TENSIONADOR DE PARAFUSOS
TIPO
TTM-M036-49-00





HEALTH & SAFETY, OPERATING AND MAINTENANCE INSTRUCTION MANUAL



Operating, Safety and Maintenance Manual

M36 Multi-Stage Typhoon Tensioner
TTM-M036-49-00

TYPHOON

BOLTIGHT®

HYDRAULIC BOLT TENSIONING

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SECTION 1

TECHNICAL INFORMATION

General Description	Page 2
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M36 x 4 Multi-stage Typhoon Tensioner TTM-M036-49-00

General Description of the Tensioner

The purpose of this tool is the tightening of M36 x 4 diameter bolts, of minimum stud protrusion 77mm above the bridge footprint and maximum 94mm. When reading this description it is helpful to have Drawing Number TTM-M036-49-00 at hand.

The pressure equipment covered by this operating manual is a multi-stage hydraulic bolt tensioning tool. The tensioner comprises two axially-stacked interlocking load cells (each comprising a body, piston, inner/outer seal and reaction nut), a common central puller bar with ½" drive socket, a spring retraction mechanism and interconnecting bridge. The bridge incorporates a spring-loaded gear-driven nut rundown mechanism for convenience, also incorporating a ½" drive socket.

The load cells are pressurised via a radial manifold block, using a CEJN 116 high pressure nipple. Each load cell is fitted with hybrid composite plastic and rubber hydraulic seals. These components are rated for use up to 1350 bar and are therefore safe for use at (but not above) the maximum operating pressure. The user must ensure that the hoses and pumps utilised to pressurise the tool are suitable for compatibility with the bolt tensioners supplied, and also rated for safe usage at this pressure. Where in doubt the operator must contact Boltight for further information.

Within the tensioner, the upper and lower Hydraulic Load Cells are interlocked for simultaneous pressurisation and are supported by the Bridge. Both load cells engage a common puller bar, whose design has been configured in conjunction with the Bridge design to provide optimum engagement with the customer's application. On M36 applications for which this tool is designed, the permanent nuts are hex nuts. The gear driven socket within the bridge has been designed to interface snugly with the across flats dimensions of these hex nuts as supplied by the customer, and nut rundown following pressurisation is achieved by rotating the gear driven socket. This is performed via the ½" square drive socket located at the top of the gearbox. This gearbox and geared socket mechanism can also be utilised to unwind nuts during de-tensioning procedures.

The mass of the tensioner is approximately 9 kgs. Thusly, it is suitable for manual handling.

The M36 tensioner TTM-M036-49-00 has a maximum stroke of 10mm. A visual indicator ring mounted near the top of the puller allows the operator to determine when this maximum stroke has been reached. Although the tensioner has been designed with a positive stop to prevent over-stroking, the tool should never be over-stroked beyond its maximum working pressure of 1350 bar. Whenever the visual indicator ring can be seen protruding through the top of the tool, the operator should immediately shut-off the pump and reset the tool to zero stroke before tensioning/de-tensioning is resumed (see Section 3 for full instructions).

The tool features a spring-actuated piston return facility. The spring retraction system comprises heavy duty springs, which are contained within the spring cap. The spring system should not require attention during the working life of the tool. When the pressure within the tool is returned to zero the spring force will retract the pistons fully back into the outer bodies. As mentioned above, care should be taken not to stroke the tool beyond its maximum stroke.

The tool also features a safe failure mechanism. In the event that the fatigue life of the tool expires, it has been engineered to fail safely and remain in-situ upon the bolt, posing no threat to adjacent personnel or equipment.

The maximum tool pressure cycles is indicated with the tool technical data. A record of pressure cycles should be kept and the tool returned for puller replacement before reaching this limit. An automatic, hydraulically actuated cycle counter has been incorporated to assist operating personnel in quantifying tensioner usage.

The tensioner must not be modified by any type of machining and no attachment can be made to the tools by any form of welding or brazing.

The tensioner has been subjected to a one-off pressure test at 1485 bar prior to despatch, and a test certificate has been issued to certify this. Please note that this is not the maximum operating pressure and it is strongly advised that the tool is NEVER operated above its maximum operating pressure of 1350 bar. The tool does not require re-testing during its working life, even after fitting new sealing elements. If the user wishes to conduct a pressure test, the tensioner should returned to the manufacturer's works for recertification.

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Tool Specification

M36 x 4

Tool No	**TTM-M036-49-00**	
Thread Size	**M36 x 4**	
Tensioner Outer Diameter	**82.5 mm**	**(3.25 in)**
Bridge Outer Diameter	**90 mm**	**(3.54 in)**
Tensioner Height	**237.5 mm**	**(9.35 in)**
Hydraulic Pressure Area	**4963 mm^2**	**(7.69 in^2)**
Maximum Pressure	**1350 bar**	**(19580 psi)**
Maximum Load @ 1350 bar	**670 kN**	**(151 klbf)**
Maximum Stroke	**10 mm**	**(0.394 in)**
Tensioner Weight	**9.0 kg**	**(19.8 lb)**
Maximum Pressure Cycles	**6,000**	



TYPHOON

M36 x 4 Multi-Stage Typhoon Tensioner

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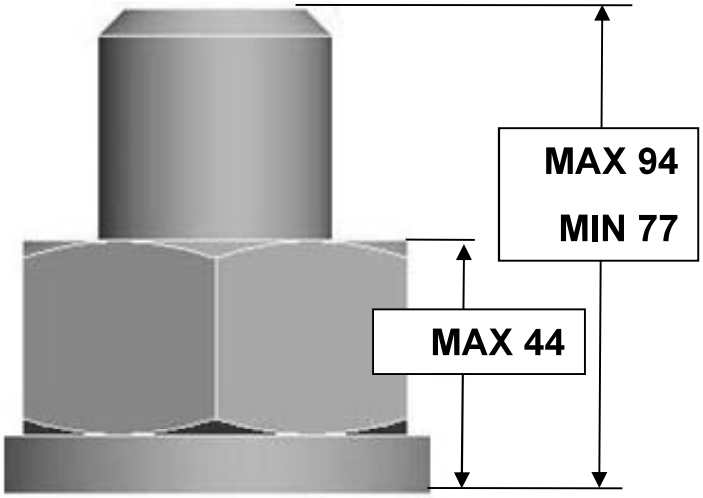
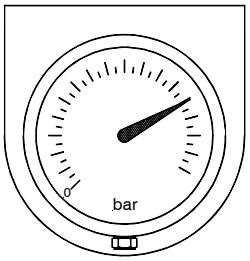
IMPORTANT INFORMATION

1. ONLY EVER USE THE TOOL WHERE THE STUD PROTRUSION IS BETWEEN 77 AND 94mm, AND WHERE THE COMBINED NUT AND WASHER HEIGHT IS NO GREATER THAN 44mm. THE WASHER SHOULD BE LESS THAN 67mm ON DIAMETER.



2. NEVER PRESSURISE THE TOOL BEYOND ITS MAXIMUM WORKING PRESSURE OF 1350 bar (19580 psi).



> 1350 bar



3. DO NOT EXCEED THE MAXIMUM STROKE OF 10mm. EVEN THOUGH THE TOOL FEATURES AN ANTI-OVERSTROKE FACILITY, THE OPERATOR SHOULD NEVER INTENTIONALLY OVERSTROKE THE TOOL.

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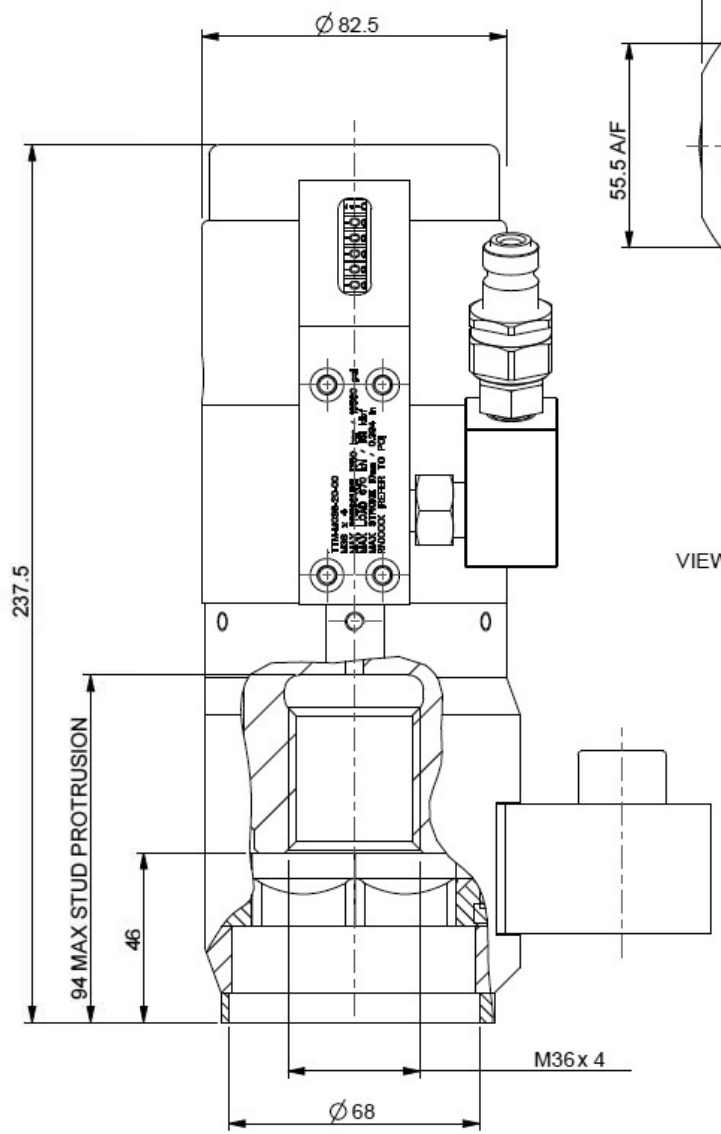
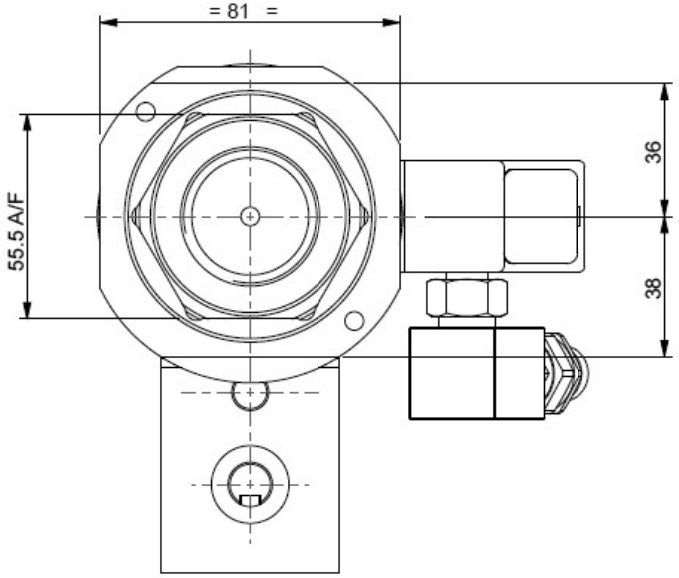
ALL DIMS MM U.S.O.

DO NOT SCALE

TYPHOON





VIEW SHOWING BRIDGE PROFILE



GENERAL VIEW
SCALE 0.500

TOOL FEATURES:

- OPTIONAL CYCLE COUNTER
- FAST SPRING RETURN
- OPTIONAL CARRYING HANDLE
- HIGH CYCLE FATIGUE LIFE
- SAFE FAILURE DESIGN
- ANTI-OVERSTROKE FACILITY
- LONG LIFE SEAL PERFORMANCE
- OPTIONAL NIPPLE/COUPLING CONFIGURATIONS
- LOW MAINTENANCE SPRING LOADED GEAR DRIVE

SPECIFICATION				
MAX WORKING PRESSURE	1350	bar	19580	psi
MAX LOAD	670	kN	151	klbf
MAX STROKE	10	mm	0.394	in
APPROX. TOOL WEIGHT	9.0	kg	19.8	lb

MATERIAL						
FINISH						
SURFACE FINISH	1.6					
LIMITS U.S.O.	±0.25 ± 0.25 °					
SIZE A3	SCALE 0.800	A	-	PJ	MR	141211
		REV	CNN	DRAWN	CHECKED	DATE

BOLTIGHT

TITLE: M36 x 4 MULTI-DECK TENSIONER

DRAWING NO. TTM-M036-49-00

ISSUE A

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SECTION 2

HEALTH & SAFETY INSTRUCTIONS

Persons using hydraulic bolt tensioning tools must read and understand this section before starting to use the equipment. Your attention is particularly drawn to the instructions in RED on Page 2 and Page 5

Important Notice	Page 2
Using Bolt Tensioning Tools	Page 3

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THINK SAFETY

HEALTH & SAFETY INSTRUCTIONS

IMPORTANT NOTICE

Thank you for purchasing or renting your hydraulic bolt tensioning equipment from **Boltight**. Bolt tensioning tools are very powerful and capable of inducing very high bolt stresses. This equipment has been designed to give many years of safe tightening of bolted connections when used in accordance with these instructions.

Persons using hydraulic bolt tensioning tools must be properly trained in the correct use of the equipment and must also take adequate steps to ensure their own safety, and the Health and Safety of others working in the area where bolt tensioning operations are being performed. **Boltight** will be pleased to quote for the provision of training courses either at its UK base or on site anywhere in the world.

Operators must read all of this instruction and maintenance manual before attempting to use the equipment. Do not use the equipment if you are not already an experienced user of hydraulic bolt tensioning tools or if you have not already received proper training. Your attention is particularly drawn to the notes in **RED**.

When tightening/loosening bolts using tensioners, extremely high loads are induced. If the bolt material is incorrectly specified or the bolt has been subjected to any damage, it is possible that the bolt may shear. This could also occur if the tool is incorrectly installed (i.e. if there is insufficient thread engagement between the tensioner and the bolt). In these scenarios the tool could be launched at high speed along the axis of the bolt. This is an extremely rare occurrence provided that procedures are followed correctly, however in the event of failure anyone standing in line with the axis of the bolt during the tensioning operation will suffer critical injury or even be killed. It is therefore essential that anyone operating this equipment is properly trained in its safe use and takes every precaution to ensure that nobody is allowed to stand, work or stray near to or into line with the axis of any bolt tensioning tool during the bolt tensioning operation.

Bolt tensioning tools are powerful and when using high pressure hydraulics it is essential that you are trained in the correct use of the equipment and adhere fully with the Health and Safety Instructions.

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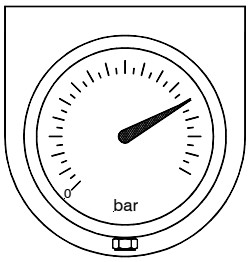
HEALTH & SAFETY INSTRUCTIONS

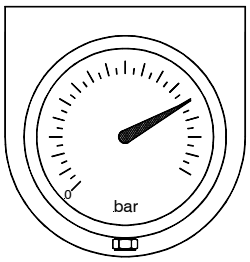
Bolt Tensioning Tools

DO NOT exceed 1350 bar Pressure



<= 1350 bar





> 1350 bar



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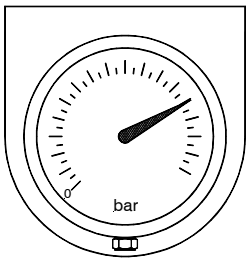
HEALTH & SAFETY INSTRUCTIONS

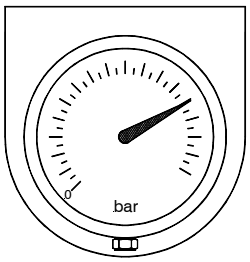
Bolt Tensioning Tools

DO NOT pressurise the bolt tensioning tool unless it is attached to a fully engaged bolt.













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HEALTH & SAFETY INSTRUCTIONS

Bolt Tensioning Tools



Bolt tensioning tools MUST always be used with a hydraulic pump which has a pressure limiting device. Always check that the pump stall pressure is set at or below the maximum working pressure for the tool being used.



Clear all personnel from the area where the bolt tensioning operation is to be performed. Position the pump a safe distance away from the bolt tensioning tools. Set up barriers and warning signs, or make other adequate arrangements to prevent unauthorised personnel from accidentally straying into the bolt tensioning area.



Ensure that nobody is allowed to stand near to a bolt tensioning tool during pressurisation. At no time should anyone allow any part of their body to be positioned over the bolt axis of a bolt tensioner whilst the pressure is rising or when it is pressurised.



Do not approach a bolt tensioning tool whilst it is being pressurised. Remember that a damaged bolt or tool is most likely to fail at this critical time. When the operating pressure has been reached, approach a pressurised bolt tensioning tool only for as long as is necessary to rotate the ring nut. Ensure that when rotating the nut you are well outside of the tensioners vertical axis.

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HEALTH & SAFETY INSTRUCTIONS

Bolt Tensioning Tools



Never leave a pressurised bolt tensioning tool unattended. Keep the bolt tensioning tools under pressure for the minimum time necessary to complete the bolt tightening operation.



Always ensure adequate PPE (Personal Protective Equipment) is worn by all personnel using bolt tensioning tools. SAFETY GLASSES and GLOVES are essential. OVERALLS and a HARD HAT are recommended.



The equipment supplied should only be used as intended (i.e. as a bolt tensioning tool). DO NOT use the tools as hydraulic jacks or for any other purpose.



Take care when handling the tools. Damage can occur through mishandling.



Do not pick up or carry bolt tensioning tools using flexible hydraulic hoses as a handle.



Do not try to tighten a leaking hydraulic connection when it is under pressure. First release the pressure, then repair the leak.



NEVER touch a hydraulic hose under pressure or allow it to rest across any part of the body. Do not pressurise a hydraulic hose if any person is or is likely to come into contact with it during pressurisation. If it requires moving or repositioning, ALWAYS release the pressure beforehand.

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SECTION 3

OPERATING INSTRUCTIONS

Introduction to Bolt Tensioning Tools	Page 2
Tool Description	Page 4
How to Tighten a Bolt	Page 6
How to Loosen a Bolt	Page 27

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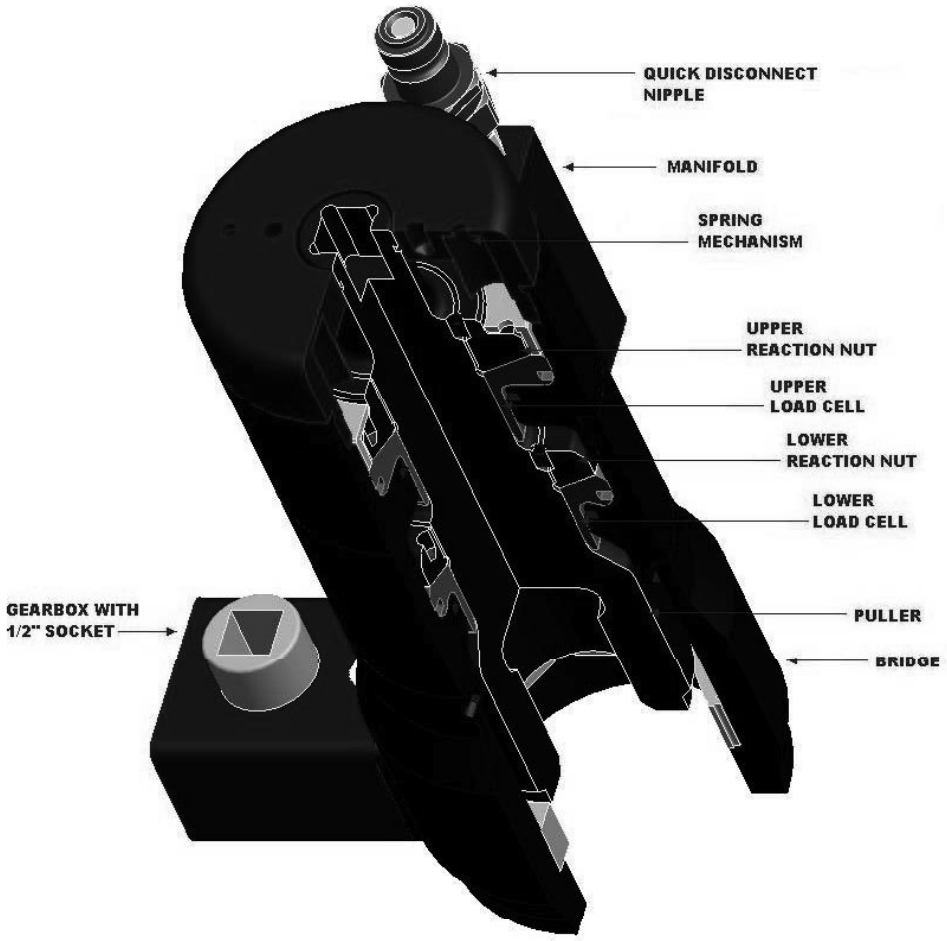
Introduction

A hydraulic bolt tensioning tool provides a quick and easy method for tightening large diameter bolts to high and accurate pre-loads. Unlike conventional methods, it does not use torque and does not require any forceful turning of the nut or bolt (as is the case using impact wrenches, flogging spanners or hydraulic torque wrenches). All of these methods have one common drawback: FRICTION. Overcoming thread friction and friction between the nut and the washer uses up over 80% of the torque energy applied to the nut or bolt, leaving less than 20% of the energy to produce useful tension in the shank of the bolt. Variations in this friction loss from bolt to bolt causes non-uniform tension in bolts that have been tightened to the same torque or impact wrench setting.



A hydraulic bolt tensioner is an annular jack which fits over the bolt and nut to be tightened. The jack pushes against the bolted joint and pulls on the end of the bolt, which typically needs to be at least one diameter longer to accommodate the bolt tensioning tool (although this varies according to the load and bolt material specified). Because the tensioner force produced is applied directly to the end of the bolt, a tension equal to the load generated by the tensioner is developed in the shank of the bolt. With the tool applying this tension, it is possible to turn the nut with zero torque until it is tight. The load applied by the tensioner is then relaxed and a known percentage (depending on the length of the bolt and its diameter) is retained within the bolt. This proportion of load retained is usually very high; thusly tensioning method offers significantly better efficiency as well as accuracy compared to other bolt tightening methods.

Bolt tensioning tools can be grouped to enable multiple bolts to be tightened simultaneously, to the same high and accurate pre-load. This is particularly useful when compressing gaskets in pipeline or pressure vessel flanged connections. The high load developed by the multiple bolt tensioning tools is evenly distributed around the joint causing the gasket to flow into the surface irregularities of the flange, resulting in a much better seal.

Flexible hoses with self sealing quick disconnect couplings are used to connect the bolt tensioning tools together to form a hydraulic ring main. The ring main and tensioning tools are usually pressurised using an air driven pump working from a compressed air supply, although hand pumps are also permissible.

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OPERATING INSTRUCTIONS

Description of Tensioning Tool TTM-M036-49-00

The Boltight Multi-stage Typhoon Tensioner TTM-M036-49-00 has been designed specifically for use with M36 x 4 bolts, in conjunction with hex nuts of dimensions specified by the customer. The Typhoon Multi-stage Range has been engineered to provide maximum load capacity under minimal radial envelope conditions.

A multi-stage bolt tensioning tool comprises two axially-stacked interlocking load cells (each comprising a body, piston, inner/outer seal and reaction nut), a common central puller bar with ½" drive socket, a spring retraction mechanism and interconnecting bridge. The bridge incorporates a gear-driven nut rundown mechanism for convenience, also incorporating a ½" drive socket. The tensioner incorporates a mechanical anti-overstroke protection facility, and also features a maximum stroke indicator. The load cells are pressurised simultaneously via a radially mounted manifold block of vertical CEJN 116 nipple configuration.

An automatic, hydraulically actuated cycle counter has been incorporated to assist operating personnel in quantifying tensioner usage.

The tool has a maximum operating pressure of 1350 bar (19580 psi), at which it develops a maximum tensioning force of 670 kN (151klbf). The maximum stroke for this tensioner is 10mm (0.394in).

Stroke Indicator

The diagram (page 5) shows a section through the stroke indicator. The operator is alerted that maximum stroke has been achieved by the indicator ring which is mounted in the shaft of the puller

When the tool reaches maximum stroke; i.e. when this indicator is visible to the operator, the operator should stop the pump and tighten the nut. No further benefit is gained by increasing the pressure at maximum stoke as the bolt cannot be stretched any further.

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OPERATING INSTRUCTIONS

HOW TO TIGHTEN A BOLT

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STEP 1 TIGHTENING A BOLT

Before commencing the bolt tensioning operation read and comply with all of the Health & Safety Instructions in Section 2. Operators should also be familiar with the 'Important Information' literature in Sections 1 and 5.

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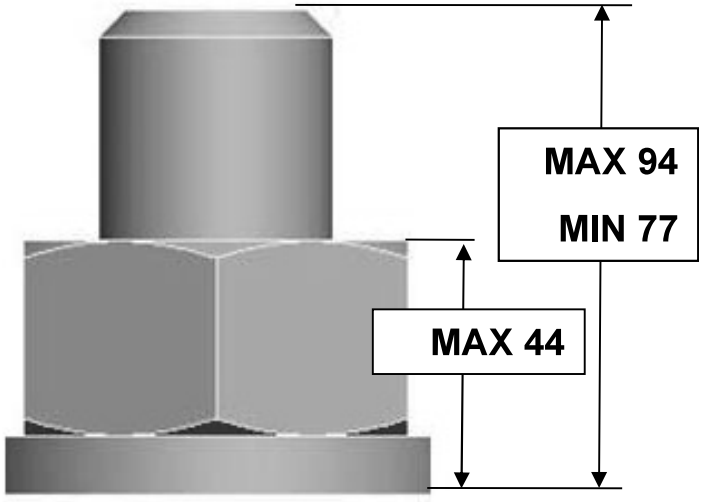
STEP 2 TIGHTENING A BOLT



Ensure that there is a minimum of 77 mm of protruding bolt for the Tensioner to engage with.

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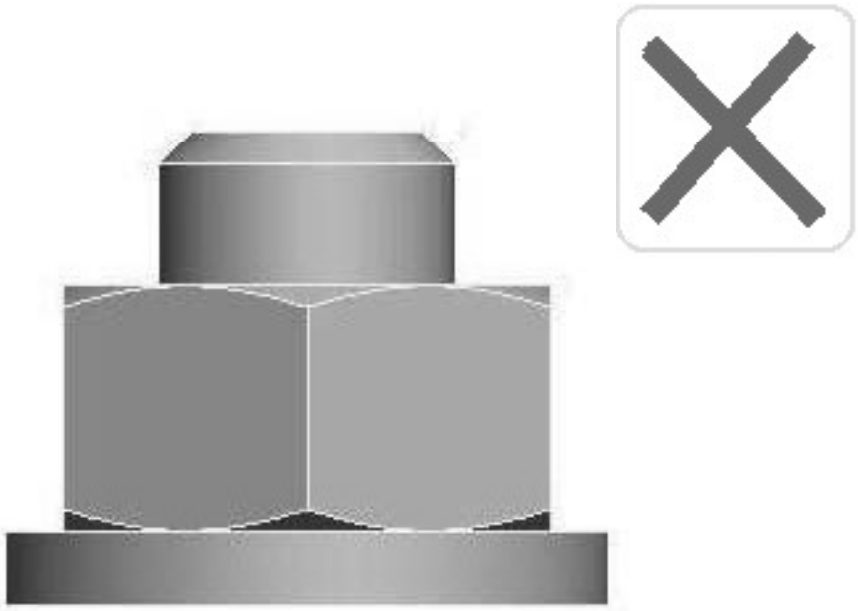

Either the stud protrusion is too short or the nut is too high up the bolt. Engagement with the Tensioner is insufficient – the bolt threads may strip and cause injury.

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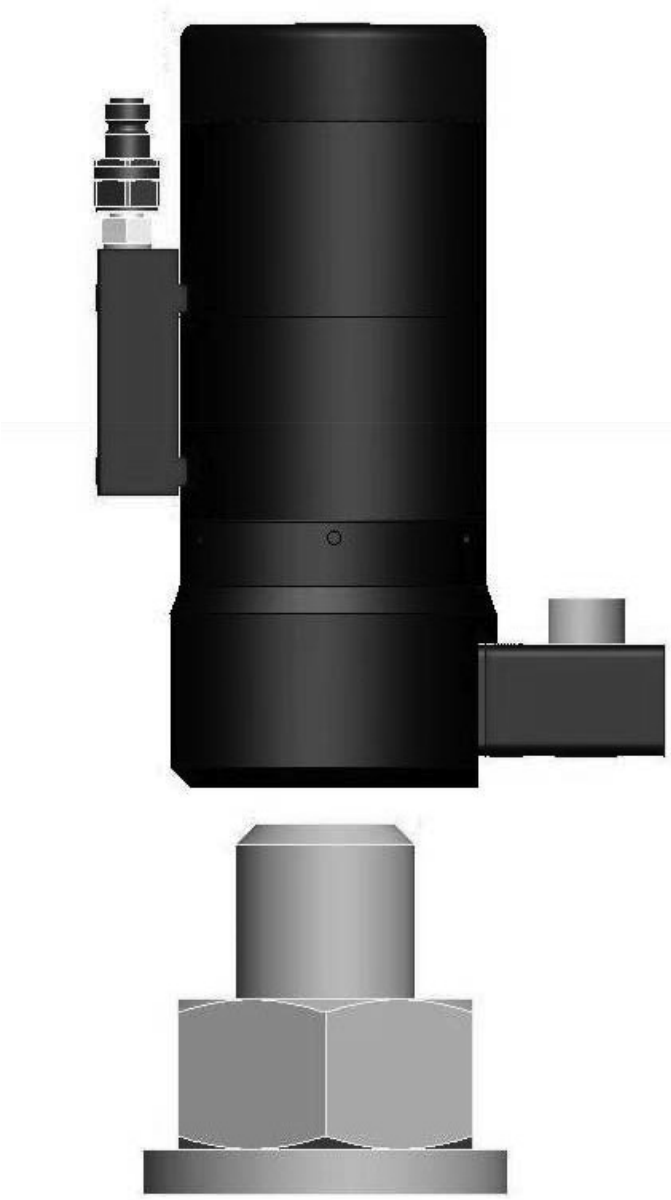
STEP 3 TIGHTENING A BOLT

Position the Tensioner over the bolt to be tightened. Orient the tensioner so that manifold is accessible, and such that the bridge window allows tommy bar access to the nut.



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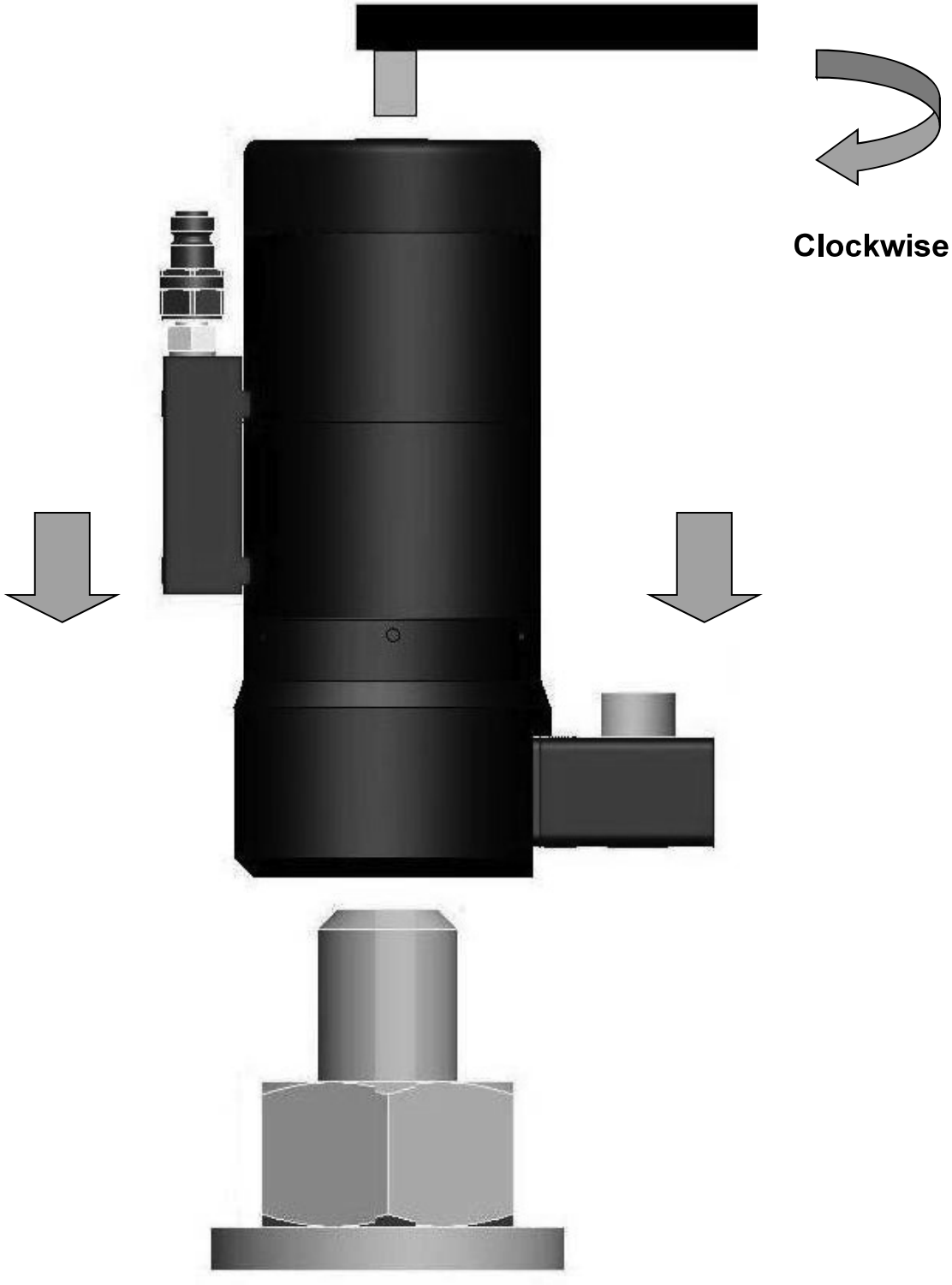
STEP 4 TIGHTENING A BOLT

Engage the Puller with the bolt. A 1/2in Square Socket is provided in the top of the Puller Bar so that the Tensioner orientation can be maintained whilst the Puller engages the bolt.



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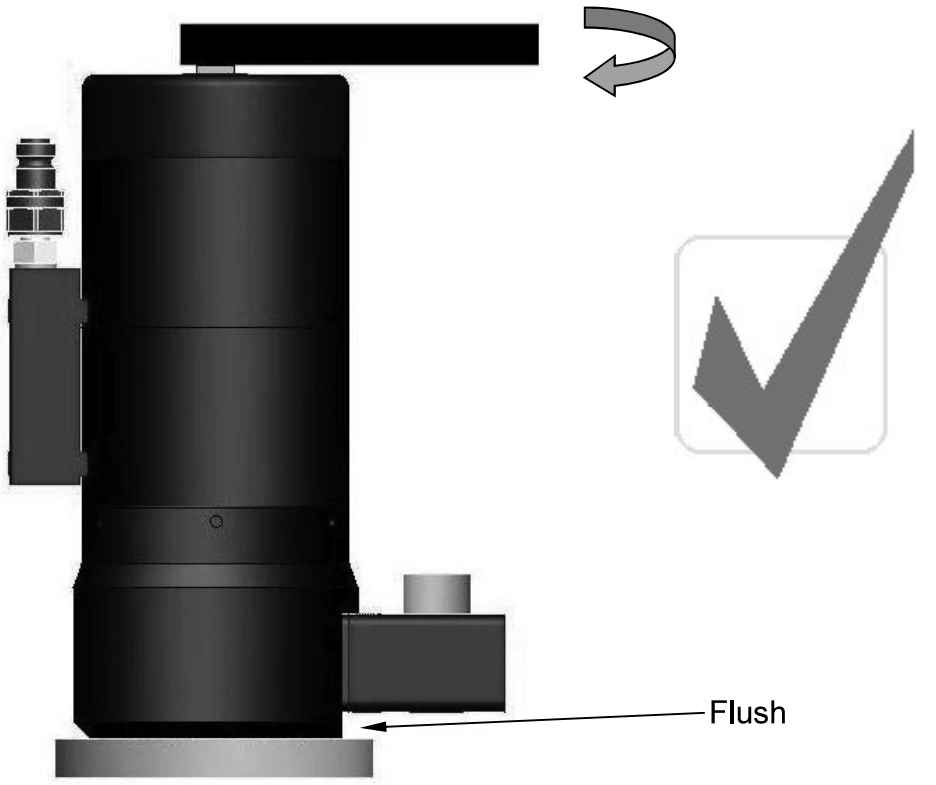
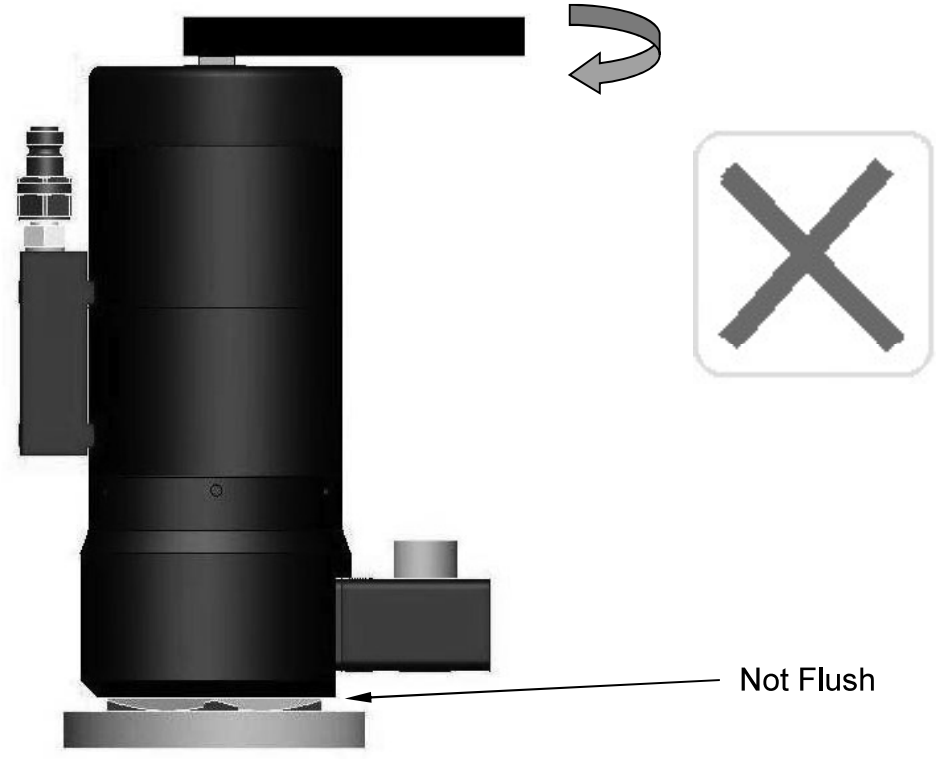
Continue rotating the Puller, increasing its engagement with the bolt until the bridge is flush with the flange. To ensure the tool is fully flush, it may be necessary to rotate the gearbox slightly whilst lowering to fully engage the gear driven socket with the nut.





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Once the Tensioner is in situ, it should still be possible to rotate the bridge to a suitable angle to access the bolt if required.



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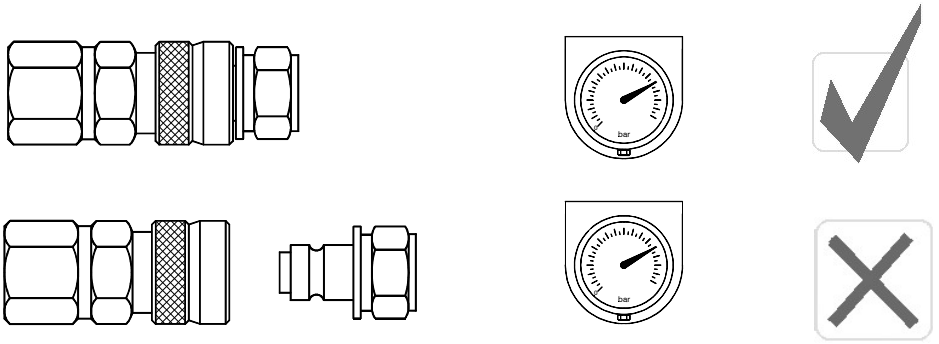
Using Quick Connect Couplings

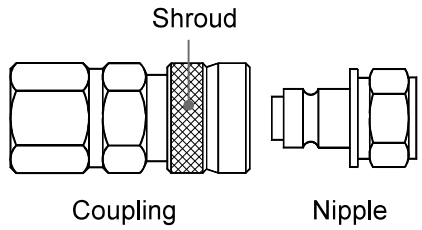
YOU MUST ENSURE YOUR COUPLINGS ARE COMPATIBLE WITH THE CEJN 116 NIPPLE FEATURED ON THIS TENSIONER!

DO NOT pressurise the connectors when they are disconnected

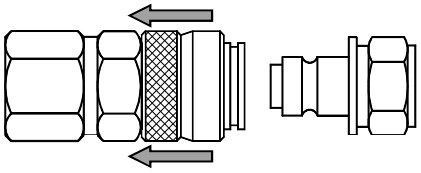
Check there is no pressure in the system before attempting to connect or disconnect the couplings.



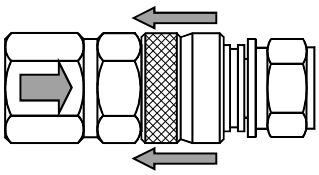
To connect the Quick Connect Coupling and Nipple, first check there is no pressure in the system. Then pull back the shroud by hand and push the coupling onto the nipple. When together, release the shroud which will spring back to lock the Coupling and Nipple together. To disconnect, first check there is no pressure in the system. Pull back the shroud, by hand, and pull the coupling and nipple apart. Release the shroud when apart.



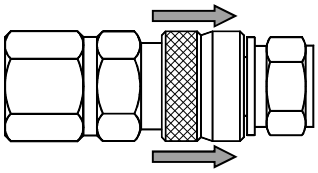
Pull the shroud back to retract



Coupling and Nipple with the shroud retracted



Coupling and nipple pushed together with the shroud still retracted



Shroud released - Coupling and Nipple are now locked together and safe to use.

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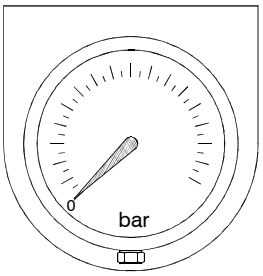
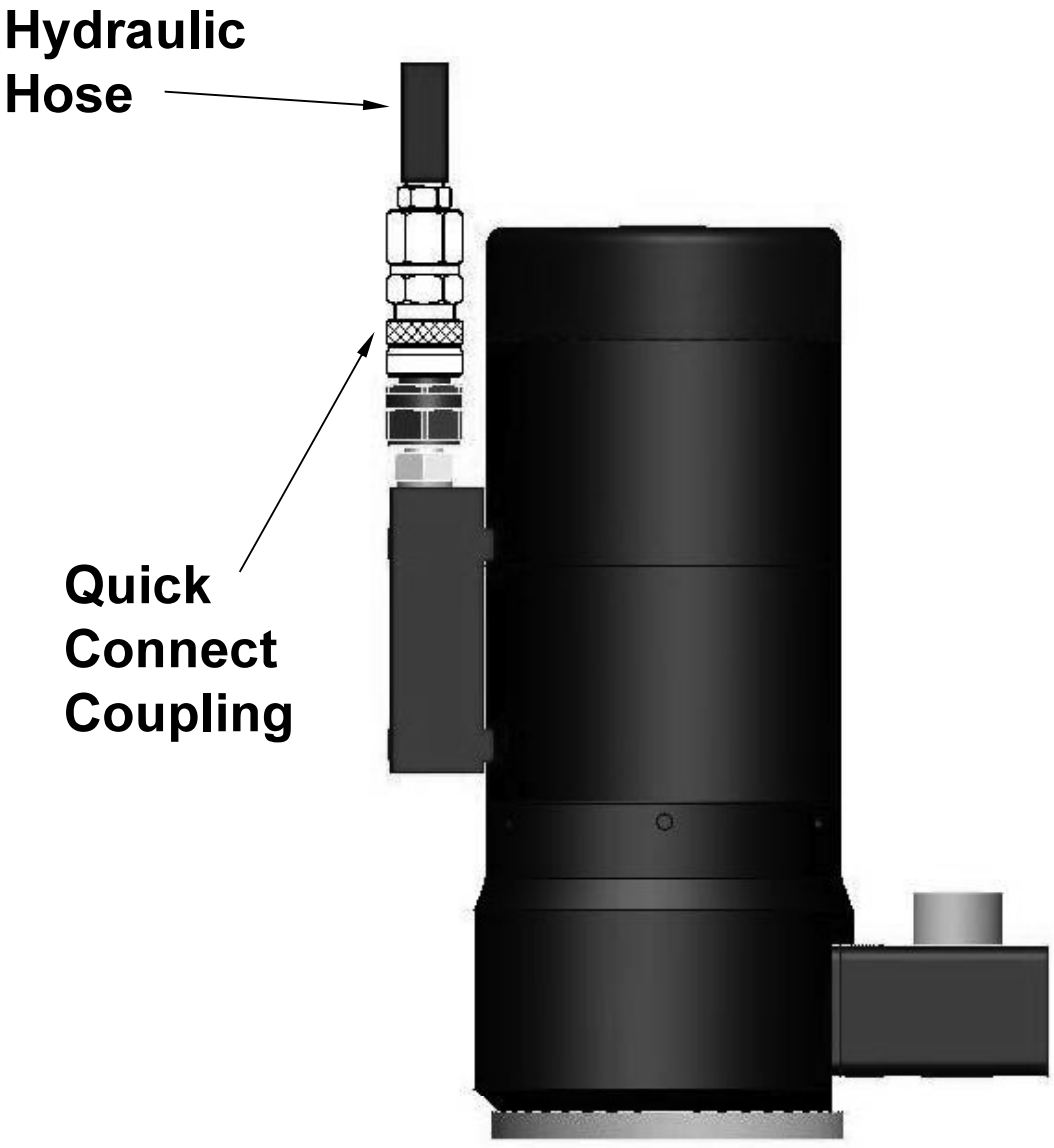
STEP 5 TIGHTENING A BOLT



Connect a SUITABLE high pressure hydraulic hose.

Make sure the quick connect coupling is fully engaged.



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MOST IMPORTANT - HEALTH & SAFETY

The Tensioner is now ready to be pressurised. Before proceeding, operators must familiarise themselves with the Health & Safety Instructions given in this manual, and proceed as follows:-

Clear all personnel from the area where the bolt tensioning operation is to be performed. Position the pump a safe distance away from the bolt tensioners. Set up barriers and warning signs, or make other adequate arrangements to prevent unauthorised personnel from accidentally straying into the bolt tensioning area.

Ensure that nobody is allowed to stand near to a bolt tensioning tool during pressurisation. At no time should anyone allow any part of their body to be positioned over the bolt axis of a bolt tensioner whilst the pressure is rising or when it is pressurised. Do not allow anyone to stand anywhere in or near the axis of a bolt during the tensioning operation.

Do not approach a bolt tensioning tool whilst it is being pressurised. Remember that a damaged bolt or tool is most likely to fail at this critical time. When the operating pressure has been reached, approach a pressurised bolt tensioning tool only for as long as is necessary to rotate the ring nut. Ensure that when rotating the nut you are well outside of the tensioner's vertical axis.

PPE (Personal Protective Equipment) must be worn by all personnel using bolt tensioning tools. SAFETY GLASSES and GLOVES are essential. OVERALLS and a HARD HAT are recommended.

Never leave a pressurised bolt tensioning tool unattended.

Release the oil pressure immediately if any unauthorised person moves into the bolt tensioning area and especially if anyone stands in the axis of a bolt being tensioned.

Determine the correct working pressure for the bolts to be tightened.

Proceed with the following operations keeping the bolt tensioning tools under pressure for the minimum time necessary to complete the bolt tightening operation.

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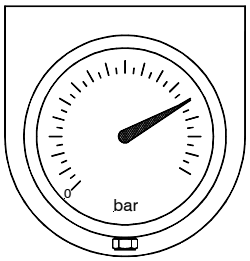
STEP 6 TIGHTENING A BOLT



Apply the correct hydraulic pressure. The tool will begin to stroke and the operator should observe the top of the Puller ascending through the top of the tool.

DO NOT exceed the maximum stroke of 10mm . This is indicated by stroke indicators around the top of the Puller.

DO NOT exceed 1350 bar pressure.



If the stroke indicators show the tensioner has reached maximum stroke before the correct hydraulic pressure has been achieved, proceed as follows :-

Go to Step 7 - Tighten the Nut

Go to Step 8 - Release the Pressure

Go to Step 9 - Retracting the Tensioner

Go to Step 10 - Reengage the tool

Go to Step 6 - Apply the correct Pressure

If necessary repeat this sequence until the bolt tensioning tool reaches the correct oil pressure without reaching the maximum piston stroke.



Do not continue increasing the oil pressure when the bolt tensioning tool has reached maximum stroke. Increasing the pressure achieves no increase in bolt tension because no further elongation can be achieved.

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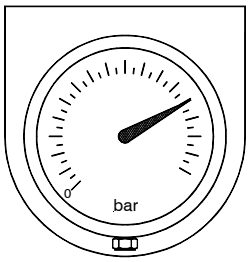
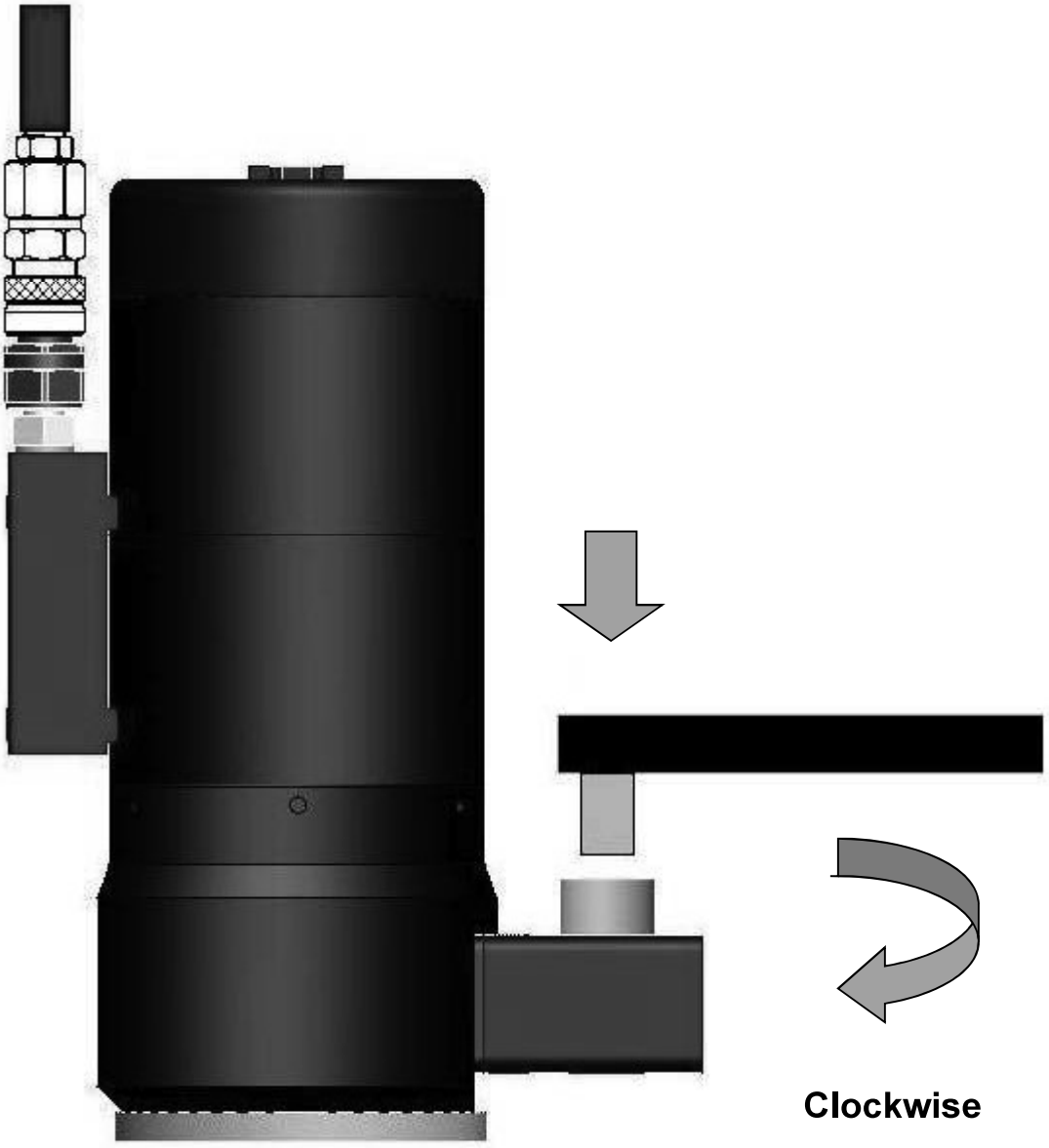
STEP 7 TIGHTENING A BOLT



Use a ½” Drive

Insert the Drive into Drive Socket on the top of the Gearbox.

Rotate the Socket until the Nut is tight.



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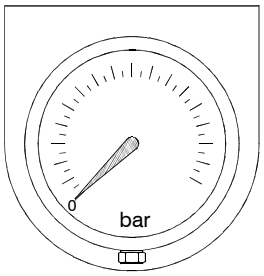
STEP 8 TIGHTENING A BOLT



Slowly release the hydraulic pressure.



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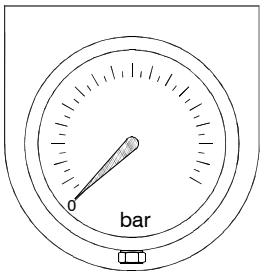
STEP 9 TIGHTENING A BOLT



The spring retract system will now fully retract the tensioning tool.

OPTIONAL - If available, connect a Low Pressure Oil Return Hose. The hose is connected between the tool and the top of the oil reservoir on the air driven pump. This will allow the tool to retract more quickly than if the hydraulic hoses are used.



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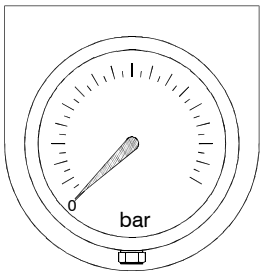
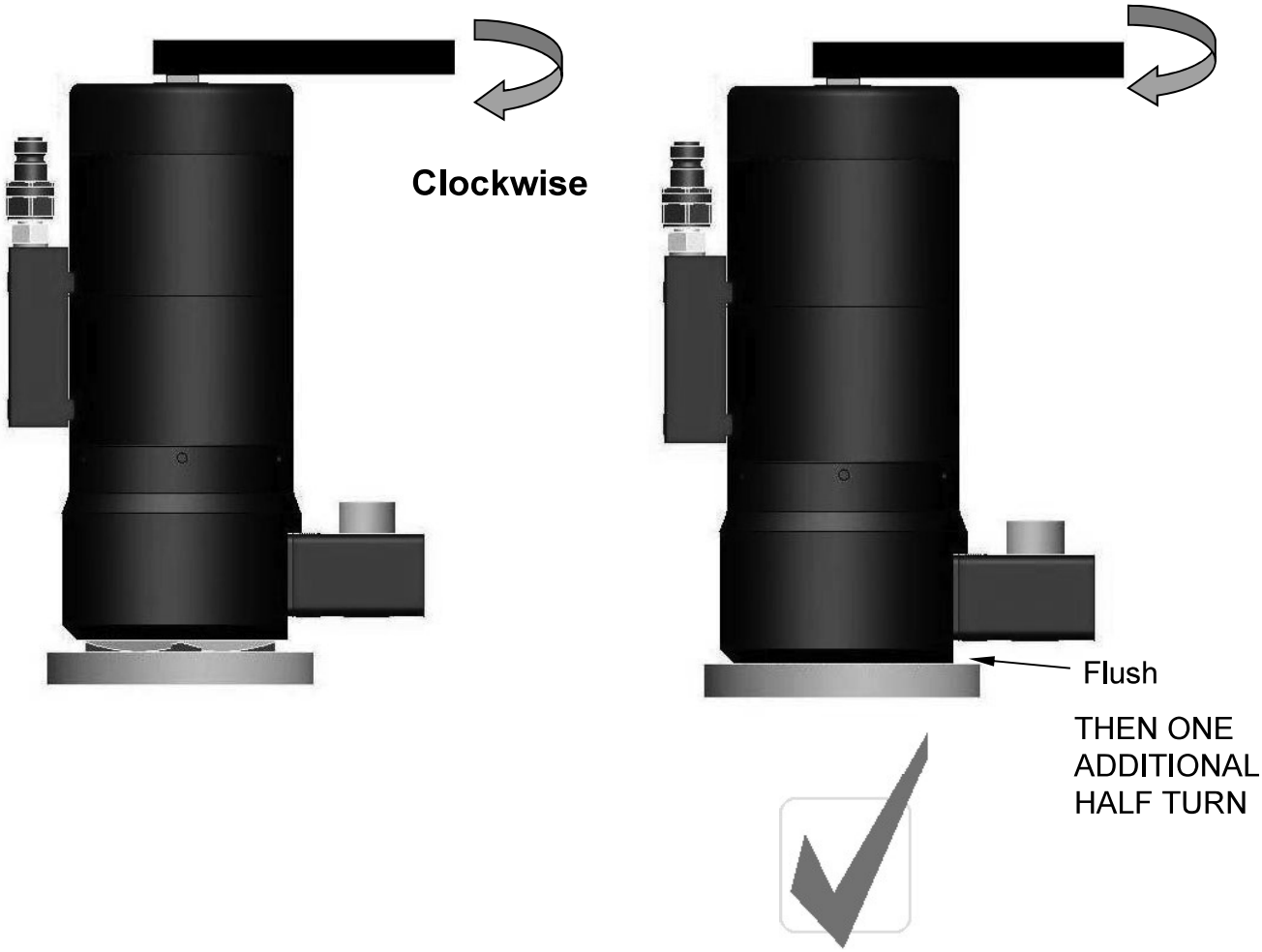
STEP 10 TIGHTENING A BOLT



The Tensioner will have retracted upwards since the bolt will have elongated. The tool will need reengaging onto the flange.

Using the 1/2in Square Drive Socket, reengage the puller onto the stud until the tool is flush with the flange. After the tensioner is flush, continue to turn the puller ONE HALF TURN FURTHER to fully reset the tool.



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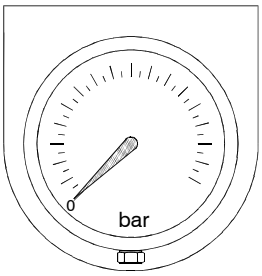
STEP 10 TIGHTENING A BOLT



Reconnect the hydraulic hose.



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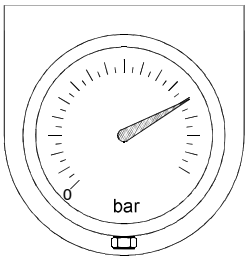
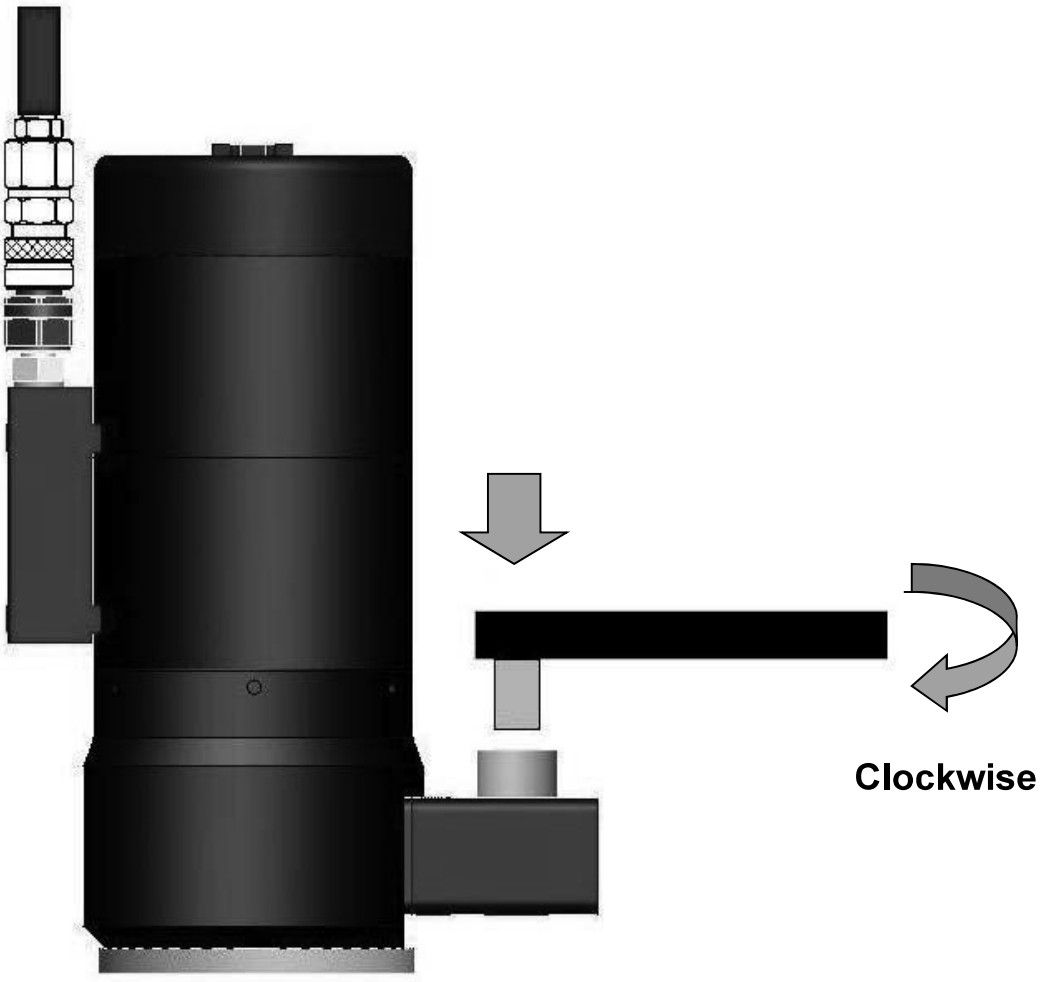
STEP 11 TIGHTENING A BOLT



Apply the correct hydraulic pressure again, and wind the nut again once this is achieved.

DO NOT exceed the maximum stroke of 10 mm. This is indicated by stroke indicators around the top of the Puller

DO NOT exceed 1350 bar pressure.



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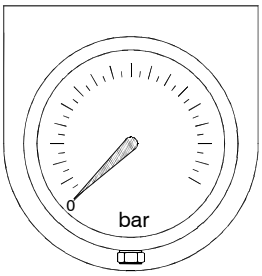
STEP 12 TIGHTENING A BOLT



Slowly release the hydraulic pressure.

If a Low Pressure Oil Return Hose is available, attach it to accelerate retraction following the procedure outlined in Step 9. Otherwise, allow the tool to retract through the hydraulic hose and then remove once the stroke has returned to zero.



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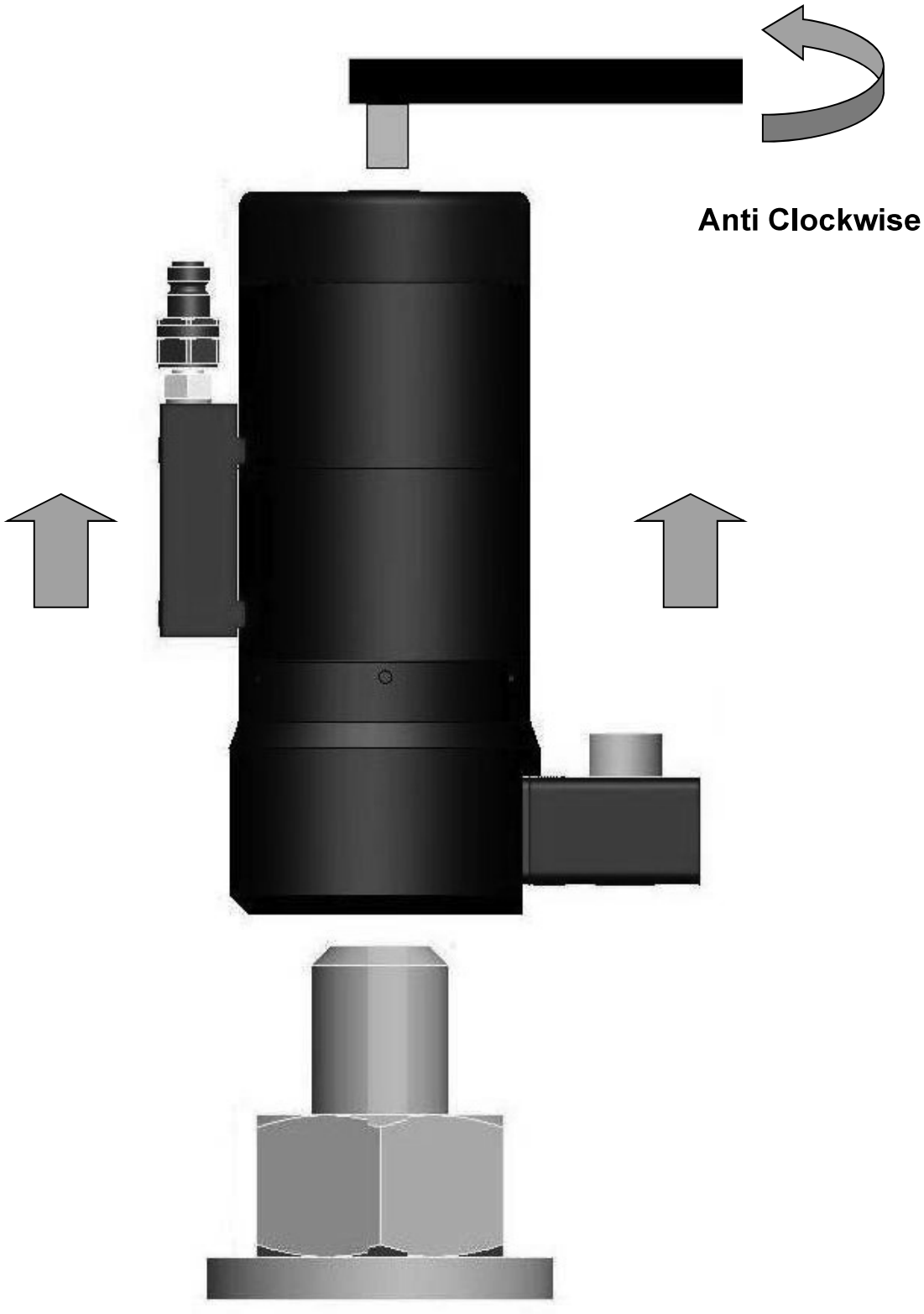
STEP 13 TIGHTENING A BOLT

Remove the Tensioner using the 1/2in Square Drive in the top of the Puller.



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OPERATING INSTRUCTIONS

HOW TO LOOSEN A BOLT

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STEP 1 LOOSENING A BOLT

Before commencing the bolt de-tensioning operation read and comply with all of the Health & Safety Instructions in Section 2. Operators should also be familiar with the 'Important Information' literature in Sections 1 and 5.

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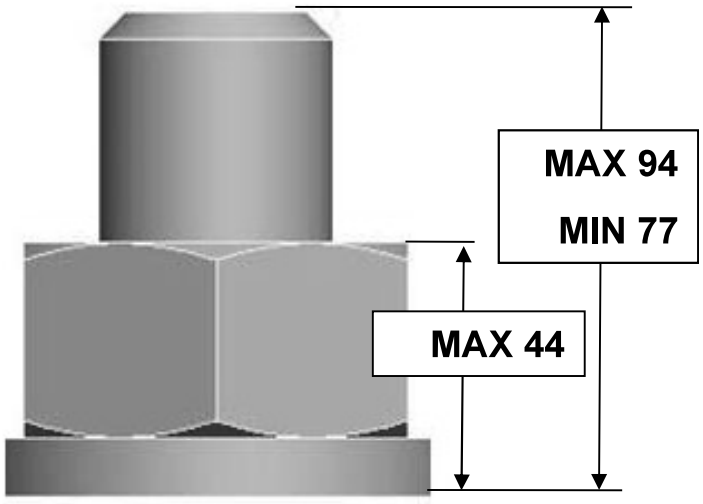
STEP 2 LOOSENING A BOLT



Ensure that there is a minimum of 77 mm of protruding bolt for the Tensioner to engage with.

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STEP 3 LOOSENING A BOLT

Position the Tensioner over the bolt to be tightened. Orient the tensioner so that manifold is accessible, and such that the bridge window allows tommy bar access to the nut.



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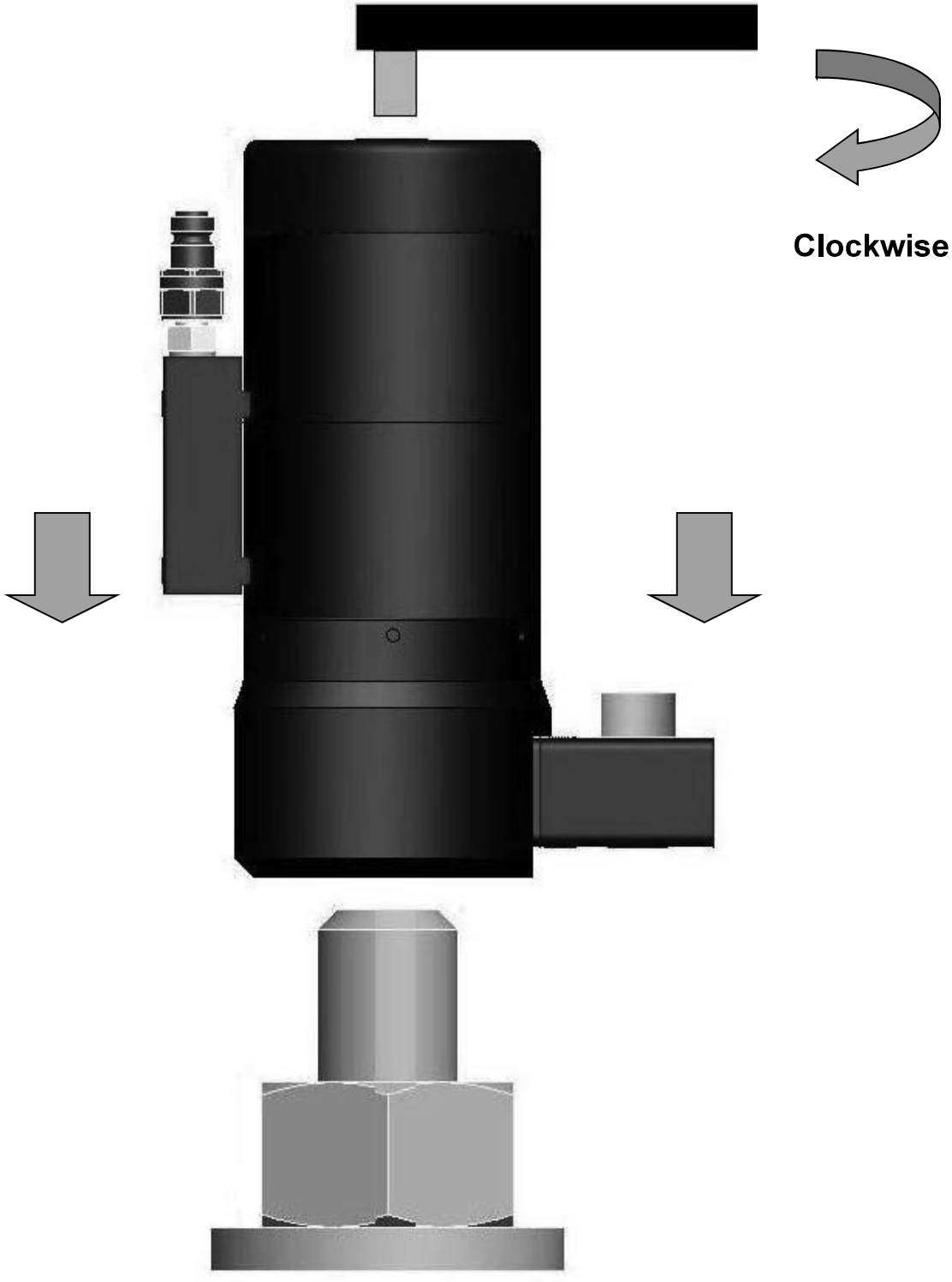
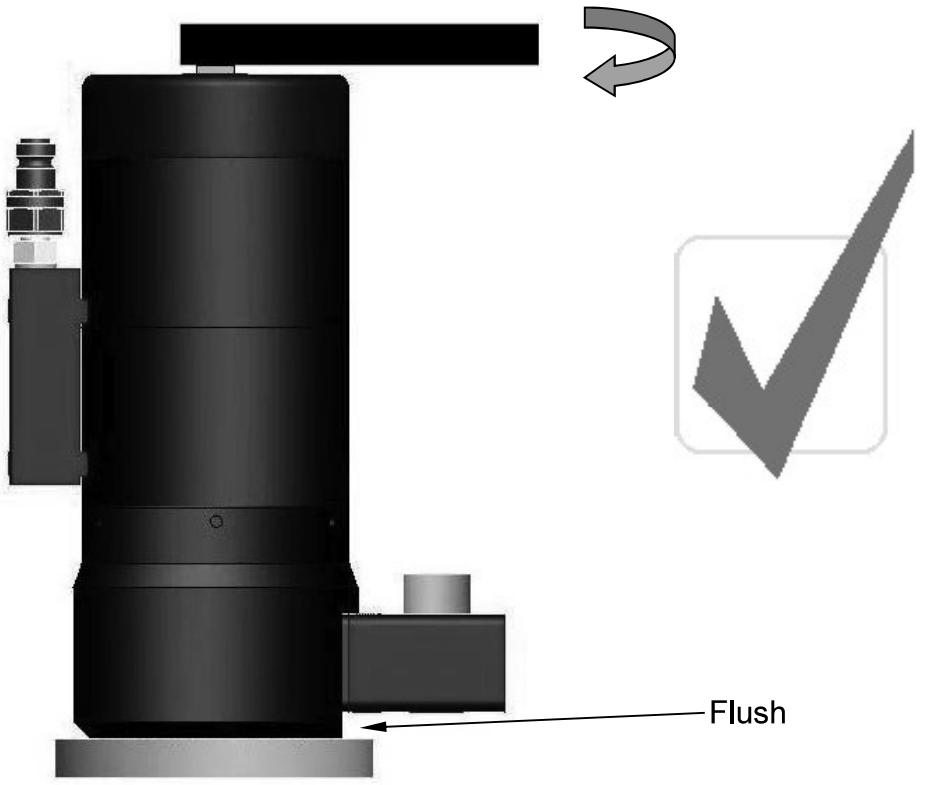
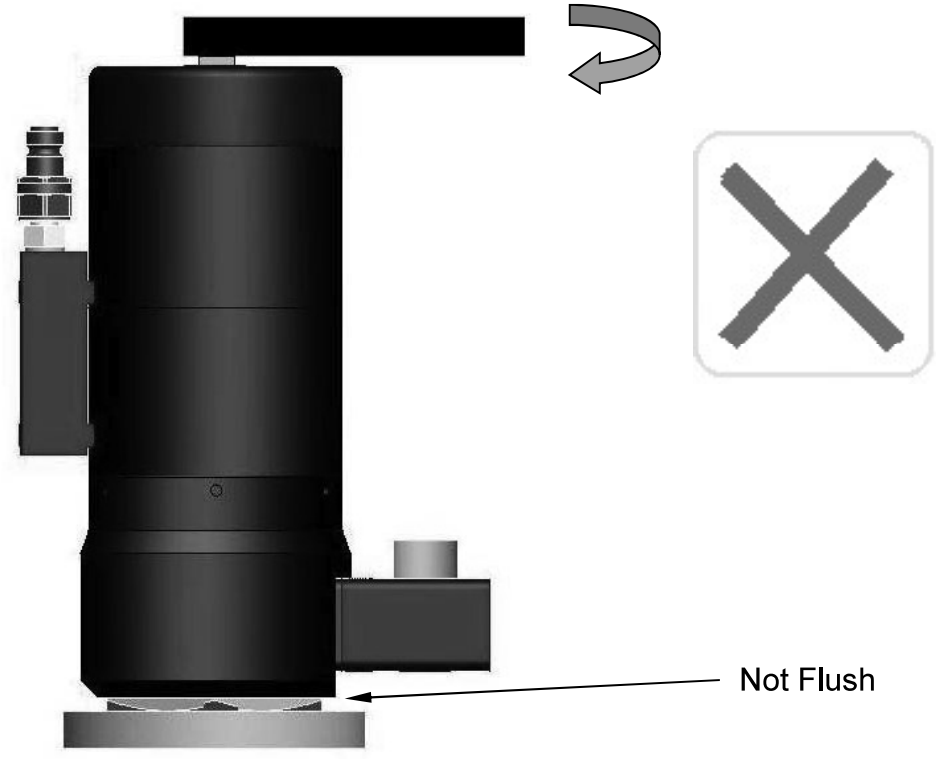
STEP 3 LOOSENING A BOLT

Engage the Puller with the bolt. A 1/2in Square Socket is provided in the top of the Puller Bar so that the Tensioner orientation can be maintained whilst the Puller engages the bolt.



Continue rotating the Puller, increasing its engagement with the bolt until the bridge is flush with the flange. To ensure the tool is fully flush, it may be necessary to rotate the gearbox slightly whilst lowering to fully engage the gear driven socket with the nut.





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STEP 4 LOOSENING A BOLT

Now rotate the Puller ANTI-CLOCKWISE BY HALF A TURN. This is to prevent the Tensioner from locking onto the stud.

Anti Clockwise half a turn



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Once the Tensioner is in situ, it should still be possible to rotate the bridge to a suitable angle to access the bolt if required.



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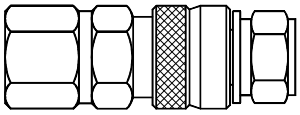
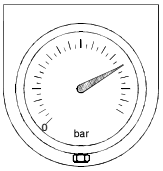
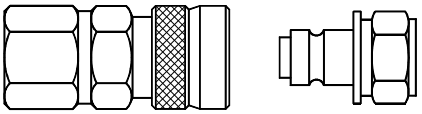
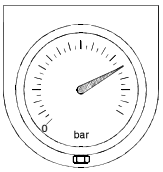
Using Quick Connect Couplings

YOU MUST ENSURE YOUR COUPLINGS ARE COMPATIBLE WITH THE CEJN 116 NIPPLE FEATURED ON THIS TENSIONER!

DO NOT pressurise the connectors when they are disconnected

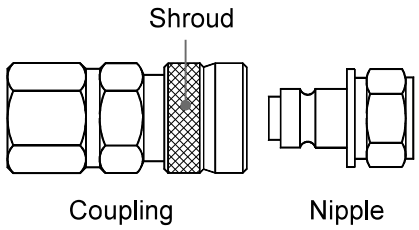
Check there is no pressure in the system before attempting to connect or disconnect the couplings.

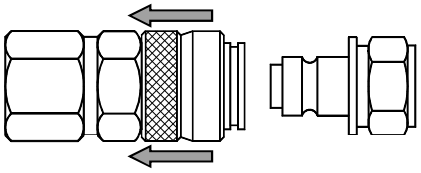


To connect the Quick Connect Coupling and Nipple, first check there is no pressure in the system. Then pull back the shroud by hand and push the coupling onto the nipple. When together, release the shroud which will spring back to lock the Coupling and Nipple together. To disconnect, first check there is no pressure in the system. Pull back the shroud, by hand, and pull the coupling and nipple apart. Release the shroud when apart.



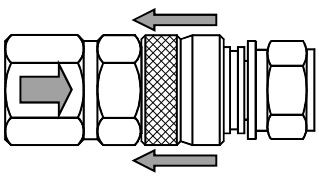
Pull the shroud back to retract





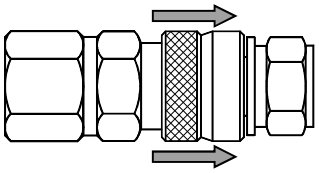
Coupling and Nipple with the shroud retracted





Coupling and nipple pushed together with the shroud still retracted





Shroud released - Coupling and Nipple are now locked together and safe to use.



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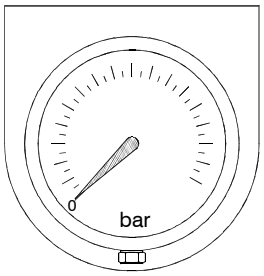
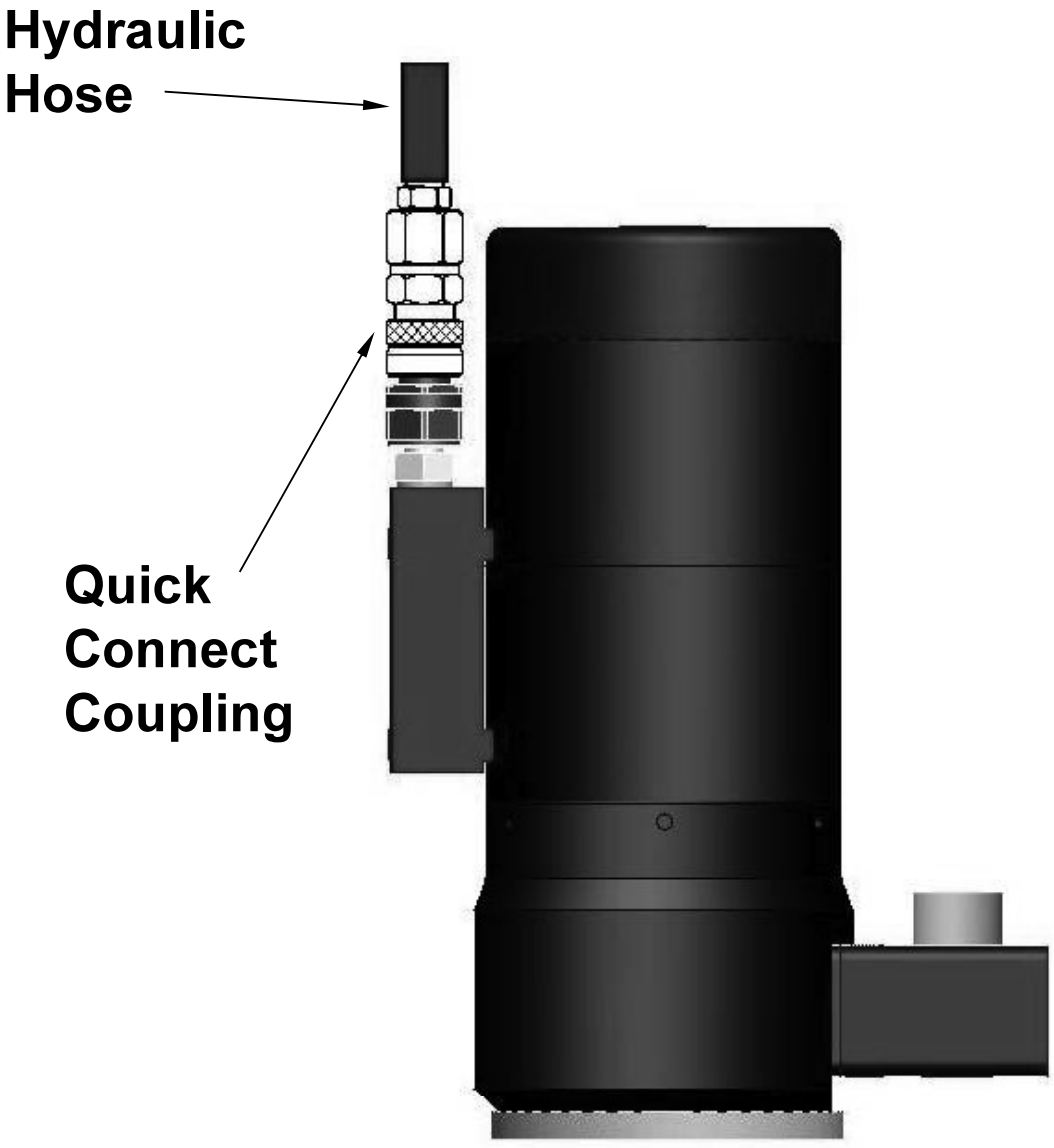
STEP 5 LOOSENING A BOLT



Connect a SUITABLE high pressure hydraulic hose.

Make sure the quick connect coupling is fully engaged.



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MOST IMPORTANT - HEALTH & SAFETY

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Determine the correct working pressure for the bolts to be tightened.

Proceed with the following operations keeping the bolt tensioning tools under pressure for the minimum time necessary to complete the bolt tightening operation.

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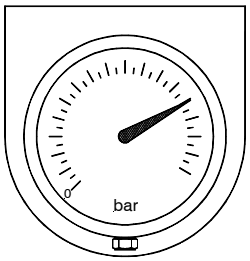
STEP 6 LOOSENING A BOLT



Apply the correct hydraulic pressure. The tool will begin to stroke and the operator should observe the top of the Puller ascending through the top of the tool.

DO NOT exceed the maximum stroke of 10mm. This is indicated by stroke indicators around the top of the Puller.

DO NOT exceed 1350 bar pressure.



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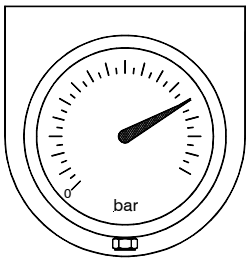
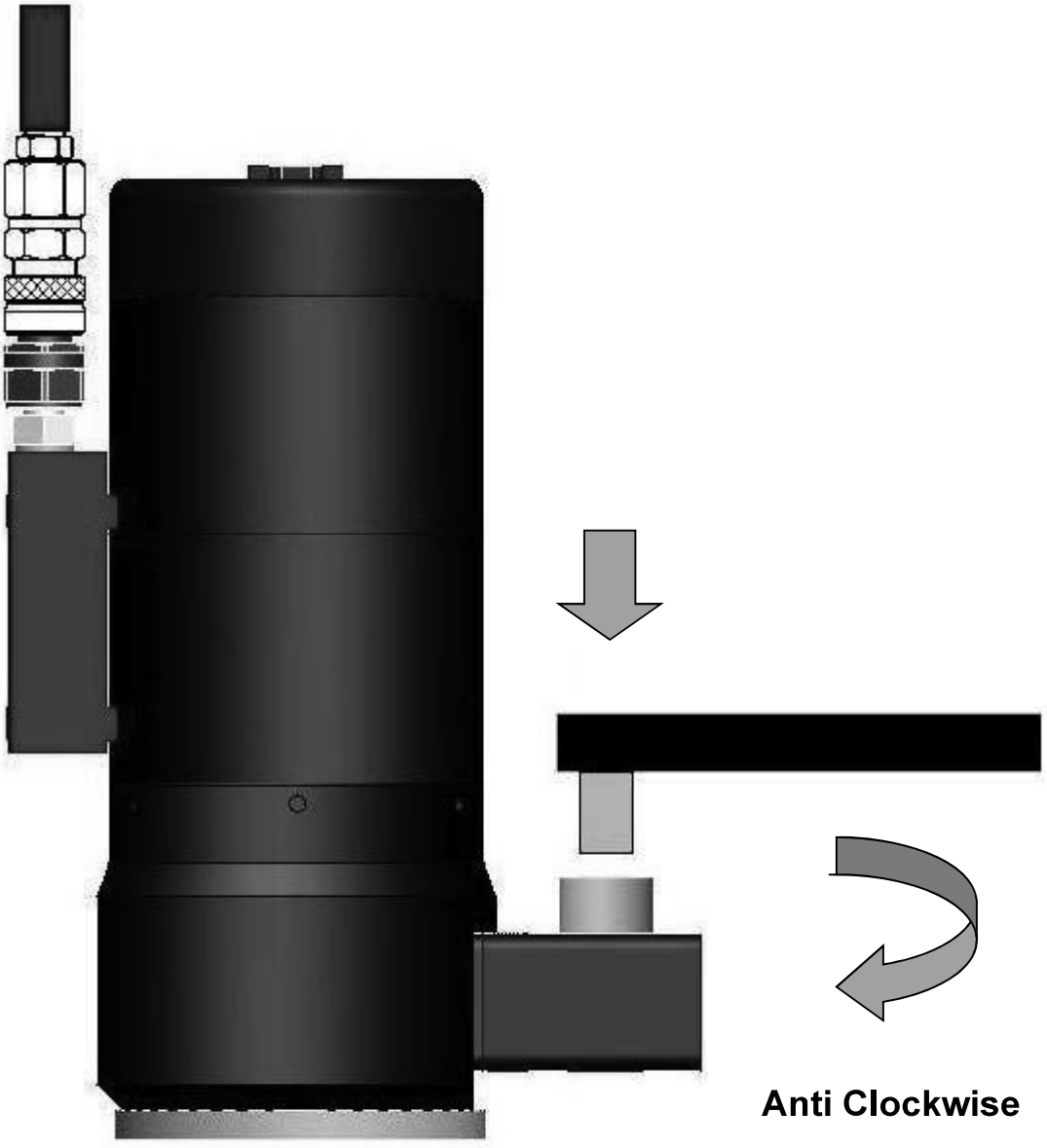
STEP 7 LOOSENING A BOLT



Use a ½" Drive

Insert the Drive into Drive Socket on the top of the Gearbox.

Rotate the Socket until the Nut is loose and clear of the flange.



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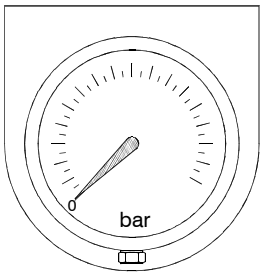
STEP 8 LOOSENING A BOLT



Slowly release the hydraulic pressure.



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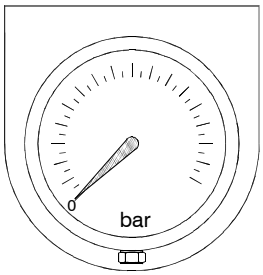
STEP 9 LOOSENING A BOLT



The spring retract system will now fully retract the tensioning tool.

OPTIONAL - If available, connect a Low Pressure Oil Return Hose. The hose is connected between the tool and the top of the oil reservoir on the air driven pump. This will allow the tool to retract more quickly than if the hydraulic hoses are used.



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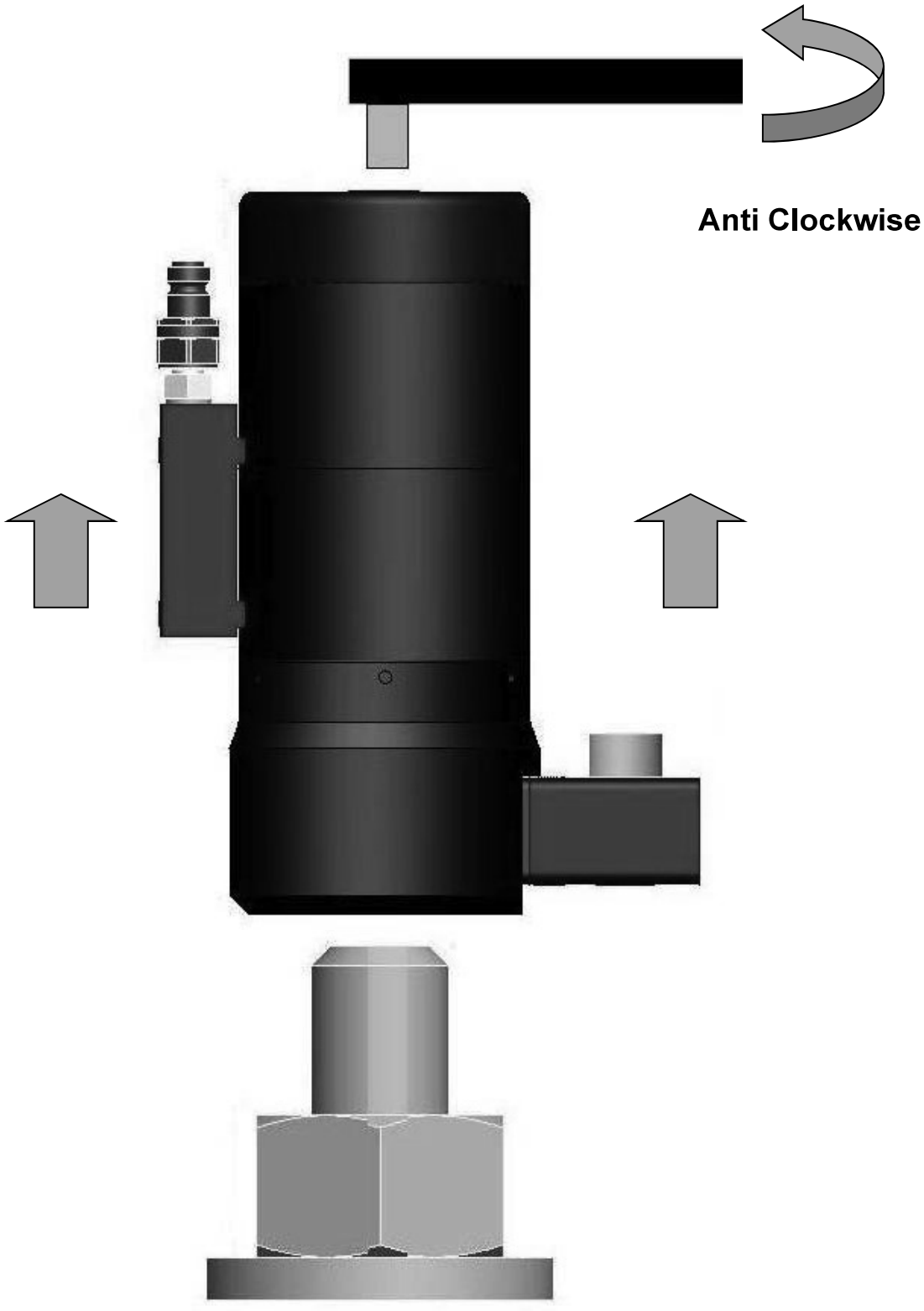
STEP 10 LOOSENING A BOLT

Remove the Tensioner using the 1/2in Square Drive in the top of the Puller.



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SECTION 4

MAINTENANCE AND STORAGE

General Information Page 2

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MAINTENACE AND STORAGE

General Information

A hydraulic bolt tensioning tool will provide many years of trouble free service if used, maintained and stored correctly.

Storage

Your tools were chemically blacked before leaving the factory. This provides a degree of corrosion protection but additional protection should be applied when the tools are to be stored for any period of time. It is recommended that, before storage, the tools should be checked for damage and if OK, lightly oiled.

Prior to storage, the tensioner must be retracted to zero stroke and the hydraulic connection must have its plastic protective cap fitted. The hydraulic bolt tensioner should be stored upright in a clean, dry environment. The tensioners were delivered in wooden cases and these can be used to store the tools.

Maintenance

Very little maintenance is required for a bolt tensioning tool. The only items which may require changing will be the seals and the quick connect fittings. However, the seals have a very long life and are not expected to require attention during the life of the bolt tensioning tool. If the seals fail to hold pressure it may be necessary to change them, however owing to the complexity of the tensioner it is not recommended that the tools are dismantled and any maintenance performed by the customer.

Boltight recommend that tools are periodically returned for factory refurbishment. Please contact us for details.

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SECTION 5
PRESSURE LOAD DATA FOR TTM-M036-49-00

Graph – Oil Pressure vs. Applied Load Page 2

Technical Information Page 3

Important Information Page 4

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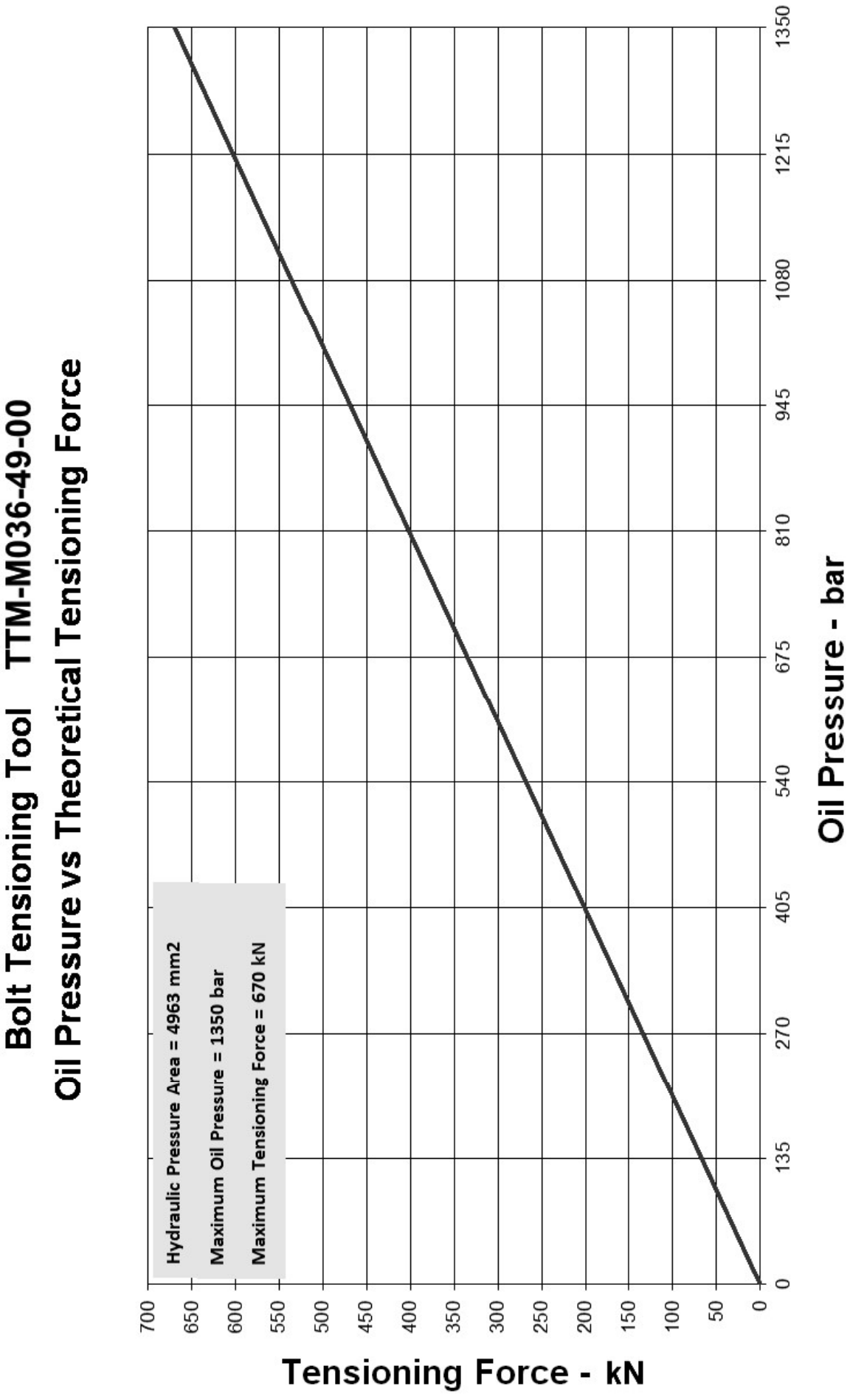

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Tool Specification

M36 x 4

Tool No	**TTM-M036-49-00**	
Thread Size	**M36 x 4**	
Tensioner Outer Diameter	**82.5 mm**	**(3.25 in)**
Bridge Outer Diameter	**90 mm**	**(3.54 in)**
Tensioner Height	**237.5 mm**	**(9.35 in)**
Hydraulic Pressure Area	**4963 mm^2**	**(7.69 in^2)**
Maximum Pressure	**1350 bar**	**(19580 psi)**
Maximum Load @ 1350 bar	**670 kN**	**(151 klbf)**
Maximum Stroke	**10 mm**	**(0.394 in)**
Tensioner Weight	**9.0 kg**	**(19.8 lb)**
Maximum Pressure Cycles	**6,000**	



TYPHOON

M36 x 4 Multi-Stage Typhoon Tensioner

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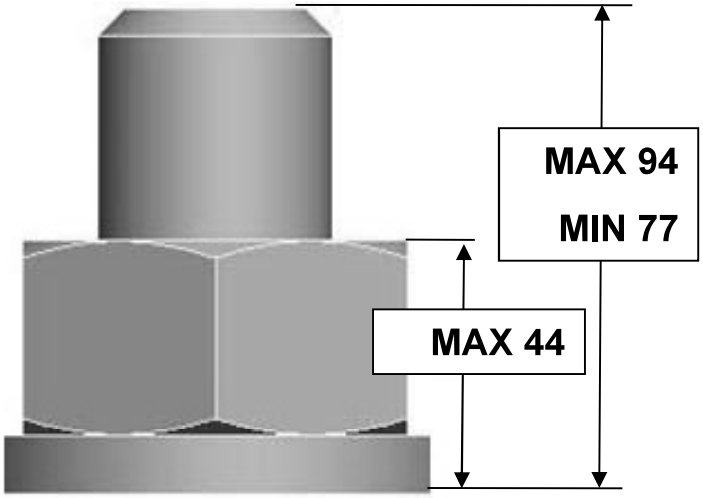
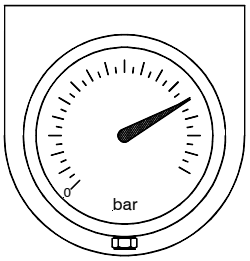
IMPORTANT INFORMATION

1. ONLY EVER USE THE TOOL WHERE THE STUD PROTRUSION IS BETWEEN 77 AND 94mm, AND WHERE THE COMBINED NUT AND WASHER HEIGHT IS NO GREATER THAN 44mm. THE WASHER SHOULD BE LESS THAN 67mm ON DIAMETER.



2. NEVER PRESSURISE THE TOOL BEYOND ITS MAXIMUM WORKING PRESSURE OF 1350 bar (19580 psi).



> 1350 bar



3. DO NOT EXCEED THE MAXIMUM STROKE OF 10mm. EVEN THOUGH THE TOOL FEATURES AN ANTI-OVERSTROKE FACILITY, THE OPERATOR SHOULD NEVER INTENTIONALLY OVERSTROKE THE TOOL.

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SECTION 6

AIR DRIVEN PUMP OPERATING INSTRUCTIONS

Introduction	Page 2
Health and Safety	Page 4
Main Components	Page 5
How the Pump works	Page 12
Setting up the Pump	Page 14
Setting the Stall Pressure	Page 17
Operating the Pump	Page 23

The pictures in this manual show a green coloured, 1000 bar working pressure, pump but the instructions apply equally to the 1500 bar and 2500 bar models.

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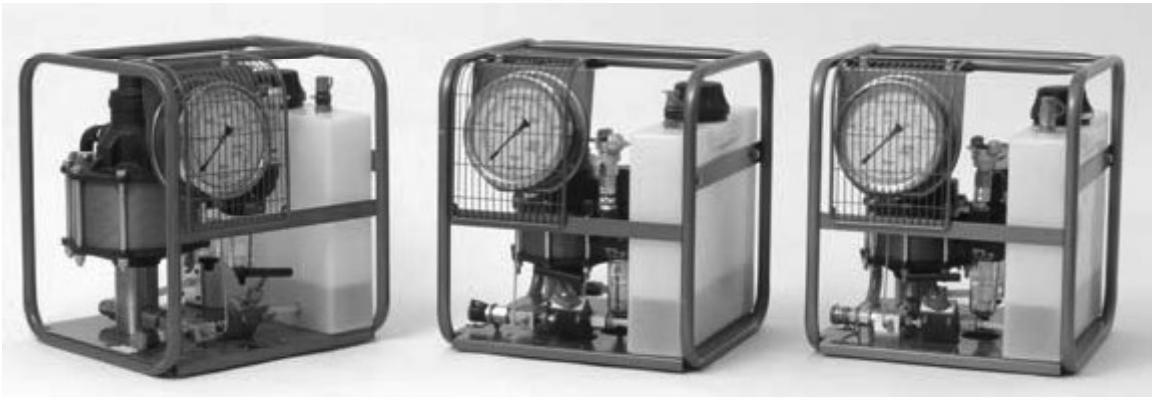
Introduction

All BOLTIGHT air driven pumps are mounted in a compact tubular steel carrying frame complete with air filter, air pressure gauge, air pressure regulator, air lubricator, air on/off valve, air pressure limit valve, 8.5 litre oil reservoir, oil pressure release valve, 150 mm dual scale oil pressure gauge with damping, pressure gauge guard and oil pressure outlet via a self sealing quick connect coupling.



RED 2500 bar BLUE 1500 bar GREEN 1000 bar

The frame is painted to correspond with the hydraulic hoses and the maximum operating pressure rating. GREEN for 1000 bar operating pressure, BLUE for 1500 bar operating pressure and RED for 2500 bar operating pressure. BOLTIGHT has a range of standard pumps, two for 1000 bar systems, two for 1500 bar systems and three for 2500 bar systems. Others designed to meet specific customer requirements are also available. The main components of the pump unit are shown in the following diagrams. The method of operation is the same for all the air driven pumps. The pictures in this manual show a green 1000 bar pump but the instructions apply to all of the models.



1000 bar pump hoses and bolt tensioning tools

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1500 bar pump hoses and fittings



2500 bar pump and hoses

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THINK SAFETY

HEALTH & SAFETY INSTRUCTIONS

The air driven pump supplied by BOLTIGHT has been designed to give a long and safe working environment for developing high hydraulic pressures for operating BOLTIGHT hydraulic bolt tensioning tools and equipment when used as instructed in this manual.

The main Health & Safety considerations when using this air driven pump relate to :-

A) The connection disconnection and use of the compressed air supply to the pump.
B) The setting of the air pressure limit valve.
C) The correct setting of the stall pressure
D) The correct connection of the hoses and other equipment to be pressurised by the pump.

A) AIR SUPPLY

Precautions should be taken when connecting and disconnecting the compressed air supply to and from the pump.

Before connecting the compressed air make sure the pump ON/OFF control valve is turned off and the return to tank valve is fully open. Check the compressed air supply pressure does not exceed 7 bar.

When disconnecting the compressed air supply, first open the return to tank valve, and close the pump ON/OFF control valve. Turn off the compressed air at the point of supply. Open the pump ON/OFF valve to release the air pressure in the pump and the pipe-work connecting the pump to the supply point. The air pipeline connection at the pump can then be safely disconnected.

Observe all the normal Health & Safety rules associated with the use of compressed air.

B) SETTING THE AIR PRESSURE LIMIT VALVE.

The air pressure limit valve is factory pre-set. BOLTIGHT does not recommend users to change the setting. Instead the user should learn to correctly set the pump stall pressure, as described later in this instruction manual. Setting the pump stall pressure will prevent the pump from operating at a pressure in excess of the recommended pressure for the equipment attached to the pump.

The air pressure limit valve prevents the pump from developing pressures above the safe limits for other components within the pump unit.



DO NOT CHANGE THE SETTING OF THE AIR PRESSURE LIMIT VALVE TO INCREASE THE PRESSURE DEVELOPED BY THE PUMP.

C) SETTING THE PUMP STALL PRESSURE

The procedure for setting the pump stall pressure is described later in this manual.

Always follow the procedure to set the pump to stall either at the maximum working pressure marked on the side of the equipment to be connected to the pump or the lower pressure at which you want the equipment to operate . Following the procedure will ensure the equipment connected to the pump is never accidentally over-pressurised.



DO NOT PRESSURISE BOLTIGHT HYDRAULIC TOOLS ABOVE THE MAXIMUM WORKING PRESSURE MARKED ON THE SIDE OF THE CYLINDER OR ON THE TOP OF THE PULLER

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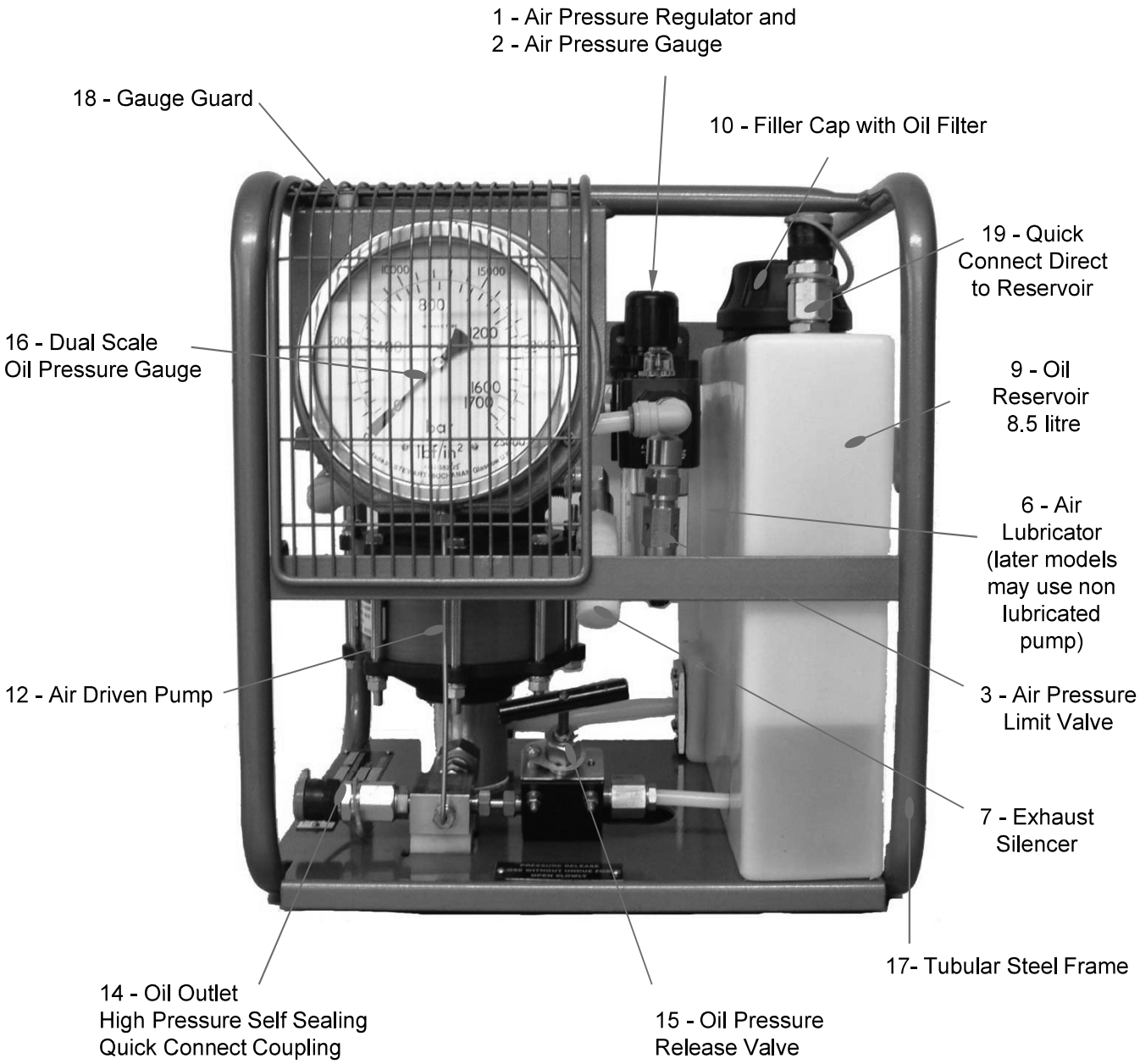
Main Components



Front View

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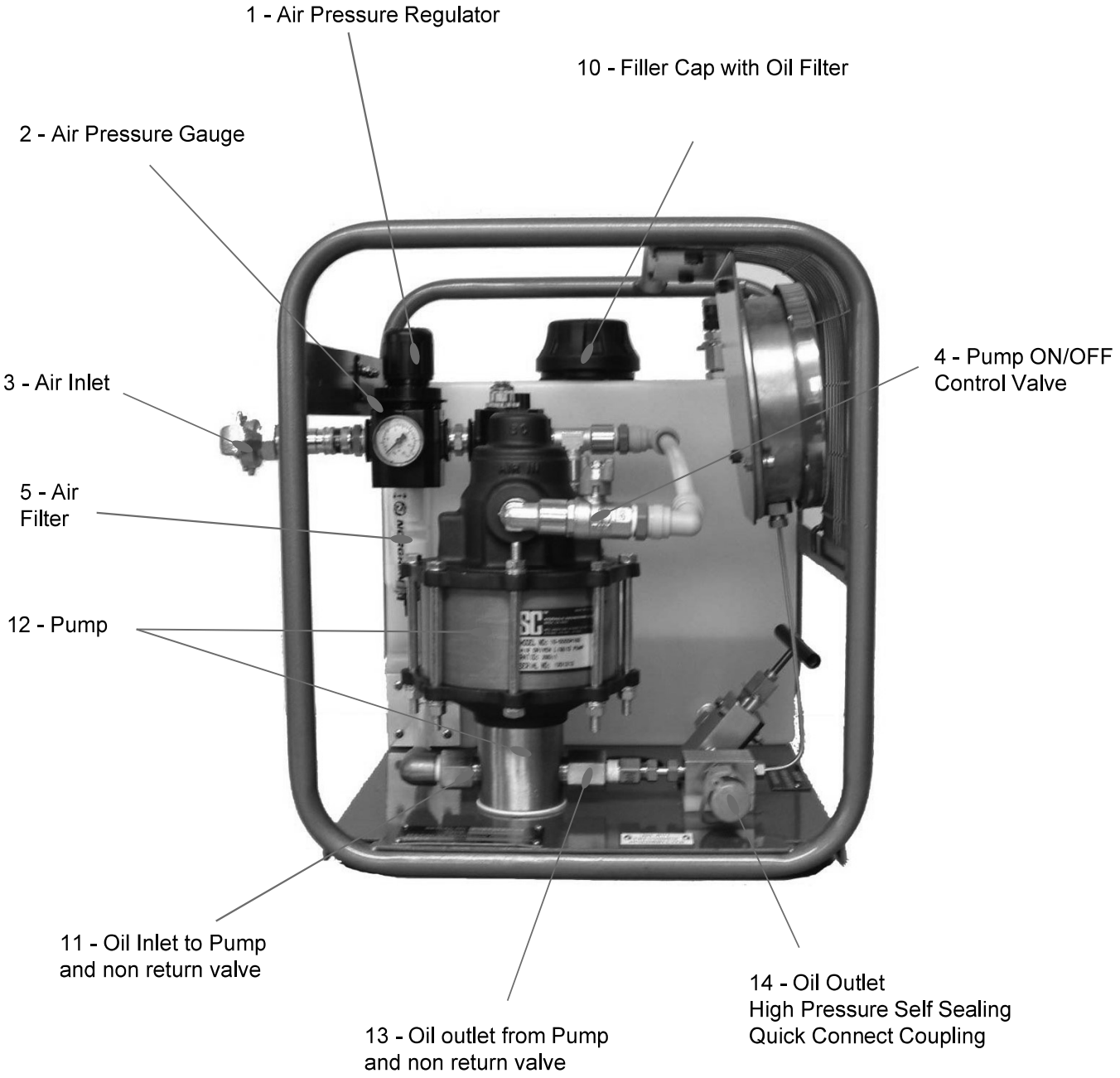
Main Components



Side View

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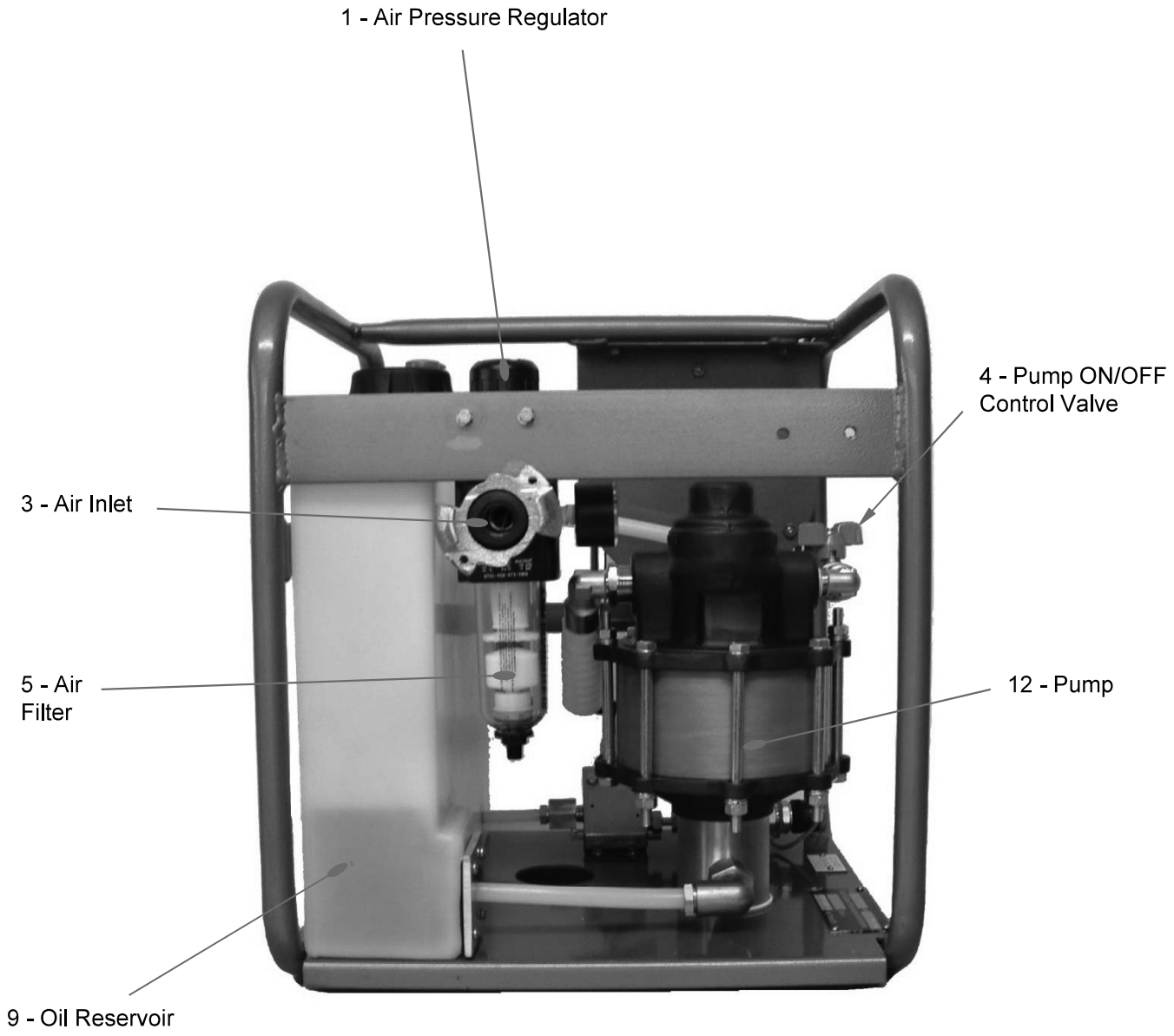
Main Components



Rear View

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Main Components

The numbers in brackets refer to the Front, Side and Rear Views.



1 - Air Pressure Regulator

The air pressure regulator controls the air pressure applied to the pump. To avoid accidental adjustment the cap has a locking mechanism. To unlock pull the cap upwards. To lock, push the cap down. When pulled up, rotate the plastic cap anti-clockwise to reduce pressure, and clockwise to increase air pressure. The controlled air pressure is displayed on the air pressure gauge (2). The controlled air pressure is limited by an air pressure limit valve (3).



2 - Air Pressure Gauge

Displays the controlled air pressure applied to the pump.



3 - Air Pressure Limit Valve

Limits the maximum air pressure applied to the pump and therefore limits the maximum oil pressure the pump can develop.



4 - Pump ON / OFF Valve

Starts and stops the pump by turning the controlled air ON or OFF. The picture on the right shows the valve in the OFF position. Turn through 90 degrees to turn fully ON and run the pump at maximum speed. The pump can be run slowly by partially opening this valve.



5 - Air Filter

The air filter is combined with the air pressure regulator (1). The filter bowl is beneath the air pressure regulator control cap. The filter removes dirt and water from the air supply. A drain valve at the base of the filter bowl can be opened to allow water to escape. When used with a wet air supply, the drain valve should be left open, just enough, to ensure the continual removal of all water entering the filter. The drain valve can remain closed when the air supply is always dry.

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Main Components

6 - Air Lubricator

Provides oil mist lubrication for the pump. This is factory pre-set and should not need attention. The lubricator bowl is pre-filled with oil and should last a very long time. Later models use a new lubrication free air motor.



7 - Exhaust Silencer

When air has passed through the pump it exits the exhaust port of the pump through a plastic silencer. The silencer should require no maintenance.



8 - Air Inlet

The air inlet is through an industry standard bayonet connector. The connector can be easily unscrewed and changed if it does not match the fittings in use at the customers premises.



9 - Oil Reservoir

A large 8.5 litre plastic oil reservoir is provided. Oil is gravity fed to the pump from the base of the reservoir through a fine filter which should not require maintenance. Oil returns to the reservoir from the Oil Pressure Release Valve (15). A quick disconnect nipple is provided on the top of the reservoir. This is used if it becomes necessary to fill or bleed any of the hydraulic hoses.



10 - Filler Cap with Oil Filter

A large black plastic filler cap is removed by turning anti-clockwise and replaced by turning clockwise. Immediately beneath the filler cap, in the mouth of the reservoir, is a course oil filter. This can be easily lifted out for cleaning. The oil filter must be in place when filling the reservoir.



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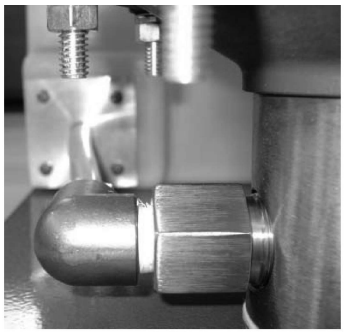
Main Components

11 - Oil Inlet to Pump and Non Return Valve

Oil enters the pump from the reservoir through a spring loaded Non Return Valve. This valve should not require attention. If problems arise with any of the non return valves it is best to return the pump to BOLTIGHT for service. Overseas customers may have a local SC pump distributor who can carry out maintenance on these parts.



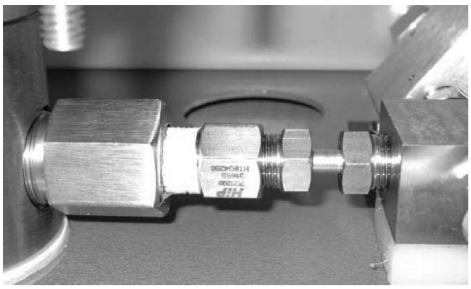
12 - Pump

The pump is manufactured by SC Hydraulic Engineering Corporation and is very robust and reliable. If used as directed the pump should not require maintenance for many years. If problems arise with the pump itself it is best to return the complete package to BOLTIGHT for service. Overseas customers may have a local SC pump distributor who can carry out maintenance on the pump.



13 - Oil Outlet and Non Return Valve

Oil leaves the pump under pressure through a spring loaded non return valve. This valve should not require attention. If problems arise with any of the non return valves it is best to return the pump to BOLTIGHT for service. Overseas customers may have a local SC pump distributor who can carry out maintenance on these parts.



14 - Oil Outlet - High Pressure Self Sealing Quick Connect Coupling

From the pump and non return valve, high pressure oil enters a 4 way distribution block. (one inlet and three outlets). One outlet feeds the oil pressure gauge(2). Another outlet goes directly to the Oil Pressure Release Valve (15). The final outlet is fitted with a self sealing quick connect coupling to which the hydraulic hose feeding the bolt tensioning tools must be connected. The coupling has a plastic dust cover which should be replaced when the pump is not in use. The pump should not be pressurised when the coupling is disconnected. A blank Quick Connect Nipple must be fitted to the coupling if the pump is to be pressurised.



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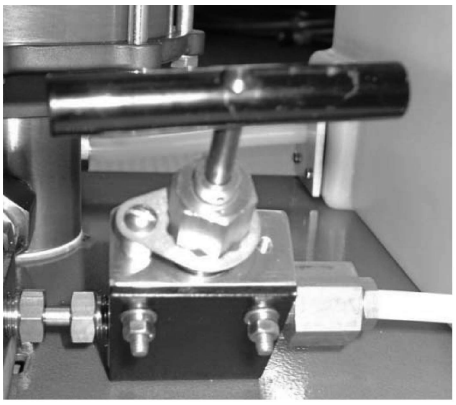
Main Components

15 - Oil Pressure Release Valve



This high pressure valve should be treated with care. It is opened by turning the T shaped handle anti-clockwise. It is closed by turning the handle clockwise. The pump cannot generate any pressure when the valve is open as oil is free to circulate to the Oil Reservoir (9). When closing the valve care must be taken. Excess tightening will damage the high pressure valve seat. Care is also needed when opening the valve under pressure. Open slowly allowing the pressure to fall gently.

16 - Oil Pressure Gauge



All pump units are fitted with damped pressure gauges. The 1000 bar systems use a gauge calibrated to 1700 bar, the 1500 bar systems use a 2000 bar gauge and the 2500 bar systems use a gauge calibrated to 3000 bar. The reciprocating pump causes pressure pulses which are damped by the gauge to display a steadily rising or falling indication during pump operation.

17 - Tubular Steel Frame



All of the pump components are mounted in an easily transported, fabricated steel tube, carrying frame. The frame is painted GREEN for 1000 bar systems, BLUE for 1500 bar systems and RED for 2500 bar systems. The colours match the colour of the flexible hoses for these systems. Only use GREEN hoses with a pump painted GREEN, BLUE hoses with a pump painted BLUE and RED hoses with a pump painted RED. Do not mix the hoses and pumps.

18 - Gauge Guard

A metal grille is provided to protect the glass face of the pressure gauge.

19 - Quick Connect Direct to Reservoir



A quick connect nipple is provided directly onto the top of the Oil Reservoir. This can be used to bleed air from hoses and Ring Mains by connecting one end to the pump outlet and the other to this connector. The connector can also be used to by - pass the Oil Pressure Release Valve during the bolt tensioner piston return operation. The hose is simply removed from the outlet and connected directly onto the tank. The bolt tensioner pistons will then be much easier to return. A Low Pressure Oil Return System is also available. In operation it is attached to this quick connector.

How the Pump Works.

The air driven pump unit is a reciprocating pump / intensifier. A large diameter piston reciprocates under air pressure of 4 bar to 6 bar and is attached to a much smaller diameter piston which generates oil pressures between 1000 bar, 1500 bar and 2500 bar depending on the model of pump.

An air flow and oil flow chart on the next page shows the movement of both air and oil through the air driven pump unit.

Air Side

Air enters the pump through the bayonet air inlet (8), and passes immediately to the air filter (5) and air pressure regulator (1). The air pressure regulator controls the pressure from the air inlet which is allowed to act on the air piston of the pump. Increasing the air pressure on the air piston will increase the oil pressure generated at the oil piston. The air pressure at the air piston is indicated on the air pressure gauge (2). From the air pressure gauge the air passes through an oil mist air lubricator (6) which provides a small amount of lubrication for the air piston seals. Later models may use a lubrication free air motor. Air then passes an air pressure limit valve (3). This valve is spring loaded and has been factory set to limit the air pressure which can be applied to the piston. From the air pressure limit valve the air passes to the air piston via the pump ON / OFF Control Valve (4). Fully opening this valve allows the pump to run at full speed. This valve can be used to throttle the air passing to the air piston causing the pump to run more slowly. The air arriving at the air piston forces it down generating oil pressure on the oil side of the pump. At the end of its downward power stroke a series of valves and springs causes the piston to return to the top of its cylinder ready for the next power stroke. During the return stroke the used air is released to the atmosphere through an exhaust silencer.

Oil Side

Oil enters the oil reservoir through the filler cap (10), passing immediately through a course oil filter. Oil is retained in the oil reservoir (9). Gravity causes the oil to pass through a fine filter at the base of the reservoir before arriving at the oil pump inlet. As the air and oil piston assembly rises, oil is drawn into the oil cylinder through an oil inlet non return valve (11). When the piston falls under the power stroke the oil is compressed and forced out of the oil cylinder through the oil outlet non return valve (14). The oil enters a high pressure distribution block where its return to the reservoir is blocked by the oil pressure release valve (15), when closed. If the oil pressure release valve (15) is open, oil is simply recycled to the reservoir (9). As long as the pump ON/OFF Control valve (4) remains open the pump will run sending oil around the oil circuit and back to the reservoir (9) but never achieving any increase in oil pressure. As soon as the oil pressure release valve (15) is closed the oil cannot return to the reservoir and oil pressure will be developed in the high pressure distribution block. The high pressure distribution block feeds oil pressure to the oil pressure gauge (16) which indicates the pressure generated. The oil pressure gauge (16) is damped to ensure a steady reading during the pressure pulses generated by the reciprocation of the pump(12). Oil passes from the pump unit through the oil outlet high pressure self sealing quick disconnect coupling (14). The bolt tensioning equipment is connected to this coupling. Oil passes to the bolt tensioning tools and the pressure generated by the pump acts on all of the tools simultaneously. The pressure generated is indicated on the oil pressure gauge (16) at all times.

Pump Stall

When the pump is working and generating an increasing oil pressure the pump will eventually begin to slow down until a stall situation arises. At this point the pump will stop and the oil pressure will be maintained. If the oil pressure starts to fall, for any reason, the pump will restart until the stall pressure has been achieved again. This stall will happen when the force on the air piston equals the force on the oil side of the piston. The stall oil pressure is effectively set by the air pressure regulator (1). A higher air pressure will result in a higher oil pressure stall and a lower air pressure will result in a lower oil pressure stall. This phenomenon of stall allows the operator to pre-set the pump to achieve a desired oil outlet pressure which cannot be exceeded. The air pressure limit valve (3) has been factory set to limit the maximum air pressure which can be applied to the pump and hence the maximum oil pressure the pump can generate.

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How the Pump Works.

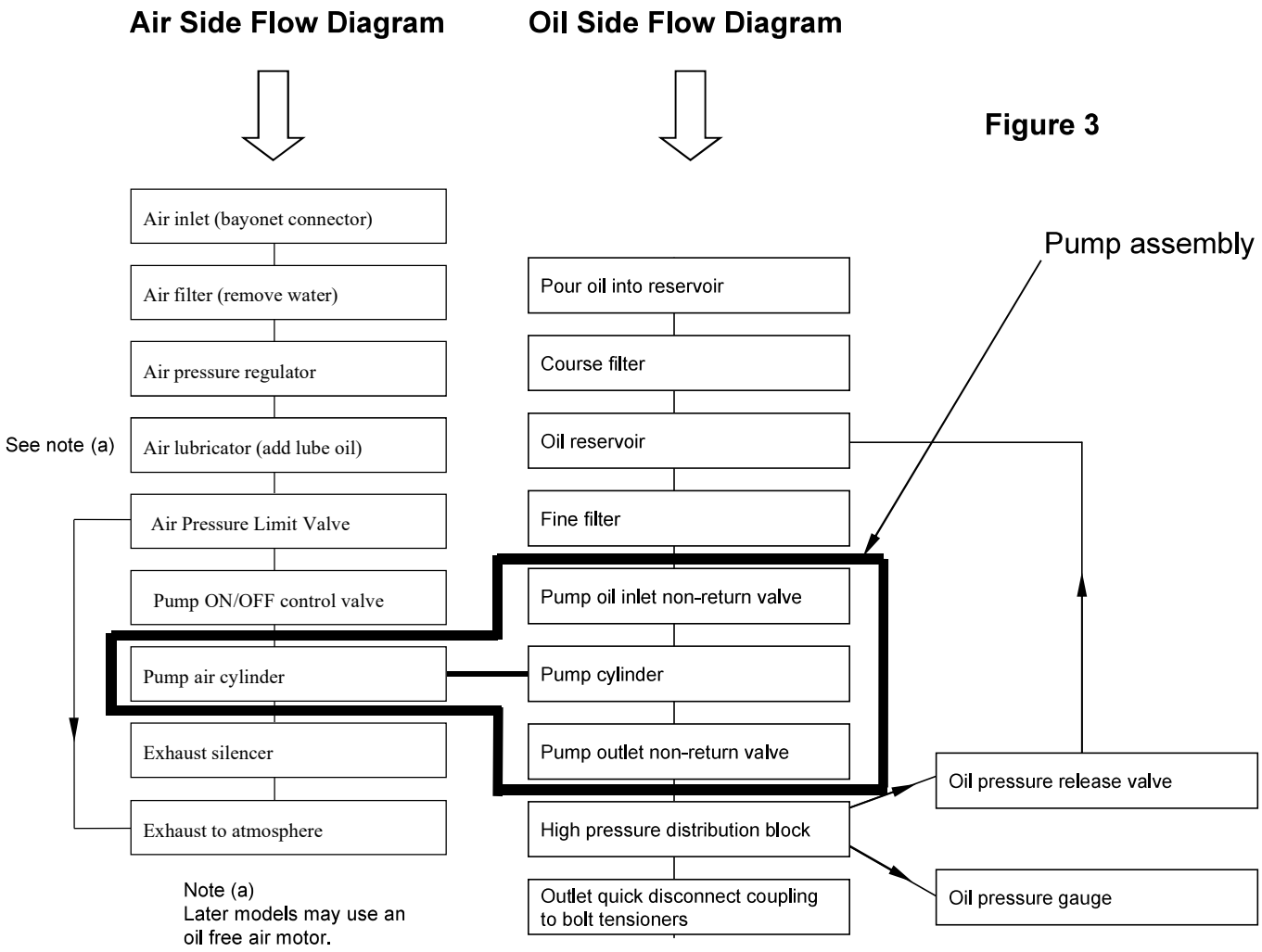

Figure 3

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SETTING UP THE PUMP

Step 1

If a packing case was ordered with the pump, carefully open the case and retain it for storing the pump when not in use. Remove the pump from the plastic bag.

Step 2



Check the air pressure inlet connection is compatible with the mains air supply you intend to use with the pump. If not fit the correct type of connector to the air inlet on the pump unit.

Step 3



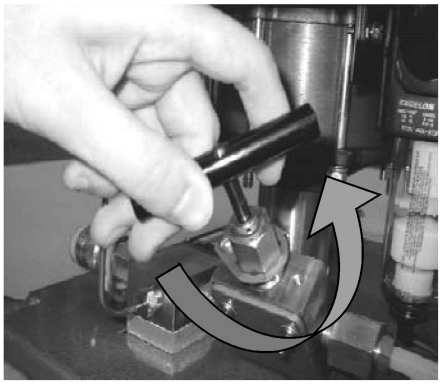
Remove the oil filler cap from the oil reservoir. Do not remove the coarse filter fitted beneath the filler cap. Pour hydraulic fluid into the reservoir, through the coarse filter until it is about three quarters full. The reservoir takes about 8.5 litres of oil when full. Refit the oil filler cap.

Step 4



Check the air lubricator to see if it is filled with lubricating oil. If not locate the lubricating oil supplied with the pump and fill the lubricator to the maximum level marked on the bowl. Do not attach the mains air before the lubricator is filled. If the mains air supply has been attached you must remove it before attempting to fill the oil lubricator.

Step 5



Fully open the Oil Pressure Release Valve. Turn the handle ant-clockwise to open the valve.

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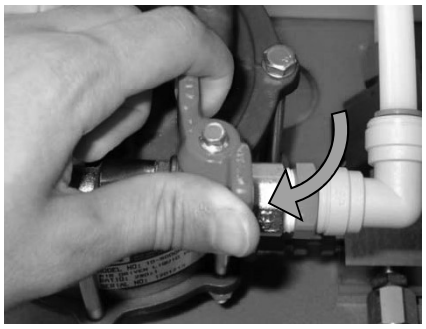
SETTING UP THE PUMP

Step 6

Close the pump ON/OFF control valve. Turn the handle a quarter turn clockwise to close the valve.



Step 7

Connect the mains air supply (70 -100 psi 5 - 7 bar).

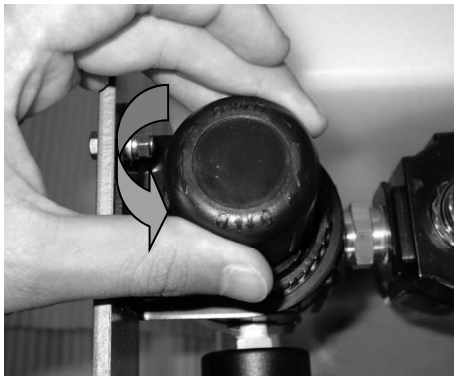
Regulated Air Pressure Gauge

Step 8

Check the regulated air pressure gauge.

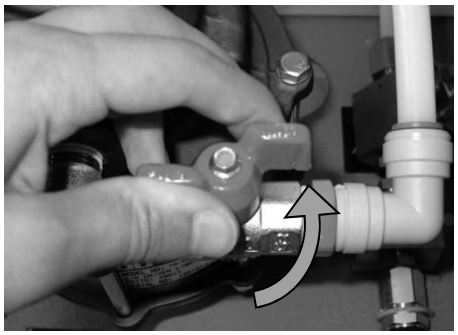


If it is not zero, Lift the black cap to unlock it and turn the air pressure regulator anti clockwise until the regulated air pressure falls to zero.



Step 9

Open the pump ON/OFF valve.
Turn the handle a quarter turn anti-clockwise to open the valve.



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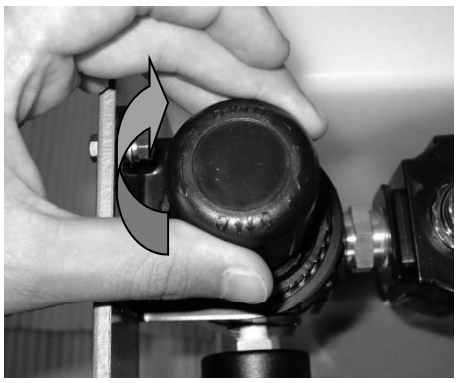
SETTING UP THE PUMP

Step 10

Slowly turn the air pressure regulator clockwise until the pump runs at a speed between 30 and 60 strokes per minute.

Leave the pump to reciprocate for two minutes to bleed all of the air from the pump and pipe-work.



Step 11

Observe the air lubricator (if fitted). This has been factory set to lubricate the air supply at the rate of one drop of oil for every fifty strokes of the pump.



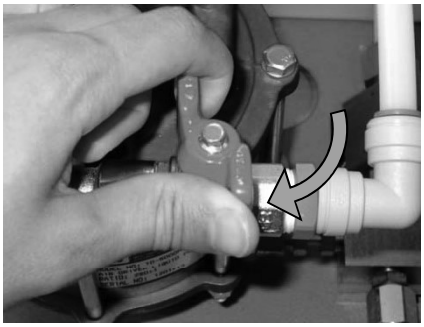
A red plastic knob is provided for adjustment if and when necessary.



Step 12

Stop the pump by closing the pump ON/OFF control valve.

The pump is now ready for use. Proceed by first setting the pump stall pressure as described in Section 6 of this manual.



SETTING THE PUMP STALL PRESSURE

The air driven pump can be set to stall at any pre-determined pressure. This is a safety feature which, prevents the operator from inadvertently exceeding the maximum working pressure for the bolt tensioning equipment.

Setting the stall pressure is achieved by adjusting the regulated air pressure which is allowed to drive the pump. To set the pump stall pressure first set up the pump as described earlier in this manual, ensure the oil reservoir has a good supply of oil and connect the pump to a suitable air supply.

With the pump ready for operation proceed as followings:-

Step 1 Attach a blank quick connect nipple to the oil pressure outlet coupling.

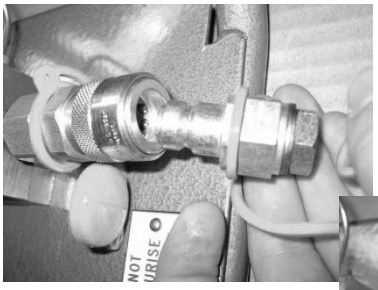
The oil outlet quick connector must not be pressurised whilst it is disconnected.

To set the stall pressure the oil pressure must be increased so a quick connect nipple with a blank end must first be fitted to the outlet connector.

The Health and Safety Section 2, gives instructions for the connecting and disconnecting of these fittings.

To fit the blank quick connect nipple, pull back the spring loaded collar on the oil outlet coupling, push the nipple into the coupling and release the collar.

Check the nipple is properly connected before proceeding.







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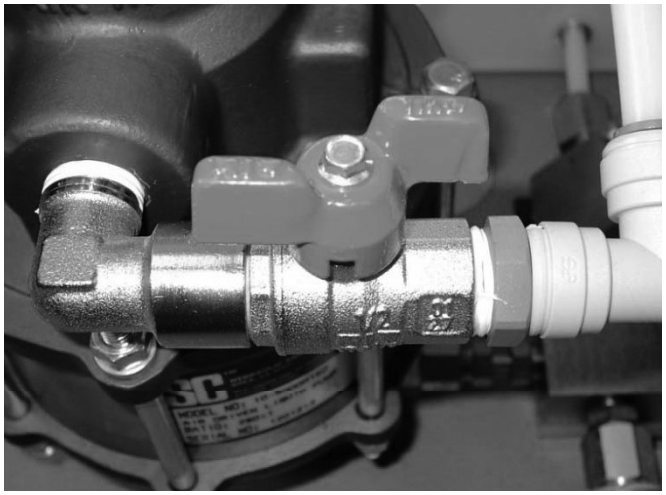
SETTING THE PUMP STALL PRESSURE

Step 2 Close the Pump ON/OFF control valve.

Turn the valve clockwise to close the valve

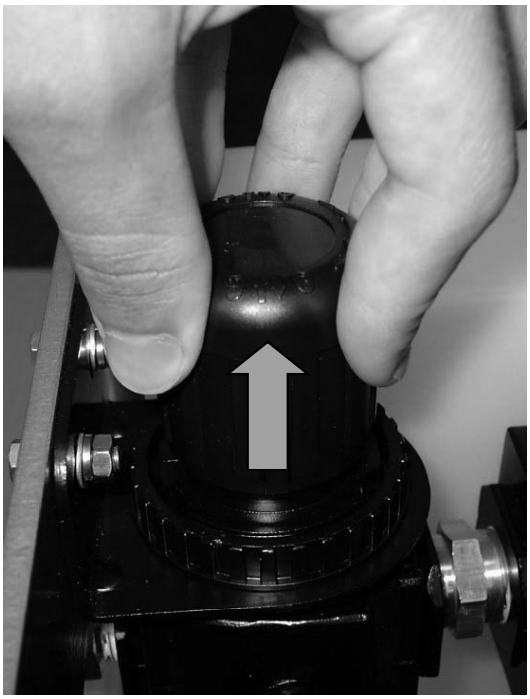


Open



Closed

Step 3 Unlock the air pressure regulator cap.



The air pressure regulator has a black cap. The cap is locked by pushing it down and unlocked by lifting it up.

Unlock the cap by lifting it.

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SETTING THE PUMP STALL PRESSURE

Step 4 Reduce the regulated air pressure to zero.

Turn the air pressure regulating cap anti-clockwise to reduce the regulated air pressure. Observe the regulated air pressure gauge. Stop turning the air pressure regulator when the regulated air pressure gauge is reading zero bar.

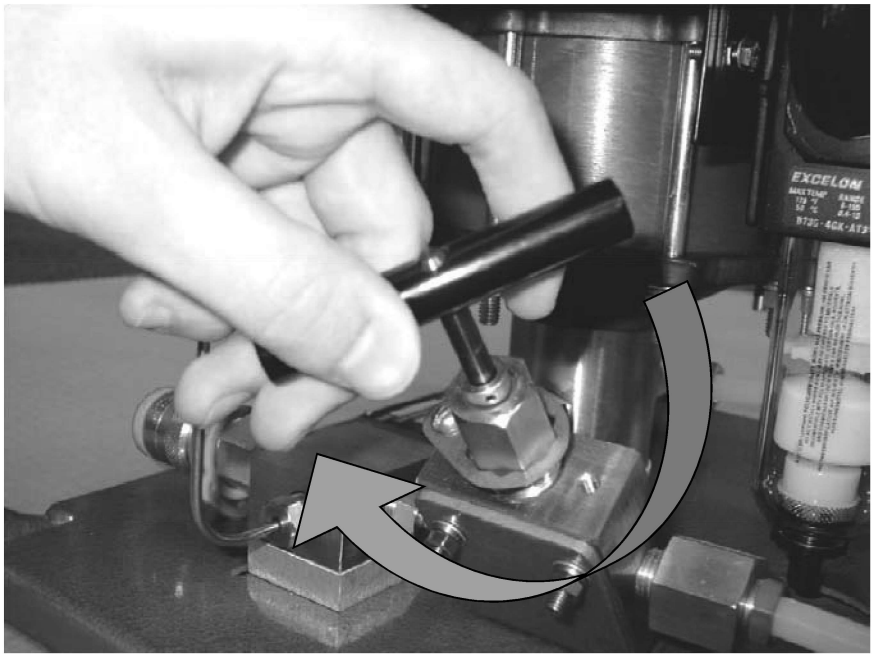




Regulated Air Pressure Gauge

Step 5 Close the oil pressure release valve.

Turn the handle on the oil pressure release valve (15) clockwise until the valve is closed. Do not over tighten this valve otherwise the seat can be damaged.



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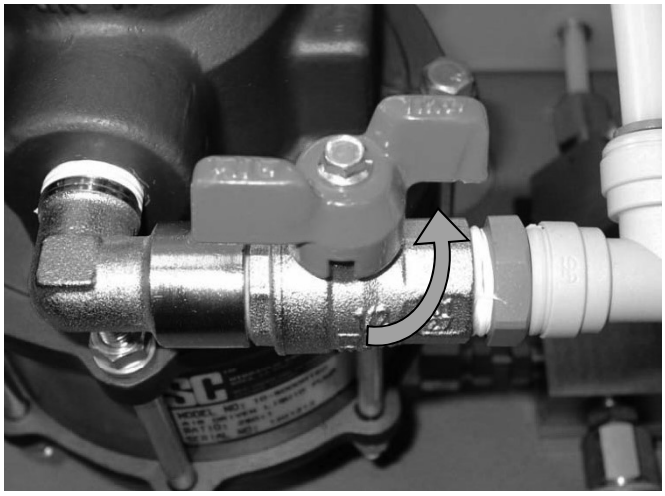
SETTING THE PUMP STALL PRESSURE

Step 6 Open the pump ON/OFF control valve.

Turn the pump control valve anti-clockwise to open it. The pump will not start at this point because the regulated air pressure has been reduced to zero bar.



Closed



Open

Step 7 Slowly increase the regulated air pressure

Turn the air pressure regulator clockwise to increase the regulated air pressure. Turn the regulator slowly. As soon as the air pressure starts to increase the pump will run. Because of the small volume of oil under pressure, the pump will quickly stall. The stall pressure will now be seen on the oil pressure gauge.

Continue to turn the air pressure regulator until the desired stall pressure is indicated on the oil pressure gauge.





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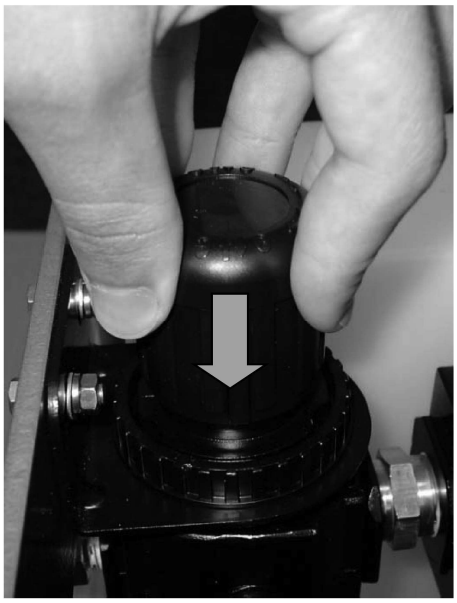
SETTING THE PUMP STALL PRESSURE

Step 8 Lock the the air pressure regulator.



Lock the air pressure regulator cap . Push the cap down to lock it.

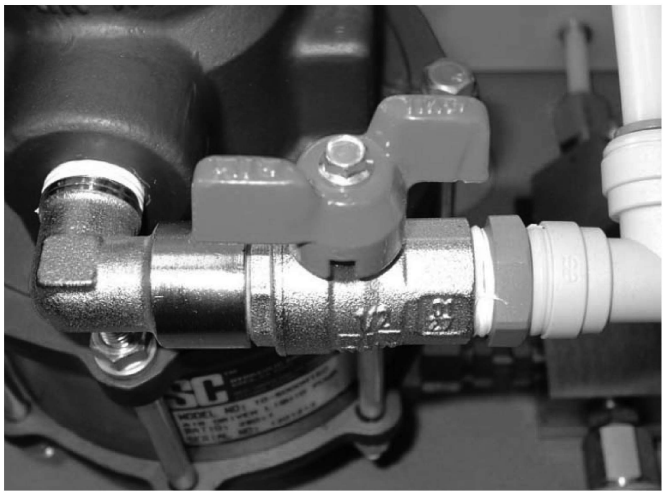
The oil pressure gauge continues to indicate the stall pressure.



Step 9 Close the pump ON/OFF control valve.

Turn the pump control valve anti-clockwise to close it.

The pump has already stalled so there will be no immediate or noticeable reaction to the closing of the ON/OFF control valve.



Open



Closed

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SETTING THE PUMP STALL PRESSURE

Step 10 Slowly open the oil pressure release valve.

Slowly turn the handle on the oil pressure release valve anti-clockwise until the valve is fully open.

The oil pressure will quickly fall to zero bar.

The pump has now been set to stall at the pre-determined oil pressure. When in use the pump will not increase the pressure above the stall pressure now set.



WARNING

This assumes a constant air pressure supply to the pump. If there are large variations in the supply air pressure, the pump may stall at a lower or higher pressure than the stall pressure setting.



OPERATING THE PUMP

Step 1 - Follow the instruction under SETTING UP THE PUMP as described from page 19 of this section of the manual.

Step 2 - Follow the instructions under SETTING THE PUMP STALL PRESSURE from page 22 of this section of the manual. Set the stall pressure of the pump to match the operating pressure of the equipment to be used.

Step 3 - Connect the equipment to be pressurised to the quick connect coupling on the outlet of the pump unit. Follow the instructions for using the quick connect couplings as described on page 6 of this section of the manual.

Step - 4 Close the Oil Pressure Release Valve.

Step - 5 Check all of the quick connect couplings on the hydraulic hoses and tools are correctly connected and ready to be pressurised.

Step - 6 Start the pump by opening the Pump ON/OFF control valve.

Step - 7 The pump will run and pressure will build up. The speed of the pump can be regulated by how much the pump ON/OFF valve is opened.

> The oil pressure will be indicated on the oil pressure gauge. The pump will run until the pressure reaches the stall pressure setting. To stop the pump before reaching the stall pressure, close the pump ON/OFF control valve.

Step - 8 Stop the pump by closing the Pump ON/OFF control valve.

Step - 9 To release the oil pressure, with the pump ON/OFF valve closed, slowly crack open the Oil Pressure Release Valve. Allow the oil pressure to fall slowly to zero. When at zero pressure, fully open the valve.



IF ANY UNSAFE WORKING SITUATION SHOULD ARISE DURING THE OPERATION OF THE PUMP IMMEDIATELY FULLY OPEN THE OIL PRESSURE RELEASE VALVE AND THEN CLOSE THE PUMP ON/OFF CONTROL VALVE.

This will dump the oil pressure and stop the pump.

TENSÃO DE PARAFUSOS
TIPO
MINI - MÁX



OPERATION MANUAL

DAKOTA ULTRASONICS

MINI-MAX

BOLT TENSION MONITOR



P/N P-156-0002 Rev 2.12, April 2010

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Chapter 1 Warranty and Safety

1.1 Warranty

The Dakota Ultrasonics ***MINI-MAX*** carries a two year limited warranty. The warranty only applies to ***MINI-MAX*** units being operated as described in this manual. Software and hardware failures of the unit will be repaired or replaced at Dakota Ultrasonics discretion. Dakota Ultrasonics will not be held liable for any damage caused, interruption of business, loss of profits, etc., resulting from such failures. Dakota Ultrasonics will not be liable to repair or replace a unit, which has been damaged, used inappropriately, or subject to unauthorized repair by the purchaser.

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Facsimile: (831) 431-9723
http://www.dakotaultrasonics.com

1.2 Safety

Using the ***MINI-MAX*** while standing in water or in a wet environment can result in serious electric shock, injury, and even death.

Operating the ***MINI-MAX*** with damaged or inadequate cables and power source can result in serious electric shock, injury, and even death.

Failure to read this manual and understand the proper operation of the ***MINI-MAX*** can result in inaccurate measurements, and lead to decisions which cause property damage, personal injury, or even death.

Use of the ***MINI-MAX*** for any other purpose, or in any other manner than described in this manual invalidates the warranty and can result in serious electric shock, injury, and even death.

Chapter 2 About this manual

This chapter is intended to help you make the best use of this manual. Readers may have different knowledge of ultrasonic bolt measurement and may find parts of this manual repetitive or unnecessary.

2.1 If you're new to Ultrasonics

There are a variety of ultrasonic applications currently being utilized in today's industry. For example weld inspection, thickness measuring, immersion testing of flaws, etc. The use of ultrasound to measure forces in fasteners is relatively new compared to the previously mentioned traditional applications.

Ultrasonic measurement of bolts provides an extremely accurate means of determining fastener load, provided the correct techniques are utilized. As a new user, careful consideration of this entire manual is highly recommended.

2.2 If you're new to fastener measurement

Assuming you are familiar with ultrasonics, but unfamiliar with fastener measurement, the chapters on transducer selection and the theory of operation can be skipped entirely.

The ***MINI-MAX*** measures load on the fastener by measuring the amount the fastener stretches. As load is applied to the fastener, it stretch's just as a spring would stretch. The stretch is proportional to the load while the load is less than the elastic limit of bolt. By measuring the stretch of the fastener and knowing the physical properties of the fastener, the load of the fastener can be calculated. The ***MINI-MAX*** measures the fastener stretch by ultrasonically measuring the change in length.

Be sure to setup and experiment with a test fixture of some kind as a means of becoming familiar with your ***MINI-MAX***.

Chapter 3 Quick Start Guide

3.1 Overview

This section demonstrates the basic procedures for setting up and measuring bolts using the ***MINI-MAX***. More in depth explanations pertaining to the individual functions and features can be found in the chapters that follow.

Here we go!

3.2 Getting the *MINI-MAX* ready

Making all the connections

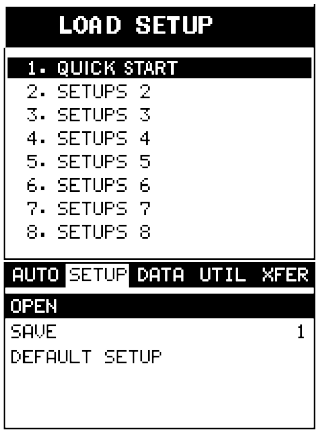
In order to get the ***MINI-MAX*** ready for operation; the following connections must be made:

1) Remove the ***MINI-MAX*** from the carrying case.
2) Connect the transducer cable to the transducer, and plug the lemo connector into the gauge.
3) If a temperature sensor is being used, connect the sensor to the ***MINI-MAX***.

3.3 Setting up the *MINI-MAX*

Please Read: In this section the ***MINI-MAX*** will be setup in its simplest form. Remember this is only a quick start guide to get the user up and measuring bolts. Before we setup the gauge to measure basic elongation, the following assumptions must be made: A preset material type will be used. The user will not be re-measuring the fasteners at a later date to monitor relaxation of the joint over time. This eliminates the need for a transducer zero. All these assumptions will be answered and explained in detail in the chapters that follow.

Selecting the Quick Start Setup



1) Press the **ON/OFF** key to power up the ***MINI-MAX***.

2) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **SETUP** menu is highlighted and displaying the submenu items.

3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **OPEN** is highlighted.

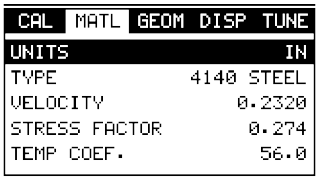
4) Press the **ENTER** key to display the list of setups.

5) Press the **UP** and **DOWN** arrow keys to scroll through the setup list until the **QUICK START** setup is highlighted.

6) Press the **ENTER** key to display the confirmation screen.

7) Press the **OK** key to select the setup and return to the menu screen, or **ESC** to cancel the selecting the setup.

Selecting the Units



Note: The Quick Start setup, selected in the previous section, automatically defaults to english units – inches. Follow the procedure below to change the units to metric, if needed.

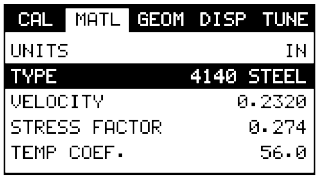
1) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **MATL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **UNITS** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll through the unit options **IN** (inches), **IN HR** (inches hi resolution), **MM** (millimeters), and **MM HR** (millimeters hi resolution).

Note: The high-resolution options display an additional digit of resolution to the measurement. This mode is typically used when measuring very short bolts with very little elongation.

Selecting the Material Type



This section allows the user the ability to select a material from a list of preset material types. Keep in mind that we are measuring elongation only. If your material is not in the list, select a similar material type. When measuring in elongation mode, the measurement consists of a difference equation only (Loaded Length – Unloaded Length = Δ Length). Therefore, it doesn't matter if the ultrasonic length is different from the actual physical length, because the Δ Length will be the same. Example: 2.0080" physical loaded length – 2.0000" physical unloaded length = 0.0080" Δ Length which is equivalent to 2.1080" ultrasonic loaded length – 2.1000" ultrasonic unloaded length = 0.0080" Δ Length.

1) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TYPE** is highlighted.

2) Press the **ENTER** key to display the list material types.

3) Press the **UP** and **DOWN** arrow keys to scroll through the material list until the appropriate type is highlighted.

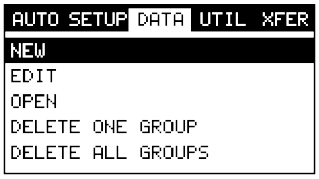
4) Press the **ENTER** key to display the confirmation screen.

5) Press the **OK** key to select the type and return to the menu screen, or **ESC** to cancel selecting the material type.

3.4 Creating a New Group to Store Measurements

Now that the ***MINI-MAX*** is all s etup, this section will explain how to get started measuring unloaded initial lengths. In order to do this, we need to create a group that contains bolts. A group c an have up to 250 bolts, each bolt containing 1 reference length (L-REF), and up to 51 elongations. Keep in mind that the ***MINI-MAX*** uses a group to store measurements and all gauge se ttings at the time of measurement.

Creating a Group Name



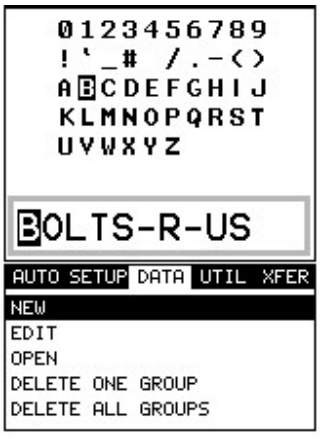
1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **NEW** is highlighted.

3) Press the **ENTER** key to display the **New Group Edit Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NAME** is highlighted.

5) Press the **ENTER** key to activate the **Alpha Edit Box**.



6) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

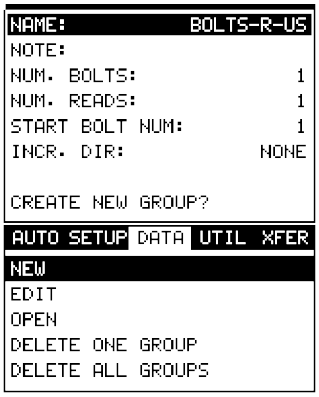
7) Press the **ENTER** key to select a character and advance to the next field of the **Group Name**.

8) Use the **CLR** key to backspace if necessary.

9) Repeat steps **6 - 8** until the **Group Name** is completed.

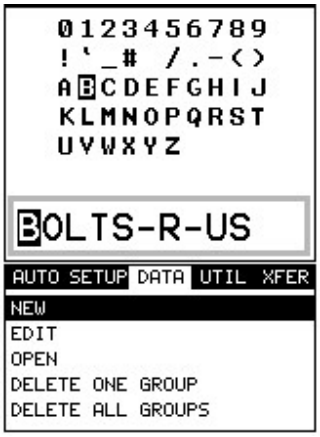
10) Press the **OK** key to save the **Group Name** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Name**.

Creating a Group Note



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NOTE** is highlighted.

2) Press the **ENTER** key to activate the **Alpha Edit Box**.



3) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

4) Press the **ENTER** key to select a character and advance to the next field of the **Group Note**.

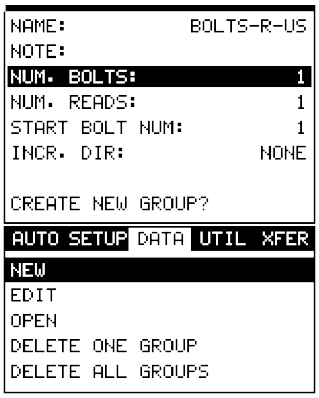
5) Use the **CLR** key to backspace if necessary.

6) Repeat steps **3 - 5** until the **Group Note** is completed.

7) Press the **OK** key to save the **Group Note** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Note**.

Selecting the Number of Bolts in the Group

Note: A group can contain up to 250 bolts. There must be at least 1 bolt in a group.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM BOLTS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM BOLTS** value is correctly displayed.

6) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

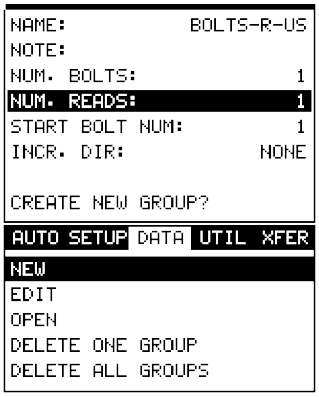
Note: If a number greater than 250 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

7) Press the **OK** key to display the **Digits Edit Box** and re-enter the **NUM BOLTS**.

8) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

Selecting the Number of Readings Per Bolt

Note: A bolt can have up to 51 possible measurements and 1 initial length (L-REF). There must be at least one reading per bolt.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM READS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM READS** value is correctly displayed.

6) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

Note: If a number less than 1 or greater than 51 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

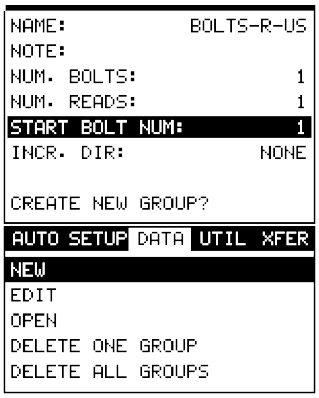
7) Press the OK key to display the **Digits Edit Box** and re-enter the **NUM READS**.

8) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

If there's not enough memory available to create the group, an error message box **"NOT ENOUGH MEMORY"** will be displayed. Press the **OK** or **ESC** key to return to the **Group List Items** menu. It may be necessary to free some memory in the ***MINI-MAX*** at this time.

Selecting the Starting Bolt Number

Note: Depending on the application and layout of the project, the user won't always want the starting bolt to be 1. This feature allows the user to define what the starting number will be.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **START BOLT NUM** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **START BOLT NUM** value is correctly displayed.

6) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

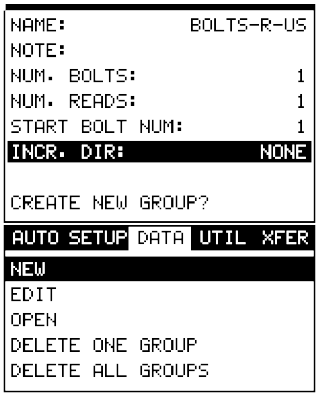
Note: If a value is enter that is greater than the maximum number of bolts allowed per group (250), an error message box “VALUE IS OUT OF RANGE” will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **START BOLT NUM**.

8) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

Selecting the Auto Increment Direction

The **Auto Increment** feature gives the user the ability to specify which direction to advance the cursor after storing a reading.



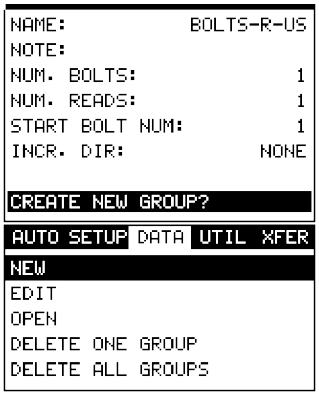
1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **INCR. DIR** is highlighted.

2) Use the **LEFT & RIGHT** arrow keys to toggle the **Increment** direction **NONE, NORTH, EAST, SOUTH, or WEST**.

3) When the correct **Increment** direction is displayed, continue on to the next section **"Saving the Group"**.

Saving the Group

Once all the parameters are set, the user has the option of saving or canceling the new group.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **CREATE NEW GROUP?** is highlighted.

2) Press the **ENTER** key to accept the group parameters, and activate the confirmation screen.

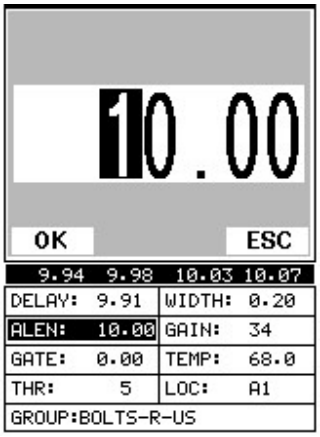
3) Press the **OK** key to save the **New Group**, or the **ESC** key to cancel **the New Group** setup and return to the **DATA** menu.

4) Press the **MEAS** key to return to the measurement screen to begin measuring reference lengths.

3.5 Setting the Approximate Length

In order to utilize the **AUTO S ET** feature of the ***MINI-MAX***, when meas uring reference lengths, the ***MINI-MAX*** has to know wher e to start looking for the detection. We can accomplish this by entering an approximate length into the gauge. The ***MINI-MAX*** will automatically take the value entered and scan +/- 5% in both dir ections of the approximate length for the detection signal. The approximate length is a very valuable feature that can be used to pin point a specific detection area. This feature will be further discussed later in the manual.

Setting the Approximate Length using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **ALEN** cell is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

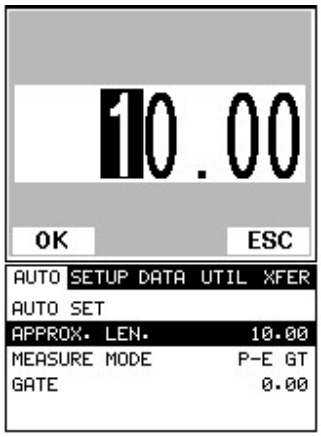
4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **ALEN** value is correctly displayed.

6) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **ALEN**.

The user can also access and set t he approximate length from the tabbed menus. However, this method is more tedious than making the adjustments using the Hot Menus. The procedure using the tabbed menus is outlined below:

Setting the Approximate Length using the Tabbed Menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **AUTO** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **APPROX. LEN.** is highlighted.

3) Press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **Approx. Len.** value is correctly displayed.

7) Press the **OK** key to set the **Approx. Len.** and return to the menu screen, or **ESC** to cancel entering the **Approx. Len.**.

8) Finally, press the **MEAS** key to return to the measurement screen and begin measuring reference lengths.

3.6 Measuring Reference Lengths

At this point, the ***MINI-MAX*** is setup and ready to st art measuring reference lengths. We've already setup a bolt group to store the reference length data, and now need to display the group storage locations prior to making measurements.

Storing a Reading

DELAY:	9.91	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	70.2
THR:	5	LOC:	B1
GROUP:BOLTS-R-US			

1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.

	A	B	C
1	10.0072	0.0039	
2	10.0072		
3			
4			

2) Press the **ENTER** key to display the **Group View Box**.

3) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

Note: The approximate lengths must always be located in the first column A for all bolts in the group.

4) Place a small amount of couplant on the transducer and attached it to the bolt. Make sure that the transducer is seated so that there is no couplant layer creating a gap between the transducer and bolt. This can be accomplished by rotating the transducer clockwise and counter clockwise while applying a very small amount of pressure to seat the transducer firmly against the bolt.

Important Note: Always be sure to place the transducer in the same exact location if it will be removed in between reference lengths and elongation measurements. This will eliminate any potential sound path error caused by moving the transducer to a completely different location on the bolt, thus causing potentially erroneous measurements. Be consistent and as methodical in your methods as possible. This will help to avoid transducer placement errors.

5) Press the **AUTO SET** key, located in the bottom left corner of the keypad, to locate the detection point, or end of the bolt.

6) Press the **ENTER** key to save the current approximate length in the highlighted cell location.

Note: If the measurement was saved in error, press the **CLR** key at anytime to clear the stored reading and re-measure using the steps **4 – 6** above.

Note: The **Group View Box** can be aborted at any time by pressing the **MEAS** key.

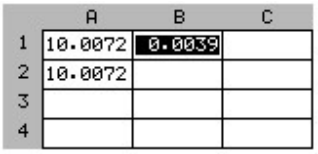
3.7 Measuring Elongations

Now that the reference lengths have been measured and saved, we're ready to start measuring elongation values. We'll start off by assuming the bolt has been stretched or tightened, the transducer has been once again coupled to the bolt in the same location as before, and we're ready to measure the elongation as follows:

Measuring an Elongation

Important Note (recap): Always be sure to place the transducer in the same exact location if it will be removed in between reference lengths and

elongation measurements. This will eliminate any potential sound path error caused by moving the transducer to a completely different location on the bolt, thus causing potentially erroneous measurements. Be consistent and as methodical in your methods as possible. This will help to avoid transducer placement errors.



	A	B	C
1	10.0072	0.0039	
2	10.0072		
3			
4			

1) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

Note: Elongation values must be stored in column B - ZZ.

Note: Do Not press the **AUTO SET** key, while measuring elongation's, as this activates a high speed mode used specifically with our shut-off box. The **AUTO SET** feature is only used when measuring reference lengths. If the **AUTO SET** key is accidentally pressed, press it again to turn the high speed mode off.

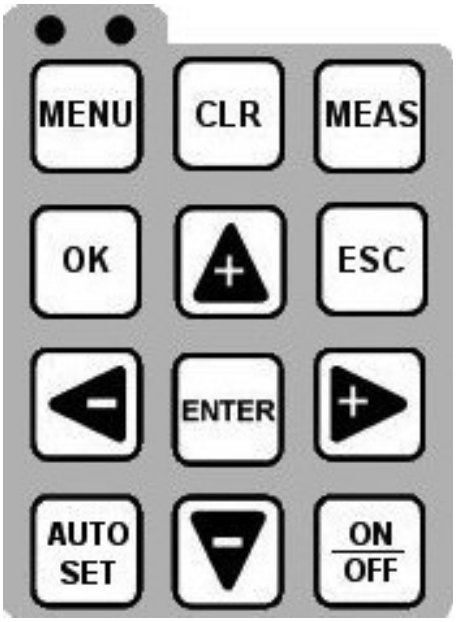
2) Press the **ENTER** key to save the current elongation in the highlighted cell location.

Note: If the measurement was saved in error, press the **CLR** key at anytime to clear the stored reading and re-measure using steps **1 & 2** above.

3) Continue to repeat this process until all the elongation measurements have been completed.

Note: The **Group View Box** can be aborted at any time by pressing the **MEAS** key.

Chapter 4 Keyboard, Menu, & Connector Reference

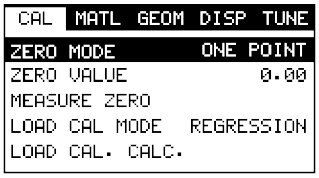


4.1 Menu Key (Operation & Sub Menus)



The **Menu** key activates the primary menu structure containing 10 menu tab groups. These tab groups then contain sub menu items, or functions. The sub menu items have been organized in tab groups according to how closely they are related to the individual tab group names. Let's first get familiar with how to move around in these tabs before continuing on to the sub menu functions. This procedure is outlined below:

Activating and Getting Around in the Menu Items



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left until the desired tab group is highlighted and displaying the submenu items.

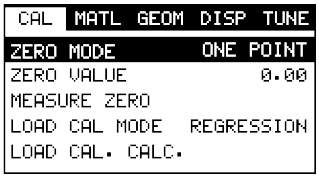
Now that your familiar with activating and moving amongst the tab groups, let's have a look at how to move around in the sub menu items as follows:

Getting Around in the Sub Menu Items

1) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until the desired function is highlighted.

2) Depending on which function is highlighted, use the **LEFT**, **RIGHT**, and **Enter** keys to scroll the options or activate the **Digit Edit** and **List Box** options.

The sections to follow will provide the user with an explanation of the sub menu functions:



4.2 CAL – Menu

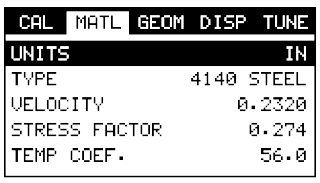
Zero Mode: The ***MINI-MAX*** is zeroed in much the same way that a mechanical micrometer is zeroed. There are th ree zero mode options availab le in *the* ***MINI-MAX*** – FI XED, ONE POINT, and TWO POIN T. Selecting the proper mode is dependent on the application requirements. Refer to Chapter 8, for an explanation of this important procedure.

Zero Value: Depending on the Zero Mode selected above, the actual zero value will be calc ulated and displayed in this sub menu item. The user can edit this value at anytime from this sub menu it em. Refer to Chapter 8 for a further explanation.

Measure Zero: Once the Zero Mode has been se lected above, this function displays and calculates the actual m easurement screen containing the known physical length, velocity, and temperature coefficient of the calibration standard versus the ultrasonic length. . Refer to Chapter 8 for a further explanation.

Load Cal Mode: Enables and disables the fiel d calibration feature of the ***MINI-MAX***. This is used to compare known and ultrasonic loads. Refer to Chapter 11 for a further explanation.

Load Cal Calc: This feature is used to calcul ate a linear regression or vector curve, once the Load Cal M ode is enabled and known and ultrasonic loads have been entered and ultrasonically measured. If the regre ssion option was selected in Load Ca l Mode, a correction load offset and loa d factor will b e calculated. If the vector option was selected, a load fact or will be calculated and the offs et will be set to zero. Refer to Chapter 11 for a further explanation.



4.3 MATL (material) – Menu

Units: Toggle between English and Metri c units and multiple resolutions for each unit (IN - .0001, INHR - .00001, or MM - .001, MM HR - .0001), Using the abbreviation HR to represent High Resolution.

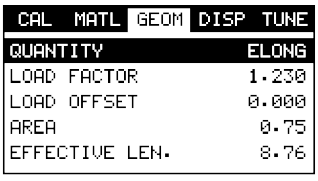
Type: Select the bolt material type from a preset list of material types. Each type contains a velocity, stress factor, and temperature factor. When a type is selected, these values are displayed in the sub menu items below and can be edited by the user at anytime.

Velocity: This feature allows the user to edit the material velocity at anytime. Once a material type is selected, the velocity of the selected material type is stored in this sub menu item and can be edited a by the user if necessary.

Stress Factor: This feature allows the user to edit the stress factor at anytime. Once a material type is selected, the stress factor of the selected material type is stored in this sub menu item and can be edited by the user if necessary. Refer to section 10.3 for further info.

Temp Coeff: This feature allows the user to edit the material temperature coefficient at anytime. Once a material type is selected, the temperature coefficient of the selected material is stored in this sub menu item and can be edited by the user if necessary. Refer to 10.4 for further info.

4.4 GEOM (geometry) – Menu



Quantity: Selectable units of measure in terms of TIME, ELONGATION, LOAD, STRESS, and % STRAIN. Refer to section 12.1 for further info.

Load Factor: The conversion factor from elongation to Load. This value is typically determined by performing a field calibration and running a regression or vector using the ***MINI-MAX*** or utility software. Alternatively, the load factor can be determined using the bolt calculator in the utility software. However, if extreme accuracy is required, performing a field calibration is a must. This sub menu item enables the user to edit the factor at anytime. Refer to section 11.1 for further info.

Load Offset: Normally the Load Offset is set to zero. However, when a field calibration is performed and regression calculated a small offset (y intercept) will result. This value is a constant added or subtracted from the measurement, and will result in correction to the load quantity. This sub menu item enables the user to edit the offset value at anytime. Refer to section 11.2 for further info.

Area: The cross sectional area of the fastener being measured. Used to convert load to stress. Set to zero if the user is not measuring the quantity in terms of stress. This sub menu item enables the user to edit the area at anytime. Refer to section 11.1 for further info.

Effective Length: The length of the region of the fastener under stress (the distance between the nut plus some amount of additional stress that occurs in the head and nut(s) of the fastener). This sub menu item enables the user to edit the effective length at anytime. Refer to section 11.1 for further info.

4.5 DISP (display) – Menu



View: Selectable RF wave, RECT (rectified), and DIGITS (large digits) views. Refer to section 12.2 for further info.

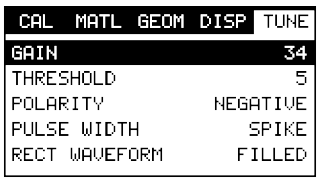
Backlight: Selectable OFF, ON, AUTO, or INVERT back light option.

Contrast: Adjustable display contrast for variable light conditions.

Delay: Provides the user the ability to change where the left side of the display window starts according to time which is convert to a length, in english or metric units. Refer to section 12.3 for further info.

Width: Provides the user the ability to change the overall size of the viewable measurement area. It functions a lot like a zoom on a camera. Refer to section 12.3 for further info.

4.6 TUNE – Menu



Gain: Increases or decreases the overall amplitude of the signal. Much like turning the volume up or down on a stereo receiver. Refer to section 12.4 for further info.

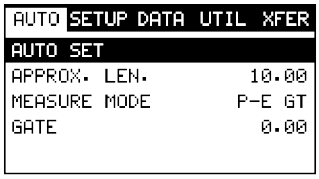
Threshold: Enables the user to set the sensitivity level of the ***MINI-MAX***. The amplitude of the signal must reach and exceed the threshold level before a measurement is detected. Refer to section 12.5 for further info.

Polarity: The ***MINI-MAX*** operates on a zero crossing detection principal. This feature toggles which stroke of the cycle the crossing detection uses, either positive or negative. Refer to 13.3 for further info.

Pulse: The ***MINI-MAX*** has an adjustable pulse width for both high penetration and resolution requirements. The pulse width refers to the duration of time the pulser is on. The options are **Spike**, **Thin**, and **Wide**. Refer to 13.1 for a further explanation.

Rect Waveform: This option provides the user an outlined or filled view option when the display setting is in RECT (rectified) wave mode only. Refer to 13.4 for further info.

4.7 AUTO – Menu



Auto Set: Automatically locates the detection point if the measurement is out of the viewable display area. Used when measuring reference lengths only. Refer to section 12.9 for further info.

Approx Len: In order for the user to use the Auto Set feature, an approximate length of the fastener must be entered. The approximate length gives the ***MINI-MAX*** some idea of where to turn on the receiver and look for the detection, or end of the bolt. This sub menu item enables the user to edit the effective length at anytime. Refer to section 12.9 for further info.

Measure Mode: Used to select the measurement mode for different application requirements. The mode options are P-E (pulse-echo), or P-E GT (pulse-echo w/gate).

Gate: Gates allow the user to view areas or sections of the waveform and ignore others. Refer to section 12.6 for further info.

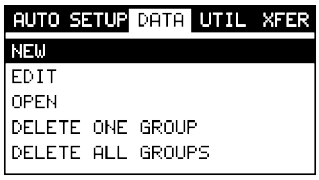


4.8 SETUP – Menu

Open: Displays a list of factory and user defined setups currently stored in memory. These setups can be recalled and used at any time. The setup contains all the information about a specific bolting application. Refer to section 15.1 for further info.

Save: Provides the user with the ability to save a custom bolting application setup that has been modified or created by the user. Refer to section 15.3 for further info.

Default Setup: Loads a basic default setup. Use only as a last resort when the setups in the ***MINI-MAX*** have been corrupted and a computer is not accessible to restore previously save setups. Refer to section 15.4 for further info.



4.9 DATA – Menu

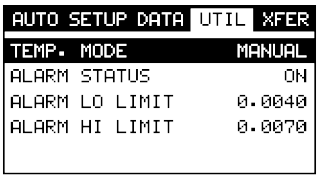
New: Allows the user the ability to create a new group with a specified number of bolts and measurements per bolt. A group can contain 250 bolts, 1 reference length, and 51 measurements per bolt, depending on the application requirements. Refer to section 14.2 for further info.

Edit: Gives the user the ability to change the note and increment direction of a previously save group. Refer to section 14.6 for further info.

Open: This function provides the user with the ability to recall a group that currently exists in memory from a list of groups. Refer to section 14.7 for further info.

Delete One Group: This function provides the user with the ability to delete a single group from a list of multiple groups previously saved in memory. Refer to section 14.5 for further info.

Delete All Groups: This function provides the user with the ability to delete all groups currently stored in memory. Refer to section 14.5 for further info.



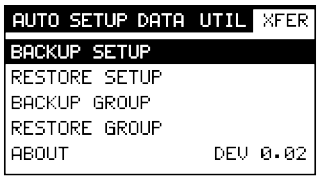
4.10 UTIL (utilities) – Menu

Temp Mode: This sub menu item enables the user to select the automatic temperature compensation mode (manual, semi-auto, and auto). This feature is only available to those units purchased with the automatic temperature compensation option and probe. Note: Contact Dakota for information on upgrading the ***MINI-MAX***. Refer to Chapter 9 for further info.

Alarm Status: Toggles alarm mode on or off. Refer to section 13.2 for further info.

Alarm LO Limit: Gives the user the ability to set the LO tolerance parameter. If the measurement falls below this value, a red light will illuminate. Refer to section 13.2 for further info.

Alarm HI Limit: Gives the user the ability to set the HI tolerance parameter. If the measurement exceeds this value, a red light will illuminate. Refer to section 13.2 for further info.



4.11 XFER (transfer) – Menu

Backup Setups: Enables the user the ability to backup the setups currently stored in the ***MINIMAX*** to a PC via RS232 port. Refer to the help section of the ***MINIMAX*****view** software for a complete electronic manual.

Restore Setups: Enables the user the ability to restore the setups currently saved on a PC to a ***MINI-MAX*** via RS232 port. Refer to the help section of the ***MINIMAX*****view** software for a complete electronic manual.

Backup Grid: Enables the user the ability to backup groups currently stored in the ***MINI-MAX*** to a PC via RS232 port. Refer the help section of the ***MINIMAX*****view** software for a complete electronic manual.

Restore Grid: Enables the user the ability to restore groups currently saved on a PC to a ***MINI-MAX*** via RS232 port. Refer to the help section of the ***MINI-MAX*****view** software for a complete electronic manual.

About: Provides the user with Dakota Ultrasonics contact information and the ***MINI-MAX*** software version.

4.12 CLR (clear) Key



The primary functions of the **CLR** key, is to clear a measurement from a group cell location, and backspace in an **Alpha Edit Box**. If a user has already saved a measurement and waveform to a cell location, use this key to clear the measurement at any time.

4.13 MEAS (measurement mode) Key



The **MEAS** key puts the ***MINI-MAX*** into its primary mode of operation. In this mode, the user has a complete view of the LCD, as well as control of the **Hot Menu Functions**. These hot functions provide the user with the ability to make crucial adjustments to the display, waveform settings, and access group storage locations without having to search through the menu and sub menu items. It's important to first get familiar with moving around in the hot functions as follows:

Getting Around in the Hot Menus

DELAY:	9.93	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	68.0
THR:	5	LOC:	A1
GROUP:BOLTS-R-US			

1) Press the **MEAS** key at any time to return to the primarily measurement mode.

2) Press the **MEAS** key multiple times to tab right through the menu fields, and the **ESC** key multiple times to tab left through the menu fields, until the desired hot function is highlighted.

Now that you're familiar with a ctivating a nd moving amongst the hot function fields, let's have a look at how to adjust or change the values of these fields:

Adjusting the Values of the Hot Menus

1) Use the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to increase and decrease the values of the hot function fields.

2) **Repeat step 1** until the desired value has been achieved.

Alternatively, the delay, width, alen, gain, gate, temp, and threshold hot function fields can be changed using the **Digit Edit Box** as follows:

1) Press the **ENTER** key to display the **Digits Edit Box**.

2) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

4) Repeat steps **2 & 3** until the delay, width, alen, gain, gate, temp, or threshold number is correctly displayed.

5) Press the **OK** key to set and return to the measure screen, or **ESC** to cancel entering the delay, width, alen, gain, gate, temp, or threshold value.

4.14 OK Key



The primary function of the **OK** key is confirmation of a change or selection. Additionally, when the group data is being displayed, the **OK** key will allow the user to advance the cursor to a specific bolt number in the group.

4.15 ESC Key



The **ESC** key is used in the **MENU**, **MEAS**, and **EDIT** functions as a back or escape function. Additionally, when the group data is being displayed, the **OK** key will allow the user to toggle the display view options: RF, RECT, and DIGITS.

4.16 Arrow Keys



The **Arrow Keys** are used to navigate through the menus, increase/decrease values, and toggle specific function keys.

4.17 ENTER key



The **ENTER** key is used in the overall menu selection process, to activate list and edit boxes, and save measurements to bolt group locations.

4.18 AUTO SET Key



The **AUTO SET** key attempts to locate the detection of the signal, or end of the bolt. This key is used to activate two completely different functions:

1. **Reference Lengths** – When measuring reference lengths, will locate the detection point (end of the bolt or target), and optimize the scope settings.

This feature will prove to be very valuable, avoiding the tedious process of manually trying to locate the detection point.

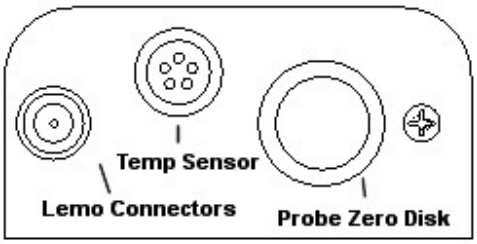
2. **High Speed Update –** Activates the high speed update mode, when using Dakota's special shut-off box, installed and connected to a pump. This feature can only be activated while measuring quantities other than the reference lengths, and should only be activated if connected to the shut-off box.

4.19 ON/OFF Key

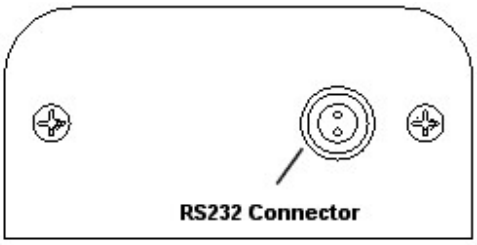


The **ON/OFF** key simply powers the unit either **ON** or **OFF**. Note: Unit will automatically power off when idle for 5 minutes. All current settings are saved prior to powering off.

4.20 Top & Bottom End Caps



Top End Cap



Bottom End Cap

The top & bottom end panels are where all connections are made to the ***MINI-MAX***. The diagram above shows the layout and description of the connectors:

Transducer Connector

Refer to Diagram: The transducer connector, temperature sensor (option), and battery cover/probe zero disk are located on the ***MINI-MAX's*** top end cap. The transducer connector is of type Lemo "00", and the temperature sensor connector is of type Lemo 1 5 pin.

Probe Zero Disk & Battery Cover

Refer to Diagram: The Battery cover is the large round disk shown in the diagram. Simply remove the cover when replacing the batteries (3 AA cells). **Important:** Be sure to follow the polarity labels located on the back label of the ***MINI-MAX***. **Note:** Rechargeable batteries can be used, however they must be recharged outside of the unit in a stand alone battery charger.

RS-232 Connector

Refer to Diagram: The **RS-232** connector, located on the bottom end cap, is a 2 pin female Lemo connector. It is designed to connect directly from the ***MINI-MAX*** to a standard AT serial port on a PC. The cable supplied with the ***MINI-MAX*** is a Lemo to 9 pin serial cable. This **RS-232** connector is also used to connect a 2 pin Lemo to 2 pin Lemo serial cable directly to our special shut-off box, used in conjunction with a pump. **Note:** This connector is also used to upgrade the ***MINI-MAX*** with the latest version of firmware.

Chapter 5 Theory of Operation

5.1 Ultrasonic Measurement of Bolts

Note: The terms *bolt*, *fastener*, and *threaded fastener* are used interchangeably.

Ultrasonic measurement has proven to be the most reliable and cost effective solution when:

- Variations in friction or joint geometry prevent applied torque from controlling the actual clamping force produced by the fastener with the required accuracy.
- The clamping force must be monitored over the service life of the bolt.

Ultrasonic measurement of clamping load is obtained through a predictable decrease in the sound velocity within the body of the bolt as the tensile load is increased. By introducing a sonic pulse at one end of the bolt and accurately measuring the time required for the echo to return from the opposite end, the ultrasonic length is determined. As the fastener is tightened, the change in this ultrasonic length is used to calculate and display the actual clamping force produced.

The physics governing this process are clearly understood, and have been employed for many years in the fields of active sonar, or radar. Send a pulse of energy toward an object (in this case the opposite or reflecting end of the fastener), and then measure the time between the initial pulse and the returning echo.

While the concept is comparatively simple and ultrasonic measurement can produce astoundingly accurate results, the selection of the optimum bolt and transducer, and their coupling can be difficult. The ***MINI-MAX*** minimizes these difficulties to the greatest extent possible:

- The variable width pulser system can send the maximum amount of energy to the ultrasonic transducer, allowing the broadest possible range of transducers for a given application.
- The low noise and gain features of the receiver system allow signal detection and measurement in the most difficult applications.
- The digital signal processor optimizes the measurement process.

5.2 Features of the *MINI-MAX*

The Dakota Ultrasonics ***MINI-MAX***, Ultrasonic Bolt Tension Monitor, defines the State of the Art in the measurement of the actual clamp load produced by tightening a fastener. The ***MINI-MAX*** can measure time, elongation, load, stress, or %strain in bolts of virtually any material from 1 inch to 8 feet in length, depending on the ***Mini-Max*** version. By storing the reference waveform and displaying it for comparison while the elongation is being measured, the ***MINI-MAX*** minimizes operator training.

5.3 Ultrasonic waves

Ultrasonic measurement requires the transmission of a suitable quantity of ultrasonic energy through the length of the bolt. The relationship of the energy pulse frequency to its penetration is important in energy transmission. Lower frequencies produce longer wavelengths that will travel further through a given substance: while higher frequencies produce shorter wavelengths. To use a familiar example: AM radio signals are broadcast at relatively low frequencies and can be received hundreds of miles away, over the horizon. Higher quality FM radio and television signals are broadcast at much higher frequencies, and can only be received within a comparatively short line-of-sight or distance.

The same phenomenon exists with ultrasound. A low frequency 1 MHz pulse travels much farther through metal than a 5 MHz pulse. Therefore, a lower frequency transducer is able to achieve an echo in a longer bolt, or in a bolt made of metal with higher resistance to sound transmission (attenuation). While the lower frequency has more penetration power, it also produces more unwanted noise. Low frequency energy tends to spread, much like an unfocussed beam of light. When low frequency energy is introduced at the end of a bolt, a significant portion is bounced from side to side within the cylindrical shape, producing a noisy and distorted echo. Higher frequency pulses tend to travel more directly down and back the centerline of a bolt, with less noise and distortion.

Chapter 6 Bolt Preparation

The best balance between maximum frequency and noise suppression requires selecting the best transducer for bolt measurement. The diameter of the transducer (which is generally specified by the diameter of the actual piezoelectric crystal) directly effects energy transmission: Larger diameter crystals have greater ability to send and receive energy, and less of the energy tends to spread laterally. The ***MINI-MAX*** Bolt Tension Monitor strives to achieve this ideal balance: direct transmission of the strongest possible pulse, with the least amount of noise and distortion, down and back the center of the bolt to obtain the most accurate measurement.

6.1 Use of ultrasonic couplant

Sonic energy of the frequency used by the ***MINI-MAX*** travels well through solid materials and most liquids. It does not travel well through air. This variable resistance to the passage of sonic energy is called *sonic impedance*. It is the sudden change in impedance which occurs when the sound pulse attempts to cross the metal / air boundary at the end of the bolt, which causes most of the energy to be returned as an echo. To make a familiar comparison: light crossing the transparent glass boundary of a mirror and reflecting back an image from the nontransparent silvered back is much like an echo.

Any air gap between the face of the transducer and the end of the bolt will prevent the sonic energy from crossing. The gap must be filled with a suitable coupling fluid. Normally, a liquid ultrasonic couplant is applied between the transducer and the bolt. Since liquid has sonic impedance closer to the transducer and bolt material than air, it forms a continuous path for the outgoing pulse and the returning echo.

Many liquids can serve as an adequate couplant, however liquids with lower sonic attenuation will produce better results. Liquids containing glycerin offer such low impedance, and couplant manufactured for ultrasonic testing, such as the one shipped with the ***MINI-MAX***, produce the best results.

The single purpose of the couplant is to fill the air gap between the transducer and the bolt end. This is accomplished more easily with a liquid that is viscous enough to stay in place. Very viscous substances can create such a thick layer between the transducer and bolt that measurement errors occur. Also, viscous substances can trap air bubbles, which prevent adequate energy transmission. Again, the ultrasonic couplant provided with the ***MINI-MAX*** works best. Apply only the smallest quantity of couplant required to fill the air gap, and carefully seat the transducer so that any trapped air or excess couplant is squeezed out of the interface.

6.2 Transducer contact requirements

The goal is to transmit as much sonic energy as possible from the transducer into the bolt, and to send that energy, to the greatest extent possible, down and back the center of the bolt, as shown in Figure 1.

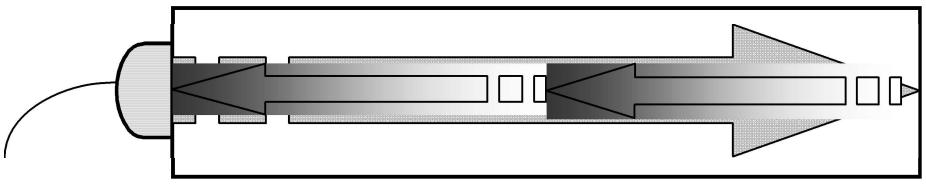


Figure 1 Sound path in a good bolt

Smooth, even surfaced bolt ends that seat the entire active surface of the transducer with minimum gap are required for accurate signal transmission. Bolt ends may need to be cleaned, ground, etc. to achieve the required surface.

Avoid:

- Rough or irregular surfaces which prevent adequate contact with the transducer. Irregular or rough surfaces can be filled with couplant, but energy transmission will still be reduced and dispersed causing mode conversions to occur from reflections off the side walls of the bolt, as shown at left of Figure 2.

- Bolt ends not perpendicular to the axis of the bolt, as shown at right of Figure 2. Energy will be transmitted toward the side wall and reflect along the bolt, yielding poor signal quality and possible measurement errors. Avoid alignment errors exceeding 2 degrees.



Figure 2 Rough and angled transducer contact

- Rusted, dirty, or thick paint-covered bolt ends. These coatings prevent sonic energy from traveling between the transducer and the bolt. Very thin coating or plating is acceptable.

- Bolt ends with recessed grademarks, as sh own at left of Figure 3. Couplant can be used to fill rec essed grademarks. Small indentations cause some loss of signal strength, but normal measurement is st ill poss ible. Large or numerous indentations cause the sign al to be too weak for a reliable measurement.

- Bolt ends with raised grade marks, or i ndentations with a ra ised edge, whic h cause the transducer to be seated at an angle to the axis of the bolt, thus preventing adequate contact, as shown at right of Figure 3.



Figure 3 Effect of lowered and raised grade marks

6.3 Bolt end reflectors

Smooth, flat reflecting bolt ends that are per pendicular to the axis of the bolt are required for accurate echo reception. Bolt ends may need to be cleane d, ground, etc. to achieve the required surface.

Note: Misalignment exceeding 2 degrees can cause significant errors.

Avoid:

- Rough reflecting bolt ends. As shown in Figure 4, if the reflecting end of the bolt is roug h or curved, most of the reflected energy will b e dispersed and a weak or distorted echo will be received.

- Reflecting bolt ends not perpendicular to the axis of the bolt. Sonic energy will be reflected toward the sidewall of the bolt, as shown in Figure 5.

- Nonperpendicular reflecting bolt ends due to bending of the bolt as shown in Figure 6.

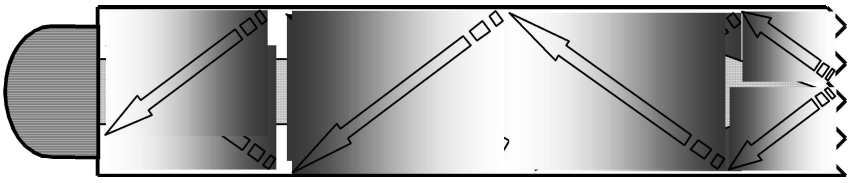


Figure 4 Rough reflective surface

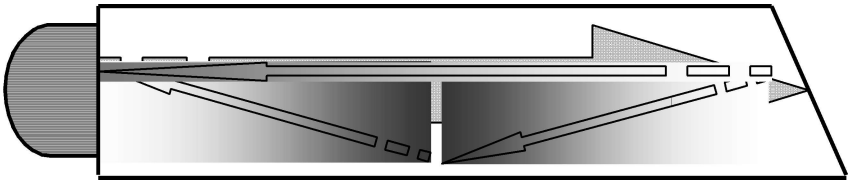


Figure 5 Non Parallel reflecting Surface

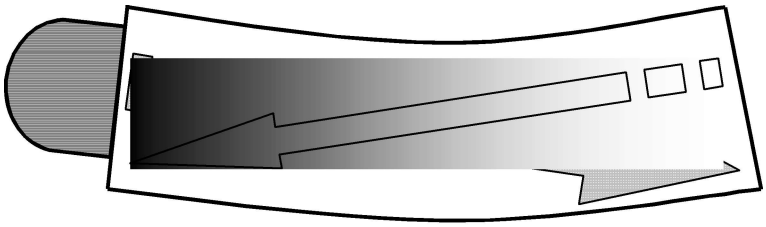


Figure 6 Reflection in a bending bolt

Chapter 7 Transducer Selection

7.1 Selecting the Transducer

Transducer selection is a very important part of getting the best results from the ***MINI-MAX***. The frequency and diameter of transducer should be carefully selected using the following information:

- Select the largest diameter transducer that will seat completely on the end of the bolt. If there are multiple applications and diameters to consider, select a diameter that will work for as many applications as possible, thus reducing the overall number of transducers needed.

- When selecting the proper frequency, the following items should be taken into consideration:

  Higher frequencies are typically a better choice when measuring smaller diameter bolts as the sound is better focused resulting in less beam spread and more directivity.

  Lower frequencies are more forgiving of potential bending and attenuative materials. This is primarily due to the longer wavelength avoiding smearing or distortion of the waveform. Longer wavelengths require more of a phase shift before distortion will occur. Lower frequencies offer an increased amount of dispersion and a reduced amount of directivity. As this may seem to go against what may typically be considered a good choice, in the case of bending it's actually the best choice overall.

Chapter 8 Measuring System Zero (calibration)

8.1 Introduction

System zeroing is the method of calculating the time required for each ***MINI-MAX*** and transducer combination to detect the echo. When an echo travels back through the bolt to the transducer face, there is an electronic delay before the ***MINI-MAX*** detects the echo. Because of differences in the electronic parts, or the transducer and cable, the delay is slightly different for each combination of ***MINI-MAX*** and transducer. The time delay is called the *delay factor* or *zero time offset*.

The ***MINI-MAX*** is designed for use with two calibration bars having a known ultrasonic velocity and known length. Comparing their known physical length and measured ultrasonic length determines the system delay factor, or zero time offset. The system delay factor makes the Dakota Ultrasonics ***MINI-MAX*** interchangeable with all other calibrated ***MINI-MAX*** systems.

Once the delay factor is determined, the ***MINI-MAX*** software automatically subtracts it from the apparent measurement of the time required for the sonic signal to travel through the bolt. Thus, the actual time of signal travel is determined, and compensation is made for the slight difference in each system. Since every *zeroed* ***MINI-MAX*** makes the same time measurement, the systems give the same result and are interchangeable.

System Zeroing is only required if:

- More than one ***MINI-MAX*** or transducer will be used while measuring a set of bolts. If the same ***MINI-MAX*** and transducer are used, the amount of the delay is constant. If unloaded length measurements were made with one ***MINI-MAX***, and the load measurements were made with another, the difference in the delay factor could cause an error, though in most cases the error would be very small. If it is uncertain that the same unit and transducer will always be used, it is strongly recommended that System Zeroing be checked whenever the ***MINI-MAX*** used.

- The application requires that the bolts be monitored over periodic intervals through their service life. In this case, the ***MINI-MAX*** must be zeroed in order to maintain reliable and accurate measurements. Once again, If a transducer, cable, or unit is replaced, the delay factor will change, resulting in erroneous measurements.

8.2 Calibration / Zero misnomer

In the past there have been instances where users were under the impression that zeroing the unit was the same as calibrating the unit. If the ultrasonic unit could successfully measure the calibration blocks, the unit was calibrated. However, this is not the case. The linearity of the unit and material type of the bolts are not calibrated following a zero procedure. *This is a misnomer.*

- The ***MINI-MAX*** should be sent in for calibration by Dakota Ultrasonics, or other authorized service representative, on a periodic basis to verify proper operation of the instrument. Dakota Ultrasonics recommends one-year intervals.

- Depending on the how critical the application is, bolts should be calibrated in a lab against a known load prior to measuring. A temperature bath should also be used to determine the necessary temperature factors required.

The following sections are typical methods of how to perform and calculate a probe zero using the ***MINI-MAX***. The proper method should be determined by the level of accuracy required and the specifications and conditions of the application itself.

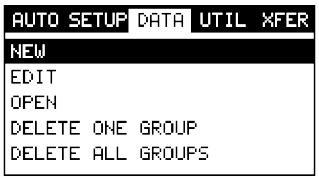
8.3 Using a standard bolt

Using any fastener that provides a good ultrasonic echo with both ends ground and polished can make a simple and effective calibration standard. The primary objective is to verify a zero value prior to measuring to avoid measurement errors if the ***MINI-MAX***, transducer, or cable is replaced. While this sounds like an economic way to go, the user must keep in mind that certified calibration standards are usually inclusive of an ultrasonic length, velocity, and temperature coefficient and are certified according to a specific set of standards. The following procedures outline how to use a standard bolt as follows:

The first step is to setup a group to document our probe zero data. By doing this, all the values and settings will be saved to the cell location for easy recall at a later time. This will allow the user to easily verify the zero value and make any necessary changes to the ***MINI-MAX***, by adjusting the zero value or temperature depending on the circumstances or conditions.

Creating a Group Name to Document Probe Zero Data

Note: Select a name that references this group to **Probe Zero Data**.



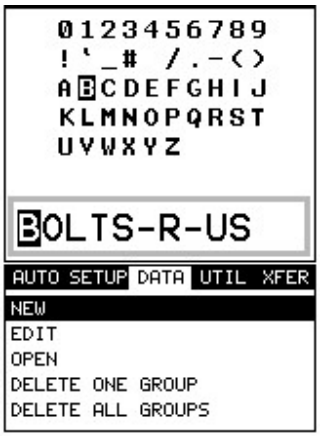
1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **NEW** is highlighted.

3) Press the **ENTER** key to display the **New Group Edit Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NAME** is highlighted.

5) Press the **ENTER** key to activate the **Alpha Edit Box**.



6) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

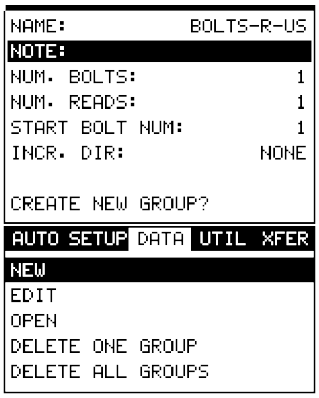
7) Press the **ENTER** key to select a character and advance to the next field of the **Group Name**.

8) Use the **CLR** key to backspace if necessary.

9) Repeat steps **6 - 8** until the **Group Name** is completed.

10) Press the **OK** key to save the **Group Name** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Name**.

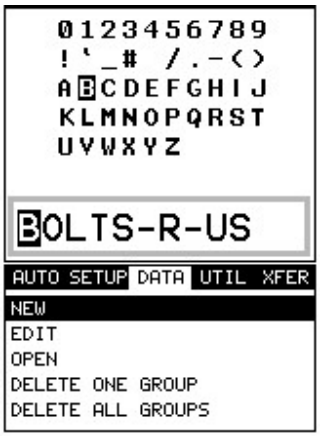
Creating a Group Note



Note: Be sure to include a note that describes and references the **Probe Zero** data and bolt.

1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NOTE** is highlighted.

2) Press the **ENTER** key to activate the **Alpha Edit Box**.



3) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

4) Press the **ENTER** key to select a character and advance to the next field of the **Group Note**.

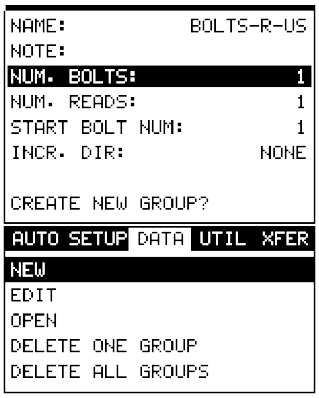
5) Use the **CLR** key to backspace if necessary.

6) Repeat steps **3** through **5** until the **Group Note** is completed.

7) Press the **OK** key to save the **Group Note** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Note**.

Selecting the Number of Bolts in the Group

Note: A group can contain up to 250 bolts. There must be at least 1 bolt in a group. If multiple bolts will be used to zero the ***MINI-MAX***, you will need to create multiple bolts in the group. In some cases the user will opt to use a bolt that is a representative bolt from each application, rather than just an arbitrary bolt. This would typically be done in critical applications.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM BOLTS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM BOLTS** value is correctly displayed.

6) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

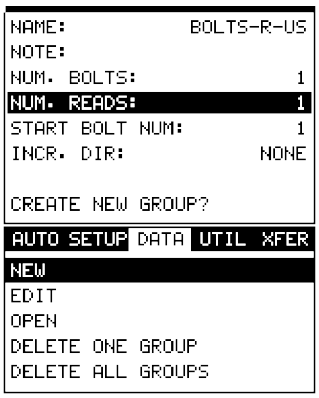
Note: If a number greater than 250 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **NUM BOLTS**.

8) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

Selecting the Number of Readings Per Bolt

Note: A bolt can have up to 51 possible measurements and 1 initial length (L-REF). There must be at least one reading per bolt. Since this group is being created to store probe Zero Data and verify your probe zero periodically, or before starting a new application, consider selecting all 51 measurements locations.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM READS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM READS** value is correctly displayed.

6) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

Note: If a number less than 1 or greater than 51 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

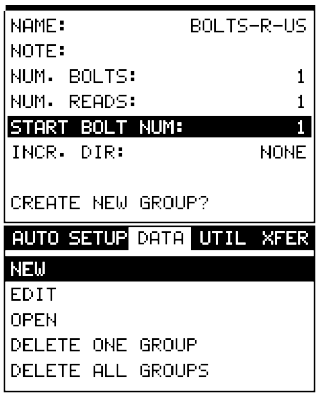
7) Press the OK key to display the **Digits Edit Box** and re-enter the **NUM READS**.

8) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

If there's not enough memory available to create the group, an error message box **"NOT ENOUGH MEMORY"** will be displayed. Press the **OK** or **ESC** key to return to the **Group List Items** menu. It may be necessary to free some memory in the ***MINI-MAX*** at this time.

Selecting the Starting Bolt Number

Note: Depending on the application and layout of the project, the user won't always want the starting bolt to be 1. This feature allows the user to define what the starting number will be.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **START BOLT NUM** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **START BOLT NUM** value is correctly displayed.

6) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

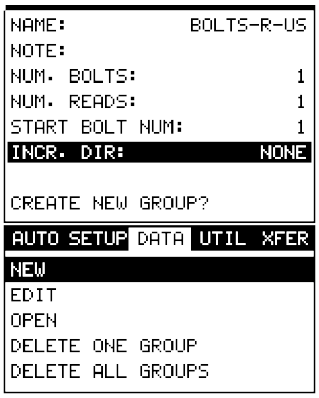
Note: If a value is enter that is greater than the maximum number of bolts allowed per group (250), an error message box "VALUE IS OUT OF RANGE" will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **START BOLT NUM**.

8) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

Selecting the Auto Increment Direction

The **Auto Increment** feature gives the user the ability to specify which direction to advance the cursor after storing a reading.



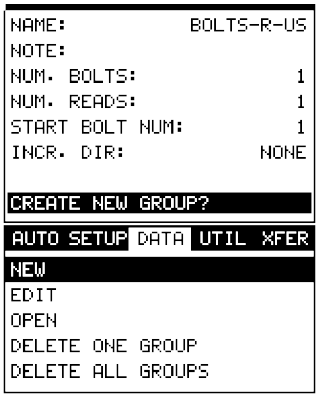
1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **INCR. DIR** is highlighted.

2) Use the **LEFT & RIGHT** arrow keys to toggle the **Increment** direction **NONE, NORTH, EAST, SOUTH, or WEST**.

3) When the correct **Increment** direction is displayed, continue on to the next section **"Saving the Group"**.

Saving the Group

Once all the parameters are set, the user has the option of saving or canceling the new group.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **CREATE NEW GROUP?** is highlighted.

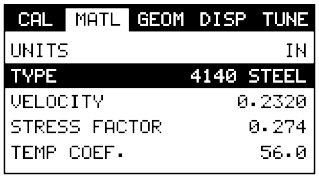
2) Press the **ENTER** key to accept the group parameters, and activate the confirmation screen.

3) Press the **OK** key to save the **New Group**, or the **ESC** key to cancel **the New Group** setup and return to the **DATA** menu.

4) Press the **MEAS** key to return to the measurement screen to begin measuring reference lengths.

Now that a group has been created to store our probe zero data, the material type of the standard probe zero bolt must be selected. This will load the appropriate values for velocity and the temperature coefficient into memory.

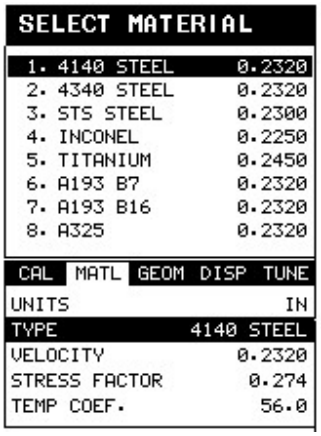
Selecting the Bolt Material Type



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **MATL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TYPE** is highlighted.

3) Press the **ENTER** key to display the list of material types.



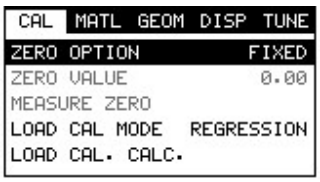
4) Press the **UP** and **DOWN** arrow keys to scroll through the material list until the appropriate material is highlighted.

5) Press the **ENTER** key to display the confirmation screen.

6) Press the **OK** key to select the material and return to the menu screen, or **ESC** to cancel the material selection.

Now that a bolt group has been created and material type selected to save and document the probe zero data, this next section will go through the process of obtaining the information needed to use the standard bolt for a probe zero calibration bar.

Setting up a Bolt Standard – For the First Time



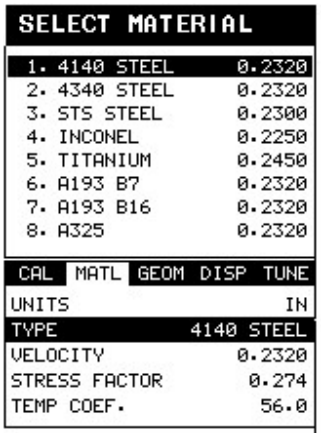
1) With the menu items already active, press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **CAL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO MODE** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the zero mode options until the **FIXED** option is displayed.

Note: The fixed option sets the delay factor to zero. In other words, disables the zero feature altogether.

4) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **MATL** menu is highlighted and displaying the submenu items.



5) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TYPE** is highlighted.

6) Press the **ENTER** key to display the list of bolt types.

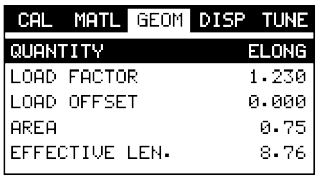
7) Press the **UP** and **DOWN** arrow keys to scroll through the bolt material types until the appropriate bolt type is highlighted.

8) Press the **ENTER** key to display the confirmation screen.

9) Press the **OK** key to select the bolt type and return to the menu screen, or press **ESC** to cancel the bolt type selection.

10) The new bolt type selected will be displayed to the right of the sub menu item. Write down the values for the **Velocity** and **Temperature Coefficient** also displayed next to the sub menu items below. These values will be needed in one of the following steps.

11) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **GEOM** menu is highlighted and displaying the submenu items.



12) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **QUANTITY** is highlighted.

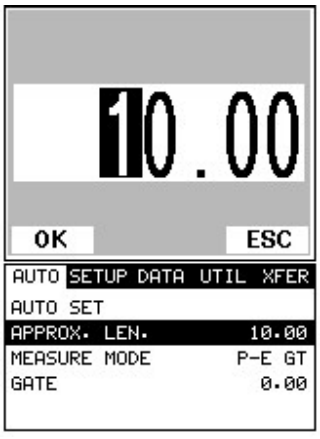
13) Use the **LEFT** and **RIGHT** arrow keys to scroll the quantity options until the **ELONG** option is displayed.

14) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **AUTO** menu is highlighted and displaying the submenu items.

15) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **APROX LEN** is highlighted.

Note: This is the approximate physical length of the fastener or bolt. This tells the ***MINI-MAX*** where to turn on the receiver and look for an echo. The area scanned will be +/- 5% from the approximate length.

16) Press the **ENTER** key to display the **Digits Edit Box**.



17) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

18) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

19) Repeat steps **16 & 17** until the **APPROX LEN** value is correctly displayed.

20) Press the **OK** key to set the **Approximate Length** and return to the menu screen, or **ESC** to cancel entering the **Approximate Length**.

21) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **AUTO SET** is highlighted.

Note: Both the *Approximate Length* and *Auto Set* feature could have also been set and activated using the **Hot Menu** Items, and **Keypad Auto Set** button as well. However, since you were already in the **Tab Menu** Items, it was just as easy as returning to the **Hot Menu** Items screen.

22) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt surface. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors cause by changing the sound path.*

23) Press the **ENTER** key and the **Ultrasonic Length** of the bolt will be displayed and should be documented and scribed on the bolt, along with the **Velocity** and **Temperature Coefficient**, for future zero verification.

24) Proceed to the next section to save this length in the **Probe Zero** group created in the previous section. DO NOT REMOVE THE TRANSDUCER FROM THE BOLT.

Now that we've gathered all the data for the probe zero bolt, we need to document it as outlined in the next section.

Storing the Reference Length

DELAY:	9.91	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	70.2
THR:	5	LOC:	B1
GROUP:BOLTS-R-US			

1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.

	A	B	C
1	10.0072		
2	10.0072		
3			
4			

2) Press the **ENTER** key to display the **Group View Box**.

3) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

Note: The first column must be used to store reference lengths.

4) Press the **ENTER** key to save the current reading in the highlighted cell location.

5) Abort the **Grid View Box** by pressing the **MEAS** key at any time.

6) Proceed to the next section to perform and store the first **Probe Zero** verification. DO NOT REMOVE THE TRANSDUCER FROM THE BOLT.

The next two sections outline t he procedur es of how to perform a probe zero calibration by calculating a zero value, or alternatively adjusting the temperature value to match the existing probe ze ro value. When s hould I use the **Calc Zero** feature versus adjusting the **Temperature**, and why?

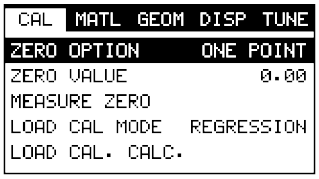
The only time the **Calc Zero** feature should be used is when a different ***MINI-MAX***, transducer, or transducer cable is be ing used, other than the one initially

used to obtain the pr obe zero data for t he probe zer o calibration bolt. In this case, calculating the probe zero value forces the new hardware to match with the original. If the hardware has not changed, the user should not use this feature. If the hardware hasn't c hanged only the tem perature value shou ld be adjusted to match the existing zero values.

The next t wo sections outline first, the procedure for calculat ing a probe zero because the hardware has c hanged, and s econd, by adjusting t he temperature value because the hardware is the same and the values do not match.

Performing a Probe Zero Calibration

Note: User has selected this section because the ***MINI-MAX***, transducer, or transducer cable has changed.

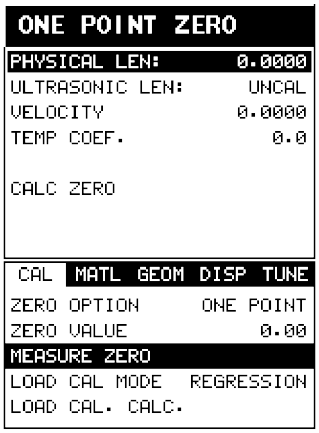


1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **CAL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO OPTION** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll the zero mode options until **ONE POINT** is displayed.

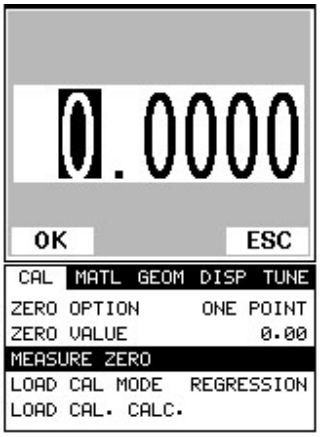
4) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **MEASURE ZERO** is highlighted.



5) Press the **ENTER** key to display the **One Point Zero Edit Box**.

6) Use the **UP** and **DOWN** arrow keys to scroll through the **One Point List Items** until **PHYSICAL LEN** is highlighted.

7) Press the **ENTER** key to display the **Digits Edit Box**.



Note: Enter the known ultrasonic length of the bolt that was documented and stored in the previous section. We will consider this ultrasonic length to be the actual physical length from this point forward. Reminder: It was stored in the first column of the probe zero group.

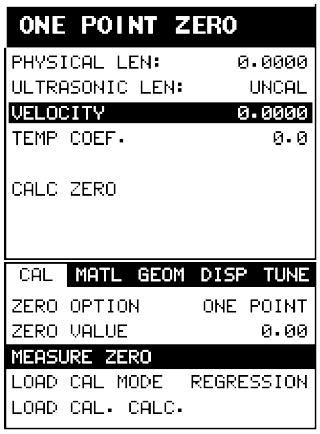
8) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

9) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

10) Repeat steps **8 & 9** until the **PHYSICAL LEN** value is correctly displayed.

11) Press the **OK** key to return to the **One Point Zero List**, or **ESC** to cancel entering the **PHYSICAL LEN** value.

12) Use the **UP** and **DOWN** arrow keys to scroll through the **One Point Zero List Items** until **VELOCITY** is highlighted.



13) Press the **ENTER** key to display the **Digits Edit Box**.

Note: Enter the velocity value of the bolt that was documented in the previous section. Reminder: The value was written down and scribed on the side of the bolt. It is the velocity used for the probe zero bolt.

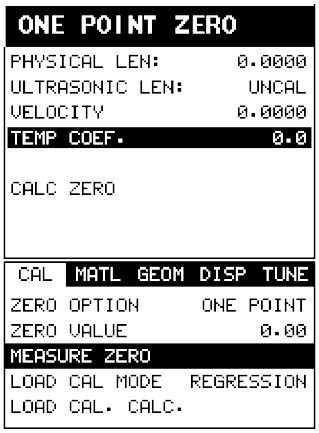
14) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

15) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

16) Repeat steps **14 & 15** until the **VELOCITY** value is correctly displayed.

17) Press the **OK** key to return to the **One Point Zero List**, or **ESC** to cancel entering the **VELOCITY** value.

18) Use the **UP** and **DOWN** arrow keys to scroll through the **One Point Zero List Items** until **TEMP COEF** is highlighted.



19) Press the **ENTER** key to display the **Digits Edit Box**.

Note: Enter the temperature coefficient value of the bolt that was documented in the previous section. Reminder: The value was written down and scribed on the side of the bolt. It is the temperature coefficient used for the probe zero bolt.

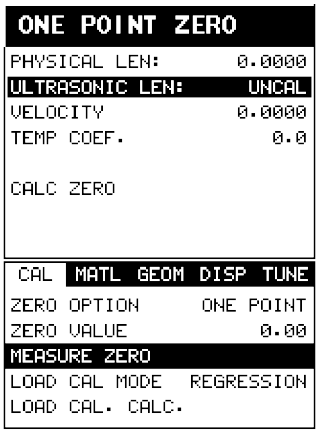
20) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

21) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

22) Repeat steps **20 & 21** until the **TEMP COEF** value is correctly displayed.

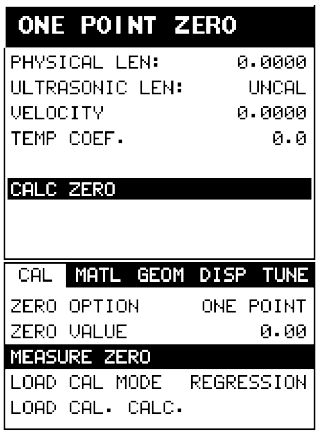
23) Press the **OK** key to return to the **One Point Zero List**, or **ESC** to cancel entering the **TEMP COEF** value.

24) Use the **UP** and **DOWN** arrow keys to scroll through the **One Point Zero List Items** until **ULTRASONIC LEN** is highlighted.



25) Press the **ENTER** key and the length value currently being measured, will appear in the **ULTRASONIC LEN** field.

26) Use the **UP** and **DOWN** arrow keys to scroll through the **One Point Zero List Items** until **CALC ZERO** is highlighted.



27) Press the **OK** key to set the **Zero Value** and return to the menu screen, or **ESC** to cancel entering the **Zero Value.** Notice the delay value has been inserted in the **Zero Value** field.

28) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

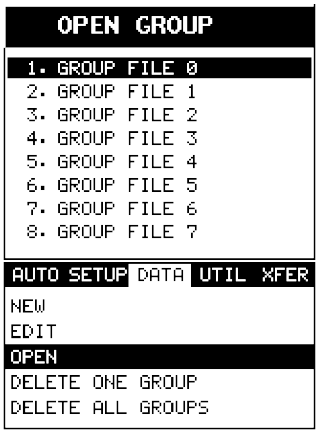
Typically when the zero va lue is off and the hard ware has not changed, it's because the temperature of the bolt has changed. In this case, the zero value

should not be changed, but the temperature value should be. Therefore the bolt becomes sort of temperature sensor in itself. This is also a good way to monitor temperature changes in the bolt. The procedures below demonstrate how to adjust the temperature to match the zero value.

Adjusting the Temperature to Match the Zero Value

Note: User has selected this section because the ***MINI-MAX***, transducer, or transducer cable has not changed and the zero value does not match.

Note: Let's assume that the group containing the probe zero calibration data is not the current group open. Therefore, the procedures that follow will demonstrate how to open the probe zero calibration group, verify the zero match, and make adjustments accordingly.



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **OPEN** is highlighted.

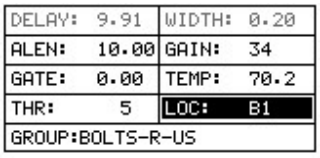
3) Press the **ENTER** key to display the **Group List Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the groups until the target group is highlighted.

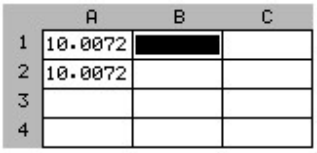
5) Press the **ENTER** key to activate the confirmation screen.

6) Press the **OK** key to load the group from memory.

7) Press the **MEAS** key to return to the measure screen.



8) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.



9) Press the **ENTER** key to display the **Group View Box**.

10) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the stored readings and corresponding display view. Notice as the cursor is moved to a different cell, the display will be updated with the display view saved with the reading.

11) Scroll the cursor to the next blank cell for the probe zero bolt. This will always be a cell located in columns **B – ZZ**. As soon as the user has scrolled to blank cell, the ***MINI-MAX*** will switch into elongation mode and use all the data from the probe zero bolt initially stored.

12) Press the **MEAS** key to return to the measure screen.

13) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **TEMP** cell is highlighted.

DELAY:	9.93	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	68.0
THR:	5	LOC:	A1
GROUP:BOLTS-R-US			

14) Use the **UP**, **DOWN**, **LEFT**, or **RIGHT** arrow keys to scroll the **TEMP** value.

15) Continue to scroll the temp value until the elongation reads 0.0000. When the value is at 0.0000 the ***MINI-MAX*** is officially zeroed and ready to store or document the zero data prior to making measurements.

16) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.

	A	B	C
1	10.0072		
2	10.0072		
3			
4			

17) Press the **ENTER** key to display the **Group View Box.** Notice that the cursor is still in the same cell location previously scrolled.

18) Press the **ENTER** key to store the 0.0000 elongation value. Why bother storing the 0.0000 elongation value? Because the adjustment to temperature is also stored with the measurement. This documents the changes for reporting requirements.

19) Finally, press the **MEAS** key to return to the measurement screen, set up a new bolt group, and begin taking readings.

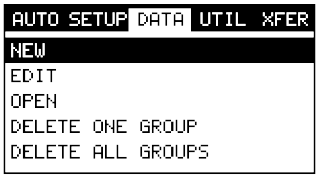
8.4 Calibration / Zero Bars & Triple Sided Glass Block

Historically a set of 3" & 6" mild steel calibration bars, or a triple sided glass block have been used for performing a probe zero . These bars/block are generally measured and certified to a specific set of standards in a professional calibr ation lab, and the corresponding length, velo city, and temperature coefficient are documented. Dakota Ultrasonics carries a custom set of ca l bars and an optical glass block that are meas ured and calibrated according to national stan dards. The primary advantage of us ing these bars/block v ersus setting a standard bolt aside, as explained in the pr evious section, is the pos sibility of losing the stand alone bolt. Because t he factory 3" & 6" bars and glas s block are calibrated with documentation, these can be interchanged between units and cal bars/blocks.

While the 3" & 6" bars provide two spec ific points to demonstrate linearit y, the triple sided glass bloc k has a third refer ence point. The glass block has a 1", 2", & 3" reference. Generally the us er will set up the two-point calibration on th e 1" & 3" sides first, and use the 2" side for additional v erification purposes. This section explains the procedure for usi ng the factory calibration bars and glass block as a means of probe zeroing the ***MINI-MAX***.

The first step is to setup a group to document our probe zero data. By doing this, all the values and settings will be saved to the cell loc ation for easy recall at a later time. This will allow the us er to easily verify the zero value and make any necessary changes to the ***MINI-MAX***, by adjusting the zero value or temper ature depending on the circumstances or conditions.

Creating a Group Name to Document Probe Zero Data



Note: Select a name that references this group to **Probe Zero Data**.

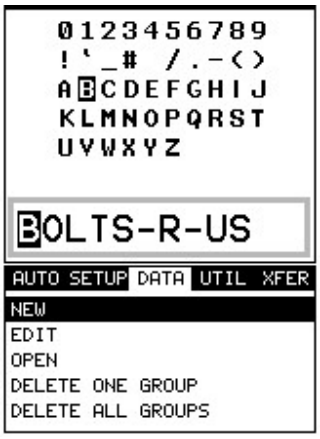
1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **NEW** is highlighted.

3) Press the **ENTER** key to display the New **Group Edit Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NAME** is highlighted.

5) Press the **ENTER** key to activate the **Alpha Edit Box**.



6) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

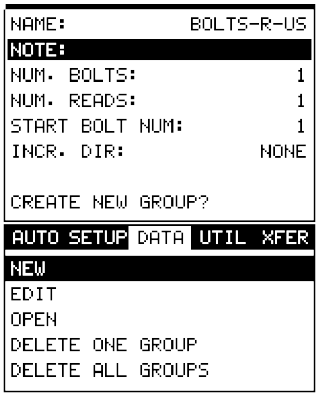
7) Press the **ENTER** key to select a character and advance to the next character of the **Group Name**.

8) Use the **CLR** key to backspace if necessary.

9) Repeat steps **6 - 8** until the **Group Name** is completed.

10) Press the **OK** key to save the **Group Name** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Name**.

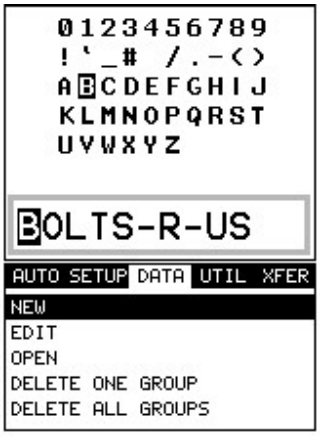
Creating a Group Note



Note: Be sure to include a note that describes and references the Probe Zero data and calibration apparatus used (3" & 6" bars or Triple sided glass block).

1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NOTE** is highlighted.

2) Press the **ENTER** key to activate the **Alpha Edit Box**.



3) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

4) Press the **ENTER** key to select a character and advance to the next character of the **Group Note**.

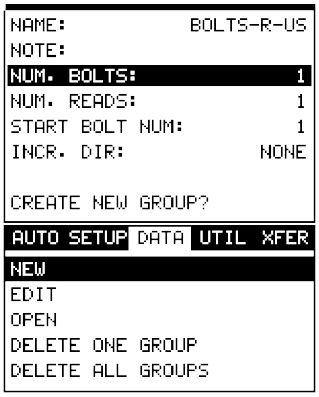
5) Use the **CLR** key to backspace if necessary.

6) Repeat steps **3 - 5** until the **Group Note** is completed.

7) Press the **OK** key to save the **Group Note** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Note**.

Selecting the Number of Bolts in the Group

Note: A group can contain up to 250 bolts. In this case, the number of bolts in the group can be thought of as the number of reference points on the calibration standards. If the 3" & 6" cal bars are being used, then the group should contain 2 bolts. If the triple sided glass block is being used, then the group should contain 3 bolts.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM BOLTS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

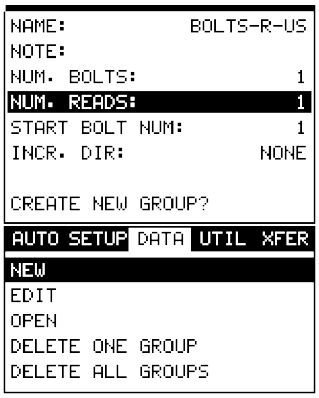
4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM BOLTS** value is correctly displayed.

6) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

Selecting the Number of Readings Per Bolt

Note: A bolt can have up to 51 possible measurements and 1 unloaded reference length (L-REF). There must be at least one reading per bolt. Since the group is being created to store probe **Zero Data** and verify linearity on a periodic basis prior to measuring or starting a new application, consider selecting all 51 readings. By selecting all 51 readings, all probe zero verification can be saved and reported “Cover your backside”.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM READS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM READS** value is correctly displayed.

6) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

Note: If a number less than 1 or greater than 51 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

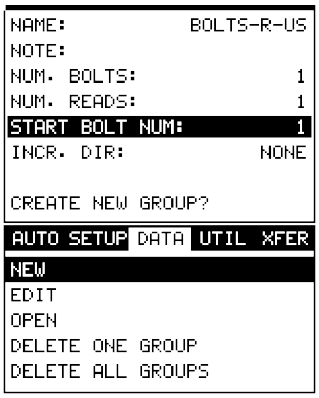
7) Press the **OK** key to display the **Digits Edit Box** and re-enter the **NUM READS**.

8) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

Note: If there's not enough memory available to create the group, an error message box **"NOT ENOUGH MEMORY"** will be displayed. Press the **OK** or **ESC** key to return to the **Group List Items** menu. It may be necessary to free some memory in the ***MINI-MAX*** at this time.

Selecting the Starting Bolt Number

Note: Depending on the application and layout of the project, the user won't always want the starting bolt to be 1. This feature allows the user to define what the starting number will be.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **START BOLT NUM** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **START BOLT NUM** value is correctly displayed.

6) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

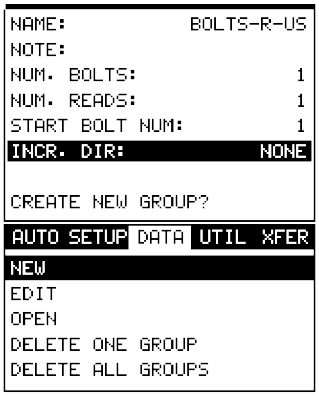
Note: If a value is enter that is greater than the maximum number of bolts allowed per group (250), an error message box "VALUE IS OUT OF RANGE" will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **START BOLT NUM**.

8) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

Selecting the Auto Increment Direction

The **Auto Increment** feature gives the user the ability to specify which direction to advance the cursor after storing a reading.



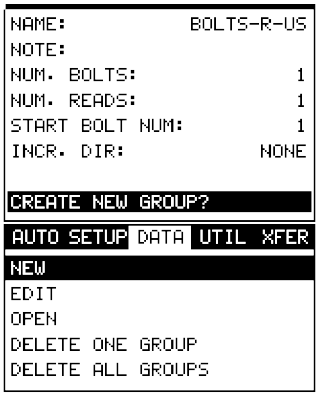
1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **INCR. DIR** is highlighted.

2) Use the **LEFT & RIGHT** arrow keys to toggle the **Increment** direction **NONE, NORTH, EAST, SOUTH, or WEST**.

3) The most logical direction in terms of this calibration section is **EAST**. When the correct **Increment** direction is displayed, continue on to the next section **"Saving the Group"**.

Saving the Group

Once all the parameters are set, the user has the option of saving or canceling the new group.



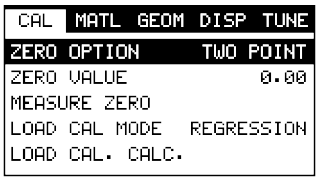
1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **CREATE NEW GROUP?** is highlighted.

2) Press the **ENTER** key to accept the group parameters, and activate the confirmation screen.

3) Press the **OK** key to save the **New Group**, or the **ESC** key to cancel **the New Group** setup and return to the **DATA** menu.

Now that the bolt group has been created to document the probe zero data, we're ready to get started with the probe zero process. The first thing to note is, the procedures in the next section demonstrate a **Two-Point** calibration. However, the same procedures apply to the **One-Point** calibration option also. The user would simply follow the same procedures and ignore references to the second point.

Measuring Calibration Standards – For the First Time



1) With the menu items still active from the previous section, press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **CAL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO MODE** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the zero mode options until the **TWO POINT** option is displayed.

Note: The two-point option allows the user to use two separate points for the probe zero calibration. Note: The one point option can optionally be selected if only one cal bar will be used. Although the procedures below are described with the two-point option in mind, they will also work in the case of a one-point calibration.

4) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **MEASURE ZERO** is highlighted.

5) Press the **ENTER** key to display the **Two Point Zero** list box.

6) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **PHY LEN 1** is highlighted.

Note: PHY LEN 1 is the actual physical length of the first calibration standard. If the glass block is being used, the 1" side should be used for **PHY LEN 1**.

7) Press the **ENTER** key to display the **Digits Edit Box**.

8) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

9) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

10) Repeat steps **8 & 9** until the **PHY LEN 1** value is correctly displayed.

11) Press the **OK** key to return to the **Two Point Zero** list, or **ESC** to cancel entering the **PHY LEN 1**.

12) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **PHY LEN 2** is highlighted.

Note: PHY LEN 2 is the actual physical length of the second calibration standard. If the glass block is being used, the 3" side should be used for **PHY LEN 2**.

13) Press the **ENTER** key to display the **Digits Edit Box**.

14) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

15) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

16) Repeat steps **14 & 15** until the **PHY LEN 2** value is correctly displayed.

17) Press the **OK** key to return to the **Two Point Zero** list, or **ESC** to cancel entering the **PHY LEN 2**.

18) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **VELOCITY** is highlighted.

Note: This refers the velocity of the probe zero cal bars. Since there is a velocity for each cal bar, use the velocity of the longest cal bar as it will be

most significant – 6" bar. If the glass block is being used, it will have only one velocity specified for the block.

19) Press the **ENTER** key to display the **Digits Edit Box**.

20) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

21) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

22) Repeat steps **20 & 21** until the **VELOCITY** value is correctly displayed.

23) Press the **OK** key to return to the **Two Point Zero** list, or **ESC** to cancel entering the **VELOCITY**.

24) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **TEMP COEF** is highlighted.

Note: This should be set to 55 (99 metric) for the 3 & 6" bars supplied by Dakota Ultrasonics. If the glass block is used, it should be set to 0. The reason for this is because glass has a very low temperature coefficient.

25) Press the **ENTER** key to display the **Digits Edit Box**.

26) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

27) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

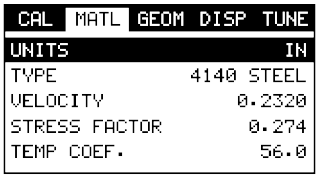
28) Repeat steps **26 & 27** until the **TEMP COEF** value is correctly displayed.

29) Press the **OK** key to return to the **Two Point Zero** list, or **ESC** to cancel entering the **TEMP COEF**.

30) Press the **ESC** key once to leave the **Two Point Zero** list.

31) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **MATL** menu is highlighted and displaying the submenu items.

Note: In order for the Mini-Max to display the correct measurement value during calibration, the material velocity and temperature coefficient must be set to the same values as in the calibration section.



32) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **VELOCITY** is highlighted.

33) Press the **ENTER** key to display the **Digits Edit Box**.

34) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

35) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

36) Repeat steps **34 & 35** until the **VELOCITY** value is correctly displayed.

37) Press the **OK** key to return to the **MATL** menu, or **ESC** to cancel entering the **VELOCITY**.

38) Repeat steps **32 – 37** to enter the **TEMP COEF**.

39) Repeat steps **32 – 37** to enter the **STRESS FACTOR to 1.000"**.

40) Proceed to the next section.

Before the probe zero is calculated the cal bars / glass block needs to be ultrasonically measured. Once the zero value has been calculated, the results will then need to be documented. This procedure is demonstrated in the next section.

Setting up the *MINI-MAX* for Measurement

Note: Check to see if the system was previously calibrated. You should **NOT** change the calibration unless the transducer, transducer cable, or instrument has been changed. In any event, the probe zero calibration should always be checked prior to changing it and only changed if it is required, as you can introduce error by uncertainty during the zero procedure. If the ***MINI-MAX*** has been previously calibrated, open the calibration data saved in the ***MINI-MAX*** and check the probe zero by simply measuring the bars in an empty location (columns B – ZZ) in the existing probe zero data group. *If the zero is slightly off, minor adjustments to the temperature, located in the* ***Main Measure Menu****, should be all that's necessary to bring the error between the two bars within a tolerance of* ***.0005"***.

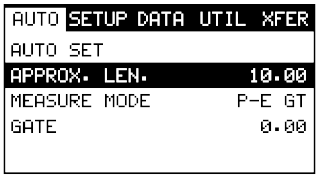
1) With the menu items still active from the previous section, press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **GEOM** menu is highlighted and displaying the submenu items.



2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **QUANTITY** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the quantity options until the **ELONG** option is displayed.

4) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **AUTO** menu is highlighted and displaying the submenu items.



5) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **APROX LEN** is highlighted.

Note: This is the approximate physical length of the cal standard currently being measured. This tells the ***MINI-MAX*** where to turn on the receiver and look for an echo. The area scanned will be +/- 5% from the approximate length. For this example, 3" & 6" cal bars are used. Start with the 3" cal bar first. Note: If the glass block is being used as the standard, use the 1" side.

6) Press the **ENTER** key to display the **Digits Edit Box**.

7) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

8) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

9) Repeat steps **7 & 8** until the **APPROX LEN** value is correctly displayed.

10) Press the **OK** key to set the **Approximate Length** and return to the menu screen, or **ESC** to cancel entering the **Approximate Length**.

Note: Alternatively, the **Approximate Length** can be entered from the main measurement screen using the **ALEN** measure menu item. This can be accessed by pressing the **MEAS** button on the keypad multiple times until the **ALEN** field is highlighted.

11) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **AUTO SET** is highlighted.

12) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the **3" calibration bar**.

13) Pressthe **ENTER** key and the ***MINI-MAX*** will automatically locate and measure the **Ultrasonic Length** of the first cal bar.

Note: Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and cal bar surface. Remove and replace the transducer a couple of times in the exact same location on the cal bar, rotating it each time to obtain the minimum value measured. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors caused by changing the sound path.*

Note: Once an echo is found and the ***MINI-MAX*** is measuring the cal bar, the **GAIN**, as well as the **POLARITY** may need to be adjusted. The cal bars produce an extremely strong signal and often the gain should be set to the minimum 20dB depending on the diameter of the transducer. A thorough understanding of the section on **"Interpreting the Waveform"** is very important prior to making any adjustments. Once this section has been reviewed, the **GAIN** and **POLARITY** features are located in the **TUNE** tabbed menu. Alternatively, the gain can also be adjusted in the hot menus on the main measurement screen.

14) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **CAL** menu is highlighted and displaying the submenu items.

15) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **MEASURE ZERO** is highlighted.

16) Press the **ENTER** key to display the **Two Point Zero** list box.

17) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **ULTRASONIC 1** is highlighted – 3" bar or 1" side of glass block.

18) Press the **ENTER** key to store the measured value of the 3" bar or 1" side of glass block.

19) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the **6" calibration bar** (or 3" side of glass block). Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and cal bar surface. Remove and replace the transducer a couple of times in the exact same location on the cal bar, rotating it each time to obtain the minimum value measured. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors caused by changing the sound path.*

20) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **ULTRASONIC 2** is highlighted – 6" bar or 3" side of glass block.

21) Press the **ENTER** key to store the measured value of the 6" bar or 3" side of glass block.

22) Press the **UP** and **DOWN** arrow keys to scroll through the **Two Point Zero** list until **CALC ZERO** is highlighted.

23) Press the **ENTER** key to calculate the zero.

24) Press the **OK** key to confirm "overwrite settings".

25) Press the **ENTER** key once again to open the **TWO POINT ZERO** list and evaluate the error.

Evaluate the Error: Compare the difference between the physical and ultrasonic lengths. If the error exceeds 0.0005" the temperature must be adjusted, and the CAL procedure repeated for 3" & 6" bars – *Setting Up the MINI-MAX for Measurement*.

Note: This shouldn't be necessary when using the glass block as the calibration standard.

Calculating Temperature Adjustment: Use the difference between the physical and ultrasonic lengths of the 6" bar only and multiply the error by 3. This is the same as OVER correcting the error by 300%.

[(Ultrasonic Length 6" Bar) – (Physical Length 6" Bar)] * 3

example using the equation above:

[(6.0077) – (6.0049)] * 3 = 0.0084".

The over corrected error must now be subtracted from the physical length of the 6" bar: 6.0049" – 0.0084" = 5.9965"

26) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **TEMP** cell is highlighted.

27) Use the **LEFT** and **RIGHT** arrow keys to scroll the temperature value until the measured value is reading the over corrected value calculated above.

Note: Lower temperatures will make the bolt read longer, and higher temperatures shorter.

28) Repeat steps 14 – 25 above to re-calculate the zero value using the adjusted temperature setting.

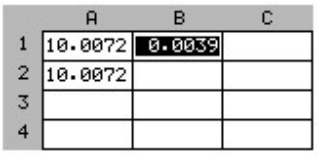
Note: The above steps may need to be repeated a couple of times in order to bring the probe zero calibration into specification - .0005". Note: This is typically not necessary when using the glass block as a cal standard.

29) Once the zero/calibration is within specification, these initial lengths should be saved in column A of the zero group previously created for future reference and verification.

Note: A periodic check should be conducted to prior to starting a project, to confirm the zero is still accurate. If it's determined the ***Mini-Max*** is out of spec, only minor adjustments to the temperature should be necessary. Refer to the section on *"Verifying the probe zero calibration".*

Note: Now that the zero is within spec, the values should be documented in the probe zero calibration group created and opened in an earlier section.

30) Press the **MEAS** key twice to activate measurement screen. Press the **MEAS** key multiple times to move right, and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.



	A	B	C
1	10.0072	0.0039	
2	10.0072		
3			
4			

31) Press the **ENTER** key to display the **Group View Box**.

32) Pressthe **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

Note: Since these are the first cal bar measurements taken, the measurements have to be stored in column **A**. In fact, the most logical approach would be to store the **3"** bar in **A1**, and the **6"** bar in **A2**. However, if the glass block is the standard, store the **1"** side in **A1**, **2"** side in **A2**, and the **3"** side in **A3**.

33) Place the transducer on the 3" bar in the exact location as before.

34) Pressthe **ENTER** key to save and document the current reading in the highlighted cell location.

35) Repeat steps **33 & 34** for the 6" bar in location **A2.** Note: Repeat the steps an additional time for the extra point on the glass block.

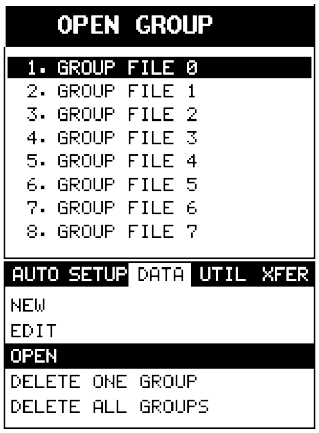
Note: The ***Mini-Max*** is now properly zeroed and ready for action.

This next section demonstrates how to go back and verify if the probe zero value is still linear and "In Spec" at a later time. *It's important to note that user should never have to change or re-calculate the probe zero value again, unless the* ***MINI-MAX****, transducer, or cable has been replaced*. If the transducer or cable has changed, and the probe zero value re-calculated, the change in the zero value should be very small. Therefore, if the zero is re-calculated and the delta is very large, something else has gone wrong and the user should become suspicious of the how well the probe zero was performed.

If we consider the initial probe zero value constant, as the hardware cal bars or glass block have not been replaced, the future verifications should always show an elongation value of +/- 0.0001", in order to be considered "In Spec". If the probe zero is out of spec, the user should make adjustments only to the physical temperature setting in the ***MINI-MAX***. In other words, the primary reason the probe zero is out of spec is because the physical temperature of the probe zero calibration standards has changed. **If the accessory temperature sensor is being used, the sensor will automatically adjust the physical temperature and the *MINI-MAX* should be "In Spec" and displaying an elongation value of 0.0000" +/- .0001".** The next section outlines the verification procedures.

Verifying the Probe Zero at a Later Time

1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DATA** menu is highlighted and displaying the submenu items.



2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **OPEN** is highlighted.

3) Press the **ENTER** key to display the **Open Group List Box.**

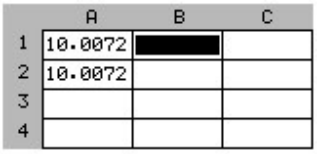
4) Use the **UP** and **DOWN** arrow keys to scroll through the list menu items until the *group name containing the probe zero data* is highlighted.

5) Press the **ENTER** key to load the zero data group into memory, followed by pressing the **OK** key to confirm loading the group into memory.

Note: The user will always use this group for the zero verification procedure, as it contains the original settings and measurement data of the probe zero calibration standards.

6) Apply a drop of couplant to the cal standard or transducer, and attach it to one end of the cal standard. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and cal standard. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors caused by changing the sound path.*

7) Press the **MEAS** key once to activate the measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **LOC** cell is highlighted.



8) Press the **ENTER** key to display the **Group View Box**.

9) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

Note: Since this is the 1st verification following the initial measurement of the **Probe Zero Cal Bars**, the cursor should be located on a cal standard in **column B**. It's also important to note that the **L-REF** stored in **column A**, also contains all the ***MINI-MAX*** settings when the **L-REF** was initially measured. **These settings will automatically be copied to all the columns B-ZZ, for each individual bolt.** Therefore, **no adjustments** to the ***MINI-MAX*** should be necessary.

10) If the elongation is +/- .0001" and "In Spec", Press the **ENTER** key to save the current reading in the highlighted cell location, storing all the current probe zero verification data. **Repeat steps 6 - 19 for the other probe zero calibration standards. If the probe zero is "Out of Spec", proceed to the next step.**

11) Assuming the elongation is "Out of Spec", Press the **MEAS** key once to activate the measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **TEMP** cell is highlighted.

12) Use the **LEFT** and **RIGHT** arrow keys to adjust the temperature value util the elongation is 0.0000", or "In Spec" at +/- 0.0001".

13). Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **LOC** cell is highlighted.

14) Press the **ENTER** key to display the **Group View Box.** Notice the elongation value is now "In Spec".

15) Press the **ENTER** key to save the current reading in the highlighted cell location, storing all current probe zero verification data.

16) **Repeat steps 6 - 19 for the other probe zero calibration standards. Once again, If the probe zero is "Out of Spec", repeat steps 20 – 25.**

Chapter 9 Temperature Compensation

9.1 Purpose

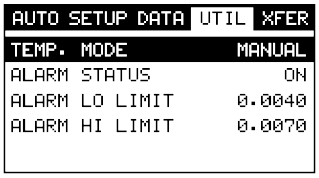
The temperature of a fastener affects the overall physical length, as well as the velocity of a fastener. As the temperature of a fastener increases, the ultrasonic length increases at a rate greater than the physical change in length. If the user intends to measure the same fastener at different time intervals over the service life of the bolt, temperature compensation is very important to produce accurate results. However, if a fastener will only be measured once, never to be measured again, temperature compensation is not needed, as long as the reference length and elongation are measured at the same temperature and time.

The thermal expansion of the fastener and the ultrasonic change in velocity as a result of temperature are two separate effects. However, for the purpose of the ***MINI-MAX***, they are combined in a single factor known as the Temperature Coefficient (Tc). The sections that follow outline the procedures for selecting and using the temperature compensation mode with the accessory temperature sensor.

9.2 Manual Mode

The manual mode option relies on the user to enter in the current temperature before measuring. This is useful to those users that do not require temperature compensation, or have an external temperature device measuring the temperature.

Selecting Manual Temperature Mode



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **UTIL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TEMP MODE** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the temperature mode options. Once the **MANUAL** temperature mode is displayed, press the **MEAS** key to return to the measurement screen.

4) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right, and the **ESC** key multiple times to move left until the **TEMP** cell is highlighted.

DELAY: 9.93	WIDTH: 0.20
ALEN: 10.00	GAIN: 34
GATE: 0.00	TEMP: 68.0
THR: 5	LOC: A1
GROUP:BOLTS-R-US	

5) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

6) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

7) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

8) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

9) Repeat steps **7 & 8** until the **TEMP** value is correctly displayed.

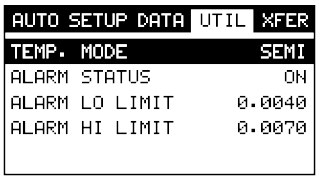
10) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **TEMP**.

9.3 Semi Automatic Mode

The semi automatic mode gives the user an opportunity to initiate when the temperature is read and automatically adjusted. This mode may be desirable to those users want to use the automatic mode but want to retain some control as to when the temperature is changed, rather than take for granted the temperature is automatically changing. Some companies and application procedures may call for manually initiating and physically viewing the change in temperature by

adding a manual step to the procedures. The semi automatic mode answers requirements such as these.

Selecting Semi Automatic Temperature Mode



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **UTIL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TEMP MODE** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the temperature mode options. Once the **SEMI AUTO** temperature mode is displayed.

4) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right, and the **ESC** key multiple times to move left until the **TEMP** cell is highlighted.

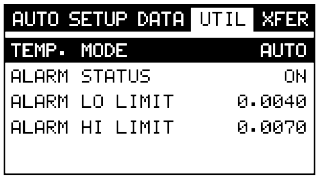
5) Press the **ENTER** key to activate the **Digits Edit Box** and the temperature will be displayed and active.

6) Press the **OK** key to accept the temperature and return to the measurement screen, or **ESC** to cancel entering the **TEMP**.

9.4 Automatic Mode

The automatic mode constantly monitors and compensates for temperature when the accessory temperature sensor is attached to the ***MINI-MAX*** and placed on the joint or fastener being measured. While this mode eliminates the need to manually insert or initiate a temperature measurement, it also requires that the user be very cautious that the sensor is properly attached to the joint or fastener, and not accidentally removed or misplaced during the measurement process.

Selecting Automatic Temperature Mode



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **UTIL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TEMP MODE** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the temperature mode options. Once the **AUTO** temperature mode is displayed.

4) Press the **MEAS** key once to return to the measurement screen.

Chapter 10 Bolt Material Calibration

10.1 Why do we need to calibrate

The preset bolt types in the ***MINI-MAX*** contain average factors for the material type. These are approximate values only. In a tightly controlled application where extreme accuracy is required, it is necessary to obtain all the information possible about the fasteners being measured. By calibrating the fasteners, the ultrasonic and physical lengths of the bolts will match. However, if a field calibration is done, a complete calibration is not necessary. An important thing to note is the fact that everything done in the calibration process result in average values. Since a sample of fasteners will be used in the calibration process, and given the slight differences in material, the result will always be an average value of that sample.

10.2 Velocity calibration

A velocity calibration is generally performed by adjusting the velocity in the ***MINI-MAX*** to the point where the ultrasonic and physical lengths match. Again, since a sample of fasteners will be used in this process, the velocities will vary by a very small amount, thus resulting in an average velocity value. To accurately calibrate the velocity, a calibrated set of mechanical calipers is required to determine the exact physical lengths of the fasteners. The following procedure outlines this process.

Calibrating the Velocity

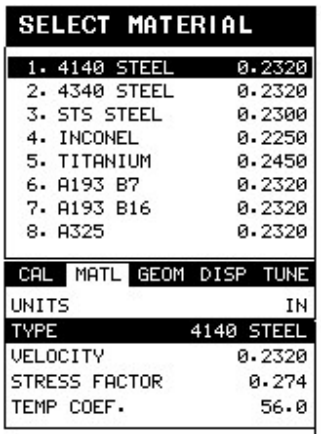
CAL	MATL	GEOM	DISP	TUNE
QUANTITY				ELONG
LOAD FACTOR				1.230
LOAD OFFSET				0.000
AREA				0.75
EFFECTIVE LEN.				8.76

1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **GEOM** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **QUANTITY** is highlighted.

3) Press the **LEFT & RIGHT** arrow keys to scroll the quantity until **ELONG** is displayed.

4) Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **MATL** menu is highlighted and displaying the submenu items.



5) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **TYPE** is highlighted.

6) Press the **ENTER** key to display the list of bolt material types.

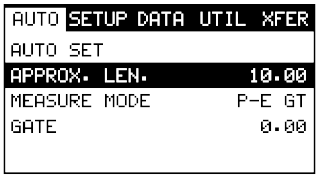
7) Press the **UP** and **DOWN** arrow keys to scroll through the material list until the appropriate material type is highlighted.

Note: If the material type is not in the list of types, select a similar type. This step is only to get the velocity value in a close proximity – not critical. **Write down the velocity of the material type selected. This will be considered the *Current Velocity*.**

8) Press the **ENTER** key to display the confirmation screen.

9) Press the **OK** key to select the type and return to the menu screen, or **ESC** to cancel selecting the material type.

10) Pressthe **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **AUTO** menu is highlighted and displaying the submenu items.



11) Usethe **UP** and **DOWN** arrow keys to scroll through the sub menu items until **APPROX LEN** is highlighted.

12) Pressthe **ENTER** key to display the **Digits Edit Box**.

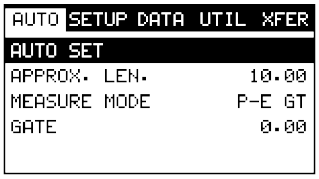
13) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

14) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

15) Repeat steps **10 & 11** until the **APPROX LEN** value is correctly displayed.

16) Press the **OK** key to set the **Approximate Length** and return to the menu screen, or **ESC** to cancel entering the **Approximate Length**.

17) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **AUTO SET** is highlighted.



18) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt surface. *Be sure to always place the*

transducer in the same location. This will help to eliminate any potential measurement errors caused by changing the sound path.

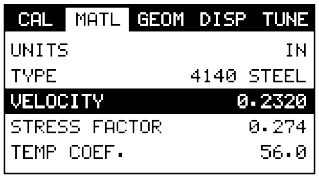
19) Press the **ENTER** key and the **Ultrasonic Length** of the bolt will be displayed.

Note: Alternatively, the **Auto Set** key can be pressed to activate **the Auto Set** routine.

20) Calculate the correct velocity using the following equation:

$$\frac{PhysicalLength}{UltrasonicLength} * CurrentVelocity = CorrectVelocity$$

21) Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **MATL** menu is highlighted and displaying the submenu items.



22) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **VELOCITY** is highlighted.

23) Press the **ENTER** key to display the **Digits Edit Box**.

Note: Enter the Correct Velocity calculated above.

24) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

25) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

26) Repeat steps **21 & 22** until the **VELOCITY** value is correctly displayed.

27) Press the **OK** key to set the **Velocity** and return to the menu screen, or **ESC** to cancel entering the **Velocity**.

28) Finally, press the **MEAS** key to return to the measurement screen. *The ultrasonic length displayed should now match the known physical length.*

10.3 Stress factor calibration

The sonic stress factor is an empirically determined value for the bolt material or type of bolt being measured. It expresses the ratio of the actual elongation, or stretch, of the bolt, to the apparent ultrasonic change in length. Since the change in ultrasonic length is approximately 3 times the change in physical length, due to the change in velocity , a stress factor mu st be applied to correct the ultrasonic length in the ***MINI-MAX***.

Following steps determine the Sonic Stress Factor for bol ts of a specific bolt material and specific geometry by meas urement of the actual change in bolt length.

Required Equipment:

- A laboratory or room in which the temperature can be maintained at between 66° to 70° F.
- A means of applying load to the bol t. Ideally this would be a tensile load machine, capable of measuri ng the applied load to within 100 lbs. However, since the actual value of the applied load is not used in calculating the stress factor, any means of applying an approximate load to the bolt will suffice. This includes tightening the bolt against a fixture that simulates the actual joint. A mechanical means of traceable measurement of the physical length of the sample fasteners at various tensile loads to an accuracy of plus or minus 0.0001 inch. Examples of such devices include the following
  - Length measurement function of sophisticated tensile test machine
  - Mechanical or electronic height gages
  - Averaged values of length meas urement with mechanical and electric micrometers.
- A Dakota Ultrasonics ***MINI-MAX*** Ultrasonic Bolt Tension Monitor.

- A minimum of three sample bolts which are representative of the bolt type and geometry for which the Sonic Stress Factor is to be determined.

NOTES:

- The Dakota Ultrasonics ***MINI-MAX*** must be calibrated, or zeroed, as described in the Zero Calibration procedure section 8.4.

- The Velocity Calibration should be performed prior to determining the Stress Factor. Refer to section 10.2.

- The sample bolts must be left to soak in the controlled temperature environment for a period of not less than 24 hours. Care must be taken through out the measurement process to avoid significant change in the bolt temperature due to handling of the sample bolts, or the process of applying load.

- The mechanical apparatus for measurement of length must be calibrated in accord with governing QA procedures. The device should be configured so that minimum handling of the sample bolts will be required during the measurement process.

Determination of the Sonic Stress Factor is accomplish by solving the equation:

$$SonicStressFactor = \frac{\Delta L_{MECHANICAL}}{\Delta L_{ULTRASONIC}} = \frac{L_{Ml} - L_{M0}}{L_{Ul} - L_{U0}}$$

$$L_{U0} = UltrasonicLength@ZeroLoad$$
$$L_{M0} = MechanicalLength@ZeroLoad$$
$$L_{Ul} = UltrasonicLength@Load$$
$$L_{Ml} = MechanicalLength@Load$$

Calibrating the Stress Factor

1) Using the mechanical measuring device, measure and record the Mechanical Length at Zero Load "L_{M0}" for each sample bolt.

Note: The following steps assume that the user has performed the steps in the previous section and calibrated the velocity. Therefore, the velocity has been adjusted, approximate length already entered, and the ***MINI-MAX*** is currently setup and ready to measure in elongation mode.

2) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors cause by changing the sound path.*

3) Record the Ultrasonic Length at Zero Load "L_{U0}".

4) **Repeat step 2 & 3** for each sample bolt.

5) *Place the first sample bolt in the loading apparatus. Apply approximately 1/3 of the maximum load, which is to be placed on the bolt under actual working conditions. Using the mechanical measuring device, measure and record the Mechanical Length at Load 1 "L_{M1}" for the current sample bolt.*

6) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt. Measure and record the Ultrasonic Length at Load 1 "L_{U1}"for the current sample bolt.

7) *Increase the applied load to approximately 2/3 of the maximum load, which is to be placed on the bolt under actual working conditions. Using the mechanical measuring device, measure and record the Mechanical Length at Load 2 "L_{M2}" for the current sample bolt.*

8) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt. Measure and record the Ultrasonic Length at Load 2 "L_{U2}"for the current sample bolt.

9) *Increase the applied load to approximately the maximum load, which is to be placed on the bolt under actual working conditions. Using the mechanical measuring device, measure and record the Mechanical Length at Load 3 "L_{M3}" for the current sample bolt.*

10) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt. Measure and record the Ultrasonic Length at Load 3 "L_{U3}" (Maximum) for the current sample bolt.

11) **Repeat Steps 5 – 10** for the remaining bolts.

12) *Calculate the value of the Sonic Stress Factor at each load on each sample bolt.*

$$SSF_{B1L1} = \frac{L_{M1} - L_{M0}}{L_{U1} - L_{U0}} \; SSF_{B1L2} = \frac{L_{M2} - L_{M0}}{L_{U2} - L_{U0}} \; SSF_{B1L3} = \frac{L_{M3} - L_{M0}}{L_{U3} - L_{U0}}$$

13) *Determine the average value of the Sonic Stress Factor by dividing the sum of all SSF values divided by the total number of SSF values.*

10.4 Temperature factor calibration

The thermal expansion of the fastener and the ultrasonic velocity change with temperature are two separate effects. However, for the purpose of the ***MINI-MAX*** they are combined into a single factor known as the Temperature Factor.

The important thing to note is that both the thermal expansion and the velocity are changing with respect to changes in temperature. The ***MINI-MAX*** always measures a fastener at 68 ° F. If the temperature of the fastener is currently being measured at 108 ° F, the ***MINI-MAX*** will compensate, or correct, the measurement back to 68 ° F. Note: This is an arbitrary temperature range only. The primary thing to consider is to use a respectable temperature range with at least 5 different temperature points. The following procedure outlines the process for experimental determination of the Temperature Factor for a bolt made of a specific material type and geometry.

Required Equipment.

- A means of varying and measuring the temperature of the sample bolts between 48 ° to 108 ° F to an accuracy of +/- 2 ° F. The device must allow for a transducer to be connected to one end of the bolt for the purpose of measuring.

  Many sophisticate temperature chambers are commercially available, and ideally suited for this function. However, a simple and inexpensive method can be achieved by immersion of the sample bolts in a water bath, which can be heated to boiling or cooled by adding ice. At sea level this will reliably vary the bolt temperature between approximately 48° to 108° F depending on water purity and atmospheric pressure. By measuring the temperature of the stirred water bath with a precise mercury thermometer, while reading the ultrasonic length of the bolt, accurate calibration points can be obtained.

- A Dakota Ultrasonics ***MINI-MAX*** Ultrasonic Bolt Tension Monitor.
- A minimum of three sample bolts, which are representative of the bolt type and geometry for which the Temperature Factor is to be determined.

NOTES:

- The Dakota Ultrasonics ***MINI-MAX*** must be calibrated, or zeroed, as described in the procedure entitled Measuring System Zero in Chapter 8.
- The sample bolts should be left to soak at the measured temperature points for a period of not less than 20 minutes, to insure that temperature is uniform throughout the sample.
- If a water bath is used, care must be taken to avoid immersion of the ultrasonic transducer.

Determination of the Temperature Factor is accomplish by solving the equation:

Where:

$T_p = \frac{(L_0 - L_T)}{L_T(T_0 - T)} \times 10^6$ *Temperature Factor*	L_0 = Ultrasonic Length at Beginning Temperature (T_0) L_T = Ultrasonic Length at Ending Temperature (T) T_0 = Beginning Temperature T = Ending Temperature

Calibrating the Temperature Factor



1) *Stabilize the sample bolt at approximately 48^0 F. If the water bath method is used this is accomplished in a stirred bath of ice and water. Measure and record this minimum temperature as T_0.*

Note: The following steps assume that the user has performed the steps in the previous section and calibrated the velocity. Therefore, the velocity has been adjusted, approximate length already entered, and the ***MINI-MAX*** is currently setup and ready to measure in elongation mode.

2) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors caused by changing the sound path.*

3) Record the ultrasonic length "L_0" of the sample bolt at the above minimum temperature - 48^0 F.

4) **Repeat step 1 - 3** at the target temperatures (T_1 through T_5) – 48, 68, 88, and 108 ^{0} F (other similar range with 5 temperatures), measuring the ultrasonic lengths (L_1 through L_5) respectively. This process must be done for each of the sample bolts in the experiment.

5) Use the equation below to calculate a linear regression, using the temperatures and lengths recorded for all the sample bolts to determine the temperature factor.

$$TemperatureFactor = \frac{\sum xy - \frac{\left(\sum x\right)\left(\sum y\right)}{n}}{\sum x^2 - \frac{\sum (x)^2}{n}} * 10^6$$

x = temperature, y = change in reference length, n = number of sample points per bolt

Chapter 11 Load Measurement

11.1 Calculating a load factor

The load factor is an empirically determi ned value for the geometry of the bolt. It is the amount of load requi red to elongate the bolt 0.001" in Englis h Unit s or 0.01mm in Metric Units. The accurate l oad factor for the bolts being measured is determined by the Calibrate Bolt function.

An approximate value of this geometry dependent factor can be calculated as follows:

$$L_F = \frac{A_\sigma E}{(C_L + D)} \times 10^{-3}$$

Load Factor

A_σ = Cross Sectional Area of the Bolt
E = Modulus of Elasticity
C_L = Clamp Length of the Bolt
D = Diameter of the Bolt

Note: If no load factor has been entered the *MINI-MAX* defaults to zero.

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.

Hooke's Law expresses this relationship:

$P = \frac{\Delta l \times AE}{L_E}$ *Hooke's Law*	P = *Load* L_E = *Average length under stress* ΔL = CHANGE IN LENGTH (ELONGATION) A = CROSS SECTIONAL AREA OF THE BOLT E = Modulus of elasticity

The cross sectional area of the bolt is defined as the average area of a fastener under stress. This factor is only used in the ***MINI-MAX's*** calculation of load. It has no effect on stress or elongation, time , or strain, and is directly proportional to the load measured ultrasonic ally. If t he cross sectional area is off by 5%, the

load measurement will also be off by 5% proportionally. For a cylindrical bolt with the same geometry, the area may be approximated as follows:

$A = \pi\left(\frac{D}{2}\right)^2$ *Area*	*D = minor diameter of the bolt, allowing for threads.*

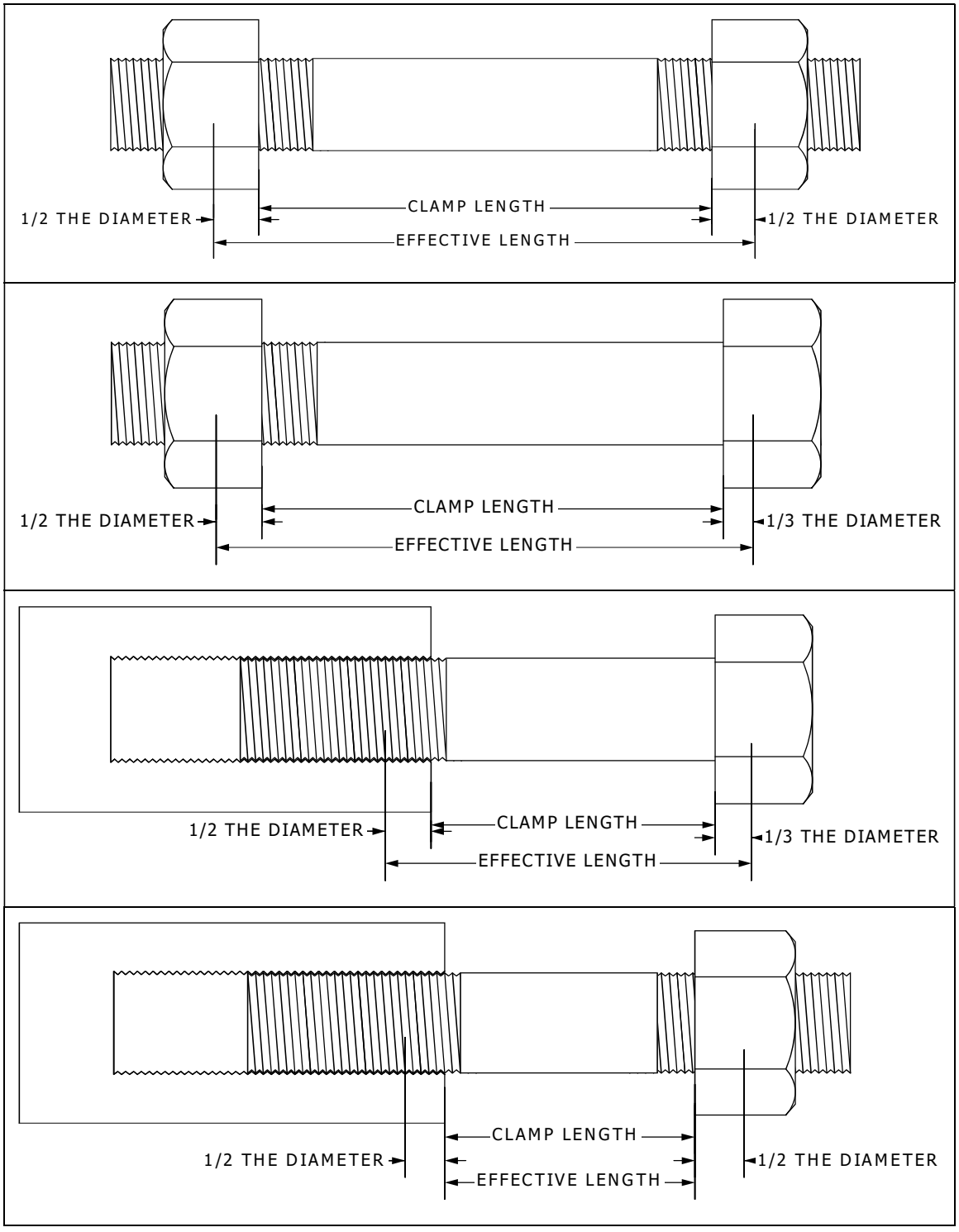
For bolts with complex geomet ry, the ar eas should be estimated by averaging each individual area and length. In the case of a hollo w fastener, the area of the hole must be subtracted from the overa ll area. The area of a fastener with complex geometry can be estimated as follows:

$A_{AVG} = \frac{\sum AL}{\sum L}$ *Average Area*	*A = Area of a region* *L = Length of a region*

The value for the Modulus of Elasticity , or Young's Modulus, should be provided directly from the manufacturer of the bolts.

E = Modulus of Elasticity of the Bolt Material	*From Manufacturer*

The effectiv e length is t he average length of th e fastener u nder stress when a loa d is applied. F or an applied constan t load, the elongation of a fastener is dir ectly proportional to the effective length. Therefore, errors in the effective length will resu lt in load errors by a proportional amount. The effective length of a fastener is a combination of the actua l clamp leng th of the joint being fa stened, plus that area of stress foun d in the head, nut(s), and or blind hole of the fastener.



	L_E = *Average length under stress*

$L_E = C_L + D_X$ *Effective Length*	C_L = *Clamp length* D_X = *Additional diameter added for head, nut(s), and or blind hole.*

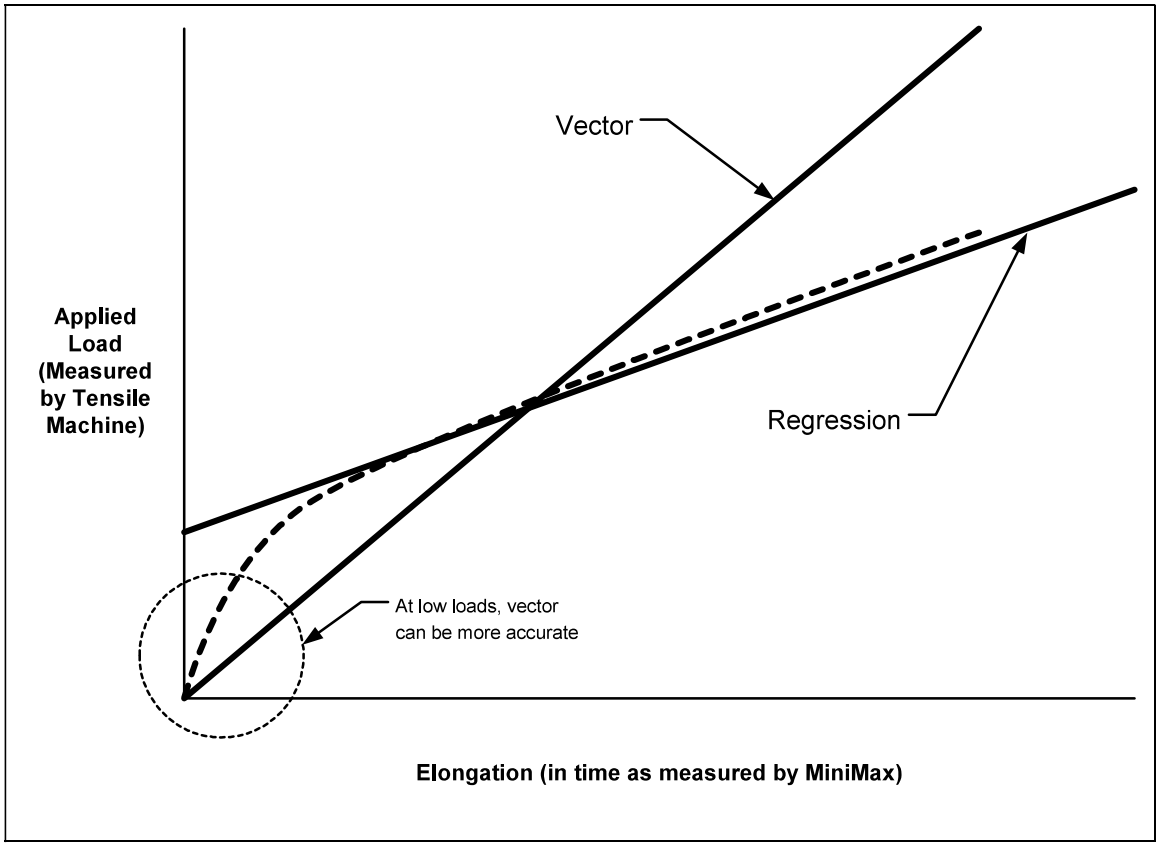
Note: A convenient way to perform the above Load Factor calculations is to use the bolt calculator included in the ***MINI-MAX***view PC software.

It's important to note that performing the calculations above is only a good approximation at best. In all cases, if possible, a field calibration should be performed if the user intends to perform measurements in terms of load.

11.2 Calibrating a load factor (Field Calibration)

Clearly, the most effective way of calibrating the load factor is by performing a field calibration. Often times, material constants are unknown or cannot be calibrated in a laboratory environment. In cases such as these, a field calibration is the most accurate means of calibration. A field calibration is accomplished using a tensile tester, load cell, or other calibrated load device to compare known loads against ultrasonic elongations. The ***MINI-MAX*** is equipped with a self-calibrating feature that uses a linear regression or vector equation to produce a best-fit line through the known loads, minimizing error.

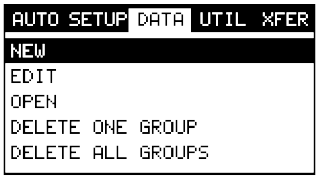
The result is an added load offset (intercept), in the case of regression, and a load factor (slope) to correct the ultrasonic measurements to the known loads. The regression produces a load offset and load factor, while the vector sets the offset to zero and produces only a load factor. Why are both options needed? In applications where a small amount of load is applied to the fastener, thus producing very little elongation, the regression option can potentially produce non-linear results. In cases such as these, a vector may sometimes produce better results as the offset is set at zero. It is recommended to use and compare both results, following a field calibration, to determine which method is most suitable for the application and producing the best results.



11.3 Performing a Field Calibration

This section outlines the necess ary procedur es to perform a field calibration to determine a Load Factor and Offs et (in the case of using regression). I n the calibration procedures below, three samp le bolts will be used with three loads applied to each bolt (1/3, 2/ 3, & Max). This should be considered the minimum requirement when performing a field calibration.

Creating a Group Name to Document Field Calibration Data

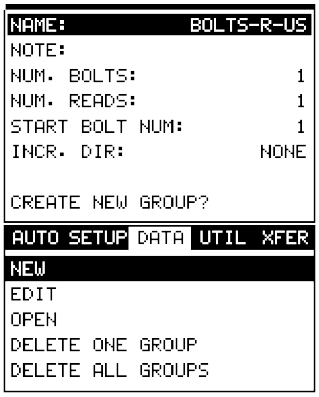


Note: Select a name that references this group to **Field Calibration Data**.

1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DATA** menu is highlighted and displaying the submenu items.

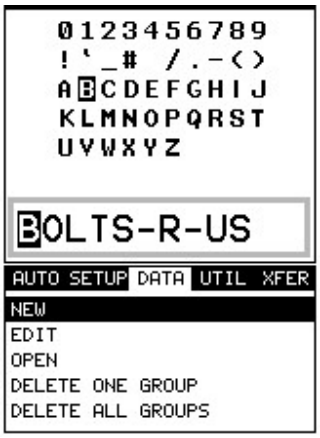
2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **NEW** is highlighted.

3) Press the **ENTER** key to display the **New Group Edit Box**.



4) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NAME** is highlighted.

5) Press the **ENTER** key to activate the **Alpha Edit Box**.



6) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

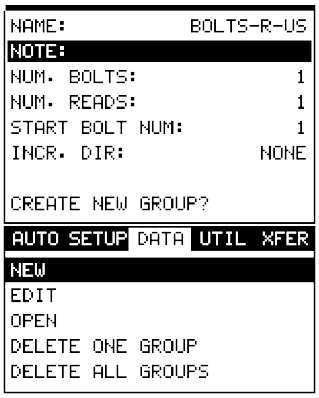
7) Press the **ENTER** key to select a character and advance to the next field of the **Group Name**.

8) Use the **CLR** key to backspace if necessary.

9) Repeat steps **6 - 8** until the **Group Name** is completed.

10) Press the **OK** key to save the **Group Name** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Name**.

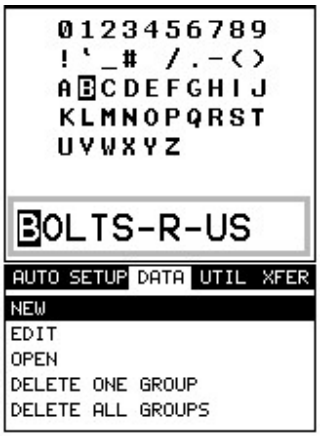
Creating a Group Note



Note: Be sure to include a note that describes and references the Field Calibration data and bolt.

1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NOTE** is highlighted.

2) Press the **ENTER** key to activate the **Alpha Edit Box**.



3) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

4) Press the **ENTER** key to select a character and advance to the next field of the **Group Note**.

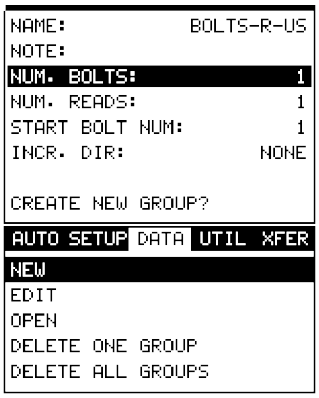
5) Use the **CLR** key to backspace if necessary.

6) Repeat steps **3 - 5** until the **Group Note** is completed.

7) Press the **OK** key to save the **Group Note** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Note**.

Selecting the Number of Bolts in the Group

Note: In this example the minimum requirement of 3 sample bolts will be used.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM BOLTS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

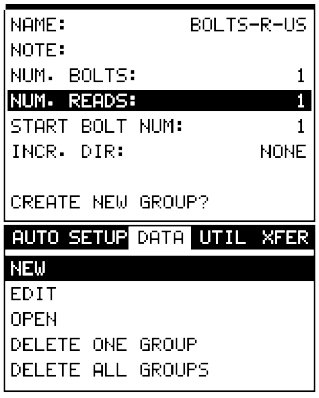
4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM BOLTS** value is correctly displayed.

6) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

Selecting the Number of Readings Per Bolt

Note: In this example 3 loads will be applied to each sample bolt.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM READS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM READS** value is correctly displayed.

6) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

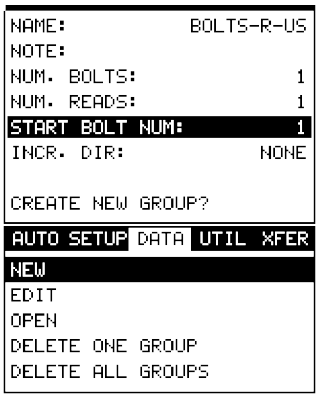
7) Press the OK key to display the **Digits Edit Box** and re-enter the **NUM READS**.

8) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

If there's not enough memory available to create the group, an error message box **"NOT ENOUGH MEMORY"** will be displayed. Press the **OK** or **ESC** key to return to the **Group List Items** menu. It may be necessary to free some memory in the ***MINI-MAX*** at this time.

Selecting the Starting Bolt Number

Note: Depending on the application and layout of the project, the user won't always want the starting bolt to be 1. This feature allows the user to define what the starting number will be.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **START BOLT NUM** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **START BOLT NUM** value is correctly displayed.

6) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

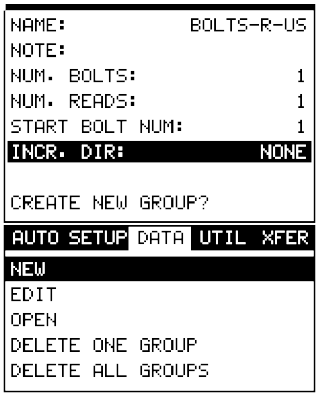
Note: If a value is enter that is greater than the maximum number of bolts allowed per group (250), an error message box “VALUE IS OUT OF RANGE” will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **START BOLT NUM**.

8) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

Selecting the Auto Increment Direction

The **Auto Increment** feature gives the user the ability to specify which direction to advance the cursor after storing a reading.



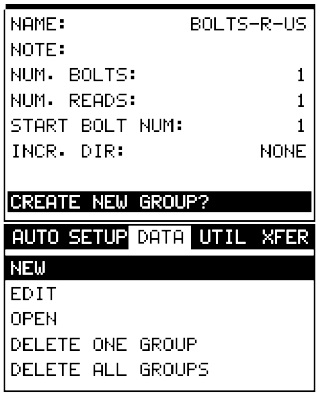
1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **INCR. DIR** is highlighted.

2) Use the **LEFT & RIGHT** arrow keys to toggle the **Increment** direction **NONE, NORTH, EAST, SOUTH, or WEST**.

3) When the correct **Increment** direction is displayed, continue on to the next section **"Saving the Group"**.

Saving the Group

Once all the parameters are set, the user has the option of saving or canceling the new group.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **CREATE NEW GROUP?** is highlighted.

2) Press the **ENTER** key to accept the group parameters, and activate the confirmation screen.

3) Press the **OK** key to save the **New Group**, or the **ESC** key to cancel **the New Group** setup and return to the **DATA** menu.

4) Press the **MEAS** key to return to the measurement screen to begin measuring reference lengths.

Now that a group has been created to store the field calibration data, the group must be activated and ready to store reference lengths and elongations.

Storing the Reference Length

DELAY:	9.91	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	70.2
THR:	5	LOC:	B1
GROUP:BOLTS-R-US			

1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.

	A	B	C
1	10.0072		
2	10.0072		
3			
4			

2) Press the **ENTER** key to display the **Group View Box**.

3) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

Note: The first column must be used to store reference lengths.

Selecting the Calibration Mode (Vector or Regression)

CAL	MATL	GEOM	DISP	TUNE
ZERO OPTION			TWO POINT	
ZERO VALUE			0.00	
MEASURE ZERO				
LOAD CAL MODE			REGRESSION	
LOAD CAL. CALC.				

1) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **CAL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **LOAD CAL MODE** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll through the unit options **OFF**, **VECTOR** (zero offset), **REGRESSION**, until the correct mode is displayed.

4) Press the **MEAS** key to return to the measurement mode.

Now that a group has been created and acti vated, and the load calibration m ode selected, we're ready to perform the field calibration.

Performing a Field Calibration

1) Place the first sample bolt in the load apparatus.

Note: The following steps assume that the user has previously selected a similar material type for the list of materials and the approximate length of the bolt has been entered. Therefore, the ***MINI-MAX*** is currently setup and ready to measure in elongation mode.

2) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors cause by changing the sound path.*

3) Record the ultrasonic reference length at zero Load by pressing the **ENTER** key.

Note: The reference lengths must be saved in column A in the group.

4) *Apply approximately 1/3 of the maximum load, which is to be placed on the bolt under actual working conditions.*

5) Measure and record the Ultrasonic Length at Load 1 by pressing the **ENTER** key. The **Digits Edit Box** will be displayed.

Note: Load 1 should be stored in column B.

6) Enter the **Known Load** value by pressing the **UP** and **DOWN** arrow keys to scroll the highlighted value.

7) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

8) Repeat steps **6 & 7** until the **Known Load** value is correctly displayed.

9) Press the **OK** key to store the **Known Load** and return to the measurement screen, or **ESC** to cancel entering the **Known Load**.

10) *Increase the applied load to approximately 2/3 of the maximum load, which is to be placed on the bolt under actual working conditions.*

11) Measure and record the Ultrasonic Length at Load 2 by pressing the **ENTER** key. The **Digits Edit Box** will be displayed.

Note: Load 2 should be stored in column C.

12) Enterthe **Known Load** value by pressing the **UP** and **DOWN** arrow keys to scroll the highlighted value.

13) Pressthe **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

14) Repeatsteps **8 & 9** until the **Known Load** value is correctly displayed.

15) Pressthe **OK** key to store the **Known Load** and return to the measurement screen, or **ESC** to cancel entering the **Known Load**.

16) *Increase the applied load to approximately the maximum load, which is to be placed on the bolt under actual working conditions.*

17) Measure and record the Ultrasonic Length at Load 3 by pressing the **ENTER** key. The **Digits Edit Box** will be displayed.

Note: Load 3 should be stored in column D.

18) Enter the **Known Load** value by pressing the **UP** and **DOWN** arrow keys to scroll the highlighted value.

19) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

20) Repeat steps **18 & 19** until the **Known Load** value is correctly displayed.

21) Press the **OK** key to store the **Known Load** and return to the measurement screen, or **ESC** to cancel entering the **Known Load**.

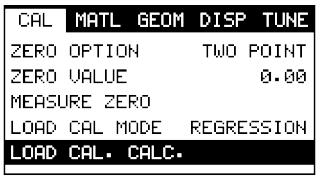
22) **Repeat Steps 1 – 21** for sample bolts 2 & 3.

Now that we have measured and document ed three sample bolts, we're now ready to run the vector or regression ca lculation to determine a load factor and offset (regression only).

Running a Regression or Vector

1) Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **CAL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **LOAD CAL CALC** is highlighted.



3) Press the **ENTER** key to run the calculation and display the confirmation screen.

Note: The regression or vector coefficient will be displayed. The closer this number is to 1, the better the fit, or least amount of error.

4) Press the **OK** key to accept the calculation, or the **ESC** key to cancel and return to the **CAL** menu.

5) Press the **MEAS** key to return to the measurement screen.

Note: The new **Load Factor** and **Offset** values can be reviewed and edited in the **GEOM** tabbed menu item.

6) Calibration is completed.

Chapter 12 Measurement and the Waveform Display

12.1 Quantities of Measurement

The ***MINI-MAX*** has the abilit y to measure in a number of measurement quantities: Time (nanoseconds), Elongation, Load, Stress, and Strain (in terms of %). While there are a number of quantity options available, the easiest and most fail safe quantities to consider are Time and Elongation. *If Load, Stress, or Strain will be used on a regular basis, a calibration of the bolts for the specific application is required.*

The equations below outline the required factors and constants necessary for each quantity. When measuring in terms of time and elongation, very little information is required, as the measurement is simply a difference equation. The stress factor and velocity will typically not vary more than 5%, in total, over the entire range of possible steel fasteners. Therefore the worst cas e error is 5%. However, when measuring in t erms of load, stress, or strain, the error can be enormous if errors in effective length, load factor, or cross sectional area are made. These factors will resu lt in proportional errors over all. T herefore, if the load factor is off by 10%, the load measurement will be in error by the same 10% proportionally.

$X_E = [(S_F)(V_0)]\Delta T$ ***Elongation***	X_E = *Elongation* S_F = *Sonic Stress Factor* V_0 = *Material Velocity* ΔT = *Change in time.*

$P = (X_E)(L_F) + L_o$ ***Load***	P = *Load* X_E = ELONGATION L_F = Load Factor L_O = *Load Offset*

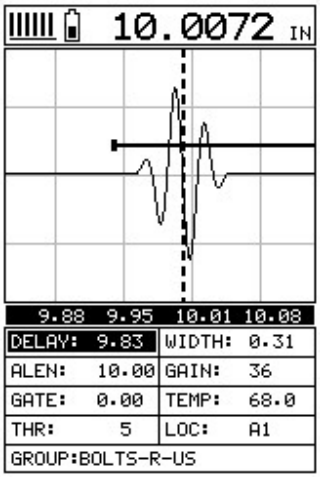
$S = \left(\frac{P}{A}\right)$ ***Stress***	S = *Stress* P = *Load* A = *Cross sectional error*

$S_N = \left(\frac{X_E}{L_E}\right) * 100$ ***%Strain***	S_N = *%Strain* X_E = *Elongation* L_E = *Effective Length*

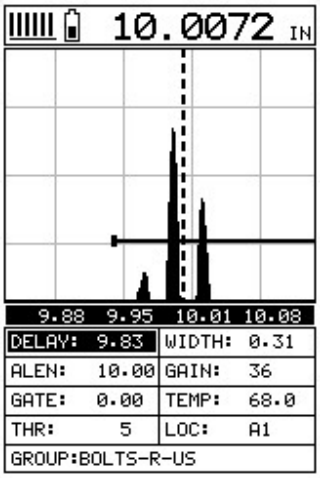
12.2 Display View Options

A key feature of the ***MINI-MAX*** is the versatility of the display views available to the user. The waveform views are a graphical representation of the actual sound reflections traveling through a fastener and returning back to the transducer. The waveform display shows the amplitude of the signal received on the vertical (Y) axis and time (displayed in terms of length) on the horizontal (X) axis. The two waveform display options are **RF**(Full) wave, and **RECT**(rectified) half wave either positive or negative. These wave form options give the user the ability to view the actual waveform and point of detection. In this view option the user has better control over where the ***MINI-MAX*** is detecting, selecting the proper phase of the signal, and adjusting the gate and threshold (sensitivity) to eliminate noise or to force a specific detection point.

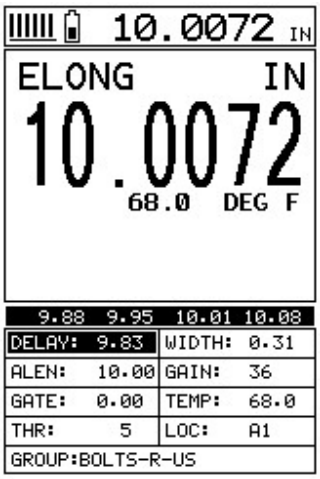
The **RF** waveform view is recommended when initially setting up the ***MINI-MAX*** for an application. This display view gives the user the ability to view the entire waveform, both positive and negative cycles, to determine the appropriate phase of the signal for measurement. The **Large Digits** display view is a general digital display of the quantity selected. It's a nice easy viewing option that is typically used following setup of the initial application. The digits view is also equipped with a limits bar that if the alarm status is activated and in a measurement location other than an **L-REF** (reference length). If tolerance values were setup in the **MINI-MAX**, the user could use the limit bar and alarm lights to view when the fastener was in the required tolerance region, and avoid having to constantly watch the digital readout for a target value to appear.



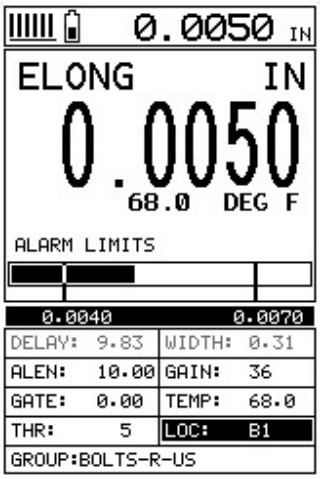
RF



RECT (rectified)

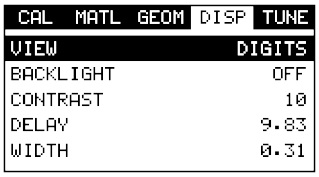


Large Digits



Large Digits & Limits Bar

Changing Display Options

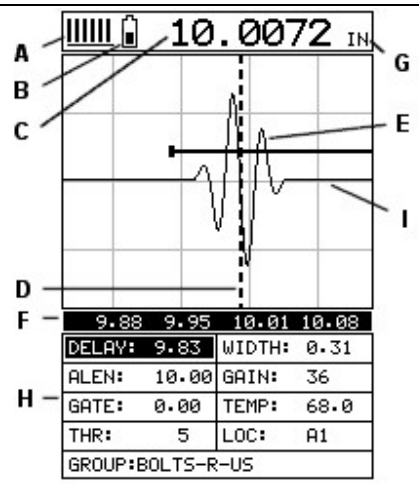


1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to

tab left, until the **DISP** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **VIEW** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to scroll the view options. Once the appropriate view is displayed, press the **MEAS** key to return to the measurement screen.



RF View

RF

The RF mode shows the waveform in a similar fashion to an oscilloscope. It shows both the positive and the negative peaks. The peak (either positive or negative) selected for measurement is shown in upper portion of the display.

It's important to note that a measurement must fall inside the displays viewable range in order to see the waveform. However, even if the waveform is outside of the viewable range of the display , a measurement can be taken and viewed on the digital readout. If the wave is outside of the display range, you can manually change the range by adjusting the **Delay** and **Width** values, or you can use the **Auto Find** feature located in the **UTIL** menu of the tabbed menu items.

The following is a list of the viewable features on the display:

A) **Stability of Reading Indicator** – Indicates the stability of the return echo on a scale of 1 to 6 – the solid bars displayed in the figure above indicate a repeatable signal. If the ***MINI-MAX*** is displaying a reading from memory, the repeatability indicator will be replaced by the text **"MEM"**.

B) **Battery life Indicator** – Fully charged batteries will appear filled in solid. Note: The diagram shows the batteries at approximately 50%.

C) **Length Measurement –** Digital readout of quantity (english or metric).

D) **Detect Indicator –** The broken vertical line displays the zero crossing (flank) detection point on the waveform where the measurement has been obtained. Notice that the digital quantity readout is the same as the location of the detect indicator according to the measurement labels F, also in the diagram.

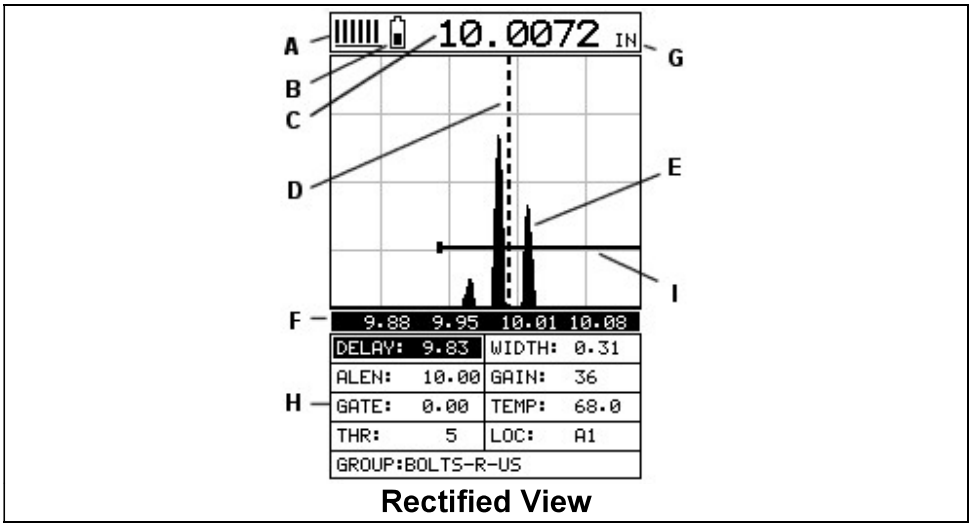
E) **Echo Signal –** Graphical full waveform representation of the echo signal displayed as an amplitude (vertical or "Y" axis) plotted against time (horizontal or "X" axis), this time is then converted to a physical measurement in terms of a specific quantity.

F) **Measurement Labels** – The measurement labels are calculated and displayed based on where the left side of the display has been set **(Delay)**, and the overall viewable area **(Width)** of the display. Note: The gray hash marks break the display up into 5 segments, or quadrants. The measurement labels correspond to the measurement at each hash mark.

G) **Units Label** - Displays the current quantity of measurement.

H) **Hot Menus** - Each of the fields located under the waveform display are called the **Hot Menu Fields**. These fields allow quick control of some of the fine adjustments needed to control the display settings, measurement modes, and group memory control. All of these fields can be adjusted without having to activate the tabbed menu items and searching through a variety of menus to make adjustments.

I) **Gate –** Used to block signal noise, force detection on a specific waveform or cycle, and view the threshold according to the waveform and signal amplitude.



Rectified View

Rectified

The rectified A-Scan mode shows half of the waveform. Either the positive or negative peaks are displayed, depending on the polarity selected.

It's important to note that a measurement must fall inside the viewable display range in order to see the waveform. However, even if the waveform is outside of the viewable area, a measurement can be taken and viewed on the digital readout. If the waveform is outside of the display range, you can manually change the range by adjusting the **Delay** and **Width** values, or you can use the **Auto Find** feature located in the **UTIL** menu in the tabbed menu items. Refer to page **Error! Bookmark not defined.** for additional information on the **Auto Find** feature.

The following is a list of the viewable features on the display:

A) **Stability of Reading Indicator** – Indicates the stability of the return echo on a scale of 1 to 6 – the solid bars displayed in the figure above indicate a repeatable signal. If the ***MINI-MAX*** is displaying a reading from memory, the repeatability indicator will be replaced by the text **"MEM"**.

B) **Battery life indicator** – Fully charged batteries will appear filled in solid. Note: The diagram shows the batteries at approximately 50%.

C) **Length Measurement** – Digital readout of quantity (english or metric).

D) **Detect Indicator** – The broken vertical line displays the zero crossing (flank) detection point on the waveform where the measurement has been obtained. Notice that the digital quantity readout is the same as the location of the detect indicator according to the measurements labels F, also in the diagram.

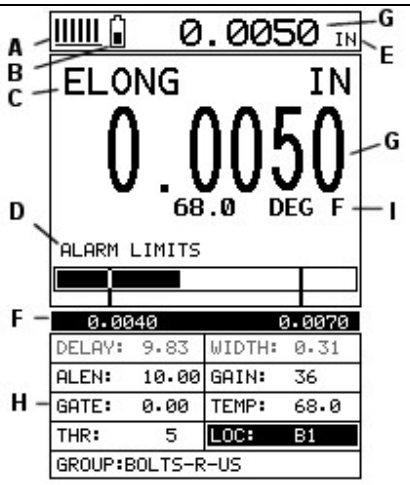
E) **Echo Signal** – Graphical full waveform representation of the return echo displayed as an amplitude (vertical or "Y" axis) plotted against time (horizontal or "X" axis), this time is then converted to a physical measurement in terms of a specific quantity.

F) **Measurement Labels** – The measurement labels are calculated and displayed according to where the left side of the display has been set **(Delay)**, and the overall viewable area **(Width)** of the display. Note: The gray hash marks break the display up into 5 segments, or quadrants. The measurement labels correspond to the measurement at each hash mark.

G) **Units Label** - Displays the current quantity.

H) **Hot Menus** - Each of the fields located under the waveform display are called the **Hot Menu Fields**. These fields allow quick control of some of the fine adjustments needed to control the display settings, measurement modes, and group memory control. All of these fields can be adjusted without having to activate the tabbed menu items and searching through a variety of menus to make adjustments.

I) **Gate** – Used to block signal noise, force detection on a specific waveform or cycle, and view the threshold according to the waveform and signal amplitude.



DIGITS VIEW

DIGITS

The Digits view is a basic digital look and feel. The larger digits make it much easier for the operator to monitor the measurements. The Limits Bar has also been added to the Digits view to provide the user with yet another visual tool for easily monitoring if the fastener is inside specific tolerances.

The following is a list of the viewable features on the display:

A) **Stability of Reading Indicator** – Indicates the stability of the return echo on a scale of 1 to 6 – the solid bars displayed in the figure above indicate a repeatable signal. If the ***MINI-MAX*** is displaying a reading from memory, the repeatability indicator will be replaced by the text **"MEM"**.

B) **Battery life indicator** – Fully charged batteries will appear filled in solid. Note: The diagram shows the batteries at approximately 50%.

C) **Quantity** – Displays the current measurement quantity (currently Elongation).

D) **Limits Bar** – The limits bar is used to verify if the bolt being fastened is in inside of a specific set of tolerances. The alarm or tolerance values are shown at (F). When the bolt is in tolerance, the limit bar will be filled and inside the corresponding limits.

E) **Units Label** - Displays the current quantity of measurement.

F) **Alarm (Tolerance) Values** – Displays the minimum and maximum alarm values or tolerances.

G) **Length Measurement** – Digital readout of quantity (English or metric).

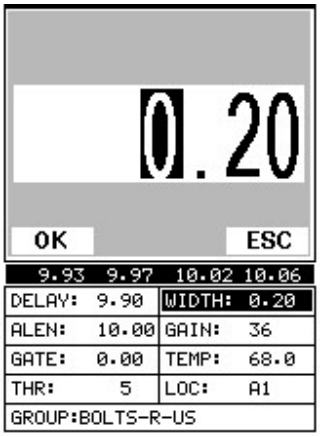
H) **Hot Menus** - Each of the fields located under the waveform display are called the **Hot Menu Fields**. These fields allow quick control of some of the fine adjustments needed to control the display settings, measurement modes, and group memory control. All of these fields can be adjusted without having to activate the tabbed menu items and searching through a variety of menus to make adjustments.

I) **Temperature** – Display's the current temperature of the fastener (manual, semi-automatic, or automatic).

12.3 Adjusting the Display

The width refers to the overall viewable range, with respect to length, being displayed on the screen. The starting length is displayed at the lower left side of the screen, and the ending length is shown at the lower right hand side of the screen. The difference between these values is called the **Width**. The procedures to adjust the **Width** are outlined below:

Adjusting the Width using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **WIDTH** cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

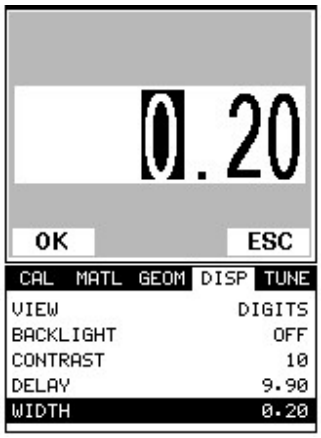
5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **WIDTH** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **WIDTH**.

The user can also access and adjust the width from the tabbed menus. However, this method is a more tedious than making the adjustments using the Hot Menus. The procedure using the tabbed menus is outlined below:

Adjusting the Width using the Tabbed Menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DISP** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **WIDTH** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct width is being displayed, **proceed to step 8**.

4) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

7) Repeat steps **5 & 6** until the **Width** value is correctly displayed.

8) Press the **OK** key to set the **Width** and return to the menu screen, or **ESC** to cancel entering the **Width**.

9) Finally, press the **MEAS** key to return to the measurement screen.

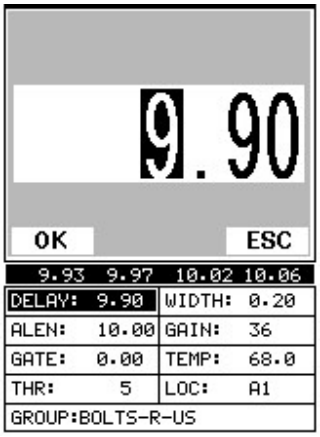
Starting delay

The starting **DELAY**, or starting length, is the value displayed on the bottom lower left side of the display in both **RF** and **RECT** (Rectified) views. The **DELAY** will also be represented in the **DIGITS** (Scan Bar) view, as the length. The starting length is the minimum length that can be viewed on the display.

Note: Once the range is set, it will remain the same for all the views respectively.

The procedures to adjust the **Delay** are outlined below:

Adjusting the Delay using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **DELAY** cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

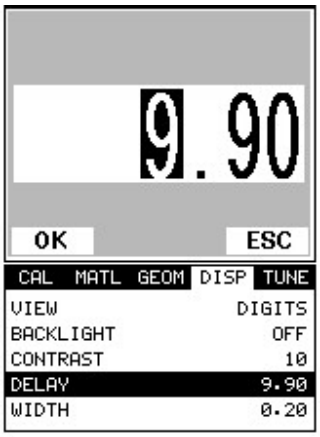
5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **DELAY** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **DELAY**.

The user can also acce ss and adjust the delay fr om the tabbed menus. However, this method is more tedious than making the adjustments using the Hot Menus. The procedure using the tabbed menus is outlined below:

Adjusting the Delay using the Tabbed Menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DISP** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **DELAY** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct **Delay** is being displayed, **proceed to step 8**.

4) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

7) Repeat steps **5 & 6** until the **Delay** number is correctly displayed.

8) Press the **OK** key to set the **Delay** and return to the menu screen, or **ESC** to cancel entering the **Delay**.

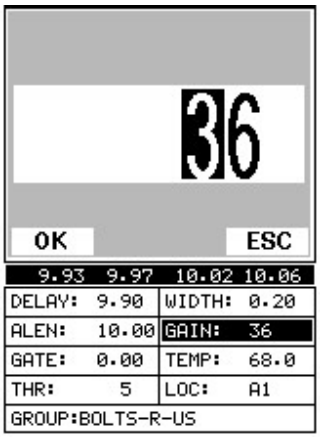
9) Finally, press the **MEAS** key to return to the measurement screen.

12.4 Gain

The gain, or amplification of the return echoes, can be adjusted over a wide range. The setting of the gain is crucial in order to obtain valid readings during the measurement process. Too much gain may result in erroneous measurements, by detecting on noise rather than the length of the fastener itself. Too little gain may result in detection on an undesirable section of the waveform. It may also result in a "peak jump" to another part of the waveform later in time, resulting in measurement errors. The gain can easily be compared to the volume control of a home stereo system. If you turn it up too much, you can't hear the music clearly. If it's turned down too much, you can't hear it at all.

The procedures to adjust the **Gain** are outlined below:

Adjusting the Gain using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right, and the **ESC** key multiple times to move left until the **GAIN** cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

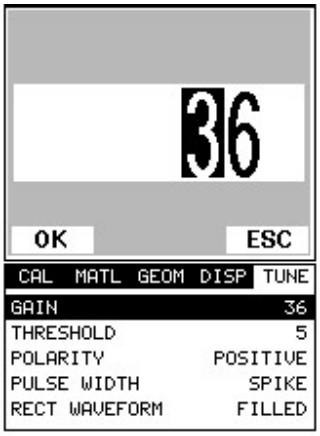
5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **GAIN** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **GAIN**.

The user can also access and adjust the gain from the tabbed menus. However, this method is more tedious than making the adjustments using the **Hot Menus**. The procedure using the tabbed menus is outlined below:

Adjusting the Gain using the Tabbed Menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **TUNE** menu is highlighted and displaying the submenu items.
2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **GAIN** is highlighted.
3) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct **Gain** is being displayed, **proceed to step 8**.
4) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.
5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.
6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.
7) Repeat steps **5 & 6** until the **Gain** value is correctly displayed.
8) Press the **OK** key to set the **Gain** and return to the menu screen, or **ESC** to cancel entering the **Gain**.
9) Finally, press the **MEAS** key to return to the measurement.

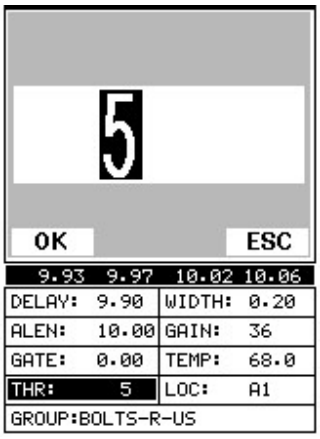
12.5 Threshold

The **Threshold** is the level (sensitivity) of the signal amplitude required to trigger detection. This level can be used in conjunction with the gain. Example: suppose the user is not detecting on the first cycle of the waveform because the amplitude of the first cycle is not large enough to break the current threshold. Either the **Threshold** can be decreased (lower sensitivity), or the **Gain** increased to cause a detection on the first cycle. This is also very important when the reference length is being measured. If the threshold is set so that the amplitude of the signal is just barely reaching the threshold, it should be decreased. If the user does not increase it at that time, when the fastener is put under a load, the same peak jumps can occur. Even though the threshold can be adjusted at a

later time to correct the peak jump, errors can be overlooked during the measurement process. Therefore, it's always best to make these adjustments when initially measuring the reference lengths.

The procedures to adjust the **Threshold** are outlined below:

Adjusting the Threshold using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **THR** (threshold) cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

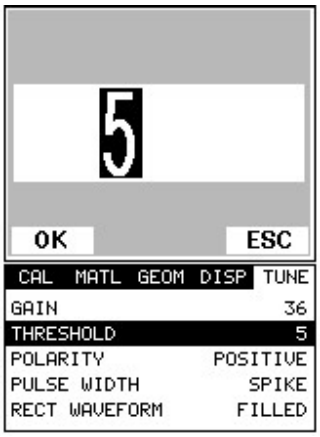
5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **THR** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **THR**.

The user c an also ac cess and adjust the **Threshold** from the tabbed menus. However, this method is more tedious than making the adjustments using **the Hot Menus.** The procedure using the tabbed menus is outlined below:

Adjusting the Threshold using the Tabbed Menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **TUNE** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **THRESHOLD** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct threshold is being displayed, **proceed to step 8**.

4) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

7) Repeat steps **5 & 6** until the **Threshold** number is correctly displayed.

8) Press the **OK** key to set the **Threshold** and return to the menu screen, or **ESC** to cancel entering the **Threshold**.

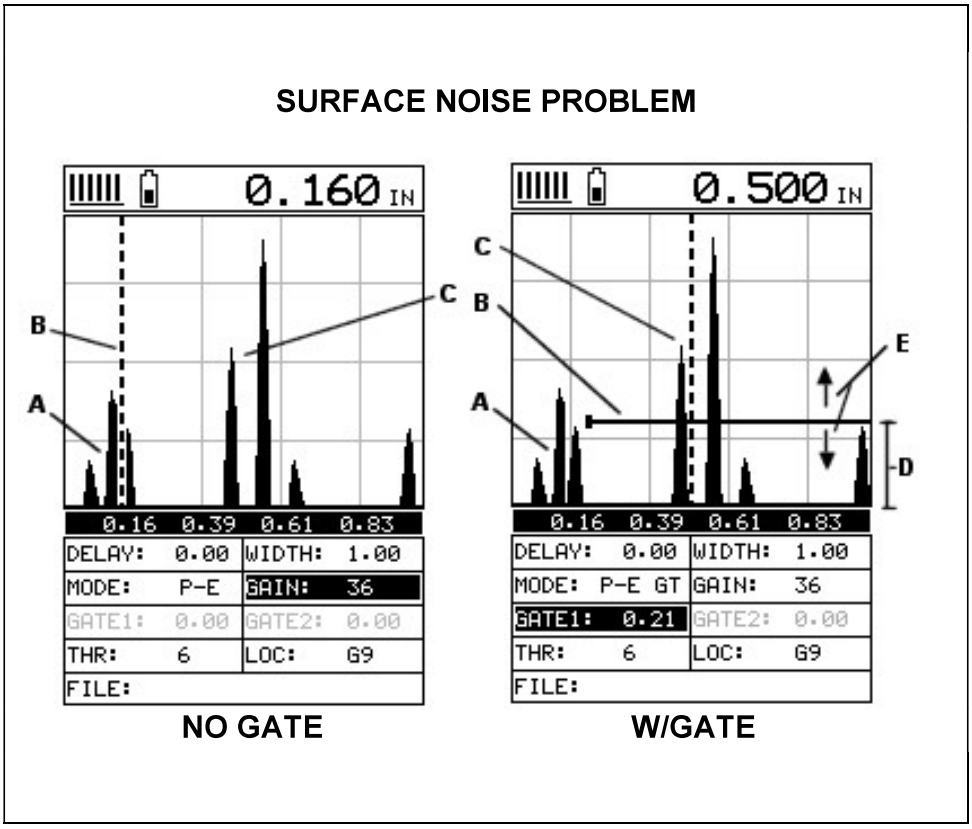
9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

12.6 Gate

The ***MINI-MAX*** is equipped with a single gate typically used to eliminate noise that is present prior to the reflection off the end of the bolt, and also to force a detection at or on a specific location or waveform. Often times the first reflection off the end of the bolt will produce a poor signal. However, if the user looked further out in time (length), a reflection from a mode conversion very well may be a better alternative signal to detect on. A mode conversion is simply a reflection of energy that took a longer path, reflecting off the sidewalls of the bolt, resulting in a return echo slightly longer than the overall length of the bolt. Use of a gate allows the user to force the ***MINI-MAX*** to use this signal for measurements.

Another potential issue is general transducer or low frequency noise. In this type of situation, the noise interferes with the ***MINI-MAX***, and is high enough in amplitude to cause the ***MINI-MAX*** to detect on the noise rather than the true return reflection. The diagrams below illustrate both cases:

Note: In order to adjust the gates they must be activated. The gates will only be active if the measurement mode is set to P-E GT (pulse – echo w/gate). In standard P-E (pulse echo) mode, the gates are not active.



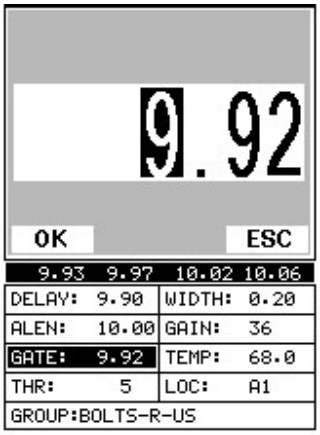
The diagrams above can be illustrate a typical example of both cases. Let's start with the noise condition first. Refer to the **NO GATE** diagram: **(A)** refers to the noise in front of th e true reflection signal **(C)**. Notice that without a gate activated, the ***MINI-MAX*** is detecting on the noise **(A)** as shown at point **(B)**. However, the true measurement should be taken at point **(C)**. Given the threshold and gain levels the ***MINI-MAX*** is currently set to in the **NO GATE** diagram, the amplitude fr om the noise is sufficient enough to cause the ***MINI-MAX*** to detect, or measure the noise rather than the end of the bolt **(C)**.

Now refer to the **W/GATE** diagram. The horizontal line at the top of **(D)**, is **GATE**. The start point of **GATE** has been adjusted to just beyond the noise **(A)** so that the ***MINI-MAX*** ignores the noise and detects the true back wall **(C)**. Note: the ***MINI-MAX*** will only detect on signals th at are located inside t he dimensions of the **GATE (B)**. Therefore, the ***MINI-MAX*** cannot see **(A)** at all, with respect to the starting point of the gate at **(B)**. Also notice, the **THR** (threshold) level is the height of t he distance **(D)** from the baseline. Zero th reshold is indicated by the bottom of the range **(D)**, and **THR: 6** (threshold) is indica ted at the top of the range at **(D)**. Therefore, the ve rtical height of **GATE1** is the **THR** (threshold) level. The threshold level can be increas ed to decrease sensitivity, or decreased to increase sensitivity.

If the threshold level were increased in the **NO GATE** diagram, so that the level was higher than the amplitude of the noise **(A)**, the ***MINI-MAX*** would have detected on the correct reflection **(C)**. Alternatively, if the gain level was decreased, the signal amplitude of the noise **(A)** would have decreased below the threshold level, and the ***MINI-MAX*** would have also detected the correct reflection **(C)**. This example brings all the fine adjustments into consideration, and demonstrates the importance and versatility of having fully functional scope available.

Now, let's look at the diagrams again but in a slightly different way. Let's look at the case of a potential mode conversion issue. Let's assume that **(A)** is the actual true reflection off the end of the bolt, and the ***MINI-MAX*** is detecting on the echo at **(B)**. However, the signal has a horrible first cycle and is relatively week. But as we look further out in time or length, the second mode conversion reflection **(C)** looks like a much cleaner signal to use. Now refer to the **W/GATE** diagram. By activating and setting the start time of the **GATE (B)**, we can force the ***MINI-MAX*** to use the mode conversion reflection **(C)**, instead of **(B)**. Once again, the same gain and threshold tools can be use for fine adjustment signal optimization.

Adjusting the Gate using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **GATE** cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

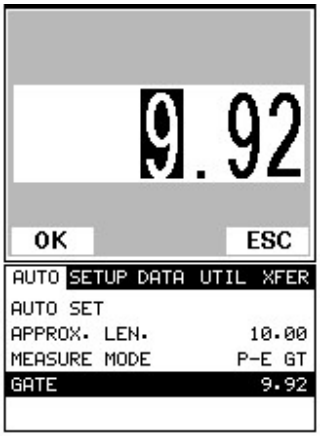
5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **GATE** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **GATE** value.

The user can also access and adjust the gate from the tabbed menus. However, this method is more tedious than making the adjustments using the **Hot Menus**. The procedure using the tabbed menus is outlined below:

Adjusting the Gate using the Tabbed menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **AUTO** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **GATE** is highlighted.

3) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct gate is being displayed, **proceed to step 8**.

4) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

7) Repeat steps **5 & 6** until the gain number is correctly displayed.

8) Press the **OK** key to set the **Gate** value and return to the menu screen, or **ESC** to cancel entering the **Gate** value.

9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

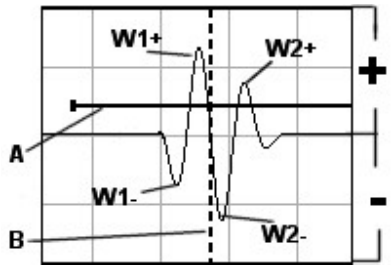
12.7 Interpreting the Waveform

One of the most important things to consider, when using the ***MINI-MAX***, is how to interpret the waveform in order to choose the proper phase (polarity) and gain setting. It's also important to understand what's taking place during a basic measurement. The user has the option of selecting the phase only once during the **L-REF** (reference length measurement). Once the phase is chosen and the **L-REF** measurement taken and stored for a particular bolt, all the elongation and loads taken for that particular bolt will assume the sample phase. At first, this might not seem all that critical. In most cases, with well prepare bolts, this might very well be the case. While both phases may look fine at first sight, during the **L-REF** mode, deformations in the joint can occur when a load is applied to the bolt.

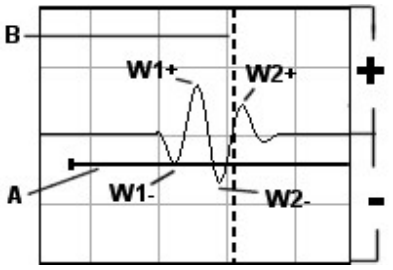
When a load is applied on a bolt, the velocity of the fastener decreases. Any deformations in the joint (bending) will disrupt the sound path and potentially cause an overall decrease in signal amplitude. When this occurs, the decrease in amplitude can cause the ***MINI-MAX*** to lose the first cycle altogether. If the fist

cycle is lost, the ***MINI-MAX*** will " peak Jump" to another cycle later in time with greater amplitude. Often times the transducers have a very slow ramp up time in their construction. In other words, the amplitude of the first cycle is lower in amplitude than the second cycle. For this reason, selecting the proper phase is very important.

The **Auto Set** feature built into the ***MINI-MAX*** will do a lot of this work for you. However, it's always a good idea to understand how to interpret the waveform. The following diagrams offer a brief explanation:



Correct Phase (Polarity) – Fig. 1



Incorrect Phase (Polarity) – Fig. 2

Refer to the illustrations above. The first thing to note is that the screen shots above are split into positive and negative regions. The centerline is assumed zero, and the two regions in the upper portion of the display are positive, while the two lower halves are negative. Refer to **Fig.1**. Notice that the height or amplitude of **W1+** is greater than the height of **W2+** from the zero crossing (centerline). These are the positive cycles, as they are in the upper regions. Now consider that the height of **W1-** is lower in amplitude than **W2-**. These are the negative cycles as they are in the lower regions. Keeping that in mind, the ***MINI-MAX*** uses a zero crossing (Flank) style of detection. Therefore, the detection will always occur to the right side of the positive or negative cycle being detected. With this said, the detection in **Fig.1 (B)** is occurring on the zero crossing of the positive first cycle **W1+**. In this example, the correct (positive) polarity has been selected.

Why? I'm getting to that! Refer to **Fig.2**. Notice that when the bolt is tightened, the signal amplitude has decreased due to the applied stress, and a peak jump has occurred from **W1-** to **W2-** at **(B)**. If we look at the height of **W1-** it has a much lower amplitude than **W2-**. Therefore, when stress was applied to the bolt, the amplitude of **W1-** was decreased beyond the threshold **(A)** and the **MINI-MAX** jumped to the next available signal with sufficient amplitude. However, this could never happen in **Fig.1**. This is because **W1+** has more amplitude than **W2+**, and a peak jump could never occur without losing the signal entirely.

Good Rule of Thumb: *Always look at the height of the positive and negative cycles separately. Ask yourself if the first cycle (from left to right) is greater in height (amplitude) than the second. If so, chances are you've selected the correct phase (polarity).*

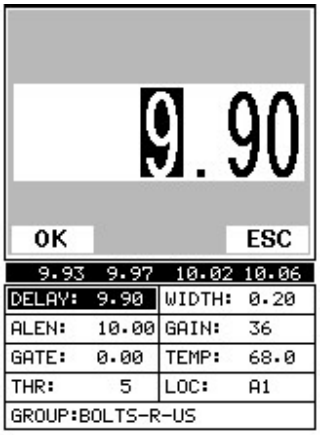
If a situation does occur, as in **Fig.2** above, and you're able to notice the peak jump during the process of loading, increasing the gain or lowering the threshold will generally correct the error. However, if it goes unnoticed, all your measurements will be in error. Therefore, it's critical that the user takes the necessary time to select the proper phase in the initial setup process.

Once again, the Auto Set feature built into the ***MINI-MAX*** will attempt to optimize and select the polarity for you. Use of this feature is further explained in the sections that follow.

12.8 Manually Locating the echo

The echo can be manually located by simply adjusting the delay and width values of the ***MINI-MAX***. While this is process is very tedious and will most often not be used because of the **Auto Set** feature, it should be explained for general control of the instrument. The following procedures outline how to locate the echo using delay and width.

Adjusting the Delay to Locate the Echo



Note: The delay should be adjusted to a length slightly shorter than the physical length of the fastener. If the length of the fastener is unknown, the user will be forced to scroll the delay until the echo is located. However, if

the Length is known, use the digits edit box to enter the value and save time.

1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **DELAY** cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

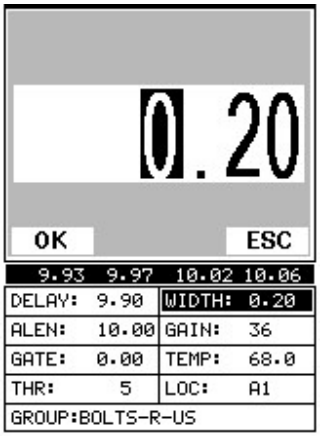
4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **DELAY** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **DELAY**.

Adjusting the Width using the Hot Menus



Note: The width acts like a zoom on a camera. Therefore, adjust the width to the desired view.

1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **WIDTH** cell is highlighted.

2) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the highlighted value.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

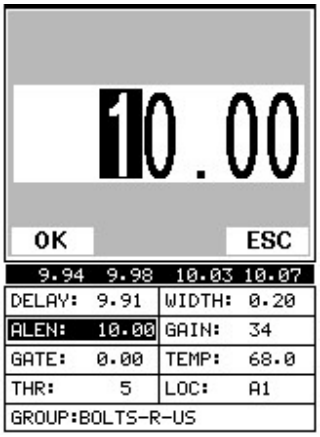
6) Repeat steps **4 & 5** until the **WIDTH** value is correctly displayed.

7) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **WIDTH**.

12.9 Automatic echo optimization

The ***MINI-MAX*** is equipped with a built in Auto Set feature for echo optimization. The **Auto Set** uses a variety of algorithms, evaluating the positive and negative and negative cycles, and selects the best phase (polarity) to use for measurement. It also optimizes the gain, sets the delay and width, and activates and sets the gate accordingly. Use of this feature will save the user a great deal of time in the measurement process. In order to use the **Auto Set** properly, an approximate length of the bolt must be entered into the ***MINI-MAX***. The approximate length tells the ***MINI-MAX*** where to start looking for the echo. The ***MINI-MAX*** will search **+/- 5%** from the value entered. The following procedures outline the **Auto Set** feature.

Setting the Approximate Length using the Hot Menus



1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left, until the **ALEN** cell is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

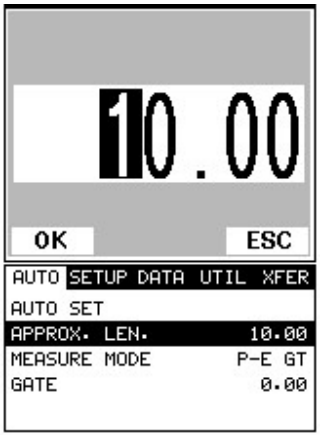
4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **ALEN** value is correctly displayed.

6) Press the **OK** key to return to the measurement screen, or **ESC** to cancel entering the **ALEN**.

The user can also access and set the approximate length from the tabbed menus. However, this method is more tedious than making the adjustments using the Hot Menus. The procedure using the tabbed menus is outlined below:

Setting the Approximate Length using the Tabbed Menus



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **AUTO** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **APPROX. LEN.** is highlighted.

3) Press the **ENTER** key to display the **Digits Edit Box**.

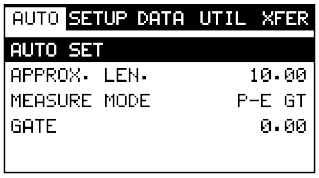
4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **Approx. Len.** value is correctly displayed.

7) Press the **OK** key to set the **Approx. Len.** and return to the menu screen, or **ESC** to cancel entering the **Approx. Len**.

Using Auto Set



Note: If the Approximate length has been entered into the ***MINI-MAX***, the **Auto Set** feature can be run simply by pressing the **AUTO SET** key on the bottom left side of the keypad.

1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **UTIL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **AUTO SET** is highlighted.

3) Apply a drop of couplant to the bolt or transducer, and attach it to one end of the bolt. Rotate the transducer clockwise and counter clockwise applying a small amount of pressure to eliminate any excess couplant between the transducer and bolt surface. *Be sure to always place the transducer in the same location. This will help to eliminate any potential measurement errors caused by changing the sound path.*

4) Press the **ENTER** key to automatically adjust the display settings and bring the waveform into view.

5) Once the signal is displayed, press the **MEAS** key to return to measurement mode.

12.10 Unloaded length and Elongation measurements

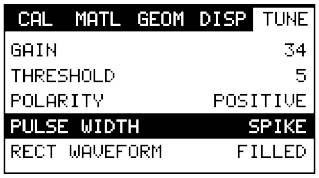
The entire procedure to effectively prepare, setup, and measure is located in the quick start guide in Chapter 3. Please refer to this section for further instructions.

Chapter 13 Additional Features

13.1 Pulse Width

The ***MINI-MAX*** is equipped with an adjustable pulse width option. Pulse width; refers to the duration of time the pulser is left on. This time results in increased energy sent into the test material. There are three width options (**SPIKE, THIN,** and **WIDE**). The **SPIKE** setting may be desirable for high resolution and general applications to decrease the overall noise. This can be considered the normal or standard setting. When additional energy is needed, more penetration, the **THIN** and **WIDE** options may be necessary. The procedure to change the pulse width is outlined below:

Selecting the Pulse Width

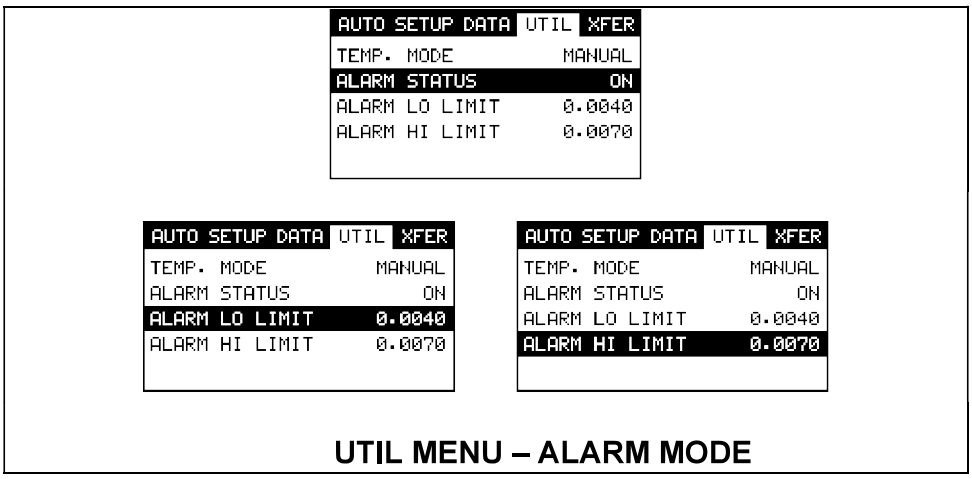


1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **TUNE** menu is highlighted and displaying the submenu items.
2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **PULSE WIDTH** is highlighted.
3) Use the **LEFT** and **RIGHT** arrow keys to scroll the **Pulse** options.
4) Once the correct **Pulse** is displayed, press the **MEAS** key to return to measurement screen.

13.2 Alarm Mode

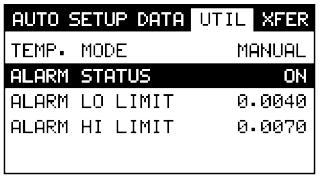
The **Alarm Mode** feature of the ***MINI-MAX*** provides the user with a method of setting tolerances, or limits, for a particular application requirement. This feature

may be convenient for those users who want to have a quick verification without having to constantly watch the display for a specific value to appear. The alarm mode uses red and green LED's to let the user know when the fastener is inside the tolerance limits. The limits are also displayed on the LCD in terms of a bar graph presentation. There are two limits, or alarm values, that can be set up in the ***MINI-MAX*** – **ALARM LO LIMIT** and **ALARM HI LIMIT**. However, the user may choose to activate and utilize only one of the limit values, depending on their specific application requirements. The procedures to use the **ALARM MODE** feature are outlined below:



UTIL MENU – ALARM MODE

Toggle Alarm Status (on/off)



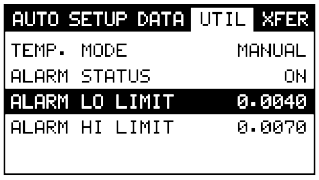
1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **UTIL** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ALARM STATUS** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **ALARM STATUS** on/off.

4) Continue on to the next section **"Setting the Alarm Lo Limit"**.

Setting the Alarm LO Limit



1) Assuming the **ALARM STATUS** is **ON**, use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ALARM LO LIMIT** is highlighted.

2) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct alarm value is being displayed, **proceed to step 7**.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

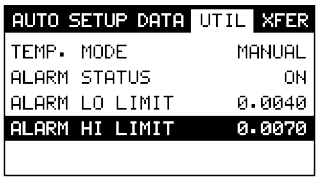
4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **ALARM LO** value is correctly displayed.

7) If only one limit will be used, press the **MEAS** key to return to the measurement screen and begin taking readings. Otherwise, continue on to set the **ALARM HI LIMIT**.

Setting the Alarm Hl Limit



1) Assuming the **ALARM STATUS** is **ON**, use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ALARM HI LIMIT** is highlighted.

2) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct alarm value is being displayed, **proceed to step 8**.

3) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

5) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

6) Repeat steps **4 & 5** until the **ALARM HI** value is correctly displayed.

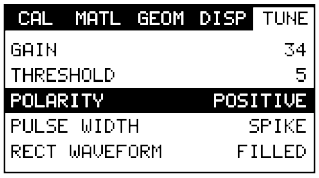
7) Press the **OK** key to set the **ALARM HI** value and return to the menu screen, or **ESC** to cancel entering the **ALARM HI** value.

8) Press the **MEAS** key to return to the measurement screen.

13.3 Polarity

Refer to section 12.7 interpreting the Wa veform, for a detailed explanation on how to select the proper polarity . T he following procedures are the necess ary steps to change the polarity only.

Toggle Polarity (+/-)



Note: Before toggling the **Polarity**, the ***MINI-MAX*** should be set to the **RF** display view option. The **RF** view will give the user the best opportunity to correctly view the positive and negative cycles of the waveform. Please refer section 12.2 for information on selecting the **Display Views**.

1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **TUNE** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **POLARITY** is highlighted.

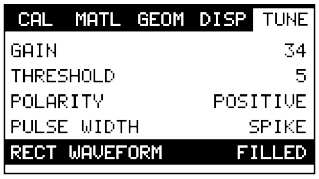
3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **POLARITY** negative or positive.

4) Press the **MEAS** key to return to the measurement screen and begin taking readings.

13.4 Rectified Waveform (Filled/unfilled)

The ***MINI-MAX*** has yet another feature primar ily included for user personal viewing preference. When the ***MINI-MAX*** is in the **Rectified Display View**, the waveform can be completely filled in black, or simply outlined. The procedures to toggle this feature, are outlined below:

Toggle Rect Wave (filled / Unfilled)



Note: Before toggling the **Rect Wave**, the ***MINI-MAX*** should be set to the **RECT** display view option. Please refer to section 12.2 for information on selecting the **Display Views**.

1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **TUNE** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **RECT WAVEFORM** is highlighted.

3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **RECT WAVEFORM** filled or unfilled.

4) Press the **MEAS** key to return to the measurement screen.

Chapter 14 Data Storage – Setup, Edit, & View Groups

14.1 Introduction to Group (spreadsheet) format

Data is stored in the ***MINI-MAX*** in a spreadsheet like format called a **GRID**. A **GRID** is simply a table of readings. In the case of the ***MINI-MAX*** they will be discussed in terms of a **GROUP**. The location in a group is specified by giving a row and column coordinate. The rows are numbered from 1 to 99 and the columns are labeled from A to Z, then AA to ZZ giving a maximum of 52 possible columns.

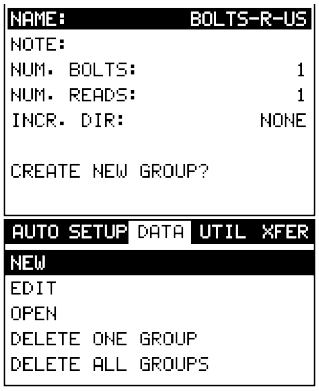
The largest grid that can be held in the ***MINI-MAX*** can contain **250** bolts, **1** Unloaded length **(L-REF)**, and **51** Elongations. Multiple groups can be created and stored until the ***MINI-MAX***'s memory is full. If the user attempts to store a grid in the ***MINI-MAX*** when the memory is full, the ***MINI-MAX*** will respond with an error message indicating that the memory is unable to store the new group.

The ***MVX*** can store a total of **8,000 readings** with a corresponding waveform stored with every reading. The **Display Views** and **Quantities** can be toggled for each and every possible option of the ***MINI-MAX***, provided that the correct factors have been entered into the gauge and are being used. To make this as clear as possible, the **Display Views (RF, RECT, and DIGITS)** can be toggled with any stored measurement. Also, the **Quantities (Time, Elong, Load, Stress, and %Strain)** can be toggle with any stored measurement. Therefore, the data recordation of MINI-MAX is an extremely powerful tool for purposes of documentation.

14.2 Creating a new Group

Important Note: This entire section is a step by step guide to successfully create a group. The instructions must be used in the sequential order specified, as follows:

Creating a Group Name



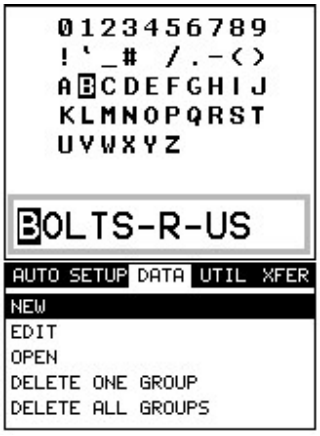
1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right, and the **ESC** key multiple times to tab left, until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **NEW** is highlighted.

3) Press the **ENTER** key to display the new **Group Edit Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NAME** is highlighted.

5) Press the **ENTER** key to activate the **Alpha Edit Box**.



6) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

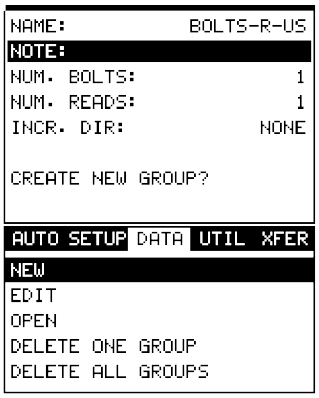
7) Press the **ENTER** key to select a character and advance to the next field of the **Group Name**.

8) Use the **CLR** key to backspace if necessary.

9) Repeat steps **6 - 8** until the **Group Name** is completed.

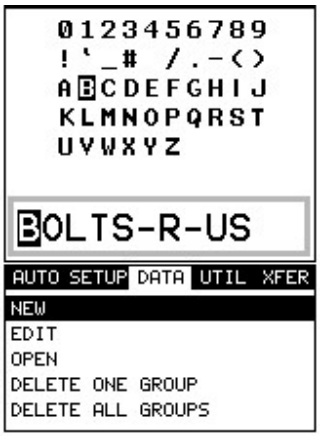
10) Press the **OK** key to save the **Group Name** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Name**.

Creating a Group Note



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NOTE** is highlighted.

2) Press the **ENTER** key to activate the **Alpha Edit Box**.



3) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

4) Press the **ENTER** key to select a character and advance to the next field of the **Group Note**.

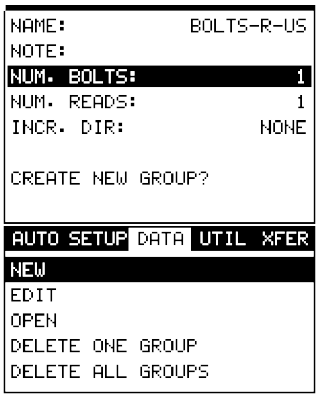
5) Use the **CLR** key to backspace if necessary.

6) Repeat steps **3 - 5** until the **Group Note** is completed.

7) Press the **OK** key to save the **Group Note** and return to the **Group List Items** menu, or **ESC** to cancel entering the **Group Note**.

Selecting the Number of Bolts in the Group

Note: A group can contain up to 250 bolts. There must be at least 1 bolt in a group.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM BOLTS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM BOLTS** value is correctly displayed.

6) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

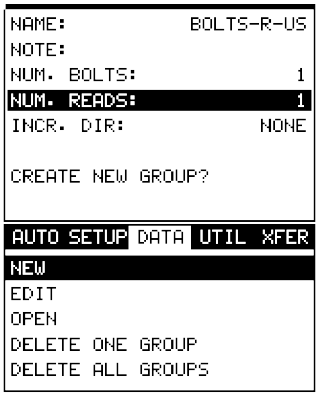
Note: If a number greater than 250 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **NUM BOLTS**.

8) Press the **OK** key to save the **NUM BOLTS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM BOLTS**.

Selecting the Number of Readings Per Bolt

Note: A bolt can have up to 51 possible measurements and 1 initial length (L-REF). There must be at least one reading per bolt.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **NUM READS** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **NUM READS** value is correctly displayed.

6) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

Note: If a number less than 1 or greater than 51 is entered, an error message box "VALUE IS OUT OF RANGE" will be displayed.

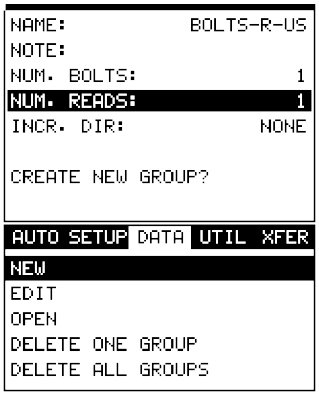
7) Press the OK key to display the **Digits Edit Box** and re-enter the **NUM READS**.

8) Press the **OK** key to save the **NUM READS** and return to the **Group List Items** menu, or **ESC** to cancel entering the **NUM READS**.

If there's not enough memory available to create the group, an error message box **"NOT ENOUGH MEMORY"** will be displayed. Press the **OK** or **ESC** key to return to the **Group List Items** menu. It may be necessary to free some memory in the ***MINI-MAX*** at this time.

Selecting the Starting Bolt Number

Note: Depending on the application and layout of the project, the user won't always want the starting bolt to be 1. This feature allows the user to define what the starting number will be.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **START BOLT NUM** is highlighted.

2) Press the **ENTER** key to display the **Digits Edit Box**.

3) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.

4) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.

5) Repeat steps **3 & 4** until the **START BOLT NUM** value is correctly displayed.

6) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

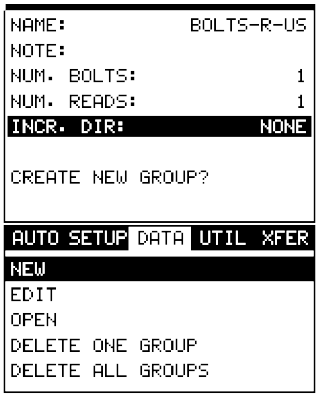
Note: If a value is enter that is greater than the maximum number of bolts allowed per group (250), an error message box "VALUE IS OUT OF RANGE" will be displayed.

7) Press the OK key to display the **Digits Edit Box** and re-enter the **START BOLT NUM**.

8) Press the **OK** key to save the **START BOLT NUM** and return to the **Group List Items** menu, or **ESC** to cancel entering the **START BOLT NUM**.

Selecting the Auto Increment Direction

The **Auto Increment** feature gives the user the ability to specify which direction to advance the cursor after storing a reading.



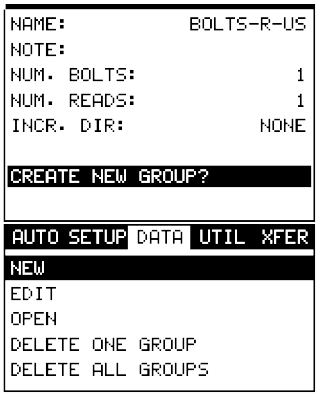
1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **INCR. DIR** is highlighted.

2) Use the **LEFT & RIGHT** arrow keys to toggle the **Increment** direction **NONE, NORTH, EAST, SOUTH, or WEST**.

3) When the correct **Increment** direction is displayed, continue on to the next section **"Saving the Group"**.

Saving the Group

Once all the parameters are set, the user has the option of saving or canceling the new group.



1) Use the **UP** and **DOWN** arrow keys to scroll through the new **Group List Items** until **CREATE NEW GROUP?** is highlighted.

2) Press the **ENTER** key to accept the group parameters, and activate the confirmation screen.

3) Press the **OK** key to save the **New Group**, or the **ESC** key to cancel **the New Group** setup and return to the **DATA** menu.

4) Press the **MEAS** key to return to the measurement screen to begin measuring reference lengths.

14.3 Storing a reading

Now that a grid has been created, it's time to make some measurements and store the readings. The following procedures outline this process:

Storing a Measurement

DELAY:	9.91	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	70.2
THR:	5	LOC:	B1
GROUP:BOLTS-R-US			

1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.

	A	B	C
1	10.0072		
2	10.0072		
3			
4			

2) Press the **ENTER** key to display the **Group View Box**.

3) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the target cell cursor to the desired storage location.

4) Press the **ENTER** key to save the current reading in the highlighted cell location.

5) Abort the **Group View Box** by pressing the **MEAS** key at any time.

Note: Every time a reading is saved to memory, the waveform data is automatically saved with the reading.

14.4 Viewing stored measurements and waveforms

It is sometimes necessary to go back and view, or toggle, the stored readings and waveforms using the ***MINI-MAX*** without a PC. The following procedures outline this process:

Viewing Stored Readings & Waveforms

DELAY:	9.91	WIDTH:	0.20
ALEN:	10.00	GAIN:	34
GATE:	0.00	TEMP:	70.2
THR:	5	LOC:	B1
GROUP:BOLTS-R-US			

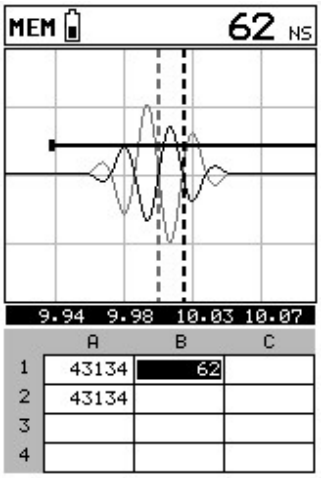
1) Press the **MEAS** key once to activate measure menu items. Press the **MEAS** key multiple times to move right and the **ESC** key multiple times to move left until the **LOC** cell is highlighted.

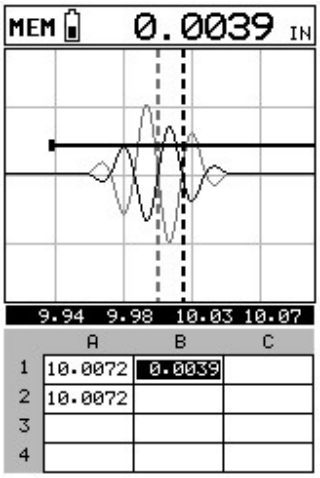
	A	B	C
1	10.0072	0.0039	
2	10.0072		
3			
4			

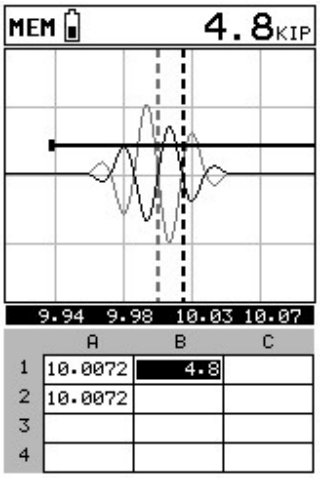
2) Press the **ENTER** key to display the **Group View Box**.

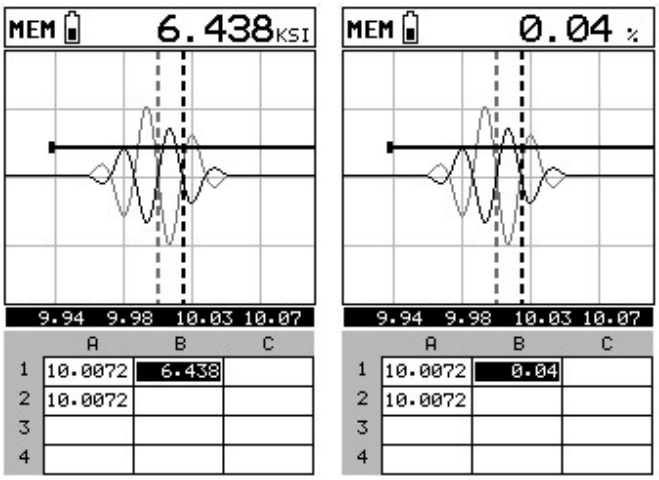
3) Press the **UP**, **DOWN**, **LEFT**, and **RIGHT** arrow keys to scroll the stored readings and corresponding display view. Notice as the cursor is moved to a different cell, the display will be updated with the display view saved with the reading.

4) Press the **OK** and **ESC** keys to toggle the quantities **TIME**, **ELONG**, **LOAD**, **STRESS**, and **%STRAIN**.

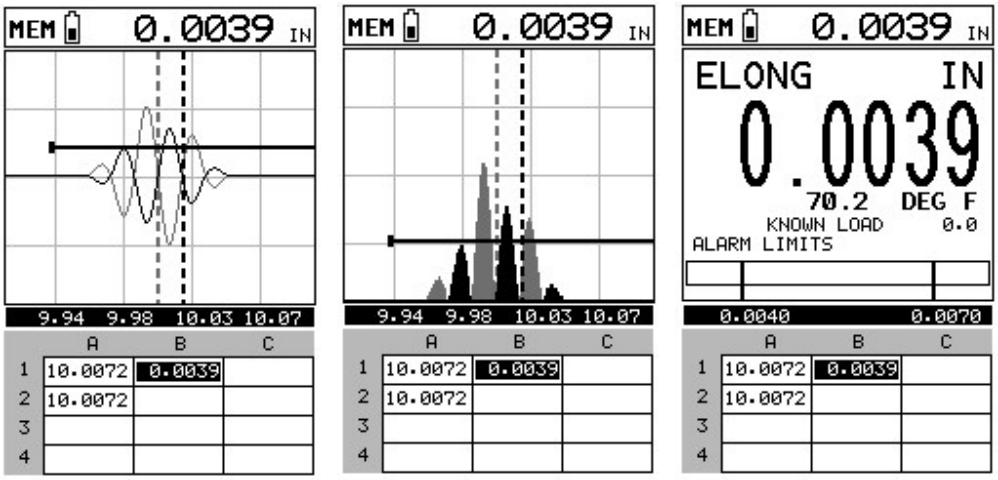








Note: Refer to section 12.2 Display View, to toggle the view options.



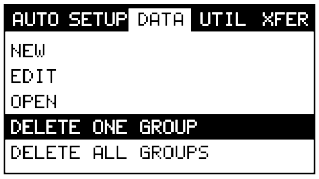
5) The user may opt to clear a specific reading and save a new one at any time. Press the **CLR** key in the appropriate cell location to clear the reading, take a new measurement, and press the **OK** key to save the new reading.

6) Abort the **Group View Box** by pressing the **MEAS** key at any time.

14.5 Deleting a group

Deleting One or All Groups from Memory

Deleting One Group



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **DELETE ONE GROUP** is highlighted.

3) Press the **ENTER** key to display the **Group List Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the stored **Groups** until the target **Groups** to delete is highlighted.

5) Press the **OK** key to delete the **Groups**.

6) Press the **MEAS** key to return to the measurement screen.

Deleting All Groups



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to

tab left until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **DELETE ALL GROUPS** is highlighted.

3) Press the **ENTER** key to activate the confirmation screen.

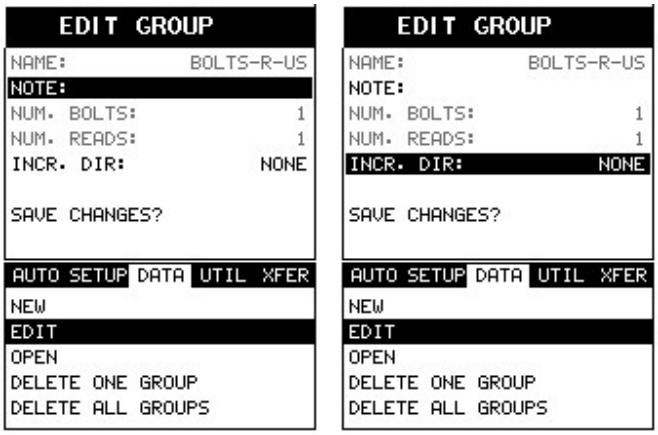
4) Press the **OK** key to delete **All Groups** from memory, or the **ESC** key to abort.

5) Press the **MEAS** key to return to the measurement screen.

14.6 Editing a group

Once a group has been created and saved to memory, the user can edit the **Note** or **Increment Direction** at a later time. The following procedures outline this process:

Editing a Group



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **EDIT** is highlighted.

3) Press the **ENTER** key to display the **Edit List Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the **Edit** options until **NOTE** or **INCR. DIR** is highlighted.

Note: If editing the **INCR. DIR**, simply use the **LEFT** or **RIGHT** arrow keys to scroll **NONE, NORTH, EAST, SOUTH,** or **WEST. Proceed to step 10**.



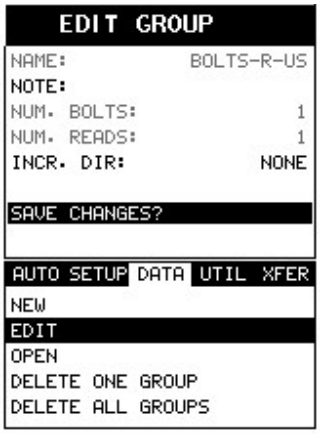
5) Press the **ENTER** key to activate the **Alpha Edit box – Only used when editing the NOTE**.

6) Use the **UP, DOWN, LEFT, & RIGHT** arrow keys to highlight the appropriate alpha characters.

7) Press the **ENTER** key to select a character and advance to the next field of the **Comments**.

8) Use the **CLR** key to backspace if necessary.

9) Repeat steps **6 - 8** until the **Comments** are completed.



10) Press the **UP** or **DOWN** arrow key to highlight **SAVE CHANGES**, and the **OK** key to activate the confirmation screen.

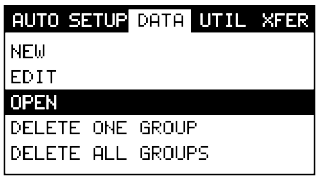
11) Press the **OK** to save the changes or the **ESC** key to cancel editing the group parameters.

12) Press the **MEAS** key to return to the measurement screen.

14.7 Changing the active group (Open)

The user may have transferred group templates from a PC to the ***MINI-MAX***, or setup groups using the ***MINI-MAX*** at an earlier time. The name of the currently active group is always displayed at the bottom of the **Hot Menu Items** in measurement mode. It's not only important to recognize what grid is currently active, but also be able to change the active grid at any time. The following procedures outline this process:

Changing the Active Group



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **DATA** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **OPEN** is highlighted.

3) Press the **ENTER** key to display the **Group List Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the groups until the target grid is highlighted.

5) Press the **ENTER** key to activate the confirmation screen.

6) Press the **OK** key to load the group from memory.

7) Press the **MEAS** key to return to the measure screen.

Chapter 15 Setups – Create, Store, Edit, & Recall

15.1 Introduction to Setups

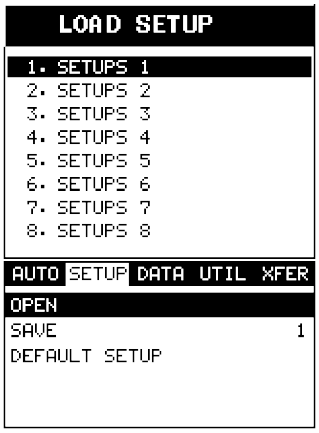
Often times, users are faced with a variety of tasks and applications that are sometimes similar, but often times very different. Different materials of bolts with specific geometries call for specific setups to be created and recalled for use at a later time.

The increased number of features and parameters also adds to the overall setup time, or amount of time to set up marginal applications with perfection and understanding. Because of the additional time involved, the ***MINI-MAX*** has been equipped with the ability to save these setups to memory and be recalled at any time. The ***MINI-MAX*** can store **64 custom setups**. These setups can be bi-directionally transferred to and from a PC. Therefore, the user can save as many setups as necessary for all of the individual applications. This saves a great deal of time and knowledge for future inspections of the same job or project. This feature also eliminates error between two or more users during the setup, measurement, and calibration process.

15.2 Opening a Setup

The ***MINI-MAX*** is loaded with a single Default setup from the factory. This setup, along with all the additional empty setups, can be opened, edited, and saved to any one of the **64 setup locations**. If the factory setup is written over, the user can simply reload the default factory set up at anytime using the utility software included with the ***MINI-MAX***. The factory setup is a general setup **Only**. It has been provide to serve as an excellent starting point for the user. The following procedures outline how to open factory and custom setups:

Opening a Setup



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **SETUP** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **OPEN** is highlighted.

3) Press the **ENTER** key to display the **Setup List Box**.

4) Use the **UP** and **DOWN** arrow keys to scroll through the setups until the target setup is highlighted.

5) Press the **ENTER** key to activate the confirmation screen.

6) Press the **OK** key to load the setup from memory.

7) Press the **MEAS** key to return to the measure screen.

15.3 Saving a Setup

Once the ***MINI-MAX*** parameters and features have been adjusted for an application, the user may elect to save these settings to a specific setup location for future use. This can potentially save time and reduce error between users.

It is sometimes necessary to rename a previously saved setup, or add additional comments about a particular setup. The setup name may have been entered incorrectly, or the user needs to use the setup for a completely different project. An inspector's name or other comments about the project may also be required for additional documentation purposes. The following procedures outline the necessary steps for saving and editing a setup:

Saving the Setup



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **SETUP** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **SAVE** is highlighted.

3) Press the **ENTER** key to display the **Save Setup Parameters List Box**.

4) Press the **UP** and **DOWN** arrow keys to scroll the **Name** and **Note** parameters.

5) When the parameter to edit is highlighted, press the **ENTER** key to activate the **Alpha Edit Box**.

6) Use the **UP, DOWN, LEFT,** and **RIGHT** arrow keys to scroll through the characters, the **ENTER** key to select characters, and the **CLR** key to backspace through the characters, until the **Name** or **Note** fields have been edited.

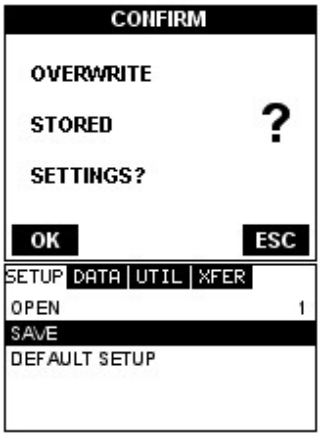
7) Press the **OK** key to return to the **Save Setup Parameters List Box**.

8) If both parameters will be edited, **repeat steps 4 – 7**.

9) Use the **UP** and **DOWN** arrow keys to scroll to and highlight **SAVE SETUP**.

10) Press the **ENTER** key to activate the **Setup List Box**.

11) Use the **UP** and **DOWN** arrow keys to scroll through the setups until the target location to save the **Setup** is highlighted.



12) Press the **OK** key to activate the confirmation screen.

13) Press the **OK** key to save the **Setup**, or **ESC** to cancel saving the **Setup**.

14) Finally, press the **MEAS** key to return to the measurement screen.

Note: The **Name** and **Comments** of the **Setup** can be edited at any time by simply repeating the **Save Setup** routine described above. Therefore, **the Save Setup** function can also be considered an **Edit Function**.

15.4 Using the Default Setup

The default setup feature was added to the ***MINI-MAX*** to use, as a last resort, if there are no setups stored in the gauge –factory or otherwise. The only time this might possibly occur is if the setup file in the ***MINI-MAX*** was somehow corrupted, and the user does not have access to a computer to re-load the factory setup

back into t he ***MINI-MAX***. This gives the user the ability to load and modify a basic setup as follows:

Using the Default Setup



1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **SETUP** menu is highlighted and displaying the submenu items.

2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **DEFAULT SETUP** is highlighted.

3) Press the **ENTER** key to load the Default Setup and display the **Warning Message Box**.

4) Press the **OK** key to return to the measurement screen.

Chapter 16 Using the Utility Software

16.1 Computer System Requirements

MINIMAXview will run on many different operating systems: Windows 95, Windows 98 (1st or 2nd edition), Windows NT 4.0 with Service Pack 5, Windows ME, Windows XP, Windows 2000 Professional, Windows 2000 Server, or Windows 2000 Advanced Server operating systems running on Intel or AMD hardware.

A Pentium 166MHz or faster processor with at least 32 megabytes of physical RAM is required. You should have 40 megabytes of free disk space before attempting to install **MINIMAXview.**

MINIMAXview requires an available communications port in order to transfer data to and from the ***MINI-MAX***. **MINIMAXview** supports COM1, COM2, COM3, and COM4.

USB to Serial Converter

Some newer laptop computers do not have standard serial ports. In this case it is possible to use a USB to Serial converter. If a serial to USB cable is needed,

Contact Dakota Ultrasonics (pt# N-402-0510).

16.2 Installing MINI-MAXview 1.X

MINIMAXview comes on a CD-ROM with an automatic installer program. Place the CD in your computer's CD tray and close the door. Open the CD-ROM by double clicking on the My Computer ICON, then double click on the CD. Finally, double click on the **SETUP** icon to begin the installation.

Refer to the help section in **MINIMAXview**, for the complete operating manual, setup, and operation.

16.3 Upgrading the Firmware

The ***MINI-MAX*** has the ability to be flash programmed from anywhere in the world. As new features, bugs, and additional software requests become available, Dakota offers the user the ability to upgrade the firmware without having to ship the unit back to the factory, or authorized service center. The user can certainly send the unit back to the factory at any time if he/she does not feel comfortable programming the unit themselves. To check the current firmware

revision, visit the software page at www.dakotaultrasonics.com, or contact the factory direct.

MATERIAL SAFETY DATA SHEET

N/A = not applicable or not available (To comply with 29 CFR 1910.1200)

SECTION 1 – PRODUCT IDENTIFICATION

Product Name: **SOUNDSAFE**®
Generic Name: Ultrasonic Couplant
Manufacturer: Sonotech, Inc.
774 Marine Dr., Bellingham, WA 98225
(360) 671-9121

NFPA Hazardous Materials
Identification System (est)
Health……0
Flammability……0
Reactivity……0

SECTION 2 – HAZARDOUS INGREDIENTS

This material does not contain any ingredients having known health hazards in concentrations greater than 1%.

This material does not contain any known or suspected carcinogens.

SECTION 3 – PHYSICAL DATA (nominal)

Boiling Point: >220°F
Freezing Point: <20°F
Vapor Pressure: N/A
Evaporation Rate: N/A
Solubility in Water: complete
Appearance and Odor: water white, opaque gel; bland odor
pH: 7.35 – 7.9
Acoustic Imp.: 1.726×10^6
Vapor Density: N/A
Specific Gravity: >1.02

SECTION 4 – FIRE AND EXPLOSION HAZARD DATA

Flash Point: none
Upper Exposure Limit: none
Lower Exposure Limit: none
Special Fire Fighting Procedures: N/A
Extinguishing media: N/A
Unusual Fire and Explosion Hazards: none

SECTION 5 – REACTIVITY DATA

Stability: Stable
Conditions to Avoid: none
Incompatibility (Materials to Avoid): none known
Hazardous Polymerization: will not occur
Hazardous Decomposition or Byproducts: none known

SECTION 6 – HEALTH HAZARD AND FIRST AID DATA

Routes of Entry:[1]
Skin: not likely
Eyes: not normally
Ingestion: not normally
Inhalation: no
Effects of Overexposure: *Acute*: May cause temporary eye irritation
Chronic: none expected

First Aid Procedures:
Skin: Remove with water if desired.
Eyes: Flush with water for 15 minutes.
Ingestion: For large quantities, induce vomiting and call a physician.
Inhalation: N/A

SECTION 7 – STORAGE AND HANDLING INFORMATION

Precautions to be taken in handling and storage: Store between 20°F and 120°F. Spills are slippery and should be cleaned up immediately.
Steps to be taken in case material is released or spilled: Pick up excess for disposal. Clean with water.
Waste disposal method: Dispose of in accordance with federal, state, and local regulations.

SECTION 8 – CONTROL MEASURES

Respiratory Protection: not required
Ventilation: not required
Protective Gloves: on individuals demonstrating sensitivity to SOUNDSAFE®
Eye Protection: as required by working conditions
Other Protective Equipment: not required

[1]**SOUNDSAFE**® contains only food grade and cosmetic grade ingredients.

SONOTECH, INC.

774 Marine Dr., Bellingham, WA 98225
Toll Free: 1-800-458-4254 **Telephone: (360) 671-9121** **Fax: (360) 671-9024**