

OPERATION MANUAL DELTA SIGMA



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NOTES

On receipt of your Delta Sigma (DS-1), the instrument should be connected to the charger and the batteries recharged. Plug in the included charger, then turn on the Delta Sigma and leave it charging for 12hrs. After 5 minutes of inactivity the display will shut off, but the batteries will continue charging. Once the batteries are fully charged the Delta Sigma will shut down. The blinking red LED indicates charging mode.

The charger/battery system is designed for a long, safe battery life. The charger will not over charge the batteries. Connecting to the charger without turning on the Delta Sigma will NOT charge the batteries. If there is insufficient power in the batteries, the Delta Sigma will reset to the main menu when attempting to measure a bolt.



1 HOW TO USE THIS MANUAL

This manual is written for the novice to skilled user. Please visit our Youtube channel for training videos











For easy access: Scan the QR code for correct web address
or
<https://www.vasi.no/products/delta-sigma>

The manual is divided into 9 chapters.

1. How to use this manual
2. Introduction to ultrasonic bolt measurement and description of the Delta Sigma
3. Description of the various setup menus.
4. Setup of projects, bolts and bolt types
5. Measuring of bolts
6. Transfer of data between the Delta Sigma and a PC
7. Reference to Elongation Function
8. Important notes on operation
9. Specifications and features
10. Appendix

Standard Symbol Explanation

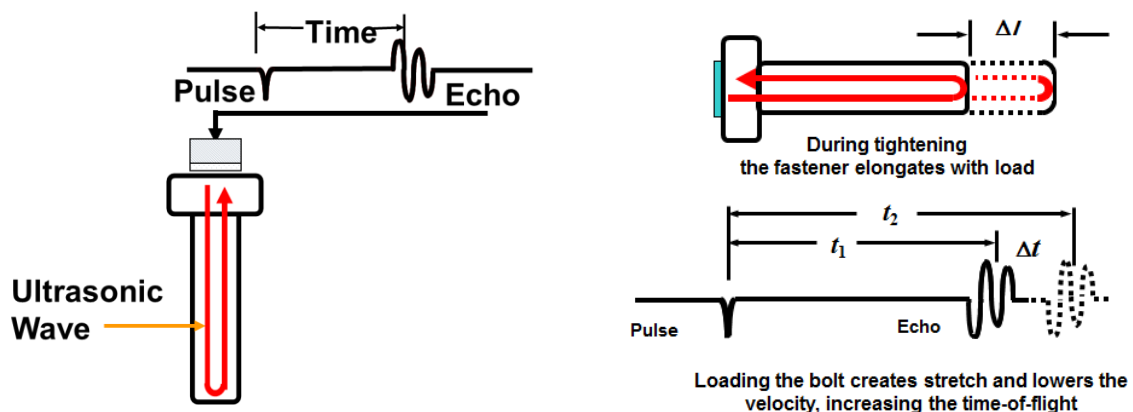
	Power Button The on and off button above the screen.
	Back Button Returns the user to the previous screen.
	Next Button Moves to the next screen.
	Home Button Returns the user to the Start-Up Screen
	Apply and Return Button Saves any changes and returns the user to the previous page.
	Apply and Save Button Saves any information and goes to relevant page.
	View or Edit information Button To view or edit information, press this button
	View info Button To view information, press this button

2 INTRODUCTION TO ULTRASONIC BOLT MEASUREMENT AND DESCRIPTION OF THE DELTA SIGMA

Introduction

Load in a bolt is determined ultrasonically by measuring the change in the time-of-flight (TOF) of an ultrasonic wave through a bolt as the bolt is loaded (tightened). This technology was developed in the early '70s to keep cryogenic joints together in rocket engines and is still used for that purpose by most of the world's engine and satellite builders.

When a fastener is loaded (tightened) or unloaded (operational loss or disassembly) the ultrasonic TOF will change due to the change in load (tension stress) in the fastener. It is this change in TOF that we use to calculate load, by storing a "Reference" length or time and calculate the difference between that "Reference" time and the "as found" time. This delta time is directly proportional to the load or stretch in the fastener.



The intuitive software was created specifically for the bolting industry, the automatic echo detection algorithm has been developed with input from the most experienced users and electronic developers in the bolt tightening industry. Communicates to any PC with a standard USB connection.

Bolted Joint

A bolted joint is a structure that contains one or more bolts whose purpose is to hold the structure together through the combined clamping force of the bolts in the joint. These bolts may all be the same size or may be of different diameters and lengths (types). The data structure used in the Delta Sigma is setup to accommodate this logical bolted joint structure. The Project file includes the basic joint information and stores the Length, Stretch and Load data.

The Delta Sigma requires geometric, ultrasonic and material information specific to a type of bolt to determine the load ultrasonically. This information is stored in the Bolt Type File. A bolt type must be named and entered for any group of bolts sharing the same geometry, grip length and metallurgy (bolt grade).

The Delta Sigma Description

The Delta Sigma pulse-echo ultrasonic time-of-flight measurement device; measures, displays, stores and transfers bolt load data. The Delta Sigma uses a sealed colour touch screen for all operator I/O. All data is entered and presented on a 4.3" colour, resistive touch screen. Data and digital signal traces are stored for later display and transfer. The unit has automatic temperature compensation from a magnetic temperature probe. For data integrity, the Delta Sigma memory is divided into a secure sector (A) for all bolt data and a public sector (B) for transfer via USB to a computer. The unit incorporates the latest smart-charge system; it will charge through an external power supply or the waterproof micro USB connector from any standard 5V USB device, battery pack or power supply.

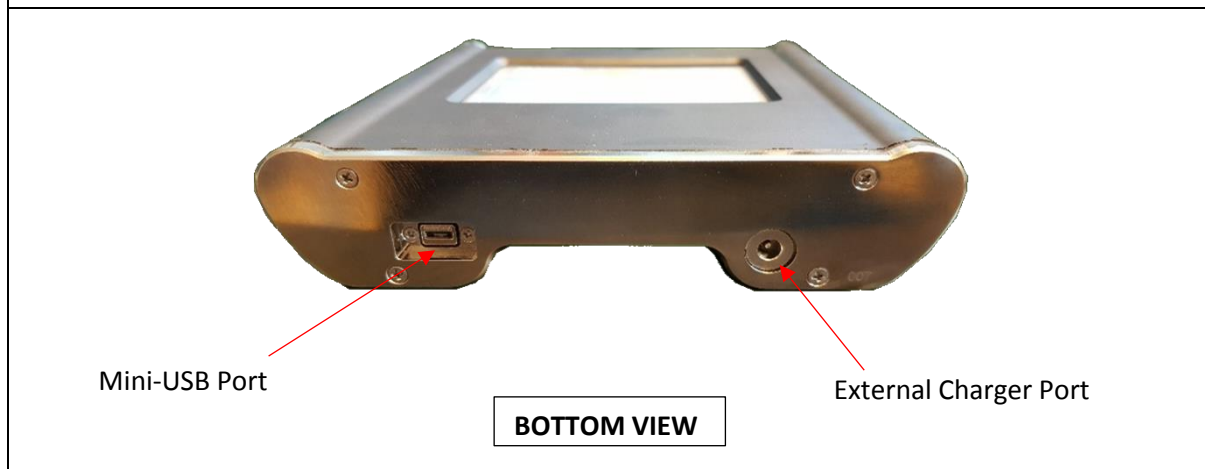
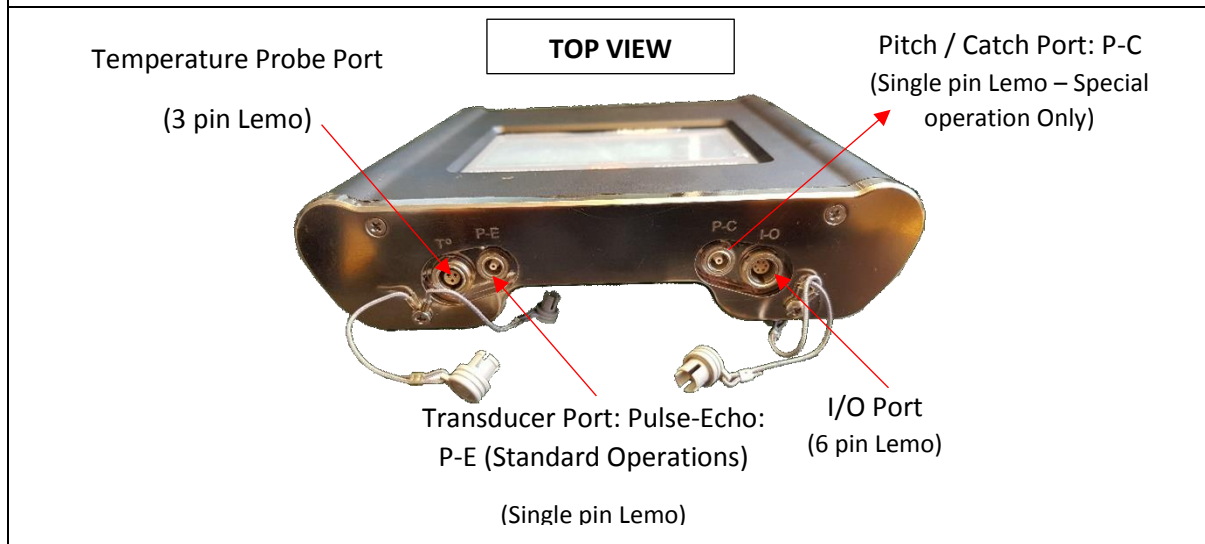
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Overview

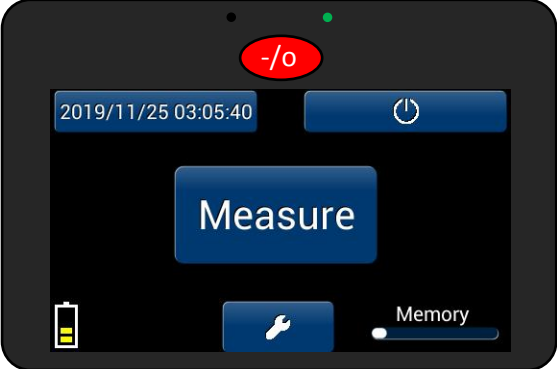
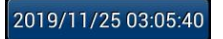







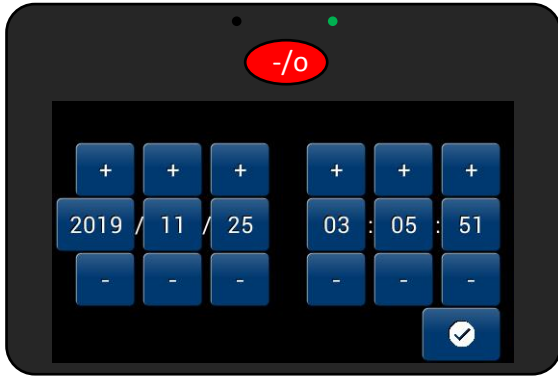
3 DESCRIPTION OF THE VARIOUS SETUP MENUS.

On receipt of your Delta Sigma the instrument should be connected to the charger and the batteries recharged. Plug in the included charger, then turn on the Delta Sigma and leave it charging for 12hrs. After 5 minutes of inactivity the display will shut off, but the batteries will continue charging. Once the batteries are fully charged the Delta Sigma will shut down. The blinking red LED indicates charging mode.

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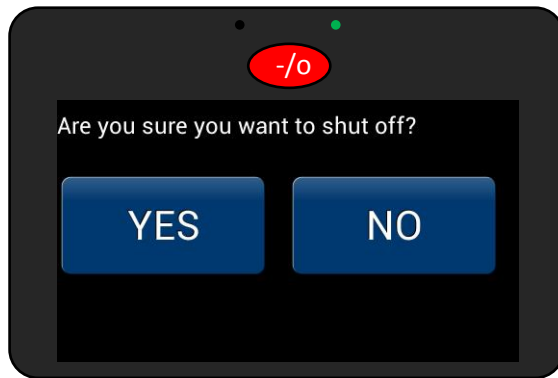
Once power is turned on the Delta Sigma will display the Start-up Screen as shown below.

	<h3>Start-up Screen</h3> <p>This is the Start-up Screen. It shows time & date, a power button, the measure button, the settings button as well as a battery symbol and a memory status.</p>
	<p><i>Time & Date Button</i> Enables the user to change the current time and date.</p>
	<p><i>Power Button</i> Enables the user to turn off the instrument. (The instrument will enter sleep mode after 5 minutes if not measuring a bolt.)</p>
	<p><i>Measure Button</i> Accesses the bolt measurement screens.</p>
	<p><i>Battery Symbol/Button</i> Displays the charge level of the battery.</p>
	<p><i>Settings Button</i> Enables the user to access the Settings Screen where it is possible to perform system configuration changes.</p>
	<p><i>Memory Status</i> Showing the current memory usage of the instrument.</p>



Time & Date Screen

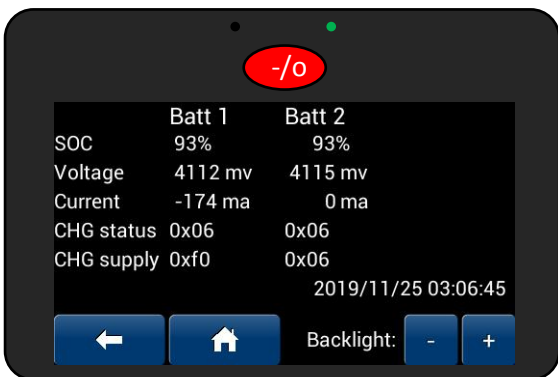
This is the Time & Date Screen. This enables the user to change the current time & date. There is no automatic time zone adjustment or daylight-saving option. Time and date must be set manually.



Shut-off Delta Sigma

Pressing the red Power Button above the display or the Power Button icon on the Start-up Screen enables the user to turn the Delta Sigma off.

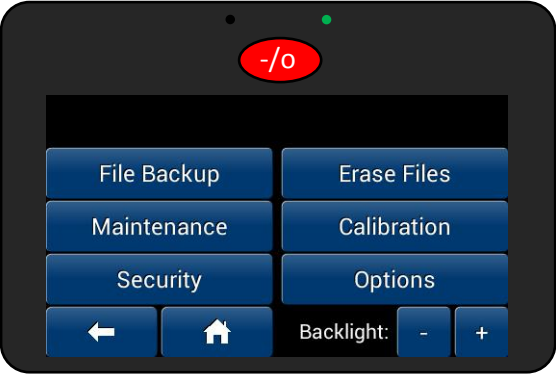






Choosing YES will turn off the instrument. Choosing NO will automatically return the user to the Start-up Screen

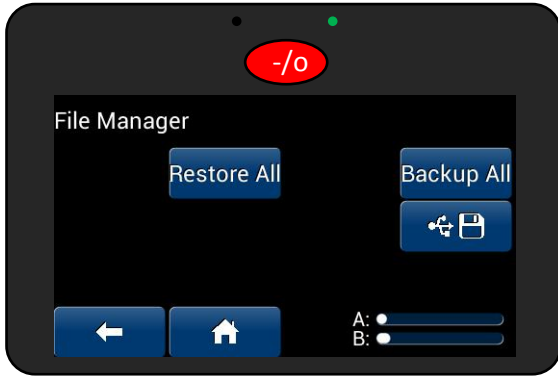


Battery Status Screen

Pressing the Battery icon allows the user to see the battery status details.

The user may also adjust the brightness of the screen by pressing the Backlight plus or minus button

		<h2 style="text-align: center;">Settings Screen</h2> <p>This is the Settings Screen where it is possible to perform system configuration changes.</p> <p>The user may also adjust the screen brightness by pressing the Backlight "+" or "-" buttons.</p>
	<p><i>File Backup Button</i> Enables the user to backup files and ready them for transfer to a PC.</p>	
	<p><i>Maintenance Button</i> <i>This area is password protected. Access is not required for normal operation.</i></p>	
	<p><i>Security Button</i> Enables the user to set the instrument in secure mode, limiting the options of the operator. This is also where the security password is set.</p>	
	<p><i>Erase Files Button</i> Here the user may erase individual projects, bolt types, individual measured bolts or bolt elongations.</p>	
	<p><i>Calibration Button</i> Enables a skilled lab technician to standardize multiple instruments. (Contact vendor for more information on this function.)</p>	
	<p><i>Option Button</i> Enables the user to choose between Basic, Normal and Expert Mode. Number Format for USA & International Excel users to choose between "," or "." as the decimal divider. Last, the user can enable the Manual Scope Mode.</p> <p><u>Basic</u> operational mode is recommended for standard measurement of normal steel bolts.</p>	



File Backup Screen

Restore All

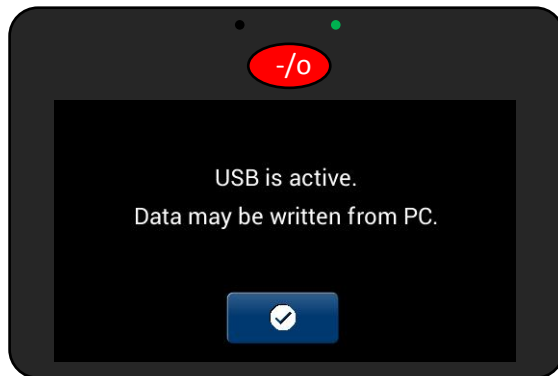
Restores backup files from the PC to the Delta Sigma

Backup All

Creates backups of all files from Drive A and places the copies to Drive B

USB-Connection Icon

Opens the USB connection between the Delta Sigma and the PC.

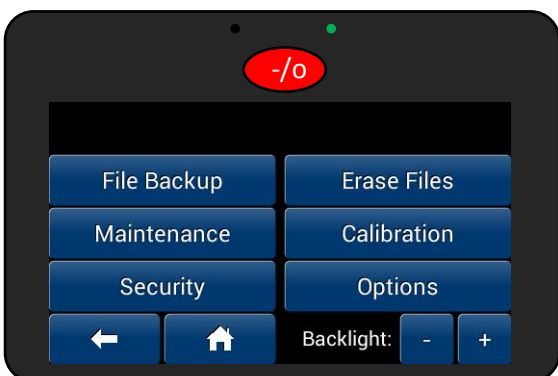


Plug the USB-cable into the Delta Sigma and the PC and press the Connection Icon.



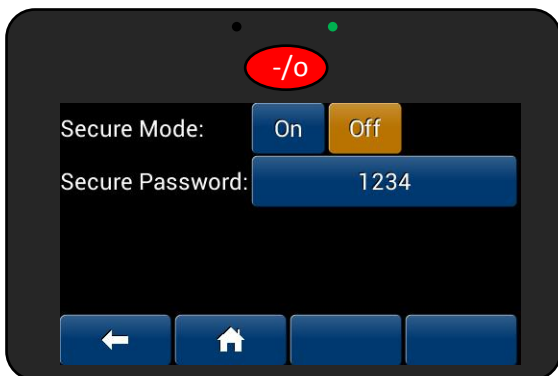
The Delta Sigma will not automatically show up as an external hard drive unless the USB Connection button has been pressed.

The image to the left indicates when the link between the Delta Sigma and PC has been established and ready for data transfer.



Maintenance Screen

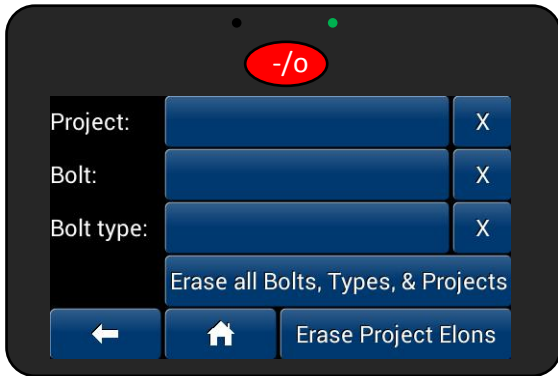
This area is password protected. If access is required, you will be instructed by Vendor Technical Support on how to proceed.



Security Screen

Enables the user to set the instrument in secure mode, limiting the options of the operator.

This is also where the security password is set.

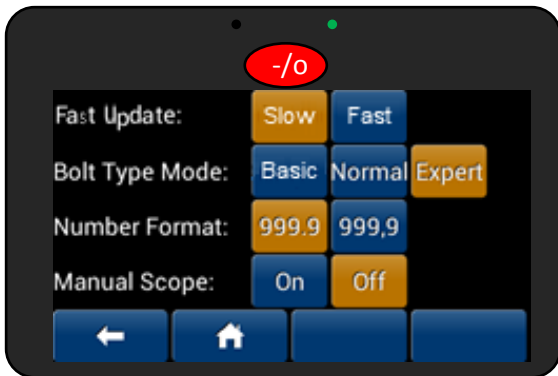


Erase Files Screen

The operator may erase single bolts, bolt types and projects. Choose the data to be deleted, by pressing the corresponding box, chose the file and then press the "X" to delete it.

The operator may also delete all recorded data by pressing the button "Erase all Bolts, Types & Projects".

The last option is the "Erase Project Elon". This will erase all elongation data but will keep the reference measurements of the bolts.

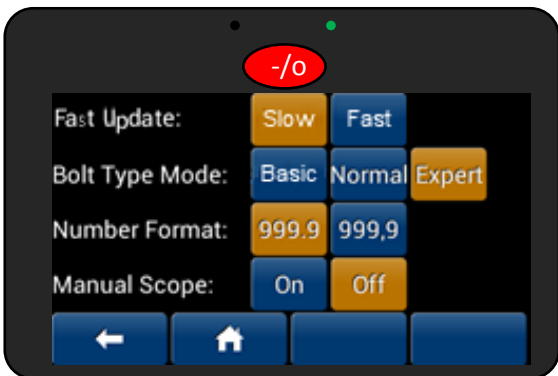


Options Screen

Fast update is only to be used in high sampling frequency applications. (Not normal operation) Enables the user to choose between Basic, Expert and Normal Bolt Type Mode. Normal mode is default.

The user can choose between comma "," or "." as decimal divider.

Manual Scope Mode provides additional instrument receiver controls and is only to be used by experienced users.

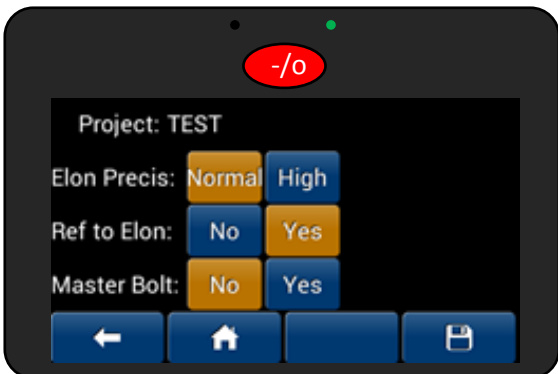


Expert Mode

From the Options screen chose "Expert" in the "Bolt Type Mode". This mode will turn on the expanded information entry for the Bolt Type: number of cycles, P/E or P/C, and stored 'scope trace selection. The "Expert" mode also opens up advanced selection screens in the Project information.

NOTE!

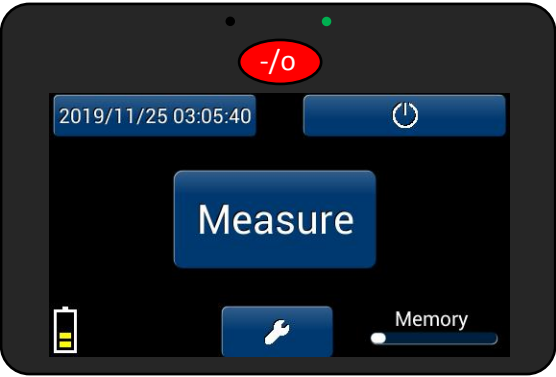
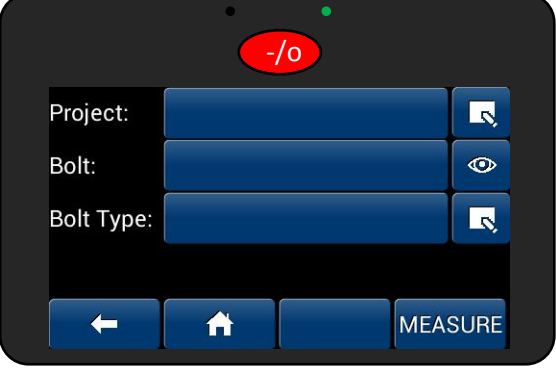


The use of "Expert Mode" or "Manual Scope" requires special training. Please contact a vendor to book a training session by use of MS Teams or other arrangements.



Advanced selection screen

Elon Precision "High displays; 4 places in metric, 5 places in Imperial when reading bolt elongation, selecting ; "Ref to Elon" will when reading a Ref Len, the operator can choose "R to E" and enter a stretch from another device allow the operator to reduce Zero ref time on a multiple bolt setup in the "Master Bolt" function.

4 SETUP OF PROJECTS, BOLTS AND BOLT TYPES

 <p>The Start-up Screen shows a red '-/o' indicator at the top. Below it is a date and time display '2019/11/25 03:05:40' and a power button. A large blue 'Measure' button is centered. At the bottom, there is a battery icon, a wrench icon, and a 'Memory' indicator with a slider.</p>	<h3>Start-up Screen</h3> <p>Before going to the next step, make sure that an ultrasonic transducer is connected to the Delta Sigma. A DS-TP temperature probe may also be connected but is not required. If no temperature probe is used the temperature must be taken and input manually.</p> <p>To start measuring bolts, press the Measure Button.</p> <p>You will now enter the Bolt Information Screen</p>
 <p>The Bolt Information Screen has a red '-/o' indicator at the top. It features three input fields: 'Project:', 'Bolt:', and 'Bolt Type:'. Each field has a blue button with a cursor icon to its right. At the bottom, there are navigation buttons: a left arrow, a home icon, and a 'MEASURE' button.</p>	<h3>Bolt Information Screen</h3> <p>This is the bolt menu where an operator can define projects, bolt numbers/names and bolt type.</p> <p>To edit information, press the  button. To enter new or choose previous Projects, Bolts or Bolt Type, press the blue rectangle next to the text: </p>
 <p>The Project Screen shows a red '-/o' indicator at the top. It has a 'Project:' label on the left. On the right, there is a list of project names with a left arrow button. Below the list are four buttons: an up arrow, 'New', a down arrow, and a checkmark button.</p>	<h3>Project Screen</h3> <p>If there are any projects stored in the Delta Sigma, they would be listed here. The operator may choose a stored project by pressing the project name or create a new project by pressing the "New" button. The up/down arrows are used to scroll through the project names if too many are present to all be displayed at one time.</p> <p>When the project is chosen, press the Apply and Return Button.</p>

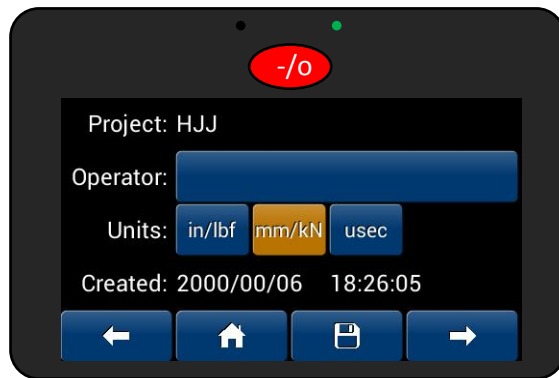


New Project - Screen 1

If you want to make a new project, you must name your project. The name you chose should be easy recognizable for the application. This name will be used in the bolt report.

For numbers and special characters, press the "#". For lower case letters, press the "a". upper case letters are default. Note: Special characters used in the Project or Bolt Type names will be converted to underscores (_).

Confirm your new project name.

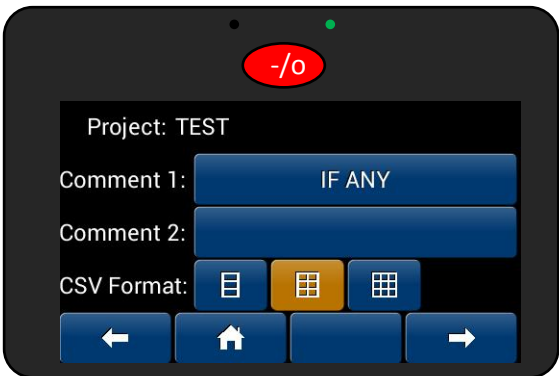


New Project - Screen 2

Press the "Operator" button and enter the name of the operator, if desired.

Then, chose unit type: in/lbf, mm/kN or usec.

Then, press the "Next" button.



New Project - Screen 3

Enter any relevant project comments if desired in the comment fields.

Choose the CSV Format and then "Next Button"

Short Report



The short report contains bolt numbers, reference length and last elongation measurement.

Normal Report



The normal report is the default report. This report contains all typically required information.

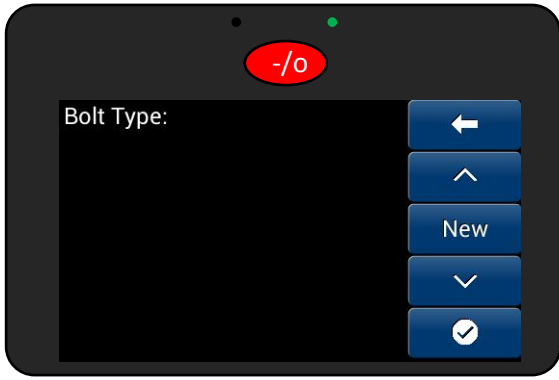
Extended Report



The extended report contains all available data. Not recommended unless nano-second data is required.

On the next screen, you may activate the master bolt function to assign the default receiver settings from Bolt "0" to all bolts in the project. Master bolt function is off by default.

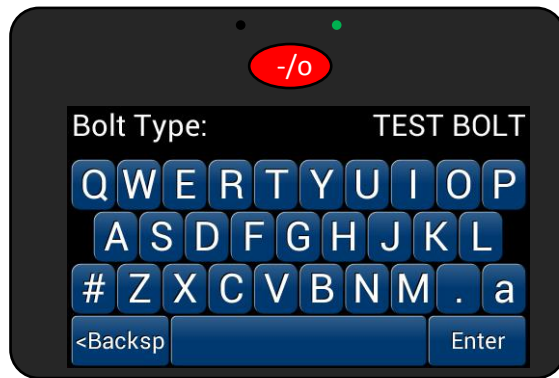
Then press the "Save Button"



New Bolt Type - Screen 1

Like the Project Screen; if there are any bolt types stored in the Delta Sigma, they would be listed here. The operator may choose a stored bolt type by pressing the bolt type name or establish a new bolt type by pressing the "New" Button.

When the bolt type has been chosen, press the Apply and Return button

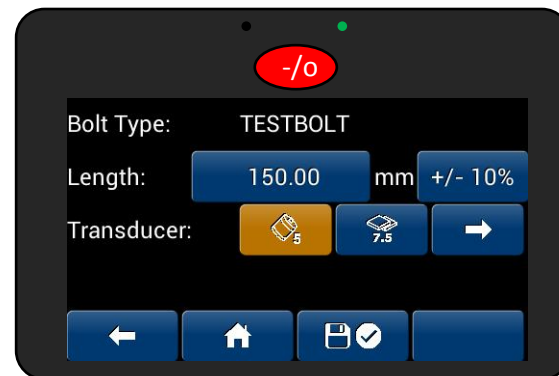


New Bolt Type - Screen 2

Again, just like on the Project Screen, if you want to make a new bolt type, you must name the bolt type. The name you chose should be representative for the bolt type.

For numbers and special characters, press the "#". For lower case letters, press the "a". upper case letters are default.

Confirm the new bolt type name.



New Bolt Type - Screen 3 (Simple Mode)

This is the main bolt type setup page where the bolts characteristics are defined in **Basic Mode**. (To change modes, check Option Section)

Length: 150.00

Click on the "Length" button and enter the approximate length of the bolt.

mm +/- 10%

Click on the +/- Button to define the length tolerance acceptance.



Choose the transducer frequency by using the icon buttons. Default setting is 5Mhz for standard magnetic transducers. 7,5MHz for Glue-on transducers. Default bolt material type is set to "Steel" in this mode.

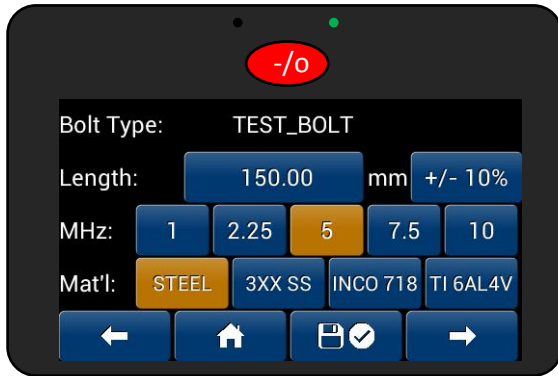


In order to enter Normal mode where you can choose other materials or transducer settings etc. Press the arrow key

New Bolt Type - Screen 3

(Normal Mode)

This is the main bolt type setup page where the bolts characteristics are defined in Normal Mode. (To change modes, check Option Section)



Length: 150.00

Click on the "Length" button and enter the approximate length of the bolt.

mm +/- 10%

Click on the +/- Button to define the length accuracy acceptance.

MHz: 1 2.25 5 7.5 10

Choose the transducer frequency. Default setting is 5Mhz for standard magnetic transducers. 7,5MHz for Glue-on transducers.

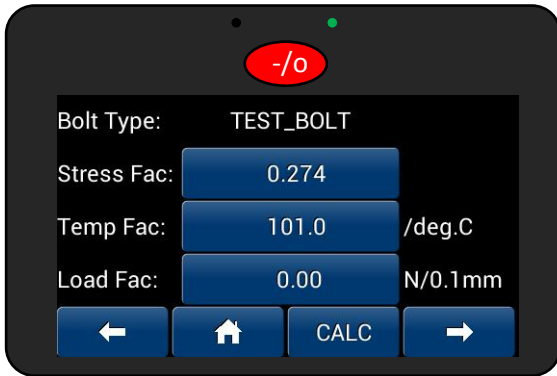
Mat'l: STEEL 3XX SS INCO 718 TI 6AL4V

Choose the bolt material. If the bolt material is not listed, or if you need to specify other bolt properties, you may enter bolt properties manually by pressing the "Next" button. If the material is listed and the bolt properties are OK, press "Save and Apply" button.

For further setup, press the "Next" button



The following screens (Pg. 17 & 18) are to be used by trained personnel only!



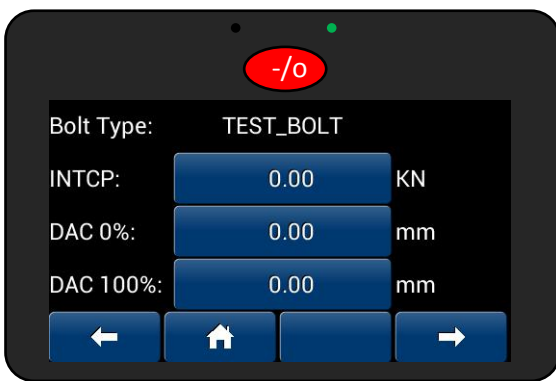
New Bolt Type - Screen 4

(Normal mode)

To display load, the calculated or calibrated stiffness of the bolt is entered here. Stress and temperature factor and details are default values from material choice. Temperature and Stress Factors are listed in Appendix A for specific materials.

There is also a bolt calculation option for experienced users where special bolts may be defined. Covered in Appendix C

Press "Next Page" to continue



New Bolt Type - Screen 5

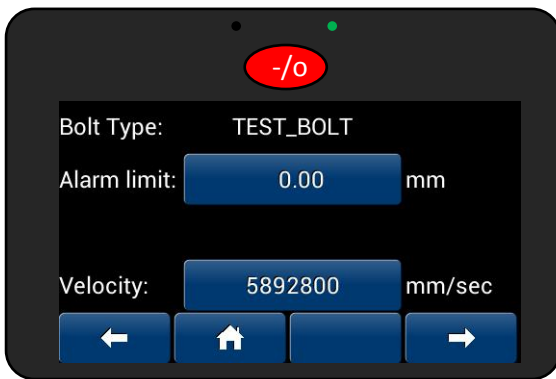
(Normal mode)

INTCP: If known enter the Y-Intercept in kN (or lbs)

DAC 0% & DAC 100%: The Delta Sigma will output a 0-10V DC analogue signal from the I/O port. Enter the values in mm (or inches).

See Appendix A for suggested stress factor details (if needed).

Press "Next Page" to continue



New Bolt Type - Screen 6

(Normal mode)

Alarm limit: Enter limits to turn on internal buzzer and digital SSR in I-O port.

Velocity: Enter the material velocity. See Appendix A for material velocity details (if needed).

Press "Next Page" to continue

New Bolt Type - Screen 7

(Expert mode)

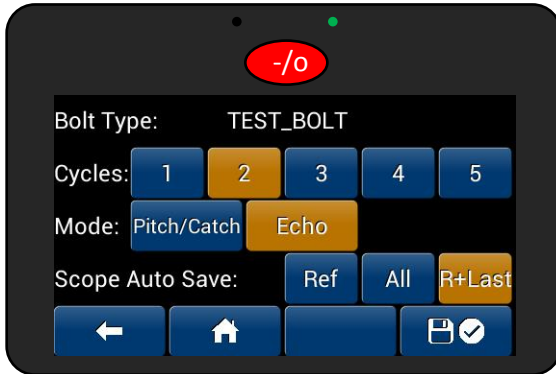
Cycles: An operator can alter cycles and measurement mode. (Not recommended unless you are an experienced user.)

The number of pulse cycles used to excite the transducer is a function of transducer frequency and size. For All standard applications 2 cycles is optimal.

In exceptional cases with extremely long fasteners, large diameter, low frequency transducers and difficult materials, i.e. precipitation hardened alloys; more cycles of excitation may be required.

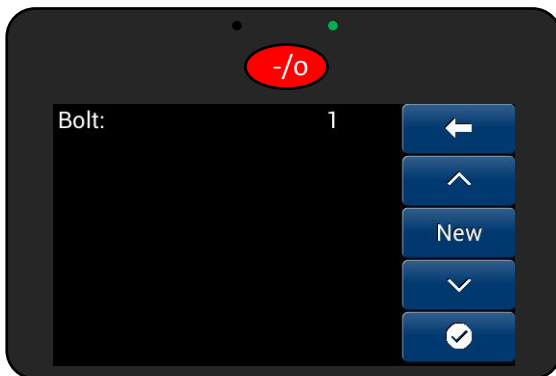
Mode: Use "Echo" (Pulse/Echo) when using one transducer. "Pitch/Catch" is only used when two transducers are required, one on each end of the bolt (special mode – not in use for new apps).

Scope Auto Save: "R+Last" reference plus last elongation is default. Other options are: "Ref" reference length only or "All" all measurements. Press the "Apply and Save Button"



Bolt Screen

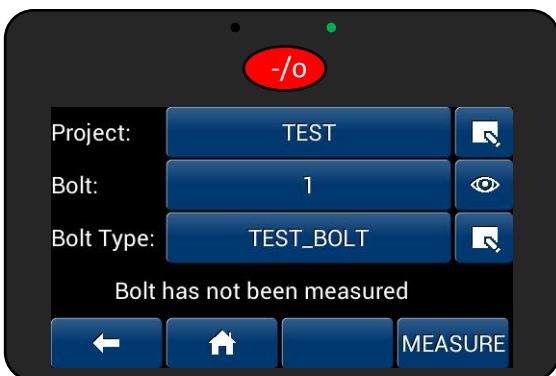
The operator chooses the bolt to measure. If there is no bolt, press "New" and write the bolt number or other bolt ID and press enter. The last chosen bolt or newly numbered bolt is set as default.



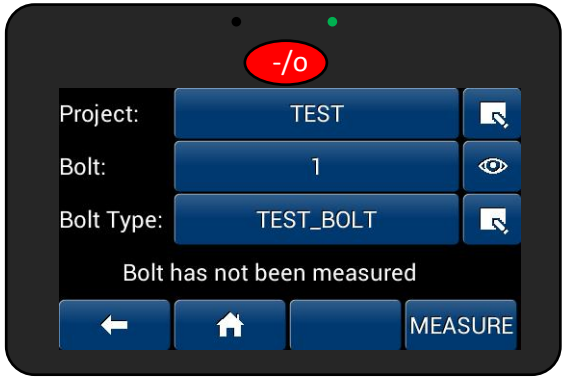

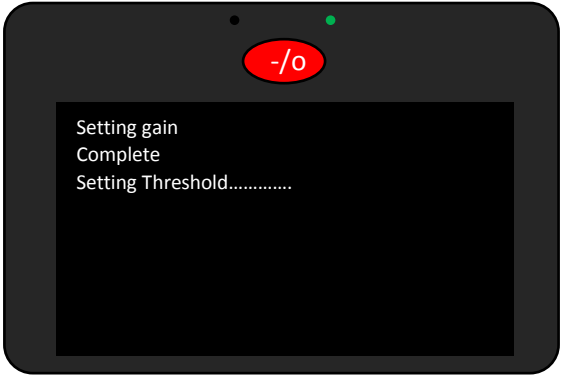
Bolt Information Screen

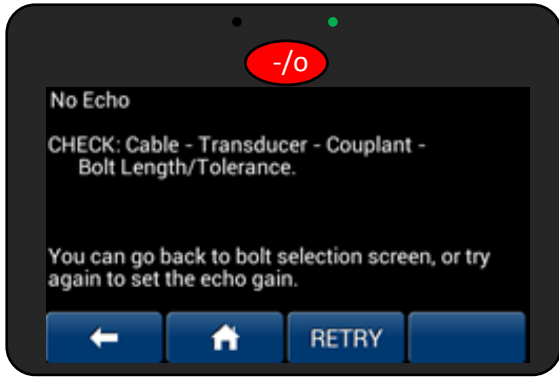
You are now back at the Bolt Information Screen with the chosen Project, Bolt and Bolt Type.

You are now ready to do your reference length measurement (zero load measurement).



5 MEASURING OF BOLTS

	<h3>Bolt Information Screen</h3> <p>You are now ready to do your reference length measurement (zero load measurement).</p> <p>Attach the transducer to the bolt. Apply one drop of ultrasonic couplant to the bolt end or transducer and gently rotate/"wiggle" the transducer onto the axis of the bolt head or end.</p>  <p>Then press the "Measure Button"</p>
<p>Note: There is a difference in ultrasonic time of flight (TOF) readings between the first application of the transducer and the following readings. It seems that once the surface has been wet with couplant and the transducer is removed and replaced (R&R), the readings are different, but the next readings are consistent. This property is from anecdotal evidence through discussions with users of every type of ultrasonic bolt measuring device. We typically recommend that 3 R&R readings are taken, the last 2 readings are typically consistent: Store one of the repeated readings as such.</p> <p>The other major contributor to R&R reading differences is the end finish of the fastener under the transducer repeatability of transducer placement. For consistent and certain R&R readings, the end must be flat and parallel to the reflector end and have a surface finish of Ra = 0.98 or better.</p> <p>Apply the transducer, remember reference length, wipe bolt end, reapply couplant and transducer, is current length within $\pm 0.005\text{mm}$ (or better). If this test doesn't produce repeatable readings then the bolt is not finished correctly (either end) or the operator cannot R&R the transducer in a consistent manner.</p>	
	<p>If no temperature probe is attached, a message showing "Temperature Sensor Failed" will show. Push the temperature button and manually enter the bolt temperature. Then press the "CONTINUE" button.</p> <p>If a temperature probe is attached, this menu will not appear.</p> <p>The Delta Sigma will adjust the pulser and receiver for several seconds while it determines the best echo peak for this bolt. The LED-light will flash red/green while adjusting. If the instrument is to be used to measure large homogenous bolt population we recommend to use the "masterbolt" function (as this will speed up the zero ref data registration considerably).</p>



If the DELTA SIGMA-instrument fails to find a signal from the bolt, this error message will show: "No Echo" CHECK: Cable -Transducer-Couplant. Please also check the Bolt Type page and make sure that the data is entered correctly.

Make sure that the transducer cable is attached to both the transducer and the P-E transducer port on the instrument. Then apply more couplant. Also look for burrs, debris or surface irregularities where the transducer was placed and remove or repair as necessary. Confirm that the bolt length, percentage of accuracy and material is correct. Then press "RETRY".

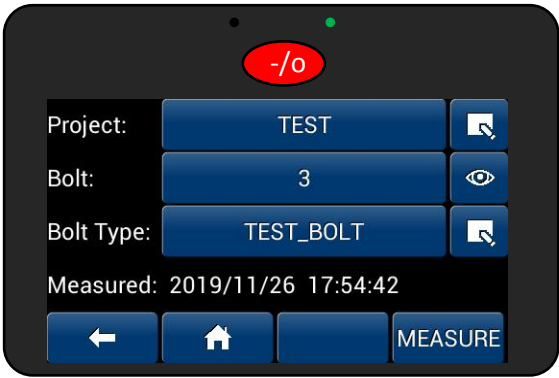


If you are using standard settings and the Ref Len is within ~4-5% of the physical measured length, the signal should be acceptable for you to accept the reading by pressing the Apply and Save Button. Pressing Disk+1 button, saves the current bolt measurement, and automatically moves the measurement to the next bolt (increment). AKA. "Next bolt" function. We also recommend to view/inspect the actual echo graph by pressing the SCOPE button.



This shows the scope view with the following options

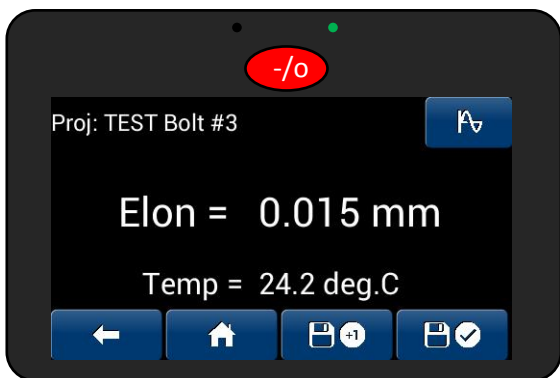
	Echo zoom or compression
	Move echo L or R to view or select different echo packet.
	Automatic Gain Control. IF "AGC" FLASHES RED, PRESS IT
	New signal acquisition. IF "PK" FLASHES RED, PRESS IT
	Zero crossing selector (Δ), choose different zero crossing
	Will save the scope trace for later viewing – all Ref Len scope traces are auto stored
	Saves time reading and receiver settings.



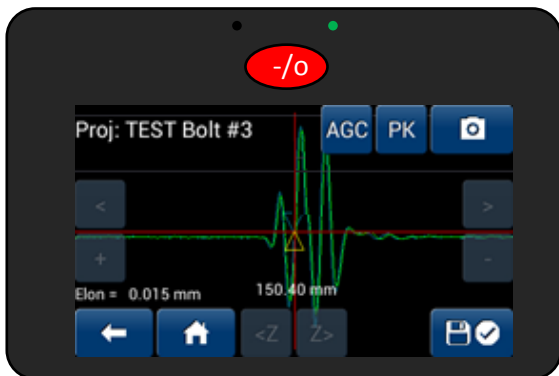
Your Zero Load (Ref-Len) measurement is now done and you are now ready to do more Ref-Len measurements on other bolts or to start measuring elongation.

The Delta Sigma automatically goes to the elongation screen when a reference length is saved. If the bolt is then tightened, press "DONE" to store the elongation. If tightening will take place later or you want to measure another bolt, press "BACK" to return to the main bolt screen.

When returning to a bolt that already has a stored reference length measurement, the Delta Sigma will go to the elongation screen.



In the Elon screen, the elongation will be displayed in real-time as shown.



You can also view the elongation in scope mode by pressing the "SCOPE" button. You will see the green elongation scope trace move real-time, to the right as the bolt is tightened. The blue reference length scope trace will also be displayed as shown in the picture below.

Once you have reached the required elongation, you press Save and Check. The elongation data is stored in the DELTA SIGMA.

Operational Discussion

The DS will search and find the largest amplitude echo packet returning from the end of the fastener in the time window (length) defined in the Bolt Type. Usually, when a bolt is stressed the amplitude of the signal will be lower. In Ref Len and Elon screens, if the signal is lower than amplitude threshold (white horizontal line or the stored Blue (Ref Len) stored reference trace), pushing AGC (automatic gain control) will bring the signal behind the reading up to the correct level.



If the fastener has other features in the end; hex wrench recess, lifting hole, long and thin (large L/D), etc., you may see other reflections before or after the true end reflection. Depending on the profile of the end region, you may want to adjust the receiver to read the echo time off the recess feature or go by it to the end reflection. In the Manual Scope On mode, selected in OPTIONS, there is an ADJ button that will display full pulser-receiver adjustment buttons.



In addition to the standard magnetic transducers, Glue-On transducers are available. The bolt end finish requirements are the same for Glue-Ons as for the standard transducers. Glue the transducer to the centre of the bolt according to procedure. Then place the probe so that the connector pin touches the transducer. The rest of the procedure is identical to standard magnetic transducers.

See Appendix B for additional finish and gluing information.

NOTE!

The use of "Expert Mode" or "Manual Scope" requires training.

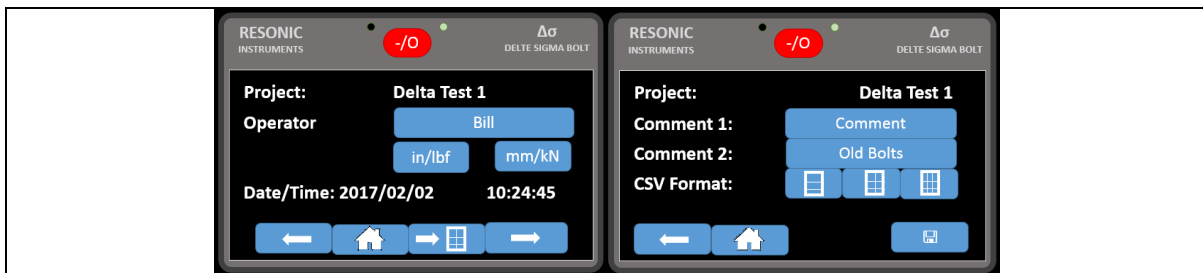
Please contact vendor to book a training session by use of MS Teams or other arrangement.

6 TRANSFER OF DATA BETWEEN THE DELTA SIGMA AND A PC

Important notice!


- The Delta Sigma USB-PC port is **ONLY** active when in File Manager and the USB icon is activated in the back-up Screen-
- Once the USB-cable is plugged into the Delta Sigma, and activated, you cannot enter or change data on the Delta Sigma from the program.
- The Delta Sigma will look like a Removable Disk / USB-Memory Stick
- The PC should run on Win7 or later MS Windows version
- Be sure to follow the instructions on the screen and always Eject the drive before pulling the USB cable!

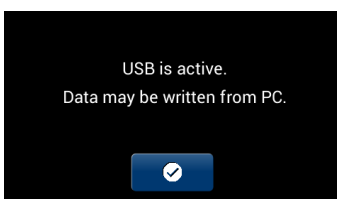
The Delta Sigma will write Excel readable .csv files into the public PC formatted USB accessible drive from the system (binary) Project files in the secure drive. Before you connect the Delta Sigma to your PC, you should make the system bolting data readable. The default setting is CSV. Return to the main Bolt menu, choose the project you want to export to your PC and press → button



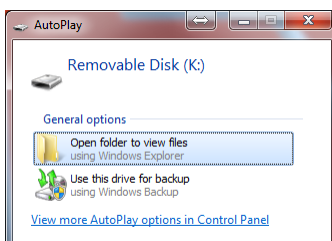
By pressing the grid button, you create a readable file in the Delta Sigma public Drive for you to access later. You can generate files from all projects, but you must enter each project to do so.

In the next screen you have the option to choose report type (short/normal/extended).

Once you have the Projects in Excel format, plug the provided USB-cable into the Delta Sigma and your PC. In Delta Sigma, go to Options - File Backup, push USB icon. 



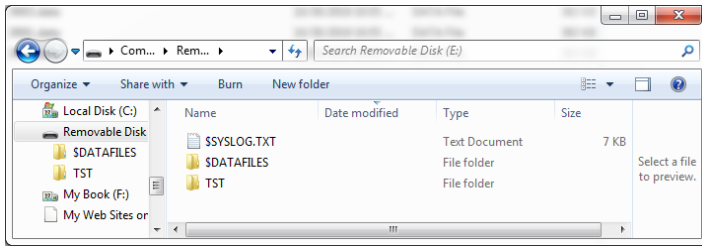
Windows will now recognize the Delta Sigma as an external hard drive or memory stick. Depending on your PC configuration you should now get a dialogue box like using other external drives (Removable Disk).



NOTE!

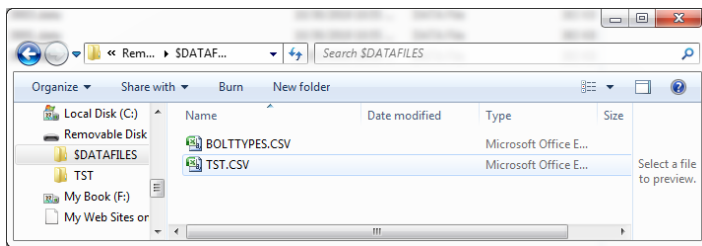
The Delta Sigma uses 2 – EEPROMs. The second EEPROM is presented to the USB port as a Removable Drive. This visible drive is the 'public' drive, when you plug a USB from a PC into the Delta Sigma. This public drive appears in Explorer. This drive holds the user data files created by pushing CSV in various places of the program.

The \$DATAFILES folder contains the CSV files for each project and all the Bolt types 'printed' (CSV):



The folder called \$DATAFILES contains your generated CSV files information. The Project folder: TST contains the csv scope files. If multiple projects have been written, you will see them all here.

In \$DATAFILES:



Copy the \$DATAFILES folder from the Delta Sigma to your local hard drive.

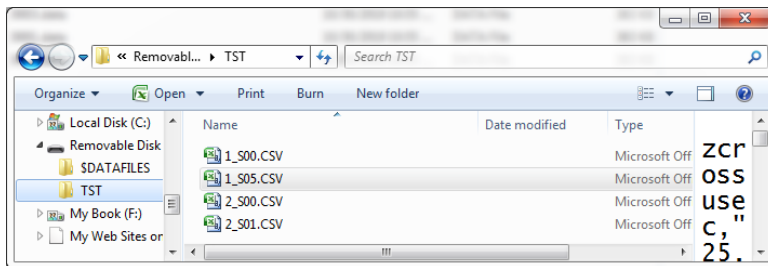
To open the files, you need to start MS Excel first and then open document. Then choose "All files" in the document type. Then go to the file path where you stored the \$DATAFILES folder. Find the required


document named "project-name".csv. MS Excel will ask you if you want to use "Data using column, tabulators etc.". Press "Next" and then "Complete".

The file will now open as a standard MS Excel file for you to review, print and analyze.

It is not possible to export this Excel data back to the Delta Sigma. That is covered in the next section.

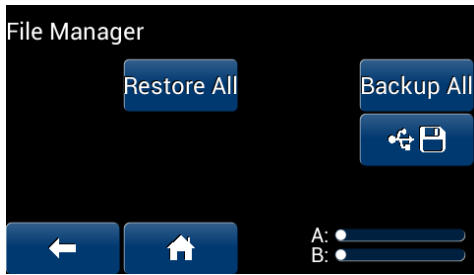
Also, in drive B are the system scope traces and the CSV/TSV formatted scope traces:



When finished, remember to Eject from PC and now pull USB cable, push  exit USB active mode.

EXPORT SYSTEM PROJECT data from the Delta Sigma to a PC FOR DATA BACK UP AND TRANSFER INTO THE SAME OR DIFFERENT Delta Sigma UNITS

The non-public raw bolt data is stored on drive A, this drive is not user accessible.



In the Options - File Manager screen there is "BACKUP ALL". This function will write all Delta Sigma formatted project (binary) to the B (removable) drive.

The BACKUP ALL function will also write all system Bolt Type and scope files to B.

When the backup is completed, the program will return to the File Manager screen. From here:


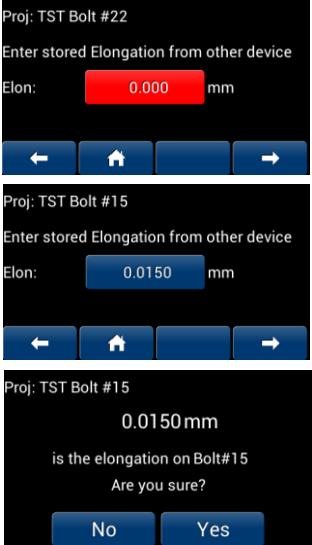
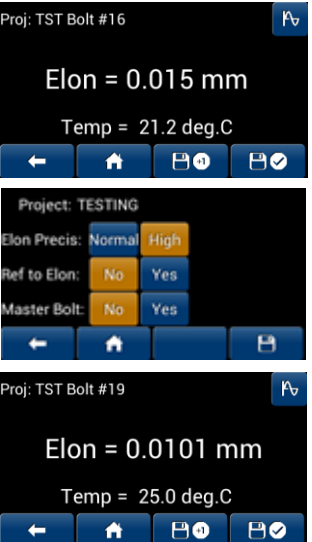
1. Push USB icon.
2. Plug USB cable into PC, removable drive will come up on PC.
3. Copy files to the PC. (Syslog is an operational record of the Delta Sigma. It is only for diagnostics and can be left on drive)
4. When finished copying files, Eject drive from PC.
5. Disconnect the USB cable.

To RESTORE the raw project data back to Delta Sigma from the PC;

1. From File Manager - with active USB mode, put all saved binary data back on Delta Sigma, B drive from PC. When finished, Eject USB from PC and pull cable.
2. In File Manager screen, push Restore All, this function moves all project and scope data back to the protected A drive.

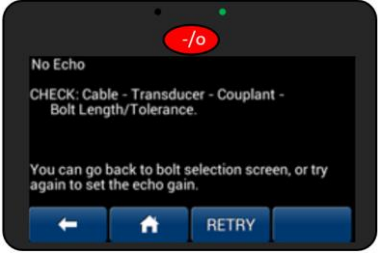
All Project and Bolt type data is ready to call up and re-read

7 REFERENCE TO ELONGATION FUNCTION

 <p>The start-up screen displays 'Proj: TEST' at the top left. A red circle with '-/0' is at the top center. Below it, 'Ref Len = 76.362 mm' and 'Temp = 21.8 deg.C' are shown. At the bottom are four buttons: a left arrow, a home icon, a save icon, and 'R-to-E'.</p>	<h3>Start-up Screen</h3> <p>This feature allows a user to enter a bolt elongation into the DFS taken with another instrument. The DS will calculate a new reference length and display the same stretch on the bolt as the other device read. In the Ref Len mode, pushing the R-to-E button, on a previously tightened bolt, the DS-1 is reading a reference length, pushing the R-to-E button</p>
 <p>The first screen shows 'Proj: TST Bolt #22' and 'Enter stored Elongation from other device' with 'Elon: 0.000 mm'. The second screen shows 'Proj: TST Bolt #15' and 'Enter stored Elongation from other device' with 'Elon: 0.0150 mm'. The third screen shows 'Proj: TST Bolt #15', '0.0150 mm', and 'is the elongation on Bolt#15 Are you sure?' with 'No' and 'Yes' buttons.</p>	<p>The DS will ask for the elongation on the bolt:</p> <p>Enter the bolt's elongation and double check.</p>
 <p>The first screen shows 'Proj: TST Bolt #16' and 'Elon = 0.015 mm' with 'Temp = 21.2 deg.C'. The second screen shows 'Project: TESTING' with 'Elon Precis: Normal High', 'Ref to Elon: No Yes', and 'Master Bolt: No Yes'. The third screen shows 'Proj: TST Bolt #19' and 'Elon = 0.0101 mm' with 'Temp = 25.0 deg.C'.</p>	<p>The DS will now calculate and store a new reference length, and now read the transferred stretch:</p> <p>If High Resolution is selected in the "Expert" project entry screen:</p> <p>The elongation readout screen will be have 4 places of resolution in metric mode and 5 places of resolution in imperial mode.</p> <p>Remember, when entering new data in either; Options, Bolt Type or Project, save all changes by pressing the save icon.</p>

8 IMPORTANT NOTES ON OPERATION

Receiver is unable to AGC on signal – From the Bolt Info Screen



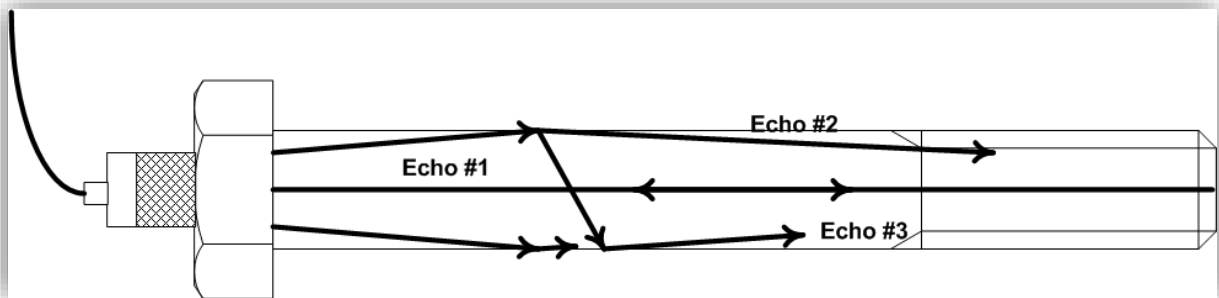
When the MEASURE Button is pushed and the receiver setting screen appears, then the program returns to the main menu screen there is something wrong with the ultrasonic connection. Check the Bolt Type File:

- Make sure that the Approximate Length is correct
- Check Cable connection
- Check Bolt/Transducer contact and bolt end finish

Bolt length displayed is not within 2-4% of actual measured length:

Mode Conversion

This may be from a property common in long – slender bolts or studs with a solid shank or stud section. The ultrasonic “beam” has a spread angle; this angle is a function of transducer frequency and diameter. The Operational Discussion portion of the Measure Bolts section covers how to move the scope window to re-trigger on the end echo packet that is always in front of the mode conversion packet.



Materials Evaluation/44/April 1986, Glenn M. Light, Narayan R. Joshi, Soung-N.Liuc



See Youtube Channel for video instructions on Mode Conversion.

9 SPECIFICATIONS AND FEATURES

Intuitive operation

- No buttons, fewer steps, programmable touch pad QWERTY alpha-numeric input
- Creation, storage, retrieval of individual projects (group 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.

Weight & Dimensions

- Small, lightweight, rugged
- A = 6,88" / 175mm
B = 7,08" / 180mm
C = 1,61" / 41mm
- 3.186 lb / 1445 Grams

Fast digital signal: location, amplitude and threshold detection

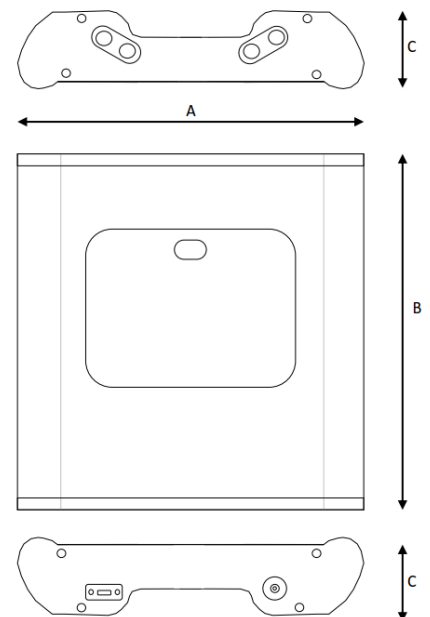
- Real time signal tracking: amplitude, peak jumps
- Storage of individual signal parameters for qualitative R&R reading comparison

Connectors

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

Display

- 3.8x2.2 in / 97x56 mm
480x272 - 24bit colour, sunlight readable touch panel display
- -20 to +70°C operating range
- Full touch panel program operation
- Rugged/sealed display module (IP 44)



Temperature transducer

- Class A PT100

Microprocessor

- 32-bit ARM®

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

Real time oscilloscope trace of echo

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

Batteries

- 4 sealed 3.4mAH Li Ion 18650 cells, twin smart chargers 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+hrs
- 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

10 APPENDIX

Appendix A

MATERIAL F BOLT	SONIC STRESS FACTOR	TEMPERATURE FACTOR		SOUND VELOCITY		MODULUS OF ELASTICITY	
		F	C	IN / SEC	MM / SEC	PSI X 10 6	Mpa X 10 3
ISO SPECIFICATIONS SR898							
Gr.8.8	0.276	58	104	232000	5892800	29.9	205
Gr.9.8	0.276	58	104	232000	5892800	29.9	205
Gr.10.9	0.274	57	103	232000	5892800	29.9	205
Gr.12.9	0.274	57	103	232000	5892800	29.9	205
MATERIAL SPECIFICATIONS							
4140 STEEL	0.274	56	101	232000	5892800	29.9	205
4340 STEEL	0.285	55	99	232000	5892800	30	207
STS STEEL	0.250	80	144	230000	5840000	29	200
INCONEL	0.296	62	111	225000	5710000	31	214
TITANIUM	0.490	64	115	245000	6220000	16.5	114
ASTM SPECIFICATIONS							
A193 B7	0.280	57	103	232000	5892800	30	207
A193 B16	0.280	57	103	232000	5892800	30	207
A325	0.274	56	101	232000	5892800	29.9	205
A490	0.299	60	108	232000	5892800	29.9	205
A540	0.299	60	108	232000	5892800	30	207
SAE SPECIFICATIONS 1038							
Gr.2	0.275	57	103	232000	5892800	29.9	205
Gr.5	0.275	57	103	232000	5892800	29.9	205
Gr.6	0.277	60	108	232000	5892800	29.9	205
Gr.8	0.274	57	103	232000	5892800	29.9	205
Gr.9	0.275	58	104	232000	5892800	29.9	205

Disclaimer /Note: The above listed values are approximate average values based on standard table values for sound velocity in common bolt materials. Specific material velocities has to be individually confirmed to reduce uncertainty.

Appendix B GLUE-ON INSTRUCTIONS

- 1 Bolt end finish for the transducer should be minimum of Ra 0.98.
Clean the end of the bolt with Loctite cleaner or eq.



- 2 Place a small amount of glue in the centre at end of the bolt using brush/cocktail/toothpick or similar device. For normal bolts; use Loctite 620 or equivalent (fast - glue-paste). For bolts to be used in high temperatures, use Loctite 638 or equivalent. (NB Do not use liquid "fast glue" as this will cause the readings to fail as the glue will crack against the chip).



- 3 Place the transducer on the glue and align the transducer at the center. Use a pin or a pair of tweezers. Then press the transducer down towards the bolt. Alternatively, one can use scotch tape and place transducer on the glue-side of the tape for easier application of glue and later placing onto bolt.



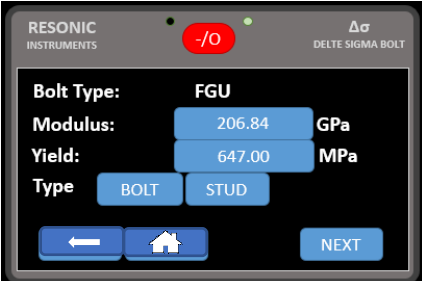



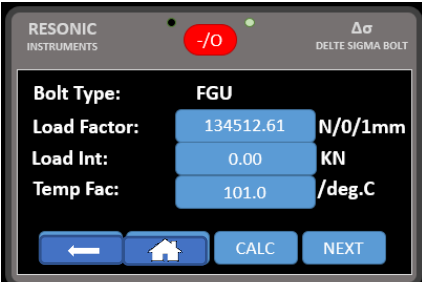
- 5 Place a cover of plastic over the newly glued transducer and place a magnet or weight on top of it to let it harden. Leave for 5-10 minutes and remove plastic



- 6 The bolt is now ready.

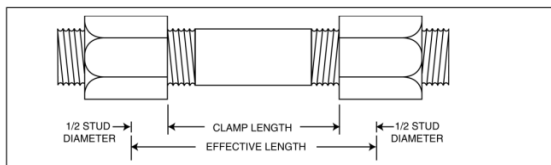


Appendix C

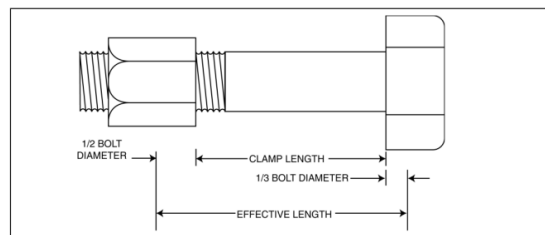
CALC SETUP	
<p>Enter the Material Modulus if it is different from the selected Material in Bolt screen. Enter the Yield value of the material. E.g: 8.8 = 640 MPa ; 10.9 = 900 MPa B7 = 724 Mpa (check the material constants with appendix). NB: It is not necessary to enter Yield value unless %- yield is to be displayed. Choose bolt or stud pending application.</p>	
<p>Enter the geometric values for the bolt or stud. See Appendix D for geometric terms. Enter thread pitch or threads per inch.</p>	
<p>The Engagement Factor is the percentage of the diameter at the thread or head section that carries/sees the stress from the structure. The default values for a steel-steel standard bolt connection is 0,4 at the head and 0,5 for the nut. For a stud bolt the engagement factor is 0,5 and 0,5 for both in standard steel. Ext. See Appendix D.</p>	
<p>This page displays results from calculation.</p>	
<p>The results of the load factor calculation is now displayed on the load factor entry row (make sure to store the value by completing the bolt type entry sequence)</p>	

Appendix D – Units of Measure and Geometric prop.

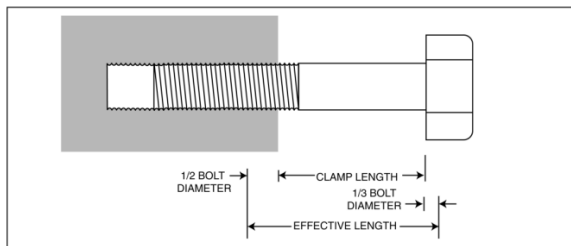
Measurement Modes	Pulse/Echo (normal operation) –	Pitch/Catch (special operation)	
Transducer Frequency	Megahertz (MHz)		
Tone Burst length	Pulses		
Analog Output	Volts		
Measured Item	Metric 1	Metric 2	Imperial
Length	Kilonewtons/mm	Kilograms/mm	Pounds / Inches
Elongation	Millimetres	Millimetres	Inches
Diameter	Millimetres	Millimetres	Inches
Load	Kilotons	Kilograms	Pounds
Stress	MPa	Kg/Sq.mm	PSI



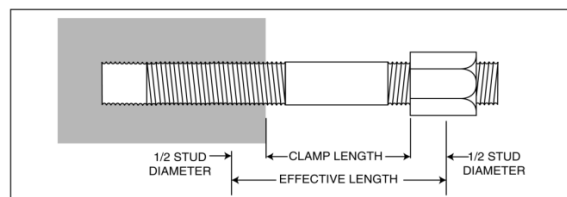
This is a typical stud configuration. The effective length of a stud with nuts on each end is found by adding the stud diameter to the clamp length.
 Engagement factor 1: 0,50
 Engagement factor 2: 0,50



This is a typical through bolt configuration. The effective length of a bolt with a single nut is found by adding half the diameter to one-third the diameter (5/6 of the diameter total) to the clamp length
 Engagement factor 1: 0,50
 Engagement factor 2: 0,40



This is typical of a configuration with a bolt (screw) turned into a threaded hole.
 Engagement factor 1: 0,50
 Engagement factor 2: 0,40



This is typical of a configuration with a stud turned into a threaded hole. When a stud is threaded into a blind hole and a nut is placed on the opposite end, find the effective length by adding the stud diameter to the clamp length
 Engagement factor 1: 0,50
 Engagement factor 2: 0,50

Appendix E – Estimating a Theoretical Load Factor

The Load Factor is defined as the tensile load required which will produce one unit of elongation in the bolt. When operating in English units the factor is defined as the number of pounds required per inch of elongation. In metric unit systems the factor is defined as Newton's or per 0.1mm.

The relationship between load and elongation is a function of the elasticity of the bolt material, and the geometry of the bolt in the application being measured.

$$P = \frac{\Delta l \times AE}{L}$$

Hooke's Law expresses the relationship:

P= Load

ΔL = Elongation

A = Cross Sectional Area of the Bolt

$$LoadFactor = LF = \frac{100AE}{L} = \frac{100AE}{(L_g + D)}$$

Worked example for a bolted joint in Metric units:

Data: M20 x 2,5: ISO 8.8 Stud Bolt with and 200 mm effective length (clamp length + load section of nut and length/thickness of washers):

E (Youngs Modulus) for 8.8 = 206,15 kN/ mm²

A (Iso for M20) = 245 mm²

L- Effective length = 200 mm

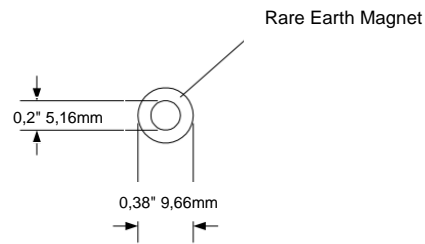
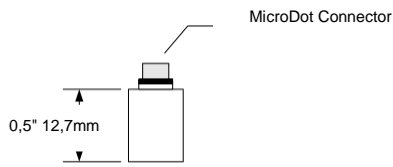
$$LoadFactor = LF = \frac{100x(245x206,15)}{200} = \frac{25253N}{0,1mm} = 252,5kN/mm$$

Hence the load factor entered the Delta Sigma for this bolt joint example would be: 25253

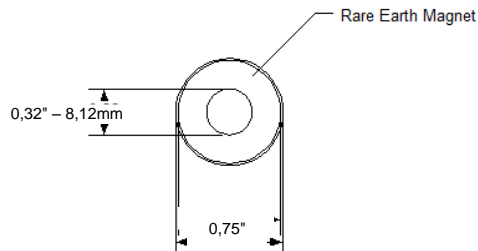
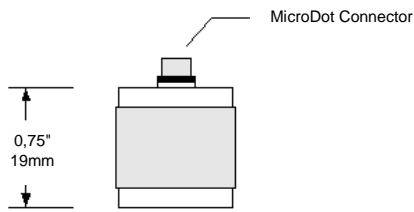
Note: It should be noted that this estimation is inherently less accurate than calibration of the actual Load Factor by using actual known loads which correspond to measured elongation.

Appendix F – Transducers

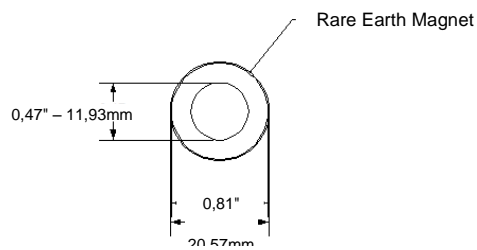
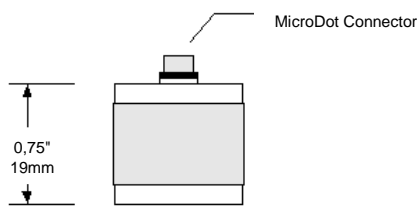
3/16" Magnetic 5MHz – P/N 2050-01



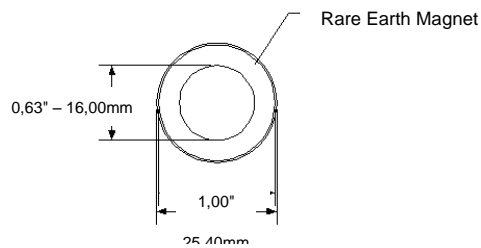
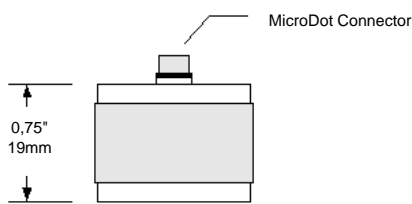
1/4 " Magnetic 5MHz – P/N 2050-02



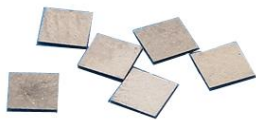
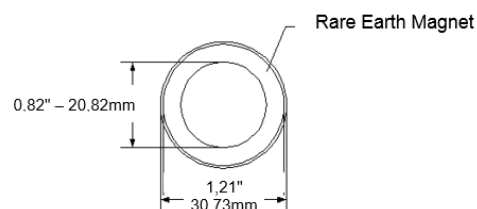
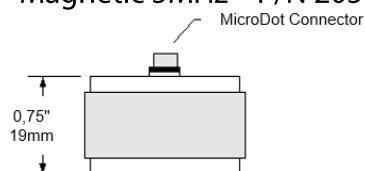
3/8" Magnetic 5MHz – P/N 2050-03



1/2" Magnetic 5MHz – P/N 2050-04



3/4" Magnetic 5MHz – P/N 2050-05



3x3mm Glue-on transducers – P/N 3000-01

The glue-on transducers comes in sheets of 100 transducers. They are simply glued-on the bolts and tested by using the 4000-TC or 4000-RH cable.

