GB

Operating instructions

Diagnostic electronics with Modbus TCP interface for vibration sensors

VSE153

11448194 / 00 03 / 2022

Contents

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 architect 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.
- The design of the unit corresponds to protection class III (EN61010) except for the terminal blocks. Protection against accidental contact (safety from finger contact to IP 20) for qualified personnel is only ensured if the terminals have been completely inserted. Therefore the unit must always be mounted in a control cabinet of at least IP 54 which can only be opened using a tool.
- For DC units the external 24 V DC supply must be generated and supplied according to the requirements for safe extra-low voltage (SELV) since this voltage is provided near the operating elements and at the terminals for the supply of sensors without further protection measures.

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 Sensor 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, VSM, 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

Alternatively, the dynamic inputs can also be used like an analogue input with an analogue current signal (4...20 mA).

The hardware outputs can be configured as 2 x binary (no/nc) or as 1 x analogue (0/4…20 mA) and 1 x 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 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 limits from the PLC to the diagnostic electronics

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 (> 850,000 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. The respective object states per sensor are also indicated via the 4 sensor LEDs.

The system LED displays the operating status of the device.

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/Use the latest 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.

During the firmware update, the parameter set and the history on the device are deleted. All counters are reset.
The IP settings of the configuration and fieldbus interface are retained.

▶ Recommendation: Run a parameter backup before the firmware update.

5 Installation

▶ Mount the unit in a control cabinet with a protection rating of at least IP 54 to ensure protection against accidental contact with dangerous contact voltages and against atmospheric influence.

The control cabinet should be installed in accordance with local and national rules and regulations.

▶ Mount the unit vertically on a DIN rail.

▶ Leave enough space between the unit and neighbouring heat sources and the top or bottom of the control cabinet to enable air circulation and to avoid excessive heating.

▶ Prevent penetration of conductive or other dirt during installation and wiring.

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 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.

▶ During installation, all connector locking mechanisms (screws, coupling nuts) must be firmly tightened in order to ensure the best possible contact between shielding and ground. Before initial start-up, the ground or shielding connection of cables must be checked for low-resistance continuity.

5.2 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.

5.3 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.

Only operate the device when mounted on a grounded DIN rail in order to dissipate electrostatic charges.

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 device, connection via Combicon connectors (pre-mounted).
- ▶ To prevent negative effects on the functions caused by noise voltages, lay sensor cables and load cables separately. Maximum length of the sensor cable: 250 m.
- ▶ Use a screened sensor cable.

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).

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.

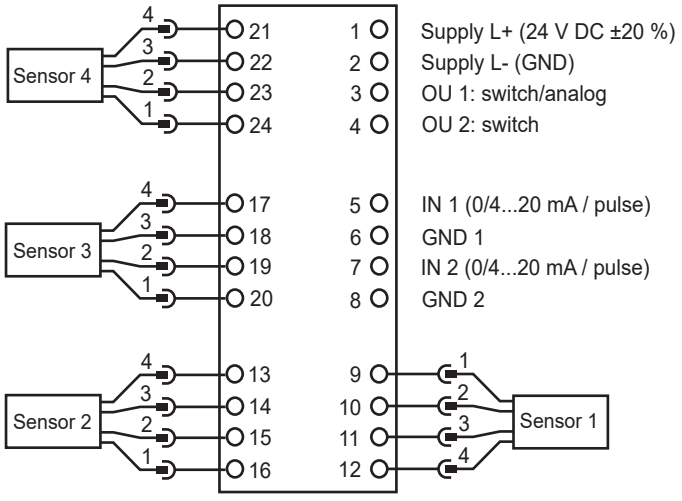
6.1 Connection technology

ATTENTION

Terminal block not connected with connectors.

- ▷ Protection rating IP 20 not ensured.
- ▶ Cover unused terminals with connectors.

6.2 Wiring



Wiring of sensors 1...4 (S1...S4) according to their use

Sensor				VSA	IEPE/VSP	0...20 mA
S1	S2	S3	S4			
09	16	20	24	BN: L+ (+ 9 V)	not connected (n.c.)	not connected (n.c.)
10	15	19	23	WH: Signal	IEPE +	Signal
11	14	18	22	Caption: GND	IEPE -	GND
12	13	17	21	BK: Test	not connected (n.c.)	not connected (n.c.)

Sensor input	**Use**		
S1…S4	VSM		
9,16,20,24	not connected (n.c.)		
10,15,19,23	IEPE x	IEPE y	IEPE z
11,14,18,22	IEPE -		
12,13,17,21	not connected (n.c.)		Test *

* The self-test is only carried out via the Z axis.

▶ Connect both cables to the same terminal of a suitable evaluation unit (e.g. VSExxx).

▷ Terminal 1 Supply L+
When using an IEPE input 24 V + 20% (Integrated Electronics Piezo Electric)

▷ The ground GND of the DC supply is directly connected with the ground GND of the sensor supply. Therefore the SELV criteria have to be met for the DC supply.

▶ Protect the supply voltage externally (max. 2 A).

6.3 Ethernet connection

The RJ45 socket is used for the connection to the Ethernet.

7 Modbus TCP

7.1 Properties

Request	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 Fieldbus parameter data model

Input (PLC)				
Source		**Data type / Byte order / Unit**	**Data size**	**Use**
Dynamic inputs				
	<input name>	• Real or DINT with factor • Big or Little Endian	4 bytes	Value of the signal connected to dynamic input (sensor 1…4) if it has been configured as a “DC input”.
Analogue inputs				
	<input name>	• Real or DINT with factor • Big or Little Endian	4 bytes	Value of the signal connected to the analogue input (IN1, IN2)
External inputs				
	<input name>	• Real or DINT with factor • Big or Little Endian	4 bytes	Value of the external input (External_xx)
Objects (time domain, frequency domain, upper/lower limit monitor)				
	<object name>			
	Value	• Real or DINT with factor • Big or Little Endian • Has a unit (default SI unit)	4 bytes	Object value has a unit

Input (PLC)				
	Status	Byte	1 byte	Current status/state of the object 0: OK 1: warning alarm 2: damage alarm 3: inactive 4: error
	Error	Word	2 bytes	Error codes for description of error in object state 0x0000: no error 0x0001: internal error 0x0002: calculation error 0x0004: speed out of range 0x0008: speed not stable 0x0010: invalid baseline 0x0020: invalid reference value (1) 0x0040: invalid reference value (2) 0x0100: deactivated by signal weighting 0x0200: reference value out of range 0x1000: warning alarm 0x3000: warning and damage alarm 0x8000: object inactive (by variant)
	Rotational speed	• Real or DINT with factor • Big or Little Endian	4 bytes	Trigger - rotational speed
	Reference value	• Real or DINT with factor • Big or Little Endian	4 bytes	Trigger - reference value
	Warning alarm	• Real or DINT with factor • Big or Little Endian	4 bytes	Limit - warning alarm (relative)
	Damage alarm	• Real or DINT with factor • Big or Little Endian	4 bytes	Limit - damage alarm (relative)
	Baseline	• Real or DINT with factor • Big or Little Endian • Has a unit (default SI unit)	4 bytes	Limit - unit-based baseline for time and frequency objects Note: This parameter is not applicable for the upper/lower limit monitor objects
Counter				
	<counter name>	• DINT • Big or Little Endian	4 bytes	Counter value (in seconds)
History				
	<object name>			

Input (PLC)				
	History value	• Real or DINT with factor • Big or Little Endian • Has a unit (default SI unit)	4 bytes	Unit-based current history entry of the object
	Average value of the history	• Real or DINT with factor • Big or Little Endian • Has a unit (default SI unit)	4 bytes	Unit-based average value of the current history entry of the object
	Speed of the history	• Real or DINT with factor • Big or Little Endian	4 bytes	Trigger - speed of the current history entry of the object
	Reference value of the history	• Real or DINT with factor • Big or Little Endian	4 bytes	Trigger - reference value of the current history entry of the object
	Input counter of the history values	• DINT • Big or Little Endian	4 bytes	Counter of the received history entries of the object
Alarms (OUT1 / OUT2)				
	<alarm name (OUT1)>	• Float or DINT with factor • Big or Little Endian	4 bytes	Configuration as analogue alarm output: value of alarm output
		Byte	1 byte	Configuration as digital alarm output: alarm state Configuration as NC No alarm: 1 Alarm: 0 Configuration as NO No alarm: 0 Alarm: 1
	<alarm name (OUT2)>	Byte	1 byte	Alarm state Configuration as NC No alarm: 1 Alarm: 0 Configuration as NO No alarm: 0 Alarm: 1
Alarms (IO1 - IO8)				
	<alarm name>	Byte	1 byte	Alarm state Configuration as NC No alarm: 1 Alarm: 0 Configuration as NO No alarm: 0 Alarm: 1
General				
	Variant	Byte	1 byte	Value of the active variant (0...31)

Input (PLC)				
	System mode	Byte	1 byte	Current system mode of the device 0x00: reserved 0x01: supervise (normal monitoring) 0x02: set-up (parameter setting) 0x03: measure (spectrum, raw data) 0x04: start-up (system booting) 0x05: self-test (self-test active)
	Self-test result	Byte	1 byte	Bit pattern Bit1 - sensor 1 Bit2 - sensor 2 Bit3 - sensor 3 Bit4 - sensor 4 Note on evaluation 0x00: Sensors OK 0x01: sensor 1 self-test failed 0x02: sensor 2 self-test failed 0x04: sensor 3 self-test failed 0x08: sensor 4 self-test failed 0x0F: sensor1…4 self-test failed
	Current queue level	Byte	1 byte	Current queue level of the internal device communication
	Queue overflow counter	• DINT • Big or Little Endian	4 bytes	Overflow counter of the internal device communication
	Checksum error counter	• DINT • Big or Little Endian	4 bytes	Checksum error counter of the internal device communication
	Read time	DINT	4 bytes	Read device time (UTC) PROFINET devices: U32:0x00ssmmhh EtherNetIP devices: U32:0x00hhmmss EtherCAT devices: U32:0x00hhmmss MODBUS devices: U32:0x00hhmmss
Placeholder				
	<placeholder>	Byte	xx byte	Placeholder for fieldbus transmission

Output (PLC)			
Source	Data type / Byte order / Unit	Data size	Fieldbus representation

Output (PLC)				
External inputs				
	<input name>	• Real or DINT with factor • Big or Little Endian	4 bytes	Set value of the external input (External_xx)
Objects (time domain, frequency domain)				
	<object name>			
	Baseline	• Real or DINT with factor • Big or Little Endian • Has a unit (default SI unit)	4 bytes	Limits - set unit-based baseline for time and frequency objects to adjust damage limits
General				
	Variant	Byte	1 byte	Set current variant (0...31)
	Do self-test	Byte	1 byte	Execute self-test Note A value change from 0 to ≠ 0 starts the self-test After completion of the self-test, the unit automatically switches to the “Monitoring” system mode
	Set time	DINT	4 bytes	Set time (always UTC format) PROFINET devices: U32:0x00ssmmhh EtherNet/IP devices: U32:0x00hhmmss EtherCAT devices: U32:0x00hhmmss MODBUS devices: U32:0x00hhmmss
	Set counter ID	Byte	1 byte	Set the ID of the counter (1…32)
	Set counter value	• DINT • Big or Little Endian	4 bytes	Set value of the counter selected with the ID (in seconds)
Placeholder				
	<placeholder>	Byte	xx byte	Placeholder for fieldbus transmission

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	"VSE153"
39050	R	2	Production status of the device	“AA”
39052	R	10	Firmware version	“V1.0.0”
39062	R	2	Serial number	Is defined in the production process
39064	R	20	Brief device description	Diagnostic electronics VSE153

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

7.7.1 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 VSE153 is done in the master tool by writing to the address "0" via FC6.

8 Factory setting

8.1 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

8.2 Factory setting VSE153 - Modbus TCP

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

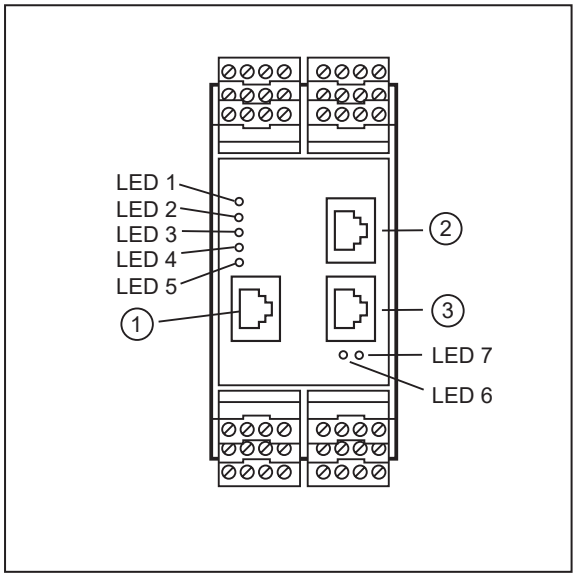
Requirement	Parameter
IP address	192.168.0.100
Subnet mask	255.255.255.0
gateway	192.168.0.244
Port	502

9 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.

10 Operating and display elements



1: Config: TCP/IP, IP address 192.168.0.1 (factory setting), parameter setting and data interface (e.g. VES004)
2: IE 1: Modbus TCP
3: IE 2: Modbus TCP

10.1 LEDs for sensors

LED 1 for sensor 1 LED 4 for sensor 4	
Green on	sensor connected and parameterized
Green flashing	Sensor with set parameters Type VSA: Sensor not connected or faulty Type IEPE: Sensor not connected
Yellow on	Warning
Red on	damage alarm
Green/yellow flash alternately	Teach process active
Yellow/red flash alternately	no parameter set loaded

10.2 Operating states for the status LEDs on the industrial Ethernet ports 1 and 2

VSE153 has two industrial Ethernet ports (RJ45 sockets) with one integrated link and activity LED each.

Designation	**Colour**	**State**	**Description**
Link	Green	on	Connection present at port 1/2
	Green	Off	Connection not present at port 1/2
Activity	Yellow	flashes	Data transfer at port 1/2
	Yellow off	No data transmission at port 1/2	Device functions reliably (normal operation)

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

Designation	Meaning	Colour	State	Description
LED 6 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 7 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 error
		Orange	flashes	Firmware image is loaded to the RAM
		Orange	flashes	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

11 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.