ATESTEO

Excellence in drivetrain testing

Manual DST Series

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List of content

1   Introduction

Thank you for choosing ATESTEO GmbH & Co. KG quality product.
Please read the system description carefully so you make the most of the versatile features of your product.
This operating manual is a component of the DST series and should always be carefully kept with the DST series until it is disposed of.
It is impossible to eliminate every danger to persons or material that the DST series might present. For this reason, every person working at the DST series or is involved in its transport, setting up, control, maintenance or repair must be properly instructed and be informed of the possible dangers.
For this purpose, the operating instructions and, especially, the safety instructions must be carefully read, understood and observed.
Company ATESTEO GmbH & Co. KG reserves the right to carry out changes at its products, which serve the technical further development the company ATESTEO GmbH & Co. KG. These changes aren't documented expressly in every individual case.
This operator's manual and the information contained in it were compiled with the advisable care.
Company ATESTEO GmbH & Co. KG takes on no liability for misprints or other faults or damages resulting from it.
The brands mentioned in this operator's manual and product names are trademarks or registered trademarks of the respective title holders.
Please do not miss to contact us if there is anything in the operating instructions that you cannot clearly understand. We are grateful for any kind of suggestion or criticism that you may wish to make; please let us know or write to us. This will help us to make the operating instruction still more user-friendly in taking account of your wishes and requirements.

1.1 Change log

V1.5 – 15.03.2023:
- Part number of female connector for X800 added
- Tolerances for shaft diameter added
- Wrong information about maximum measurable speed removed
- Maximum mechanical speed added
- Clipping description reworked
- Functions described in chapter 3
- Product picture updated

V1.4 – 28.11.2022:
- Clipping and simulation value correctly explained (related to frequency band, not rated torque)

V1.3 – 13.10.2022:
- Explanations for sensitivity sources added
- Explanations for user sensitivities editor added
- Explanations for trace configuration editor added
- Cable colors and diameter for X800 updated

V1.2 – 09.11.2021:
- PC software added to manual
- Shaft marks changed from IN/OUT to A/B
- UART driver source added
- Clipping description added

V1.1 – 28.05.2021:
- DAkkS logo removed
- Clipping description added
- Filter description updated in specification
- Sampling rates updated

- UART driver installation information added

V1.0 - 18.02.2021:
- First version

1.2　　　　Manufacturer

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1.3　　　　Background

In this manual you will find all steps which are necessary to start-up the ATESTEO torque and speed measurement system.

This manual is usable for the following types of torquemeter:

Torquemeter DST 5
Torquemeter DST 10
Torquemeter DST 20
All measurement systems work contactless and are maintenance-free. The data transfer is realized by a frequency modulated infrared transmitter. The power of the rotating electronic module works inductive.

1.4　　　　Disposal and environment

Electrical and electronic products are subject to special conditions for disposal. Proper disposal of old equipment prevents health hazards and environmental damage.

Packaging
The original packaging of ATESTEO equipment can be recycled, as it is made of recyclable material. However, you should keep the packaging for at least the warranty period. In the event of a complaint, the torque flange, as well as the accessories, must be returned in the original packaging.

Due to ecological aspects, the return of the empty packaging should be waived.

Legally prescribed labeling for disposal

Electrical and electronic devices bearing the symbol are subject to European Directive 2002/96 / EC on waste electrical and electronic equipment. The symbol indicates that waste equipment that is no longer usable must be disposed of separately from regular household waste in accordance with European environmental protection and recycling regulations.

However, the disposal regulations vary from country to country, which is why we ask you, if necessary, your supplier how to dispose your waste.

2 Safety Instructions

2.1 General safety instructions

The manual must be read carefully before start-up, maintenance work or any other work on the torque measuring system. Prerequisite for the safe and proper handling of the equipment knows all safety instructions and safety regulations of the attachment.

Every DST needs to be correctly mounted and fully functional before any start-up.
Shafts or adapters mounted to the torquemeter must be properly designed, so that critical bending moment is avoided.

Exclusively qualified laborers are allowed to do maintenance work on any electrical components (see chapter Qualified personnel).
If the torquemeter is sold on, these safety instructions must be included.

Note on additional standards:

Low Voltage Directive 73/23/EWG, Electromagnetic Compatibility Directive 89/336/EWG and the harmonized standards
DIN EN 292-1   Safety of machinery
DIN EN 292-2   Safety of machinery

Maintenance and inspections on the electrical equipment are to be executed by trained personal. Non-designated use and modifications of the measurement system will make the EG-Conformity declaration invalid.

2.2 Explanation of symbols and notice

Warnings
Warnings are indicated by symbols in these safety instructions. The hints are going through
Signal words are introduced, which express the extent of the hazard. It is imperative that you follow the instructions and act with care to avoid accidents, personal injury and material damage.

Information
Draws attention to important information about correct handling.

Caution
Warns of a potentially dangerous situation in which failure to comply with safety requirements can result in slight or moderate physical injury.

2.3   Appropriate use

The torquemeter is highly accurate and resistant to rotational speed. The signals from the flange serve to control the test bench and to analyze the components.
The torque flange is used just for torque measurement tasks within the load limits in the specification (see Technical specs). Any other use is not permitted.

The torquemeter is not allowed for use as a safety component.

The torquemeter may not be used as pillow block.

Note
Stator operation is only permitted when rotor is installed as described in the mounting instruction.

2.4   Modifications/conversions

Any modifications/conversions of the design or safety engineering of the torquemeter without the explicit agreement from ATESTEO will lead to the loss of warranty or liability. Any damages or injuries of personnel therefrom are in responsibility of the operator.

2.5   Operator's responsibility

Standards
The ATESTEO torquemeter was designed and constructed taking account of a risk analysis and careful selection of harmonized standards and other

technical specifications with which it complies. It represents the state of the art and guarantees a maximum degree of safety.

Qualified personnel
Qualified personnel are persons who by reason of their training, experience, instruction and their knowledge of the relevant standards, regulations, accident prevention rules and working conditions have been authorized by the person responsible for the safety of the machine/product to perform the appropriate activities required, and thereby are able to recognize and prevent potentially dangerous situations (For the definition of skilled workers see VDE 0 105 or IEC 364, which also regulate the prohibition of the employment of unqualified persons).
Knowledge of first aid and the local rescue organization must also be available.

Transportation, assembly, installation, commissioning, maintenance and repair will be performed by qualified personnel or controlled by responsible skilled hands.

Safety relevant disconnecting device
The torquemeter cannot implement any safety relevant cut-offs. It is in the operator´s responsibility to integrate the torquemeter into superior safety system.
The electronically acquired measurement signal should be designed so that measurement signal failure does not subsequently cause damage.

Residual risks
The power and scope of delivery of the torquemeter covers only a subset of the torque measurement technology. Safety aspects of torque measurement technology must be planned, implemented and taken into account by the system planner, supplier or operator in such a way that residual risks are minimized. Each existing regulation must be observed.

Attention should be drawn to residual risks associated with torque measuring technology.
In the case of a shaft break, you must ensure that there is no risk of injury. This should be done with a shaft protection cover in a closed test room with corresponding security doors. During operation, no person should stay in the test room.

Usage recommendations for personal protective equipment

Working in a workshop generally requires the wearing of safety shoes.

Use suitable gloves when handling corrosive or irritating solutions and adhesives.

Transport and storage

Check the delivery immediately for completeness and shipping damage.

Use working gloves during transport/ assembly/ maintenance.

Storage

do not store outdoors

store dry and dust-free

do not expose to aggressive media

protect from sunlight

avoid mechanical shocks

storage temperature according data sheet

If stored for more than 3 months, regularly check the general condition of all parts and packaging.

2.6 Safety notes for assembly

Stator bottom plate
The DST system must be properly mounted on the ground via the bottom plate (see 4.1.2.1).

Tightening torque
When tightening the screws, the specified tightening torques (see 4.1.2) must be observed.

Shaft alignment
The shaft of the DST must be aligned properly to avoid parasitic loads which influence the accuracy and could lead to damage.

Clutch installation
If a clutch is installed on the DST shaft, follow the mounting instruction of the clutch for proper installation.

Electric wire
All cables must be professionally laid according to the actual standards. The system must be grounded (see 4.2.2). Fuses according to national regulations must be used to protect the power supply of DST.

Rotating parts
Rotating parts must be grounded- risk of static electricity.

2.7 Safety notes for operation

As accident prevention a covering has to be fitted once the torquemeter have been mounted. This is the fact if the torquemeter is already fully

protected by the design of the machine or by existing safety precautions. Please pay attention to following requirements for the covering as accident prevention:

The covering must not be free to rotate
Covering must be positioned at a suitable distance or be so arranged that there is no access to any moving parts within.
Covering should prevent squeezing or shearing and provide sufficient protection against parts that might come loose.
Covering must still be attached even if the moving parts of the torque flange are installed outside people´s movement and working range.

Note
Improper use and handling as well as constructional changes will invalidate the EC declaration of conformity.

System measurement signals (speed or torque) may not be used for safety functions of the test bench without verification. Verifications such as Target/Actual comparison, plausibility check (grade analysis, peak analysis) or redundant signals for comparison must be implemented in the automation system. Error flags or information must be observed and handled by the automation program.

2.8 Load limits

Observe technical data sheets when using the torquemeter. Pay particular attention to never exceed the respective maximum loads. For example:

• Load limits

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- Torque oscillation width,
- Temperature limits,
- Longitudinal limit force, lateral limit force or limit bending moment,
- Limits of electrical load-carrying capacity,
- Limit rotation speed.

Limits are specified in the data sheet of the product.

3   System description

The DST combines torque measurement technology with integrated speed measurement technology in a smart, compact housing. The torque measurement values can be easily recorded via a USB interface on the PC or measured via the integrated precise high dynamic frequency output. Additionally, signals can be measured via the analogue voltage output.

Figure 3-1 Photo of DST system

3.1 Specifications

Power Supply	24V DC min. 0.5A
Sample rate of torque signal	2 Samples/s … 2,000 Samples/s
Sample rate of speed signal	
n > 2,000 rpm	max. 2,000 Samples/s
n < 2,000 rpm	n Samples/s
Lowest Speed, which can be measured	1 rpm (Speed < 1 rpm -> 0 rpm)
Highest Speed, which can be measured	30,000 rpm (Speed > 30,000 rpm is clipped*[1])
Mechanical maximum speed	20,000 rpm
Speed sensor type	Optical speed sensor, 60 ppr
Analog Output Range	Selectable 0..3 V, 0..5 V, 0..10 V, -3..+3 V, -5..+5 V, -10..+10 V
Max. Analog Output Range	-12..+12 V
Analog Output Signal Resolution	16 bit
Analog Output Impedance	50 Ohm
Filter	*Torque frequency*, *Torque over USB*, *Torque over Voltage-Out*: Analog LP, 7.2 kHz *Speed*: no filter
USB port	Emulated serial port, 921,600 Baud, 2 … 2,000 Samples/s
Frequency outputs	Torque: RS422 Speed: RS422

Table 3-1 Specifications

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[1] Described in chapter 0

3.2 Features & Functions

The DST series provides the following features:
- Disturbance insensitive IR transmission
- Adjustable torque sampling rate from 2 Hz to 2 kHz
- Frequency output proportional to torque 60 kHz ±20 kHz
- Analogue output [V] proportional to torque with torque sampling rate
- Frequency output proportional to speed pulses
- USB interface with emulated serial port

This section explains several features and functions of DST. The usage (trigger, activation, etc.) is explained in later chapters.

3.2.1 Speed measuring system

The speed of the rotor is detected with an optical switch on the stator and a slotted disc on the rotor. The speed sensor is located completely inside the housing and is thus protected by external influences. The slotted disc generates 60 pulses per revolution. The pulses are ready for use as RS422 signal. Furthermore, the evaluation unit calculates the resulting speed. This can be recorded via the UART interface or system software.

3.2.2 Overvoltage protection

The measuring system is protected against overvoltage and reverse polarity. If the power LED on the meter body does not light up, check the wiring for reverse polarity and the power supply for excessive supply voltage. All outputs are short-circuit-protected.

3.2.3 Analogue voltage output

The analogue voltage output converts the measured torque value into an analogue voltage value. The update interval is set via the UART interface in the following steps: 2 kHz, 1 kHz, 500 Hz, 200 Hz, 100 Hz, 50 Hz, 20

Hz, 10 Hz, 5 Hz and 2 Hz. There are four modes available for setting the voltage swing: 0 V – 3 V, -3 V – 3 V, -5 V – 5 V, 0 V – 10 V and -10 V – 10 V. In the unidirectional modes, the output value is limited to ±100% of the nominal torque. In the bidirectional modes, the voltage output value is limited based on the frequency signal which is in the range of around ±110% (frequency band 60±20kHz -> 38 … 82 kHz).

3.2.4 Zero adjustment

Zero balancing sets the current measured torque signal as new zero signal. This function has a big impact on the measurement system and must only be used by experienced personnel. The shafts of DST must be without load. Optimum are disconnected shafts (read more here 8.1 and here 8.1.5)). The zero adjustment will take several seconds. The torque signal will jump through different stages (signal noise). Any measurement or control system must ignore the torque signal of DST during zero balancing. Once the zero balancing is finished, the related status LED will be deactivated.

3.2.5 Test signal

The test signal function will add a certain frequency (load) onto the current measurement value. The exact gain is mentioned in the test report (typically 4 kHz). The test signal can be used to check the setup of your measurement chain (measurement device configuration). The test signal gain affects the UART interface frequency value, the analogue voltage output and the frequency output.
Make sure the test signal is switched off before you start a measurement.

3.2.6 Simulation values

Simulation values will create a completely simulated signal (no effect from load of the measurement shaft). The simulation value is related to the nominal rated torque of the system and it can be "switched off" (for real

measurement), 0%, 50%, 100%, -50% or -100%. This function can be used to check the system and the applied measurement chain.
Turn this function off to receive real measurement values. The simulation values are related to the frequency band of 60±20kHz. The lowest values of 40 kHz will be activated with -100%. The highest value of 80 kHz will be activated with +100%.

The simulated values have effect on the analogue output and the UART interface. The frequency output is not affected.

3.2.7 Strain gauge short circuit

The inputs from the strain gauge amplifier are shorted in this mode. The strain gauge measurement value is ignored. This function is only used when required by ATESTEO service (for experts only).

3.2.8 Nominal value adjustment

The rotor must be loaded with the rated torque during execution. The input is automatically reset. This function is only used when required by ATESTEO service (for experts only). Using this function will reset the internally stored calibration data!

3.2.9 Data sheet

The data sheet of the torquemeter contains useful information such as serial number, software versions or calibration data. The data sheet can be requested by the UART interface and the PC software.

3.2.10 Value clipping

When a measurement signal exceeds its limit value (min/max), it is cut to this limit value. This feature is called clipping. Values lower or higher than the limit values cannot be transferred or measured.

Torque values are clipped to 38 … 82 kHz and speed values are clipped ±110% of the nominal speed. The analogue outputs are limited to 100% if they are operated with only positive voltage ranges (e. g. 0 … + 5V).

3.2.11   Value sampling

The internal value sampling is done by measuring the number of peaks in a fix time window. After this time window, the time between the first and the last peak are taken as measurement time and the frequency is calculated based on the peak count and the measurement time.

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4 Installation

Before installation, check that all parts of the measuring system are present and not damaged.

4.1 Mechanical installation

4.1.1 Part list

The complete measuring equipment consists of the following parts:
- Torquemeter
- Connector 12 pole female (cable assembly optional)
- Manual

4.1.2 Mounting

4.1.2.1 Mounting on ground

The DST is placed on a fix ground. Four screws at the bottom plate must be used for mounting. Use screws of type M5. The length of the screws depends on the environment. A minimum lengths of 12mm is suggested. The tightening torque is 6 Nm for screws of strength grade 8.8 (recommended) and 8 Nm for screws of strength grade 10.9.
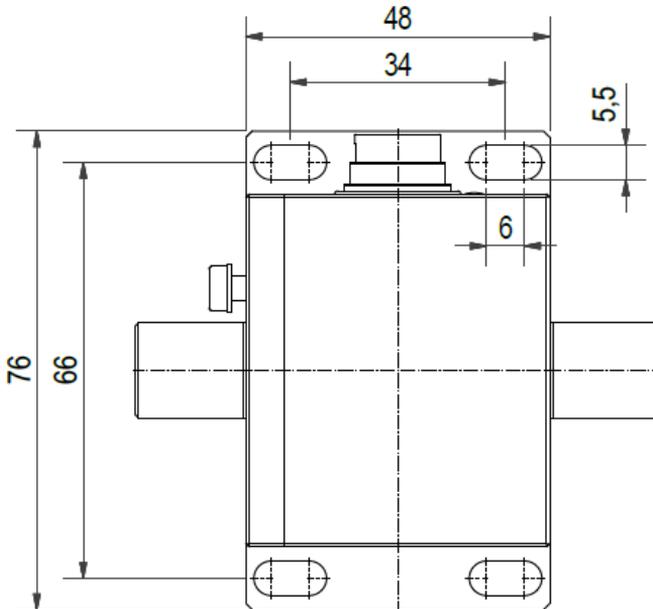
Figure 4-1 Top view with bottom plate for fixing

4.1.2.2 Mounting of shafts

Both sides of the DST are labelled with marks. The single bearing is located on the side "A". The torque sensor is located close to the side "B".

After the DUT there should be a bearing to avoid bending of the measurement shaft. The arrangement of "side A" with "DST in-house-bearing" -> "strain gauge" -> "side B" -> "DUT" -> "customer bearing".

Figure 4-2 A / B marks at the sides

4.1.3 Mechanical dimensions
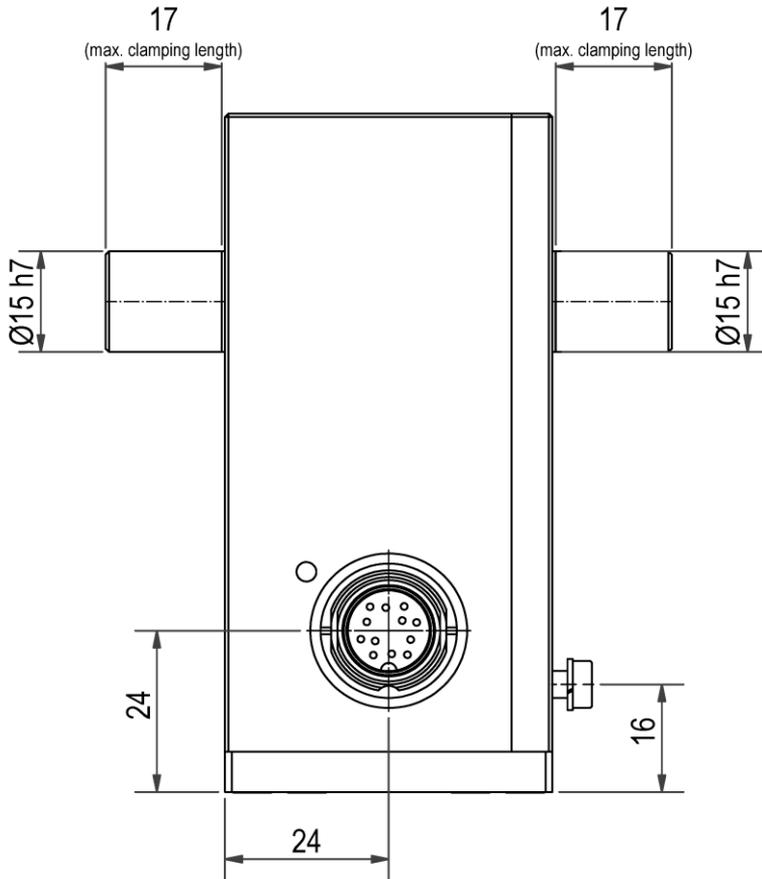

*Figure 4-3 Front side view*
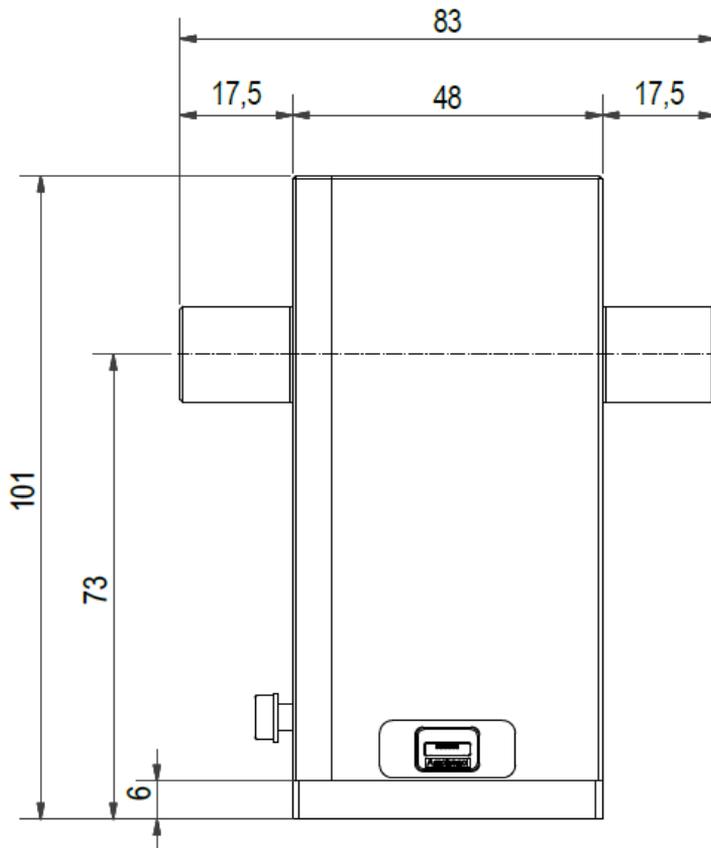
Figure 4-4 Back side view
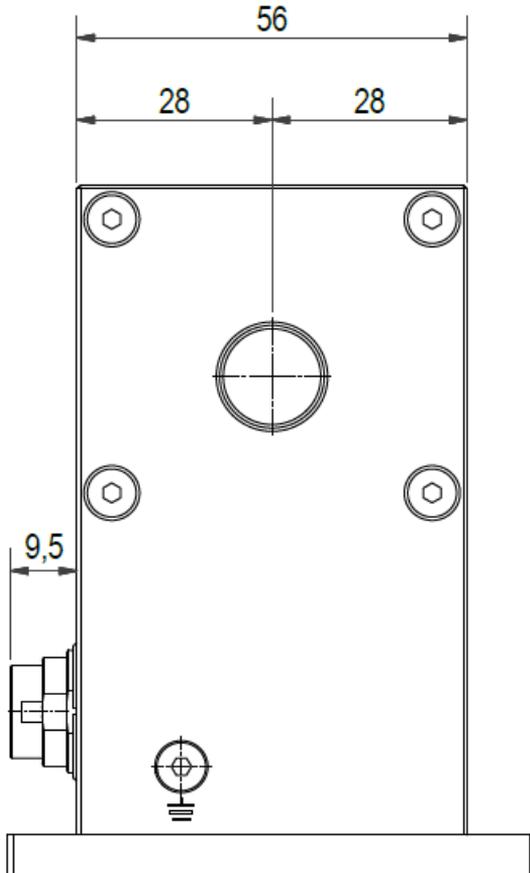
Figure 4-5 Side view A

4.2 Electrical installation

The parts delivered are dependent upon customer specific orders. If you have ordered a complete measurement system, all electrical and software parameters are pre-installed.

4.2.1 Power Supply

The purchased ATESTEO measuring system has to be powered with DC voltage of 24-30V / 1A. The power consumption range is 6 to 10 watts. The power supply must be protected with a 1AT fuse against overcurrent.

4.2.2 Earthing

The housing of the measuring system has an earth connection. The internal ground is separated from that earth. The torquemeter *must* be connected to the earth of the test bench for proper working. Screws of the type M4 must be used.

Screw length
The maximum length of the screw is **8mm**. Longer screws could damage the electronic inside of the product!

Grounding screw

Figure 4-6 Grounding screw (side A)

4.2.3 Connecting the torquemeter with a data acquisition system

Following the EMC standards (Standard EN61000-6-4 / VDE 0839 parts 6-4) requires application of the following steps:

Use shielded servo cable with 4x 2x 0.14 mm² (twisted pair) and 4x 0.25 mm² wires.

The shielding of the cable must be connected to the connectors on both ends. The following grounding scheme is recommended:
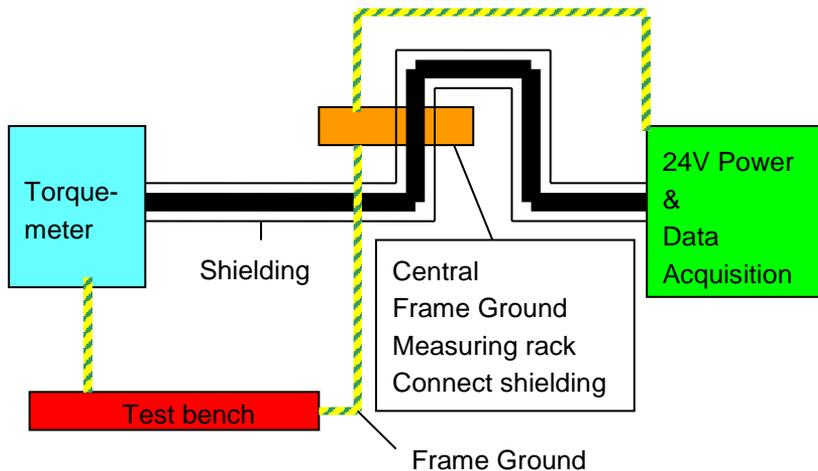

Figure 4-7 Grounding scheme

The shielding must be connected on both sides (torquemeter and measuring rack).

The usage of the equipment assumes keeping the general safety regulations in mind!

5 Interfaces & commands

5.1 USB interface (UART interface)

The USB/UART interface can be used to connect the DST with any computer. When using the USB interface with Windows, the driver will be automatically installed by Windows. During installation, the DST can be detected as mouse. Movement and clicks are possible. It is recommended to plug the USB cable when computer is locked. Then wait for 5 minutes until the installation is completed.

If the driver could not be found, it must be downloaded and installed manual. The latest driver can be found online on
https://ftdichip.com/drivers/vcp-drivers/

In the moment of release of this manual, the latest version was 2.12.36.4.

Each DST system will create one interface port on the computer. When multiple DST systems are used on one computer, the number of used ports gets high. Systems which are no longer in use can be removed with the Windows™ device manager. Start the Windows™ device manager and unhide unplugged system via the "View" menu. Select the related DST system and open the context menu (right mouse button). Chose "Uninstall" to remove the system and free the port.
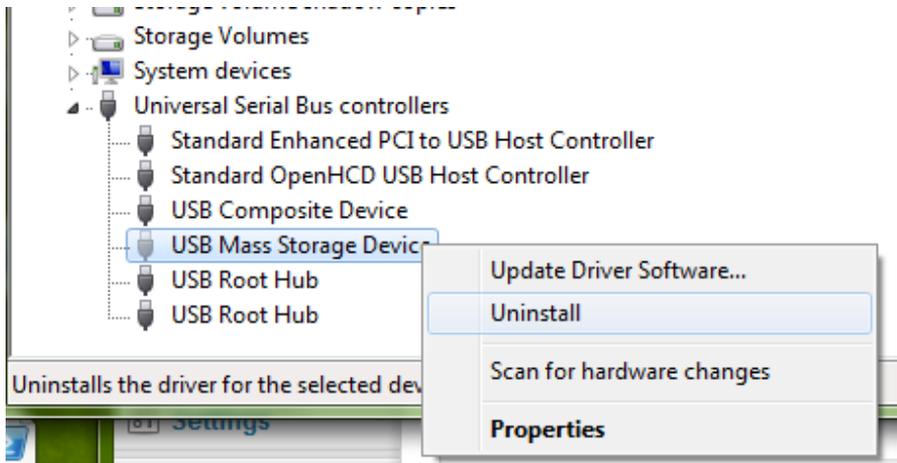
Figure 5-1 Example of removing an USB device in the device manager

5.1.1 Port settings

The following port settings are needed to use the simulated serial port:

Parameter	Value
Speed	921,600 Bd
Data	8 bit
Parity	none
Stop bits	1 bit
Flow control	none
Delays	none

Table 5-1 Overview of serial port settings

5.1.2 Sending information

The following commands can be executed with the UART interface:

Mainboard configurations	Rotor configurations
Activate test alarm output pin	Trigger zero adjustment
Activate simulated values for torque	Activate Nominal value adjustment
Set torque sampling rate	Activate Test signal
Set DAC range	Activate strain gauge short circuit
	Transfer / display data sheet
	Calibration value strain gauge supply voltage

Table 5-2 Overview of serial port settings

The commands are triggered as follows:

5.1.3   Command overview

Command to rotor	Action
Z	Zero adjustment
D	Nominal value adjustment
K	Test signal on
L	Test signal off
Q	Strain gauge short circuit on
W	Strain gauge short circuit off
S	Request data sheet
N	Activate data transfer
*	Stop data transfer

Table 5-3 Rotor command set overview

Command to main board	Action
A	Activate alert output (2 s)
B0	Simulate values off
B1	Simulate values -100% (40 kHz)
B2	Simulate values -50% (50 kHz)
B3	Simulate values 0% (60 kHz)
B4	Simulate values 50% (70 kHz)
B5	Simulate values 100% (80 kHz)
T1	Sampling rate = 2 Hz
T2	Sampling rate = 5 Hz
T3	Sampling rate = 10 Hz
T4	Sampling rate = 20 Hz
T5	Sampling rate = 50 Hz
T6	Sampling rate = 100 Hz
T7	Sampling rate = 200 Hz
T8	Sampling rate = 500 Hz
T9	Sampling rate = 1,000 Hz
T0	Sampling rate = 2,000 Hz
U0	DAC range ±10V
U2	DAC range 0V – 3 V
U3	DAC range ±3V
U4	DAC range 0V – 5V
U5	DAC range ±5V
U9	DAC range 0V – 10V

Table 5-4 Mainboard command set overview

5.1.4 Command details

5.1.4.1 Activate test alarm output pin

The command is triggered by pressing the 'A' key. The hardware alarm output remains active for 2s and automatically shuts off.

5.1.4.2 Activate simulated values for torque

The command is triggered by pressing the 'B' key. Then enter one of the following numbers to select the torque value to simulate.

Number	Simulated value
'0'	No simulation
'1'	-100 % (40 kHz)
'2'	-50 % (50 kHz)
'3'	0 % (60 kHz)
'4'	+50 % (70 kHz)
'5'	+100 % (80 kHz)

Table 5-5 Overview of simulated values for torque

Other characters cause the routine to abort.

5.1.4.3 Set torque sampling rate

The command is triggered by pressing the 'T' key. The sampling rate affects the analog output and the UART interface. The frequency output is not affected. Enter one of the following numbers to select the sampling rate for torque:

Number	Sampling rate
'1'	2 Hz
'2'	5 Hz
…	*Same as command to main board*
'0'	2 kHz

Table 5-6 Overview of sampling rates and block filter values for UART-Interface

Other characters cause the routine to abort.

5.1.4.4 Set DAC range

The command is triggered by pressing the 'U' key. Then enter one of the following numbers to select the DAC-Range:

Number	DAC range		
'2'	0 V	–	3 V
'3'	-3 V	–	3 V
'4'	0 V	–	5 V
'5'	-5 V	–	5 V
'9'	0 V	–	10 V
'0'	-10 V	–	10 V

Table 5-7 Overview of different DAC ranges

Other characters cause the routine to abort.

5.1.4.5 Trigger zero adjustment

The command is triggered by pressing the 'Z' key. The rotor must be unloaded during execution. The input is automatically reset.

5.1.4.6 Trigger nominal value adjustment

The command is triggered by pressing the 'D' key.

5.1.4.7 Activate test signal

The command is triggered by pressing the 'K' key. The command is switched off again by pressing the 'L' key.

5.1.4.8 Activate strain gauge short circuit

The command is triggered by pressing the 'Q' key. The command is switched off again by pressing the 'W' key.

5.1.4.9   Transfer / display datasheet

The command is triggered by pressing the 'S' key. The rotor sends the rotor parameters to the stator. The parameters are transmitted by a modulation of the torque measured values. Therefore, the output at the analog output and at the UART interface is fixed to the last value, before the parameter transfer. The frequency output is not fixed during the parameter transmission.
The stator then generates a data sheet from rotor and stator parameters. The data sheet is sent directly after parameter reception via the UART interface. Further information on the data sheet can be found in the chapter "Receiving Information". Data reception continues immediately after the data sheet has been sent.

5.2   Enhanced system commands

The following commands are reserved for the calibration of the measuring shaft or the analogue output and should not be entered manually:
    'C', 'P', 'V', "X", "Y"

5.2.1   Receiving information

The received data stream is ASCII coded and in CSV format. Recorded measurements can thus easily be opened and evaluated with conventional spreadsheet programs. In the recorded measurement, each new line represents a new torque measurement. The update rate via the UART interface is customizable (2 Hz … 2 kHz).
A line consists of four parameters separated by semicolons: Watchdog, torque, speed and system-state. The measured value representation is described in the following subchapters.

5.2.2   Watchdog

The watchdog is incremented by one with each newly calculated line. It counts from zero to nine. After nine, it starts again at zero. The watchdog value occupies one ASCII character from the line.

5.2.3 Torque

The torque is displayed as a relative value in Hz with one decimal place. The maximum positive and negative torque values are limited to ±120% of the nominal torque. The torque is calculated as follows:

$$M_{D,Nm} = \left(M_{D,Hz} - 60000\ Hz\right) \cdot \frac{M_{D,Rated}}{20000\ Hz}$$

$M_{D,Nm}$: Torque in Nm
$M_{D,Hz}$: Torque in Hz
$M_{D,Rated}$: Rated Torque in Nm

The torque value occupies seven ASCII characters (including decimal mark) from the line.

5.2.4 Speed

The rotor speed is given in rpm with one decimal place. The speed value occupies seven ASCII characters (including decimal mark) from the line.

5.2.5 System state

The system status consists of 14 contiguous ASCII characters without separators in between. Each character describes the state of one system component. In the following table, the ASCII characters are assigned to the associated system components:

Character position	System component
14 (left)	Torque sampling rate: 1: 2 Hz, 2: 5 Hz, …, 0: 2 kHz *Same as command to main board*

13	Simulated values for torque (rel. to 60±20kHz):
	0: off, 1: -100%, 2: -50%, 3: 0%, 4: +50%, 5: +100%
12	Torque overload:
	0: off, 1: negative overload, 2: positive overload
11	Torque clipping*[2]:
	0: off, 1: negative clipping*[2], 2: positive clipping*[2]
10	Speed overload:
	0: off, 2: positive overload
09	Speed clipping*[2]:
	0: off, 2: positive clipping*[2]
08	Test signal:
	0: off, 1: on
07	Strain gauge short circuit:
	0: off, 1: on
06	Zeroing:
	0: off, 1: on
05	Nominal value adjustment:
	0: off, 1: on
04	Datasheet transfer:
	0: off, 1: on
03	DAC range:
	2: (0V - 3V), 3: (-3V - 3V), 4: (0V - 5V), 5: (-5V - 5V),
	9: (0V - 10V), 0: (-10V - 10V)
02	DAC calibration mode:
	0: off, 1: 5573 digit, 2: 33771 digit, 3: 46370 digit,
	4: 59969 digit
01 (right)	Data transfer
	0: normal operation, 1: data transfer error

Table 5-8 Overview of system state indices

---

[2] Described in chapter 3.2.10

5.2.6   Datasheet

The datasheet mode is initialized by the 'S' key and 7 seconds after system startup. During transmission, the UART and analogue torque output is kept constant. Character position three of the system status identifies the active transfer. During transmission, no rotor-relevant data entries are permitted. After transmission of the data sheet via UART, the measure mode is continued with current torque values. The data sheet with stator firmware higher or equal 1.04 is composed as follows:

Line by line Representation	Description
* *	Start sequence for datasheet
Serial: XXXXX	Serial number of the measurement system
Firmw. Rotor: XX.YY	Firmware of rotor
Firmw. Stator: XX.YY	Firmware of stator
Rated Torque [Nm]: XXXXX	Rated Torque in Nm
Sens.-Pos. [Hz/Nm]: XXXXX.XXXX	Positive sensitivity in Hz/Nm (CW)
Sens.-Neg. [Hz/Nm]: XXXXX.XXXX	Negative sensitivity in Hz/Nm (CCW)
Vs-Rotor [digit]: XXXX	Rotor supply voltage in digit
Temp. [digit]: XXXX	Current rotor temperature in digit
Temp.-Max [digit]: XXXX	Maximum reached rotor temperature in digit
Temp.-Fault [digit]: X	Error code for temperature sensor in digit: 0: ok, 1: fault
EEPROM-Fault [digit]: X	Error code for EEPROM in digit 0: ok, 1: fault
DAC-Value [digit]: XXXXX	DAC value for reference voltage of strain gauge bridge in digit

Comp.-Value [digit]: XXXXX	DAC value for temp. compensation in digit

Table 5-9 Overview of datasheet

X and Y represent the number of characters for each value. The decimal separator is point.

The digit values for "Vs-Rotor", "Temp." and "Temp.-Max" can be converted into natural quantities as follows:

5.2.7 Vs-Rotor

$$U_{VOLT} = 0{,}024862 \, \frac{\text{V}}{digit} \cdot (U_{DIGIT} - 2 \, digit)$$

$U_{VOLT} : Rotor \ voltage \ in \ V$
$U_{DIGIT} : Rotor \ voltage \ in \ digit$

5.2.8 Temp. & Temp.-Max

$$T_{°C} = 0{,}0625 \, \frac{°\text{C}}{\text{digit}} \cdot T_{DIGIT} - 40 \, °C$$

$T_{°C} : Temperature \ in \ °C$
$T_{DIGIT} : Temperature \ in \ digit$

5.2.9 Digital Interface

Zero adjustment
The signal is triggered by a 3.3 V (max. 36 V) high level on pin L "Zeroing in". Zero adjustment is triggered 0.5 seconds after the rising edge of the input signal.

Activate test signal
The signal is triggered by a 3.3 V (max. 36 V) high level on pin D "Test signal in". The test signal will be engaged 0.5 seconds after the rising edge

of the input signal. The test signal will be disabled 0.5 seconds after the falling edge of the input signal.

Alarm-out

The digital alarm output on Pin K "Alarm-out" operates as collective fault. It is an open collector output. The measured output signal is inverted. The maximum collector-emitter voltage is rated with 36V (50mA).

A pull-up resistor must be used at customer side to connect to the power supply of the customer's evaluation unit.

The alarm is collective for the alerts
- Torque overload
- Speed overload (over speed)
- IR error (data transfer error)

Alarm details can be analysed by the UART system state (Status word 5.2.5).

Alarm reset is not required. The alarm will be reset automatically once the root cause is solved.

5.3 LED

After powering up, the system will reflect its status via the status LED built into the chassis. The color and pulse encoding is displayed first with the highest display priority in the following overview:

Prio.	Color	Frequency	Description
1	Turquoise	16 Hz (very-fast)	Active datasheet transmission
2	Blue	2 Hz (slow)	Zeroing active
3	Purple	2 Hz (slow)	Test signal active
4	Red	ON	No data transfer

5	Orange	8 Hz (fast)	Torque or speed clipping*[3]
6	Green	8 Hz (fast)	Torque or speed in overload
7	Green	2 Hz (slow)	Normal operation

Table 5-10 Overview of Status LED encoding

---

[3] Described in chapter 3.2.10

6 PC Software

DST can be connected with a Windows™ PC software. That software can be downloaded in latest version on ATESTEO's website. The software can be used to

- get basic information about the DST (such as serial number)
- check states (Zero balancing active, data sheet transfer, …)
- show torque values and charts
- show speed values and charts
- change DST settings (DAC output level, …)
- trigger functions (Zero balancing, …)
- acquire measurement data (Time, watch dog, torque, speed)

6.1 Authentication

Some functions of the PC software are protected by password to prevent malfunction or wrong settings. The software has three authentication levels:

1. Basic functions: Access for everyone without password
2. Setup functions: Access only with "Setup" password
3. Expert functions: Access only with "Expert" password

The type of requested authentication is shown in the title of the upcoming password dialogue.

If an authentication has been successfully done, a re-login is not required in the next ten minutes for the related authentication level.

The default "Setup" password is "*AT_DST_2021*". The password can be changed by the user via dialogue. The password can be reset by deleting the complete line "password_setup" in the file "config.xml".

Figure 6-1 Password line in configuration file

The "config.xml" file is located in the "Settings" folder of the program directory.

The expert password is known to the ATESTEO service team only. It might be shared on demand.

6.2　　　Settings

6.2.1　　　Program

The program settings can be changed via dialogue by clicking the main menu "Settings" -> "Program…".
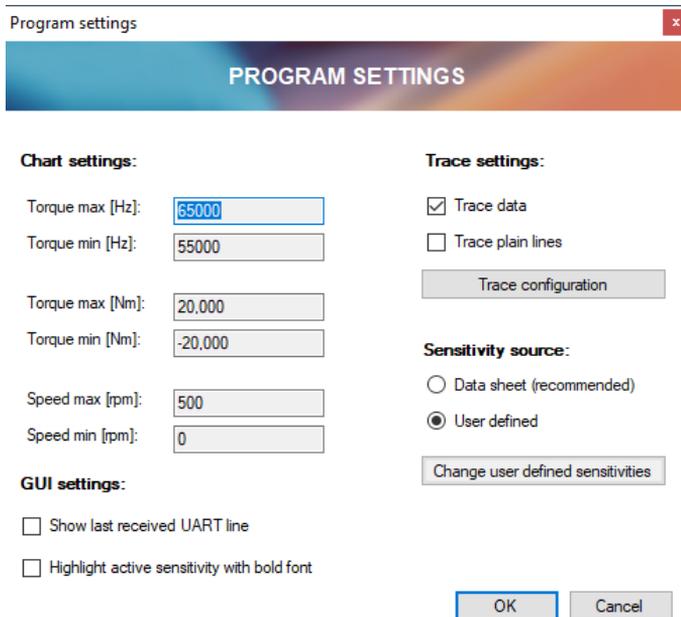
Figure 6-2 Program settings dialogue

Chart settings:

Given values can be changed to modify the scaling of the y axes in the chart. The min value must always be smaller than the maximum value.

GUI settings:

The option "Show last received UART line" will display a text field in the main window which shows the raw data lines received from the DST recently. This information is for debug purpose only.

Highlighting the active sensitivity value (clockwise direction or counter-clockwise direction) can be activated in the second checkbox. In this case, the active sensitivity value will be displayed in bold font.

Trace settings:
Allows the user to select between trace data file (csv) or/and plain text file (txt, UART lines). Further details of the trace settings can be set up in a separate dialog by clicking "Trace configuration" (see 6.2.1.1).

Sensitivity source:
The sensitivity values can have two source.
- **a)** from the rotor (requires DST with rotor firmware 1.04)
- **b)** from user definition

It is recommended to use the rotor sensitivities (a) which are transferred by the data sheet (see 6.3.1.5). Only if rotors with older firmware or rotors which have not been calibrated by ATESTEO are used, the user defined sensitivity values (b) are recommended.

The sensitivity values are used to convert the frequency torque signal into Newton meter torque signal. Wrong or outdated sensitivity values result in wrong values. Missing sensitivity values will lead to display in Hz.

The sensitivity values are separated into two directions (clockwise = CW and counter-clockwise = CCW).

User defined sensitivity values can be defined in the separate editor by clicking on the button "Change used defined sensitivities" (see 6.2.1.1).

6.2.1.1   Trace configuration

The trace configuration defines the design of the output format. Based on the requirement of the applied analysis software, the format can be changed. Title rows can be activated or deactivated. Column separators can be chosen and remarks for trace pause and systems states can be added.
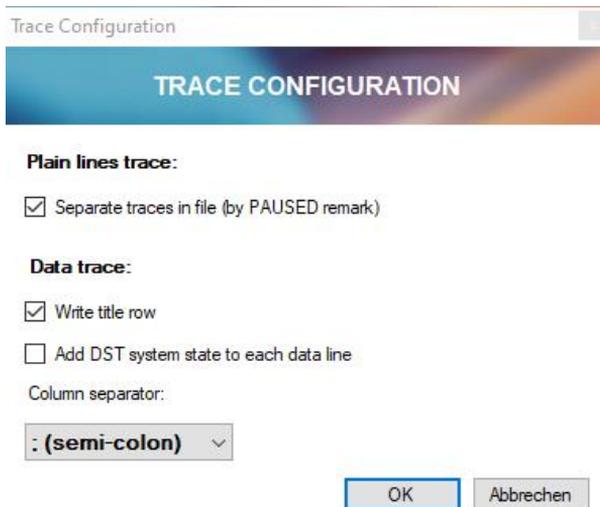
Figure 6-3 Editor for trace configuration

6.2.1.2 User sensitivities

The editor allows to enter the two sensitivity values (clockwise and counter-clockwise) and basic information such as serial number and date of the calibration (age of sensitivities). The serial number and calibration date help to check if the sensitivity values are still valid after the software has not been used for longer time.
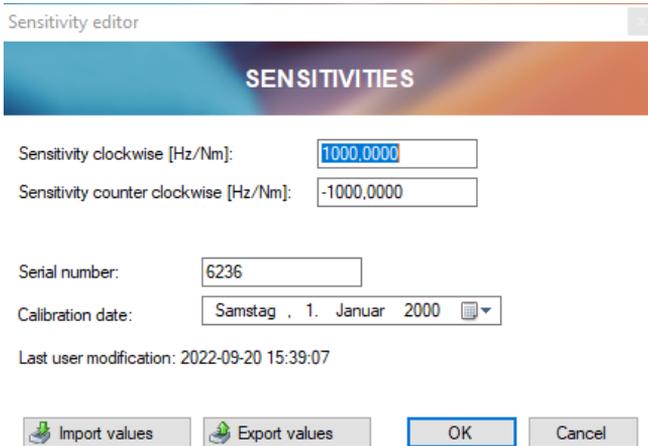
Figure 6-4 Editor for user sensitivities

Settings of this dialogue can be exported to file or imported from a file (*.dsf).

6.2.2 DST

The main menu "Settings" -> "DST" allows to change settings of the DST. This menu is only active if a DST is connected properly. The "SETUP" password must be entered for access (see 6.1).
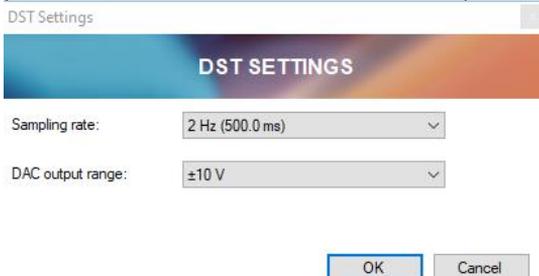
Figure 6-5 DST settings dialogue

Sampling rate:
A sampling rate of the DST can be changed here. This has influence to the x axis of the chart.

DAC output range:
The output voltage range of the analogue output of DST can be changed here as explained in 1.1. Make sure that the output range is matching to an acquisition unit before connecting the unit with the DST!

6.3   Main window

The main window contains the most important functions. It can be separated into five areas.
1. Connect and configure area
2. Status area
3. Chart area
4. Data area
5. Log message area
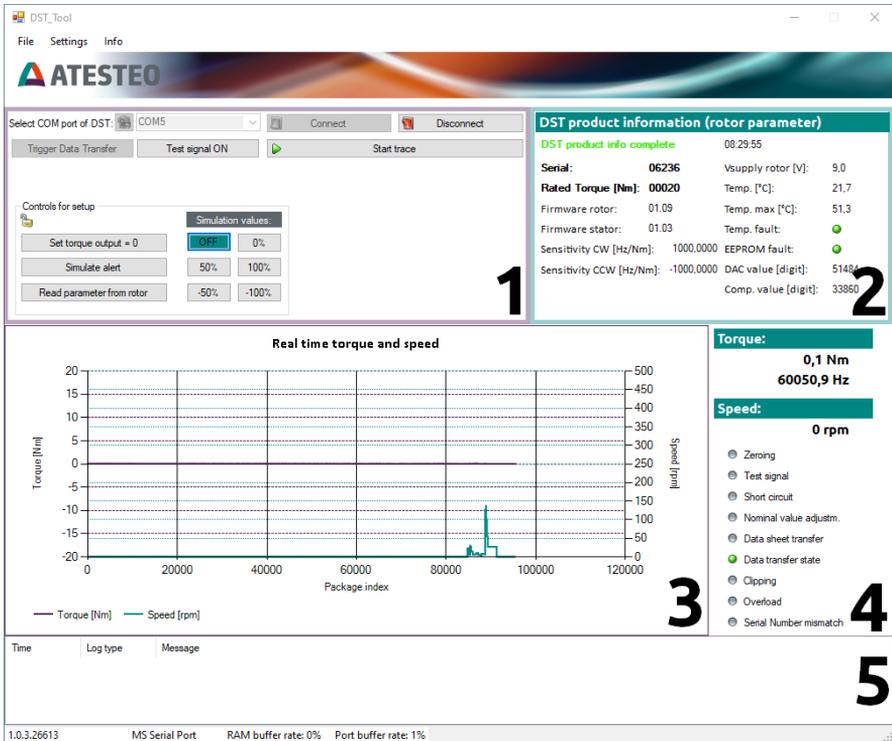
Figure 6-6 PC software - main window

6.3.1 Connect & configure area

6.3.1.1 Connection

First step to connect a DST is the selection of the correct COM port. The COM port can be detected in the Windows™ device manager. If the COM port is not available in the drop down menu, connect and empower the DST system, then press on the "refresh" button left from the drop down menu. Press "Connect" to begin the communication. The connect action usually takes less than 1 second. The measurement data is automatically transferred from the rotor. The "product information" (data sheet) can be updated by clicking on "Read parameter from rotor" (see 6.3.1.5). This is

recommended since it also contains the product serial number and the stored sensitivity values.

6.3.1.2 Trace acquisition

Traces can be acquired when a DST is connected. The PC software supports two modes:

- Trace data
- Trace plain lines

The trace type can be selected in the program settings.

The data trace will be a csv file which can be loaded by MS Excel or other tools which support csv import. It is a simple measurement data format.

The plain lines are text files which contain the raw data lines from DST. Those files are for debugging only.

The trace acquisition can be started and stopped by the button on the main windows. The data files are generated when the DST is disconnected. This allows to combine several measurements in one file.
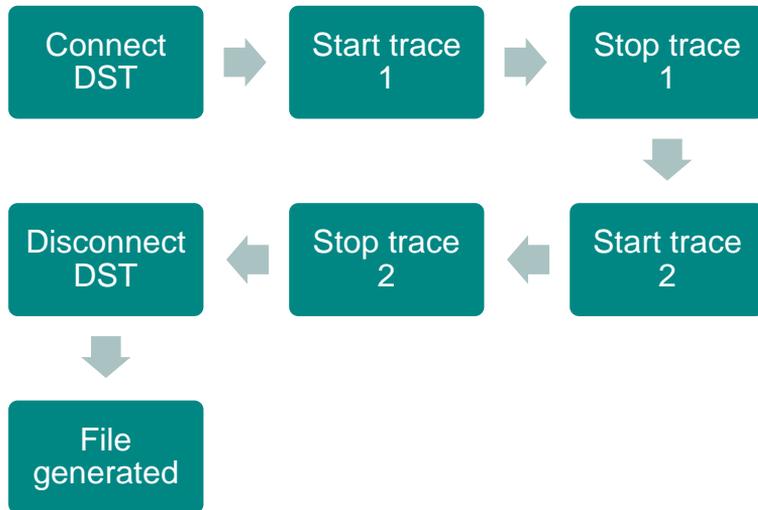
Figure 6-7 Trace flow logic

6.3.1.3 Zero adjustment

Press the button "set torque output = 0" to start the zero adjustment (authentication required).

6.3.1.4 Simulate alert

Activates the simulation of the alert output as described in 5.1.4.1.

6.3.1.5 Read parameter from rotor

Triggers the DST to send the data sheet from rotor to the software. The signals of DST will be undefined during data transfer and must be ignored by any connected controller system. This task will take few seconds. Afterwards the "DST product information" is updated in the main window. The sensitivity values from the rotor were now received and if the sensitivity source is "data sheet", the torque values will be converted by the rotors sensitivities from now.

6.3.1.6 Simulation values

The given buttons allow to trigger different simulation values for the torque signal. The frequency will be converted into torque with the defined sensitivities (see "Sensitivity source" in 6.2.1). Click on the button "OFF" to turn off the simulation and to receive real measurement values

6.3.2 Status area

The status area contains information about the connected DST. Once the data has been received from the DST, the data is shown and the time stamp of the data is shown on the top right corner. If the data is not updated, click on "Read parameter from rotor" to trigger the update manually.

After receiving the data, the PC software knows the nominal torque of the connected DST and the torque signal (single value) is converted from Hz into Nm.

Information such as firmware version, serial numbers and temperatures are important if you contact the ATESTEO service.

The applied sensitivity (direction depending) value is optionally displayed in bold font.

6.3.3 Chart area

The chart shows the measurement data from the DST in real time. The torque signal is shown as "Hz" on the left y axis. The rotation speed of the DST is shown on the right y axis as "rpm". The scaling of the y axes can be changed in the settings menu (see 6.2.1).

The x axis has no dimension. It shows the index of the received data package. Each time a measurement data pair is received from the DST, the package index is increased by one. The data rate of the DST can be changed in the settings menu (see 6.2.2). The chart shows data of the last 60 seconds.

6.3.4 Data area

The data area shows the measurement values torque and speed and states of the DST.

Torque

Torque is shown in Hz. Once the data sheet is fully transferred from DST to PC software or if user-defined sensitivities are used, the value will also be displayed in the unit "Nm".

Speed

Speed is shown in rpm.

States

The states are shown as LED. Grey represents inactive. Green is active. Red is a warning or an error.

State	Description
Zeroing	Zero adjustment active.
Test signal	Test signal is active.
Short circuit	Short circuit at strain gauge active.
Data sheet transfer	Data sheet was transferred from DST to the PC software.
Data transfer state	Data transfer in progress.
Clipping	Torque or speed values are clipped.
Overload	Torque overload present.
Serial number mismatch	This warning LED is active (Red colour) if the serial number of the user-defined sensitivities do not match to the serial number of the DST (or if the data sheet has not been received from DST). In this case please ensure that the user-defined sensitivity values are really matching to the connected DST.

Table 6-1 DST states in PC software

6.3.5 Log message area

The log message area shows text information about events. Events can be warnings, errors such as connection errors or data errors as well as action messages. Each log message displays the date/time, type and text of the event.

Warnings
Non critical warning to the user.

Errors
Connection errors usually only happen if the connection is not set up properly, if wrong COM ports are selected or the cable is unplugged. Data errors can happen if the communication to the DST is distorted. If that happens rarely, those errors can be ignored. If the connection is distorted frequently, please contact the service.

Action messages
Action messages are triggered by user action (authentication, trace storage, …).
Trace file generation notification can be double clicked to open the file directly with the default program (for txt or csv file extensions).

7 Connections

7.1 Plug connection at DST

7.1.1 X800

12 pol male Binder plug. Please use matching female connector described in 7.2.1.

7.1.2 USB

Micro-B USB 2.0 plug male	
Pin	**Description**
1	Supply voltage ($\perp_D$)
2	Data$_{DIFF-}$ ($\perp_D$)
3	Data$_{DIFF+}$ ($\perp_D$)
4	Not connected
5	Supply GND ($\perp_D$)

Table 7-1 Pin description of micro USB connector.

7.2 Cable connection

7.2.1 X800

X800 - Cable 12 pol M16 female Amphenol C091 31D012 201 2 U			
Pin	**Description**	**Wire type**	**Wire color**
A	Analog GND ($\perp_A$)	0.14mm² - twisted pair	Blue
B	Analog out, M$_d$ ($\perp_A$)	0.14mm² - twisted pair	Red (thin)
C	Digital GND ($\perp_D$)	0.25mm²	Black
D	Test signal in ($\perp_D$)	0.14mm² - twisted pair	White
E	M$_{df}$-out$_{DIFF+}$ ($\perp_D$)	0.14mm² - twisted pair	Green
F	M$_{df}$-out$_{DIFF-}$ ($\perp_D$)		Yellow
G	N-out$_{DIFF-}$ ($\perp_D$)	0.14mm² - twisted pair	Grey (thin)
H	N-out$_{DIFF+}$ ($\perp_D$)		Pink

X800 - Cable 12 pol M16 female Amphenol C091 31D012 201 2 U			
Pin	Description	Wire type	Wire color
J	Supply voltage ($\downarrow_S$)	0.25mm²	Red-Blue
K	Alarm-out (open collector)	0.25mm²	Grey-Red
L	Zeroing in ($\downarrow_D$)	0.14mm² - twisted pair	Brown
M	Supply GND ($\downarrow_S$)	0.25mm²	Purple

Table 7-2 Cable description for connector X800.

	X	Y
A	-0,41	-3,45
B	2,29	-3,61
C	4,10	-1,21
D	3,20	1,34
E	2,71	3,59
F	0,41	3,45
G	-2,29	3,61
H	-4,10	1,21
J	-3,20	-1,34
K	-2,71	-3,59
L	2,00	-1,51
M	-2,00	1,51
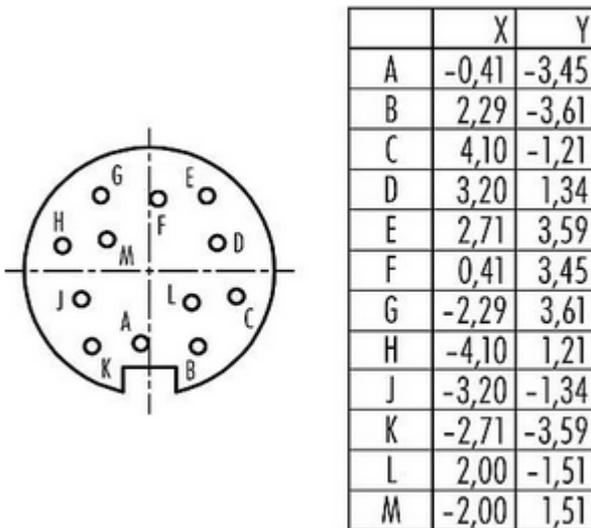
Figure 7-1 Pin position at Binder plug (female)

7.2.2   USB

Use a commercially available USB-Micro-B to USB-A adapter cable to connect the measuring system to a PC with USB-A interface.

8   General references

8.1   Resetting the zero point

With each measuring element, from a flexible spring element that is measured by its elastic deformation, there will always be a zero drift even if no load is applied.

Related to strain gauge based torque measuring systems, zero-drifts in a load-free condition can be caused by the following circumstances:

8.1.1   Thermal influences

Despite of a complex temperature compensation a zero-drift related to high temperature fluctuations can always be observed. Due to various temperature influences interacting permanently with the torquemeter, another reason for exiguous zero-drifts is given.
The temperature stability defined in the technical specifications, e.g. $0.1\%/10^{\circ}K$ is determined by the allowed temperature drift of $\pm0.1\%$ of the rated torque per 10° Kelvin difference.

8.1.2   Hysteresis-caused influences

If a sensor during a test is mostly loaded in one direction it can indicate a drift after the test is terminated. This drift cannot to be traced back to a temperature compensation problem but to the natural hysteresis of the sensor and strain gauges.
The change of the zero value depends on the torque applied or on the test duration. In any case, the value of the zero-drift variation will not be larger than the linearity and hysteresis specified in the technical data for the sensor.

8.1.3 Aging

If a strain gauge based sensor is dynamically loaded for a long period of time a zero-drift can occur. This value depends on the cycle count and the strain amplitude. This zero-drift will affect the sensitivity of the sensor. Even though this is a natural effect for strain gauge sensors, ATESTEO torque sensors drift is very low due to a low sensitivity at nominal torque.

8.1.4 Lateral force influence

Considering that each torque sensor is part of a powertrain, every component linked to the sensor generates a lateral force. This load will be influenced by the size and installation of the components. This lateral force will be added to the measuring signal. If the installation is performed as specified in the technical specifications, this influence will be extremely small.

8.1.5 General

All the above mentioned items that influence the zero-drift are still in the range of calibration tolerance, as long as the sensor is properly maintained and handled and no transportation damages occurred to the sensor or strain gauges.

Due to the fact that all the above mentioned zero-drifts can happen in different situations at the same time it is very difficult to suggest a general zero-reset procedure.
After considering all the information acquired through our experience and customers feedback we can suggest and comment different scenarios for a proper zero-reset of the torque sensor.

- A zero-reset is only allowed if the torque is zero.
- If a great zero shift (>10 Hz) is observed during the mounting of the torquemeter please check the adapter flange due to the mechanical properties. A lower zero-shift can be reset.

- The test bench engineer has to decide, whether the accuracy request of the actual test requires a reset of the zero point. Generally it is possible to improve the accuracy by resetting the zero torque after the warming-up period of the test stand and before starting the measurement.
- If the zero shift is greater than 2% of the rated torque, the torquemeter must be checked. These tests (recalibration and other tests) have to be done by ATESTEO to find out the reason for the malfunction.
- A zero shift of 0.05% of the rated torque per month has no influence to the accuracy of the system.

8.2 CE Manufacturer's Declaration:

The manufacturing's declaration is a separate document which can be sent on demand.

9 Appendix

9.1 Table of figures

9.2 Table of tables

ATESTEO
Manual DST – Version V1.5

Notes

Notes

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