

AAT



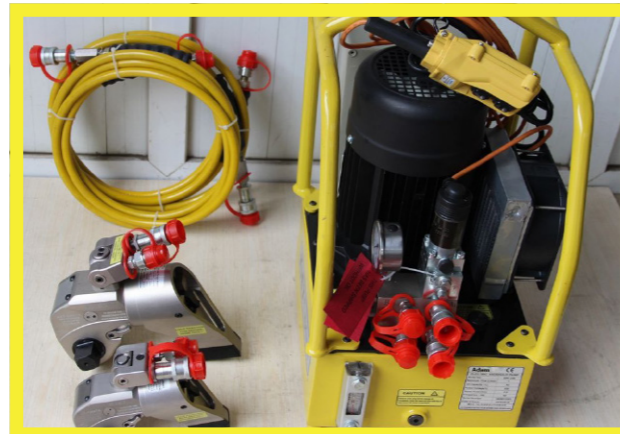
Norbart Delta Sigma Ultrasonic Bolt Tension

Norbar Delta Sigma

Potentially, one third of all scheduled maintenance time within a wind turbine is devoted to bolt retightening and pre-load checking using hydraulic bolt torque and tensioning equipment.

Bolt torque and tensioning equipment has several disadvantages:

- A risk to personnel from high-pressure equipment failure, manual handling and lifting operations.
- Time consuming to move equipment, set up and carry out task.
- Generally, does not provide a record of the preload value or if the bolt was actually tightened.
- Does not provide information on the integrity of the actual bolt.
- Indirect measurement.
- Less accurate than Ultrasonic Testing



Ultrasonic Bolt Testing 'UBT': Preload Testing

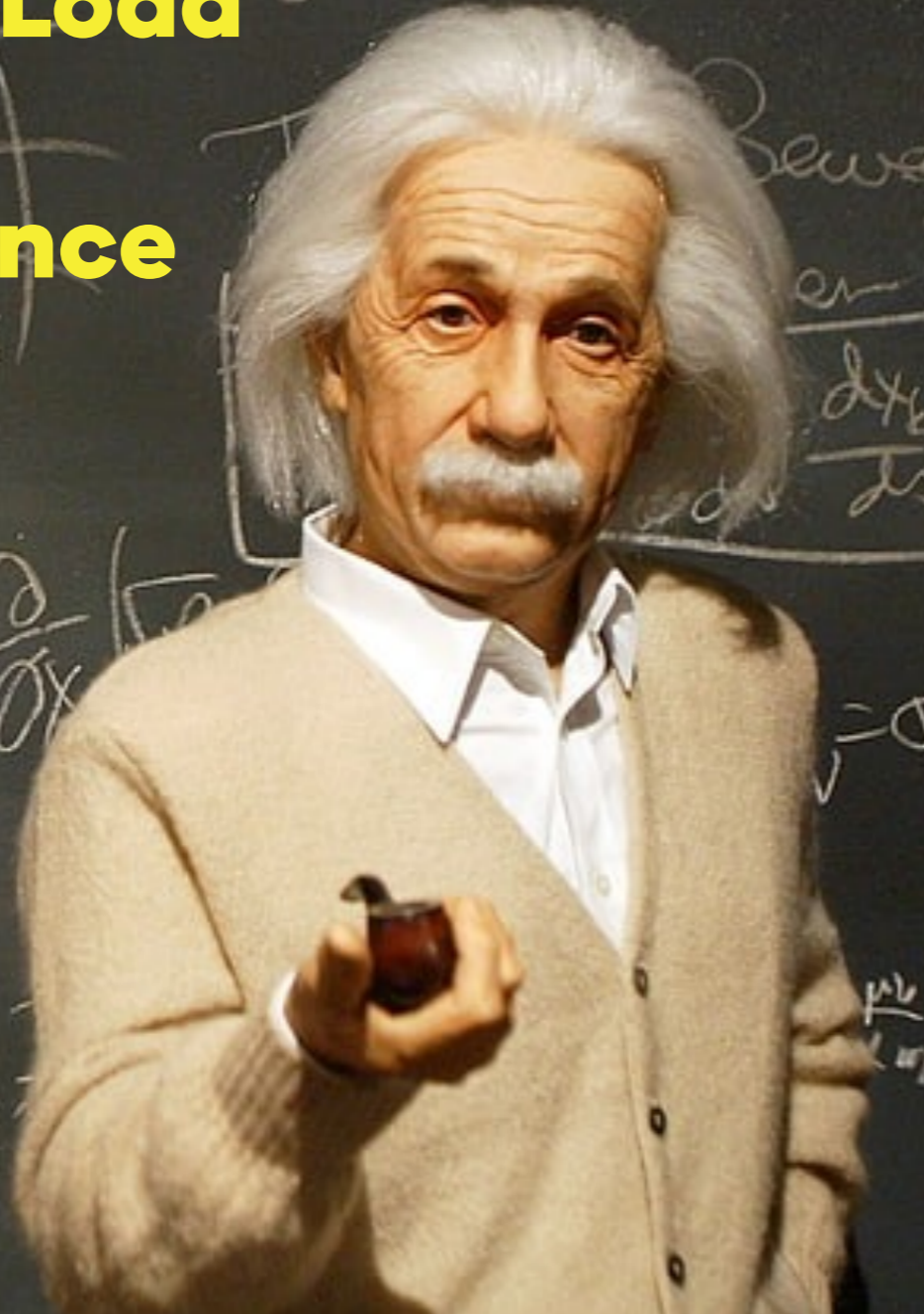
The use of pulse-echo ultrasonic time-of-flight can be used to check the preload of the bolt, with an average time to test of under 30 seconds per bolt.

The advantages of UBT Preload Testing are:

- No risk from hydraulics, lifting or manual handling.
- Large quantity of bolts inspected quickly.
- No requirement to re-torque bolts.
- Single technician using handheld equipment.
- High accuracy of $\pm 2\%$ 1% accuracy for extension and typically 2% accuracy when measuring load.
- VDI 2230 stated most accurate method of determining load.
- Reduction in maintenance costs.
- Increase in power production.
- Can be used as part of an ongoing condition-based maintenance regime and as part of an asset risk management programme.
- Provides Quality Assurance.
- Data can be used to identify specific site or turbine trends or problems.



UBT Pre-Load Testing: The Science



Ultrasonic measurement provides a very precise method of determining the elongation of a bolt due to tightening.

Load in a bolt is determined ultrasonically by measuring the change in the time-of-flight (TOF) of an ultrasonic wave passing through a bolt as the bolt is loaded (either by torque or tension).

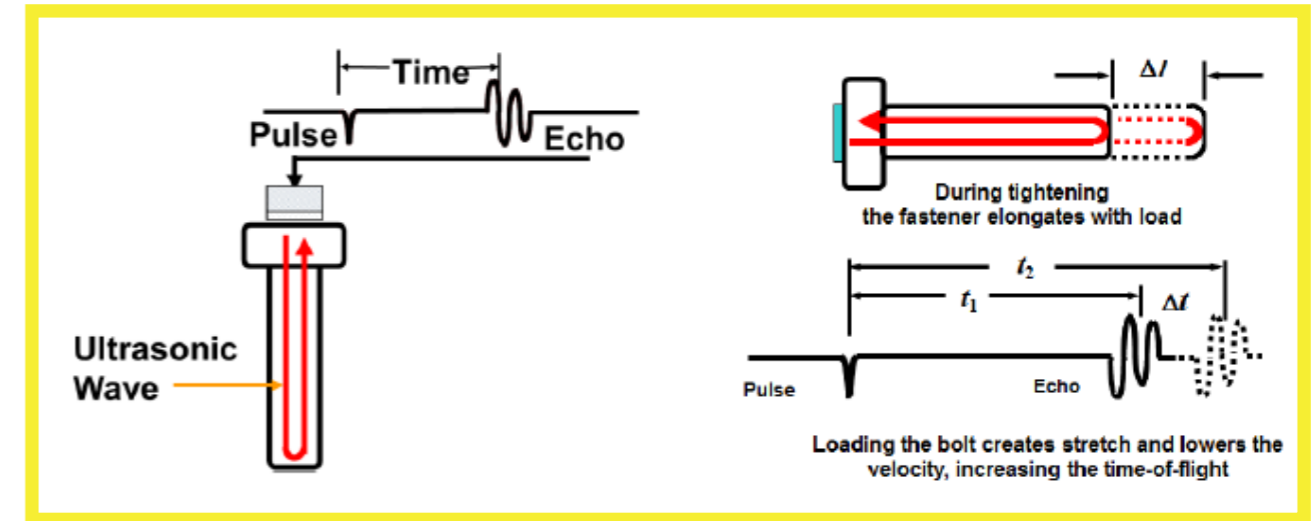
A transducer (probe) is placed on the bolt head and measures the time for an acoustic signal to pass through the bolt, hit a 'reflector' (the end of the bolt) and return to the probe.

This is known as "Time of Flight".

The ultrasonic test unit then converts this into an 'acoustic length' of the fastener, providing a baseline from which, future measurements will be made.

The UBT equipment measures, displays, stores and transfers bolt load and elongation data, with high automation and minimises the need for operator interpretation.

The included software will transfer the data to a computer for backup of file, the creation of project reports and the conversion of data to excel format for further analysis.



The Norbar Delta Sigma

The Delta Sigma pulse-echo ultrasonic time-of-flight measurement device; measures, displays, stores and transfers load bolt data.

The Delta Sigma is a small, rugged, IP44 rated battery powered unit weighing 11445 Grams and measuring 175mm wide x 180mm in height x 41mm in depth.

The Delta Sigma uses a 97 x 56mm sealed colour touch screen with a 480 x 272 – 24bit sunlight readable touch pane display.

Data and digital signal traces are stored for later display and transfer.

The unit has automatic temperature compensation from a magnetic temperature probe.

The unit incorporates the latest smart-charge system and will charge through an external power supply or the waterproof micro-USB connector from any standard 5V USB device, battery pack or power supply.

The charger/battery system is designed for a long, safe battery life and the charger will not over charge the batteries.



Norbar Delta Sigma Specifications and Features

Weights & Dimensions

- Small, lightweight, rugged
- A = 6.88" / 175mm
 - B = 7.08" / 180mm
 - C = 1.61" / 41mm
- 3,186lb / 1445 Grams

Fast Digital Signal; Location, Amplitude and Threshold Detection

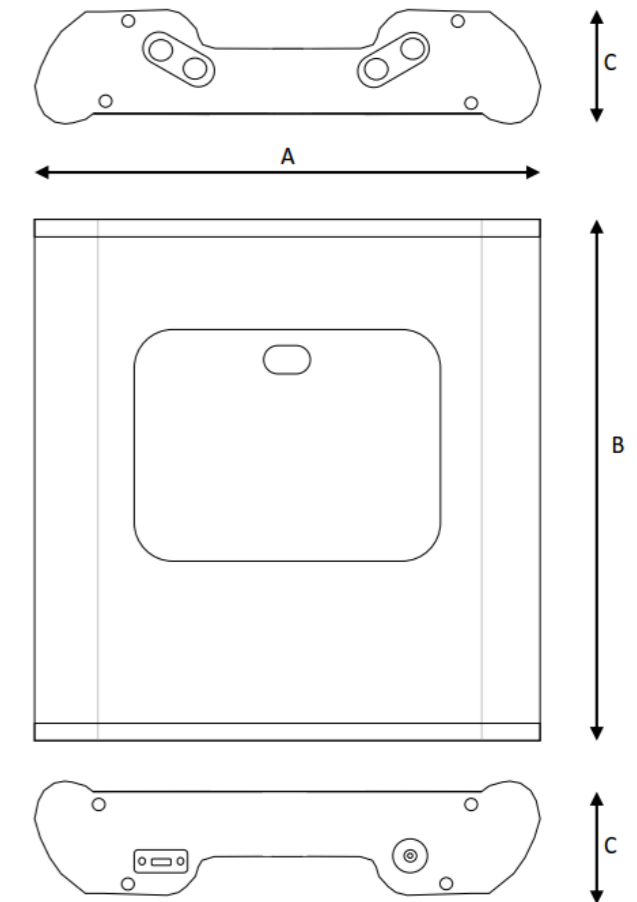
- Real time signal tracking: amplitude, peak jumps
- Storage of individual signal parameters for qualitative R&R reading comparison

Connectors

- Lemo 00: Ultrasonic and 0B: temperature and I/O
- USB – Rugged, sealed USB micro-B

Display

- 3.8x2.2in / 97x56mm
- 480x272 – 24bit colour, sunlight readable touch panel display
- -20 to +70°C operating range
- Full touch panel program operation
- Rugged/sealed display module (IP444)



Norbar Delta Sigma Specifications and Features

Intuitive operation

- No buttons, fewer steps, programmable touch pad QWERTY alpha-numerical input
- Creation, storage, retrieval of individual projects (groups of fasteners)
- Bolt types for projects (geometry, material, etc.) stored individually for repeated use/retrieval
- Unlimited bolts/readings per project
- Temperature, signal parameters, scope trace and date/time stored with each reading
- Selectable, password protected restricted operating mode; locks selected variables

Data Storage

- Secure data file area – operator controlled public file area
- Password protected
- No special PC software required
- Flexible bolt data storage options, no limits on bolts or load data
- Store and display echo traces of every signal for every reading, date/time stored with each reading

Temperature Transducer

- Class A PT 100

Microprocessor

- 32-bit ARM



Norbar Delta Sigma Specifications and Features

A-D

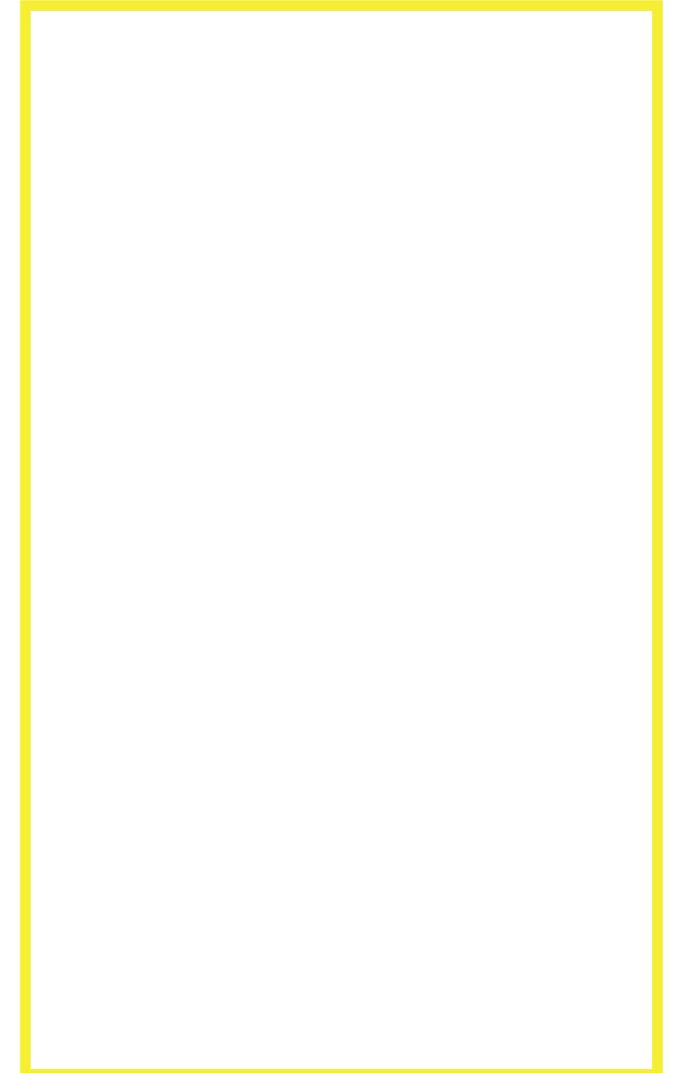
- Single Shot
- Time resolution to 0.1ns or better
- 100dB receiver
- Programmable pulser: amplitude, frequency, cycles

Fast A-D and /or dig out control

- Windowing (hi-res) analogue output, scaled to SETUP parameters, 0-10V
- Digital, isolated I/O for external control
- SSR Switched on programmable limits
- SSR EN50130-4 compliant

Data Storage

- Secure data file area – operator controlled public file area
- Password protected
- No special PC software required
- Flexible bolt data storage options, no limits on bolts or load data
- Store and display echo traces of every signal for every reading, date/time stored with each reading



Norbar Delta Sigma Specifications and Features

Real time oscilloscope trace of echo

- Can be stored with each reading
- Automatic signal requisition
- Full control of receiver option

Batteries

- 4 sealed 3.4mAH Li Ion 18650 cells, twin smart charger with SOC monitoring
- The Delta Sigma can be sent or carried onboard airplanes as it meets current ITAR/FAA: Lithium Metal Batteries contained in equipment regulations: UN3481, P.I. 967, Section II.
 - *Acceptable to all locations*
 - *Cells equal to or less than 20Wh; and Batteries*
 - *Equal to or less than 100Wh*
 - *"...these packages do not require a lithium battery handling label."*
- Operating time 20+ hours
- Dual charger inputs
- Fast 9V standard 2.1mm power supply input
- Mini USB charge/operation

Additional Features

- Real time clock – date-time stored with every reading
- Sleep mode and auto shut off
 - *Continuous read on bolt*
- Power/sleep LED



UBT Preload Testing in Action

Using the Norbar Delta Sigma, AAT can carry out testing, either as a standalone service or as part of other works, such as turbine safety equipment statutory inspections, tower weld inspection and blade inspection or repair, achieving increased utilisation and reduced turbine down time.

For the most accurate results in-service, it is recommended that a 'baseline' survey be carried out.

The bolt is tested with the load applied, then the bolt is loosened, and the bolt tested at rest with no load applied. This will show a reduction in elongation and confirm that the bolt has not been overtightened and gone through its yield point.

The correct load is applied, and the bolt is re-tested. There will be an increase in elongation.

At the next periodic test, the bolt is tested and compared against its previous results. Any changes in elongation are noted.

AAT personnel, on finding bolts without the correct pre-load, can either report the anomaly or re-set the pre-load using EvoTorque battery or mains powered torque tools or hydraulic

torque and/or tensioning tools.

If you want to carry out the testing in-house using your own personal or sub-contractors, the equipment is available for sale or hire.

Training and procedures will be provided as part of a sales or hire package.



Summary of Ultrasonic Bolt Pre-Load Testing

- **Reduced H&S Risk**
- **Eliminate Retightening / Tensioning**
- **Reduce Costs & Increase Production**
- **Inspection combined with Other Services**



Thank you for taking the time to read this
information booklet. For further information
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