



THE HEART OF THE REVOLUTION

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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 module 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 analogue 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 mo-

dules, 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. ■

Why Raspberry Pi ?



Raspberry Pi Compute Module

Raspberry Pi has had an impressive career ever since its launch early 2012. Up until September 2016, the small and inexpensive single-board computer was sold more than 10 million times.

Behind the development of Raspberry Pi was the idea of producing an inexpensive and simply constructed PC that could introduce children and kids 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. Compute Module actually only contains a BCM2835 processor with 500 MByte RAM from Broadcom as well as a 4 GByte eMMC flash memory. ■

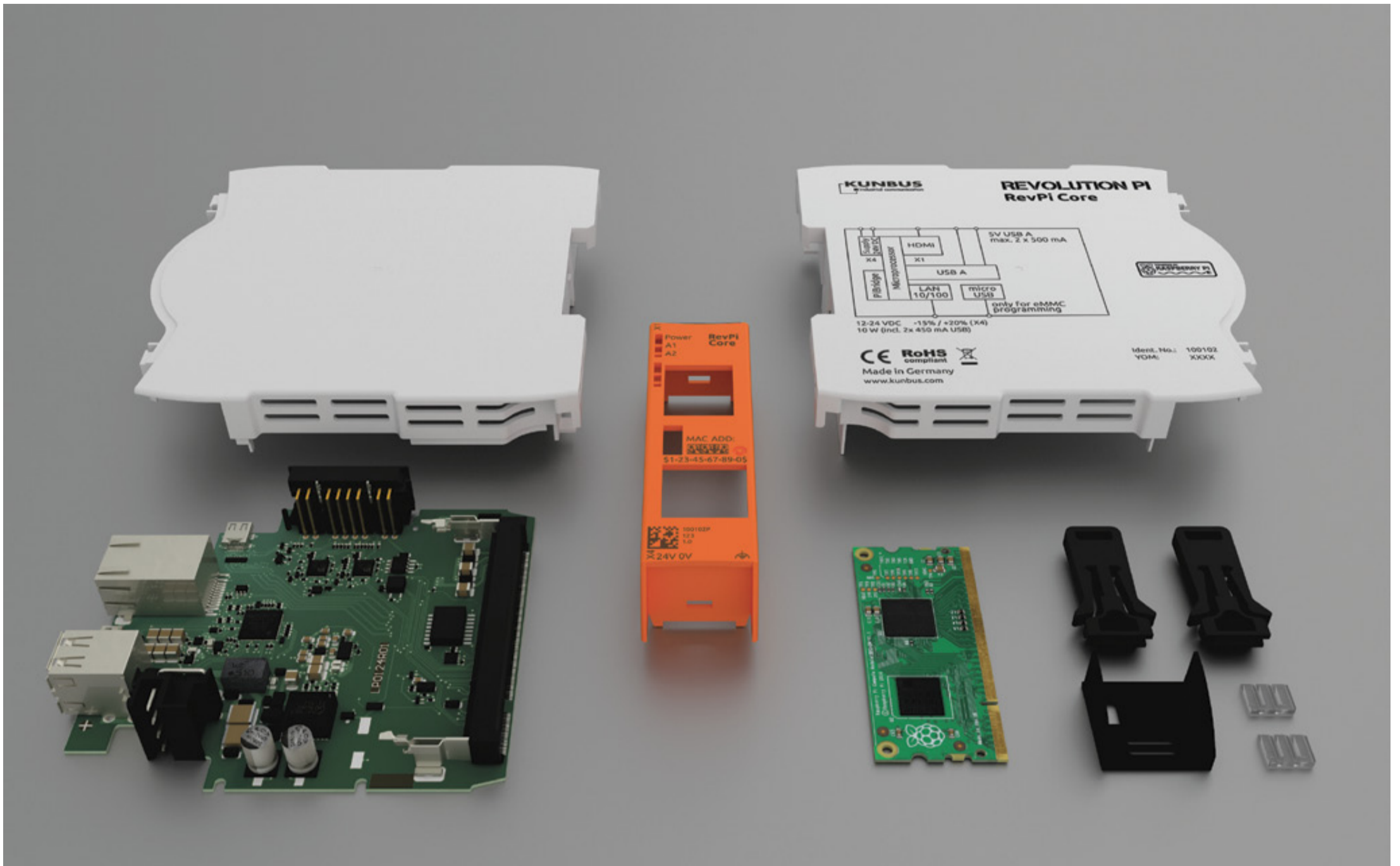
Revolution Pi - more than just a device

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 Revolution 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. ■



No secrets - The circuit diagrams of the base module RevPi Core are disclosed.

RevPi Core - the base module from Revolution Pi

RevPi Core is the central processing unit of our modular system. The module is largely compatible with a Raspberry Pi model B+. To achieve this, we have installed the Compute Module of Raspberry Pi.

A very important element of our RevPi Core is its power supply unit. 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 RevPi Core not only runs 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 RevPi Core can withstand a voltage drop of 10 ms without disruptions (at full load

of the USB sockets) and even 25 ms without 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 RevPi Core.

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 RevPi Core 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.

As with the Raspberry Pi model B+, USB and Ethernet sockets are connected to the primary USB connection of the Broadcom processor via a Hub/Gateway-module LAN9514 from Microchip. Thus, we have ensured extensive compatibility with the Raspberry Pi model B+ here, too.

USB and Ethernet connections have a suppressor circuit. Irradiations or ESDs (static discharges) cannot harm the RevPi Core.

The Broadcom processor of the Compute Module provides high-resolution graphic functions. For this reason, the RevPi Core is 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.

The RevPi Core 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 4. ■



- › Prozessor: BCM2835, 700 MHz
- › RAM: 500 MByte
- › Flash: 4 GByte
- › Operating system: Raspbian / Debian with RT patch of the kernel
- › RTC with 24h buffering by means of a maintenance-free capacitor
- › Driver / API: Driver writes process data cyclically in a process image, access to process image via Linux file system as API to third-party software.
- › Communication connections: 2 x USB 2.0 A (each can be charged with 500 mA), 1 x micro USB, HDMI, Ethernet (RJ45) 10/100 Mbit/s
- › Power supply: min. 10.7 V, max. 28.8 V, maximum 10 Watt*
- › Permissible ambient temperature: -40 to +55 °C**
- › Housing dimensions: (HxWxL) 96 mm x 22.5 mm x 110.5 mm (without connected connector)
- › ESD protection: 4 kV / 8 kV according to EN61131-2 and IEC 61000-6-2
- › Surge / burst tests: according to EN61131-2 and IEC 61000-6-2 connected to power supply voltage, Ethernet and IO lines
- › EMI tests: according to EN61131-2 and IEC 61000-6-2

* 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.

** 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.



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 mm² 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 ac-

ording 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.

For the cyclical transmission time of the data between RevPi Core and I/O modules we obtained the following test results depending on the system configuration: In the case of one I/O module and two gateway modules, a cycle time of 5 ms is guaranteed. In the case of three I/O modules and two gateway modules, a cycle time of 10 ms is guaranteed. This only applies if the configuration of the task priorities in the scheduler of the operating system are correct.

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 volta-

ge 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 Gates 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 RevPi Core via the overhead Pi Bridge 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 RevPi Core 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 RevPi Core disproportionately. For, the lower the cycle times set in the driver, the greater the system load is of the RevPi Core 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:



EtherNet/IP®

DeviceNet®

EtherCAT®

CANopen

ETHERNET POWERLINK

SERCOS the automation bus



DMX

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.

PiCtory is a browser application. The server is preinstalled by us on the RevPi Core. Alternatively, you can also use a PC program (Windows) which ins-

talls 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 mo-



dules 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 and transferred to RevPi Core. ■



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 dri-

vers for the expansion modules are obviously already preinstalled.

On this basis, you can purchase the Soft PLC from logi.cals and SCADA software SpiderControl 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. ■

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 or will soon be available for you:

KUNBUS Cloud

KUNBUS Cloud enables traditional pools of IoT data to be provided as a cloud service. A software agent installed on RevPi Core 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 the net. KUNBUS Cloud can be booked as a service or installed on a customer's server. ■

PROCON-WEB

PROCON-WEB 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 Runtime can run over the RevPi Core webserver, the data can be securely accessed from the internet via our RevPi Connect Service or the new TeamViewer Client. The associated PROCON Designer editor has a high degree of freedom and runs on a Windows PC. ■

LineMetrics



With LineMetrics on RevPi Core, you can create, for example, up to 25 addresses in the process image (also with symbolic names) which can be moved cyclically to the LineMetrics Cloud. The evaluation options also naturally include an extensive alarm system. If values in your system vary from the usual pattern, you can then, for example, have alarms sent immediately to your smartphone. Do you for example want to verify uninterrupted cool chains? With LineMetrics and Revolution Pi, it is child's play. Even remote control from the Cloud is possible. Completely new horizons are opening up to the applications as well as possibilities for new added values. ■

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 RevPi Core turn the Raspberry Pi Compute Module into a SPS mini controller for industrial applications. ■

Modbus TCP Master/Slave

Fully available via the new 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. ■

qmd4



qmd4 offers the first EN61131-3 based control software by which control programmes can be written solely via a browser. Programming is done graphically with function blocks. A graphical editor serves to visualise or write a HMI. Control or operation is then possible using a multitude of devices with internet access like PCs, laptops or smartphones. ■

SIWIAT



SIWIAT is a modular software package that allows you to transfer pre-processed sensor data cyclically from the control system to higher-level systems (ERP, databases, Cloud systems, mobile phones, etc.) without requiring in-depth know-how and with only a small budget. Once installed on the RevPi Core, you thus have a data gateway that is simple to set up. ■

SMS / TTS Service

Devices already registered on the RevPi Connection Server can use the service free of charge during an introductory phase. Via a new adapter for PiCtory, a SMS or TTS service respectively can be accessed via the process image. In doing so, your predefined text with variable parts will be sent to a telephone subscriber as an MSM or voice call as soon as a bit is placed in the appropriate place in the process image. ■

Snap7

Snap 7 is an open source library for communication with Siemens® S7 products or devices and software respectively that speaks the protocol. We have installed the library on RevPi Core and expanded it to include access to the process image. Data can therefore now be exchanged between RevPi Core and the Siemens® world. ■

SpiderControl



SpiderControl from iniNet offers one the possibility to establish visualisations and HMI to meet one's own requirements. SpiderControl uses a webserver (SCADA server) on the RevPi Core to exchange and visualise process data with any browser. Using the corresponding editor, you can realise both simple displays and highly complex process visualisations with alarms and setpoints. Webservers and browsers can also exchange the data over a secure connection via internet. With the help of a basic interpreter, you can also integrate your own small lines of code into the software. ■

TeamViewer



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



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