Torque Application Procedure

TABLE OF CONTENTS

PURPOSE & SCOPE

This procedure describes the requirements and responsibilities of applying torque on L3 Communication Systems – West (CSW) product in the Salt Lake City and Carlsbad facilities. This procedure outlines the detailed methods to apply the torque values defined by Torque Specification 60083155 or on the engineering drawing. Tool selection, torque sequence, tool verification and fastener retention are discussed in this procedure and other referenced documents.

PROCEDURE

1. RESPONSIBILITIES

1.1. CSW personnel have the responsibility to ensure torque is applied properly, all work performed is documented in the Shop Order and the applicable tools are properly logged according to procedure.

1.2. Personnel moving or handling tooling or equipment will maintain its integrity and report any actions and/or conditions that may affect its function and/or calibration.

1.3. It is the responsibility of the person applying torque with a calibrated tool to ensure that:

- The equipment under use is within the allowable calibration date range; and
- The torque value applied by the equipment is within the applicable calibrated torque range.

2. DEFINITIONS AND ACRONYMS

Applied Torque – The torque transmitted to the fastener by the installation tool.

Assembly Sequence – A method indicating the order of assembling fasteners in a prescribed pattern. Other similar terms are installation sequence or tightening sequence.

Assembly Torque – This is the design-specified torque applied at final assembly. It is intended to be a torque that matches the net effect of the following friction and torsion/tension reaction portions in the junction:

- The torque required to overcome kinetic friction between the mating bearing surfaces and the mating threads (also called free-running torque),

- The torque required to overcome any self-locking feature (also called prevailing torque), if any, and
- The torque required to apply to desired axial load to a fastener and junction.

This assembly torque is measured in the tightening direction. It may also be called installation torque or tightening torque.

BSPT – British Standard Pipe, Tapered

EMI – Electromagnetic Interference

Electronic Torque Tools – Calibrated torque tools that use an electric motor and transducer to drive in hardware at a specified torque.

Fastener – A threaded component that joins two or more parts together to transfer load between them.

Finger Tight – Tightened by using fingers as far as possible without the use of tools.

Hand Tight – Tightened by hand until snug, with or without the use of tools.

Hand Torque Tools – Calibrated torque tools that do not have an electric motor. (In scope of ASME B107.300-2021)

JIS – Japanese Industrial Standards

Locking Feature – A device, chemical substance, or other physical characteristic added by design to one or more elements of a threaded fastening system to resist vibration-induced loosening or to provide retention against complete disengagement of the fastening elements. (Other similar terms are locking element, locking device, and secondary retention device.) For further discussion of common locking features, reference 60083155.

Mechanical Hard-Stop – A feature incorporated into a gasketed joint design that controls the amount of gasket compression that occurs when the tightening the joint. This feature provides a hard surface to clamp against and prevents the gasket from being in the main load path of the joint preload.

MDM – Micro-D Metal (not a trademark, variations on this are, but this references connectors from a specific MIL-SPEC)

MIL – Military

NPSM – National Pipe Straight Mechanical

NPT – National Pipe Taper (ANSI B1.20.1)

NPTF – National Pipe Taper, Fuel (ANSI B1.20.3)

PTFE – Polytetrafluoroethylene (Teflon®)

Running Torque – The torque required to overcome kinetic friction in the mating threads plus the torque required to overcome the locking feature when the entire locking feature is engaged, and the fastener is unseated. The phrase “running torque” is understood as the average locking torque when it is not prefixed by the word’s “maximum” or “minimum.” Running torque does not contain any torque component for axial loading of the fastener assembly. The running torque may be measured in a loosening or tightening direction while the fastener is in motion. Other terms that describe this are prevailing torque, self-locking torque, run-in torque, or run-down torque.

SAE – Society of Automotive Engineers

Seated – A fastener is considered seated when the bearing surface of the fastener contacts the material being joined; any additional applied torque will produce residual axial stress in the junction.

Set torque – The torque value a tool is physically set to after adjustments are made (outlined in section 4.2 of this document.)

Snug – The condition where the threaded fastener has been tightened to the point where the joint is compressed, and “feels” tight to the operator installing the hardware. There is no perceptible play between the mated hardware threads at a minimum compression, and the threads have not yielded.

Specified torque – The torque value calculated from the torque spec (60083155), documented in the work instructions or noted on the drawing.

Through Hole Application – A joint design in which both sides of the stack-up must be accessed to apply an installation torque. For example, a screw with a nut on the opposing side of the joint, where the screw head must be held while applying torque to the nut.

Torque – Torque is a rotational force or turning moment that produces rotational movement or stress. It is described in terms of applied load and the length of the moment arm where the load is applied. Typical values are expressed in units of inch-ounces (in-ozs), inch-pounds (in-lbs), foot-pounds (ft-lbs), Newton-meters (N·m), or Newton-millimeters (N·mm).

Unseated – A fastener is considered unseated when the application of torque to remove the fastener disengages the bearing surface of the fastener from the material being joined, and there is not axial stress present on the junction.

3. TOOL SELECTION

This section describes the proper tool selection, based on the tool style and ability of the tool to provide an applied torque that meets the requirements of the published torque value and tolerance.

3.1. Tool Calibration

CSW calibrated tools are subject to the controls in 1M-160, Manage Tool Services (Calibration Services), and should display current calibration, prior to use in mating torque applications, torque verification, and or acceptance of product.

Tools must have an active calibration (within the calibrated date and the expiration date) and be used within the calibrated range. Using a tool that has the same units as the published torque value is preferred; however, using tools for an alternate torque unit is permissible, if the torque value with tolerance converts to new unit using the conversion factors provided in the torque specification. Tools are calibrated to +/- 6% accuracy per ASME B107.300-2021, Hand Torque Tools and Torque Testers. Observe the tool resolution to limit the degree of rounding from the conversion of the original torque value and tolerance.

3.2. Tool Adapters and Non-Calibrated Tools

Select the correct tool adapter: the specific bit, socket, wrench head, connector adapter, etc. for your application. Reference connector-specific tooling documentation for tool selection with specific connectors. If tooling has not been determined or is not available for your specific application, contact a Manufacturing Process Engineer (MPE) for assistance.

When possible, use tools that do not require calibration to drive down and seat fasteners, prior to applying torque. The non-calibrated tools may be used prior to, or in conjunction with calibrated tools, provided they do not alter the applied torque in a way that cannot be calculated or measured. As an example, a screwdriver connected to a torque wrench may provide an interface with the fastener. For tooling that may alter the applied torque, the section on Tooling Correction will discuss the calculations needed to adjust the torque setting on a tool so the junction has the same applied torque.

The rotation axis of a torque driving element should be within fifteen degrees of the fastener axis.

3.3. Tool accuracy

3.3.1. Hand torque tools are calibrated to +/- 6% accuracy per ASME B107.300-2021. Set torque of a tool shall be set within 4% of the specified torque to meet the +/-10% tolerance defined in the torque spec, 60083155.

3.3.2. Electronic torque tools shall have accuracy no less than +/-10%. Set torque shall be equal to specified torque on electronic torque drivers to meet the +/-10% tolerance defined in the torque spec, 60083155.

3.3.3. If the drawing specifies a torque tolerance that differs from the +/-10% in the torque spec, the tool shall have a set torque that meets the drawing's tolerance while simultaneously accounting for the tool's accuracy. G-082,Torque Tool Selection Guide contains additional information on how to account for tool accuracy.

3.4. Minimum torque values

Some tools do not have sufficient accuracy to be used over the entire listed range of the tool. Where this is the case, the tool shall be set to a torque at or above the greatest of the following values:
1) The manufacturers minimum recommended torque value
2) 20% of the tools maximum torque value
3) The minimum value denoted on special markings or stickers on the tool, if any special markings exist.

4. DETERMINING THE TORQUE VALUE

4.1. Source of Torque Values

Torque specification 60083155 contains torque values for common threaded items. These calculated values consider the specific materials and other conditions that are present in the junction.

Some drawings have torque values for a specific threaded junction; Torque Specification 60083155 indicates when the design entity calculates and places a torque value on the drawing.

Manufacturers may publish their own recommendations for installation or tightening a threaded hardware item or connector item they produce. In the event of a conflict between the text of this document or the torque specification and the torque application/installation instructions provided by the hardware or connector manufacturer, the manufacturer's instructions will take precedence.

In addition to measured torque values, there are specified values for threaded hardware (certain pipe and hose fittings, adapters) that applied torque is through several "turns from a finger tight" or "flats from an initial wrench resistance" position.

If a torque value is not available from any of these sources, Torque Specification 60083155 directs how to obtain a torque value.

4.2. Torque Value Adjustments

There may be variation in the assembly torque requirement on threaded applications due to additional conditions that exist in the junction.

4.2.1. Correction Factors

Torque Specification 60083155 lists the common correction factors for threaded joint configurations. Common conditions that require adjustment include thread material types, locking features, or use of a lubricant. These factors will adjust the listed torque values for threaded junctions except threaded pipe/hose fittings and adapters.

4.2.2. Above Running Torque Requirements

When a threaded joint includes specific characteristics that increase the torque requirement as the threads run down (a locking insert or other torque-based retention), the assembly torque values may adjust to compensate for the increased requirement. Instructions to add the mean value of the measured running torque value(s) to the defined torque value may be added to the drawing to determine this final assembly torque. Addition of a portion or the full amount of an observed prevailing torque to a defined torque value without engineering direction may cause the fastener or other portions of the junction to exceed the material strength of the fastener or surpass the design parameters. Observe that the prevailing torque features exhibit a prevailing torque within the specified ranges (as described in Section 6), for known prevailing-torque-type retention features. Deviation of the prevailing torque value outside of the documented ranges for these known features may indicate either damage or a feature in the junction that is out of specification.

Measurement of the value of the prevailing torque is determined during installation of the threaded item(s), prior to seating. Obtain measurements for running torque with a calibrated digital or analog torque device. Fully engage the fastener with the locking features and observe the torque value within two rotations of the fastener.

When specified by the drawing, the found prevailing torque may be used on each individual fastener, or an average value from a subset of fasteners may be determined for use. If it is desired to use an average, determine the average value of prevailing torque found by observing five fasteners or 10% of the total amount of fasteners (whichever is greater) of the same size and type in the equivalent junction condition, at the same installation event, by the same person. The drawing may specify to add this found value or the found average value to the torque value presented in the torque specification (or drawing) to determine the final assembly torque. Record the determined assembly torque(s) in the job-specific build documentation.

Some combinations of hardware and design features may induce a prevailing torque value that is significantly larger than the base torque value and/or has a large range of variability to the "above running torque" requirement for a junction. The junction may not have the optimal thread materials or design features for a consistent value. If an unsatisfactory junction clamp force is observed from the design torque value alone, consult with the design authority that is responsible for the junction prior to adding additional prevailing torque. Attempting to overcome the additional friction in the junction by adding the prevailing torque without consultation may result in plastic deformation of the fastener and/or a junction that does not meet the original design parameters.

4.2.3. Tooling Corrections

When using a "crow's foot" extender, it is preferred to attach the extender to the torque wrench oriented 90° from the wrench handle. When an attachment angle other than 90° is necessary, adjust the setting on the torque wrench to a value calculated using Equation 1.

$$T_{wrench} = F \times T_{required}\ , \qquad (1)$$

where T_{wrench} = torque setting on the wrench,

F = crow's foot wrench extender correction factor, and

$T_{required}$ = torque requirement for the threaded device being installed.

The crow's foot correction factor, F, is given as

$$F = \frac{L}{L + C\cos A}\ , \qquad (2)$$

where L = length of the torque wrench (measured to the center of the handle),

C = length of the crow's foot tool (measured to the axis of the threads), and

A = angle between the crow's foot extender and the torque wrench (0°-180°),

as depicted in Figure 1.

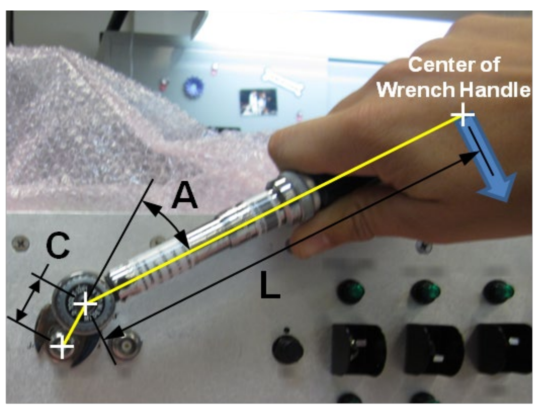

Figure 1: Torque wrench with crow's foot extender attached at angle A.

5. APPLICATION OF TORQUE

This section describes the application of torque and the use of documented torque values, published on the drawing or other approved torque specifications. Torque application applies during initial assembly and any subsequent reassembly after test debug, rework, or engineering modification.

5.1. Sequence of torque application

Tighten all threaded hardware that has a torque requirement with the appropriate tool, using this two-step procedure:

1. Run the hardware down until the bearing surface of the hardware is in full contact with the mating

surface, tighten the hardware to clamp the junction so no perceptible play exists between the mating hardware threads.

2. Apply the assembly torque to the hardware using the appropriate tool to meet the specified value within the tolerances listed in 60083155 or tolerances explicitly stated on the drawing.

Apply the torque to the nut, whenever possible. When applying torque to a fastener head, verify there is no binding between the fastener shank and the clearance hole or under the fastener head. Binding would affect how tight the junction is.

It is acceptable if the hardware does not rotate further when applying torque in step #2. Reference the torque verification section for direction on verifying the torque after the initial application of torque.

This applies to inch-series fasteners and set screws, metric-series fasteners, Spiralock® threaded items, self-sealing screws, and other threaded items that do not have specific manufacturer instructions or directions specified in this document.

Take caution when applying torque to self-sealing screws; the O-ring should not squeeze out and be visible around the head of the screw when tightened. This typically indicates improper hole geometry for the screw or an over-torque condition. A damaged O-ring may allow leakage when pressurized.

5.2. Multi-fastener Joints

When a multi-fastener joint is present, apply torque to the threaded hardware in a sequence similar to the example shown in Figure 2, unless the drawing has a defined torque application pattern. When there is a non-circular fastener pattern, use a spiral type tightening sequence shown in Figure 2(c), starting from the middle. When there is a circular fastener pattern, use the tightening sequence shown in Figure 2(a) or 2(b).

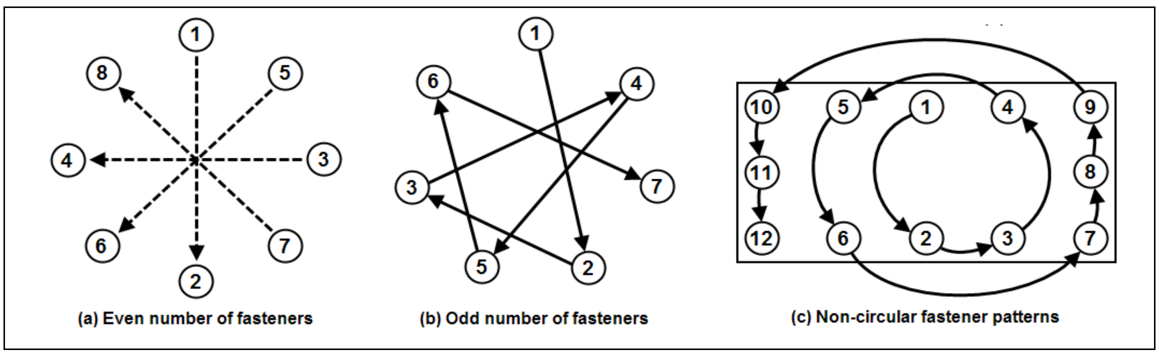

Figure 2: Tightening sequence for multi-fastener joints.

Multi-fastener joints typically include a gasket; when a gasket is present, apply the torque in two stages:

<u>First pass</u>: Using the selected assembly sequence, tighten all fasteners in the joint to approximately one-half the applicable assembly torque value.

<u>Second pass</u>: Following the same sequence, apply the full assembly torque to all fasteners in the joint.

Joint surfaces that use a gasket without a mechanical hard-stop adjacent to the gasket require a designed torque value for the joint, with the value present on the drawing. Reference Torque Specification 60083155 for determination of this torque value.

5.3. Applying Torque to Specific Threaded Pipe/Hose Fittings and Adapters

For these listed threaded pipe/hose fittings and adapters, use the specific directions for the types of fittings and adapters defined.

For fittings and adapters that are tightened to a specified number of turns through “turns from finger tight” or “initial wrench resistance position”, the nut position may be marked relative to the fastener body, using a longitudinal mark on one of the nut flats onto the fastener body, as shown in Figure 3. After applying torque, the fastener body may be marked at the finish position of the nut position mark. This secondary mark may act as indicator of applied torque on the joint and may have use as a reference if loosening and reassembling the joint.

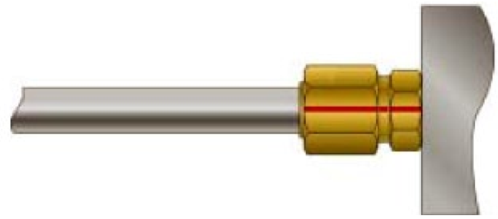

Figure 3: Typical reference mark on nut and tube body.

5.3.1. Parallel (Straight) Thread Ports (including SAE J1926)

Install per the Manufacturer's recommendations using the torque values provided in Torque Specification 60083155.

5.3.2. Tapered Thread Ports (including NPT, NPTF and BSPT or JIS "PT")

5.3.2.1. Inspect the components to ensure that the male and female port threads and sealing surfaces are free of burrs, nicks and scratches, or any foreign material.

5.3.2.2. Apply sealant/lubricant to the male pipe threads, if applicable and not already pre-applied.

Note: *With any sealant, leave the first one to two threads uncovered to avoid system contamination. If PTFE (Teflon®) tape is used, wrap 1-1/2 to 2 turns of tape in a clockwise direction when viewed from the pipe thread end. More than two turns of tape may cause distortion or cracking of the port.*

5.3.2.3. Screw the adapter into the port to the finger tight position.

5.3.2.4. Wrench-tighten the adapter to the applicable number of turns from finger tight (T.F.F.T.) specified in Torque Specification 60083155.

Note: *Never back-off (loosen) a pipe-threaded connector to achieve alignment. Normally, the total number of engaged tapered threads should be between 3-1/2 and 6. Any number outside of this range may indicate either under-/over-tightening of the joint or out-of-tolerance threads. If the joint is under-tightened, tighten it further, but not more than one full turn. If the joint is over-tightened, check both sets of threads for cracks and distortion.*

5.3.3. O-Ring Face Seal (ORFS) Fittings (including SAE J1453)

Install per the Manufacturer's recommendations using the torque values provided in Torque Specification 60083155.

Note*: A second wrench may be required to prevent the fitting from moving during assembly.*

5.3.4. JIC 37° Flare Fittings

5.3.4.1. Align the tubing to the flare (nose) of the fitting body.

5.3.4.2. Place the nut on and tighten the nut lightly with a wrench (approximately 30 in-lbs), clamping the tube flare between the fitting nose and the sleeve. This is the initial "wrench resistance" position.

5.3.4.3. Starting from this position, tighten the nut further to the applicable number of flats from wrench resistance (F.F.W.R.) specified in torque specification 60083155. (A "flat" is one side of the hexagonal tube nut and equates to 1/6 of a turn.)

Note: *Do not force an improperly bent rigid tube into alignment or draw-in a tube that is too short, using the fitting. This puts undesirable strain on the joint that may lead to leakage.*

5.3.5. Pipe Swivel Assembly (NPSM) (Including SAE J514)

5.3.5.1. Thread the nut into the mating male pipe threads; tighten to the finger tight position.

5.3.5.2. Wrench-tighten the nut further to the number of flats from finger tight (F.F.F.T.) specified in Torque Specification 60083155. (A "flat" is one side of the hexagonal swivel nut and equates to 1/6 of a turn.)

5.4. Connector Torque Application

Connector specific torque tooling may be required for some connectors. A connector may have a coupling torque and/or multiple assembly stages to complete assembly. W-572, Connector & Adapter Torque Application, has detailed tool use and techniques that support this procedure.

5.4.1. RF Connectors

Assemble RF connectors per the manufacturer directions; apply torque during assembly.

5.4.2. Circular MIL Connectors

5.4.2.1. Coupling/Mating Connectors

Connectors that mate without tools and do not have a corresponding torque are hand tightened:

- Bayonet Coupling: Turn the coupling ring through the partial rotation until the ring locks into place. If there are colored stripe indicators, they align at the coupling lock point.
- Threaded Coupling: Engage the threads, turn the coupling ring until the receptacle covers the engagement color band.
- Threaded Coupling with Ratchet Mechanism: Engage the threads, turn the ratcheting coupling ring until the receptacle covers the engagement color band and the plug ratchet clicks.

5.4.2.2 Backshell/Adapter Installation

5.4.2.2.1 Single Stage Backshells

Align the teeth, castellation or other grounding and alignment features. Hand-tighten the ring while manipulating the backshell to engage the features. Apply torque using the appropriate tool.

5.4.2.2.2 Multi-Stage Non-Environmental Backshells

Align the teeth, castellation or other grounding and alignment features and hand-tighten all stages as they are installed, front to back. Hand-tighten the rings while manipulating the backshell to engage the features on each stage. Apply torque to each stage using the appropriate tool and torque value for each stage.

5.4.2.2.3 Multi-Stage Environmental Backshells

Align the teeth, castellation or other grounding and alignment features and hand-tighten all stages as they are installed, front to back. Hand-tighten the rings while manipulating the backshell to engage the features on each stage. Tighten the backshell to compress the grommet securely. Apply torque to each stage beginning with the stage that compresses the grommet first. Apply torque using the appropriate tool and torque value for each stage. For backshells that use a style 2 reducer, reference the section on Style 2 Reducers. For backshells that use a cable clamp, reference the section on backshells with cable clamp assemblies.

5.4.2.2.4 Angled Backshells

Align the teeth, castellation or other grounding and alignment features and hand-tighten all stages as they are installed, front to back. Hand-tighten the rings while manipulating the backshell to engage the features on each stage. Apply torque to the front stage using the appropriate tool and torque value. Apply torque to the back of the angled adapter, then the remainder of the stages using the appropriate tool and torque value. For backshells that use a style 2 reducer, reference the section on Style 2 Reducers. For backshells that use a cable clamp, reference the section on backshells with cable clamp assemblies.

5.4.2.2.5 Style 2 Reducers

Style 2 backshells supply with a reducer to attach to either a connector or another stage. The smaller threads and larger threads torque to their respective sizes. Align the teeth, castellation or other grounding and alignment features and hand-tighten the first side near the connector, then the other side. Hand-tighten the rings while manipulating the backshell to engage the features on each side. Apply torque to each side using the appropriate tool and torque value.

5.4.2.2.6 Backshells with Cable Clamp Assemblies

Backshells that have a cable clamp feature have torque applied as a staged backshell does; apply the torque on the accessory thread side of the connector. The cable clamp side has a torque value that relates to the clamp size. Cable clamps that use elastomeric sealing grommets should not have the sealing grommet extrude. Apply torque to the set of screws on the cable clamp incrementally, so the clamp faces may remain close to parallel and compress the cable and/or the grommet evenly. If assembly is required to install the backshell to the cable clamp assembly with a conical metal EMI ferrule, there are minimum torques for this combination listed in Torque Specification 60083155.

5.4.3 Glenair®

5.4.3.2 Mighty Mouse

5.4.3.2.1 Series 801 coupling

Series 801 couplings are hand tightened until the plug fully covers the engagement color band on the receptacle.

5.4.3.2.2 Series 803 bayonet coupling

Series 803 connectors are “push-to-mate” couplings that push together, then turn the ring ¼ turn until locked in place.

5.4.3.2.3 Series 804 push pull coupling

Series 804 connectors couple by pushing the connector and ring on until hearing an audible click.

5.4.3.2.4 Series 805 ratcheting coupling

Series 805 connectors have a ratcheting lock engagement ring that couple by hand tightening the ring until the plug covers the engagement color band and the ratchet mechanism clicks.

5.4.3.2.5 Series 807 coupling

Series 807 connectors are custom connectors for CSW, and the coupling styles are either series 801 or series 804 couplings and will mate with their respective instructions.

5.4.3.2.6 All Mighty Mouse series adapter mating

The torque values for Mighty Mouse series connectors and adapters list by shell size designation in Torque Specification 60083155. Align the teeth, castellation or other grounding and alignment features. Hand-tighten the ring while manipulating the backshell to engage the features. Apply torque using the appropriate tool.

5.4.3.3 D-Sub EMI Backshell

Torque application on the “A” thread, “B” thread and “C” thread is similar to torque application on Circular MIL Connector Backshell/Adapters with gaskets. If a cable clamp exists, apply torque per the Backshells with Cable Clamp Assemblies section.

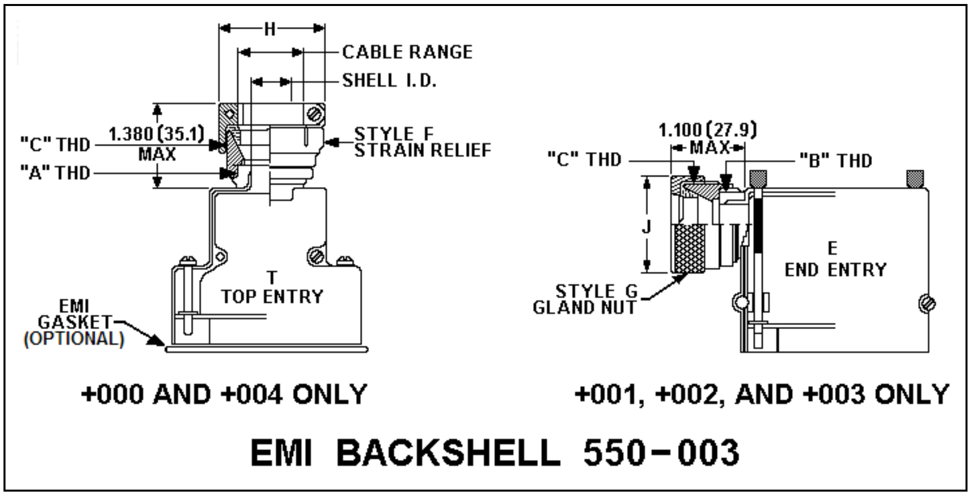

Figure 4: Diagram of the Glenair® D-Sub EMI backshell.

5.4.4 Raychem®

Apply torque to the Raychem® connector jam nuts with the appropriate tooling for hex shaped jam nuts.

5.4.5 LEMO®

Torque values are listed by connector size for the appropriate series. Apply torque to LEMO® type connectors with the appropriate tooling for hex shaped jam nuts.

5.4.6 ODU®

Coupling is with a push/pull coupling mechanism. Torque values are listed by connector series size. Apply torque to the rear nut of ODU®-type connectors with the appropriate tooling for hex shaped jam nuts.

5.4.7 Thor Electronics®

Torque Specification 60083155 lists coupling torques, and connector jam nut torques by CSW part number. Apply torque using the appropriate tooling for a coupling ring or connector jam nut.

5.4.8 TFOCA-I/-II® Fiber Optic Connectors

Amphenol® fiber optic connectors have coupling, and jam nut torques. Apply torque using the appropriate tooling for a coupling ring or connector jam nut.

5.4.9 MIL-Spec Jackposts and Mating Jackscrews

Reference W-522, D-sub Jackpost Installation, and W-104, Jackscrew Installation for Rectangular (D-Type) Electrical Connectors, for direction on the application of torque on these type fasteners. Micro-D Metal (MDM) connectors with EMI gaskets have independent torque values using similar tooling. Otherwise, use an appropriate socket or bit on torque tooling to apply torque to these items. Torque the nut on jack posts when possible.

5.4.10 Flange Mount Connectors

The drawing specifies torque values for flange mount connectors. If there are multiple fasteners, use the Multi-Fastener Joint torque application method. Apply torque in three steps:

1. Tighten all fasteners to the full assembly torque value.
2. Wait at least 15 minutes.
3. Tighten all fasteners the full assembly torque value, using the same sequence used in step 1, prior to milliohm resistance testing.

5.4.11 Other Miscellaneous Connectors and Accessories

Torque values are listed by material number in Torque Specification 60083155 and 6008315500. Apply torque using the appropriate tooling.

5.4.12 Hexashield Adapters

Install Hexashield connector adapters without a specified torque per Torque Specification 60083155.

5.4.13 Strain Relief Clamps

Apply torque to the fasteners on strain relief clamps evenly, until the split lock washer is flat. Torque Specification 60083155 specifies the locking feature requirements and acceptability requirements for the cable bundle.

5.4.14 Connector Dust Caps

Apply torque to connector dust caps hand-tight until snug, per Torque Specification 60083155.

6. LOCKING FEATURES

A locking feature is any portion of the junction that provides resistance to relative movement of mated threads after the initial mating or preload of the threaded junction. Deformed or special thread profiles, use of lock wire, or use of a chemical compound are a few methods that may provide this resistance. Further definition of this is contained in Torque Specification 60083155. IS-001, Use of Non-Specified Hardware/Material and Drawing Notes, provides direction on some materials that may be used as a locking feature.

Directions on the use of wire and chemical thread locking compounds, when specified on the drawing, are contained in W-554, Lock/Safety Wire, and W-587, Loctite® Threadlocker Application Guidelines.

Some of the methods used directly in a threaded junction may lubricate the junction or increase prevailing torque. This may require correction of the applied final torque value as described in this document.

6.1. Reuse and Replacement of Prevailing-Torque-Style Locking Fasteners and Mating Components

When a threaded junction uses a prevailing-torque-style locking feature, the components may experience wear and deformation. If considering the components for reuse, identify excessively worn and/or damaged components visually or by observation of the prevailing torque required to drive down the fastener. When one or both components have wear, the junction may exhibit less prevailing torque than the minimum values or larger than the maximum values indicated in the following tables or the applicable NAS or NASM specification for the locking feature. When wear or a variation is observed, replace the worn/damaged components per the indications in Torque Specification 60083155.

6.2. Locking Threaded Insert (NAS1130L Series) Prevailing Torque Ranges:

TABLE A- UNIFIED COARSE THREAD (UNC)

Nominal Thread Size	Minimum	Maximum
1 (.073)-64	2 in-ozs	15 in-ozs
2 (.086)-56	3 in-ozs	20 in-ozs
3 (.099)-48	7 in-ozs	32 in-ozs
4 (.112)-40	10 in-ozs	48 in-ozs
5 (.125)-40	13 in-ozs	75 in-ozs
6 (.138)-32	1 in-lbs	6 in-lbs
8 (.164)-32	1.5 in-lbs	9 in-lbs
10 (.190)-24	2 in-lbs	13 in-lbs
¼1/4 (.2500)-20	4.5 in-lbs	30 in-lbs
5/16 (.3125)-18	7.5 in-lbs	60 in-lbs
3/8 (.3750)-16	12 in-lbs	80 in-lbs
½1/2 (.5000)-13	24 in-lbs	150 in-lbs
9/16 (.5625)-12	30 in-lbs	200 in-lbs
¾3/4 (.7500)-10	60 in-lbs	400 in-lbs
7/8 (.8750)-9	82 in-lbs	600 in-lbs
1 (1.000)-8	110 in-lbs	800 in-lbs
1-1/8 (1.1250)-7	137 in-lbs	900 in-lbs
1-1/4 (1.2500)-7	165 in-lbs	1000 in-lbs
1-3/8 (1.3750)-6	185 in-lbs	1150 in-lbs
1-1/2 (1.5000)-6	210 in-lbs	1350 in-lbs

TABLE B- UNIFIED FINE THREAD (UNF)

Nominal Thread Size	Minimum	Maximum

2 (.086)-64	3 in-ozs	20 in-ozs
3 (.099)-56	7 in-ozs	32 in-ozs
4 (.112)-48	10 in-ozs	48 in-ozs
6 (.138)-40	1.0 in-lbs	6 in-lbs
8 (.164)-36	1.5 in-lbs	9 in-lbs
¼1/4 (.2500)-28	3.5 in-lbs	30 in-lbs
5/16 (.3125)-24	6.5 in-lbs	60 in-lbs
3/8 (.3750)-24	9.5 in-lbs	80 in-lbs
½1/2 (.5000)-20	18.0 in-lbs	150 in-lbs
9/16 (.5625)-18	24.0 in-lbs	200 in-lbs
¾3/4 (.7500)-16	50.0 in-lbs	400 in-lbs
7/8 (.8750)-14	70.0 in-lbs	600 in-lbs
1 (1.000)-14	92.0 in-lbs	800 in-lbs
1 (1.000)-12	90.0 in-lbs	800 in-lbs
1-1/8 (1.1250)-12	117.0 in-lbs	900 in-lbs
1-1/4 (1.2500)-12	143.0 in-lbs	1000 in-lbs
1-3/8 (1.3750)-12	165.0 in-lbs	1150 in-lbs
1-1/2 (1.5000)-12	190.0 in-lbs	1350 in-lbs

TABLE C- METRIC COARSE

Nominal Thread Size	Minimum	Maximum
M2x0.4	0.4 in-ozs	17.0 in-ozs
M2.2x0.45	2.8 in-ozs	19.8 in-ozs
M2.5x0.45	8.5 in-ozs	31.2 in-ozs
M3x0.5	14.2 in-ozs	62.3 in-ozs
M3.5x0.6	1.1 in-lbs	6.0 in-lbs
M4x0.7	1.4 in-lbs	8.0 in-lbs
M5x0.8	2.7 in-lbs	14.2 in-lbs
M6x1	3.5 in-lbs	26.6 in-lbs
M7x1	5.3 in-lbs	38.9 in-lbs
M8x1.25	7.1 in-lbs	53.1 in-lbs
M10x1.5	12.4 in-lbs	88.5 in-lbs
M12x1.75	19.6 in-lbs	132.8 in-lbs
M14x2	26.6 in-lbs	203.6 in-lbs
M16x2	37.2 in-lbs	283.2 in-lbs
M18x2.5	48.7 in-lbs	371.7 in-lbs
M20x2.5	62.0 in-lbs	477.9 in-lbs
M22x2.5	79.7 in-lbs	619.6 in-lbs
M24x3	97.4 in-lbs	708.1 in-lbs
M27x3	106.2 in-lbs	840.8 in-lbs
M30x3.5	123.9 in-lbs	973.6 in-lbs
M33x3.5	141.6 in-lbs	1106.3 in-lbs
M36x4	159.3 in-lbs	1239.1 in-lbs
M39x4	177.0 in-lbs	1327.6 in-lbs

TABLE D- METRIC FINE

Nominal Thread Size	Minimum	Maximum
M8x1	7.1 in-lbs	53.1 in-lbs
M10x1	12.4 in-lbs	88.5 in-lbs
M10x1.25	12.4 in-lbs	88.5 in-lbs
M12x1.25	19.5 in-lbs	132.8 in-lbs
M12x1.5	19.5 in-lbs	132.8 in-lbs
M14x1.5	26.6 in-lbs	203.6 in-lbs
M16x1.5	37.2 in-lbs	283.2 in-lbs
M18x1.5	48.7 in-lbs	371.7 in-lbs
M20x1.5	62.0 in-lbs	477.9 in-lbs
M22x1.5	79.7 in-lbs	619.6 in-lbs
M18x2	48.7 in-lbs	371.7 in-lbs
M20x2	62.0 in-lbs	477.9 in-lbs
M22x2	79.7 in-lbs	619.6 in-lbs
M24x2	97.4 in-lbs	708.1 in-lbs
M27x2	106.2 in-lbs	840.8 in-lbs
M30x2	123.9 in-lbs	973.6 in-lbs
M33x2	141.6 in-lbs	1106.3 in-lbs
M36x2	159.3 in-lbs	1239.1 in-lbs
M39x2	177.0 in-lbs	1327.6 in-lbs
M36x3	159.3 in-lbs	1239.1 in-lbs
M39x3	177.0 in-lbs	1327.6 in-lbs

6.3. NASM21075 Locking Nutplate Prevailing Torque:

TABLE E- UNIFIED COARSE THREAD (UNC)

Nominal Thread Size	Minimum	Maximum
2 (.086)-56	0.2 in-lbs	2.5 in-lbs
4 (.112)-40	0.5 in-lbs	5 in-lbs
6 (.138)-32	1 in-lbs	10 in-lbs
8 (.164)-32	1.5 in-lbs	1 in-lbs
¼1/4 (.2500)-20	4.5 in-lbs	30 in-lbs
5/16 (.3125)-18	7.5 in-lbs	60 in-lbs
3/8 (.3750)-16	12 in-lbs	80 in-lbs
½1/2 (.5000)-13	24 in-lbs	150 in-lbs
9/16 (.5625)-12	30 in-lbs	200 in-lbs
¾3/4 (.7500)-10	60 in-lbs	400 in-lbs
7/8 (.8750)-9	82 in-lbs	600 in-lbs
1 (1.000)-8	110 in-lbs	800 in-lbs
1-1/8 (1.1250)-7	137 in-lbs	900 in-lbs
1-1/4 (1.2500)-7	165 in-lbs	1000 in-lbs
1-3/8 (1.3750)-6	200 in-lbs	1200 in-lbs
1-1/2 (1.5000)-6	230 in-lbs	1400 in-lbs

TABLE F- UNIFIED FINE THREAD (UNF)

Nominal Thread Size	Minimum	Maximum
¼1/4 (.2500)-28	3.5 in-lbs	30 in-lbs
5/16 (.3125)-24	6.5 in-lbs	60 in-lbs
3/8 (.3750)-24	9.5 in-lbs	80 in-lbs
½1/2 (.5000)-20	18 in-lbs	150 in-lbs
9/16 (.5625)-18	24 in-lbs	200 in-lbs
¾3/4 (.7500)-16	50 in-lbs	400 in-lbs
7/8 (.8750)-14	70 in-lbs	600 in-lbs
1 (1.000)-12	90 in-lbs	800 in-lbs
1-1/8 (1.1250)-12	117 in-lbs	900 in-lbs
1-1/4 (1.2500)-12	143 in-lbs	1000 in-lbs
1-3/8 (1.3750)-12	180 in-lbs	1200 in-lbs
1-1/2 (1.5000)-12	210 in-lbs	1400 in-lbs

7. LUBRICANTS

Materials specified on a drawing, for use in a threaded junction, may act as a lubricant. Junctions with anti-seize, lubrication and/or certain thread locking materials may need torque value adjustments as described in Torque Specification 60083155 and in this document.

Observe the manufacturers' recommendations for use of lubrication on threaded pipe hose fittings and adapters, when applying materials specified on a drawing. Apply PTFE (Teflon®) tape to tapered pipe threads only, unless specifically directed by a fitting manufacturer or otherwise specified on the engineering drawing.

If an EMI gasket of any type is included in the stackup, lubricants, including anti-seize lubricants, shall not interfere with the interface between the gasket and any adjacent mating surfaces, unless otherwise specified on the engineering drawing.

8. TORQUE VERIFICATION

8.1. Torque Verification

Threaded hardware torque and tightness shall be verified per W-392, Tightness and Torque Verification. The guidelines provided below shall also apply when the verification is performed.

8.2. Verification Torque Values

The applicable verification torque value of 75% of the assembly torque value used to install the threaded items is used to verify the application of torque. If a correction factor was applied to the assembly torque, the same correction factor is applied to the verification torque value. For "above running torque" callouts that appear on the engineering drawing, the corresponding verification torque value is 75% of the assembly torque value that was determined and used at installation. This may require records of the assembly torque value used, at the time of installation.

8.3. Exceptions to Torque Verification

There are some situations where torque verification is either prohibited or not required. Several of these exceptions are included in this section. In general, any threaded hardware item that is not torqued when installed shall not be torqued during inspection. Such items shall be checked for tightness only.

8.3.1. Adjustment/Tuning Hardware

Adjustment/Tuning hardware is not intended to be torqued at installation. The torque on this type of hardware shall not be verified.

8.3.2. Junctions with Thread Locking Compound or Tamper Evident Compound

The torque on threaded joints that include thread locking adhesive in the stack up shall not be checked after the adhesive has cured. Such verification risks breaking the adhesive bond that has formed between the mated threads, thus negating the locking effectiveness of the adhesive.

8.3.3. Through Hole Applications

To properly verify torque, relative rotation between the male and female threads must be possible. In some thru hole applications, applying torque on one side of the joint without simultaneously holding the other side will simply cause the entire screw/nut stack up to spin together (i.e., not checking the torque). For this reason, torque verification shall not be performed on thru hole applications if the following two conditions are met:

1. Access to the backside of the threaded joint is not possible at the time the torque is checked.
2. There is no design feature in the joint that prevents the threaded hardware on the inaccessible side from rotating (e.g., the anti-rotation flat in a D-hole connector cutout).

8.3.4. Pipe Threads

Torque verification shall not be performed on threaded fittings that are tightened to a certain number of turns rather than a single torque value. These will need to be inspected for tightness using other methods. Reference marks may be incorporated into verification procedures for this type of threaded joint.

RECORDS

Identification	Production data associated with a given shop order are maintained electronically in the SAP system and are identified by the shop order number.
Storage	Records are stored electronically by the SAP system.
Protection	Electronic copies are protected against loss or damage via the normal back-up system provided by the Information Technology (IT) Department.
Retrieval	Records can be retrieved electronically from SAP by searching for the shop order number.
Retention Time	All records stored in SAP are retained indefinitely.
Disposition	N/A

END OF DOCUMENT

DOCUMENT INFORMATION

Responsible Organization:	Operations
Function/Sub-function:	Manufacturing, Torque Application
Governing Document(s):	60083155, Specification of Torque and Retention Requirements for Threaded Hardware IS-001, Use of Non-Specified Hardware/Material and Drawing Notes Y-001, L3 Technologies CSW Quality ManualManual
Subordinate Document(s):	G-032, Test Engineering Equipment & Hardware Standardization W-104, Jackscrew installation for Rectangular (D-Type) Electrical Connectors W-392, Tightness and Torque Verification W-481, Torque Validation Work Instruction W-498, Tightness Verification at Receiving Inspection W-522, D-sub Jackpost Installation W-554, Lock/Safety Wire W-572, Connector & Adapter Torque Application W-587, Loctite ® Threadlocker Application Guidelines
Related Document(s):	1M-070, Setup and Execute Production 540-PG-8071-1-2B, Mechanical Fastener Torque Guidelines, NASA GSFC 60102381, Interpreting L3 Cable/Harness Drawings AS1310, Definitions of Fastener Torque for Threaded Applications, SAE ASME B107.300-2021, Hand Torque Tools and Torque Testers G-082, Torque Tool Selection Guideline G-680, Inspection Rework Guideline P-046, Receiving Inspection W-432, Practices for EMC-Electromagnetic Compatibility WS-025, COTS Items – Condition and Appearance Acceptabilit
Related Training:	Manufacturing Execution
Approval Requirements:	Business Change Control Board Chair Operations Change Control Board Representative Manufacturing Operations Engineering Lead Manufacturing Process Engineering Representative Design Producibility Engineering Manager Quality Engineering Representative
Review Requirements:	Director, Manufacturing Mechanical Engineering Manager Operations Business Analyst Asset Management Manager Quality Engineering Manager Manufacturing Operations Manager

Manufacturing Operations Engineering Manager

Revision History Summary

Revision #	Description of Change	Date
00	Initial release.	10/21/2020
NA	Updated point of contact. No revision upgrade necessary.	7/29/2021
01	Removed references to W-215, added reference to external explanatory documents. Added definitions for Assembly Torque and Hand tight and changed “hand” to “using fingers” in definition of finger tight in section 2. Updated Figure 2 to combine the 3 images. Expanded torque verification section and expanded the instruction in finding average prevailing torque values. Updated the torque application steps and some definitions to agree with the updates that exist in 60083155. Added direction on the tool drive angle relative to the fastener axis in section 3.2.	11/3/2021
NA	Updated point of contact. No revision upgrade necessary.	4/10/2024
02	Updated in response to CAR-012897. Added Carlsbad facility in Purpose and Scope. Add definitions of ‘set torque’ and ‘specified torque’. Add section 3.3 and to account for tool accuracy and 3.4 to specify minimum torque values. Reword 5.1 step 2 of torque process. Added ASME and G-082 to list of related documents.	11/13/2025
03	Added definitions on Electronic torque tools and Hand torque tools. Changed “hand tools” to “non-calibrated tools” in section 3.2. Updated section 3.3 to specify tool accuracy and set torque of electronic torque tools.	4/16/2026