OPERATION AND MAINTENANCE MANUAL

BLUE LOGIC

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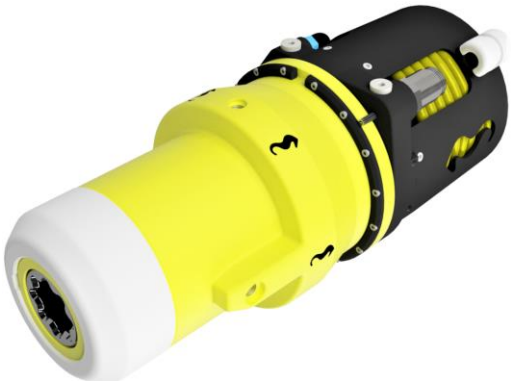

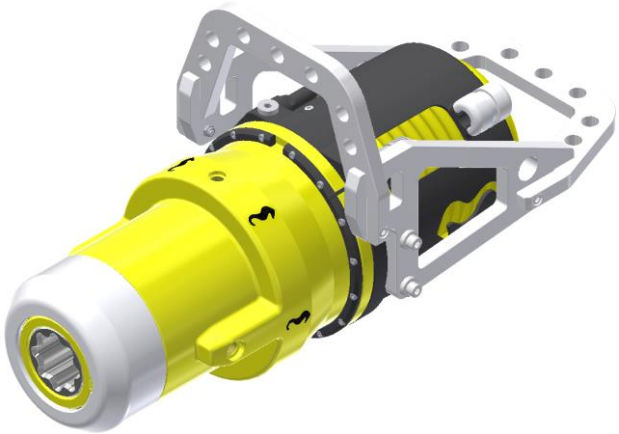

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REVISION CHANGE/RECORD

REV	REASON FOR REVISION/ DESCRIPTION OF CHANGES
01	Document initiated for use
02	Instructions regarding gear box mode added in section 5.1.5 Note regarding risk for backspin after high torque outputs added.
03	Section 11 updated wrt. information regarding check of oil-level and pressure. Appendix 1 Drawings added

TABLE OF CONTENT

1. INTRODUCTION

1.1. PURPOSE AND SCOPE

The objective of this document is to present a comprehensive user manual for the Blue Logic Light Weight Electrical Torque Tool, LWETT. Relevant technical aspects for information and familiarization are covered as well as detailed technical data.

The Light Weight Electrical Torque Tool is designed as a low-weight, compact and accurate multipurpose Torque Tool. Due to the low weight, it is suitable for operation by smaller ROVs, subsea drones (AUV) and divers. Separate configurations are available for ROV, AUV and diver and covered by this manual.

This OMM covers the following specific Torque Tool kit:

Art. No.:	Description:
BB3551	2,7kNm Light Weight El TT System for ROV/Diver/AUV

1.2. ABBREVIATIONS

LWETT	Light Weight Electrical Torque Tool
ELTTS	Electrical Torque Tool System
EPC	Electrical Power Can
GND	Ground
GUI	Graphical User Interface
IC	Inductive Coupler
OMM	Operation and Maintenance Manual
ROV	Remotely Operated Vehicle
TT	Torque Tool
EFR	Equipment Failure Report
CP	Cathodic Protection
PFC	Power Factor Control
CW	Clockwise
CCW	Counter Clockwise

1.3. SYMBOLS

The following words and symbols found throughout this manual, highlights special messages to alert the operator of specific information.

WARNING: The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. All users must be familiar with the contents of the appropriate manuals before attempting to install, operate, maintain or in any other way work on the equipment. Blue Logic AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

CAUTION: The equipment to which this manual applies operates on high voltage and may cause death or severe injury if handled incorrect. The equipment should only be handled by qualified personnel. The equipment contains no serviceable parts inside.

1.4. WARRANTY CONDITIONS AND GUARANTEES

It is the responsibility of the end user to make sure that the product is used in such a manner for which it is designed. This includes accounting for material/fluid compatibility, sour service, temperature, pressure rating etc.

When performing operation above water; do not run tool at full load for prolonged periods. Arrange for water-cooling if operation is expected to take time. Consider ambient temperature.

When operating at high torque output, make sure to gently reduce torque once completed. Slide the torque bar slowly to relief applied torque. A sudden torque reduction may cause backspin in gearbox. This is crucial during any operation using external gearbox and during torque calibration on deck, with or without gearbox.

Future software update to include auto-reduction of torque.

1.5. REFERENCES

Latest version of the following documents

Id.	Doc. No	Originator	Document Title
/01/	BB3551	Blue Logic	2,7kNm Light Weight El TT System for ROV/Diver/AUV
/02/	BB3394	Blue Logic	General Arrangement Light Weight Electrical Torque Tool
/03/	BA2024	Blue Logic	Test Jig Class 4 Torque tool
/04/	BA7719	Blue Logic	BL Power Supply 2kW
/05/	BB1538	Blue Logic	2,7kNm Light Weight Electrical Torque Tool 500m Diver Handle

2. HEALTH, SAFETY AND ENVIRONMENT

Safety must always be the highest priority when performing operations, maintenance and tests when using the LWETT.

Personnel involved in the test/work operation shall be familiar with the contents of this document.

2.1. PERSONAL PROTICTIVE EQUIPMENT

The following minimum PPE must be worn when operating the LWETT.

Personal Protective Equipment
Protective glasses
Protective shoes
Protective gloves

2.2. QUALIFICATIONS AND TRAINING

It is essential that all operating personnel have been given training and education in how to operate and maintain the equipment described in this manual.

3. SYSTEM OVERVIEW

The Electric Torque Tool System is supplied in kit containing relevant equipment for use. Reference is made to below illustration and list of content.

3.1. BB3551 – LIGHT WEIGHT ELECTRICALTORQUE TOOL KIT

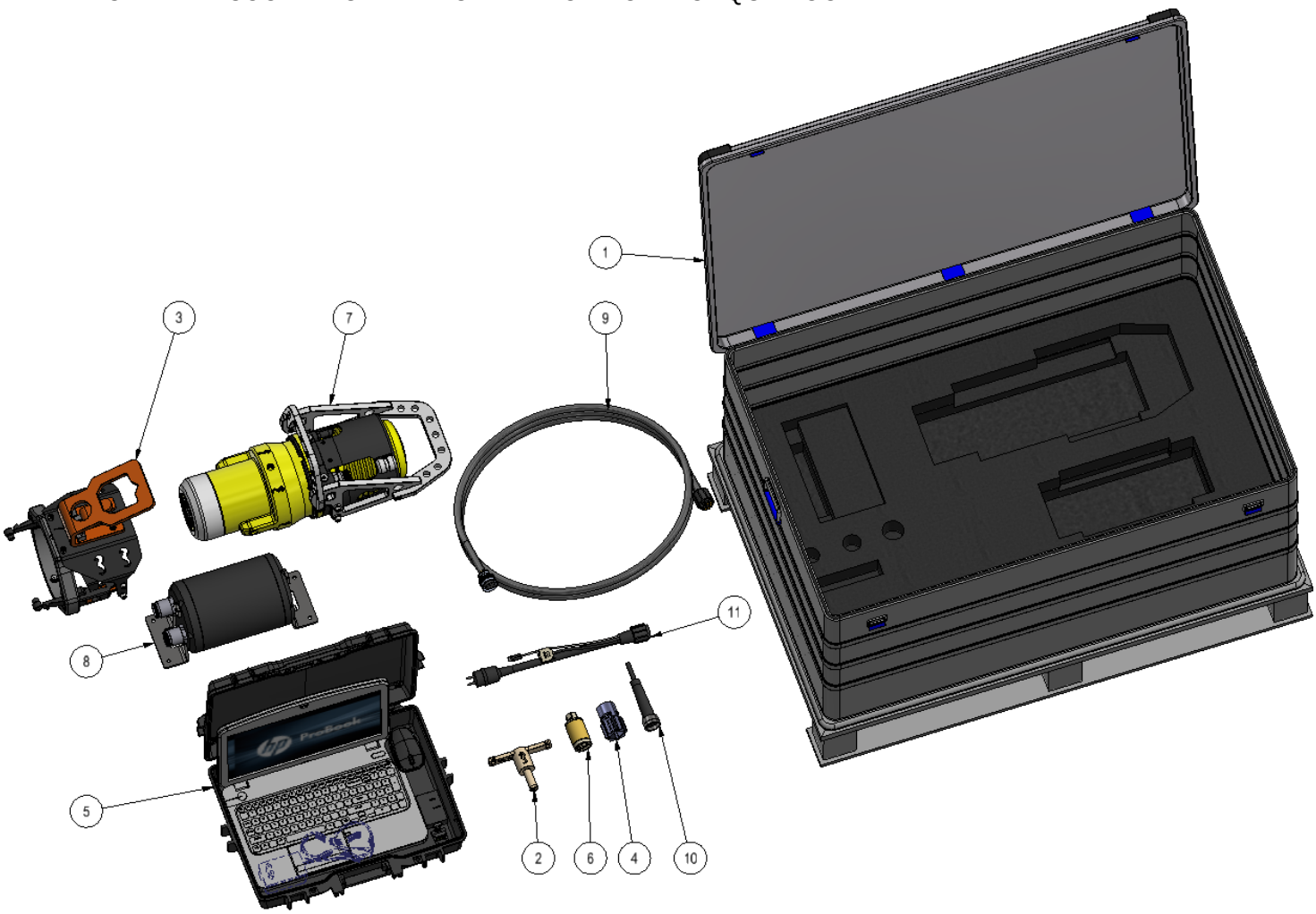


Figure 1: BB3551 Torque Tool Kit

The BB3551 kit consist of:

ID	QTY	Art No.:	Description
1	1	BB3840	Alu Transport Box
2	1	BB3698	Key for Replacement of Sockets
3	1	BB3557	ROV Latch and Handle
4	1	BB3129	Class 3 Adapter, Subsea Replaceable
5	1	BB2958	ETT Control PC w/GUI Software and Pelicase
6	1	BB2962	Class 1 & 2 Adapter
7	1	BB1538	Diver Handle
8	1	BA7719	BL Power Supply, 2kW
9	1	103651	Comm. Cable w/Burton 470 VDC & RS232, 4,5m
10	1	102860	Burton Dummy Connector 5501-2008-0000
11	1	102768	Test Cable OM10F to 250W Prim USB and 2kW Power Supply, 3m

3.1.1. Technical Description of LW Electrical Torque Tool

The LWETT is a compact, flexible, and robust precision torque tool for subsea operation by ROV, AUV or diver. This kit contains all required components for shifting between the 3 configurations.

The Blue Logic LWETT System combines all known advantages from a hydraulic torque tool system with the technology and advantages from a modern servo based electrical controlled drive system. Also included is an auto detect system which detects what type of *mechanical interface class 1-4 socket* has been installed, and automatically switches between Low Torque (LT) mode and High Torque (HT) mode accordingly.
The tool is based on Blue Logic's standard electrical torque tool but optimized with respect to reduce the weight to enable operation by small ROVs and subsea drones.

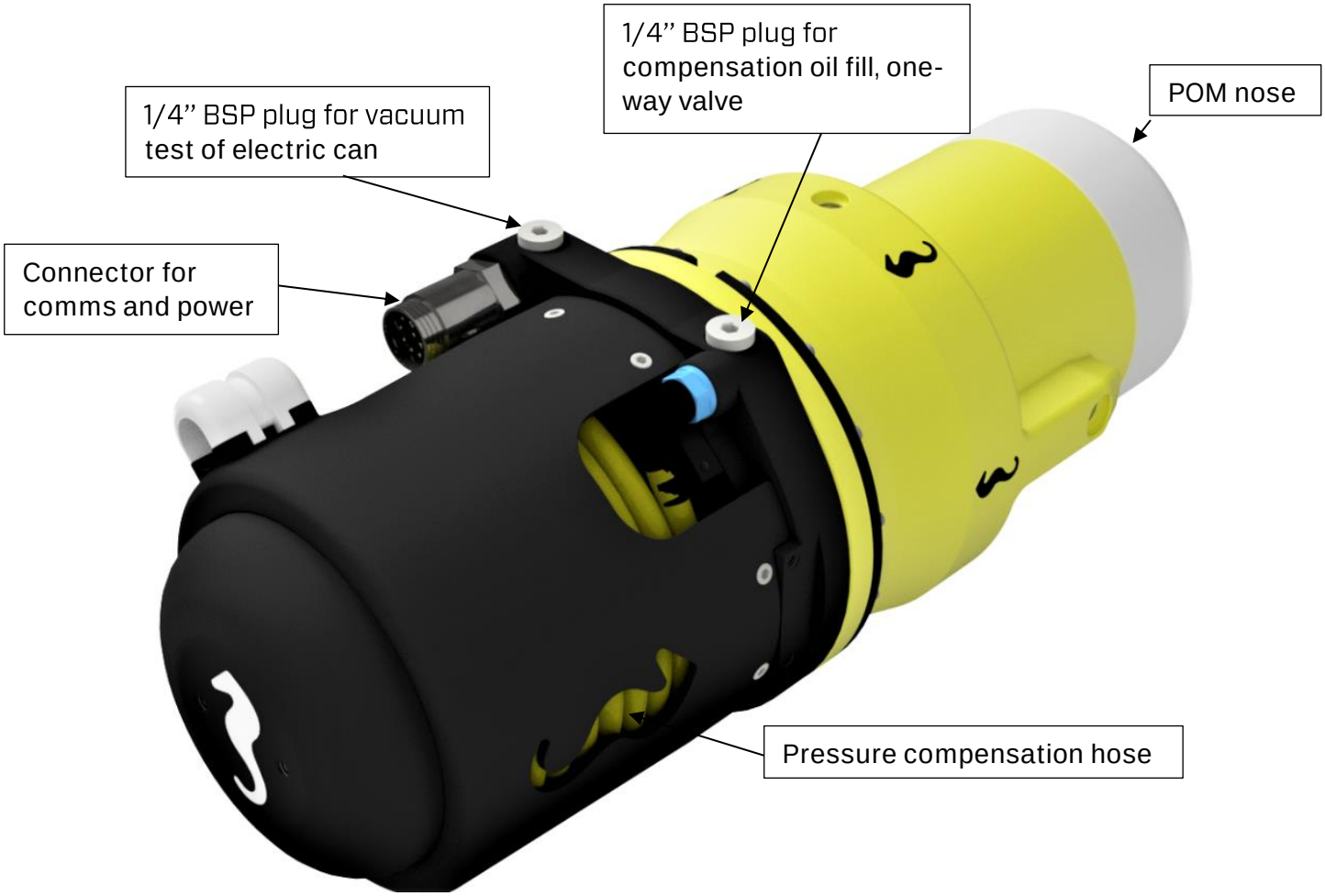


Figure 2: LWETT

HIGH VOLTAGE: The Torque Tool operates on high voltage and may cause death or severe injury if handled incorrect. The equipment should only be used by qualified personnel. The equipment contains no serviceable parts inside.

WARNING: Rotating parts can be hazardous. Keep hands and body out of the operating area. Failure to follow these warnings could result in death or severe personal injury.

3.1.1.1. Technical Data

Mechanical Data:

Description	ROV Configuration	AUV Configuration	Diver Configuration
Dimensions, W x H x L	270x371x524	201 x 200 x524mm	248x308x624mm
Weight in air	32,4kg	21,5kg	25kg
Weight in water	18,8kg	9,5kg	14,1kg
Depth rating	500m	500m	500m

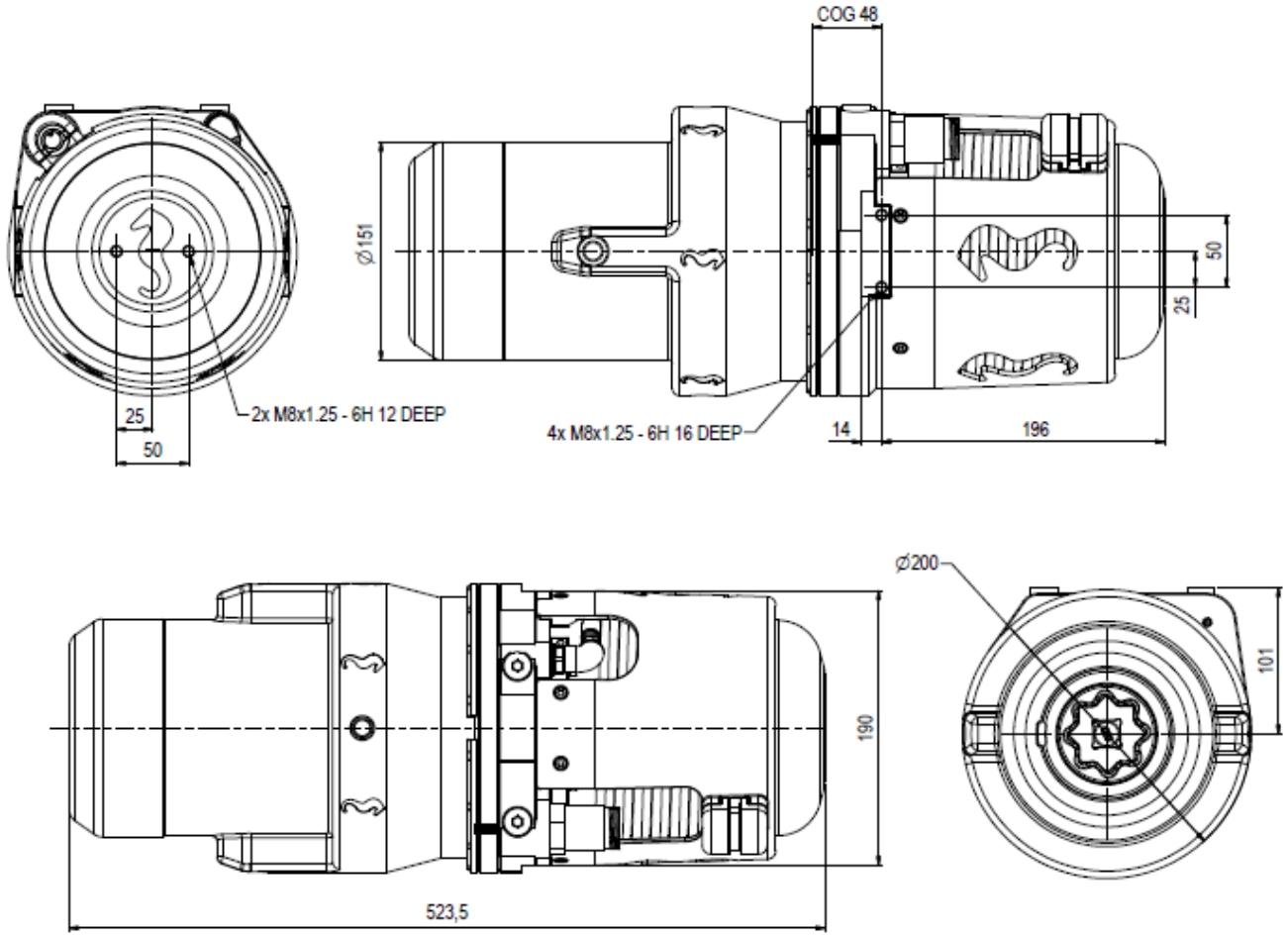


Figure 3, Torque Tool dimensions, AUV configuration

Performance Data:

Description	Specifications
Low Torque Mode, MaxTorque	271Nm (500Nm)
Low Torque Mode, Max speed	6 rpm
High Torque Mode, MaxTorque	2700Nm (3000Nm)
High Torque Mode, Max speed	1,8 rpm 0.5 @ 500W

Electrical Interface, Power Supply Canister:

Pin #	Input, Host	Output, Torque tool
	Subconn BCR2410M 10-pin connector, male	Subconn BCR2410F connector, female
1	100-250VAC / 145-350VDC	370VDC
2	100-250VAC / 0VDC	0VDC
3	Chassis	Chassis
4*	RS232 RX or RS485 +D	RS232 RX or RS485 +D
5*	RS232 TX or RS485 -D	RS232 TX orRS485 -D
6	Com Gnd	Com Gnd
7	TX_p	TX_p
8	TX_n	TX_n
9	RX_p	RX_p
10	RX_n	RX_n

*Protocol will be either RS232 or RS485, protocol type to be clearly marked on the tool.

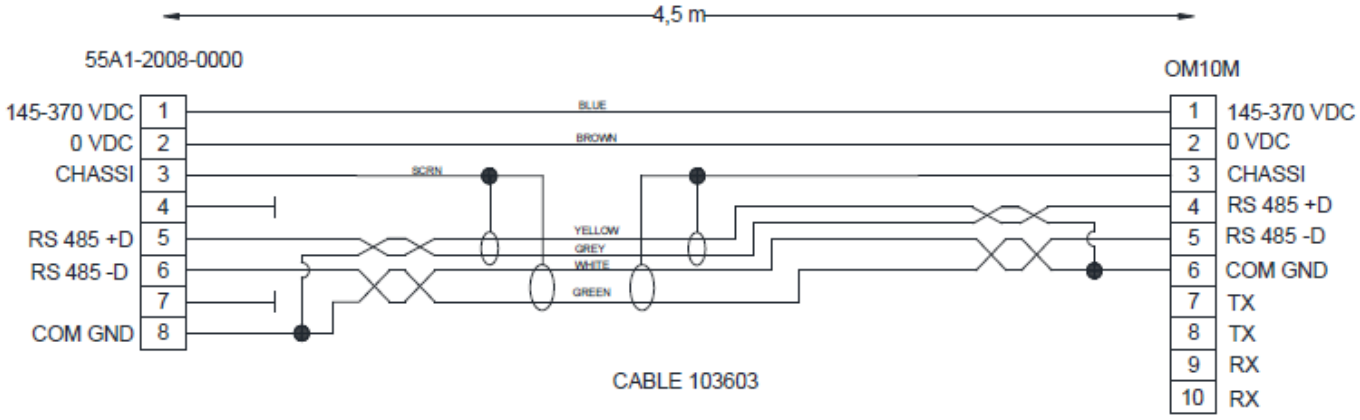


Figure 4 Interface cable

Compensation Fluid Data:

Description	Specifications
Oil*	Q8 T 65 LS
* The LWETT system is partly oil compensated	

Electrical Requirements:

Description	Specifications
Power*	500W
*To achieve 2700 Nm @ 0,5 rpm 500W is required. Lower power supply can be used with reduced maximum speed, adjustable in Setup. Formula: Power = Torque (Nm) * ((speed(rpm)/60)*6,28)	

Minimum ROV Requirements:

Description	Specifications
Power	10A 230/115 VAC
Current consumption at max speed and torque.	20A

Communication Data:

Description
RS485 (RS 232)

Actual protocol type to be labelled on the torque tool.

3.1.1.2. Interface Description

Mechanical Interface according to ISO 13628-8:

Interface	Class	Torque
ISO	1	67 Nm
ISO	2	271 Nm
ISO	3	1 355 Nm
ISO	4	2 711 Nm

The LWETT has mechanical interface class 1-4 socket designed according to ISO 13628-8 valves class 1-4. The mechanical socket is easily changed topside using the special key (BB2423). LWETT will automatically switch between High Torque (HT) and Low Torque (LT) mode. Class 1 and 2 valves are operated in Low Torque mode, whereas Class 3 and 4 are operated in High Torque mode. It is not necessary to change the LWETT motor between HT and LT mode.

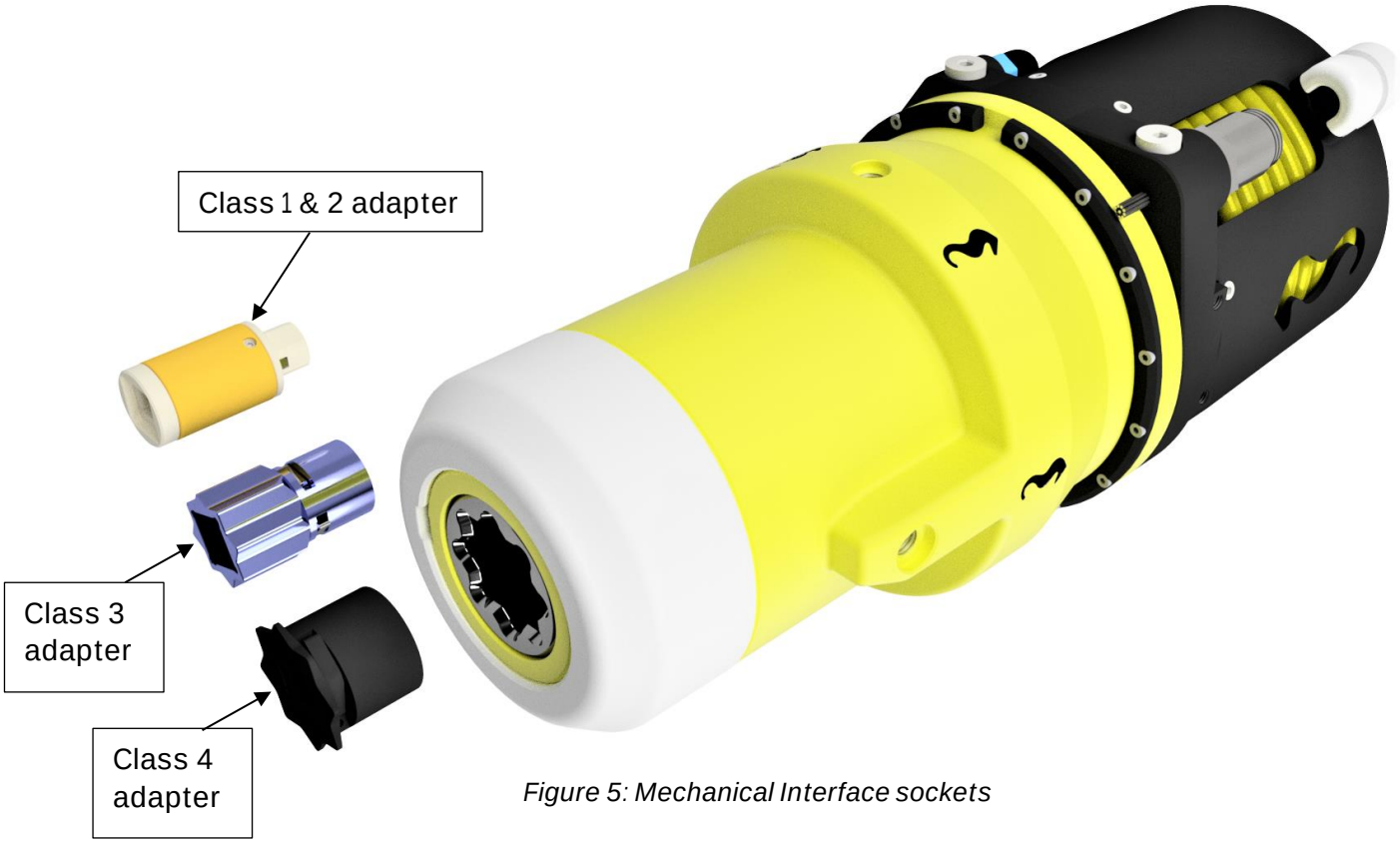


Figure 5: Mechanical Interface sockets

To replace the mechanical socket, see section 8.2.2.

3.1.1.3. Position Feedback

The LWETT is featured with electrically socket position feedback system, providing feedback through the GUI. The position feedback presented in the GUI has a reset function making it possible to reset revolutions and angle at any time.

4. TORQUE TOOL CONFIGURATIONS

The different handling configurations are described in this section; ROV, AUV and diver config. Operation of the torque tool is similar in all configurations, the difference is related to handling the tool.

4.1. ROV CONFIGURATION

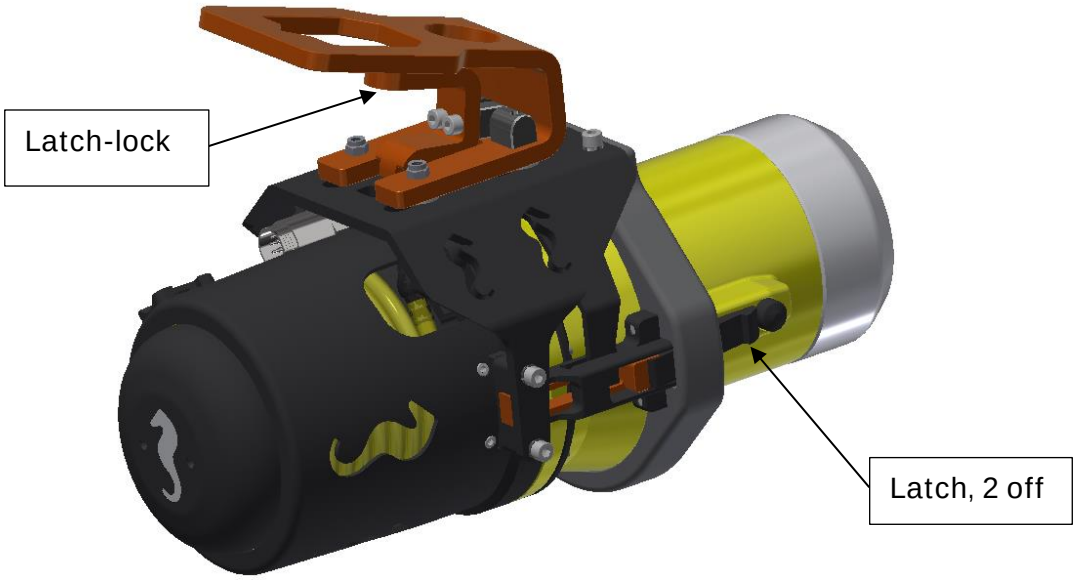


Figure 6 Torque Tool with ROV handle and latch-mechanism

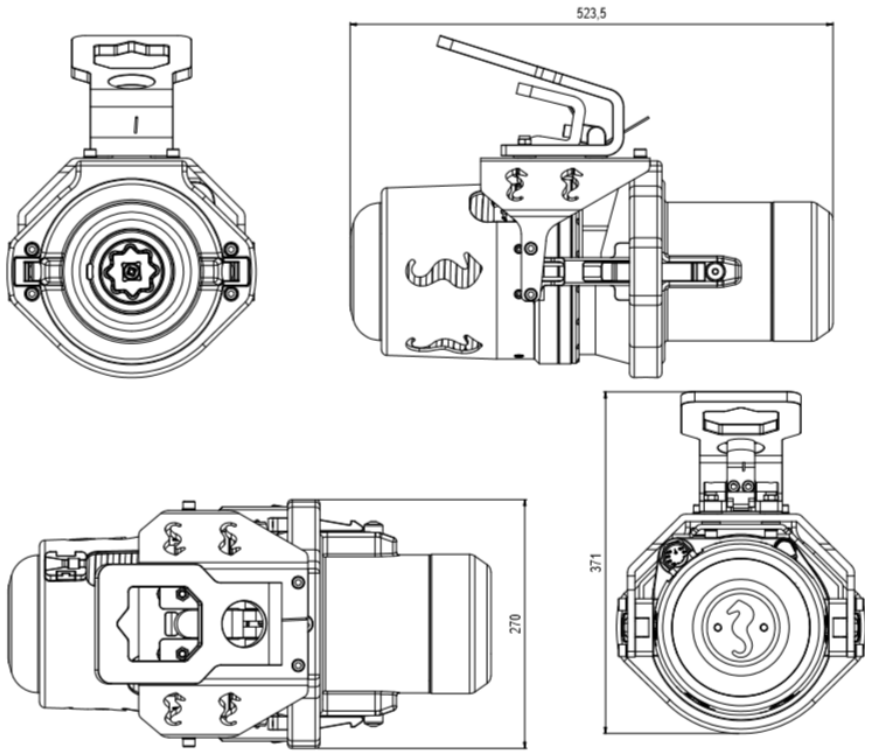


Figure 7 LWETT in ROV configuration - main dimensions

In the ROV-configuration, the LWETT is equipped with a ROV handle for handling and operation of the latch-locks. The latch/unlatch function is managed by sliding the handle forward/backward. A lever has to be lifted in order to slide the handle.

4.1.1. Latch Lock and Release

The latches' purpose is to lock the tool in the torque-bucket during operation. This mechanism is operated using the ROV manipulator and has two modes; lock and release. Shifting between lock and release is performed by lifting the spring-loaded latch-handle and slide the ROV-handle forward (lock) or backward (release). A spring-loaded mechanism will keep the latch-lock in either position.

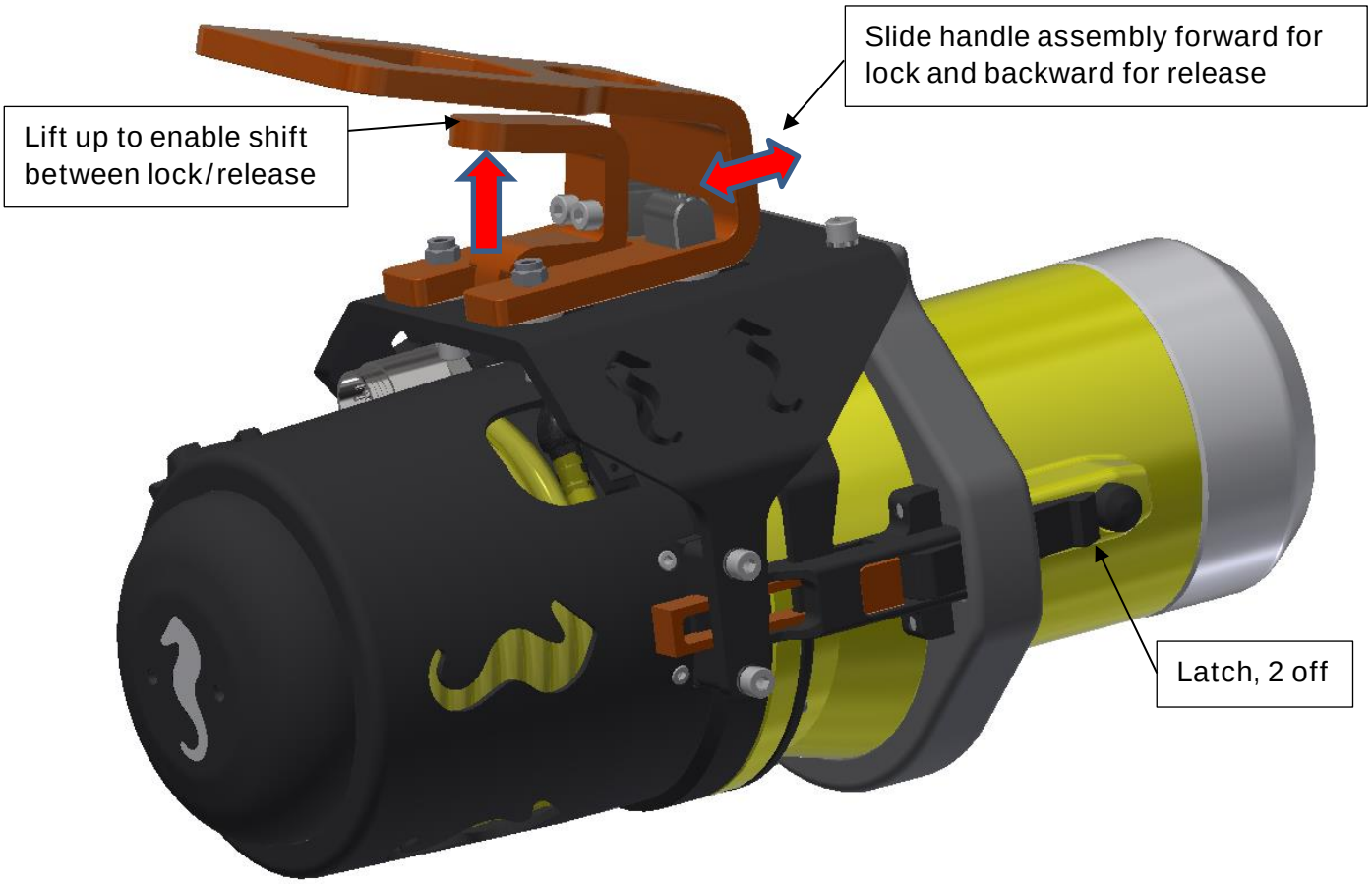
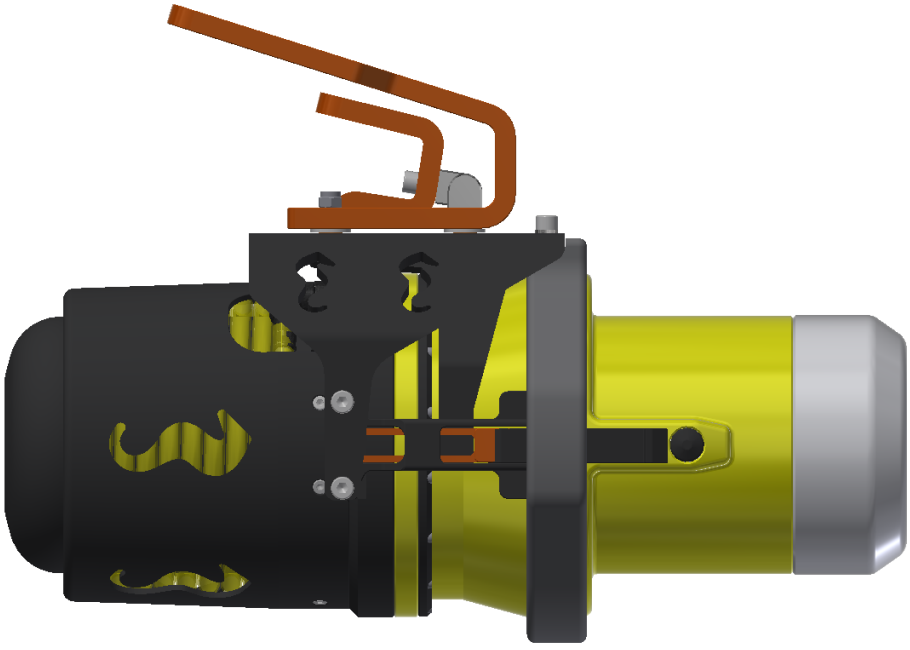


Figure 8, Latch mechanism

Prior to inserting the torque tool into the torque-bucket, the locking mechanism shall be put in backward, unlocked position. The latches will then be able to click into the slots in the torque-bucket and thus locked to the torque-bucket. Once in position, the latches shall be engaged by lifting the latch-lock and slide the ROV handle into forward position.

In order to release the torque tool, the latch-lock must be put in release mode, i.e. in backward position. The tool can then be pulled out of the torque-bucket.

Release and installation mode, i.e. handle in backward position

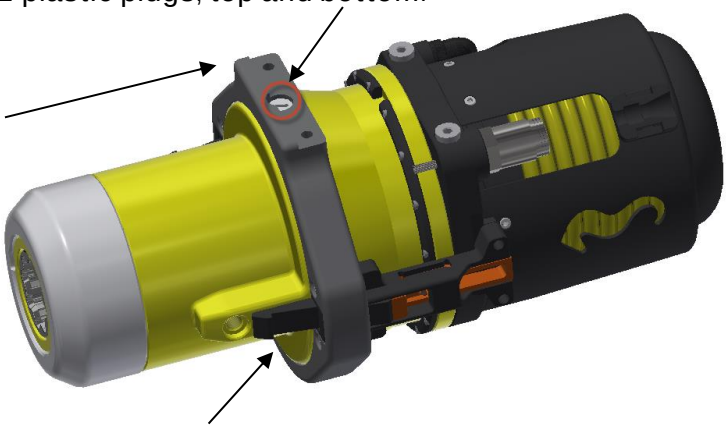
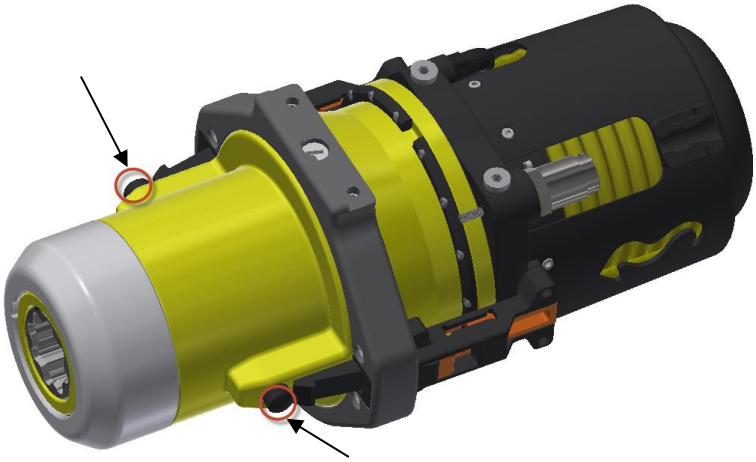


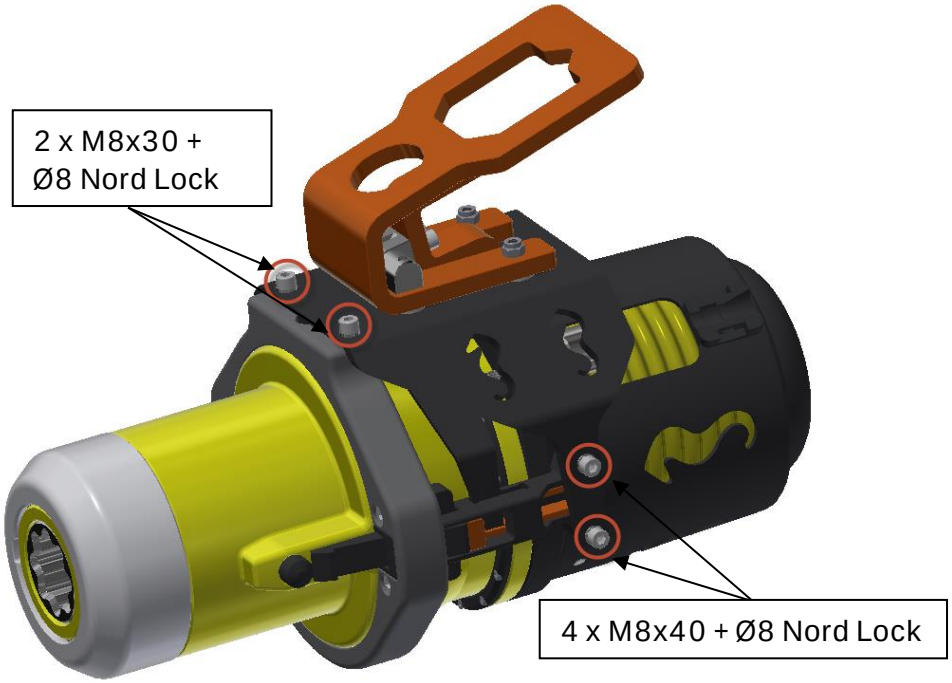
Lock mode, i.e. handle in forward position

Figure 9, Locked and released mode

4.1.2. Installation of ROV Latch & Handle

Installation of the handle must be performed in a specific sequence as described below.

No	Description	Check/Verified
01	Assemble the handle's interface ring as shown. 	
02	Slide the ring-assy onto the torque tool from the front and fasten the 2 plastic plugs, top and bottom. 	
03	Install the 2 plastic protection plugs. 	
04	Insert the square nuts into the dedicated slots in the main ring.	

No	Description	Check/Verified
		
05	Install the ROV handle assembly onto the torque tool. 	
06	Fasten the M8 bolts with Nord Lock washers as shown below. 	
07	Operate the handle several times to verify correct function. Make sure that the handle locks in correct aft and forward position.	

4.2. AUV CONFIGURATION

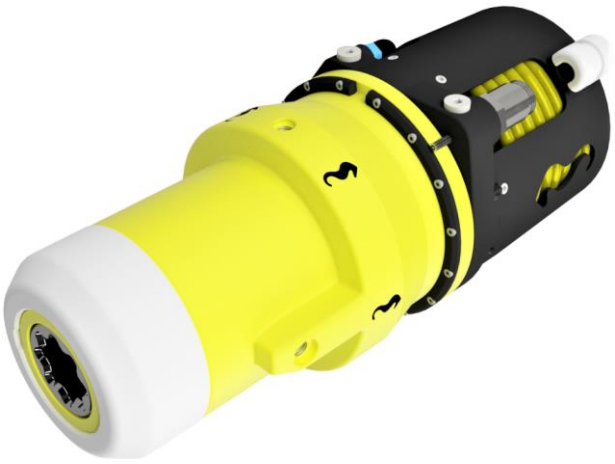


Figure 10 LWETT in AUV configuration

The above figure shows a typical configuration when operated by AUV or subsea drone. The tool will then be bolted onto the vehicle, i.e. fully integrated. The LWETT has 6 off dedicated threaded M8 bolt-holes to be used for installation onto the AUV.

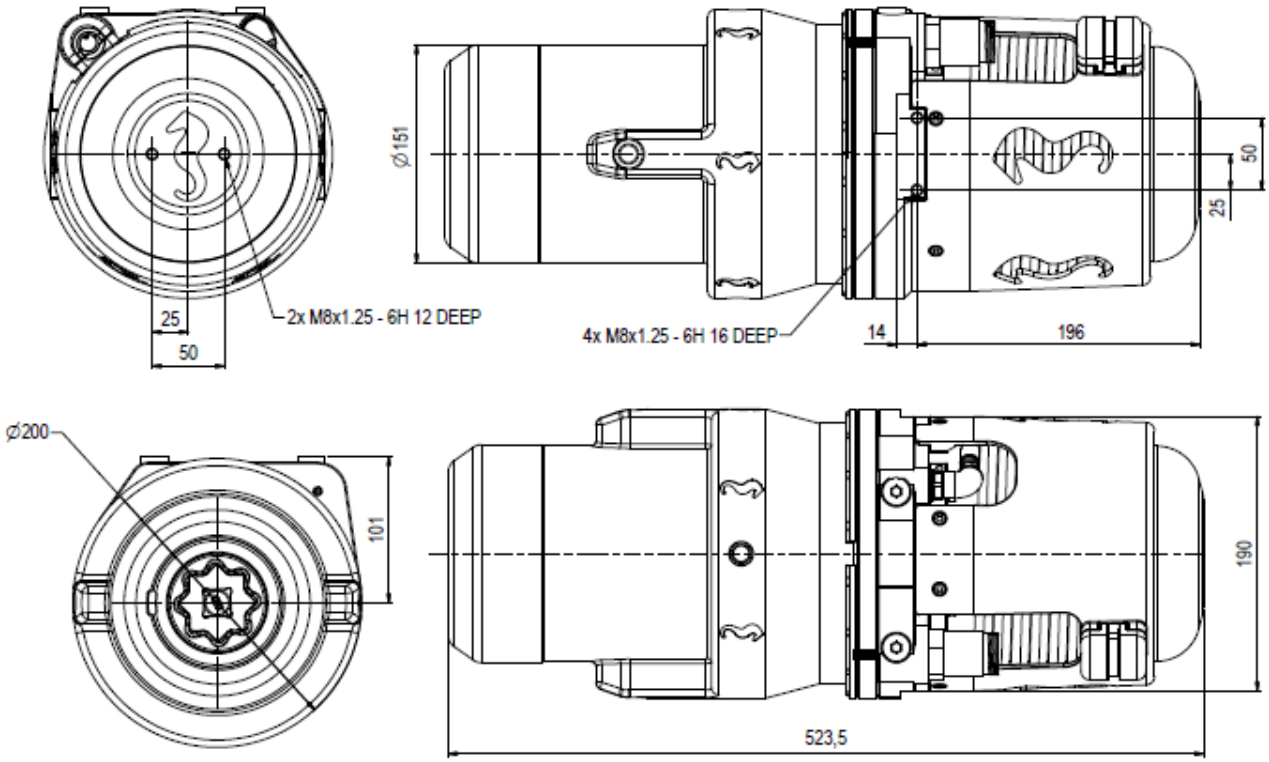


Figure 11 LWETT AUV configuration - main dimensions and bolting interface

4.3. DIVER CONFIGURATION

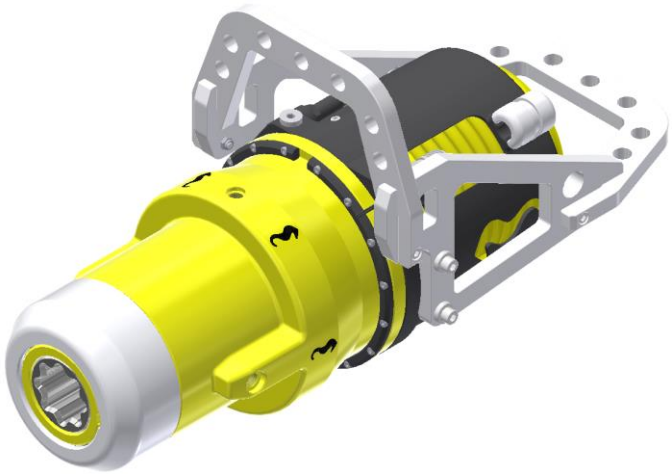


Figure 12 LWETT in diver configuration

For operation by diver, a low-weight handle has been designed. The handle is constructed in plastic, POM, and provides easy operation in both horizontal and vertical orientation.

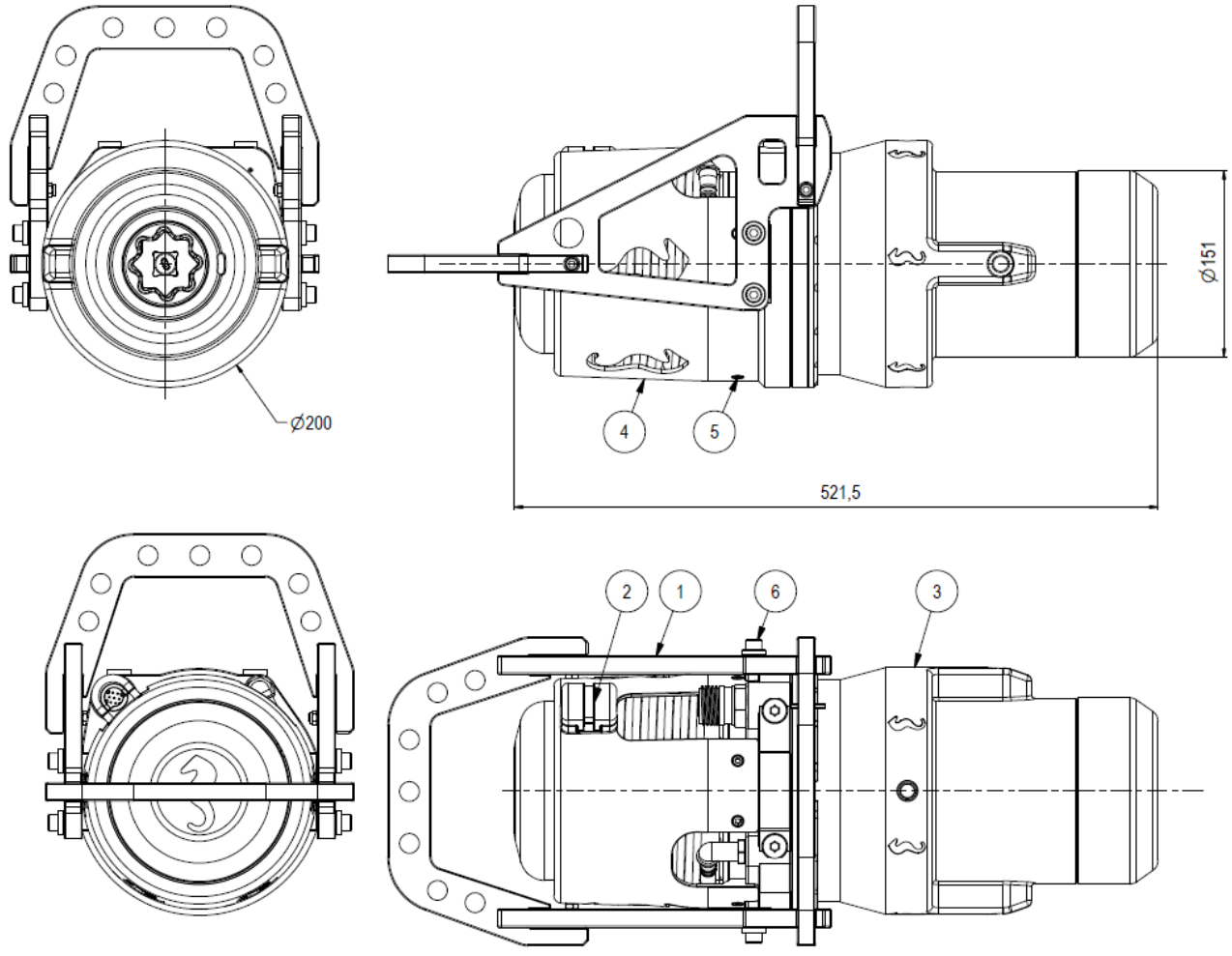


Figure 13 LWETT diver configuration - main dimensions

5. TOPSIDE CONTROL SOFTWARE

The control software for the LWETT is installed on a laptop that is operated from topside. The software controls the TT output, either in Nm, revolutions per minute or turn count.
The software is also able to log/load operational data.

5.1. GRAPHICAL USER INTERFACE, GUI

The GUI has two windows Main Window and Setup Window. The LWETT is operated from the Main Window and displays tool feedback. It contains all operational data such as torque, speed, socket angle, torque graph, set limits and more.

The Setup Window is password protected and enables the user to change parameters and selecting set limits.

Password can be made available on request to supplier.

Operation Modes	Description
Manual	Normal start/ stop in selected direction, torque limit but no turn or angle limit.
Multi turn	Running the tool a specified number of turns and/or angle.

Figure 14: Main window

Figure 15: Setup Window

5.1.1. Main Window

Main window is split into eight sections named boards. The different boards contain all tool controls and information on tool feedback.

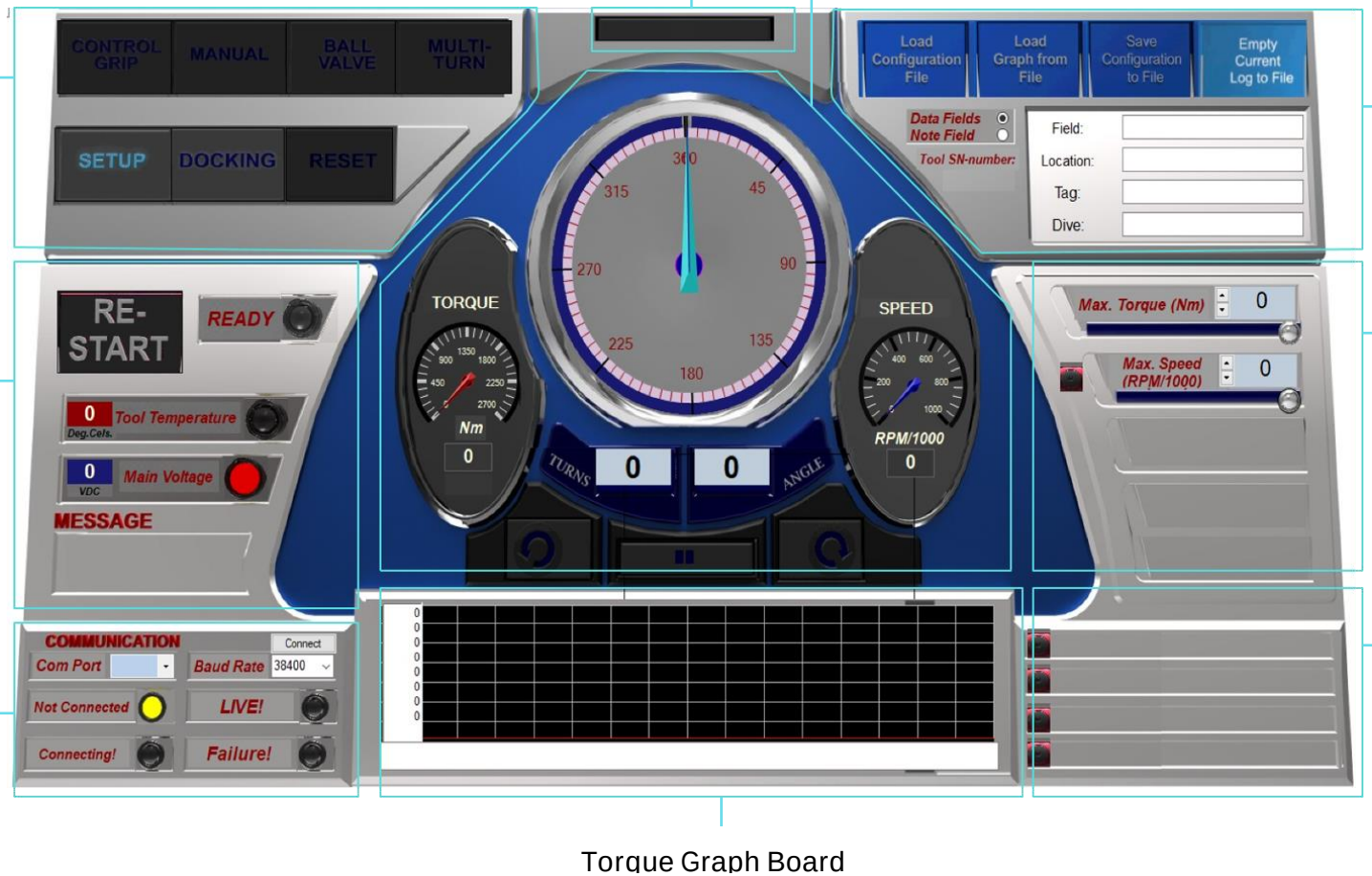
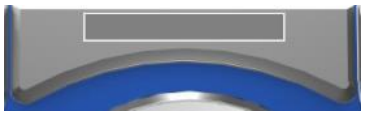
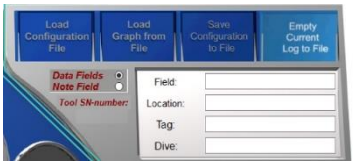
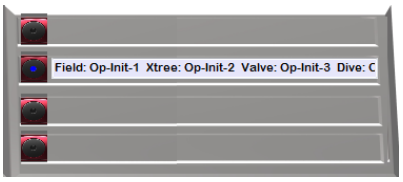


Figure 16: Main Window Overview

5.1.2. Main Window Information Boards

Board	Model	Description
Operation Mode Board		The Operation Mode Board let the user select the different operational modes. In addition, the Setup Window can be entered here. Manual mode: Starts running when command button is clicked and stops when stop button is clicked. Multiturn mode: Rotates the tool towards a preset position. It will move and stops when target position is reached.
Critical Tool Feedback Board		Critical tool information is presented in this board. If self-protect function has shut down the tool, restarting the tool is done via this board. The Message window shows more detailed messages related to instrument lamps and status. Messages are: - Description of alarms/warnings. - Status indication (e.g. Initializing or Operating.
Communication Board		Presents communication information
Command and Operation Dashboard		This board holds the command buttons on operating the tool and the operational feedback.

Class Detection Board		This field will default show the auto detected Iso Class output pipe. This field will by default show the auto detected Iso Class output pipe (governed by if the pipe is connected to stage 2 or 3 in the gear) In special cases where special designed output pipes are used, the field can be manually edited, see section 8.3.2
Archiving Board		Report Board holds the Archive and filing functions.
Operation Set Limit Board		Holds the operational set limits used when running the tool.
Graph archive Information Board		The Graph Archive Information Board presents data information on the loaded graph file. Left button/Indicator shows/hides selected graph.
Unit setting		By default, position unit appears as turns and degrees. *** Work In Progress, not yet functional *** By pressing the unit button, a selection window gives the possibility to change monitored position units.

5.1.3. Setup Window

Setup window is divided into four sections holding the different set limits, limiting the operational freedom found in the Main Window. The set limits can have a huge impact on LWETT performance; a password has been applied in order to change values.

Both the Performance Config and Failsafe Configurations are password protected, with two different passwords.

Passwords can be made available on request to supplier.

Setup window also shows actuator data that are loaded from the actuator during connection.

An additional “Advanced settings” window may be opened containing Alarm/warning settings and limits.

Advanced settings (typical factory settings only)

Performance config

Operation times and motor data (read only)

Archiving setup

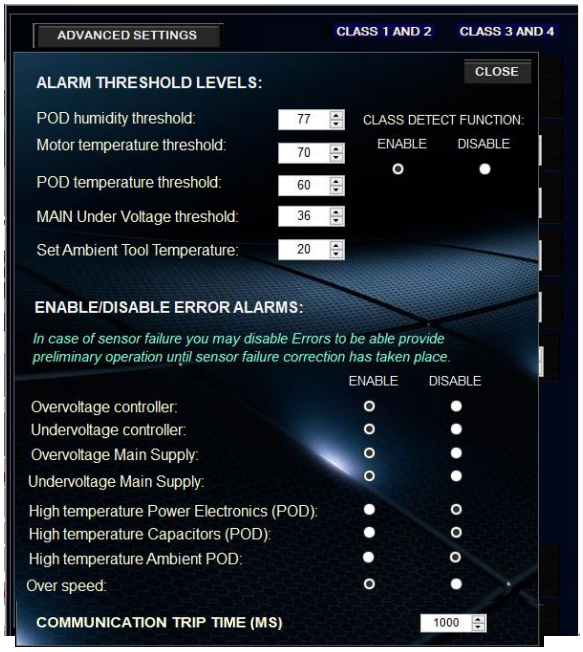
Functional and Failsafe configurations

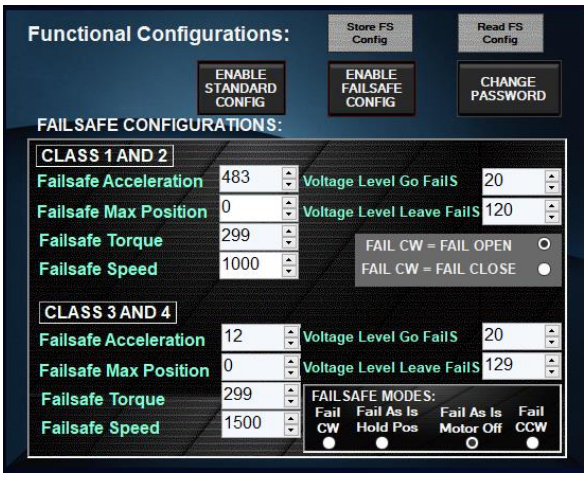
Class and sensor factors

Figure 17: Setup Window Overview

5.1.4. Setup Window Sections

Section	Mode	Description
Performance Config.		This board holds all absolute max limits towards socket output values (Torque speed). Acceleration/deceleration settings can also be accessed here Large number = fast speed change. Low number = slow speed change Changes require password (Ref. section 3.4.1.3)
Operation times and Motor data (Read only)		Times –Total live time; Complete time when tool has been connected are shown Total operation time; Shows accumulated time when tool have been performing operation

Advanced settings		Advanced settings are factory settings for alarms. Alarm threshold levels These are levels that when reached will cause errors that shuts down operation to protect the system. Class detect function Here you can lock class and disable the class Detect function. If disabled class sensing will not occur but chosen class in “select class” will automatically be set. Warning: be sure that correct socket is installed, otherwise operation failure will occur, and possible damage may occur. Enable/Disable error alarms Alarms may be disabled to prevent shutdown in case of sensor failure. Warning: When any alarms are disabled the system protection level is reduced. Thorough consideration and manufacturer approval should be performed before any alarms are disabled. Communication trip time: This setting defines how long Time Torque tool will operate without receiving any data from GUI. Default; if Torque tool do not receive any data for 1 second (1000 ms) operation will shut down.

		If communication is very slow this value may be increased to avoid trip, or some critical operations may require a lower value for faster shut down.
Functional and Failsafe Configurations		Standard configuration and failsafe configuration are password protected with unique passwords (Ref. section 3.4.1.3) Calibrate standard configuration Gives the user access to change performance limits. Enable failsafe configuration Gives the user access to failsafe configuration Note: be sure of the rotating direction of failsafe; open or close
Checkout and Confirmations		In order to exit Setup Window click the close button The configuration is auto saved when Setup Page is closed

5.1.5. Operational Modes

The different operational modes are pre fixed operation programs designed to suit LWETT operations. By being able to select between several modes containing different safety and limit features, the operation can be conducted with high safety.

Two modes are available: *Manual* and *Multi Turn. In addition a gearbox mode is available for operation of class 7 gearbox.*

Manual:

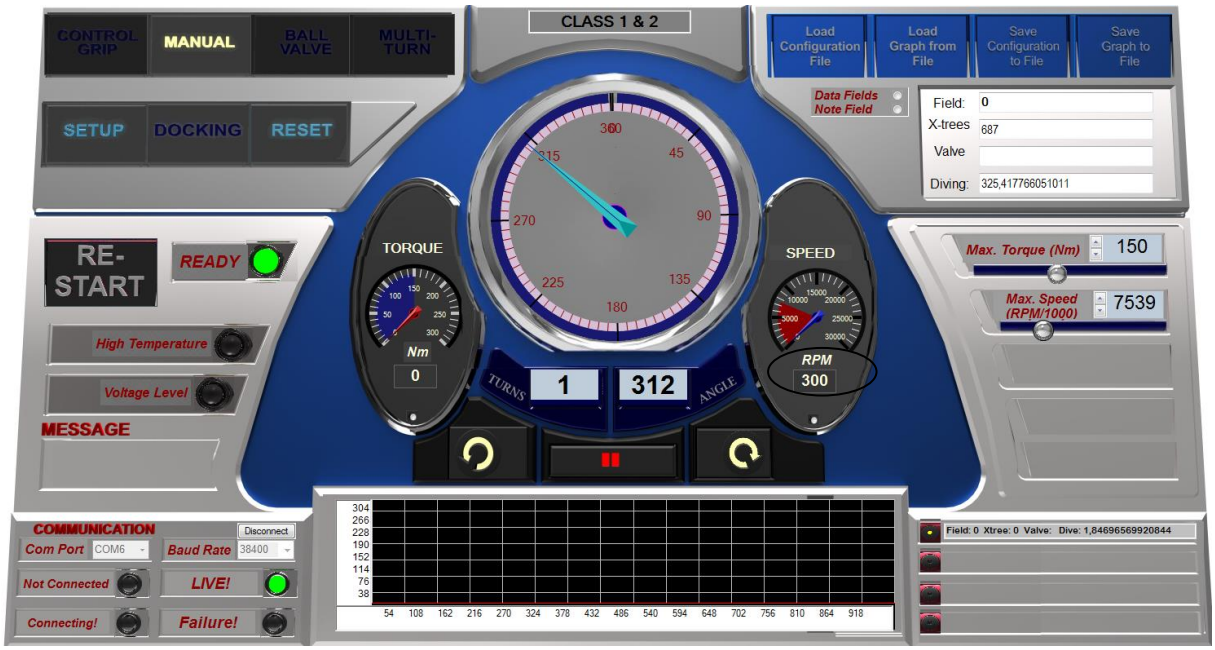


Figure 18: GUI Manual Mode

In Manual mode the LWETT will start continuously running according to selected speed. If required torque is higher than selected torque, actual speed will be lower than selected speed. Tool output will be stopped when stop button is engaged, or selected torque limit prevents running. Target position or number of rotations cannot be set in this mode.

Multi Turn:

In Multi Turn mode the operator can select relative number of turns and rotational degrees the LWETT shall run before it stops. This mode is available first when reset are activated and all positions are set to zero. When in Multi Turn Mode a section in Operation Set Limit Board will appear where to set target position before operation. Set position is relative according to present position.

Ex.: If 2 turns and 126 degrees are set, Torque tool will rotate to the given distance in selected direction.

When target position is reached a new operation will rotate the output shaft the same distance in addition.

E.g.: if 1 turn and 180 degrees are set, and the Torque Tool has reached target position. If a new operation activates with the same settings target position will be 3 turns and 0 degrees. Alternatively, if a new operation in opposite direction is activated target position will be 0 turns and 0 degrees. (See point 3 below).

Speed setting and torque limit may be change during operation.

The Following functions are available in this mode:

1. Stop:
   During operation, it is possible to stop the rotation by pressing the stop button. If target position is not reached the rest of the operation is excluded. Pressing new operation will start a new distance according to selected rotational distance.

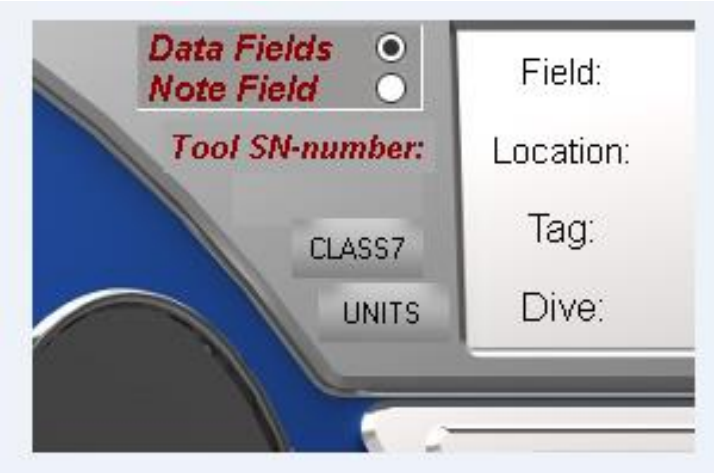
2. Freeze:
   If freeze is selected operation will stop temporary. A blinking message will indicate that temporary stop is activated, and the freeze button text will change to “unfreeze”. Selecting the unfreeze button will continue the operation until target position is reached.

3. See target absolute position.
   When relative move is set, the absolute target position can be shown by holding the mouse pointer over the start buttons. (Either clockwise or counterclockwise). Target position is shown in the miniature Turns and angle windows.

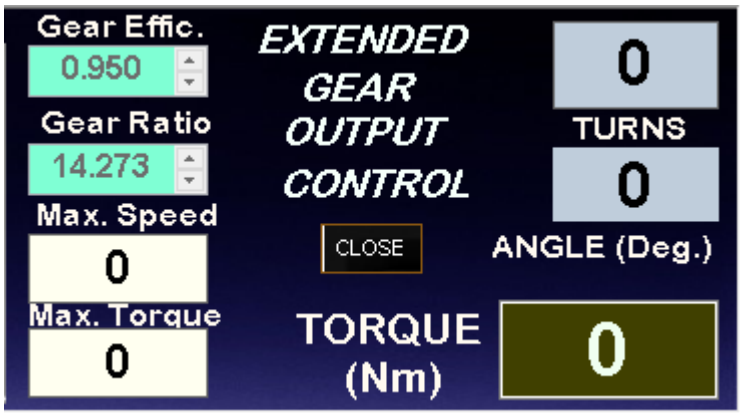
4. Change target position during operation.
   If new target position is changed during operation, output shaft will start to rotate towards new target automatically. If actual position is beyond new target position rotation, will immediately change direction and move towards new target position.

Class 7 Gearbox Mode

By activating this mode, the turns and torque output will be displayed as actual output values for the gearbox. Hence torque and turns will be presented as calculated values based on a gear ratio of 14,273.
The gearbox mode is available from the archiving board; press the button labelled CLASS 7 to enable gearbox mode.



A new window for gearbox information including actual turns and torque will appear at the lower right corner of the GUI when activating the gearbox mode. Max. speed and torque output can be set in this window. Gear efficiency and gear ratio is pre-set and not available for adjustment, password protected.



6. AUXILIARY EQUIPMENT

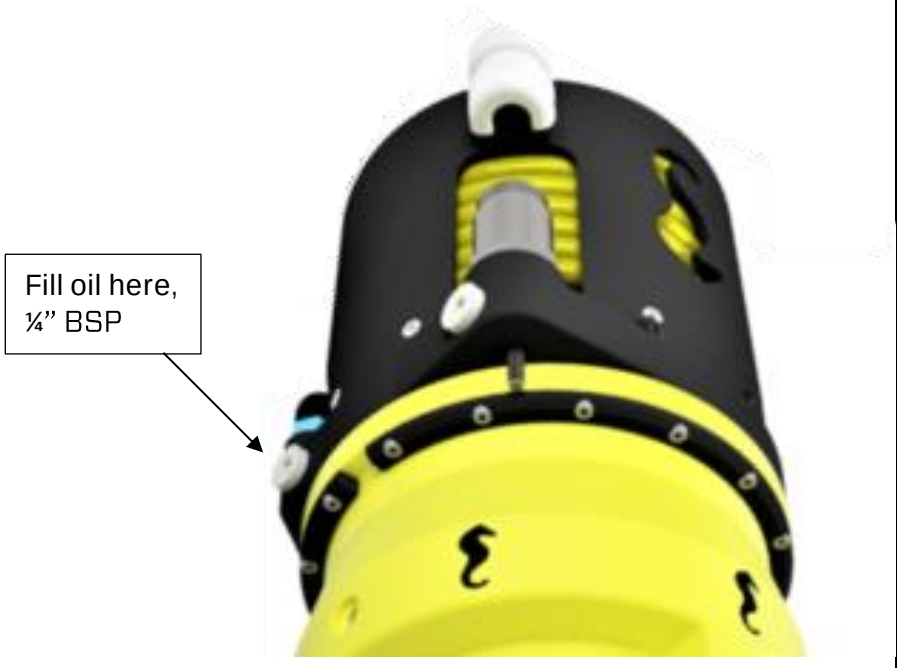
6.1. EQUIPMENT MATRIX

Equipment	LOGISTICS	MOBILIZATION	DE-MOBILIZATION	PRE DIVE PREP.	POST DIVE PREP.	OPERATION	MAINTENACE
Typical Tools. Allen Keys, Wrench and sockets.		X		x	x	x	x
PPE	x	x	x	x	x	x	X
Calibration jig		X					x

7. MOBILISATION/DE-MOBILISATION

7.1. ONSHORE PREPARATIONS

Prior to shipping offshore, a mobilization/ verification check shall be performed. All functions to be tested and verified. The following checklist shall be used as a guideline for activities to be performed prior to offshore mobilization

No.	Description	Check/Verified
01	Inspect Tool (LWETT) for visual damage or unusual wear and tear.	
02	Inspect EPC for visual damage or unusual wear and tear. Special attention should be focused on its connectors.	
03	Inspect Umbilical/Cable for visual damage or unusual wear and tear.	
04	Inspect that the ISO key is secure and fastened.	
05	Assemble the LWETT system and connect to power.	
06	Verify that the LWETT functions can be operated when connected.	
07	Verify that the torque is accurate by use of a calibration jig.	
08	Check that pressure compensation hose is completely oil-filled and no air bubbles. If refill is required, oil can be topped up from the 1/4" plug with one-way valve.  Keep the tool in an up-right position, i.e. output socket down. Make sure to evacuate any trapped air through the hose. Black cover must be removed to access the end of the hose. Max pressure 10Psi.	

No.	Description	Check/Verified
09	Disassemble LWETT and put in transport box.	
10	Verify correct packing and documentation in the transport box. The transport box should include as a minimum Electrical Torque Tool Operation and Maintenance Manual.	

7.2. MOBILISATION PROCEDURE

Item	Procedure
1	Check the condition of the transport box. Repair any damage or replace if necessary.
2	Check all items to be present according to the inventory list.
3	If any, check and follow the check-out procedure before delivering the tool for shipping.

7.3. DE-MOBILISATION PROCEDURE

Item	Procedure
1	Perform preventive maintenance accord ing to /05/.
2	Check the condition of the transport box. Repair any damage or replace if necessary.
3	Check all items to be present according to the inventory list.
4	Fill in EFR if necessary. (To be stored in transport box.)
5	Storage according to chapter 10.3

8. OPERATION

8.1. TOPSIDE OPERATION

Whenever performing operation on deck; do not run tool on full load for prolonged periods.

Observe the Graphical User Interface for temperature warnings.

Consider water-cooling if operation is expected to take time.

Consider ambient temperature.

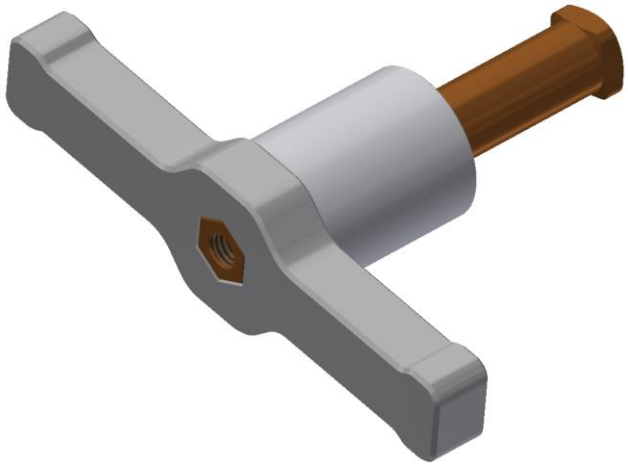
8.2. OFFSHORE PREPARATIONS

8.2.1. Pre-Dive Check

Prior to dive, the Electrical Torque Tool System shall be inspected and function tested.

No	Description	Check/Verified
01	Inspect Tool (LWETT) for visual damage or unusual wear and tear	
03	Inspect Umbilical/Cable for visual damage or unusual wear and tear	
04	Inspect that the ISO key is secure and fastened.	
05	Verify that the LWETT is connected to power	
06	Verify that the LWETT functions can be operated when connected.	
07	Verify torque in calibration jig if available	
08	Verify and test locking mechanism	

8.2.2. Changing the ISO Key

No.	Description	Check/Verified
01	 Use the special key-tool (BB2423) to loosen the socket installed in the LWETT.	
02	Insert the key into the socket and twist to release the locking dogs. Pull out to remove socket.	
	For Class 3 & 4 adapter; CCW twist to unlock	
	For Class 2; CW twist to unlock (Class 2 may require a punch with a soft hammer to remove)	
03	Insert the required socket with the key all the way in. Make sure that the guide slot for indicator pin is aligned	
04	Make sure that the socket clicks into correct position and remove the key.	

8.3. PRE-DIVE OPERATION STARTUP

After communication has been established, the following must be done in order to start an LWETT operation:

- Check set-up settings
- Detect interface socket
- Select operation mode
- Add archiving information

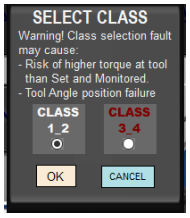
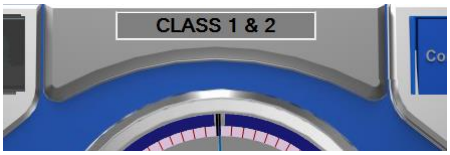
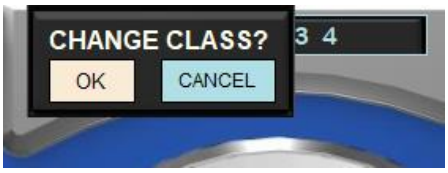
8.3.1. Check Setup Settings

When defining setup settings, the following checklist shall be followed, though not limited to:

No.	Description
01	Max LWETT power consumption set according to host power supply
02	LWETT max motor rpm is set according to highest suitable operational socket rpm
03	Max output torque is set according to operation
04	Max output torque, Ball Valve mode, set according to operation
05	Docking torque set according to operation
06	CW acceleration set
07	CCW acceleration set
08	Break torque end position
09	Seating Torque start position
10	Arrange archiving file structure
11	Verify Failsafe Config

8.3.2. Torque Class Detection

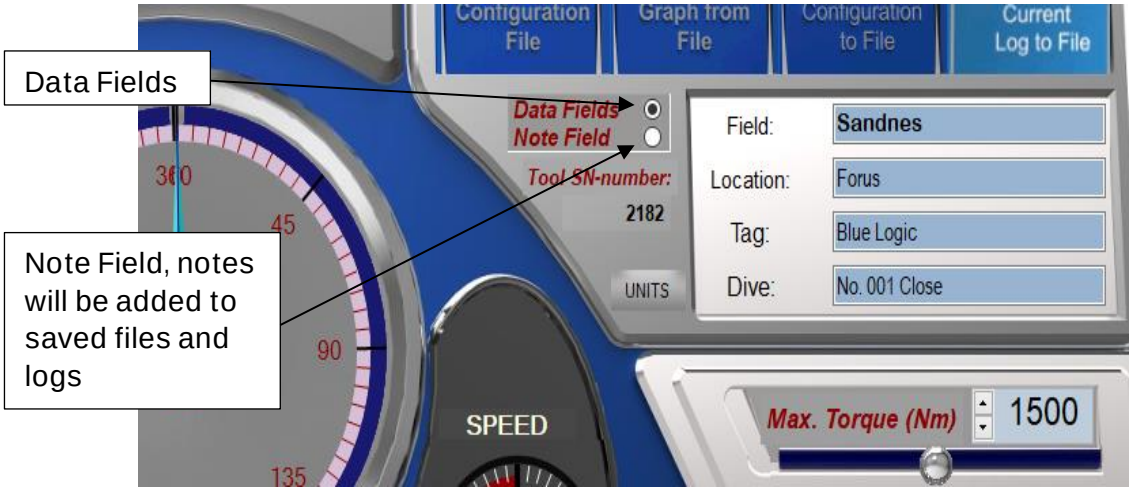
By recognizing socket interface class, the tool will automatically select between Low and High Torque mode. If changing Class socket; always power-cycle tool and restart GUI.

No.	Description	Figure
01	Push Class identification button to detect class. A small motion starts for sensing output socket type.	
02	Confirm automatic or manual class detection	
03	If manual mode is selected chose class, consider warnings and confirm with OK	
04	When selected class is detected, define configuration and limits respectively. Class is shown in top window	
05	Startup is completed and Torque tool is ready for operation	
06	If socket class is not detected, all operations are disabled. (See trouble shooting section; “Not able to Class Detect”)	
07	To change class at a later stage, perform following instructions: Turn off current selected mode. Now the Class Identification button are blinking weakly. Push the button and process class detection as described above	

8.3.3. Add Archiving Information

In order to edit Tag information, select “Data Fields”.

Click in the fields and fill in the texts



The following operations data may be typed in or imported by loading configuration file (See section 8.9.1).

Pressing the button for Note Field a field for notes appear. Here the operator can include notes or free text related to the operation. This text will be included in the Configuration file together with operational data, date and time. (See section 8.9.1).

8.4. SUBSEA OPERATION

No.	Description	Check/Verified
1	Start LWETT Software and communication.	
2	Verify LWETT Engage Latch Handle to be positioned in Mid position.	
3	Adjust max torque value according to equipment to be operated.	
4	Dock LWETT into selected location. If TT does not interface valve bucket due to un-alignment of valve stem and interface socket, start Docking Mode in GUI.	
5	Operate Torque Tool in order to complete operation. Note: If comments to valve operation gains additional track information. Add comments to note board.	
6	Stop Torque Logging	
7	Release Torque Tool from valve bucket.	

When operating at high torque output, make sure to gently reduce torque once completed. Slide the torque bar slowly to relief applied torque. A sudden torque reduction may cause backspin in gearbox. This is crucial during any operation using external gearbox and during torque calibration on deck, with or without gearbox.

Future software update to include auto-reduction of torque.

8.5. POST DIVE CHECK

No.	Description	Check/Verified
01	Recover LWETT equipment to deck.	
02	Perform a visual inspection Electrical connector Output socket Latches ROV handle and latch mechanism Surface treatment Compensation hose and oil level/air bubbles	
03	Flush all equipment thoroughly with fresh water.	
05	Dry off equipment and apply protective oil, WD40 or similar, prior to storage	

8.6. HOOK-UP AND COMMUNICATION

The LWETT System is easily installed to its host, connect the Torque Tool to EPC. When the program is started, communication must be established and verified (see table below).

Figure 19: Communication Board

No.	Description
01	Select com port
02	Press Connect
03	Connecting!: Yellow – Connection in progress. LIVE: Green – communication with Torque tool established. Failure!: Red – Communication with Torque Tool failed. (See trouble shooting section; “Communication problems”).

8.7. LWETT OPERATION

8.7.1. Operational Controls

This section describes general operation controls for start, stop and adjustments:

	The right and left arrows will start rotation in direction as indicated (clockwise or counterclockwise). If the symbol is steady lit the LWETT is ready to operate.
	If any symbols are dark, the ELTT is unable to perform that operation. Typical If the system is not ready or no mode has been selected.
	Only valid in speed mode. Symbol light rolling. This occurs when button is clicked (NOT double clicked) and left mouse button is held down. Output shaft rotates clockwise according to torque and speed settings and stops when left mouse button is released.
	Output shaft rotates clockwise according to torque and speed settings, even if the left mouse button is released. (To stop rotation stop button needs to be pressed, or target position are achieved.)
	If stop button is dark the operation is not valid : - No rotation started - No mode set - System not ready
	The stop button light is steady red when output shaft rotates. Pressing stop button will stop the rotation. To activate soft stop according to the set deceleration, press stop button once (do not double click). Stop button will start blinking until rotation has completely stopped. To activate quick stop, double click the button

8.7.2. Unit settings

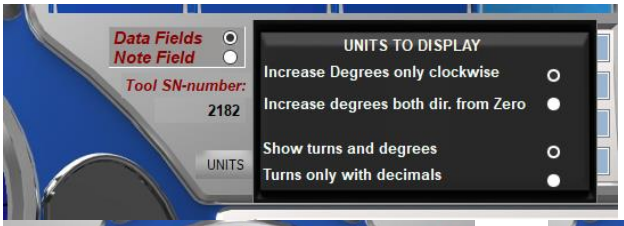
Two units are selectable:

1. Turns and degrees.
2. Turns with decimals *** Work In Progress, not yet functional ***

The position instrument and angle number reports position as an absolute protractor i.e. that during a counter clockwise operation degrees goes from 359 – 0. This may be a bit confusing since if you will go 45 degrees from 0 counter clockwise, the instrument and angle will show -270 degrees.

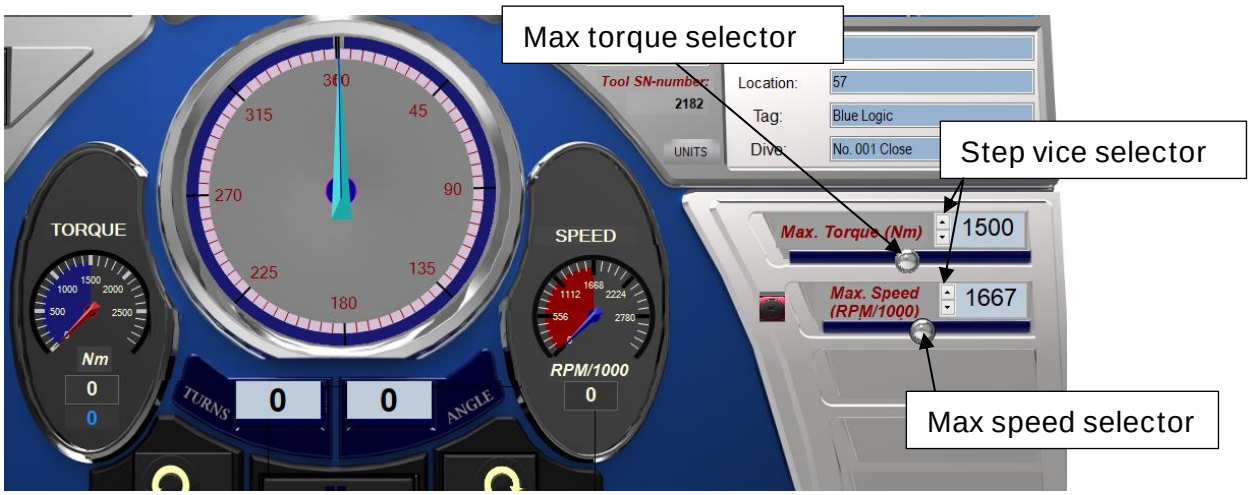
Default unit are “Increase Degrees only clockwise” The position instrument shows the outputs sockets absolute position. If distance to run are 45 degrees counterclockwise from zero, the needle will stop at 270 degrees. To achieve the same output socket rotational position by running clockwise the distance must be 270 degrees.

If you select “Increase degrees both dir. From Zero” the instrument will change scale when passing 0. This means that Instrument and angle number will show correct proceed distance from 0 in both directions. Counterclockwise side of zero will appear with (-) sign. Valid in both units. Here set angle value will always respond with angle position value and instrument value.



8.7.3. Adjustment Operations

In every mode and before or during operation, Torque limit and speed can be adjusted in the Operation Set Limit Board or Command and Operation Dashboard



Adjustment can be performed by pressing and dragging the slider handles in the Operation Set Limit Board, or by clicking the one-step vice selector. Values can also be typed directly in the Operation Set Limit Board.

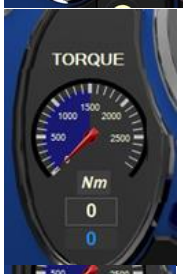
Maximum values are limited by the absolute max values set in Setup Window (see section 5.1.4). If a higher value is typed, the value will change to predefined absolute max value (for safety reasons). The Slider bar range will always be adjusted according to the predefined absolute maximum value in the setup.

8.7.4. Torque and Speed Monitoring (Meters)

Instrument range:
Range for instruments is defined by absolute max values set in the setup window.

Marked area:
Marked area in instrument are defined by selected max value set in the Operation Set Limit Board (Section 3.4.1.2).

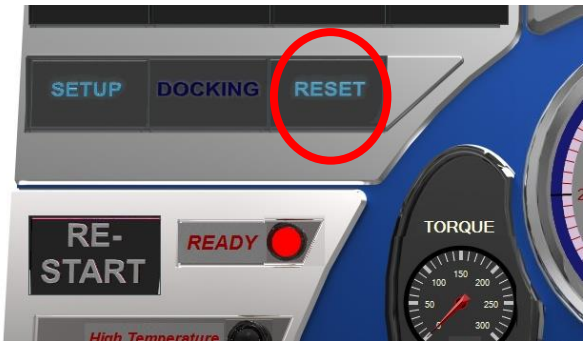
Meter needle:
Meter Needle show measured instrument value. (Also given in text below instrument).



Torque limit verified:
Torque limit shown in blue below the instrument are Torque limit load from control POD (safety control). Shall be equal to Torque limit set in Operation Set Limit Board

8.7.5. Reset Socket Position

Pressing reset will set actual output socket position to zero.



8.7.6. Diagnostics and Restart

The LWETT System Diagnostics contain continuously monitoring of the following parameters:

- El-Pod temperature
- Transistor cooling block temperature
- Actuator temperature
- Main Supply voltage
- Motor current
- Performed Torque
- Motor position
- Actuator output shaft position

Warnings according to the above list will change the “Health” lamp to yellow, and specified details will occur in the “MESSAGE” window.

Error will change the “Health window” to red and operation is shut down. Exception is if detected error is disabled. (see section 3.7.7)

Specified details will occur in “MESSAGE” window.

If high temperature is detected, reset will not be possible until acceptable temperature is reached again.

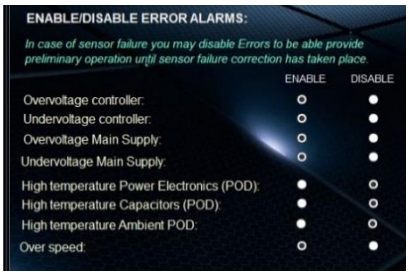
8.7.7. Error Shut Down Override Function

If sensor failure occurs, operation may shut down and the tool will be impossible to operate.

If it is obvious that sensor value is a result of sensor failure, shut down function can be overridden by disabling respective sensor in Setup; advanced settings (Section 3.1.4; Advanced Settings).

If error is disabled in Setup, and confirmed by operator during startup, error message will still occur, but operation will not be shut down.

In addition to the error message in the message window a blinking message will appear below the message window to notify the operator that error shut down is overridden. If one or more errors are disabled at startup and the operator decide to have all errors enabled select “Enable all errors” and continue without entering setup.



Pressing the restart button will reset the error and reactivate the tool. The ready lamp will change from red to green. If the error reset is not possible as a result of hazardous failure, the ready lamp will stay red and error message will remain. (See section 3.7.6).

8.8. XLS TORQUE REPORTING

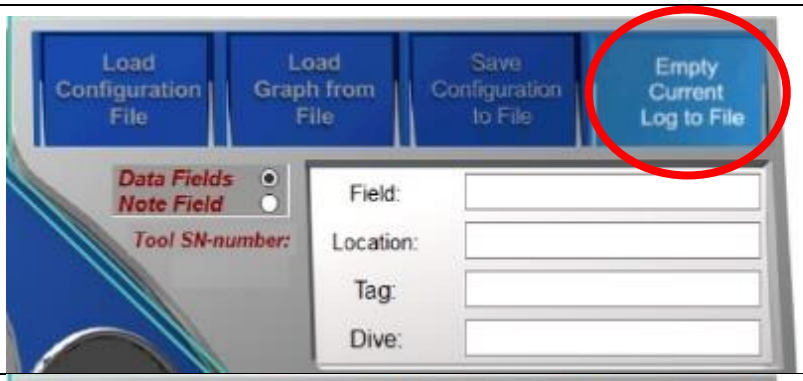
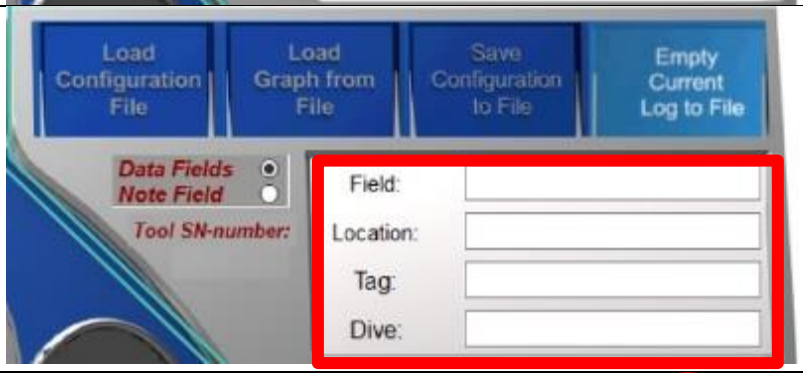
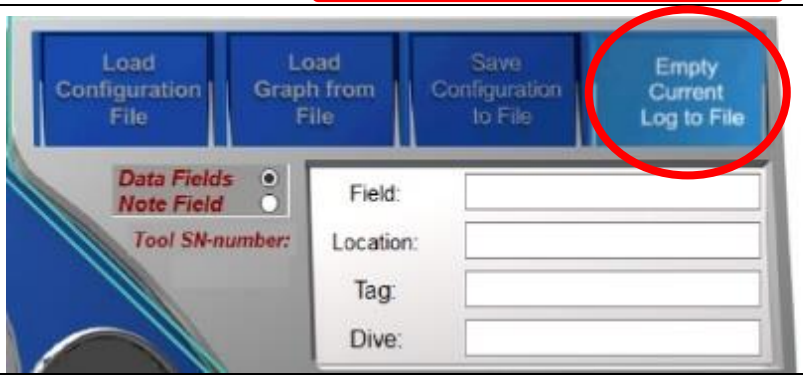
The logging function is divided into 3 levels:

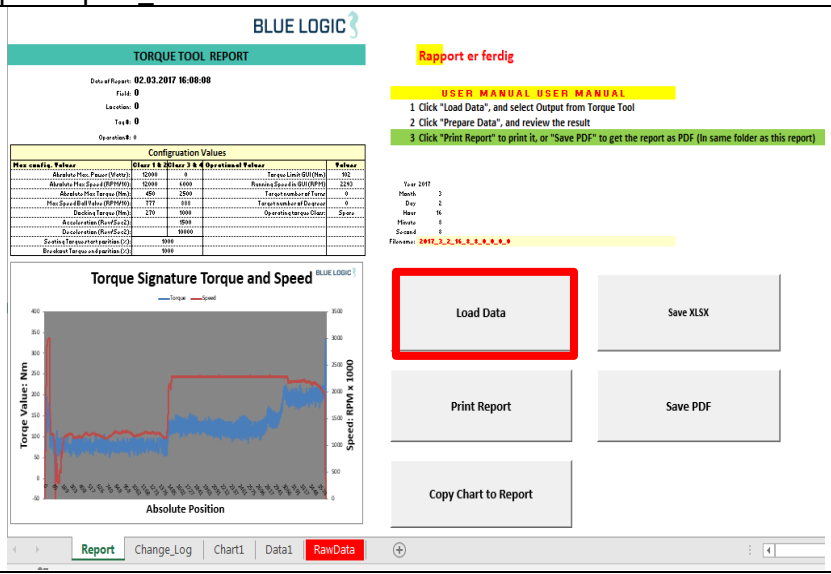
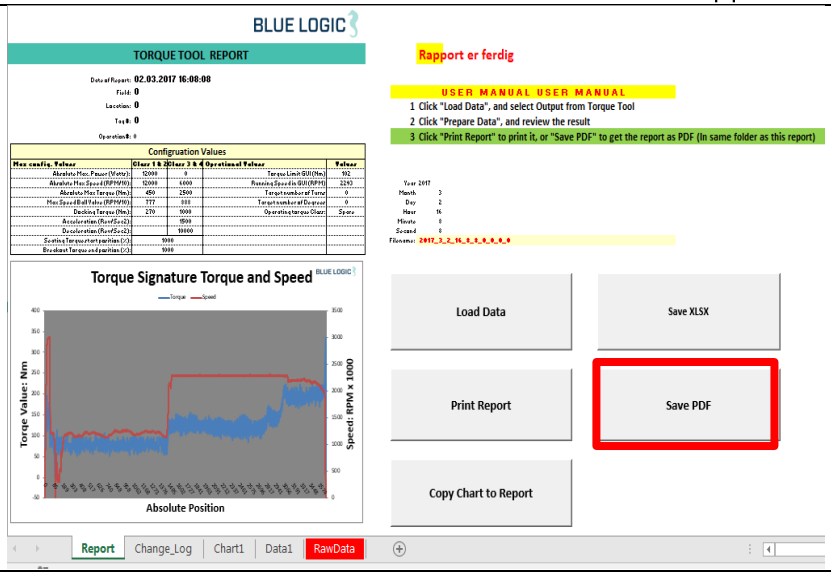
1) Tool Level: Everything done with the tool (automatic)
2) Log Level: one file for every active change in “Archiving Information”
3) Start Stop Level: every time you push “Save Graph to File” button.

All of the 3 files can be printed to a report in .xls file

8.8.1. Generate Operation Report (PDF)

Use the following sequence to generate a PDF rapport:

1	Click the “Empty current log to file” in the Archive Board (see Figure 16)	
2	Enter data in the Data Fields	
3	After operation: Click the “Empty current log to file” in the Archive Board (see Figure 16)	

4	Open the following Excel file: E:\Torquetool log files\Torque Import_rev4.xlsm	
5	Click the “Load Data” button	
6	Open the following Excel file: E:\Torquetool log files\” Choose desired date folder” \” Choose desired .xlsm rapport”	
7	Click the “Save PDF” button The PDF is saved in the relevant	

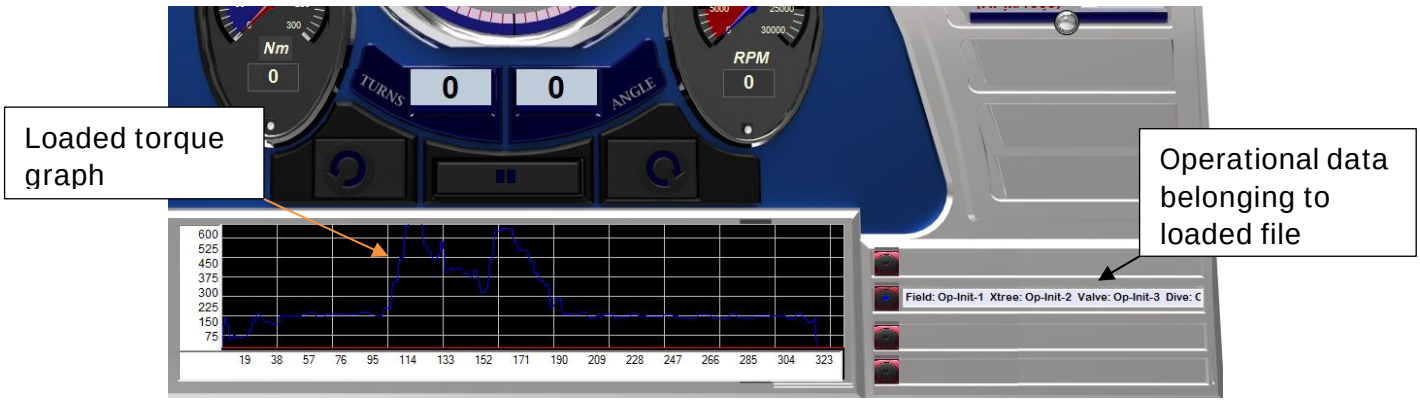
8.8.2. Save or Print Report

In order to print the entire report, the user must select all the tab at the same time:

First select the “Report” tab hold down the “Shift” key on the keyboard and click the “Data1” Tab, now all tabs are white and will be printed or saved to PDF. When all tabs are selected, a change in the spread sheet cells will make a change to the call of all the tabs at the same time. It is important that you unselect the sheets after print or Save, hold shift and click on “Report” tab.

8.8.3. Load Graph from File

It is possible to load a previous graph to the display:



The loaded graph will appear in the graph window and torque-position ranges will be adjusted accordingly. Operational data for the loaded graph appears in the side window.

8.8.4. Report Front Page

All operational configuration parameter will be included in the top section:

TORQUE TOOL REPORT

Date of Report: **02.03.2017 16:08:08**

Field: **Sandnes**

Location: **Forus**

Tag #: **Blue Logic**

Oparation#: No. 001 Close

Configuration Values

Max config. Values	Class 1 & 2	Class 3 & 4	Oprational Values	Values
Absolute Max. Power (Watts):	12000	0	Torque Limit GUI (Nm)	102
Absolute Max Speed (RPM/10):	12000	6000	Running Speed in GUI (RPM)	2293
Absolute Max Torque (Nm):	450	2500	Target number of Turns	0
Max Speed Ball Valve (RPM/10):	777	888	Target number of Degrees	0
Docking Torque (Nm):	270	1000	Oparating torque Class:	Spare
Acceleration (Rev/Sec2):		1500		
Deceleration (Rev/Sec2):		10000		
Seating Torque start position (%):	1000			
Breakout Torque end position (%):	1000			

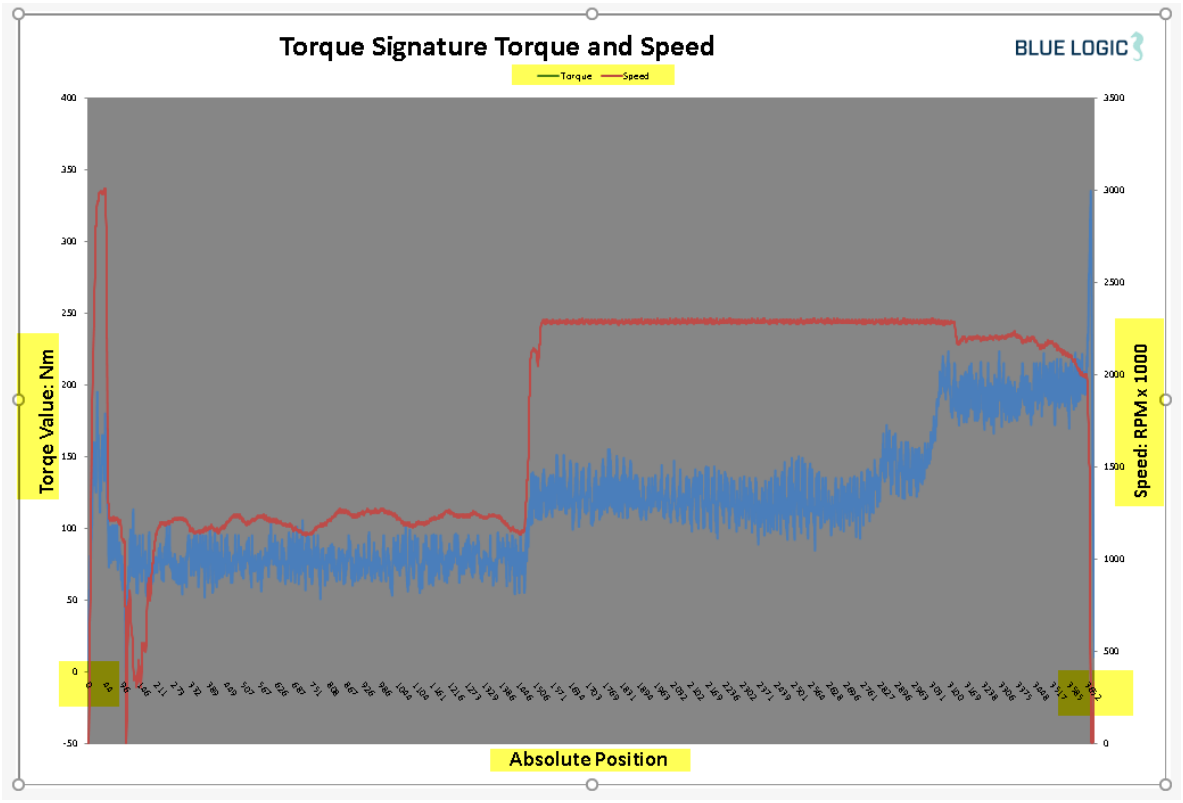
The max configuration values should be the damage torque and the Operational values should be the running torque of the task at hand.

8.8.5. Chart

The plot of a torque job is presented in a 2D chart. Both Torque (Blue) and Speed (Red) are plotted.

The speed value is plotted in the same value as input on the tool RPM multiplied with 1000. E.g. a plotted speed of 2500 is equal to an RPM of 2.5.

On the X-Axis the Start position and stop position is plotted as a value of 3663 degrees divided by 360= 10,18 revolutions, or 10 revolutions and 63 degrees.



8.8.6. Automatic Filename Calculation

Year	2017
Month	3
Day	2
Hour	16
Minute	8
Second	8
Filename:	2017_3_2_16_8_8_Sandnes_Forus_Blue Logic_No. 001 Close

Year, Month, Day, Hrs, Minute, and second + the for location parameter.

8.8.7. Change Log

All key strokes by the tool operator is logged. The Tool position, time stamp, torque value, speed and system action, and manual notes will be included in the change/event log.

BLUE LOGIC

TORQUE TOOL REPORT

Date of Report: **02.03.2017 16:08:08**
Field: **Sandnes**
Location: **Forus**
Tag #: **Blue Logic**
Oparation#: No. 001 Close

Change Log

Absolute Pos	Time Stamp	Torque	Speed	Action
0	02.03.2017 15:56:01	0	0	Sys_Class manual selected
0	02.03.2017 15:56:05	0	0	Sys_Manual Mode Set
0	02.03.2017 15:56:07	0	0	Sys_Start Clockwise
0	02.03.2017 15:56:07	0	0	Sys_Start Clockwise
0	02.03.2017 15:56:07	0	0	Sys_Start Clockwise
105	02.03.2017 15:56:19	69	1103	Sys_Stop
108	02.03.2017 16:01:38	0	0	Sys_Start Clockwise
108	02.03.2017 16:01:38	13	4	Sys_Start Clockwise
133	02.03.2017 16:01:46	66	368	Sys_Start Clockwise
133	02.03.2017 16:01:46	66	368	Sys_Start Clockwise
134	02.03.2017 16:01:46	67	364	Sys_Start Clockwise
134	02.03.2017 16:01:46	67	364	Sys_Start Clockwise
134	02.03.2017 16:01:46	75	366	Sys_Start Clockwise
134	02.03.2017 16:01:46	75	366	Sys_Start Clockwise
3664	02.03.2017 16:07:53	90	39	Sys_Stop

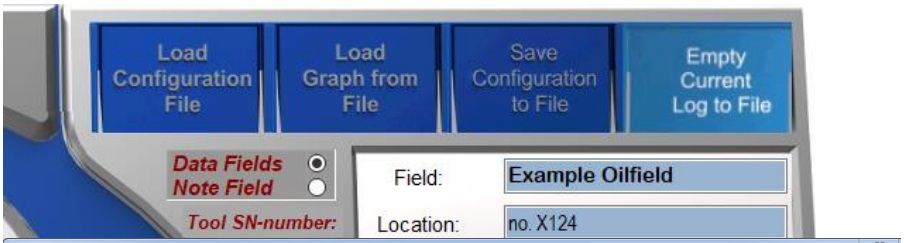
All reports will also have a time stamp of when they were printed to the csv file.

8.9. PREDEFINED OPERATIONS

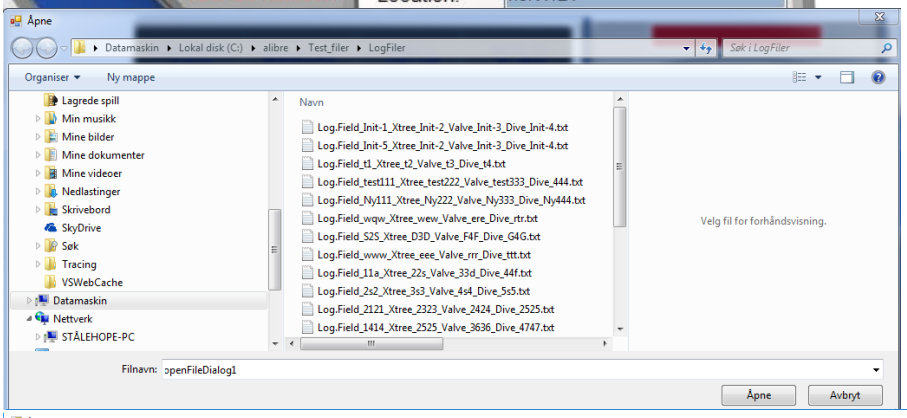
It is possible to predefine an operation by manipulating certain files.

8.9.1. Save to/load from Files

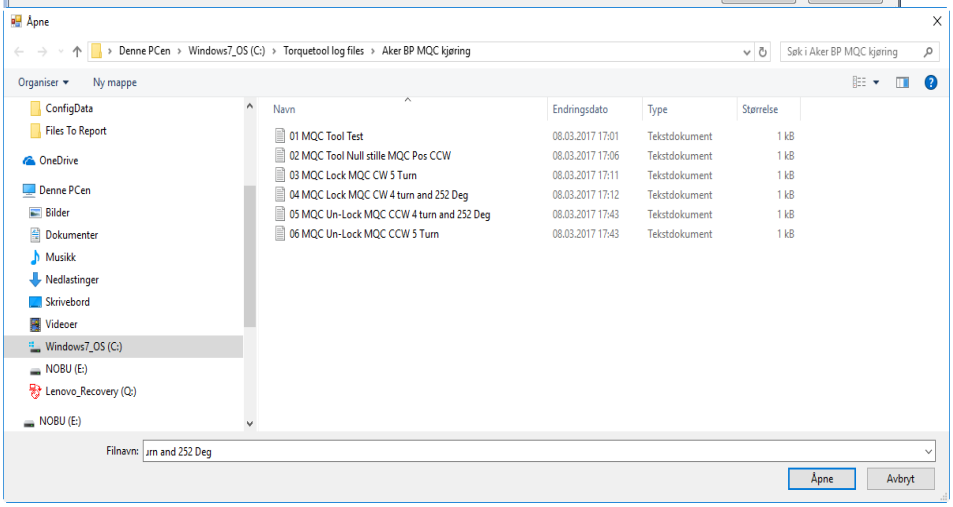
Configurations, torque-position graphs can be loaded from file or saved to new files. Filename will contain operational data. File folder can be defined in the setup window. Otherwise, a folder will automatically be established on the C-drive, with relevant subfolders.



Select «Load Configuration File» to load



Select desired files for loading



Select desired files for loading

Predefined or default folder is shown in the open window. Since operational data is part of the filename, it should be easy to select the relevant file. When the file is selected, press “Open”. The configuration is imported and data in the setup window will be updated.

It is important to verify that the intended configuration file is correct loaded since configuration files contain limits. These limits can have a huge impact on ELTT performance.

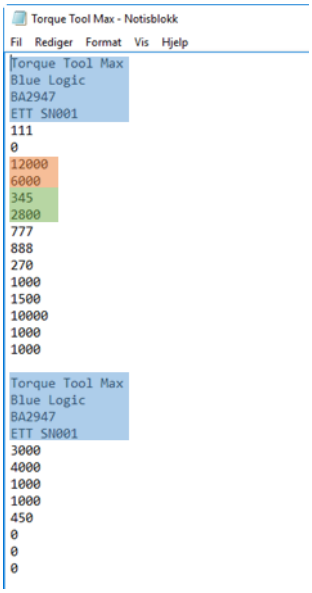
Press Setup and check configuration data.

All files saved in txt format.

When each operation is completed a graph-file are automatically saved to a folder named the current date, in E:\Graphfiles\.

(E.g. E:\Graphfiles\2019.3.26\ReportLog.Field_Location_Tag_dive_3.txt)

8.9.2. Preparation of Configuration Files for Each Activity



First 4 lines of the torque report (in blue)

Class 1-2 Max speed (in orange)
Class 3-4 Max speed (in orange)

Class 1-2 Max Torque (in green)
Class 3-4 Max Torque (in green)

Note: the colors do not appear in notepad

Open in Note pad to adjust.

In order to prepare the ROV operation it can be valuable to prepare separate files for every torque operation. That way it is much easier to change wording on the torque graph reporting during the offshore campaign.

See example below:

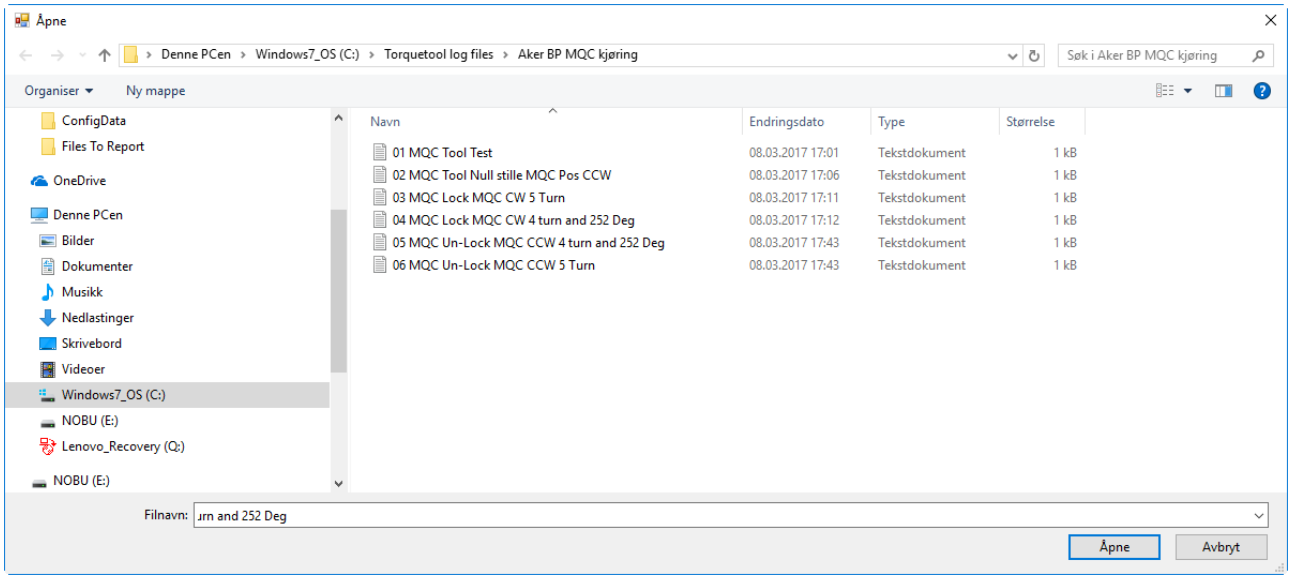


Figure 20: Example files

9. TROUBLE SHOOTING

9.1. GENERAL

In case of loss or bad operation, failure in log file production or GUI application crash, the following are helpful to localize and solve the problems.

9.2. LOSS OF CONFIGURATION

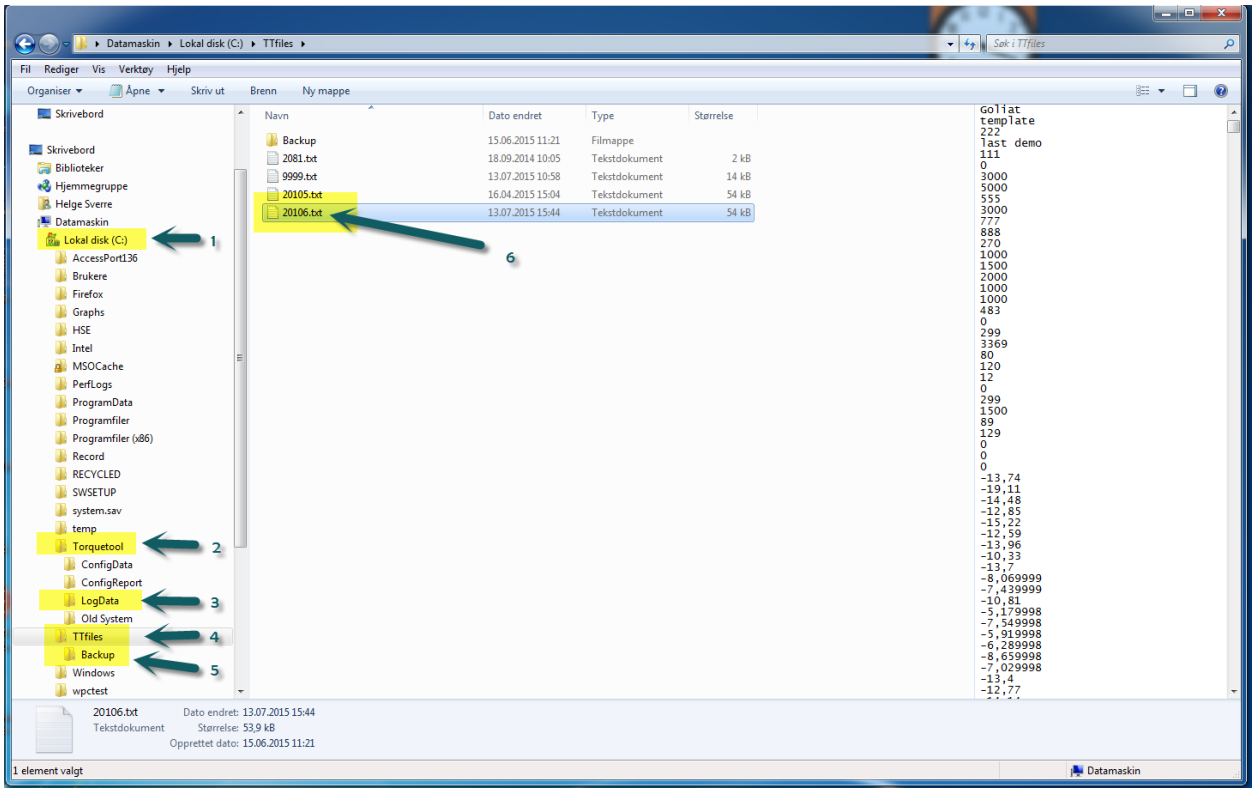


Figure 21: Torque Tool Files

If for any reason the system configuration is lost or corrupt you will not be able to boot the Torque Tool.

The following message will appear:

If a valid Configuration file is present as Backup select “Abort” and follow the instruction.

Overwrite the corrupt configuration file using the backup configuration file:

1. From the backup folder, copy the specific torque tool configuration file
2. Paste and overwrite the corrupt configuration file in the TTfiles folder located on the C: drive

NOTE:
The configuration file is named e.g. “20105.txt” as shown in Figure 21. This name is specific for each torque tool

9.2.1. Generate New Backup File

If Backup file are missing or corrupt you need to create new configuration file as follows:

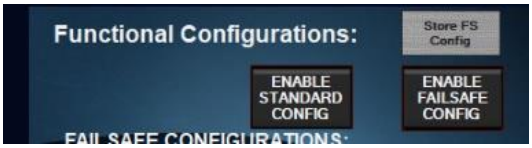
Select “Create new configuration file”. Following window appears:

Alternative 1:

"Load configuration from file" are selected.
Main limits will automatically be loaded and can be monitored by entering Setup window.
Still, advanced settings need to be manually written.

Alternative 2:

Manually adding Configuration data using setup.
Open Setup window.
Enable write data by selecting "Enable Standard Config"
Followed by valid password. (see section 3.4.1.3)
Write configuration data into all fields including advanced settings.
If Failsafe functions are present, select Enable failsafe config.
Write failsafe config data. And select "Store FS Config".



NB! Shaft position sensors calibration will be lost.

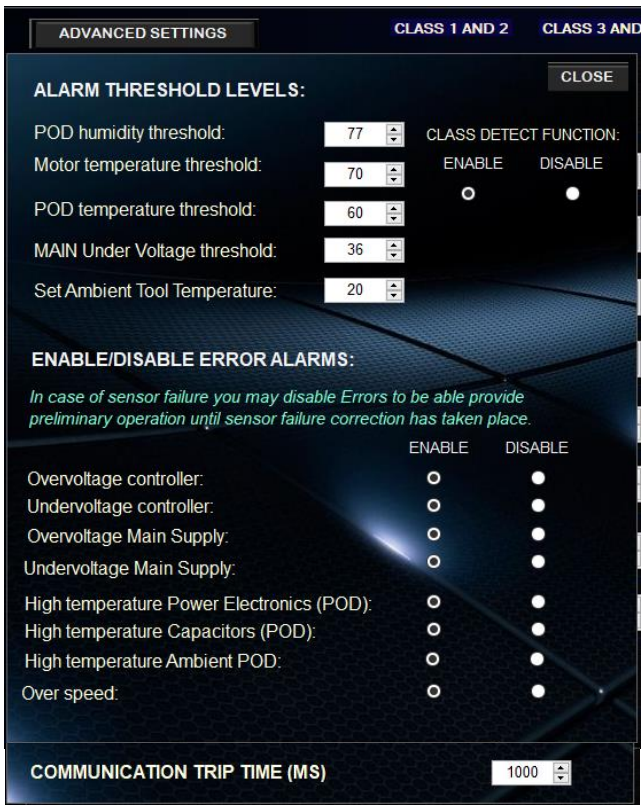
Execute shaft position calibration as follows:

Close Setup. Following window will appear blinking

Select Manual mode.
Ensure the tool are equipped with class 3-4 socket, and that
Class 3-4 mode are selected.
Ensure no load at the tool shaft.
Start manual CW operation with speed approx. 200.
After approx. 3 turns the calibration windows will disappear.
Stop operation.
Close GUI.

Setup data and calibration data are now stored in new Configuration file.

Default "Advanced Settings" data:



9.3. TROUBLE SHOOTING TABLE

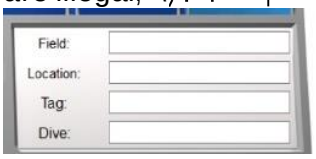
Error message/ behaviour	Explanation	Recommended action
Position sensor fault	Occurs if serial communication between POD's controller and position sensor controller are lost or poor. (Sensor failure has no impact).	See section Error! Reference source not found..
Motor overload	Occurs when motor current exceeds current threshold set in POD's controller	See section 9.3.1
Motor over temperature	Occurs when tool temperature exceeds tool temperature threshold. (Typical if tool has reached end stop and continues performing high torque over time).	Measure surface temperature at tool. Is the temperature close to reported motor temperature? Yes: Cool down. No: Change motor *over-temperature* threshold setting in GUI. OK? No: Motor temperature sensor failure. Change MENC-LS. (Ref. Section 5.1.4; Advanced Settings).
Motor over speed	Occurs if motor speed exceeds the max speed threshold set in POD's controller (Typical reached if spring force rotate rotor with high energy when motor is disabled, or very quick loss of load occurs.	Reduce acceleration and deceleration in Setup OK? No: If possible, reduce set speed and torque to avoid external force back drive. OK? No: Increase parameter 21 (Using MEFCASIM. (Ref. parameter 21 in Extended protocol TT - SEFA protocol v1.1)

Motor Driver tripped	Occurs when motor current exceeds motor Drivers hardware fuse limit.	Reset error. OK? Yes: Reduce performance if possible. OK? No: Follow procedure in section 9.3.1 Reset error OK? No: Power stage failure. Transistor shortened. *<u>Note!</u> Frequently repeated errors may cause major control system damage.*
Main overvoltage	Occurs if measured main voltage reaches a dangerous high level	Main overvoltage shall not exceed 500VDC. Reduce external back drive force. (Typical valve spring force).
Main undervoltage	Occurs if measured main voltage reaches a dangerous low level	Check Main undervoltage threshold in Setup Advanced settings. OK? No: Check if System power supply are sufficiently dimensioned. 110VAC min.1500W 230VAC min.2000W. OK? No: Increase power supply power or reduce performance settings. OK? No: Check if voltage drops when tool is enabled, but without any load. YES: Hardware fail; CapController No: Check calibration. (Ref. Section 5.1.4; Advanced Settings).

Controller overvoltage	Occurs if measured controller level reaches a dangerous high level	Open POD: Measure MENC- is 24VDC output. OK? YES: Replace Servo controller. OK? No: Replace MENC-ISI.
Controller undervoltage	Occurs if measured controller level reaches a dangerous low level	Open POD: Measure MENC- is 24VDC output. OK? YES: Replace Servo controller. OK? No: Replace MENC-ISI.
Communication lost	Occurs if POD's controller has not received any data from GUI during 1 second after communication is established.	Check system communication device. (Typical MOXA usb/RS232 unit). Are output LED on the device blinking? No: Change unit. OK? Yes: Check communication cable configuration according to wiring diagram. OK? No: Open POD. Measure 24VDC input to Servo controller. Are 24VDC present? Yes: Change Servo controller. No: Change MENC-ISI.

Poor communication	GUI sends approximately 50 data packets per second to POD's controller and POD's controller sends same amount of data packets to GUI. Controller and GUI verifies the data packets validity using Checksum. Number of data packets approved and failed are counted and the percentage of failed packets vs approved are calculated. If the failure percentage reaches a certain level poor communication error are shown and communication are stopped.	Check communication send /receive duration time and fault rate. See section 9.3.2 Check RS232 communication cables shield and ground, and POD shield and ground. OK? NO: Replace system communication device. OK? No: Replace Servo Controller.
Communication failure	If GUI's communication with the topside communication device (port) fails, communication shuts down and communication failure is indicated.	Check port settings in windows device manager. Are Selected Com number present in the device manager? No: Are there any com ports available in device manager? No: Reconnect communication device. OK? No: Update communication device drive and reconnect. OK? Yes: Try to connect with the present Com number. OK? No: Change the communication device and try again.

Data not present in Setup	Configuration file is corrupt. (See section 9.2)	When “connect” is activated “Tool SN-Number” are shown. Open explorer and go to C:\TTfiles”. Open the file with the same name as Tool SN-number. If all numbers on first page are 0, copy the file with the same name from folder C:\TTfiles\Backup. OK? No: Continue and open “Setup”. Write all data manually in setup and close GUI. Reopen GUI and connect.
Class detect failure	No relative deviation between motor position sensor and socket position sensor occurs during class detect operation.	Check that a socket is mounted. OK? Yes: Make sure that tool is turning freely. (No load). OK? Yes: Select class manually. Operate tool and check that position feedback works correctly. OK? Yes: Close GUI. Open GUI and run class detect. OK? No: Open setup and check value in “class detect value”. If 0 increase the value to approx. 40. Try again. OK? No: Increase “class detect value” further. OK? No: Select class manually and run speed in manual. Check that

		mechanical position indicator turns. OK? Yes: Check output shaft calibration using calibration GUI. OK? No: Recalibrate output shaft. Yes: Increase further.
Socket position failure (Output shaft position sensor).	When starting and stopping manually or multiturn operation the GUI's position meter performs a jump larger than 1-2 degrees	If motor unit has been opened there is a risk that the output position sensor shaft is mounted 180 degrees offset since calibration was performed. If so, recalibrate output shaft position sensor using calibration GUI. Thereafter a fine position calibration must be performed using the GUI. When this calibration is completed data is stored automatically when GUI is closed.
Failure in Log file production	When operation has been performed and button "Empty current log to file" has been operated no file are generated in folder: E:\\Torquetool log files\(Current date)".	If a character is typed here that is illegal for wiring filename the file generating will be excluded witout any notice. Following characters are illegal; \/:*?"<>| 

When operation is activated but no torque is output, motion or error message occurs	No failure identified. May be hardware failure, calibration failure or parameter setting failure.	This an abnormal situation where the following action should be taken: If possible, operate output shaft using external force to verify if the position sensor operates correctly and in correct direction. OK? Yes: Open calibration GUI and run; Motor position sensor; “Load graph”. Observe visually that motor turns during this operation.
Motion or torque is performed when communication is lost or disconnected	Failsafe mode are unintentional activated. Motor runs in a given direction using torque and speed values defined in parameters.	Open Setup in GUI and enable failsafe config. Select failsafe mode “Fail as is, motor off”. Close setup and close GUI. Reopen GUI and try again. OK? No: Repeat above.
Motion is performed with fixed speed and only in one direction	May occur as a result of calibration failure.	Serious calibration error; Open calibration GUI and check motor position sensor calibration. OK? Yes: Commutation number may be wrong. Check Commutation number (See section 3.4.1.4 Operation times and Motor data). Is the Commutation number equal to the latest documented Commutation number? No: Type the correct Commutation number (HallCAlibrate using Mefca Simulator) and store. Try again. OK? No:

		Recalibrate. OK? No: Check motor windings. OK? Yes: Try another tool. OK? No: Change Servo controller. OK? No: Change Power stage.
DC-bus voltage drops rapidly when operation mode is activated, and the tool is loaded.	Hardware failure or power supply failure.	Check a different tool system connected to the same power supply. OK? Yes: Probably Cap controller failure. (POD hardware failure)
No error messages, but torque and speed are significant lower than selected limits	Parameter “Max-PWM” may be set low. Reduces general performance	Use MEFCASIM and check parameter Max_PWM. If < 15000 adjust to 15000 press “W1” write and store to flash. Try Again

9.3.1. Motor Overload

1	Check output torque present when overload occurred. If above 2700Nm, reduce torque limit and/or speed, restart and try again. OK? No: run the tool without load for 5 minutes @ speed 2500. Try again. OK?
2	If torque is less than 2600Nm when error occurs check current limit parameters and increase to max. 7800. OK? No: Open calibration GUI. Load graph for Menc-HS. Check deviation. OK?
3	Perform Total calibration. Calibration succeeded? No:
4	Open motor and check magnets regarding metal chips and magnets position. Remove chips and make sure correct position. Calibrate again. OK?
5	Magnet failure or sensor board failure. Load graph when Mag-Sense A are selected. Repeat with mag sense B. Compare graph's with previous stored Mag-Sense graph if possible. Are graph's similar? Yes: Position sensing OK! No: Check rotor friction. OK? Yes: Change magnet. No:
6	Reduce rotor friction to normal and calibrate. OK? No: Change Magnet. OK? No:
7	Check motor winding resistance according to wiring diagram and motor datasheet. OK? No
8	Replace Power stage in POD
(Ref. parameter 22 and 27 in Extended protocol TT - SEFA protocol v1.1)	

9.3.2. Slow Communication

Torque tool communicates at Baud rate 38400. Each command or request packet to/from POD will normally use (((1/38400)*8 (bytes)*8(bits)*2(1send+1receive) = 3,3ms. Processing time in each side need to be added to achieve communication cycle time.

Normal cycle time will be approx. 4-5 milliseconds.

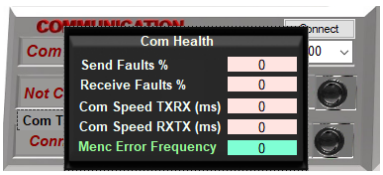
Most commands include speed command (Manual mode) or position command (Multiturn mode).

Following cycle times are estimated to be:

Speed and position command	10 ms. (100 times/sec.)
Torque limit command	150 ms. (6-7 times/sec.)
Speed, position and torque monitor	10 ms. (100 times/sec.)
Warning error update and sensor updates	150 ms. (6-7 times/sec.)

If communication lines are distributed through several converters additional delays may occur. Then if cycle updates appear abnormally slow check communications health and speed by:

Send Faults (%)	Number of data packets sent to POD that are not approved by POD. % are number of faults register each 5 second.



Receive Faults (%)	Number of data packets received but not approved by GUI
Com SpeedTXRX (ms)	Time from 1 packet are sent from GUI till GUI has received responding packet from POD
Com SpeedRXTX (ms)	Time from 1 packet are received from GUI till GUI are sending the following packet

10. LOGISTICS

Verify the following

1. Sender Name and Address clearly visible
2. Receiver Name and address clearly visible
3. Inventory list correct filled out

10.1. HANDLING AND LIFTING

To be lifted in dedicated transportation box. (Fork lift pockets to be used for transportation boxes above 40 Kg).

10.2. TRANSPORTATION

Transport in dedicated transportation box.

10.3. STORAGE

Description
Store the TT system in its dedicated transportation box
Thoroughly coat all exposed surfaces of the Tool with a preservation oil (e.g. WD-40)
Long term storage temperature = 15 deg C

11. MAINTENANCE

The Electric Torque Tool is a simple and robust subsea system with few critical moving parts. There are however a few important inspections points that require attention.

Inspection and maintenance can be performed by the operator, it is however recommended to return the LWETT to Blue Logic for a yearly service, maintenance and calibration.

11.1. DAILY INSPECTION

No.	Description	Check/Verified
01	Perform a visual inspection of LWETT. Special attention should be given to the following: - Hose/cable - Electrical connector - Latch mechanism - ROV handle - Output socket - Excessive wear and tear	
02	Flush with fresh water	

11.2. WEEKLEY INSPECTION

No.	Description	Check/Verified
01	Perform a visual inspection of LWETT. Inspect surface treatment and verify no corrosion. Special attention should be given to the following: - Oil level; verify that compensation hose if oil-filled and no air bubbles present. Ref. section 7.1 for instructions if filling is required. - Seal areas - Hose - Fittings - Surface treatment	
02	Flush with fresh water	

11.3. MONTHLY INSPECTION

No special activities are required on a monthly basis. If the Electrical Torque Tool system has been extensively used and repeatedly exposed to dirt and aggressive fluids, pay extra attention to seal areas. Disassemble front socket and clean thoroughly.

11.4. HALF YEARLY INSPECTION AND MAINTENANCE

No.	Description	Check/Verified
01	Inspection and maintenance every 6 months are recommended to be performed by blue Logic. The tool will go through a full teardown and calibration. If available, new software will be installed.	

12. SUPPORT CONTACT

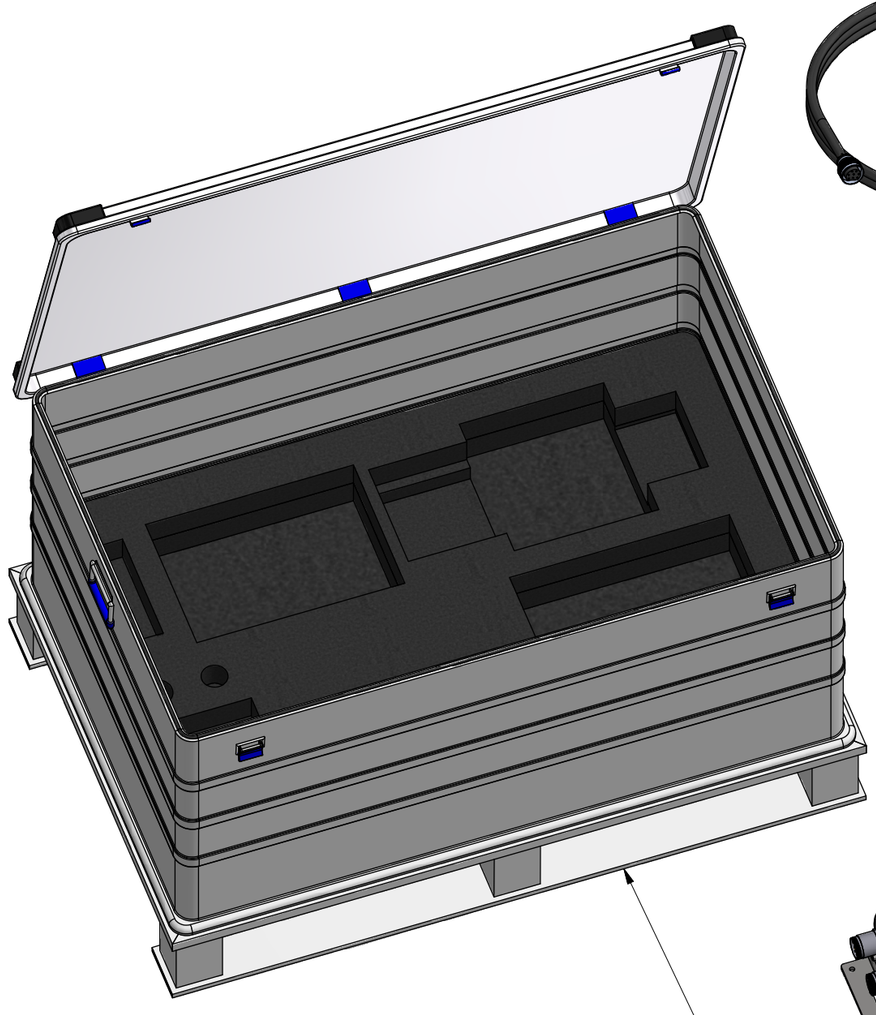
BLUE LOGIC AS
Forus
Luramyrveien 29
4313 SANDNES
NORWAY

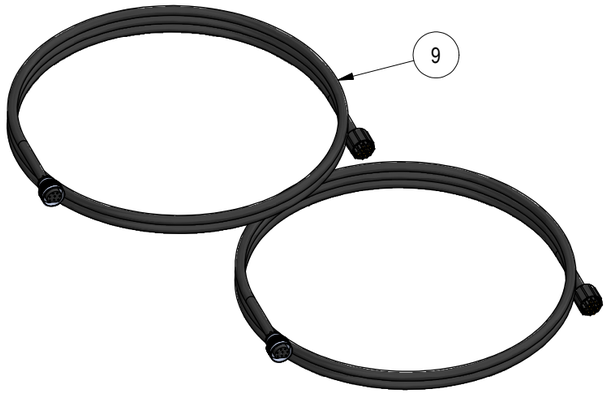
Lars Gunnar Hodnefjell
R&D Manager
Mob: +47 992 63 950
lgh@bluelogic.no

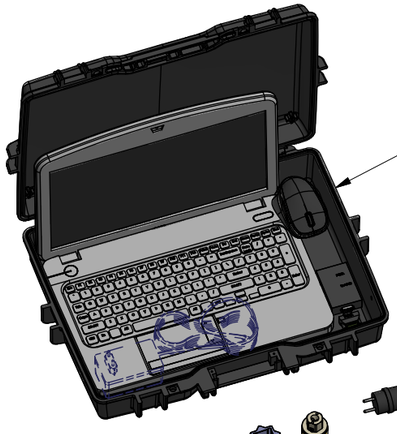
APPENDIX 1 DRAWINGS

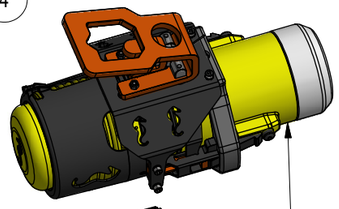
Dwg. No	Drawing Title
BB3551	2,7kNm Light Weight El TT System for ROV/Diver/AUV
BB3394	General Arrangement Light Weight Electrical Torque Tool
BA2024	Test Jig Class 4 Torque tool
BA7719	BL Power Supply 2kW
BB1538	2,7kNm Light Weight Electrical Torque Tool 500m Diver Handle

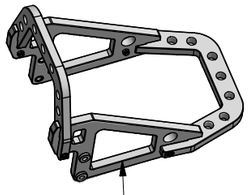
Parts List				
ITEM	QTY	PART No.	TITLE	WEBLINK
1	1	BB3840	Alu Box wFoam	N/A
2	1	BB3698	Key for Top Side	http://e-sea.bluelogic.no/main.aspx?page=article&artno=BB3698
3	1	BB3129	Class 3 Adapter Subsea Replaceable V2	http://e-sea.bluelogic.no/main.aspx?page=article&artno=BB3129
4	1	BB2985	ETT Control PC wGUI Software and Pelicase	N/A
5	1	BB2962	Class 1 & 2 Adapter	http://e-sea.bluelogic.no/main.aspx?page=article&artno=BB2962
6	1	BB1538	2,7kNm El. Torque Tool Light Weight 500m ROV Latch Handle	http://e-sea.bluelogic.no/main.aspx?page=article&artno=BB1538
7	1	BA7719	BL Power Supply 2kW	http://e-sea.bluelogic.no/main.aspx?page=article&artno=BA7719
8	1	600144-TD-0014	Operation and Maintenance Manual Electric Torque Tool Class 1 - 4	N/A
9	2	103651	Com. Cable wBurton 470 VDC & RS232 4,5m EL-TT	N/A
10	1	102860	Burton Dummy	N/A
11	1	102768	Test Cable L=3m OM10F to 250W Prim USB and 2kW Power Supply	N/A
12	1	101138	Connector SubConn Pigtail F	N/A
13	1	BB3676	Handle Assy for ELTT	N/A

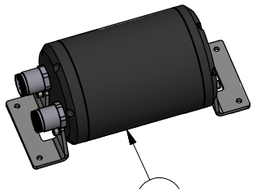


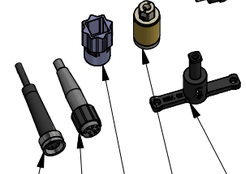












NOTE: 1
DESIGN CODE:
API 17H/ISO 13628-8

NOTE: 2
TECHNICAL CLASSIFICATION:

Article Type:	008-Actuation
Main Group:	8.01. ISO 1 to 4 Actuation
Intermediate Group:	8.44.01. Tool
Sub Group:	8.44.114.02. Intervention

NOTE: 3
INTERFACE INFORMATION:

Pressure Rating Bar:	N/A
Design Water Depth:	N/A
Material:	N/A
Weight:	62,1 kg
Volume:	138,6 dm^3
Submerged Weight:	-79,93 kg
Surface Area:	257441 cm^2
Hydraulic:	N/A
Mechanical:	N/A
Electrical:	PFC: 100-250 VAC/145-350 VDC
Com. & Protocol:	RS232/RS485

NOTE: 4
SPAREPARTS:
BB1852

NOTE: 5
ADDITIONAL INFORMATION:
Complete Light Weight Class 1-4 Electrical Torque Tool System with Power Supply, Cables, Control PC and Class 1-4 interfaces. Two alternative handles included: ROV Handle with Latches and Diver friendly polymerical Handle for easy and precise operation.
Typically powered by ROV/AUV included Cable or Topside powered for diver operation using additional longer Cable.

Rev.	Date	Reason for issue		Made	Chk'd	Appr.
03	20.12.2021	7-IFC (Issued for Construction)		WTJ	LGH	WTJ
02	25.3.2020	7-IFC (Issued for Construction)		WTJ	LGH	KHA
01	4.11.2019	7-IFC (Issued for Construction)		WTJ	LGH	WTJ
			Revision change			

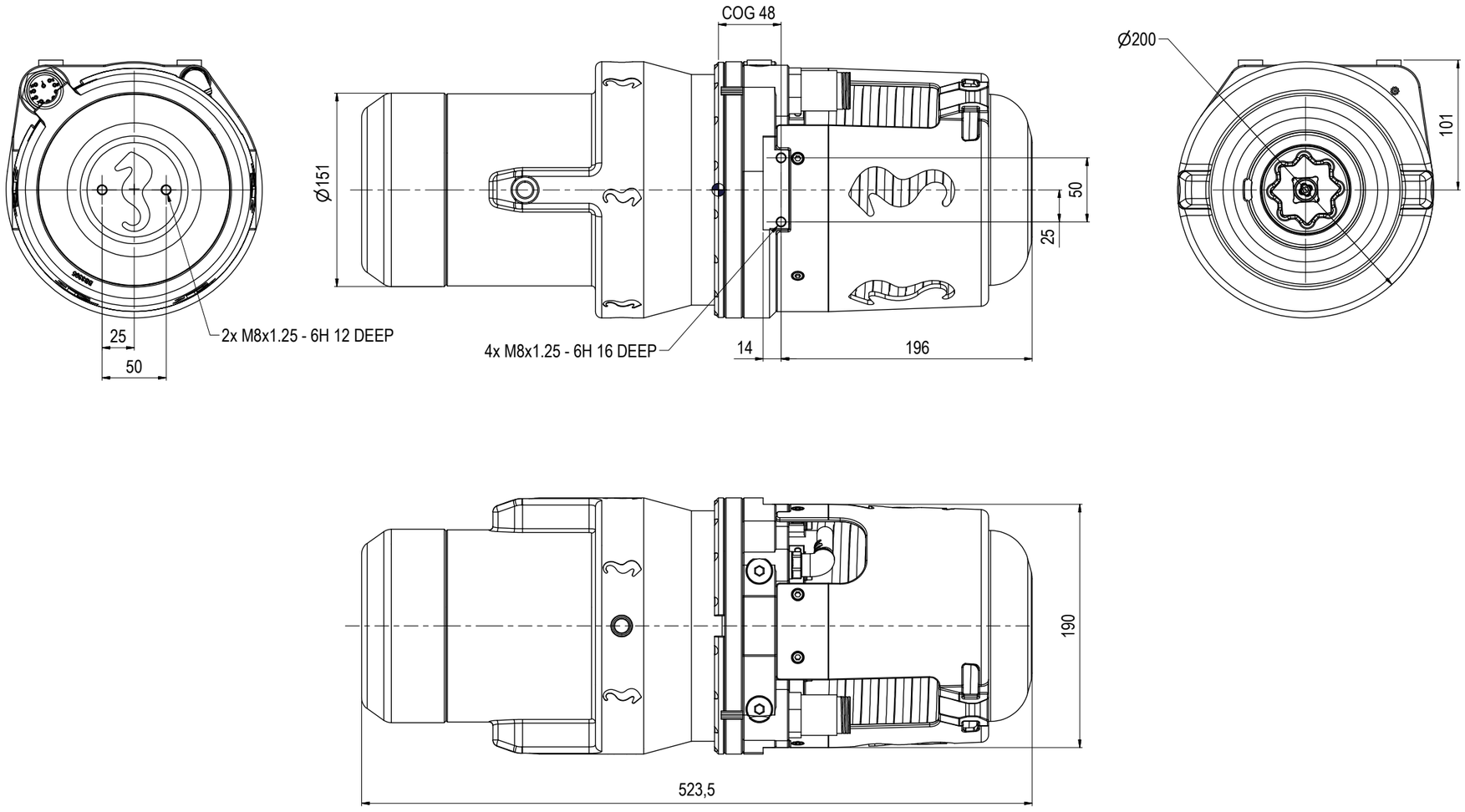
BLUE LOGIC

Dwg Scale: NTS
Dwg Proj:
Dwg Format: A3

Drawing title: 2,7kNm Light Weight EL TT System for ROV/AUV

Drawing number: BB3551

Rev. 03



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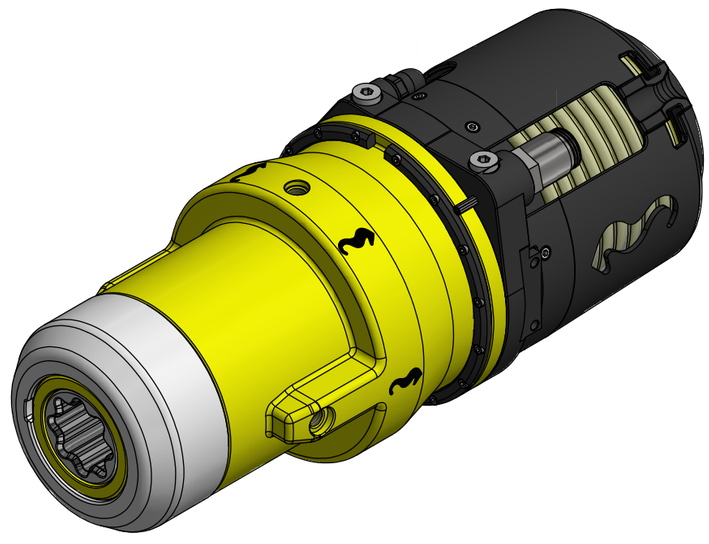
Article Type:	008-Actuation
Main Group:	8.01. ISO 1 to 4 Actuation
Intermediate Group:	8.44.01. Tool
Sub Group:	8.44.114.02. Intervention

NOTE: 3
INTERFACE INFORMATION:

Pressure Rating Bar:	NA
Design Water Depth:	3000m
Material:	Intervention
Weight:	21 kg
Volume:	11,72 dm^3
Submerged Weight:	9 kg
Surface Area:	43386 cm^2
Hydraulic:	Iso Class 1-4 Interface
Mechanical:	4xM8 16 DEEP Side & 2xM8 12 DEEP Rear
Electrical:	48 VDC (Subconn BCR2010M)
Com. & Protocol:	RS232

NOTE: 4
ADDITIONAL INFORMATION:
Light Weight Class 1-4 Electrical Torque Tool for use down to 3000m water depth. Built in passive pressure compensator and integrated control electronics.
Prepared for installation into Subsea Drones using bolted connection. Alternatively replaceable ROV Handle can be installed.
Max power: 500W@0,5 rpm
Max rpm in Low torque mode: 8
Max rpm in High torque: 1,8



Rev.	Date	Reason for issue	Revision change	Made	Chk'd	Appr.
05	27.10.2021	9-IFU (Issued for Use)		WTJ	KHA	WTJ
03	28.8.2019	9-IFU (Issued for Use)		WTJ	LGH	WTJ
02	26.6.2019	9-IFU (Issued for Use)		WTJ	LGH	WTJ
01	28.5.2019	2-IFT (Issued for Tender)		WTJ	LGH	WTJ

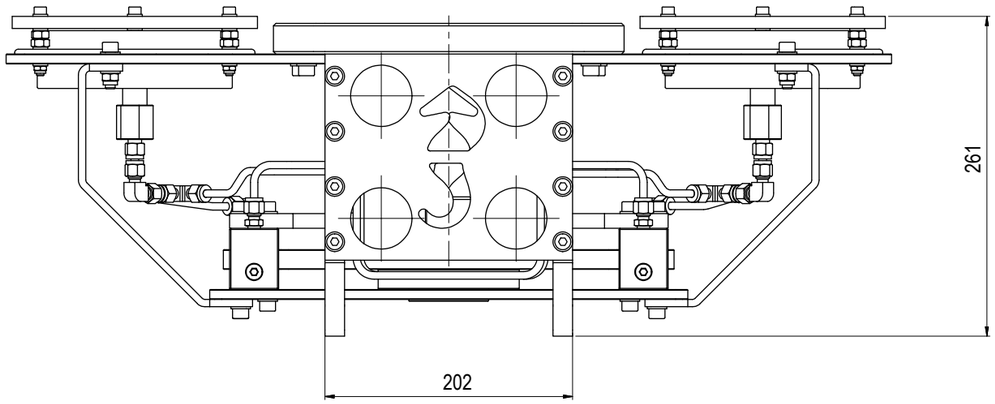
BLUE LOGIC

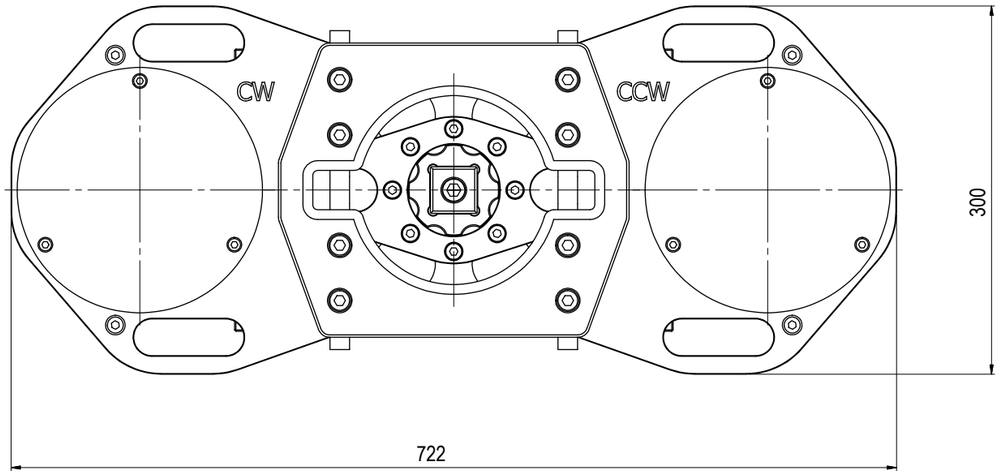
Dwg Scale: NTS
Dwg Proj:
Dwg Format: A3

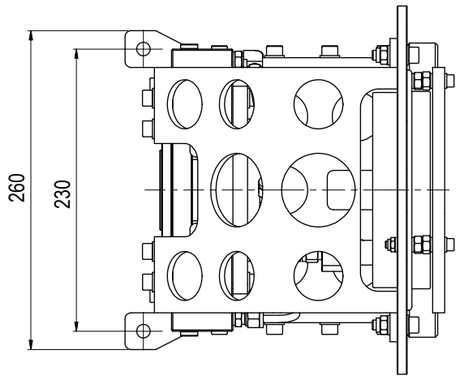
Drawing title: 2,7kNm Electrical Torque Tool LW 3000m Class 1-4 Interface

Drawing number: BB3394

Rev. 05







NOTE: 1
DESIGN CODE:
API 17H

NOTE: 2
TECHNICAL CLASSIFICATION:

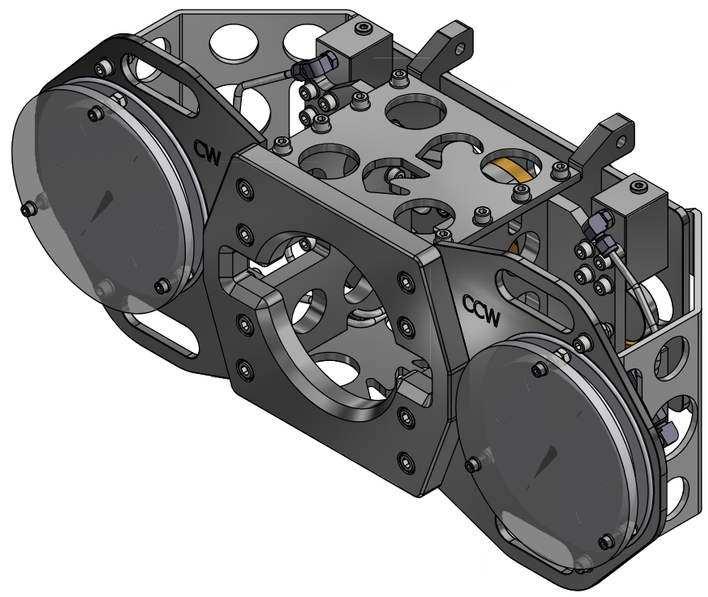
Article Type:	008-Actuation
Main Group:	8.01. ISO 1 to 4 Actuation
Intermediate Group:	8.44.04. Test Jig
Sub Group:	8.44.132.02. Intervention

NOTE: 3
INTERFACE INFORMATION:

Pressure Rating Bar:	N/A
Design Water Depth:	300m
Material:	Aluminium
Weight:	24,8 kg
Volume:	6,48 dm^3
Submerged Weight:	18,13 kg
Surface Area:	20449 cm^2
Hydraulic:	N/A
Mechanical:	N/A
Electrical:	N/A
Com. & Protocol:	N/A

NOTE: 4
ADDITIONAL INFORMATION:
Hydraulic Torque Test Jig for Class 4 Torque Tool.
Max Torque 2,7kNm

Interchangable Interfaces for Class 1 to 4.



Rev.	Date	Reason for issue	Revision change	Made	Chk'd	Appr.
04	2.10.2019	7-IFC (Issued for Construction)		WTJ	TBA	WTJ
03	24.9.2019	9-IFU (Issued for Use)		WTJ	TBA	LGH
02	4.9.2012	7-IFC (Issued for Construction)		LIB	N/A	N/A
01	2.11.2011	7-IFC (Issued for Construction)		LGH	N/A	N/A

BLUE LOGIC

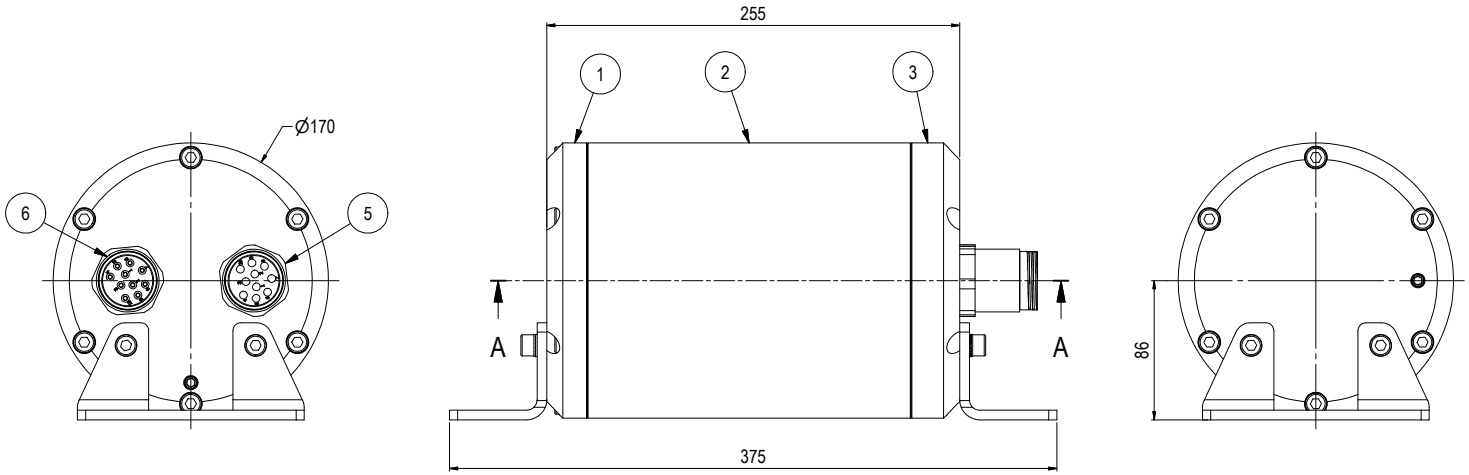
Dwg Scale: NTS
Dwg Proj:
Dwg Format: A3

Drawing title: Test Jigg Class 4 Torque Tool

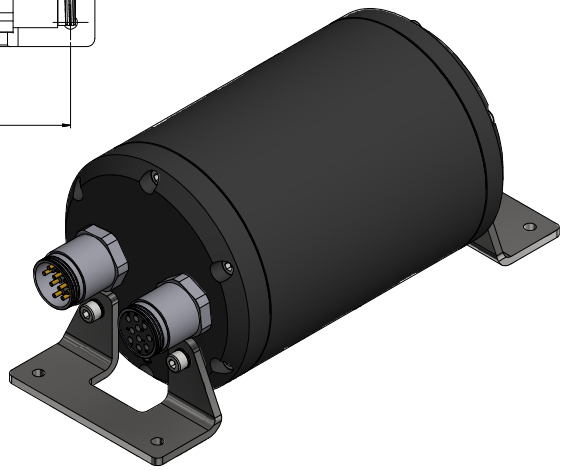
Drawing number: BA2024

Rev. 04

Parts List				
ITEM	QTY	PART No.	DESCRIPTION	MATERIAL
1	1	BA7106	Flange Housing PFC	AL 6082 T6
2	1	BA6785	Housing PFC	AL 6082 T6
3	1	BA6784	End Flange Housing PFC	AL 6082 T6
4	4	101770	O-Ring BS159 D1=126,67 D2=2,62	NBR Shore 70
5	1	100782	Connector Subconn BCR2410F	Stainless Steel
6	1	100780	Connector Subconn BCR2410M	Stainless Steel



SECTION A-A



NOTE: 1
DESIGN CODE:
N/A

NOTE: 2
TECHNICAL CLASSIFICATION:

Article Type:	006-El. Connectors
Main Group:	6.01. Subsea USB
Intermediate Group:	6.28.03. 200-900W Subsea USB
Sub Group:	6.28.156.00. Generic

NOTE: 3
INTERFACE INFORMATION:

Pressure Rating Bar:	300 (3000m)
Material:	Hard Anodized Aluminium
Weight:	11,1 kg
Volume:	5,93 dm^3
Surface Area:	13212 cm^2
Hydraulic:	N/A
Mechanical:	Flange Mount.
Electrical:	In: 100-250 VAC/145-350 VDC Out: 370 VDC
Com. & Protocol:	Pin to Pin, Ethernet, RS232 feed through

NOTE: 4
ADDITIONAL INFORMATION:
The Blue Logic 2kW Power Supply is an atmospheric air filled canister which converts the ROV supplied voltage (100-250 VAC or 145-350 VDC) to 370 VDC voltage required for the primary Subsea-USB connector. The Power Supply will typically be installed onto the ROV frame at a suitable place, and is equipped with input and output connectors for power & communication. All power& communication signals will go through the 2 kW Power Supply canister before connected to the primary connector.
The unit is designed for intervention applications. Canister material is hard anodized aluminium.

Design proof pressure - 365Bar.
Max allowable working pressure - 304Bar
Communication speed RS232 - Approx. 230 kbps
Communication speed Ethernet - Approx. 80 Mbps - (half Duplex)
Operating ambient temperature (0-30°C)
Storage temperature (-30-55°C for one month continuously)

Operation and Maintenance Manual BL ROV Power Supply:
600128-TD-0013

NOTE 5
Connector Housing is atmospheric and not compensated

NOTE 6
Subconn Pin Configuration:

PFC input with RS232			PFC output with RS232		
Connector: Subconn BCR2410M			**Connector**: Subconn BCR2410F		
Pin #	**Signal**		**Pin #**	**Signal**	
Pin 1	100-250VAC / 145-350VDC		Pin 1	370VDC	
Pin 2	100-250VAC / 0 VDC		Pin 2	0 VDC	
Pin 3	CHASSIS		Pin 3	CHASSIS	
Pin 4	RS232RX	(input)	Pin 4	RS232RX	(input)
Pin 5	RS232TX	(output)	Pin 5	RS232TX	(output)
Pin 6	RS232GND		Pin 6	RS232GND	
Pin 7	TX_p		Pin 7	TX_p	
Pin 8	TX_n		Pin 8	TX_n	
Pin 9	RX_p		Pin 9	RX_p	
Pin 10	RX_n		Pin 10	RX_n	

Rev.	Date	Reason for issue	Revision change	Made	Chk'd	Appr.
11	21.1.2020	9-IFU (Issued for Use)		WTJ	LGH	WTJ
10	23.10.2019	9-IFU (Issued for Use)		WTJ	LGH	WTJ
09	23.8.2019	9-IFU (Issued for Use)		WTJ	LGH	WTJ
08	10.5.2019	9-IFU (Issued for Use)		WTJ	TBA	WTJ

BLUE LOGIC

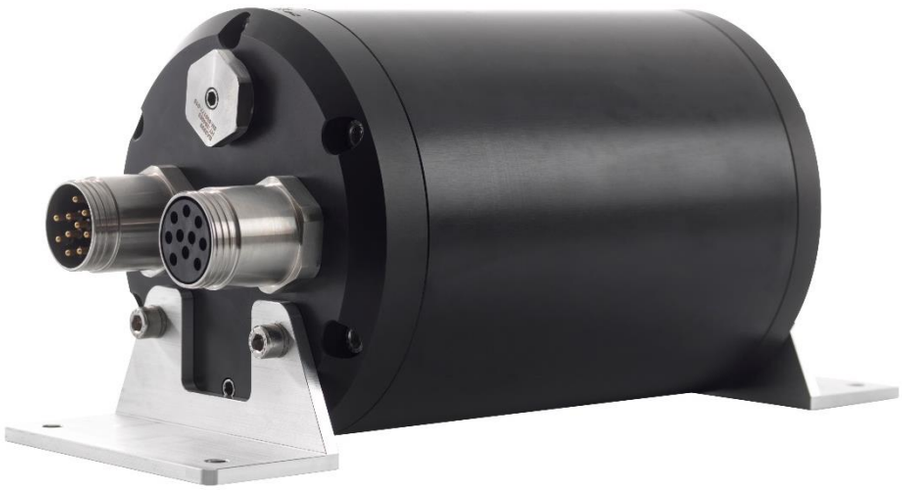
Dwg Scale: NTS
Dwg Proj:
Dwg Format: A3

Drawing title: BL Power Supply 2kW
Drawing number: BA7719
Rev. 11

DATASHEET

2kW ACDC POWER

Art nr: BA7719



General description

The PFC use a high efficiency interleaved technology and use advanced switching technology to reduce harmonic distortion.

Applications

Power to 2kW dome or flat connector

Main features

- AC to DC Power Factor Corrector
- High efficiency - up to 97%
- Universal input voltage range
- Up to 2.2 kW load
- Internal active switch bypassing external inrush current components
- Over temperature Protection

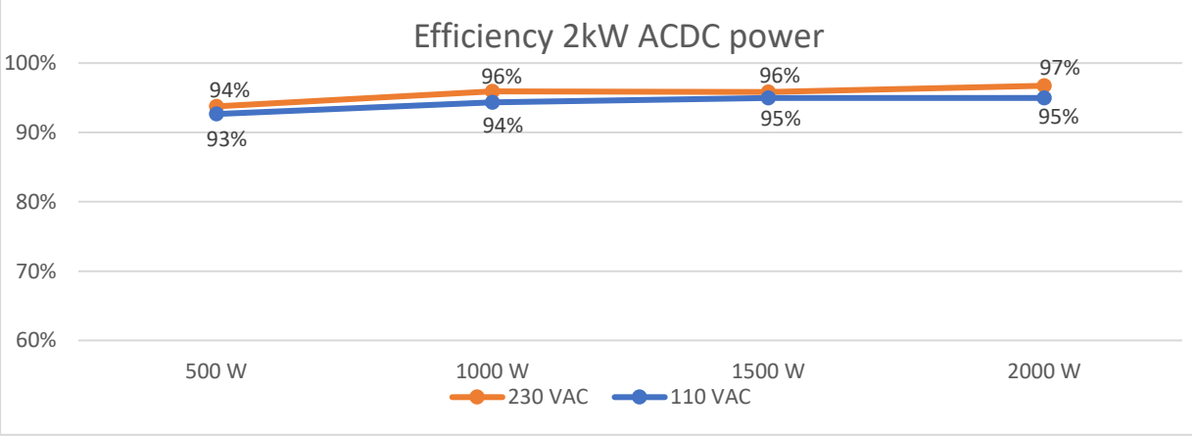
BLUE LOGIC

ELECTRICAL CHARACTERISTICS

All parameter not mentioned are measured with Ta=25ºC

Parameter	Min	Typ	Max	Unit	Comment
Depth rating		3000		m	
Input voltage	100		250	VAC	
	145		350	VDC	
Output voltage	360	370	415	VDC	
Output power	0		2.2	kW	
Output current	0		6	A	
Max load step from 0W load		2.2		kW	Rise time > 300ms*
Max load drop from 2.2kW load		2.2		kW	Fall time >100ms**
Max resistive load at startup		300		W	Until output voltage has reached +360VDC
Power draw no load 230VAC input		5		W	
Efficiency 1.1kW 230VAC input		96		%	
Efficiency 2.2kW 230VAC input		97		%	
Power draw no load 110VAC input		4		W	
Efficiency 1.1kW 110VAC input		94		%	
Efficiency 2.2kW 110VAC input		95		%	
Ambient temperature	-10		+45	°C	See max continuous on time with max load
Max continuous operation with 2.2kW load. In air		30		min	22°C Air and 110VAC
Max continuous operation with 2.2kW load. In water		∞		min	22°C Water and 110VAC
Overheat protection			60	°C	Internal casing temperature

**Output voltage will drop below 360VDC for faster rise time than 300ms.*
***Output voltage can increase to 430VDC for faster drop time 100ms.*
The output has no short circuit protection and a shortening can destroy the unit

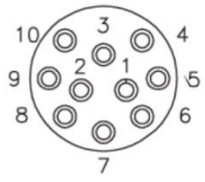


BLUE LOGIC

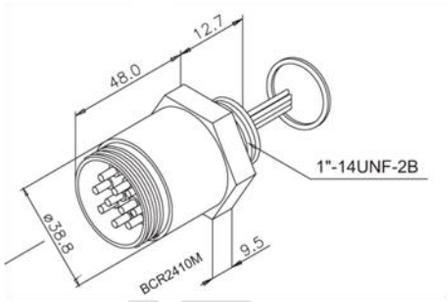
PINOUT MALE

Connector: Subcon BCR2410M	
Pin #	**Signal**
Pin 1	VAC/DC
Pin 2	VAC/DC
Pin 3	CHASSIS
Pin 4*	RS232RX*
Pin 5*	RS232TX**
Pin 6*	RS232GND
Pin 7*	TX_p
Pin 8*	TX_n
Pin 9*	RX_p
Pin 10*	RX_n

**Not internal connected. Only wiring between male and female connector.*
**Data going into unit.*
*** Data going out of unit.*



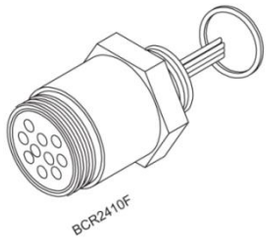
Male Face View



PINOUT FEMALE

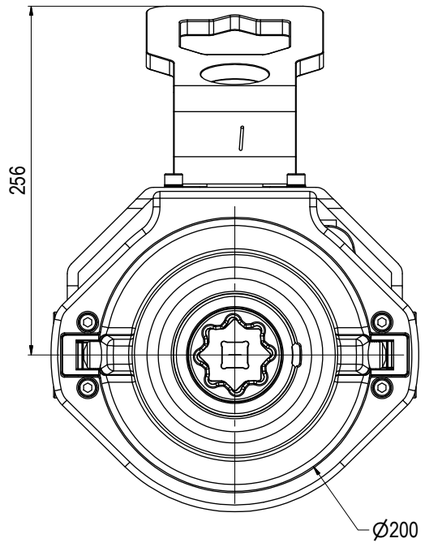
Connector: Subcon BCR2410F	
Pin #	**Signal**
Pin 1	+370VDC
Pin 2	GND
Pin 3	CHASSIS
Pin 4*	RS232RX**
Pin 5*	RS232TX***
Pin 6*	RS232GND
Pin 7*	TX_p
Pin 8*	TX_n
Pin 9*	RX_p
Pin 10*	RX_n

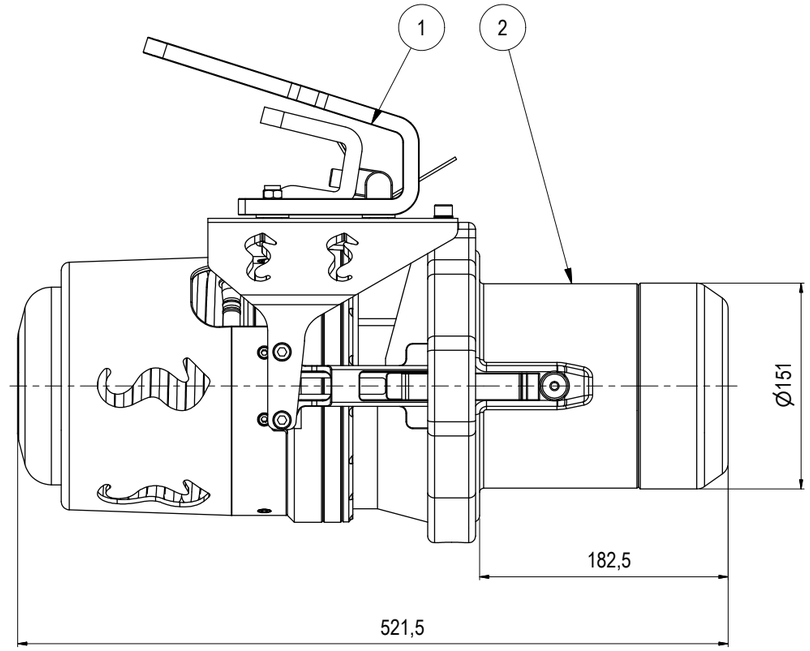
**Not internal connected. Only wiring between male and female connector.*
**Data going into unit.*
*** Data going out of unit.*

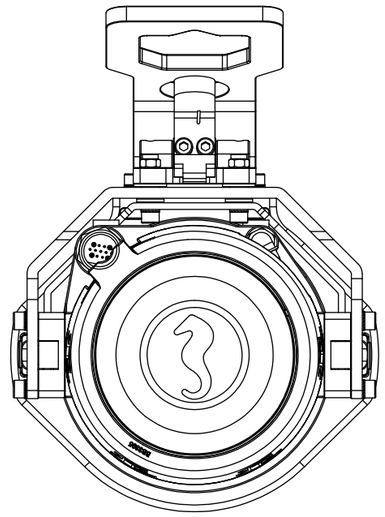


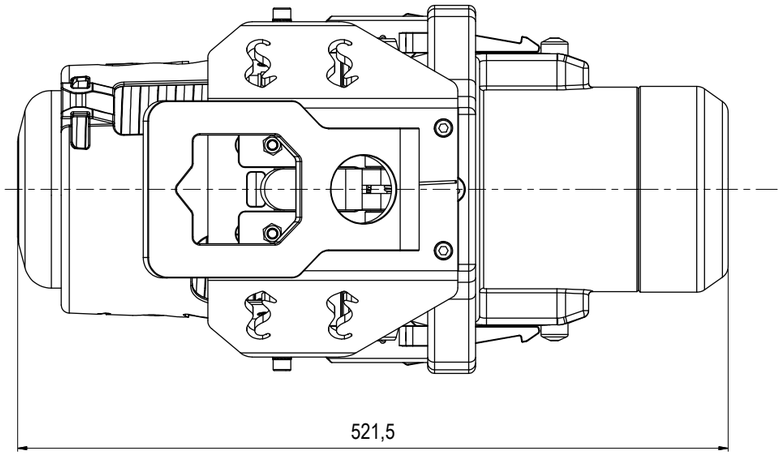
BLUE LOGIC

Parts List			
ITEM	QTY	PART No.	TITLE
1	1	BB3557	ROV Latch and Handle for EL TT LW
2	1	BB3553	2,7kNm Electrical Torque Tool Light Weight 500m 325VDC









NOTE: 1
DESIGN CODE:
API 17H/ISO 13628-8

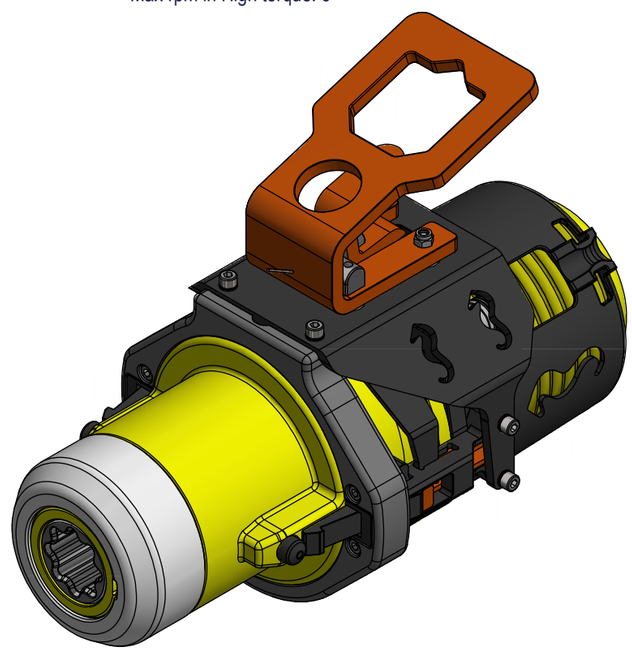
NOTE: 2
TECHNICAL CLASSIFICATION:

Article Type:	008-Actuation
Main Group:	8.01. ISO 1 to 4 Actuation
Intermediate Group:	8.44.01. Tool
Sub Group:	8.44.114.02. Intervention

NOTE: 3
INTERFACE INFORMATION:

Pressure Rating Bar:	50
Design Water Depth:	500m
Material:	N/A
Weight:	23 kg
Volume:	13,23 dm^3
Submerged Weight:	9,43 kg
Surface Area:	47256 cm^2
Hydraulic:	Iso Class 1-4 Interface
Mechanical:	4xM8 16 DEEP
Electrical:	325 VDC (Burton BCR 5507-2008-0004)
Com. & Protocol:	RS232/RS485

NOTE: 4
ADDITIONAL INFORMATION:
Light Weight Class 1-4 Electrical Torque Tool for use down to 500m water depth with diver friendly Handle. Built in pressure compensator and integrated control electronics.
Also suitable and prepared for AUV and Subsea Drones through bolted connection.
Alternatively replaceable ROV Handle can be installed.
Max power: 2000W
Max rpm in Low torque mode: 30
Max rpm in High torque: 6



Rev.	Date	Reason for issue	Revision change	Made	Chk'd	Appr.
05	20.12.2021	7-IFC (Issued for Construction)		WTJ	LGH	WTJ
04	23.8.2019	9-IFU (Issued for Use)		WTJ	LGH	WTJ
03	10.7.2019	7-IFC (Issued for Construction)		LGH	N/A	N/A
02	27.6.2019	9-IFU (Issued for Use)		WTJ	LGH	WTJ

BLUE LOGIC

Dwg Scale: NTS
Dwg Proj:
Dwg Format: A3

Drawing title: 2,7kNm El. Torque Tool Light Weight 500m ROV Latch Handle

Drawing number: BB1538

Rev. 05