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## THE HEART OF THE REVOLUTION

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# INDUSTRY 4.0

## DON'T JUST CLAIM IT - MAKE IT!

In launching Revolution Pi, KUNBUS has brought an open, modular and inexpensive industrial PC based on the established Raspberry Pi to the market. Equipped with Raspberry Pi Compute Module, the base modules can, depending on requirements, be expanded seamlessly using appropriate I/O modules and fieldbus gateways.

Based on the Raspberry Pi Compute Module, KUNBUS has developed an industrial PC composed of open hardware and software meeting the EN61131-2 standard. Thanks

to the modular structure, Revolution Pi can, depending on customer requirements, be supplemented by digital or analog I/O modules respectively as well as appropriate fieldbus gateways to connect it to an industrial network. Installed in a DIN rail housing, the base module of the Revolution Pi already has USB, Ethernet and HDMI connections. The base modules and expansion modules are supplied with 24 volts which is the norm in the industry.

In addition to revealing the circuit diagrams, KUNBUS is rigorously pursuing the Open Source concept within the software. The established Raspbian operating system from Raspberry Pi, including the

drivers for the expansion modules, are preinstalled. Using Raspbian ensures that basically any software or application running on Raspberry Pi will also run on Revolution Pi. Full root access allows obstacle-free programming and implementation of customised programs. By cooperating with various software manufacturers, KUNBUS provides inexpensive and powerful control and SCADA software for users preferring off-the-peg software solutions. As a result, Revolution Pi can be developed into an industrially viable small control system.

One aim of KUNBUS is to provide a tool with Revolution Pi enabling companies to offer

new sales opportunities, such as for example Cloud Services. Revolution Pi enables the development of business models and services that open up new markets. Value added chains of companies using Revolution Pi can be shifted significantly.

An online forum networks Revolution Pi developers and users from all over the world. Problems, solutions and suggestions for improvements can therefore be exchanged quickly, openly and easily.

## Revolution Pi - more than just a device

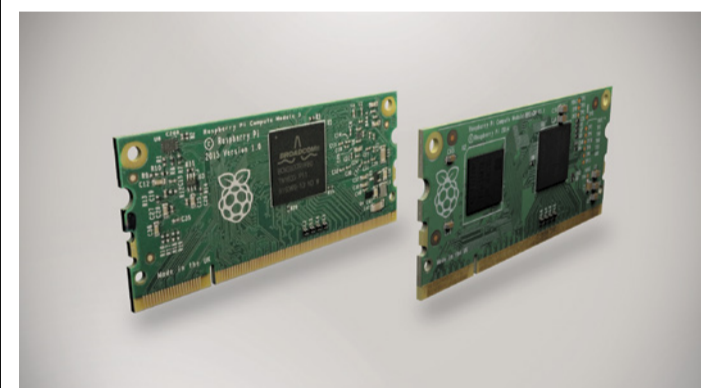
Revolution Pi is more to us than just a device. We believe it is time to break down the fossilized structures within the industry with the Open Source concept. We will reveal our source code and all the circuit diagrams belonging to Revolu-

tion Pi devices. Our customers should not be limited to our ideas and solutions. This allows you to give free rein to your own ideas. If the ideas are then exchanged just as freely with other users on the Revolution Pi platform, a strong

community will develop. We will provide the tools for such networking with Facebook, video channels, forums and blogs. In the future, there will be an app store where you can search for solutions or provide them yourself. Together we are

strong and can invent brilliant contributions for the challenges of the 4th industrial revolution.

## Why Raspberry Pi ?

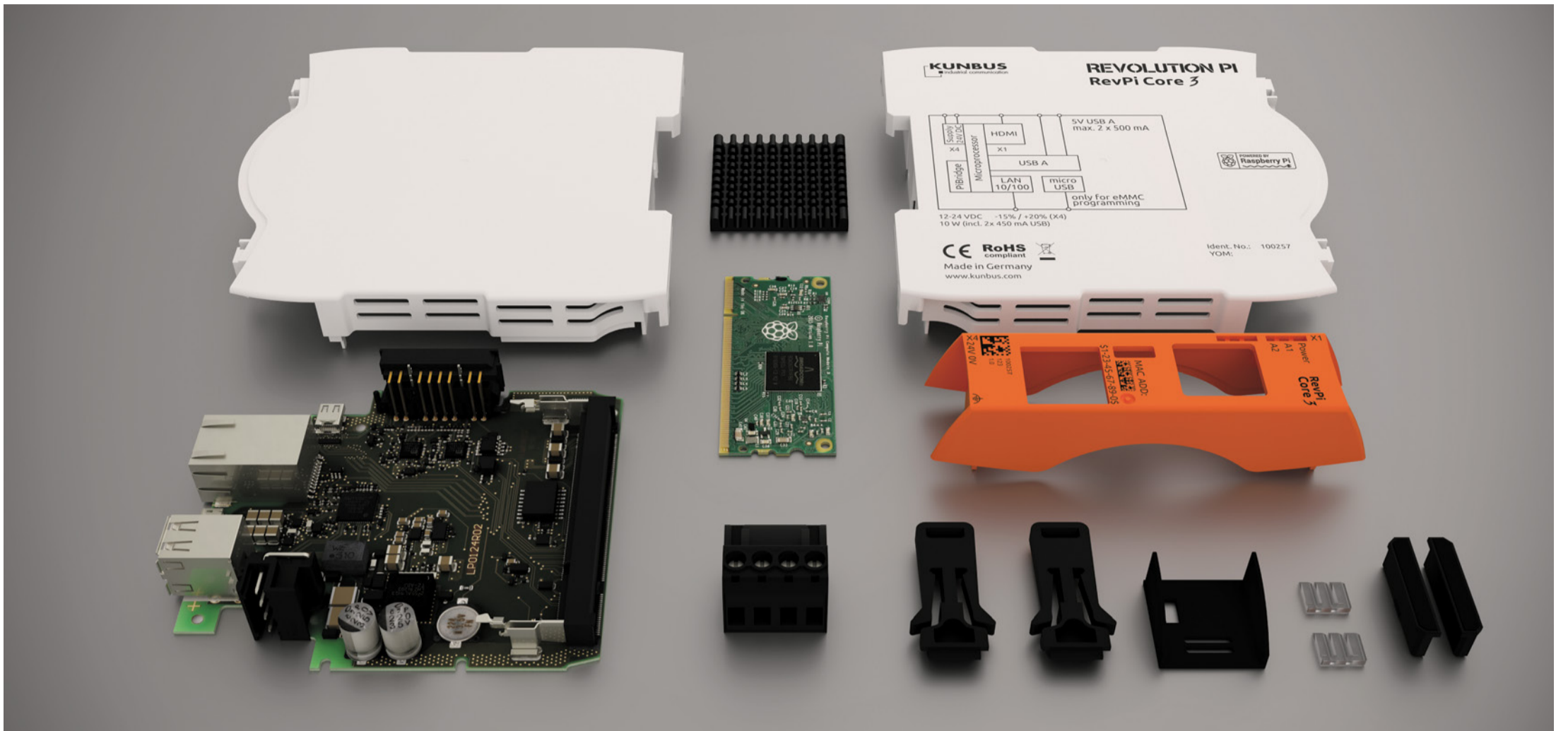


Raspberry Pi Compute Module 1 (right) & Compute Module 3 (left)

Raspberry Pi has had an impressive career ever since its launch early 2012. Up until end of 2017, the small and inexpensive single-board computer was sold more than 17 million times.

Behind the development of Raspberry Pi was the idea of producing an inexpensive and simply constructed PC that could introduce kids and teenagers to the world of programming. Even though a great majority of Raspberry Pis in circulation today are used as a media centre at home, Raspberry Pi is also found increasingly in test environments and laboratories in the industry.

Raspberry Pi comes in a variety of versions. We at KUNBUS have decided in favour of the lesser known variant going by the name of Compute Module. Why? Quite simply because by using Compute Module, Raspberry Pi is limited to the most essential. We therefore had sufficient leeway to design its connections etc in an industrially viable way. Two versions of the Compute Module, one with a single core processor, the other with a quad core processor, are available.



No secrets - The circuit diagrams of the base modules are disclosed.

## The base modules - the foundation of the revolution

**RevPi Connect, RevPi Core 3 and RevPi Core are the central processing units of our modular system. By using the Raspberry Pi Compute module, the devices are largely compatible with a Raspberry Pi model 3 or Raspberry Pi B+.**

**A** very important element of our Revolution Pi base modules are their power supply units. To ensure that heat losses are kept to a minimum, we have used the most advanced and highly efficient

DC-DC converters (overall efficiency > 80%), which generate the necessary operating voltages from the standard 24 V in industrial switching cabinets.

However, the base modules not only run within the standardised voltage range from 20.4 V to 28.8 V, but at just 10.7 V supply voltage as well\*. Thus, car batteries or solar power systems can also be used as a voltage source. At 24 V supply, the devices can withstand a voltage drop of 10 ms without disruptions (at full load of the USB sockets) and even 25 ms with-

out load at the USB sockets. The power supply voltage and a functional earthing are connected from below using a very robust connector.

A complex suppressor circuit guarantees unimpaired function even in the case of massive disruptions on the power supply line, provided that the functional earthing is connected. Lightning strikes or adjacent welding units were simulated in a certified test laboratory and could not affect the devices.

At the front are two USB-A sockets for connecting

USB 2.0 client devices. Both sockets supply the full 500 mA current on the 5 V connections. As a result, USB hard disks or surf sticks can also be easily connected without an external, active hub. The micro-USB socket in the middle is used to connect a USB host system (normally a PC) and switches the system to the passive memory card mode. In this way, a PC can access an installed eMMC flash memory and store software there, for example.

A LAN can be connected at the RJ45 Ethernet socket. Alternatively, the connection

to a LAN can be established via a WLAN-USB dongle. USB and Ethernet connections have a suppressor circuit. Irradiations or ESDs cannot harm the Revolution Pi system.

The Broadcom processor of the Compute Module provides high-resolution graphic functions. For this reason, the Revolution Pi base modules are fitted with a micro-HDMI socket at the top that can be used to connect a monitor with sound output. Thus, a fully equipped PC is available together with a mouse and keyboard.

The PiBridge is the data highway interconnecting the individual modules of Revolution Pi. Two adjacent modules on the top of the housing are each interconnected via a system connector.

Revolution Pi includes Raspbian as an operating system by default (a Debian variant) with a Real-Time patch of the kernel. Further information on software, drivers etc. can be found on page 5.

## RevPi Connect - for all who need more interfaces

The RevPi Connect pays tribute to those users who want to use the Revolution Pi System as an IIoT gateway. Therefore, the base module was supplied with even more interfaces. Like the RevPi Core 3, the RevPi Connect is equipped with the Raspberry Pi Compute Module 3.

Two Ethernet interfaces enable the device to be simultaneously integrated

within the automation network and the IT network to transmit machinery data from, for example, the shop floor to the Cloud or a superordinate IT system.

A hardware watchdog allows the RevPi Connect to be used anywhere, even in areas that are difficult to access. The hardware watchdog monitors the status of the RevPi Connect, a relay output serves to ensure that

connected devices or expansion modules can be monitored or reset respectively. The RevPi Connect additionally has a 24V input to receive shutdown signals of an UPS.

Instead of having two PiBridge connectors at the top as with the RevPi Core 3 or RevPi Core, the RevPi Connect has one PiBridge and one ConBridge connector each. While the PiBridge is responsible for connecting

the various IO expansion modules and fieldbus gateways, a CAN bus and M-Bus expansion module can be connected via the ConBridge. In the future, further expansion modules for different radio standards will follow which can exclusively be connected via the ConBridge.

The RevPi Connect also has a 4-pole RS-485 interface on the front, for example to connect Modbus sensors.



At 45mm, the RevPi Connect is twice as wide as the RevPi Core 3.

\* 2 x 500 mA USB output current are only available with output voltages >11 V. The bridging time of voltage drops lasting at least 10 ms required by En 61131-2 is only guaranteed for supply with 20.4 to 28.8 V. This time reduces significantly for 12 V supply, especially when accessing power from the USB sockets.



# Base modules - facts & figures

## Specifications

	RevPi Connect	RevPi Core 3	RevPi Core
Processor	BCM2837	BCM2837	BCM2835
Number of cores	4	4	1
Clock rate	1.200 MHz	1.200 MHz	700 MHz
RAM	1 GB	1 GB	500 MB
eMMC flash memory	4 GB	4 GB	4 GB
Power supply	12 - 24 V	12 - 24 V	12 - 24 V
Size (L x W x H)	111 x 45 x 96 mm	111 x 22.5 x 96 mm	111 x 22.5 x 96 mm
Operating temperature	-40°C...+55°C**	-40°C...+55°C**	-40°C...+55°C**
Storage temperature	-40°C...+85°C	-40°C...+85°C	-40°C...+85°C
Humidity	93%, non-condensing	93%, non-condensing	93%, non-condensing
Protection class	IP 20	IP 20	IP 20
ESD protection	4 kV/8 kV	4 kV/8 kV	4 kV/8 kV
EMI tests	Passed (according to EN61131-2 and IEC 61000-6-2)	Passed (according to EN61131-2 and IEC 61000-6-2)	Passed (according to EN61131-2 and IEC 61000-6-2)
Surge/Burst tests	Passed (according to EN61131-2 and IEC 61000-6-2)	Passed (according to EN61131-2 and IEC 61000-6-2)	Passed (according to EN61131-2 and IEC 61000-6-2)
CE	Yes	Yes	Yes
RoHS	Yes	Yes	Yes
Operating system	Customized Raspbian with RT-Patch	Customized Raspbian with RT-Patch	Customized Raspbian with RT-Patch

## Interfaces (quantity)

	RevPi Connect	RevPi Core 3	RevPi Core
RJ45 Ethernet ports (10/100 Mbit/s)	2 (each with its own MAC address)	1	1
USB 2.0 socket	2	2	2
Micro HDMI socket	1	1	1
Micro USB 2.0 socket (for firmware uploads only)	1	1	1
RS485 screw terminal (4 pole)	1	-	-
PIBridge (for RevPi expansion modules)	1	2	2
ConBridge (for RevPi Con expansion modules)	1	-	-
24V input for shutdown signal of an UPS	1	-	-
Freely programmable relay switching contact	1	-	-

## Available expansion modules

Name	Function	Item no.	RevPi Connect	RevPi Core 3	RevPi Core
RevPi DIO	Digital IO module	100197	X	X	X
RevPi DI	Digital Input module	100195	X	X	X
RevPi DO	Digital Output module	100196	X	X	X
RevPi AIO	Analog IO module	100250	X	X	X
RevPi Gate PROFINET IRT	Gateway PROFINET IRT Device/Slave	100074	X	X	X
RevPi Gate PROFIBUS	Gateway PROFIBUS Slave	100069	X	X	X
RevPi Gate EtherNet/IP	Gateway EtherNet/IP Adapter/Slave	100066	X	X	X
RevPi Gate DeviceNet	Gateway DeviceNet Adapter/Slave	100071	X	X	X
RevPi Gate EtherCAT	Gateway EtherCAT Slave	100073	X	X	X
RevPi Gate POWERLINK	Gateway POWERLINK CN/Slave	100076	X	X	X
RevPi Gate SERCOS III	Gateway SERCOS III Slave	100075	X	X	X
RevPi Gate Modbus TCP	Gateway Modbus TCP Slave	100088	X	X	X
RevPi Gate Modbus RTU	Gateway Modbus RTU Slave	100090	X	X	X
RevPi Gate CANopen	Gateway CANopen Slave	100070	X	X	X
RevPi Gate DMX	Gateway DMX Master/Slave	100237	X	X	X
RevPi Gate Serial	Gateway Serial Slave	100068	X	X	X
RevPi Con M-Bus	Wireless M-Bus module (868 MHz)	100281	X		
RevPi Con M-Bus VHP	Wireless M-Bus module (169 MHz)	100282	X		
RevPi Con CAN	CAN bus module	100286	X		

\*\* Up to 65°C ambient temperature could easily be achieved during tests at 24 V power supply voltage, low USB load and unrestricted heat emission from the housing. A cold start of the cooled system is only ensured up to -30°C ambient temperature and 24V power supply voltage. (valid for RevPi Core 1)

\*\* There should be no cutbacks of compute power at ambient temperatures under 20°C. At 25°C ambient temperature 3 cores may run with full clock speed while with 4 cores the clock frequency is lowered from 1.2 to 1.1 GHz after 10 to 20 minutes of full stress. At 40°C ambient temperature 4 cores under full stress will still work with 1 GHz while stressing just 1 core results in no down clocking. At 50°C ambient temperature 4 fully stressed cores are running at average 0.7 GHz, having short down clockings to 0.6 GHz and short up clockings to 0.9 GHz. , 1 core under full stress does result in no down clocking. At 65°C ambient temperature and either 4 or 1 core under full stress results in an "emergency mode" with just 0.4 GHz, after longer periods even 0.3 GHz. (valid for RevPi Core 3)



Digital I/O module RevPi DIO with 14 inputs and outputs.

## Digital I/O modules

To transform Revolution Pi into an industrial control unit, various digital I/O modules, amongst other things, can be connected to the base module RevPi Core.

The I/O modules come in three versions. All have the same 28-pin I/O connector at the front (connector with two rows of 14 pins each – two suitable 14-pin socket connectors with spring clamp contacts for the connection of up to 1.5 mm<sup>2</sup> stranded hook-up wires are supplied). Apart from the standard version with 14 digital inputs and 14 digital outputs, there are also two special versions that exclusively have either 16 digital inputs or 16 digital outputs. In all three variants, the inputs or outputs are galvanically isolated from the logic component with the PiBridge (600 VRMS isolation voltage). In the standard

version, the inputs are also galvanically isolated from the outputs. All three versions are protected against disturbances according to EN61131-2 and can be operated between -40 and +50°C ambient temperature and up to 80% relative humidity. The standard version of the module is also fitted with PWM outputs (pulse width modulation) and counter inputs.

The inputs work at 24 V supply with switching thresholds, as required by the EN61131-2 standard for type 1 and type 3. The input current is limited to a maximum of 2.4 mA per input. At 12 V power supply, this standard no longer takes effect. If the power supply voltage should discontinue and fall below 9 V, an alarm is sent automatically to RevPi Core to indicate that the transmitted input values no longer match the reliable threshold values as laid down in the standard according to 24 V switching logic. An

adjustable low-pass filter can be used for debouncing input signals. It can always only be switched on simultaneously for all inputs. The filter only passes on input changes if an input assumes a stable state for at least 25 µs, 750 µs or 3 ms. The filter can also be switched off completely. Inputs are protected against static discharges, burst and surge impulses in accordance with EN61131-2 requirements.

Each of the outputs can be configured separately as a high-side-switch with up to 500 mA current carrying capacity or as push-pull-output with at least 100 mA current load capacity. All outputs are short-circuit proof independent of the operating mode. A watch-dog circuit ensures that the outputs are set to 0 (safe state), once the STM processor no longer transmits any data from the PiBridge to the outputs. The outputs are set to 0 also in the event of undervoltage at the

power supply connection for the outputs or in the case of overtemperature. These last two error states as well as the triggering of the short circuit fuse per channel are transmitted to RevPi Core via the PiBridge.

In addition, the outputs can be configured so that an open load detection (line break) is also switched on and a corresponding alarm is transmitted to the RevPi Core for high-side output type. Just like the inputs, the outputs are also protected against static discharges, burst and surge impulses in accordance with EN61131-2 requirements.



Available for all common industrial network protocols, the RevPi Gate modules help to integrate Revolution Pi into an industrial network.

## Fieldbus connection

It is not easy at all to integrate a device into an industrial network. Special protocols are often used for data transmission, such as Profinet or Profibus. When using our gateways - called RevPi Gate - integrating Revolution Pi into an industrial network is however no problem.

Like all Revolution Pi expansion modules, the gateways are also connected to the base module via the overhead PiBridge connector. Thus, up to two gateway modules can be used per system. These, like all modules, are supplied with 24 volts that is the norm within the industry.

We have currently set the cycle time between the base module and a gateway to 5 ms by means of drivers. Though the gateway modules could reach cycle times of less than 2 ms, it would burden the system load of the base module disproportionately. For, the lower the cycle times set in the driver, the greater the system load is of the device that has to be expended for this process.

We currently offer gateways for the network protocols shown below. All module variants have been tested and certified at the respective user organisations:

## Analog I/O - module

Expand Revolution Pi by using the analog IO module RevPi AIO. You can expand your system not only by 4 analog inputs and 2 analog outputs but also by 2 inputs for RTDs.

The 2 RTD inputs enable temperatures to be measured with high precision from -165°C to +600°C in steps of 0.5°C using common RTDs sensors like Pt100/Pt1000 probes. The probes can be connected directly to the module with 2, 3 or 4 cables.

Inputs, RTD inputs and outputs are galvanically isolated to each

other. Differential inputs eliminate ground loops.

RevPi AIO expansion module is connected to your RevPi base module by the means of the overhead PiBridge plug.

Just like the digital IO modules, RevPi AIO is protected against disturbances according to EN61131-2 and can be operated between -40 and +50°C ambient temperature and up to 80% relative humidity. It is also protected against static discharges, burst and surge impulses in accordance with EN61131-2 requirements.



RevPi Core 3 and RevPi AIO on DIN rail.



EtherNet/IP

DeviceNet



CANopen

ETHERNET POWERLINK

SERCOS the automation bus



DMX



## Open source also with the software

Revolution Pi is for starters an open platform upon which everything, from the operating system to applications, can be installed that also run on a Raspberry Pi.

We have decided to preinstall Raspbian (a Debian vari-

ant) with a Real-Time patch of the kernel. In our view, it is the best compromise to remain as close as possible to the original development environment of a Raspberry Pi and still maintain a high level of control over the priorities of the tasks that the scheduler manages.

The scheduler, which controls the execution of the tasks by the operating system, can be configured extensively with this modified kernel to ensure that the delays normally caused by network access and other I/O access operations are avoided. Appropriate

drivers for the expansion modules are obviously already preinstalled.

On this basis, you can purchase the Soft PLC from logi.cals and SCADA software PROCON-WEB IoT among other things from our online

shop. These components enable you to have a complete and operational PLC.

But maybe you would also like to write your own software under Linux with Python? Then you can just use our driver and the optimised opera-

ting system version to access all process data. For this purpose, we, in a memory area, keep a process image with all the current process values which can easily be written in or read from.

## Simple configuration with PiCtory

**Every Revolution Pi system is supplied with the PiCtory configuration software. It enables you to define the positioning of hardware modules and the symbolic names of the input and output signals. Furthermore, PiCtory can also be used to configure connected hardware modules or installed drivers.**

Revolution Pi is a high grade, modular and expandable system. For example, you can write your own drivers to integrate your special hardware seamlessly into the system. The central process image in the memory is the link between all components. The components, no matter whether they are hardware modules or software applications, always exchange their data with this process image. However to do so, drivers as well as software applications must know exactly where (at which address in the memory) the individual process values can be found.

PiCtory is a browser application. The server is preinstalled by us on the base modules.

Alternatively, you can also use a PC program (Windows) which installs a small web server.

You can arrange the system you require by drag & drop. Predefined rules help you to position the modules correctly. Unfeasible combinations are detected automatically and prevented. Apart from the expansion modules we provide, you can also add your own modules to the configuration tool.

PiCtory also supports you when defining, for example, all I/O signals. You can assign symbolic names and define which adapter supplies and retrieves the data. An adapter can be a hardware module on the PiBridge but it can also be a "virtual device" – driver software for example – for which the memory location is reserved in the process image and for which process values can be defined with symbolic names. The finished configuration file is stored as a JSON file.



PiCtory helps you to set up your Revolution Pi system.

## SOFTWARE SPECIAL

Revolution Pi is a very flexible solution because we offer a great variety of software ready for use on the Revolution Pi hardware family. If you need an IoT tool or a PLC software - just choose the software which fits your needs. Here is a list of application programs which are already available for you (additional licensing costs may apply):

### CODESYS



The manufacturer-independent IEC 61131-3 automation software for planning control systems turns the Revolution Pi into a small industrial controller. Thanks to the built-in soft master functionality for various industrial protocols, the Revolution Pi system can be integrated into an industrial network without the use of gateway modules.

### Node-RED



With the open-source software Node-RED, the user has a browser-based programming tool at his hand to map (IoT) application cases quickly and without much effort. In addition to control tasks, Node-RED can also be used to create browser-based HMIs.

### logi.CAD 3



logi.CAD 3 is the engineering software for creating control applications meeting IEC 61131-3 for Revolution Pi. Special adaptations of the Logi RTS runtime system for Revolution Pi turn the device into a SPS mini controller for industrial applications.

### Modbus TCP & Modbus RTU

Fully available via the PiCtory functions, Modbus Master and Slave can exchange data cyclically with the process image and therefore with all other SW components. The destination and intervals for communication with the Modbus protocol are freely configurable. It means that, alongside RevPi Gate, there's an additional low-cost method of connecting a multitude of sensors, actuators and controllers to Revolution Pi devices.

### PROCON-WEB IoT

PROCON-WEB IoT is a highly professional HMI software which can visualise data from the process image via a browser-based interface. In the opposite direction, data can also be written in the process image via the browser to, for instance, remotely adjust setpoints. As PROCON-WEB IoT runtime can run over the RevPi webserver, the data can be securely accessed from the internet using the new TeamViewer Client. The associated PROCON-WEB IoT DESIGNER is an editor with a high degree of freedom and runs on a Windows PC.

### RevPi7

RevPi7 is the S7 software interface running on our Revolution Pi that can be used with all S7 devices which have a PN connectivity. It consists of a virtual master and a slave module which can be configured by PiCtory. The RevPi7 master offers up to 64 bytes of input, output and marker which reside in the RevPi's process image and can be written or read by any S7 HMI talking with PLCs via PN connector. The RevPi7 slave can be configured with cyclical tasks to poll or write data from a S7 PLC via PN into the RevPi's process image. Of course this is not a substitution for a PROFINET or PROFIBUS gateway – it is much slower (task cycle times start from 100 ms). But compared to a gateway solution there is no need to make any changes to your PLC software. Just activate HMI access to all inputs, outputs, markers or DBs you want to read or write to. That's all!

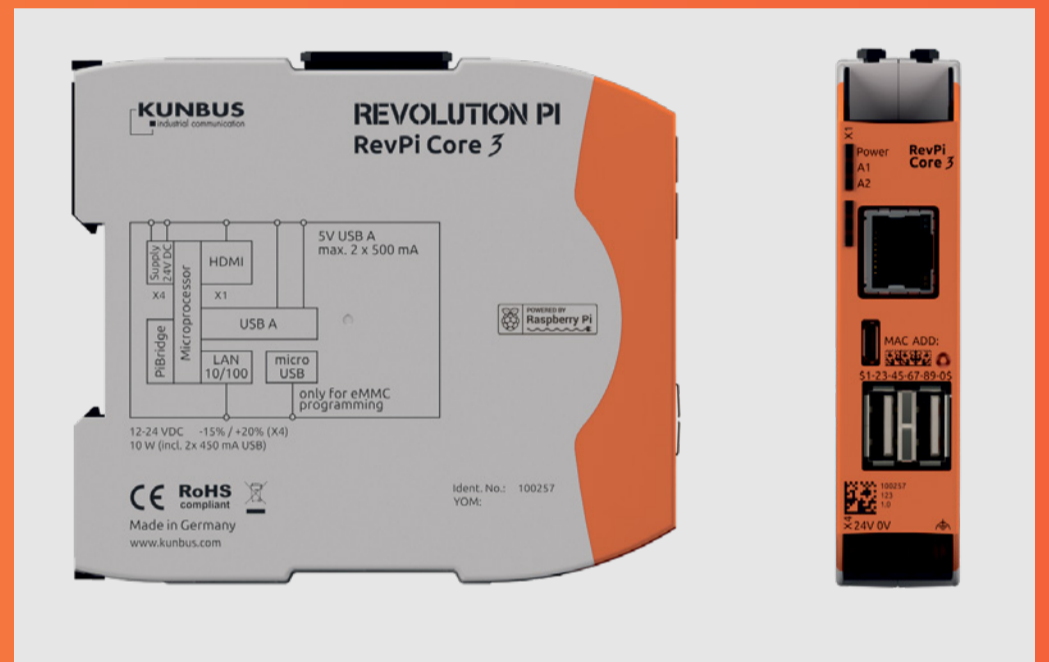
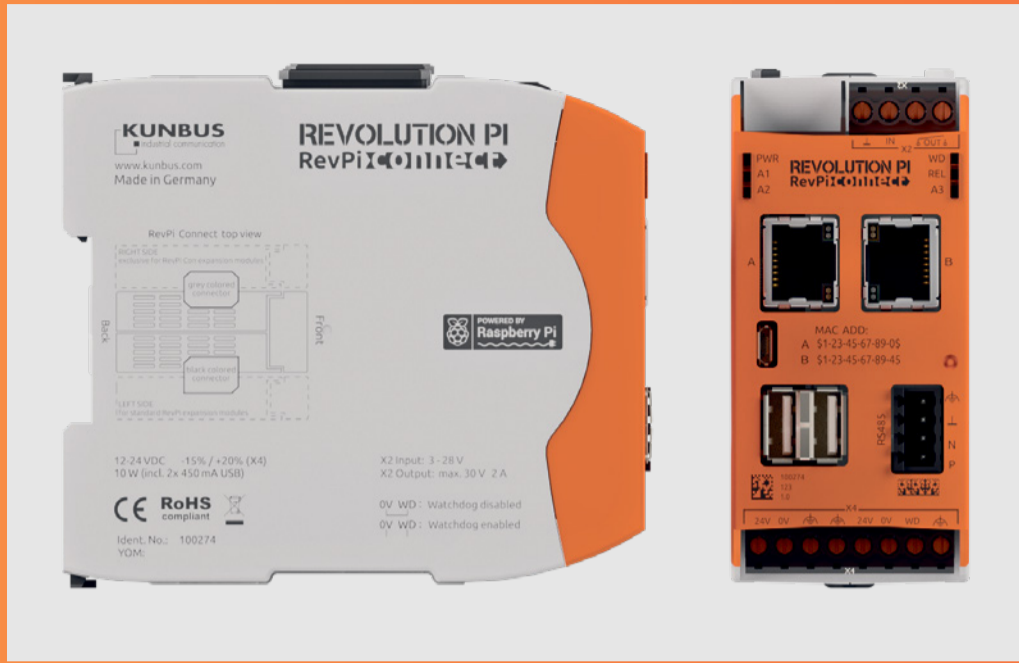
### KUNBUS Cloud

KUNBUS Cloud enables traditional pools of IoT data to be provided as a cloud service. A software agent installed on the Revolution Pi establishes the highest level of security and at the same time user-friendliness. Each device can be set up individually to determine which data should be pooled and in which intervals. It can also be configured via internet. KUNBUS Cloud can be booked as a service or installed on a customer's server.

### TeamViewer



By means of software agent that is activated at the start, TeamViewer users can now also reach and remotely control their Revolution Pi devices via the internet. It is made possible by means of a very secure and user-friendly TeamViewer technology to access the RevPi webserver via a browser window. Available therefore are all the functions that can be processed via the server and the ones offering a browser.



## GET IN TOUCH

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