PART NUMBER	PART DESCRIPTION
A019-959-008/01	ISO CLASS 1-4 TORQUE TOOL OPERATION AND MAINTENANCE MANUAL

CONTENTS

FET SUBSEA who are internationally recognised UK suppliers of underwater equipment, remotely operated vehicles (ROVs) and manipulators.
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Notices

Whenever you see the symbols shown below, i.e. 'Warning', 'Caution' or 'Notice' heed their instruction!

Always follow safe operating and maintenance practices.

WARNING

This warning symbol identifies special instructions or procedures, which if not correctly followed, could result in personal injury, or loss of life.

CAUTION

This indicates special instruction or procedures, which if not strictly observed, could result in damage to, or destruction of the equipment.

NOTE: *This indicates points of particular interest for more efficient or convenient operation*

1 INTRODUCTION

This manual is intended to serve as a “user point of reference” for the safe operation, maintenance, repair and the identification of manufacturer’s proprietary replacement parts.

The manual has been devised with the intention of being simple, yet informative. This manual is to be used to complement the appropriate assembly drawings, to show how the unit is built in a step to step manner, allowing a technician to carry out any maintenance or repair work in the field.

Before commencing work on the product please read this manual thoroughly.

If the purchaser of the end user is not familiar with underwater ROV systems, it is recommended that product training in the operation and maintenance of the system be obtained from the manufacturer.

2 SPECIFICATION

This manual is for an ISO 13628-8 Class 2-4 torque tool. This interface is commonly used for valve overrides and similar ROV interventions on subsea oil well equipment. It is also suitable for jumper lead flying and locking tasks.

The tool is ideal for use in applications where torque control is of a critical nature. As well as a precise torque feedback sensor, it features a motor with a low torque ripple characteristic. This means that for a given pressure difference the stall torque is very similar at any motor position around the clock.

The base specification of the tool is a gerotor type motor driving the socket via a single stage torque multiplier. The socket drive shaft is fitted with a metal sensing inductive sensor. The gearbox area is oil filled and shared with the motor casing. The final drive shaft supporting the socket is held in a robust plain bearing to prolong the gearbox life and accuracy. The torque multiplier can be removed and replaced with a direct drive adapter to reduce the torque range by a factor of 5.

The latching wings are driven by a single acting annular cylinder with a failsafe spring to open if pressure is lost.

The sensor section directly measures the torque between the reaction lugs of the tool and the driven shaft. The sensor is a strain gauge bridge optimised for torsion measurement.

2.1 SAFETY

Treat with caution - as with any hydraulic/mechanical assembly on the ROV.
Only authorised and qualified personnel should work on the system.

Beware of finger trapping risk. Do not insert fingers inside the tool unless the system is isolated.

Do not attempt to tighten any leaking fittings whilst under pressure. Breakage could result leading to injury from flying components and/or oil jets.

Take care when inspecting, commissioning, repairing or maintaining the system to avoid jets of oil issuing from open orifices, pipe ends etc. if pressure is applied. Particular care should be taken to protect the eyes.

Trying to lift heavy components in an awkward position by hand without the assistance of correct lifting equipment, or lifting any component without adopting the correct stance can lead to serious injury.

Always follow safe operating and maintenance practices.

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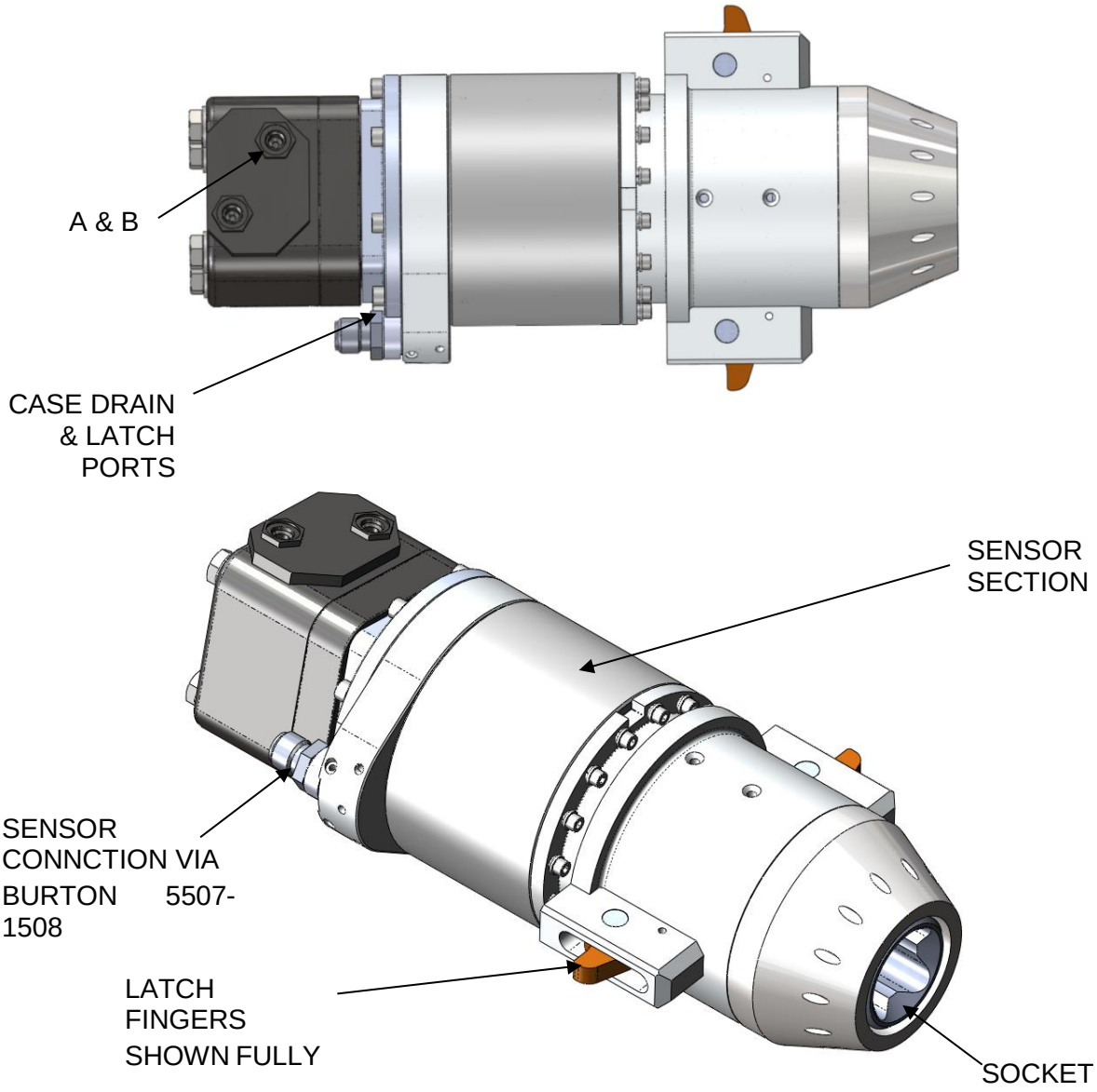
3 DESCRIPTION

3.1 SPECIFICATION

Standard Interface:	API 17D appendix H fig C921.9 Class 4 ISO 13628-8: Dec 2002: Figure 18 Class 4
Socket size:	1-1/2” sqr Class 4 (option) Class 3 socket 1-1/8” sqr (option) Class 1 & 2 socket 11/16” sqr
Maximum torque:	2000 ftlbs (2712 Nm) at 200 bar (gearbox fitted) 400 ftlbs (542 Nm) at 200 bar (direct drive adaptor) 74 ftlbs (100 Nm) at 200 bar (Class 1 motor kit)
Typical Repeatability:	+/- 6% (geroter variation at full load)
Recommended range:	400 – 2000 ftlbs (542 - 2712 Nm) (gearbox) 80 - 400 ftlbs (108 - 542 Nm) (direct drive) Up to 74 ftlbs (100 Nm) at 200 bar (Class 1 motor kit)
Motor turns counter:	5 pulses per inductive sensor per rev, 2 sensors on tool
Motor size:	250cc nominal (50cc Class 1 motor kit)
Materials:	Steel motor and gearbox, duplex socket, aluminium housing, acetal nose
Estimated weight:	36 kg air / 28kg in water
Hydraulic:	Oil based, requires A and B and Drain ports, 1/4” SAE connection, maximum supply pressure 200 bar, flow rate 4 to 8 litres per minute.
Latching fingers:	Greater than 1 tonne holding force at 200 bar, single port function, 1/4” SAE
Recommended fluid:	Hydraulic mineral oil AWS 22 or 32 or similar
Electrical:	8 pin Burton bulkhead male connector (part no 5507-1508) for both turns and torque feedback

CAUTION

Damage can occur to tool if full ROV system pressure (210bar) is applied abruptly. Required torque is achieved by progressive ramp up of pressure.



4 SETTING UP FOR OPERATION

4.1 MECHANICAL SETUP

The tool is supplied with a D-type ROV manipulator handle. The handle fastens to a rear guard weldment this protects the rear of the tool, whilst acting as a means to mount optional Subsea Universal Display & battery pack for real-time torque and turns displays (Top level variant A019-959-959/02). Various ISO & API handle types are available upon request. Current design of the guard & handles use a 2 piece clamp to secure around the Torque Reaction Housing. Previous versions clamped around the cylindrical main barrel of the tool (strain gauge housing). If this version is being used, always use a thin layer of rubber under the clamp to avoid distortion to the strain gauges on the inner surface of the main tool body.

4.2 HYDRAULIC SETUP

The tool has 4 hose connections

1. Latch – pressure on this line causes the wing latches to come out. A 1/8" hose is adequate. Releasing pressure causes latches to retract (on springs).
2. Drain – needs to be connected to the main return of the ROV system. A 1/4" hose is recommended
3. Motor A – connect with a 1/4" hose
4. Motor B – connect with a 1/4" hose

If the latch is not needed then connect to the casing drain line so that the hydraulic volumes are depth compensated.

We recommend only using meter-in/free-flow-return controls to avoid excessive back-pressure.

Note: The motor casing drain is shared with the tool gearbox. When the unit is first connected up, set the tool socket side down and drive unloaded for a few minutes while rocking the tool to shift any air pockets. This will drive most air out of the system.

4.3 ELECTRICAL SETUP

There is a turns counter and a torque sensor. If not required, the Burton connector can be capped with a dummy plug or cable tail.

Burton connector (5507-1508) pin out:

Pin	Designation (reedswitch fit)	Designation (inductive switch fit)
1	Strain gauge Excitation +	Strain gauge Excitation +
2	Strain gauge Excitation -	Strain gauge Excitation -
3	Strain signal +	Strain signal +
4	Strain signal -	Strain signal -
5	Turns counter contact switch 1	Inductive sensor excitation +
6	Turns counter contact switch 1	Inductive sensor excitation -
7	Turns counter contact switch 2	Inductive sensor #1 signal +
8	Turns counter contact switch 2	Inductive sensor #2 signal +

4.3.1 Torque Sensor

The recommended excitation voltage is 5 to 10V.

The nominal output is 0.75 mV/V at 2200 ftlbs (3000 Nm), (refer to calibration certificates for actual output)

Example:

Say signal is 3.5mV using an excitation of 10V.

Therefore torque = 2200 x (3.5 / 10) / 0.75

= 1027 ftlbs (1392 Nm)

4.3.2 Turns counter – reed switch type

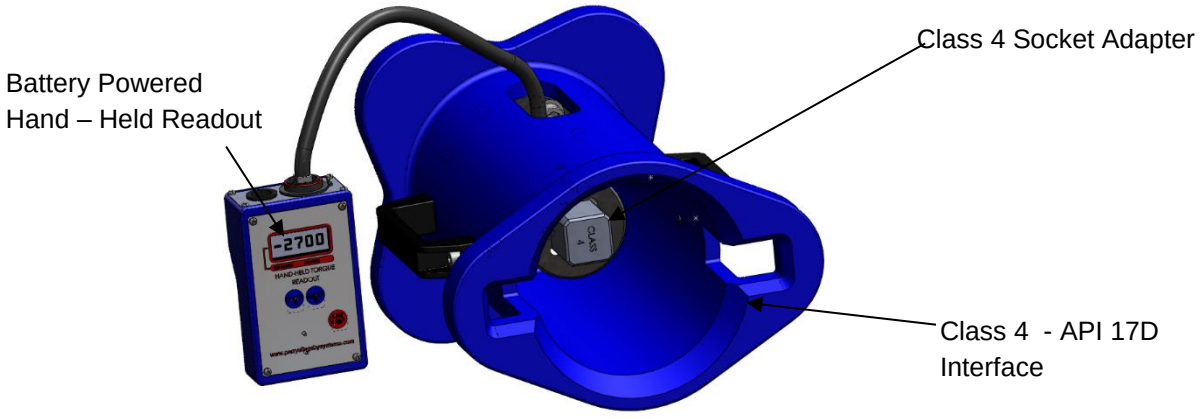
The turns counter is a normally open reed-switch. As the socket shaft rotates there are four magnets that pass the switch and cause the contacts to close. This means that there are 4 counts per revolution of the drive socket. A second switch is fitted for the benefit of tool control systems that sense direction.

4.3.3 Turns counter – inductive type

The turns counter comprises of two inductive type sensors. The recommended excitation voltage is 10-35 v dc. When the sensor operates the signal line goes +v. Depending on the type of inductive sensor trigger 5 pulses (or 4 on early versions) will be generated per revolution of the tool per sensor. The two sensors are 60° apart.

4.4 TORQUE SETTING FROM VERIFICATION UNIT, A019-958-152/02

The Forum Mk II Verification Unit is for surface use only. It can be used in conjunction with a Forum Torque Tool Control System (A286-001-050/04) in order to calibrate the torque tool. It consists of a near equivalent API bucket with torque sensor and hand held battery powered torque readout. The central shaft of the verification unit can be removed for the insertion of other interfaces (e.g. class 3 etc.)



Insert the tool into the unit and operate in one direction, adjust the pressure controller (customer equipment) until the desired torque is shown on the display. Reverse tool and reapply to confirm setting. A variation in torque of up to +/-6% is typical with this type of drive motor at different clock positions on the same pressure setting.

The unit may be supplied with a low torque sensor as well as high torque sensor. The two units have a simple bolted flange changeover. Take care not to over torque by incorrect tool setup.

4.5 TORQUE SETTING FROM PRESSURE CHART

This should be used if a torque verification unit is not available.

The supply pressure should be set using the performance charts supplied in the tool certificates. Pressure quoted is differential pressure (difference between A and B ports).

Notes: pressure can only be set when the tool is connected if the tool is stalled against something (e.g. a tooling interface or the verification unit).

As an approximate guide:

250cc motor & 1:5 gearbox

Torque (ftlbs) = pressure (psi) x 0.81

Torque (Nm) = pressure (bar) x 15.9

250cc motor & 1:1 gearbox

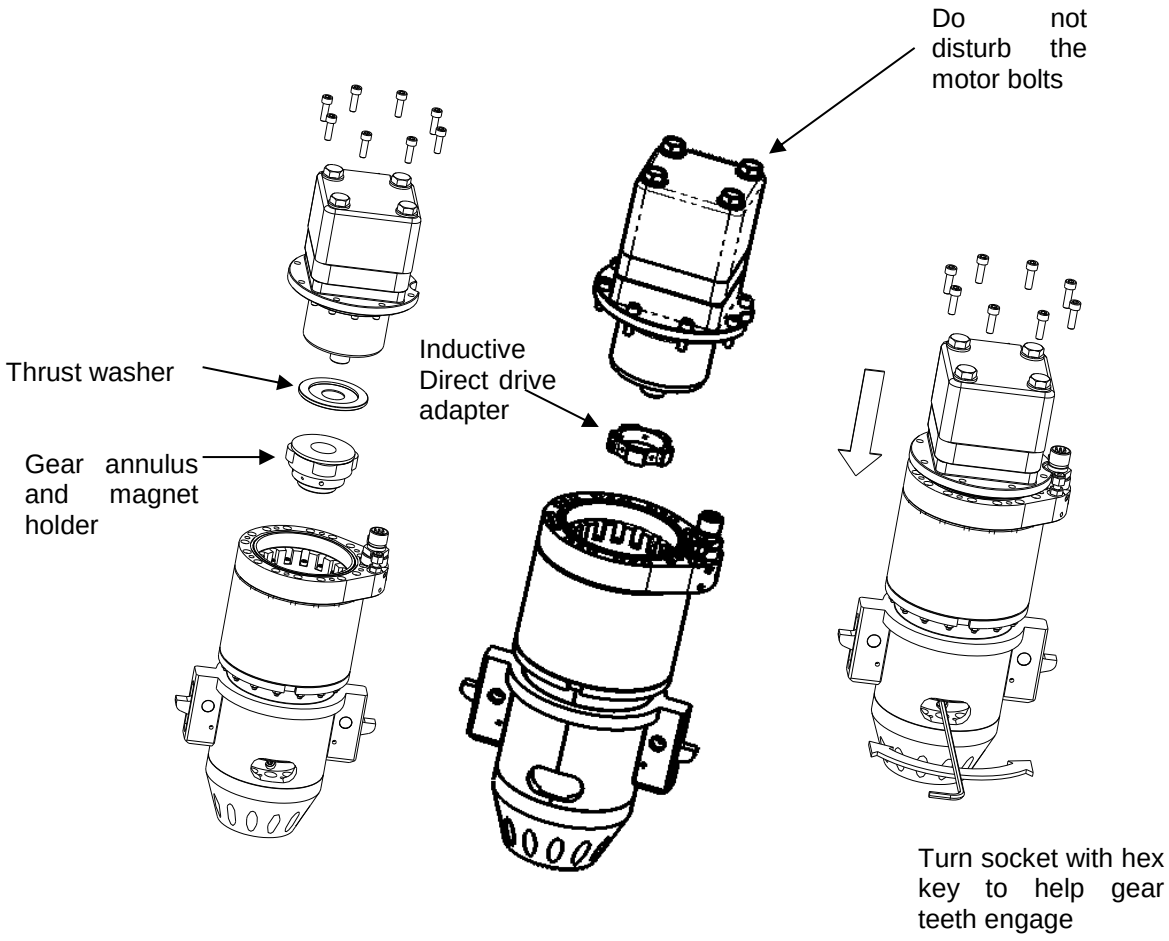
Torque (ftlbs) = pressure (psi) x 0.17

Torque (Nm) = pressure (bar) x 3.2

Class 1, 50cc motor & 1:1 gearbox

Torque (ftlbs) = pressure (psi) x 0.08

Torque (Nm) = pressure (bar) x 1.58



5 CONFIGURATION

5.1 CHANGING GEARBOX FOR DIRECT DRIVE ADAPTER (STANDARD 250CC MOTOR)

- The Danfoss motor is mounted on a tool plate by four bolts and should not be disturbed unless the motor is to be replaced.
- Place the tool nose down to conserve compensation oil and clean outside thoroughly to avoid dirt entering.
- The motor assembly (Item 93) compromising of the mounting plate, motor, adapter shaft & bearings, can be lifted from the tool assembly once the 8 cap bolts are removed, as shown below to gain access to the gearbox.

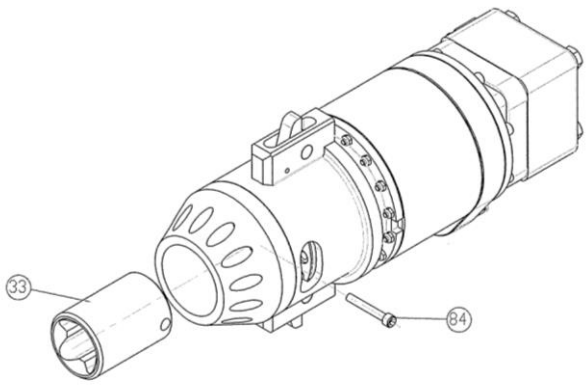
5.2 CHANGING TO CLASS 1 MOTOR KIT (50CC MOTOR) A019-959-082

Refer to attached GA A019-959-081, these instructions are for additional reference.

- Position the tool on its nose with the motor vertically upwards.
- Remove the 250cc motor assembly and 8 CAP screws as per section 5.1.
- Remove the gearbox & thrust washer or direct drive converter from the tool, along with the inductive sensor trigger, and stow away for future use.
- Position the drive adapter from the Class 1 motor kit (Item 14), assembled with additional inductive trigger, onto the square shaft in the torque tool housing.
- Ensure that the trigger can spin freely without catching the two inductive sensors; adjust the position of the sensors if required.
- Position new thrust washer (Item 13) onto the shaft adapter in the tool housing.
- If not already done so, with the motor painted with Corroless, mount the motor to the motor housing (item 11) with acetal washer (Item 16), using modified screws (Item 12) and O-rings (Item 23). Torque the screws to 14Nm.
- As section5.1, align the new motor assembly over the top of the housing and rotate the socket until the keyway on the shaft on the motor aligns with the converter shaft, and the motor is seated.
- Secure the motor mount plate using the original M8 CAP screws, torqued to 24Nm.

5.3 CHANGING THE SOCKET

On the underside of the tool nose there is an access window. The socket should be powered around until the cap screw holding the socket can be viewed and removed. The socket then slides out.



5.4 STRIPPING DOWN THE TOOL ASSEMBLY

The tool may need to be stripped down occasionally to clean sand etc from the nose and latch area. The first item to remove is the nose plastic cone and all the springs behind it.

1. Remove (drift out) the main pins from the tool wings. The latch fingers can now be removed.
2. The white Acetal nose of the tool is held on with 13 M6 SHCS. The nose is compressing 12 springs so care needs to be taken when removing the nose to prevent dangerous release of the stored energy. It is recommend to use a hydraulic press as in picture below. Once this has been done the nose and springs can be removed.

3. The main latching nose section of the tool can now be removed by undoing the ring of nuts around the main diameter.
4. Access is now clear for cleaning the tool.

Further strip down requires considerable care and is best performed in a clean workshop. Note that the Burton connector for the sensor has to be removed and de-soldered before that plate can be split from the sensor section.

Detail strip down instructions are attached to this manual in document A019-959-038.

5.5 REMOVING/INSTALLING THE 250CC MOTOR

Two types of motor are used on the Class 2-4 Torque Tools, both nominally 250cc/rev. These are manufactured by Danfoss and by White Drive Products. The Danfoss motor has a square shaped main body and 4 main bolts holding the unit together. When re-installing the Danfoss motor, these 4 bolts must be torqued up to 135-145 Nm in order to maintain motor torque characteristics.

The White motor (now discontinued) has a cylindrical housing and 7 main bolts holding it together which should not need to be removed. The motor is separated from the tool by removing the 4 cap screws which run through the mounting plate into the front flange of the motor. If the 7 motor bolts are removed they must be torqued back up to 125 Nm.

6 SERVICE SCHEDULE

The tool should be treated as any other piece of hydraulic equipment on an ROV, that is;

- Monitor the return oil from time to time. Investigate any signs of water ingress (i.e. cloudiness).
- Wash down with fresh water after use and dry off before putting in its box. Touch up paint chips.
- Grease the output shaft of the gearbox when changing sockets (Aqualube or Ensis K recommended).
- When not in use, always cap the motor ports to prevent dirt entry.
- If disassembling any part, use Aqualube on the fastener threads on reassembly.
- The front housing of the tool may fill up with debris over time. This can be removed by inserting a hose-pipe into the socket access hole in the front housing of the tool. For a more thorough clean, follow the strip-down instruction.

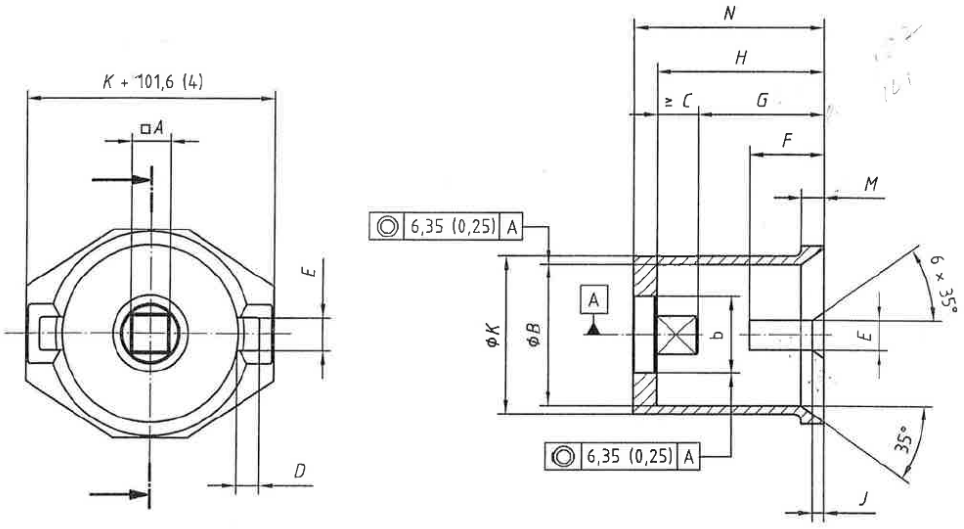
Action	**Prior to Shipment**	**Mobilization**	**Demob./**	**Action**
Wash down with fresh water			X	X
Ensure any open hydraulic ports or hoses are capped/plugged	X		X	
Ensure all protective coatings/paint is intact – touch up if necessary	X		X	X
Protect exposed connectors with a plastic cap or blanking plug	X		X	
Preservation performed as described above	Date:		Signature:	

Action	Onshore Storage	Offshore Storage
Store the assembly in its dedicated packing case	X	X
Storage performed as described above:	Date:	Signature:

Action	Prior to / after use	Prior to / after shipment	Mobilisation	De-mobilisation	During Storage (every XXX months)
Wash with fresh water	X			X	
Make good any damage to protective coatings	X		X	X	X (every 6 months)
Check for loose fittings/leaks	X		X	X	
Check cables/connectors	X		X	X	
Preventive Maintenance performed as described above	Date:		Signature:		

1. Interval	2. Interval	3. Interval
Weekly	Monthly	
Check all functions for operation	Check all functions for operation	
Check for loose fittings/leaks and damaged cables/connectors	Check for loose fittings/leaks and damaged cables/connectors	
Maintenance performed as described above	Date:	Signature:

7 CLASS 1-4 INTERFACE



a Clearance both ends.
b See Note in Table 4.

Figure 18 — Rotary torque receptacle

Table 4 — Dimensions for receptacle classes 1 to 7 (see Figure 18)

Dimensions in millimetres (inches)

Dimension	Class						
	1	2	3	4	5	6	7
A square	17,50 (0,687)	17,50 (0,687)	28,60 (1,125)	38,10 (1,50)	50,80 (2,00)	66,67 (2,625)	88,90 (3,50)
B	154,0 (6,06)	154,0 (6,06)	154,0 (6,06)	154,0 (6,06)	190,5 (7,50)	243,0 (9,56)	243,0 (9,56)
C min.	41,0 (1,62)	41,0 (1,62)	41,0 (1,62)	41,0 (1,62)	63,5 (2,50)	89,0 (3,50)	89,0 (3,50)
D	38,0 (1,50)	38,0 (1,50)	38,0 (1,50)	38,0 (1,50)	57,0 (2,25)	82,25 (3,25)	82,25 (3,25)
E	32,0 (1,25)	32,0 (1,25)	32,0 (1,25)	32,0 (1,25)	38,0 (1,50)	44,5 (1,75)	44,5 (1,75)
F	82,5 (3,25)	82,5 (3,25)	82,5 (3,25)	82,5 (3,25)	127,0 (5,00)	178,0 (7,00)	178,0 (7,00)
G min.	140,0 (5,51)	140,0 (5,51)	140,0 (5,51)	140,0 (5,51)	140,0 (5,51)	222,0 (8,75)	435,0 (17,13)
G max.	146,0 (5,75)	146,0 (5,75)	146,0 (5,75)	146,0 (5,75)	146,0 (5,75)	228,0 (9,00)	441,0 (17,38)
H	181,0 (7,12)	181,0 (7,12)	181,0 (7,12)	181,0 (7,12)	206,0 (8,12)	—	—
J	12,7 (0,50)	12,7 (0,50)	12,7 (0,50)	12,7 (0,50)	—	—	—
K	168,5 (6,63)	168,5 (6,63)	168,5 (6,63)	168,5 (6,63)	—	—	—
M	25,4 (1,00)	25,4 (1,00)	25,4 (1,00)	25,4 (1,00)	—	—	—
N	194,0 (7,63)	194,0 (7,63)	194,0 (7,63)	194,0 (7,63)	—	—	—

As an alternative to dimension *A*, end effector shapes as found in Annex D for the appropriate torque range may be used.

All dimension tolerances are as follows:

0,*x* ± 0,5 (0,020)

0,*xx* ± 0,25 (0,010)

C: $^{+1,27}_{0}$ $\left(^{+0,05}_{0}\right)$

NOTE 1 Chamfer on the end of the end effector profile is 45° × 1,65 (0,06) max.

NOTE 2 Clearance behind anti-rotation slots [*E* × *F* × 50,8 (2)] is to allow for locking feature option provided by some tools.

Rotary actuator intervention fixture classification

Class	Max design torque	
	Nm	(lbf.ft)
1	67	(50)
2	271	(200)
3	1 355	(1 000)
4	2 711	(2 000)
5	6 779	(5 000)
6	13 558	(10 000)
7	33 895	(25 000)

8 SERVICE, SUPPORT & SPARE PARTS

Forum Subsea Technologies operates a comprehensive sales support and technical after sales service based in Kirkbymoorside, Yorkshire, England. Most spare parts will be held in stock at our premises. When ordering spare parts, our part number references on the drawings should be quoted.

Any technical queries should be directed to our technical department. A 24 hour helpline is normally in operation. A number will be available on the answering system after normal working hours.

If you should have cause to call our Technical Support Service please have the following details to hand before calling about technical queries as this will help our technical department to answer any questions.

- System Serial Number (if applicable)
- Product Part Number
- Fault Description
- Any remedial action already implemented.

To contact our Technical Support Service please refer to Page 2 of this manual.

9 WARRANTY

Forum Subsea Technologies warrants their Products on a back-to-base basis for a period of 12 months. Replacement parts will not be issued until the defective items have been returned for inspection. Costs of returning defective components to Forum Subsea Technologies shall be at the buyer's expense. This warranty does not apply to any product that has been misused, modified or damaged by accident. The warranty does not include shaft seals, spooling equipment followers and any other part subject to wear under normal operating conditions. Forum Subsea Technologies will not warrant any unauthorised modifications to their products and will not accept liability for such alterations. Equipment sold by, but not manufactured, by Forum Subsea Technologies such as cameras, video monitors, sonar heads and processors etc will be warranted only to the extent and in the manner of that warranted to Forum Subsea Technologies by the seller and then only to the extent that the seller is able to enforce such a warranty.

10 DRAWING PACKAGE

This section of the manual contains a list of mechanical and electrical drawings for the Product.

10.1 DRAWINGS

The following drawings are attached and should be used in conjunction with this manual for installation and maintenance procedures.

Drawing No.	Drawing Title
A001-350-006	Datasheet
A019-959-959	System General Assembly
A019-959-202	Torque Tool General Assembly
A019-959-001	Torque Tool Class 2-4 Assembly Ref
A019-959-050	Danfoss Motor Assembly
A019-959-005	Torque Tool Wiring Diagram
A019-959-038	Torque Tool Assembly Instructions
A019-959-004	Torque Tool Test Specification
A019-959-081	Class 1 Motor Kit GA
A019-959-082	Class 1 Motor Kit P/L