smartRAIL(-S) V2 - MVB

Technical data and description

Around the powerful processors of the ARM Cortex-A9 family in the quad-core (smartRAIL) or single-core (smartRAIL-S) version, the system offers the following interfaces in a compact design in a robust M12 version:

- Power supply 9-36 V (24 V according to EN50155)
- 100 Mbit Ethernet
- USB 2.0
- 2x CAN 2.0 B with power supply for smartIO modules
- Integrated LTE modem
- Integrated GNSS receiver with high resolution and update rate

Internally, the smartRAILs have an eMMC memory that offers a high level of data security in HIREL configuration and, in addition to 2 operating system partitions (YOCTO), provides a further partition for the applications. A third operating system partition is provided internally on an optional µSD card, with which a "take-me-home" function can be realised. A second µSD card is installed for storing measurement data and temporary files. Both are equipped with a specially parameterised version of the ext4 file system for high data security and robustness against unforeseen shutdowns. Optionally, SSD memory can be connected externally via USB.

A micro-controller serves as a CPU-independent watchdog that can monitor the entire boot process of the CPU and switch to another boot partition in the event of an error. It can switch the power supply of the smartRAIL completely off and on again (cold start) to realise a very energy-saving sleep mode and time-controlled wake-up.

The high-performance variant with quad-core processor (smartRAIL) has a heat pipe with an external heat sink so that the CPU can continue to provide full performance even at extreme outside temperatures. This cooling is not necessary in the single-core version (smartRAIL-S).

The units are delivered with a Linux operating system based on YOCTO and the smartCORE software platform. For customised software configurations or own developments on this platform, please contact us.

In the "MVB" variant described here, a feedback-free smartIO MVB is integrated in the module and connected internally to the smartRAIL via USB. Of course, the MVB extension also fulfils the insulation requirements.

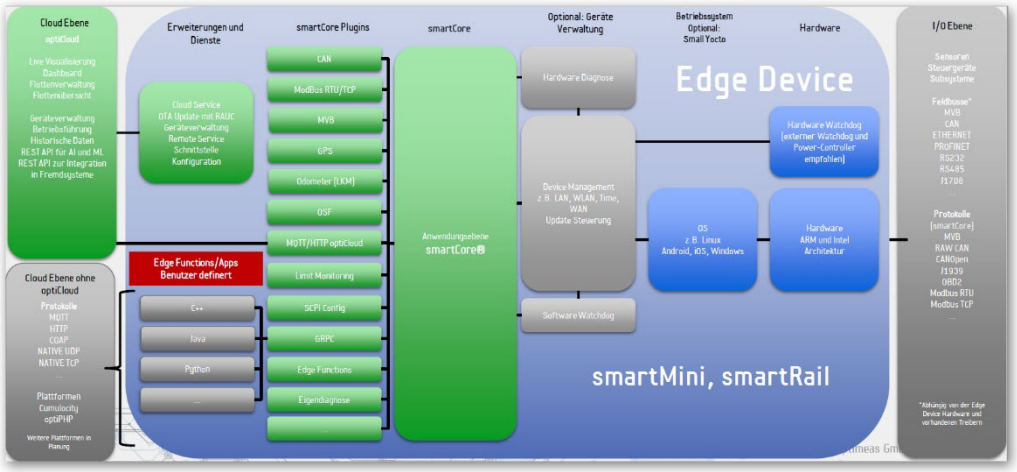
smartCORE

The smartCORE[1] is an "out of the box" software for embedded IoT and IIoT solutions that we have developed specifically for the smartMINI and smartRAIL device family. With the smartCORE, smartMINI and smartRAIL become the perfect, flexible and high-performance

Measuring device, control system, data logger or gateway for
Condition Based Monitoring and *Predictive Maintenance*

for

- Seamless data recording
- Extensible plug-ins for hardware, interfaces or functions
- Intelligent data preprocessing
- Integrated alarm centre
- Almost any protocols
- Cloud connection



In this ecosystem, the smartCORE serves not only as an efficient, fast data pool for exchanging data between the various plug-ins with producer and/or consumer functions, but also for configuring, coordinating and monitoring the individual software components. Typical producer plug-ins are those that receive data from GNSS, MVB, Modbus or CAN bus, for example, and break it down into individual data channels in an interpreted form. Consumer plug-ins are used for data storage or forwarding of temperatures, pressures, speeds, etc. to the data cloud. The storage of data in OSF format is optimised for secure, gapless recording and transmission. High-resolution time stamps on each data value are just as much a matter of course as different sampling rates or data reduction without loss of information.

[1] For detailed information, please refer to the smartCORE data sheet.

YOCTO-Linux

Hardware

The YOCTO Linux used on the smartRAIL and smartRAIL-s units is set to the following hardware properties:

Properties	smartRAIL	smartRAIL-s
CoM	KARO TX6Q-1036	KARO TX6S-8035
Processor	NXP i.MX 6QuadPlus	NXP i.MX6 Solo
Family	Quad ARM® Cortex®-A9	ARM® Cortex®-A9
Clock	800 MHz	800 MHz
RAM	2 GB DDR3 SDRAM	512 MB DDR3 SDRAM
ROM	4 GB HIREL eMMC	2 GB HIREL eMMC
Temperature	-40 °C … 105 °C	-40 °C … 105 °C
µSD card 1	Measurement data memory	
µSD card 2	Take-Me-Home OS	
USB hub		
Modem	Quectel with QMI support, e.g. EG25-G	
I2C		
RTClock	RTC-RV-4162	
Pwr controller	Atmel SAMD21	
+ GPIO	Boot control	
CAN	Port 0, Port 1	
UART[2]	RS485 or RS232	
GPS	Quectel L76	

Software and libraries

With the YOCTO, the following software packages come on the device for the operation of the smartCORE framework:

- Kernel Version 5.10 including PREEMPT_RT
- GCC 12.2.0 Runtime-Libraries
- Qt 6.6.3
- JSON Message Pack 4.0
- GRPC 1.46.7
- ProtoBuf 3.19.6
- RAUC 1.11.1 used for Dual-Boot and Take-Me-Home-function

The smartCORE framework itself is based on standardised interfaces to the Linux operating system.

Interfaces of the module

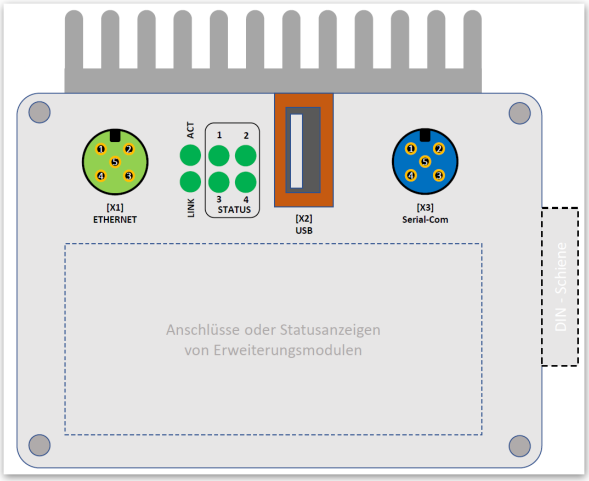
[2] UART as a placement option

The new smartRAIL(-S) V2 is available in different enclosure variants. This makes it possible to integrate expansion modules directly in an enclosure next to the CPU and to integrate a heat sink for the higher processor performance of the quad core. The position of the connections and the pin assignment remain the same, even with different enclosure heights.

Ethernet, status displays, USB, serial communication (RSxxx)

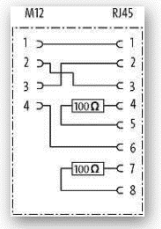
On one side, in addition to status indicators, are the connections for Ethernet, USB 2.0 and the serial interface, which is isolated as RS232 or RS485 depending on the option. The USB connection is type A and insulated from the housing with a separate collar. The voltage potential (5V) on this connection corresponds to the supply potential.

If other technical interfaces (CAN adapters, measuring systems, interfaces) are connected to this USB connection, it is mandatory that they have insulation between the USB and the process side in accordance with EN50155!



A 4-pole, D-coded M12 connector is used for the **Ethernet connection,** to which commercially available cables from Phoenix Contact, Metz Connect and other manufacturers can be connected.

M12 pin	Signal	Type. Colour code	RJ45 pin
1	Tx P	white/orange	1
3	Tx N	orange	2
2	Rx P	white/blue	3
4	Rx N	blue	6

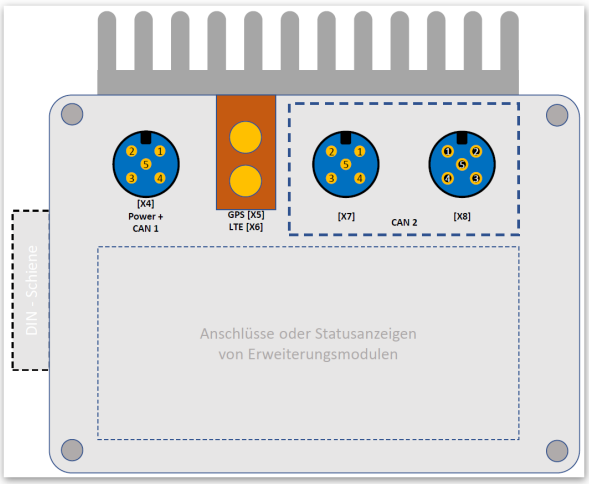


A 5-pin, A-coded M12 connector (F on the device side) is available for the **serial interface.** Here the pin assignment is as follows:

Pin	Signal	Description
1	A / Tx	RS485 / RS232 (optional)
2	B / Rx	RS485 / RS232 (optional)
3	GND	Reference ground for power supply and RS485
4	n.c.	
5	n.c.	

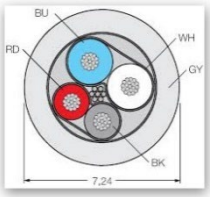
CAN with power supply and antenna signals

Connections for process measurement technology (CAN 1 and 2) and the antenna connections for modem and GPS are led out on the opposite side of the device. The module is supplied with power via the CAN 1 connection, as is the case with the smartIO modules in the RAIL version.

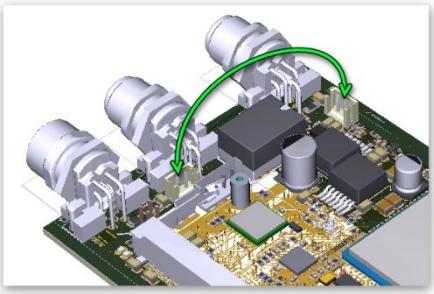


For the direct connection of the smartIO measuring modules, **CAN bus** 1 is provided on a 5-pole, A-coded M12 connector [X4] (**male on the device side**) in the standardised Device-Net assignment. Commercially available Device-Net or MVB cables leading from socket to plug can be used, as well as T / Y adapters or terminators from this environment. In the case of assembled cables, twisted pair cable bundles must be selected for connection pairs 2 and 3 as well as 4 and 5. At least the CAN line pair CAN_H and CAN_L must comply with the usual CAN 2.0B, CANopen or DeviceNet specifications with regard to impedance, bus topology and termination.

Pin	Signal	Description	DeviceNet colour codes
1	n.c.		
2	+24V	Power supply +24V (wide range see technical data)	Red
3	GND	Reference ground for power supply and CAN bus	Black
4	CAN_H	CAN bus: CAN high	White
5	CAN_L	CAN bus: CAN-LOW	Blue
Housing	Umbrella	Shielding is realised via the connector housing	



The smartRAIL is also supplied with voltage via the **CAN 1** [X4] connection. This eliminates the need for additional external wiring if, for example, the system is supplied from a smartIO BATMON. This connection is looped through to the smartIO in RAIL version (male and female on the device side), so that several different smartIO modules can be connected in series at these connections. If no further smartIO module follows, the CAN bus must be terminated with a connector (**female**) with integrated terminating resistor (120 Ω). If no BATMON is used, the required terminating resistor can be combined with a voltage feed at the last unit. CAN-GND is identical to the supply ground.



At the **CAN 2** connection [X7] and [X8], no supply voltage is initially led out, but it is looped through between [X7] and [X8]. This ensures that CAN 2 is isolated from the supply voltage, the CPU and CAN 1 in accordance with EN50155. *Optionally*, the supply voltage of CAN 1 *can* be bridged to CAN 2 in the smartRAIL (connection[3] X100 - X101), e.g. to supply a CAN-Click adapter[4] with voltage. In this case, the output is protected against overcurrent by a PPTC fuse, the permissible current load is max. 100mA (@ 20°C). If other technical interfaces (measuring systems, external systems, interfaces) are connected to this internally supplied CAN connection, it is imperative that they have insulation between the CAN and the process side in accordance with EN50155!

Connection CAN 1 is already terminated internally, while connection CAN 2 is ***not*** terminated for insertion into an existing CAN network.

The connections for **antenna signals** for LTE mobile radio [X6] and GPS [X5] are designed as screwable **SMA sockets.** If adapters to other connector standards have to be used to connect the antennas, it is recommended that they be designed as cable adapters (see illustration) in order to minimise the mechanical stress on the sockets.

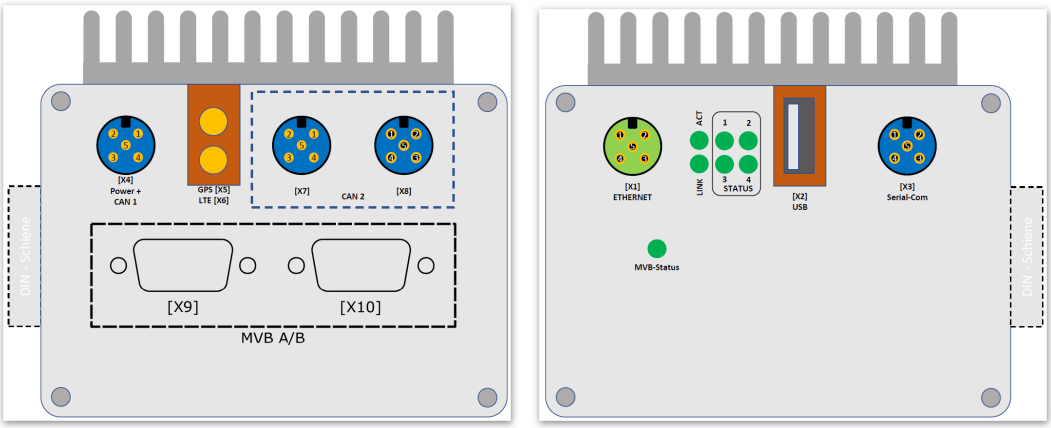
[3] When ordering, please state whether the supply on CAN 2 is required.

[4] Designation of a sensor family for capacitive and feedback-free tapping of the CAN bus signals for replication of the data traffic on an independent, subscriber-free CAN bus.

Integrated extension: smartIO MVB

The functional and technical properties of the smartIO MVB listed here are only an excerpt from the smartIO MVB data sheet, which is available separately. Please refer to the latest versions.

In the **smartRAIL(-S) MVB** version, a smartIO MVB module is already integrated in the same housing and connected to the CPU via an internal USB interface. This module allows feedback-free reading of the entire MVB data traffic via feedback-free capacitive coupling to the bus signal. The module implements a device of MVB Class 0, which technically has no transmitting unit and thus cannot actively participate in MVB communication. Both EMD and ESD versions of the MVB are supported via a signal conditioning system for which optiMEAS has applied for a patent.



While the two 9-pin MVB connections can be found on the side of the fieldbus connections on the device, only one status display of the MVB module is additionally present opposite. On the MVB connections, pins 1 to 5 are connected between [X9] and [X10]. Pins 6 to 9 offer an option for standard-compliant termination of an EMD bus as standard.

Pin	Signal	Description EMD (standard)	Description ESD (option[5])
1	A+	Data line bus A, positive	
2	A-	Data line bus A, negative	
3	[TxE]	(without use)	(TxE, without use)
4	B+	Data line bus B, positive	
5	B-	Data line bus A, negative	
6	Term/GND	Termination-A, positive (Z=120Ω)	Supply Term.-A, GND
7	Term/GND	Termination-A, negative	Supply Term.-B, GND
8	Term/5V	Termination-B, positive (Z=120Ω)	Supply Term.-A, 5V, 100mA
9	Term/5V	Termination-B, negative	Supply Term.-B, 5V, 100mA

[5] Available as placement option, then selectable via jumper in the EMD/ESD system

The function of the MVB extension is indicated by the flashing codes of the status LED. Thereby mean:

Flash code	Meaning
blue:	

Special approvals and declarations

For ***smartRAIL*** and ***smartRAIL-s, in*** addition to the CE declaration of conformity, the following certifications to EN50155 are also carried out:

EC Declaration of Conformity		The CE mark indicates conformity with the • EMC Directive, • RoHS 2011/65/EU (08.06.2011) and the • Low Voltage Directive.
Railway applications - Electronic devices on Rail vehicles. EN 50155:2008		The systems meet the standard for the following properties: • *Ambient conditions*: ○ AX (2000m) EN50125-1 §4.2.1 ○ TXEN50155 §4.1.2 • *Climate*[6] ○ Refrigeration EN50155 §13.4.5.2 ○ Dry heatEN50155 §13.4.5.3 ○ Humidity heatEN50155 §13.4.5.7 cyclic • *SwingIEC61373* §8 + 9 • *ShockIEC61373* §10 • *EMVEN* 50121-3-2 EN 61000-3-2/3 EN 55016-2-1/2 EMC 06 • *Fire protectionEN45545-2*

[6] Already according to EN 50155:2017

Technical data

Supply voltage / ambient conditions

Symbol	Parameter	Comment	Min	Type	Max	Unit
V_{CC}	Supply voltage	with reverse polarity protection	9	24	36	V DC
	Surge protection	Limitation and Poly-Fuse		yes		
	ESD protection	TVS diode			40	V
I_{CC}	Power consumption	@ 24V (without load on USB/CAN)	100	250	420	mA
	Connector	Together with CAN 1		M12		
	Coding			5-pin/A		
	Version	On the device side		male		
	Same potential with			CAN 1, USB, antennas		
$T_{operating}$	Operating temperature	EN 50155 / Range TX	-40		85	°C
	Relative humidity	Nano-coating, 50°C	5		95	%
	Housing			Aluminium		
L	Dimensions: Length	without plug / feet / clip		124		mm
		With plugs		149		mm
B	Wide			85		mm
H	Height	smartRAIL-S V2		45		mm
		smartRAIL(-S) V2 (with heat sink and extension)		85		mm
m	Weight	smartRAIL-S V2		440		g
		smartRAIL(-S) V2 (with heat sink and extension)		760	860	g
	Assembly	Option mounting feet or				
		Mounting rail (EN 50022)		TS 35		
	Cooling			passive		
	Protection class	(ISO 20653 - 2013)		IP54		

CPU

Symbol	Parameter	Comment	smartRAIL	smartRAIL-s
	CoM		**KARO TX6Q-1036**	**KARO TX6S-8035**
	Processor		NXP i.MX6 QuadPlus	NXP i.MX6 Solo
	Family		Quad ARM® Cortex®-A9	ARM® Cortex®-A9
	Clock		800 MHz	800 MHz
	RAM	DDR3 SDRAM	2 GB	512 MB
	ROM	HIREL eMMC	4 GB	2 GB
	Operating temperature		-40 °C … 105 °C	-40 °C … 105 °C

SD / SSD

Symbol	Parameter	Comment	Capacity
	µSD 1, internal	Measurement data	32 - 256 GB[7]
	µSD 2, internal	Take me Home, optional	From 2 GB
	SSD, external	via USB 2.0	Capacity according to demand

The µSD memory cards, like the mini-SIM card of the modem, are not accessible from the outside to protect against unauthorised access and should already be fitted during production.

Interfaces

Symbol	Parameter	Comment	Min	Type	Max	Unit
	Type / Quantity	**Ethernet**		1		
	Transmission rate		10		100	Mbit/s
	Connector			M12		
	Coding			4-pole/D		
	Version	on the device side		female		
	Status LED	Link, Activity		2		
	Type / Quantity	**USB 2.0**		1		
	Connector			Type-A		
	Type / Quantity	**CAN 2.0B, ISO 11898-2**		2		
	Baud rate	parameterisable		500	1000	kBit/s
	Connector			M12		
	Coding			5-pin/A		
	Version	CAN 1, device side		male		
		CAN 2, device side		male/female		
	Plug diameter				19	mm

[7] Depending on availability and actual need

Symbol	Parameter	Comment	Min	Type	Max	Unit
U_{CAN1}	Supply	CAN 1, external	9	24	36	V
U_{CAN2}		CAN 2, optionally from CAN 1		external		
Z_{Term}	Scheduling	CAN 1, internal, permanent		120		Ω
		CAN 2		no		
	Type / Quantity	**RS485**		1		
	Connector	Together with digital input		M12		
	Coding			5-pin/A		
	Version	on the device side		female		
	Type / Quantity	**RS232 (instead of RS485)**		1		
	Connector	(identical with RS485)		M12		
	Type / Quantity	**Status LED**		4		
		Meaning defined by software				

Integrated "periphery

Symbol	Parameter	Comment	Type / Value
	Real Time Clock	via I²C	RTC-RV-4162
	Buffer tank	Gold Cap	0,22F
	Temperature sensor	via I²C	LM75BD,118
	Acceleration sensor	3D, via I²C	LIS3DHTR LGA16
	Micro Controller	Boot, Watchdog, GPIO	Atmel SAMD21
	Modem	G4 (LTE Cat 4)	Quectel EG25-G
	Cover		worldwide
	Download		up to 150Mbps
	Upload		up to 50Mbps
	SIM	mini-SIM	15 x 12 x 0.76 mm
	GNSS	GPS, GLONASS, BeiDou, Galileo, QZSS	Quectel L76
	Resolution	Autonomous	< 2.5m CEP
	Update rate		1Hz (default), up to 10Hz

Integrated smartIO module: MVB

The technical data of the smartIO MVB listed here is only an excerpt from the smartIO MVB data sheet, which is available separately. Please refer to the latest versions.

Symbol	*Parameter*	*Comment*	*Min*	*Type*	*Max*	*Unit*
	Type / Quantity	**MVB**		1		
	Transmission rate			1.5		Mbit/s
	Standard			DIN EN 61375-3-1		
	MVB bus type	Reading only		EMD, ESD		
	MVB device class			Class 0		
	Connector			D-SUB-9, UNC4-40[8]		
	Coding			Standard		
	Version	on the device side		male/female		
C_{Input}	Coupling capacity			18		pF
Z_{Input}	Input impedance	3 MHz…100 kHz	30	50	250	kΩ
$Z_{Term,EMD}$	MVB Termination[9]	EMD (Standard, R-Internal)		120		Ω
$U_{Term,ESD}$		ESD[10] (option, R-net-external)	4.9	5	5.1	V DC
$I_{Term,ESD}$					100	mA
	Status LED	Status, Activity, Command		RGB		
	Interpretation	Single Line / Redundant Line		Ports, Messages, Events, Status		

Contact

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[8] A conversion kit for M3 threaded bolts is available (item no.: 20745)
[9] To be activated via termination plug according to standard for EMD / ESD
[10] Available as a placement option

Technical drawing