

Operating Instructions

OEM Spectrometer

**RU40/90 basic
BlueSpecCube
LanSpecCube**



JETI Technische Instrumente GmbH
Göschwitzer Straße 48
D-07745 Jena
Tel.: +49 3641 23292 00
Fax: +49 3641 23292 01
E-mail: sales@jeti.com
Internet: www.jeti.com

Contents

1	Introduction	6
1.1	RU40/90 basic	6
1.2	BlueSpecCube	7
1.3	LanSpecCube	7
2	Features	8
3	Mechanical Dimensions	11
3.1	RU40/90	11
3.2	BlueSpecCube	12
3.3	LanSpecCube	13
4	Connectors	13
4.1	Optical Connector	13
4.2	Electrical Connectors	14
4.2.1	USB	14
4.2.1.1	Full Speed USB	14
4.2.1.2	USB Pinout	15
4.2.1.3	USB Signals	15
4.2.2	Bluetooth	15
4.2.3	LAN	17
4.2.4	TTL/ UART	18
4.2.5	Laser diode driver	18
4.2.6	Battery connector(s)	19
4.2.6.1	Battery charging	20
4.2.7	General Purpose Input Output Pins	20
4.2.8	Real Time Clock Calender - RTCC	20
4.2.9	Option: 5 V or 7 V–28 V external voltage supply (only RU40/90 LAN)	21
4.2.10	Option: Reset-Button (on RU40/90 extended and BlueSpecCube) . . .	21
4.2.11	Operation switches (BlueSpecCube)	21
4.2.12	Option: Switch/Trigger-Connector (only RU40/90 extended)	22
5	Status LEDs	22

6	Operating	22
6.1	Installation of Hardware	22
6.2	Firmware	23
6.3	DLL	23
6.4	JETI software	23
7	Specification	24
7.1	Optical parameters	24
7.2	Electronic parameters	24
7.3	Mechanical parameters	25
7.4	Scope of delivery	25
8	Safety instructions	26
9	Service	27

1 Introduction

RU40/90 is a new fiber coupled spectrometer for the wavelength range of 300 nm–1000 nm. It is available in four different versions, which are distinguished by their electrical configurations.

RU40/90 is especially foreseen for the development of mobile spectrometric measurement equipment.

Examples for applications are:

- Colorimeter
- Spectroradiometer
- Analytical instrumentation
- Multichannel spectrometric systems
- Online analyzers

The following manual is valid for all models (here commonly named RU40/90/ BlueSpec-Cube). If a part of the description is not valid for all models it is marked individually.

1.1 RU40/90 basic

Spectrometer with FSMA Input, mechanical shutter.



1.2 BlueSpecCube

Complete system for stand alone operation, based on **RU40/90 extended**, added functions: battery, on/ off switch and measuring button.



1.3 LanSpecCube



Same as **BlueSpecCube**, but with LAN interface instead of Bluetooth.

2 Features

The *JETI* broadband OEM spectrometers **RU40/90/ BlueSpecCube** are new flat field spectrographs combined with powerful processing electronics.

They are characterized by:

- A high quality image with very low aberrations over the whole spectral range
- A high dynamic range
- A compact design
- Internal mechanical shutter (piezo driven)
- High speed USB interface
- TTL UART Interface (RU40/90 basic, extended and LAN)
- LAN (RU40/90 LAN) or Bluetooth interface (RU40/90 extended and BlueSpecCube)
- Laser diode controller (e.g. for RAMAN, SERS, only RU40/90 extended, RU40/90 LAN and BlueSpecCube)
- Li polymer battery charger (RU40/90 extended, RU40/90 LAN and BlueSpecCube)
- Rechargeable battery (RU40/90 extended, RU40/90 LAN and BlueSpecCube)
- External trigger input
- Optional Real Time Clock Calendar RTCC (only RU40/90 extended, RU40/90 LAN and BlueSpecCube)

The spectrometers have several controller functions such as:

- internal storage of wavelength pixel relation
- preprocessing of data, dark signal correction, absolute calibration
- internal calculations like averaging, interpolation, transmission, reflexion, absorption, color coordinates
- dedicated control syntax (SCPI compliant)

The communication interfaces are:

- USB Hi-Speed up to 40 MB/s, optional USB Full Speed
- BlueTooth ultra low power with up to 921 600 bit/s
- TTL UART 8N1 with 3 000 000 bit/s, 921 600 bit/s, 230 400 bit/s, 115 200 bit/s or 38 400 bit/s.
- LAN 10/100 with up to 10 Mbit/s data rate

The **RU40/90/ BlueSpecCube** spectrometer electronics has the following advanced features:

- 100 MHz MIPS 4 K core based RISC CPU with 512 kB flash program memory and 128 kB RAM
- Possibility of in field programming by integrated bootloader
- Firmware, that can be used in general application or user specific OEM applications in spectroscopy
- SCPI compliant control syntax for setting operation parameters, configuration, measurement, data format, endianes, etc.
- user accessible nonvolatile memory of 64 kB (e.g. for linearization, straylight compensation etc.)
- 16 bit 5 MS ADC with programmable offset correction and gain
- Power supply via USB or external 5 V/ 7 V–28 V
- Power down feature by digital input or by SCPI
- Digital trigger input LV-TTL
- Shutter/lamp control output LV-TTL
- Busy or 5 V power supply output

Summary of features:

Feature	RU40/90 basic	RU40/90 extended	RU40/90 LAN	BlueSpec- Cube
Mechanical shutter	X	X	X	X
USB high speed	X	X	X	X
TTL UART	X	X	X	X
3 GPIO-Pins		X	X	X
7 GPIO-Pins	X			
BlueTooth		X		X
LAN			X	
Battery controller		X		X
Li-ion battery		X (separate)		X
Status LEDs		X	X	X
Reset button		X	X	X
External power supply			5 V (7-28 V optional)	

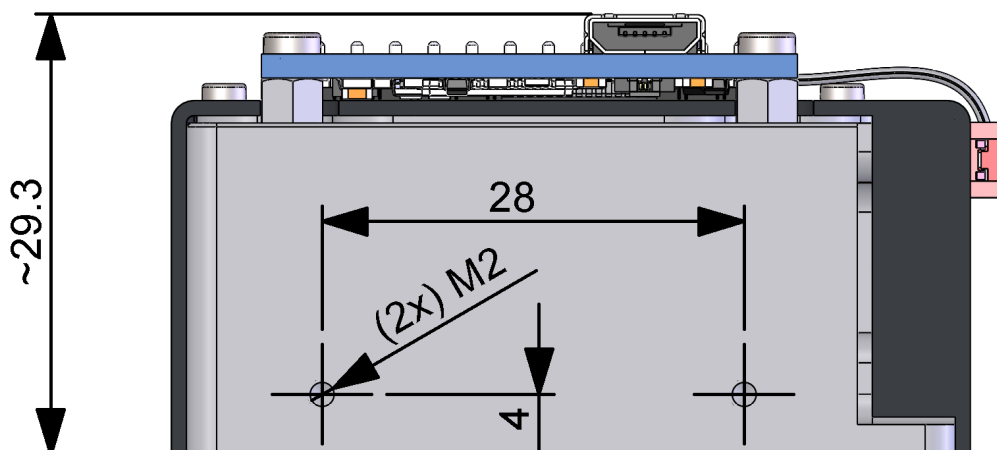
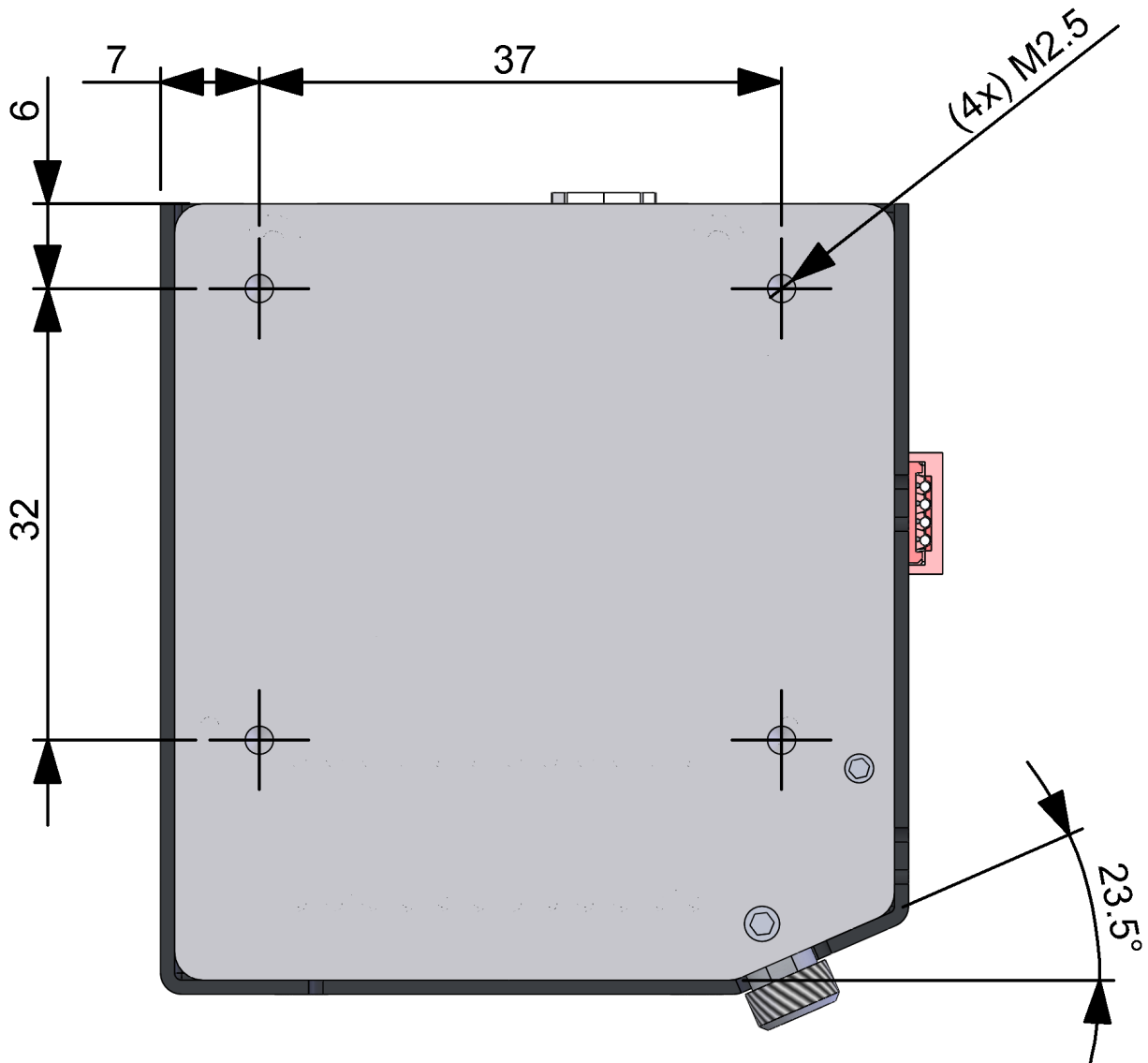
Additional features:

- SPI Communication Interface (Master/Slave)
- Real Time Clock Calender (Coin Cell inclusive)
- SD-Card connector with firmware included file system
- Second battery connector for two batteries in parallel
- Laser Diode Controller with PWM
- Near Field Communication Interface (NFC)
- LCD Display Interface (using SPI)
- Other connector solutions e.g. for access to GPIO's and communication signals.

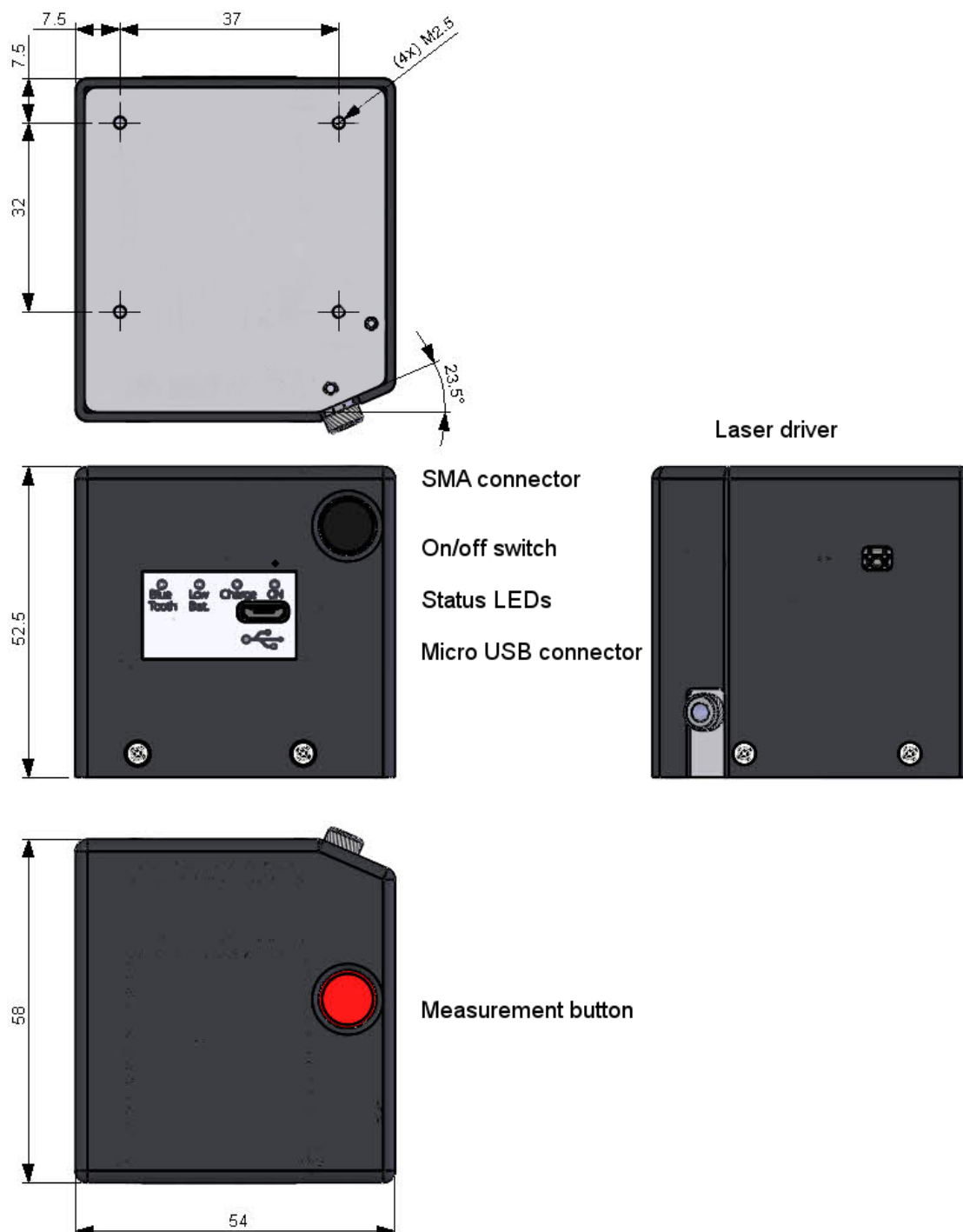
These features, other combinations and individual solutions are available on request.

3 Mechanical Dimensions

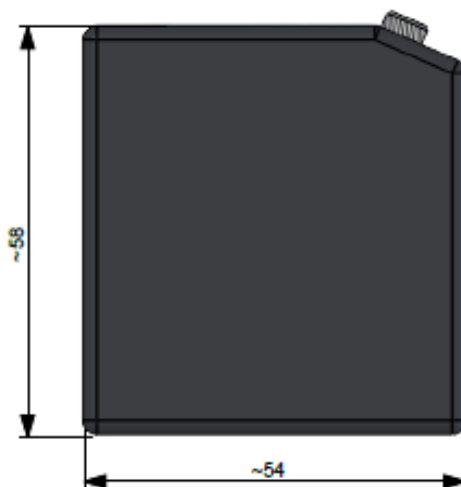
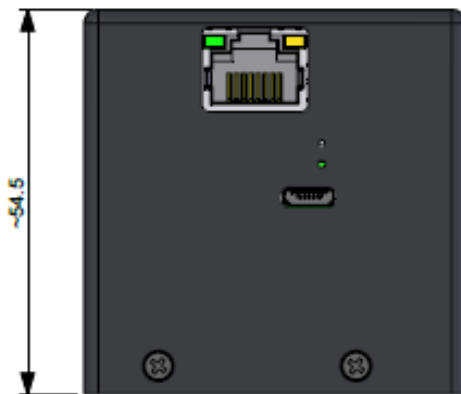
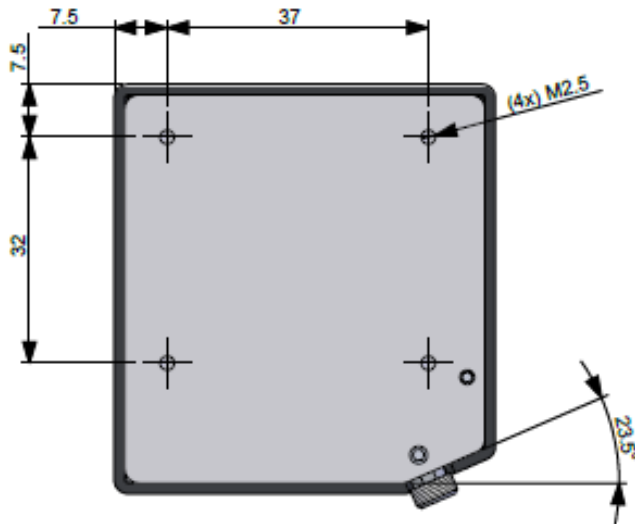
3.1 RU40/90



3.2 BlueSpecCube



3.3 LanSpecCube



4 Connectors

4.1 Optical Connector

The spectrometers RU40/90 / BlueSpecCube have a FSMA connector. It is recommended to use an optical fiber with 200 µm core diameter (other diameters are not recommended because of possible loss of optical resolution or light intensity). The fiber should be connected (or directed using some additional optics) to the light source, which has to be measured.

4.2 Electrical Connectors

4.2.1 USB

All models have a micro USB connector. The USB communication port can be used for powering the units, on condition it is connected to an active USB hub capable to draw up to 500 mA current at minimum voltage of 4.7 V.

Note:	Passive USB hubs do not provide sufficient power. In this case the electronics has to be powered externally.
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For battery charging or if connected via Bluetooth an external USB charging adapter can be used to draw up to 1250 mA.

The USB powering design provides a USB 2.0 compliant power management sequence during plugin and enumeration of the device.

The OR gated low drop out power circuitry switches automatically over to USB powering or external power, which voltage is ever higher.

4.2.1.1 Full Speed USB

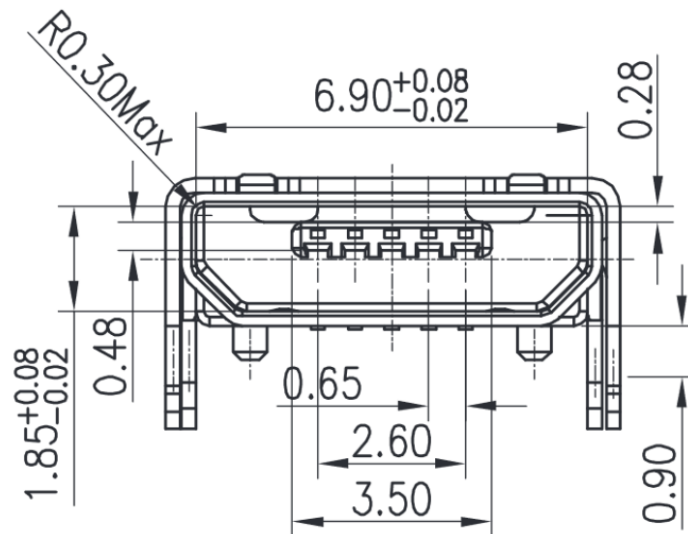
On USB 2.0 Full Speed option the communication takes place via a USB to serial bridge device FTD230XQ using a virtual COM Port driver from FTDI Ltd., which can be obtained for the used operating system from here: <http://www.ftdichip.com/Drivers/VCP.htm>. The following transmission speeds are possible:

3 000 000 bit/s,
921 600 bit/s,
230 400 bit/s,
115 200 bit/s,
38 400 bit/s.

The protocol settings are 8N1 (1 startbit, 8 bit, no parity, 1 stopbit) and no handshake.

Users program or the OS must provide sufficient communication queue memory in case of huge amount of data to be transmitted at once.

4.2.1.2 USB Pinout



The connector in use is a micro USB 2.0 Type B receptacle connector with SMT and THT components for maximal stability.

4.2.1.3 USB Signals

Pin-No.	Description	Signal	Level	Min	Typ	Max	Unit
1	USB Power	VUSB		4.7	-	5.5	V
2	Differential Data -	USB D-	Low	0	-	0.4	V
			High	2.4	3.3	5.5	
3	Differential Data +	USB D+	Low	0	-	0.4	V
			High	2.4	3.3	5.5	
4	USB OTG Signal	USBIDN	Not used, electronics is always device				
5	USB GND	GNDUSB		-	0	-	V

4.2.2 Bluetooth

RU40/90 extended and **BlueSpecCube** can be alternatively connected to a PC via Bluetooth.

The ultra-low power Bluetooth 2.1 module PAN1322-SPP of class 2 with up to 921 600 bit/s UART Interface and EDR is used.

Automatically switch over between different low power modes and adaption of transmission power drastically reduces current consumption.

A blue status LED signalizes a successful established Bluetooth connection. Bluetooth- and LAN-modules are mutually exclusive.

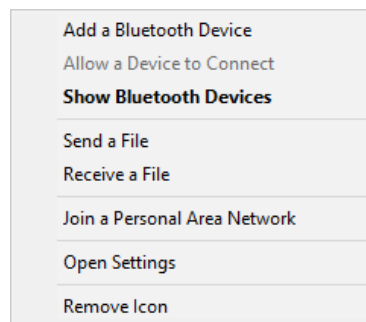
The Bluetooth interface is often integrated into modern computers. If your computer is not equipped with it, you need to use the Bluetooth dongle included in the delivery or a Bluetooth 2.1 compatible one. Please connect it to the computer and switch on the spectrometer.

The software guides you through the installation.

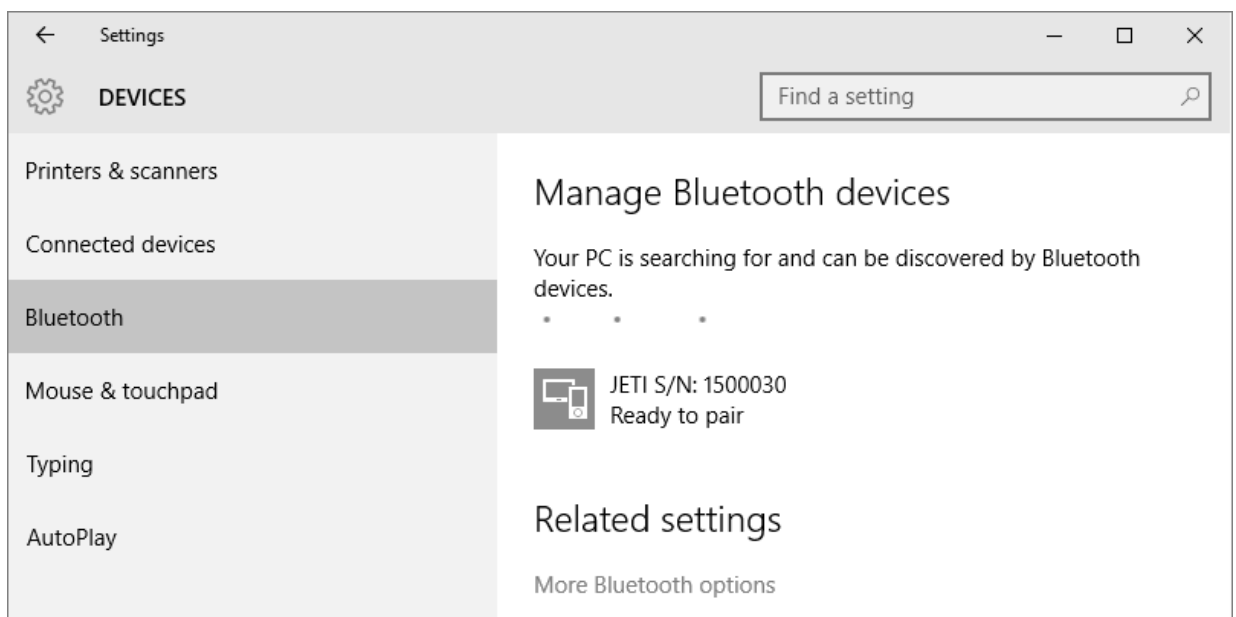
- Click on the Bluetooth symbol.



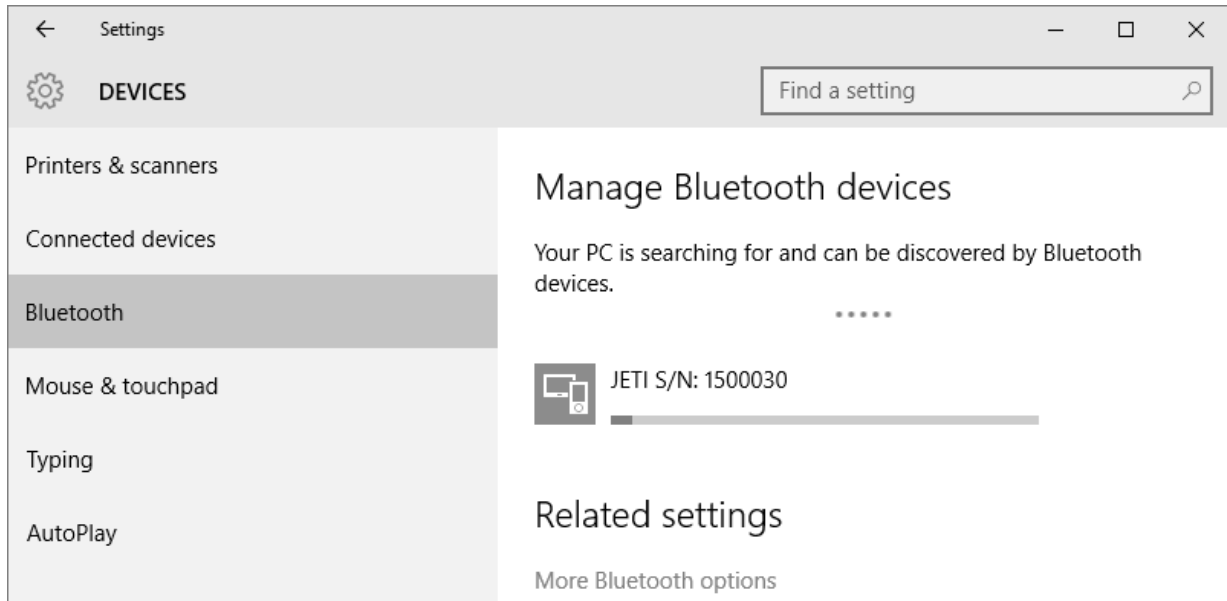
- Click **Add a Bluetooth Device**.



- After a short time, the spectrometer will be recognized. Click **Ready** to pair.



- If the following screen appears, the installation is complete and the device is ready to use:



- Close the window.

4.2.3 LAN

If necessary, a complete LAN/Ethernet Module can be provided on the SDCM3_5Piggy board. The module with typical RJ45-package is connected via SPI-Bus and can reach up to 24 MHz SPI-Clock speed for communication and 10 Mbit/s data rate.

The module supports:

- 10/100 Base TX
- Half/full duplex operation
- Hardware Internet protocols: TCP, IPv4, UDP, ICMP, ARP, PPPoE, IGMP
- Hardware Ethernet protocols: DLC, MAC
- IEEE 802.3/802.3u

Bluetooth- and LAN-module are mutually exclusive.

The RU40/90 device and the controlling PC must use the same network address space to communicate with the RU40/90 via a network connection.

The default network setting of the RU40/90 device is set to DHCP (obtain network settings automatically). If a DHCP server is running in your network, the device will obtain an IP address from within the local network address space, and no further steps are required.

If no DHCP server is available (e.g. during a direct connection to a PC) or you want to give the device a fixed IP address for some other reasons, the network setting of the RU40/90 device must be changed through a serial terminal program with firmware commands (see firmware documentation for further information). Connect the device to a PC via USB and open a terminal program with settings 8N1 (1 startbit, 8 bit, no parity, 1 stopbit) and no handshake. The default baudrate is 3 000 000 bit/s. First one has to disable the DHCP mode with '*PARA:ETH:DHCP 0' and set the network settings for IP address (*PARA:ETH:IPADDR), standard gateway address (*PARA:ETH:GWADDR) and subnet mask address (*PARA:ETH:SNMASK), for example:

```
*PARA:ETH:IPADDR 192.168.115.100<CR>
*PARA:ETH:GWADDR 192.168.115.1<CR>
*PARA:ETH:SNMASK 255.255.255.0<CR>
```

After this the device must be restarted by disconnecting and reconnecting to power supply.

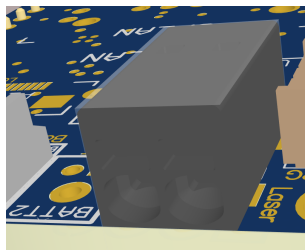
4.2.4 TTL/ UART

The LV TTL UART interface provides an easy to use serial interface for direct communication with embedded hosts, bridging the hard- or software effort for other serial interfaces. The following transmission speeds are possible:

3 000 000 bit/s,
921 600 bit/s,
230 400 bit/s,
115 200 bit/s,
38 400 bit/s.

The protocol settings are 8N1 (1 startbit, 8 bit, no parity, 1 stopbit) and no handshake.

4.2.5 Laser diode driver

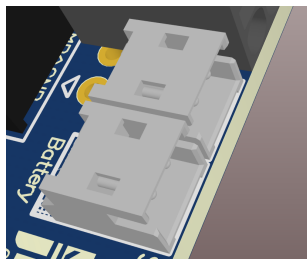


The optional Laser diode controller provides a hardware programmable current up to 150 mA and 100 Hz 256Step software PWM function. Possible fields of application are RAMAN, SERS, Pointer etc.

For Laser monitoring a photodiode can be evaluated using MCU's analog input AN27.

All concerning connections can be established using TSM 0,5/ 4-2,5 connector with two or four pins. Please ask for individual realisations.

4.2.6 Battery connector(s)



The battery Option on SDCM3_3Piggyback-Board includes a Li-Ion battery charging IC for 4.2 V single cells. On active USB-Hub (5 V, 500 mA) charging current up to 500 mA (at 3 V–4.2 V) is possible. For fast charging or large battery capacities a charging current of up to 1200 mA can be reached using an external USB-Charger with sufficient supply current. Users can choose between three connection options:

- One Connector pointing off the board (BAT1 = Standard)
- Connectors for two batteries simultaneously, pointing off the board (BAT2)
- One Connector pointing to the board (BAT180)

All using WR-WTB 648002117322 connectors.

Charging is signalized by a yellow status LED.

Battery functionality also includes a synchronous boost converter to generate stabilized 4.67 V from 1.8 V–5.5 V battery voltage. If USB or external supply voltage is higher than that or the device is turned of, discharge current is typically below 1 μ A, much less than battery self-discharge.

If battery voltage drops below a hardware-programmable value (standard 2.95 V) a red status LED lights up (see chapter 5 'Status LEDs', page 22). Decreasing further and below a firmware programmed value (standard 2.9 V) the device is turned off if no external voltage source is applied.

4.2.6.1 Battery charging

The battery can be charged using the USB battery charger or using the USB port of a PC. To use USB port for charging, plug in the USB device cable and make sure that the device is recognized by Windows correctly.

The battery will remain in **BlueSpecCube**, it is not exchangeable by the user.

Remark: Connect the **BlueSpecCube** to your PC to charge the battery via USB signaled by shining yellow LED (see chapter 5 'Status LEDs', page 22) on the rear side of the device.

If the **BlueSpecCube** is connected to PC via Bluetooth and the connection is interrupted, it is switched off immediately.

4.2.7 General Purpose Input Output Pins

The electronic includes 7(3) user configure and controllable input/output pins.

Digital input with pull-up, pull-down or floating characteristics	D-IO
Digital out	D-IO
Analog input (10 bit ADC)	A-IN
5 V-tolerant (3.3 V otherwise)	5 V

	Configurations	Available on	Pin No. on PCB
D1	D-IO, 5 V	basic	17
D2	D-IO, A-IN	basic	18
D3	D-IO, 5 V	basic	19
D4	D-IO, A-IN	basic	20
D5	D-IO, A-IN	basic, ext, ext-LAN	21
D6	D-IO, A-IN	basic, ext, ext-LAN	22
D7	D-IO, A-IN	basic, ext, ext-LAN	23

Hardware accessible via 12-Pin row on PCB with 2.54 mm pitch.

4.2.8 Real Time Clock Calender - RTCC

RU40/90 and BlueSpecCube are optionally fitted with a real time clock calendar circuit (RTCC), operating Li coin cell battery buffered. This feature allows to get time stamps for measurements with the granularity of one second. Usable Li coin cells are CR1216, CR1220 or CR1225. This allows continuous operation of the RTCC for minimum 4 years. The RTCC internal clock, delivered from a 32 768 Hz fork crystal clock can be fine-tuned to achieve a sufficient precision under intended operating temperature conditions.

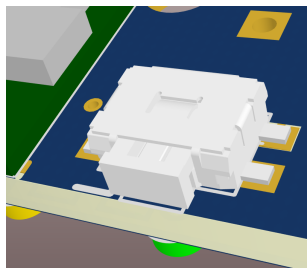
The RTCC communicates with the processor via I2C interface.

4.2.9 Option: 5 V or 7 V–28 V external voltage supply (only RU40/90 LAN)

This Option includes a 5 V fixed output voltage dc/dc step down regulator with up to 500 mA output current. The converter allows to use the electronics with supply voltages of 5 V or between 7 V and 28 V and provides a sufficient low output voltage ripple (typ. 10 mV) and a peak efficiency up to 95 %.

Battery-Function and 5 V / 7 V–28 V external Voltage supply are mutually exclusive.

4.2.10 Option: Reset-Button (on RU40/90 extended and BlueSpecCube)



Physical button to reset the whole electronics. Triggering Master Reset of the microcontroller performs reset routine and brings all periphery to initial state.

Active-low Master-Reset-Signal is internal pulled up to VCC over 10 k Ω .

Mutually exclusive with LAN-module.

4.2.11 Operation switches (BlueSpecCube)

BlueSpecCube includes an on/ off switch (black) and a Measurement switch (red).



If you want to use the device via BlueTooth and battery driven it has to be switched on using the on/ off switch.

4.2.12 Option: Switch/Trigger-Connector (only RU40/90 extended)



For easy accessing of Switch/Trigger functionality, the WR-WTB 653004117322 connector can be used on Piggy Board. It is a 4Pin, Male shrouded header with 1.25 mm pitch and 1 A current rating.

5 Status LEDs



Green:	Device is on	
Yellow:	On	Device is charging
	Off	Device is not charging
	5× flashing after of switching on	Battery below 30 %
	Permanent flashing	Charging error
Red:	Battery below ~10 %. Device needs immediate power supply or will be switched off.	
Blue:	Active Bluetooth connection	

6 Operating

6.1 Installation of Hardware

Unpack the spectrometer carefully and check the delivered parts.

- Install the driver from the CD.

- Connect the spectrometer via USB. Please note the file `install.txt` on the CD.
- The instrument will be switched on automatically shortly after it was connected to a PC or other USB-Power when the USB cable is used. This will be shown by the shining green LED.

After the spectrometer is connected to USB, it will be automatically recognized by Windows as a valid USB-device.

Generally there are three ways to control the spectrometer:

- with firmware commands
- with DLLs
- with *JETI* PC software

6.2 Firmware

One needs any terminal program, which allows a connection via virtual COM-port, to communicate using firmware commands. For the command syntax see the description Firmware OEM Spectrometer RU40/90 on the CD or at www.jeti.com. Furthermore the application note 8 at <http://www.jeti.com/cms/index.php/application-notes> gives an overview about the different possibilities of the command syntax.

6.3 DLL

To communicate via DLLs the user must write a sort of a program in any programming language, allowing to embed external libraries, which include at least one of the following *JETI*-DLLs: `jet_core.dll`, `jet_spectro.dll` or `jet_spectro_ex.dll`. A description of the different DLL functions, their handling and parameters, can be found in the individual DLL descriptions included in the SDK documentation.

6.4 JETI software

However, the easiest way to use a RU40/90 spectrometer is to do it with a software like *JETI VersaSpec*. It contains all basic features to make measurements and also some additional mathematics. For a description see the *JETI VersaSpec* operating instructions on the CD or at www.jeti.com.

7 Specification

7.1 Optical parameters

Spectral range	300 nm–1000 nm
Optical bandwidth	<4.5 nm FWHM (50 µm slit) (other slit widths on request)
Asymmetry factor	0.7–1.1
Optical input	F-SMA connector for a 200 µm fiber
Wavelength accuracy	≤0.2 nm (HgAr linesource)
Wavelength reproducibility	≤0.02 nm (HgAr linesource)
Stray light	<0.1 % (ASTM E387, GG495, $\lambda = 420 \text{ nm} / 600 \text{ nm}$)
Spectrometer	Holographic grating, flat field
Detector	Hamamatsu S11639
Shutter	Piezo-electric, opening/ closing time <20 ms

7.2 Electronic parameters

Digital resolution	16 bit
Dynamics	≥3000
Typical sensitivity	for 50 µm slit, 200 µm fiber, S11639, pixelbinning 3, gain 1: 3×10^{17} counts/(W · s) at 300 nm 4×10^{17} counts/(W · s) at 600 nm 0.1×10^{17} counts/(W · s) at 1000 nm
Sampling speed	up to 4 MS/s
Transfer speed	up to 3 Mbit/s (via Full Speed USB virtual COM Port)
Integration time	0.01 ms–65 535 ms
Power supply	USB powered or Li-Ion battery
Interfaces (basic)	USB (Full Speed), TTL UART (up to 3 MBaud), 3 programmable I/O, 2 analog inputs 10 bit (0 V–3.3 V)
Interfaces (additional - RU40/90 extended, RU40/90 LAN or BlueSpecCube)	Laser diode controller, battery charger, display control, LAN or Bluetooth, Micro SD card slot

7.3 Mechanical parameters

Dimensions	55.4 mm × 56.8 mm × 29.3 mm (RU40/90 basic) 55.4 mm × 56.6 mm × 39.6 mm (RU40/90 extended) 55.4 mm × 56.6 mm × 53.7 mm (RU40/90 LAN) 54 mm × 58 mm × 53 mm (BlueSpecCube)
Weight	115 g (RU40/90 basic) 130 g (RU40/90 extended) 140 g (RU40/90 LAN) 200 g (BlueSpecCube)

7.4 Scope of delivery

- RU40/90/ BlueSpecCube
- USB cable
- USB battery charger
- Battery (RU40/90 extended and BlueSpecCube)
- Switch/Trigger connector and cable (RU40/90 extended, RU40/90 LAN and BlueSpecCube)
- External power supply cable (RU40/90 LAN)
- Bluetooth adapter (RU40/90 extended and BlueSpecCube)
- PC software *JETI VersaSpec*
- *JETI* SDK for Windows
- Firmware command list

8 Safety instructions

- Leave the component in the antistatic packaging in which it is sent, until you want to install the component.
- Do not touch the PCB to avoid damaging by static discharging.
- Plug in connectors only when the PCB is not power supplied.
- Avoid mechanical damages of the connectors by careful handling.
- Avoid contamination of the optical input to avoid damaging the slit.

9 Service

Please contact in case of any question or technical problem:

JETI Technische Instrumente GmbH
Göschwitzer Strasse 48
D-07745 Jena
GERMANY
Tel.: +49 3641 23292 00
Fax: +49 3641 23292 01
E-mail: support@jeti.com
Internet: www.jeti.com

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