

## Measuring the Unloaded Length

In order to measure the elongation of a bolt, it is necessary to measure the unloaded length. At first, it might seem that this step is unnecessary. Why not machine all the bolts to a known length and then only one ultrasonic measurement (of the stretched bolt) would be required.

Unfortunately, the variation in sound velocity from bolt to bolt, and in fact, from place to place on a single bolt, makes this unworkable. Instead, it is necessary to measure an unloaded length for each fastener, store that length, and then recall it after the bolts are tightened.

### Number the bolts

Because we must be able to recall the unloaded length for each bolt, it is very important to be able to clearly identify each bolt.

Sometimes, the position on the flange or engine block is enough to identify each bolt uniquely. Other times, the number is marked on the flange or structure with a white grease pencil. An electric engraving pen can put the number directly on the head of the bolt (do NOT put the number where the transducer goes!)

### Set Up the Instrument

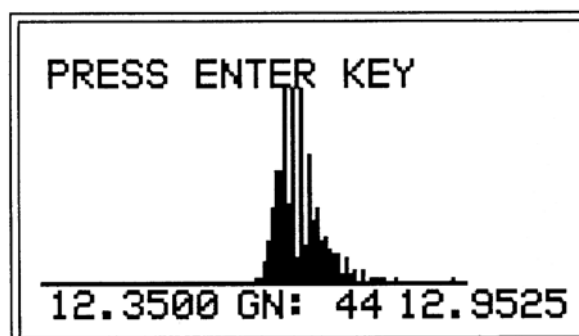
This section is specific to the Norbar USM-2. If you are using a different instrument, the steps are similar but obviously the menus and order of the steps may be different. Also, we're assuming that you have already calibrated the USM-2 instrument. (see preceding page). If so, you have determined the transducer zero, as well as knowing what factors belong in the instrument for best results. We will further assume that you have selected the right transducer, and that you have set up the USM-2 for the proper transducer frequency.

Start by setting up a new group. From the main menu select "Bolt or Group Data", then "Create/Modify Group". Now select "Add Group". Key in a number or name designates the bolt group you want to measure and press enter. The USM-2 will search it's memory to see if the bolt group name exists. If the name is new, you will be asked if you want to create a new group. Next enter how many bolts are in the group. Next you are given the choice of entering two optional comments. Now you can enter the factors that are used for every bolt in the group. The stress factor, the approximate length, the velocity, the temperature factor, and the load factor and offset can all be entered at this time. Press "Save Group" to store the group in the non-volatile memory.

Now, we are ready to measure, and the USM-2 will return to the main menu. Select "Measure", and you will see the current temperature and the bolt group you just created. If you need to change the temperature, press the F1 key, otherwise, proceed by pressing the F3 key.

The bolt number we are about to measure is now displayed. Press "Enter" if this is the bolt you want to measure. You can press F3 to scroll to the next bolt, or key in any bolt in the group and press enter.

You will now get the echo histogram screen. This display shows a graph of the echo received versus time. Note that the left and right edge of the display is labeled with a length. This shows plus or minus 5% of the approximate length entered at the time the group was created.

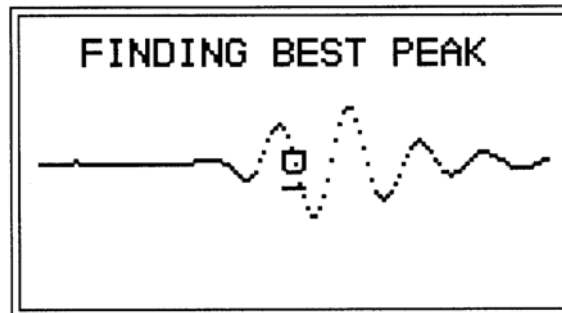


The purpose of this screen is to allow the user to adjust the transducer to get the maximum signal back. This is done by moving the transducer to minimize the gain, shown in the above example as 44. The lower this number is, the less gain is required to make the signal full screen.

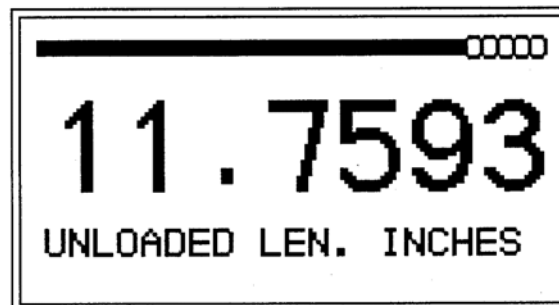
The "Delay" and "Width" controls are only active in this screen. This allows the user to examine the echo signal to determine if there are problems. By changing the width setting, the depth setting of the right side of the display is modified. This allows setting the scanning to a wider or narrower range. By changing the delay setting, the depth setting of both sides of the screen is increased or reduced. A good waveform is illustrated in the picture above. It has a quiet flat line before the main signal. It also has a steep front edge and the gain is nice and low.

If you do not get this type of signal, you should try moving the transducer. Also use the delay to search around to see if you are missing the main echo signal due to an incorrect approximate length or velocity value.

When you have optimized the signal press the "Enter" key. The USM-2 will begin its analysis of the signal, and determine the best settings for the signal. You will see a message "Finding Best Peak" displayed and see the waveform being analyzed. (Note this step is skipped if the USM-2 is set to Auto trigger.)



If the USM-2 is able to identify a suitable peak, it will automatically switch to measuring Unloaded Length, and the length reading will be displayed.



At this point, you can press enter to save the unloaded length reading in memory, or you can choose to view the waveform or information screens. To view the waveform, press the F2 key. To view the information screen, press F1. To return to the original large reading screen press F3. At any point, press the Enter key to store the reading.

That's it, we now have made our unloaded length reading and stored it!

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