imc fieldbus interfaces

Along with the capture of data with the modular amplifiers, imc measurement devices can also collect data from digital bus systems. This document lists the currently supported bus systems and describes the available options for such interfaces.

The data acquired from such bus systems are processed and administered completely uniform and consistent with the other conventional anlog and digital data sources. They can synchronously be processed in real time, linked and be subjected to calculations with other channels. They can derive trigger conditions and be subjected to triggers and can be stored both on the device and on PC mass storage.

Depending on the chosen bus system, also selective data output onto the bus is supported.

Device platform, max number of interface modules in one device

Device	CAN-Bus	CAN FD-Bus	LIN-Bus	ARINC-Bus	FlexRay-Bus	XCPoE-Master	XCPoE-Slave	PROFIBUS	PROFINET-IRT	EtherCAT	MVB-Bus	Modbus	IPTCom	RoaDyn
CRFX	11900028	11900202	11900029	11900226	11900031	11900211	11900212	11900093	11900253	11900040	11900081	11900272	11900097	11900084
ET	11910019	11910114	11910066	11910130	11910022	11910122	11910123			11910038	11910023		11910028	11910058
CRC	11700010	11700251	11700011	11700177	11700048	11700265	11700266	11700146	11700046	11700026				11700150
ET	11710011	11710145	11710012		11710048	11710049	11710151			11710023				11710136
CRC-R	11700133		11700134	11700178	11700135	11700267	11700268	11700147	11700285					11700151
ET	11710092		11710093		11710094									
SPAR-N	11300095		11300096	11300098	11300097									
ET	11310038		11310039	11310041	11310040									
CRXT		11100003	11100004	11100047	11100005	11100045	11100046	11100052	11100091	11100051				
CRSL	11800009		11800010	11800012	11800068							--		
BUSFX	12400008	12400009	12400010	12400013	12400012	12400014	12400028			--	12400015	12400043		

legend:	--	not available
		no sales item number created yet

Physical structure

All listed fieldbus interfaces are configuration options ("configurations modules"), devices can only be equipped ex-factory with those modules. An exchange or plug-in by the user is not supported.

Operating conditions

The modules are available as variant for standard or extended temperature range. Operating conditions apply as stated in the data sheets for the respective device model. Power supply and data storage are provided by the host system.

CAN-Bus

CAN-Bus is a fieldbus system with a maximum transfer rate of 1 Mbit/s which is widely prevalent and accepted in the automotive and other manufacturing industries. The imc CAN-Bus Interface offers two independent, electrically isolated CAN nodes via which the two CAN-busses can be integrated into an imc measurement device both for receiving and sending.

Terminal connection:

- 2x DSUB-9 (1 isolated node per connector)

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the system.
- The CAN Bus settings are made by means of an assistant (wizard program). The operation of the assistant is described in the manual of the operating software.
- As extra options for the devices equipped with a CAN interface, a package is available (in conjunction with imc Online FAMOS), which supports ECU protocols: OBD-2, CCP, KW2000, XCPoC (XCP over CAN), and more.

Transfer protocol:

- CAN High Speed (ISO 11898) 1 MBaud
- CAN Low Speed (ISO11519) 125 KBaud
  is software-configurable for each node

Isolation strength:

- 60 V to system ground (case, CHASSIS)

Remarks:

- Configuration of imc CANSAS measurement modules directly via the CAN-Bus interface.
- Terminator resistor (120 Ω) can be software-activated for each node.
- CAN High Speed and CAN Low Speed is software-configurable for each node

Technical Specs - CAN-Bus

Parameter	Value	Remarks
Number of CAN-nodes	2	one galvanically isolated node per connector (each with CAN IN and CAN OUT)
Terminal connection	2x DSUB-9	
Topology	bus	
Transfer protocol	configurable per software: CAN High Speed (max. 1 MBaud) CAN Low Speed (max. 125 KBaud)	individually for each node according to ISO 11898 according to ISO 11519
Operating mode	Multi Master principle	
Direction of data flow	sending and receiving	
Baud rate	5 kbit/s to 1 Mbit/s	configurable via software; maximum is depending on selected protocol (High/Low Speed)
Max. cable length at data transfer rate	25 m at 1000 kBit/s 90 m at 500 kBit/s	CAN High Speed cable delay 5.7 ns/m
Termination	120 Ω	switchable by software for each node
Isolation strength	60 V	to system ground (case, CHASSIS)
Direct access for configuration of imc CANSAS modules	yes	via the CAN node of the device, with imc STUDIO

Note Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

CAN FD Bus

CAN FD Bus is an expansion of the standard CAN protocol, having a flexibly increasable transfer rate of up to 8 Mbit/s. In the automotive field in particular, it expands the scope of applications, the data transfer rate, and the bus capacity. The imc CAN FD Bus interface provides two independent, galvanically isolated CAN-nodes, via which two CAN-busses can be integrated into an imc measurement device, with the ability to both send and receive. It can be software-configured both for CAN FD mode and conventional standard CAN mode, and supports all relevant variants of the CAN FD standard (ISO and non-ISO).

Terminal connection:

- 2x DSUB-9 (1 galvanically isolated node per connector)

Software and operation:

- The module is fully supported by the imc STUDIO operating software.
- The CAN FD interface can be configured by software to operate in either CAN FD mode or standard CAN protocol (max. 1 MBaud).
- The CAN Bus settings are made by means of an assistant (wizard program). Operation of the assistant is described in the manual for the operating software.
- As extra options for the devices equipped with a CAN interface, a package is available (in conjunction with imc Online FAMOS), which supports ECU protocols: OBD-2, CCP, KW2000, XCPoC (XCP over CAN), and more.

Transfer protocol:

- CAN FD (ISO 11898-1:2015) 8 MBaud
- CAN High Speed (ISO 11898) 1 MBaud
- CAN Low Speed (ISO 11519) 125 KBaud

Isolation strength:

- 60 V to system ground (case, CHASSIS)

Software minimum requirements:

Operation of devices with CAN FD interface requires software of the following group:
imc STUDIO 5.0 R5 in conjunction with firmware and driver package imc DEVICES 2.9 R6.

Note Upgrade-Option

An upgrade option is exclusively available for imc CRONOS*compact* (CRC) systems and imc CRONOS*flex* (CRFX) base units that have been delivered after 2015 and equipped with a CAN Bus Interface 2. The upgrade will replace the CAN Bus Interface with CAN FD Bus interface.

Technical Specs - CAN FD-Bus

Parameter	Value	Remarks
Number of CAN-nodes	2	one galvanically isolated node per connector
Terminal connection	2x DSUB-9	
Topology	bus	
Transfer protocol	configurable per software: CAN FD (ISO Standard) (max. 8 MBaud) non-ISO CAN FD (Draft) (max. 8 MBaud) CAN High Speed (max. 1 MBaud) CAN Low Speed (max. 125 KBaud)	individually for each node current standard according ISO 11898-1:2015 former draft (Bosch) according ISO 11898 according ISO 11519
Operating mode	Multi Master principle	
Direction of data flow	sending and receiving	
Baud rate	5 kbit/s to 8 Mbit/s	configurable via software; maximum is depending on selected protocol (FD/High/Low Speed)
Termination	120 Ω	switchable by software for each node
Isolation strength	60 V	to system ground (case, CHASSIS)
Direct access for configuration of imc CANSAS modules	yes	via the CAN node of the device with imc STUDIO (CAN High Speed Mode only)

Note — Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

LIN-Bus

LIN-Bus is an especially simple and affordable fieldbus standard from the automotive field, which is specially designed for networking smart sensors and actuators. The gross transfer rates can extend up to 20 kbit/s. The imc LIN-Interface offers two independent, electrically isolated nodes which can operate as a slave and with limited basic functionality also as a master. When operating as a master, only a fixed schedule table in the LDF file is supported, i.e. a fixed polling cycle (base clock).

Terminal connection: 2x DSUB-9 (1 isolated LIN-node per connector)

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the system.
- For configuration of the LIN-Bus, a dedicated software assistant is provided.

Transfer protocols:

- LIN 2.1; LIN 2.0; LIN 1.3 (both LIN specifications (LIN 1.3 und 2.x) can run on the fieldbus simultaneously)

Isolation strength: 60 V to system ground (case, CHASSIS)

Remarks: "Master Node" 1 kΩ resistor connectable by software for each node.

Technical Specs - LIN-Bus

Parameter	Value	Remarks
Nodes	2	for each node LIN_IN / LIN_OUT
Terminal connection	2x DSUB-9	one DSUB for each node
Topology	Bus	
Transfer protocol	LIN 2.1, LIN 2.0, LIN 1.3	LIN 1.3 and LIN 2.x specifications can run on a bus simultaneously
Operating mode	Master and/or Slave	Master: with fixed schedule table in the LDF file
Direction of data flow sending receiving	 Display variables, virtual bits LIN data in measurement channels	
Baud rate	1 to 20 kbit	
Data rate	30 kS/s	
Termination	Pull up resistor	selectable via software Master/Slave
Isolation strength	60 V	to system ground (case, CHASSIS)

ARINC-Bus

The ARINC Bus is a fieldbus system specially adapted to aerospace engineering (aviation), having transfer rate of up to 100 kbit/s.

Terminal connection:

- 2x DSUB-15 (imc standard, a custom pin configuration can be realized)
  8 Rx receive channels, 4 Tx transmit channels

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the measurement system.
- For configuration of the ARINC-Bus, a dedicated software assistant is provided. The operation with the assistant is described in the software manual.

Transfer protocols:

- ARINC 429

Technical Specs - ARINC-Bus

Parameter	Value typ.	min. / max.	Remarks
Number of Rx-channels	8		
Number of Tx-channels	4		
Terminal connection	2x DSUB-15		
Transfer protocol	ARINC 429		
Baud rate	Low (12.5 kbit/s) High (100 kbit/s)		
Max. voltage for each Rx connection		±29 V	to System ground (protection ground)
Max. voltage for each Tx connection	5 V	4.5 V / 5.5 V	to GND "ZERO": min -0.25 V .. max 0.25 V
	10 V	9 V / 11 V	differential "ZERO": min -0.5 V .. max 0.5 V
Isolation strength	no galvanically isolation		

FlexRay-Bus

FlexRay is a serial fieldbus system from the automotive industry which serves the purpose of networking ECUs and offers transfer rates of up to 10 Mbit/s.

The imc FlexRay Interface provides a connection to the associated bus both for receiving (reading) and for sending (writing).

The module processes a FlexRay cluster consisting of two FlexRay channels, which can be operated either in parallel or separately.

Terminal connection: 1x DSUB-9 (channel A & B together)

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the measurement system.
- For configuration of the FlexRay-Bus, a dedicated software assistant is provided. Operation of this assistant is described in the user's manual for the software.
- Import of Fibex files containing the description of the FlexRay cluster's parameterization is supported. The settings can be edited using the software assistant. The data on the FlexRay cluster can be captured.
- The Interface can also transmit frames. The content of the frames is defined by means of the process vector, virtual bits and display variables. imc Online FAMOS is required for this operation.

Transfer protocols:

- FlexRay protocol specification v3.0

Isolation strength:

- 60 V to system ground (case, CHASSIS)

Technical Specs - FlexRay-Bus

Parameter	Value	Remarks
Number of FlexRay nodes	1 additional 1 cold start node	1x channel A+B
Terminal connection Standard	1x DSUB-9 per module	optionally 2x DSUB-9 (channel A+B separately)
Topology	Bus	
Transfer protocol	FlexRay protocol specification v3.0	
	XCP- specification Universal Measurement and Calibration Version 1.2.0; Date: 2013-06-20"	• ASAM_AE_MCD-1_XCP_BS_Protocol-Layer_V1-2-0.pdf "ASAM MCD-1 (XCP); Protocol; Protocol Layer Specification; • ASAM_AE_MCD-1_XCP_AS_Flexray-Transport-Layer_V1-2-0.pdf "ASAM MCD-1 (XCP on FlexRay); Protocol; FlexRay Transport Layer;
Operating mode	Sync nodes, cold start nodes or normal nodes	
Direction of data flow sending	Display variables, Virtual bits, Process vector variables and Ethernet bits	Cyclic and Single Shot Frames with imc Online FAMOS
Baud rate	2.5 / 5.0 or 10.0 Mbit/s	
Max. cable length at data transfer rate	see FlexRay protocol	
Data rate	max 60 kSample/s	per module
Isolation strength	60 V	to system ground (case, CHASSIS)

XCPoE Master-Slave

The "Extended Calibration Protocol" XCP is a transfer protocol with particular importance in the automotive industry, dedicated mainly to communication between control units (ECUs). This module provides and XCP interface for imc devices, using Ethernet as the transport layer (oE = over-Ethernet). Both Master and Slave are available.

Terminal connection:

- 1 x RJ45 Ethernet 100 Mbit/s

Slave:

The imc measurement device operates as the Slave and can provide the data it captures to external applications via Ethernet. In this case, the imc device behaves as a control unit. This enables it to be integrated into other environments: the data are directly accessible for standard software packages from various manufacturers, such as Canape by Vector, or INCA by ETAS.

The "Slave" mode causes the communication to be mainly governed by the external XCP-Master and not be the imc system. Slave mode does not actually determine in which direction (in/out) this communication flows. In principle, for an XCP-Slave, not only the output of variables is defined, but also the input (stimulus), even though this mode is not currently supported by the imc Slave module!

- Configuration of the XCPoE destination device is achieved by means of an A2L-file which is automatically composed when an imc system configuration is prepared.

The following channel types can be used as the signal source:

- analog/digital sampled input channels
- analog/digital sampled Fieldbus input channels, but no fieldbus protocol channels
- sampled virtual channels (imc Online FAMOS channels, but no FFTs and no histograms)
- The channels must be triggered by the "*BaseTrigger*" (an "*immediate trigger*").

This channel mapping concept is applicable as of the following software version:
imc STUDIO 5.0 R1 in conjunction with imc DEVICES 2.8 R5 SP4 firmware and drivers

For full functionality (especially pv and sending functions) imc Online FAMOS Professional OFA Pro (additional license) is required.
The XCPoE client requests the measured data after configuration of the device. High-speed synchronized data transfer up to 50 kHz per channel is achieved via Ethernet:

- The channel data are propagated via XCP at their individual and original data rates.
- This also applies to the virtual channels, which thus allows more than 2 data rates within the system. A maximum of 5 different output rates are supported: this limit is imposed by the XCP protocol itself!
- The XCP messages are assigned a time stamp which refers to the date of acquisition by the imc system. All channels in the XCP message are perfectly synchronous, because this is the case for the entire imc system, even across different types of modules and channel types.

Master:

The imc measurement device operates as the XCPoE Master and can capture data from an ECU via the XCP protocol.

- Configuration of the XCP-Master (imc device) is achieved by means of an A2L-file which must be available for the ECU addressed.
- The sampling rate for recording the XCP channels can be set up to max. 10 kHz.

Software and operation:

- The module is fully supported by the operating software imc STUDIO.
- The XCPoE settings are made by means of an assistant (setup wizard). Operation of this assistant is described in the operating software's user manual.

Transfer protocols:

"XCP -Part 1- Overview"	Ver. 1.0; ASAM e.V.
"XCP -Part 2- Protocol Layer Specification"	Ver. 1.0; ASAM e.V.
"XCP -Part 3- Transport Layer Specification XCP on Ethernet (TCP/IP und UDP/IP)"	Ver. 1.0; ASAM e.V.
"XCP -Part 4- Interface Specification"	Ver. 1.0; ASAM e.V.

Isolation strength: Standard isolation of Ethernet interface

Technical Specs - XCPoE Master-Slave

Parameter	Value	Remarks
Nodes	1	
Terminal connection	1x RJ45	
Transfer protocol	XCP -Part 1- Overview XCP -Part 2- Protocol Layer Specification	Ver. 1.0; ASAM e.V. Ver. 1.0; ASAM e.V.
	XCP -Part 3- Transport Layer Specification XCP on Ethernet (TCP_IP and UDP_IP)	Ver. 1.0; ASAM e.V.
	XCP -Part 4- Interface Specification XCPplus	Ver. 1.0; ASAM e.V.
Operating mode	Master or Slave	A2L file can be imported (XCPplus support included) A2L-file will be generated
Transmittable channel type when operating as slave	All meas. channels (analog, digital, fieldbus-, as well as virtual channels (OFA)	
Data rate per channel	 max. 50 kHz max. 10 kHz	depending on system configuration Slave Master
Max. cable length	100 m	
Hardware interface (Physical Layer)	Ethernet 100 Mbit/s	
Isolation strength	standard Ethernet specification	

PROFIBUS

PROFIBUS-DP has achieved world-wide prevalence as an industrial fieldbus for production- and process automation. Both sensors and actuators as well as multiple distributed control systems can be networked at data rates of up to 12 Mbit/s.

The imc PROFIBUS Interface allows the active communication within a Profibus network to be logged and interpreted. It provides the ability to extract individual messages from that communication stream and to display the data they contain as measurement channels.

To configure the interface, detailed knowledge of the Profibus network's configuration is required. For instance, in order to extract a datagram from a message, the following information is needed:

1. the PROFIBUS network's data transfer rate
2. the PROFIBUS protocol used
3. the bus address of the message's sender
4. the bus address of the message's recipient
5. Byte/bit offset of the datagram in the message.

In general, the information required can be obtained from the configuration of the PROFIBUS Master and the description of the respective PROFIBUS-Slave (GSD-file).

Note: Since there is no logic connection to the Profibus network, sending and receiving data as a bus subscriber is not supported. In consequence, the imc PROFIBUS Interface does neither constitute a master nor a slave, but works instead as an independent "sniffer", capable of logging and observing the existing communication.

Terminal connection: 1x DSUB-9

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the measurement system.
- For configuration of the PROFIBUS, a dedicated software assistant is provided.

Transfer protocols: DPV0, DPV1

Isolation strength: 60 V to system ground (case, CHASSIS)

Technical Specs - PROFIBUS

Parameter	Value	Remarks
Nodes	1	
Terminal connection	1x DSUB-9 per module	RS 485
Transfer protocol	DPV0, DPV1	
Operating mode	Sniffer (logging of existing bus communication)	no master, no slave
Baud rate	max. 12 Mbit/s	
Max. cable length at data transfer rate	PROFIBUS specification	
Isolation strength	60 V	to system ground (case, CHASSIS)

PROFINET-IRT

Profinet as the communication standard of the real-time-capable Industrial Ethernet is used in particular for networking industrial controllers such as PLCs and machine tools.

The PROFINET-IRT interface supports the connection of imc devices to such environments for bidirectional exchange of machine parameters, control variables, measured values, alarms etc. It is implemented according to conformity class CC-C, and thus supports real-time functionality, in particular through mechanisms of synchronization (PTP) and reserved bandwidth (IRT = Isochronous Real Time).

The interface turns an imc device into a full-fledged IO-Device participant and is physically coupled or looped into the control network by two dedicated RJ45 connectors (internal Ethernet switch).

For full functionality (especially pv and sending functions) imc Online FAMOS Professional OFA Pro (additional license) is required.
The properties of the imc system as a Profinet IO-Device are encapsulated and completely described in a GSD file (General Station Description). This file is also available via the imc website. This allows to get an overview of the module's capabilities already offline and to create configurations with a Profinet configuration tool such as TIA Portal or similar.

Within imc STUDIO the interface is fully supported by an Assistant (configuration wizard). It allows for example the assignment of the variables and data to be exchanged to channels and pv-variables of the device. The software also includes a data type converter which can map and match various data formats (e.g. Int, .Float, Big-Endian / Little-Endian).

Technical Specs - PROFINET-IRT

Profinet-Class	Value	Remarks
Node	1	
Device class	IO-DEVICE	
Functionality	CC-C	Conformance Class C
Profinet-Certification	Netload Class III certified according to PNIO-version V2.34	
Cyclic data exchange	RT, IRT	
Minimum supported bus cycle time	250 µs	Isochronous Real Time (IRT)

Network connection	Value	Remarks
Terminal connection	2x RJ45	internal network switch labeling: Port 1 and Port 2
Network	100 Mbit/s	full duplex with autonegotiation
Isolation	standard Ethernet specification	
Supported topologies	star/tree/line/circular	
NET status LED	green / red displays the following status information: connection with IO-Controller Run / Stop State network identification error of identification IRT synchronization	
MOD status-LED	green / red displays the following states: initialization normal operation diagnostic events internal errors firmware-update	
Network status-LEDs	green (left) / yellow (right) displays: activity and baud rate	on each RJ45 100 Mbit/s vs. 10 Mbit/s

Configuration options	Value	Remarks
Supported variable assignments	channels, pv-variables	assignment to Profinet variables
Max. number of pv-variables	800	general system limit for imc CRONOS devices
Endianess support	Big-Endian / Little-Endian	Byte order (Motorola/Intel), via wizard
internal data type converter	yes	
Save / Load configurations	yes	via wizard
Validation of configurations	yes	via wizard
Number of pluggable slots	40	Profinet: logical module structure "plugging" of slots = parameterization of logical units
max. pluggable output modules	20	
Size per output modules	64 Byte	
max. pluggable input modules	20	
Size per input module	64 Byte	
Maximum I/O process space	1280 Byte each	20 · 64 Byte

EtherCAT Slave

The fieldbus module EtherCAT Slave Interface (imc ECAT-Slave-IF) provides the integration of imc measurement devices and fieldbus loggers into an automation system based on an EtherCAT fieldbus.

The complete imc CRONOS device is integrated via the interface into the EtherCAT fieldbus as a Slave module, which is operated by an external EtherCAT Master.

Data from the imc measurement device are thus available throughout an EtherCAT system and integration of the device into other system environments is achieved. This interface is not limited to readout of data and variables from the imc system. Moreover, variables and system parameters of the imc system (Slave) can also be set and manipulated by the external EtherCAT Master, which allows for close interaction and further control schemes.

Terminal connection:

- 2x RJ45 EtherCAT 100 Mbit/s
- with CRONOS-XT (CRXT) 2x M8 - EtherCAT 100 Mbit/s

EtherCAT cable (CRXT System Bus)		
ACC/CABLE-ECAT-M8-2M	EtherCAT cable CRXT, on both sides M8-plug, 2 m	13500386
ACC/CABLE-ECAT-M8-RJ45-2M	EtherCAT cable CRXT, on one side M8-plug to RJ45, 2 m	13500387
ACC/CABLE-ECAT-M8-10M	EtherCAT cable CRXT, on both sides M8-plug, 10 m	13500388
ACC/CABLE-ECAT-M8-RJ45-10M	EtherCAT cable CRXT, on one side M8-plug to RJ45, 10 m	13500389

Software and operation:

The module is fully supported by the imc STUDIO operating software for the measurement system. For the configuration, a dedicated software assistant is provided. The assistant's instructions can be found in the manual of the operating software.

For full functionality (especially pv and sending functions) imc Online FAMOS Professional OFA Pro (additional license) is required.

- As the signal source, the imc device’s process vector is used. This means that the measurement channels and virtual channels represented by process vector variables are available to external subscribers and systems via EtherCAT. The data are available and valid directly after preparation, independently of trigger releases.
- Via the interface, it is possible to read and write process vector variables (pv-variables) of the imc system. Reading and writing can occur either cyclically or irregularly.
  - Cyclic data are transmitted periodically after the fieldbus and the imc measurement system start.
  - Irregular data can be queried asynchronous by the EtherCAT Master by means of the protocol CoE (CANopen over EtherCAT), which is supported by the imc system.
- The imc measurement device is parameterized via the device software imc STUDIO. The configuration is transferred to the EtherCAT master via an "EtherCAT-Slave-Information" document (ESI) in XML format.

Transfer protocol:

- EtherCAT Specification – Part 4 - Data Link Layer protocols specification
- EtherCAT Specification – Part 6 - Application Layer protocol specification

Isolation strength: Standard isolation of EtherCAT interface

Technical Specs - EtherCAT Slave

Parameter	Value	Remarks
Nodes	1	
Terminal connection with CRXT all others	 2x M8 2x RJ45	EtherCAT in / out
Transfer protocol	EtherCAT Specification – Part 4 Data Link Layer protocols specification EtherCAT Specification – Part 6 Application Layer protocol specification	Along with cyclical data transfer on the basis of EtherCAT, the interface is parameterized using CANopen® over EtherCAT (CoE)
Operating mode	slave	
Direction of data flow sending receiving	 process vector process vector	
Max. cable length	100 m	EtherCAT 100 Mbit/s
Max. bus transfer cycle	200 µs (5 kHz)	
Max. channel count for cyclic transfer	bus cycle / 4.5 µs - 10	max. 34 channels at 200 µs bus rate
Isolation strength	standard EtherCAT specification	

MVB-Bus

MVB is the abbreviation of "Multipurpose Vehicle Bus". This is a serial communication bus for rail vehicles. It connects control devices with each other as well as with simple sensors and actuators.

The MVB is standardized by the International Electrotechnical Commission (IEC) and the "Deutsches Institut für Normung (DIN)", as well as other bodies.

The MVB-Bus Interface integrates the associated fieldbus into an imc measurement device in order to make the measurement channels, status information and control communication which is already present in the vehicle, directly available for the imc system. Upon request, it can be equipped with fiber-optical transmission instead of wired transport layers, in order to meet electric rail vehicles' special requirements in terms of immunity to electromagnetic interference.

Terminal connection:

- 2x DSUB-9

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the measurement system.
- For configuration of the MVB-Bus, a dedicated software assistant is provided.

Remarks regarding operational reliability:

- The interface is hard-wired for either EMD or ESD+. The user must ensure that the device is connected to and operated by only one bus which conforms to the selected standard. Correct functioning of the MVB bus is not guaranteed in case of incorrect (incompatible) wiring, which may lead to disturbance of the bus communication, malfunctioning of third–party bus subscribers, or even irreversible damage to the device.

Technical Specs - MVB-Bus

Property	Characteristics
Node	1
Transmission medium	Copper: twisted pair, RS485
Terminal connection	2x DSUB-9
Topology	Bus
Protocol standards	IEC 61375-3-1 Electronic Railway Equipment - Train Communication Network - Part 3-1: MVB - Multipurpose Vehicle Bus IEC 61375-3-2 Electronic railway equipment - Train communication Network - Part 3-2: MVB - Multipurpose Vehicle Bus Conformance Testing
Physical Layer	EMD Electrical Middle distance medium non-reactive tapping of data **or as an option** (alternatively): ESD+ Electrical short distance
Operation mode	logging of periodical process data
Max. cable length	200 m with up to 32 subscribers
Redundancy	duplication: messages sent on both lines
Gross data rate	1.5 Mbit/s
Address room	4095 physical devices, 4095 logical ports, 8-bit station addresses for messages
Frame size	16, 32, 64, 128 and 256 bit
Isolation strength	500 V_{RMS} (1 min.)

Modbus

The imc Modbus interface is a fieldbus module that can be used to equip imc measurement devices. Modbus[1] is a communication protocol widely used in industrial automation devices.

The interface acts as Modbus client and can address and receive data from several Modbus server devices. It is used to integrate 3'rd party devices equipped with Modbus as additional measurement data sources into imc measurement systems and data loggers.

Both protocols and interfaces (physical layer) that are standardized for Modbus are supported:

- Modbus TCP Ethernet (100 Mbit)
- Modbus RTU Serial interface (RS232, RS485 half duplex and full duplex)

Both hardware interfaces are provided on the module (RJ45 and DSUB-9) and can also be operated together, in parallel.

1: Modbus® is a registered Trademark of Schneider Automation, Inc.

Typical applications:

- Integration of external devices and sensors with Modbus interface into an imc data acquisition system.
- Extension of the capabilities of an imc system to include specific special functions or sensors that can only be covered by 3'rd party devices.
- Use of special instruments (e.g. power meters, power analyzers, laboratory instruments), sensors (e.g. humidity or ph sensors, pyrometers), sensor systems (e.g. weather station) or test infrastructure (measurement of current temperature of climatic chambers)
- Low-speed monitoring of environmental parameters and electrical power
- Use of standard equipment from the field of industrial test automation
- Using an imc system as a central platform and gateway, with recording, processing of data from a wide variety of sources (imc system, analog, Modbus, field buses) and exchange and networking with higher-level systems via CAN bus, EtherCAT or XCPoE.

Features:

- Dedicated processor avoids use of resources of the main processor on the imc system and ensures performance and scalability
- Maximum flexibility: Both hardware interfaces are provided and can be operated simultaneously
- Device-based integration into the measurement system allows the use of all advanced capabilities and functionalities such as live data analysis with imc Online FAMOS, integration into real-time test automation (imc STUDIO Automation) etc.
- Acquisition of input data (measurement data) from Modbus devices, no output via Modbus (no control of e.g. actuators, controllers, etc.)
- Plug & Play solution with convenient configuration wizard in imc STUDIO.

Functionalities:

Function codes available for selection are:

- 01 (0x01) Read Coils
- 02 (0x02) Read Discrete Inputs
- 03 (0x03) Read Holding Registers
- 04 (0x04) Read Input Registers

The imc measuring device processes the acquired **Modbus data** as:

- channels ("FIFO channels")
- pv-variables ("process vector")

Software minimum requirements:

Operation of devices with Modbus interface requires software of the following group:
imc STUDIO 2023 R1 in conjunction with firmware and driver package imc DEVICES 2.16 R1.

Technical Specs - Modbus

General		
Parameter	**Value**	**Remarks**
Interfaces	1x Ethernet (Modbus TCP) 1x serial port (Modbus RTU) service-jack	both interfaces simultaneously, parallel operable 3.5 mm jack, for service purposes, not to be used by the user
Module width	requires 1 slot	fixed installation, ex factory
Modularity	order option	upon request
Max. number of interfaces in one system	3 8 1 / 2 / 3 / 5	totally in one CRFX base unit totally in one CRC, SPAR system totally in one BUSFX-4/-6/-8/-12 system

Modbus Protocol		
Parameter	**Value**	**Remarks**
Supported function codes	01 (0x01) 02 (0x02) 03 (0x03) 04 (0x04)	Read Coils Read Discrete Inputs Read Holding Registers Read Input Registers
Supported operating mode	client - server	direct addressing of server devices read (receiving data) write (sending data): not supported

Ethernet Interface (Modbus TCP)		
Parameter	**Value**	**Remarks**
Terminals / Nodes	1	
Terminal connection	1x RJ45	
Topology	bus	
Transfer protocol	TCP / IP	IEEE Norm 802.3
Baud rate	100 MBit 10 MBit	100BaseT (Half- and Full-duplex) 10BaseT (Half- and Full-duplex) Auto-sensing
Isolation strength	60 V	to system ground (CHASSIS)

Serial interface variant		
Parameter	**Value**	**Remarks**
Terminals / Nodes	1	
Terminal connectors	1x DSUB-9	
Baud rate	300, 1200, 2400, 4800, 9600, *14400*, 19200, *28800*, 38400, 57600, 115200, 230400	special bit-rates: 14400 and 28800
Isolation Isolation strength	galvanically isolated 60 V	to system ground (CHASSIS) nominal working voltage
Operation modes	RS 232 RS 485 (half-/full duplex)	flexibly configurable: multi-protocol transceiver
RS232 mode		
Parameter	**Value**	**Remarks**
Topology	point-to-point	
Signal type	Tx, Rx, GND CTS, RTS	base signals handshake, flow control
Byte format	8 data bits, 2 stop bits (none parity) or 1 stop bit (odd/even parity)	
Flow control	XON/XOFF, RTS/CTS	
RS485/422 mode		
Topology	bus	
Operating mode	Half- and Full-duplex	activated via software
Signal type	2x Tx, 2x Rx, GND	basis signals, differential
Termination	120 Ω	activated via software

IPTCom

IPTCom is an Ethernet network on board a train, based on the Internet-Protocol (IP). The DHCP, ARP, TCP and UDP protocols which are used are all based on the Internet-Protocol (IP). IPTCom makes use of these protocol layers in order to implement its own protocol.

Terminal connection:

- IPTCom is a 100 Mbit/s network having special connectors (“D” coded 4-pin M12 connector according to IEC 61076-2-101). The imc IPTCom Interface is equipped with a RJ45 connector and requires an adaptor.

Software and operation:

- The imc IPTCom Interface is fully supported by the measurement system’s imc STUDIO operating software
- The IPTCom-Protocol comprises two main protocols: IP-ProcessData and IP-MessageData.
- An IPTCom-Client is implemented, which is only able to read IP-ProcessData. These data can be captured as an imc channel, e.g. as time stamped signed INT16/FLOAT channels.
- This IPTCom-Protocol is at the moment specifically implemented and tested for BOMBARDIER. If you have questions for your own compatibility, please do not hesitate to contact us.

Isolation strength:

- 60 V to system ground (case, CHASSIS)

Technical Specs - IPTCom

Parameter	Value	Remarks
Node	1	
Terminal connection	1x RJ45	
Operating mode	Slave	
Data transfer direction receive	 SINT16/FLOAT-channels	
Data rate	max. 100 kS/s	total
Ethernet	100 Mbit/s	
Isolation strength	60 V	to system ground (case, CHASSIS)

RoaDyn Interface

The RoaDyn® Interface provides the interface between the wheel force transducer system RoaDyn® System 2000 by Kistler and an imc CRONOS measurement device.

Along with the RoaDyn® system's (3x force, 3x torque, angle, angular velocity, temperature, supply voltage) main channels, all additional service channels (single force components, errors etc.) are available.

Terminal connection: 2x BNC (Trigger und SYNC) and 1x RJ45

Software and operation:

- The module is fully supported by the imc STUDIO operating software for the measurement system.
- For the RoaDyn® configuration a dedicated software assistant is provided. The handling of this assistant is described in the software manual.
- The imc CRONOS measurement system has to be equipped with imc Online FAMOS Professional.

Technical Specs - RoaDyn Interface

Parameter	Value	Remarks
Nodes	Interface for a Kistler 2000 system max. 4 wheels	
Terminal connection	2x BNC RJ45	Clock and Trigger for the data exchange
Channels	all channels of the RoaDyn® system available: 10 main channels (3x force, 3x torque, angle, angular velocity, temperature, supply voltage additionally all service and additional-channels (single force, error cases etc.)	
Transmission medium	Ethernet 100 Mbit/s	10/100 Mbit/s, approvable cable length for 100 Mbit/s Ethernet max. 100 m according IEEE 802.3
Delay of tested Kistler unit - Version: 4.01a - DSP-Type: SBC31	2 ms plus 16 Samples	complete delay is compensated in the data processing imc Online FAMOS calculates with measurement data
Sampling rate	max. 1 kHz synchronized to imc system	