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Certificate #L2216

Calibration Certificate

#2210022

(Level 4) ANSI/NCSL Z540.3-2006 & ISO/IEC 17025:2017 Accredited Calibration

Customer

Illiana Instrumentation Service LLC (7954)
1831 Govert Drive
Schererville, Indiana 46375
PO Number: 4317

Instrument Profile

Manufacturer: *Craftsman*
Model: *44598*
Asset ID: *1293*
Serial: *012498*
Description: *Electronic Rotary Torque Sensor System, Torque Sensor*

Calibration Information

†Requested Interval:
Calibration Date: *07/18/2022*
†Due Date: _____/_____/_____
Temperature: *70.0 ºF (21.1 ºC)*
Batch #: *1923946*
Calibration Location: *Indiana Physical Lab*
Calibration Procedure: *CP-0136*
Relative Humidity: *50.3 %*

The customer has requested that the calibration interval and the applicable due date be left blank. The Due Date has a template for convenience to b completed by the end-user. This instrument will not be listed on the courtesy Calibration Reminder Letter issued by Cal Lab and it's timely recalibration is left up to the customer.

Instrument Condition

As Received: *In Tolerance*
As Returned: *In Tolerance*
Tolerance(s): *Manufacturer specification(s) unless otherwise specified.*
Phys. Damage: *No apparent evidence of physical or cosmetic damage noted during this calibration.*

Quality & Traceability Statements

Level ❹ Calibration

The results reported herein apply only to the calibration of the item described above. All calibration standards used in this calibration are traceable to the International System of Units (SI) through NIST or equivalent National Measurement Institute signatories to the CIPM MRA. Supporting documentation relating to this traceability is initiated by the Trace Number listed in the Calibration Standards section of this certificate. Additional documentation is available for review by a scheduled appointment. Our Quality System is accredited to ISO/IEC 17025:2017, ANSI/NCSL Z540-1:1994 and ANSI/NCSL Z540.3:2006 via the ANSI National Accreditation Board. Details of our scope of accreditation are available at www.anab.org.

†Per the requirements of ISO-17025:2017, Cal Lab does not make recommendations for recall therefore the listed Due Date is dictated by the owner of this equipment. Although the item calibrated meets the conditions or specifications at the time of the calibration, due to a number of factors the due date of the item calibrated does not imply continuing conformance during the calibration interval. The parameters of this calibration are directly or indirectly covered under our current scope of accreditation unless otherwise noted.

*The reported Estimated Measurement Uncertainty [EMU] is reported at a coverage factor of k=2, which for a normal distribution corresponds to a confidence level of approximately 95%. The EMU **does** include the resolution of the instrument calibrated, which in some cases, may be a dominate source of error, but does not include Type A contributors (repeatability/reproducibility studies) of the instrument calibrated unless specifically requested by the customer. The uncertainty values reflect the measurement processes uncertainty and may not reflect the measurement uncertainty listed on our scope of accreditation. Statements of compliance are further defined on the final page of this certificate.*

For purposes of determining conformance with the listed specifications (tolerances), the observed value or a calculated value has been rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of ASTM Practice E 29 for Using Significant Digits in Test Data to Determine Conformance with Specifications.

This certificate may contain calibration data with results listed as either Pass or Fail. These attributes are typically listed as a functional check based on an applied measurand or verification, however, this is strictly Qualitative and should not be interpreted as a Quantitative measurement.

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Jeff Breidigan
Review & Approval
Jeff Breidigan
Metrology Manager
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Calibration Standard(s)

Description	Manufacturer	Model	ID#	Due Date	Traceability #
Torque Transducer, 4 lbf-in to 250 lbf-ft	*CDI*	*2000-400-0*	*1583*	*08/31/2022*	*2205569*
Thermohygrometer, (Environmental Only)	*Dickson*	*TM320*	*2530*	*10/31/2022*	*2208454*

Indicates that this equipment is only used to monitor & record environmental conditions as listed in the Calibration Information Section.

Technician Remarks

Sensor SN: 012498 was calibrated with display SN: 012498

Calibration Data

>>> For quick review, any Function/Attribute with an Out-of-Tolerance reading (OOT) has been highlighted. <<<

Function / Attribute	Nominal Value	As Found	OOT	As Left	OOT	Tolerance
Torque Clockwise	30.00 lb·ft	30.30		30.30		28.50 to 31.50 lb·ft g: 28.63 to 31.37 lb·ft [EMU 0.44 lb·ft] [TUR 3.4:1]
Torque Clockwise	90.00 lb·ft	91.30		91.30		87.30 to 92.70 lb·ft [EMU 0.53 lb·ft] [TUR 5.1:1]
Torque Clockwise	150.00 lb·ft	150.60		150.60		145.50 to 154.50 lb·ft [EMU 0.61 lb·ft] [TUR 7.4:1]
Torque Counterclockwise	30.00 lb·ft	29.90		29.90		28.50 to 31.50 lb·ft g: 28.63 to 31.37 lb·ft [EMU 0.44 lb·ft] [TUR 3.4:1]
Torque Counterclockwise	90.00 lb·ft	90.00		90.00		87.30 to 92.70 lb·ft [EMU 0.53 lb·ft] [TUR 5.1:1]
Torque Counterclockwise	150.00 lb·ft	151.20		151.20		145.50 to 154.50 lb·ft [EMU 0.61 lb·ft] [TUR 7.4:1]

ANSI/NCSL Z540.3 Accredited Calibration Information

Test Uncertainty Ratio *(TUR)*

Test Uncertainty Ratio (TUR) is defined as the ratio of the acceptable tolerance (*T*) of the UUT, represented by the difference between the upper (*Tu*) and lower (*Tl*) tolerance limits, divided by 2 times *EMU* as expressed in the following formula:

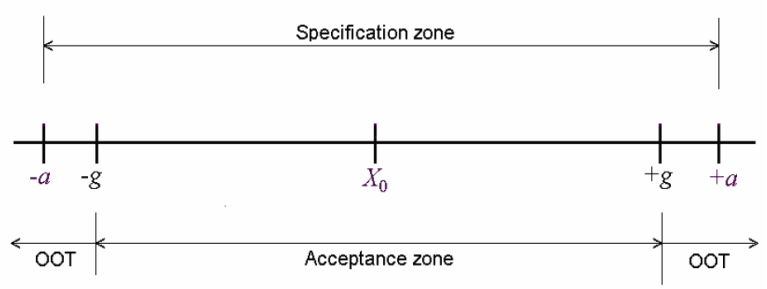
$$TUR = \frac{T_U - T_L}{2 \cdot EMU}$$

Determination of Guard-Band Tolerance Limits (*g*)

Upper and lower guard-band tolerance limits *TgU* and *TgL* are derived from *Tu* and *Tl* by application of a Z% guard band factor, as expressed in the following formulas:

$$T_{g^U} = T_U - Z \cdot EMU$$
$$T_{g^U} = T_L + Z \cdot EMU$$

Upper and lower limits on guard-band tolerance are found by first multiplying *EMU* by factors of *Z* and then either adding the result to the lower tolerance limit (*TL*) or subtracting it from the upper tolerance limit (*TU*)



In the figure below is an example of how these triggers are depicted on this certificate.
The first line indicates the original tolerance, the second line indicates the Guard-Band tolerance reduced by **30**%, the third line indicates the Estimated Measurement Uncertainty (EMU) and the forth line indicates the Test Uncertainty Ratio (TUR).

Tolerance
999.945 to 1000.055 V
g: 999.951 to 1000.049 V
[EMU 19.9 mV]
[TUR 2.8:1]

Determination of Z-Factor (*Z%*)

Guard-Bands are applied as requested by the customer to maintain consumer risk at or below levels provided by the 4:1 ratio yet should seek to minimize false rejects (i.e., producer risk) in efforts to lessen the burden on the user's quality system in investigating unwarranted nonconformance and potential equipment recall determination. Unless otherwise specified by the customer, Cal Lab's policy is to apply a Z-Factor of 30% of the Estimated Measurement Uncertainty (*EMU*). With this percentage applied, this provides an acceptance zone to maintain a <2% Probability of False Accept, even if the TUR reaches a level of 1:1.

Customer Requested Parameters/Triggers

The following are the parameters that were agreed upon during contract review by the Customer and Cal Lab.

Percent of EMU used to calculate Guard-Banded Tolerances: **30**%

TUR (minimum) used to trigger Guard-Banding **4:1**