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Operating instructions
Diagnostic electronics with Modbus TCP interface for vibration sensors
VSE953

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1 Safety instructions

- The unit described is a subcomponent for integration into a system.
  - The system architect is responsible for the safety of the system.
  - The system creator undertakes to perform a risk assessment and to create documentation in accordance with legal and normative requirements to be provided to the operator and user of the system. This documentation must contain all necessary information and safety instructions for the operator, the user and, if applicable, for any service personnel authorised by the architect of the system.
- Read this document before setting up the product and keep it during the entire service life.
- The product must be suitable for the corresponding applications and environmental conditions without any restrictions.
- Only use the product for its intended purpose (→ Intended use).
- If the operating instructions or the technical data are not adhered to, personal injury and/or damage to property may occur.
- The manufacturer assumes no liability or warranty for any consequences caused by tampering with the product or incorrect use by the operator.
- Installation, electrical connection, set-up, operation and maintenance of the product must be carried out by qualified personnel authorised by the machine operator.
- Protect units and cables against damage.

2 Preliminary note

You will find instructions, technical data, approvals, accessories and further information using the QR code on the unit / packaging or at www.ifm.com.

2.1 Symbols used

✓	Requirement
▶	Instructions
▷	Reaction, result
[...]	Designation of keys, buttons or indications
→	Cross-reference
	Important note Non-compliance may result in malfunction or interference.
	Information Supplementary note

2.2 Warnings used

ATTENTION

Warning of damage to property

CAUTION

Warning of personal injury

▷ Slight reversible injuries may result.

WARNING

Warning of serious personal injury

▷ Death or serious irreversible injuries may result.

3 Intended use

The device has been designed for process value monitoring, vibration monitoring and analysis of dynamic signals.

4 Device functions

The diagnostic electronics has

- 2 analogue inputs
- 4 dynamic inputs
- 1 analogue or digital output
- 1 digital output
- 1 TCP/IP parameter setting interface
- 2 Modbus TCP ports

Input IN1: connection for a pulse signal (HTL).

Input IN2: connection for an analogue current signal (4...20 mA).

The analogue inputs can be used

- as trigger for measurements (e.g. rotational speed for vibration diagnostics)
- as trigger of a counter
- for process monitoring

VSA, VSP or standard IEPE acceleration sensors can be connected to the dynamic inputs.

The dynamic inputs can be used for

- vibration monitoring
- vibration diagnostics
- analysis of other dynamic signals

The hardware outputs can be configured as 2 x binary (NO/NC) or as 1 x analogue (0/4…20 mA) and 1x binary (NO/NC).

The outputs can be used for

- time-critical alarms (e.g. machine protection, response time up to 1 ms)
- alarm output
- analogue value output of values measured by the diagnostic electronics

The parameter setting interface (TCP/IP) is used for communication between the diagnostic electronics and a PC (e.g. VES004 parameter setting software).

The parameter setting interface can be used for

- parameter setting of the device
- online data monitoring
- reading the history memory
- firmware update

The Modbus TCP ports are used for the communication between the diagnostic electronics and a Modbus TCP client/master (e.g. PLC).

The Modbus TCP interface can be used for

- transferring the current measured values, limits and alarm states of the diagnostic electronics to the PLC
- reading the counter readings of the diagnostic electronics
- writing rotational speeds and other values from the PLC to the diagnostic electronics
- writing teach values from the PLC to the diagnostic electronics

ATTENTION

The device is not approved for safety-related tasks in the field of operator protection.

4.1 Function description

This device allows for

- vibration monitoring (total vibration to ISO)
- condition monitoring (condition-based monitoring on the basis of vibration characteristics)
- machine protection/process monitoring (monitoring vibration characteristics in real time with a very fast response time up to 1 ms)

to be implemented.

Monitoring of

- up to 24 objects (indicators for different machine parts, vibration characteristics or process values)
- dynamic values within the time range (e.g. v-RMS to ISO)
- dynamic values within the frequency range FFT or HFFT (e.g. unbalance or rolling element bearing)
- process values (analogue signals) for current value above or below the limit

The device has an internal history memory (600,000 values) with real-time clock and flexible memory interval per object. The memory is a ring memory (FIFO).

Up to 32 counters can be configured to measure the duration of operating times and/or how long a limit value is exceeded.

The signals at the inputs are permanently picked up and continuously monitored according to the set parameters.

With objects in the frequency range (unbalance, rolling element bearing ...), monitoring is done in multiplex mode.

With objects in the time range (v-RMS, a-RMS and a-Peak), all 4 dynamic inputs are monitored simultaneously and without interruption.

The two outputs OU1/2 can be used for alarms.

Parameter setting of monitoring tasks and alarming is done via the VES004 software. The software allows to display and record the current measured values, spectra and time signals (online data).

Via the Ethernet interface of the device, networking is possible to visualise data (measured values, alarm states, ...) in other systems (e.g. SCADA, MES, ...).

Data (e.g. measured values, alarm states, limits, rotational speeds, timer readings, ...) is exchanged between the diagnostic electronics and the Modbus TCP client/master (e.g. PLC) via the Modbus TCP ports.

4.2 Firmware

▶ Recommendation: Install the firmware to use all device functions.

The firmware can only be updated via the VES004 PC software. Only the firmware of the entire device can be updated.

▷ Firmware and operating software → download area www.ifm.com

▷ A description of all firmware parameters and their meaning → VES004 PC software manual.

5 Mounting

- ▶ Disconnect the power to the machine during installation.
- ▶ Use a flat mounting surface for installation.

▶ Fix the device to the mounting surface using screws (max. M6) and washers.

▶ Ground the device with the earthing screw provided.

When preparing for cable installation, the local conditions and the corresponding mounting regulations are very important. Cables can be installed, for example, in cable ducts or on cable bridges.

A minimum distance between the cabling and possible sources of interference (e.g. machines, welding equipment, power lines) is defined in the applicable regulations and standards. During system planning and installation, these regulations and standards must be taken into account and observed.

Protect the bus cables from sources of electric/magnetic interference and mechanical strain.

Observe the guidelines regarding "electromagnetic compatibility" (EMC) to keep mechanical risks and interference to a minimum.

5.1 Emission

This is a class A product. The device may cause radio interference in domestic areas.

▶ It if necessary, take measures to prevent radio interference.

5.2 Sources of interference

▶ Signal cables and power supply lines should not be installed in parallel.

▶ If necessary, metal isolating segments should be placed between the power supply lines and signal cables.

5.3 Cable routing

Network/bus cables: Install network/bus cables in separate cable ducts or separate cable bundles.

▶ Where possible, do not install network/bus cables parallel to power supply lines.

▶ Install network/bus cables at least 10 cm away from power lines.

5.4 Installation instructions

Electrostatic discharge

The device contains components that can be damaged or destroyed by electrostatic discharge.

▶ When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

6 Electrical connection

The national and international regulations for the installation of electrical equipment must be adhered to. Avoid contact with dangerous contact voltages.

▶ Disconnect power.

▶ Connect the device.

▶ To prevent negative effects on the functions caused by noise voltages, lay sensor cables and load cables separately.

Maximum cable length for the sensors 1…4: 250 m.

Maximum cable length for the inputs IN1 and IN2: 30 m.

▷ Connect the screen at the sensor.

▷ Use a screened sensor cable (self-assembled).

The outputs are short-circuit proof and can be configured as either normally closed or normally open.

In addition, an analogue signal can be provided on output [OU 1] (0/4...20 mA) (e.g. acceleration values).

6.1 Wiring

Sensor 1…4	
M12 socket, A-coded	
1: L+ (bn)	
2: Signal (wh)	
3: GND (bu)	
4: Test (bk)	
5: not used	

Config / IE1 / IE2	
M12 socket, D-coded	
1: TxD+	
2: RxD+	
3: TxD-	
4: RxD-	
5: not used	

IN 1	
M12 socket, A-coded	
1: 24 V DC (bn)	
2: not used	
3: GND (bu)	
4: IN pulse (bk)	
5: not used	

IN 2
M12 socket, A-coded

IN 2	
1: 24 V DC (bn)	
2: IN 4...20 mA (wh)	
3: GND (bu)	
4: not used	
5: not used	

OU / Supply	
M12 connector, A-coded	
1: 24 V DC (bn)	
2: analogue or digital (wh)	
3: GND (gn)	
4: OU2: switch	

6.2 Connection of the sensors

Adhere to the SELV criteria (safety extra-low voltage, circuit electrically isolated from other circuits, ungrounded) when the sensors are connected so that no dangerous contact voltages are applied to the sensor or transferred to the device.

If the DC circuit is to be grounded (e.g. due to national regulations), the PELV criteria must be adhered to (protective extra-low voltage, circuit electrically isolated from other circuits).

Sensor and diagnostic electronics supply are not electrically isolated.

7 Modbus TCP

7.1 Properties

Requirement	Parameter
Register access	only acyclical r/w
Register addressing	based on 1
Transmission rate	100 Mbits/s, 10 Mbits/s
Protocols	Modbus TCP/IP
Data format	big-endian
Modbus TCP/IP Max. input and output process image	 1024 bytes (512 registers)
Configuration	via PC with configuration tool: VES004
Max. number of socket connections	8x Modbus TCP
Register filing of the input data	analogue input register 16 bits (r)
Register filing of the output data	analogue holding register 16 bits (r/w)
Supported function codes	FC3, FC4, FC6, FC16
Write max. byte length for registers	1...123 registers
Read max. byte length for registers	1...125 registers
Register access	only acyclical r/w

7.2 Data model

Input (PLC)					
Source			**Type**	**Size**	**Use**
Analogue inputs (DC)					
	<input name>		Real	4 bytes	Value of the connected signal at the analogue input (IN1, IN2)
External inputs					
	<input name>		Real	4 bytes	Value of the external input (External_xx)
Objects					
	Time domain				
	<object name>				
		Value	Real	4 bytes	Object value in SI unit (m/s², m/s)
		Status	Byte	1 byte	“(Alarm) state of the object 0: OK 1: Warning alarm 2: Damage alarm 3: Inactive 4: Error (description: see Error)”

Input (PLC)				
Source		**Type**	**Size**	**Use**
	Error	Word	2 bytes	“Error code for object state Hex0000: No fault Hex0001: Internal fault Hex0002: Calculation error Hex0004: Speed out of range Hex0008: Speed not stable Hex0010: Invalid baseline Hex0020: Invalid reference value (1) Hex0040: Invalid reference value (2) Hex0100: Deactivated by signal weighting Hex0200: Reference value out of range Hex1000: Warning alarm Hex2000: Damage alarm Hex8000: Object inactive (by variant)”
	Speed	Real	4 bytes	Trigger - rotational speed
	Reference value	Real	4 bytes	Trigger - reference value
	Warning alarm	Real	4 bytes	Limits - warning alarm (relative)
	Damage alarm	Real	4 bytes	Limits - damage alarm (relative)
	Baseline	Real	4 bytes	Limits - baseline in SI unit (m/s², m/s)
Frequency range				
<object name>				
	Value	Real	4 bytes	Object value in SI unit (m/s², m/s, m)
	Status	Byte	1 byte	“(Alarm) state of the object 0: OK 1: Warning alarm 2: Damage alarm 3: Inactive 4: Error (description: see Error)”
	Error	Word	2 bytes	“Error code for object state Hex0000: No fault Hex0001: Internal fault Hex0002: Calculation error Hex0004: Speed out of range Hex0008: Speed not stable Hex0010: Invalid baseline Hex0020: Invalid reference value (1) Hex0040: Invalid reference value (2) Hex0100: Deactivated by signal weighting Hex0200: Reference value out of range Hex1000: Warning alarm Hex2000: Damage alarm Hex8000: Object inactive (by variant)”
	Speed	Real	4 bytes	Trigger - rotational speed
	Reference value	Real	4 bytes	Trigger - reference value
	Warning alarm	Real	4 bytes	Limits - warning alarm (relative)
	Damage alarm	Real	4 bytes	Limits - damage alarm (relative)
	Baseline	Real	4 bytes	Limits - baseline in SI unit (m/s², m/s)

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Input (PLC)					
Source			**Type**	**Size**	**Use**
	Upper/Lower limit monitor				
		<object name>			
		Value	Real	4 bytes	Object value in SI unit (m/s², m/s, m)
		Status	Byte	1 byte	“(Alarm) state of the object 0: OK 1: Warning alarm 2: Damage alarm 3: Inactive 4: Error (description: see Error)”
		Error	Word	2 bytes	“Error code for object state Hex0000: No fault Hex0001: Internal fault Hex0002: Calculation error Hex0004: Speed out of range Hex0008: Speed not stable Hex0010: Invalid baseline Hex0020: Invalid reference value (1) Hex0040: Invalid reference value (2) Hex0100: Deactivated by signal weighting Hex0200: Reference value out of range Hex1000: Warning alarm Hex2000: Damage alarm Hex8000: Object inactive (by variant)”
		Speed	Real	4 bytes	Trigger - rotational speed
		Reference value	Real	4 bytes	Trigger - reference value
		Warning alarm	Real	4 bytes	Limits - warning alarm (relative)
		Damage alarm	Real	4 bytes	Limits - damage alarm (relative)
Counters					
	<counter name>		DINT	4 bytes	Counter value (in seconds)
Alarms					
	<alarm name>		Byte	1 byte	Alarm state (0, 1)
General					
	Variant		Byte	1 byte	Current variant (0...31)
	System mode		Byte	1 byte	“System mode: 0: Self-test 1: Supervise (normal monitoring) 2: Set-up (parameter setting) 3: Measure (spectrum, raw data) 4: Start-up (system booting)”
	Self-test result		Byte	1 byte	“Binary bit pattern 0: Sensors OK 1: Sensor 1 self-test failed 2: Sensor 2 self-test failed 4: Sensor 3 self-test failed 8: Sensor 4 self-test failed”
	Current queue level		Byte	1 byte	Current level of the fieldbus communication
	Queue overflow count		DINT	4 bytes	Overflow counter of the fieldbus communication
	Checksum error counter		DINT	4 bytes	Checksum error counter of the fieldbus communication

Input (PLC)					
Source			**Type**	**Size**	**Use**
Output (PLC)					
External inputs					
	<input name>		Real	4 bytes	Set value of the external input (External_xx)
Objects					
	<object name>				
		Baseline	Real	4 bytes	Limits - set baseline in SI unit (m/s², m/s, m) to adapt the limits
General					
	Variant		Byte	1 byte	Set current variant (0...31)
	Do self-test		Byte	1 byte	Do self-test (≠ 0)
	Set time		DINT	4 bytes	“Set time, always UTC, format: VSE953: U32: 0x00hhmmss”
	Set counter ID		Byte	1 byte	Set ID (1...32) of the counter
	Set counter value		DINT	4 bytes	Set value of the counter selected with the ID (in seconds)

7.3 Register

7.3.1 Device identification register

Address	Access	Length (word)	Requirement	Parameter
39000	R	30	Vendor name	“ifm electronic”
39030	R	20	Product name	"VSE953"
39050	R	2	Production status of the device	"AA"
39052	R	10	Firmware version	"V1.01.04"
39062	R	2	Serial number	Is defined in the production process
39064	R	20	Brief device description	Diagnostic electronics VSE953

7.3.2 Register mapping input (FC4)

Register no.	IEC61131 address	Access	Memory area
30001…30512	%IW0…%IW511	R	Input area

7.4 Input function code

Function code	Parameter
Code 4 (dec)	Read input register

7.5 Register mapping output (FC3, FC6 and FC16)

Register no.	IEC61131 address	Access	Memory area
40001…40512	%QW0…%QW511	r/w	Output area

7.6 Output function code

Function code	Description
Code 3 (dec)	Read holding register
Code 6 (dec)	Write single holding register
Code 16 (dec)	Write multiple holding register

7.7 Exception response

Function code	Name
Code 01	Illegal function
Code 02	Illegal data address
Code 03	Illegal data value
Code 04	Server device failure

7.8 Factory setting VSE953 - Modbus TCP

There is read and write access to the device settings. The following default values are set by the factory:

Requirement	Parameter
IP address	192.168.0.100
Subnet mask	255.255.255.0
Gateway	192.168.0.244
Port	502

7.9 General factory setting

Requirement	Parameter
Parameter set	None
Host name	No name assigned
IP address	192.168.0.1
TCP/IP port	3321
Subnet mask	255.255.255.0
Default gateway	192.168.0.244
MAC address	Is defined in the production process

7.10 Note for programmers

Input registers are marked with 3xxxx and can be read via the Modbus function code 4 (FC4).

Output (holding) registers are marked with 4xxxx.

An individual register can be written via the Modbus function code 6 (FC6), several registers simultaneously via FC16.

The Modbus function code (FC3) allows reading of the output register.

For programming the register access in the Modbus master tools (e.g. PLC) addressing often starts at address "0", depending on the setting of the "Base Addr." also at "1".

The distinction between input and output registers is made via the use of the respective function code.

Examples

- Reading the register 30001 from the device is done in the master tool by querying the address "0" via FC4.
- Reading the vendor name in the register 39000 is done in the master tool by querying the register "9000" via FC4.
- Writing the register 40001 to the VSE953 is done in the master tool by writing to the address "0" via FC6.

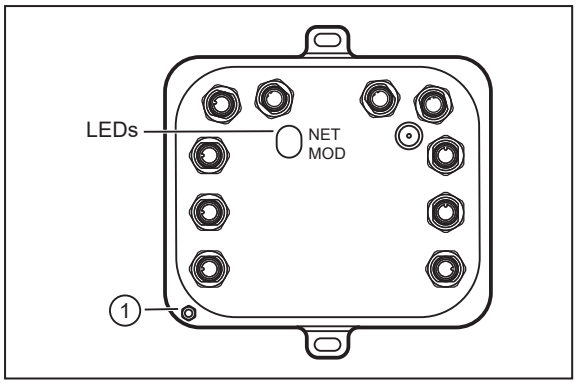
7.11 Parameter setting

The device parameters are set exclusively via the VES004 PC software. All parameters of the configured application are bundled in a parameter set and transferred to the device.

For a detailed description of all parameters and possible configurations we refer you to the VES004 software manual.

8 Operating and display elements

For quick identification of error states, the device has two diagnostic LEDs on the device front.



1: Earthing screw

8.1 Operating states of the network (NET) and mode (MOD) status LED

Designation	Meaning	Colour	State	Description
LED NET	Network status	n.a.	Off	The device is switched off
		Green	Flashing (approx. 2 Hz)	No connection has been established, an IP address was assigned
		Green	On	Device connected to the network
		Red	On	Error on the fieldbus
LED MOD	Modbus TCP/IP status	n.a.	Off	Device is switched off (no voltage supply)
		Green	On	Device functions reliably (normal operation)
		Red	On	Device fault
		Orange	Flashing	Firmware image is loaded to the RAM
		Orange	Flashing	Firmware image is loaded to the flash
		Green	Flashing for 2 s (approx. 2 Hz)	Firmware image has been written correctly to the flash
		Orange	Flashing for 2 s (approx. 2 Hz)	Parameter set was successfully transferred

9 Maintenance, repair and disposal

The operation of the unit is maintenance-free.

Only the manufacturer is allowed to repair the unit.

▶ After use dispose of the device in an environmentally friendly way in accordance with the applicable national regulations.

Cleaning the unit:

▶ Disconnect the unit from the voltage supply.

▶ Clean the unit from dirt using a soft, chemically untreated and dry micro-fibre cloth.