

Frequently Asked Questions

Where can LMF+ be used?

- Rotational bolts, foundation bolts, liner bolts, slew ring, high pressure pumps, pipeline flanges, fluid sealing, gear boxes, gear rings, pinions, cranes

What are the size limitations?

- 3/4" (m20) and up on headed product, 1 1/8" (m30) and above on threaded studs

What type of fasteners can be used?

- LMF+ can be installed on any headed or threaded end of fasteners. It can be used in hex bolts, 12 points, square heads, round heads, double-ended studs. In some cases, such as a socket head cap screw, it may be necessary to switch to a 12 point or install in the threaded end due to the broach.

Where is LMF+ currently being used and how is the performance?

- Since 2015 Data Monitoring Fasteners have been used successfully around the world:
 - South America, Europe, and Asia
 - Wind Energy, Europe and USA
 - Oil & Gas, USA
 - Petrochemical, China
 - And many more...

Does LMF+ compromise the strength of the fastener?

- The LMF+ instrumentation will not compromise the integrity or strength of a headed fastener. Bolts typically fail in the minimal loaded stress area which is in the threaded region. For studs or any threaded end, the fasteners are slightly derated which in nearly all cases is negligible. For example, the derated value for 2.25" diameter 8 T.P.I. bolt would be less than 1%. Tensile and shear tests have verified this, and can be done upon customer request.

Are Data Monitoring Fasteners accurate?

- Data monitoring fasteners typically adhere to ASTM F2483 which specifies, "The load-indicating fastener shall be calibrated to $\pm 5\%$ accuracy up to the proof load of the fastener unless otherwise specified at the time of order." Calibration certificates and records can be provided for each fastener.
- The calibration process is robust and uses a calibrated digital pressure dial connected to a hydraulic actuator. Cross checks are routinely conducted using calibrated equipment such as tensile testing machines and electronic strain gauges.

Has LMF+ been designed for longevity in harsh environments?

- Numerous failure modes considerations during the design of this proprietary technology: Mechanical failures, electronic failures, extreme temperature failures, electromagnetic interference, vibrations and shock, water/moisture/dust ingress, battery polarity reversal, and loss of contact with the battery.
- LMF+ comes standard with IP65 water resistance and can be sealed to IP68.
- Corrosion resistance is improved by features such as gold plated pcb pads and application specific sealing systems.
- LMF+ can be easily programmed to provide readings at desired intervals. At 1-hour intervals, the battery will generally exceed 4 years.
- LMF+ module production conforms to BSI ISO-9001 management and documentation standards and supplies a variety of instrumentation for mission critical applications including Royal Navy propulsion systems, hydroelectric power plants, mines, wind turbines, automotive engines, and rail.

Can LMF+ withstand vibrations, cyclic loads, and shock?

- LMF+ has been proven to sustain expected and some unexpected in-service conditions.
- Upon customer request, 3rd party vibration and shock tests can be conducted at amplitudes, frequency ranges, and other parameters that match and exceed the expected application.
- The strain gauge is not susceptible to fatigue failure as it operates below its endurance limit.

Does LMF+ come with warranty protection?

- Warranty is available and is application specific.

Are replacement parts available?

- Caps and components are stock items from the supplier and available for immediate replacement.
- Damaged caps can easily be replaced in the field and while in service.

Can I monitor the status of more than one fastener?

- LMF+ provide the ability to simultaneously read multiple fasteners.

How long do the batteries last and can they be replaced?

- Typical battery life is approximately 4 years and can easily be replaced in the field or caps with new batteries can be supplied from Copper State in exchange for units with depleted batteries.

How long will the LMF+ last?

- The LMF+ has been designed to last decades for most applications.

What is the difference between the Load Monitoring Fastener and the Load Indicating Fastener?

- The Load Monitoring Fastener includes a cap that will continually send out data at predetermined intervals which can be captured and stored locally or on the Internet. This information can be accessed and used during installation and while the equipment is in service.
- The Load Indicating Fastener is used in conjunction with a detachable cap that enables real time data collection.
- Load Indicating Fasteners and the detachable readers can be used during installation and to spot check the status of a fastener when the user has physical access to the fastener.
- Load Indicating Fasteners can easily be converted to Load Monitoring Fasteners instantly by attaching a Bolt Cap Module.

What tightening tools can be used with the LMF+?

- Any conventional tool such as impact wrench, hydraulic torque wrench, pneumatic torque multiplier, tensioner.

Do I need to calibrate my tightening tool?

- No, the LMF+ will allow the user to know the tension in the bolt.

Can the LMF+ be used to calibrate my tightening equipment?

- Yes, the LMF+ can be used to verify or determine the calibration of a tool or the actual nut factors in an assembly.

What is the range of the LMF+ signal?

- The Bluetooth® signal can typically be read at least 150 feet away, but depending on the environment, could significantly exceed that distance or in some cases have reduced range. Wireless transceivers can be placed and transfer data to the Internet so that it can be viewed anywhere.

How can the Global Network help me?

- The Global Data Network enables automated, remote monitoring and trending of bolt preload over an extended period of time.
- When preload drops below a pre-determined level, reports are automatically deployed via email or text messages to key stakeholders. This ensures maintenance is only conducted on bolts requiring attention and allows immediate action to be taken on those installed in mission critical applications.
- The data generated also enables maintenance teams to build a picture of recurring incidents, informing proactive investigation, troubleshooting, and predictive maintenance.

Can I get assistance interpreting data and troubleshooting problems?

- Transmission Dynamics and Copper State together have decades of experience in assisting customers in critical fastener applications, mechanical engineering, sensor hardware/software design and advanced data analytics.
- Transmission Dynamics are global leaders in combining these skill sets to help identify and resolve root causes to reduce maintenance costs and extend asset life.

Technical Summary Sheet for the Data Monitoring Fastener

I	<p>Adheres to ASTM F2482:</p> <ul style="list-style-type: none">• Classifies as "4.1.3 Strain Gauge Type (ST)—This type of fastener incorporates a bonded device wired in a Wheatstone bridge configuration which, through changes in relative resistance, reports tension in the fastener."• Calibration will be conducted with tension forces at 25 % increments up to the fastener proof load and must exhibit ± 5 % accuracy.• Performance. The load-indicating fastener shall be calibrated to ± 5 % accuracy up to the proof load of the fastener unless otherwise specified at the time of order.• Calibration Accuracy Test Reports may be requested and shall show the heat number (to ensure that the chemical composition is on record and could be furnished upon request), calibration loads, nominal size, calibration of accuracy lot identification number, ASTM designation, type or grade, and issue date, and purchase order number.
II	Electronics Supplier conforms to BSI ISO-9001:2015 management and documentation standard.
III	Battery life will vary depending upon environment and programmed intervals of data collection. For reference, long term testing has shown that with 5-minute intervals average battery life is 3.8 years and typical life with 1-hour data collection intervals can exceed 5 years.
IV	<p>Operating Temperature Ranges:</p> <ul style="list-style-type: none">• -25°C to 85°C with standard battery• -40°C to 85°C with non-standard battery• Elevated temperature models available
V	Standard water resistance conforms to IP65 and can be sealed to IP68
VI	Application specific 3rd party testing for vibration, shock, temperature, cyclical loading, corrosion, and combined environment can be conducted at customer's request.
VII	Electronic PCB pads are gold plated for corrosion resistance.
VIII	Shock and Vibrations IEC61373
IX	Corrosion ASTM B117
X	Standard O-ring material is Viton. Application specific sealing is available. Changing O-ring at same time as battery is recommended.