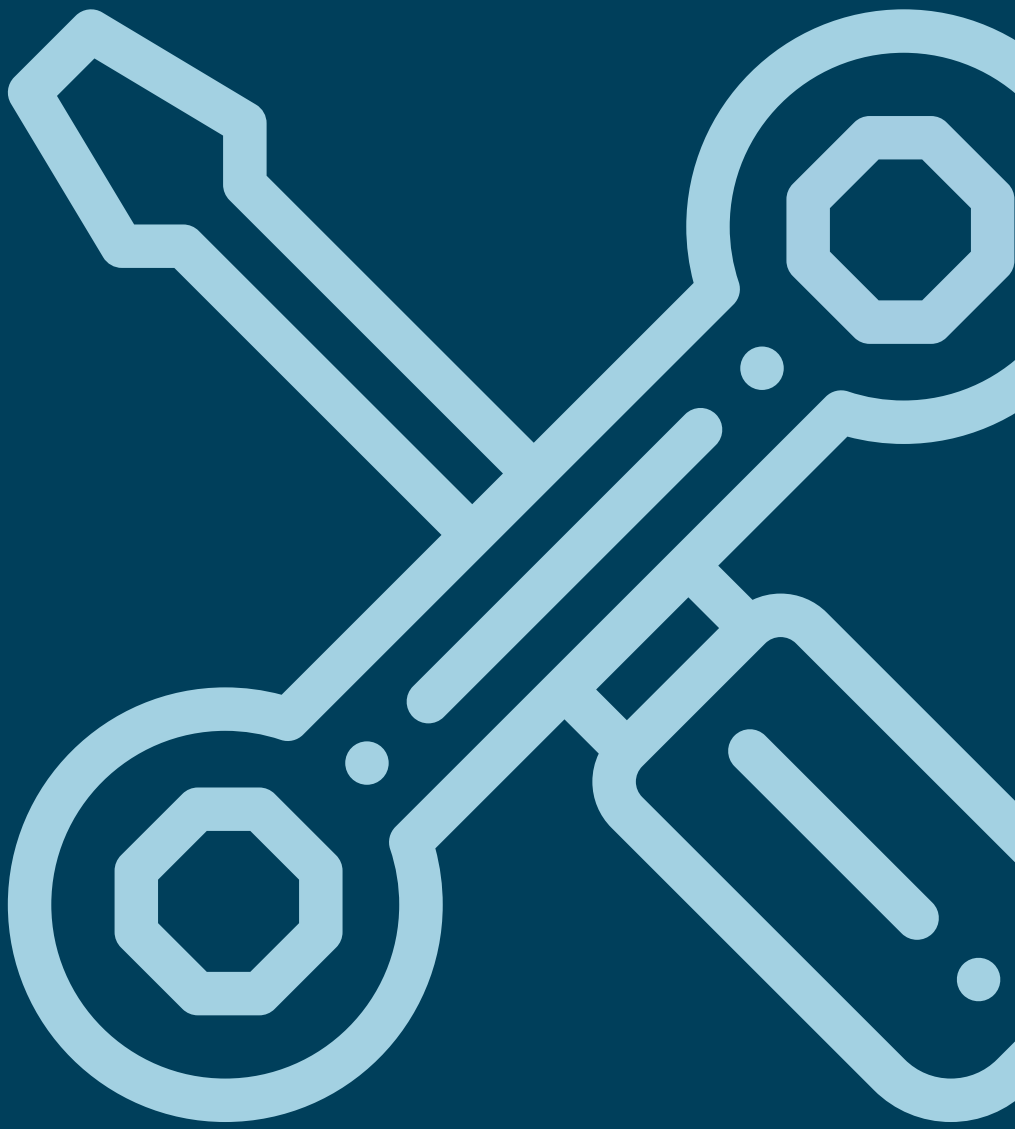

Operation Manual

Bolt-Check Standard Mk.2

R&D Engineering A/S

Rev. date. 18-09-2024

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1 Document Revision Table

Rev. no.:	Rev. Date:	Change:	Responsible
8b	20-11-2023	Updated “Troubleshooting”	LJK
08e	13-05-2024	Review + comments	FSN
08k	08-07-2024	Added new chapters	MGK
09	09-07-2024	Minor changes + Issued to customer	JAS
10	18-09-2024	Added 8.3.7 temperature sensor instructions under operation. Added handling of ultrasonic sensor in 8.3.6. Added 10.4 error from wrong measured wave.	JES

2 Introduction

2.1 Purpose

The purpose of this operating manual is to describe the usability of the R&D Bolt-Check Standard device and secure safe and correct use of the equipment.

The R&D Bolt-Check Standard is used to measure elongation on fasteners under tension. A bolt traceability system is incorporated in the Bolt-Check Standard to systematize the measured bolts. This saves time and reduces uncertainty regarding the bolt placement system while full traceability is maintained.

2.2 Customer support

R&D maintains a customer support, capable of assistance regarding questions not covered in this operation manual. Customer support can be reached via the following:

Customer support
R&D Engineering A/S Sigma 3 8382 Hinnerup Denmark **Mail:** service@rdas.dk **Phone:** +45 28 51 89 50

2.3 Disclaimer

This manual must be read and understood prior to use. Lack of understanding can lead to inaccurate measurements and damage to the equipment and/or personal injuries.
This manual only covers the R&D Bolt-Check Standard device, which consists of two devices:

- A tablet
- An ultrasonic measurement device.

To download additional operation manuals regarding Bolt-Check Standard browse to:

https://rdtestsystems.com/bolt-check/manuals/

2.4 Warranty

The R&D Bolt-Check Standard comes with a one-year limited warranty. The warranty only applies to Bolt-Check Standard units which can be documented to have been bought from R&D Engineering A/S. Use of the device in ways beyond what is described in this operation manual is not covered. Repairs on software and hardware will be conducted at R&D Engineering A/S' discretion.

R&D Engineering A/S will not be held liable for any damage caused by failure, nor interruption of business, loss of profit, etc. R&D Engineering A/S will not be liable to repair or replace damaged devices, used beyond the scope of this operation manual or that have been subjects to unauthorized repair.

2.5 Field of scoop

Bolt-Check Standard device is designed exclusively to:

- Conduct length and elongation measurements on fasteners, massive metal rods or similar.

Bolt-Check Standard is not suitable as:

- A thickness gauge
- A flaw detector
- An exact length measurement device

*Just to mention some examples.

Bolt-Check is not suitable for measuring on:

- Austenitic steel (Must be verified before using this on such alloys)
- Non-metallic
- Non-solids

For requests on equipment for these matters, contact R&D Engineering A/S using the contact information in "2.2 Customer support"

3 Before you begin

3.1 Safety First!

Before you use your Bolt-Check product, read, and understand the manuals provided with the equipment. Improper operation or maintenance can result in hazardous conditions that can cause severe personal injury or death, or damage to your equipment. Again, read and understand the safety information provided with the equipment before you continue. It is very important that you remain aware of hazards that apply to your equipment.

3.2 Other Documents

In addition to this manual, you will receive additional documents. These documents are highly relevant for the understanding of your product.

- 0001-403-MAN-Bolt-Check Cloud Manual
- Dakota-Ultrasonics-MAX-II-Manual
- TOUGHPAD-FZ-G1- Manual

3.3 Hazard Illustrations

Hazard notices may be embedded in this manual. These notices contain important safety information. Read all hazard notices carefully and follow all directions and recommendations. Three different levels of hazard notices may appear in the manual. Following are explanations of all three levels.

⚠ DANGER

DANGER:

Danger notices indicate the presence of a hazard with a high level of risk which, if ignored, will result in death, severe personal injury, or substantial property damage.

⚠ WARNING

WARNING:

Warning notices indicate the presence of a hazard with a medium level of risk which, if ignored, can result in death, severe personal injury, or substantial property damage.

⚠ CAUTION

CAUTION:

Caution notices indicate the presence of a hazard with a low level of risk which, if ignored, could cause moderate or minor personal injury or equipment damage, or could endanger test integrity.

4 Safety Information

Before you use your Bolt-Check device, read, and understand the safety information. Improper operation can result in hazardous conditions that can cause personal injury or damage to your equipment.

4.1 Overview

4.1.1 Intended Use

Bolt-Check is used to measure elongation on fasteners under tension. A bolt traceability system is incorporated to handle the measured bolts. This saves time and reduces uncertainty regarding bolt placement while full traceability is maintained.

4.1.2 Foreseeable Misuse

When you prepare to operate the equipment (and also during operation), ensure the following. Foreseeable misuse includes, but is not limited to, the following.

- Avoid breaking or cutting the cables on sharp objects.
- Avoid walking on cables as it might damage them.
- Avoid dropping the Bolt-Check Standard.
- Do not use Bolt-Check Standard for anything other than what it is intended for, e.g. use of it as a step ladder.
- Do not pull the device by the cables.
- Avoid using Bolt-Check Standard in wet conditions, such as rainy weather or submerged.

4.2 Personnel Qualifications

⚠ WARNING

WARNING:

Equipment maintenance, setup, and operation require specialized training.

Installation, maintenance, setup, and operation of the equipment by unqualified personnel can expose them, and others, to hazards that can cause damage to equipment and personal injury or death.

Do not allow unqualified personnel to perform any of the equipment installation, maintenance, setup, or operating procedures. Maintenance, setup, and operating procedures should only be performed by trained personnel.

4.3 Avoid Water

Bolt-Check Standard can withstand small amounts of water splashes but should not be used in rainy weather. It should under no circumstances be submerged in water.

4.4 Energy Isolation

Energy isolation is a prime safety consideration where unexpected energizing, startup, or release of stored energy could occur and cause injury. Before any employee performs service or maintenance on the equipment or a component, the equipment must be isolated from the energy source and rendered inoperative. The customer is responsible for establishing a program of energy control procedures and employee training to ensure that the equipment is isolated from energy sources.

4.5 Site Precautions

⚠ WARNING

WARNING:

The equipment is designed to operate in an environment where precautions have been taken to minimize hazards to personnel and the equipment.

Ignoring hazards and failing to take necessary precautions can result in injury or death to personnel, and damage to equipment.

Do not install or operate the equipment in a hazardous environment.

⚠ WARNING

WARNING:

Hazardous situations or conditions can arise suddenly and without warning.

If immediate action is not taken to remove the hazard or remove personnel from the hazard, serious injury or death can result.

Do not operate the equipment unless you have full view of it.

⚠ WARNING

WARNING:

Working environments that are designed using insufficient or inappropriate ventilation, lighting, heating, and cooling or that use equipment, furniture, or equipment/furniture placements that are non-ergonomic can result in operator fatigue and stress.

Operator fatigue and stress can result in operator errors which can result in injury to personnel or damage to the equipment and/or specimen.

Make sure that ventilation, lighting, heating, cooling, and ergonomic issues are considered in the layout of the operating area to limit operator stress and fatigue.

⚠ WARNING

WARNING:

Service activities (that are outside the bounds of equipment operation and maintenance) may require specialized tools, fixtures, and expertise.

Attempting to perform these activities can result in personal injury and/or damage to equipment components.

Service activities must be performed or managed by R&D or qualified personnel only. Contact R&D Service & Installation before attempting any service activity.

Official direct contact information for R&D Service and Installation:

Telephone: +45 2851 8950

E-mail: service@rdas.dk

4.6 General Safety Practices

If you have equipment related responsibilities (that is, if you are an operator, service engineer, or maintenance person), you should study this manual carefully before you attempt to perform any procedure.

You need to receive training on this equipment to ensure a thorough knowledge of it and the safety associated with its use. In addition, you should gain an understanding of its functions by studying the other manuals supplied with your equipment.

It is very important that you study the following safety information to ensure that your procedures and the equipment's operating environment do not contribute to or result in a hazardous situation. Remember, you cannot eliminate all the hazards, so you must learn and remain aware of the hazards that apply at all times. Use these safety guidelines to help learn and identify hazards so that you can establish appropriate training and operating procedures and acquire appropriate safety equipment.

Improper operation or maintenance of your equipment can result in hazardous conditions that can cause personal injury, invalid test results, or damage to the equipment. Common sense and a thorough knowledge of the equipment can help to determine an appropriate and safe approach to its operation.

Observe the following safety practices before and during operation.

4.6.1 Safety Practices Before Operating the Equipment

Before you apply power to the equipment, review and complete all of the safety practices.

4.6.2 Read All Manuals

Study the contents of this manual and the other manuals provided with your equipment before attempting to perform any function for the first time. Procedures that seem relatively simple or intuitively obvious may require a complete understanding of the equipment to avoid unsafe or dangerous situations.

4.6.3 Visually Inspection Before Operating the Equipment

Whenever you prepare to apply power to the equipment, R&D recommends that you visually inspect the state of your equipment to make sure that it is not worn out.

4.6.4 Locate and Read Hazard Placards/Labels

Find, read, and follow any hazard placard instructions located in vicinity of the application of the equipment.

4.6.5 Know Facility Safe Procedures

Most facilities have internal procedures and rules regarding safe practices within the facility. Be aware of these safe practices and incorporate them into your operation of the equipment.

4.6.6 Know Controls

Before you operate the equipment for the first time, make a trial run through the operating procedures. Locate all hardware and software controls and know what their functions are and what adjustments they require. If any control function or operating adjustment is not clear, review the applicable information until you understand it thoroughly.

4.6.7 Have First Aid Available

Accidents can happen even when you are careful. Make sure to have first aid available.

4.6.8 Practice Good Housekeeping

Keep the floors in the work area clean. Hydraulic fluid, oil, or water that is spilled on any type of floor can result in a dangerous, slippery surface. Do not leave tools or other items not specific to the operation, lying about on the floor.

4.6.9 Protect Cables

Protect all equipment cables from sharp or abrasive objects that can cause them to fail. Never walk on cables or move heavy objects over them.

4.6.10 Record Changes

If you change any operating procedure, write the change and the date of the change in the appropriate manual.

4.6.11 Provide Adequate Lighting

Ensure that adequate lighting is available to minimize operating errors, equipment damage, and personal injury.

4.6.12 Ensure Correct Cable Connection

If a cable has been disconnected, ensure that you establish the correct relationship during reconnection.

4.7 Safety Practices While Operating the Equipment

4.7.1 Wear Appropriate Personal Protective Equipment (PPE)

Wear appropriate PPE.

- Wear eye protection when you work with anything that could break apart.
- Wear ear protection when you work near electric motors, pumps, or other devices that generate high noise levels.
- Wear appropriate protection (gloves, boots, suits, respirators) whenever you work in proximity to fluids, chemicals, or powders that may irritate or harm the skin, respiratory system, or eyes.
- Wear appropriate protection (gloves, safety shoes, glasses) whenever you work in proximity to sharp edges or objects that could fall onto you.

4.7.2 Do Not Disturb Sensors

Do not bump, wiggle, adjust, disconnect, or otherwise disturb a sensor or its connecting cable when electrical power is applied.

4.7.3 Ensure Secure Cables

Do not change, connect, or disconnect any cable connections when electrical power is applied. If you attempt to change a cable connection while the system is in operation, a spark can occur. In certain environments this could result in severe personal injury, death, or damage to equipment.

4.7.4 Stay Alert

Avoid extended periods of work without adequate rest. In addition, avoid extended periods of repetitious, unvarying, or monotonous work because these conditions can contribute to accidents and hazardous situations. If you are too familiar with the work environment, it is easy to overlook potential hazards that exist in that environment.

5 System Overview

Machine description

- The R&D Bolt-Check Standard is used to measure elongation on fasteners under tension. This is done by first making a reference measurement of the selected fastener in its untightened stage.

- A traceability tag system is incorporated in the Bolt-Check Standard to scan the bolts measured. This saves time and reduces uncertainty regarding the bolt placement system while full traceability is maintained.

- Incorporated into the Bolt-Check Standard system are a cloud/website for easy access to download or upload data, also a good overview over all the different sites a costumer may have.

Graphical Description

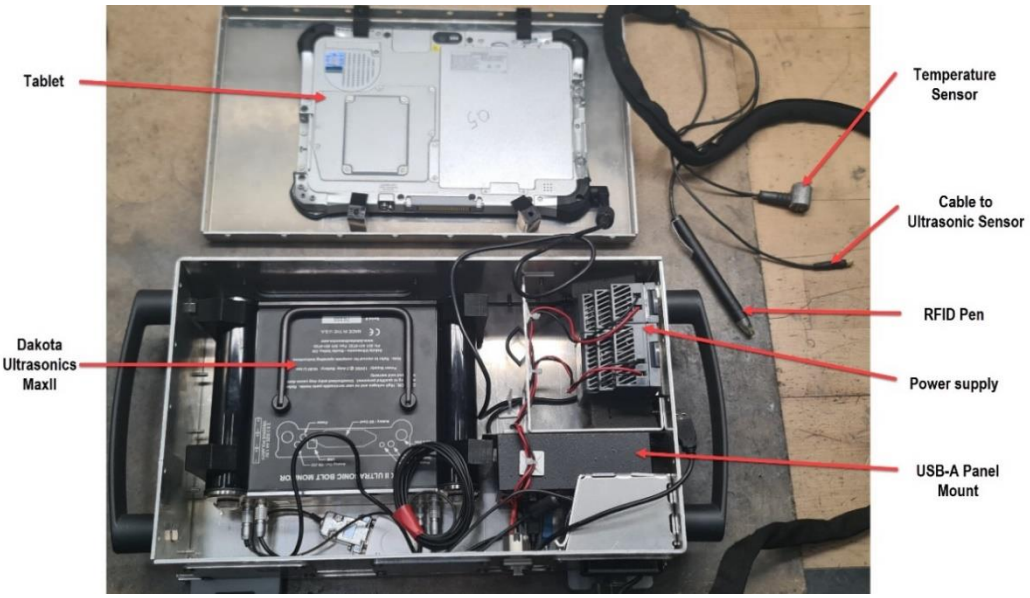
From the outside the Bolt-check Standard is protected by a metal case all around, to secure the equipment for any damages if dropped. The case also comes with handles on each side as shown on “Front” picture, this makes it for better handling the equipment. On the “Back” picture a foot is fabricated to avoid any damage to the cables.

Inside the metal case:

- Tablet
- Dakota Ultrasonics Max II
- Power Supply
- USB-A Panel Mount
- Power cables

Cables going out of the metal case:

- Temperature Sensor cable
- Ultrasonic Sensor cable
- RFID Pen



Specific applications that are prohibited

Any underwater applications of this product are prohibited and should under any circumstances be avoided. The product is designed to withstand splashes of water but cannot be used wet conditions. The application temperature of this product is within –10° to 60° Celsius.

Key specifications

Length with handles: 48 cm.
Length without handles: 39 cm.
Width: 11.5 cm.
Height: 25.5 cm.
Weight with transportation case: 16.3 kg.
Weight without transportation case: 7.1 kg.

Characteristics of the power supply
The tablet is powered by a Mean Well DDR-60G-15.
Dakota Ultrasonics Max-II is powered by a Mean Well DDR-30G-12.
Both power supplies are powered through XLR Connectors to a 230V electrical plug.

Limits for intended operating conditions, such as temperature, relative humidity and air pressure
The temperature limit of this product is –10° to 60° Celsius.

Intended life limit of the machine
The intended life limit of R&D Bolt-Check Standard is 4 years.

Control and display description

Control panel on the front of the Bolt-Check Standard

The panel is a Panasonic Tough pad FZ-G1 tablet, it runs on Windows 10 Pro 64 bit with a display of.
10.1" WUXGA 1920 x 1200 with LED backlighting
10-point capacitive multi touch + Waterproof Digitizer pen daylight-readable screen
– 2-800 nit
– IPS display with direct bonding
– Anti-reflective and anti-glare screen treatments
– Ambient light sensor, digital compass, gyro and acceleration sensors
– Automatic screen rotation
– Intel® HD Graphics 620 (Built-in CPU) video controller
10-point gloved multi touch + digitizer screen
– Supports bare-hand touch and gestures and electronic waterproof stylus pen
– Supports glove mode and wet-touch mode
7 tablet buttons (2 user-definable)
On-screen QWERTY keyboard

Control panel on the back of the Bolt-Check Standard

The panel is Dakota Ultrasonic Max II.
Blanview sunlight readable QVGA TFT colour display (320 x 240 pixels). Viewable area 4.54 x 3.40 in (115.2 x 86.4 mm), or 5.7 in (144.78 mm) diagonal. 16 colour palate, multiple colour options and variable brightness.
Membrane switch with 21 tactile keys.

Requirements regarding place or environment

The foreseen application environment of the R&D Bolt-Check Standard is indoor or under cover from the elements. It's crucial the device is standing/laying in a dry spot and not in any water, since it might get into the device and cause a short circuit. The device is suitable for most places such as wind turbines, bridges, assembly halls and so on.

6 Transportation, Handling, and Storage

Physical characteristics

During transportation, the device should be transported in the Peli Air 1605 Case as it's delivered in when acquired.
The Peli Air 1605 Case:
Length – 73,3Cm
Width – 42,6Cm
Height – 23,2Cm
Weight – 16,3Kg including all cables and sensors, calibration rod, ultrasonic gel and the Bolt-Check Standard.
Lifting the Peli Air 1605 Case should be done by lifting it in the handle.

Recommended transportation and handling

Under transportation the Peli Air 1605 Case is recommended to be secured, in case of an accident no harm is done to people around it.
Recommended skills, how to properly secure items in car.
Recommended equipment, a transport strap for securing items.

Environmental conditions for storage

The Peli Air 1605 Case with its content should be stored in a dry place, direct sunlight does not affect the case or equipment. The case can withstand temperatures of -51°C up to 71°C and it's IP67 & MIL-SPEC certified, waterproof and dustproof. However, the equipment should not be stored outside the temperature limits of -10°C up to 60°C.

7 Quick Start

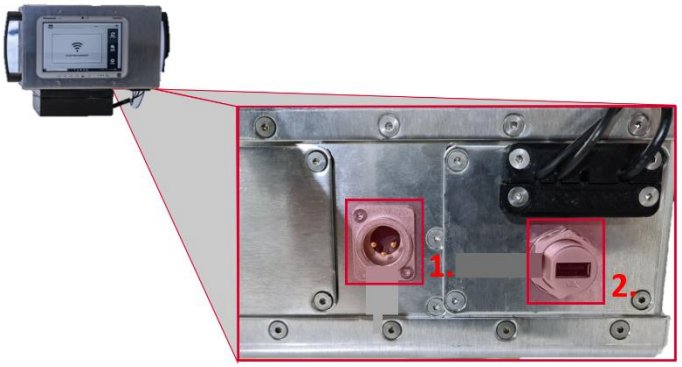
This chapter covers the basics for measurements and is intended as a brush up for already trained operators.

Turn on devices

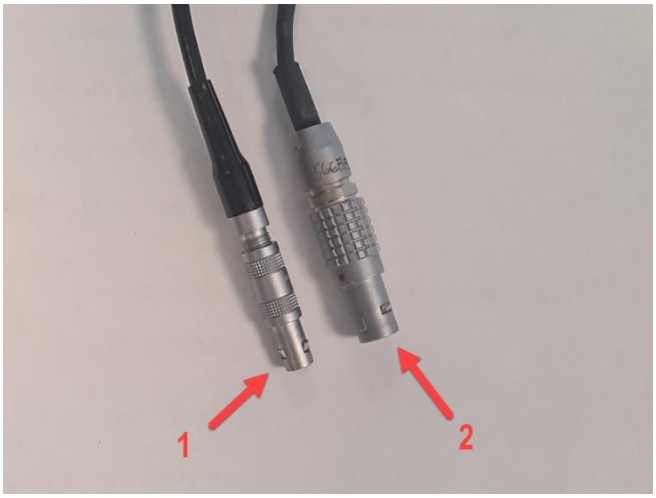
- Turn on the Bolt-Check Standard tablet by pressing the *on button*. (1)
- Turn on the Ultrasonic Device by pressing the *on button*. (2)
- The tablet has a touch screen and can be operated by either a clean dry finger or with a touch pen.

Connecting cables

- Charging power + Port for USB
- It is possible to connect to the Bolt-Check Standard without dismounting the Bolt-Check Standard case, placed on the side of the cabinet.
- Charging power (24V). (1)
- Port for USB. (2)

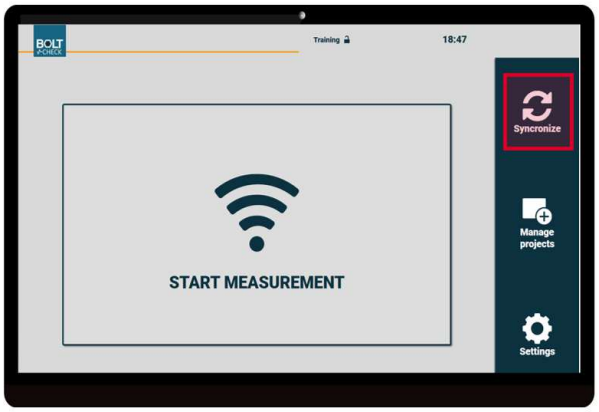


- The Ultrasonic sensor cable is a small cable and has only one pin in the middle of the termination. (1)
- The Temperature sensor cable is a bit bigger than the Ultrasonic and consist of 5 pins in the middle. (2)



Synchronize

- To measure on an existing project, the project has to be synchronized and downloaded.
- To do that, press “Synchronize” and then “sync down” the project/projects.



Create a project

See section “Starting Up a Measurement Project” on page 20.

Choose sensor

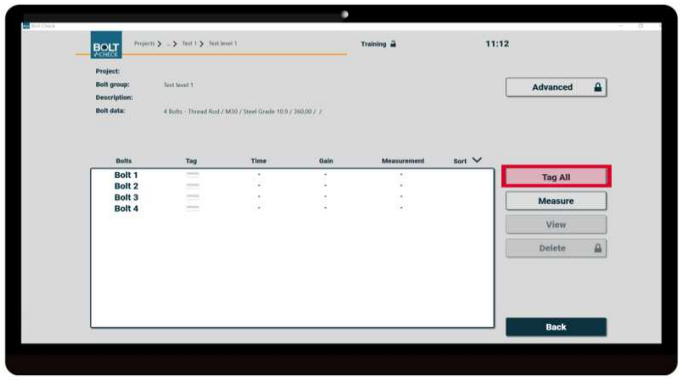
The size of sensor is standardized for repeatability.

Application	Diameter	MHz
> M12	1/8”	5
M12 – M16	1/4”	2,25
M20 – M27	3/8”	2,25
M30 – M56	1/2”	2,25
M60 +	3/4"	2,25

Scan sensor/tag

- Use the RFID Pen to read the traceability tag for the sensor and for the bolt tags.
- For more info about scanning and assigning tags, look at: “Preparing Tags, Sensors” on page 24.

- Press “Tag all” and follow the instructions on the screen.
- For more info about using Bolt-Check Standard, look at: “Menu and Functions” on page 45.



Measure bolts

- Find the sensor, which you are going to use to make the measurements.
- Place a small amount of ultrasonic gel on the sensor. Do not use more than what corresponds to the size of a pea.

- Begin by placing the edge of the sensor on the surface.
- Place the sensor on the bolt by tilting it. Doing so will squeeze away air trapped inside the gel.
- Rotate the ultrasonic sensor clockwise and counterclockwise until excess gel is squeezed out of the contact surface and the friction feels higher.
  For more info about tags and sensors, look at: “Preparing Tags, Sensors” on page 24.
- Now adjust the “Delay/Width and gain” for the optimal picture.
- Press “Capture” when the optimal picture is achieved.
- For more info about optimal picture, look at: “Measuring Elongation on page 41”.

8 Operation

8.1 Starting Up Bolt-Check Standard Device

This chapter covers the equipment included with Bolt-Check Standard and how to prepare it.

8.1.1 Device Content

The Bolt-Check Standard device comes in a robust case with:

- Bolt-Check standard
- UT-Sensors
- Tags
- RFID pen
- Calibration rod
- Ultrasonic gel
- Temperature sensor
- Charger and cables
- Centring pads
- Rigged Case

Bolt-Check device	UT-Sensor	Tags	RFID pen
			
Ultrasonic gel	**Temperature sensor**	**Sensor cable**	**Rigged case**
			
Calibration rod	**Centring pads**	**Charger and cable**	
			

Bolt-Check Standard device consists of two different devices: a tablet, and an ultrasonic device. Both devices are built into the same case with an interface on each side.

Tablet	Ultrasonic device (Bolt-Check Basic)
	

8.1.2 Preparing a Device for Measurements

Before starting a measurement, control that the following wires are connected to the device:

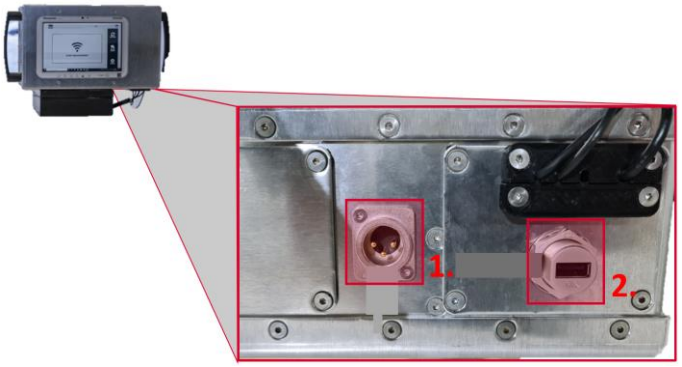
- Ultrasonic sensor
- Temperature sensor
- RFID pen

Ultrasonic sensor	Temperature sensor	RFID pen
		

- Turn on the Bolt-Check Standard tablet by pressing “on button”. (1)
- Turn on the Ultrasonic Device by pressing on “button”. (2)
- The tablet has a touch screen and can be operated by either a clean dry finger or with a touch pen.

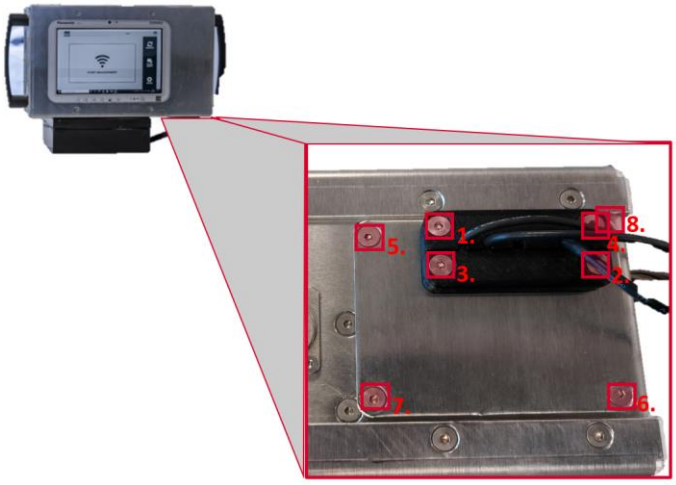
8.1.3 Connecting or Changing cables

- It is possible to connect to the Bolt-Check Standard without dismounting the Bolt-Check Standard case, placed on the side of the cabinet.
- Charging power (24V). (1)
- Port for USB. (2)

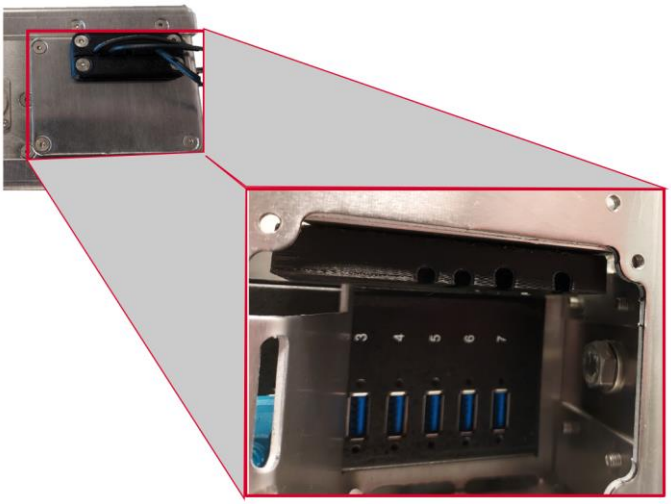


- RFID pen
- The RFID pen is connected to the Bolt-Check Standard on the side of the cabinet.
- To change the RFID pen, dismount the bottom part of the cable lock using a 2.5 mm hex key.
- Start to remove screw 1 to 4.
- Afterwards dismount the lid with the cable lock top, by continuing to remove screw 5 to 8.

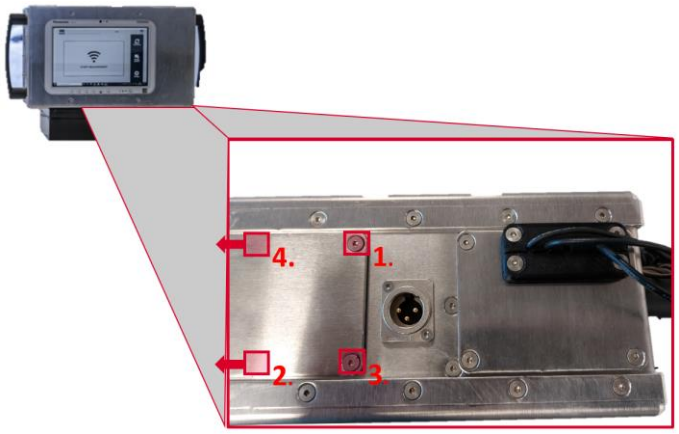
*Note that screw 8 is difficult to access and must be removed lastly.



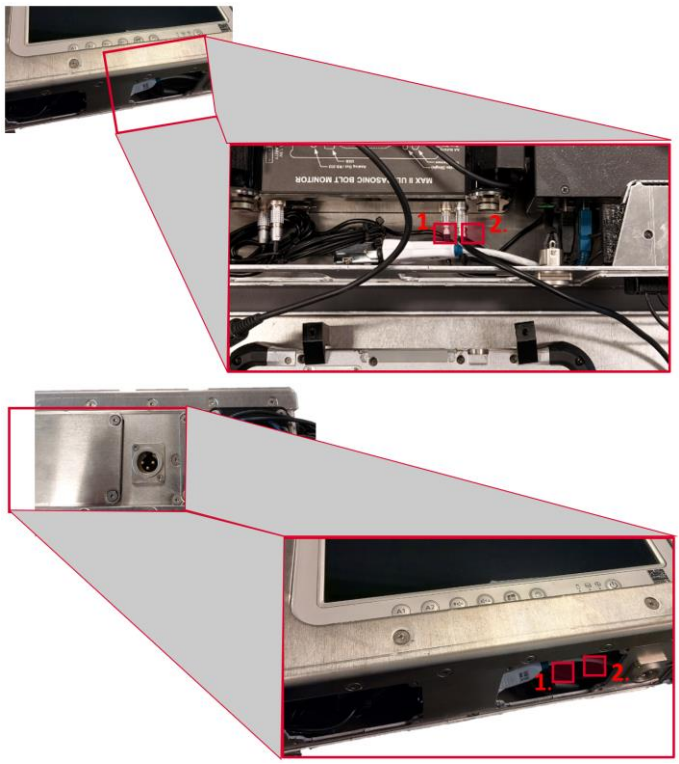
- It is now possible to remove the RFID pen from the USB socket and replace it with a new RFID pen.



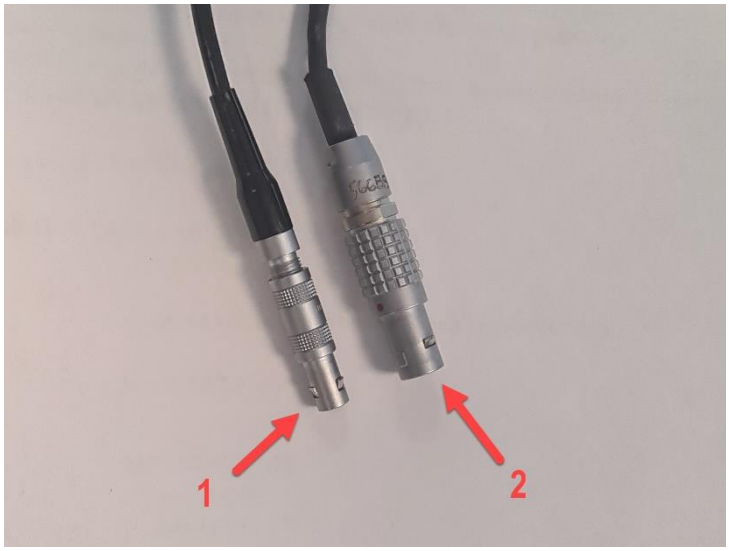
- The temperature sensor and the ultrasonic sensor is connected to the Bolt-Check Standard device on the side of the cabinet.
- In order to change the temperature sensor and ultrasonic sensor cable, the steps for removal of the RFID pen must be completed first.
- Afterwards it is possible to remove the lid placed in the middle of the cabinet side, beside the lid you have just removed.
- Dismount the lid by using a 2.5 mm hex key on screw (1 to 4).



- It is now possible to access the ultrasonic device interface and change the
  1. Plug to the ultrasonic sensor
  2. Plug to the temperature sensor
- It is now possible to replace the desired cable and remount all lids and cable locks.



- The ultrasonic sensor cable is a small cable and consist of only one pin in the middle of the termination. (1)
- The temperature sensor cable is a bit bigger than the ultrasonic and consists of five pins in the middle. (2)



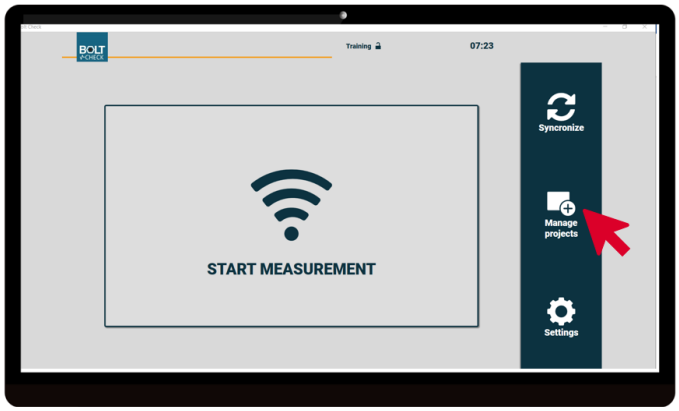
8.2 Starting Up a Measurement Project

This chapter covers how to set up a measurement project via the program.

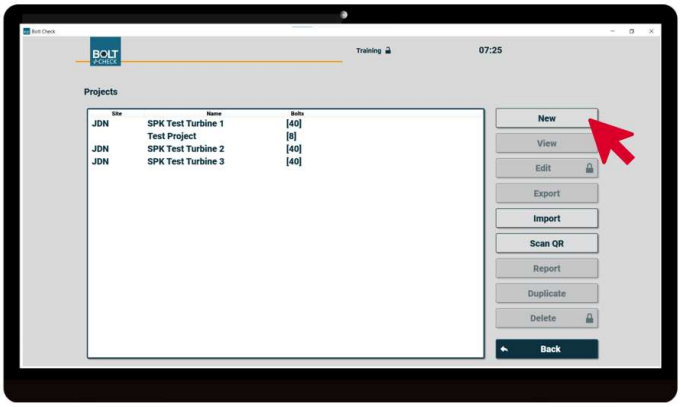
The easiest way to set up a measurement project is on a computer where the Bolt-Check program is installed, but it is also possible to do it on the device.

If a project is already created and stored in the cloud, synchronization must be conducted. For more information see Synchronization on page 45

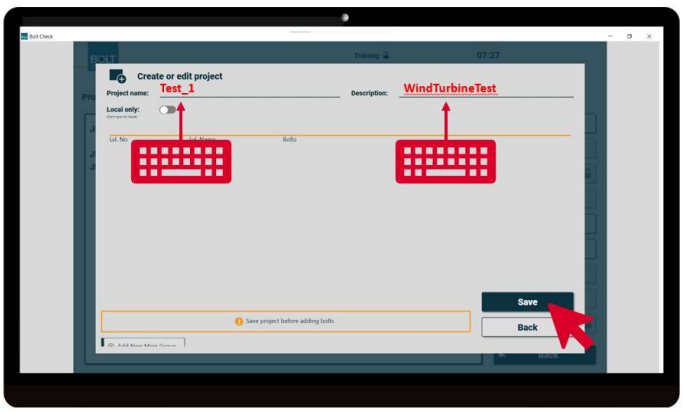
- Press “Manage projects”.



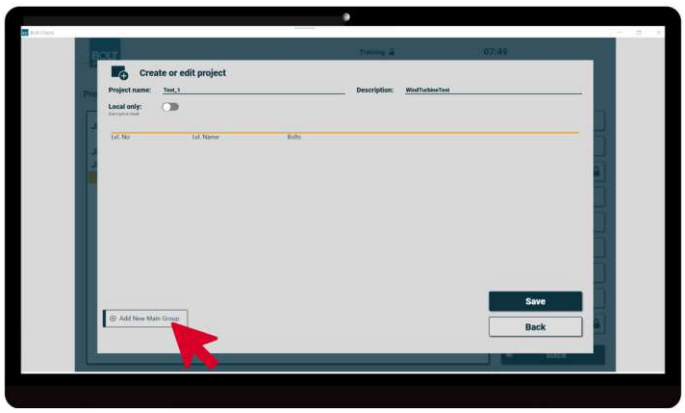
- Select “New”.



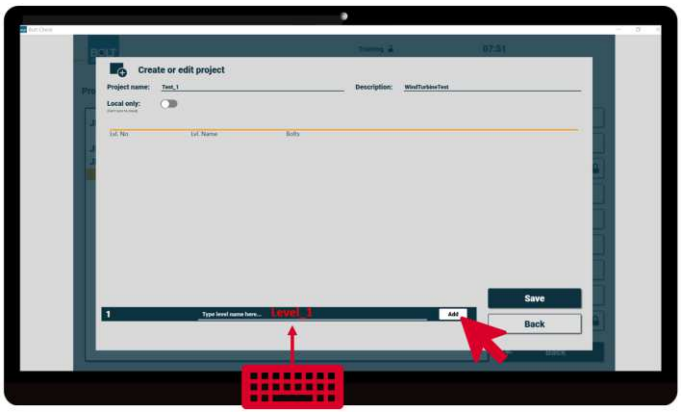
- Enter project name.
- Enter a description (optional).
- Press “Save”.



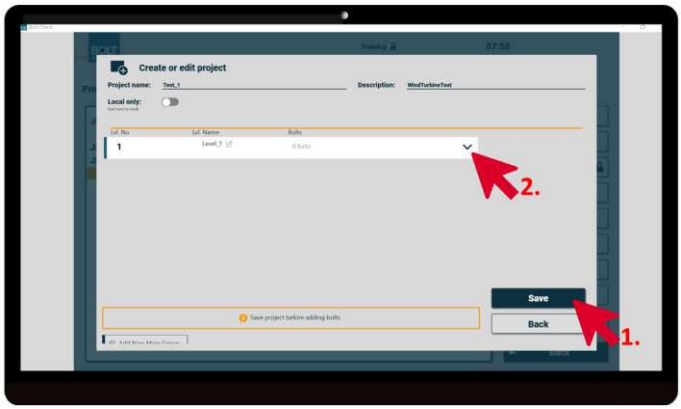
- Press “Add New Main Group”.



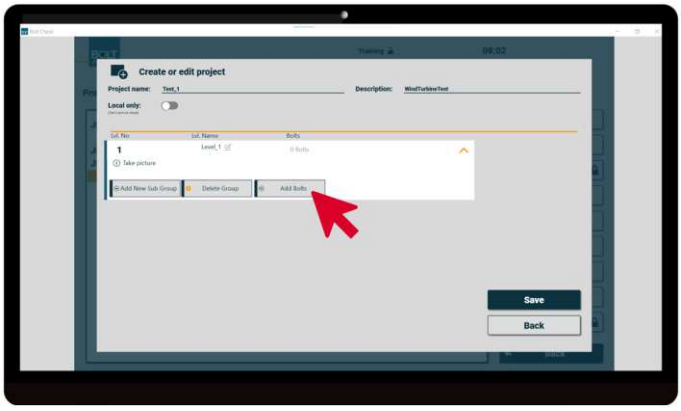
- Type in the name of the group.
- Press ”Add”.
- An info is shown, that the project must be saved before bolts can be added.



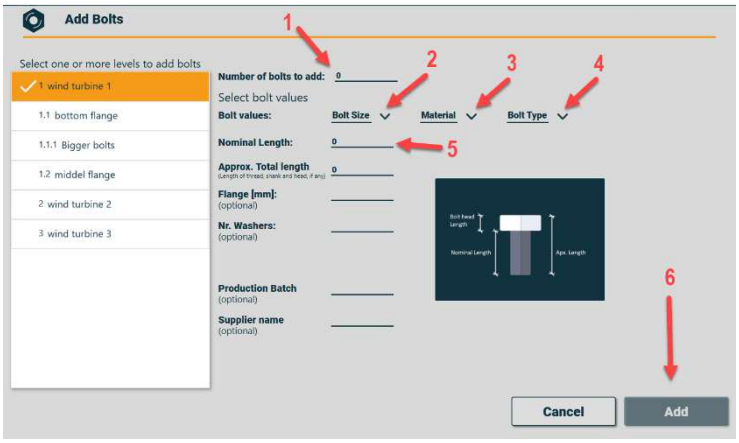
- Press “Save”. (1)
- Expand the level. (2)
- Now it is possible to add bolts or add subgroups.



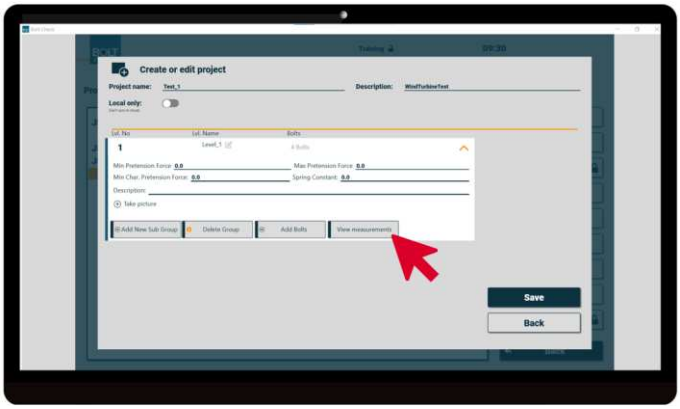
- Press “Add Bolts”.



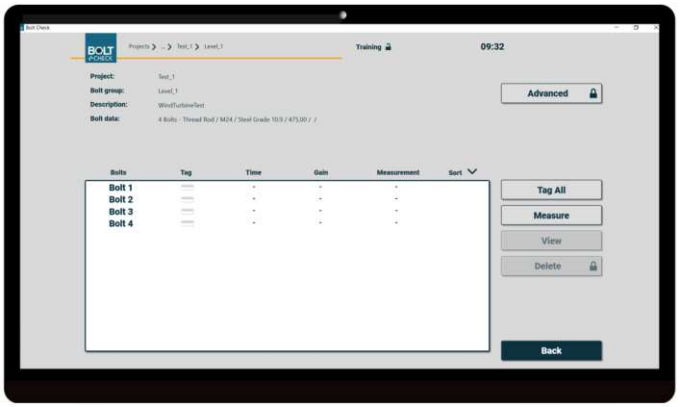
- Enter number of bolts. (1)
- Select bolt size in the drop-down menu. (2)
- Select bolt material in the drop-down menu. (3)
- Select bolt type in the drop-down menu. (4)
- Enter total length of the bolt / fastener, excl. bolt head, if present. (5)
- Enter the clamping length. (optional) The distance between the bolt head and the nut.
- Enter the number of mounted washers, if they are not already measured as a part of the clamping length. (Optional)
- Enter the batch of the production. (Optional)
- Enter the name of the supplier. (Optional)
- Press “Add”. (6)
- Now a bolt group has been created.



- Inside the group there are four options:
  - Add a new Subgroup
  - Delete Group
  - Add Bolts
  - View measurements
- Press “View measurements” as shown on the picture.



- Now the project is ready to have traceability tags assigned.



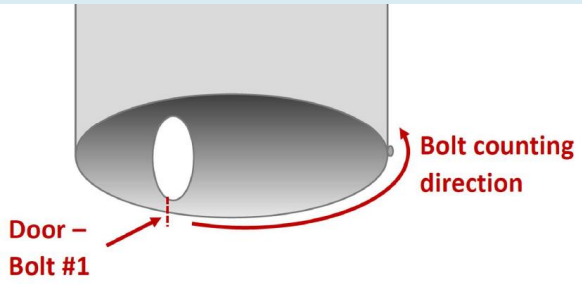
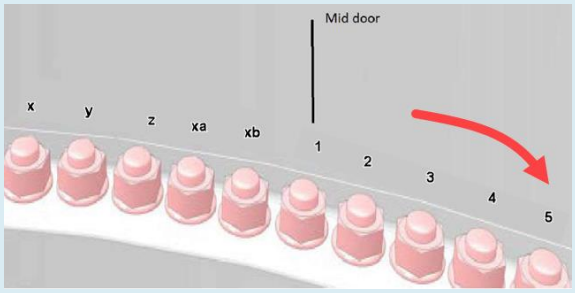
8.3 Preparing Tags, Sensors, and Bolts

This chapter covers how to prepare, assign, and place tags, sensors, and bolts.

8.3.1 Placing traceability tags

Before assigning traceability tags it should be considered where, when, and in which order this is desired. For an example see the two pictures of a numbering system from a wind turbine.

Places to assigning traceability tags

Door-Bolt	Mid-Door
	

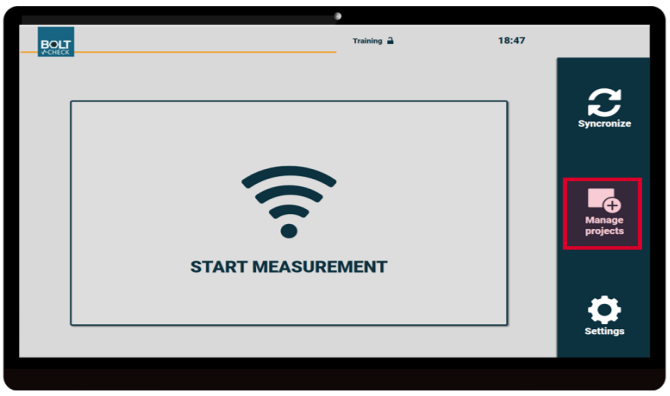
The tags can be placed on mounted bolts or on bolts not yet mounted. If bolts are already mounted the tags can profitably be placed and scanned in order from 1 to N, following the numbering order already used on site or a newly specified order.

The magnetically mounted tags can be attached with additional glue.
(e.g. Sikaflex 521 or similar non-brittle adhesive).

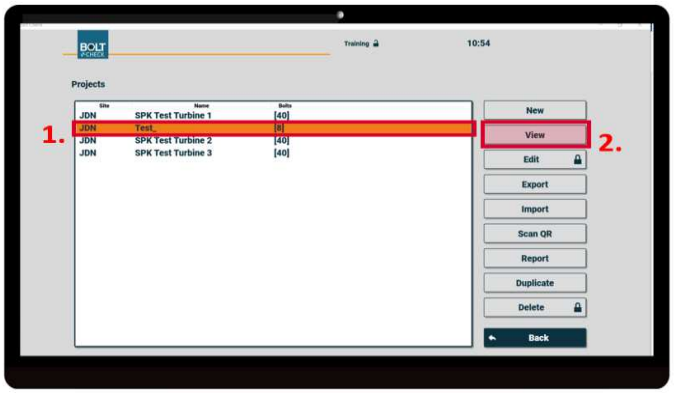
Example of tags


8.3.2 Assigning Traceability Tags

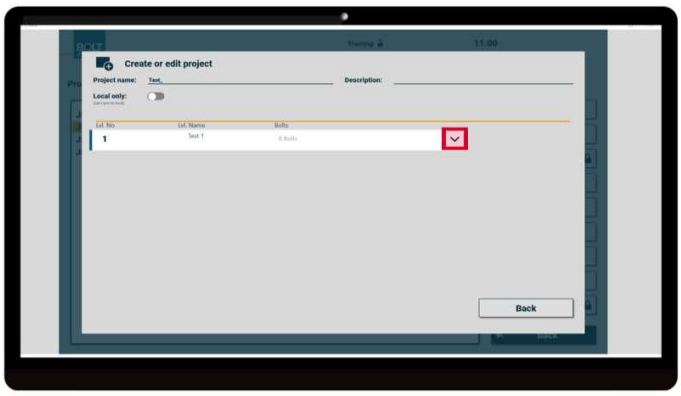
- Press “Manage projects”.



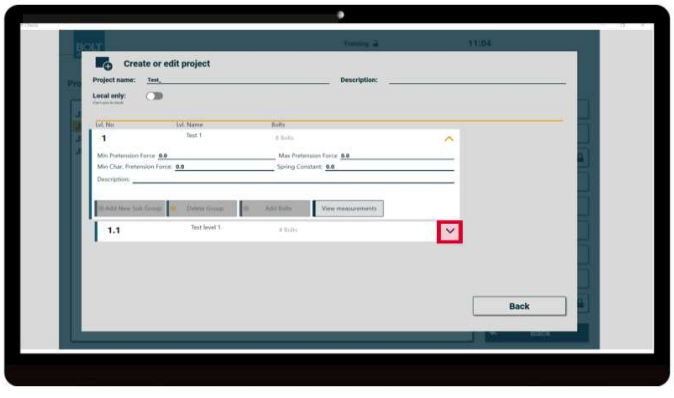
- Choose the desired project to measure. (1)
- Press “View”. (2)



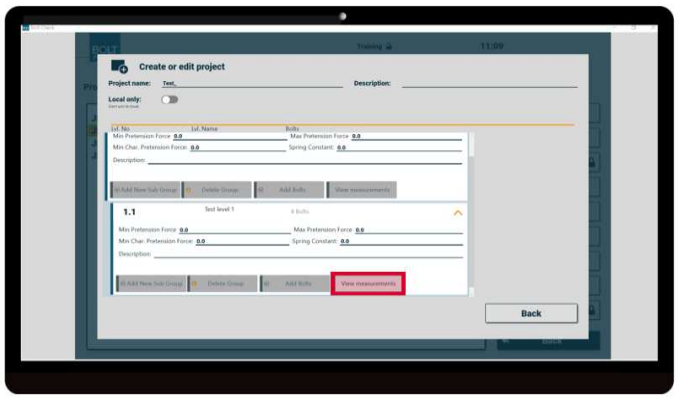
- Press on the arrow, so the dropdown will appear.



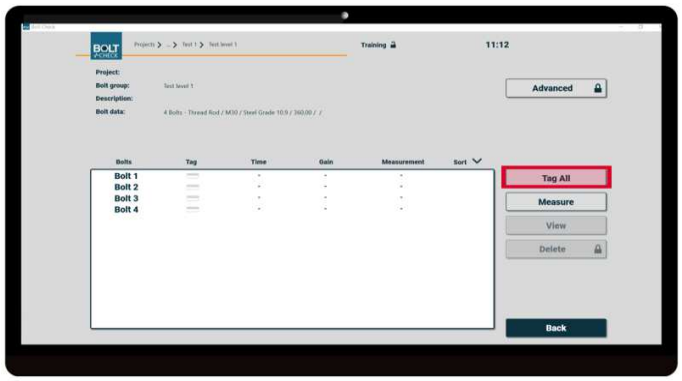
- Press on the arrow until the desired level is reached.



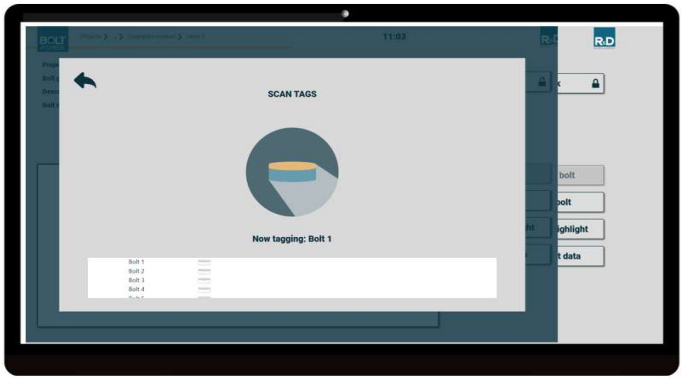
- Press “View measurements”.



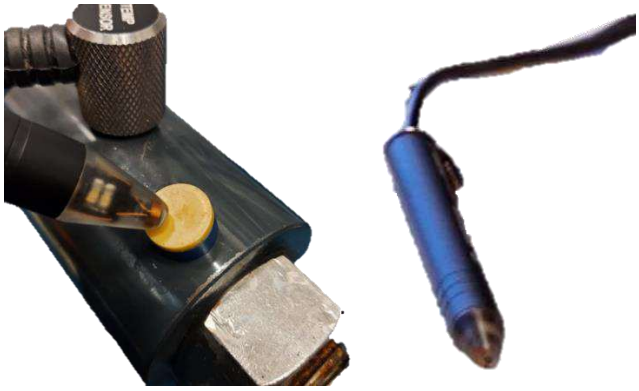
- Press “Tag all”.



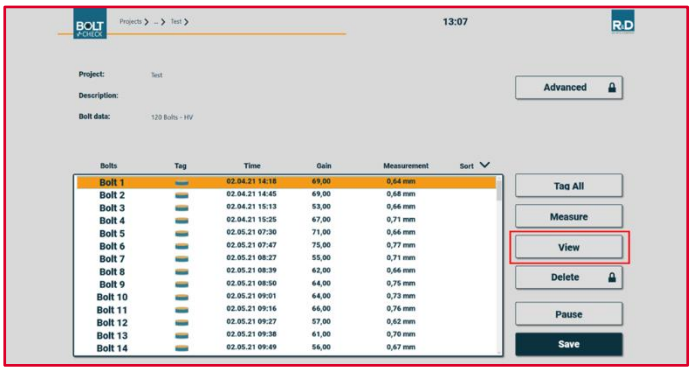
- A “scan tags” page will appear.



- Use the RFID reader and place the tip on top of the traceability tag (yellow side). When the traceability tag is scanned, a pitch sound is played as a confirmation.
- Simultaneously the upper tag is coloured on the screen and moved to the bottom.
- When all bolts are tagged, the project is ready for measurements.

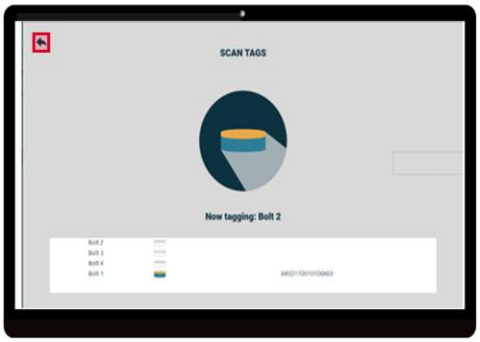


- All reference measurements and elongation measurements listed.



- If an elongation measurement is to be deleted, simply highlight the elongation, and click “Delete”.
- Go to “Menu and Functions on page 45” for more information about “Delete”.

- When measuring bolts in a group they should all be measured from the same end (either the head or threaded rod end) to get the best and most consistent measurements.
- If all bolts in the group cannot be accessed from the same site (e.g. like in the picture). The measurement menu can be reached by pressing the arrow as shown on the picture.



8.3.3 Choosing Correct Sensor

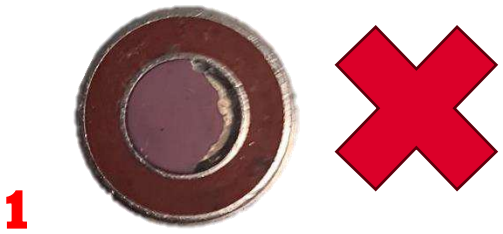
The size of sensor is standardized for repeatability. Sensor sizes are handled by the program as well, meaning that measurements with a wrong sensor size is not possible.

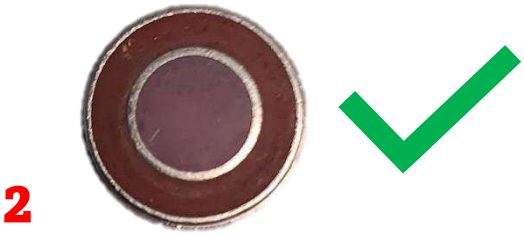
Application	Diameter	MHz
> M12	1/8”	5
M12 – M16	1/4”	2,25
M20 – M27	3/8”	2,25
M30 – M56	1/2”	2,25
M60 +	3/4"	2,25

For purchasing of additional sensors and calibration rods for operational calibration, contact the Bolt-Check team using the contact information in “Customer support” on page 4.

8.3.4 Preparing Sensor and Bolts

- Make a visual inspection on the sensor, ensuring the measuring surface has no cracks, and does not have any areas where the surface is damaged.
- Clean the sensor surface using a clean rag.
- A visual check of sensors must be conducted.
  - Picture (1) illustrates a heavy worn sensor with a crack. This may not be used.
  - Picture (2) illustrates a slightly worn sensor without any cracks and all intact. This sensor may be used.
- Check the sensor cable for cracks and verify that all connectors tightened in the thread.
- Remove any loose particles on the bolt surface, using a wire brush or similar.
- Remove any kind of additional surface protection from the bolt surface, for example Tectyl or Non Nafta, using proper cleaning agent.
- If installing new hot dip galvanized bolts, it can be beneficial to lightly sand the bolt surface, using a fine grinding paper or gently use a grinder to remove the small galvanizing peaks at the surface.
- Make a visual assessment of the measuring surface on the bolt, to decide if additional preparation of the bolt is needed. The placement of the sensor on different types of measuring surfaces is given in the table below.





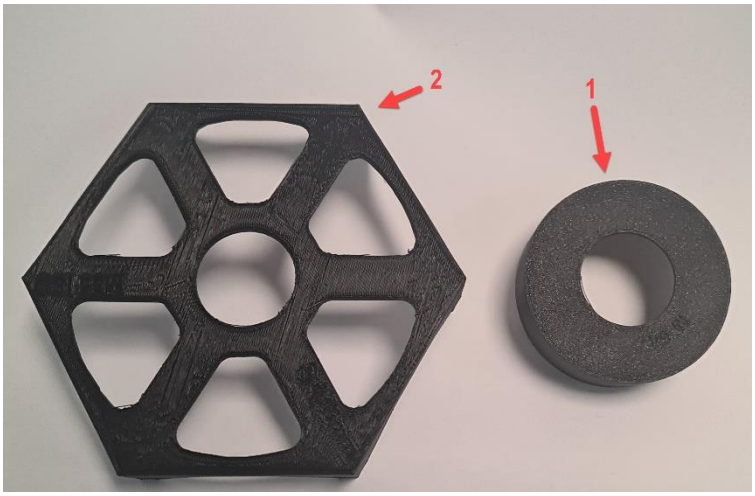
Example	Description	Suitable for sensor surface	Suitable for reflection surface
	**Type** Forged head. **Batch info** In the centre of the head, negative texture. **Texture** The bolt head is a bit rough, but by selecting the right UT sensor, it is possible to conduct a measurement. The batch info diameter must not exceed 0,75 x Crystal diameter. **Note:** If the batch info is laying below the flat part of the bolt head, this will not have significant influence on the measurement on the bolt, as long as the UT sensor is placed at the bolt end.	(✓) Sensor surface	✓ Reflection surface
	**Type** Forged head. **Batch info** No info in the middle of the bolt head. **Texture** The bolt head is a bit rough. The surface is suitable as reflection surface. The surface can be used as sensor surface, by selecting largest possible sensor, without interfering with the stamped letters on the bolt head. **Note:** If the surface is grinded or milled to reduce the roughness it can improve the results (especially the repositioning of the sensor by subsequent measurements).	✓ Sensor surface	✓ Reflection surface

Example	Description	Suitable for sensor surface	Suitable for reflection surface
	**Type** Forged head. **Batch info** In the centre of the head, raised characters on in the measuring area. **Texture** The bolt head is okay, but the presence of the raised characters close to the middle of the bolt head, makes it difficult to position the UT sensor accurately enough.	✗ Sensor surface	✓ Reflection surface
	**Type** Bolt or stud end. **Batch info** Plain without any info or marks. **Texture** The bolt head is acceptable, and the threaded rod is a good surface to measure on. **Note:** The best area to place the UT sensor.	✓ Sensor surface	✓ Reflection surface

Example	Description	Suitable for sensor surface	Suitable for reflection surface
	**Type** Stud end. **Batch info** Plain with marks for batch info. **Texture** The ends are normally sawed, and for this reason smooth and perpendicular to the bolt. **Note:** Typically, this information is printed as negative holes. This rarely cause problems for positioning the UT sensor. This is a good area to place the UT sensor.	✓ Sensor surface	✓ Reflection surface
	**Type** Bolt or stud end, non-planar, typically hollow. **Batch info** No info. **Texture** This is the worst surface to perform measurement on. Due to the shape of the end, it is possible to vary the results significantly. Even as a reflection surface, if measuring on the bolt head, the readings will be subject to some uncertainty. **Note:** Surfaces like this is mostly seen for bolt sizes up to M36 as they are often cold forged	✗ Sensor surface	✗ Reflection surface
	**Type** Bolt end after milling. **Batch info** No info. **Texture** The bolt end shown above can be milled to make it suitable for measurements. **Note:** Milling procedure can be sent on request After milling the surface is very suitable both as sensor surface as well as reflection surface.	✓ Sensor surface	✓ Reflection surface

8.3.5 Centering Pads

- The position/centering pads are designed to ensure that the measuring position on bolts, is repeated. These pads can be purchased at R&D to fit any size stud or bolt.
- Centering cap to fit stud, on picture (1).
- Centering cap to fit hex, on picture (2)



8.3.6 Placing Ultrasonic Sensor

The ultrasonic sensor must have a contact surface with a thin layer of gel to function properly. This removes air between sensor and material, thus improving the transmission of ultrasound.
Special attention is required when handling the sensor and cable. Handling sensor on cable may cause the cable to break as it is fragile.

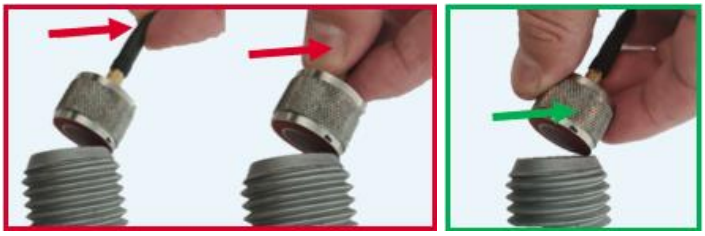
- Find the ultrasonic gel and the sensor.

- Apply a small amount of ultrasonic gel to the sensor. The amount should be the size of a pea.

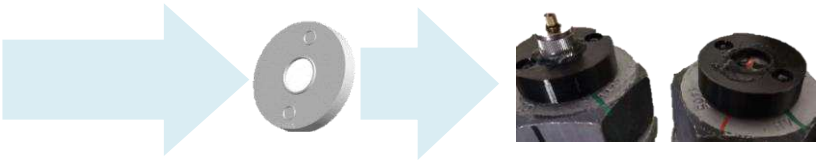
- Place the edge of the sensor on the surface.
- Place the sensor on the bolt by tilting it. Doing so will squeeze away air trapped inside the ultrasonic gel.
- Rotate the ultrasonic sensor clockwise and counterclockwise until excess ultrasonic gel is squeezed out of the contact surface and the friction feels higher.
- If the sensor can tilt or does not seem to have a stable contact to the measuring surface, then try to clean the surface and sensor followed by a repositioning.
- If the issue is caused by a dent or similar on the surface of the fastener this must be removed.

- The ultrasonic sensor must be held on the textured metal surface, and not on the connection cable to avoid cable damage.
- Measurements should be conducted several times on each fastener to ensure proper placement.
- A method is to reposition the sensor three times and memorize the numbers. If the readings are within ±0,02 mm, the measurement is assumed to be correct.

= Incorrect = Correct



- Use of a centering pad is recommended to ensure correct re-positioning of sensor.

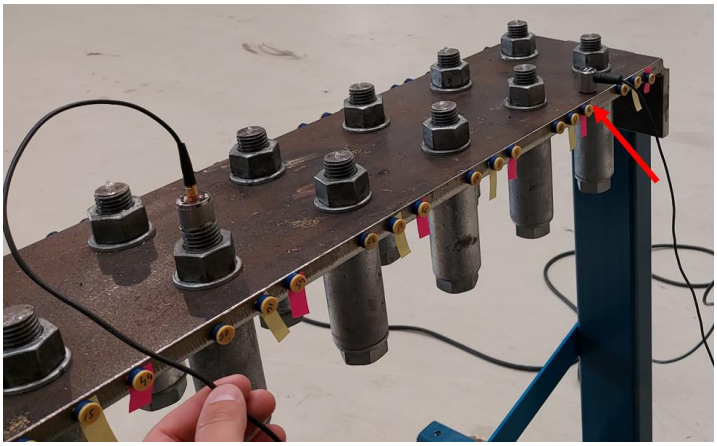


8.3.7 Placing Temperature Sensor

The temperature sensor is sensitive to external temperature sources, such as warm fingers and storage in pockets. Therefore, the temperature sensor must be handled with special attention as this could affect the measurement. Show special attention in cold conditions with strong sunlight, and similar situations, as this may cause certain areas to be warmer than other.

- Handle sensor on the wire only.
- Keep sensor within 40 cm of the measured fastener.

- Mount sensor on fastener or flange.

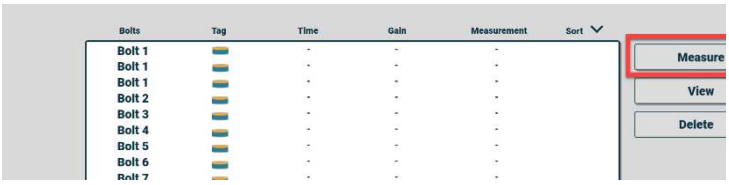


8.4 Creating Reference Data

This chapter cover the process of measuring reference data, using a project already set up.

For information on how to adjust the picture, read “Measurement Specifications” on page 60

- Press “Measure” at the bolt group. A scanning menu will now appear.



- Use the RFID Pen to read the traceability tag and measure the bolt.
- This will be the reference measurement and will be the zero point for this bolt afterwards.

- The ultrasonic reflection is displayed.
- For the first measurement it might be necessary to press “Autoset” to tune in on the correct image.
- On the remaining bolts this “Autoset” should only be used if the image needs adjusting, due to a different batch of bolts etc. (1)

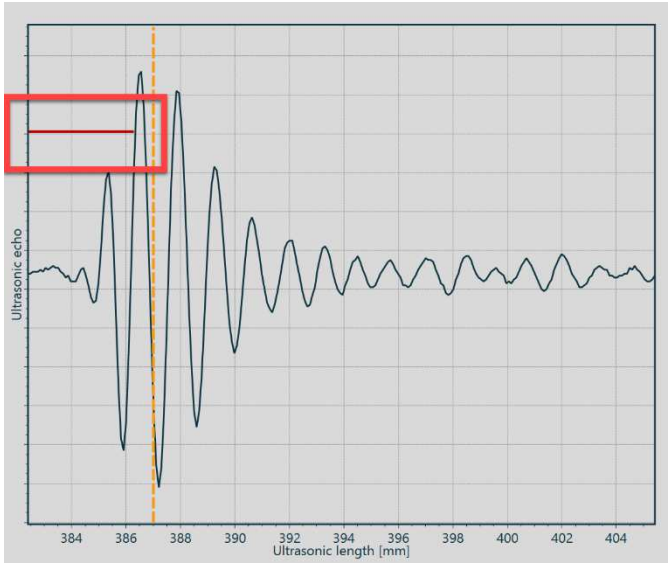
- When the reading on the screen looks satisfying press “Capture”.
- A good image is shown on the picture.
- The ultrasonic length is displayed as showed on the picture.
- This is the reference, and it displays the calculated length.

8.4.1 Measured Wave

This chapter cover how and where to read the measured wave correctly.

- The red horizontal line displays the point of measurement.
- The wave measured can be with positive (+) or negative (-) polarity. This can be changed on the ultrasonic device interface.
- The polarity defines if it is a positive or negative wave that the measurement is performed on. The polarity cannot be changed after a reference measurement is made.
- The reference length will vary a bit depending on the polarity, but as the polarity is fixed afterwards, it will not have any influence on the elongation measurements.

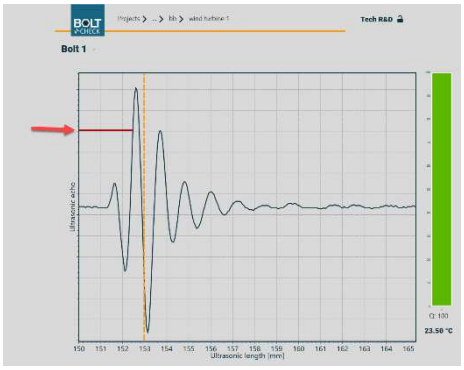
*NB: All calibrations on the devices are made using positive (+) polarity.

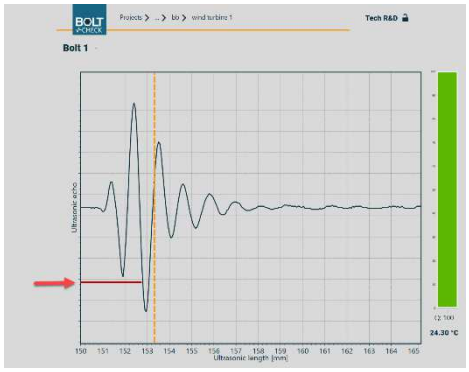


- To change the polarity, press (1) "STORE".
- Position the cursor at an empty field in column A (2) by using the arrows at left (3).
- Press (MEAS" (4) until the "POLARITY" (5) is highlighted.
- Use the left and right arrows to change polarity at the right (6).
- The choice of which polarity to measure on depends on the measured fasteners. Most often the "Autoset" dictates which polarity that should be used.
- It is recommended to change the polarity from "Autoset". To do that, you must participate in the Bolt-Check training course.

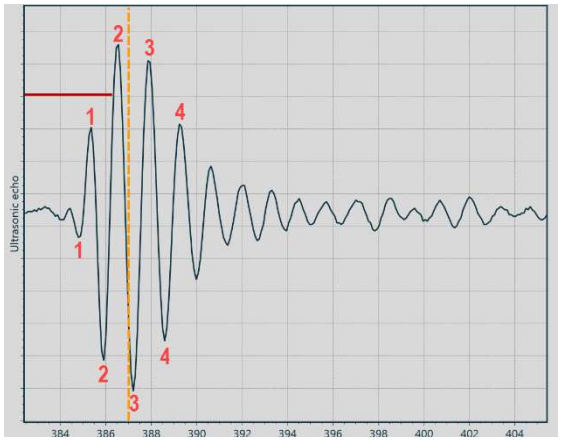
*For request on training or support, find contact information in Customer support on page 2.2.

- Illustration of measurement on positive and negative settings on the same image on the two pictures.
  - Top picture is measured on the positive side.
  - Bottom picture is measured on the negative side.





- The first four waves are numbered on both the positive and negative side.
- The fasteners should be measured on the second wave since this is often the easiest to repeat, even after an elongation where the ultrasonic image can change a bit.



8.4.2 Stress Factor

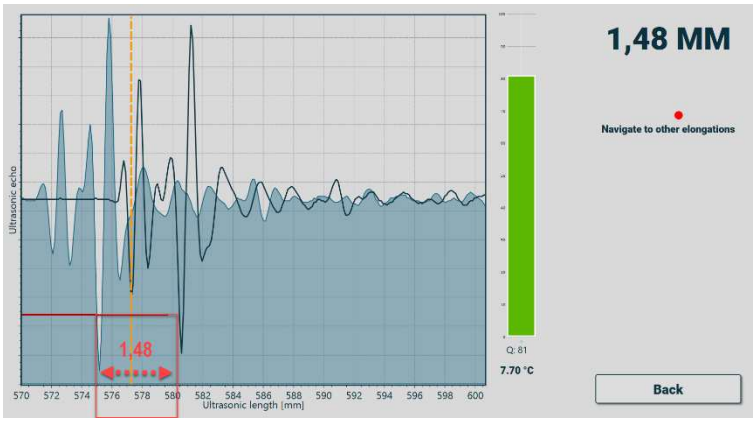
This chapter covers the stress factor and its visual impact during measurements.

The ultrasonic image on the graph does not show the actual elongation. The ultrasonic measurements have a “stress factor” which is a material constant. This is due to a change in the speed of sound through a material which is stretched.

Stress factor is a constant between the difference between raw ultrasonic elongation measurement, and physical elongation. It is defined as $\frac{Physical\ elongation\ [mm]}{Ultrasonic\ elongation\ [mm]}$ and is a constant without a unit.
The stress factor is material specific, and relatively stable between different steel batches.
For Bolt-Check Standard measurements a stress factor for steel is used on 0,274.

The visual impact of the stress factor is a difference between the displayed elongation on the image, and the displayed elongation in digits. This means that for each mm on the ultrasonic image scale, this only represents 0,274 mm elongation.
During reference measurements it must therefore be considered when choosing the width of the image. If an elongation on 1 mm is expected, the ultrasonic image will then need 3,65 mm free space. Width must therefore be adjusted, so that the image has space enough from reference image and through all future measurements.

- On elongation images the shadow represents the reference measurement, and the line represents the actual reading.
- Data treatment of stress factor impact is handled automatic by Bolt-Check Standard.
- The operator should only focus on reading at the right wave peak and adjust the height of the curve to get the best result as possible.



Stress factors can be calculated on batch level, but it is normally not recommended. For further information on stress factor calibration see ref. [2] chapter 10.3.

8.5 Measuring Elongation

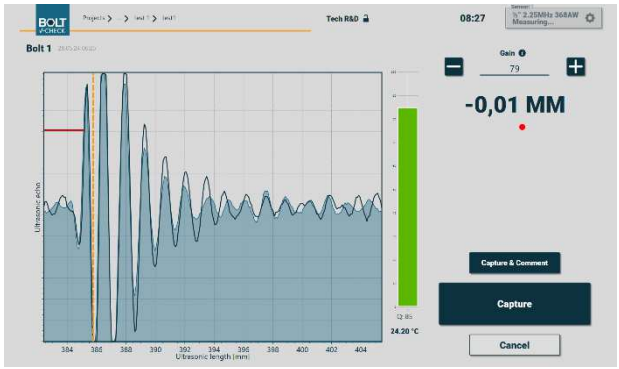
This chapter covers elongation measurements, which are always performed after reference measurements.

Bolt-Check Standard equipment is used to obtain an ultrasonic reflection image. The reference measurement is measured on the bolt before any tightening is conducted. Afterwards when the tightening is done, the elongation measurement is performed to measure the elongation of the bolt. Measurements can be performed after tightening procedure or during tightening procedure if measurement surface is available during tightening.

When measuring an elongation, the procedure is the same as when measuring a reference.

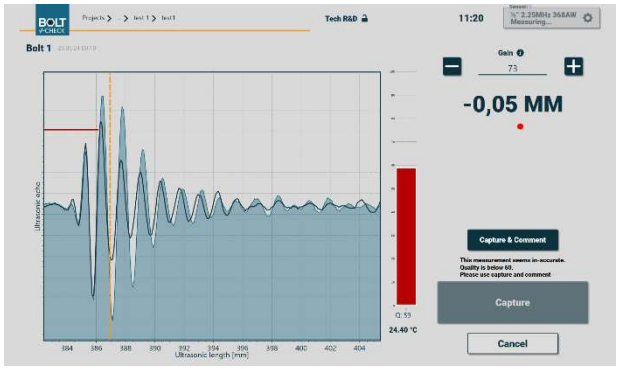
- Press “START MEASUREMENT” on the main screen to be directed to the bolt group.
- Press “Measure” at the bolt group.
- Scan traceability tag.

- The display appears with a blue shadow curve which is the reference curve.
- When placing the ultrasonic sensor on the bolt, a dark blue line appears. This line displays the current ultrasonic image.



- Quality indicator. This helps repositioning the sensor to find an ultrasonic image similar to the reference. (1)
- Measured temperature from temperature sensor, representing bolt temperature. (2)
- Elongation in mm. (3)
- "Gain + & - ". By adjusting the gain, it might improve the value of the quality indicator. (4)
- Capture and comment. If the quality indicator has a low value, or some observations are made, it is possible to assign comments to the individual measurement. (5)
- Capture. This captures the measurement. Afterwards the program returns to the scanning menu. (6)

- If the quality cannot get higher than 59 it is not possible to press Capture. Several scenarios may cause this:
  - The measurement is conducted on the wrong wave. In this case the Gain should be adjusted to find the optimal reflection.
  - The contact surface needs gel or a cleaning.
  - The cable is not connected properly to the ultrasonic sensor.
  - The measurement is conducted on the wrong bolt. In this case, Cancel should be pressed, and the correct traceability tag should be scanned.
  - Low quality. In this case the button Capture & Comment should be used.



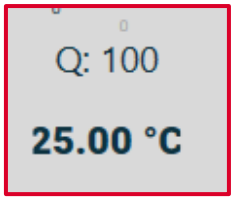
8.5.1 Quality Indicator

When performing measurements, a quality indicator is shown on the right side of the screen in form of a bar with colour scale. This reflects the quality of the measurement and therefore, a high quality indicates a reliable measurement.

The quality indicator has two functions:

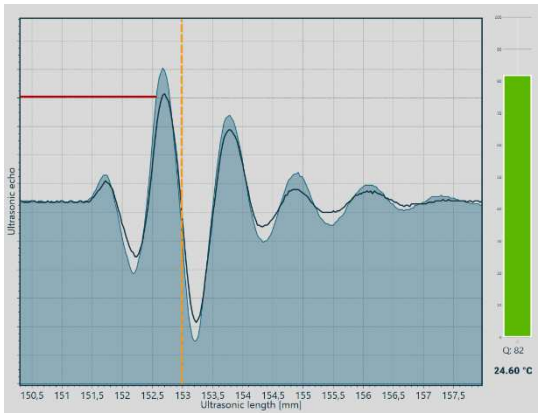
- When performing **reference measurements**, it shows if the signal is satisfying. It does not show if the image is satisfying regarding wave measured, delay, width, and gain. That, the operator must decide.
- When performing **elongation measurements**, it shows the similarity of the elongation image compared to the reference. This is to verify that the ultrasonic wave measured is the same as the reference and that the gain is correct.

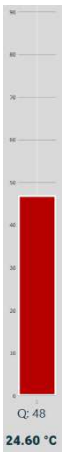
- The quality is displayed both in the height and colour of the bar and numerically below the bar.
- Position of sensor and gain will impact the quality indicator.



- The increase of the quality indicator is obtained primarily by a changed height of the curves. Normally the readings are made at the second wave. The height of the first three curves are the most important to regain if possible.
- Elongation measurements should as a rule have the same wave height on the measured wave as the reference to ensure good quality indication.
- If a wrong wave is measured, the image must be adjusted with the gain option.

- When performing elongation measurements, it is recommended to always try and change the gain up or down if the quality indicator is below 90, to see if it can increase.
- Good quality measurements increase credibility and reduce doubt in unexpected results.
- There are three different colours for the quality indicator:
  - Green
  - Yellow
  - Red
- The colours indicate how much the current elongation measurement, looks like the reference measurement.
- This doesn't mean that the measurement is wrong, only that the picture of waves has changed.





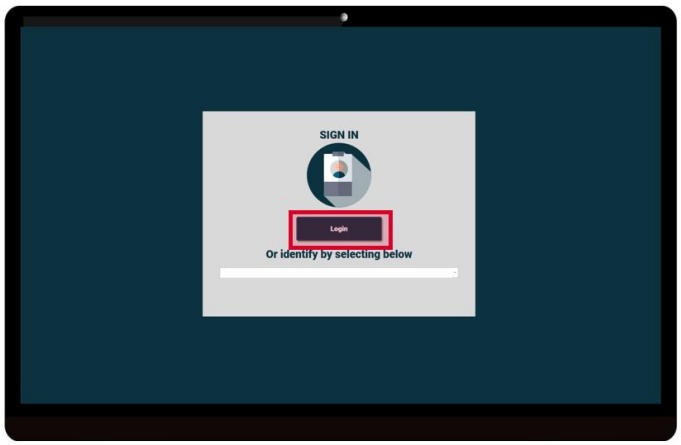
9 Menu and Functions

This chapter cover different menu topics and navigation in the Bolt-Check Standard program.

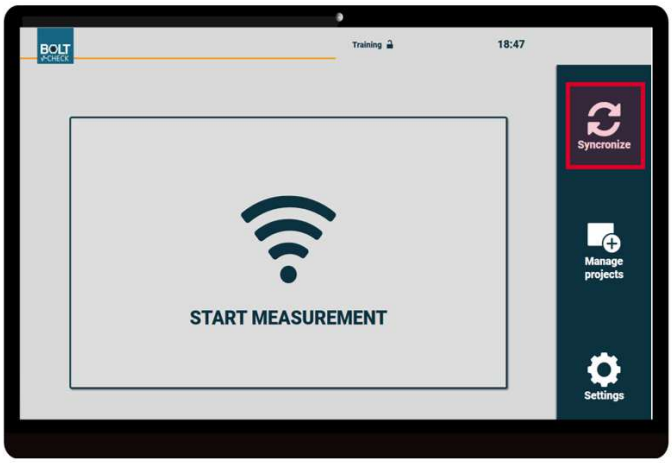
9.1 Synchronization

This chapter cover synchronization between Bolt-Check Standard device and Bolt-Check cloud.

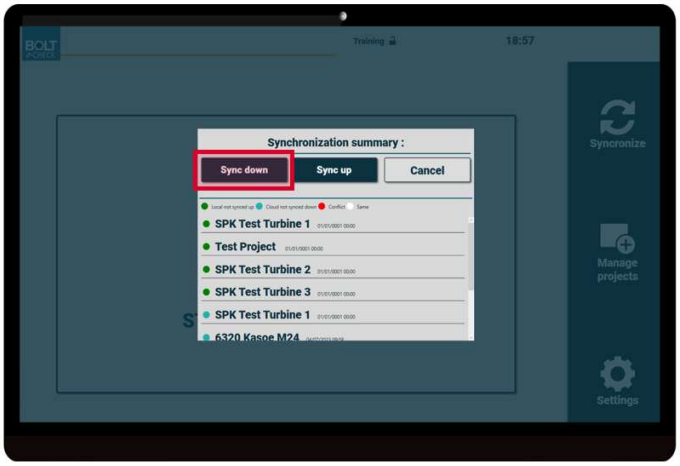
- Press “Login”.
- Enter the login received from Bolt-Check team or admin consisting of an e-mail and a password.



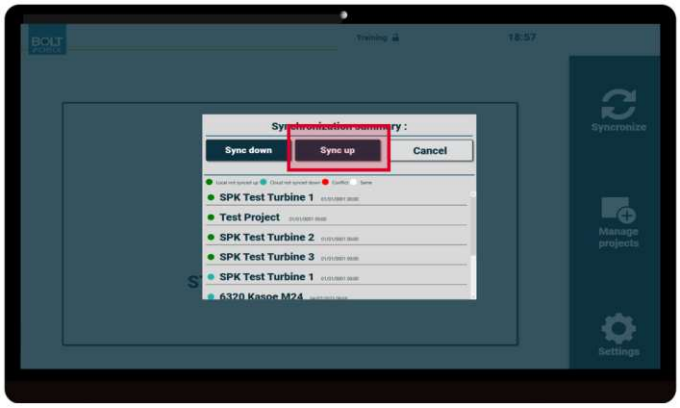
- To measure an existing project which is stored in the cloud, the project must be synchronized.
- Press “Synchronize”.



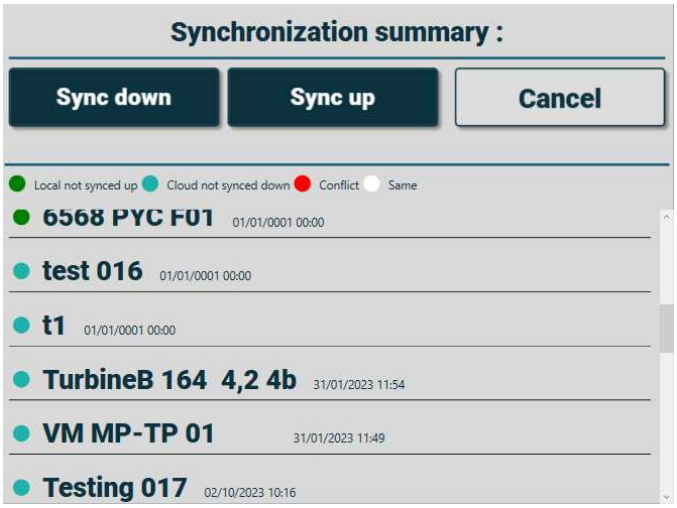
- To update the device with data from cloud, use “Sync Down”.
- It is now possible to continue measurements on a project from the cloud.



- To update the cloud with data from device, use “Sync Up”.
- The cloud is now updated with newest data from device.



- Local not synced up (green) means the project is only updated at the Bolt-Check device and not on the cloud.
- Cloud not synced down (blue) means the project is not synced down from the cloud, any changes made in the cloud will not be visible before it has been synced down.
- Conflict (red). If any conflict is detected, it will appear in red e.g. If the internet went out while synchronizing.
- Same (white). If the project appears white, it’s because cloud and device are already aligned on a project.



9.2 Manage Projects

This chapter cover all options under "Manage projects" found on the start screen.

New

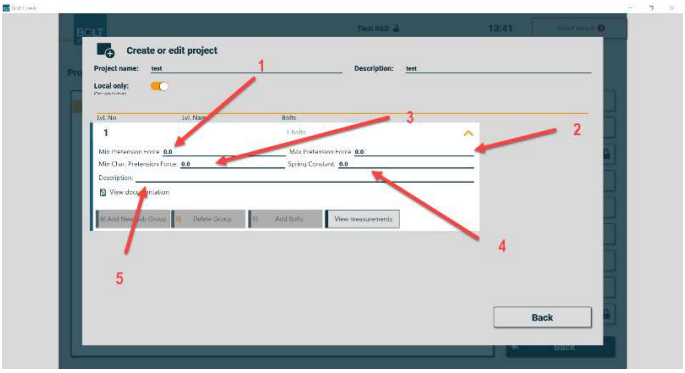
Go to "Starting Up a Measurement Project" on page 20 for full introduction on how to start a new project.

View

When the project is selected press "View".
Thereafter press the "arrow" to get the menu opened.

- "Min Pre-tension Force" is set after the specific joint. (1)
- "Max Pretension Force" is also set after the specific joint. (2)
- "Min Char. Pretension Force". (3)
  $\mu - Kn.\sigma$
  μ: Mean of sample
  Kn: Coefficient from table
  σ: Sample standard deviation
- "Spring Constant" is an individual force dependency for each joint that is calculated and set here. (4)
- "Description" Another Description can be given here for personal use. (5)

*Information can only be viewed here. To make changes the project must be opened by using the edit button.



Characteristic Pretension

$\mu - k_n \sigma$

where:
μ : mean of sample
k_n : coefficient from Table 13-1
σ : sample standard deviation
n : number of measurements in sample

n	3	4	5	6	8	10	20	30	∞
k_n	3.37	2.63	2.33	2.18	2.00	1.92	1.76	1.73	1.64

Table 13-1: Value for the k_n for the 5% characteristic value, based on EN 1990:2002+A1:2005 (E).

For values of n not available in Table 13-1, the following approach can be used for obtaining k_n depending on n value of interest:

- for $3 < n < 30$,

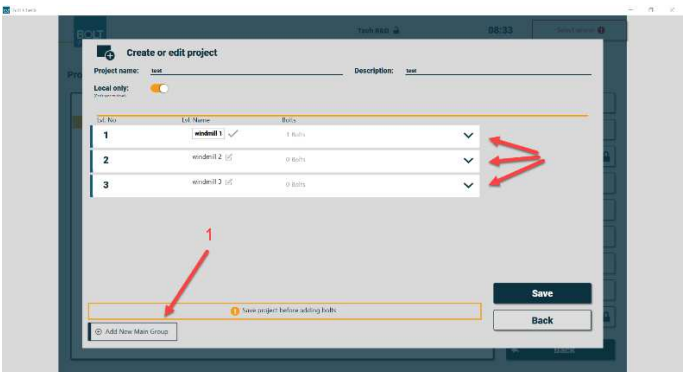
$$k_n = \frac{(n_2 - n)}{(n_2 - n_1)} \cdot k_{n1} + \frac{(n - n_1)}{(n_2 - n_1)} \cdot k_{n2}$$

Corresponding to a linear interpolation using the following values from Table 13-1:
n_2 : n value closest to and immediately higher than n
n_1 : n value closest to and immediately lower than n
k_{n2} : k_n value correspondent to n_2
k_{n1} : k_n value correspondent to n_1

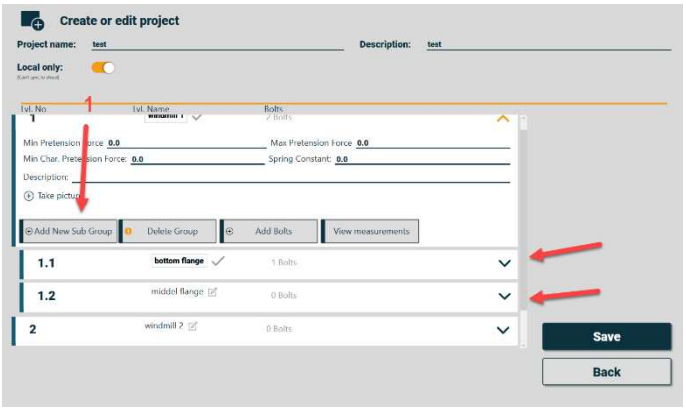
- for $n > 30$, $k_n = k_{30}$.

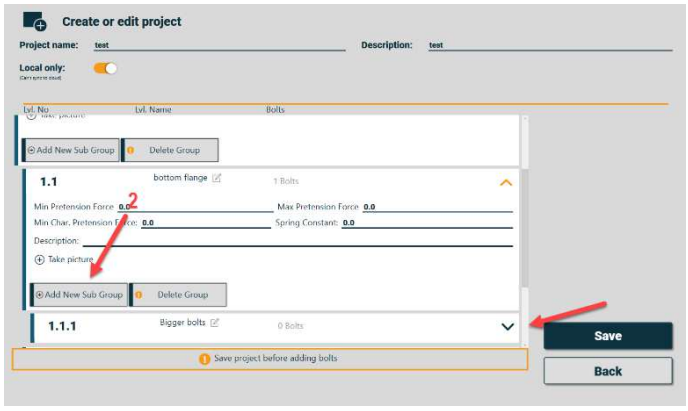
Edit

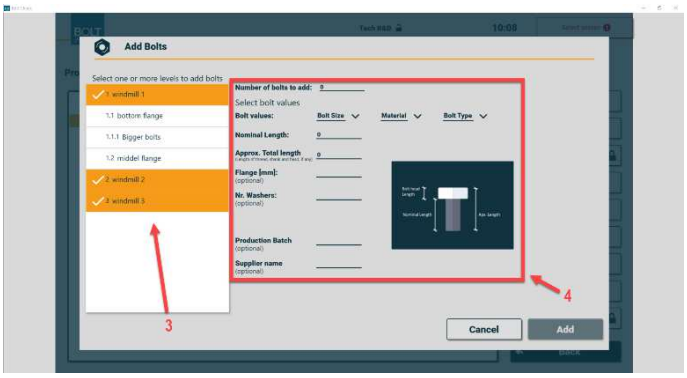
- Under edit as shown in “View on page 47” there are some options to be set with every group and sub group.
- “Add New Main Group” is used to design a structure of the location/project. (1)



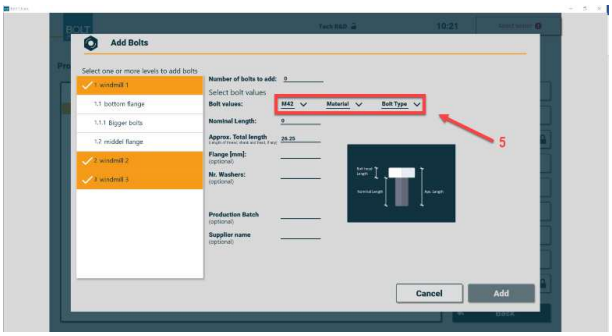
- “Add New Subgroup” is used to set up subgroups to a main group.
- As shown in the picture it is possible to have a flange assembly or several under the specific wind turbine. (1)
- There is also an option to add more subgroups e.g. if there is two kinds of bolt types.
- Press “Add New Subgroup” under the desired group, press save and open it again. This will make it available to insert min/max pretension etc. (2)
- To “Add Bolts” every main group and subgroup needs to be saved.
- Press “Add Bolts”
- A window will open, from here select every main and subgroup with the same bolts. (3)
- Insert every relevant information such as: (4)
  - Number of bolts
  - Bolt size
  - Material
  - Bolt type
  - Nominal length
  - Flange [mm]
  - Washers
  - Production batch
  - Supplier name

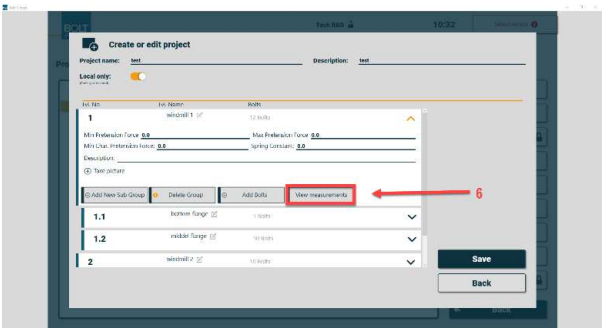


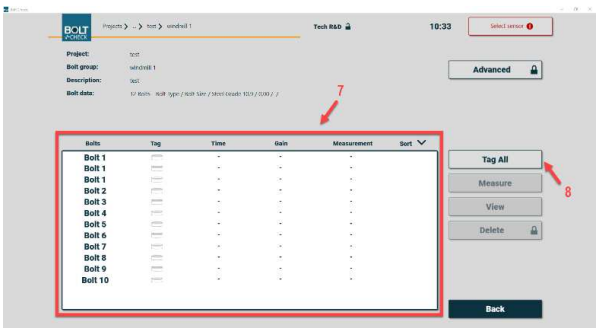




- Bolt properties regarding size, material and type can be chosen from a drop down menu. Simply click the arrow. (5)
- When all required and relevant information is entered, press “Add”. New bolts are now added to the selected flanges.
- Press “View Measurement” to view every bolt in a specific group. This needs to be done with every main and subgroup. (6)
- Additional information on a flange is shown. This includes: (7)
  - Tag
  - Time
  - Gain
  - Measurement
- Another option from here is to “Tag All”. An in depth explanation can be found under the chapter “Assigning Traceability Tags” on page 25. (8)

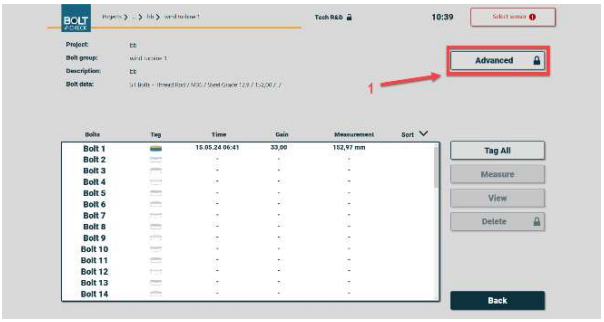


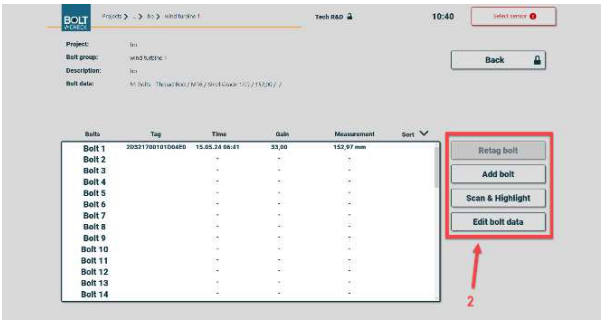




Advanced

- Under “Advanced” on flange level there is a sub menu, from there additional options occur: “Retag bolt”, “Add bolt”, “Scan & Highlight” and “Edit bolt data”. (1)
- The tags change from icons to the actual traceability numbers.
- Press “Retag bolt” if a tag is lost for a known bolt. This will initiate a process to scan a new tag to be associated with the selected bolt.
- Press “Add bolt” if more bolts are needed in the group. Follow the instructions on screen.
- Press “Scan & Highlight” to verify tag association. The associated bolt with the scanned tag will be highlighted on screen.
- Press “Edit bolt data” if any edits needs done to e.g. Bolt Size/Material/Bolt Type/Nominal length/Approx. Total length/Flange/Nr. Washers/Production Batch/Supplier name.



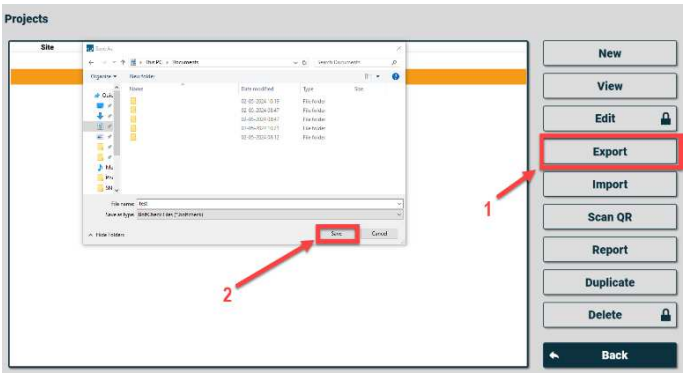


Export

By exporting the selected project, it can be saved to a desired location.

- This file can only be opened by Bolt-check software.
- For importing it see “Importing Data” on page 71”
- Press “Export” and a window will pop up to choose where to export file to. (1)
- Press “Save” after navigating to desired location. (2)

*more in depth version can be found under “Exporting Data” on page 69.

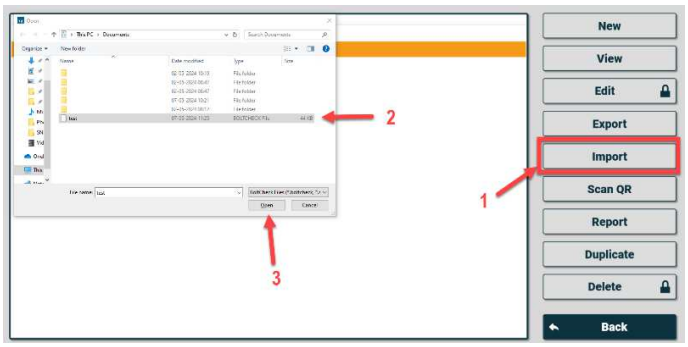


Import

By importing a bolt-check file, it is possible to open a project away from the “Bolt-Check standard” equipment.

- Press “Import” to import the new file to the Bolt-Check software. (1)
- Select the Bolt-Check file to be imported by highlighting it. (2)
- Press “Open” and the project will be available under “manage projects”. (3)

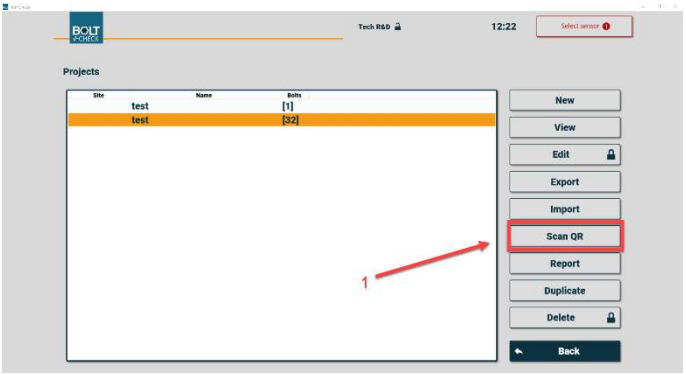
*More in depth version can be found here “Importing Data” on page 71.



Scan QR

"Scan QR" makes it possible to scan QR codes, designed to include all relevant flange and bolt data.

- This makes it easier to navigate if there is a lot of projects on the Bolt-Check Standard.
- Press "Scan QR" and the camera will open.
- Point the camera at the QR code, the project will now open. (1)



Format for QR codes are:
{ "metadata": [1, "*Location ID*", "*Rotor size*", "*Power rating*", "*Mark*", "*Bolt_group_path*", "NOT USED", *Number_of_Bolts*, *Number_of_Tags*, "Bolt_M_Size", "*Bolt_Material_Grade*", "*Bolt_Type*", Nom_Bolt_Length*_mm, Bolt_kN_min_pretension, Bolt_kN_max_pretension, Bolt_kN_min_characteristic_pretension, Bolt_liniar_relationship_kN_mm]*
}

Example:
{ "metadata": [1, "ABC53", "164", "4,2", "4b", "Tower/Section1", "NOT USED", 50, 32, "M56", "10.9", "HV", 220, 200, 300, 190, 309]
}

This is turned into a QR code, and looks like this:

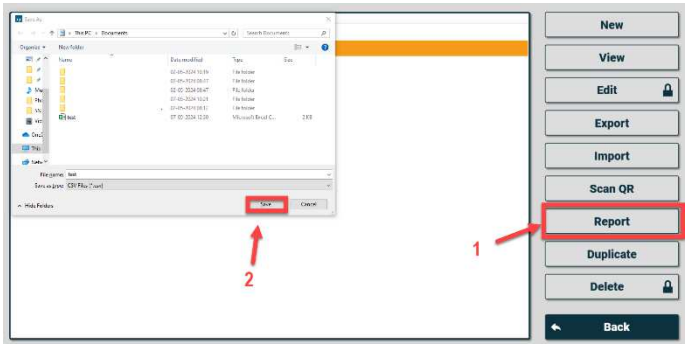
Report

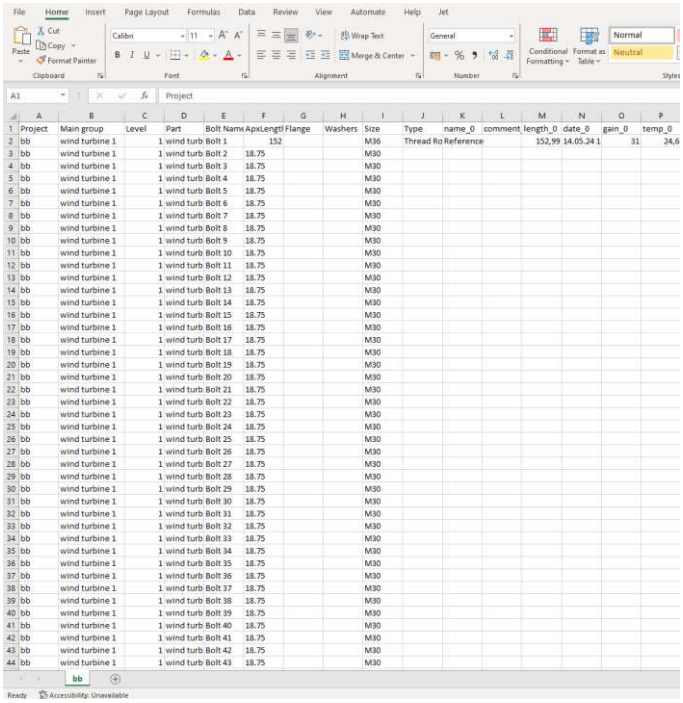
"Report" extracts data from the selected project, this file is saved as a .csv file which can be used for further data treatment.

- Press "Report".(1)
- Select a desired location to store the file and press "Save". (2)
- When opened with Excel the information is displayed, so that every bolt has its own line with all information on the same row. Displayed information is:
  - Project
  - Main group
  - Level/Subgroup
  - Part
  - Bolt name
  - AptLenght
  - Flange
  - Washers
  - Size
  - Type
  - Ref measurement
  - Measurement 1
  - Measurement 2

  And more measurements if conducted

*Ref, measurement 1 and 2 are not on the picture because they were not conducted.

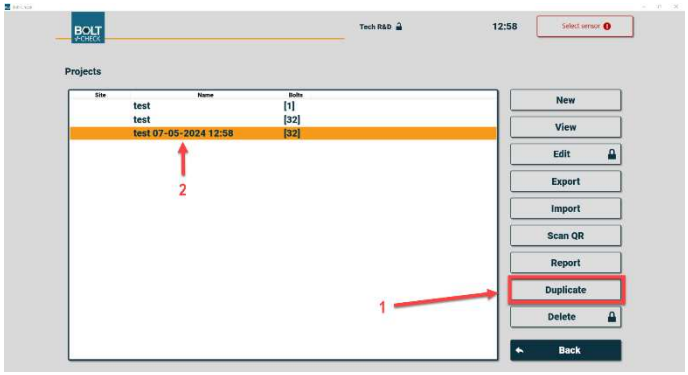




Duplicate

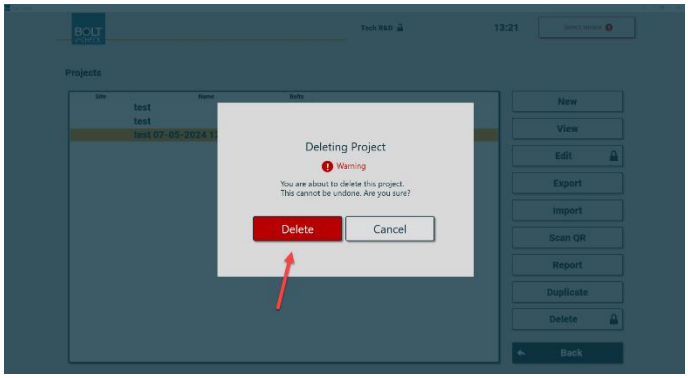
Duplicate is used for duplicating a project to save time.

- It takes time to set up a site with locations and flanges. Therefore, it is possible to use an existing project to duplicate.
  It is only the structure which is copied. Any results or association to tags are not a part of the duplicate project.
- Select the project by highlighting it.
- Press “Duplicate”. (1)
- Another project will appear with date and time it was duplicated. (2)



Delete

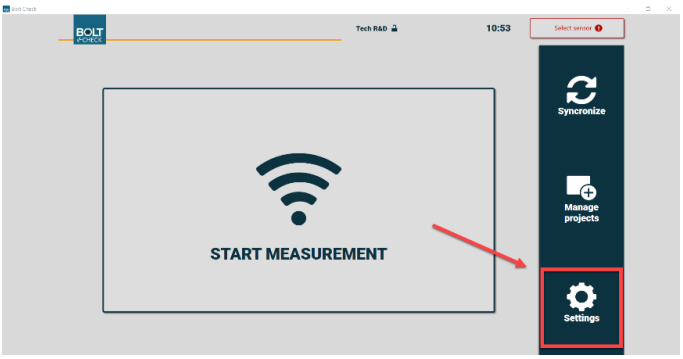
- Delete will delete any highlighted project; the system comes with a warning before deleting.
- As shown on the picture the warning pops up, deleting a project cannot be undone unless the project has been exported or synchronized already.



9.3 Settings

This chapter covers all options under settings.

- Settings button is located at the start screen on Bolt-Check Standard
- From there navigation is possible to manage:
  - Measurement Device,
  - RFID Scanner
  - System
  - Sensors
  - Calibration rods

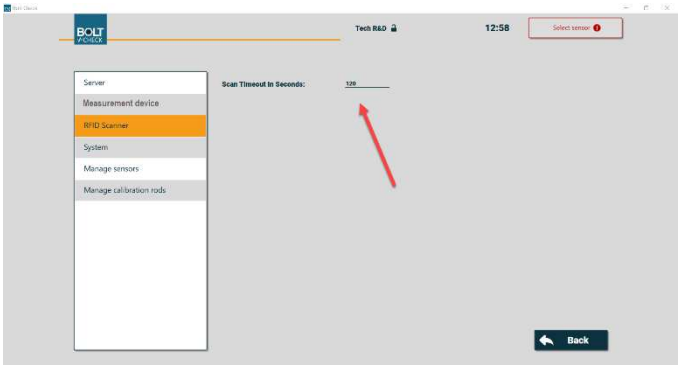


Measurement device

- "Default Gain" is standard set to 50. (1)
- "Capture Threshold" is set to 60, this means if the quality idicator is less than 60 there cannot be captured an elongation unless a comment is written.
- This is useful to change if a batch of bolts are all clearly correctly measured, but the quality indicator is low on all bolts. (2)
- "Com port" should not be changed. (3)

RFID Scanner

- The timeout for the RFID Scanner can be adjusted.



System

The system tap contains information and some action buttons.

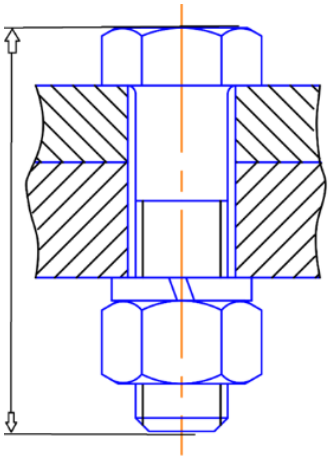
- Send dianogstics if something is wrong with the Bolt-Check Standard program. This will then be avaliable to R&D as an error report when contacting R&D following an error(1)
- The program can be updated to newest version. Use "Updates" to be directed to the website from where software can be downloaded. (2)
- Measurement system software version is shown here. (3)

Managing sensors and calibration

When receiving the equipment, it will have a basis calibration from R&D, based on R&D master calibration rods.
If separate rods are delivered along with Bolt-Check Standard, the calibration will be based on these rods.
This calibration is based on the actual setup of the device at delivery.

To ensure repeatability of the measurements the Bolt-Check setup must be calibrated in the following situations.

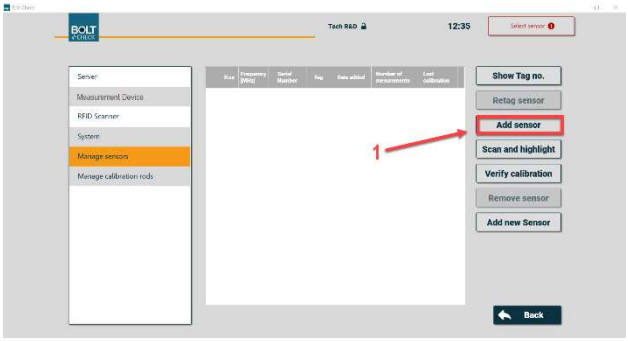
- Initial calibration of the setup using delivered Ultrasonic sensor
- If replacing a ultrasonic sensor
- If replacing a signal cable
- On a regular basis, max 31 days, controlled by the Bolt-Check SW.

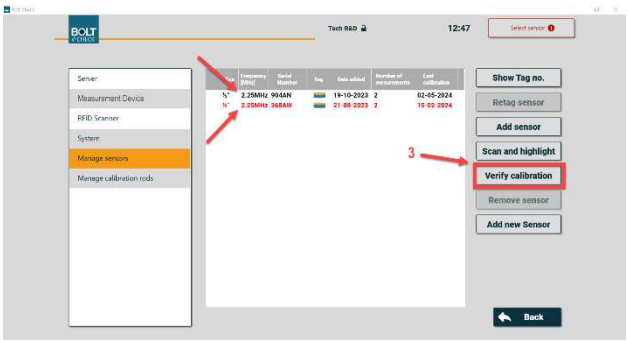


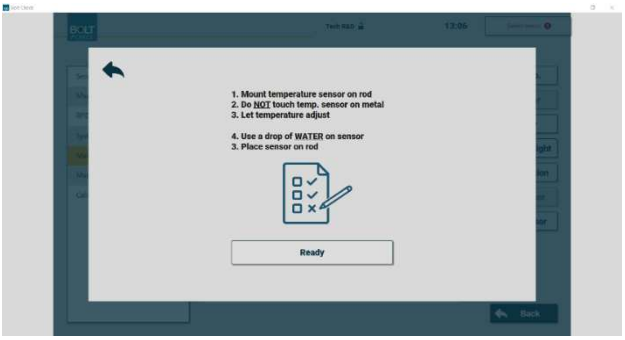
Managing and connecting ultrasonic sensors

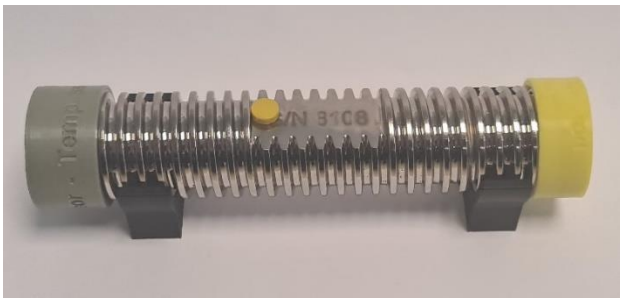
- When receiving a new Bolt-Check Standard Device or a new sensor, sensor must be added in the Bolt-Check program.
- A tag is present on each individual sensor.
- Press on “Add sensor”. (1)
- Scan the tag on sensor.
- Sensor name and details will appear on the new sensor, and the text will be red. This means that a calibration is required.
- Press “Verify Calibration” and scan the tag on the sensor that need calibration. (3) The calibration wizard will guide the user through the calibration process.
- Scan the tag on sensor and afterwards on the calibration rod.
- A checklist appears, guiding the user to prepare sensor and rod for calibration:

1. Mount temperature sensor on rod
   - The grey cap on rod is intended for temp. sensor, and no other sensors fit.
2. Do not touch temp. sensor or metal
   - Heat from fingers affect the temperature reading.
3. Let temperature adjust
   - Observe the temperature over a few minutes, and perform calibration when temperature is stable.
4. Use a droplet of WATER on sensor
   - It is very important to use <u>WATER</u>
   - Ultrasonic gel is NOT ALLOWED. It increases uncertainty during calibration.
5. Place sensor on rod
   - Prepare the calibration rod with a centring pad corresponding to the sensor size.
   - Place the sensor.
   - Now “ready” can be pushed and calibration is initiated.







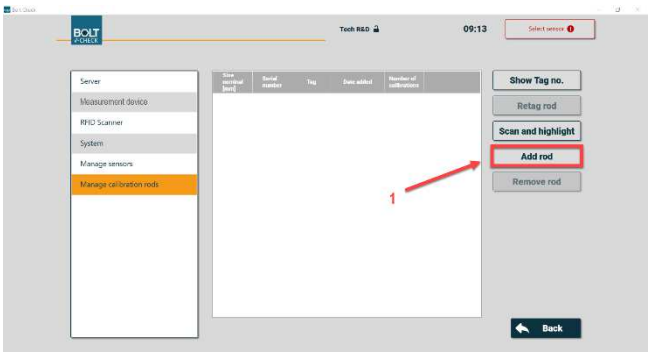


- Reposition the sensor a few times to find a stable measurement.
- If the elongation is less than ± 0,005 mm press “Verify calibration”
  If the elongation length is above ± 0.005 mm press “Adjust calibration” and the device will automatically calibrate. (6)
  While one button is active, the other is inactive.
- Wait for the calibration to execute and the calibration is complete.

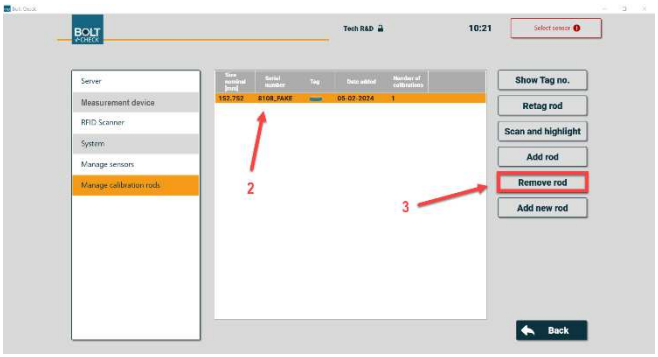
Managing rods

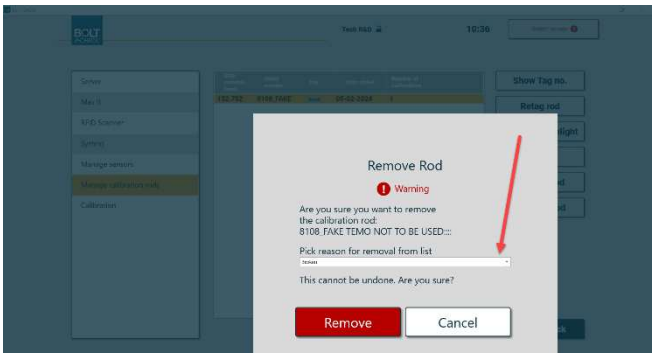
When receiving a Bolt-Check Standard a calibration rod is assigned to the equipment. Independently of the measurement task, the rod is always used to have a calibration reference for future measurements.

- Press “Add rod” and scan the tag on the rod. (1)
- Now the rod is ready to go.
- The rod must be added to the program before any calibration of sensors can take place.

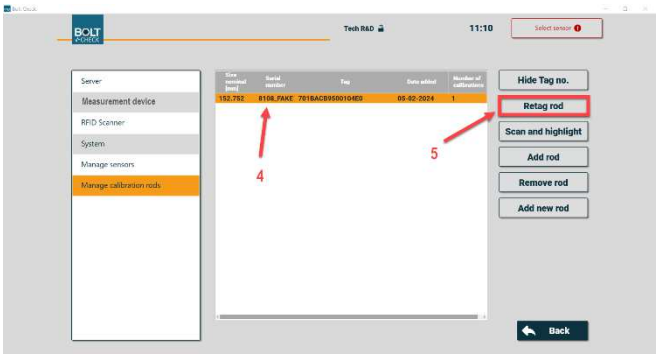


- If the rod is lost and not possible to use again it can be removed from the list.
- Press and highlight the rod to be removed. (2) Press “Remove rod” and a window will appear where the reason for removal can be chosen from a list (3). Three options appear:
  - Broken
  - Missing
  - Other
- After choosing a reason, the rod will be removed from the list.





- If a tag from the rod is lost, but the rod is still in good condition, the tag can be replaced on site for a temporary repair.
- Press on the rod-line to highlight it. (1)
- Press “Retag rod”. (2)
- A window will open, requesting scan of new tag.
- Scan the new tag for the calibration rod. (3)
- Place the new temporary traceability tag on the rod.
- Contact Bolt-Check to request a repair for a more permanent solution.



10 Measurement Specifications

There are three basic adjustments and three advanced that can be used during reference measurements.

Basic adjustments

- *Delay* defines the starting point for the ultrasonic image
- *Width* defines the width of the visible image on the screen.
- Example: a bolt is 500 mm in loose condition. Delay should be approximately 497 mm and width should be approximately 15 mm. Thereby the image is within the visible field.
- *Gain* controls the power of he input signal and thereby also the resulting return signal, hence it controls the height of the ultrasonic waves.

Advanced adjustments

- *Polarity* defines the side of the "0-line" in the centre of the ultrasonic image on which the measurements are performed. Measurements can be conducted on both positive and negative polarity, but only during reference measurements.
- *Threshold* defines the height from the "o-line" for which the measurements are performed. A higher threshold means that the ultrasonic waves must be higher in order to be registered as a measurement.
- *Gate* defines the starting point from which the device looks for waves to be measured.
- Example: If a bolt is 500 mm, the gate should be a bit before this value, perhaps 480 mm.

10.1 Adjusting Delay

Adjusting the delay changes the offset of the image. The ideal position for the reference measure point on a loose bolt is approximately 2 mm of the screen width, from the left. This is controlled in the software, so no reference measurement can be conducted closer to the edges of the ultrasonic image.

Moves the field of view to the left

Moves the field of view to the right

Example

A bolt having a reference length of 472 mm and a clamping length of 400 mm.

Expected elongation is 1,5 mm. Minimum visible measuring area after the reference is 1,5 mm x 4 = 6 mm.

If this bolt is to be **loosened**, this reference image would be unusable since there is no space in the image for the reading to move left.
If this bolt is to be **tightened**, this reference image is suitable.

If the measured bolt is to be **loosened** when measuring the reference, it is recommended to move the reading point to a position where the expected elongation (when loosening, the elongation will be negative) in mm **multiplied by 4*** can easily be within the field of view to the left. See picture.

*For explanation see Ultrasonic error

10.2 Adjusting Width

Adjusting width changes how much of the image there is available for the measurement to move. In some cases, it may be necessary to have a high width, e.g. if it is expected to perform a long stretch.
If the measured bolt is to be tightened, then there must be enough space, so that the expected elongation in mm **multiplied by 4** can easily be within the field of view to the right.

*Note that the expected elongation must be multiplied by 4 to have the approximate ultrasonic elongation. This should be considered when deciding the width.

Example

In the pictures below the same waves are seen with two different widths. The first has a width of 7,7 mm.

The second picture has a width of 15,3 mm.

10.3 Adjusting Gain

Gain describes the strength of the ultrasonic sound and thereby also the ultrasonic reflection, which is shown as the height of the waves. It is comparable to the volume on a loudspeaker system. This might have to be adjusted between the individual bolts, and when performing elongation measurements.

When capturing the reference length for a bolt, all settings except gain are locked and cannot be adjusted further during elongation measurements.

Gain is always possible to adjust. In the picture below a reference value is already captured and therefore only gain can be adjusted.

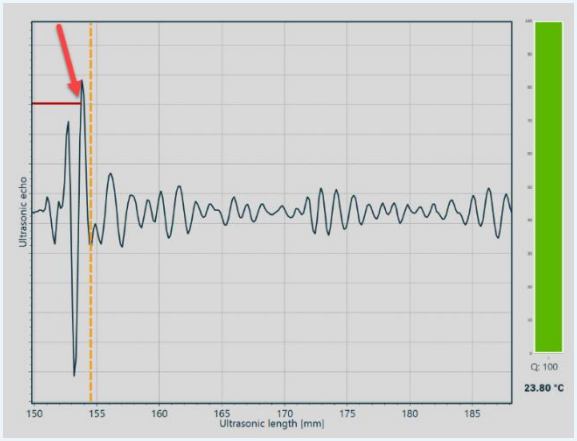
Gain can be used to tune in on the correct wave as described in “Adjusting Gain” on page 63.

The next three images show different measurement curves with different gain.

Example

Gain 38

Here the measurement is conducted on the third wave, which is wrong. Therefore, the measurement needs more gain to increase the reflection so that the second wave gets large enough to be measured on.

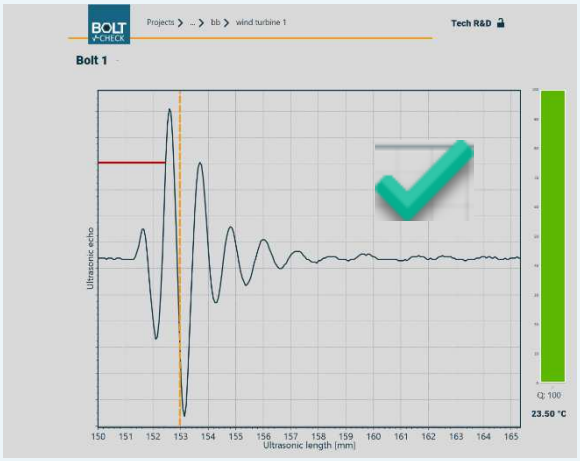


Gain 39

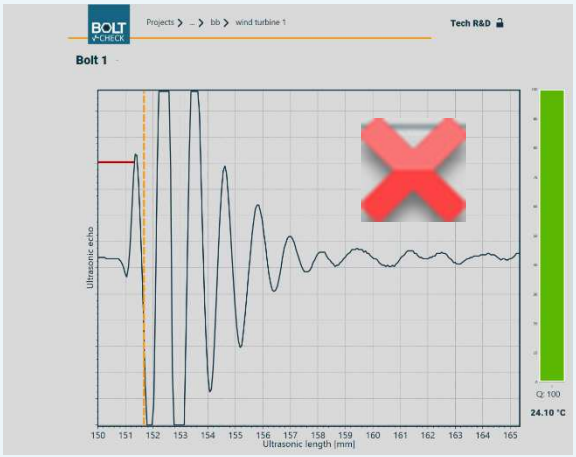
Here the measurement is conducted on the second wave, which is correct. The only issue is that the measurement is conducted on the tip of the wave which can be difficult to repeat. Therefore, the measurement needs more gain to increase the second wave reflection. It is recommended to increase the gain, so most of the height of the display is used.

Gain 42

Now the second wave is measured at a stable point.



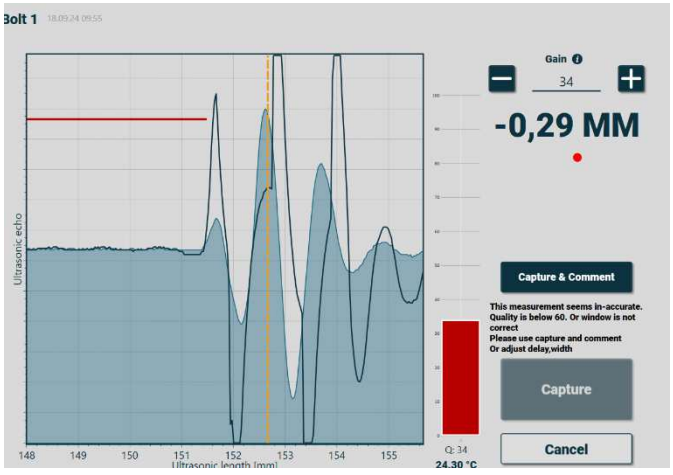
Applying too much gain will also result in unsuitable measurements. In this case wave no. 1 is measured instead of no. 2 The peaks are now outside the display, which should be avoided.



10.4 Error from Wrong Wave Measurement

A typical error during elongation measurement is to accidentally measure on another wave than the reference measurement was performed on.

- Measuring on same wave results in a correct measurement. In this case a 0 measurement.
- Measuring on an earlier/later wave (1 wave) results in an error on approx. ±0,3mm.
- To compensate for this wrong measurement, identify correct wave and adjust gain until correct/reference wave is measured on.



11 Gate

- Gate is used to search for a good echo at the right length, instead of searching the entire length of the stud/bolt. Gate can be adjusted if the echo catches some noise.
- To adjust gate press “+” or “–“ depending on what is needed.

11.1 Threshold

- Threshold is used to change the measurement point “Red horizontal line” on the vertical axis.
- To adjust threshold press “+” or “–“ depending on if it is too high or low.

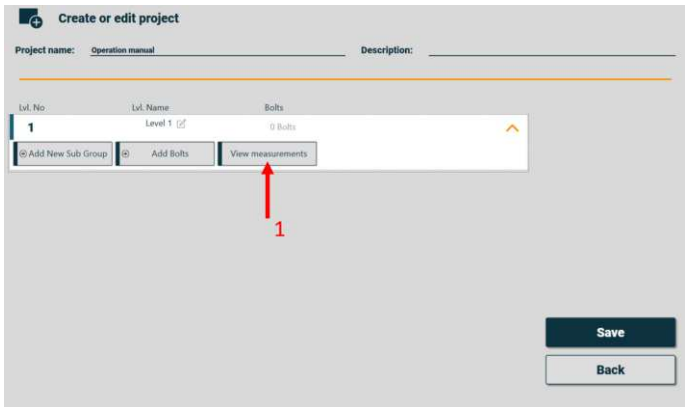
12 Polarity

- Polarity can be set to positive or negative by pressing “+” or “-“.
- Polarity is often correctly decided by using the “Autoset” function but can also be manually changed.
- The most suitable polarity is dependent on each type of fastener.

13 Pre-measurement Method

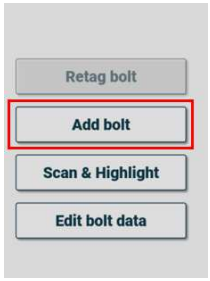
In the scenario where bolts are already pre-measured by a Bolt-Check certified bolt manufacturer, the approach for adding bolts is different. Bolts must be synchronized onto the Bolt-Check device before these steps are conducted. This is done by pressing “Synchronize” from the main screen. See “Synchronization” on page 45.

- Press “Edit” measurements. (1)
- Now the project opens, and there are no bolts added.

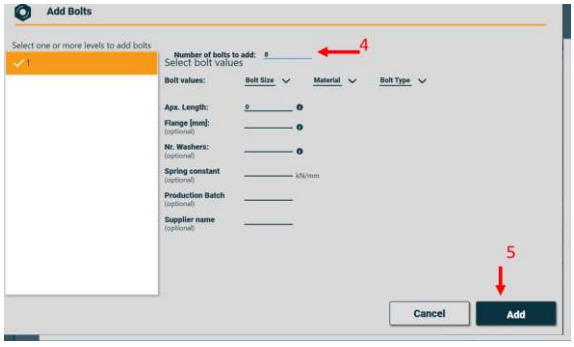


- Click “Advanced”. (2)

- Select “Add bolt”.(3)
- Now a window appears like this one, when adding bolts manually.

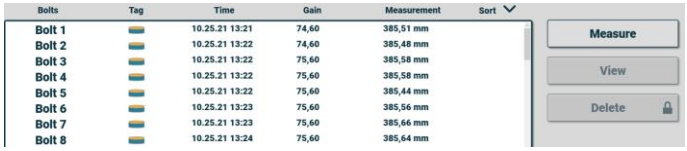


- Select the number of bolts to be imported. **No other data** may be entered. (4)
- Press “Add”. (5)



- The system automatically enters tagging mode.
- Scan each tag in the order intended.
- The tag should be located inside the bolt. It is visible as a small yellow dot.
- If the ultrasonic gel was not properly removed during previous measurement, the yellow dot may appear white.

- After scanning all traceability tags, and all bolts have an assigned tag, the reference measurements for the individual bolts are also a part of the project.
- Elongation measurements can now be conducted.



14 Data Processing

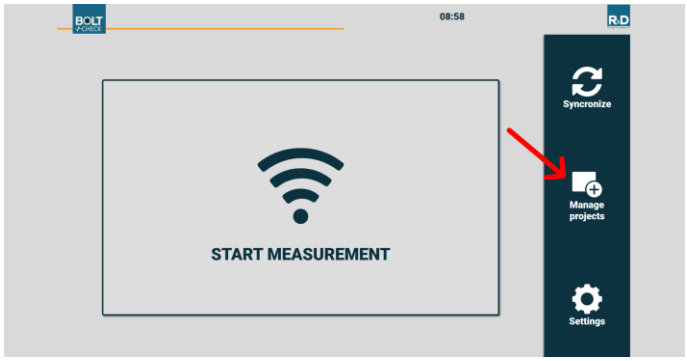
When a measurement has been finalized, the data can be “Reported” as a numeric value comma separated file (“csv” file) or exported as a Bolt-Check data file, which also contains ultrasonic information for future measurements.

14.1 Exporting and importing data

It is possible to import and export the different measurements as a Bolt-Check file.
This makes it possible to switch devices or send the datafiles to another location if synchronization is not an option.

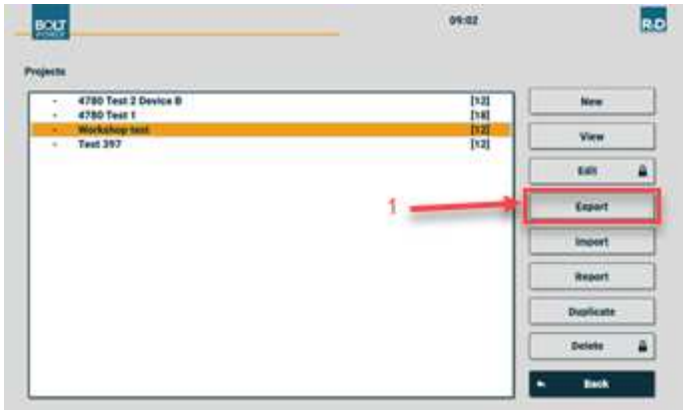
14.1.1 Exporting Data

- Press “Manage projects”.

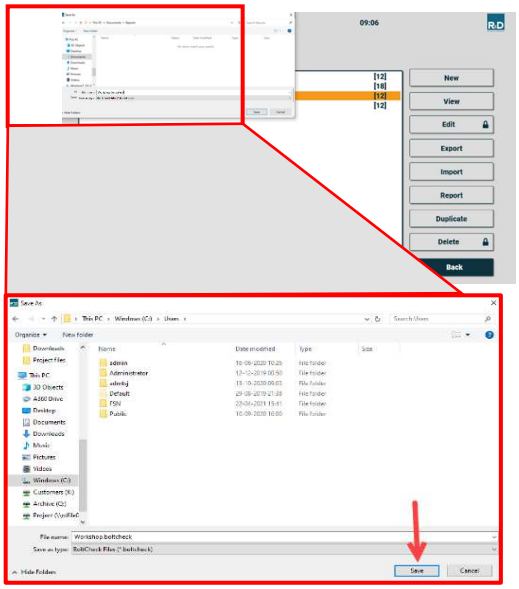


- Select the project from which data is to be exported. This is done by pressing the project and highlighting it.

- Press “Export”. (1)



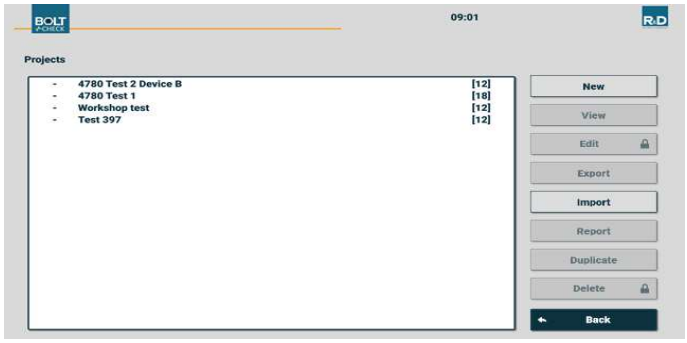
- Navigate to the preferred location and write a name for the project.
- Press “Save”.



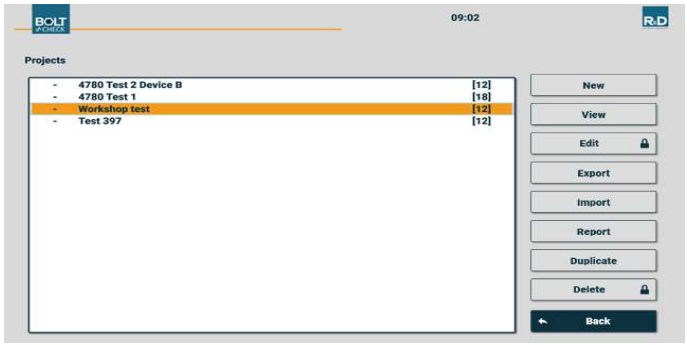
14.1.2 Importing Data

- Press “Manage projects”.

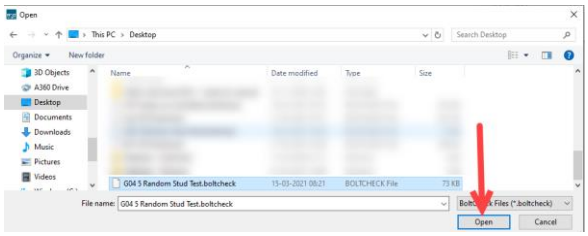
- Select the project from which data is to be imported. This is done by pressing the project and highlighting it.



- Press “Import”.



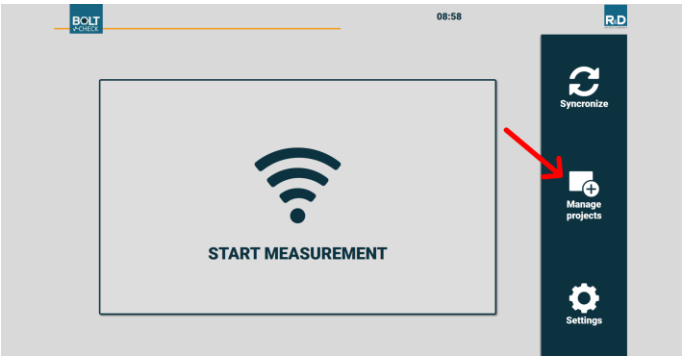
- Select the files to import and press “Open”.



- The new project is now imported to Bolt-Check Standard and can be found under “Manage projects”.

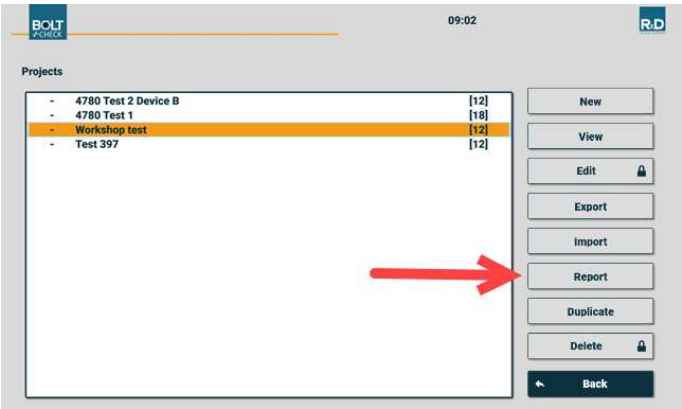
15 Report Data as CSV-file

- To extract data as a CSV-file, go to the Bolt-Check program main screen and press “Manage projects”.
- The manage projects page will appear.

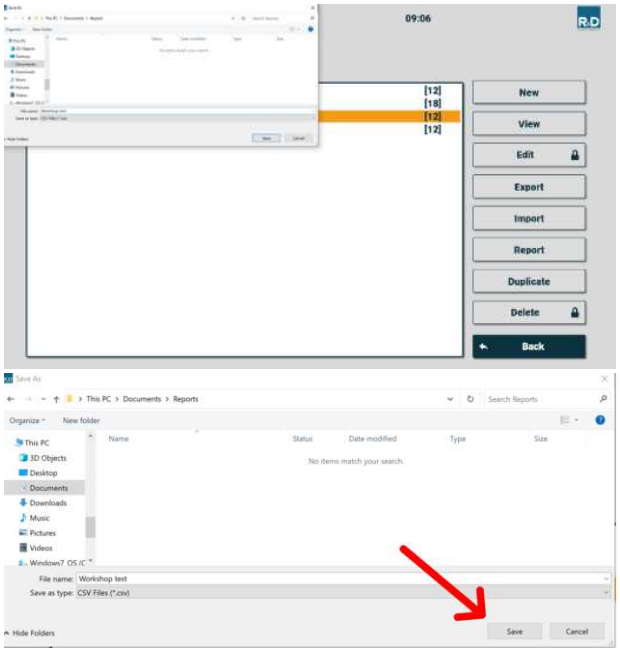


- Select the project from which data is to be extracted. This is done by pressing the project and highlighting it.
- In this example it is “Workshop test”.

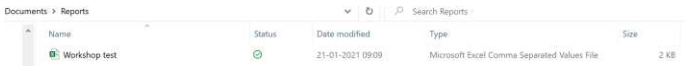
- Press “Report”.
- A box pops up where the path for the stored file is to be specified.



- Navigate to the preferred location and write a name for the project.
- Press “Save”.



- The file is stored as a Microsoft Excel Comma Separated Value File (.csv file)

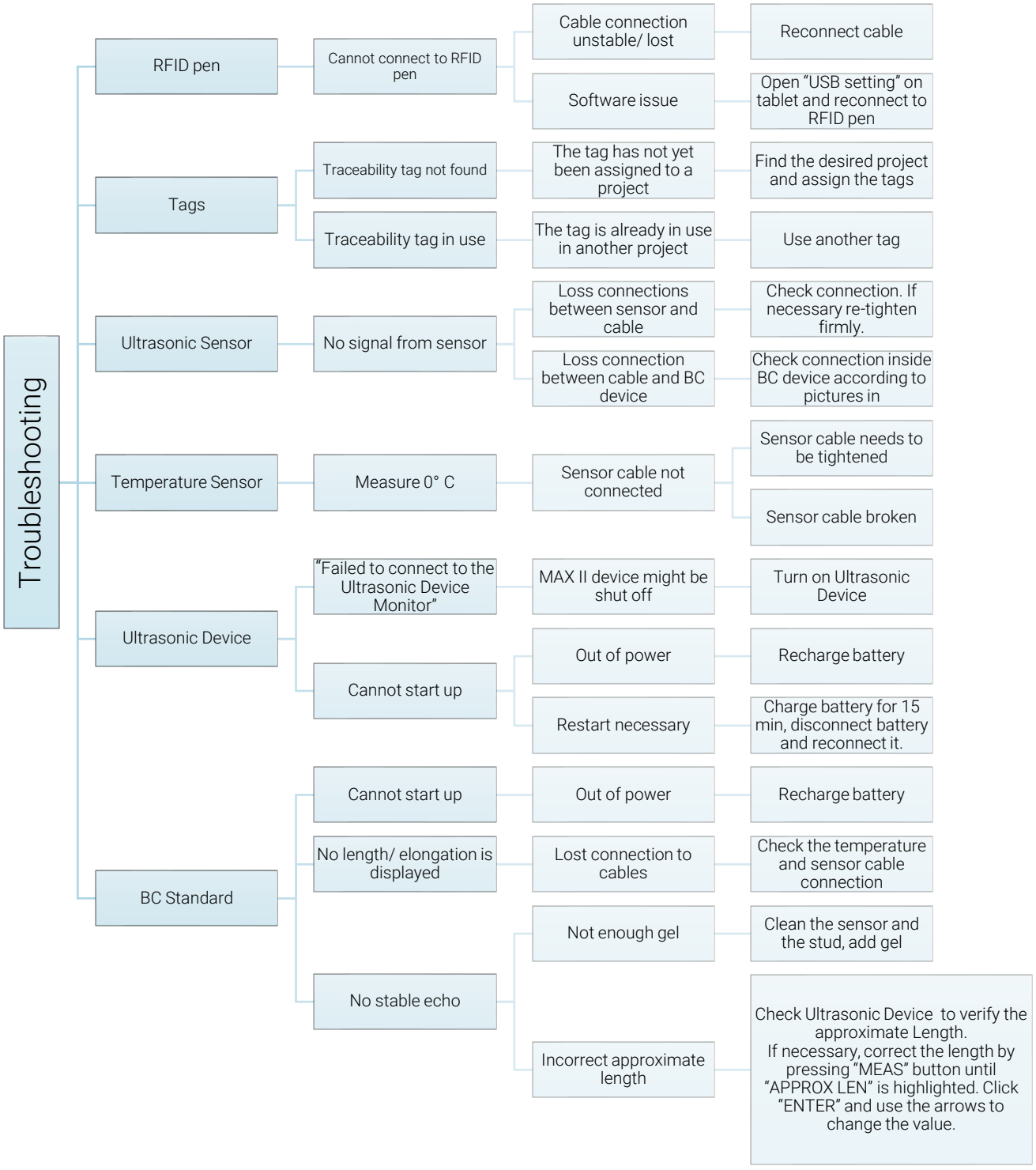


16 Troubleshooting

The purpose of the chapter is to give the operator of the Bolt-Check Standard device a guide to handle some of the issues that can occur when performing ultrasonic measurements.
The foreseen issues are summarized in the list below and elaborated on the following pages.

- Table of troubleshooting
- Bolt-Check Standard cannot start up
- Ultrasonic Device cannot start up
- No length/elongation is displayed
- No signal from sensor
- Traceability tag not found
- Traceability tag in use
- RFID Pen not found
- No connection to Ultrasonic Device

Table of troubleshooting



Bolt-Check Standard device cannot start up

Battery is discharged => Recharge it with the charger.

Ultrasonic Device cannot start up or freezes

Battery is discharged => Recharge it with the charger.

If still won't start up, it may need a hard reset.

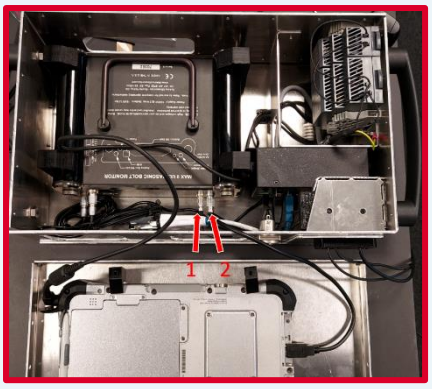
1. *First charge the battery for 15 minutes.*
2. *The battery must be disconnected and reconnected.*
3. *Open the lang lid, so the ultrasonic device is accessible.*
4. *Use a straight screwdriver to open the Ultrasonic Device lid.*
5. *Pull the battery 10 mm out for 10 seconds and re-install.*
6. *It should now be possible to restart.*

No length or elongation displayed

Check the temperature sensor cable connection.

1. *Remove the lid to the left of the charging port.*
2. *It is now possible to access the ultrasonic device interface.*

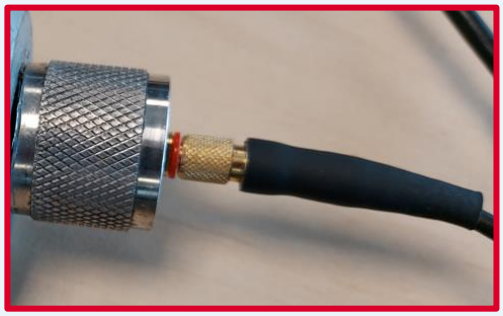
3. *An overview of the Bolt-Check Standard inside can be seen here.*



No signal from sensor

Control connection in both ends.

1. *First check the connection between sensor cable and sensor. It should be slightly tight.*
2. *If loose, tighten firmly with two fingers.*
3. *Check connection between sensor cable and Ultrasonic Device.*
4. *Open the lid as described in "No length or elongation displayed".*
5. *Check plug 1 for sensor cable.*



Traceability tag not found

If a traceability tag is scanned but not recognized, it is because it has not yet been assigned to a project.

1. *First go to the desired project and assign the tags.*

Traceability tag in use

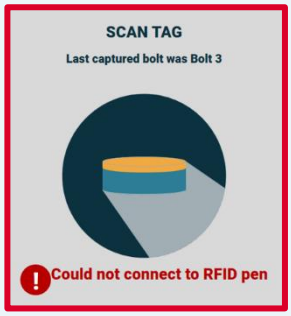
If a traceability tag is not accepted, because it is already in use in another project.

1. *Find the other project or use a new tag.*

RFID Pen not found

If a traceability tag is to be scanned and the following error occurs:

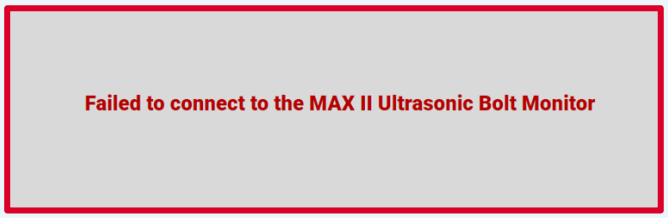
1. *Ensure correct USB connection.*
2. *Remove lid to USB switch following the connection guide "*Connecting or Changing cables*" on page 16.*
3. *Check the connection.*



No connection to Ultrasonic Device

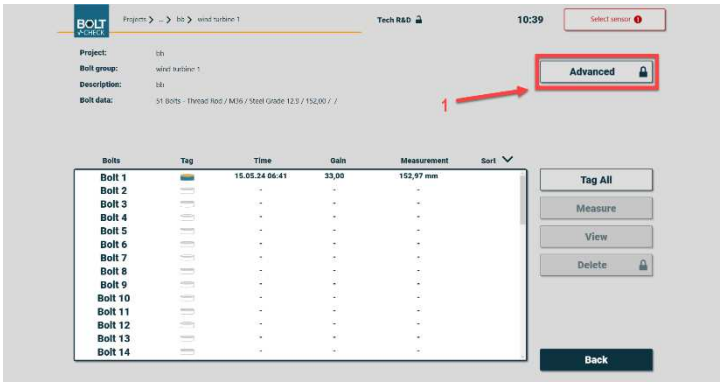
If the following error occurs:

1. *Turn on ultrasonic device.*

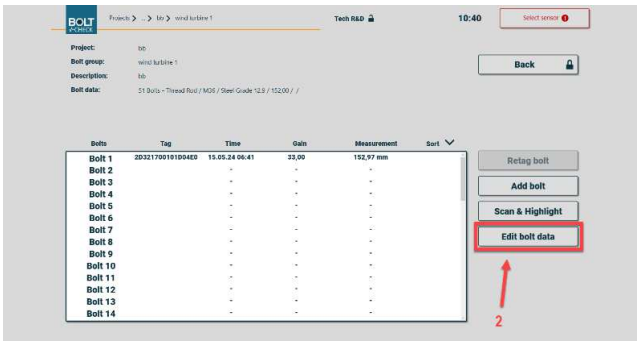


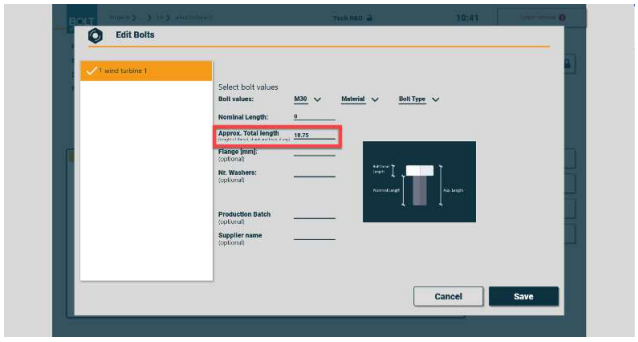
Wrong approximate length

- If the approximate length value is wrong, navigate to group overview. Press “Advanced”. (1)



- Press “Edit bolt data” and select the right “Approx. Total length” (2)





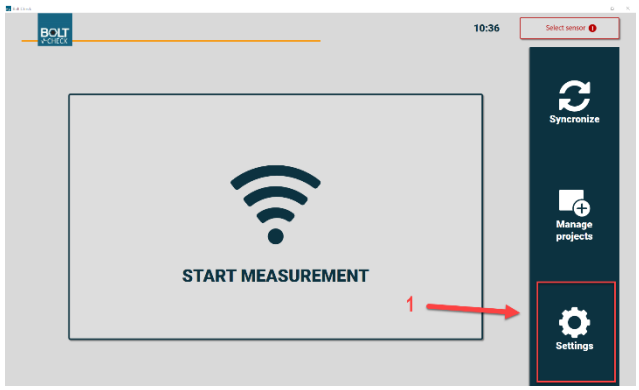
17 Software

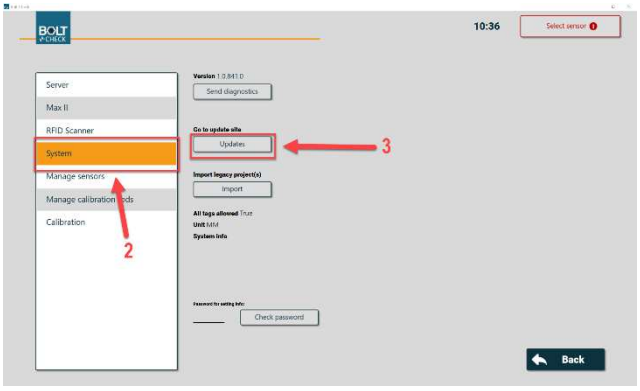
This chapter cover the software administration.

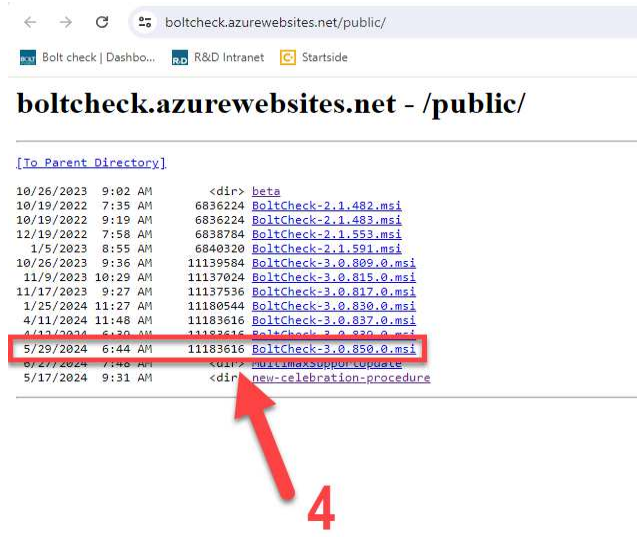
17.1 Downloading Software

- Bolt-Check software update files can be downloaded from the settings menu.
- Go to the starting screen on Bolt-Check Standard device.
- Follow directions on the picture, press on “Settings” as shown. (1)
- Go to “System” (2)
- Press on “Updates” this will open an internet browser, so control internet connection before opening. (3)
- Now, find the newest Bolt-Check file, either look at the dates for their upload or look for the numbers at the end of their name. In this case “BoltCheck-3.0-850.0.msi” is the newest version (4)

  Install the new software to your Bolt-Check Standard.







17.2 Download and Install Bolt-Check Standard Software

Software is used to:

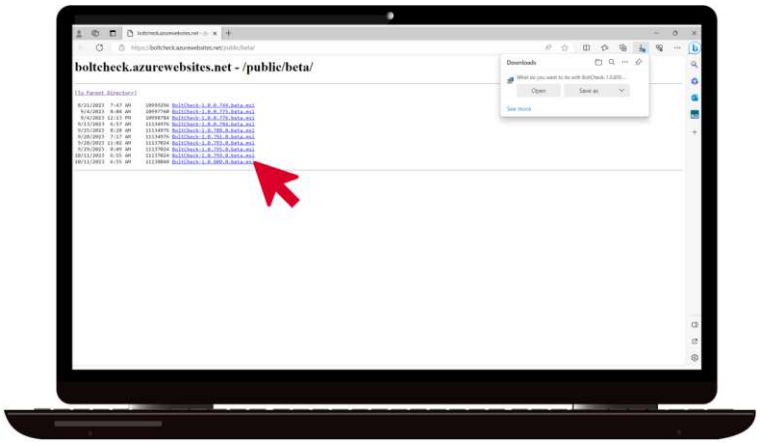
- Manage bolted connections.
- Perform measurements.

First step is to install the Bolt-Check Standard software on your computer.
To install the software, click on the link below:

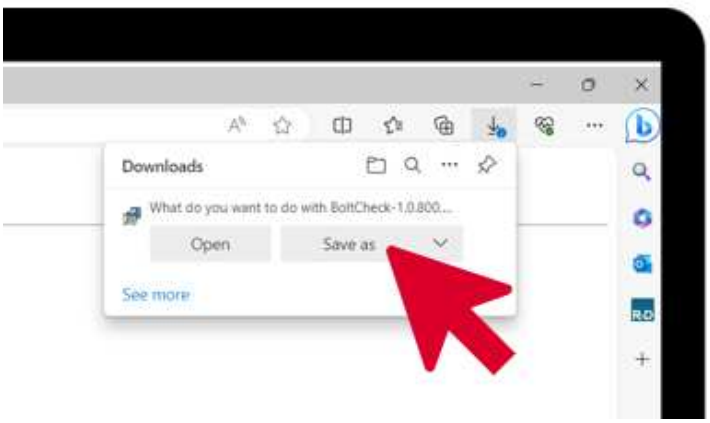
Installation link
boltcheck.azurewebsites.net - /public/beta/

Follow the steps:

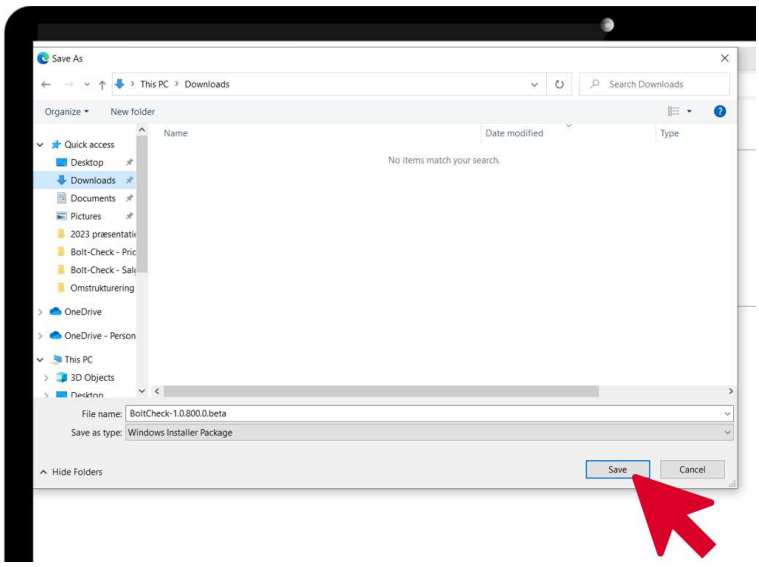
- Press on the newest link.
- Open the downloads.



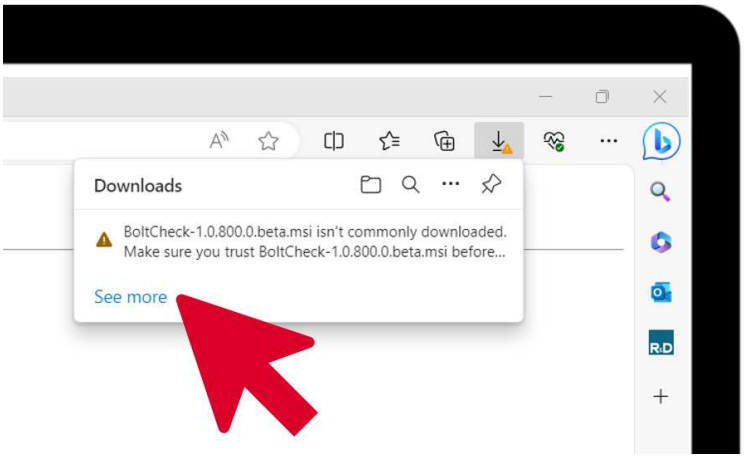
- Press “Save as”.



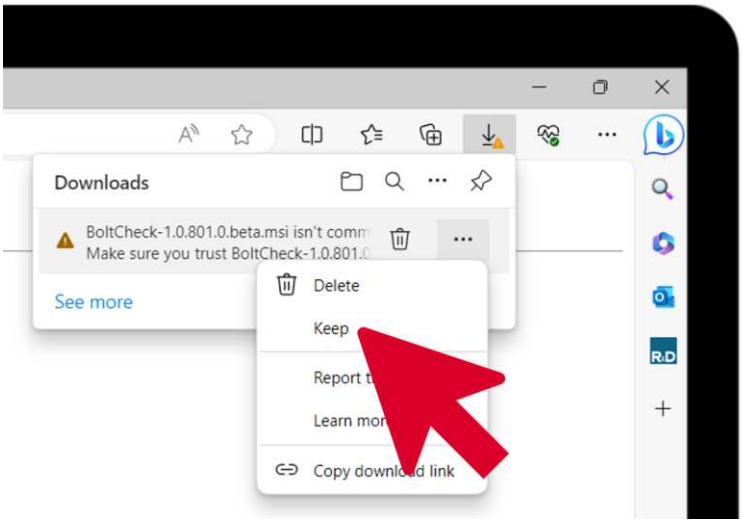
- Choose the file location for the program.



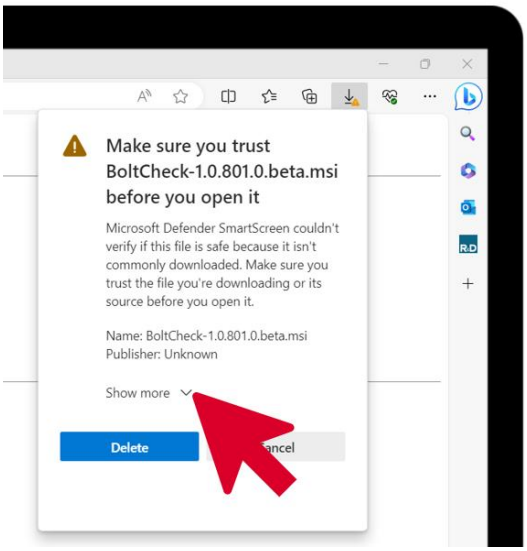
- A pop-up warning will appear in the downloads.
- Press “See more”.



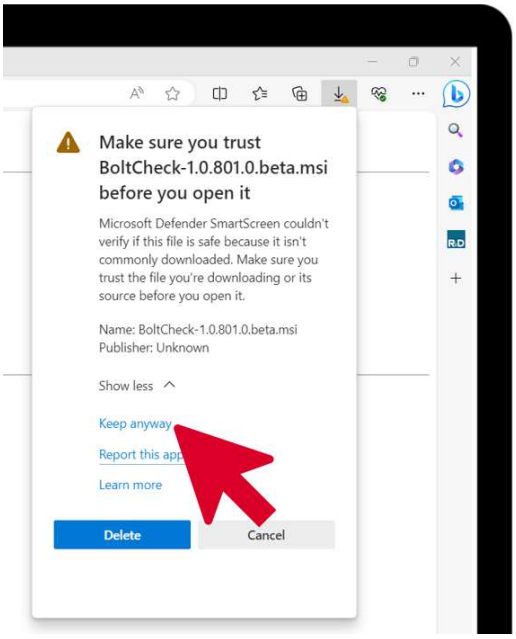
- Place your cursor on the warning and click on the three dots.
- A drop-down menu will appear.
- Choose “Keep”.



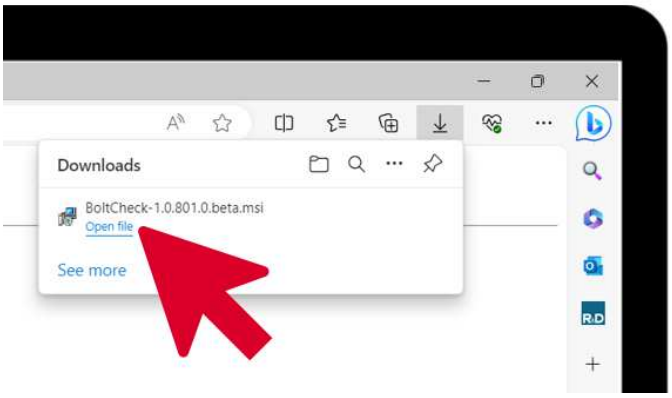
- A Microsoft Defender warning will appear.
- Press “See more”.



- Press “Keep anyway”.

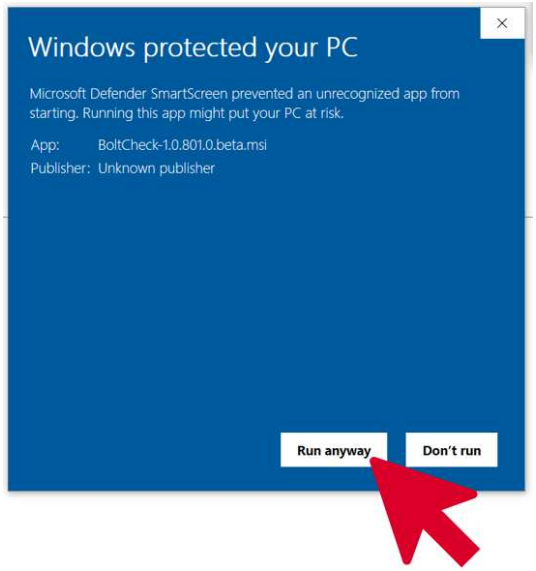


- Press “Open file”.

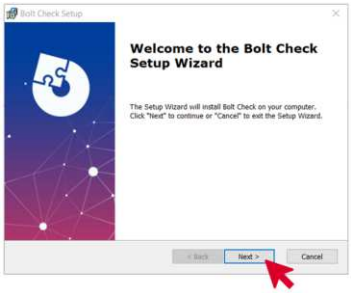


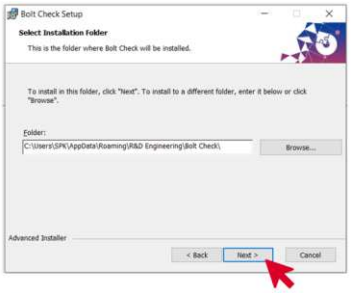
- Microsoft Defender will once again warn you.
- Press “See more”.

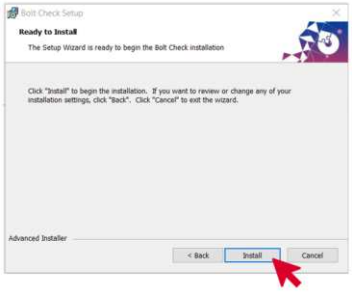
- Press “Run anyway”.

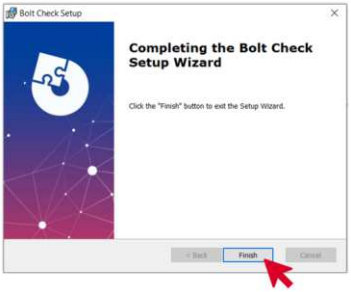


- A set-up window will appear.
- Press “Next >”.
- Select installation folder and click “Next >”.
- Press “Install”.
- Complete the installation by clicking “Finish”.

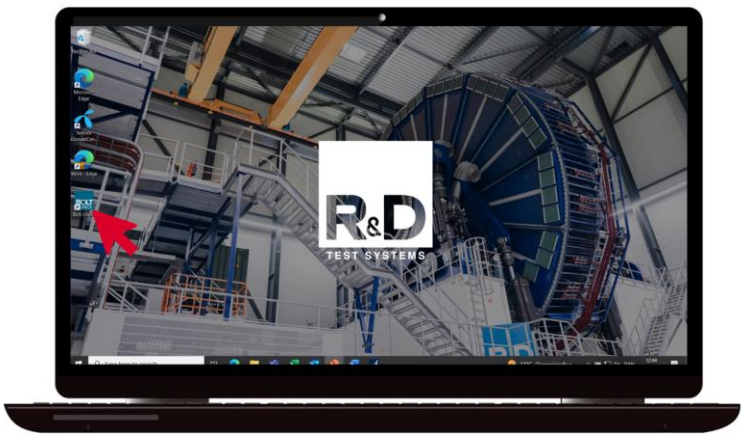




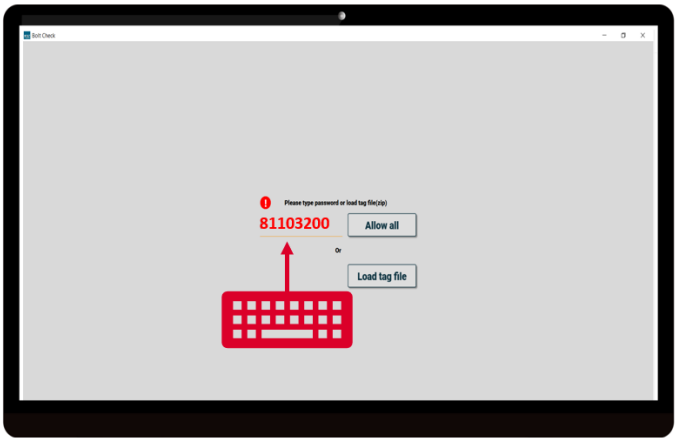




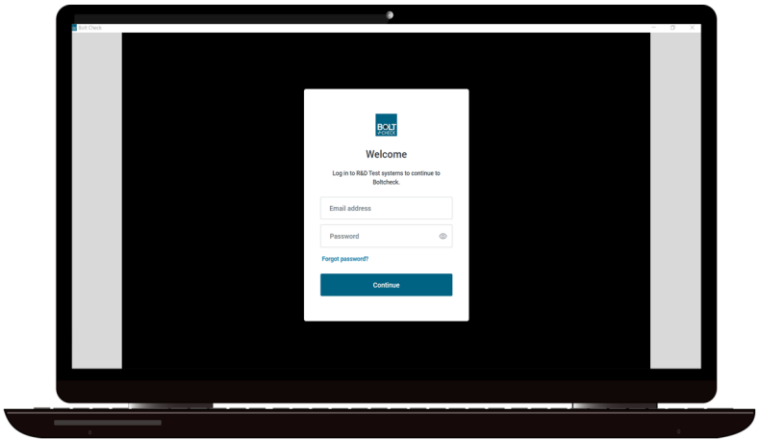
- Go to your desktop.
- Open “Bolt-Check” by clicking on the Bolt-Check shortcut.



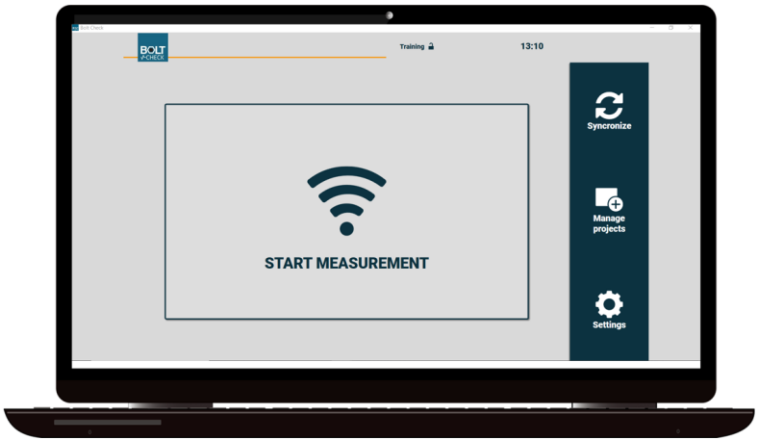
- The Bolt-Check software is now updated, and the program can run.
- If prompted for a password, it is “8103200”.



- Enter the login you have received from Bolt-Check consisting of an e-mail and a password.



- The homepage of the Bolt-Check software will appear.
- You have now successfully installed the Bolt-Check Software and are now able to start a project.



17.3 Updating the Ultrasonic Device Firmware

The Max-II needs to be updated every now and then.
For this matter the USB ports outside the Bolt-Check Standard cannot be used. Instead, a lid in the side must be opened to access the MAX-II.

- Open the lid in the opposite side of the cables.

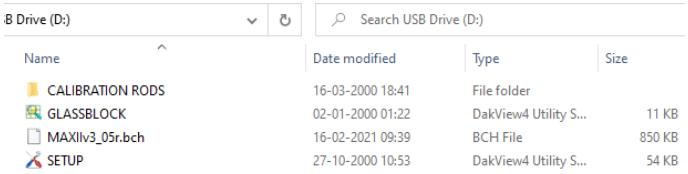
- From here the USB-B port for the MAX-II must be used. Note, it is not required to remove the big lid, this image is just to show the exact location.

- Use a USB-B to USB-A cable.

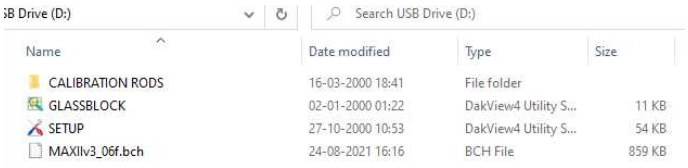
- Plug USB-B. Into the ultrasonic device and USB-A. Into a PC.
- Turn on the ultrasonic device.

- On the PC find new firmware file *(can be delivered on request)*.

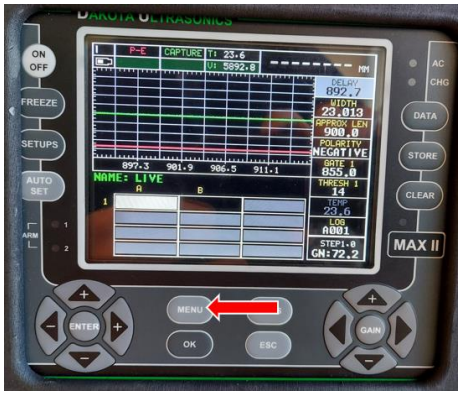
- Find the Ultrasonic Device main folder.
- Delete any old firmware files.
- In this case it is “MAXIIv3-05r”.



- Copy the new setup file into the ultrasonic device main location.
- Close folder and remove USB cable.

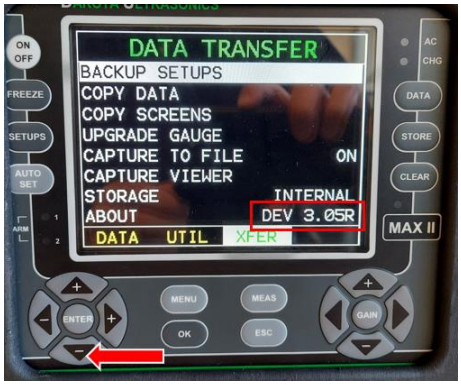


- Use the ultrasonic device interface.
- Press “MENU”.

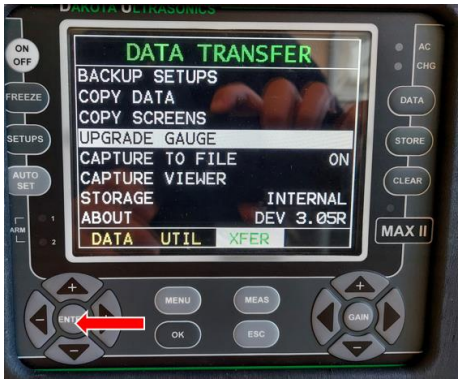


- Use the “-“ or “+” to navigate to XFER.

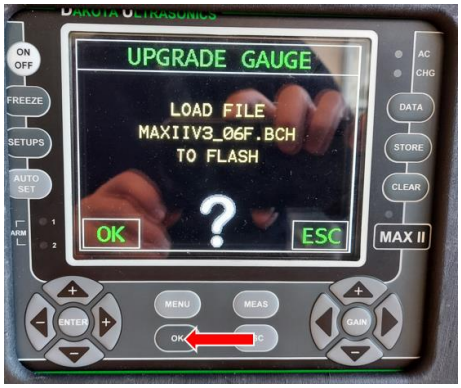
- In XFER notice current firmware number.
- Navigate to “UPGRADE GAUGE” using “+” or “-“.



- Upgrade gauge by pressing “ENTER”.

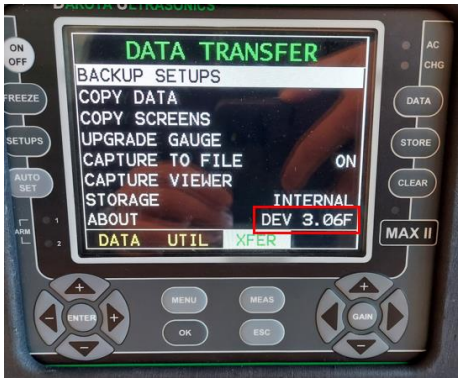


- Verify upgrade by pressing “OK”.



- Let the ultrasonic device update for two minutes or until all LEDs have stopped.

- Turn on the ultrasonic device again and navigate to XFER.
- Verify firmware version is updated.



18 Service and Maintenance

The maintenance shall be carried out by qualified technical maintenance personnel.

⚠ WARNING	WARNING: Attempting to perform system maintenance can expose personnel to electrical hazards and sharp edges. Do not attempt to perform any maintenance procedure unless you have read and fully understand the information provided in the “Safety Information”.

Official direct contact information for R&D Service and Installation:
Phone: +45 2851 8950
Mail: service@rdas.dk

18.1 Inspection

R&D recommends inspecting the product before using it. Pay attention to damages, missing or loose fasteners, dirt, and worn-out cables. Make sure to get all identified defects repaired. Contact R&D for support.

18.2 Cleaning

R&D recommends keeping the product clean. Use a damp cloth to remove dirt from the exterior of the Bolt-Check Standard and associated equipment.

18.3 System calibration

Once a year a system calibration must be performed. It is recommended that this is included in a service agreement with R&D. The calibration will be conducted by R&D. Book a system calibration by contacting R&D and then deliver the entire product with associated equipment to R&D before the agreed calibration date.

R&D Engineering A/S
Sigma 3
8382 Hinnerup
Denmark
Mail: service@rdas.dk
Phone: +45 2851 8950

19 Dismantling, Disabling, and Scrapping

The decommissioning, including dismantling, disabling, and scrapping, shall be carried out by qualified technical personnel.

WARNING:
Attempting to perform decommissioning can expose personnel to electrical hazards and sharp edges.
Do not attempt to perform any decommissioning procedure unless you have read and fully understand the information provided in the “Safety Information”.

Energy control

Make sure to disconnect the charging cable from the Bolt-Check Standard and turn the device off before opening it up.

Risk reduction and PPE

Following PPE must be equipped before decommissioning is performed. This reduces the risk of electrocution, cuts from sharp edges, and impact from dropping the equipment.

- Electrically insulated gloves.
- Safety shoes.

Sequence for decommissioning

The sequence or chronology for decommissioning Bolt-Check Standard consists of following overall steps.

1. Equip PPE, as described above.
2. Open the device and disconnect all the electronic components with the necessary precautions.
3. Disconnect and disassemble all other components
4. Sort everything in their respective waste group and dispose of or recycle accordingly to local legislation.
    - Electrical
    - Plastic
    - Metal
    - Other waste

20 References

Ref. [1] 0001-403-MAN-Bolt-Check Cloud Manual rev. 01
Ref. [2] Dakota-MAX2-Manual