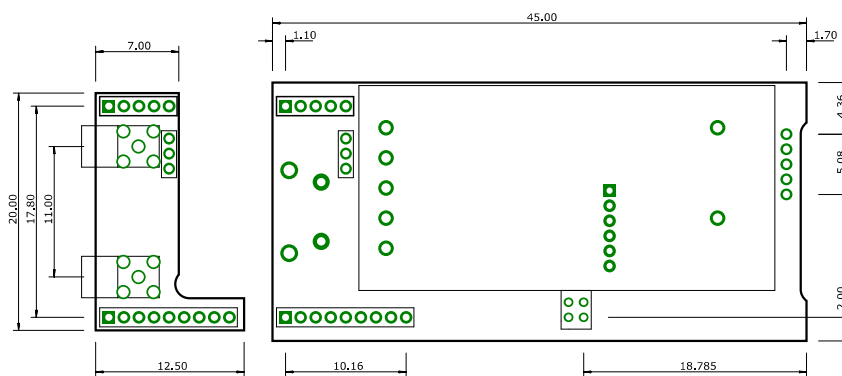

Figure 26: Cube USB Add-On Board Outline

15.2.6 RS485 Add-on

The PCB provides a RS485 interface with Lemo-socket, a DC/DC converter with wide input voltage range for power supply as well as the integration of an HV2000 module.
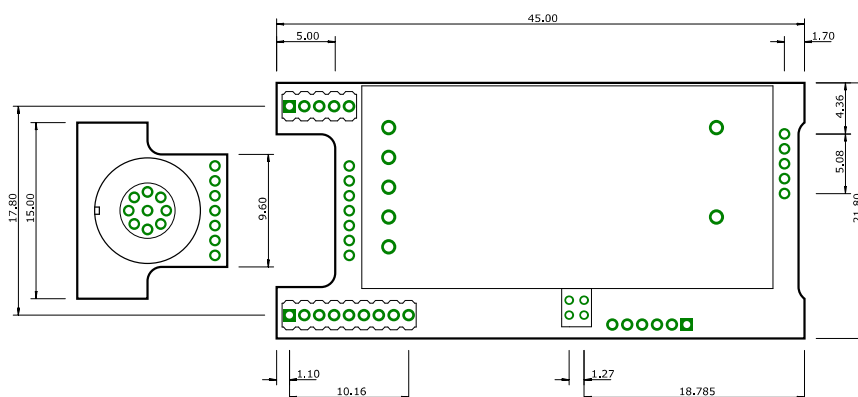See also chapter *15.1.6* for technical background.
.

Figure 27: Cube_RS485 Add-On Board Outline

15.2.7 Cube TTL Add-on

With the Cube_TTL addon board (BG-GBS-CUBE_TTL_ADDON) it is possible to build a Cube527-based spectrometer with a simple TTL-UART interface. The board requires a MCA527microE device (A-GBS-MCA527MICRO-E) and a modified Cube_USB board
 (A-GBS-MCA527MICRO-E-CUBE-USB) for operation. The TTL-Interface is available on the X15 connector (figure 1), table 16 shows the signals. X15 may be populated with a simple right-angle DIL-header (1.27mm pitch) or with other compatible connectors like Molex Picoblade. Power must be supplied via the VIN and GND pins, the UART is available on RxD and TxD. Like the Cube527 device this board also provides two GPIO signals (OUT1 and IN2). These signals have the same functionality as in the Cube527, but the signal voltage level is flexible.
The signal voltage level is the same for all four TTL signals (RxD, TxD, IN2, OUT1) and can be configured with a wire jumper. When no wire jumper is installed, the pin VCCIO becomes an input and a supply voltage in the range of 1.7V … 5.5V must be applied here for the TTL interface. When a wire bridge is installed between TP5 and one of TP4, TP3, TP2, the TTL interface voltage is set according to table 5 and VCCIO becomes an output. In this case VCCIO may be used to power external drivers if they draw less than 10mA.
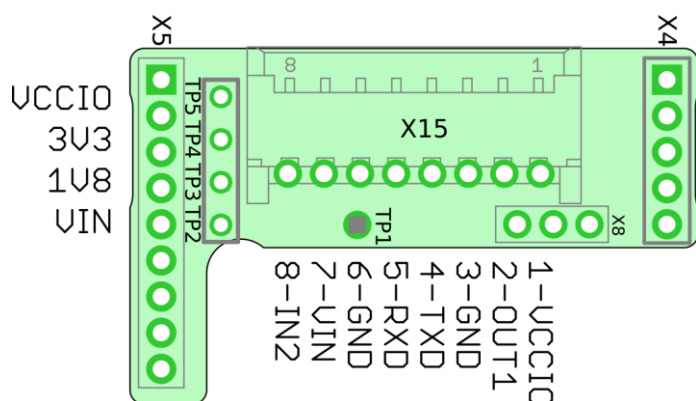

Figure 28: Cube TTL Add-on board

Table 16 X15 Pinout

Pin	Name	Direction	Description
1	VCCIO	Input / Output	TTL Interface Supply Voltage (1.7V … 5.5V) max. 10mA load current when configured as output
2	OUT1	Output	Extension Port OUT1
3	GND	Power	Ground
4	TXD	Output	UART TxD
5	RXD	Input	UART RxD
6	GND	Power	Ground
7	VIN	Input	Supply Voltage (4.8V … 5.5V)
8	IN2	Input	Extension Port IN2

Table 17 Configuration of VCCIO

Connection	VCCIO Direction	VCCIO Voltage
none	Input	VCCIO from external
TP5-TP4	Output	3.3V
TP5-TP3	Output	1.8V
TP5-TP2	Output	VIN
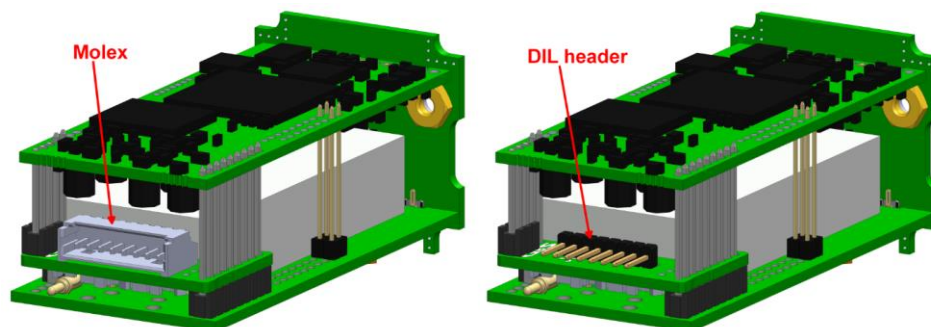
Figure 29: Example of Interface connections

15.2.8 HV2000P

The HV2000V Module is an Add-on for the Cube_Eth-USB, CUBE-USB-, or CUBE-RS485 PCB. It was intended to supply CZT - or other semiconductor detectors with up to 2000V.
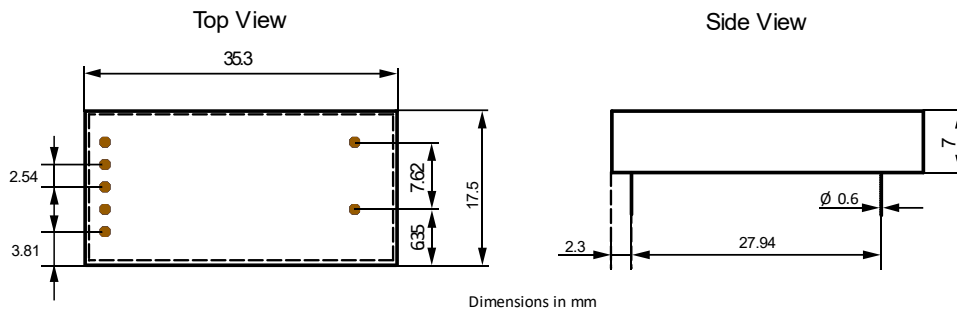
We kindly refer to our datasheet for the HV2000P module

Figure 30: HV2000 module outline

15.2.9 Add-on Order Codes

Order code	Chapter - Description
BG-GBS-MCA527MICRO-CUBE-ADCDRV	*15.2.1 Cube Driver*
BG-GBS-MCA527MICRO-E-CUBE-USBETH	*15.2.2 Cube_Eth USB*
BG-GBS-MCA527MICRO-E-POE	*15.1.3 PoE Add-On*
BG-GBS-CUBE_POE_0_4_CABLE	*15.1.4 PoE Add-On cable*
BG-GBS-MCA527MICRO-E-CUBE-USB	*15.2.5 Cube_USB*
BG-GBS-MCA527MICRO-E-CUBE-RS485	*15.2.6 RS485 Add-on*
BG-GBS-CUBE_TTL_ADDON	*15.2.7 Cube TTL Add-on*
A-GBS-MCA527MICRO-HV2000P	*15.2.8 HV2000P*

15.2.10 Examples of add-on combinations

MCA527MicroE/E+
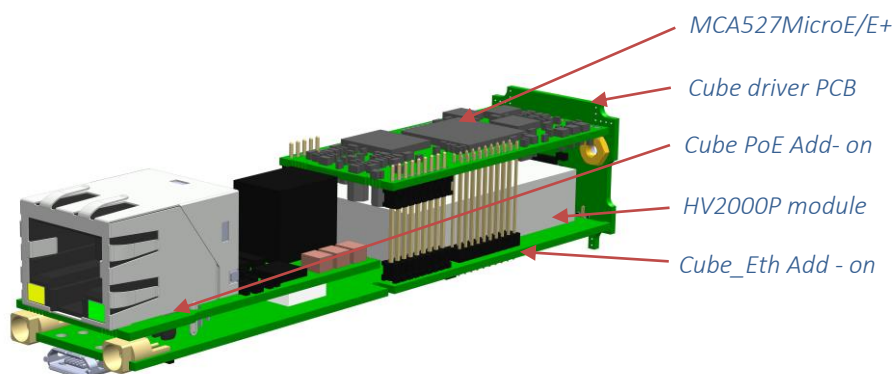
Cube driver PCB

Cube PoE Add- on

HV2000P module

Cube_Eth Add - on

Figure 31: Together with a detector module, this combination corresponds to a spectrometer with USB-, Ethernet an GPIO interfaces
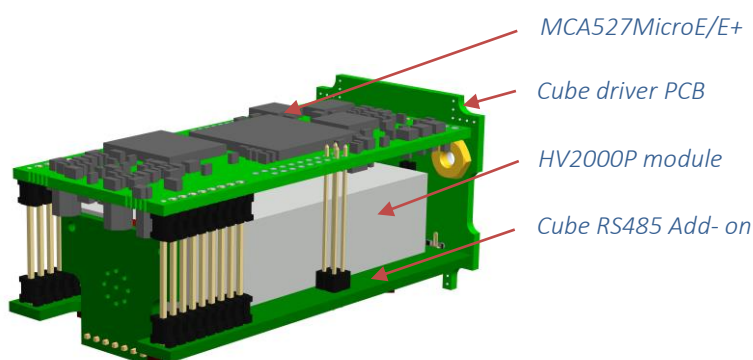
MCA527MicroE/E+

Cube driver PCB

HV2000P module

Cube RS485 Add- on

Figure 32: Together with a detector module, this combination corresponds to a spectrometer with an RS485 interface

MCA527MicroE/E+

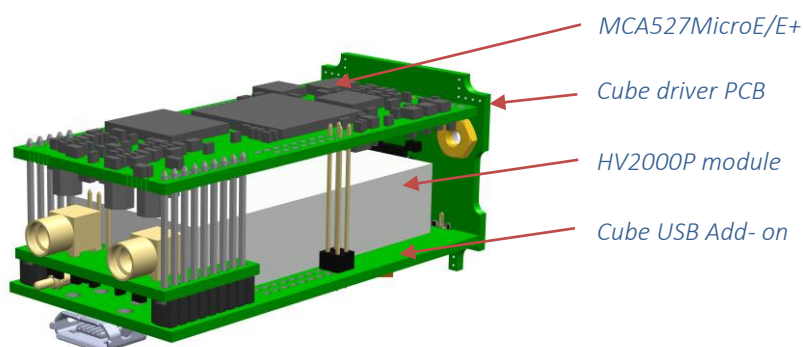Cube driver PCB

HV2000P module

Cube USB Add- on

Figure 33: Together with a detector module, this combination corresponds to a spectrometer with an USB- and GPIO Interface

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