

FAG



FAG SmartCheck

High process security by means
of decentralised machinery monitoring

SCHAEFFLER

Foreword

Reducing maintenance costs

Increasing competition leads to increased cost pressures and drives companies to reduce their maintenance costs. It is therefore vital to avoid unplanned downtime and maximise machinery lifetime. In expensive plant in the steel and paper industries, for example, rolls and the associated bearing arrangements have therefore been fitted for many years with complex and costly continuous online monitoring systems.

In the case of standard machinery such as pumps, motors and gearboxes, continuous monitoring is often not applied since an affordable online solution has not been available so far.

Low purchase costs

FAG SmartCheck is a cost-effective, innovative online measuring system for the continuous monitoring of machine and process parameters on a decentralised basis. It offers the performance features of expensive systems but is compact in design, easy to fit and simple to use.

The system can be expanded on a modular basis at any time. Where requirements change, retrofitting can also be carried out at any time.

Alliance with Mitsubishi

Schaeffler is one the partners in the e-F@ctory Alliance established by Mitsubishi Electric Corporation. The companies represented in this initiative are market leaders in their respective industries.

The e-F@ctory Alliance offers the customer the best possible complete solutions for automation projects. In this way, the overall costs of production and maintenance can be reduced.

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FAG SmartCheck

- Features** FAG SmartCheck is an innovative online system that can be used on numerous machines.
- FAG SmartCheck has numerous advantageous features including:
- condition monitoring and diagnosis of rolling bearings and machinery by a single device
 - small dimensions
 - robust design
 - cost-effective solution
 - intuitive operation
 - expandable
 - preconfigured system
 - comprehensive information on the condition of machinery taking account of process parameters such as:
 - load
 - speed
 - temperature
 - condition of machinery shown at a glance in the Web browser
 - information available on the long term development of machine condition by means of the integrated data memory
 - interfaces for connection to a control station or controller
 - reliable alarm system by means of automated alarm threshold adjustment
 - direct system access via Ethernet and Web browser
 - protected data by means of a multistage access concept
 - free of charge app for smartphones.

- Operation and communication** FAG SmartCheck can be used easily and on an intuitive basis by means of two capacitive keys.
- Due to the software FAG SmartWeb integrated in the device, it can be accessed via a Web interface using any standard browser.
- FAG SmartCheck includes an implementation of the communication protocol SLMP from Mitsubishi. This protocol allows direct transfer of information on the status of components such as rolling bearing damage, imbalance or misalignments. This information can be outputted by the controller, for example on operator terminals in the form of text.

The device can be connected via analogue and digital interfaces to, for example, a controller or control station, *Figure 1*.

- ① Status LED, red, yellow, green
- ② Membrane key, alarm reset
- ③ Membrane key, activate teach mode
- ④ Interface:
Ethernet, power supply PoE
- ⑤ Interface:
power supply
- ⑥ Interface:
inputs and outputs, analogue and digital



Figure 1
LEDs, keys and interfaces

Function

FAG SmartCheck is ready for immediate use as soon as it is delivered. The integrated characteristic value set allows general, reliable monitoring.

For more precise monitoring, a component template stored in the device can be selected for applications such as fans or pumps. The component template is filled with the component data. The device has an integrated rolling bearing database containing data for FAG and INA standard bearings. The user can add further rolling bearings to the database at any time.

Depending on the component template selected, certain parameters can be adjusted, such as:

- bearing type
- number of fan blades
- gear teeth
- belt lengths.

For adjustment of the component template, the user is supported by software wizards. The characteristic value set thus generated allows highly precise monitoring of the machine.

FAG SmartCheck

- Configuration** With one FAG SmartCheck, it is possible to monitor several components of a machine at the same time. For example, all seven bearings in a compressor can be monitored using a single device. Several component templates are simply combined in an overall configuration for the machine to be monitored. This configuration can be copied to any number of FAG SmartCheck devices required.
- Monitoring** Vibrations and process parameters such as speed and temperature are determined and correlated.
- Alarm system** The automatic alarm threshold adjustment allows a reliable alarm system. An alarm is indicated immediately by an LED on the device. The alarm can be transmitted to the control station by means of interfaces. A free of charge app can convert any smartphone into an alarm receiver on a WLAN network, *Figure 2*.



Figure 2
Smartphone as alarm receiver

Application

The device detects damage to a wide variety of machines at an early stage. A selection is shown in *Figure 3*.

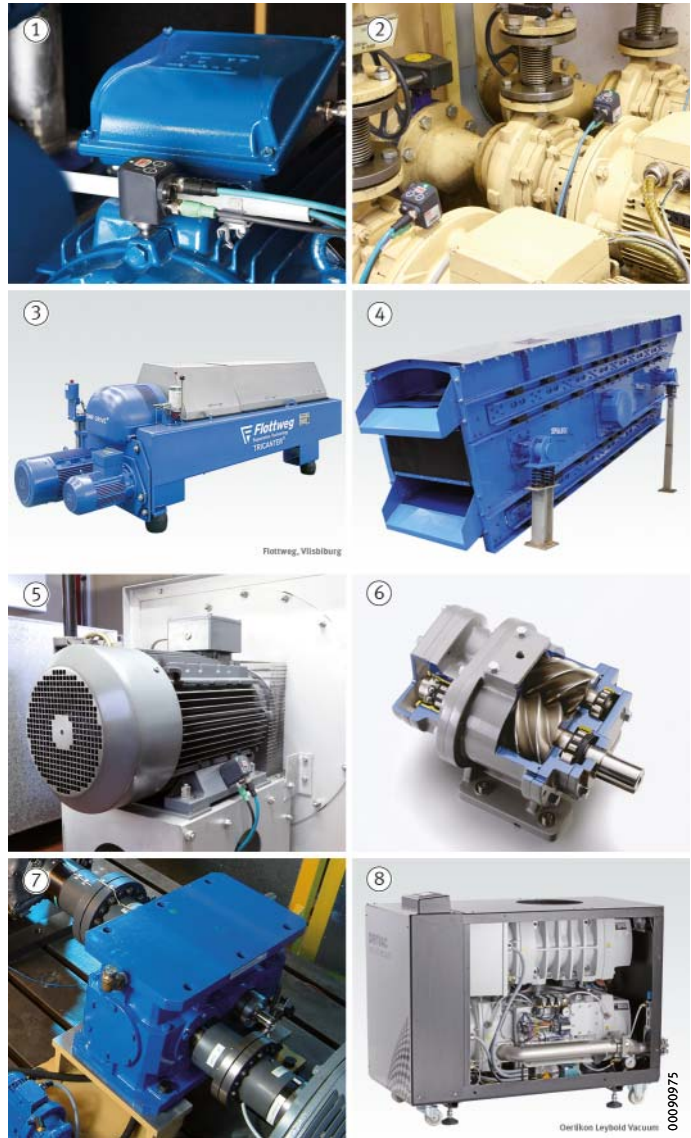


Figure 3
Equipment subjected to monitoring

FAG SmartCheck

Standard templates The standard templates in FAG SmartCheck detect the following damage:

- rolling bearing damage
- unbalance
- misalignment
- impacts.

Expanded monitoring The user can apply the standard templates for monitoring. He also has the option of using templates for specific equipment. FAG SmartCheck analyses the signals, compares these with the data from the template and, in this way, can detect the damage patterns and their cause. A typical example of this is bearing damage.

However, not all damage detected can be automatically allocated by FAG SmartCheck. Some damage patterns are very complex and must be analysed by an expert. Examples are shown in the table.

Templates for specific machines

Machine	Expert detection of
Electric and geared motors	Winding damage and loose rotor bars
Vacuum and fluid pumps	Wear and cavitation
Ventilators and fans	Blade and vane rotational frequencies
Compressors	Operation outside specification
Gearboxes	Tooth set damage
Separators and decanters	Cavitation, floating unbalance between screw and drum
Vibrating screens	Settling of screen mats, loose springs, spring breakage

Concept Monitoring using FAG SmartCheck can be carried out in three stages. In the first stage, individual machines are monitored on a decentralised basis. If the user selects the second stage, the device is intelligently integrated in the machine controller. In the third stage, the service is provided from a single source by an external service provider. This can include remote access via an Internet connection as well as advice and other services, *Figure 4*.

- ① Decentralised machinery and process monitoring
- ② Intelligent process integration
- ③ Service from a single source

Figure 4
Multistage concept



Decentralised machinery and process monitoring

Installation and cabling of FAG SmartCheck is a simple process. The device is ready for immediate use. Data can be accessed directly from the device.

Intelligent process integration

Intelligent process integration is the option of communication via interfaces. During communication, data and information are exchanged with, for example, a controller or a database agent.

Service from one source

The Web interface for FAG SmartCheck allows remote access to measurement data via an Internet connection. Monitoring can thus be outsourced to an external service provider.

FAG SmartCheck

Software FAG SmartCheck can be configured using FAG SmartWeb, FAG SmartUtility light or FAG SmartUtility.

Functional scope

Function	SmartWeb	SmartUtility light	SmartUtility
Display characteristic value status	●	●	●
Display system information	●	●	●
Display measurement data	●	●	●
Display trend	●	●	●
Select component templates	●	●	●
Configure inputs and outputs	●	●	●
Configure and activate validator	●	●	●
Configure and activate trigger	●	●	●
Configure user administration	●	●	●
Display input signals in real time	●	●	●
Configure TCP/IP settings	●	●	●
Update firmware	●	●	●
Download and save data	●	●	●
Manage all FAG SmartCheck devices in the network	–	●	●
Analyse data	–	–	●
Load and send configurations	–	–	●
Create measurement report	–	–	●

FAG SmartWeb Each FAG SmartCheck includes the integrated software FAG SmartWeb. The IP address of a device is indicated in a Web browser and the device can then be directly accessed. A typical example is the use of a single FAG SmartCheck device.

FAG SmartUtility light The PC software FAG SmartUtility light is free of charge and is included in the scope of delivery. The scope of performance corresponds to that of FAG SmartWeb, but a list of IP addresses of all connected FAG SmartCheck devices is displayed, so a device can be selected quickly and easily. Manual input of the IP address is thus unnecessary. A typical example is the use of several FAG SmartCheck devices.

The use of this software requires a Windows PC, see the hardware requirements in the table, page 18.

FAG SmartUtility The paid-for PC software FAG SmartUtility allows unrestricted access to all the functions in FAG SmartCheck. It is thus possible to configure several devices at the same time. Saved configurations can be loaded and, for example, sent to other locations. Furthermore, data can be analysed and all FAG SmartCheck devices in the entire network can be managed. Typical applications are in central management of production machinery at all sites or the analysis of data for which, however, substantial expert knowledge is necessary.

The use of this software requires a Windows PC, see the hardware requirements in the table, page 18.

Data analysis

FAG SmartCheck offers extensive possibilities for analysing measurement data and assessing the condition of the machine being monitored.

The following general characteristic values are determined from the acceleration and acceleration envelope signal:

- ISO 10816
- RMS, broadband
- peak-to-peak value.

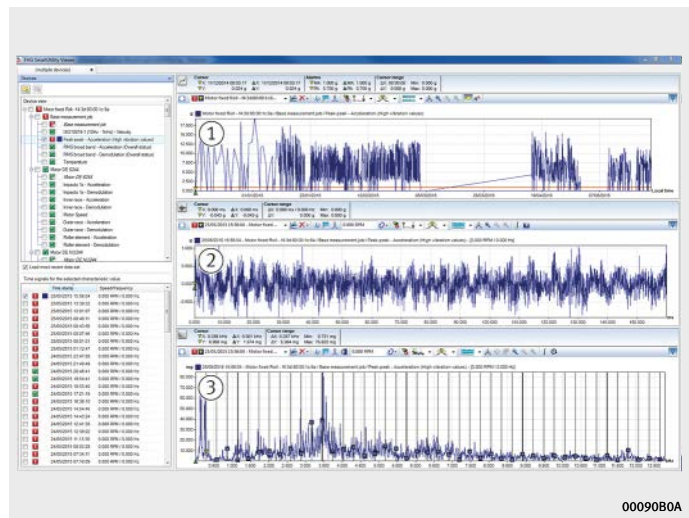
FAG SmartCheck does not, however, only calculate the general characteristic values. In addition, the component templates integrated in the device offer frequency-selective monitoring matched to various components.

Characteristic patterns in components such as shafts, belt pulleys or fan wheels indicate incipient damage at an early stage. The device provides time signals that can be displayed using the Viewer function. This analysis tool is part of the software FAG SmartUtility and allows experts to analyse the time signals, *Figure 5*.

In conjunction with process parameters such as temperature, load or speed, it is possible to make precise statements relating to the damage progress and draw conclusions about the reason for failure.

- ① Trend
- ② Time signals
- ③ Frequency spectrum

Figure 5
FAG SmartUtility,
user interface for analysis



FAG SmartCheck

Presentation of trends

Presentation of trends is a simple and authoritative presentation of characteristic values. A change in the vibration behaviour can be detected at a glance. Even slight changes are visible in the trend pattern and simultaneous presentation of several trends allows particularly precise analysis, *Figure 6*.

- ① Trend to ISO 10816
- ② Trend in bearing monitoring

Figure 6
Several trends shown simultaneously

In-depth analysis

For this analysis, the Viewer function in FAG SmartUtility is used. The Viewer function offers numerous tools that assist the experienced user in carrying out analysis.



Alarm threshold adjustment

In the delivered condition, FAG SmartCheck uses preset alarm thresholds. The vibrations in a machine are decisively influenced by the specific operating condition. In order to adjust the alarm thresholds to match the specific machine, FAG SmartCheck has an automatic teach mode.

The user must start the teach mode at the time of commissioning. The associated vibration value is then measured and allocated for each operating condition of the machine. Based on the measurement data for vibrations and process values, FAG SmartCheck determines the correct alarm thresholds itself. The dependence of vibrations on several process values is also taken into consideration. If the teach mode is not started directly at the time of commissioning, it can be activated at any time using the keys on FAG SmartCheck or by means of FAG SmartWeb. The teach mode can be applied as many times as required.

As soon as sufficient measurement data are available, FAG SmartCheck automatically substitutes the newly determined alarm thresholds for the preset values.

If the machine is operated in different operating modes, it may be advisable to define a separate alarm threshold for each operating mode. A signal is created at the analogue or digital input. This signal indicates the operating mode of a machine parameter. The teach mode is automatically terminated when sufficient values have been determined. If one or more operating modes (in this case speed ranges) are achieved only rarely, the teach mode will correspondingly take longer. Two signals can be created if two machine parameters are to be taken into consideration.

FAG SmartCheck

Measurement report

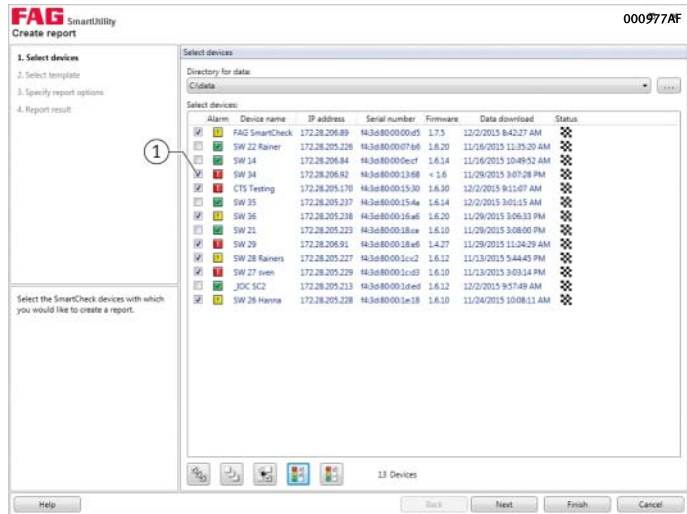
The user can create measurement reports with the software FAG SmartUtility. A measurement report is based on the measurement data determined and can contain the following information:

- device information
- alarm status
- trend data
- logbook.

All these types of information are contained in the standard templates.

Selecting a device

A report may contain the data from one or more FAG SmartCheck devices. When the menu item “Create report” is selected, a list is shown of the devices from which data have been downloaded. The user can select the device or devices whose measurement values are to be outputted in the form of a report. Selected devices are marked by means of a tick, *Figure 7*.



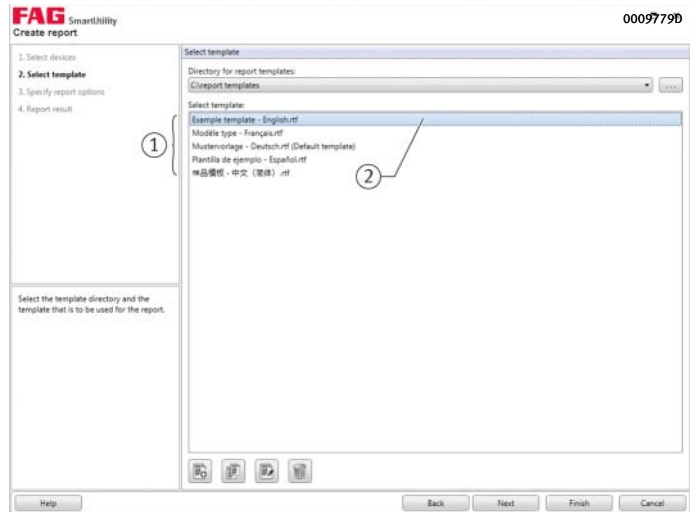
① Devices selected

Figure 7
Device selection

Selecting a template

A template will define the content and form of the report. The templates for reports are available in the same languages as the software, see page 17. The templates can be used immediately, *Figure 8*. Existing templates can also be modified and then saved as new templates.

The file format for measurement reports is RTF, a widely used exchange format for text. The templates can be edited with any software that can read and write RTF.

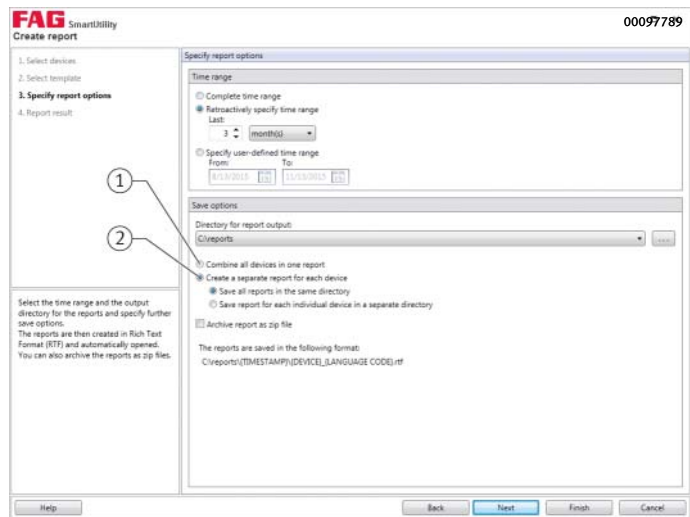


- ① List of templates
- ② Selected template

Figure 8
Templates

Defining report options

The report is created for the data that were measured and generated by the device in the selected time period. If the menu item “Create separate report for each device” was selected, a separate report will be created for each device selected, *Figure 9*.



- ① One report for all selected FAG SmartCheck devices
- ② One report for each FAG SmartCheck device

Figure 9
Options

FAG SmartCheck

- Service** Schaeffler offers extensive services ranging from strategy development through commissioning to remote monitoring.
- Commissioning** In partnership with the customer, the suitable monitoring strategy is determined, devices are mounted and reference measurements are carried out.
- Training courses** Employees are trained as a function of their prior knowledge and requirements. The training course covers the operation of FAG SmartCheck, the use of the software and the integration of the device in networks.
- Operation** We are pleased to offer our experience at any time. For example, our experts can assist in the assessment of measurement results. If the measurement results indicate any damage, they can provide advice on further action.
- Remote monitoring** If the necessary expert knowledge is not available or trained employees are not present on site, remote monitoring may be advantageous, *Figure 10*.



Figure 10
Remote monitoring
with data evaluation by Schaeffler

If Schaeffler is tasked with remote monitoring, the customer receives regular reports on the machine condition and recommended actions for improving plant availability. If FAG SmartCheck detects incipient damage, the customer is informed immediately. Repair can then be planned and replacement parts sourced in good time.

Further information can be found at www.FAG-SmartCheck.com or by simply contacting us.

FAG SmartCheck

FAG SmartCheck	
Features	Description
Size (W×H×D)	44 mm×57 mm×55 mm
Mass	≈ 210 g
Housing material	Glass fibre reinforced plastic
Mounting foot material	High alloy steel 1.4301
Location	Screw M6
	Contact surface on the machine: ∅ 25 mm
Protection class	IP 67
MTBF ¹⁾	78,9 years (EN/IEC 61709)
Power supply	DC 16 V to DC 32 V
	Power over Ethernet (in line with IEEE 802.3af; Mode A is supported)
Maximum power consumption	200 mA at 24 V
Ambient temperature	-20 °C to +70 °C
Internal operating temperature	-20 °C to +85 °C
Operating system	Embedded Linux
Software (languages: German, English, Chinese, Spanish, French)	FAG SmartWeb (recommended: Windows XP: Internet Explorer 7, Firefox 16; Windows 7: Internet Explorer 8, Firefox 16)
	FAG SmartUtility light

¹⁾ Mean time between failures of electronic components in FAG SmartCheck.

Interfaces	
Features	Description
Control elements	2 keys for teach mode, alarm reset, restart, default settings
Display elements	1 LED for status and alarm display
	1 LED for confirmation of keys
	2 LEDs for communication display
Communication	Ethernet 100 MB/s
Electrical connections	3 polarity protected M12 push-fit connectors for power supply, analogue and digital inputs and outputs, Ethernet

Memory	
Features	Description
Program and data memory (compression algorithm)	64 MB RAM, 128 MB Flash

Piezoelectric accelerometer	
Features	Description
Frequency range	0,8 Hz to 10 kHz
Measurement range	±50 g

Measurements	
Features	Description
Measurement functions	Acceleration, velocity and displacement by integration
	System temperature and process parameters such as speed, load, pressure via external signals or sensors
Diagnostic methods	Time signal, envelope curve
	Speed and frequency tracking
	Spectrum and trend analysis
Characteristic values in time and frequency range	Defined characteristic values: DIN ISO 10816
	Calculated characteristic values: RMS, frequency-selective RMS, DC, peak, peak-to-peak, crest factor, condition guard
Special features	Other user-defined characteristic values are possible

FAG SmartCheck

Signal processing	
Features	Description
Frequency resolution	1 600 lines, 3 200 lines, 6 400 lines, 12 800 lines
Measurement accuracy	24 Bit, A/D converter
Frequency range	0,8 Hz to 10 kHz
Low pass filter	50 Hz to 10 kHz Stages: 50 Hz, 100 Hz, 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz
High pass filter, envelope curve only	750 Hz, 1 kHz, 2 kHz
Special features	Other filters available by agreement

Inputs and outputs	
Features	Description
Inputs	2 analogue inputs, 12 Bit, frequency range 0 Hz to 500 Hz:
	Voltage: 0 V to 10 V, 0 V to 24 V
	Input resistance: 10 k Ω
	Current: 0 mA to 20 mA, 4 mA to 20 mA
	Input resistance: 500 Ω
1 pulse input:	0 V to 30 V, 0,1 Hz to 50 kHz
Outputs	1 analogue output, 12 Bit:
	Voltage: 0 V to 10 V
	Minimum load resistance: 1 000 Ω
	Current: 0 mA to 20 mA, 4 mA to 20 mA
	Maximum load resistance: 250 Ω
1 switching output:	Open collector, max. 1 A, 30 V
Special features	Electroplated separation of inputs and outputs and electroplated separation of the power supply for inputs and outputs

Accessories	
Ordering designations	Description
SMART-CHECK.CONNECT-BOX	Connection box: Power supply and distribution of additional signals
SMART-CHECK.LAMP	Lamp: Display of alarm status for FAG SmartCheck
SMART-CHECK.CONTROL	Compact controller: Capture and distribution of additional signals to a maximum of 25 FAG SmartCheck devices
SMART.VISUAL	PC software: Visualisation of FAG SmartCheck
SMART-CHECK.CABLE-POW-P-M12-OE-10M	Power supply cable: 10 m, 8 pin, M12 socket on free connection end
SMART-CHECK.CABLE-ETH-P-M12-RJ45-10M	Ethernet cable: 10 m, M12 plug on RJ45
SMART-CHECK.CABLE-IO-P-M12-OE-10M	Input/output cable: 10 m, 8 pin, M12 socket on free connection end
Special features	Other accessories available by agreement

Software	
Ordering designations	Description
SMART.UTILITY	Paid-for PC software for system management and analysis

System requirements for the use of FAG SmartUtility and FAG SmartUtility light	
Features	Description
System architecture	Windows 7
Processor speed	1 GHz or faster
RAM (minimum)	2 GB (recommended 4 GB)
Screen resolution	At least 1024 \times 768, font size normal
Free space on hard disk	40 MB
Browser	Internet Explorer from Version 10, Mozilla Firefox from ESR 38

FAG SmartCheck

Product variants	
Ordering designations	Description
SMART-CHECK	FAG SmartCheck including Web interface, FAG SmartWeb and PC software, FAG SmartUtility light
SMART-CHECK-STARTER-KIT	1×FAG SmartCheck with accessories (starter configuration, cable and basic manual) ¹⁾
SMART-CHECK-KIT-010	1×FAG SmartCheck with comprehensive accessories (mounting material for any mounting situation, basic manual, cable, CD-ROM, plug-in power supply unit and transport case) ²⁾
Special features	Other product variants available by agreement

- ¹⁾ Particularly suitable for gaining experience with FAG SmartCheck on simple monitoring tasks. Further information on the starter kit, commissioning, teach mode and handling an alarm as well as tips on integration in networks can be found at www.fag-smartcheck.de in the section Videos.
- ²⁾ This kit is particularly suitable for service applications in which FAG SmartCheck is used on unfamiliar machinery.

Services	
Ordering designations	Description
SMART-CHECK-SERVICE-001	Preparation of an application-specific or equipment-specific monitoring strategy in consultation with the customer
SMART-CHECK-SERVICE-002	Preparation of a monitoring configuration based on templates for FAG SmartCheck
SMART-CHECK-SERVICE-005	Mounting and commissioning of FAG SmartCheck
Special features	Other services available by agreement

Product overview Accessories

Visualisation software

SMART.VISUAL



Connection box Lamp

SMART-CHECK.CONNECT-BOX



SMART-CHECK.LAMP



Compact controller

SMART-CHECK.CONTROL



Accessories

- Features** The options available with FAG SmartCheck can be expanded by means of accessories.
- Software** By means of the software FAG SmartVisual, the status of several FAG SmartCheck devices can be displayed on the PC. Each user can create an individual display by hierarchy-based linking of individual views.
- Connection box** The FAG SmartConnectBox can be used to distribute voltage and additional signals such as load or speed to a maximum of four FAG SmartCheck devices. The industrial grade housing (IP66) has standard connectors for cables connecting to the FAG SmartCheck accessories. The FAG SmartLamp and an inductive or optical speed sensor can also be connected. The FAG SmartConnectBox and the standard configurations of FAG SmartCheck are matched to each other. No settings or adjustments by the user are necessary.
- Lamp** The FAG SmartLamp gives an optical display of the highest alarm status of the FAG SmartCheck connected by cable to the connection box: green (= no alarm), yellow (= pre-alarm) and red (= main alarm). The FAG SmartCheck is supplied with prior configuration that allows the FAG SmartLamp to be commissioned directly for operation.

Accessories

Compact controller The FAG SmartController distributes analogue and digital additional signals to a maximum of 25 FAG SmartCheck devices, *Figure 1*. It captures the condition of all connected FAG SmartCheck devices and transmits the highest alarm status via the combined alarm function. In combination with a PoE switch, only one cable is required per FAG SmartCheck device.



Figure 1
FAG SmartController

- Inputs** The FAG SmartController has four analogue inputs. Switching between these is by means of the display. The following measurement ranges can be set: 0 V to 10 V, -10 V to +10 V, 0 mA to 20 mA and 4 mA to 20 mA. In addition, eight digital inputs are available.
- Display** The display allows configuration of the FAG SmartController. The implemented monitor function ensures simple installation and function testing. The display changes its background colour as a function of the system status between white, green, yellow and red. This gives the user a rapid overview of the system status.
- Modbus TCP server** For incorporation in local field bus systems, the FAG SmartController has an integrated Modbus TCP server. This server can receive additional signals directly from the equipment controller. In addition, the server can read out the alarm status of each connected FAG SmartCheck.

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