imc SPARTAN

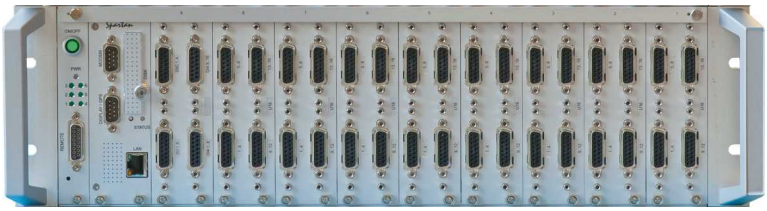
Compact measurement systems for measuring voltage, current, temperature and bridges

imc SPARTAN-N is a family of compact measurement instruments with 21 to 128 channels. Depending on the actual system configuration, that needs to be selected upon order, the devices will be equipped ex-factory with certain modules (T16, U16, B16, BCF16, LVDT16) that enable precise measurements of voltage, current (20 mA), temperature (thermocouples and PT100 and bridge (DC and CF mode) as well as LVDT.

imc SPARTAN-2

The basic standard configuration of all imc SPARTAN instruments always includes 16 digital inputs, 8 digital outputs, 4 incremental counter for the measurement of RPM, velocity or displacement, or for direct counting of pulses.

Furthermore individual expansions are interfaces for fieldbus systems from the automotive, avionics, railway engineering, industrial automation sector (e.g. CAN FD, FlexRay, XCPoE, ARINC, MVB, EtherCAT).



imc SPARTAN-RACK

Housings and variants

Parameter	SPAR-2	SPAR-4	SPAR-6	SPAR-8	SPAR-RACK
Housing type	portable housing				19" rack chassis
SPARTAN Sockets (2 slots each)	2	4	6	8	8
Max. channel count per device	32	64	96	128	128
Modularly configurable	SPARTAN modules and fieldbus modules: order option ex factory				
Dimension in mm W x H x D	271 155 264	352 155 264	433 155 264	514 155 264	427 133 310
Weight (ca.)	9 kg	10.5 kg	12.5 kg	14.5 kg	9..12 kg

imc SPARTAN analog modules

	size		connector		speed		iso	voltage mode				mA	temp		ICP,		bridge mode						
module name SPAR/xxx	channels	slots (1 slot = 4 HP)	standard connector	TEDS	max. sampling rate (per channel)	signal bandwidth (-3dB)	isolated (voltage / TC)	voltage mode	min. voltage range (mV)	voltage up to 10V	voltage up to 50/60V	20mA shunt plug	Thermocouple (TC)	RTD (PT100)	ICP plug	sensor supply	full bridge	half bridge	quarter bridge	DC excitation	AC excitation (CF)	single SENSE	double SENSE
Voltage & Temperature Measurement																							
T16	16	2	DSUB-15	●	5 Hz	1 Hz	●	●	50	●	●	●	●	●		o							
T16-TC-K	16	2	Thermo (green)		5 Hz	1 Hz	●						●										
T16-TC-UNI	16	2	Thermo (white)		5 Hz	1 Hz	●	●	50	●	●		●										
U16	16	2	DSUB-15	●	500 Hz	200 Hz	●	●	50	●	●	●	●	●	o	o							
U16-TC-K	16	2	Thermo (green)		500 Hz	200 Hz	●						●										
U16-TC-UNI	16	2	Thermo (white)		500 Hz	200 Hz	●						●										
Bridge & Strain Gauge Measurements																							
B16	16	4	DSUB-15	●	500 Hz	200 Hz		●	5	●		●			o	●	●	●	●	●		●	
BC16	16	2	DSUB-26-HD		500 Hz	200 Hz		●	5	●		●				●	●	●	●	●		●	
BCF16	16	4	DSUB-15	●	500 Hz	200 Hz		●	5	●	●	●			o	(●)	●	●	●	●	●	●	●
LVDT16	16	4	DSUB-15		500 Hz	50 Hz		●	500							●	●	●			●		●
LVDTC16	16	2	DSUB-26-HD		500 Hz	50 Hz		●	500							●	●	●			●		●

Key: ● default, o optional, (●) restricted

Conditioners

For isolated measurements of voltage and temperature, the two modules **T16** and **U16** are available, which differ in the maximum sampling rates they provide. The measurement inputs of these SPARTAN modules can be ordered as standard DSUB-15 (voltage and temperature) or thermocouple connectors (TC temperature mode only).

For measurement of bridges and strain gauge, the **B16** modules (with DSUB-15) are available. These modules are also available as C-variant ("compact"), equipped with High-Density DSUB-26-HD connectors and therefore only half as wide as B16 (C-variants do not support TEDS technology).

Another bridge module, **BCF16**, additionally supports, beside the DC mode, the carrier frequency (CF) and allow measurements of bridges and strain gauge and also LVDT type transducers such as inductive displacement sensors.

Finally, the inexpensive **LVDT16** conditioning module is specially designed for LVDT measurements (Schaevitz coils according to the transformer principle and inductive half bridges) and is also available in a compact DSUB-26-HD version (LVDTC16).

Configuration

The imc SPARTAN measurement instruments work either in conjunction with a PC or in stand-alone mode with UPS (uninterruptable power supply) and auto-start mode. Upon a short term power outage the device will operated from its integrated UPS. As this power failure persists, a running measurement will automatically be stopped, data files saved and shutdown procedure initiated.

The optional imc Online FAMOS platform allows arbitrary realtime processing, data analysis and control functionality directly embedded into the device. Based on signal processor technology it guarantees predictable realtime response and allows the implementation of realtime test automation. It doesn't require programming skills but is easily configurable by simple formula editing.

The associated operating software imc STUDIO is an integrated package that accesses very versatile functionalities. It not only serves as an interactive operating system but is also capable to realize comprehensive solutions from lab test to mobile data logging and up to complete industrial test rigs.

Overview of available variants

Standard version		**ET-version**	**Properties**
Order code	**article-no.**	**article-no.**	
Portable housing			
SPAR/SPARTAN-2-N	11300140	11310XXX	2 free SPARTAN sockets (4 Slots)
SPAR/SPARTAN-4-N	11300141	11310XXX	4 free SPARTAN sockets (8 Slots)
SPAR/SPARTAN-6-N	11300142	11310XXX	6 free SPARTAN sockets (12 Slots)
SPAR/SPARTAN-8-N	11300143	11310XXX	8 free SPARTAN sockets (16 Slots)
19" rack chassis (Rack, 3 U / 84 HP)			
SPAR/SPARTAN-R-N	11300144	not available	8 free SPARTAN sockets (16 Slots)

Extra options (factory order options)

- Extended temperature range (ET) for operating temperatures of -40°C to 85°C with allowed condensation. ET-version of the devices and modules have a separate article-no.
- Internal WiFi-adaptor
- HDD / SSD

Modules for imc SPARTAN-N

So-called conditioner modules can be individually combined: At time of order the customer may select his desired configuration that will be build as a fixed system configuration ex-factory. That includes:

- analog measurement amplifier
- analog outputs
- digital inputs and outputs
- pulse counter unit (incremental counter inputs)

Furthermore, **fieldbus modules** can be provided as fixed options when ordering the device. In addition to vehicle and industrial buses, this also includes an application-specific programmable interface module (APPMOD). It allows custom specific solutions for connecting devices, telemetry and protocols via Ethernet or serial interfaces.

Fieldbus modules usually occupy one device slot, corresponding to half a SPARTAN module socket. The first (e. g. CAN FD Interface) can be installed in a slot reserved exclusively for this purpose. All others then occupy the slots for conditioning modules accordingly. In any case, the maximum number is limited to 7 fieldbus modules. Further information and technical data are contained in separate data sheets.

1 standard module (e.g. U16) = 1 SPARTAN socket = 2 slots = 2 x 20.32 mm = 40.64 mm = 8 HP
1 fieldbus module (e.g. CAN) = 1/2 SPARTAN socket = 1 slots = 1 x 20.32 mm = 20.32 mm = 4 HP

A distinction is made between module versions for the SPARTAN housing and SPARTAN rack ("-R"), which differ slightly from the front panel.

An integrated **sensor supply module** with selectable supply voltages is available as an extension for the U16 and T16 modules (with DSUB-15 sockets) and does not require an additional slot.

Overview of the available analog modules

Standard version		ET-version	slots	properties
Order code	**article-no.**	**article-no.**		
T16	**voltage and temperature quasi-static**			
SPAR/T16	11300149	11310027	2	DSUB-15 (thermo couple, PT100, voltage)
SPAR/T16-SUPPLY	11300XXX	11310XXX	2	DSUB-15, additional adjustable sensor supply 3 W
SPAR/T16-TC-K	11300145	11310028	2	thermo couple type K, TC-connector
SPAR/T16-TC-N	11300146	11310XXX	2	thermo couple type N, TC-connector
SPAR/T16-TC-UNI	11300148	11310XXX	2	thermo couple universal type, TC-connector (Cu)
U16	**voltage and temperature dynamic**			
SPAR/U16	11300150	11310029	2	DSUB-15 (thermo couple, PT100, voltage)
SPAR/U16-SUPPLY	11300XXX	11310XXX	2	DSUB-15, additional adjustable sensor supply 3 W
SPAR/U16-SUPPLY-6W	11300XXX	11310XXX	2	DSUB-15, additional adjustable sensor supply 6 W
SPAR/U16-TC-K	11300151	11310030	2	thermo couple type K, TC-connector
SPAR/U16-TC-N	11300152	11310XXX	2	thermo couple type N, TC-connector
SPAR/U16-TC-UNI	11300154	11310XXX	2	thermo couple universal types, TC-connector (Cu)
SPAR/U16-NTC850K	11300225	11310XXX	2	NTC-measurement max. 850 kΩ with Iref 1,25 µA
B16	**voltage, bridge and strain gauge: DC-mode**			
SPAR/B16	11300155	11310031	4	DSUB-15

Standard version		ET-version	slots	properties
Order code	article-no.	article-no.		
SPAR/BC16	11300156	11310032	2	DSUB-26-HD
BCF16	**voltage, bridge and strain gauge: DC- and CF-mode**			
SPAR/BCF16	11300157	11310XXX	4	DC and CF-mode, DSUB-15
LVDT16	**LVDT: inductive, CF-mode**			
SPAR/LVDT16	11300158	11310XXX	4	DSUB-15
SPAR/LVDTC16	11300159	11310XXX	2	DSUB-26-HD

Overview of the available digital modules

Standard version		ET-version	slots	properties
Order code	article-no.	article-no.		
DIO-ENC-DAC	**Multi-IO**			
SPAR/DI16-DO8-ENC4	11300160	11310033	2	16 digital inputs, 8 outputs, 4 counter inputs
SPAR/DI8-DO8-ENC4-DAC4	11300161	11310034	2	8 digital inputs, 8 outputs, 4 pulse signals, 4 analog outputs
DIO	**digital inputs and outputs**			
SPAR/DI16	11300162	11310035	1	16 digital inputs
SPAR/DO16	11300163	11310036	1	16 digital outputs
DAC	**analog outputs**			
SPAR/DAC	11300164	11310037	1	8 analog outputs

Overview of available extension modules (fixed configuration ex-factory)

Standard version		ET-version	slots	properties
Order code	article-no.	article-no.		
Fieldbus modules				
SPAR/CAN2	11300165	11310038	1	2 CAN nodes
SPAR/CAN-FD	11300166	11310059	1	2 CAN FD nodes
SPAR/LIN	11300167	11310039	1	2 LIN nodes
SPAR/ARINC-8RX-4TX	11300175	11310XXX	1	ARINC Bus, 8x Receive, 4x Transmit
SPAR/FLEXRAY2	11300169	11310040	1	1 FlexRay nodes
SPAR/XCPOE2-MASTER	11300170	11310XXX	1	XCPoE Master
SPAR/XCPOE2-SLAVE	11300171	11310XXX	1	XCPoE Slave
SPAR/ECAT-SLAVE	11300176	11310XXX	1	EtherCAT Slave
SPAR/MVB-EMD	11300172	11310XXX	1	MVB-Bus (type EMD)
SPAR/MVB-ESD	11300173	11310XXX	1	MVB-Bus (type ESD)
SPAR/MODBUS	11300XXX	11310XXX	1	Modbus interface
SPAR/IPTCOM	11300174	11310XXX	1	IPTCom interface
Special expansions				
SPAR/ROADYN	11300177	11310XXX		Kistler RoaDyn 2000
SPAR/APPMOD-NET-COM	11300178	11310XXX		Ethernet, RS232/422/485

The order codes of the module versions for the SPARTAN RACK housing are expanded with the suffix: "-R" and have different article numbers.

Device extension

WLAN			
SPAR/WLAN-I	11300046	11310XXX	WiFi, 2.4 GHz

Additional device software (upgrade options)		
SPAR/OFA	11300022	imc Online FAMOS
SPAR/OFA-UP	11300023	Update from imc Online FAMOS to OFA-Professional
SPAR/VEC-DATB	11300027	Vector data base interface
SPAR/imc-REMOTE	11300128	imc REMOTE
SPAR/ECU-P	11300024	ECU protocols for the CAN Interface

Software options

	Features	Licensing	
Software product	Functionality	License model	included
Operating Software			
imc STUDIO Standard	Operating software, integrated test & measurement suite	PC	o
imc STUDIO Professional / Developer	Customized operation, scripting, application development	PC	o
imc DEVICES	Firmware and driver package	Device	●
imc CANSAS	In-situ configuration of imc CANSAS modules		●
imc SENSORS	Sensor data base	PC	o
Real-time Data Analysis			
imc Online FAMOS	Real-time calculations, immediate results	Device	o
imc Online FAMOS Professional	Real-time control extensions, PID control etc.	Device	o
imc Online FAMOS Kits	Class counting (fatigue analysis), order tracking	Device	o
Post Processing			
imc FAMOS Reader	Data visualisation	PC	●
imc FAMOS Standard / Professional	Data visualisation, analysis, reporting, scripting	PC	o
imc FAMOS Enterprise	incl. class counting. Order tracking, ASAM-ODS Browser	PC	o
Remote Access			
imc LINK	Remote device access, automatic data transfer	PC	o
imc REMOTE	Web Server, secure https device access	Device	o
CAN			
Vector database	Vector database interface	Device	o
ECU protocols	for CAN interface: KWP 2000, CCP, OBD-2	Device	o
Development			
LabView™ VI's	LabView VI components		●
imc COM	ActiveX programming interface (API)	PC	o
imc API	.NET programming interface (API) for imc STUDIO	PC	o

Accessories, Connectors and Mounting

Included accessories

AC/DC power adaptor 110-230V AC (with appropriate LEMO plug)		
CRPL/AC-ADAPTER-150W	AC/DC power adaptor, 24 V DC, 150 W, LEMO.2B	10800029

Documents
Certificates and calibration protocols: Detailed information on certificates supplied, the specific contents, underlying standards (e.g. ISO 9001 / ISO 17025) and available media (pdf etc.) can be found on our website, or you can contact us directly.

Optional accessories

Power connector		
ACC/POWER-PLUG2	DC supply plug LEMO FGG.2B.302, with solder contact, max. 0.34 mm^2	13500024
Mounting brackets for fixed installations		
SPAR/BRACKET-CON	Mounting bracket 180°; coupling of two devices on top of each other	11300119
SPAR/BRACKET-90	Mounting bracket 90°; mounting imc SPARTAN devices on a flat surface	11300118
SPAR/BRACKET-BACK	back panel mounting bracket	11300120
Miscellaneous		
ACC/SYNC-FIBRE	optical synchronization adaptor, for extended temperature range	13500156

Further accessories (see separate price list of the accessories)

- recommended and verified removable flash storage media
- external display (via DSUB-9)
- GPS-receiver (with DSUB-9 connection)

DSUB Connector plugs overview

Type / Description	Article #	Order Code	TEDS	Module types: compatible (●)						
				T16	U16	B16	BC16	BCF16	LVDT16	LVDTC16
Screw terminal plugs for signals										
DIO-ENC-DAC DSUB-15 (all device types)										
Plug with screw terminals for 8 digital inputs: DI4-8	**13500174**	ACC/DSUBM-DI4-8								
Plug with screw terminals for 8 digital outputs: DO-8	**13500173**	ACC/DSUBM-DO8								
Plug with screw terminals for 4 pulse counter input: ENC4	**13500171**	ACC/DSUBM-ENC4								
Plug with screw terminals for 4 analog outputs: DAC4	**13500177**	ACC/DSUBM-DAC4								
Analog Inputs DSUB-15 (depending on device type)										
Plug with screw terminals for 4 temperatures (incl. CJC) or volt.: T4	**13500167**	ACC/DSUBM-T4		●	●					
Plug with screw terminals for 4 voltages: U4	**13500166**	ACC/DSUBM-U4		●	●					
Plug with screw terminals for 2 bridges/strain gauge: B2	**13500170**	ACC/DSUBM-B2				●		●	●	
Plug with screw terminals and shunts for 4 currents (20 mA): I4	**13500168**	ACC/DSUBM-I4		●	●					
Plug with screw terminals and shunts for 2 currents (20 mA): I2	**13500180**	ACC/DSUBM-I2				●		●		
Analog Inputs DSUB-26-HD (for compact versions "C")										
Plug HD with screw terminals and shunts for 4 currnets (20mA): I4	**13500195**	ACC/DSUBM-HD-I4					●			
Plug HD with screw terminals for 4 bridges/strain gauge: B4	**13500197**	ACC/DSUBM-HD-B4					●			●
DSUB-HD-26 plug male (for soldering, no screw terminals)	**13500132**	ACC/DSUB-HD26M					●			●
Screw terminal plugs for signals (with TEDS)										
Analog inputs with TEDS (plug & measure) DSUB-15										
Plug with screw terminals for 4 temp. (incl. CJC) or volt.: T4 (TEDS)	**13500190**	ACC/DSUBM-TEDS-T4	✓	●	●					
Plug with screw terminals for 4 voltages: U4 (TEDS)	**13500189**	ACC/DSUBM-TEDS-U4	✓	●	●					
Plug with screw terminals for 2 bridges/strain gauge: B2 (TEDS)	**13500191**	ACC/DSUBM-TEDS-B2	✓			●		●	●	
Plug with screw terminals, shunts for 4 currents (20 mA): I4 (TEDS)	**13500192**	ACC/DSUBM-TEDS-I4	✓	●	●					
Plug with screw terminals, shunts for 2 currents (20 mA): I2 (TEDS)	**13500193**	ACC/DSUBM-TEDS-I2	✓			●		●		
Extension plugs										
DSUB-Extension plugs for IEPE/ICP DSUB-15										
Extension plug for 4 IEPE/ICP transducers: ICP4 (screw terminals)	**13500032**	ACC/DSUB-ICP4			●					
Extension plug for 2 IEPE/ICP transducers: ICP2I (isolated, 2 x BNC), slow	**13500293**	ACC/DSUBM-ICP2I-BNC-S	✓			●		●		
Extension plug for 2 IEPE/ICP transducers: ICP2I (isolated, 2 x BNC), fast	**13500294**	ACC/DSUBM-ICP2I-BNC-F	✓			●		●		
Push-In clamp plugs (for strain gauge quarter bridge)										
DSUB-15 plug with Push-In clamps for quarter bridge (3 wire strain gauge) with SPAR/B-16	**13500268**	ACC/DSUBM-QB2-PH				●				
Filter-Plug for ESD suppression DSUB-15										
In-line filter plug ESD (compatible with all amplifier types)	**13500211**	ACC/DSUBM-ESD		●	●	●		●	●	

Technical Specs for all devices

Terminal connections		
Parameter	**Value**	**Remarks**
PC / network Ethernet TCP/IP	RJ45 100 MBit	max. 100 m cable with 100 MBit (according to IEEE 802.3)
Removable flash storage	CF-Card Slot	can also be read out via network
Internal hard drive (HDD)	O	option, only ex-factory: SSD or magnetic; 400 kS/s data storage achievable with 16 bit / sample
Internal WiFi (WLAN) adaptor (optional)	1 antenna IEEE 802.11g max. 54 MBit/s, 2.4 GHz	
Sync	BNC	isolated (marked with yellow ring)
External display	DSUB-9	
External GPS module	DSUB-9	
Power supply	type LEMO.2B (2-pin)	compatible with LEMO.FGG.2B.302
Remote (remote controlled main power switch)	DSUB-15	
Programmable status indicator	6 LED (green)	operation via imc Online FAMOS
Measurement inputs	depending on actual system configuration	typically DSUB-15

Power supply	Value	Remarks
DC supply input	10 V to 32 V DC	galvanically isolated of housing (CHASSIS)
DC-input LEMO type	FGG.2B.302.CLAD 82ZN	
AC/DC power adaptor	24 VDC, 150 W 110-230V AC 50-60 Hz	included in delivery
Power-on threshold (typ.)	10.9 V	min. input voltage required for power-on (open circuit)
Shutdown threshold (typ.)	9.8 V	input voltage at which internal UPS buffering is activated respectively the delayed automatic deactivation is triggered
Power consumption	<130 W	depending on model and equipment

UPS and data integrity		
Autarkic operation without PC	✔	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is applied
Auto data-saving upon power outage	✔	buffering (UPS) with "auto-stop": auto-stop of measurement, data storage and automatic shutdown
UPS	integrated	with automatic charge control
USV coverage	complete system	
UPS delay per power outage	30 s (Default), configurable	"buffer time constant": required duration of a continuous outage that will trigger auto shutdown procedure
Minimum charging for 1 min. buffer duration	≤53 min.	typ. 23°C, with empty battery depending on device variant
Additional power consumption during charging time	3.5 W (max.)	device activated
Charging power	2.5 W (typ.)	device activated
Charging time ratio: charge / discharge	buffer time * 1.2 * (total power / 2.5 W)	worst case example: total power consumption of system 100 W, buffer duration 1 min., resulting charging time ≤ 48 min. (charging ratio 48:1)
UPS batteries		**Remarks**
Battery type	NiMH	
Effective buffer capacity	≥55 Wh	typ. 23°C, battery fully charged
Max. buffer duration	>30 min.	total buffer duration depending on device variant, total power consumption ≤110 W
Charging time for complete battery recovery	36 h	device activated
UPS-takeover threshold (typ.)	9.8 V 11.1 V	takeover internal buffer battery switch back to external supply

Data acquisition, trigger		
Parameter	**Value**	**Remarks**
Max. aggregate sampling rate	400 kS/s	
Channel individual sampling rates	selectable in 1–2–5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	✔ for all channels of the types: analog, DI and counter (incremental counter) and CAN	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	✔	e.g. logical combination of multiple channel events (threshold, transition) to create triggers that start and stop acquisition of assigned channels
Multi.triggered data acquisition	✔	multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Maximum channel count per device										
Active channels		512		Active channels of the current configuration: Total sum of analog, digital, fieldbus and virtual channels as well as possible monitor channels						
Active analog channels		198		Activated analog channels of the current configuration (sum of primary channels and possibly monitor channels)						
Fieldbus channels		1000		Number of defined channels (active and passive); Currently activated channels are limited by the total number of activated channels (512).						
Process vector variables		800		Single-value variables, each containing the latest current measured values. A process vector variable is automatically created for each channel.						
		without monitor channels					**with monitor channels**			
Channel type	**determined by**	**limit (aktive+passive)**		**activated**	**total activated**		**limit (aktive+passive)**		**activated**	**total activated**
Analog channels	system-expansion	Channel	240	198	512		Channel	240	198	512
							Monitor	240		
Incremental counter	system-expansion	Channel	16	16			Channel	16	16	
							Monitor	16	16	
DIO/DAC-Ports	system-expansion	Port	16	16			Port	16	16	
							Monitor	16	16	
Fieldbus channels	flexible	Channel	1000	512			Channel	1000	512	
							Monitor			
Virtual channels (OFA)	flexible	-	-	512			-	-	512	

Occupancy for ports (examples):

- one DO module (e.g. DO-16) occupies 1 port
- one DI8-DO8-ENC4-DAC4 module occupies 3 ports
- one DAC module (e.g. DAC-8 or DAC-4) occupies 1 port

Monitor-ports: DI-ports (respectively channels) have monitor-ports, DO/DAC-ports in contrary do not have monitor-ports

Storage, signal processing		
Parameter	**Value**	**Remarks**
Internal flash storage	CF-card	removable cover for the CF slot
Removable flash storage media	CF	recommended media available at imc; the specified operating temperature range of the media is relevant
Storage on NAS (network storage)	✔	alternatively to onboard Flash storage
Arbitrary memory depth with pre- and post trigger	✔	maximum pretrigger limited by size of Circular Buffer RAM; posttrigger only limited by available mass storage (Flash)
Circular buffer mode	✔	cyclic overwrite of circular buffer memory on mass storage media
Synchronization	DCF 77 GPS IRIG-B NTP	Master / Slave via external GPS-receiver TTL via network

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to 50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (Standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request

Synchronisation and time base

Time base of individual device without external synchronization			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Accuracy RTC		±50 ppm 1 µs (1 ppm)	not calibrated (standard devices), at 25°C calibrated devices (upon request), at 25°C
Drift	±20 ppm	±50 ppm	-40°C to +85°C operating temperature
Ageing		±10 ppm	at 25°C; 10 years

Time base of individual device with external synchronization signal				
Parameter	**GPS**	**DCF77**	**IRIG-B**	**NTP**
Supported formats	NMEA / PPS(1)		B000, B001 B002, B003(2)	Version ≤4
Precision	±1 µs			<5 ms after ca. 12 h(3)
Jitter (max.)	±8 µs			
Voltage level	TTL (PPS (1)) RS232 (NMEA)	5 V TTL level		---
Input impedance	1 kΩ (pull up)	20 kΩ (pull up)		---
Input connection	DSUB-9 "GPS" not isolated	BNC "SYNC" (isolated) (test voltage: 300 V, 1 min.)		RJ45 "LAN"
Cable shield connection		BNC: isolated Signal-GND (marked with yellow ring)		---

Synchronization of multiple devices via DCF (Master/Slave)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Max. cable length		200 m	BNC cable type RG58 (propagation delay of cable needs to be considered)
Max. number of devices		20	only slaves
Common mode SYNC not-isolated	0 V		with non-isolated BNC connector: devices must have the same ground voltage level, otherwise signal integrity issues (signal artifacts and noise) may result
SYNC isolated		max. 50 V	with isolated BNC connector: SYNC-signal is already internally isolated, for reliable operation even with different ground voltage level (ground loops)
Voltage level	5 V		
DCF input/output	"SYNC" connection		BNC

(1) PPS (Pulse per second): signal with an impulse >5 ms is necessary
(2) using BCD information only
(3) Max. value, concerning the following condition: first-synchronization

Analog modules

T16: Voltage, Temperature quasi-static (isolated)

Inputs, measurement modes		
Parameter	**Value**	**Remarks**
Inputs	16	
Measurement mode T16 (DSUB-15)	 voltage measurement current measurement thermocouples, RTD (PT100)	 standard plug (ACC/DSUBM-U4) current plug (ACC/DSUBM-I4) thermo-plug (ACC/DSUBM-T4)
Measurement mode T16-TC-K T16-TC-N T16-TC-UNI	 thermocouple type-K thermocouple type-N thermocouple universal types R, S, B, J, T, E, K, L, N	miniature thermocouple terminal connector 2-pin, green connector 2-pin, pink connector 2-pin UNI (Cu), white
Width	2 slots	

Sampling rate, Bandwidth, TEDS			
Parameter	**Value**		**Remarks**
Sampling rate	max. 5 Hz (200 ms) / channel		internal sampling: 2 Hz with additional interpolation: 5Hz for higher rates:output of doubled values max. allowable input signal frequency: 1 Hz
Bandwidth	1 Hz		-3 dB
Resolution	16 bit		
Noise suppression @ 50 Hz (±2%) at sampling rate: 1 Hz > 1 Hz	49 Hz to 51 Hz 68 dB 34 dB		noise frequency recommended sampling rate 1 Hz other sampling rates > 1 Hz
Bandwidth / max. signal freq. vs. noise suppression @ 50 Hz at sampling rate: 0.5 Hz 1 Hz 2 Hz 5 Hz	Bandwidth and max. signal frequency 0.25 Hz 0.5 Hz 1 Hz 1 Hz	noise suppression ≥60 dB 48.5 Hz 48.5 Hz 50 Hz 50 Hz	suppression of ≥60 dB is achieved for: noise frequency ≥48.5 Hz noise frequency ≥50 Hz
Max. settling time	max. 1 s		sampling rate 5 Hz (200 ms) complete settling as a response to input step
Synchronicity (at sampling rate)	constant time offset between two equally configured channels: max. 500 ms		 sampling rate ≥2 Hz
TEDS	conforming to IEEE 1451.4 Class II MMI		esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)
Characteristic curve linearization	user defined (max. 1023 supporting points)		

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation nominal test voltage	 ±60 V 300 V (10 s)		 channel to frame (housing, CHASSIS) and channel to channel
Overvoltage protection	±60 V ESD 2 kV transient protection: automotive load dump ISO 7636		diff. input voltage, (long term) human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input configuration	differential, isolated		electrical isolation to system-GND (housing, CHASSIS)
Input impedance	10 MΩ 1 MΩ 50 Ω		voltage mode (range ≤±2 V), temperature mode voltage mode (range ≥±5 V) current mode (shunt plug)
Static input current	1 nA	10 nA	
Dynamic input current	0.1 mA 30 nA	1.5 mA 600 nA	peak dynamic input current value (typ. @100 mV, max. @2 V) mean dynamic input current value (typ. @100 mV, max. @2 V)
Input current upon overvoltage		1.5 mA	$\|V_{in}\|$ > 7 V in the range ≤±2 V or device deactivated
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	 independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input range	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV			
Gain error	<0.025%	<0.05%	of the reading, at 25°C	
Gain drift		6 ppm/K 36 ppm/K	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error		<0.05% <3 µV	of input range	
Offset drift		3 ppm/K	over entire temperature range	
Non-linearity	<30 ppm		range: ±10 V	
Noise voltage (RTI)	<0.5 μV_{rms} <3.0 μV_{pkk} (<1 LSB)		sampling rate 5 Hz (200 ms)	
CMRR/ IMR (isolation mode rejection)	all sampling rates >110 dB (50 Hz) >95 dB (50 Hz) >65 dB (50 Hz)		 range ≤±2 V range ≤±2 V range ≥±5 V	 R_{source} = 0 Ω R_{source} = 100 Ω R_{source} = 100 Ω
Channel isolation	<50 pF, <100 nA		Channel to protection ground (CHASSIS); Channel-to-channel	
Channel cross-talk damping Suppression of square wave on neighboring channels	all sampling rates >116 dB (50 Hz) >101 dB (50 Hz) >123 dB @ sampling rate 200 ms		 range ≤±2 V range ≤±2 V range ≤±2 V	 R_{source} = 0 Ω R_{source} = 100 Ω R_{source} = 100 Ω
Max. source impedance	5 kΩ			

Current measurement with shunt plug				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input range	±1 mA / ±2 mA / ±5 mA ±10 mA / ±20 mA / ±40 mA			
Shunt resistor	50 Ω		external plug ACC/DSUBM-I4	
Gain error	<0.07%	<0.15%	of the reading, at 25°C	
Gain drift		6 ppm/K 36 ppm/K	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error		<0.05%	of input range	
Offset drift		3 ppm/K	over entire temperature range	

Temperature measurement - Thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input mode	R, S, B, J, T, E, K, L, N		
Input ranges	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K
Resolution	0.063 K (1/16 K)		
Measurement error (gain error + offset)		<±0.5 K ±0.05%	type K, range -150°C to 1200°C plus indicated value
Drift (gain error + offset)	±0.02 K/K·ΔT_a		ΔT_a=|T_a–25°C| ambient temperature T_a
Error of cold junction compensation		<±0.15 K <±0.5 K <±0.7 K <±1 K	DSUB (ACC/DSUBM-T4) thermo plug (green) type K thermo plug (white) with type K thermo plug (white) other types
Drift of cold junction temp.	±0.001 K/K·ΔT_a		ΔT_a=|T_a–25°C| ambient temperature T_a
Sensor breakage recognition	display: "-2000°C"		indicating unconnected input

Temperature measurement – PT100 (RTD)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	-200°C to 850°C -200°C to +250°C		
Resolution	0.063 K (1/16 K)		
Measurement error (gain error + offset)	<±0.1 K ±0.05%		-200°C to +850°C, 4-wire configuration plus indicated value
Drift (gain error + offset)	±0.01 K/K· ΔT_a		ΔT_a=|T_a–25°C| ambient temperature T_a
Reference current (PT100)	250 µA		non-isolated (CHASSIS is Ground)

Sensor supply (T16-SUPPLY)				
Parameter	**Value typ.**		**max.**	**Remarks**
Configuration options	5 selectable settings			The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Netpower 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels optional, special order: +12 V or 15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V optional, special order, +15 V can be replaced by ±15 V
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	<0.25 %		0.5 % 0.9 % 1.5 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

U16: Voltage, Temperature dynamic (isolated)

Parameter	Value	Remarks
Inputs	16	
Measurement modes U16 (DSUB-15)	 voltage measurement current measurement thermocouple, RTD (PT100) current fed sensors (IEPE/ICP)	 standard plug (ACC/DSUBM-U4) shunt plug (ACC/DSUBM-I4) thermo plug (ACC/DSUBM-T4) with IEPE DSUB-15 expansion plug: ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F [1], isolated
Measurement mode U16-TC-K U16-TC-N U16-TC-UNI	 thermocouple type-K thermocouple type-N thermocouple universal types R, S, B, J, T, E, K, L, N	miniature thermocouple terminal connector 2-pin, green connector 2-pin, pink connector 2-pin UNI (Cu), white
Width	2 slots	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 200 Hz	-3 dB
Filter (digital) cut-off frequency characteristic type and order	 1 Hz to 200 Hz	 Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cut-off}$ = 0.4 f_a
Resolution	16 Bit	internal processing 24 Bit
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)
Characteristic curve linearization	user defined (max. 1023 supporting points)	

1 When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used. Only the IEPE base functionality is supported by this module, see also TD ACC/DSUBM-ICP2I-BNC.

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation	galvanically isolated		channel-to-channel and against system ground (housing, CHASSIS, PE), as well as against common reference of all PT100 current sources and TEDS. not isolated when using ICP plug and PT100 mode
nominal rating	±60 V		
test voltage	±300 V (10 s)		
Overvoltage protection	±60 V ESD 2 kV transient protection: automotive load dump ISO 7637		differential input voltage, continuous human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input configuration	differential, isolated		
Input impedance	6.7 MΩ 1 MΩ 50 Ω		range ≤±2 V and temperature mode range ≥±5 V or device powered down with shunt plug ACC/DSUBM-I4
Input current operating conditions on overvoltage condition		 1 nA 1 mA	for operation $\|V_{in}\|$ > 5 V on ranges <±5 V or device powered-down
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5 % >0.2 A <1.2 Ω	for IEPE/ICP plug independent of optional sensor supply, short circuit proof power per DSUB-plug

Voltage measurement				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Voltage input ranges	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV			
Gain error	<0.02 %	<0.05 %	of the measured value, at 25 °C	
Gain drift		6 ppm/K ·ΔT_a 50 ppm/K ·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over full temp. range
Offset error	0.02 %	<0.05 %	of the measurement range, at 25°C	
Offset drift		2.5 ppm/K ·ΔT_a	over entire temperature range ΔT_a=$\|T_a$ -25°C$\|$ ambient temperature T_a	
Non-linearity	<120 ppm		range ±10 V	
Signal noise	2.5 μV_{rms} 20 μV_{pkpk}		bandwidth 0.1 Hz to 1 kHz; in the range: ±50 mV	
IMR (isolation mode rejection)	140 dB 64 dB	>130 dB >60 dB	range ≤±2 V range ≥±5 V	R_{source}= 0 Ω, f=50 Hz
Channel isolation	>1 GΩ, < 40 pF		channel-to-ground / CHASSIS (case)	
	>1 GΩ, <10 pF		channel-to-channel	
Channel isolation (crosstalk)	>165 dB (50 Hz) >92 dB (50 Hz)		range ≤±2 V range ≥±5 V	R_{source} ≤100 Ω

Current measurement with shunt plug				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA			
Shunt impedance	50 Ω		external plug ACC/DSUBM-I4	
Input configuration	differential			
Gain error	<0.02 %	<0.05 % <0.1%	of the measured value, with 25 °C additional error of 50 Ω in plug	
Gain drift		6 ppm/K ·ΔT_a 50 ppm/K ·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error	0.02 %	<0.05 %	of the measurement range	
Offset drift		2.5 ppm/K ·ΔT_a	over entire temperature range ΔT_a=|T_a -25 °C| ambient temperature T_a	

Temperature measurement - thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement mode	R, S, B, J, T, E, K, L, N		
Measurement range	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K
Resolution	0.063 K (1/16 K)		16-Bit integer
Measurement error		<±0,6 K <±1.0 K <±1.5 K	type K, range -150°C to 1200°C type T, range -150°C to 400°C type N, range 380°C to 1200°C type K, range -200°C to -150°C type T, range -200°C to -150°C type N, range -200°C to 380°C
Temperature drift	±0.02 K/K ·ΔT_a		ΔT_a=|T_a -25°C| ambient temperature T_a
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-T4
Temperature drift	±0.001 K/K ·ΔT_a		ΔT_a=|T_a -25°C| ambient temperature T_a

Temperature measurement – PT100		
Parameter	**Value**	**Remarks**
Measurement range	-200°C to +850°C -200°C to +250°C	
Resolution	0.063 K (1/16 K)	
Gain error	<±0.05%	of measured value (corresponding resistance)
Offset error	<±0.2 K	with 4-wire configuration
Offset drift	±0.01 K/K ΔT_a	ΔT_a=|T_a -25°C| ambient temperature T_a
Sensor feed	250 µA	non-isolated

Sensor supply (U16-SUPPLY)				
Parameter	**Value typ.**		**max.**	**Remarks**
Configuration options	5 selectable settings			The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Netpower 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels optional, special order: +12 V or 15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V Special order: +15 V can be replaced by ±15 V. With the LEMO variant, TEDS support is omitted with this choice, see manual.
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	<0.25 %		0.5 % 0.9 % 1.5 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

B16: Voltage, Bridges and strain gauge (DC-Mode)

Parameter	Value	Remarks
Inputs	16	
Measurement modes B16 (DSUB-15)	Bridge sensors Strain gauges Voltage measurement Current measurement Current-fed sensors IEPE (ICP)	Bridge plug ACC/DSUBM-B2 full, half, quarter bridge Shunt-plug ACC/DSUBM-I2 with DSUB-15 expansion plug: ACC/DSUBM-ICP2I-BNC-S/-F, isolated
Measurement modes BC16 (DSUB-26-HD)	Bridge sensors Strain gauges Voltage measurement Current measurement	ACC/DSUBM-HD-B4 Shunt-plug ACC/DSUBM-HD-I4
Width	2 slots 4 slots	BC16 (4x DSUB-26-HD) B16 (8x DSUB-15)

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 200 Hz	-3 dB
Filter (digital) cut-off frequency characteristic order	1 Hz to 200 Hz	 Butterworth, Bessel (digital) low pass or high pass filter 8th order band pass, LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
TEDS only SPAR/B16	conforming IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)
Characteristic curve linearization	user defined (max. 1023 supporting points)	

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		±40 V	permanent
Input coupling	DC		
Input configuration	differential		
Input impedance	20 MΩ	±1%	
Auxiliary supply voltage available current internal resistance	 +5 V 0.26 A 1.0 Ω	 ±5% 0.2 A <1.2 Ω	only with DSUB-15 variant for IEPE/ICP expansion plug independent of integrated sensor supply, short-circuit protected power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	±10 V, ±5 V, ±2.5 V, ±1 V... ±5 mV		
Gain error	0.02%	0.05%	of the measured value, at 25°C
Gain drift	10 ppm/K·ΔT_a	30 ppm/K·ΔT_a	ΔT_a=|T_a -25°C|; ambient temperature T_a
Offset error	0.02%	≤0.05% ≤0.06% ≤0.15%	of the input range at 25°C range >±50 mV range ≤±50 mV range ≤±10 mV
Offset drift	±0.7 µV/K·ΔT_a ±0.1 µV/K·ΔT_a	±6 µV/K·ΔT_a ±1.1 µV/K·ΔT_a	range ±10 V to ±0.25 V range ≤±0.1 V ΔT_a=|T_a -25°C|; ambient temperature T_a
Nonlinearity	10 ppm	50 ppm	
CMRR (common mode rejection ratio)	110 dB 138 dB	>90 dB >132 dB	DC and f≤60 Hz range ±10 V to ±50 mV range ±25 mV to ±5 mV
Noise (RTI)	0.6 μV_{RMS} 0.14 μV_{RMS}	1.0 μV_{RMS} 0.26 μV_{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	50 Ω		external plug ACC/DSUBM-I2
Over load protection		±60 mA	permanent
Input configuration	differential		
Gain error	0.02%	0.06% 0.1%	of reading, at 25°C plus error of 50 Ω shunt
Gain drift	15 ppm/K·ΔT_a	55 ppm/K·ΔT_a	ΔT_a=|T_a -25°C| ambient temperature T_a
Offset error	0.02%	0.05%	of range, at 25°C
Noise (current)	0.6 nA_{RMS} 0.15 nA_{RMS}	10 nA_{RMS} 0.25 nA_{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC		
Measurement modes	full-, half-, quarter bridge		bridge supply ≤5 V with quarter bridge
Input ranges bridge supply: 10 V bridge supply: 5 V bridge supply: 2.5 V bridge supply: 1 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ... ±0.5 mV/V ... ±1 mV/V ... ±2 mV/V ... ±5 mV/V		 (as an option) (as an option)
Bridge excitation voltage (as an option)	10 V 5 V (2.5 V and 1 V)	±0.5% ±0.5%	The actual value will be dynamically captured and compensated for in bridge mode.
Min. bridge impedance Max. bridge impedance	120 Ω, 10 mH full bridge 60 Ω, 10 mH half bridge 5 kΩ		
Internal quarter bridge completion	120 Ω, 350 Ω		internal, switchable per software
Input impedance	20 MΩ	±1 %	differential, full bridge
Gain error	0.02%	0.05%	of reading
Offset error	0.01%	0.02%	of input range after automatic bridge balancing
automatic shunt calibration	0.5 mV/V	±0.2%	for 120 Ω and 350 Ω
Cable resistance for bridges (without return line)	<6 Ω <12 Ω		10 V excitation 120 Ω 5 V excitation 120 Ω

Sensor supply				
Parameter	**Value typ.**		**max.**	**Remarks**
Configuration options	5 selectable settings			The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage (+1 V) (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Power 0.6 W 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for eight channels of a module upon request, also 2.5 V and 1 V settings are available, for example by replacing the +12 V or +15 V setting. An arbitrary set of 5 setting can be chosen preferred selections: +24 V, +12 V, +10 V, +5.0 V, +2.5 V +15 V, +10 V, +5.0 V, +2.5 V, +1 V upon request, special order: +15 V can be replaced by ±15 V. This eliminates the internal current- and quarter bridge measurement.
Short-circuit protection	unlimited duration			to output voltage reference ground: "-VB"
Accuracy of output voltage	<0.25 %		0.5 % 0.9 % 1.5 %	at terminals, no load at 25 °C over entire temperature range plus with optional bipolar output voltage
Compensation of cable resistances	3-line control: SENSE line as refeed (-VB: supply ground)			calculated compensation with bridges
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

BCF16: Voltage, Bridge and strain gauge (DC and CF-Mode)

Parameter	Value	Remarks
Inputs	16	
Measurement modes	bridge sensors strain gauge LVDT voltage measurement current measurement current-fed sensors IEPE/ICP	bridge plug ACC/DSUBM-B2 full-, half-, quarter bridge inductive transducers (CF) voltage or bridge mode global for all four channels Shunt-plug ACC/DSUBM-I2 with IEPE/ICP expansion plug (DSUB-15): ACC/DSUBM-ICP2I-BNC-S/-F, isolated
Width	4 Slots	8x DSUB-15

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 200 Hz	-3 dB -3 dB
Filter cut-off frequency characteristic order	1 Hz to 200 Hz	 Butterworth, Bessel low pass filter 8. order Anti-aliasing filter: Cauer 8. order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)
Characteristic curve linearization	user defined (max. 1023 supporting points)	

Full sensor TEDS support, including the DS2431 type used in most current IEPE sensors, is only available for modules of the imc CRONOS*flex* (CRFX) and imc CRONOS-XT (CRXT) device platforms.

General	Value typ.	min. / max	Remarks
Overvoltage protection		±50 V ±80 V	long term (differential- and SENSE-inputs) short-term
Input impedance	10 MΩ 1 MΩ		range ±5 mV to ±2 V range ±5 V to ±50 V and for deactivated device
Input current		40 nA	
Input capacitance	300 pF		
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5 % >0.2 A <1.2 Ω	for IEPE (ICP)-expansion plug independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V ±500 mV / ±250 mV / ±100 mV ±50 mV / ±25 mV / ±10 mV / ±5 mV		
Gain error	0.02 %	≤0.05 %	of reading (measurement value)
Gain drift	60 ppm / K	<100 ppm / K	
Offset drift	0.02 %	≤0.05 % ≤0.1 % ≤0.2 %	of measurement range range ≥±25 mV range = ±10 mV range = ±5 mV
Input offset-drift	0.05 µV / K	0.3 µV / K	DC voltage measurement
Non-linearity	<200 ppm		
Common mode voltage (max.)	±50 V ±2.8 V		ranges ±50 V to ±5 V ranges ±2 V to ±5 mV
Common mode rejection ratio (CMRR) range: ±5 mV to ±25 mV ±50 mV to ±100 mV ±250 mV to ±2 V ±5 V to ±50 V ±5 mV to ±2 V ±5 V to ±50 V all ranges	 >100 dB >68 dB 	 >120 dB >110 dB 95 dB >54 dB >90 dB >54 dB >50 dB	DC f ≤ 50 Hz f = 5 kHz
SNR (signal to noise ratio)	>90 dB >88 dB >82 dB >75 dB >69 dB		full-scale / rms-noise full bandwidth ranges ±100 mV to ±50 V range ±50 mV range ±25 mV range ±10 mV range ±5 mV
Input noise, voltage (RTI)	16 nV/√Hz$_{rms}$ 16 µV$_{pk-pk}$ 2 µV$_{rms}$ 0.6 µV$_{pk-pk}$		DC-Mode (range ±5 mV) spectral noise density 1 kHz 0 Hz to 10 kHz 0 Hz to 10 kHz 0.1 Hz to 10 Hz

Current measurement with shunt plug		
Parameter	**Value**	**Remarks**
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA ±400 µA / ±200 µA / ±100 µA	
Shunt impedance	50 Ω	shunt plug ACC/DSUBM-I2

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC, CF		

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sensors	LVDT, strain gauge: full-, half-, quarter bridge piezo-resistive bridge transducer potentiometer		directly connectable
Measurement mode	full-, half-, quarter bridge		
Input ranges	 ±1 mV/V to ±400 mV/V ±2 mV/V to ±800 mV/V ±5 mV/V to ±2000 mV/V		for bridge voltage: 5 V 2.5 V 1 V
Bridge supply DC CF (5 kHz)	 1 V; 2.5 V; 5 V (symmetric) 1 V; 2.5 V; 5 V (peak)		set globally for 4-channel groups corresponding to ±0.5 V, ±1.25 V, ±2.5 V corresponding to RMS: 0.7 V; 1.8 V; 3.5 V
Internal quarter-bridge completion	120 Ω, 350 Ω		selectable
Min. bridge impedance Bridge impedance (max.)	120 Ω, 10 mH full bridge 60 Ω, 5 mH half bridge 5 kΩ		bridge supply = 1 V to 5 V, $I_{load} \leq 42$ mA
Gain error	<0.05 %		of measurement value
Offset after bridge balance	<0.02 %		of the range
Input offset-drift	0.01 µV/V / K	0.06 µV/V / K	DC full bridge (Bridge supply=5 V, 1 mV/V range) without ext. bridge offset
Drift of bridge balance Equivalent offset drift corresponding to balanced ext. bridge offset	50 ppm/K 0.05 µV/V/K	<90 ppm/K 0.09 µV/V/K	of compensated offset value full bridge (DC or CF), ext. bridge offset = 1 mV/V 1 mV/V input range
Half-bridge drift (int. half-bridge)	0.05 µV/V/K	1 µV/V/K	DC or CF
Bridge balancing range	≥measurement range not less than: ≥±5 mV/V ≥±10 mV/V ≥±25 mV/V		 for bridge supply = 5 V for bridge supply = 2.5 V for bridge supply = 1 V
Cable length (max.)	500 m (one-way length)		A = 0.14 mm², R = 130 mΩ/m, 65 Ω
Cable-Compensation full bridge / half bridge quarter bridge	 4-wire-technique 3-wire-technique with shunt-calibration full compensation in 3-wire-technique		 any cable for symmetric (similar) cables one-time non-adaptive compensation including Gain-Correction!
Automatic shunt-calibration	0.5 mV/V		for 120 Ω and 350 Ω bridges
Input noise (bridge) DC full bridge	 3 µV/V_{pkpk}, 0.39 µV/V_{rms} 0.9 µV/V_{pkpk}, 0.12 µV/V_{rms} 0.3 µV/V_{pkpk}, 0.04 µV/V_{rms}		range: 1 µV/V (bridge voltage = 5 V) 0 Hz to 10 kHz 1 kHz, lowpass filter 100 Hz, lowpass filter

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
	0.1 $\mu V/V_{pkpk}$		10 Hz, lowpass filter
DC half-/quarter bridge	3.3 $\mu V/V_{pkpk}$, 0.45 $\mu V/V_{rms}$		0 Hz to 10 kHz
	1.1 $\mu V/V_{pkpk}$, 0.15 $\mu V/V_{rms}$		1 kHz, lowpass filter
	0.35 $\mu V/V_{pkpk}$, 0.05 $\mu V/V_{rms}$		100 Hz, lowpass filter
	0.3 $\mu V/V_{pkpk}$		10 Hz, lowpass filter
CF full bridge, half bridge	3.5 $\mu V/V_{pkpk}$, 0.47 $\mu V/V_{rms}$		0 Hz to 10 kHz
	1.7 $\mu V/V_{pkpk}$, 0.22 $\mu V/V_{rms}$		1 kHz, lowpass filter
	0.6 $\mu V/V_{pkpk}$, 0.07 $\mu V/V_{rms}$		100 Hz, lowpass filter
	0.3 $\mu V/V_{pkpk}$		10 Hz, lowpass filter

LVDT16: CF-Mode (inductive displacement sensors)

Inputs, Measurement modes		
Parameter	**Value**	**Remarks**
Inputs	16	
Measurement modes	LVDT bridge mode voltage measurement	Carrier Frequency mode (CF) 5 kHz
Terminal connection LVDT16	8x DSUB-15	2 channels per plug, recommended plug: ACC/DSUBM-B2
LVDTC16	4x DSUB-26-HD	4 channels per plug, recommended plug: ACC/DSUBM-HD-B4
Width	2 slots 4 slots	LVDTC16 (4x DSUB-26-HD) LVDT16 (8x DSUB-15)

Sampling rate, Bandwidth, Filter		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 50 Hz	allowable bandwidth of mechanical signal
Filter (digital) Frequency Characteristic Order	1 Hz to 20 Hz	 Butterworth, Bessel low pass 6th order
Resolution	16 Bit	internal processing 24 Bit
Characteristic curve linearization	user defined (max. 1023 supporting points)	

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation (nominal rating)	±60 V (nominal)		galvanically block isolated to System-GND (case, CHASSIS) no channel-to-channel isolation
Max. common mode voltage	±5 V		channel-to-channel
Overvoltage protection	ESD 2 kV transient protection		
Input current operating conditions on overvoltage condition power off	 0.2 nA	 25 nA 1 mA ≤5 mA	voltage mode, static
Non-linearity	<30 ppm		±2 V range, voltage mode
Auxiliary supply	+5 V (max. 160 mA / plug) non isolated		only with DSUB-15 variant

LVDT measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	CF		carrier frequency (5 kHz)
Bridge configuration	full bridge		LVDT transformer type transducers ("Schaevitz", transformator principle)
	half bridge		inductive half bridge transducers
Input ranges	±800 mV/V,±400 mV/V, ±200 mV/V, … ±100 mV/V, ±50 mV/V, ±20 mV/V		bridge supply = 2.5 V
	±2000 mV/V,±1000 mV/V, ±500 mV/V,.. .. , ±250 mV/V, ±100 mV/V, ±50 mV/V		bridge supply = 1 V
Bridge excitation voltage (VB)	2.5 V, 1 V		peak, sine wave, individually selectable per channel
	max. 28 mA		short circuit proof
Minimum transducer impedance	50 Ω, 10 mH		bridge supply = 1 V
	120 Ω, 10 mH		bridge supply = 2.5 V
Cable compensation	dual wire sense		adaptive compensation
Offset compensation range		≥±100% of range	of selected range
		9%	±2000 mV/V (bridge supply = 1 V)
		9%	±800 mV/V (bridge supply = 2.5 V)
Input impedance	6.7 MΩ	±1%	
Gain error	<0.025%	<0.05%	of the measured value
Gain drift		15 ppm/K·ΔT_a	$\Delta T_a = \lvert T_a - 25\ °C \rvert$; ambient temperature T_a
Offset error	<0.02%	<0.05%	of input range after automatic bridge balancing
Offset drift		1 µV/V /K·ΔT_a	full bridge, no ext. bridge offset
			$\Delta T_a = \lvert T_a - 25\ °C \rvert$; ambient temperature T_a
Half-bridge drift	0.5 µV/V /°C	1 µV/V /°C	internal half bridge completion
Max. lead wire resistance	<60 Ω		single cable
	<460 m		with cable: 0.14 mm², 130 mΩ/m, AWG26
Input noise	5 $\mu V/V_{rms}$		bridge mode (bridge supply = 1 V) bandwidth 0.1 Hz to 50 Hz

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±5 V, ±2 V, ±1 V, ±500 mV		
Input coupling	DC		
Input configuration	differential		
Input impedance (differential)	6.7 MΩ 1 MΩ		ranges ≤±2 V range ±5 V
Gain error	<0.025%	<0.05%	of reading, 25°C
Gain drift		15 ppm/K·ΔT_a 50 ppm/K·ΔT_a	ranges ≤±2 V range ±5 V $\Delta T_a = \lvert T_a - 25°C \rvert$; ambient temperature T_a
Offset error	<0.02%	<0.05%	of range
Offset drift		0.6 µV/K·ΔT_a 30 µV/K·ΔT_a	ranges ≤±2 V range ±5 V $\Delta T_a = \lvert T_a - 25°C \rvert$; ambient temperature T_a
CMRR	>95 dB (50 Hz)		R_{source} = 0 Ω
Input noise	<2.6 μV_{rms} <15 μV_{pkpk}		bandwidth 0.1 to 50 Hz

Digital modules

imc SPARTAN devices are already equipped as standard with 16 digital inputs, 8 digital outputs and 4 pulse counter inputs for incremental encoders.

For the module (DI16-DO8-ENC4) one socket (2 slots) has already been reserved, it is not included in the number of freely assignable slots. Additional units of this module can also be configured in free slots, as well as additional modules with digital inputs (DI), digital outputs (DO) and analog outputs (DAC).

The technical specs listed below apply in general, the respective number of bits or channels depends on the specific module type.

Digital Inputs

Parameter	Value	Remarks
Channels	16 or 8 depending on module variant 4	common ground reference for each 4-channel group, isolated from the other input group
Configuration options	TTL or 24 V input voltage range	configurable at the DSUB globally for 8 Bits: • jumper from LCOM to LEVEL: activates TTL-mode • LEVEL unconnected: activates 24 V-mode
Sampling rate	≤10 kHz	
Isolation strength	±50 V	tested ±200 V isolated to system ground, supply and channel-to-channel
Input configuration	differential	
Input current	max. 500 µA	
Switching threshold	1.5 V (±200 mV) 8 V (±300 mV)	5 V level 24 V level
Switching time	<20 µs	
Supply HCOM	5 V max. 100 mA	electrically isolated from system (case), Configuration signal "LEVEL" is referenced to HCOM, LCOM
Terminal connection	DSUB-15	ACC/DSUBM-DI4-8

Digital outputs

Parameter	Value		Remarks
Channels / bits	16 or 8 depending on module variant 4		Group of 8 bits, galvanically isolated; common reference potential ("LCOM") for each group
Isolation strength	±50 V		to system ground (case, CHASSIS)
Output configuration	totem pole (push-pull) or open-drain		configurable at the DSUB globally for 8 Bits: • jumper from OPDRN to LCOM: totem pole • OPDRN unconnected: open-drain
Output level	TTL or max. U_{ext} -0.8 V		internal, galvanically isolated supply voltage by connecting an external supply voltage U_{ext} with "HCOM", U_{ext} = 5 V to 30 V
State upon system power up	high impedance (High-Z)		Independent of output configuration (OPDRN-pin)!
Activation of the output stage following system start	upon first preparation of measurement		with initial states which can be selected in the experiment (High / Low) in the selected output configuration (OPDRN-pin)
Max. output current (typ.)	HIGH	LOW	
TTL 24 V-logic open-drain	15 mA 22 mA ---	0.7 A 0.7 A 0.7 A	external clamp diode needed for inductive load
open-drain with intern. 5 V supply		160 mA	for all outputs
Output voltage	HIGH	LOW	for load current:
TTL	>3.5 V	≤0.4 V	I_{high} = 15 mA, I_{low} ≤0.7 A
24 V-logic (U_{ext} = 24 V)	>23 V	≤0.4 V	I_{high} = 22 mA, I_{low} ≤0.7 A
Internal supply voltage	5 V, 160 mA (isolated)		available at terminals
Switching time	<100 µs		
Terminal connection	DSUB-15		ACC/DSUBM-DO8

ENC4: Pulse counter for incremental encoder

Parameter	Value		Remarks
Channels	4 + 1 (5 tracks)		four single-tracks or two two-track channels one index track
Measurement modes	Displacement, Angle, Events, Time, Frequency, Velocity, RPMs		
Sampling rate	50 kHz		per channel
Time resolution of measurement	31.25 ns		counter frequency: 32 MHz
Data resolution	16 bits		
Input configuration	differential		
Input impedance	100 kΩ		
Input voltage range	±10 V		differential
Common mode input range	min. -11 V	max. +25 V	
Switching threshold	-10 V to +10 V		detection level selectable per channel
Hysteresis	min. 100 mV		selectable per channel
Analog bandwidth	500 kHz		-3 dB (full power)
Analog filter	Bypass (no Filter), 20 kHz, 2 kHz, 200 Hz		selectable (per-channel) 2nd order Butterworth
Switching delay	500 ns		signal: 100 mV squarewave
CMRR	70 dB 60 dB	50 dB 50 dB	DC, 50 Hz 10 kHz
Gain error	<1 %		of input voltage range @ 25 °C
Offset error	<1 %		of input voltage range @ 25 °C
Overvoltage strength	±50 V		to system ground
Sensor supply	+5 V, 300 mA		not isolated (reference: GND, CHASSIS)
Terminal connection	DSUB-15		ACC/DSUBM-ENC4

Analog outputs

Parameter	Value typ.	min. / max.	Remarks
Channels	4 or 8 depending on module variant 4		
Output level	±10 V		
Load current	max. ±10 mA / channel		
Resolution	16-bit		15-bit, no missing codes
Non-linearity	±2 LSB	±3 LSB	
Max. output frequency	50 kHz		
Analog bandwidth	50 kHz		-3 dB, low pass 2nd order
Gain error	<±5 mV	<±10 mV	-40 °C to 85 °C
Offset error	<±2 mV	<±4 mV	-40 °C to 85 °C
Terminal connection	DSUB-15		ACC/DSUBM-DAC4