rexroth
A Bosch Company

Operating instructions

OPEX®

Electronic torque wrench

3 842 899 013 / 0 609 xxx xxx

ENGLISH

3 842 892 017, version: 2024-09, replaces: 2024-04, EN

The data specified above serve to describe the product. Should information be provided on use, these are only examples of applications and suggestions. Properties given as information in the catalog are not assured. The information given does not release users from the obligation to exercise their own judgment and verification. Our products are subject to a natural wear and aging process

The cover shows an example application. The delivered product may therefore differ from the product which is pictured.

The original manual was written in the German language.

DE Die Betriebsanleitung OPEX® ist als PDF-Datei zum Download aus dem Medienverzeichnis verfügbar:
www.boschrexroth.com/medienverzeichnis
Geben Sie in die Suchmaske (oben rechts, unter „**Suche**“) **3 842 892 000** ein, dann klicken Sie auf „🔍“.

EN The OPEX® operating instruction is available as a PDF file for download from the media directory:
www.boschrexroth.com/en/us/download-center
Enter **3 842 892 017** in the search mask (top right, under "**Search**") then click on "🔍".

FR Le manuel d'utilisation OPEX® est disponible sous forme de fichier PDF à télécharger à partir du répertoire des médias :
www.boschrexroth.com/medienverzeichnis
Saisissez dans le masque de recherche (en haut à droite, sous "**Recherche**") **3 842 892 018** puis cliquez sur "🔍"

IT Le istruzioni per l'uso sono disponibili in formato PDF e possono essere scaricate dalla Media Directory:
www.boschrexroth.com/medienverzeichnis
Inserire nella maschera di ricerca (in alto a destra, sotto "**Ricerca**") **3 842 892 019**, quindi fare clic su "🔍".

ES Las instrucciones de servicio de OPEX® están disponibles en formato PDF para su descarga en el directorio de medios:
www.boschrexroth.com/medienverzeichnis
Introduzca en la pantalla de búsqueda (arriba a la derecha, en "**Buscar**") **3 842 892 020** o y haga clic en "🔍".

PT As instruções de operação estão disponíveis como arquivo PDF para download no diretório de mídia:
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Digite na máscara de pesquisa (canto superior direito, em "**Pesquisar**") **3 842 892 021** e, depois, clique em "🔍".

ZH OPEX®操作说明以PDF文件形式提供,可从以下媒体目录下载 **www.boschrexroth.com/medienverzeichnis**
在搜索界面(右上角,“**搜索**”下方)输入**3 842 892 045**,然后单击“🔍”。

Contents

1 About this documentation

1.1 Validity of the documentation

This documentation is valid for the following product:

- Electronic torque wrench OPEX®

This documentation is intended for fitters, operators, maintenance and service personnel.

This documentation contains important information on the safe and appropriate installation, transport, operation, maintenance and removal of the product and on simple troubleshooting.

▶ Read this documentation completely, especially the chapter "Safety instructions" on page 9 before working with the product.

1.2 Required documentation

The following additional documentation, marked with the book symbol 📖, must be available to you and observed by you before you start using the product:

Tab. 1: Required documentation

	Title	Document no.	Document type
📖	Operating Instructions OPEXwin®	**3 842 892 002**	Operating Instructions
📖	Safety Instructions OPEX®	**3 842 892 001**	Safety Instructions
📖	OPEX® EC Declaration of Conformity	**3 842 892 016**	EC Declaration of Conformity

[1] Download at: **www.boschrexroth.com/medienverzeichnis**

1.3 Display of information

Uniform safety instructions, symbols, terms and abbreviations are used in this documentation to enable you to work quickly and safely with this product. To give you a better understanding they are explained in the sections below.

1.3.1 Safety Instructions

Safety instructions appear in this documentation before a series of actions in which there is a risk of personal injury or material damage. The risk avoidance measures described must be observed.

Safety instructions are set out as follows:

⚠ SIGNAL WORD

Type and source of danger

Consequences of noncompliance

- ▶ Measure for avoiding risk
- ▶ ...

- **Warning sign:** draws attention to the hazard
- **Signal word:** identifies the degree of the danger
- **Type and source of danger:** names the type and source of the hazard
- **Consequences:** describes what occurs if the risk avoidance measures are not complied with
- **Precautions:** Indicates how to avoid the danger

The safety instructions contain the following hazard classes.
The danger class describes the risk of noncompliance with the warning.

Tab. 2: Danger classes as per ANSI Z535.6

Warning sign, signal word	Meaning
⚠ DANGER	Identifies a dangerous situation that will result in death or serious injuries if it is not avoided.
⚠ WARNING	Identifies a dangerous situation that may result in death or serious injuries if it is not avoided.
⚠ CAUTION	Identifies a dangerous situation that may result in minor to moderate injuries if it is not avoided.
NOTICE	Material damage: The product or the environment may be damaged.

1.3.2 Symbols

The following symbols mark notes that are not safety-relevant but which increase understanding of the documentation.

Tab. 3: Meaning of the symbols

Symbol	Meaning
	If you do not observe this information, you will not be able to operate the product optimally.
▶	Single, independent step
1. **2.** **3.**	Numbered instruction: The numbers specify that the steps are completed one after the other.
• ... • ...	Listing format

1.3.3 Safety symbols on the device (as per national specifications)

Symbol	Meaning
	WEEE 2 symbol: The product must not be disposed of with household waste
	Read and observe the Operating Instructions
	CE Declaration of Conformity
	UK Conformity Assessed
	Canadian Standards Association test mark
	China Compulsory Certification test mark
	Eurasian Conformity mark
	Regulatory Compliance Mark (RCM)
	KC Mark Korea Certification
	NOM-ANCE mark
	IRAM conformity mark
	ICT certification logo
	SIRIM certification mark
	Symbol for protective grounding

1.3.4 Symbols on the packaging

Symbol	Meaning
	International recycling symbol
	Fragile goods
	Protect from moisture
	Protect from heat

Symbol	Meaning
	This side up (do not turn)
	Adhesive tape with the following inscription: **Vorsicht! Hochempfindliche Elektrogeräte!** **Caution! Highly sensitive electronic equipment!**

1.3.5 Designations

This documentation uses the following designations:

Tab. 4: Designations

Abbreviation	Meaning
IO	OK (measured value)
NIO	Not OK (measured value)
M	Torque
φ	Rotation angle

2 Safety instructions

2.1 About this chapter

The product has been manufactured in accordance with the generally accepted rules of current technology. Nevertheless, there is a risk of personal injury and material damage when using the product if you do not observe this chapter and the safety instructions and warnings in this documentation.

- ▶ Read this documentation completely and thoroughly before working with the product.
- ▶ Keep this documentation in a location where it is accessible to all users at all times.
- ▶ Always pass the product on to third parties together with the necessary documentation.

2.2 About this chapter

The product has been manufactured in accordance with the generally accepted rules of current technology. Nevertheless, there is a risk of personal injury and material damage when using the product if you do not follow the instructions in this and the above documentation.

Risk of personal injury and material damage:

- ▶ Read the safety instructions and the operating instructions thoroughly and completely before installing, commissioning or maintaining the product.
- ▶ Store documents such that they are accessible to all users at all times.
- ▶ Always pass the product on to third parties together with the safety instructions and the installation instructions.

2.3 Intended use

The OPEX® electronic torque wrench is intended only for tightening and checking screw connections. Any other use or use beyond this is considered improper. No liability will be accepted for resulting damage.

Intended use also includes the regular inspection and servicing of the product.

The product is intended for commercial use and not for private use.

Only authorized, qualified persons are permitted to use the product.

Intended use also includes ensuring that you have read and understood the required documentation (see “"Required documentation", page 6) in full.

2.4 Improper use

Any use other than that described as intended use shall be considered as improper and is therefore impermissible.

Bosch Rexroth AG shall accept no liability whatsoever for damage resulting from improper use. The user shall bear all risks arising from improper use.

Improper use of the product includes:

- The use of socket tubes on the tool.
- Operation in a non-commercial area.
- Operation of the product in a wet environment.

2.5 Personnel qualifications

The activities described in this documentation require basic mechanical and electrical knowledge, as well as knowledge of the associated technical terms. To guarantee safe use, these activities are only to be performed by suitable personnel or by persons who have been given instruction under the supervision of a qualified specialist.

A qualified specialist is somebody who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant regulations associated with the work to be done. Qualified personnel must observe the rules relevant to the subject area.

Instructed personnel have been given instruction by the operator or by another qualified person in the tasks assigned to him and possible risks resulting from improper conduct.

The operator is responsible for ensuring that his personnel are given proper instruction.

Personnel must be given regular instruction by the operator. Keep a log of instruction given for better tracking.

Personnel being trained, for instance trainees or temporary employees, are not familiar with all risks that can occur when operating the OPEX®. Work may only be performed with the OPEX® under the supervision of qualified or instructed persons.

2.6 General safety instructions

- Observe the applicable accident prevention and environmental protection regulations.
- Observe the safety regulations and provisions of the country in which you are using/operating the product.
- Only use products of Bosch Rexroth AG when they are in good technical order and condition.
- Observe all notes on the product.
- Persons who install, operate, remove or maintain products of Bosch Rexroth AG must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
- Only use accessories and spare parts that are approved by the manufacturer.
- Comply with the technical data and ambient conditions specified in the product documentation.
- Check the product for obvious transport damage.
- Keep unauthorized persons away from the work area and suspend work so long as unauthorized persons are in the work area.
- Never attempt to modify the design of the product.
- Wear suitable protective equipment (e.g. safety shoes) when working with the product.

2.7 Product- and technology-dependent safety instructions

General

- Do not attempt to modify the design of or convert the product.
- Do not expose the product to any mechanical loads under any circumstances. Do not place any objects on it.

IT security

- The OPEX® should only be operated in a secure internal network. Note the usual requirements for IoT devices on a secure IT corporate network.
- During commissioning, change the default passwords documented in the manual.
- Set up the WLAN in accordance with the IT security concept. Do not use unencrypted WLAN

Transport and storage

- Please comply with the transport instructions given on the packaging.
- During storage and transportation, always maintain the ambient conditions specified in the Operating Instructions.

During commissioning

- Allow the product to acclimatize for a few hours before commissioning as condensation could otherwise precipitate in the housing. In the event of condensation, the unit may only be switched on after a waiting period of approx. 12 hours.
- Only commission a product that is completely installed and parameterized.
- Make sure that the product has no signs of damage.
- Make sure that all safety equipment belonging to the product is present, properly installed and fully operational.
- Check the product for malfunctions.

During operation

- Make sure that only qualified and authorized personnel perform work with the product.
- Exercise caution when working! Always assume that a screw connection could suddenly come loose.
- Work in such a way that nobody is put at risk even if the tool slips.
- Make sure that any inserts used (sockets, ratchets, etc.) show no signs of damage, that they are properly fitted and that their operation is checked.
- When working with the product, comply with all operational instructions issued by the system operator and all safety instructions and equipment on site.

During cleaning

- Do not allow cleaning agents to ingress into the product.
- Never use solvents or aggressive detergents. Only clean the product using a slightly damp, lint-free cloth. Only use water and, if necessary, a mild cleaning agent that is also suitable for TFT screens.
- Do not use a high-pressure cleaner for cleaning.

During maintenance and repair

- Perform the specified maintenance work at the intervals stated in the Operating Instructions.

During disposal

- Dispose of the product according to the national regulations of your country.

2.8 Safety equipment

- When using the product, utilize all relevant safety equipment on the system on which work is being performed with the product. Only perform work with the product following the prior instruction of the operator.

2.9 Personal protective equipment

- As the operator, you are responsible for using suitable protective equipment when working with the product (e.g. wearing safety shoes). All components of the personal protective equipment must be intact.
- While working with the product, wear the necessary protective equipment:
  - Wear safety shoes to prevent injury from falling parts or tools.
  - Wear safety goggles if parts can be expected to chip or if there is a risk of eye injury if you slip.
  - Use protective gloves and clothing to protect yourself, for example if you slip.
- Follow the specific national regulations regarding PPE.

3 Delivery contents

Included in the delivery contents:

- Electronic torque wrench OPEX® (further equipment as per configuration)
- USB-C to USB-A data cable
- OPEX® Safety instructions
- The following products and documents are available for download at www.boschrexroth.com/en/us/download-center:
  - OPEX® Operating Instructions
  - OPEXwin® Windows® software with operating instructions

Please note:

▶ Check the product for visible transport damage on arrival.

▶ Immediately report any transport damage to the delivering agent.

3.1 Unpacking

1. Remove the packaging and dispose of packaging materials such as foil and adhesive tape properly.
   Keep the original packaging for possible re-transportation.
2. Check the delivery for completeness based on the order.
3. Check the contents of the packaging for visible transport damage.
   In the event of transport damage or discrepancies between the contents of the packaging and the order, report these immediately to Bosch Rexroth AG.
4. Keep all documents supplied.

3.2 Optional accessories

Examples of available accessories (refer to media directory for further accessories):

- 21700 lithium-ion battery
- WLAN wireless module (see section 3.2.1, page 13)
- Charging cradle with charger (see section 3.2.3, page 14)
- Rubber protective cover (see section 3.2.4, page 15)
- Transport case (see section 3.2.5, page 16)

3.2.1 WLAN wireless module

An optional plug-in WLAN wireless module is available for the OPEX®. (This can be removed from the tool and inserted into another tool).

The wireless module allows data communication via a TCP connection. The OPEX® can act as both a client and a server. If required, a device server can also be used as the opposite side for conversion into a serial signal, for example.

3.2.2 Internal barcode scanner

All common 1D and 2D barcodes can be scanned with the optional barcode scanner that can be integrated in the tool. The barcode may consist of ASCII numbers ("0" to "9") and ASCII letters ("a" to "z" and "A" to "Z").

A maximum of 40 characters is possible.

Examples of barcodes

3.2.3 OPEX® charging cradle

Fig. 1: OPEX® with charging cradle

An optional charging cradle is available for the OPEX®. This serves as a safe storage position when not in use, as well as an intermediate charging option for continuous operation.

The following components are supplied:

- Charging cradle (aluminum profile with plastic tool base, charging contacts, port for plug-in power supply unit)
- Device feet
- Plug-in power supply with AC adapter set
- Snap-on ferrite

⚠ CAUTION

Risk of electric shock and short circuit

Electrostatic charge can cause restrictions in the operation of the OPEX® or an electric shock or short circuit.

▶ Perform grounding using a standard-compliant grounding cable at the ground terminal of the charging tray.

Risk of injury due to incorrect batteries or incorrect use

The use of batteries that have not been approved by the manufacturer or charging batteries that are not rechargeable can cause injury due to overheating, explosion and toxic vapors escaping.

▶ Do not attempt to recharge non-rechargeable batteries.

▶ Do not place the measuring tool on the charging tray if non-rechargeable batteries are in use.

▶ Only use type 21700 rechargeable batteries with a corresponding safety circuit which have been approved by the manufacturer.

NOTICE

Use of incorrect accessories

Using incorrect accessories can cause failure and damage to the OPEX®.

▶ Only use the charger and accessories supplied with the charging tray.

▶ To safely dissipate electrostatic discharge, use the grounding connection of the charging cradle to connect the grounding cable.

Please note:

To prevent the battery of the OPEX® from discharging completely, the tool should be placed on the charging cradle regularly after use.

Charging cradle features

- Defined storage option for the screwdriving tool
- Charging function for the battery of the attached screwdriving tool
- Suitable for the relevant size (30 - 800 Nm)
- Device feet
- Universal mounting option thanks to aluminum profile with groove 8

Charging cradle voltage supply

Fig. 2: OPEX® plug-in power supply with AC adapter set for charging cradle

Included in the delivery contents:

- Mean Well GE24I09-P1J (9 VDC / 2.22 Amax.) plug-in power supply
- Würth Elektronik 74271733 snap-on ferrite

3.2.4 OPEX® rubber protective cover

An optional protective cover for the OPEX® is available to provide mechanical protection for the housing and to prevent damage to the screw point (e.g. damage to the paintwork).

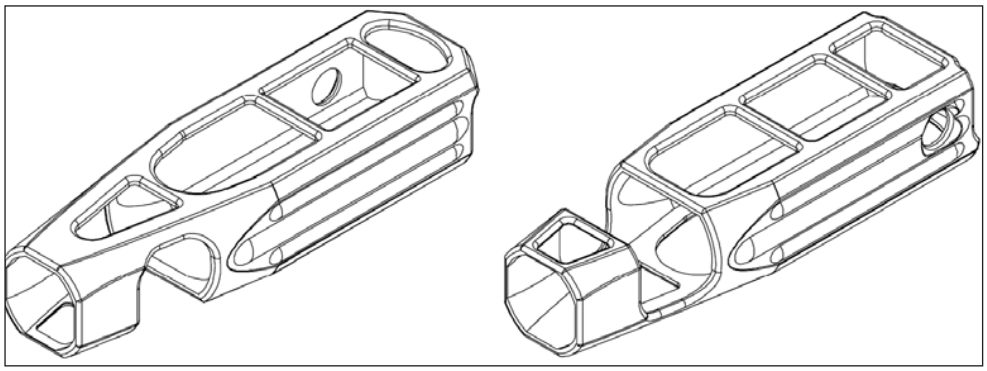


Fig. 3: OPEX® rubber protective cover

The protective cover is pulled over the measuring head from the front over the wrench. Make sure that the larger recess for the charging cradle and the barcode scanner is located on the underside.

Mechanical adjustment of the charging cradle is not necessary after retrofitting the rubber protective cover.

Protective cover features

- Protective function for the tool and all surfaces in the vicinity of the screwdriving point
- Suitable for all sizes (30 - 800 Nm)
- Free from paint-repellent substances
- High resistance to oils and fuels
- Suitable for use with the optional shelf with integrated charger

3.2.5 Transport case

For safe transportation of the OPEX®, a transport case lined with the appropriate foam inserts is available as an option. This can also be used for shipping the tool.

Fig. 4: OPEX® Transport case

Please note:

The case may be damaged during shipping.

- ▶ When shipping the transport case, always use the original packaging used on delivery.

4 Product description

4.1 Performance description

The OPEX® torque wrench has the following features:

- Torque ratings: 30/60/100/200/300/400/600/800 Nm (for measuring ranges, see "Technical data", page 87)
- Interchangeable square drive system for insertion tools
- Measuring head can be swiveled by ± 60°
- Torque control
- Angle control
- Yield point control
- Audit functions for checking pre-tightened screw connections
- Internal end value memory
- Communication protocol for external controller
- Wireless data transmission by WLAN [1)]
- Tray with integrated charger[1)]

[1)] Optional

4.2 Device description

The OPEX® electronic torque wrench is a microprocessor-controlled hand tool that can be used to assemble and check screw connections using various methods. The following screwing methods are possible with the OPEX®:

- **Torque method:**
  Tightening the connection to a preset torque value.
- **Rotation angle method:**
  Tightening the connection to a preset rotation angle value, whereby the rotation angle is recorded from a preset torque (joining torque).
- **Yield point method:**
  Determination of the torque gradient ΔM / ΔØ to determine the material yield point.
- **Prevail torque method:**
  Dynamic determination of the residual torque of pre-tightened bolted connections at the expected transition to sliding friction after breaking loose.
- **Release/tighten method:**
  Dynamic determination of the residual torque of pre-tightened rundowns after the screw has been loosened and re-tightened to the initial angle.

The integrated USB interface allows connection to a Windows-compatible computer.

In conjunction with OPEXwin® Windows software, it is possible to conveniently create, manage and read out parameters and results data.

Mains-independent operation for up to 8 hours, simple handling and versatility allow the torque wrench to be used in laboratory operations, quality control, production, maintenance and repair.

The optional WLAN interface enables connection to a controller/process control system via various protocols.

4.3 Tool overview

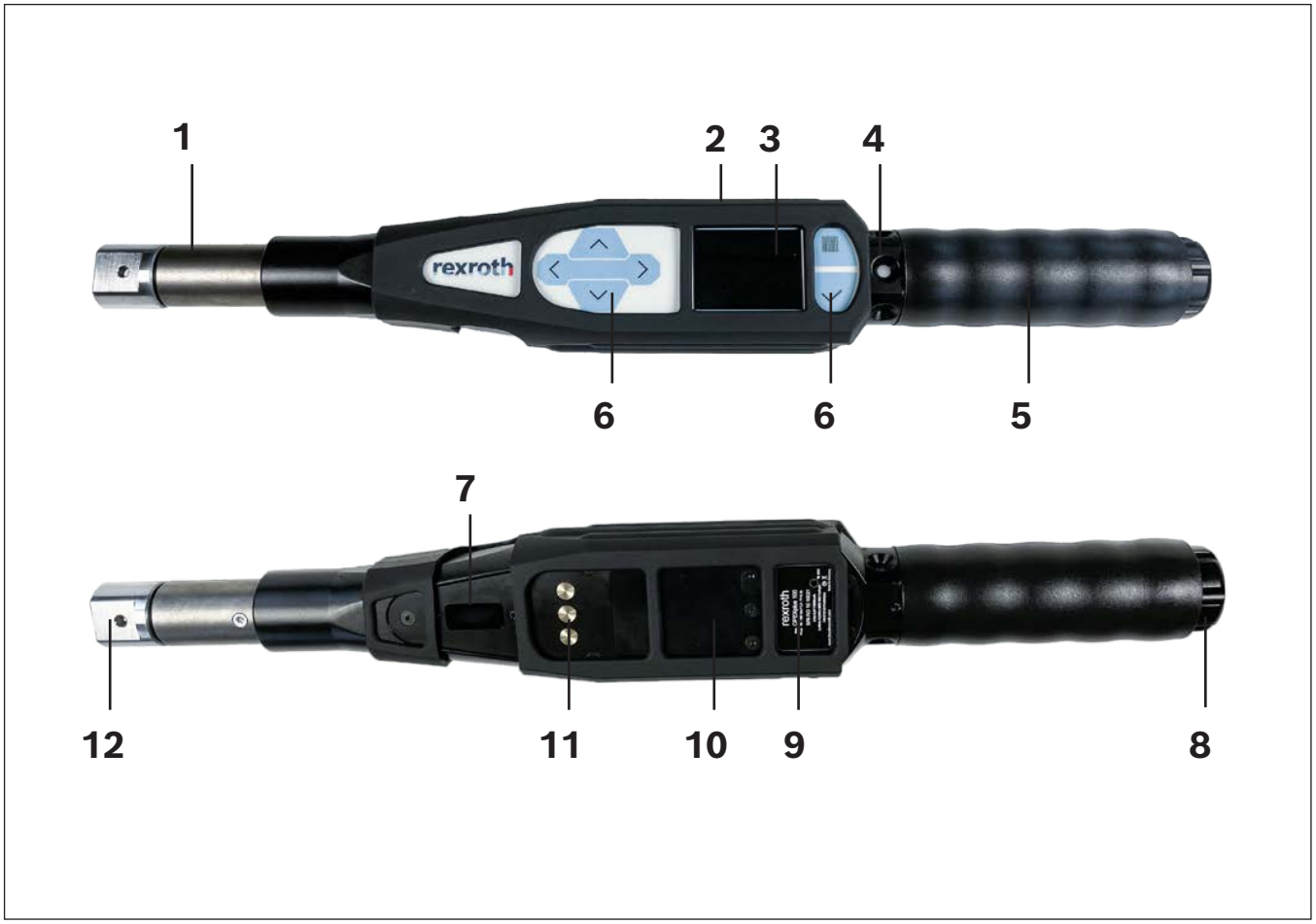


Fig. 5: Overview of OPEX® torque wrench

1	Measuring head for torque measurement
2	USB-C connection with FT230XQ-T chip as virtual COM port for tool communication [11)]
3	TFT display
4	LED ring
5	Handle for tool guidance
6	Membrane keys
7	Barcode scanner
8	Battery cap for exchangeable battery
9	Name plate
10	Inspection flap for wireless module
11	Charging contacts
12	Square drive for mounting output

[1)] Download the current driver at https://ftdichip.com/drivers/vcp-drivers/

4.4 Identification of the product

A name plate with the most important information about the tool is attached to the back of each tool. Please keep this information to hand at all times if you have any queries about this tool.

1 Barcode scanner
2 Name plate

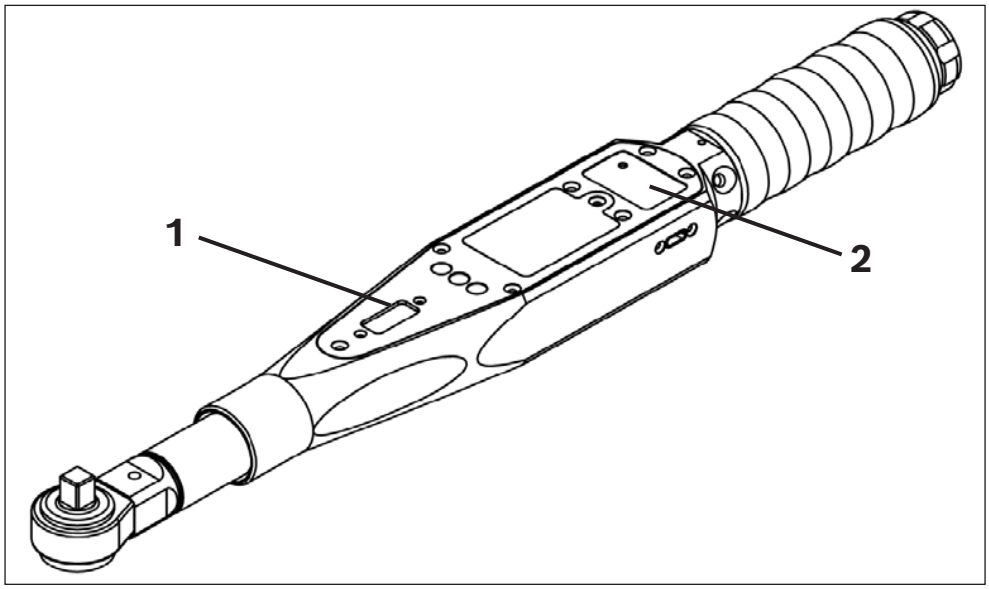


Fig. 6: Position of type plate on the product

1 Manufacturer logo
2 Type designation
3 Rated torque
4 Rexroth 2D code
5 Designation of origin
6 Company address
7 Safety and conformity symbols
8 Battery information
9 Rated frequency
10 Rated voltage
11 Serial number
12 Production date
13 Material number

Fig. 7: Name plate, example

5 Transport and storage

NOTICE

Incorrect storage/transport

Incorrect storage or faults during transportation can damage the tool.

- ▶ Despite its robust structure, the components installed are sensitive to strong vibrations and impact. For this reason, you should protect the torque wrench against severe loads during transportation.
- ▶ Only use the original packaging for shipping. Shipping the torque wrench in any other packaging that the original packaging will invalidate any guarantee/ warranty entitlement.
- ▶ During transportation in cold climatic conditions or extreme temperature fluctuations, make sure that no humidity (condensation) can precipitate in the torque wrench.

5.1 Lifting, setting down and transporting the product

- Observe the transport instructions on the packaging (see "Symbols on the packaging", page 8).
- Transport weight: see delivery documents.
- Always maintain the specified ambient conditions during storage and transportation, see "Storing the OPEX® torque wrench", page 20.
- Keep the original packaging so that you can reuse it when transporting the device again.

5.2 Storing the OPEX® torque wrench

- The batteries must be removed from the OPEX® for longer periods of storage.
- For long-term storage (in the case of replacement batteries), the cells should have a state of charge of approx. 30% ±15%.
- Store the batteries in a dry place, not above 30 °C.
- Charge the batteries for one hour every 6 months. Fully charge the batteries before use after a long period of storage.

6 Commissioning

6.1 Initial commissioning

⚠ CAUTION

Improper handling and lack of space.

There is a risk of injury if the required working equipment and/or components are located too close.

- ▶ Select the place of installation of the OPEX® such that the necessary room for movement is guaranteed and any danger to third parties is ruled out.
- ▶ Make sure that the product has been correctly installed by qualified personnel (see "Personnel qualifications", page 10) before commissioning the product.
- ▶ Only activate the functions needed.

NOTICE

Operational malfunctions due to faulty commissioning

The product can be damaged and the service life can be adversely affected.

- ▶ Commissioning requires basic mechanical and electrical knowledge.
- ▶ The product may only be commissioned by qualified personnel (see "Personnel qualifications", page 10).

- Only commission the product if all safety equipment on the system you are working on is installed and ready for operation.
- Only commission a completely installed product.
- Comply with all safety regulations and safety equipment of the system on which you are working with the OPEX®.
- Keep a commissioning log.

Proceed as follows for initial commissioning:

1. Check the OPEX® for visible damage and correct function before using it. Eliminate any faults found or have them rectified by authorized qualified personnel. The OPEX® may only be operated if it is in perfect condition.
2. Check the charge status of the battery and recharge it if necessary.
3. Switch on the torque wrench.
4. If necessary, install the OPEXwin® parameterization software on the PC (see operating instructions for the OPEXwin® software)
5. Set up the connection from OPEX® to the system control or PC via the USB port or WLAN (see "Installing the OPEXwin® parameterization software", page 22)
6. Make all the settings required for use on the OPEX® (see "Parameterization and measurement", page 43)
7. Configure the OPEX® (see "OPEX® tool configurations", page 57).
8. Assemble the required tools.

ENGLISH

6.2 Checking and charging the battery

Before using the torque wrench, the charge status of the battery must be checked to avoid deep discharge.

If necessary, charge the battery (see

6.3 Switching the torque wrench on/off

See "Switching the tool on / off", page 75.

6.4 Installing the OPEXwin® parameterization software

The installation of the software is described in the OPEXwin® operating instructions.

6.5 Connecting the torque wrench to the process control system

6.5.1 IEEE 802.11a/b/g/n WLAN radio transmission system

Depending on the configuration, the OPEX® hand tool can be optionally equipped with an xPico 240 WLAN module.

This module forms a bridge in the tool between the WLAN TCP stack and the internal serial UART interface of the tool. Therefore, all communication between the tool and the process control system takes place in serial form via this one interface on a TCP port.

The xPico 240 can be integrated directly into the process control system via the TCP stack. The WLAN parameters are permanently stored in the WLAN module, i.e. the tool is always permanently assigned to a controller or a master PC.

As an alternative to the TCP direct connection, an additional WLAN base station can also be used, which provides a PC-type interface with RS232 or USB (adapter required for USB).

If the serial interface of the optional base station is used (RS232 or USB), the following interface parameters must be used:

- Baud rate: 9600 baud
- Number of stop bits: 1
- Number of start bits: 1
- Parity: None
- Number of data bits: 8
- Protocol: No protocol
- Handshake: No handshake

If the existing WLAN infrastructure is not to be used, this base station can also be equipped with its own access point. (TCP direct connection using the Ethernet cable interface of the access point is also possible via this additional access point).

6.5.2 Structure of the radio link

In order for a radio link to be established, the corresponding WLAN base station or WLAN infrastructure must be switched on before switching the tool on and must be within the tool's reception range.

6.5.3 Installing and replacing the wireless module

See "Installing and replacing the wireless module", page 84.

6.5.4 xPico 240 WLAN module configuration

Network interfaces and default settings

The xPico 240 module offers two independent WLAN interfaces. It is possible to establish a connection to the module via the internal access point or to connect the module to a WLAN infrastructure. The interface for the access point ap0 is independent of the interface for the infrastructure connection wlan0. The interfaces are configured as follows as standard:

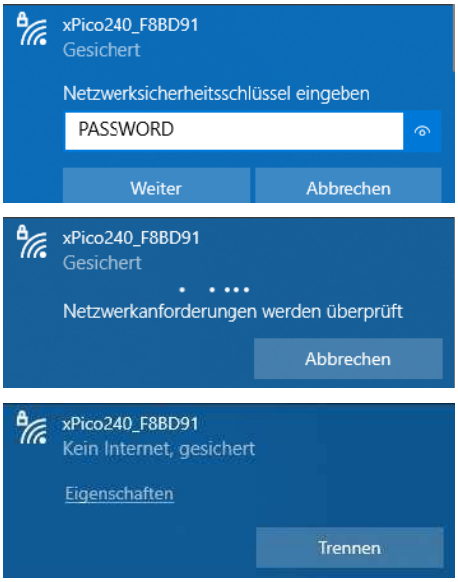
- ap0
  - IP address: 192.168.0.1
  - Subnet mask: 255.255.255.0
  - SSID: xPico_XXXXXX
  - DHCP server: active
  - WPA key: PASSWORD
  - Web interface user: admin
  - Web interface password: PASSWORD
  - WLAN channel: 1
- wlan0
  - IP address: DHCP / Dynamic

Please note:

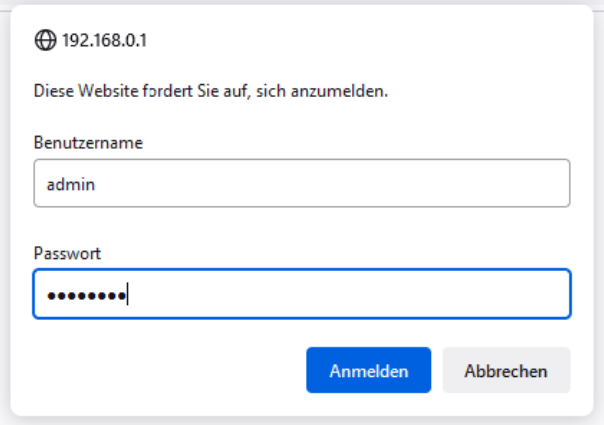
The module provides a TCP server and a TCP client. By default, the TCP server is activated on port 4002.

Establishing a connection to the web interface

1. Switch on the wrench with the integrated xPico 240 WLAN module.
   After a few seconds, the SSID of the module's internal access point becomes visible. The standard format of the SSID is **xPico_XXXXXX,** where the last 6 digits correspond to the serial number of the module.
2. Use the WPA key "PASSWORD" to establish a connection to the internal access point.



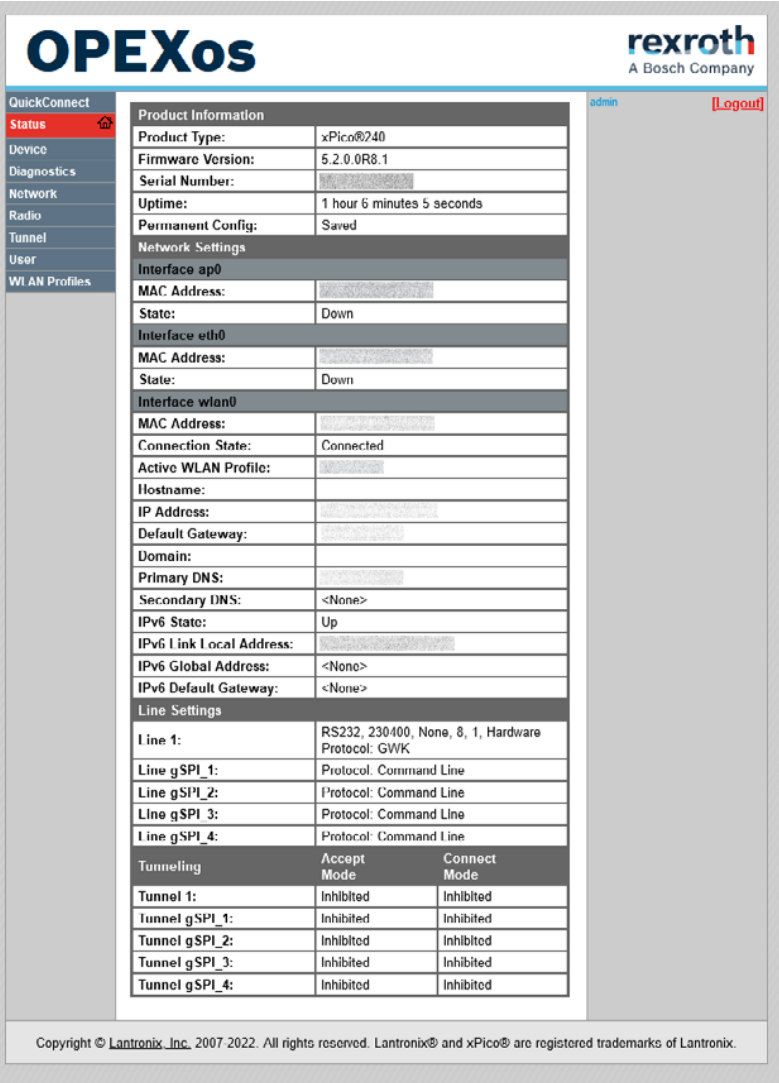
3. Start a browser and call up the URL http://192.168.0.1.
4. Log in with the user name "admin" and the password "PASSWORD".



You should now be logged into the web interface.

Configuration via the web interface

After logging in, the status display is selected. You can return to the status display by clicking on the **Status** button.

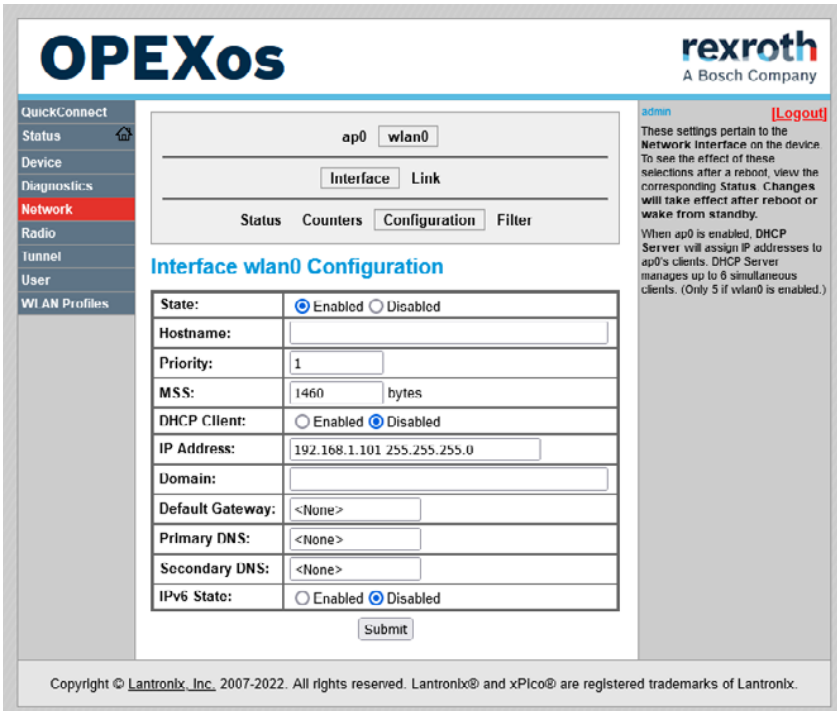


Configuring network

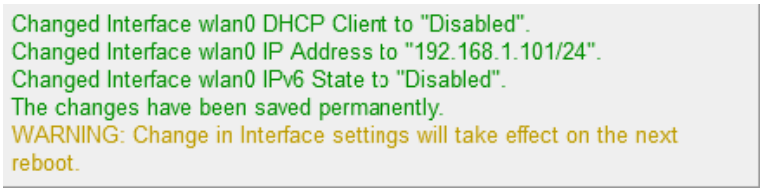
Two independent WLAN interfaces are available for WiFi connections. As a rule, a connection via an external central WLAN infrastructure with the wlan0 interface is used in the industrial sector.

Proceed as follows:

1. In the web interface, click on the **Network** button on the left.
2. Select the network interface **ap0** or **wlan0**.
3. Make the settings under **Interface → Configuration**.
4. Confirm the new setting with the **Submit** button.



In this example, the static IP address 192.168.1.101 with the subnet mask 255.255.255.0 was set for wlan0.

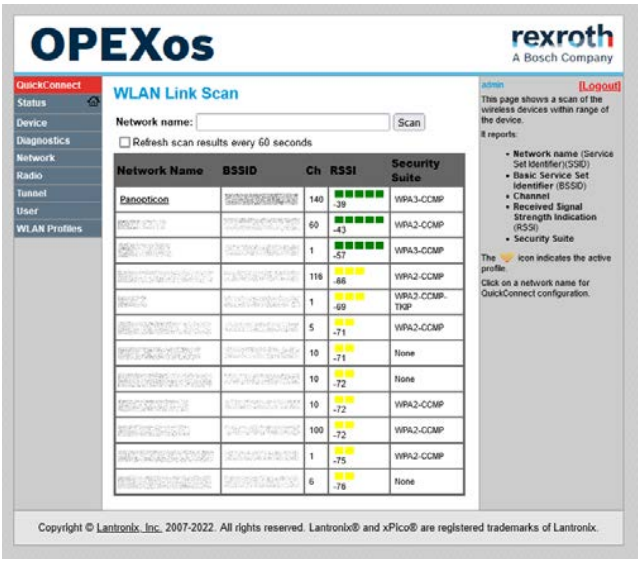


The new network settings are applied the next time the module is restarted.

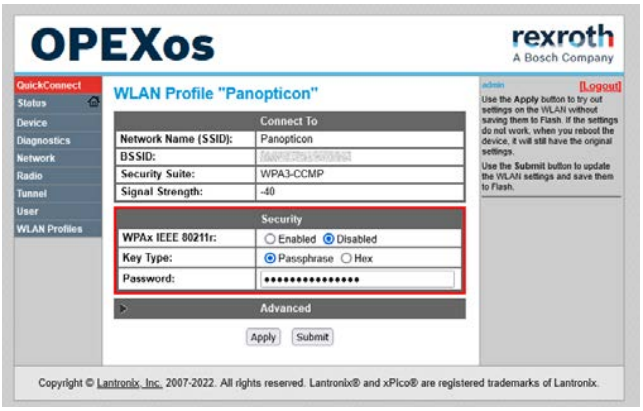
Connecting to a WiFi network

Proceed as follows:

1. In the web interface, click on the **QuickConnect** button on the left.
2. Click on the SSID with which the connection is to be established.

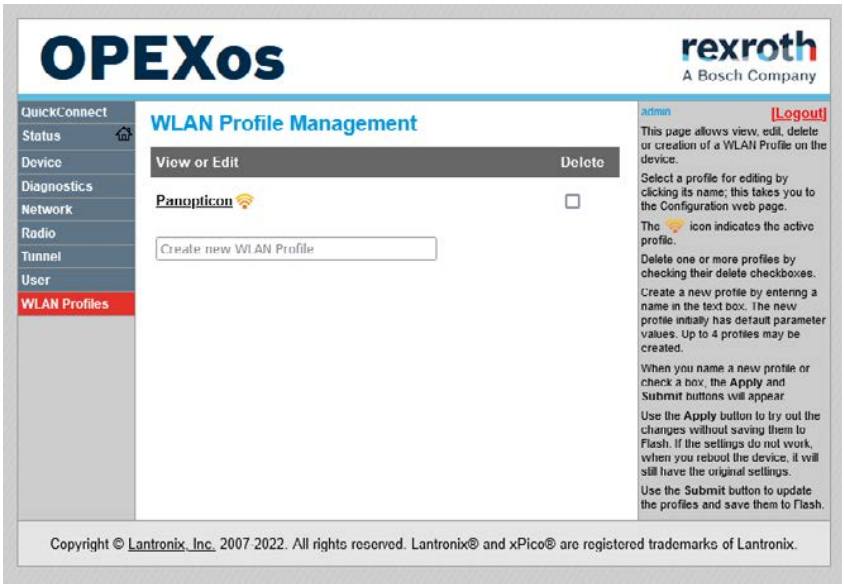


3. Enter the WPA key and confirm with the **Submit** button.



Changed WLAN Profile New_Profile Instance to "GWK_2_4_GHZ_Demo".
Changed WLAN Profile New_Profile Basic Network Name to "GWK 2,4 GHZ Demo".
Changed WLAN Profile New_Profile Security Suite to "WPA2".
Changed WLAN Profile New_Profile Security WPAx Passphrase to "<Configured>".
The changes have been saved permanently.

4. In the web interface, click on the **WLAN Profiles** button on the left to display the WLAN profiles that have been set up.



The icon shows the WLAN profile to which the module is actively connected.

Configuring the TCP server and client

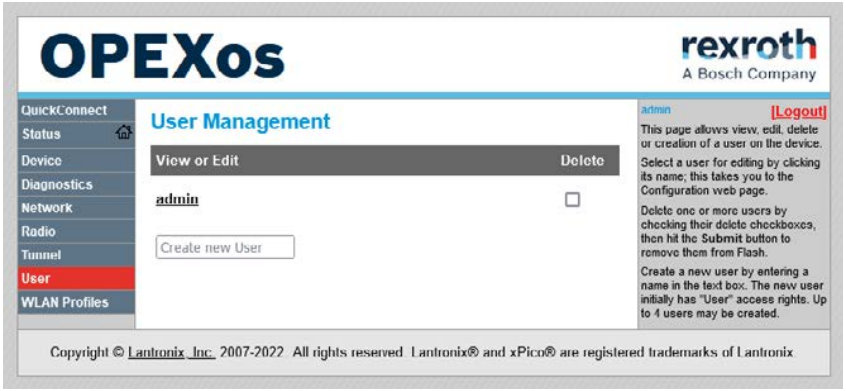
The new DUB protocol makes the TCP tunnel on the web interface of the xPico module unavailable. If an existing device still has an older firmware version without the DUB protocol installed, contact our Technical Support.

Securing the user password

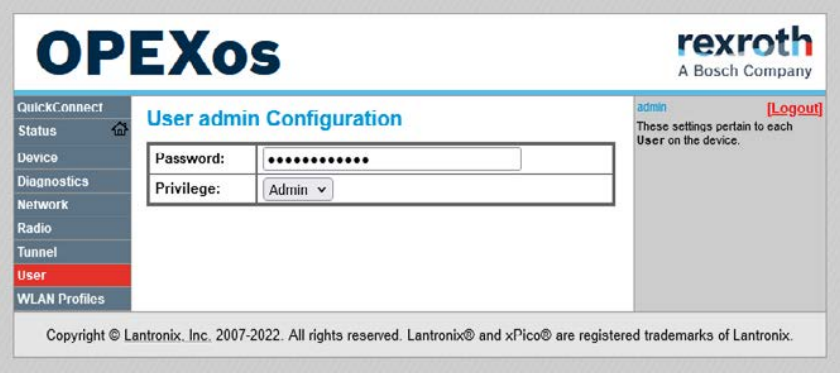
If the web interface is accessible in the network, it is recommended to change the user password.

Proceed as follows:

1. In the web interface, click on the **User** button on the left and select the user whose settings are to be changed.



2. Change the settings and confirm them with the **Submit** button.



Restarting and resetting the module

Proceed as follows:

- ▶ Click on the **Device** button in the web interface.
  - – The module can be restarted with the **Reboot** button.
  - – Use the **Factory Defaults** button to restore the factory settings and then restart the module.

Please note:

If you can no longer access the web interface, e.g. because you have mistyped the new user password, you can use the **RF Module Reset** function on the wrench to restore the factory settings of the xPico 240 WLAN module (see "Boot menu", page 63).

6.6 OPEX® serial console

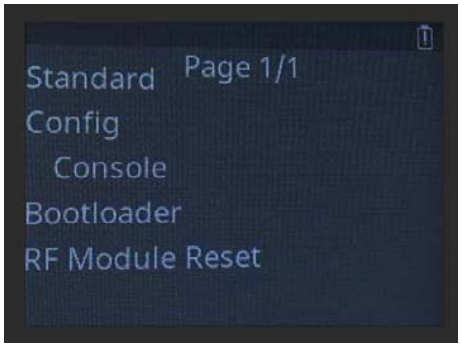
With the serial OPEX® console interface, it is possible to change further settings on the wrench and rectify faults.

Depending on the service password entered, either additional service functions or the command line interface can be called up.

A suitable data cable for the side cable interface and an ASCII terminal are required to get started.

6.6.1 Starting the serial console

1. Use the ASCII terminal to open the virtual COM port provided by the data cable with the following parameters:
   – 115200 baud
   – 8 data bits
   – No parity
   – 1 stop bit
   – No handshake
2. Click on the terminal window with the mouse and make sure that the cursor is flashing.
3. Make sure the wrench is switched off. If not, press and hold the ✔ button on the panel until the wrench shuts down.
4. Press and hold the ◀ button until the boot menu appears on the display. Then release the button again.
5. Use the ▲ and ▼ buttons to select the **Console** entry.
   The selected entry is shown inserted on the right.
6. Confirm the selected **Console** entry with the ✔ button.



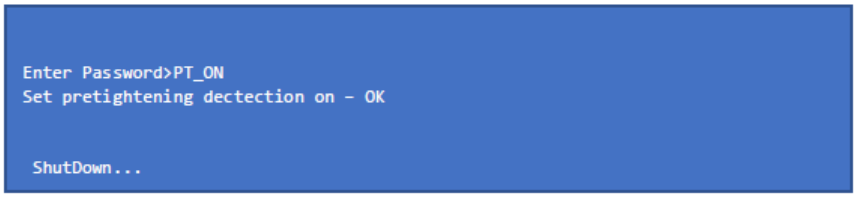
You should now see a password entry on the terminal.

6.6.2 Service functions

Switching on pre-tightening control

This activates the setting for the pre-tightening control (see "Explanation of basic terms for parameterization and measurement", page 43).

▶ Enter the service password for switching on the pre-tightening control in the terminal **PT_ON** and confirm the entry with **Return**.



Switching off pre-tightening control

This deactivates the setting for the pre-tightening control.

- In the terminal, enter the service password for switching off the pre-tightening control **PT_OFF** and confirm the entry with **Return**.

```
Enter Password>PT_OFF
Set pretightening dectection off - OK

 ShutDown...
```

Activating torque peak value determination of the last 4 degrees

This activates the determination of the torque peak value in the last 4 degrees of the rundown (see "Explanation of basic terms for parameterization and measurement", page 43).

- In the terminal, enter the service password for activating the torque peak value determination of the last 4 degrees **END_4DEGPEAK_ON** and confirm the entry with **Return**.

```
Enter Password>END_4DEGPEAK_ON
Set END_4DEGPEAK on - OK

 ShutDown...
```

Deactivating torque peak value determination of the last 4 degrees

This deactivates the determination of the torque peak value in the last 4 degrees of the rundown.

- In the terminal, enter the service password for deactivating the torque peak value determination of the last 4 degrees **END_4DEGPEAK_OFF** and confirm the entry with **Return**.

```
Enter Password>END_4DEGPEAK_OFF
Set END_4DEGPEAK off - OK

 ShutDown...
```

Open Protocol serial integration

This activates serial integration for the Open Protocol (see "Open Protocol integration types", page 100).

- In the terminal, enter the service password for serial Open Protocol integration **OP_SER** and confirm the entry with **Return**.

```
Enter Password>OP_SER
OP_SER - OK

 ShutDown...
```

Integrating Open Protocol via TCP/IP

This activates the integration of the Open Protocol via TCP/IP.

▶ In the terminal, enter the service password for TCP/IP Open Protocol integration **OP_TCP** and confirm the entry with **Return**.

```
Enter Password>OP_TCP
OP_TCP - OK

 ShutDown...
```

6.6.3 Command Line Interface

Starting Command Line Interface

▶ In the terminal, enter the default user password for the command line interface **12345** and confirm with **Return**.

```
Enter Password>*****
```

```
Welcome to the GWK Operator Command Line Module!

cmd>_
```

Available service routines for the user

- The command **lsr** + **Return** allows the service routines that are available for the user to be displayed.

```
cmd>lsr
-------------------------------------------------------------------------------
| 96: Tool Info    |135: Reset PCPar  |168: Test Tool ID |200: Key Test     |
| 97: Version Info |136: Reset ManPar |169: Write Tool ID|202: Barcode Test |
|100: Basic Taring |140: ShutDown     |172: Bolt center  |233: TrqDecPlaces |
|112: Hardware Test|165: Set RTC Time |179: Torque serial|240: RFID Setup   |
|125: Tool Mode    |166: Show RTC Time|180: Calib. Reboot|241: RFID On      |
|126: TCP Setup    |167: Set Tight. ID|182: Factory Setup|242: RFID Off     |
-------------------------------------------------------------------------------
Start service routine with >sr [Number], e.g. "sr 112" for Hardware Test
```

- The command **sr** + **service routine no.** + **Return** allows the corresponding service routine to be called up.

Service routine no. 96: Tool Info

The tool information and settings are displayed here:

```
cmd>sr 96
---------------------------------
Service routine  96:
Tool Info
---------------------------------
-= HARDWARE =-
HIB Revision:      1
Hardware ID:       0x0101
Hardware Revision: 1.03
Hardware Variant:  0x00
Production Year:   2022
Production Week:   19


-= PRODUCT =-
PIB Revision:          1
Product ID:            0x4100
Product Revision:      1
Product Manufacturer:  0x00
Serial Number:         P3105
Production Year:       2023
```

(Excerpt from display)

Service routine no. 97: Version Info

Only the information about the currently installed firmware is displayed here:

```
cmd>sr 97
---------------------------------
Service routine  97:
Version Info
---------------------------------
FIB Revision:      2
Firmware ID:       0x8100
Firmware Variant:  0
Version:           23.27.00
Repository Link:   3051
Size:              778472
Compiler:          7.3.1
Build Machine:     NB-OSTOERKEL
Signature Status:  Unsigned



cmd>
```

ENGLISH

Service routine no. 100: Version Info

This service routine allows the measuring technology to be re-tared if it has accidentally been incorrectly tared.

```
cmd>sr 100
---------------------------------
Service routine 100:
Basic Taring
---------------------------------


DMS ADC Channel DAC

| DAC[Ch1] 01950  AD[Ch1] 00231 | DAC[Ch2] 01950  AD[Ch2] 00191 |
| DAC[Ch1] 01900  AD[Ch1] 00234 | DAC[Ch2] 01900  AD[Ch2] 00900 |
| DAC[Ch1] 01850  AD[Ch1] 01767 | DAC[Ch2] 01850  AD[Ch2] 02447 |
| DAC[Ch1] 01800  AD[Ch1] 03521 | DAC[Ch2] 01800  AD[Ch2] 04209 |
| DAC[Ch1] 01750  AD[Ch1] 05081 | DAC[Ch2] 01750  AD[Ch2] 05765 |

.........

| DAC[Ch1] 01550  AD[Ch1] 11711 | DAC[Ch2] 01550  AD[Ch2] 12415 |
| DAC[Ch1] 01500  AD[Ch1] 13272 | DAC[Ch2] 01500  AD[Ch2] 13967 |
| DAC[Ch1] 01450  AD[Ch1] 14825 | DAC[Ch2] 01450  AD[Ch2] 15524 |
| DAC[Ch1] 00950  AD[Ch1] 32742 | DAC[Ch2] 00973  AD[Ch2] 32650 |
| DAC[Ch1] 00949  AD[Ch1] 32743 | DAC[Ch2] 00972  AD[Ch2] 32649 |
| DAC[Ch1] 00949  AD[Ch1] 33003 | DAC[Ch2] 00972  AD[Ch2] 32913 |

Determine torque offset


Determined torque offset Ch1: 33001.1  Ch2: 32911.4

Please keep the tool steady!!!
.........

New angle offset: 32723.5

End...


cmd>_
```

Service routine no. 112: Hardware Test

This service routine can be used to display the raw values of the measurement technology of the OPEX® for remote diagnosis purposes.

```
cmd>sr 112
---------------------------------
Service routine 112:
Hardware Test
---------------------------------


(End with [Enter] or [ESC])

| ANGLE:32716 | DMS_CH0:32946 | DMS_CH1:32960 | BAT:3675mV |

cmd>_
```

Service routine no. 125: Tool Mode

This service routine can be used to change the tool configuration (see "OPEX® tool configurations", page 57) for the desired application

```
cmd>sr 125
----------------------------------
Service routine 125:
Tool Mode
----------------------------------

Available preset tool configurations:

  0 - Preset Mode_03 EasyWin
  1 - Preset Mode_06 SPS WLAN
  2 - Preset Mode_59 OpenProtocol
  3 - Preset Mode_62 GWK SPS

You can enter a new value. Continue with [ENTER]. Abort with [ESC]


Please select a preset tool configuration, new value=2
 "Preset Mode_59 OpenProtocol" selected.

"Preset Mode_59 OpenProtocol" loaded.


Available EasyWin protocol versions:

  8 - Protocol 8a
  9 - Protocol 9a

Current EasyWin protocol version:   8 - Protocol 8a
Please select an EasyWin protocol version, new value=8
 "Protocol 8a" selected.


Reset to factory settings? (Recommended) (Y/N)>y



 Really process factory reset? (Y/N)>y

 ShutDown...
```

Service routine no. 126: TCP Setup

This service routine allows the TCP sockets to be configured for the new DUB protocol.

```
cmd>sr 126
---------------------------------
Service routine 126:
TCP Setup
---------------------------------

=== Current TCP settings: ===
+TCP Connection
 +Socket 1
  |--D TCP Socket 1 Mode          TCP Server Socket 1 (2)
  |--S Socket 1 Port              4545
 +Socket 2
  |--D TCP Socket 2 Mode          Disable TCP Socket 2 (0)
 +Socket 3
  |--D TCP Socket 3 Mode          Disable TCP Socket 3 (0)
 +Socket 4
  |--D TCP Socket 4 Mode          Disable TCP Socket 4 (0)



Do you want to change any of the TCP settings? (Y/N)>n

End...



cmd>_
```

At present, all implemented wireless transmission protocols only use socket 1.

```
Do you want to change any of the TCP settings? (Y/N)>y


--- Please select a socket by number to change the settings for ---

Socket number 1 selected.

--- Available socket modes ---:
0) Disable TCP Socket 1
1) TCP Client Socket 1
2) TCP Server Socket 1

Please select a socket mode
_
```

- Select socket 1 to edit the TCP settings.

```
Please select a socket mode
Mode 1 (TCP Client Socket 1) for socket number 1 selected.

--- Please put in an IP address for socket number 1 ---:

Socket 1 Host IP=[192.168.1.100], new value=192.168.1.100
Socket 1 Host IP=192.168.1.100


--- Please put in a port for socket number 1 ---:

Socket 1 Port=[4545], new value=4002
Socket 1 Port=4002



=== Current TCP settings: ===
+TCP Connection
 +Socket 1
 |--S TCP Socket 1 Mode          TCP Client Socket 1 (1)
 |--D Socket 1 Host IP           192.168.1.100
 |--D Socket 1 Port              4002
 +Socket 2
 |--D TCP Socket 2 Mode          Disable TCP Socket 2 (0)
 +Socket 3
 |--D TCP Socket 3 Mode          Disable TCP Socket 3 (0)
 +Socket 4
 |--D TCP Socket 4 Mode          Disable TCP Socket 4 (0)
```

TCP client mode corresponds to Connect mode in the tunnel of the earlier xPico module.

```
Do you want to change any of the TCP settings? (Y/N)>y

--- Please select a socket by number to change the settings for ---

Socket number 1 selected.

--- Available socket modes ---:
0) Disable TCP Socket 1
1) TCP Client Socket 1
2) TCP Server Socket 1

Please select a socket mode
Mode 2 (TCP Server Socket 1) for socket number 1 selected.

--- Please put in a port for socket number 1 ---:

Socket 1 Port=[4002], new value=4545
Socket 1 Port=4545
```

TCP server mode corresponds to Acceptance mode in the tunnel of the earlier xPico module.

Service routine no. 135: Reset PCPar

This service routine resets the parameterization with OPEXwin® and deletes all saved parameter sets.

```
cmd>sr 135
----------------------------------
Service routine 135:
Reset PCPar
----------------------------------

Really reset the EasyWin parameterization? (Y/N)>y


EasyWin parameter file number: 0


cmd>_
```

Service routine no. 136: Reset ManPar

This service routine can be used to reset the values for manual parameterization to the recommended default values.

```
cmd>sr 136
----------------------------------
Service routine 136:
Reset ManPar
----------------------------------

Really reset the manual parameterization? (Y/N)>y


ManPar_Trq_T_nom   : 20.0 Nm


ManPar_Ang_A_nom   : 45.0 Degrees
ManPar_Ang_T_snug  : 10.0 Nm


ManPar_Ycs_Hardness: Medium
ManPar_Ycs_T_snug  : 10.0 Nm


Manpar_Ftr_A_ftr   : 5.0 Degrees
Manpar_Ftr_M_fuege : 10.0 Nm


ManPar_Ltg_W_loes  : 20.0 Degrees
ManPar_Ltg_T_snug  : 10.0 Nm

cmd>_
```

Service routine no. 140: ShutDown

This service routine is used to exit the command line interface and shut OPEX® down.

```
cmd>sr 140
----------------------------------
Service Routine 140:
ShutDown
----------------------------------
```

Service routine no. 165: Set RTC Time

This service routine can be used to set the real time clock of the OPEX®.

```
cmd>sr 165
----------------------------------
Service routine 165:
Set RTC Time
----------------------------------
Please enter RTC time

YRS: =[23], new value=23
YRS: =23

MON: =[7], new value=7
MON: =7

DAY: =[5], new value=5
DAY: =5

HRS: =[13], new value=14
HRS: =14

MIN: =[44], new value=44
MIN: =44

SEC: =[55], new value=32
SEC: =32


cmd>_
```

Service routine no. 166: Show RTC Time

This can be used to display the set date and time of the RTC.

```
cmd>sr 166
----------------------------------
Service Routine 166:
Show RTC Time
----------------------------------
 Real Time Clock (UTC) -  YRS:23 MON:05 DAY:05 HRS:10 MIN:32 SEC:23

cmd>_
```

Service routine no. 167: Set Tight. ID

This can be used to set the rundown counter in the non-volatile memory.

```
cmd>sr 167
----------------------------------
Service routine 167:
Set Tight. ID
----------------------------------

Current Thightening ID: 5918
New Thightening ID> 4711

cmd>_
```

Service routine no. 168: Test Tool ID

This service routine allows an RFID tag to be read.

```
cmd>sr 168
----------------------------------
Service routine 168:
Test Tool ID
----------------------------------
Waiting for Tag (press [ESC] to skip)...

Tool ID: 0x00000007 (7) - PAR007

End...



cmd>_
```

ENGLISH

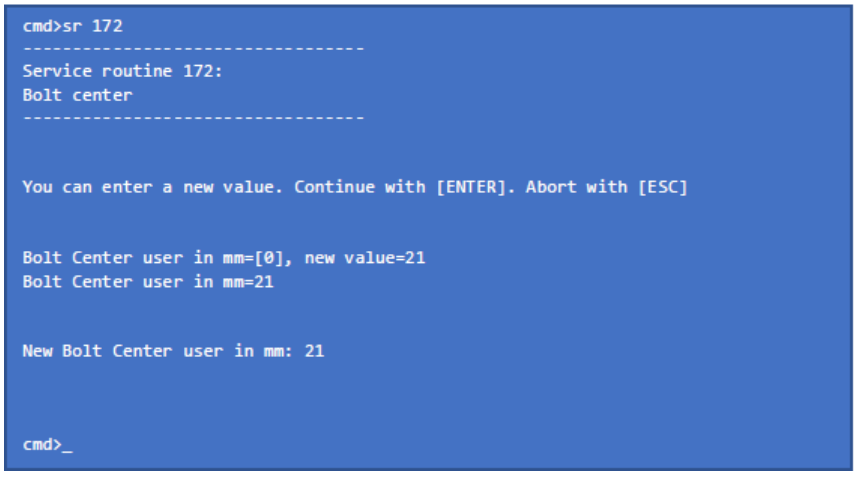
Service routine no. 169: Write Tool ID

This service routine allows an RFID tag to be written.

Notice: RFID is in the prototype stage and is not yet officially supported by Bosch Rexroth.

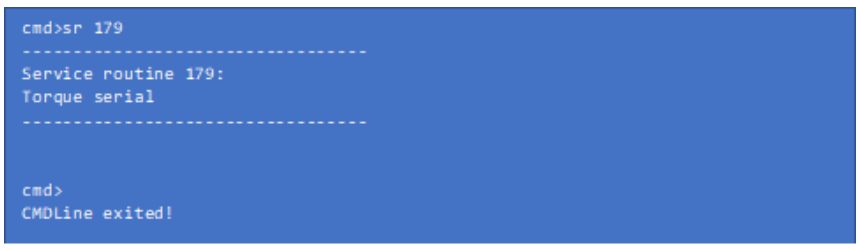
Service routine no. 172: Bolt center

This service routine can be used to set the gauge stored for the torque measurement technology (see "Explanation of basic terms for parameterization and measurement", page 43) if this is not part of the parameter set.



Service routine no. 179: Torque serial

This service routine starts the wrench with the torque test mode for counter-measurement.



Service routine no. 180: Calib. Reboot

This can be used to start the wrench with the calibration mode for counter-measurement.

```
cmd>sr 180
----------------------------------
Service routine 180:
Calib. Reboot
----------------------------------


cmd>
CMDLine exited!
```

Service routine no. 182: Factory Setup

This service routine restores the OPEX® factory settings.

```
cmd>sr 182
----------------------------------
Service routine 182:
Factory Setup
----------------------------------




 Really process factory reset? (Y/N)>y

 ShutDown...
```

Service routine no. 200: Key Test

This service routine can be used to test the membrane keypad on the OPEX® screen.

```
cmd>sr 200
----------------------------------
Service routine 200:
Key Test
----------------------------------


(End with [Enter] or [ESC])

Please press a key:


Taste = 17


End...



cmd>_
```

Service routine no. 202: Barcode Test

This can be used to test the internal barcode scanner of the OPEX®.

```
cmd>sr 202
----------------------------------
Service routine 202:
Barcode Test
----------------------------------


Please scan with [SCAN] key, end with [ESC]


 00156DD87CC3
 4061458041447

End...



cmd>_
```

ENGLISH

Service routine no. 233: TrqDecPlaces

This service routine can be used to set the number of torque decimal places in the measurement technology (see "Setting the torque decimal places", page 45).

```
cmd>sr 233
---------------------------------
Service routine 233:
TrqDecPlaces
---------------------------------


You can enter a new value. Continue with [ENTER]. Abort with [ESC]


Torque decimal places (1..2)=[1], new value=2
Torque decimal places (1..2)=2


Torque decimal places: 2



cmd>_
```

Service routine no. 240: RFID Setup

This service routine sets the Start byte of an RFID tags with the OPEX® RFID tool.

```
cmd>sr 240
---------------------------------
Service routine 240:
RFID Setup
---------------------------------
Tool ID: 0x00000005 (5) - PAR005


You can enter a new value. Continue with [ENTER]. Abort with [ESC]


start byte value=[5], new value=7
start byte value=7

Start byte value successfully written.

cmd>_
```

Service routine no. 241: RFID On

This service routine activates RFID detection with the OPEX® RFID tool.

```
cmd>sr 241
---------------------------------
Service routine 241:
RFID On
---------------------------------

RFID_ON - OK

cmd>_
```

Service routine no. 242: RFID Off

This service routine deactivates RFID detection with the OPEX® RFID tool

```
cmd>sr 242
---------------------------------
Service routine 242:
RFID Off
---------------------------------

RFID_OFF - OK

cmd>_
```

Notice: RFID is in the prototype stage and is not yet officially supported by Bosch Rexroth.

6.7 Parameterization and measurement

The OPEX® unit is parameterized manually on the torque wrench using the WLAN wireless transmission system or with the OPEXwin® Windows software.

In stand-alone mode, final values and parameters are read out using the OPEXwin® Windows software.

6.7.1 Explanation of parameterization terms

Tab. 5: Explanation of basic terms for parameterization and measurement

Term	Description
Minimum torque	Minimum torque (2% of the nominal load capacity of the tool, e.g. 4 Nm for an OPEX® 200), from which the rotation angle measurement of the measuring technology begins.
Joining torque	Torque threshold from which the rotation angle measurement begins relative to nominal values and the quality window. As a value for the joining torque, it is recommended to select the torque at the head contact (start of the joint) of the screw.
Nominal torque, nominal rotation angle	Target values for torque or rotation angle. Once reached, various stop signals are triggered.
Yield strength	Upper limit of the elastic deformation range of the screw. Reaching the yield point results in a permanent elongation of the screw of approx. 0.2% of the free clamping length.
Prevail torque (WDM)	Dynamic prevail torque for determining the residual torque of already assembled screw connections.
Stop criterion	Reaching the nominal torque, the nominal angle or the yield point
Screw joint hardness	Rigidity of the entire composite. • hard: e.g. ring gear, screw of strength class > 10.9 • medium: No strongly yielding elements, screw of strength class 8.8 • soft: Expansion shank bolts, e.g. cylinder head, connections with gaskets, etc.
Pre-tightening check	The pre-tightening check is used to detect pre-tightened screws that have already been screwed in. The test checks whether the screw rotates less than 4° in the torque range from 2 % of the nominal load capacity of the tool at the start of a rundown until the joining torque is reached. If the pre-tightening check is activated, this is displayed as a fault and the rundown is aborted.
Release torque	Torque, opposite to the preset direction of rotation (CW, CCW). This setting can be used to monitor whether the fitting has been subjected to impermissible stress in the release direction when moving a static drive (e.g. fork insert, without ratchet). Notice: Set the value for the release torque to 0 to deactivate this function.
Quality window	In addition to the nominal values, monitoring limits for the torque and the rotation angle can also be parameterized for OK/NOK evaluation. • LTL: Lower torque limit in the quality window • UTL: Upper torque limit in the quality window • LAL: Lower angle limit in the quality window • UAL: Upper angle limit in the quality window
Rundown mode	Defines the measuring method used for the rundown, torque controlled, angle controlled or yield point controlled, as well as the audit modes release / tighten and prevail torque.

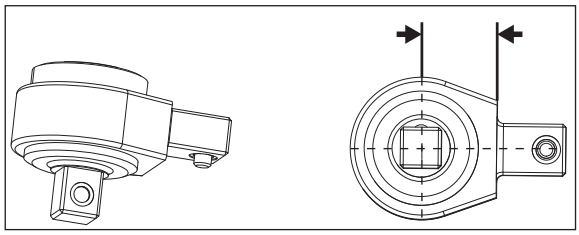
6.7.2 Torque peak value determination of the last 4 degrees

This procedure can be activated as a service function in the console. When activated, only the torque curve of the last 4 degrees is evaluated for the final peak torque value, not the torque curve of the entire rundown.

This is useful, for example, for pre-tightened screws with a breakaway torque that can be higher than the final torque.

6.7.3 Gauge

The torque applied with the hand tool depends on the total lever length of the tool. The total length is the length of the hand tool up to the screw attachment holder and the length of the screw attachment up to the pivot point, the so-called gauge.



NOTICE

Incorrect internal dimension

Incorrect torque measurement results are possible it the internal dimension is incorrectly parameterized.

- ▶ Always use the output drive with the correct internal dimension.
- ▶ Make sure the correct setting or parameterization of the gauge is used (see "Service routine no. 172: Bolt center", page 40).

Please note during parameterization:

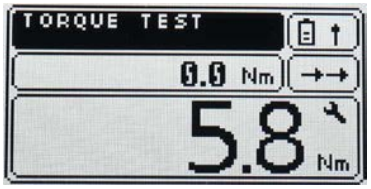
- If the value zero is parameterized for the gauge block, the measurement technology uses the standard gauge value stored in the tool.
- The torque measurement of the handheld screwdrivers is calibrated with the standard ratchets as output (screw attachment), unless otherwise ordered.
- The standard gauge of the output drive for the respective torque measuring range can be found in the technical data (see "OPEX® dimensions (without tool insert)", page 87

6.7.4 Setting the torque decimal places

The torque measurement technology of the OPEX® can be set so that it measures with one or two torque decimal places (see "Service routine no. 233: TrqDecPlaces", page 42)

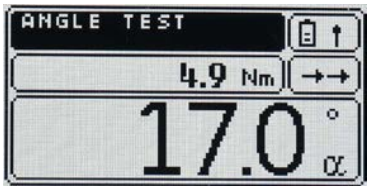
This concerns the display of the torque on the TFT display, as well as the serial data transmission of the torque as far as this is supported by the protocol used.

Examples for the representation of the torque with one or two torque decimal places:

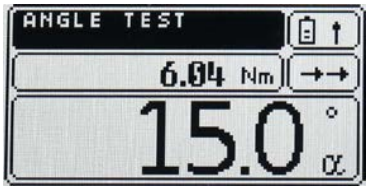


Torque-controlled measurement with one torque decimal place

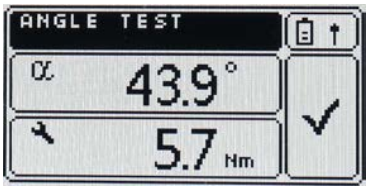
Torque-controlled measurement with two torque decimal places



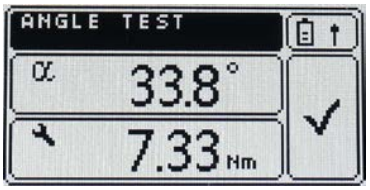
Angle controlled measurement with one torque decimal place



Angle controlled measurement with two torque decimal places



Result with one torque decimal place



Result with two torque decimal places

Release/tighten result with one torque decimal place

Release/tighten result with two torque decimal places

6.7.5 Measuring with the OPEX® and parameterization

Torque mode

In torque mode, you can tighten a screw connection up to a preset nominal torque within parameterizable lower or upper limits. The angle measurement allows additional monitoring of the tightening. The rotation angle in relation to the quality window is measured after the preset joining torque has been exceeded.

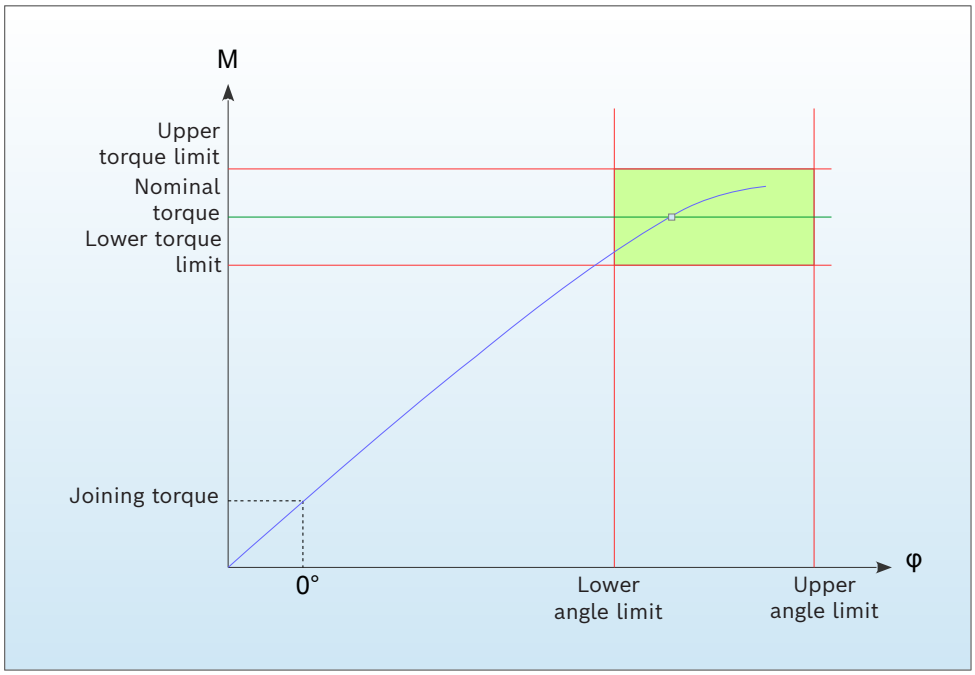


Fig. 8: Torque control curve

Adjustable parameters	Values can be saved	Final value check on the device
• Parameter set name • Number of repetitions (cycle) • Rundown mode (torque control) • Joining torque • Mnom, nominal torque, STOP criterion • Quality window – LTL (lower torque limit) – UTL (upper torque limit) – LAL (lower angle limit) – UAL (upper angle limit) • Torque unit of measurement (Nm / ft.-lbs.) • WR (direction of action, CW/CCW/Auto) • Memory function • Screw attachment gauge	• Torque end value (peak value) • Rotation angle end value (peak value)	If the measured peak values of torque and rotation angle are within the defined limit range (green area in the torque check), the result is evaluated as OK. The unit acknowledges the OK measurement with the following signals or outputs: • LED ring flashes green • Continuous acoustic signal If a NOK measurement occurs: • LED ring flashes red • Intermittent acoustic signal

Please note:

You can use this rundown mode for non-critical rundowns.

Guideline value for the joining torque: approx. 25 % – 40 % of the set nominal torque.

Rotation angle mode

In rotation angle mode, you can tighten a screw connection until a preset nominal rotation angle is reached. The rotation angle is measured in relation to the nominal rotation angle and the quality window after the preset joining torque has been exceeded.

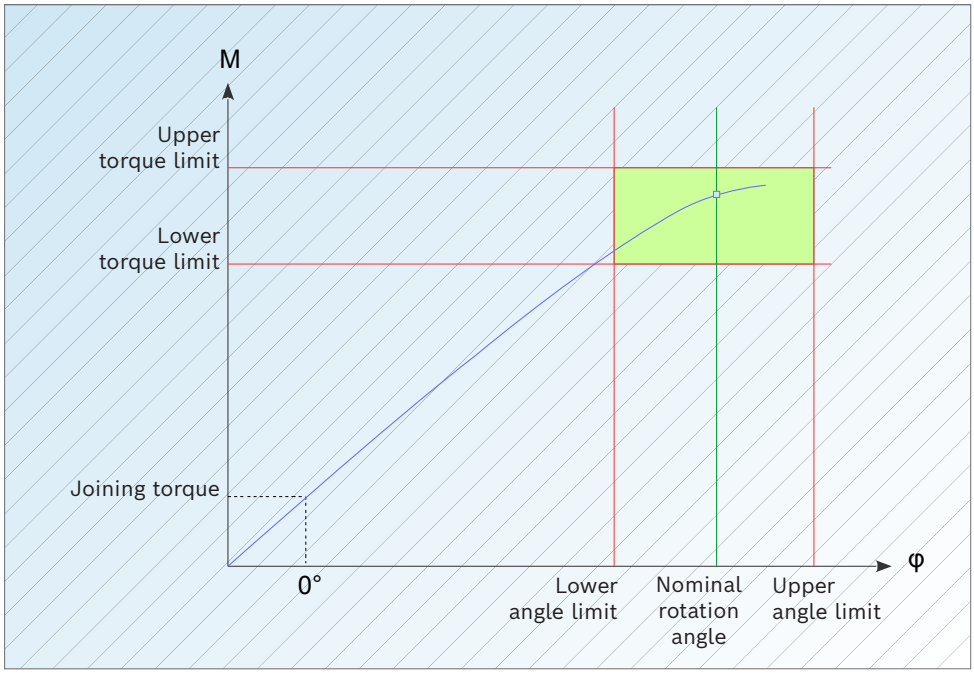


Fig. 9: Angle control curve

Adjustable parameters	Values can be saved	Final value check on the device
• Parameter set name • Number of repetitions (cycle) • Rundown mode (torque control) • Joining torque • Mnom, nominal torque, STOP criterion • Quality window – LTL (lower torque limit) – UTL (upper torque limit) – LAL (lower angle limit) – UAL (upper angle limit) • Torque unit of measurement (Nm / ft.-lbs.) • WR (direction of action, CW/CCW/Auto) • Memory function • Screw attachment gauge	• Torque end value (peak value) • Rotation angle end value (peak value)	If the measured peak values of torque and rotation angle are within the defined limit range (green area in the torque check), the result is evaluated as OK. The unit acknowledges the OK measurement with the following signals or outputs: • LED ring flashes green. • Continuous acoustic signal. If a NOK measurement occurs: • LED ring flashes red. • Intermittent acoustic signal.

Please note:

You can use this rundown mode to tighten screws in the overelastic deformation range within certain fault limits. The rotation angle rundown allows you to eliminate some of the effects of friction.

Joining torque value according to specification e.g. 20 Nm + 90° here joining torque setting = 20 Nm.

Yield point mode

In this rundown mode, you can tighten a bolted joint until the yield point is reached. The determination of the gradient ΔM / ΔΦ begins when the joining torque is reached. The yield point is considered to have been reached when the value of the gradient S2 has fallen to a fraction of S1. You can set the spread of the measuring interval via the screw joint hardness (hard: narrow, medium: medium, soft: wide).

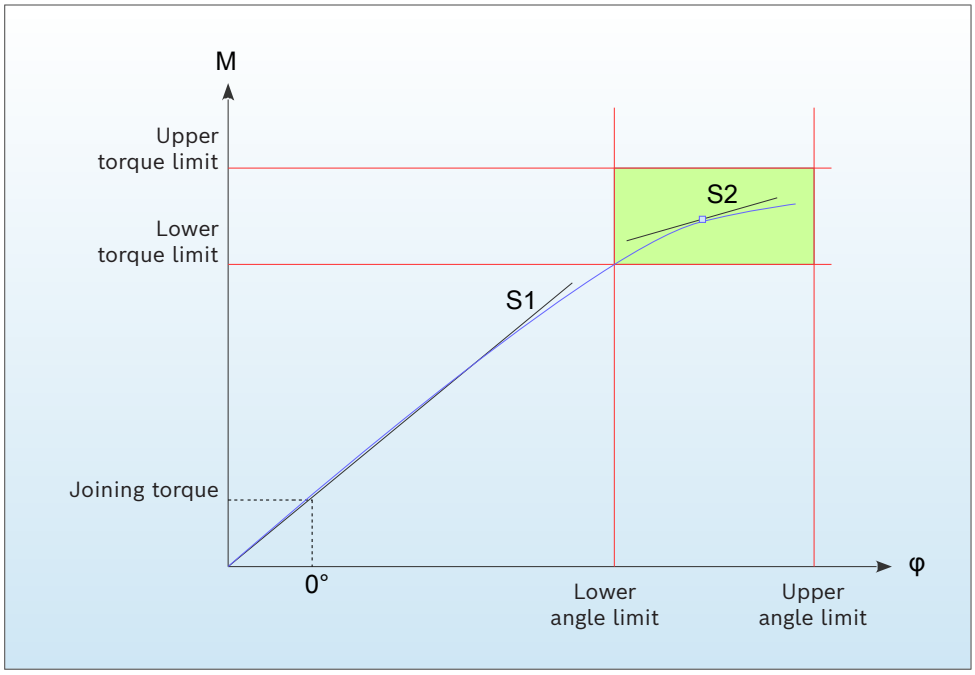


Fig. 10: Yield point control curve

Adjustable parameters	Values can be saved	Final value check on the device
• Parameter set name • Number of repetitions (cycle) • Rundown mode (yield point control) • Joining torque • Screw joint hardness (hard/medium/soft), STOP criterion • Quality window – LTL (lower torque limit) – UTL (upper torque limit) – LAL (lower angle limit) – UAL (upper angle limit) • Torque unit of measurement (Nm / ft.-lbs.) • WR (direction of action, CW/CCW/Auto) • Memory function • Screw attachment gauge	• Torque end value (peak value) • Rotation angle end value (peak value)	If the measured peak values of torque and rotation angle are within the defined limit range (green area in the yield point check), the result is evaluated as OK. The unit acknowledges the OK measurement with the following signals or outputs: • LED ring flashes green. • Continuous acoustic signal. If a NOK measurement occurs: • LED ring flashes red • Intermittent acoustic signal

Please note:

Guideline value for the joining torque (m): approx. 25% - 40% of the expected torque at the yield point.

To ensure correct detection of the yield point, you should not tighten the screw further than the joining torque. After reaching approx. 90% of the expected yield point torque, do not ratchet up the torque, but continue to turn continuously until the stop signal is given.

Release/tighten (LA)

Release/tighten mode enables the residual torque of assembled screw connections to be determined. To do this, the screw is first released by a parameterized angle amount (flashing display **Loosen**). The screw is then tightened by the same angle amount to the starting point (flashing display **Tighten**). The starting point is therefore reached in the sliding friction phase. When the rotation angle is reached, a continuous signal tone is emitted. The LED ring also changes to green. The torque value achieved can be read in the result display.

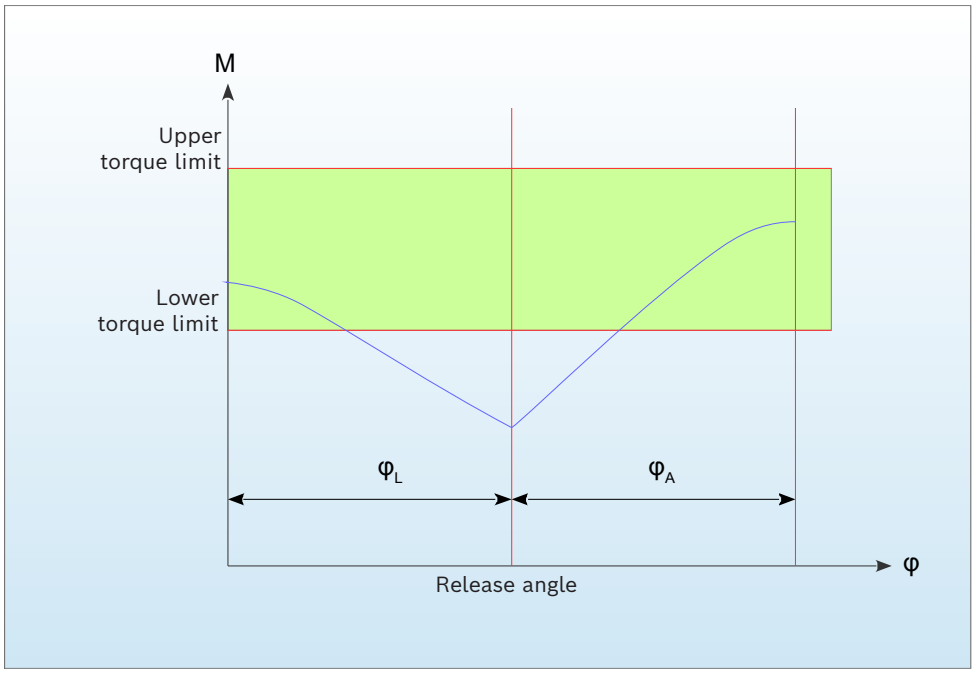


Fig. 11: Curve for release / tighten

Adjustable parameters	Values can be saved	Final value check on the device
• Parameter set name • Number of repetitions (cycle) • Rundown mode (release/tighten) • Joining torque • Wrelease, nominal release angle, STOP criterion for the release phase • Quality window – LTL (lower torque limit) – UTL (upper torque limit) – LAL (lower angle limit) – UAL (upper angle limit) • Torque unit of measurement (Nm / ft.-lbs.) • WR (direction of action, CW/CCW/Auto) • Memory function • Screw attachment gauge	• Torque end value release phase (peak value) • Torque end value retightening phase (peak value)	If the measured peak values of torque and rotation angle are within the defined limit range (green area in the release/tighten curve), the result is evaluated as OK. The unit acknowledges the OK measurement with the following signals or outputs: • LED ring flashes green. • Continuous acoustic signal. If a NOK measurement occurs: • LED ring flashes red • Intermittent acoustic signal

Please note:

Guideline value for the joining torque (m): approx. 2% – 10% of the expected nominal torque. During the release process, the measured torque should not fall below the set joining torque.

Prevail torque control (WDM)

In this mode, you can check pre-assembled connections. The applied torque is measured immediately after the transition from the static friction phase to the dynamic friction phase at the expected rotation angle. At the end of the measurement, you will receive the prevail torque and the actual rotation angle.

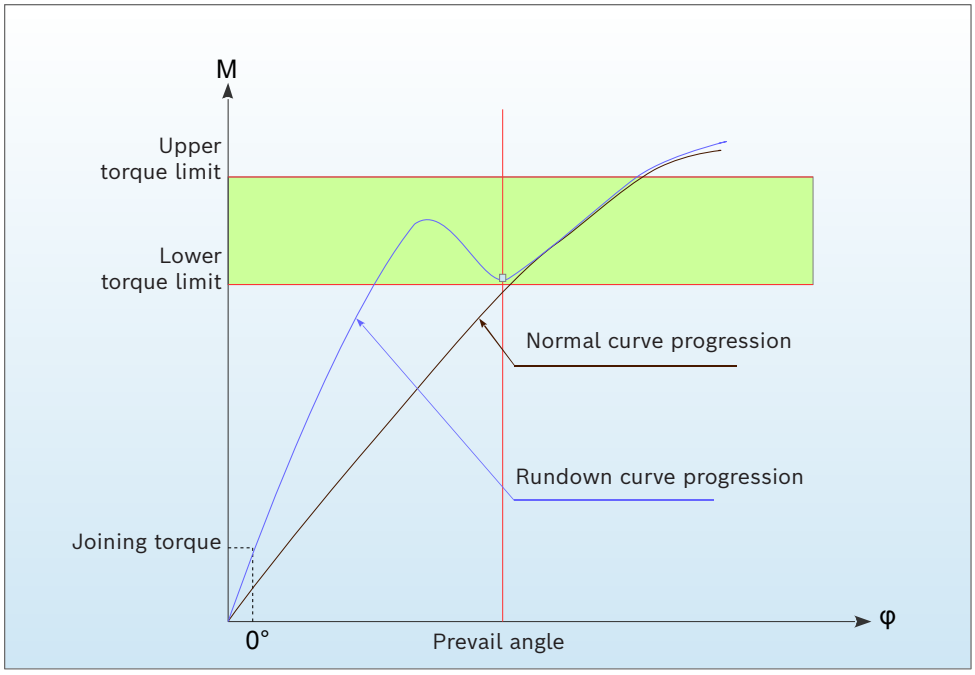


Fig. 12: Prevail torque curve

Adjustable parameters	Values can be saved	Final value check on the device
• Parameter set name • Number of repetitions (cycle) • Rundown mode (prevail torque) • Joining torque • Prevail angle (nominal rotation angle), STOP criterion • Quality window – LTL (lower torque limit) – UTL (upper torque limit) • Torque unit of measurement (Nm / ft.-lbs.) • WR (direction of action, CW/CCW/Auto) • Memory function • Screw attachment gauge	• Prevail torque (current value at prevail angle) • Rotation angle end value (peak value)	If the measured peak values of torque and rotation angle are within the defined limit range (green area in the release/tighten curve), the result is evaluated as OK. The unit acknowledges the OK measurement with the following signals or outputs: • LED ring flashes green • Continuous acoustic signal If a NOK measurement occurs: • LED ring flashes red • Intermittent acoustic signal

Please note:

Guideline value for the joining torque (m): approx. 2% – 10% of the expected prevail torque. The measured torque should not fall below the set joining torque while continuing to turn.

Tightening stages (tightening phases) and multi-stage tightening

Please note:

The additional tightening stages and multi-stage tightening described in this section are only possible with the set tool configuration **no. 3**: **OPEX® WLAN with extended bidirectional communication protocol for external controller** available!

AD method (torque tightening method) Torque controlled / angle controlled

The AD method is torque controlled and angle controlled.

In torque mode, you can tighten a bolted joint up to a preset nominal torque $\mathbf{M_A}$ within the parameterizable lower and upper limits **M+** and **M-**.

The angle measurement allows additional monitoring of the tightening. The rotation angle is measured after the preset switching parameter MS is reached, which can be freely parameterized as a torque threshold value ($\mathbf{M_I} \geq \mathbf{M_S}$).

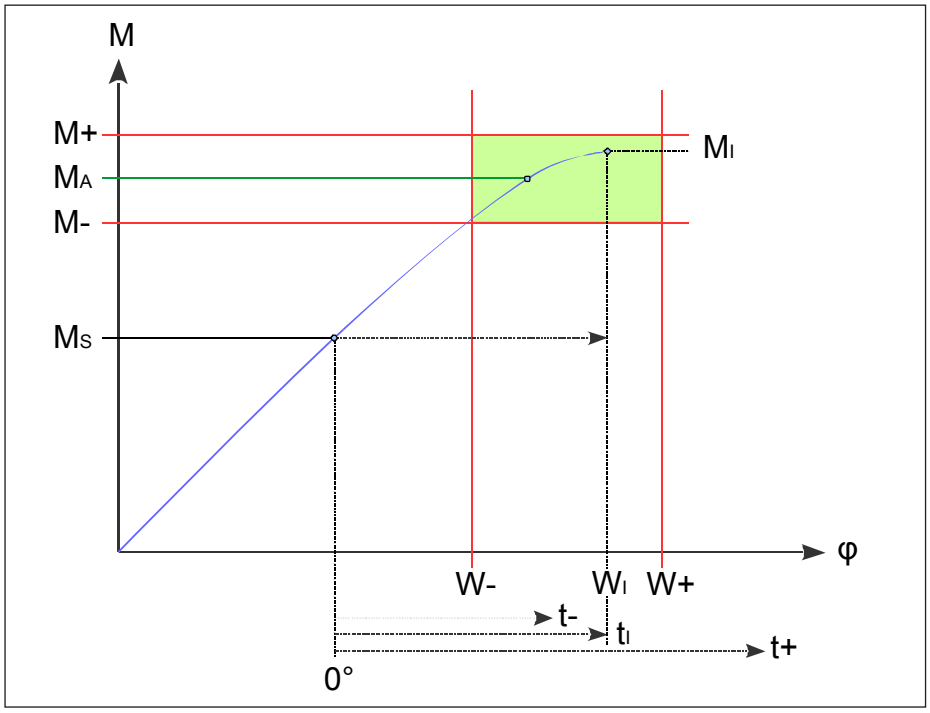


Fig. 13: Curve for AD method

M_A: Torque setpoint[1)]
M_S: Torque threshold value[1)]
M+: Upper tolerance torque[1)]
M-: Lower tolerance torque[1)]
W+: Upper tolerance angle[1)]
W-: Lower tolerance angle[1)]
t+: Upper tolerance time[1)]
t-: Lower tolerance time[1)]
M_I: Torque actual value
W_I: Angle actual value
t_I: Time actual value
SSC: Screw status code[1)]

[1)] Parameter adjustable

AW method (rotation angle tightening method)

The AW process is angle controlled and torque controlled.

In rotation angle mode, you can tighten a bolted joint until a preset nominal rotation angle W_A is reached. The torque measurement allows additional monitoring of the tightening. The rotation angle is measured after the preset switching parameter has been exceeded M_S, which can be freely parameterized as a torque threshold value. ($M_I \geq M_S$).

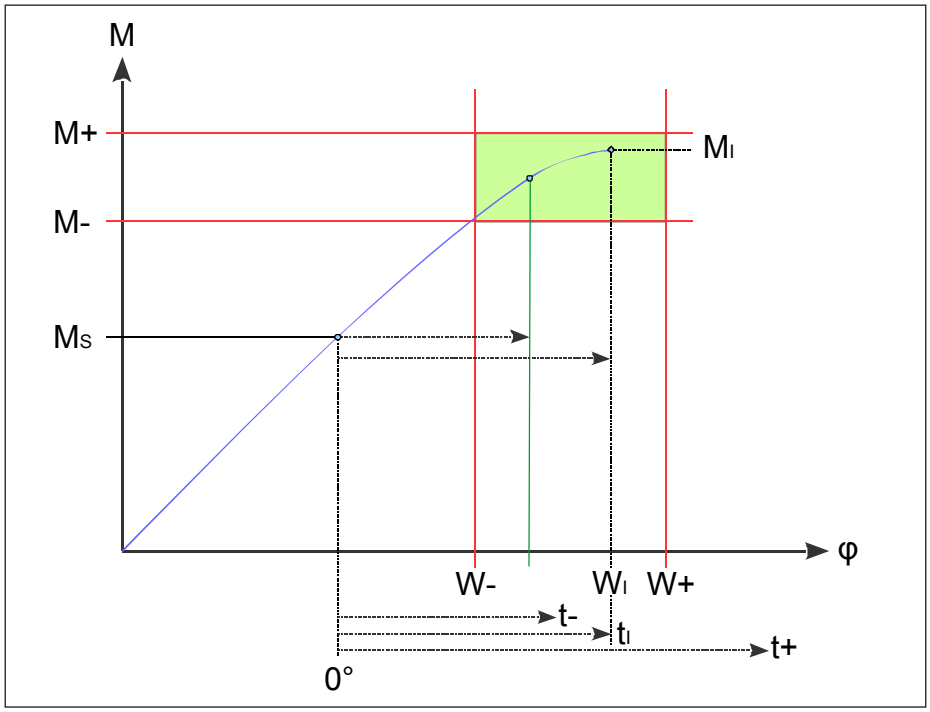


Fig. 14: Curve for AD method

W_A: Angle setpoint[1)]
W_S: Angle threshold value[1)]

M+: Upper tolerance torque[1)]
M-: Lower tolerance torque[1)]
W+: Upper tolerance angle[1)]
W-: Lower tolerance angle[1)]

t+: Upper tolerance time[1)]
t-: Lower tolerance time[1)]

M_I: Torque actual value
W_I: Angle actual value
t_I: Time actual value
SSC: Screw status code[1)]

[1)] Parameter adjustable

Release stage

To loosen a rundown, a release stage is implemented, which consists of a derived tightening stage and is based on the AW method. The release angle W_A can be parameterized. After the release process, the final values and the screw status code are transmitted to the controller.

An end tightening stage can be parameterized as a release stage in the opposite direction of action of the tightening. **Release torque monitoring** (M_I > -M_S **in loosening direction**) can be used to monitor that the screw has not been tightened again until the release stage has been completed.

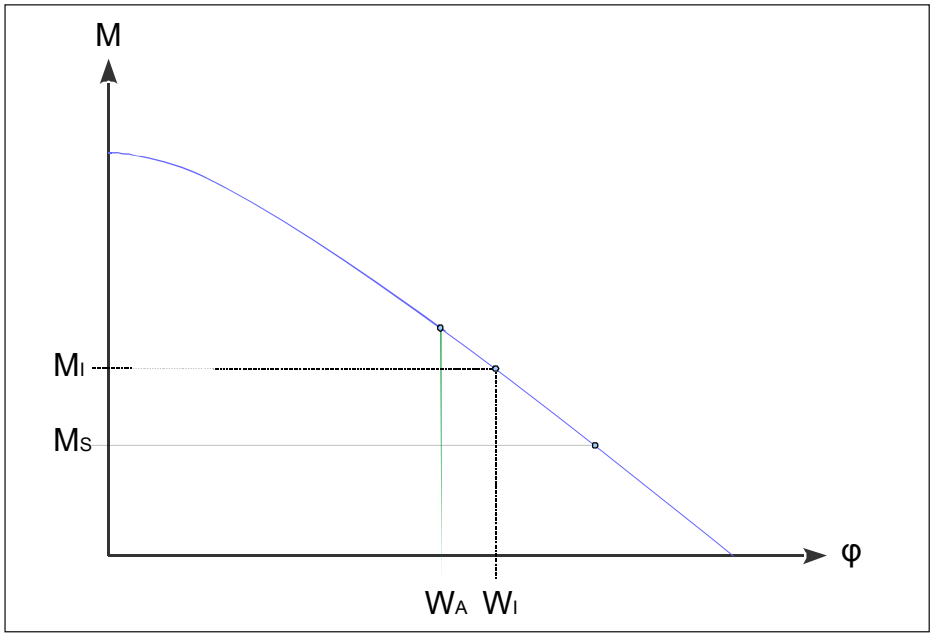


Fig. 15: Curve for release stage

W_A: Release angle setpoint[1)]
-M_S: Torque threshold value[1)]
SSC: Screw status code[1)]
W_I: Angle actual value
M_I: Torque actual value

[1)] Parameter adjustable

Please note:
In the simplest case, the release stage should be parameterized so that the screw is evaluated as released again when the actual value of the angle W_I before falling below the torque threshold value M_S reaches or exceeds the minimum release angle W_A.

Monitoring stage (monitored rest phase)

The monitoring stage is used to monitor the handheld screwdriver when it is not ready to screw. The torque measurement is monitored in both directions of action CW and CCW. Unintentional operation of the tool is detected and reported to the controller.

The monitoring stage is started automatically after switching on the screwdriving tool and after stopping a tightening operation.

The torque threshold value **M_S** of the monitoring level can be parameterized as required by sending a parameter set of the monitoring stage type. This **M_S** value remains permanently stored in the screwdriving tool and is available again after switching on. The factory setting for **M_S** for the monitoring stage is 2% of the nominal torque load capacity of the screwdriving tool, e.g. 2 Nm for a nominal torque load capacity of 100 Nm.

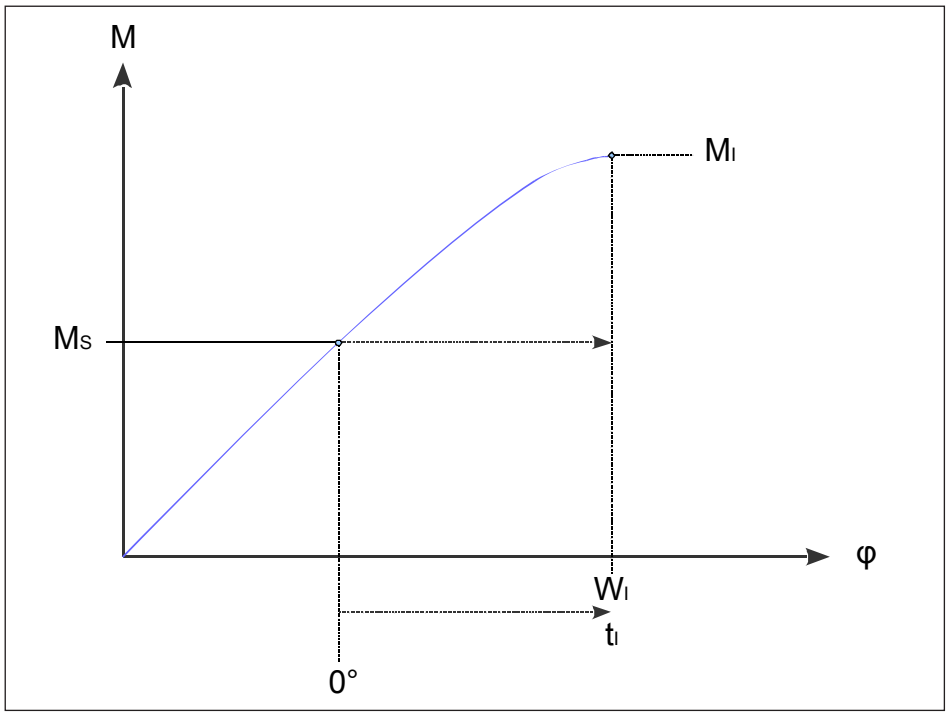


Fig. 16: Curve for monitoring stage

M_S: Torque threshold value[1)]
SSC: Screw status code[1)]
W_I: Angle actual value
M_I: Torque actual value

[1)] Parameter adjustable

Please note:

The rotation angle is measured after the torque threshold value **M_S** ($|M_I| \geq M_S$) has been reached. After **M_S** has been exceeded, the unintentional rundown is immediately assessed as a premature NOK and the worker is requested to relieve the load.

After unloading, the result data of the incorrect rundown is transferred to the controller.

Multi-stage tightening

Depending on the set tool configuration, the OPEX® can be used for both single-stage and two-stage tightening:

- **Single-stage tightening mode:**
  - Tightening starts directly with the *final tightening stage*
  - The screw is tightened directly to the target value $\mathbf{M_A}$ or $\mathbf{W_A}$
  - The AD method or the AW method can be used

- **Two-stage tightening mode:**
  - Tightening starts with the first *pre-tightening stage* (always in AD procedure)
  - Tightening continues with the second *final tightening stage* (either in the AD procedure or in the AW procedure)
  - Example see Fig. 17, page 56

Pre-tightening stage

The pre-tightening stage monitors the screwing process up to the head support.

The lower torque threshold of the pre-tightening stage $\mathbf{M_{S(1)}}$ can be freely parameterized, but should be at least 2% of the nominal load capacity of the handheld screwdriver due to the measuring technology of the handheld screwdriver, e.g. at least 2 Nm for a handheld screwdriver with a nominal load capacity of 100 Nm.

When the torque target value $\mathbf{M_{A(1)}}$ for the pre-tightening stage is reached, tightening in two-stage tightening mode switches to the final tightening stage. The quality window parameters $\mathbf{M\text{-}_{(1)}}$, $\mathbf{M+_{(1)}}$, $\mathbf{W\text{-}_{(1)}}$, $\mathbf{W+_{(1)}}$ and the time window parameters $\mathbf{t\text{-}_{(1)}}$ and $\mathbf{t\text{-}_{(1)}}$ allow the pre-tightening stage to be assessed and prematurely evaluated as NOK and canceled.

Final tightening stage

The final tightening stage is used to tighten to the target value $\mathbf{M_{A(2)}}$ or $\mathbf{W_{A(2)}}$ and to check the final tightening.

The lower torque threshold for the final tightening stage $\mathbf{M_{S(2)}}$ can be freely parameterized.

Care must be taken to ensure that $\mathbf{M_{S(2)}} \geq \mathbf{M_{A(1)}}$. For a smooth transition between the pre-tightening stage and the final tightening stage $\mathbf{M_{S(2)}} = \mathbf{M_{A(1)}}$ must be true.

When the target value $\mathbf{M_{A(2)}}$ or $\mathbf{W_{A(2)}}$ for the final tightening stage is reached, tightening is considered complete. The quality window parameters $\mathbf{M\text{-}_{(2)}}$, $\mathbf{M+_{(2)}}$, $\mathbf{W\text{-}_{(2)}}$, $\mathbf{W+_{(2)}}$ and the time window parameters $\mathbf{t\text{-}_{(2)}}$ and $\mathbf{t+_{(2)}}$ allow the final tightening stage to be assessed and can be prematurely evaluated as NOK and canceled.

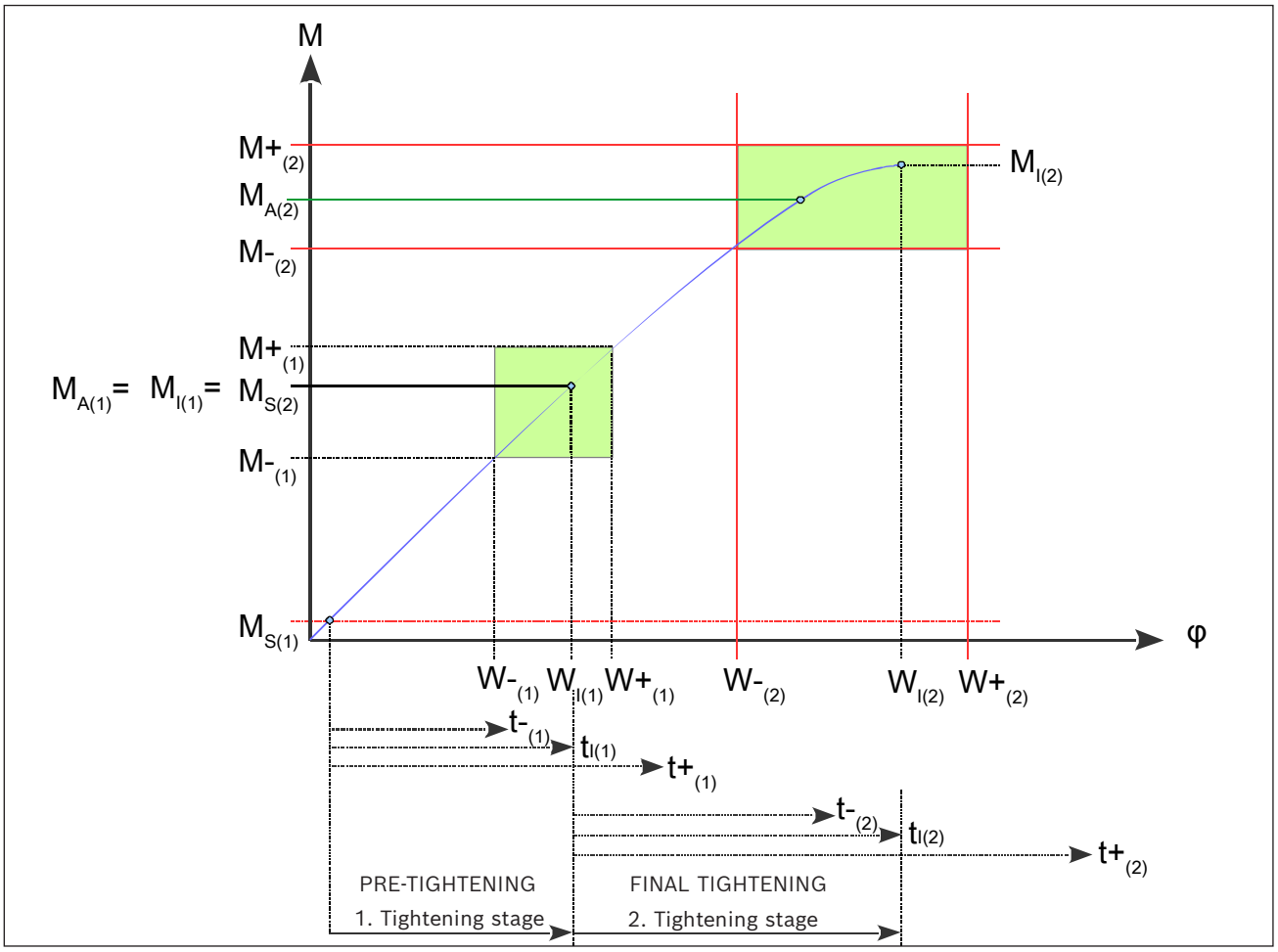


Fig. 17: Example of two-stage tightening with AD pre-tightening and AD final tightening; parameterization: $M_{S(2)} = M_{A(1)}$ with a smooth transition from the pre-tightening stage to the final tightening stage.

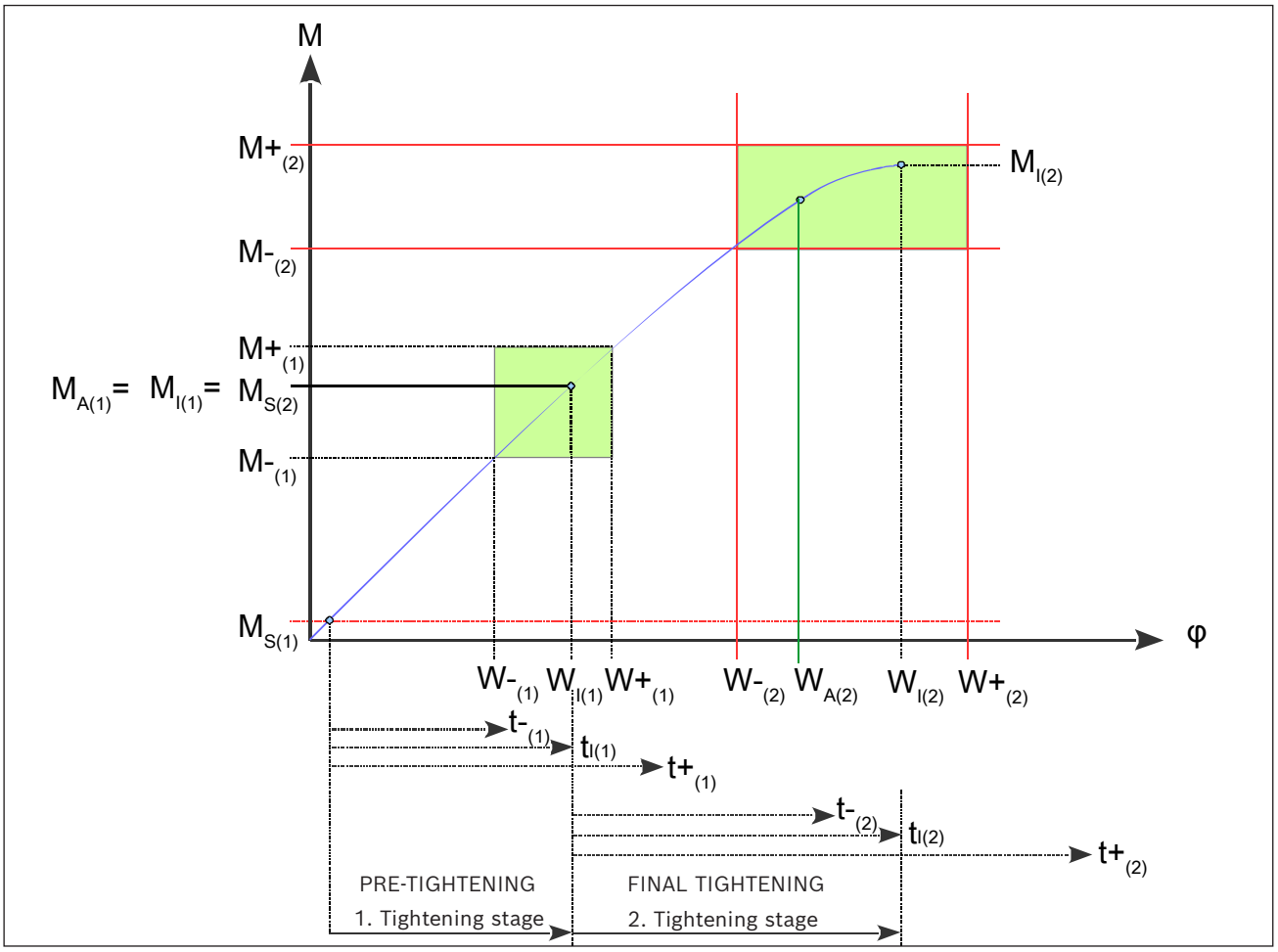


Fig. 18: Example of two-stage tightening with AD pre-tightening and AW final tightening; parameterization: $M_{S(2)} = M_{A(1)}$ with a smooth transition from the pre-tightening stage to the final tightening stage.

6.8 OPEX® tool configurations

The tool can be set in various configurations (operating modes) to meet the different requirements of the OPEX® in the field (see "Service routine no. 125: Tool Mode", page 35).

Please note:

- The various communication protocols via the optional WLAN interface are described in the specification for tool communication with external controller (see "Appendix - OPEX® tool communication", page 93).
- If the wireless link fails, the controller or the process control system fails, stand-alone emergency operation is possible for every tool configuration with a switched-off wireless module with a parameter set parameterized with OPEXwin®.

The possible configurations (operating modes) and their properties are listed below.

6.8.1 No. 0: OPEX® stand-alone with OPEXwin® communication and manual parameterization

This configuration is designed to operate the OPEX® independently without connection to a controller or process control system.

Options	Properties
Supported screwdriving modes	**Torque mode** Torque controlled (angle monitored)
	Rotation angle mode Angle controlled (torque monitored)
	Yield point mode Yield point controlled (angle and torque monitored)
	LA mode Release / tighten a rundown (angle controlled, torque monitored)
	WDM mode Checking the prevail torque of an already tightened rundown (angle controlled, torque monitored)
Tool communication	**USB** • Console Make further settings with an ANSI terminal • Communication with OPEXwin® Parameterization of up to 100 parameter sets in the non-volatile parameter set memory. Saving and reading out end values in the non-volatile end value memory
WLAN	**Communication with OPEXwin®** Parameterization of up to 100 parameter sets in the non-volatile parameter set memory. Saving and reading out end values in the non-volatile end value memory
Available menus	**Parameter set selection** Menu for parameter set selection by pressing a button
	Main menu Main menu can be called up by pressing a button
	Manual parameterization Menu for manual parameterization can be called up in the main menu
	Graphic setup menu The graphic setup menu can be called up in the main menu or when booting by pressing a button
Special functions	**Manual parameterization** Parameterization and start of a simple parameter set (without quality window) is possible directly without an external PC or controller using the operating elements of the OPEX® hand tool
Wireless communication with OPEXwin®	As no wireless interface is used by a controller or process control system, this interface can be used with an optional WLAN wireless module as an alternative to the USB cable for communication with OPEXwin®.

6.8.2 No. 1: OPEX® WLAN with bidirectional communication protocol for external controller

This configuration is designed for operation of the OPEX® connected to a controller or a process control system.

Parameterization with OPEXwin® is not intended for normal use.

Options	Properties
Supported screwdriving modes	**Torque mode** Torque controlled (angle monitored)
	Rotation angle mode Angle controlled (torque monitored)
	Yield point mode Yield point controlled (angle and torque monitored)
Tool communication	**USB** • Console Make further settings with an ANSI terminal • Communication with OPEXwin® Stand-alone emergency operation with 1 parameter set in the non-volatile parameter set memory when the WLAN is switched off
WLAN	**Bidirectional communication protocol** Parameterization and start/stop of temporary parameter sets from the controller, receipt of final values and screwdriving curves (optional), transmission of barcodes (optional)
Available menus	**Graphic setup menu** The graphic setup menu can be called up when booting by pressing a button
Special functions	**Barcode scanner** The wrench can optionally be equipped with a barcode scanner, allowing barcodes to be transmitted through the wireless interface.

6.8.3 No. 2: OPEX® WLAN with Open Protocol communication for external controller

This configuration is designed for connecting the OPEX® to a controller or a process control system with Open Protocol. Parameters can be set in OPEXwin® using the USB cable and later selected and started using the wireless interface.

Options	Properties
Supported screwdriving modes	**Torque mode** Torque controlled (angle monitored)
	Rotation angle mode Angle controlled (torque monitored)
	Yield point mode Yield point controlled (angle and torque monitored) Screw joint hardness: Hard, medium or soft (parameterizable)
	LA mode Release / tighten a rundown (angle controlled, torque monitored)
	WDM mode Checking the prevail torque of an already tightened rundown (angle controlled, torque monitored)
Tool communication	**USB** • Console Make further settings with an ANSI terminal • Communication with OPEXwin® Stand-alone emergency operation with 1 parameter set in the non-volatile parameter set memory when the WLAN is switched off

Options	Properties
WLAN	**Open Protocol communication** Selection and start/stop with OPEXwin® parameterized parameter sets. Receipt of final values and curves can be optionally subscribed to, transmission of barcodes and other Open Protocol functions available (see "Open Protocol serial communication", page 100).
Available menus	**Parameter set selection** Menu for parameter set selection by pressing a button (to be subscribed to via Open Protocol)
	Graphic setup menu The graphic setup menu can be called up in the main menu or when booting by pressing a button
Special functions	**Open Protocol functions** Other special functions such as text output on the display are possible via the Open Protocol (see "Open Protocol serial communication", page 100).
	Barcode scanner The wrench can optionally be equipped with a barcode scanner, allowing barcodes to be transmitted through the wireless interface.

6.8.4 No. 3: OPEX® WLAN with extended bidirectional communication protocol for external controller

Similar to tool configuration no. 1, the wrench is connected to a controller or a process control system via WLAN. The extended bidirectional communication protocol offers more options, but makes programming on the remote station more complex.

Options	Properties
Supported screwdriving modes	**Torque mode** Torque controlled (angle monitored)
	Rotation angle mode Angle controlled (torque monitored)
Tool communication	**USB** • Console Make further settings with an ANSI terminal • Communication with OPEXwin® Stand-alone emergency operation with 1 parameter set in the non-volatile parameter set memory when the WLAN is switched off
WLAN	**Extended bidirectional communication protocol for external controller** Parameterization, start/stop of parameter sets from the controller. Transmission of end values, screwdriving curves and barcodes as well as other tool information (see "Bidirectional communication protocol for external controller", page 93).
Available menus	**Graphic setup menu** The graphic setup menu can be called up in the main menu or when booting by pressing a button
Special functions	**Parameterization of two-stage tightening** With the extended bidirectional communication protocol for external controller, it is possible to parameterize a two-stage screw tightening with pre-tightening stage and final tightening stage.
	Monitoring stage Monitoring of the screw position to prevent unintentional operation of the wrench.
	Barcode scanner The wrench can optionally be equipped with a barcode scanner, allowing barcodes to be transmitted through the wireless interface.

6.9 Recommissioning

Proceed as for first commissioning.

7 Operation

⚠ CAUTION

Improper handling!

There is a risk of injury due to improper handling.

- ▶ Always hold the tools at the middle of the handle do not guide it by any other support point.
- ▶ To prevent injuries, do not work in excessively tight spaces.

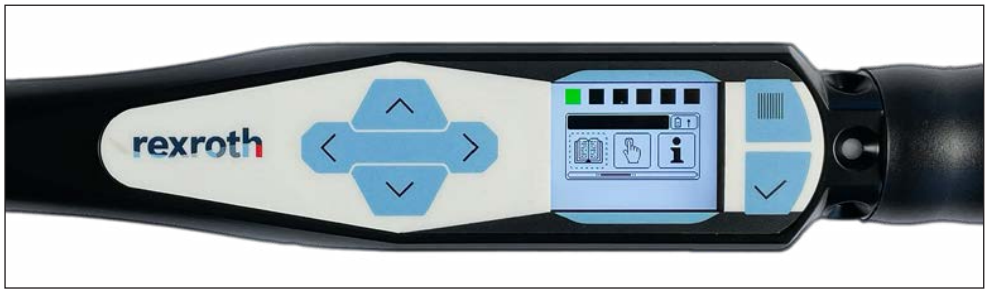
NOTICE

Improper handling!

Improper handing can impair the function of the tool or damage the tool. This can cause faulty torque measurements.

- ▶ Avoid impacts on the tool during operation.
- ▶ Always hold the tools at the middle of the handle do not guide it by any other support point.
- ▶ Only use attachments that are intended for the torque wrench.
- ▶ Apply torque to the tool such that it is not damaged.

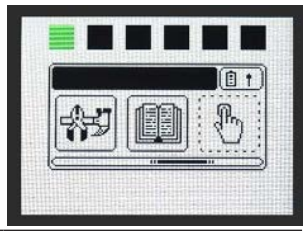
7.1 Controls and indicators



7.1.1 TFT display

Measurement (angle controlled)

Result display



Main menu

The TFT display is used to show the current measured values and results, as well as other status messages and menus.

The status fields in the upper area are used in parallel to the LED ring for additional status and progress display (see "OPEX® user interface", page 62)

7.1.2 LED ring

Display	LED	Meaning
Progress indicator, based on the nominal value	(red)	Screw progression between 50% and 90%
	(yellow)	Screw progression between 90% and 100%
	(green)	Nominal value reached(≥ 100%)
Evaluation display, intermittent after stop	(red)	NOK (not OK)
	(green)	OK
Battery warning indicator, permanently flashing	(yellow)	Battery capacity < 20%

7.1.3 Acoustic signals

Signal	Display	Description
Acoustic signal transmitter		If the signal transmitter is activated (see "Graphic setup menu", page 64), an acoustic signal is triggered after an OK rundown: • OK rundown → Continuous signal • NOK rundown → Intermittent signal
Vibrating alarm		With the vibration alarm, a continuous vibration signal is triggered after an OK rundown: • OK rundown → Continuous vibration • NOK rundown → Intermittent vibration

7.1.4 Membrane keys

Keys	Function
◀ ▶	**Left/Right:** Navigation and selection, always navigate to the left to exit menus and functions
▲ ▼	**Up/Down:** Setting and selection
	**SCAN:** Activation of the barcode scanner
✔	**OK:** Confirming and selecting functions, canceling a rundown

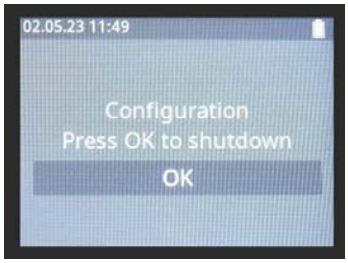
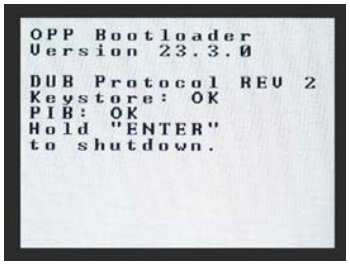
7.2 OPEX® user interface

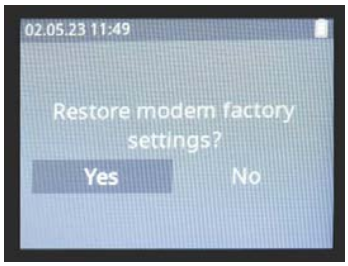
Depending on the set tool configuration, not all menus and functions are always available.

The exact descriptions of the parameterization and measurement with the various screwdriving modes (screwing methods) as well as the various tool configurations are documented in the sections "Parameterization and measurement" on page 43 from page 43 and "OPEX® tool configurations" from page 57.

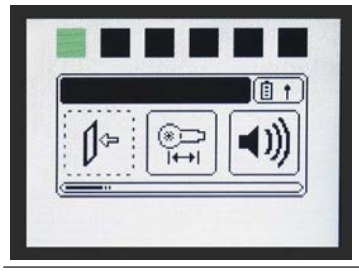
7.2.1 Menus

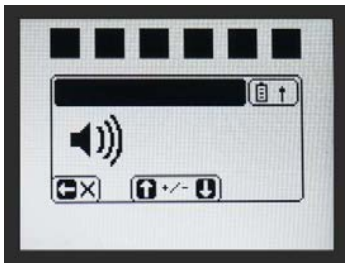
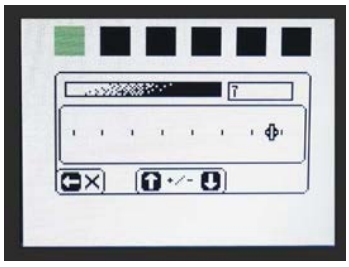
Boot menu

Functions	Callup / Description
	**Call up menu** ▶ With the wrench switched off, press and hold the ◀ button on the panel until this menu appears after switching on. **Select menu items** ▶ The individual menu items can be selected using the ▲ and ▼ buttons. The text of the selected point is inserted to the right. Press the ✔ button to start the selected menu item.
Standard	This can be used to restart the firmware as normal if the menu was called up by mistake.
Config 	This can be used to start the configuration mode for the OPEX®, which is used, for example, for commissioning the wrench and in future also for other user settings. Press the ✔ button to end this function and switch the wrench off again.
Console 	This allows the Command Line module to be started via the side USB interface for further service functions using an ASCII terminal. A detailed description of the Command Line module can be found in "OPEX® serial console", page 29).
Bootloader 	This can be used to start Bootloader (see "Firmware update with OPEX® Bootloader", page 81) to install new firmware for the OPEX®. Press the ✔ button to exit Bootloader and shut down the wrench.

Functions	Callup / Description
RF Module Reset 	This can be used to restore the factory settings for the xPico WLAN module. ▶ Use the ◀ and ▶ buttons to select between **Yes** and **No**. ▶ The selection can be confirmed with the ✔ button. **Notice:** **Loss of setting and function of the WLAN module possible!** An unintentional reset of the xPico WLAN module can lead to a failure of the radio link to the controller. ▶ If the wrench was delivered together with a WLAN base station, the xPico module configuration for this base station will also be lost. ▶ If you have called up this function by mistake, always select **No**. **Please note**: When resetting the xPico WLAN module to the factory settings, the factory settings of the manufacturer Lantronix are restored, not the settings made by Bosch Rexroth AG on delivery.

Graphic setup menu

Functions	Callup / Description
	**Call up menu** **1.** With the wrench switched off, press and hold the ▶ button on the panel until the **Service** display appears.
	After releasing the button, a pin code query appears. **2.** Use the ◀ and ▶ buttons and to navigate the cursor for the digit to be set. **3.** Use the ▲ and ▼ buttons to set the value and then confirm the pin code with the ✔ button. **Please note:** • The pin code can be changed by the user with OPEXwin® via the USB cable on the side. • The factory setting for the pin code is **12345**.
	If the pin code is invalid, the tool information is shown on the display: ▶ The wrench can be switched off using the ◀ or ✔ buttons.
	A valid pin code takes you to the graphic setup menu: ▶ Use the ◀ and ▶ buttons to navigate the animated cursor to the icon with the desired menu item. ▶ Use the ✔ button to select the desired menu item.

Functions	Callup / Description
Exit setup menu 	This allows you to exit the graphical setup menu and return to the main menu.
Gauge  	This can be used to set the standard gauge (see "Gauge", page 44) for the torque measurement technology if this is not provided by the parameter set used (e.g. for manual parameterization). ▶ The cursor can be navigated using the ◀ and ▶ buttons. ▶ Press the ◀ button again to exit the gauge setting without accepting the value. ▶ The value for the gauge can be changed using the ▲ and ▼ buttons. ▶ Press the ✔ button to save the newly set value for the gauge.
Volume  	The volume of the acoustic piezzo signal transmitter can be set in this menu item. ▶ The volume can be changed using the ▲ and ▼ buttons. ▶ Press the ✔ button to accept the new volume. ▶ You can exit the volume setting again by pressing ◀.
Backlighting  	The brightness of the TFT display backlighting can be changed here. ▶ The brightness can be changed using the ▲ and ▼ buttons. ▶ Press the ✔ button to accept the new volume. ▶ You can exit the volume setting again by pressing ◀.

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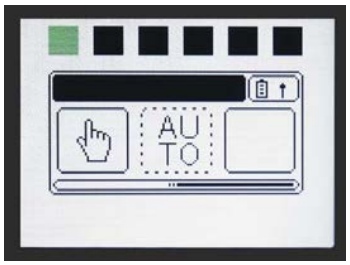
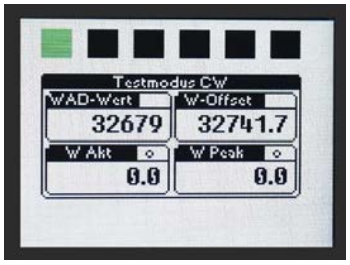
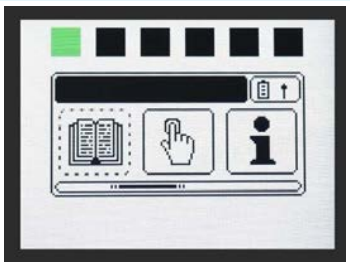
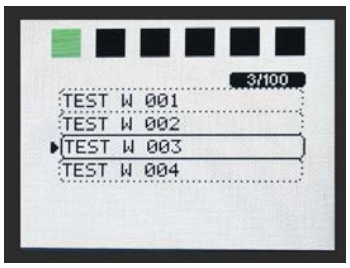
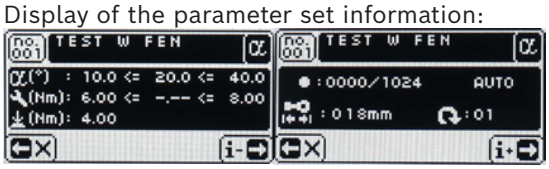
Functions	Callup / Description
Confirmation of a rundown  	This setting makes it possible to adjust the behavior of the wrench when ending a rundown. ▶ Either the wrench automatically jumps to the result display after releasing, or the rundown must also be acknowledged with the ✔ button after releasing. Only then does the wrench jump to the result display and is ready for the next rundown.
Extras  	This can be used to call up further service functions. ▶ A service function can be selected using the ▲ and ▼ buttons. ▶ The service function can be started using the ✔ button ▶ Press ◀ to return to the main menu.
Extras sub-functions: • ***Test mode CW*** • ***Test mode CCW*** 	This can be used to test or counter-measure the angle measurement of the wrench. ▶ The ✔ button can be used to reset the angle values to zero. ▶ The wrench can be tared again with the ▼ button. ▶ Test mode can be ended with the ◀ button.
• ***Internal Accesspoint***	This service function can be used to reactivate the internal access point of the xPico WLAN module if it was switched off for security reasons after the wireless module was set up.
• ***xPico Reset***	This can be used to restore the factory settings of the xPico WLAN module.
• ***Signal Simulation***	This is used to simulate the activation of all possible signals, e.g. to measure the radiation emitted by of the wrench.
• ***Signal Test***	Here, the signals can be tested individually one after the other, e.g. during commissioning or maintenance of the wrench. • All signals off • Horn quiet • Horn loud • [...]
• ***Reboot->Config Mode***	The wrench can be restarted in configuration mode here.
• ***Reboot->Terminal***	Here the wrench can be restarted in the command line interface in the console.

Functions	Callup / Description
• ***Reboot->Bootloader***	This can be used to restart Bootloader to install new firmware.

Main menu

Functions	Callup / Description
	The most important functions of OPEX® can be called up in the main menu. This is particularly important for stand-alone operation. ▶ Use the ◀ and ▶ buttons to navigate to the icon of the desired menu item. ▶ Use the ✔ button to select the desired menu item.
Setup menu 	After a successful pin code request, the graphic setup menu appears.
Parameter set operation 	Selecting this icon takes you to measurement mode with OPEXwin® parameterized parameter sets. ▶ Press ◀ to return to the main menu. ▶ If more than one parameter set has been parameterized, press the ▶ button to access the **Parameter Set Selection** menu.
Parameter set operation  	▶ Press the ◀ button to return to parameter set mode. ▶ A new parameter set can be selected using the ▲ and ▼ buttons and started with the ✔ button. ▶ Use the ▶ button to display additional information on the selected parameter set. Display of the parameter set information:  – Press ◀ to return to the parameter set selection menu. – You can switch between the display levels using the ▶ button.

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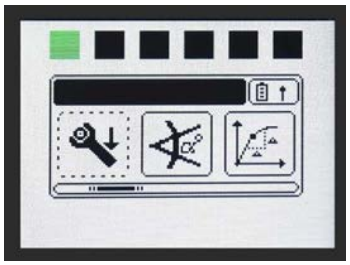
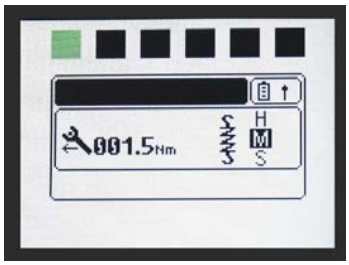
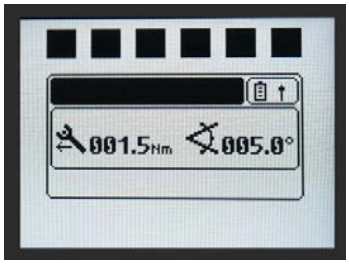
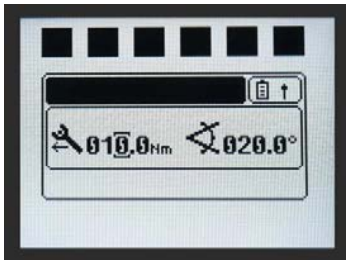
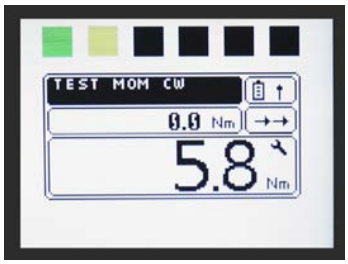
Functions	Callup / Description
Manual parameterization  	Manual parameterization makes it possible to parameterize and start a simple parameter set (without a quality window) directly on the OPEX®. ▶ Use the ◀ and ▶ buttons and to navigate to the icon of the desired menu item. ▶ Use the ✔ button to select the desired menu item for manual parameterization.
Manual parameterization sub-functions	▶ In the parameterization screens, the cursor can be navigated using the ◀ and ▶ buttons or the parameterization screen can be exited by navigating the cursor to the left stop. ▶ Use the ▲ and ▼ buttons to change the parameters. ▶ The rundown can be started using the ✔ button.
• ***Exit manual parameterization*** 	This allows you to exit the manual parameterization menu and return to the main menu.
• ***Manual parameterization***  	With the manually parameterized torque-controlled rundown, the following parameter can be parameterized: • Nominal torque The joining torque corresponds to the minimum torque of the measurement technology of the wrench (2% of the nominal load capacity, e.g. 4 Nm with a nominal load capacity of 200 Nm).
• ***Rotation angle rundown mode***  	The following parameters can be parameterized for the manually parameterized angle controlled rundown: • Joining torque • Nominal angle

Functions	Callup / Description
• ***Yield strength rundown mode***  	The following parameters can be parameterized for manually parameterized yield point controlled rundowns: • Joining torque • Screw joint hardness – H: hard, M: medium, S: soft
• ***Prevail torque rundown mode***  	The following parameters can be parameterized for manually parameterized angle controlled rundowns to determine the prevail torque: • Joining torque • Extension angle
• ***Release/tighten rundown mode***  	The following parameters can be parameterized for manually parameterized angle controlled rundowns to determine the retightening torque: • Joining torque • Release/retighten angle
• ***Show tool information***  	The most important tool information is displayed here. • Hardware version • Firmware version • Serial number • Set configuration ▶ Press ◀ or ✔ to return to the main menu.

ENGLISH

7.2.2 Measurement screens

Measurement

Display	Description
Torque-controlled 	When measuring a torque-controlled rundown, the following measured variables are displayed: • Secondary size: Current life torque • Main size: Currently determined peak torque (peak)
Angle controlled 	The following measured variables are displayed for an angle controlled rundown: displayed here: • Secondary size: Current peak torque (peak) • Main size: Current peak rotation angle (peak)

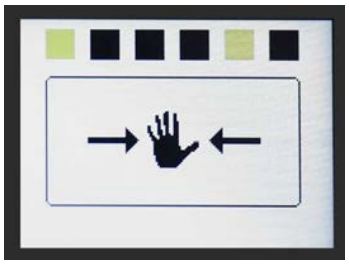
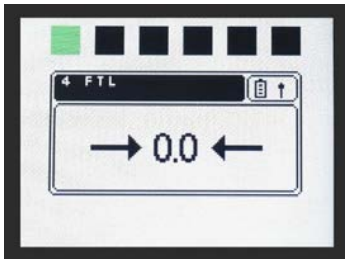
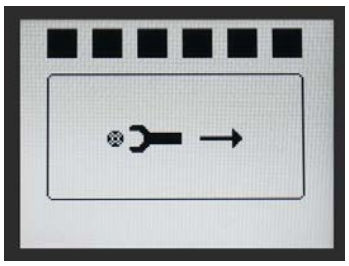
Result display

Display	Description
Torque-controlled   	Depending on the rundown mode, the following measured variables are displayed: • Torque • Rotation angle • Yield strength – Peak rotation angle reached – Peak torque reached • Prevail torque – Peak rotation angle reached – Peak torque reached at the parameterized prevail angle • Release/retighten – Peak torque reached in the release phase – Peak torque reached in the retightening phase when the retightening angle is reached

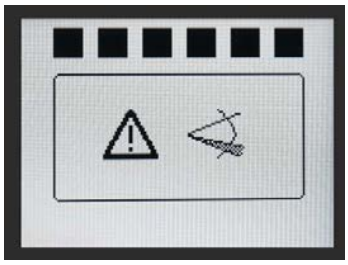
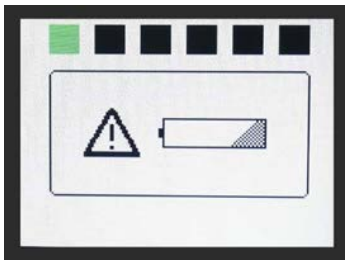
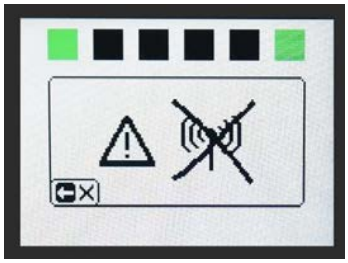
Monitoring stage

Display	Description
Torque-controlled 	Depending on the tool configuration, the monitoring stage is started outside of measuring mode. This allows the wrench to be monitored against unintentional operation.

Other displays in measuring mode

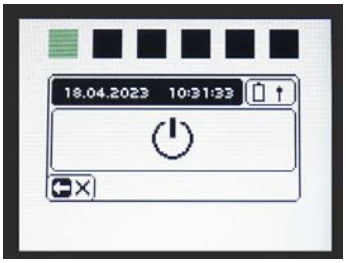
Display	Description
Stop display 	The display indicates that the nominal value or the stop criterion of the rundown has been reached and prompts the user of the wrench to relieve the load.
Taring 	The torque measurement technology of the wrench is re-tared. ***NOTICE:*** The wrench must be **completely relieved of load** during taring.
Load relief 	The user is prompted to relieve load from the wrench and leave the screw position.

Fault displays

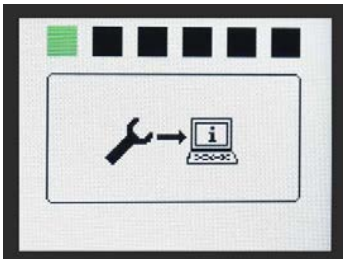
Display	Description
Overload 	The torque measuring head has been overloaded. The rundown is aborted. (NOK result) ▶ The user must relieve load from the tool immediately.
Tightened too quickly 	The wrench was tightened outside the maximum permissible angular speed. The rundown is aborted. (NOK result)
Battery warning 	The battery is almost flat and should be recharged or replaced with a charged battery. ***NOTICE:*** Continued use of the wrench with a flat battery can lead to the loss of tightening results.
Transmission problem 	A problem has occurred with the radio link to the external controller when transmitting a tightening result or a screwdriving curve. The wrench continues trying to re-establish the radio link and transmit the data again. The user then has the option of ensuring sufficient WLAN coverage of the wrench again. ▶ This process can be canceled with the ◀ button. ***NOTICE:*** Interrupting the re-establishment of the radio link will cause a loss of the data being transmitted.

7.3 Measuring operation with the OPEX®

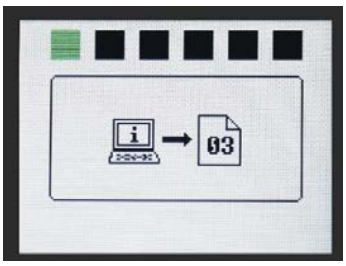
7.3.1 Stand-alone operation with OPEXwin® parameterization



Standby: Wrench is not parameterized



Read out tool configuration

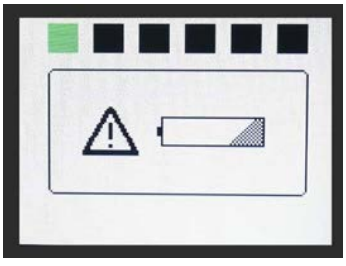


Parameterize tool configuration

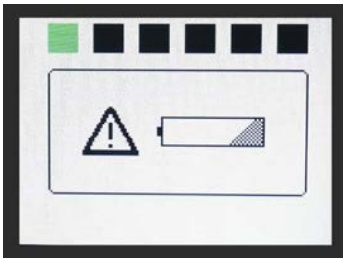
Select a parameter set

Perform measurement

Display / save result



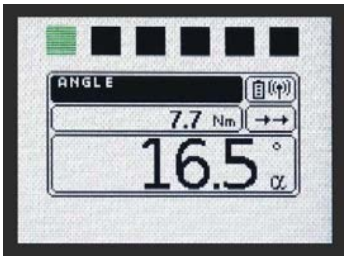
Read out final value information



Read out / delete final values

7.3.2 WLAN operation with external controller

Standby: Wrench is stopped or not parameterized

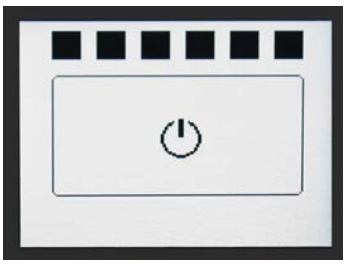


Measurement started

Result / screwdriving curve is sent to external controller

Result is displayed

7.3.3 Shutdown



Wrench is shut down

7.4 Switching the tool on / off

7.4.1 Switching on

- After charging the batteries, the hand tool must be switched on once by pressing a button.
  Automatic shutdown is deactivated when the radio link is activated.

Please note:

If it is available, the tool should be placed on the charging cradle regularly after use to avoid total discharge of the hand tool battery in continuous operation.

To parameterize the tool with the OPEXwin® PC software, it must be connected to the PC via the cable interface, using the USB cable supplied. When using a WLAN connection, no cable needs to be used for stand-alone operation.

7.4.2 Switching off

- Press and hold the ✔ button on the control panel for approx. 6 seconds.

7.5 Charging and replacing batteries

7.5.1 Notes on handling batteries and rechargeable batteries

Observe the following instructions when using batteries and rechargeable batteries:

- Only operate the tool with batteries and rechargeable batteries approved by the manufacturer.
- Only recharge the batteries with a charger that is approved by the manufacturer.
- Comply with the instructions of the battery manufacturer when working on the batteries.
- No not use any battery or rechargeable battery that shows signs of damage!
- Dispose of batteries and rechargeable batteries correctly in accordance with the applicable regulations in your country (see section "Disposal", page 85).
- To prevent data from being lost in the internal memory of the OPEX®, the tool should always be switched off before opening the battery compartment.
- If the wrench is kept in storage for a lengthy period of time, it is advisable to remove the batteries and to check their load state to prevent deep discharge.

7.5.2 Charging the battery

⚠ CAUTION

Risk of electric shock and short circuit

Electrostatic charge can cause restrictions in the operation of the OPEX® or an electric shock or short circuit.

- ▶ Perform grounding using a grounding cable at the ground terminal of the charging tray.

⚠ CAUTION

Risk of injury due to incorrect batteries or incorrect use

The use of batteries that have not been approved by the manufacturer or charging batteries that are not rechargeable can cause injury due to overheating, explosion and toxic vapors escaping.

- ▶ Do not attempt to recharge non-rechargeable batteries.
- ▶ Do not place the measuring tool on the charging tray if non-rechargeable batteries are in use.
- ▶ Only use type 21700 rechargeable batteries with a corresponding safety circuit which have been approved by the manufacturer.

NOTICE

Incorrect charging accessories

Using incorrect accessories can cause failure and damage to the product.

- ▶ Only use the charger and accessories supplied with the charging tray.
- ▶ To safely dissipate electrostatic discharge, use the grounding connection of the charging cradle to connect the grounding cable.

Only use the following charging options to charge the batteries:

- Chargers approved by the manufacturer
- The OPEX® charging cradle with the corresponding voltage supply (see "OPEX® charging cradle", page 14).

7.5.3 Changing the battery / rechargeable battery

A cell is installed in the handle of the tool to operate the OPEX®.

Fig. 19: Battery compartment in the handle of the OPEX® torque wrench

1. Switching off the handheld screwdriver
2. Unscrew the screw cap of the battery compartment at the back of the handle.

CAUTION:

- Damaged batteries must not be reused.
- Battery acid is corrosive to the skin. Avoid contact with liquids leaking from the battery with skin, eyes and clothing.

3. Remove the cell and replace it with a new or charged one.
   When inserting (rechargeable) batteries **pay attention to the correct polarity**. The anode of the battery (positive pole side with contact pad) must point towards the measuring head, and the cathode must point towards the battery screw cap.
4. Screw the screw cap back on.

7.6 Reading the barcode

- Start the scan process by pressing the **Scan button** .
  If the barcode is read successfully, it is sent as an event from the tool to the master PC.

7.7 Shutting down in an emergency

If a malfunction, smell of smoke, damage or a defect is detected on the OPEX®, it must be shut down immediately.

1. Unscrew the screw cap of the battery compartment at the back of the handle.
2. Remove the battery.

Please refer to "Changing the battery / rechargeable battery", page 77.

7.8 Tilt function of the measuring head

To improve the visibility of the display at the screwdriving point, the tool can be tilted to the left or right.

1. Press the measuring head into the tool until the bayonet catch releases.
2. Snap the measuring head into a new position.

Please note:

If it is necessary to rotate the tool by 180°, an opposite effective direction of rotation can alternatively be parameterized in the parameter set (e.g. CCW instead of CW) so that the display remains visible.

8 Maintenance and repair

⚠ CAUTION

Use of incorrect replacement parts.

Incorrect or faulty replacement parts can cause damage, malfunctions or a total failure and can also affect safety.

- Only use original spare parts.
- Procure all replacement parts from Bosch Rexroth AG.

If you have any questions regarding maintenance or repair, please contact the Bosch Rexroth AG service department, Tel: +49 9352 40 50 60, e-mail: service.svc@boschrexroth.de

8.1 Cleaning and care

⚠ CAUTION

Harmful cleaning agents

Using cleaning agents that contain solvents or aggressive detergents or using such substances incorrectly can constitute a health hazard or a risk of injury.

- Never use solvents or aggressive detergents.
- Comply with the instructions of the cleaning agent manufacturer.
- Keep away from ignition sources.

NOTICE

Improper use of cleaning agents

Improper use of cleaning agents can cause damage to the unit and to the environment!

- Only use suitable cleaners!
- Only clean the product with water and a slightly moist cloth.
- Comply with the instructions of the cleaning agent manufacturer.
- Do not apply cleaning agents directly onto the unit.
- Comply with the instructions regarding disposal.

8.1.1 Cleaning the housing

Use a solvent-free surface cleaner that is also suitable for TFT screens to clean the outside and the display of the OPEX®.

Take care not to apply the cleaner directly to the tool. Use a soft cleaning cloth on which you apply the cleaner and check that the cloth is free of dirt.

8.1.2 Clean the screw cap of the battery compartment

If the battery is changed frequently, the contact surfaces of the battery screw cap should be treated with contact cleaner to prevent contact problems. Use an oxide-dissolving contact cleaner for this purpose.

Avoid direct application here too.

Use a cleaning cloth to treat the inner and outer threads of the battery cover and the contact spring.

8.2 Maintenance

To ensure trouble-free operation of the OPEX®, it is advisable to check the calibration and carry out a detailed status check every year.

Further measures are listed in the table below:

Tab. 6: Maintenance

Maintenance interval in years	Measure1
1	Calibration and status check by qualified personnel
2 – 3	Replacing the storage battery
Maximum 3	Change connecting cables if necessary

8.3 Repair

Please note

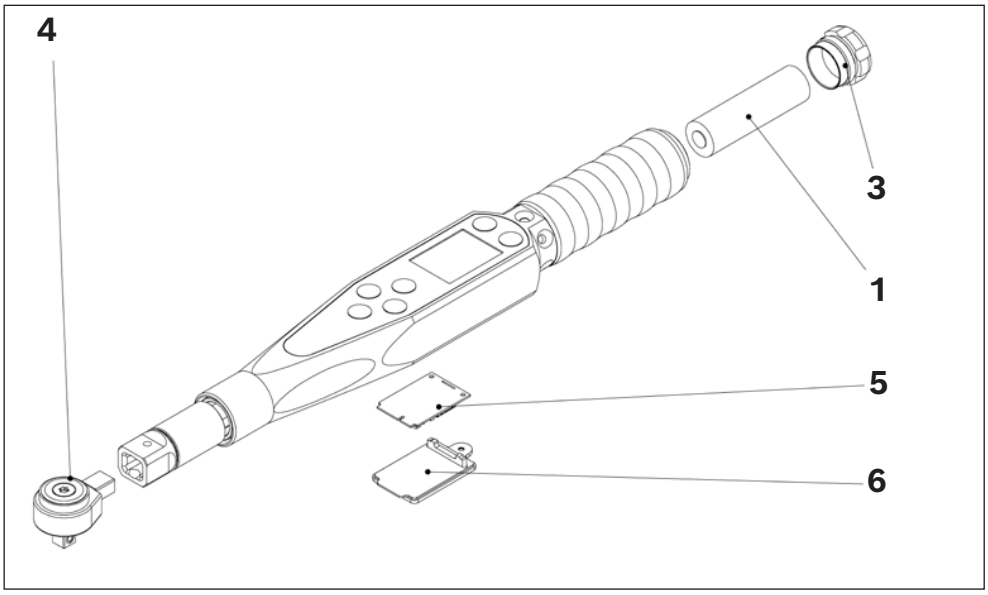
The repair of defective OPEX® torque wrenches by the operator is not intended. Opening the appliance housing will invalidate warranty and guarantee entitlement.

The product must not be modified.

Always send the defective device to Bosch Rexroth AG Service for repair.

8.4 Spare parts

The following spare parts are available for the OPEX® torque wrench:



1 Rechargeable battery 3.6 V / 5000 mAh

2 Interface cable (standard USB A to USB C)

3 Screw cap (battery cap)

4 Fine-tooth insert ratchet (variants for different tool sizes)

5 WLAN module

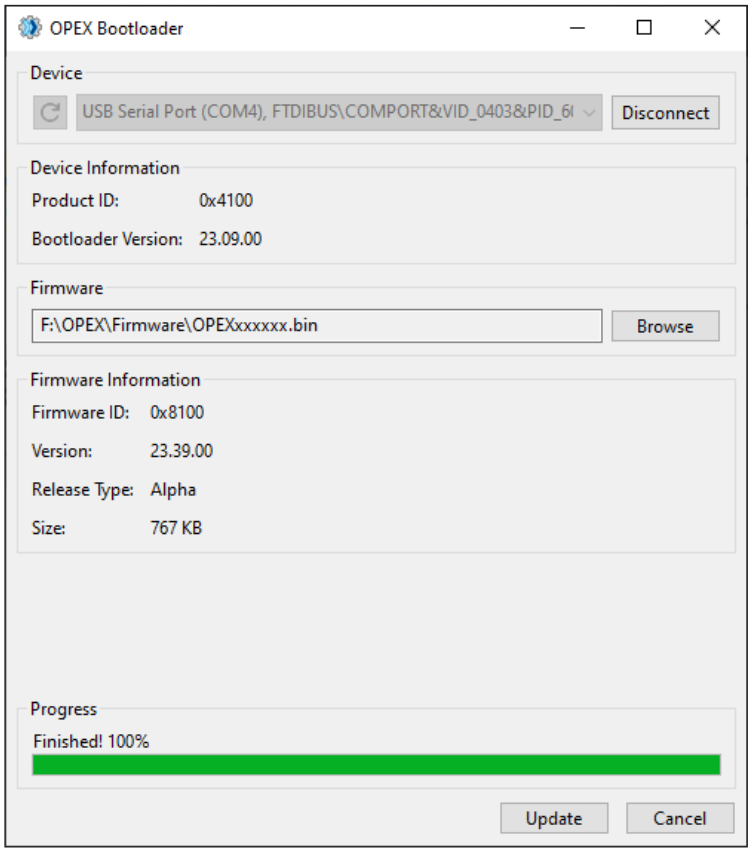
6 Bottom cover

The spare parts listed can be found in the OPEX® compact catalog (EN: R999002329).

Download at www.boschrexroth.com/en/us/download-center

9 Firmware update with OPEX® Bootloader

The OPEX® Bootloader allows a firmware update to be installed on the wrench using the USB interface on the side.



9.1 Preparations for the firmware update

NOTICE

Incorrect firmware

Loading software can have unforeseeable consequences. At worst, the torque wrench may be rendered unusable.

- ▶ Always make sure that the firmware version that is loaded is valid for the wrench.

9.1.1 Required files

The Bootloader Tool for Windows and the firmware file to be installed are required to carry out a firmware update.

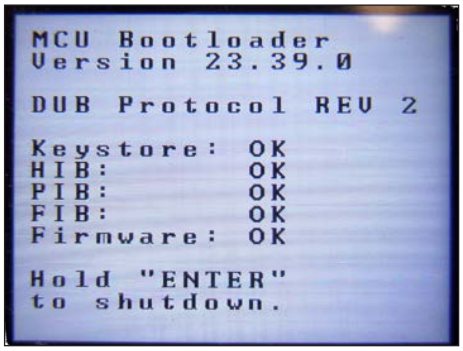
- Bootloader.exe (Bootloader client)
- OPEXxxxxx.bin (firmware binary file)

9.1.2 Saving the OPEXwin® parameterization

Depending on the OPEXwin® parameterization, this must be saved before the firmware update and deleted in the OPEX®, as the internal memory structures may have changed between two different firmware versions.

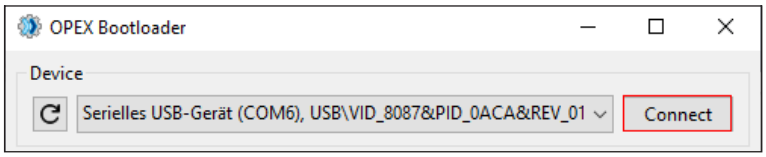
9.1.3 Start Bootloader

- ▶ With the wrench switched off, simultaneously press the ◀ and ✔ buttons on the panel until the wrench indicates on the display that Bootloader has started



9.1.4 Connection setup

1. Start the Bootloader application and select the COM port of the wrench.
2. Click on the **Connect** button.



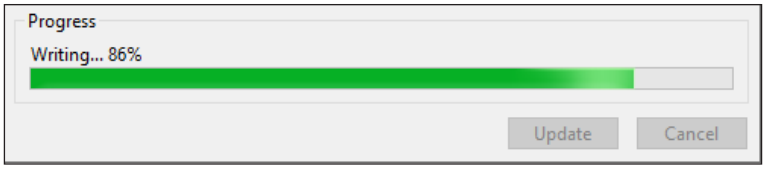
After successful connection to Bootloader has been established, the tool information is displayed:

9.1.5 Select binary file

▶ Click on the **Browse** button and then select the appropriate binary file with the firmware to be installed.
If it is a valid binary file, the firmware information is displayed.

9.1.6 Performing a firmware update

1. Click on the **Update** button and start the firmware update.



2. Once the update is complete, click on the **Disconnect** button and close the program.

3. Press and hold the ✔ button on the panel until the wrench switches off.

10 Decommissioning

Proceed as follows when decommissioning the torque wrench:

1. Switch off the torque wrench.
2. If present, disconnect the cable connection between the torque wrench and the system control.
3. Remove the battery from the torque wrench.

10.1 Prepare the OPEX® torque wrench for storage/further use

- Protect the product from environmental influences such as dirt and moisture.
- Protect the product from mechanical impact.
- Observe the ambient conditions, see "Technical data" from page 87.

11 Removal and replacement

⚠ CAUTION

Applied electrical voltage!

Risk of injury by electric shock.

- ▶ Switch the OPEX® off and disconnect it from the power supply or remove the batteries before disassembly/exchange.
- ▶ Wear the necessary protective clothing.

11.1 Removal

The wrench must be dismantled and completely disassembled for disposal.

- ▶ Remove the components using suitable tools.
- ▶ Work may only be carried out by qualified specialist personnel.

11.2 Replacement

11.2.1 Installing and replacing the wireless module

NOTICE

Applied voltage

The electronics of the WLAN wireless module can be damaged if it is changed with a battery inserted.

- ▶ Remove the battery from the handle of the screwdriving tool before changing the WLAN module.

An inspection flap is provided on the back of the OPEX® for installing and replacing the xPico 240 WLAN module.

- ▶ To do this, unscrew the Phillips screw provided to open the inspection flap.

NOTICE: The ribbon cable underneath must not be removed from the connector! Unintentional removal of this cable can damage the OPEX®!

12 Disposal

- The materials used are environmentally friendly.
- The possibility of reuse (if necessary after refurbishment and replacement of components) is provided for.
- Separate materials and packaging waste by type and recycle them.
- Disconnect electrical and electronic components in accordance with Directive 2012/19/EU.
- Electronic components such as printed circuit boards must be disposed of in accordance with national electronic waste regulations.
- Metal parts can be sent for metal recycling.
- Do not dispose of batteries and rechargeable batteries with household waste.
- Comply with the regulations on waste avoidance and proper waste recycling and disposal during all work. Dispose of the product, its components and accessories as well as the packaging in accordance with the national regulations of your country.
- Dispose of cleaning agents and aids used to clean the unit in accordance with local regulations and in compliance with the instructions in the manufacturer's safety data sheets.
- WEEE registration number: **EN 58406203**
  WEEE stands for "Waste of Electrical and Electronic Equipment" and refers to the European Directive (WEEE Directive) on the reuse and recycling of electrical and electronic equipment imported into the EU, manufactured in the EU and exported from the EU.

13 Extension and conversion

- Only the WLAN module (see "Installing and replacing the wireless module", page 84) may be installed or removed from the product.
- No other modifications may be made to the product.
- Bosch Rexroth's warranty only applies to the delivered configuration and extensions that were taken into account during configuration. The warranty expires after a conversion or extension that goes beyond the conversions or extensions described here.

14 Troubleshooting

The OPEX® can generally be operated trouble-free between maintenance intervals. Points that can be resolved by the operator are listed below. Contact the manufacturer in the event of other faults.

- Intermittent contact problems have been observed with frequent battery changes. This may cause the unit to switch off suddenly. The section "Clean the screw cap of the battery compartment", page 79 describes how to clean the contact surfaces correctly.
- The ageing of rechargeable batteries can lead to a significant reduction in operating times. How long a battery lasts depends heavily on usage and charging cycles. Replace the battery regularly and refer to the information in the section "Battery information", page 88.
- If the wrench cannot be switched on, check that the battery polarity is correct. The negative terminal of the battery must point towards the end of the handle.

If you are unable to rectify a fault that has occurred, please contact one of the addresses listed at www.boschrexroth.com.

15 Warranty

Bosch Rexroth AG products are covered by a two-year warranty (proof by invoice or delivery note).

Damage caused by natural wear and tear, overloading or improper handling is excluded from the warranty.

The warranty applies only to the delivered configuration.

The warranty will be invalidated in the event of incorrect installation, improper use and/or improper handling.

16 Service and sales

Our global service network is available to you at any time in over 40 countries. Detailed information about our service locations in Germany and worldwide can be found on the internet at: www.boschrexroth.com/en/us/service

We can help you quickly and efficiently if you have the following information ready:

- Detailed description of the fault and the circumstances
- Information on the type plate of the products concerned, in particular material and serial numbers
- Telephone and fax numbers and e-mail address where you can be reached for queries.

Additional information on service, repair and training as well as the current addresses of our sales offices can be found at www.boschrexroth.com

Outside Germany, please get in touch with your nearest contact person.

Service Germany

Tel.: +49 9352 40 50 60

e-mail: service.svc@boschrexroth.de

Sales Germany

Bosch Rexroth AG

Postfach 1161

71534 Murrhardt

Fornsbacher Str. 92

Tel.: +49 71 92 22 208

Fax : +49 71 92 22 181

e-mail: rfq.jt@boschrexroth.de

17 Technical data

17.1 General technical data

Voltage supply	1x Li ion battery, 3.6 V / 5000 mAh for approx. 8 hours of continuous operation
Display	IPS TFT 320x240 pixels
Torque measuring accuracy	±1% of the scale value (calibration range according to DIN/ISO 6789 from 10% to 100% of the nominal load capacity)
Torque display	2% to 110% of the nominal load capacity, resolution 0.1 Nm or 0.01 Nm (adjustable)
Rotation angle measuring accuracy	± 1° absolute (based on a nominal rotation angle of 100°)
Rotation angle display	Maximum rotation angle 6400°, resolution 0.1°
Temperature range	+0 °C to +40 °C
Humidity	20% to 80%, non-condensing
Permissible altitude	up to 3000 m
IP protection class	IP20 (DIN EN 60529)
Degree of contamination	Degree of contamination 2 (DIN EN 6101-1)
Noise emission	approx. 65 dB
Vibration emission	< 2.5 m/s^2

17.1.1 OPEX® torque

Measuring head [Nm] (rated load capacity)	**30**	**60**	**100**	**200**	**300**	**400**	**600**	**800**
Display resolution [Nm] (recommended)	0,01	0,01	0,01	0,1	0,1	0,1	0,1	0,1
Accuracy (% of scale value)	± 1	± 1	± 1	± 1	± 1	± 1	± 1	± 1
Max. torque load capacity [Nm]	30	60	100	200	300	400	600	800
Display range [Nm]	0,6 – 33	1,2 – 66	2 – 110	4 – 220	6 – 330	8 – 440	12 – 660	16 – 880
Measuring range [Nm]	3 – 30	6 – 60	10 – 100	20 – 200	30 – 300	40 – 400	60 – 600	80 – 800

17.1.2 OPEX® dimensions (without tool insert)

Measuring head [Nm]	**30**	**60**	**100**	**200**	**300**	**400**	**600**	**800**
Length [mm]	417	427	427	520	799	799	1045	1045
Width [mm]	50	50	50	50	50	50	50	50
Height [mm]	32	32	32	32	32	32	38	38
Weight [kg]	approx. 1.0	approx. 1.0	approx. 1.0	approx. 1.2	approx. 1.8	approx. 1.8	approx. 2.4	approx. 3.0
Square mount [mm]	9·12	9·12	9·12	14·18	14·18	14·18	14·18	14·18
Output drive	3/8"	3/8"	1/2"	1/2"	1/2"	3/4"	3/4"	3/4"
Gauge of reversible ratchet head [mm]	18	18	18	25	25	25	30	45

17.2 Battery information

Battery information as per European Directive 2006/66/EC. contains the technical details of the cells used.

Model	Fenix ARB-L21-5000
Technology	Lithium ion battery
Type	21700
Protective circuit	Short circuit, overcharging, deep discharge
Nominal voltage	3.6 V
Capacity	5000 mAh
Weight per cell	approx. 73 g
Charging current	1 A recommended / 5 A maximum
Size (D x H)	21.5 mm x 76.0 mm

17.3 Charging cradle technical data

Charging cradle input	DC 9 V / 2.22 A
Power supply input	AC 110 - 230 V / 0.5 A
Ambient temperature [°C]	0 – 40 °C

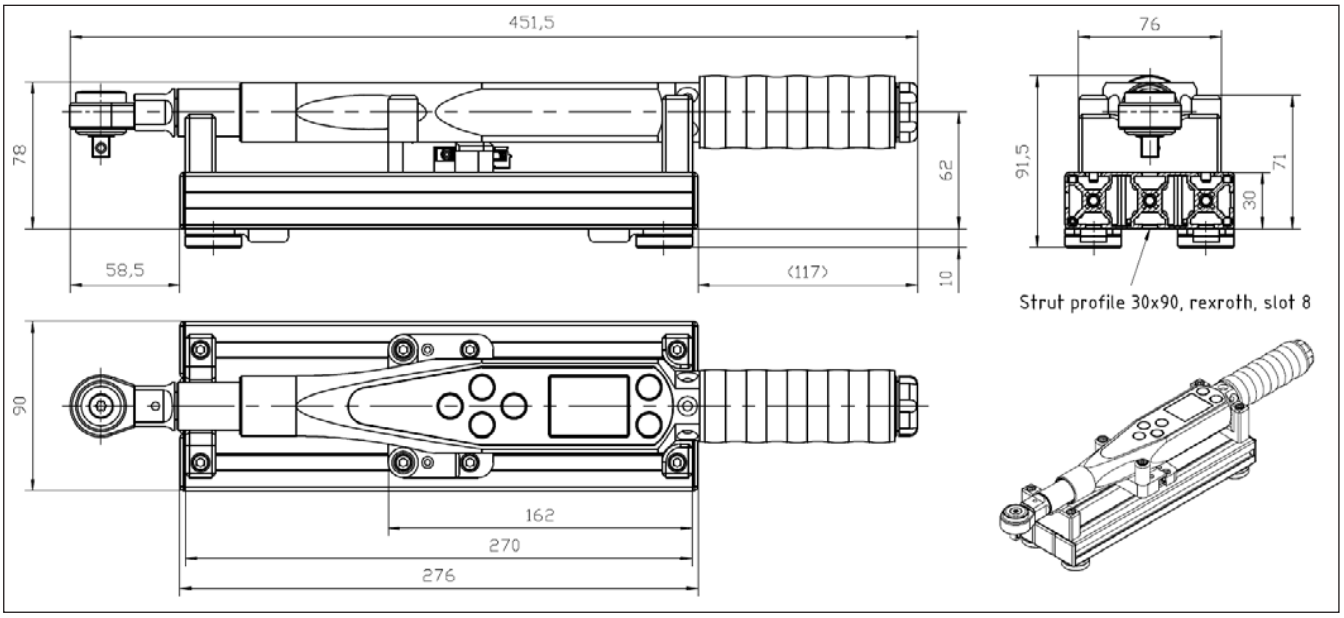


Fig. 20: Size 30 Nm (dimensions in mm)

Measuring head [Nm]	**30**	**60**	**100**	**200**	**300**	**400**	**600**	**800**
Length [mm]	274	274	274	354	604	604	804	1204
Width [mm]	80	80	80	80	80	80	80	80
Height[1)] [mm]	61 (71)	61 (71)	61 (71)	61 (71)	61 (71)	61 (71)	61 (71)	61 (71)
Weight[2)] [kg]	0.7	0.7	0.7	0.9	1.3	1.3	1.6	2.3

[1)] Values in brackets including appliance feet

[2)] Weight of the charging cradle without plug-in power supply unit

17.4 Protective cover technical data

Material	NBR
Hardness [Shore A]	40 – 50
Weight [g]	70
Ambient temperature [°C]	-10 - 80 °C

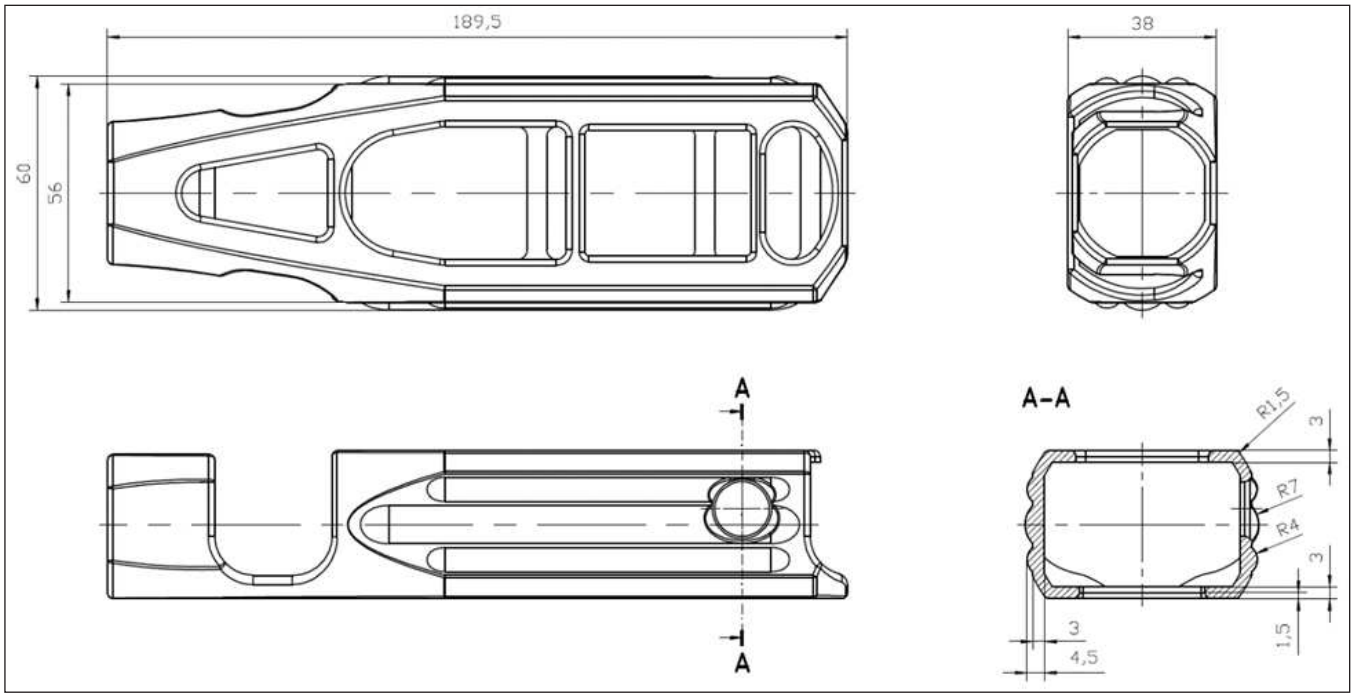


Fig. 21: Protective cover (dimensions in mm)

17.5 WLAN wireless module technical data

Transmission standard	IEEE 802.11 a/b/g/n
Frequency range:	
Europe	2.412 – 2.472 GHz 5.180 – 5.845 GHz
Australia/New Zealand	2.412 – 2.472 GHz 5.150 – 5.250 GHz 5.250 – 5.350 GHz 5.470 – 5.600 GHz 5.650 – 5.725 GHz
Argentina	2.412 - 2,472 GHz 5.150 – 5.250 GHz 5.250 – 5.350 GHz 5.470 – 5.600 GHz 5.650 – 5.725 GHz 5.725 – 5.850 GHz
Brazil	2.412 – 2.472 GHz 5.150 – 5.250 GHz 5.250 – 5.350 GHz 5.470 – 5.725 GHz 5.725 – 5.850 GHz
China	2.412 – 2.472 GHz 5.150 – 5.250 GHz 5.150 – 5.350 GHz 5.725 – 5.850 GHz
South Africa	2.412 – 2.472 GHz 5.150 – 5.350 GHz 5.470 – 5.725 GHz 5.725 – 5.875 GHz
USA	2.412 – 2.462 GHz 5.150 – 5.350 GHz 5.470 – 5.895 GHz 5.925 – 7.125 GHz
Canada	2.412 – 2.462 GHz 5.150 – 5.250 GHz 5.250 – 5.350 GHz 5.470 – 5.600 GHz 5.650 – 5.725 GHz 5.725 – 5.850 GHz
Safety	WPA, WPA2, WMM, WMM-PS (UAPSD), WMMSA, AES, TKIP
Output power	Max. 17 dBm ±2dBm @ 2.4 GHz Max. 13 dBm ±2dBm @ 5 GHz

18 Legal Information

18.1 Legal information for the USA

Includes FCC ID: R68XPICO200

FCC statement – §15.19(a)3:

"This device corresponds to Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."

FCC caution - §15.21:

"Changes or modifications not expressly approved by the party responsible for compliance could void the user‘s authority to operate the equipment."

FCC statement – §15.105(b):

"This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help."

Responsible party information – §2.909:

"Identification of the responsible contractual party (who must be located in the United States) on the basis of name, address and telephone number or internet contact information."

18.2 Legal information for Canada

Includes IC: 3867A-XPICO200

CAN ICES-003(A) / NMB-003(A)

RSS-Gen statement:

„Dieses Gerät entspricht den lizenzfreien RSS-Standards von Industry Canada. Der Betrieb unterliegt den folgenden beiden Bedingungen: (1) Dieses Gerät darf keine Störungen verursachen und (2) dieses Gerät muss jegliche Störungen tolerieren, einschließlich Störungen, die einen unerwünschten Betriebszustand des Geräts verursachen können.“

"This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device."

“Le présent appareil est conforme aux CNR d‘Industrie Canada applicables aux appareils radio exempts de licence. L‘exploitation est autorisée aux deux conditions suivantes : (1) l‘appareil ne doit pas produire de brouillage, et (2) l‘utilisateur de l‘appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d‘en compromettre le fonctionnement.“

18.3 Legal information for the EU

CE

Radio communications technology	: 2.4 GHz & 5 GHz WLAN
Operating frequencies	: 2.4 GHz and 5150-5350 MHz and 5470-5725 MHz
Transmission output	: 2.4 GHz: 17.22 dBm & 5 GHz: 17.50 dBm

19 Appendix - OPEX® tool communication

19.1 Bidirectional communication protocol for external controller

19.1.1 Tool communication

The tool is completely parameterized by the customer using the WLAN TCP interface. The exact procedure is described in the following section.

The values received are not checked for plausibility by the tool.

The transmitted parameter set always remains available in the tool until it is overwritten.

Once the rundowns have been completed, the tightening results are output by the tool. The rundown status (OK, NOK ...) is output by the tool using codes.

Data transmission is secured by creating checksums by continuously adding the transmitted bytes to an unsigned 16-bit value, which must be initialized with 0 before data transmission begins.

19.1.2 Terminology

- **Joining torque:**
  Torque threshold from which angle measurement starts.
- **Release torque:**
  Torque in the opposite direction to the preset direction of rotation (CW, CCW). This setting can be used to monitor whether the fitting has been subjected to impermissible stress in the release direction when moving a static drive (e.g. fork insert, without ratchet).
  Notice: Setting the value for the release torque to 0 deactivates this function.
- **Nominal angle:**
  Target rotation angle (in rotation angle rundown mode)
- **LAL, UAL:**
  Lower or upper limit of the rotation angle
- **Nominal torque:**
  Target torque (in torque rundown mode)
- **LTL, UTL:**
  Lower or upper torque limit
- **Rundown mode:**
  – Torque controlled (angle monitoring)
  – Angle controlled (torque monitoring)
  – Yield point controlled (torque and angle monitoring): Hard, Medium, Soft
- **Parameter byte:**
  Defines the unit (N*m, foot-pound) and direction of rotation (CW, CCW).
- **Result output format byte:**
  Determines whether only the final values reached or also the screwdriving curve should be output afterwards.

19.1.3 Tool parameterization

Preliminary remarks

- Torque and angle values consist of an unsigned 16-bit value, which is always transmitted with the higher value byte followed by the lower value byte.
- All torque values are transmitted multiplied by a factor of 10.
- Rundown mode selection:
  - Torque (rotation angle monitored): 1 byte (dec. 72)
  - Rotation angle (torque monitored): 1 byte (dec. 73)
  - Yield strength (torque and rotation angle monitored)
    hard: 1 byte (dec. 75)
    medium: 1 byte (dec. 76)
    Soft: 1 byte (dec. 77)
- Parameter byte:
  Defines the direction of action of the rundown and the torque unit.
  - Always set bit 0 to 1
  - Bit 1 to 0 Direction of action CW
  - Bit 1 to 1 Direction of action CCW
  - Bit 2 to 0 Torque unit Nm
  - Bit 2 to 1 Torque unit foot-pound
  - Always set bits 4,5,6,7 to 0
- Result output format byte:
  - Final value string only, 9600 Bd: 1 byte (dec. 0)
  - Final value string & screwdriving curve, 9600 Bd: 1 byte (dec. 1)

Tool parameterization sequence

→ Data is transmitted to the tool

← Data is received from the tool

Sequence		Description	Bites
1.	→	0xA3 (dec. 163) Transmit start code to tool	1
2.	←	Tool responds with 0xA3 (dec. 163)	1
		*** Start checksum generation ***	
3.	→	Transmit parameter set name (ASCII) to tool	20
4.	→	Transmit MSB (higher value byte) joining torque	1
5.	→	Transmit LSB (lower value byte) joining torque	1
6.	→	Transmit MSB release torque	1
7.	→	Transmit LSB release torque	1
8.	→	Transmit MSB nominal angle	1
9.	→	Transmit LSB nominal angle	1
10.	→	Transmit MSB LAL (lower angle limit)	1
11.	→	Transmit LSB LAL	1
12.	→	Transmit MSB UAL (upper angle limit)	1
13.	→	Transmit LSB UAL	1
14.	→	Transmit MSB nominal torque	1
15.	→	Transmit LSB nominal torque	1
16.	→	Transmit MSB LTL (lower torque limit)	1
17.	→	Transmit LSB LTL	1
18.	→	Transmit MSB UTL (upper torque limit)	1

Sequence		Description	Bites
19.	→	Transmit LSB UTL	1
20.	→	Result output format byte	1
21.	→	Transmit parameter byte	1
22.	→	Transmit rundown mode (type)	1
		*** End of checksum generation ***	
23.	→	Transmit MSB of checksum	1
24.	→	Transmit LSB of checksum	1
25.	←	Tool transmits confirmation (ready to measure) / fault 0xD2 (dec. 210) = OK, 0xD3 (dec. 211) = NOK	1

Transmission example based on a parameterization

Parameterizing the tool

In this example, the tool is parameterized with the following data:

- Rundown mode: Angle
- Direction of action: CW
- Parameter set name: "GEAR HEAD"
- Joining torque: 5.0 Nm
- LTL: 10.0 Nm
- UTL: 30.0 Nm
- Nominal angle: 45°
- LAL: 20°
- UAL: 60°
- Release torque: 12.0 Nm

Request: Incoming data to tool
Answer: Outgoing data from tool

Port opened with the "Parameter EST.exe" operation (PID: 3208)

Request: 20.05.2008 11:01:02.37064 (+210.0272 seconds)

```
A3                                                £
```

Answer: 20.05.2008 11:01:02.46464 (+0.0937 seconds)

```
A3                                                £
```

Request: 20.05.2008 11:01:02.46464 (+0.0000 seconds)

```
47 45 54 52 49 45 42 45 4B 4F 50 46 20 20 20 20   GEARHEAD
20 20 20 20 00 32 00 78 00 2D 00 14 00 3C 00 00       .2.x.-...<..
00 64 01 2C 00 01 49 06 79                        .d.,..I.y
```

Answer: 20.05.2008 11:01:02.52664 (+0.0156 seconds)

```
D2                                                Ò
```

Port closed

Stopping measurement

NOTICE: Answer 0xAF (175 dec) is also transmitted if the tool has already been stopped.

Port opened with the “Parameter EST.exe” operation (PID: 3208)

Request: 20.05.2008 11:09:57.14664 (+170.6910 seconds)

```
AF                                              ¯
```

Answer: 20.05.2008 11:09:57.59964 (+0.4527 seconds)

```
AF                                              ¯
```

Port closed

Parameterize, stop and parameterize again

Port opened with the “Parameter EST.exe” operation (PID: 3208)

Request: 20.05.2008 11:18:11.69364 (+95.7493 seconds)

```
A3                                              £
```

Answer: 20.05.2008 11:18:11.78764 (+0.0937 seconds)

```
A3                                              £
```

Request: 20.05.2008 11:18:11.78764 (+0.0000 seconds)

```
47 45 54 52 49 45 42 45 4B 4F 50 46 20 20 20 20   GEARHEAD
20 20 20 20 00 32 00 78 00 2D 00 14 00 3C 00 00       .2.x.-...<..
00 64 01 2C 00 01 49 06 79                        .d.,..I.y
```

Answer: 20.05.2008 11:18:11.84964 (+0.0156 seconds)

```
D2                                              Ò
```

Port closed

Port opened with the “Parameter EST.exe” operation (PID: 3208)

Request: 20.05.2008 11:18:12.27064 (+1.4205 seconds)

```
AF                                              ¯
```

Answer: 20.05.2008 11:18:13.72264 (+0.4527 seconds)

```
AF                                              ¯
```

Port closed

Port opened with the “Parameter EST.exe” operation (PID: 3208)

Request: 20.05.2008 11:18:14.94064 (+1.2175 seconds)

```
A3                                              £
```

Answer: 20.05.2008 11:18:14.03364 (+0.0937 seconds)

```
A3                                              £
```

Request: 20.05.2008 11:18:14.03364 (+0.0000 seconds)

```
47 45 54 52 49 45 42 45 4B 4F 50 46 20 20 20 20   GEARHEAD
20 20 20 20 00 32 00 78 00 2D 00 14 00 3C 00 00       .2.x.-...<..
00 64 01 2C 00 01 49 06 79                        .d.,..I.y
```

Answer: 20.05.2008 11:18:14.09664 (+0.0156 seconds)

```
D2                                              Ò
```

Port closed

19.1.4 Final value output tool & output codes

After completing a rundown, the tool transmits values and/or fault messages in the form (always 19 ASCII characters + 1 character CR): **"M:XXX.X W:YYY S:ZZZ", CR**

XXX.X:	Final torque value of the rundown
YYY:	Rotation angle end value of the rundown
ZZZ:	Status code of the rundown
CR:	"Carriage return" control character

A code (ZZZ) is added to the value string (XXX.X / YYY) according to the following list. This additional code can be used to evaluate the rundown status. If it is purely a status message, the measured values are output with 000.0 or 000.

Notice: Additional code ≥ 220: Battery status low, additional code < 220: Battery status OK (monitoring of the tool operating voltage).

Output after OK rundown

- 220 (092): OK rundown
  – „M:XXX.X W:YYY S:092“, CR

Output after NOK rundowns (general)

- 221 (093): Abort rundown
  – „M:XXX.X W:YYY S:093“, CR
- 222 (094): Pre-tightened screw detected
  – „M:000.0 W:000 S:094“, CR
- 223 (095): Release torque reached or exceeded
  – „M:000.0 W:000 S:095“, CR
- 224 (096): Tool overload
  – „M:000.0 W:000 S:096“, CR
- 225 (097): (Angle > UAL) & (Torque > UTL)
  – „M:XXX.X W:YYY S:097“, CR
- 226 (098): (Angle > UAL) & (Torque < LTL)
  – „M:XXX.X W:YYY S:098“, CR
- 227 (099): Angle > UAL
  – „M:XXX.X W:YYY S:099“, CR
- 228 (100): (Torque > UTL) (Angle < LAL)
  – „M:XXX.X W:YYY S:100“, CR
- 229 (101): Torque > UTL
  – „M:XXX.X W:YYY S:101“, CR
- 230 (102): Torque < LTL
  – „M:XXX.X W:YYY S:102“, CR
- 231 (103): Angle < LAL
  – „M:XXX.X W:YYY S:103“, CR

19.1.5 Tool screwdriving curve output (optional)

Depending on the result output format byte, the tool can be parameterized so that the curve values of the rundown are also output after the final value output.
To activate the curve output, the result output format byte must have the value 1.

The curve values are output immediately after the final value output.

The curve values are transmitted in a grid of 1°, the maximum angle value is 999°.

The number of curve values is represented by an unsigned 16-bit value. During transmission, the higher value byte is transmitted first, followed by the lower-value byte.

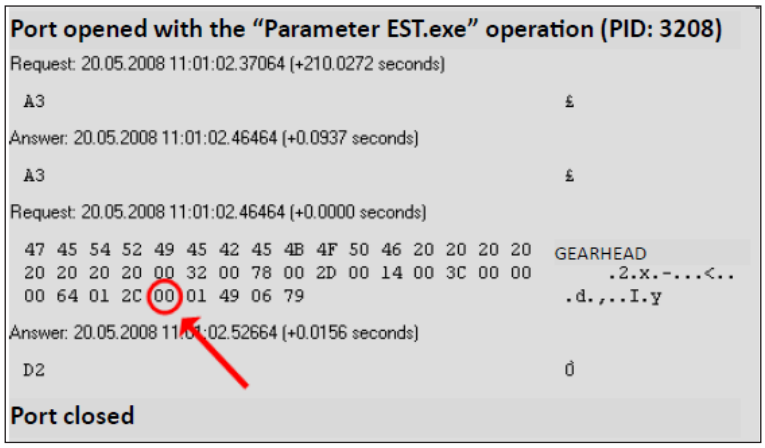
Output format

The curve values are transferred in the following data format:

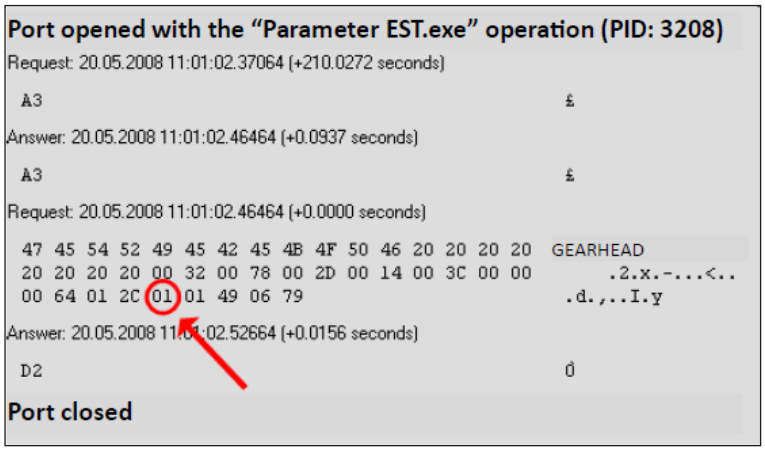
Sequence	Description	Bites
1.	0x02 (STX) Start character	1
2.	Number of curve values (higher value byte)	1
3.	Number of curve values (lower value byte)	1
4.	Torque value at 1° (higher value byte)	1
5.	Torque value at 1° (lower value byte)	1
...	...	...
...	...	...
5+(n-1)	Torque value for n° (higher value byte)	1
6+(n-1)	Torque value for n° (lower value byte)	1
7+(n-1)	0x03 (ETX) Stop character	1

19.1.6 Transfer examples: Parameterization of output format

Output format: Final value string only, 9600 Bd



Output format: Final value string & screwdriving curve 9600 Bd

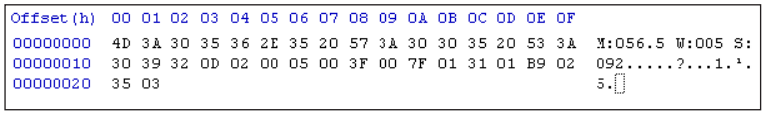


Transfer example: Final value and curve output

The following example shows a simplified example of the output of a screwdriving curve.

Angle	Torque value	Decimal value	Hexadecimal value
1°	6.3 Nm	63	0x003F
2°	12.7 Nm	127	0x007F
3°	30.5 Nm	305	0x0131
4°	44.1 Nm	441	0x01B9
5°	56.5 Nm (final value)	565	0x0235

The tool is parameterized so that the screwdriving curve is output after the end value string. This results in the following program:



19.1.7 Tool "Alive" signal

The operating status of the tool and the current connection status can also be queried via the WLAN interface.

If the tool is parameterized correctly and the parameter set is started so that the tool is ready for screwing, it reacts with an echo to the alive byte hexadecimal 0xB0.

If the tool is not ready for screwing but the radio link is established, the tool returns the value 0xB1 as an echo.

If no echo is returned, the tool is not ready to receive.

```
Request: 21.05.2012 15:03:29.85064 (+16.4844 seconds)
B0 B0 °°
Answer: 21.05.2012 15:03:29.91264 (+0.0625 seconds)
B0 °
Request: 21.05.2012 15:03:38.81864 (+8.9063 seconds)
AF ¯
Answer: 21.05.2012 15:03:38.88164 (+0.0625 seconds)
AF ¯
Request: 21.05.2012 15:03:45.28764 (+6.4063 seconds)
B0 °
Answer: 21.05.2012 15:03:45.35064 (+0.0625 seconds)
B1
```

NOTICE: The Alive signal function is blocked during the output of rundown results.

19.2 Open Protocol

19.2.1 Implementation and bibliographical reference

In OPEX®, the **Open Protocol Version 1.4 Revision 6** is implemented for communication with a higher-level controller.

Open Protocol is a communication protocol specified by Atlas Copco Tools and Assembly Systems.

The OPEX® provides a subset of this communication protocol which is based on the Atlas Copco specification version 1.4 revision 6.

The detailed and complete documentation is available from Atlas Copco under the number 9836 4415 01.

19.2.2 Open Protocol serial communication

Open Protocol integration types

Communication between the OPEX® screwdriver and the higher-level controller takes place via the serial PLC interface.

This can be integrated either via TCP/IP, e.g. by WLAN, or directly/serially, e.g. using RS232.

In the remainder of this description, the OPEX® is referred to as the "controller" and the higher-level controller as the "integrator".

The structure of the telegrams distinguishes between TCP/IP and serial integration by adding an STX (0x02) at the beginning and an ETX (0x03) at the end of the telegram for serial communication.

Therefore, the type of integration must be set on the OPEX® with a serial service function before commissioning.

Setting the Open Protocol integration type

The Open Protocol integration type can be set in the serial console (see "Open Protocol serial integration", page 31).

The standard Open Protocol integration type is set to TCP.

Telegram examples with different integration types

The following examples show an Open Protocol 1.4 telegram with the MID 0041 (tool data upload reply) with serial integration and with integration via TCP/IP.

In the rest of this description, integration via TCP/IP is always used.

Telegram example for serial integration:

```
<-- MID 0004 Tool Data Upload Reply:
 02 30 30 38 31 30 30 34  31 30 30 31 30 20 20 20  .0081004 10010
 20 20 20 20 20 30 31 57  45 52 4b 42 41 4e 4b 20       01W ERKBANK
 34 20 20 20 20 30 32 30  30 30 30 30 30 31 30 35  4    020 00000105
 34 30 33 32 30 31 38 2d  30 31 2d 31 38 3a 30 30  4032018- 01-18:00
 3a 30 30 3a 30 30 30 34  50 33 31 32 35 20 20 20  :00:0004 P3125
 PF 20 20 00 03                                          ..
```

Telegram example for TCP/IP integration:

```
<-- MID 0005 Tool Data Upload Reply:
 30 30 38 31 30 30 34 31  30 30 31 30 20 20 20 20  00810041 0010
 20 20 20 20 30 31 57 45  52 4b 42 41 4e 4b 20 34      01WE RKBANK 4
 20 20 20 20 30 32 30 30  30 30 30 30 31 30 35 34      0200 00001054
 30 33 32 30 31 38 2d 30  31 2d 31 38 3a 30 30 3a  032018-0 1-18:00:
 30 30 3a 30 30 30 34 50  33 31 32 35 20 20 20 20  00:0004P 3125
 20 00                                              .
```

The exact structure of a telegram, such as header, data field and message end, can be found in the Open Protocol Specification Version 1.4 Revision 6 from Atlas Copco.

For this reason, no further details are given in this functional description of the screwdriving tool. Open Protocol Version 1.4 Revision 6 is implemented on the tool side.

19.2.3 Communication messages for starting and stopping an Open Protocol session (Communication Messages)

MID 0001 Communication start (Revision 1)

The integrator uses a telegram with MID 0001 to request a connection to the controller.

MID 0002 Communication start acknowledge (Revision 1)

The controller confirms the connection to the integrator with a telegram with MID 0002.

MID 0003 Communication stop (Revision 1)

Before the controller terminates the connection, it sends a telegram with MID 0003 to the integrator to log off.

The integrator does the same when the connection to the controller is to be terminated.

Telegram example for establishing and terminating a connection in an Open Protocol 1.4 Revision 6 session

Sequence:

- MID 0001: Integrator requests an Open Protocol Version 1.4 Revision 5 connection.
- MID 0004: Controller returns a command error. (Not supported.)
- MID 0001: Integrator requests a version 1.4 revision 4 connection.
- MID 0004: Controller returns a command error. (Not supported.)
- MID 0001: Integrator requests a version 1.4 revision 3 connection.
- MID 0004: Controller returns a command error. (Not supported.)
- MID 0001: Integrator requests a version 1.4 revision 4 connection.
- MID 0004: Controller returns a command error. (Not supported.)
- MID 0001: Integrator requests a version 1.4 revision 3 connection.
- MID 0004: Controller returns a command error. (Not supported.)
- MID 0001: Integrator requests a version 1.4 revision 2 connection.
- MID 0004: Controller returns a command error. (Not supported.)
- MID 0001: Integrator requests a version 1.4 revision 1 connection.
- MID 0002: Controller confirms the connection setup with revision 1.
- MID 0040: Integrator requests the tool information from the controller
- MID 0041: Controller transmits its tool information to the integrator
- MID 0003: Integrator terminates the Open Protocol connection.

Telegram example:

```
--> MID 0001 Communication Start:
 30 30 32 30 30 30 30 31  30 30 35 30 20 20 20 20  00200001 0050
 20 20 20 20 00                                          .

<-- MID 0004 Command Error:
 30 30 32 36 30 30 30 34  30 30 30 30 20 20 20 20  00260004 0000
 20 20 20 20 30 30 30 31  39 37 00                     0001 97.

--> MID 0001 Communication Start:
 30 30 32 30 30 30 30 31  30 30 34 30 20 20 20 20  00200001 0040
 20 20 20 20 00                                          .

<-- MID 0004 Command Error:
 30 30 32 36 30 30 30 34  30 30 30 30 20 20 20 20  00260004 0000
 20 20 20 20 30 30 30 31  39 37 00                     0001 97.

--> MID 0001 Communication Start:
 30 30 32 30 30 30 30 31  30 30 33 30 20 20 20 20  00200001 0030
 20 20 20 20 00                                          .
```

```
<-- MID 0004 Command Error:
 30 30 32 36 30 30 30 34  30 30 30 30 20 20 20 20  00260004 0000
 20 20 20 20 30 30 30 31  39 37 00                     0001 97.

--> MID 0001 Communication Start:
 30 30 32 30 30 30 30 31  30 30 32 30 20 20 20 20  00200001 0020
 20 20 20 20 00                                        .

<-- MID 0004 Command Error:
 30 30 32 36 30 30 30 34  30 30 30 30 20 20 20 20  00260004 0000
 20 20 20 20 30 30 30 31  39 37 00                     0001 97.

--> MID 0001 Communication Start:
 30 30 32 30 30 30 30 31  30 30 31 30 20 20 20 20  00200001 0010
 20 20 20 20 00                                        .

<-- MID 0002 Communication Start Acknowledge:
 30 30 35 37 30 30 30 32  30 30 31 30 20 20 20 20  00570002 0010
 20 20 20 20 30 31 30 30  30 31 30 32 30 31 30 33      0100 01020103
 57 45 52 4b 42 41 4e 4b  20 34 20 20 20 20 20 20  WERKBANK  4
 20 20 20 20 20 20 20 20  20 00                             .

--> MID 0040 Tool Data Upload Request:
 30 30 32 30 30 30 34 30  30 30 31 30 20 20 20 20  00200040 0010
 20 20 20 20 00                                        .

<-- MID 0041 Tool Data Upload Reply:
 30 30 38 31 30 30 34 31  30 30 31 30 20 20 20 20  00810041 0010
 20 20 20 20 30 31 57 45  52 4b 42 41 4e 4b 20 34      01WE RKBANK 4
 20 20 20 20 30 32 30 30  30 30 30 30 31 30 35 34      0200 00001054
 30 33 32 30 31 38 2d 30  31 2d 31 38 3a 30 30 3a  032018-0 1-18:00:
 30 30 3a 30 30 30 34 50  33 31 32 35 20 20 20 20  00:0004P 3125
 20 00                                              .

--> MID 0003 Communication Stop:
 30 30 32 30 30 30 30 33  30 30 31 30 20 20 20 20  00200003 0010
 20 20 20 20 00                                        .
```

19.2.4 Reply messages to handshake request messages (Request reply messages)

MID 0004 Command Error (Revision 1)

The controller transmits a fault message for a request or command back to the integrator.

MID 0005 Command accepted (Revision 1)

The controller transmits a confirmation of a request or command back to the integrator.

Telegram examples

Telegram example for MID 0004:

```
<-- MID 0004 Command Error:
 30 30 32 36 30 30 30 34  30 30 30 30 20 20 20 20  00260004 0000
 20 20 20 20 30 30 30 31  39 37 00                     0001 97.
```

Telegram example for MID 0005:

```
<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 36 30  00                           0060 .
```

19.2.5 Parameter set messages (Parameter set messages)

MID 0010 Parameter set ID upload request (Revision 1)

The integrator requests the valid IDs of the parameter sets stored in the controller.

MID 0011 Parameter set ID upload reply (Revision 1)

The controller transmits a list of the valid IDs of the parameter sets stored in the controller to the integrator.

MID 0012 Parameter set data upload request (Revision 1)

The integrator requests the parameter set data for an ID of a parameter set stored in the controller.

MID 0013 Parameter set data upload reply (Revision 1)

The controller transmits the requested parameter set data for a parameter set ID stored in the controller to the integrator.

MID 0014 Parameter set selected subscribe (Revision 1)

The integrator subscribes to the manual selection of a parameter set stored in the controller directly on the controller. It is then possible to select a parameter set manually; the ID of the selected parameter set is then transmitted to the integrator after selection.

MID 0015 Parameter set selected (Revision 1)

After manually selecting a parameter set, the controller transmits the ID of the selected parameter set to the integrator directly on the controller.

MID 0016 Parameter set selected acknowledge (Revision 1)

The integrator confirms to the controller that it has received the sent ID of a parameter set selected manually on the controller.

MID 0017 Parameter set selected unsubscribe (Revision 1)

The integrator cancels the subscriber for the manual selection of a parameter set on the controller. After this, it is no longer possible to manually select a parameter set on the controller.

MID 0018 Select Parameter set (Revision 1)

The integrator selects a parameter set stored in the controller by sending the ID of the selected parameter set to the controller.

MID 0019 Set Parameter set batch size (Revision 1)

Enables the number of repetitions of a parameter set stored in the controller to be changed during the operating time. The integrator transmits the ID of the parameter set and the new number to the controller. The parameter set stored in the controller permanently adopts this new number.

MID 0020 Reset Parameter set batch counter (Revision 1)

Enables the repetition counter to be reset to the value 0 for a parameter set with several repetitions.

Telegram example for MID 0010 and MID 0011

- **MID 0010:** The integrator asks the controller for the list of valid IDs of the parameter sets stored in the controller.
- **MID 0011:** The controller transmits the list of valid IDs of the parameter sets stored in the controller to the integrator

Telegram example:

```
--> MID 0010 Parameter Set Number Upload Request:
 30 30 32 30 30 30 31 30  30 30 31 30 20 20 20 20  00200010 0010
 20 20 20 20 00                                       .

<-- MID 0011 Parameter Set Number Upload Reply:
 30 33 32 33 30 30 31 31  30 30 31 30 20 20 20 20  03230011 0010
 20 20 20 20 31 30 30 30  30 31 30 30 32 30 30 33      1000 01002003
 30 30 34 30 30 35 30 30  36 30 30 37 30 30 38 30  00400500 60070080
 30 39 30 31 30 30 31 31  30 31 32 30 31 33 30 31  09010011 01201301
 34 30 31 35 30 31 36 30  31 37 30 31 38 30 31 39  40150160 17018019
 30 32 30 30 32 31 30 32  32 30 32 33 30 32 34 30  02002102 20230240
 32 35 30 32 36 30 32 37  30 32 38 30 32 39 30 33  25026027 02802903
 30 30 33 31 30 33 32 30  33 33 30 33 34 30 33 35  00310320 33034035
 30 33 36 30 33 37 30 33  38 30 33 39 30 34 30 30  03603703 80390400
 34 31 30 34 32 30 34 33  30 34 34 30 34 35 30 34  41042043 04404504
 36 30 34 37 30 34 38 30  34 39 30 35 30 30 35 31  60470480 49050051
 30 35 32 30 35 33 30 35  34 30 35 35 30 35 36 30  05205305 40550560
 35 37 30 35 38 30 35 39  30 36 30 30 36 31 30 36  57058059 06006106
 32 30 36 33 30 36 34 30  36 35 30 36 36 30 36 37  20630640 65066067
 30 36 38 30 36 39 30 37  30 30 37 31 30 37 32 30  06806907 00710720
 37 33 30 37 34 30 37 35  30 37 36 30 37 37 30 37  73074075 07607707
 38 30 37 39 30 38 30 30  38 31 30 38 32 30 38 33  80790800 81082083
 30 38 34 30 38 35 30 38  36 30 38 37 30 38 38 30  08408508 60870880
 38 39 30 39 30 30 39 31  30 39 32 30 39 33 30 39  89090091 09209309
 34 30 39 35 30 39 36 30  39 37 30 39 38 30 39 39  40950960 97098099
 31 30 30 00                                       100.
```

Telegram example for MID 0012 and MID 0013

- **MID 0012:** The integrator requests the parameter set data from the parameter set stored in the controller with ID=3.
- **MID 0013:** The controller transmits the parameter set data from the parameter set stored in the controller with ID=3 to the integrator.
- **MID 0012:** The integrator requests the parameter set data from the parameter set stored in the controller with ID=100.
- **MID 0013:** The controller transmits the parameter set data from the parameter set stored in the controller with ID=100 to the integrator.

Telegram example:

```
--> MID 0012 Parameter Set Data Upload Request:
 30 30 32 33 30 30 31 32  30 30 31 30 20 20 20 20  00230012 0010
 20 20 20 20 30 30 33 00                               003.

<-- MID 0013 Set Data Upload Reply:
 30 31 30 34 30 30 31 33  30 30 31 30 20 20 20 20  01040013 0010
 20 20 20 20 30 31 30 30  33 30 32 54 45 53 54 20      0100 302TEST
 57 20 30 30 33 20 20 20  20 20 20 20 20 20 20 20  W 003
 20 20 20 20 30 33 31 30  34 30 33 30 35 30 30 30      0310 40305000
 30 30 30 30 36 30 30 30  30 30 30 30 37 30 30 30  00006000 00007000
 30 30 30 30 38 30 30 30  30 30 30 39 30 30 30 30  00008000 00090000
 30 31 30 30 30 30 32 30  00                       01000020 .

--> MID 0012 Set Data Upload Request:
 30 30 32 33 30 30 31 32  30 30 31 30 20 20 20 20  00230012 0010
 20 20 20 20 31 30 30 00                               100.

<-- MID 00013 Parameter Set Data Upload Reply:
 30 31 30 34 30 30 31 33  30 30 31 30 20 20 20 20  01040013 0010
 20 20 20 20 30 31 31 30  30 30 32 54 45 53 54 20      0110 002TEST
 57 20 31 30 30 20 20 20  20 20 20 20 20 20 20 20  W 100
 20 20 20 20 30 33 31 30  34 31 30 30 30 35 30 30      0310 41000500
 30 30 30 30 30 36 30 30  30 30 30 30 30 37 30 30  00000600 00000700
 30 30 30 30 30 38 30 30  30 30 30 30 39 30 30 30  00000800 00009000
 30 30 31 30 30 30 30 32  30 00                    00100002 0.
```

Telegram example for MID 0014, MID 0015 and MID 0016

- **MID 0014:** The integrator subscribes to the manual parameter set selection on the controller.
- **MID 0005:** The controller confirms the command.
- **MID 0015:** The controller sends the ID of the currently selected parameter set to the integrator.
- **MID 0016:** The integrator confirms receipt of the ID of the parameter set currently selected in the controller.

Telegram example:

```
--> MID 0014 Parameter Set Selected Subscribe:
 30 30 32 30 30 30 31 34  30 30 31 30 20 20 20 20  00200014 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 31 34  00                           0014 .

<-- MID 0010 Set Selected:
 30 30 34 32 30 30 31 35  30 30 31 30 20 20 20 20  00420015 0010
 20 20 20 20 30 30 30 30  30 30 30 2d 30 30 2d 30      0000 000-00-0
 30 3a 30 30 3a 30 30 3a  30 30 00                 0:00:00: 00.

--> MID 0016 Set Selected Acknowledge:
 30 30 32 30 30 30 31 36  30 30 31 30 20 20 20 20  00200016 0010
 20 20 20 20 00                                        .
```

Telegram example for MID 0017

- **MID 0017:** The integrator cancels the subscription for manual parameter set selection on the controller.
- **MID 0005:** The controller confirms the termination of the subscription.

Telegram example:

```
--> MID 0017 Parameter Set Selected Unsub:
 30 30 32 30 30 30 31 37  30 30 31 30 20 20 20 20  00200017 0010
 20 20 20 20 00                                          .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 31 37  00                             0017 .
```

Telegram example for MID 0018

- **MID 0018:** The integrator selects the parameter set with ID=3 in the controller.
- **MID 0005:** The controller confirms the command to select the parameter set with ID=3. If no valid parameter set with ID=3 is stored in the controller, a fault message (MID 0004) is returned.

Telegram example:

```
--> MID 0018 Select Parameter Set:
 30 30 32 33 30 30 31 38  30 30 31 30 20 20 20 20  00230018 0010
 20 20 20 20 30 30 33 00                                 003.

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 31 38  00                             0018 .
```

Telegram example for MID 0019

- **MID 0019:** The integrator changes the number of repetitions in the parameter set stored in the controller with ID=3 to the value 13.
- **MID 0005:** The controller confirms the permanent change to the number of repetitions in the parameter set with ID=3.

Telegram example:

```
--> MID 0019 Set Parameter set batch size:
 30 30 32 35 30 30 31 39  30 30 31 30 20 20 20 20  00250019 0010
 20 20 20 20 30 30 33 31  33 00                          0031 3.

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 31 39  00                             0019 .
```

Telegram example for MID 0020

- **MID 0020:** The integrator resets the repetition counter of the parameter set stored in the controller with ID=3 to the value zero.
- **MID 0005:** The controller confirms the command to the integrator that the repetition counter of the parameter set with ID=3 has been reset to zero.
  To do this, the parameter set with ID=3 must be parameterized and selected in the controller, otherwise the controller will transmit a fault message (MID 0004) back to the integrator.

Telegram example:

```
--> MID 0020 Multistage Number Upload Request:
 30 30 32 33 30 30 32 30  30 30 31 30 20 20 20 20  00230020 0010
 20 20 20 20 30 30 33 00                              003.

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 32 30  00                          0020 .
```

Telegram example:

```
--> MID 0020 Multistage Number Upload Request:
 30 30 32 33 30 30 32 30  30 30 31 30 20 20 20 20  00230020 0010
 20 20 20 20 30 30 31 00                              001.

<-- MID 0005 Command Error:
 30 30 32 36 30 30 30 34  30 30 30 30 20 20 20 20  00260004 0000
 20 20 20 20 30 30 32 30  30 34 00                    0020 04.
```

19.2.6 Tool messages (Tool messages)

MID 0040 Tool data upload request (Revision 1)

The integrator requests the tool information from the controller.

MID 0041 Tool data upload reply (Revision 1)

The controller transmits the tool information to the integrator. These are for Open Protocol Version 1.4 Revision 1:

- The tool number can be defined using the PC software OPEXwin® (tool serial number).
- The number of rundowns that have already been carried out in the life of the screwdriving tool = Tightening ID (tool number of tightening).
- The last service date of the screwdriving tool = calibration date (last calibration date).
- The serial number of the screwdriving tool = controller, this is determined during production at GWK (controller serial number).

MID 0042 Disable tool (Revision 1)

The integrator stops the measurement technology in the controller (stop command).

MID 0043 Enable tool (Revision 1)

The integrator activates the measurement technology in the controller (start command).

Before an active measurement is started, a valid parameterized parameter set must be selected in the controller!

Telegram example for MID 0040 and 0041

- **MID 0040:** The integrator requests the tool information from the controller.
- **MID 0041:** The controller transmits the tool information to the integrator.

Telegram example:

```
--> MID 0040 Tool Data Upload Request:
 30 30 32 30 30 30 34 30  30 30 31 30 20 20 20 20  00200040 0010
 20 20 20 20 00                                        .

<-- MID 0041 Upload Reply:
 30 30 38 31 30 30 34 31  30 30 31 30 20 20 20 20  00810041 0010
 20 20 20 20 30 31 57 45  52 4b 42 41 4e 4b 20 34      01WE RKBANK 4
 20 20 20 20 30 32 30 30  30 30 30 30 31 30 35 36      0200 00001056
 30 33 32 30 31 38 2d 30  31 2d 31 38 3a 30 30 3a  032018-0 1-18:00:
 30 30 3a 30 30 30 34 50  33 31 32 35 20 20 20 20  00:0004P 3125
 20 00                                              .
```

Telegram example for MID 0042

- **MID 0042:** The integrator transmits a stop command to the controller.
- **MID 0005:** The controller confirms the stop command to the integrator. (The measurement technology in the controller is now deactivated).

Telegram example:

```
--> MID 0042 Disable Tool:
 30 30 32 30 30 30 34 32  30 30 31 30 20 20 20 20  00200042 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 34 32  00                           0042 .
```

Telegram example for MID 0043

- **MID 0043:** The integrator transmits a start command for the measurement technology in the controller.
- **MID 0005:** The controller confirms the activation of the measurement technology in the controller to the integrator.

Please note:

The controller always confirms a telegram with MID 0043 to the integrator with a telegram with MID 0005, even if no valid parameterized parameter set is selected in the controller.

The active measurement for a parameter set only starts when a valid parameterized parameter set is selected in the controller.

Telegram example:

```
--> MID 0043 Enable Tool:
 30 30 32 30 30 30 34 33  30 30 31 30 20 20 20 20  00200043 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 34 33  00                           0043 .
```

19.2.7 VIN messages (Vehicle Identification Number messages)

MID 0050 Vehicle ID Number download request

The integrator transmits a VIN to the controller, which is to be used for the current rundown.

MID 0051 Vehicle ID Number subscribe

The integrator subscribes the scanned VIN to the controller. This means that if a barcode is scanned with the OPEX®, it is not only adopted for the current rundown, but also sent directly to the controller after scanning.

MID 0052 Vehicle ID Number (Revision 1)

The controller transmits a scanned VIN to the integrator if it is subscribed to by the integrator.

MID 0053 Vehicle ID Number acknowledge (Revision 1)

The integrator confirms receipt of a VIN to the controller.

MID 0054 Vehicle ID Number unsubscribe (Revision 1)

The integrator terminates the subscription for the VIN with the controller.

Telegram example for MID 0050

- **MID 0050:** The integrator transmits the VIN "4711" to the controller
- **MID 0005:** The controller confirms receipt of the VIN.

Telegram example:

```
--> MID 0050 Vehicle Id Number Download Request:
 30 30 32 34 30 30 35 30  30 30 31 30 20 20 20 20  00240050 0010
 20 20 20 20 34 37 31 31  00                           4711 .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 35 30  00                           0050 .
```

Telegram example for MID 0051, 0052, 0053 and 0054

- **MID 0051:** The integrator subscribes to the VIN with the controller.
- **MID 0005:** The controller confirms the subscription of the VIN with the integrator.
- **MID 0052:** The controller transmits the scanned VIN "00156DD87CC3" to the integrator.
- **MID 0053:** The integrator confirms receipt of the VIN scanned in by the controller.
- **MID 0054:** The integrator terminates the subscription for the VIN with the controller.
- **MID 0005:** The controller confirms the termination of the subscription for the VIN with the integrator.

Telegram example:

```
--> MID 0051 Vehicle Id Number Upload Subscribe:
 30 30 32 30 30 30 35 31  30 30 31 30 20 20 20 20  00200051 0010
 20 20 20 20 00                                       .

<-- MID 0051 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 35 31  00                          0051 .

<-- MID 0052 Vehicle Id Number Upload:
 30 30 34 37 30 30 35 32  30 30 31 30 20 20 20 20  00470052 0010
 20 20 20 20 30 31 20 20  20 20 20 20 20 20 20 20      01
 20 20 20 30 30 31 35 36  44 44 38 37 43 43 33 00     00156 DD87CC3.

--> MID 0053 Vehicle Id Number Upload Acknowledge:
 30 30 32 30 30 30 35 33  30 30 31 30 20 20 20 20  00200053 0010
 20 20 20 20 00                                       .

--> MID 0054 Vehicle Id Number Upload Unsub:
 30 30 32 30 30 30 35 34  30 30 31 30 20 20 20 20  00200054 0010
 20 20 20 20 00                                       .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 35 34  00                          0054 .
```

19.2.8 Tightening result messages (Tightening result messages)

MID 0060 Last tightening result data subscribe (Revision 1)

The integrator subscribes the transmission of the last tightening result to the controller.

MID 0061 Last tightening result data (Revision 1)

The controller sends the last tightening result to the integrator.

The following result data is transmitted:

1. Cell ID, always "0000".
2. Channel ID, always "00".
3. Controller Name, tool number. (Can be set in OPEX® with the OPEXwin® PC software).
4. VIN Number, can be defined by the integrator or scanned in at the controller.
5. Job ID, always "00" (jobs are not implemented in OPEX®).
6. Pset ID, ID of the currently selected parameter set.
7. Batch size, specified number of rundown repetitions.
8. Batch counter, number of rundown repetitions currently reached.
9. Tightening Status, overall assessment of the rundown.
10. Torque Status, assessment of the torque.
11. Angle Status, assessment of the rotation angle.
12. Torque Min limit, lower quality window limit for torque.
13. Torque Max limit, upper quality window limit for torque.
14. Torque target, nominal torque (target torque for torque-controlled rundown).
15. Torque, peak torque reached in the rundown (final value).
16. Angle Min limit, lower quality window limit for the rotation angle.
17. Angle Max limit, upper quality window limit for the rotation angle.

18. Angle target, nominal angle (target rotation angle for angle-controlled rundown).
19. Angle, peak rotation angle reached in the rundown (final value).
20. Time Stamp, time stamp of the rundown (format: "YYYY-MM-DD:HH:MM:SS").
21. Date of the last change to the parameter set in the controller.
22. Batch Status, assessment of the number of rundown repetitions reached.
23. Tightening ID, current sequential number of the rundown (stored in the controller's non-volatile memory).

MID 0062 Last tightening result data acknowledge

The integrator confirms receipt of a tightening result to the controller.

MID 0063 Last tightening result data unsubscribe

The integrator terminates the subscription for tightening results with the controller.

MID 0064 Old tightening result upload request (Revision 1)

If tightening results are subscribed to the controller and these are not transmitted, they are saved in the controller's non-volatile memory after the send loop is canceled. Up to 40 unsent end values can be temporarily stored. The oldest saved tightening result is always overwritten.

MID 0064 allows the integrator to request the result from the controller using the tightening ID of the temporarily stored tightening result.

MID 0065 Old tightening result upload reply (Revision 1)

If an unsent tightening result is temporarily stored in the controller, it is transmitted to the integrator if the tightening ID for this result is valid.

The following result data is transmitted:

1. Tightening ID, sequential number of the rundown
2. VIN Number, VIN of the rundown
3. Pset ID, ID of the parameter set stored in the controller
4. Batch counter, number of rundown repetitions currently reached
5. Tightening Status, overall assessment of the rundown
6. Torque Status, assessment of the torque
7. Angle Status, assessment of the rotation angle
8. Torque, peak torque reached in the rundown (final value)
9. Angle, peak rotation angle reached in the rundown (final value)
10. Time Stamp, time stamp of the rundown (format: "YYYY-MM-DD:HH:MM:SS")
11. Batch Status, assessment of the number of rundown repetitions reached

Telegram example for MID 0060, 0061, 0062 and 0063

- **MID 0060:** The integrator subscribes the tightening results to the controller.
- **MID 0005:** The controller confirms the subscription for tightening results to the integrator.
- **MID 0061:** The controller transmits the tightening result to the integrator.
- **MID 0062:** The integrator confirms receipt of the tightening result to the controller.
- **MID 0063:** The integrator terminates the subscription for tightening results with the controller.
- **MID 0005:** The controller confirms the termination of the subscription for tightening results to the integrator.

Telegram example:

```
--> MID 0060 Last Tightening Result Data Subscribe:
 30 30 32 30 30 30 36 30  30 30 31 30 20 20 20 20  00200060 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 36 30  00                           0060 .

<-- MID 0061 Last Tightening Result Upload Reply:
 30 32 33 31 30 30 36 31  30 30 31 30 20 20 20 20  02310061 0010
 20 20 20 20 30 31 30 30  30 30 30 32 30 30 30 33      0100 00020003
 57 45 52 4b 42 41 4e 4b  20 34 20 20 20 20 20 20  WERKBANK  4
 20 20 20 20 20 20 20 20  20 30 34 20 20 20 20 20            04
 20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20
 20 20 20 20 30 35 30 30  30 36 30 30 33 30 37 30      0500 06003070
 30 31 33 30 38 30 30 30  31 30 39 31 31 30 31 31  01308000 10911011
 31 31 31 32 30 30 30 30  30 30 31 33 30 30 30 30  11120000 00130000
 30 30 31 34 30 30 30 30  30 30 31 35 30 30 30 37  00140000 00150007
 39 30 31 36 30 30 30 30  30 31 37 30 30 30 30 30  90160000 01700000
 31 38 30 30 30 32 30 31  39 30 30 30 33 30 32 30  18000201 90003020
 32 30 31 38 2d 30 31 2d  32 39 3a 31 31 3a 31 35  2018-01- 29:11:15
 3a 34 30 32 31 32 30 31  38 2d 30 31 2d 32 36 3a  :4021201 8-01-26:
 31 35 3a 32 38 3a 31 31  32 32 30 32 33 20 20 20  15:28:11 22023
 20 20 20 31 30 35 39 00                              1059.

--> MID 0062 Last Tightening Result Acknowledge:
 30 30 32 30 30 30 36 32  30 30 31 30 20 20 20 20  00200062 0010
 20 20 20 20 00                                        .

--> MID 0063 Last Tightening Result Data Unsub:
 30 30 32 30 30 30 36 33  30 30 31 30 20 20 20 20  00200063 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 36 33  00                           0063 .
```

Extension to MID 0061 Last tightening result data (Rev. 5)

As an alternative to MID 0061 Revision 1 for transmitting the latest tightening results, you can subscribe to MID 0061 Revision 5.

In this case, the following result data is transmitted:

1. Cell ID, always "0000".
2. Channel ID, always "00".
3. Controller Name, tool number (Can be set in OPEX® with the OPEXwin® PC software).
4. VIN Number, can be defined by the integrator or scanned in at the controller.
5. Job ID, always "0000" (jobs are not implemented in OPEX®).
6. Parameter Set Number, ID of the currently selected parameter set "000" – "999".

7. Strategy (screwing method):
   "01" = Torque controlled
   "02" = Torque controlled and angle monitored
   "04" = Angle controlled and torque monitored
   "15" = Yield point controlled
   "22" = Prevail torque
   "24" = Release/tighten
   "99" = Unknown strategy
   (see Atlas Copco protocol description MID 0061 Revision 5)
8. Strategy Options, 5 byte long bit field (see Atlas Copco protocol description MID 0061 Revision 5).
   Bit 0 = Torque window parameterized
   Bit 1 = Rotation angle window parameterized
   Bit 2 = Screwdriving sequence (batch) parameterized
9. Batch Size, "0000" – "9999"
10. Batch Counter, "0000" – "9999".
11. Tightening Status, "0"=OK, "1"=NOK
12. Batch Status, "0"=NOK, "1"=OK, "2"=N/A
13. Torque Status, "0"=LOW, "1"=OK, "2"=HIGH
14. Angle Status, "0"=LOW, "1"=OK, "2"=HIGH
15. Rundown Angle Status, "0"=LOW, "1"=OK, "2"=HIGH, always "1"
16. Current Monitoring Status, "0"=LOW, "1"=OK, "2"=HIGH, always "1"
17. Self-tap Status, "0"=LOW, "1"=OK, "2"=HIGH, always "1"
18. Prevail Torque Monitoring Status, "0"=LOW, "1"=OK, "2"=HIGH, always "1"
19. Prevail Torque Compensate Status, "0"=LOW, "1"=OK, "2"=HIGH, always "1"
20. Tightening Error Status, 10 byte long bit field (see Atlas Copco protocol description MID 0061 Revision 5)
21. Torque Min Limit, 6 ASCII characters
22. Torque Max Limit, 6 ASCII characters
23. Torque final Target, 6 ASCII characters
24. Torque (final value), 6 ASCII characters
25. Angle min Limit, 5 ASCII characters
26. Angle max Limit, 5 ASCII characters
27. Final Angle Target, 5 ASCII characters
28. Angle (final value), 5 ASCII characters
29. Rundown Angle Min, 5 ASCII characters, always "00000"
30. Rundown Angle Max, 5 ASCII characters, always "00000"
31. Rundown Angle, 5 ASCII characters, always "00000"
32. Current Monitoring Min, 3 ASCII characters, always "000"
33. Current Monitoring Max, 3 ASCII characters, always "000"
34. Current Monitoring Value, 3 ASCII characters, always "000"
35. Self-tap min, 6 ASCII characters, always "000000"
36. Self-tap max, 6 ASCII characters, always "000000"
37. Self-tap torque, 6 ASCII characters, always "000000"
38. Prevail torque monitoring min, 6 ASCII characters, always "000000"
39. Prevail torque monitoring max, 6 ASCII characters, always "000000"
40. Prevail torque, 6 ASCII characters, always "000000"
41. Tightening ID, 10 ASCII characters

42. Job sequence number, 5 ASCII characters, always "00000"
43. Sync tightening ID, 5 ASCII characters, always "00000"
44. Tool serial number, 14 ASCII characters
45. Time stamp, (format: "YYYY-MM-DD:HH:MM:SS")
46. Date/time of last change in parameter set settings, (format: "YYYY-MMDD: HH:MM:SS")
47. Parameter set name, 25 ASCII characters
48. Torque values unit '1' = Nm, '2' = ftlb, '3' = inlb
49. Result type, 2 ASCII characters (see protocol description MID 0061 Revision 5)
50. Identifier result part 2, 25 ASCII characters (filled with spaces)
51. Identifier result part 3, 25 ASCII characters (filled with spaces)
52. Identifier result part 3, 25 ASCII characters (filled with spaces)
53. Customer tightening error code, 4 ASCII characters (see protocol description MID 0061 Revision 5)

Telegram example:

```
--> MID 0060 Last Tightening Result Data Subscribe:
 30 30 32 30 30 30 36 30  30 30 35 30 20 20 20 20  00200060 0050
 20 20 20 20 00                                          .

<-- MID0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 36 30  00                           0060 .

<-- MID0061 Last Tightening Result Upload Reply:
 30 35 30 36 30 30 36 31  30 30 35 30 20 20 20 20  05060061 0050
 20 20 20 20 30 31 30 30  30 30 30 32 30 30 30 33      0100 00020003
 4c 41 44 45 4d 45 49 53  54 45 52 20 20 20 20 20  LADEMEIS TER
 20 20 20 20 20 20 20 20  20 30 34 20 20 20 20 20            04
 20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20
 20 20 20 20 30 35 30 30  30 30 30 36 30 30 31 30      0500 00060010
 37 30 34 30 38 30 30 30  30 32 30 39 30 30 30 31  70408000 02090001
 31 30 30 30 30 31 31 31  30 31 32 32 31 33 30 31  10000111 01221301
 34 31 31 35 31 31 36 31  31 37 31 31 38 31 31 39  41151161 17118119
 31 32 30 30 30 30 30 30  30 30 30 30 30 32 31 30  12000000 00000210
 30 30 36 30 30 32 32 30  30 30 38 30 30 32 33 30  00600220 00800230
 30 30 30 30 30 32 34 30  30 30 35 39 37 32 35 30  00000240 00597250
 30 30 31 30 32 36 30 30  30 34 30 32 37 30 30 30  00102600 04027000
 32 30 32 38 30 30 30 32  32 32 39 30 30 30 30 30  20280002 22900000
 33 30 30 30 30 30 30 33  31 30 30 30 30 30 33 32  30000003 10000032
 30 30 30 33 33 30 30 30  33 34 30 30 30 33 35 30  00033000 34000350
 30 30 30 30 30 33 36 30  30 30 30 30 30 33 37 30  00000360 00000370
 30 30 30 30 30 33 38 30  30 30 30 30 30 33 39 30  00000380 00000390
 30 30 30 30 30 34 30 30  30 30 30 30 30 34 31 20  00000400 0000041
 20 20 20 20 20 20 20 20  31 34 32 30 30 30 30 30           14200000
 34 33 30 30 30 30 30 34  34 50 33 30 30 30 20 20  43000004 4P3000
 20 20 20 20 20 20 20 34  35 32 30 32 32 2d 30 35         4 52022-05
 2d 31 38 3a 31 35 3a 31  35 3a 35 30 34 36 32 30  -18:15:1 5:504620
 32 32 2d 30 35 2d 31 38  3a 31 35 3a 31 34 3a 33  22-05-18 :15:14:3
 37 34 37 20 20 20 20 20  20 20 20 20 20 20 20 20  747
 20 20 20 20 20 20 20 20  20 20 20 20 34 38 31 34               4814
 39 30 31 35 30 20 20 20  20 20 20 20 20 20 20 20  90150
 20 20 20 20 20 20 20 20  20 20 20 20 20 20 35 31                 51
 20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20
 20 20 20 20 20 20 20 20  20 35 32 20 20 20 20 20            52
 20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20
 20 20 20 20 35 33 30 30  30 31 00                      5300 01.

--> MID 0062 Last Tightening Result Acknowledge:
 30 30 32 30 30 30 36 32  30 30 31 30 20 20 20 20  00200062 0010
 20 20 20 20 00                                          .
```

Telegram example for MID 0064 and MID 0065

- **MID 0061:** The controller transmits the tightening result to the integrator.
  - The controller does not receive confirmation of receipt from the integrator.
  - After a total of four transmission attempts, a fault message appears on the LCD display of OPEX®, the controller continues to try to transmit the tightening result to the integrator.
  - The worker cancels the send loop on the controller and the tightening result with the tightening ID 1060 is temporarily stored in the controller's non-volatile memory.
- **MID 0064:** Once the Open Protocol connection has been restored, the integrator requests the saved tightening result with the tightening ID 1060.
- **MID 0065:** The controller transmits the stored tightening result to the integrator.

Telegram example:

```
<-- MID 0061 Last Tightening Result Upload Reply:
 30 32 33 31 30 30 36 31  30 30 31 30 20 20 20 20  02310061 0010
 20 20 20 20 30 31 30 30  30 30 30 32 30 30 30 33      0100 00020003
 57 45 52 4b 42 41 4e 4b  20 34 20 20 20 20 20 20  WERKBANK  4
 20 20 20 20 20 20 20 20  20 30 34 20 20 20 20 20            04
 20 20 20 20 20 20 20 20  20 20 20 20 20 20 20 20
 20 20 20 20 30 35 30 30  30 36 30 30 33 30 37 30      0500 06003070
 30 31 33 30 38 30 30 30  31 30 39 31 31 30 31 31  01308000 10911011
 31 31 31 32 30 30 30 30  30 30 31 33 30 30 30 30  11120000 00130000
 30 30 31 34 30 30 30 30  30 30 31 35 30 30 30 37  00140000 00150007
 34 30 31 36 30 30 30 30  30 31 37 30 30 30 30 30  40160000 01700000
 31 38 30 30 30 32 30 31  39 30 30 30 32 36 32 30  18000201 90002620
 32 30 31 38 2d 30 31 2d  32 39 3a 31 31 3a 32 35  2018-01- 29:11:25
 3a 35 37 32 31 32 30 31  38 2d 30 31 2d 32 36 3a  :5721201 8-01-26:
 31 35 3a 32 38 3a 31 31  32 32 30 32 33 20 20 20  15:28:11 22023
 20 20 20 31 30 36 30 00                              1060.

<-- [Insgesamt 4 Sendeversuche...]

--> MID 0064 Old Tightening Result Upload Request:
 30 30 33 30 30 30 36 34  30 30 31 30 20 20 20 20  00300064 0010
 20 20 20 20 30 30 30 30  30 30 31 30 36 30 00         0000 001060.

<-- MID 0065 Old Tightening Result Upload Reply:
 30 31 31 38 30 30 36 35  30 30 31 30 20 20 20 20  01180065 0010
 20 20 20 20 30 31 20 20  20 20 20 20 31 30 36 30      01       1060
 30 32 20 20 20 20 20 20  20 20 20 20 20 20 20 20  02
 20 20 20 20 20 20 20 20  20 20 20 30 33 30 30 33              03003
 30 34 30 30 30 31 30 35  31 30 36 31 30 37 31 30  04000105 10610710
 38 30 30 30 37 34 30 30  39 30 30 30 32 36 31 30  80007400 90002610
 32 30 31 38 2d 30 31 2d  32 39 3a 31 31 3a 32 35  2018-01- 29:11:25
 3a 35 37 31 31 30 00                              :57110.
```

19.2.9 Screwdriving curve messages (Tightening curve messages)

MID 0008 Application data message subscription

MID 0008 can be used to subscribe to the screwdriving curves for the MID 0900 for the rotation angle curve and the torque curve over time.

Subscribe to rotation angle curve

You can then subscribe to the rotation angle curve.

MID:	0008
Revision:	001
Data:	0900001350000000000000000000000000000001001

Telegram example:

```
--> MID 0008 Generic Data Subscribe:
 30 30 36 34 30 30 30 38  30 30 31 30 20 20 20 20  00640008 0010
 30 30 20 20 30 39 30 30  30 30 31 33 35 30 30 30  00  0900 00135000
 30 30 30 30 30 30 30 30  30 30 30 30 30 30 30 30  00000000 00000000
 30 30 30 30 30 30 30 30  30 30 30 30 31 30 30 31  00000000 00001001
 00                                                .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 39 30 30  00                           0900 .
```

Subscribe to torque curve

The torque curve can be subscribed to below.

MID:	0008
Revision:	001
Data:	0900001350000000000000000000000000000001002

Telegram example:

```
--> MID 0008 Generic Data Subscribe:
 30 30 36 34 30 30 30 38  30 30 31 30 20 20 20 20  00640008 0010
 30 30 20 20 30 39 30 30  30 30 31 33 35 30 30 30  00  0900 00135000
 30 30 30 30 30 30 30 30  30 30 30 30 30 30 30 30  00000000 00000000
 30 30 30 30 30 30 30 30  30 30 30 30 31 30 30 32  00000000 00001002
 00                                                .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 39 30 30  00                           0900 .
```

Subscribe to rotation angle curve and torque curve

You can then subscribe to the rotation angle curve and the torque curve.

MID:	0008
Revision:	001
Data:	0900001380000000000000000000000000000002001002

Telegram example:

```
--> MID 0008 Generic Data Subscribe:
30 30 36 37 30 30 30 38  30 30 31 30 20 20 20 20  00670008 0010
 30 30 20 20 30 39 30 30  30 30 31 33 38 30 30 30  00  0900 00138000
 30 30 30 30 30 30 30 30  30 30 30 30 30 30 30 30  00000000 00000000
 30 30 30 30 30 30 30 30  30 30 30 30 32 30 30 31  00000000 00002001
 30 30 32 00                                       002.

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 39 30 30  00                           0900 .
```

MID 0009 Application Data Message unsubscribe

MID 0009 allows the subscription for the rotation angle curve and the torque curve to be terminated.

Terminate rotation angle curve and torque curve

The subscription for the rotation angle curve and the torque curve can be terminated below.

MID:	0009
Revision:	001
Data:	09000010802001002

Telegram example:

```
--> MID 0009 Generic Data Unsubscribe:
 30 30 33 37 30 30 30 39  30 30 31 30 20 20 20 20  00370009 0010
 30 30 20 20 30 39 30 30  30 30 31 30 38 30 32 30  00  0900 00108020
 30 31 30 30 32 00                                 01002.

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 39 30 30  00                           0900 .
```

MID 0900 Trace curve data message

MID 0900 can be used to transmit the screwdriving curves for the rotation angle and the torque curve over time.

Transmit rotation angle curve

In this example, a time-resolved screwdriving curve of the rotation angle is to be output.

- 10 rotation angle values have been recorded.
- The scaling of the rotation angle values is 0.1°.
- The time between 2 rotation angle values is 8.889 ms.

Telegram example:

```
<-- MID 0900 Trace curve:
 30 31 33 34 30 39 30 30  30 30 31 30 20 20 20 20  01340900 0010
 30 30 20 20 20 20 20 20  20 20 20 20 20 30 32 30  00            020
 32 31 2d 31 32 2d 30 37  3a 31 32 3a 30 31 3a 32  21-12-07 :12:01:2
 33 30 30 30 30 31 30 31  30 35 30 30 30 31 30 32  30000101 05000102
 32 31 33 30 30 33 30 31  30 30 30 30 30 30 30 30  21300301 00000000
 31 30 30 30 31 30 30 30  30 30 30 30 30 30 39 30  10001000 00000090
 30 35 30 33 32 30 32 38  2e 38 38 39 30 30 30 31  05032028 .8890001
 30 00                                             0.

--> MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 31 30 20 20 20 20  00240005 0010
 30 30 20 20 30 39 30 30  00                       00  0900 .
```

Transmit torque curve

In this example, a time-resolved screwdriving curve for torque is to be output.

- 10 torque values have been recorded.
- The scaling of the torque values is 0.01 Nm.
- The time between 2 torque values is 8.889 ms.

Telegram example:

```
<-- MID 0900 Trace curve:
30 31 33 34 30 39 30 30  30 30 31 30 20 20 20 20  01340900 0010
 30 30 20 20 20 20 20 20  20 20 20 20 20 30 32 30  00            020
 32 31 2d 31 32 2d 30 37  3a 31 32 3a 30 31 3a 32  21-12-07 :12:01:2
 33 30 30 30 30 32 30 31  30 30 31 30 30 31 30 32  30000201 00100102
 32 31 33 30 30 33 30 31  30 30 30 30 30 30 30 31  21300301 00000001
 30 30 30 30 31 30 30 30  30 30 30 30 30 30 39 30  00001000 00000090
 30 35 30 33 32 30 32 38  2e 38 38 39 30 30 30 31  05032028 .8890001
 30 00                                             0.

--> MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 31 30 20 20 20 20  00240005 0010
 30 30 20 20 30 39 30 30  00                       00  0900 .
```

19.2.10 Alarm messages (Alarm messages)

MID 0070 Alarm subscribe (Revision 1)

The integrator subscribes to alarm messages from the controller.

MID 0071 Alarm (Revision 1)

The controller transmits an alarm message to the integrator. The following alarms are implemented in the controller:

- E000: No alarm present.
- E001: Tool battery low.
- E002: Overload (from 110% of the nominal load capacity of the measuring head).
- E003: Overspeed (tightened too quickly).

MID 0072 Alarm acknowledge (Revision 1)

The integrator confirms receipt of an alarm message to the controller.

MID 0073 Alarm unsubscribe (Revision 1)

The integrator cancels the subscription for alarm messages with the controller.

MID 0076 Alarm status (Revision 1)

After subscribing to alarm messages, the controller sends the current alarm status to the integrator once.

MID 0077 Alarm status acknowledge (Revision 1)

The integrator confirms receipt of the alarm status to the controller.

Telegram examples for MID 0070, MID 0071, MID 0072, MID 0073, MID 0076 and MID 0077

- **MID 0070:** The integrator subscribes to alarm messages from the controller.
- **MID 0005:** The controller confirms to the integrator the command to subscribe to alarm messages.
- **MID 0076:** The controller transmits the current alarm status to the integrator.
- **MID 0077:** The integrator confirms receipt of the alarm status.
- **MID 0071:** The controller transmits alarm E003. (overspeed.)
- **MID 0072:** The integrator confirms receipt of the alarm message.
- **MID 0073:** The integrator cancels the subscription for alarm messages.
- **MID 0005:** The controller confirms to the integrator that the subscription for alarm messages has been terminated.

Telegram example:

```
--> MID 0070 Alarm Subscribe:
 30 30 32 30 30 30 37 30  30 30 31 30 20 20 20 20  00200070 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 37 30  00                           0070 .

<-- MID 0076 Alarm Status:
 30 30 35 36 30 30 37 36  30 30 31 30 20 20 20 20  00560076 0010
 20 20 20 20 30 31 30 30  32 45 30 30 30 30 33 31      0100 2E000031
 30 34 31 30 35 32 30 31  38 2d 30 31 2d 32 39 3a  04105201 8-01-29:
 31 33 3a 30 33 3a 31 36  00                       13:03:16 .

--> MID 0077 Alarm Status Ack:
 30 30 32 30 30 30 37 37  30 30 31 30 20 20 20 20  00200077 0010
 20 20 20 20 00                                        .

<-- MID 0071 Alarm Indication:
 30 30 35 33 30 30 37 31  30 30 31 30 20 20 20 20  00530071 0010
 20 20 20 20 30 31 45 30  30 33 30 32 31 30 33 31      01E0 03021031
 30 34 32 30 31 38 2d 30  31 2d 32 39 3a 31 33 3a  042018-0 1-29:13:
 30 33 3a 32 38 00                                 03:28.

--> MID 0072 Alarm Indication Acknowledge:
 30 30 32 30 30 30 37 32  30 30 31 30 20 20 20 20  00200072 0010
 20 20 20 20 00                                        .

--> MID 0073 Alarm Unsubscribe:
 30 30 32 30 30 30 37 33  30 30 31 30 20 20 20 20  00200073 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 37 33  00                           0073 .
```

19.2.11 Time messages (Time messages)

MID 0080 Read time upload request (Revision 1)

The integrator requests from the controller the current time of the real time clock integrated in the controller.

MID 0081 Read time upload reply (Revision 1)

The controller transmits the current time of the real time clock integrated in the controller to the integrator.

MID 0082 Set Time (MID Revision 1)

The integrator sets the time of the real time clock integrated in the controller.

Telegram example for MID 0080, MID 0081 and MID 0082

- **MID 0080:** The integrator requests the time set in the controller.
- **MID 0081:** The controller transmits the time set in its integrated real time clock to the integrator.
- **MID 0082:** The integrator transmits a new time to the controller.
- **MID 0005:** The controller confirms the command to set a new time in the RTC.

Telegram example:

```
--> MID 0080 Read Time Upload Request:
 30 30 32 30 30 30 38 30  30 30 31 30 20 20 20 20  00200080 0010
 20 20 20 20 00                                        .

<-- MID 0081 Time Upload Acknowledge:
 30 30 33 39 30 30 38 31  30 30 31 30 20 20 20 20  00390081 0010
 20 20 20 20 32 30 31 38  2d 30 31 2d 32 39 3a 31      2018 -01-29:1
 33 3a 34 39 3a 34 31 00                           3:49:41.


--> MID 0082 Set Time In Torque Controller:
 30 30 33 39 30 30 38 32  30 30 31 30 20 20 20 20  00390082 0010
 20 20 20 20 32 30 31 38  2d 30 31 2d 32 39 3a 31      2018 -01-29:1
 33 3a 35 30 3a 32 36 00                           3:50:26.

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 38 32  00                           0082 .
```


19.2.12 User interface messages (User interface messages)

MID 0111 Display user text on graph (MID Revision 1)

MID 0111 allows up to 4 lines with a maximum of 25 characters to be displayed on the OPEX® LCD display. The text is either displayed for a certain period of time or it must be confirmed.

MID 0113 Flash green light on tool (Revision 1)

Makes the LED ring on the OPEX® flash green for approx. 5 seconds.

Telegram example for MID 0111 and MID 0113

- **MID 0111:** The integrator transmits a text with 4 lines to the controller.
- **MID 0005:** The controller confirms the command and shows the text on the LCD display.
- **MID 0113:** The integrator transmits to the controller the command to flash the LED ring for approx. 5 seconds.
- **MID 0005:** The OPEX® confirms the command to the integrator and flashes the LED ring for approx. 5 seconds.

Telegram example:

```
--> MID 0111 Display user text on Graph:
 30 31 33 37 30 31 31 31  30 30 31 30 20 20 20 20  01370111 0010
 20 20 20 20 30 31 30 30  30 35 30 32 31 30 33 31      0100 05021031
 32 33 34 35 31 32 33 34  35 31 32 33 34 35 31 32  23451234 51234512
 33 34 35 31 32 33 34 35  30 34 41 42 43 44 45 46  34512345 04ABCDEF
 47 48 49 4a 4b 4c 4d 4f  50 53 54 55 56 57 58 59  GHIJKLMO PSTUVWXY
 5a 30 30 30 35 54 65 78  74 20 69 6e 20 5a 65 69  Z0005Tex t in Zei
 6c 65 20 33 20 20 20 20  20 20 20 20 20 20 30 36  le 3           06
 54 65 78 74 20 69 6e 20  5a 65 69 6c 65 20 34 20  Text in  Zeile 4
 20 20 20 20 20 20 20 20  20 00                              .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 31 31 31  00                           0111 .

--> MID 0113 Flash green light on tool:
To PF 30 30 32 30 30 31 31 33  30 30 31 30 20 20 20 20  00200113 0010
Tö PF 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 31 31 33  00                           0113 .
```

19.2.13 Controller messages (Controller messages)

MID 0270 Controller reboot request (Revision 1)

The OPEX® firmware can be rebooted with MID 0270.

To reboot the tool, the user must press the button on the tool.

Telegram example for MID 0270

- **MID 0270:** The integrator transmits a reboot command to the controller.
- **MID 0005:** The controller confirms the reboot command and reboots its firmware.

Telegram example:

```
--> MID0270 Controller reboot request:
 30 30 32 30 30 32 37 30  30 30 31 30 20 20 20 20  00200270 0010
 20 20 20 20 00                                        .

<-- MID 0005 Command Accepted:
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 31 31 33  00                           0113 .
```

19.2.14 Alive signal messages (Keep alive message)

MID 9999 Keep alive message (MID Revision 0)

The integrator transmits an alive signal to the controller. The controller transmits this alive signal back to the integrator.

Telegram example for MID 9999

- **MID 9999:** The integrator transmits an alive signal to the controller.
- **MID 9999:** The controller transmits an alive signal back to the integrator.

Telegram example:

```
--> MID 9999 Keep Alive Message:
 30 30 32 30 39 39 39 39  30 30 31 30 20 20 20 20  00209999 0010
 20 20 20 20 00                                          .

<-- MID 9999 Keep Alive Message:
 30 30 32 30 39 39 39 39  30 30 30 30 20 20 20 20  00209999 0000
```


19.2.15 MID 2500 and MID 2505 for dynamic parameterization

MID 2500 Tightening Program Message download

With the MID 2500, a new parameter set can be generated in the temporary parameter set memory and parameterized with the supported PIDs. It is only possible to parameterize one root; further branches or leaves (children) cannot be parameterized.

MID 2505 Select Parameter Set dynamically

The MID 2505 can be used to select and load a parameter set from the parameter set memory parameterized with OPEXwin®. The parameter set loaded in the temporary parameter set memory can be modified using the supported PIDs.

Data types used

The following data types are used in the subset implemented in OPEX® for MID 2500 and MID 2505.

Data type	Value in telegram	Description
UI	01	Unsigned integer
F	03	Float
S	04	ASCII string

Units of measurement used

The following units of measurement are used.

Unit	Value in telegram	Description
None	000	No unit of measurement, e.g. parameter set name etc.
Nm	001	Newton metres (the parameter set adopts the unit of measurement of the last parameterized torque value for all torque values).
Ftlb	002	Foot-pound
°	050	ASCII string

Data frame used

All data is transmitted in ASCII format (not in binary format).

MID 2500

Parameter	Bytes	Data type	Description
Node Type	3	UI	Always "001" (parameter set)
Number of data fields	3	UI	Number of data fields to be transmitted
		***** Start of data field loop *****	
Data fields	variable	variable	
		***** End of data field loop *****	
Number of Children	2	UI	Always "00" (cannot be parameterized)

MID 2505

Parameter	Bytes	Data type	Description
Parameter set ID	3	UI	3 ASCII characters, ID of the existing parameter set to be loaded ("001" - "100")
Number of data fields	3	UI	Number of data fields to be transmitted
		***** Start of data field loop *****	
Data fields	variable	variable	
		***** End of data field loop *****	

Structure of a data field

Parameter	Bytes	Data type	Description
Parameter ID (PID)	5	UI	PID of the parameter to be modified in the dynamic parameter set memory
Length in bytes	3	UI	Number of bytes (length) of the data value to be modified
Data type	2	UI	Data type of the data value to be modified
Unit of measurement	3	UI	Unit of measurement of the data value to be modified
Reserved	4	UI	Always "0000"
Data value	variable	UI, F or S	The data value to be modified

Parameter value PIDs

The data values of the following parameters can be modified, selected by the corresponding PID.

PID	Parameter	Bytes	Data type	Description
00100	Batch Size	2	UI	Number of repetitions for a parameterized screwdriving sequence (max. 99)
01000	Tightening Program Number	3	UI	ID of the parameter set (PID 01040 should be used for MID 2505).
01001	Tightening Program Name	25	S	Name of the parameter set (PID 01041 should be used for MID 2505).

PID	Parameter	Bytes	Data type	Description
01002	Tightening Program Strategy	2	UI	„02“ = Torque Control „04“ = Angle Control
01040	Dynamic Pset ID	3	UI	ID of the dynamically parameterized parameter set
01041	Dynamic Pset Name	25	S	Name of the dynamically parameterized parameter set
02000	Torque, target	max. 7	F	Target torque for torque-controlled screw connections
02002	Torque, upper limit	max. 7	F	Upper torque tolerance limit
02003	Torque, lower limit	max. 7	F	Lower torque tolerance limit
02010	Angle, target	max. 6	F	Target rotation angle for angle controlled rundowns
02012	Angle, upper limit	max. 6	F	Upper rotation angle tolerance limit
02013	Angle, lower limit	max. 6	F	Lower rotation angle tolerance limit
02014	Angle target threshold torque cycle start	max. 7	F	Joining torque to start rotation angle measurement
02060	Rotate Direction	1	UI	Direction of action, "1" = CW, "2" = CCW

Telegram example for MID 2505

In the following example, PSet 1 with MID 2505 and PIDs 01041, 02000, 02002, 02003, 02010, 02012, 02013, 02014 and 02060 is dynamically selected.

The measurement is then activated with MID 0043.

Telegram example:

```
--> Select Parameter set dynamically
 30 32 33 30 32 35 30 35  30 30 31 30 20 20 20 20  02302505 0010
 20 20 20 20 30 30 31 30  30 39 30 31 30 34 31 30      0010 09010410
 32 35 30 34 30 30 30 30  30 30 30 4d 49 44 32 35  25040000 000MID25
 30 35 20 44 52 45 48 4d  4f 4d 45 4e 54 20 54 45  05 DREHM OMENT TE
 53 54 20 20 30 32 30 30  30 30 30 33 30 33 30 30  ST  0200 00030300
 31 30 30 30 30 36 2e 33  30 32 30 30 32 30 30 37  100006.3 02002007
 30 33 30 30 31 30 30 30  30 31 30 2e 30 30 30 30  03001000 010.0000
 30 32 30 30 33 30 30 31  30 33 30 30 31 30 30 30  02003001 03001000
 30 34 30 32 30 31 30 30  30 31 30 33 30 35 30 30  04020100 01030500
 30 30 30 30 30 32 30 31  32 30 30 36 30 33 30 35  00000201 20060305
 30 30 30 30 30 34 35 2e  31 30 30 30 32 30 31 33  0000045. 10002013
 30 30 32 30 33 30 35 30  30 30 30 30 31 31 30 32  00203050 00001102
 30 31 34 30 30 35 30 33  30 30 31 30 30 30 30 30  01400503 00100000
 30 33 2e 31 30 32 30 36  30 30 30 31 30 31 30 30  03.10206 00010100
 30 30 30 30 30 31 00                              000001.

<-- Command Accepted
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 32 35 30 35  00                           2505 .

--> Enable Tool
 30 30 32 30 30 30 34 33  30 30 31 30 20 20 20 20  00200043 0010
 20 20 20 20 00                                        .

<-- Command Accepted
 30 30 32 34 30 30 30 35  30 30 30 30 20 20 20 20  00240005 0000
 20 20 20 20 30 30 34 33  00                           0043 .
```

19.3 Extended bidirectional communication protocol for external controller

19.3.1 Process parameters

Control parameters

M_S Torque threshold value

Switching value above which the rotation angle measurement of the tightening stage begins. This torque value should be selected for the final tightening stage in such a way that it corresponds to the torque value at the head contact of the screw. The guideline value for this so-called "joining torque" is **approx. 30% to 50% of the expected final torque**.

This threshold can be freely parameterized, but should be **at least 2% of the nominal load capacity** of the screwdriving tool measuring head for torque measurement.

M_A Torque setpoint

Target value for the **torque** at the pre-tightening stage and for a torque-controlled rundown at the **final tightening stage**. (AD procedure). After this setpoint is **reached**, the stop signal is triggered in the display of the handheld screwdriver in the final tightening stage.

W_A Angle setpoint

Target value for the **rotation angle** for an angle controlled rundown in the **final tightening stage** from the threshold torque MS being reached (AW method). After this setpoint is **reached**, the stop signal is triggered in the handheld screwdriver display.

Evaluation parameters

M- lower torque tolerance

Lower minimum final torque which is permissible in the parameterized quality window of the tightening stage. If the value falls below this threshold, the rundown is classified as **NOK** (see "Nine-field display in the quality window of the tightening stage", page 128).

M+ upper torque tolerance

Upper maximum final torque which is permissible in the parameterized quality window of the tightening stage. If this threshold is exceeded, the rundown is classified as **NOK**. (see "Nine-field display in the quality window of the tightening stage", page 128).

Please note:

If M+ is exceeded prematurely, a **premature NOK rundown** is recognized.

W- lower angle tolerance

Lower minimum final rotation angle which is permissible in the parameterized quality window of the **final tightening stage**. If the value falls below this threshold, the rundown is classified as **NOK** (see "Nine-field display in the quality window of the tightening stage", page 128).

W+ upper angle tolerance

Upper maximum final rotation angle which is permissible in the parameterized quality window of the **final tightening stage**. If this threshold is exceeded, the rundown is evaluated as NOK (see "Nine-field display in the quality window of the tightening stage", page 128).

Please note:

If **W+** is exceeded prematurely, a **premature NOK rundown** is recognized.

t- lower time tolerance

Lower minimum duration which is permissible for the **final tightening stage**. If this time value is parameterized with a value other than zero, the rundown is evaluated as NOK if the value falls below this time threshold.

t+ upper time tolerance

Upper maximum time duration which is permissible for the **final tightening stage** . If this time value is parameterized with a value other than zero, the rundown is evaluated as NOK if this time threshold is exceeded.

Please note:

If **t+** is exceeded, a **premature NOK rundown** is recognized.

Further parameters

Parameter set name

- 40 ASCII characters

Workpiece ID

- 40 ASCII characters

Program number

- 3 ASCII characters

Tightening stage identifier

- Monitoring stage
- Pre-tightening stage
- Final tightening stage
- Release stage

Screwing method (tightening method, "Rundown mode")

AD method (torque-controlled)

- AW method (angle-controlled)

Direction of rotation (direction of action)

- Left, counterclockwise (CCW)
- Right, clockwise (CW)

Torque unit

- Torque unit Nm (1 Nm = 1.000000 Nm)
- Torque unit foot-pound (1 Nm = 0.737562 ftlb)
- Torque unit inch-pound (1 Nm = 8.850748 inlb)

Release torque control

Release torque control is used to ensure that the screw is not inadvertently released again when using fixed drives (no ratchet).

The torque threshold value $\mathbf{M_S}$ for the final tightening stage in the opposite direction of action is used as the torque threshold value.

Release torque monitoring can be activated as an additional parameter.

The screw is evaluated as released again when the torque threshold value **MS** for the final tightening stage is exceeded in the opposite direction of action ($\mathbf{M_I < -M_S}$).

Process results

Actual values (final values)

- **M_I Actual torque value [final tightening stage]**
  Maximum torque peak end value of the final tightening stage at the end of the rundown
- **W_I Actual angle value [final tightening stage]**
  Maximum rotation angle peak end value of the final tightening stage at the end of the rundown. If the final tightening stage is not reached, this value is always zero.
- **t_I Actual time value [final tightening stage]**
  Total duration of the final tightening stage until the end of rundown. If the final tightening stage is not reached, this value is always zero.
- **Screw status code (SSC) [pre-tightening stage and final tightening stage]**

  The screw status code (SSC) is created at the end of each rundown. A screw status code not equal to zero always represents a NOK rated rundown (see "Screw status code (SSC)", page 128).

Screwdriving curves (optional) [pre-tightening stage and final tightening stage]

Depending on the parameterization, the screwdriving curve is also output. This can be selected from the moment the lower torque limit $\mathbf{M_S}$ of the pre-tightening stage or the final tightening stage is exceeded, up to the actual angle value $\mathbf{W_I}$ of the final tightening stage at the end of the rundown.

Evaluation (SSC)

Nine-field display in the quality window of the tightening stage

A further 8 tolerance windows can be derived around the OK quality window for torque and rotation angle, resulting in a total of 9 torque and rotation angle fields. The numbering is clockwise around the OK quality window.

The quality window always refers to the active tightening stage.

Pre-tightening check in the pre-tightening stage

If the evaluation parameters **W-** and **W+** are not parameterized with the value zero, the system checks whether in the pre-tightening stage once the torque threshold value $\mathbf{M_S}$ for the pre-tightening and the torque setpoint $\mathbf{M_A}$ for the pre-tightening are reached, the **actual value of the pre-tightening angle** $\mathbf{W_I}$ is in the **window between W-** and **W+**. If this is **not the case**, the rundown is considered to be **incorrectly tightened** and the corresponding error bit no. 51 (repeat rundown) is set in the screw status code field (SSC) and the rundown is aborted.

Early detection of a NOK rundown

To **prevent damage** or because further tightening of the screw is not possible, the stop signal is triggered immediately if the following parameters are violated and a rundown assessed as prematurely NOK is displayed:

- Measured upper limit of rotational speed,
- Measured upper limit of torque measurement,
- Release torque reached,
- Time t+ exceeded,
- Violation of the quality window upper limits M+ or W+.

The corresponding error bits are set in the screw status code (SSC).

In this case, the tool immediately prompts you to relieve load from the measuring head. In this case, the worker must immediately cancel the rundown.

The quality windows M+, M-, W+ and W- should always be fully parameterized (all values not equal to zero).

Screw status code (SSC)

Once a rundown has been completed, the screwdriving tool generates an 8-byte screw status code (SSC), which is used to unambiguously represent the current screw status. A total of 64 bits are defined. Bit no. 63 is the highest value bit and bit no. 0 is the lowest value significant bit. **The rundown is OK if none of the bits in the screw status code are set** (screw status code SSC = 0x0000000000000000).

Bit	Meaning	Comment
0	Nine-field 1	< W-
1	Nine-field 2	< W-, >M+
2	Nine-field 3	> M+
3	Nine-field 4	> M+, >W+
4	Nine-field 5	> W+
5	Nine-field 6	< M-, >W+
6	Nine-field 7	< M-
7	Nine-field 8	< M-, <W-
...	...	Technology not used
20	Screwdriving time control	< t-
21	Screwdriving time control	> t+
...	...	Technology not used
26	Rundown released	
...	...	Technology not used
28	Rundown not made	
...	...	Technology not used
30	Manual NOK	
31	System fault	Fault (electronics, sensors)
...	...	Technology not used
46	Release instead of tightening	< Release torque
47	Tightening instead of release	
48	Tightening not complete	
49	Wrong tool	
50	Tightening too fast	
51	Repeat rundown	Screw (incorrectly) tightened
52	Invalid ID data	
...	...	Technology not used
54	Tightening/release when the wrench is blocked	Wrench actuated in monitoring stage
...	Reserved	Technology not used

Tool status

General information

The handheld screwdriver can be in various states. It should be possible to query the status of the handheld screwdriver at any time using the process control system.

Tool parking position

An important requirement for the tool is that it can be positioned in a clearly defined parking position so that unintentional use of the tool can be clearly ruled out.

A charging cradle, for example, can serve as a parking position for cordless tools. For corded tools, this can be a storage cradle or a wall bracket, or if the tool is suspended from a balancer, when the balancer is fully rolled up so that the tool cannot be operated.

The status of the parking position is displayed in the tool status code (WSC), which is part of the ALIVE signal that is output every 7 seconds or when the parking position is changed.

Possible states of the handheld screwdriver

- **Offline**

This status cannot be clearly defined from the controller, as the tool does not respond to status requests from the controller.

In this case, the tool is either switched off or the serial connection to the controller has not been established.

In this case, it is also not possible to use serial tool communication to query whether the handheld screwdriver is in its park position. In this case, the additional binary photocoupler output of the parking position can be evaluated by the controller.

- **Online**

In this state, the tool is switched on and the serial connection to the controller is established so that the controller can request the tool status code (WSC) from the tool.

No separate bit is required in the tool status code (WSC) for the online status, as this status results from the accessibility of the tool.

Screwdriver release

The status of the screwdriver release is displayed in the tool status code (WSC), which is part of the ALIVE signal that is output every 7 seconds or when the parking position is changed.

Tightening stage released

The handheld screwdriver is parameterized and started with a single-stage or two-stage tightening and is ready to screw. Readiness for screwing is shown on the display.

Release stage released

The handheld screwdriver is parameterized and started with a one-step release stage and is ready to screw. Readiness for screwing is shown on the display.

Monitoring stage active

The handheld screwdriver monitors unintentional operation and indicates on the display that it is not ready to screw.

Battery warning limit (battery status)

If the battery voltage of a battery-operated tool has fallen below a critical threshold, the corresponding bit is set in the tool status code (WSC), which is part of the ALIVE signal that is output every 7 seconds or when the parking position is changed.

A battery warning message is also shown on the display.

System fault

If the tool detects a system fault during the self-test when it is switched on or during operation, which means that the tool is no longer functional, the corresponding bit is set in the WSC, which is part of the ALIVE signal that is output every 7 seconds or when the parking position is changed.

Tool status code (WSC)

A tool status code (WSC), which represents the status (condition) of the tool, is generated when a tool status request is received from the controller.

The WSC is implemented by a bit field (tool status register). A status condition is assigned to each bit. A total of 8 bits are defined.

The WSC is part of the ALIVE signal, which is output every 7 seconds or when the parking position is changed.

19.3.2 Communication protocol (version: 1.003)

Protocol version history (changes and extensions)

Protocol version 1.000
- This is the original version

Protocol version 1.001
- Extension: Tool serial number integrated in every telegram sent and received. (Fixed component of the data frame)

Protocol version 1.002
- Extension: Parameterization of the tool gauge of the screw attachment

Protocol version 1.003
- Extension: Telegram for screw attachment detection

Process data

Process parameter data

- **Highest protocol version (VERS)**
  General information:
  – The telegram protocol version consists of an unsigned 16-bit integer value (2 bytes)
  – For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  – The protocol version information is intended to ensure future downward compatibility between handheld screwdrivers and controllers with different protocol versions.
  – The first version of the extended communication protocol for external controller starts with version no. 1000 (0x03E8) and is increased by one version number with each expansion step.
  – To make it easier to recognize larger expansion steps, the version number is always rounded up to the nearest thousand for large expansion steps, e.g:
  Value 1000 corresponds to version 1.000 (initial version)
  Value 1001 corresponds to version 1.001 (after minor extension)
  Value 1002 corresponds to version 1.002 (after minor improvements)
  [...]
  Value 2000 corresponds to version 2.000 (after major extension)
  [...]
  – The controller and the hand tool each negotiate the highest protocol version supported on both sides and then use this together.

  Parameterizable protocol version data:
  – VERS protocol version [pre-tightening stage and final tightening stage]

- **Parameter set name (NAME)**
  General information:
  – The parameter set name consists of 40 ASCII characters (40 bytes), which is always transmitted in full.
  – Unused characters should be filled with spaces ' ' (0x20), zero termination is not required.
  – Permitted ASCII characters are the characters 'a' (0x61) to 'z' (0x7A), 'A' (0x41) to 'Z' (0x5A), '0' (0x30) to '9' (0x39) as well as the characters '+' (0x2B), '-' (0x2D), ',' (0x2C), '.' (0x2E), '/' (0x2F) and space ' ' (0x20).

  Parameterizable parameter set name data:
  – NAME Parameter set name [pre-tightening stage and final tightening stage]

- **Workpiece ID (VIN)**
  General information:
  – The workpiece ID consists of 40 ASCII characters (40 bytes), which is always transmitted in full.
  – This string is transferred back to the controller with the tightening result

  Parameterizable workpiece ID data:
  – VIN Workpiece ID [pre-tightening stage and final tightening stage]

- **Program number (PG)**
  General information:
  – The program number consists of 3 ASCII characters (3 bytes), which is always transmitted in full.
  – This string is transferred back to the controller with the tightening result

  Parameterizable program number data:
  – PG program number [pre-tightening stage and final tightening stage]

- **Torque values (MX)**
  General information:
  – Torque values consist of an unsigned 16-bit integer value (2 bytes), which is always transmitted with the higher value byte followed by the lower value byte. (For numerical reasons, this results in a valid value range from 0 to 65535).
  – For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  – The torque unit ME is Newton meters (Nm), foot-pounds (ftlb) or inch-pounds (inlb), depending on the parameterization.
  – All torque values are scaled depending on the torque unit ME:
    Newton meters: Scaling factor = 10, e.g. the value 1234 corresponds to 123.4 Nm.
    Foot-pound: Scaling factor = 10, e.g. the value 1234 corresponds to 123.4 ftlb.
    Inch-pound: Scaling factor = 1, e.g. the value 1234 corresponds to 1234 inlb.
  – The bit field for the torque unit is implemented as follows:

Bit	Meaning	Comment
0	NM	Newtonmeter (Nm)
1	FTLB	Foot-pound (ftlb)
2	INLB	Inch-pound (inlb)
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

  Parameterizable torque values:
  – **M_S** Torque threshold value [pre-tightening stage and final tightening stage]
  – **M_A** Torque setpoint [pre-tightening stage and final tightening stage]
  – **M+** Upper torque tolerance [pre-tightening stage and final tightening stage]
  – **M-** Lower torque tolerance [pre-tightening stage and final tightening stage]

  Parameterizable torque unit:
  – ME Torque unit [pre-tightening stage and final tightening stage]

NOTICE: The window limits for the evaluation of the quality window for the nine-field check should always be fully parameterized, otherwise the nine-field check will also be incomplete. (M+, M-, W+ and W- should always have a value other than zero).

- **Rotation angle values (WX)**

  General information:

  – Rotation angle values consist of an unsigned 16-bit integer value (2 bytes), which is always transmitted with the higher value byte followed by the lower value byte. (For numerical reasons, this results in a valid value range from 0 (0x0000) to 65535 (0xFFFF)).
  – For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  – The rotation angle unit is degrees (°).
  – All rotation angle values are scaled with the scaling factor = 10, e.g. the value 1234 corresponds to 123.4 °.

  Parameterizable rotation angle values:

  – **W_A** Angle setpoint [pre-tightening stage and final tightening stage]
  – **W-** Lower angle tolerance [pre-tightening stage and final tightening stage]
  – **W+** Upper angle tolerance [pre-tightening stage and final tightening stage]

NOTICE: The window limits for the evaluation of the quality window for the nine-field check should always be fully parameterized, otherwise the nine-field check will also be incomplete. (M+, M-, W+ and W- should always have a value other than zero).

- **VALUES (tx)**

  General information:

  – Time values consist of an unsigned 32-bit integer value (4 bytes), which is always transmitted with the high value byte followed by the lower value bytes. (For numerical reasons, this results in a valid value range from 0 (0x00000000) to 4294967295 (0xFFFFFFFFFF)).
  – For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  – The unit of time is milliseconds (ms)
  – All time values are scaled with the scaling factor = 1, e.g. the value 1000 corresponds to 1000 ms (or 1 s)

  Parameterizable time values:

  – **t+** Upper time tolerance [pre-tightening stage and final tightening stage]
  – **t-** Lower time tolerance [pre-tightening stage and final tightening stage]

NOTICE: The time limits for the evaluation of the time window should always be fully parameterized, otherwise the time check is incomplete. (t- and t+ should have a value other than zero.)

If the parameters t- and t+ are parameterized with the value zero, time monitoring is deactivated.

- **Tightening stage identifier (SK)**

  General information:
  - The screwdriving stage identifier is parameterized by the controller using a bit field; a total of 8 bits (1 byte) are defined.
  - The value zero (0x00) is invalid; if a parameter is set with the value zero (0x00), the tool is stopped completely and put into standby mode.
  - The bit field for the screwdriving stage identifier is implemented as follows:

Bit	Meaning	Comment
0	US	Monitoring stage
1	VS	Pre-tightening stage
2	ES	Final tightening stage
3	LS	Release stage
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

  Parameterizable screwdriving stage identifier values:
  - **SK** Screw stage identifier [pre-tightening stage and final tightening stage]

- **Screwing method (SV)**

  General information:
  - The screwing method is parameterized by the controller using a bit field; a total of 8 bits (1 byte) are defined.
  - The value zero (0x00) is invalid; if a parameter is set with the value zero (0x00), the tool is stopped completely and put into standby mode.
  - The bit field for the screwing method is implemented as follows:

Bit	Meaning	Comment
0	AD procedure	Torque tightening method
1	AW process	Rotation angle tightening method
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

  Parameterizable screwing method values:
  - **SV** Screwing method [pre-tightening stage and final tightening stage]

- **Direction of rotation (DIR)**

  General information:
  - The direction of rotation is parameterized by the controller using a bit field; a total of 8 bits (1 byte) are defined.
  - The value zero (0x00) is invalid; if a parameter is set with the value zero (0x00), the tool is stopped completely and put into standby mode.
  - The bit field for the direction of rotation is implemented as follows:

Bit	Meaning	Comment
0	CW	Right, clockwise
1	CCW	Left, counterclockwise
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

Parameterizable direction of rotation values:
– **DIR** Direction of rotation [pre-tightening stage and final tightening stage]

- **Result output options (EAO)**
  General information:
  – The result output options are parameterized by the controller via a bit field, a total of 8 bits (1 byte) are defined. It is possible to set several different bits in this bit field.
  – The bit field for the result output options is implemented as follows:

Bit	Meaning	Comment
0	Output pre-tightening values	Output pre-tightening final values
1	Output final tightening values	Output final tightening final values
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	OK screwdriving curve	Screwdriving curve output for OK rundowns
7	NO screwdriving curve	Screwdriving curve output for NOK rundowns

Parameterizable result output option values:
– EAO Result output options [pre-tightening stage and final tightening stage]

NOTICE: The parameterized result output options of the final tightening stage always apply.

- **Tool gauge (SM)**
  General information:
  – *The gauge* is part of the parameter set from protocol version 1.002.
  – The gauge describes the distance from the pivot point of the rundown to the square drive of the screwdriving tool.
  – The value of the gauge consists of an unsigned 16-bit integer value (2 bytes) which is always transmitted with the higher value byte followed by the lower value byte.
  – The scaling is 1/10 mm, e.g. the value 250 represents 25.0 mm.
  – The maximum parameterizable gauge on the OPEX® is 250 mm. A gauge >250 mm is not permissible.

  Parameterizable gauge values:
  – SM Gauge of the screw attachment [pre-tightening stage and final tightening stage]

- **Screwdriving sequence data (INDEX, ANZ)**

  General information:
  - In addition, the information for the display can be parameterized as to which step of a screwdriving sequence the controller is currently in. (e.g. 8th sequence step of a total of 10 sequence steps)
  - The index of the current sequence step and the total number of sequence steps are each transmitted as an unsigned 8-bit integer value. (With the INDEX parameter, it is possible to continue a screwdriving sequence that has been started).
  - The sequence display on the tool is active if the parameterized number of total sequence steps is not equal to zero. (For numerical reasons, this results in a valid value range from 0 (0x00) to 255 (0xFF)).

  Parameterizable screwdriving sequence data:
  - **INDEX** Index of the current sequence step [pre-tightening stage and final tightening stage]
  - **ANZ** Total number of sequence steps [pre-tightening stage and final tightening stage]

- **Additional parameters (PLUS)**

  General information:
  - Additional parameters are parameterized by the controller using a bit field; a total of 8 bits (1 byte) are defined.
  - The bit field for additional parameters is implemented as follows:

Bit	Meaning	Comment
0	Cancel blocked	User option "Cancel rundown" is blocked
1	Release torque monitoring active	If the MS of the final tightening stage is exceeded, the rundown is considered to be released again
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

  Parameterizable additional parameter data:
  - **PLUS** Additional parameter data [pre-tightening stage and final tightening stage]

Process result data

- **Final torque values (M_f)**

  General information:
  - The final torque value is calculated from the peak torque of the complete tightening process.
  - The final torque value is transmitted as an unsigned 16-bit integer value (2 bytes). (For numerical reasons, this results in a valid value range from 0 (0x0000) to 65535 (0xFFFF)).
  - For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  - The torque unit is Newton meters (Nm), foot-pounds (ftlb) or inch-pounds (inlb), depending on the parameterization.
  - All torque values are scaled depending on the tool type and the torque unit:
  - OPEX® units with the setting **1 NK** have one torque decimal place.
    Newton meters: Scaling factor = 10, e.g. the value 1234 corresponds to 123.4 Nm.
    Foot-pound: Scaling factor = 10, e.g. the value 1234 corresponds to 123.4 ftlb.
    Inch-pound: Scaling factor = 1, e.g. the value 1234 corresponds to 1234 inlb.

- OPEX® units with the setting **2 NK** have two torque decimal places.
  Newton meters: Scaling factor = 100, e.g. the value 1234 corresponds to 12.34 Nm.
  Foot-pound: Scaling factor = 100, e.g. the value 1234 corresponds to 12.34 ftlb.
  Inch-pound: Scaling factor = 10, e.g. the value 1234 corresponds to 123.4 inlb.
- The number of torque decimal places is indicated by the telegram type (TYPE) in the result telegram:
  Telegram type = 0xA5 → Tightening result with one torque decimal place (**1 NK**).
  Telegram type = 0xA6 → Screwdriving curve with one torque decimal place (**1 NK**).
  Telegram type = 0xA7 → Tightening result with two torque decimal places (**2 NK**).
  Telegram type = 0xA8 → Screwdriving curve with two torque decimal places (**2 NK**).
- If the final tightening stage is not reached (cancelled or premature NOK), the final torque value M_I of the pre-tightening stage is output.

Output torque end value data:

- **M_I** Final torque value (actual value) [pre-tightening stage and final tightening stage]

- **Final rotation angle values (W_I)**

  General information:
  - The final rotation angle values are formed from the peak angles of the entire tightening stage. (pre-tightening stage and final tightening stage)
  - Rotation angle values consist of an unsigned 16-bit integer value (2 bytes), which is always transmitted with the higher value byte followed by the lower value byte. (For numerical reasons, this results in a valid value range from 0 (0x0000) to 65535 (0xFFFF)).
  - For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  - The rotation angle unit is degrees (°).
  - All rotation angle values are scaled with the scaling factor = 10, e.g. the value 1234 corresponds to 123.4°, 1 corresponds to 1/10°.
  - If the pre-tightening stage is not measured, the final rotation angle value zero (0x0000) is output for the pre-tightening stage.
  - If the final tightening stage is not reached, the final rotation angle value zero (0x0000) is output for the final tightening stage.

  Output final rotation angle value data:
  - **W_I** Final rotation angle value (actual value) [pre-tightening stage and final tightening stage]

- **Final tightening time values (t_I)**

  General information:
  - The tightening time consists of an unsigned 32-bit integer value (4 bytes), which is always transmitted with the higher value byte followed by the lower value bytes. (For numerical reasons, this results in a valid value range from 0 (0x00000000) to 4294967295 (0xFFFFFFFFF)).
  - For variables consisting of more than one byte, the transmission of the highest value byte is started first.
  - The unit of time is milliseconds (ms)
  - The tightening time is scaled with the scaling factor = 1, e.g. the value 1000 corresponds to 1000 ms (or 1 s)
  - The tightening time is only recorded once the final tightening stage has been reached; the tightening time for the pre-tightening stage is not recorded.

  Output final tightening time value data:
  - **t_I** Final tightening time value (actual value) [pre-tightening stage and final tightening stage]

- **Sequence step (INDEX)**

  General information:
  - For a parameterized screwdriving sequence, the current index of the current sequence step is output.
  - The index of the current sequence step is transmitted as an unsigned 8-bit integer value.
  - In the case of an OK-rated rundown, the index is incremented by the handheld screwdriver and the display shows when the total number of sequence steps has been reached.

  Transmitted sequence step data:
  - **INDEX** Index of the current sequence step [final tightening stage]

- **Screw status code (SSC)**

  General information:
  - The screw status code (SSC) is a bit field with a size of 64 bits (8 bytes).
  - In addition to an error bit for each NOK evaluation in the nine-field, there are other bits for displaying faults.
  - The rundown is only evaluated as OK if no fault bits are set in the screw status code field to form the hexadecimal value 0x00000000.

  Output screw status code data:
  - **SSC** Screw status code [pre-tightening stage and final tightening stage]

Screwdriving curves

General information:

- Depending on the last parameterized result output options, the tool can be parameterized such that the curve values of the rundown are also output after the final value output.
- The handheld screwdriver can be parameterized so that the screwdriving curve is only output for OK rundowns, only for NOK rundowns or for OK and NOK rundowns.
- The screwdriving curves do not have a fixed length. The length to be transmitted is determined by the resulting length of the screwdriving curve.
- The length of the screwdriving curve to be transmitted (number of curve values) is output in the header of the screwdriving curve with two unsigned 16-bit values (4 bytes in total), followed by the actual screwdriving curve.

  Number of screwdriving curve values of the pre-tightening stage (2 bytes)

  Number of screwdriving curve values of the final tightening stage (2 bytes)
- The curve values are output immediately after the final value output. The curve values are transmitted in a grid of 1°, the maximum angle value is 999°.
- Each torque value in the screwdriving curve is output as an unsigned 16-bit value (2 bytes). The scaling of the torque values depends on the parameterized torque unit.

  (Nm = 10, ftlb = 10, inlb = 1)

The respective peak torque value per degree is calculated and saved for each 1° interval.

Output screwdriving curve data:

- $\mathbf{n_V}$ Number of curve values, pre-tightening stage [pre-tightening stage]
- $\mathbf{n_E}$ Number of curve values, final tightening level [final tightening stage]
- **GRAPH** Screwdriving curve values [pre-tightening stage and final tightening stage]

Process event data

Barcode scan

General information:

– The barcode is an ASCII string without termination and can be up to 40 characters long. The length depends on the length of the scanned barcode and is transmitted in the header of the data packet at the start of the transmission.

Output barcode scan data:

– Barcode

Process status data

Tool status code (WSC)

General information:

– The operating status of the tool and the current connection status can also be requested using the serial interface of the controller.
– The tool status code (WSC) is displayed by the handheld screwdriver using a bit field; a total of 8 bits (1 byte) are defined.

Bit	Meaning	Comment
0	Parking position	Handheld screwdriver is placed in the charger or storage tray, for example
1	Tightening stage started	Handheld screwdriver is ready to screw
2	Monitoring stage started	Handheld screwdriver monitors unintentional operation
3	Reserved	
4	Pre-tightening stage active	Pre-tightening stage active (Ms was reached in the current tightening stage)
5	Final tightening stage active	Final tightening stage active (MS has been reached in the current tightening stage)
6	Low battery	Battery status critical
7	System fault	Fault (electronics, sensors)

Output tool status data:

– Tool status code (WSC)

Process information data

Tool information

General information:

– By sending a request telegram of the type "WZGINFO", the controller can request the tool information from the hand tool.

Output tool information data:

– Tool information
  Tool type (12 ASCII characters without termination)
  Rated load capacity in Nm (unsigned 16-bit value)
  Minimum torque, lower limit for MV (unsigned 16-bit value)
  Serial number (12 ASCII characters without termination)
  Tool number (12 ASCII characters without termination)
  Firmware version (6 ASCII characters without termination)
  Firmware date (6 ASCII characters without termination)
  Highest protocol version (unsigned 16-bit value)

ENGLISH

Read out current parameter set

General information:

- By transmitting a request telegram of the type "GETPAR", the controller can read the current data from the parameter set data structure of the handheld screwdriver.
- The parameter data set structure is transmitted in the same binary data format as the parameter set is transmitted from the controller to the handheld screwdriver. (82 bytes for protocol version 1000)
- If there is no parameter set data in the parameter set data structure, it is initialized with the value zero throughout.

Output parameter set data:

- Content of the parameter set structure (75 bytes for protocol version 1000)

Process control data

Tool stop

General information:

- Byte 0xAF can be used to stop a currently started tightening stage, release stage or monitoring stage. (Current parameter set is stopped, tool goes into standby)

Transmitted process control data:

- Tool stop with confirmation

Tool start

General information:

- Byte 0xAA can be used to restart a currently parameterized tightening stage, release stage or monitoring stage.
- If a tightening stage, a release stage or a monitoring stage has already been started in the tool and stopped again by a stop telegram being transmitted, this last parameter set can be restarted by a start telegram being transmitted.
- If the parameter set is started successfully, the tool being transmits back an acknowledge telegram (positive acknowledgement of receipt).

Transmitted process control data:

- Tool start with confirmation

Tool parameterization

General information:

- The tool is re-parameterized using the process control system interface

Transmitted process control data:

- Parameter set

Examples of the data structures used

Parameter set data structure

```
//**********************************
//** Parametersatzdatenstruktur
//**********************************
//T_GWK_SPS_Parameterheader_V1000
typedef struct __attribute__((packed))
{
  //Parametersatzname
  int8_t NAME[40];      //Parametersatzname [40 Bytes]

  //Werkstueck-ID
  int8_t VIN[40];       //Werkstueck-ID [40 Bytes]

  //Programm-Nummer
  int8_t PG[3];         //Programm-Nummer [3 Bytes]
```

```
  //Schraubablauf
  uint8_t INDEX;        //Index aktueller Ablaufschritt [1 Byte]
  uint8_t ANZ;          //Gesamtanzahl der Ablaufschritte [1 Byte]

  //Drehmomenteinheit
  uint8_t ME;           //Drehmomenteinheit[1 Byte]

  //Ergebnis Ausgabeoptionen
  uint8_t EAO;          //Werkzeug Ergebnisausgabeoptionen [1 Byte]

  //Anzahl der parametrierten Schraubstufen
  uint8_t SANZ;         //Anzahl der parametrierten Schraubstufen [1 Byte]
}
T_GWK_SPS_Parameterheader_V1000;


//T_GWK_SPS_Parameterheader_V1002
typedef struct __attribute__((packed))
{
  //Parametersatzname
  int8_t NAME[40];      //Parametersatzname [40 Bytes]

  //Werkstueck-ID
  int8_t VIN[40];       //Werkstueck-ID [40 Bytes]

  //Programm-Nummer
  int8_t PG[3];         //Programm-Nummer [3 Bytes]

  //Schraubablauf
  uint8_t INDEX;        //Index aktueller Ablaufschritt [1 Byte]
  uint8_t ANZ;          //Gesamtanzahl der Ablaufschritte [1 Byte]

  //Drehmomenteinheit
  uint8_t ME;           //Drehmomenteinheit[1 Byte]

  //Ergebnis Ausgabeoptionen
  uint8_t EAO;          //Werkzeug Ergebnisausgabeoptionen [1 Byte]

  //Stichmass
  uint16_t SM;          //Stichmass [2 Bytes]

  //Anzahl der parametrierten Schraubstufen
  uint8_t SANZ;         //Anzahl der parametrierten Schraubstufen [1 Byte]
}
T_GWK_SPS_Parameterheader_V1002;


//T_GWK_SPS_Parameterdaten
typedef struct __attribute__((packed))
{
  //Schraubstufenkennung
  uint8_t SK;           //Schraubstufenkennung [1 Byte]

  //Drehmoment Werte
  uint16_t M_s;         //Moment Schwellwert [2 Bytes]
  uint16_t M_a;         //Moment Sollwert [2 Bytes]
  uint16_t M_minus;     //unteres Toleranz Moment [2 Bytes]
  uint16_t M_plus;      //oberes Toleranz Moment [2 Bytes]

  //Drehwinkel Werte
  uint16_t W_a;         //Winkel Sollwert [2 Bytes]
  uint16_t W_minus;     //unterer Toleranz Winkel [2 Bytes]
  uint16_t W_plus;      //oberer Toleranz Winkel [2 Bytes]

  //Zeit Werte
  uint32_t t_minus;     //untere Toleranz Zeit [4 Bytes]
  uint32_t t_plus;      //obere Toleranz Zeit [4 Bytes]
```

```
  //Schraubverfahren
  uint8_t SV;           //Schraubverfahren [1 Byte]

  //Drehrichtung
  uint8_t DIR;          //Drehrichtung (Wirkrichtung) [1 Byte]

  //Zusaetzliche Parameter
  uint8_t PLUS;         //Zusaetliche Parameter [1 Byte]
}
T_GWK_SPS_Parameterdaten;


//T_GWK_SPS_Parametersatzdatenblock_ES_V1000 (Nur Endanzugstufe)
typedef struct __attribute__((packed))
{
  //Parameterheader
  T_GWK_SPS_Parameterheader_V1000 HEADER;

  //Parametersaetze
  T_GWK_SPS_Parameterdaten PARAMETER_SK_ES;
}
T_GWK_SPS_Parametersatzdatenblock_ES_V1000;


//T_GWK_SPS_Parametersatzdatenblock_ES_V1002 (Nur Endanzugstufe)
typedef struct __attribute__((packed))
{
  //Parameterheader
  T_GWK_SPS_Parameterheader_V1002 HEADER;

  //Parametersaetze
  T_GWK_SPS_Parameterdaten PARAMETER_SK_ES;
}
T_GWK_SPS_Parametersatzdatenblock_ES_V1002;


//T_GWK_SPS_Parametersatzdatenblock_VS_ES_V1000 (Mit Voranzugstufe und
Endanzugstufe)
typedef struct __attribute__((packed))
{
  //Parameterheader
  T_GWK_SPS_Parameterheader_V1000 HEADER;

  //Parametersaetze
  T_GWK_SPS_Parameterdaten PARAMETER_SK_VS;
  T_GWK_SPS_Parameterdaten PARAMETER_SK_ES;
}
T_GWK_SPS_Parametersatzdatenblock_VS_ES_V1000;


//T_GWK_SPS_Parametersatzdatenblock_VS_ES_V1002 (Mit Voranzugstufe und
Endanzugstufe)
typedef struct __attribute__((packed))
{
  //Parameterheader
  T_GWK_SPS_Parameterheader_V1002 HEADER;

  //Parametersaetze
  T_GWK_SPS_Parameterdaten PARAMETER_SK_VS;
  T_GWK_SPS_Parameterdaten PARAMETER_SK_ES;
}
T_GWK_SPS_Parametersatzdatenblock_VS_ES_V1002;
```

Tightening results data structure

```
//**********************************
//** Schraubergebnisdatenstruktur
//**********************************
//T_GWK_SPS_Ergebnisheader
typedef struct __attribute__((packed))
{
  //Werkstueck-ID
  int8_t VIN[40];       //Werkstueck-ID [40 Bytes]

  //Programm-Nummer
  int8_t PG[3];         //Programm-Nummer [3 Bytes]

  //Ablaufschritt
  uint8_t INDEX;        //Index des aktuellen Ablaufschritts [1 Byte]

  //Anzahl der parametrierten Schraubstufen
  uint8_t SANZ;         //Anzahl der parametrierten Schraubstufen [1 Byte]
}
T_GWK_SPS_Ergebnisheader;

//T_GWK_SPS_Ergebnisdaten
typedef struct __attribute__((packed))
{
  //Schraubstufenkennung
  uint8_t SK;           //Schraubstufenkennung [1 Byte]

  //Drehmoment
  uint16_t M_i;         //Drehmoment Endwert [2 Bytes]

  //Drehwinkel
  uint16_t W_i;         //Drehwinkel Endwert [2 Bytes]

  //Anzugzeit
  uint32_t t_i;         //Anzugzeit [4 Bytes]

  //Drehrichtung
  uint8_t DIR;          //Drehrichtung [1 Byte]

  //Schraubstatuscode
  uint8_t SSC[8];       //SSC Endwert [8 Bytes]
}
T_GWK_SPS_Ergebnisdaten;

//T_GWK_SPS_Ergebnisdatenblock_ES (Nur Endanzugstufe)
typedef struct __attribute__((packed))
{
  //Ergebnisheader
  T_GWK_SPS_Ergebnisheader HEADER;

  //Ergebnisse
  T_GWK_SPS_Ergebnisdaten ERGEBNIS_SK_ES;
}
T_GWK_SPS_Ergebnisdatenblock_ES;

//T_GWK_SPS_Ergebnisdatenblock_VS_ES (Mit Voranzugstufe und Endanzugstufe)
typedef struct __attribute__((packed))
{
  //Ergebnisheader
  T_GWK_SPS_Ergebnisheader HEADER;

  //Ergebnisse
  T_GWK_SPS_Ergebnisdaten ERGEBNIS_SK_VS;
  T_GWK_SPS_Ergebnisdaten ERGEBNIS_SK_ES;
}
T_GWK_SPS_Ergebnisdatenblock_VS_ES;
```

Screwdriving curve data structure

```
//**********************************
//** Schraubkurvendatenstruktur
//**********************************
//T_GWK_SPS_Schraubkurve
typedef struct __attribute__((packed))
{
  //Anzahl Winkelwerte
  uint16_t n_v;         //Anzahl Winkelwerte Voranzug [2 Bytes]
  uint16_t n_e;         //Anzahl Winkelwerte Endanzug [2 Bytes]

  //Schraubkurve
  int16_t GRAPH[1000];  //Schraubkurvenwerte [bis zu 2000 Bytes]
}
T_GWK_SPS_Schraubkurve;
```

Barcode data structure

```
//**********************************
//** Barcodedatenstruktur
//**********************************
//T_GWK_SPS_Barcode
typedef struct __attribute__((packed))
{
  //Barcodelaenge
  uint8_t n;            //Anzahl der ASCII-Zeichen [1 Byte]

  //Barcode
  int8_t  Barcodes[40]; //ASCII-Barcodestring [bis zu 40 Bytes]

}
T_GWK_SPS_Barcode;
```

CRC16 checksum generation

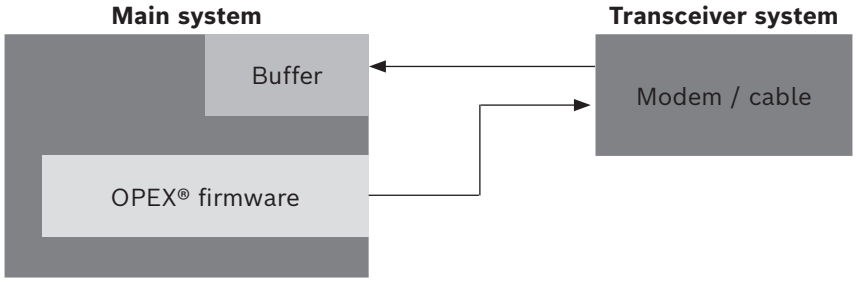
The CRC16 checksum is generated using the 0x8408 polynomial method.
The following example source code generates the following output:

```
//************************************
//** TESTROUTINE 340
//************************************
#ifdef TESTROUTINE_340
//#error ich werde kompiliert

/*****************************************************************************
* Funktion: testroutine
*           CRC16 Test 4 (0x8408 Polynom-Verfahren)
*****************************************************************************/
/******************
* Funktionscode    *
******************/
/*!
* ---------------------------------------------------------------------------
* crc16()
* ---------------------------------------------------------------------------
*
* Berechnung des CRC 16 Wert (0x8408 Polynom-Verfahren)
*
* \brief CRC 16 Berechnung
* \param *data_p Zeiger auf die Zeichenkette über die der CRC gebildet werden soll
* \param length Die Laenge der uebergebenen Zeichenkette
* \return Rueckgabewert ist der gebildete CRC-Wert
*/
unsigned int update_crc16(unsigned int crc, unsigned char byte)
{
unsigned char mask;

  for(mask = 0x01; mask; mask <<=1)
  {
    if(byte&mask)
    {
      crc^=0x0001;
    }
    crc = (crc & 0x0001) ? (crc >> 1) ^ 0x8408 : crc >> 1;
  }

  return crc;

void testroutine(void)
{
uint16_t crc16;
int8_t buffer[40];

  puts_P(PSTR(„\n\n\r TESTROUTINE: CRC16 Test 4 (0x8408 Polynom-Verfahren)\n\r“));

  sprintf_P((char*) buffer, PSTR(„123456789“)); //Testbuffer initialisieren

  printf_P(PSTR(„\n\rbuffer = \“%s\““), buffer);

  printf_P(PSTR(„\n\rstrlen(buffer) = %i“), strlen((char*) buffer));

  crc16 = 0; //CRC16 Pruefsumme initialisieren

  for(uint8_t i=0; i < strlen((char*) buffer); i++) //CRC16-Pruefsumme bilden
  {
    crc16 = update_crc16(crc16, buffer[i]);
  }

  printf_P(PSTR(„\n\rcrc16 = 0x%04X“), crc16);

}
#endif
```

19.3.3 Tool communication with the external controller

Tool receive buffer

The tool is equipped with a receive buffer with a size of 256 bytes. That means telegrams to the tool should not exceed this size.



The firmware processes the events on the tool and at the same time interrogates the receive buffer.

The receive buffer is not interrogated during a transmission process, but data can still be received from the receive buffer.

Data transmission protocol (data embedding)

Data transmission is always within a fixed framework with a sequential telegram number and embedded with a CRC16 checksum.

Sequential telegram number (NUM)

The sequential telegram number is used to detect lost data packets.

Requests and answers always have the same telegram number, which is incremented by 1 with each new request.

Each transmitter (controller and hand tool) has its own sequential telegram number, which is incremented after each new request.

The start value of the telegram number after a reset is 1. This can be done in the handheld screwdriver by transmitting a RESET telegram. Alternatively, the start value of both devices can be deliberately reset to 1 by transmitting a request with the telegram number with the value 0.

Highest protocol version (VERS)

After establishing the connection between the handheld screwdriver and the controller, the highest common telegram protocol version must first be negotiated.

To do this, the controller sends its highest protocol version to the hand tool and the hand tool compares this with its highest protocol version. The hand tool then transmits the highest protocol version back to the controller, which is supported by both participants.

The data format of the protocol version negotiation will remain the same for all future protocol versions (protocol version 1.000), so that this negotiation will always remain possible.

Tool serial number (SERNO)

When transmitting and receiving data frames (telegrams), the serial number of the screwdriving tool is always transmitted.

This is used to identify the controller to which the tool is connected.

If, for example, another tool takes over the connection, the controller can recognize that it is a different tool.

If the tool receives requests from the controller that contain a serial number of another screwdriving tool, this telegram request is ignored and answered with a NAK telegram.

Handheld screwdriver alive signal (ALIVE)

The alive signal serves as feedback for the controller as to whether the connection to the handheld screwdriver is still established or whether the connection needs to be re-established.

When the alive signal is activated, the handheld screwdriver sends an ALIVE telegram to the controller approx. every 7 seconds or when it is inserted into or removed from the charging cradle or storage cradle (park position).

The alive signal is regarded as an automatic answer, therefore the telegram number of the last request from the handheld screwdriver is used for the sequential telegram number. One component of an ALIVE telegram is the tool status code (WSC).
It is therefore also not necessary to confirm an alive signal on the control side.

The alive signal is deactivated again after a RESET telegram.

Telegram type (TYPE)

The telegram type is represented by an unsigned 8-bit integer value and determines the type of the respective telegram.

Type	Value	Description
PROTOKOLL	0x1A	Negotiating the highest protocol version
RESET	0x1B	Tool reset (controller resets the tool)
WZGINFO	0x49	Tool info (controller requests tool information)
WZGSTATUS	0x53	Tool status (controller requests the tool status code (WSC))
ALIVE	0xB1	Transmit ALIVE telegram (tool transmits the ALIVE telegram)
PARAMETER	0xA3	Handheld screwdriver parameterization (controller transmits the parameter set)
GETPAR	0xA4	Read in parameter set (controller receives the parameter set)
WZGSTOPP	0xAF	Parameter set stop (controller stops the parameter set)
WZGSTART	0xAA	Parameter set start (controller starts the parameter set)
RESULT (1 NK)	0xA5	Tightening result (tool transmits the tightening result to the controller with one torque decimal place)
CURVE (1 NK)	0xA6	Screwdriving curve (tool transmits the screwdriving curve to the controller with one torque decimal place)
RESULT (2 NK)	0xA7	Tightening result (tool transmits the tightening result to the controller with two torque decimal places)
CURVE (1 NK)	0xA8	Screwdriving curve (tool sends the screwdriving curve to the controller with two torque decimal places)

Type	Value	Description
BARCODE	0x42	Barcode (tool transmits the barcode to the controller)
SANUMMER	0x43	Screw attachment number (handheld screwdriver transmits the recognized number of the screw attachment to the controller)
SHUTDOWN	0x5A	Remote shutdown (controller shuts down the handheld screwdriver)
ACK	0x06	Acknowledgment (positive acknowledgement of receipt)
NAK	0x15	Negative acknowledgement (negative acknowledgement of receipt)

(Status: Protocol version 1.003)

Structure of the data frame

The data frame of a telegram is structured as follows:

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	Runtime-dependent	Telegram type, e.g. WZGINFO (see "Torque values (MX)", page 132)
VERS	2 bytes	Highest protocol version	Telegram protocol version (see "Highest protocol version (VERS)", page 131)
NUM	2 bytes	Runtime-dependent	Sequential telegram number (see "Sequential telegram number (NUM)", page "Sequential telegram number (NUM)" on page 146)
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	n	Number of bytes of user data
DATA	n bytes	Runtime-dependent	User data to be transmitted
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

Please note:

No DestinationID or SourceID is needed as only one tool is connected to the controller on each transmission channel.

The assignment is therefore determined by the transmission channel and the serial number contained in the data frame (from protocol version 1.001) and can be checked by the controller by reading out the tool information.

An answer from the addressed subscriber is always expected after a request telegram. An exception to this is the ALIVE telegram, which is transmitted by the screwdriving tool to the controller and is not acknowledged by the controller.

The time window until a timeout always begins after transmission has been completed (ETX has been transmitted) and is 3000 ms. The program is repeated after a timeout.

Negotiating the highest protocol version (PROTOCOL)

This function can be used to negotiate the highest telegram protocol version after the connection between the handheld screwdriver and the controller has been established.

The initial value of the jointly negotiated protocol version after switching on is 1.000.

PROTOCOL telegrams are always transmitted with protocol version 1.000.

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x1A	Telegram type: PROTOCOL
VERS	2 bytes	1000	PROTOCOL telegram is always transmitted with protocol version 1.000.
NUM	2 bytes	0	Sequential telegram number
LEN	2 bytes	2	Number of bytes of user data = 2
DATA	2 bytes	e.g. 1001	Highest protocol version supported by the controller.
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x1A	Telegram type: PROTOCOL
VERS	2 bytes	1000	PROTOCOL telegram is always transmitted with protocol version 1.000.
NUM	2 bytes	0	Sequential telegram number
LEN	2 bytes	2	Number of bytes of user data = 2
DATA	2 bytes	e.g. 1001	Jointly negotiated highest telegram protocol version
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for negotiating the highest protocol version is 3000 ms. If the controller does not receive a version proposal from the tool by this time, the negotiation was not successful.

Resetting the tool (RESET)

This function can be used to reset the tool. This stops the tool and sets it to standby mode. (Same status as after switching on.) The sequential telegram number is reset to the value one and the jointly negotiated protocol version is reset to the value 1000. (i.e. after a RESET telegram, the common protocol version must be renegotiated). RESET telegrams are always transmitted with protocol version 1.000.

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x1B	Telegram type: RESET
VERS	2 bytes	1000	RESET telegram is always transmitted with protocol version 1.000.
NUM	2 bytes	any	Sequential telegram number
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x1B	Telegram type: RESET
VERS	2 bytes	1000	RESET telegram is always transmitted with protocol version 1.000.
NUM	2 bytes	1	Sequential telegram number
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for a reset of the handheld screwdriver is 3000 ms. If the controller has not received a reset confirmation from the tool by this time, the reset was not successful.

Reading out tool information (WZGINFO)

Tool information data block

The following data is output in the tool information data block. The correct sequence and number of data bytes must be observed.

Sequence	Value / information	Description / example	Bytes
01.	Type of tool	ASCII string without termination, filled with spaces e.g. "OPEX® Plus Bidirekt"	24

Sequence	Value / information	Description / example	Bytes
02.	Rated load capacity	ASCII string without termination with leading "0" e.g. "000600" with a rated load capacity of 60 Nm	6
03.	Minimum torque of the measurement technology	ASCII string without termination with leading "0"; metrologically recommended lower limit for Ms1 e.g. "000012" with a minimum torque of 1.2 Nm	6
04.	Serial number	ASCII string without termination, filled with spaces, e.g. "P2145/T325" or "P2145"	16
05.	Tool number	ASCII string without termination, e.g. "1234_____" or "1234"	12
06.	Firmware version	ASCII string without termination, e.g. "2.112"	6
07.	Firmware date	ASCII string without termination, format DDMMYYY, e.g. "020516"	6
08.	Highest protocol version	ASCII string without termination with leading "0"; highest telegram protocol version of the control communication, unsigned 16-bit value, e.g. "001000" for version 1.000	6

In protocol versions 1.000 and 1.001, the tool information data block always has a length of 82 bytes, which are transmitted in full.

Read in tool information (controller receives tool information)

In this example, it is assumed that the tool was previously reset by a RESET telegram, e.g. after the system was switched on.

The value 1 is therefore used as the start value for the sequential telegram number.

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x49	Telegram type: WZGINFO
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 1	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	

Sequence	Length	Value	Description
TYP	1 byte	0x49	Telegram type: WZGINFO
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 1 (same as Request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	82	Length of the tool information data
DATA	82 bytes	Tool-dependent	Tool information data block
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for reading in the tool information is 3000 ms. If the handheld screwdriver does not return any data by this point, the read-in was not successful.

Requesting tool status (controller requests)

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x49	Telegram type: WZGSTATUS
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 1	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x53	Telegram type: WZGSTATUS
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 2 (same as request)	Sequential telegram number

Sequence	Length	Value	Description
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	1	Number of bytes of user data = 1
DATA	1 byte	WSC	Tool status code
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for requesting the tool status is 3000 ms. If the handheld screwdriver does not return a tool status code by this point, the request was not successful.

Hand tool alive signal (ALIVE)

When the ALIVE signal is activated, the handheld screwdriver transmits an ALIVE telegram to the controller approx. every 7 seconds. This is not acknowledged by the controller. (The screwdriving tool does not wait for acknowledgement of the ALIVE telegram from the controller).

In addition, the ALIVE signal is triggered when the tool is inserted into or removed from the charging cradle or storage cradle (parking position) so that this event is immediately transmitted to the controller.

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xB1	Telegram type: ALIVE
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	As with the last request for the handheld screwdriver	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	1	Number of bytes of user data = 1
DATA	1 byte	Runtime-dependent (WSC)	Tool status code (WSC)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

Tool parameterization (PARAMETER)

General information

- The complete parameterization of the tool is carried out by the customer using the serial interface of the controller (WLAN TCP, ZigBee or RS232). The exact procedure is described in the following section.
- The parameter set data is transmitted in embedded data frames (see "Structure of the data frame", page 148)

- Integer values consisting of several bytes are always transmitted with the higher value bytes first, the lowest value byte is always transmitted last.
- The values received are not checked for plausibility by the tool.
- The transmitted parameter set always remains available in the tool until it is overwritten.
- The maximum time window for a parameterization attempt is approx. 3000 ms. If the tool does not confirm receipt of the parameter set data with an acknowledge telegram (positive acknowledgement of receipt) by this point, parameterization was not successful.
- If the tool detects a reception error (CRC, timeout), the tool transmits a negative acknowledgement telegram (negative acknowledgement of receipt) back to the process control system.
- If parameterization is invalid, the tool always goes into standby mode and has to be parameterized again with valid parameter data.
- The following description is based on protocol version no. 1000.
- The parameter set data block must always be transmitted in full. Unused parameter set data always has to be parameterized with the value zero.
- Parameterization from the controller to the handheld screwdriver is initiated with a request telegram of type "PARAMETER".
- Reading the parameter set from the hand tool into the controller is triggered with a request telegram of type "GETPAR".

Stacking of parameter sets for parameterizing several tightening stages in a complex tightening

- Alternatively, several parameter sets can be stacked in sequence to form a complex tightening. For this purpose, several parameter sets are transmitted in sequence as independent tightening stages during parameterization.
- The number of tightening stages (parameter sets) to be transmitted is stored in the first byte SANZ of the parameter set data block. (Unsigned 8-bit integer value)

Please note:

The current firmware of the handheld screwdriver currently only supports a maximum of 2 tightening stages. In a 2-stage tightening, the first stage always has to be a pre-tightening stage using the AD method, followed by a final tightening stage using the AD or AW method.

Parameter set data block

When parameterizing, it is important to ensure that the sequence of data in the parameter set data block observed.

For variables consisting of more than one byte, the transmission of the highest value byte is started first.

Sequence	Variable	Description	Bytes
		*** Start of the parameter set data block ***	
1.	**NAME**	Parameter set name (ASCII string without termination)	40
2.	**VIN**	Workpiece ID (40 ASCII characters)	40
3.	**PG**	Program number (3 ASCII characters)	3
4.	**INDEX**	Index of the current sequence step INDEX	1
5.	**ANZ**	Total number of sequence steps	1
6.	**ME**	Torque unit ME	1
7.	**EAO**	Result output options EAO	1
8.	**SM**	Gauge, from protocol version 1.002)	2

Sequence	Variable	Description	Bytes
9.	**SANZ**	Number n of tightening stages to be transmitted (with current OPEX® firmware: 1 or 2)	1
		*** Start of parameter set loop (1 or 2 parameter sets) ***	
n. 01	**SK**	Tightening stage identifier SK	1
n. 02	**M_S**	Torque threshold value M_S (threshold for final tightening stage)	2
n. 03	**M_A**	Torque setpoint M_A	2
n. 04	**M-**	Lower torque tolerance M-	2
n. 05	**M+**	Upper torque tolerance M+	2
n. 06	**W_A**	Rotation angle setpoint W_A	2
n. 08	**W-**	Lower rotation angle tolerance W-	2
n. 09	**W+**	Upper rotation angle tolerance W+	2
n. 10	**t-**	Lower time tolerance t-	4
n. 11	**t+**	Upper time tolerance t+	4
n. 12	**SV**	Screwing method SV	1
n. 13	**DIR**	Direction of rotation DIR	1
n. 14	**PLUS**	Additional parameters PLUS	1
		*** End of parameter set loop ***	

With protocol versions 1.000 and 1.001, a parameter set data block has a length of either 88 + 26 = 114 bytes or 88 + 52 = 140 bytes. Unused parameter set data is set to the value zero.

From protocol version 1.002 onwards, the parameter set data block is increased by 2 bytes to 116 or 142 bytes due to the gauge.

Parameterize handheld screwdriver (controller transmits the parameter set)

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xA3	Telegram type: PARAMETER
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 3	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	n = 114 or 140 n = 116 or 142 from V1.002	Length of the parameter set data block
DATA	n bytes	New parameter set block	Parameter set data to be transferred
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character

Sequence	Length	Value	Description
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x06	Telegram type: WZGINFO
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 3 (same as request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for parameterizing the handheld screwdriver is 3000 ms. If the controller does not receive acknowledgement (positive acknowledgement of receipt) from the tool by this time, parameterization was not successful. In the event of faulty reception (checksum), the handheld screwdriver transmits a NAK telegram back to the controller.

Read in parameter set (controller receives the parameter set)

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xA4	Telegram type: GETPAR
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 4	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xA4	Telegram type: GETPAR
VERS	2 bytes	1003	Telegram protocol version 1.003

Sequence	Length	Value	Description
NUM	2 bytes	e.g. 3 (same as request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	n = 114 or 140 n = 116 or 142 from V1.002	Length of the parameter set data block
DATA	n bytes	Current parameter set block	Parameter set data to be transferred
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for starting the handheld screwdriver is 3000 ms. If the handheld screwdriver transmits a NAK telegram back after a start telegram, then no parameter set to be started was available in the handheld screwdriver.

Tool stop / start

If the tool has already been parameterized and the retransmission of a parameter set is not necessary, these request telegrams can be used to stop and restart the last parameterized and started parameter.

The sequential telegram number is not reset.

Stop tool (controller stops the parameter set in handheld screwdriver)

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xAF	Telegram type: WZGSTOPP
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 4	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	

Sequence	Length	Value	Description
TYP	1 byte	0xAF	Telegram type: WZGSTOPP
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 3 (same as request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	LEN 2 bytes 0 Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for stopping the handheld screwdriver is 3000 ms. If the controller does not receive a stop telegram (positive acknowledgement of receipt) from the tool by this time, the stop was not successful.

Start tool (controller starts (restarts) the parameter set in the handheld screwdriver)

→**(Request)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xAA	Telegram type: WZGSTART
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 6	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	40 + 3	Number of bytes of user data = 43
DATA	43 bytes	Current VIN and PG	Work ID and program number
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xAA	Telegram type: WZGSTOPP
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 6 (same as request)	Sequential telegram number

Sequence	Length	Value	Description
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: The maximum time window for starting the handheld screwdriver is 3000 ms. If the handheld screwdriver transmits a NAK telegram back after a start telegram, then no parameter set to be started was available in the handheld screwdriver.

Tightening result (handheld screwdriver transmits final values)

Results data block

For the tightening result, it is important to ensure that the sequence of data in the tightening result data block observed.

Sequence	Variable	Description	Bytes
		*** Start of result data block ***	
1.	**VIN**	Workpiece ID (40 ASCII characters)	40
2.	**PG**	Program number (3 ASCII characters)	3
3.	**INDEX**	Index of the current sequence step	1
4.	**SANZ**	Number n of tightening stage results to be transmitted (1 or 2)	1
		*** Start of result data loop (1 or 2 results) ***	
n. 01	**SK**	SK tightening stage identifier (see "Tightening stage identifier (SK)", page 134)	1
n. 02	**M_I**	Final torque value (actual value) M_I	2
n. 03	**W_I**	Final rotation angle value (actual value) W_I	2
n. 04	**t_I**	Final tightening time value (actual value) t_I	4
n. 05	**DIR**	Direction of rotation DIR (direction of action)	1
n. 06	**SSC**	Screw status code (SSC)	8
		*** End of result data block loop ***	

NOTICE: With protocol versions 1.000 and 1.001, the result data block has a length of either 45 + 18 = 63 bytes or 45 + 36 = 81 bytes, which must be transmitted in full.

Result data block reception (tool transmits tightening result)

→**(Request)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xA5	Telegram type: RESULT
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 7	Sequential telegram number

Sequence	Length	Value	Description
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	N = 62 or 123	Length of the result data block
DATA	n bytes	Tightening result	Result data to be transferred
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x06	Telegram type: ACK
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 7	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: Transmission is complete after the handheld screwdriver has received positive acknowledgement from the controller.

The maximum time window for receiving and acknowledging a result data block is 3000 ms.

The handheld screwdriver then repeats the transmission attempt until it receives positive acknowledgement from the controller.

This transmission loop can be canceled by the operator at the tool after the display of the handheld screwdriver shows a fault message.

If transmission of a result is canceled, any subsequent screwdriving curve output is also canceled.

As long as no new rundown is started, the tightening result will still be shown on the LCD display of the handheld screwdriver; when a new rundown is started, the last tightening result is lost.

Screwdriving curve (handheld screwdriver transmits screwdriving curve)

If the screwdriving curve output is activated, this is output after the tightening result. If screwdriving curve output is activated, the data frame for the screwdriving curve is always output.

If no screwdriving curve values exist, an empty screwdriving curve is output.

Screwdriving curve data block

For the tightening result, it is important to ensure that the sequence of data in the tightening result data block observed.

Sequence	Variable	Description	Bytes
		*** Header of the curve output ***	
01.	n_V	Number of curve values for pre-tightening stage [Pre-tightening stage]	2
02.	n_E	Number of curve values for final tightening level [Final tightening level]	2
		*** Start of curve value output ***	
03.	**GRAPH**	First curve value (from MV or MS, depending on parameterization)	2
...	**GRAPH**	The following curve values, 2 bytes each	...
n.	**GRAPH**	Last curve value	2
		*** End of curve value output ***	

With protocol version 1.000, the screwdriving curve data block always has a length of n = 2 + 2 + ((n_V + n_E) * 2) bytes, which must be transmitted in full.

Screwdriving curve data block reception (tool transmits screwdriving curve)

→**(Request)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0xA6	Telegram type: CURVE
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 7 (same as final values)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	n	Length of the screwdriving curve data block
DATA	n bytes	Screwdriving curve	Screwdriving curve data block
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x06	Telegram type: ACK
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 7 (same as request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)

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Sequence	Length	Value	Description
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: Transmission is complete after the handheld screwdriver has received positive acknowledgement from the controller.

The maximum time window for receiving and acknowledging a screwdriving curve data block is 3000 ms.

The handheld screwdriver then repeats the transmission attempt until it receives positive acknowledgement from the controller.

This transmission loop can be canceled by the operator at the tool after the display of the handheld screwdriver shows a fault message.

Barcode (handheld screwdriver transmits barcode to controller)

→**(Request)** Receive – Handheld screwdriver transmits data to the controller

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x42	Telegram type: BARCODE
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 8	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	n	Length of the barcode (max. 40 characters)
DATA	n bytes	Barcode	Barcode data block
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

→**(Answer)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x06	Telegram type: ACK
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 8 (same as request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	

Sequence	Length	Value	Description
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

NOTICE: Transmission is complete after the handheld screwdriver has received positive acknowledgement from the controller. The maximum time window for receiving and acknowledging a barcode data block is 3000 ms. The handheld screwdriver then repeats the transmission attempt until it receives positive acknowledgement from the controller. This transmission loop can be canceled by the operator at the tool after the display of the handheld screwdriver shows a fault message.

ACK / NAK (positive acknowledgement of receipt / negative acknowledgement of receipt)

Negative acknowledgement of receipt is generated in the following cases:

- Unknown telegram type
- Incomplete data frame / transmission timeout
- Faulty data block, e.g. invalid parameter set
- CRC16 checksum error

Example of a NAK telegram:

→**(Answer)** Transmit – Data is transmitted from the controller to the handheld screwdriver

Sequence	Length	Value	Description
STX	1 byte	0x02	STX start character
@@	2 bytes	0x40, 0x40	@@ Preamble
		*** Start of CRC16 checksum generation ***	
TYP	1 byte	0x06	Telegram type: NAK
VERS	2 bytes	1003	Telegram protocol version 1.003
NUM	2 bytes	e.g. 8 (same as request)	Sequential telegram number
SERNO	16 bytes	e.g. "P2345 "	Tool serial number, 16 ASCII characters (from protocol version 1.001)
LEN	2 bytes	0	Number of bytes of user data = 0
DATA	0 bytes	--	-- (Not applicable)
		*** End of CRC16 checksum generation ***	
CRC16	2 bytes	Runtime-dependent	CRC16 checksum
@@	2 bytes	0x40, 0x40	@@ Terminator
ETX	1 byte	0x03	ETX end character

20 Glossary

Joining torque

Torque threshold from which the rotation angle measurement begins relative to nominal values and the quality window. As a value for the joining torque, it is recommended to select the torque at the head contact (start of the joint) of the screw.

Release torque

Torque, opposite to the preset direction of rotation (CW, CCW). This setting can be used to monitor whether the fitting has been subjected to impermissible stress in the release direction when moving a static drive (e.g. fork insert, without ratchet). Notice: If the value for the release torque is not set, this function is deactivated.

Release angle

The release angle determines the nominal rotation angle in the release phase by which the screw must be released.

Nominal torque

Target value for the torque, which can represent a stop criterion, depending on the process.

Nominal rotation angle

Target value for the rotation angle, which can represent a stop criterion, depending on the process.

Quality window

In addition to the nominal values, additional limits for the torque and the rotation angle can also be parameterized for OK/NOK evaluation.

- LTL: Lower torque limit in the quality window
- UTL: Upper torque limit in the quality window
- LAL: Lower angle limit in the quality window
- UAL: Upper angle limit in the quality window

Screw joint hardness

Rigidity of the entire screw assembly.

- **hard:** e.g. ring gear, screw of strength class > 10.9
- **medium:** No strongly yielding elements, screw of strength class 8.8
- **soft:** Expansion shank bolts, e.g. cylinder head, connections with gaskets, etc.

Rundown mode

Defines the measuring method used for the rundown, torque controlled, angle controlled or yield point controlled, as well as the audit modes release / tighten and prevail torque.

STOP criterion

Reaching the nominal torque, the nominal angle or the yield point.

Pre-tightening check

The pre-tightening check is used to detect pre-tightened screws that have already been screwed in. The test checks whether the screw rotates less than 4° in the torque range from 2 % of the nominal load capacity of the tool at the start of a rundown until the joining torque is reached. If the pre-tightening check is activated, this is displayed as a fault and the rundown is aborted.

Prevail torque

Dynamic prevail torque for determining the residual torque of already assembled screw connections.

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Subject to modifications
Printed in Germany
3842892017/2024-09