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CHAPTER ONE INTRODUCTION

The Checkline model **TI-CMX** is an ultrasonic thickness gauge that measures with extreme versatility. It has the ability to simultaneously measure coatings and material thicknesses while maintaining the ability to still locate pits, flaws and defects in the material. Based on the same operating principles as SONAR, the **TI-CMX** is capable of measuring the thickness of various materials with accuracy as high as ± 0.001 inches, or ± 0.01 millimeters. The principle advantage of ultrasonic measurement over traditional methods is that ultrasonic measurements can be performed with access to only one side of the material being measured.

Checkline maintains a customer support resource in order to assist users with questions or difficulties not covered in this manual. Customer support may be reached at any of the following:

| |
|---|
| Checkline |
| 600 Oakland Ave |
| Cedarhurst, NY 11516 |
| Tel: 516-295-400 |
| Email: info@checkline.com |
| www.checkline.com |

1.1 Disclaimer

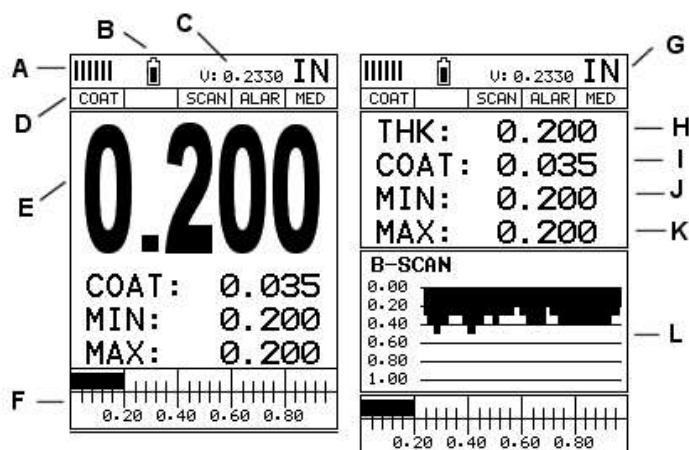
Inherent in ultrasonic thickness measurement is the possibility that the instrument will use the second rather than the first echo from the back surface of the material being measured. This may result in a thickness reading that is TWICE what it should be. Responsibility for proper use of the instrument and recognition of this phenomenon rest solely with the user of the instrument. Other errors may occur from measuring coated materials where the coating is insufficiently bonded to the material surface. Irregular and inaccurate readings may result. Again, the user is responsible for proper use and interpretation of the measurements acquired.

CHAPTER TWO QUICK STARTUP GUIDE

Turn the **TI-CMX** on and off using the switch located on the bottom right corner of the keypad. When **TI-CMX** is initially turned on, a flash logo and blinking lights will be displayed, followed by attempting to identify the transducer(probe) currently plugged into the gauge. The **TI-CMX** is equipped with an “Auto Probe Recognition” feature that attempts to identify special transducers with this built in feature. If the **TI-CMX** doesn't find a transducer equipped with this feature, the user will be advanced to a list of transducers requiring the user to select a specific transducer type. The following sections outline each scenario.

Note: *This section is primarily written as a basic startup guide only.*

2.1 TI-CMX Overview



CMX SERIES SCREEN SHOTS

In order to understand how to operate the **TI-CMX**, it's best to start off with an understanding of what it is we're looking at exactly. The **TI-CMX** has a lot of great features and tools that will prove to be a huge benefit for the variety of applications you're constantly facing on a continual basis. Let's have a brief look at the screens you'll be looking at most often:

- A. **Repeatability/Stability Indicator** – This indicator should be commonly used in conjunction with the digital thickness values displayed. When all the vertical bars are fully illuminated and the last digit on the digital thickness value is stable, the **TI-CMX** is reliably measuring the same value approximately 250 times per second (250 Hz), depending on which measurement mode and features are enabled.

- B. **Battery Icon** – Indicates the amount of battery life the **TI-CMX** has remaining.
- C. **Velocity** – The material velocity value the **TI-CMX** is currently using or calibrated for. Displayed in both English or Metric units, depending on the what units the gauge is set for.
- D. **Feature Status Bar** – Indicates the features currently enabled and in use in the following order:
 - Measurement Mode
 - Differential Mode
 - High Speed Scan Mode
 - Alarm Mode
 - Gain Setting
- E. **Digital Material Thickness Value** – Extra large font size for viewing ease.
- F. **Scan Bar** – Another view of material thickness in a deflection style horizontal bar. This is a visual tool that would enable the user the ability to see thickness changes during high speed scans from flaws and pits.
- G. **Units** – The current measurement units being used (English, Metric).
- H. **Digital Material Thickness Value** – Smaller font size when the B-Scan display view is enabled.
- I. **Coating Thickness Value** – Displays the actual thickness of any coating adhered to a metallic material surface (PECT Mode), or a coating adhered to a non-metallic surface (CT Mode).
- J. **Minimum Material Thickness** – Part of the scan feature. Displays the minimum thickness value found during a scan.
- K. **Maximum Material Thickness** – Part of the scan feature. Displays the maximum thickness value found during a scan.
- L. **B-Scan Display** – Cross section view of the material. Provides the user with graphical view of the opposite/blind surface (i.e. inside pipe wall surface), to give the user some idea of the condition, or integrity of the material being tested.

2.2 Auto Probe Recognition

When the **TI-CMX** is initially powered up, the gauge will automatically check to see if the transducer plugged into the gauge can be recognized. The steps that follow assume the **TI-CMX** recognized the probe type:

Probe Automatically Recognized

CONFIRM

1/4IN - 5.0MHZ COAT
PROBE IDENTIFIED.

USE THIS PROBE?

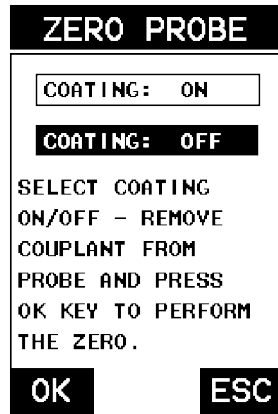
OK

ESC

1) Press the **OK** key once to use the identified probe, or **ESC** to display a list of optional transducers.

Note: *if the **TI-CMX** recognizes a specific transducer, the user should always select **OK** to use the identified probe. The only time an alternative probe should be selected from a list is if the user switched probes following initial power up and recognition.*

2) Assuming the **TI-CMX** recognized the probe and the **OK** key was pressed, the **TI-CMX** will advance to a Zero Probe menu. If the transducer was identified as a special transducer capable of measuring coating thickness, a menu will be displayed allowing the user the ability to toggle the coating thickness display on/off as follows:



- 3) Press the **UP** and **DOWN** arrow keys to toggle the coating option on/off.
- 4) Wipe all couplant from the transducer face and advance to the **Probe Zero & Calibration** section outlined below.

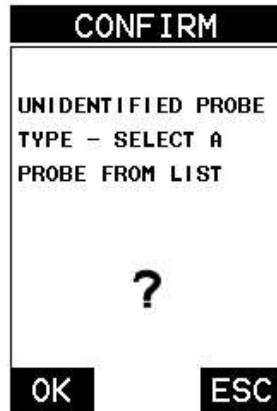
2.3 Selecting the Transducer Type

If the **TI-CMX** does not identify a specific transducer type on initial power up, the user will be required to select a type from a predefined list of types by diameter and frequency. By selecting the transducer type from the predefined list, the **TI-CMX** can recall specific properties about the transducer.

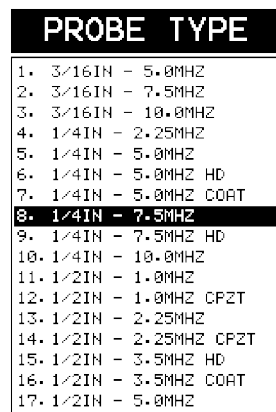
Note: *Once the transducer has been selected, the **TI-CMX** will store and recall this transducer type every time the **TI-CMX** is powered on/off. The type will only change if the user physically selects another transducer type from the list, or selects a previously saved setup. However, the **TI-CMX** will continue to take you through these steps each time the gauge is powered up. You'll notice that the probe type previously selected will be highlighted every time the probe type screen is displayed.*

Use the following steps to select your transducer type:

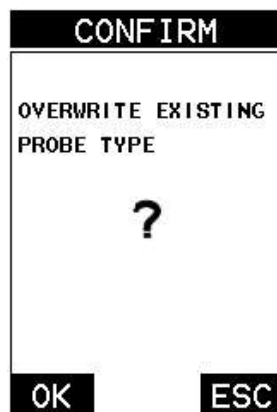
Selecting the Transducer Type



- 1) Press the **OK** or **ESC** keys to display the factory list of transducer types (by diameter and frequency).



- 2) Press the **UP** and **DOWN** arrow keys to scroll through the transducer list until the appropriate type is highlighted.



- 3) Press the **ENTER** key to select the transducer type and display overwrite existing probe screen.
- 4) Press the **OK** key to overwrite the existing probe type with the newly selected probe type. The zero probe screen will be displayed. Proceed to the zero probe section that follows.

2.4 Probe Zero & Calibration

The next steps are to perform a probe zero and calibrate the **TI-CMX** to the material and transducer being used. If the sound velocity is unknown, the **TI-CMX** can be calibrated to a known thickness sample. This demo will briefly explain both of these techniques.

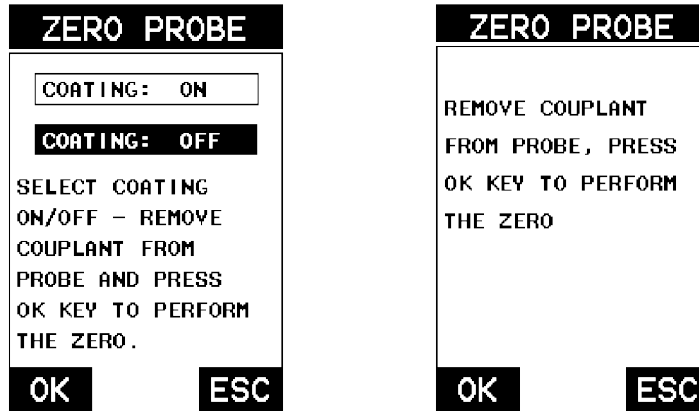
The **TI-CMX** is equipped with two zero options:

- 1) **Off Block Zero (Automatic Probe Zero)** – When this feature is enabled the **TI-CMX** will do an electronic zero automatically, eliminating the need for a zero disk or block.
- 2) **On Block Zero (Manual Probe Zero)** – When this feature is enabled the transducer must be placed on the probe zero disk (battery cover located on the top of the unit).

Note: *Transducers of the same type will have very slight mechanical and electrical variations. If it's discovered that the linearity is off following an initial auto probe zero and extreme accuracy is required, a manual zero should be performed followed by an auto zero. This will adjust and eliminate any error. This is only required if it's discovered the transducer is non-linear following an initial auto probe zero.*

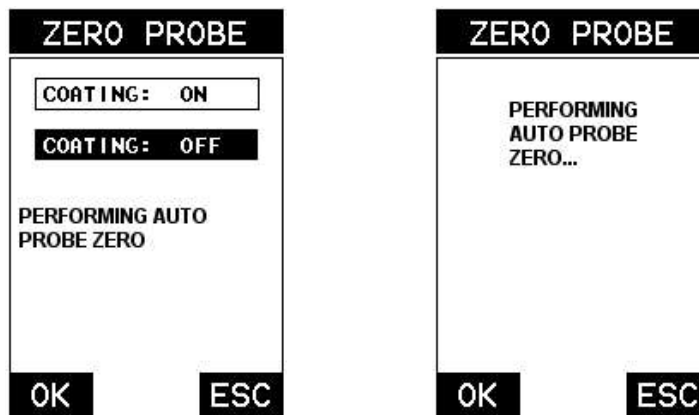
The procedures are outlined as follows:

Performing an Auto Probe Zero (Off Block)



Coating Probe Identified Coating Probe Not Identified

- 1) Be sure all couplant has been removed from the face of the transducer.
- 2) Press the **OK** key to perform the automatic probe zero, or **ESC** key to cancel the zero operation.



Coating Probe Identified Coating Probe Not Identified

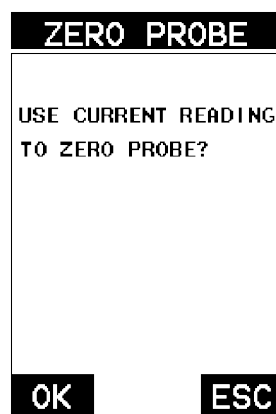
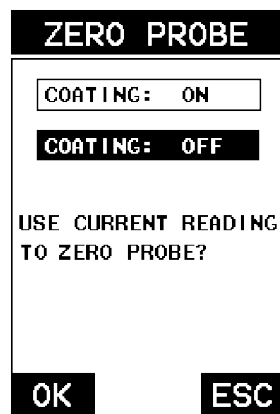
- 3) The screens illustrated above will be briefly displayed followed by the main measurement screen. The **TI-CMX** is ready to be calibrated.

Performing a Manual Probe Zero (On Block)



Note: When the zero probe option is set to manual, the probe zero disk (battery cap) located on the top of the gauge, will be used as a zero standard and the warning screen illustrated above will be displayed.

- 1) Press the **OK** or **ESC** keys to enter the main measurement screen and begin the manual zero process.
- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the probe zero disk, and obtain a steady reading.
- 3) 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 **PRB** menu is highlighted and displaying the submenu items.
- 4) Press the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO PROBE** is highlighted.



Coating Probe Identified Coating Probe Not Identified

- 5) Press the **ENTER** key to display the confirmation screen.
- 6) If a coating transducer was identified use the **UP** and **DOWN** arrow keys to toggle coating on/off.
- 7) Press the **OK** key to complete the probe zero function, or **ESC** key to cancel the probe zero function.
- 8) Remove the transducer from the probe zero disk, and proceed to the calibration section.

Note: *The value that is displayed will change depending on the current velocity setting in the **TI-CMX**. Disregard the number that is displayed. **It is not important.** What is important is accurately performing the steps outlined above to insure reliability of the probe zero calculation.*

One Point Material Calibration

For the purposes of this quick start section, we'll only be covering the most common one point calibration option to determine the sound velocity of the test material. It would be very handy to carry a set of mechanical calipers to use in conjunction with the **TI-CMX** for calibration in the field:

Using a Known Thickness

| CALIBRATE | |
|-----------------|------------------------------------|
| MAT | CUSTOM |
| MATL 1PT | 1.000 |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | UNCAL |
| COATING 2PT | UNCAL |
| COATING VEL | 0.0850 |
| PRB | CAL DISP TUNE |

Note: *Be sure that the probe zero procedure has been performed prior to performing this calibration procedure.*

- 1) Physically measure an exact sample of the material or a location directly on the material to be measured using a set of calipers or a digital micrometer.
- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the sample or actual test material. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.
- 3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **MATL 1PT** is highlighted.



- 4) 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 known thickness value is correctly displayed.

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- 8) Press the **OK** key to calculate the velocity and return to the menu screen, or **ESC** to cancel the one point calibration.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Note: ***CHECK YOUR CALIBRATION!** Place the transducer back on the calibration point. The thickness reading should now match the known thickness. If the thickness is not correct, repeat the steps above.*

2.5 Zero Coating

In order to account for very slight electronic differences in transducers of the same type, frequency, and diameter, the **TI-CMX^{DL}** has been equipped with a “zero coating” feature. This enables the **TI-CMX^{DL}** to obtain very accurate readings on coatings, eliminating potential errors incurred from slight differences in the manufacturing processes. The procedure is outlined below:

Performing a Coating Zero

| MEASURE MODE | |
|---------------------|-----------|
| COATING OFF | P-E |
| COATING ON | PECT |
| TEMP COMP | PETP |
| THRU COAT | E-E |
| THRU VERIFY | E-EV |
| COATING ONLY | CT |
| | |

- 1) Press the **MULTI MODE** key once to activate the measurement mode options.
- 2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **Coating Only (CT)** mode is highlighted.

- 3) Press the **ENTER** key to select the measurement mode and return to the measurement screen.
- 4) Apply a drop of couplant on the transducer and place the transducer in steady contact with the probe zero disk (battery cover) and obtain a steady reading.

Note: *The coating measurement displayed will potentially be a value greater or less than 0.*

- 5) 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 **PRB** menu is highlighted and displaying the submenu items.

| SETUP PROBE | |
|---------------------|----------------------|
| ZERO PROBE | AUTO |
| ZERO COATING | |
| TYPE | 11 |
| FLAW MODE | OFF |
| PRB | CAL DISP TUNE |

- 6) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO COATING** is highlighted.
- 7) Press the **ENTER** key to display the confirmation screen.
- 8) Press the **OK** key to zero the coating and return to the **PRB** menu, or **ESC** to cancel the coating zero process.
- 9) Press the **MULTI MODE** key once to activate the measurement mode options.

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- 10) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **Coating On (PECT)** is highlighted.
- 11) Press the **ENTER** key to select the measurement mode and return to the measurement screen, and begin taking readings.

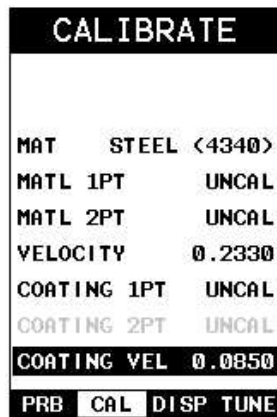
2.6 Coating Calibration

The **TI-CMX** has been preset to a default coating velocity of 0.0850 in/ μ sec (2159 m/sec). This will be very close to the most common coating material velocities used in the field. If the velocity of the coating is known, and different than the above default setting, the user can simply enter the coating velocity into the **TI-CMX**. However, if the velocity is unknown, the **TI-CMX** can also be calibrated to a specific coating sample/type using the 1pt calibration option in PECT (pulse-echo coating) mode, or a two point calibration is **CT (coating only)** mode. For the purpose of this quick start section only the 1pt option **PECT (pulse-echo coating)** mode will be covered. Refer to the calibration section of the manual for a complete explanation on the coating calibration options. The following steps below outline the necessary steps to either set the velocity of the coating, or perform a one point calibration to calculate the coating velocity:

Known Coating Velocity

If the coating velocity is known, the user may wish to simply enter the velocity number into the **TI-CMX**, rather than have the **TI-CMX** calculate the velocity value using a known thickness on a coating sample. The steps for entering the velocity are outlined below:

Using a Known Coating Velocity



- 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 **COATING VEL** 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 velocity number is correctly displayed.
- 7) Press the **OK** key to set the coating velocity and return to the menu screen, or **ESC** to cancel entering the coating velocity.
- 8) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Known Coating Thickness

When the exact velocity of a coating is unknown, the user has the option of performing a one point calibration on a sample of the coating with a known thickness

to determine the sound velocity. It would be very handy to carry a set of mechanical calipers to use in conjunction with the **TI-CMX** for calibration in the field:

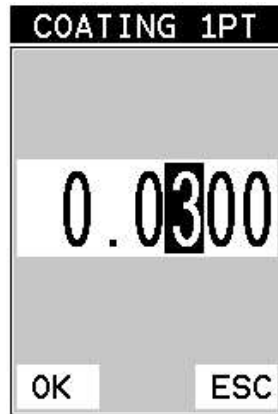
Using a Coating Sample to Calibrate

| CALIBRATE | |
|-------------|---------------|
| MAT | STEEL <4340> |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | 0.030 |
| COATING 2PT | UNCAL |
| COATING VEL | 0.0700 |
| PRB | CAL DISP TUNE |

- 1) Physically measure a location on a coating sample using a set of calipers or a digital micrometer.

Note: In **PECT** (pulse-echo coating) mode, the coating sample must be coupled to metal in order to calibrate successfully. Simply place a drop of couplant on a piece of metal, lay the coating sample over the couplant on the metal and proceed to step 2.

- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the coating (on metal) sample or actual test material. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.
- 3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **COATING 1PT** is highlighted.



- 4) 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 known thickness value is correctly displayed.
- 8) Press the **OK** key to calculate the coating velocity and return to the menu screen, or **ESC** to cancel the one point calibration.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Note: ***CHECK YOUR CALIBRATION!** Place the transducer back on the calibration point. The coating thickness reading should now match the known coating thickness sample. If the thickness is not correct, repeat the steps above.*

2.7 Measure

The **TI-CMX** is now ready to measure. There are two different measurement view options, each with a specific purpose – Digits & B-Scan. The steps below outline how to toggle between the different view mode options:

Selecting the Measurement View Option

| SET DISPLAY | |
|-------------|---------------|
| VIEW | DIGITS |
| B-START | 0.000 |
| B-DEPTH | 1.000 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL DISP TUNE |

- 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.
- 4) Once the view is displayed, press the **MEAS** key to return to measurement mode.

DIGITS: Displays the digital thickness value using a large font size. This view is useful when the TI-CMX is being used as a basic thickness gauge.

BSCAN: The Time Based B-Scan provides the user with a cross sectional view of the material being tested. This mode is useful when there is concern regarding the profile of the blind surface. This can also be a useful view when scanning for pits and flaws.

Once the view has been selected according to the application requirements, the **B-START** and **B-DEPTH** of the screen will potentially need to be adjusted if the view has been set to **BSCAN**. Use the following steps to adjust these as follows:

Note: *The B-Start and B-Depth are also used to adjust the parameters of Scan Bar.*

Adjusting B-START & B-DEPTH

| SET DISPLAY | |
|----------------|--------------|
| VIEW | DIGITS |
| B-START | 0.000 |
| B-DEPTH | 1.000 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL |
| DISP | TUNE |

| SET DISPLAY | |
|----------------|--------------|
| VIEW | DIGITS |
| B-START | 0.000 |
| B-DEPTH | 1.000 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL |
| DISP | TUNE |

- 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 **B-START** or **B-DEPTH** is highlighted.
- 3) Use the **LEFT** or **RIGHT** arrow keys to increase/decrease the start or depth values in coarse increments/decrements.
- 4) Repeat steps 2 & 3 until the range is correctly being displayed.

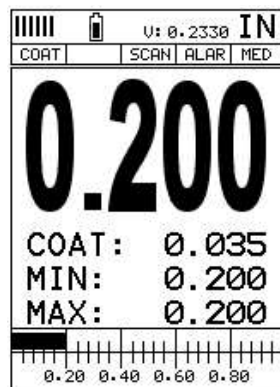
| B-START |
|---------|
| 0.000 |
| OK |
| ESC |

| B-DEPTH |
|---------|
| 1.000 |
| OK |
| ESC |

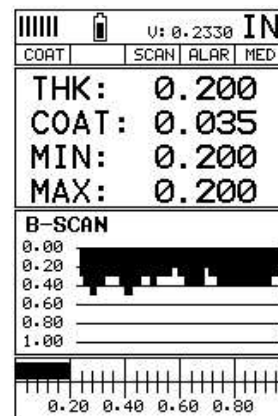
Alternatively, the **B-START** and **B-DEPTH** values can be changed using the **Digit Edit Box** as follows:

Checkline

- 1) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **B-START** or **B-DEPTH** 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 **B-START** or **B-DEPTH** value is correctly displayed.
- 6) Press the **OK** key to set the **B-START** or **B-DEPTH** value and return to the **DISP** menu, or **ESC** to cancel entering the **B-START** or **B-DEPTH** value.
Note: *The adjusted value will appear next to the B-START or B-DEPTH menu labels.*
- 7) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.



DIGITS



B-SCAN

In the upper left corner of each of the display photos above, is the repeatability indicator. The repeatability indicator is represented by five vertical bars and represents how repeatable the measurements are. In regular measurement mode, the **TI-CMX** makes 8 measurements a second. In scan mode, the **TI-CMX** makes 200 measurements a second. If the coating mode option is activated, the **TI-CMX** makes 3 measurements a second in regular measurement mode and 65 measurements a second in scan mode. When the **TI-CMX** is idle, only the left

CMX High Performance Material & Coating Thickness Gauge

vertical bar will be displayed. However, when the **TI-CMX** is making a measurement, four or five of the bars should be displayed on the repeatability indicator. If fewer than four bars are showing, the **TI-CMX** is having difficulty achieving a stable measurement and the thickness value displayed is potentially unstable.

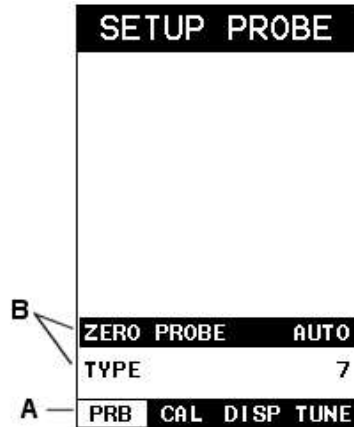
CHAPTER THREE KEYBOARD, MENU, & CONNECTOR REFERENCE



3.1 Menu Key (Operation & Sub Menus)

The **Menu** key activates the primary menu structure containing 8 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. The tab groups are illustrated above (**A**).

Now that you're 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. The sub menu items are illustrated in the diagram above (**B**).
- 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:

| | |
|--------------|---------------|
| ZERO PROBE | AUTO |
| ZERO COATING | |
| TYPE | 11 |
| PRB | CAL DISP TUNE |

3.2 Probe – Menu

ZERO PROBE: The **TI-CMX** is zeroed in much the same way that a mechanical micrometer is zeroed. If the **TI-CMX** is not zeroed correctly, all of the measurements made using the **TI-CMX** may be in error by some fixed value. The **TI-CMX** is equipped with an optional automatic or manual zero feature. Refer to the section on page 41, for an explanation of this important procedure.

ZERO COATING: In order to account for very slight electronic differences in transducers of the same type, frequency, and diameter, the **TI-CMX^{DL}** has been equipped with a “zero coating” feature. This enables the **TI-CMX^{DL}** to obtain very accurate readings on coatings, eliminating potential errors incurred from slight differences in the manufacturing processes. Refer to the section on page 41, for a detailed explanation.

TYPE: Enables the user to select the type of transducer being used from a chart of transducer types. This provides increased linearity between transducers. Refer to page 5 for a further explanation.

| | |
|-------------|---------------|
| MAT | STEEL <4340> |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | 0.030 |
| COATING 2PT | UNCAL |
| COATING VEL | 0.0700 |
| PRB | CAL DISP TUNE |

3.3 CAL – Menu

MAT: Select the material velocity from a chart of basic material types when a known sample thickness, or material velocity cannot be obtained. Refer to page 50 for further info.

MATL 1PT: Performs a single point calibration. This option allows the user to automatically calculate the velocity by entering a known sample thickness. Refer to page 47 for further info.

MATL 2PT: Performs a two-point calibration. This option allows the user to automatically calculate the velocity by entering a second known sample thickness. Refer to page 48 for further info.

VELOCITY: Function to calibrate the **TI-CMX** by setting the velocity to a known material velocity. Refer to page 45 for further info.

COATING 1PT: Performs a single point coating calibration. This option allows the user to automatically calculate the velocity by measuring a known coating sample thickness. Refer to page 76 for further info.

COATING 2PT: Performs a two-point coating calibration. This option allows the user to automatically calculate the velocity by entering a second known coating sample thickness. Refer to page 76 for further info.

COATING VEL: Function to calibrate the **TI-CMX** to a specific coating material type by entering a coating velocity. Refer to page 14 or 72 for further info.

| VIEW | DIGITS |
|-----------|--------|
| B-START | 0.000 |
| B-DEPTH | 1.000 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL |
| DISP | TUNE |

3.4 DISP (display) – Menu

VIEW: Selectable BSCAN (cross section), and DIGITS (large digits) views. Refer to page 53 for further info.

B-START: Provides the user the ability to change the start position of the B-SCAN view. Refer to page 58 for further info.

B-DEPTH: Provides the user the ability to change the overall depth of the viewable measurement area. It functions a lot like a zoom on a camera. Refer to page 60 for further info.

B-SCAN SPEED: Controls the speed of the time based B-Scan with an arbitrary scale of 0-10, with 10 being the fastest scrolling speed. Default speed set at 6. Refer to page 61 for further info.

UNITS: Toggle between English or Metric units. The readout will change from inches to millimeters.

BACKLIGHT: Selectable OFF, ON, AUTO, or INVERT backlight option.

CONTRAST: Adjustable display contrast for variable light conditions.

| MEASURE MODE | PECT |
|--------------|------|
| GAIN | MED |
| PRB | CAL |
| DISP | TUNE |

3.5 TUNE – Menu

MEASURE MODE: Toggles a variety of unique measurement modes for different application requirements. Refer to page 35 for further info.

GAIN: A five position gain switch in 3 db increments from 40 to 52 dB. Increase for better penetration or punch, and decrease to eliminate unwanted noise or better resolution. Refer to page 63 for further info.

| |
|---------------------------|
| OPEN |
| SAVE |
| DELETE |
| DEFAULT SETUP |
| |
| LANGUAGE ENGLISH |
| SET DATA UTIL XFER |

3.6 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. Refer to page 88 for further info.

SAVE: Provides the user with the ability to save a custom setup that has been modified or created by the user. Refer to page 90 for further info.

DELETE: Provides the user with the ability to delete specific setups previously save in memory. Refer to page 94 for further info.

DEFAULT SETUP: Loads a basic default setup. Use only as a last resort when the setups in the *TI-CMX* have been corrupted and a computer is not accessible. Refer to page 95 for further info.

LANGUAGE: Provides the user the ability to select different languages for the *TI-CMX*. Refer to page 97 for further info.

| | |
|---------------------------|------------|
| SCAN MODE | OFF |
| ALARM | ON |
| ALARM HIGH | 1.000 |
| ALARM LOW | 0.000 |
| DIFFERENTIAL | OFF |
| KEY CLICK | QUIET |
| SET DATE | MMDDYY |
| SHOW DATE | BOTH |
| SET DATA UTIL XFER | |

3.7 UTIL (utilities) – Menu

SCAN MODE: This function enables a hi speed scan mode that increases the overall sample rate from 65 to 200 measurements per second, depending on the current measurement mode used. Refer to page 80 for further info.

ALARM: Toggles alarm mode on, off, or audible. Refer to page 81 for further info.

ALARM HIGH: Gives the user the ability to set the HI limit parameter. If the measurement exceeds this value, a red light will illuminate and sound the internal beeper. Refer to page 81 for further info.

ALARM LOW: Gives the user the ability to set the LO limit parameter. If the measurement falls below this value, a red light will illuminate and sound the internal beeper. Refer to page 81 for further info.

DIFFERENTIAL: Gives the user the ability to set a nominal value and the **TI-CMX** will display +/- the difference from the nominal value entered. Refer to page 83 for further info.

KEY CLICK: Give the user the ability to set the level of the key press beeper, OFF, QUIET, or LOUD. Refer to page 84 for further info.

SET DATE: Gives the user the ability to set the internal date and time stamp in the **TI-CMX**. Refer to page 85 for further info.

SHOW DATE: Gives the user the ability to display the date and time in the waveform area of the **TI-CMX**. The options are OFF, DATE, TIME, BOTH. Refer to page 87 for further info.



3.8 XFER (transfer) – Menu

UPGRADE GAUGE: Enables the user the ability to upgrade the **TI-CMX** to the most current firmware revision. Latest version posted on www.Checklineultrasonics.com.

ABOUT: Provides the user with Checkline contact information and the **TI-CMX** software version. Refer the Checkline web site for information on the latest firmware versions available for download.



3.9 CLR (clear) Key

The primary function of the **CLR** key is to backspace in an **Alpha Edit Box**.



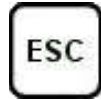
3.10 MEAS (measurement mode) Key

The **MEAS** key puts the **TI-CMX** into it's primary mode of operation. In this mode, the user has a complete view of the LCD.



3.11 OK Key

The primary function of the **OK** key is confirmation of a change or selection.



3.12 ESC Key

The **ESC** key is used in the **MENU**, **MEAS**, and **EDIT** functions as a back or escape function.



3.13 Arrow Keys

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



3.14 ENTER key

The **ENTER** key is used in the overall menu selection process to activate list and edit boxes.



3.15 MULTI MODE Key

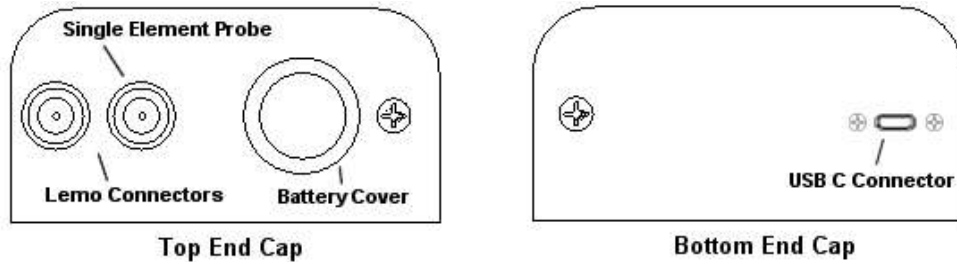
The **MULTI MODE** key opens a measurement mode screen listing all the modes that are available to the transducer specifically selected. The modes can be all or a combination of the entire set of modes the **TI-CMX** offers, depending on which transducer is being used as follows: **Coating Off (P-E)**, **Coating On (PECT)**, **Temp Comp (PETP)**, **Thru-Coat (E-E)**, **Thru Coat Verify (E-EV)**, and **Coating Only (CT)**.



3.16 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 automatically saved prior to powering off.*

3.17 Top & Bottom End Caps



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

Transducer Connectors

Refer to Diagram: The transducer connectors, and battery cover/probe zero disk are located on the **TI-CMX's** top end cap. The transducer connectors are of type Lemo "00".

Note: *There is no polarity associated with connecting the transducer to the TI-CMX.*

Probe Zero Disk & Battery Cover

Refer to Diagram: The Battery cover is the large round disk shown in the diagram.

Note: *This same disk is also used as a probe zero disk. Simply remove the cover when replacing the batteries (3 AA cells). When performing a manual probe zero function, simply place the transducer on disk making firm contact. **Important:** Be sure to follow the polarity labels located on the back label of the TI-CMX.*

Note: *Rechargeable batteries can be used, however they must be recharged outside of the unit in a standalone battery charger.*

USB-C Connector

Refer to Diagram: The **USB-C** connector, located on the bottom end cap, is a mini type C female connector. It is designed to connect directly from the **TI-CMX** to a standard USB type A port on a PC. The cable supplied with the **TI-CMX** is a USB type C to a USB type A (pt# N-003-0330).

Note: *This connector is also used to upgrade the TI-CMX with the latest version of firmware.*

CHAPTER FOUR PRINCIPALS OF ULTRASONIC MEASUREMENT

4.1 Time versus thickness relationship

Ultrasonic thickness measurements depend on measuring the length of time it takes for sound to travel through the material being tested. The ratio of the thickness versus the time is known as the sound velocity. In order to make accurate measurements, a sound velocity must be determined and entered into the instrument.

The accuracy of a thickness measurement therefore depends on having a consistent sound velocity. Some materials are not as consistent as others and accuracy will be marginal. For example, some cast materials are very granular and porous and as a result have inconsistent sound velocities.

While there are many different ultrasonic techniques to measure thickness, which will be discussed below, all of them rely on using the sound velocity to convert from time to thickness.

4.2 Suitability of materials

Ultrasonic thickness measurements rely on passing a sound wave through the material being measured. Not all materials are good at transmitting sound. Ultrasonic thickness measurement is practical in a wide variety of materials including metals, plastics, and glass. Materials that are difficult include some cast materials, concrete, wood, fiberglass, and some rubber.

4.3 Range of measurement and accuracy

The overall measurement capabilities, based on the wide variety of materials, is determined by the consistency of the material being measured

The range of thickness that can be measured ultrasonically depends on the material as well as the technique being used and the type of transducer. Thickness measurements can be made from a minimum of 0.010 inch to 9.999" in steel. However, the maximum attainable thickness is much less for more attenuative materials (materials that absorb sound).

Accuracy, is determined by how consistent the sound velocity is through the sound path being measured, and is a function of the overall thickness of the material. For example, the velocity in steel is typically within 0.5% while the velocity in cast iron can vary by 4%.

4.4 Couplant

All ultrasonic applications require some medium to couple the sound from the transducer to the test piece. Typically a high viscosity liquid is used as the medium. The sound frequencies used in ultrasonic thickness measurement do not travel

through air efficiently. By using a liquid couplant between the transducer and test piece the amount of ultrasound entering the test piece is much greater.

4.5 Temperature

Temperature has an effect on sound velocity. The higher the temperature, the slower sound travels in a material. High temperatures can also damage transducers and present a problem for various liquid couplants.

Since the sound velocity varies with temperature it is important to calibrate at the same temperature as the material being measured.

Normal temperature range

Most standard transducers will operate from 0°F to 180°F.

High temperature measurements

Special transducers and couplants are available for temperatures above 180°F up to 650°F with intermittent contact. It is necessary to cool the transducer, by submerging the transducer in water between readings, when measuring high temperatures.

Modes and temperature errors

In addition to errors caused by velocity changing with temperature, some modes (measurement techniques) are affected more than others. For example, dual element pulse-echo mode has larger errors due to changes in the temperature of the delay line. However, multi-echo techniques offer temperature compensation help to minimize these errors.

4.6 Measurement Modes

In this section we will discuss the different measurements modes the **TI-CMX** is capable of operating in, the transducers required, and the reasons for using specific modes:

Pulse-Echo Mode (Flaw & Pit detection) – Coating Off (P-E)

Pulse-echo mode measures from the initial pulse (sometimes referred to as an artificial zero) to the first echo (reflection). In this mode, either an automatic or manual zero can be performed depending on the zero probe function setting. If the manual mode has been selected, the transducer is placed on a reference disk, located on top of the **TI-CMX**, and a key is pressed to establish a zero point for the particular transducer. If the Auto Zero feature is enabled, a simple key press will perform an electronic zero to establish the same zero point.

In this mode errors result from surface coatings and temperature variations.

Since pulse-echo only requires one reflection, it is the most sensitive mode for measuring weak reflections (flaws) typically found when measuring heavily corroded metals.

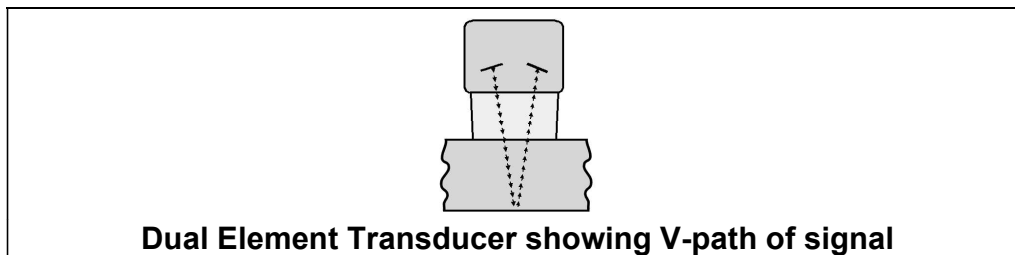
V-Path Correction

Dual element delay line transducers have two piezoelectric elements mounted at an angle on one end of the delay line. One element is used for transmitting sound, while the other element only receives sound. The two elements and their delay lines are packaged in a single housing but acoustically isolated from each other with a sound barrier. This allows the transducer the ability to achieve very high sensitivity for detecting small defects. Also, the surface of the test material does not have to be as flat in order to obtain good measurements.

Dual element transducers are normally used in pulse-echo mode for finding defects, and in echo-echo mode for through coating measurements.

Dual element delay line transducers are usable over a range of 0.025 inches to 20 inches depending on the material, frequency, and diameter.

A limitation of dual element delay-line transducers is the V shaped sound path. Because the sound travels from one element to another, the time versus thickness relationship is non-linear. Therefore, a correction table in the instruments software is used to compensate for this error.

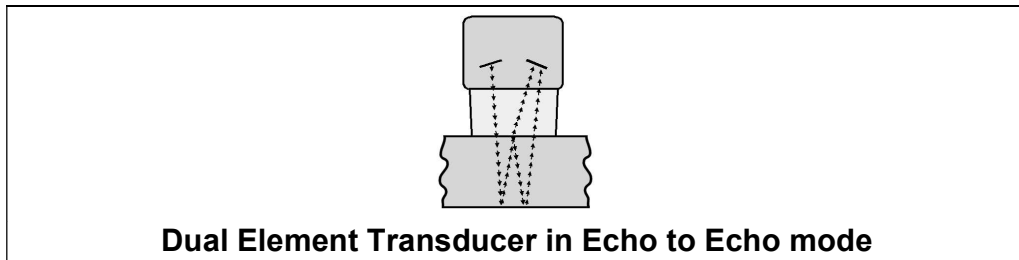


Searching for small defects

Dual element delay line transducers are especially useful in searching for small defects. In the pulse-echo mode with high amplifier gain, very small defects can be measured. This is very useful during corrosion inspections overall. The dual element style transducer will find wall deterioration, pits, and any porosity pockets during tank and pipeline inspections.

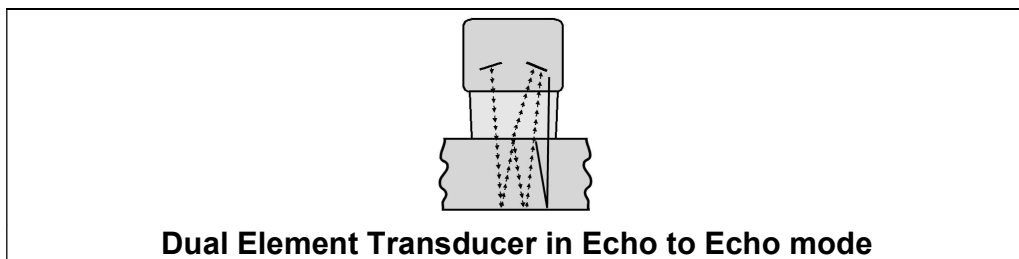
Echo-Echo Mode – Thru-Paint (E-E)

The echo-echo mode measures between two reflections. This technique is commonly used to eliminate errors from surface coatings and also to make measurements in multiple layered materials. The disadvantage is that two echoes are needed which requires a much stronger echo (reflection).



Echo-Echo Verify Mode – Thru-Verify (E-EV)

The echo-echo verify mode measures between 3 reflections. Similar to E-E mode, this technique is commonly used to eliminate errors from surface coatings and also to make measurements in multiple layered materials. The primary benefit of this mode, is that a comparison is made, between the 2nd and 3rd echoes, to verify that a peak jump has not occurred, providing an additional level of confidence to the measurement. The disadvantage is that 3 reflections are needed which requires the use of gates with controllable thresholds to adjust for sensitivity over a given measurement range.



Pulse Echo Coating Mode – Coating On (PECT)

A custom hybrid combination mode using properties from the basic modes along with a group of special techniques and theoretical wave phenomena's to measure coating and material thicknesses at the same time, while still retaining the ability to locate flaws and pits in materials. Therefore, the best description for this hybrid mode is Pulse-Echo Coating mode.

Coating Mode – Coating Only (CT)

Once again, this is a custom hybrid combination mode using special techniques to effectively measure the thickness of coatings that are either adhered to metallic surfaces or in stand alone form. In this mode a two point calibration must be performed. If the user will be measuring coating that has been applied to a metal surface, the calibration must be performed using coating samples coupled to a metal surface when calibrating. To explain further, a drop of couplant must be applied in between the coating samples and metal surface. If the coating has not been applied to a metal surface, the calibration should be performed accordingly.

Pulse-Echo Temperature Compensated Mode – Temp Comp (PETP)

This is a custom mode that combines pulse-echo and electronic zero techniques to automatically adjust for temperature changes in the transducer as a result of an increasing/decreasing temperature gradient in the test material.

Note: *Rough surface conditions can have an effect on the overall accuracy in this mode. If the surface condition is in question, the pulse-echo mode should be used in conjunction with performing an off block automatic zero as the temperature gradient changes.*

CHAPTER FIVE SELECTING THE MEASUREMENT MODE

5.1 The setup library

The **TI-CMX** contains 64 user configurable preset locations to store custom setups for easy recall. These setups can be optimized for the user's specific application needs and can also be stored on a PC and transferred bi-directionally using Checkline's PC interface software included with the instrument.

The setups supplied with the instrument cover some of the more typical applications commonly used with this type of instrument. These setups can be recalled, modified, and overwritten to one of 64 setup locations. Therefore, these factory setups can also be considered a good starting point to be modified for custom applications. The PC software includes a default setup file that can be uploaded to the gauge at any time to restore factory settings. However, it is recommended that the user consider saving modified setups to an empty location rather than overwriting the factory setups in the **TI-CMX**. Once again, these factory settings are excellent starting points for custom setups.

5.2 Which mode & transducer do I use for my application?

High penetration plastics and castings

The most common mode for these types of applications is pulse-echo. The TI-CMX has been optimized for cast materials. Cast iron applications require 1 - 5MHz frequencies, and cast aluminum requires a 10MHz frequency. Plastics typically require lower frequencies depending on the thickness and make-up of the material. Larger diameters offer greater penetration power because of the crystal size, for difficult to measure materials.

Corrosion & Pit Detection in steel and cast materials

Use pulse-echo mode whenever attempting to locate pits and flaws. Typically a 5MHz transducer, or higher, will be used for these types of applications. Use low frequencies for greater penetration and use higher frequencies for better resolution.

Measuring Material & Coatings

The pulse-echo coating mode should be used when both material and coating thickness are required, while still requiring the ability to detect flaws and pits. A special coating style transducer is required for use in this mode. There are a variety of coating transducers in various frequencies available from Checkline.

Thru Paint & Coatings

Often times users will be faced with applications where the material will be coated with paint or some other type of epoxy material. Since the velocity of the coating is approximately 2.5 times slower than that of steel, pulse-echo mode will induce error if the coating or paint is not completely removed. By using echo-echo mode, the user is able to successfully measure through both, the coating and steel, and completely eliminate the thickness of the paint or coating. Therefore, the steel can be measured without having to remove the coating prior to measuring. Users will often use pulse-echo mode and echo-echo mode in conjunction when performing inspections on coated materials.

Thru coating measurements require special high damped transducers. The most common transducers are the 3.5, 5, and 7.5MHz hi damped transducers. These transducers are suitable for use in both pulse-echo and echo-echo modes. This conveniently enables the user to accurately measure overall material thickness using the thru Coating mode, and then conveniently switch to pit detection mode without changing transducers. The ¼" 5MHz Hi damped transducer is the most commonly used transducer for standard thru coating applications.

Coating Only

The coating only mode should be used when the application calls for coating measurements only and the user is not interested in the thickness of the material the coating has been applied to. This mode can also be used as a stand alone coating thickness gauge, where the coating has not been applied to another material surface. An auto identified coating probe must be attached to the **TI-CMX** in order to enable this mode.

Thin materials

Use pulse echo mode and a high frequency transducer for these types of applications. The most common transducers are the 7.5MHz and 10MHz models with extra resolution. The higher frequencies provide greater resolution and a lower minimum thickness rating overall.

High temperature

Use and select a special 2.25MHz and 5 MHz High temperature transducer for these types of applications. Both pulse-echo and echo-echo modes will also work for these applications. However, echo-echo mode will eliminate error caused by temperature variations in the delay line of the transducer.

Noisy Material

Materials such as titanium, stainless steel, and aluminum may have inherent surface noise issues. This is a signal that appears at the surface of the material when using a dual element delay line probe. Select a higher frequency transducer to reduce this noise – 7.5MHz and higher for better resolution.

CHAPTER SIX MAKING MEASUREMENTS

The steps involved in making measurements are detailed in this section. The following sections outline how to setup and prepare your **TI-CMX** for field use.

An automatic or manual zero must always be performed. The auto zero is an off block electronic zero that does not require a zero reference block. This will most always be the zero option of choice, as it makes the zeroing process very easy and convenient to perform. However, if the manual zero option is enabled, the probe zero must be measured on the reference disk (battery disk) attached to the top of the instrument. The zero compensates for variations in the transducer. In all modes the sound velocity must be determined. The sound velocity is used to convert the transit time to a physical length. The sound velocity can be selected from a material chart in the manual, selected from a material list in the **TI-CMX**, or for greater precision determined from a sample of the test material that has been mechanically measured. To enter the velocity from a table, look up the material on the chart in the appendix of this manual and refer to the section below on Calibration to a Known Velocity. To determine the velocity of a single sample, refer to the Material Calibration section on page 47.

When measuring curved materials, it is more accurate to calibrate from two test points, one at the minimum limit of the target thickness and one at the maximum limit. In this case the reference disk mounted to the **TI-CMX** is not used. This is called two-point calibration and is described on page 48.

6.1 Auto Probe Recognition & Selecting The Transducer Type

The first step in using the **TI-CMX** is to plug the transducer into the gauge and power the unit up. The **TI-CMX** has a special built-in automatic probe recognition feature that will check to see if the probe plugged into the gauge is an auto recognized probe type. If so, the **TI-CMX** will display a message indicating the transducer type and ask the user for confirmation to use the identified probe. If the transducer is not an auto recognized probe, the **TI-CMX** will display a message indicating the transducer type has not been recognized, and force the user to select a transducer type from a list of transducers according to frequency and diameter. Whether the transducer is auto recognized or selected from a predefined list, the **TI-CMX** will recall specific properties about the transducer.

Note: *Once the transducer has been selected, the **TI-CMX** will store and recall this transducer type every time the **TI-CMX** is powered on/off. The type will only change if the user physically selects another type from the list, or selects a previously saved setup. Therefore, if you have previously gone through this section and selected the transducer you are using, proceed to the next section.*

Use the following steps to select your transducer type:

Note: *If the transducer is not identified on power up, be sure the transducer type selected is the same as the transducer plugged into the **TI-CMX**. Failure to do this will result in erroneous measurements:*

In this first example the transducer was automatically identified:

Probe Automatically Recognized

CONFIRM

1/4IN - 5.0MHZ COAT
PROBE IDENTIFIED.

USE THIS PROBE?

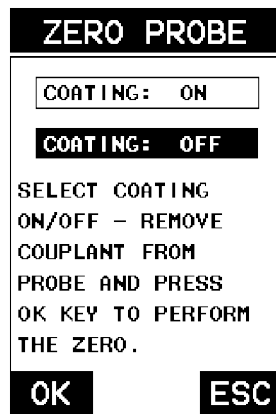
OK

ESC

1) Press the **OK** key once to use the identified probe, or **ESC** to display a list of optional transducers.

Note: *if the **TI-CMX** recognizes a specific transducer, the user should always select **OK** to use the identified probe. The only time an alternative probe should be selected from a list is if the user switched probes following initial power up and recognition, or the **TI-CMX** has somehow identified the probe in error.*

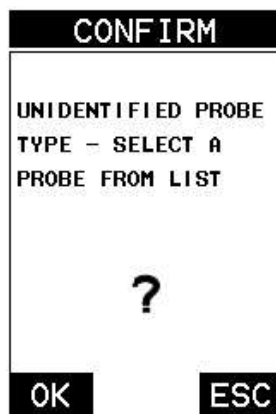
2) Assuming the **TI-CMX** recognized the probe and the **OK** key was pressed, the **TI-CMX** will advance to a Zero Probe menu. If the transducer was identified as a special transducer capable of measuring coating thickness, a menu will be displayed allowing the user the ability to toggle the coating thickness display on/off as follows:



- 3) Press the **UP** and **DOWN** arrow keys to toggle the coating option on/off.
- 4) Wipe all couplant from the transducer face and proceed to the Probe Zero section that follows.

In this second example the transducer was not identified and will force the user to select the transducer type from a predefined list of transducers:

Selecting the Transducer Type



- 5) Press the **OK** or **ESC** keys to display the factory list of transducer types (by diameter and frequency).

| PROBE TYPE | |
|------------|----------------------|
| 1. | 3/16IN - 5.0MHZ |
| 2. | 3/16IN - 7.5MHZ |
| 3. | 3/16IN - 10.0MHZ |
| 4. | 1/4IN - 2.25MHZ |
| 5. | 1/4IN - 5.0MHZ |
| 6. | 1/4IN - 5.0MHZ HD |
| 7. | 1/4IN - 5.0MHZ COAT |
| 8. | 1/4IN - 7.5MHZ |
| 9. | 1/4IN - 7.5MHZ HD |
| 10. | 1/4IN - 10.0MHZ |
| 11. | 1/2IN - 1.0MHZ |
| 12. | 1/2IN - 1.0MHZ CPZT |
| 13. | 1/2IN - 2.25MHZ |
| 14. | 1/2IN - 2.25MHZ CPZT |
| 15. | 1/2IN - 3.5MHZ HD |
| 16. | 1/2IN - 3.5MHZ COAT |
| 17. | 1/2IN - 5.0MHZ |

- 6) Press the **UP** and **DOWN** arrow keys to scroll through the transducer list until the appropriate type is highlighted.

| CONFIRM | |
|----------------------------------|-----|
| OVERWRITE EXISTING PROBE TYPE | |
| ? | |
| OK | ESC |

- 7) Press the **ENTER** key to select the transducer type and display overwrite existing probe screen.
- 8) Press the **OK** key to overwrite the existing probe type with the newly selected probe type. The zero probe screen will be displayed. Proceed to the zero probe section that follows.

6.2 Probe zero

The next step is to perform a probe zero. The zero function is a very important and necessary function that must be done prior to calibration. It should be done on a regular basis. In fact, the **TI-CMX** has been programmed to force this issue at regular intervals during operation if it hasn't been done. If the **TI-CMX** is not zeroed correctly, all the measurements taken may be in error by some fixed value. When

the **TI-CMX** is using the auto zero (electronic zero), the **TI-CMX^{DL}** can be in any measurement mode. However, when the manual zero is being used, the **TI-CMX** must be in pulse-echo mode in order to perform the zero. The **TI-CMX** will also see to it that this occurs by simply forcing the gauge into this mode when zero. Therefore, if the **TI-CMX** is in the echo-echo measurement mode and a manual zero is being performed, the **TI-CMX** will put the gauge into pulse-echo mode automatically before performing the zero. While this is a very convenient feature of the **TI-CMX**, the user should be sure to check the measurement mode following calibration to be sure the **TI-CMX** is in the desired mode. The following steps outline both of these techniques.

The **TI-CMX** is equipped with two zero options:

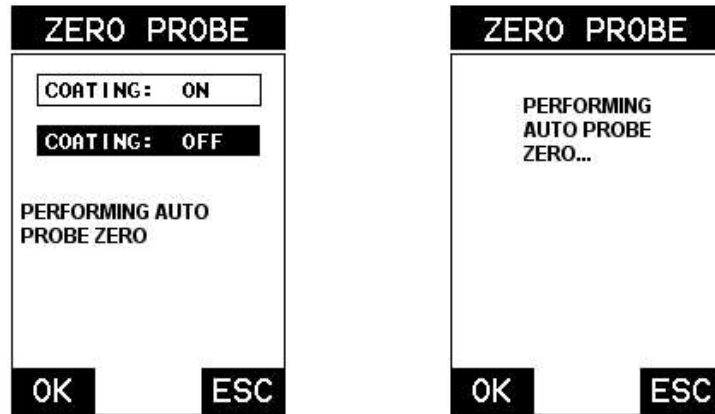
- 1) **Off Block Zero (Automatic Probe Zero)** – When this feature is enabled the **TI-CMX** will do an electronic zero automatically, eliminating the need for a zero disk or block.
- 2) **On Block Zero (Manual Probe Zero)** – When this feature is enabled the transducer must be placed on the probe zero disk (battery cover located on the top of the unit).

Both zero procedures are outlined as follows:

Performing an Auto Probe Zero (Off Block)

| | |
|---|---|
| <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">ZERO PROBE</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">COATING: ON</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">COATING: OFF</div> <p style="font-size: small;">SELECT COATING ON/OFF – REMOVE COUPLANT FROM PROBE AND PRESS OK KEY TO PERFORM THE ZERO.</p> <div style="display: flex; justify-content: space-around;"> OK ESC </div> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">ZERO PROBE</div> <p style="font-size: small;">REMOVE COUPLANT FROM PROBE, PRESS OK KEY TO PERFORM THE ZERO</p> <div style="display: flex; justify-content: space-around;"> OK ESC </div> |
| <i>Coating Probe Identified</i> | <i>Coating Probe Not Identified</i> |

- 1) Be sure all couplant has been removed from the face of the transducer.
- 2) Press the **OK** key to perform the automatic probe zero, or **ESC** key to cancel the zero operation.

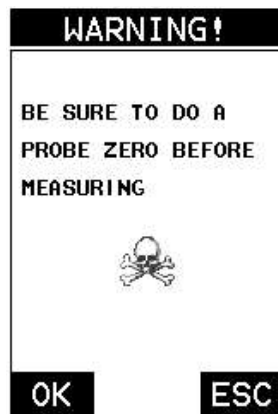


Coating Probe Identified

Coating Probe Not Identified

- 3) The screens illustrated above will be briefly displayed followed by the main measurement screen. The **TI-CMX** is ready to be calibrated.

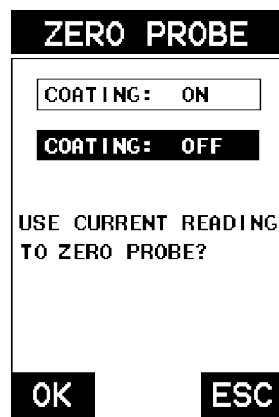
Performing a Manual Probe Zero (On Block)



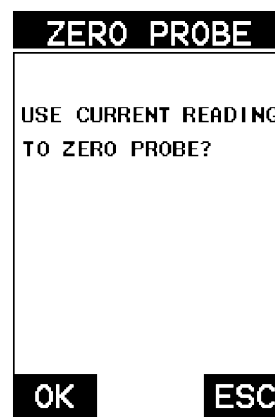
Note: *When the zero probe option is set to manual, the probe zero disk (battery cap) located on the top of the gauge will be used as a zero standard and the warning screen illustrated above will be displayed.*

- 1) Press the **OK** or **ESC** keys to enter the main measurement screen and begin the manual zero process.

- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the probe zero disk and obtain a steady reading.
- 3) 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 **PRB** menu is highlighted and displaying the submenu items.
- 4) Press the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO PROBE** is highlighted.



Coating Probe Identified



Coating Probe Not Identified

- 5) Press the **ENTER** key to display the confirmation screen.
- 6) If a coating transducer was identified use the **UP** and **DOWN** arrow keys to toggle coating on/off.
- 7) Press the **OK** key to complete the probe zero function, or **ESC** key to cancel the probe zero function.
- 8) Remove the transducer from the probe zero disk, and proceed to the calibration section.

Note: *The value that is displayed will change depending on the current velocity setting in the **TI-CMX**. Disregard the number that is displayed. **It is not***

important. What is important is accurately performing the steps outlined above to insure reliability of the probe zero calculation.

6.3 Material Calibration

In order for the **TI-CMX** to make accurate measurements, it must be set to the correct sound velocity of the material being measured. Different types of materials have different inherent sound velocities. For example, the velocity of sound through steel is about 0.233 inches per microsecond, versus that of aluminum, which is about 0.248 inches per microsecond. If the gauge is not set to the correct sound velocity, all of the measurements the gauge makes will be erroneous by some fixed percentage.

The **One Point** calibration is the simplest and most commonly used calibration method - optimizing linearity over large ranges. The **Two Point** calibration allows for greater accuracy over small ranges by calculating the probe zero and velocity. The **TI-CMX** provides four simple methods for setting the sound-velocity outlined below:

Known Velocity

If the material velocity is known, the user may wish to simply enter the velocity number into the **TI-CMX**, rather than have the **TI-CMX** calculate the velocity value using a known thickness on a material sample. The steps for entering the velocity are outlined below:

Using a Known Material Velocity

| | |
|------------------|---------------|
| CALIBRATE | |
| MAT | STEEL <4340> |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | UNCAL |
| COATING VEL | 0.0850 |
| PRB | CAL DISP TUNE |

- 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 **VELOCITY** is highlighted.

| CALIBRATE | |
|-----------------|---------------|
| MAT | STEEL (4340) |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | UNCAL |
| COATING VEL | 0.0850 |
| PRB | CAL DISP TUNE |

- 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 velocity number is correctly displayed.
- 7) Press the **OK** key to set the velocity and return to the menu screen, or **ESC** to cancel entering the velocity.
- 8) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Known Thickness

Sometimes the sound velocity of a material is unknown. In this case a sample with one or two known thicknesses can be used to determine the sound velocity. As previously discussed, the **TI-CMX** has a one or two point calibration option. The one point calibration option is most suited for linearity over large ranges, as noted above.

The user should also consider calibrating on high side of the intended measurement range, when using the one point option, minimize overall error. For example, if the measurement range is .100" (2.54mm) to 1.0" (25.4mm), the user should calibrate on a known thickness sample close to 1.0" (25.4mm).

Note: *It's always handy to carry a set of mechanical calipers to use in conjunction with the **TI-CMX** for calibration in the field:*

One Point Calibration

| CALIBRATE | |
|-----------------|------------------------------------|
| MAT | CUSTOM |
| MATL 1PT | 1.000 |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | UNCAL |
| COATING 2PT | UNCAL |
| COATING VEL | 0.0850 |
| PRB | CAL DISP TUNE |

Note: *Be sure that the probe zero procedure has been performed prior to performing this calibration procedure.*

- 1) Physically measure an exact sample of the material or a location directly on the material to be measured using a set of calipers or a digital micrometer.
- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the sample or actual test material. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.
- 3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **MATL 1PT** is highlighted.

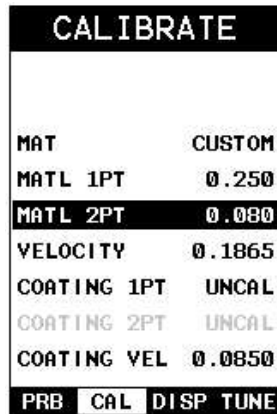


- 4) Press the **ENTER** key to display the **Digits Edit Box**.
- 5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.
- 6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.
- 7) Repeat steps **5 & 6** until the known thickness value is correctly displayed.
- 8) Press the **OK** key to calculate the velocity and return to the menu screen, or **ESC** to cancel the one point calibration.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

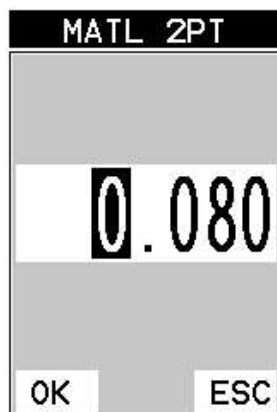
Note: ***CHECK YOUR CALIBRATION!** Place the transducer back on the calibration point. The thickness reading should now match the known thickness. If the thickness is not correct, repeat the steps above.*

At some point there may become a requirement for improved accuracy over a smaller measurement range. In this case, a two point calibration would be most suited for the job. For example, if the measurement range was .080" (2.03mm) to .250" (6.35mm), the user would perform a one point calibration on a known thickness sample close to .250" (6.35mm), followed by a two point calibration close to .080" (2.03mm). When a two point calibration is performed, the **TI-CMX** calculates the zero and the velocity. The following steps outline this procedure:

Two Point Calibration



- 1) Physically measure an exact sample of the material or a location directly on the material to be measured using a set of calipers or a digital micrometer.
- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the sample or actual test material. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.
- 3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **MATL 2PT** is highlighted.



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

Checkline

- 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 known thickness value is correctly displayed.
- 8) Press the **OK** key to calculate the velocity and return to the menu screen, or **ESC** to cancel the one point calibration.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Note: ***CHECK YOUR CALIBRATION!** Place the transducer back on the calibration point. The thickness reading should now match the known thickness. If the thickness is not correct, repeat the steps above.*

Basic Material Type

If the material velocity is unknown, and a sample thickness cannot be taken from the material, the user may opt to choose a basic material type from a list with approximate velocity values according to various material types. It's important to note that these velocities will not always be an exact representation of the material being tested. Use these values only if a close approximation is acceptable. Follow the steps below to select a basic material type:

Selecting a Basic Material Type

| CALIBRATE | |
|-------------|--------|
| MAT | CUSTOM |
| MATL 1PT | 1.000 |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | UNCAL |
| COATING 2PT | UNCAL |
| COATING VEL | 0.0850 |
| PRB | CAL |
| DISP | TUNE |

- 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 **MAT** is highlighted.

| MATL TYPE | |
|-------------------------|---------------|
| 18. MONEL | 0.2110 |
| 19. NICKEL | 0.2220 |
| 20. NYLON | 0.1060 |
| 21. PLATINUM | 0.1560 |
| 22. PLEXIGLASS | 0.1060 |
| 23. POLYSTYRENE | 0.0920 |
| 24. PUC | 0.0940 |
| 25. QUARTZ GLASS | 0.2260 |
| 26. RUBBER, VULCAN | 0.0910 |
| 27. SILVER | 0.1420 |
| 28. STEEL (1020) | 0.2320 |
| 29. STEEL (4340) | 0.2330 |
| 30. STEEL, STAIN. | 0.2230 |
| 31. TEFLON | 0.0540 |
| 32. TIN | 0.1310 |
| 33. TITANIUM | 0.2400 |
| 34. TUNGSTEN | 0.2040 |

- 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.

| CALIBRATE | |
|-------------|------------------------------------|
| MAT | STEEL (4340) |
| MATL 1PT | 1.000 |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | UNCAL |
| COATING 2PT | UNCAL |
| COATING VEL | 0.0850 |
| PRB | CAL DISP TUNE |

- 5) Press the **ENTER** key to overwrite the material type and display the menu items with the new material type selected.
- 6) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

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To calibrate the *TI-CMX* for a specific type of coating using samples with known thicknesses, please refer to the **chapter 9 – Pulse-Echo Coating (PECT) or Coating (CT)** for a complete explanation of using the *TI-CMX* for coating measurements.

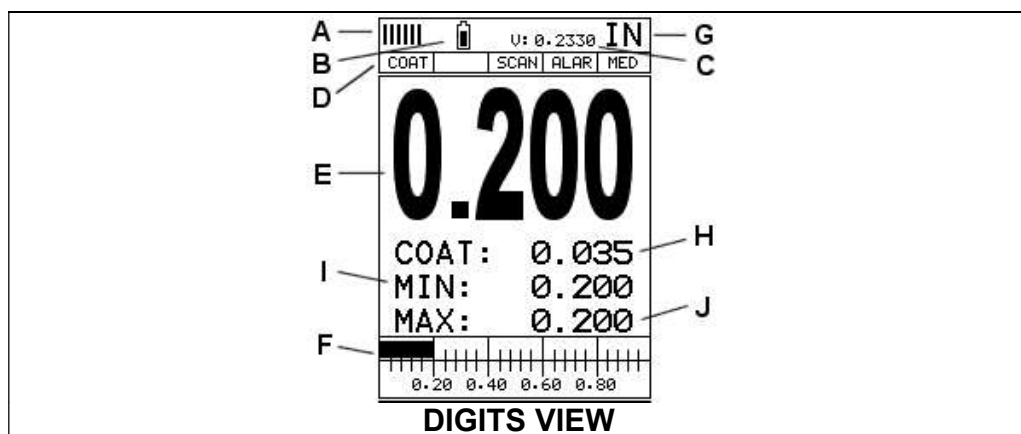
CHAPTER SEVEN USING THE DIGITS & B-SCAN DISPLAYS

A key feature of the **TI-CMX** is the ability to toggle between two different display options, Digits and B-Scan. The Digits view provides the user with a large digital readout of the thickness. Both views also include a scan bar features that uses a bar graph to indicate thickness. The Scan bar can be very handy while scanning a tank or pipe wall by graphically displaying deflections from pits or internal flaws, rather than having to constantly watch for changes in the digital readout. It's just another visual aid to alarm the user when something out of the ordinary has been detected.

The B-Scan display is also very useful when scanning surfaces and viewing the cross section of the test material. It provides a convenient way of visually profiling, or drawing a picture of, the blind surfaces during a scan. The B-Scan display is also equipped with a scan bar representing the overall thickness. Once again, the scan bar gives the user a visual indication when a flaw or defect has been passed over during the scan process. The scan bar will deflect off of the defect and return back to the overall thickness. In this chapter we'll outline some of the fine adjustment features of the **TI-CMX**. We'll take a better look at these options in this chapter.

Note: *In order to recall and use the new adjustments made to the **TI-CMX** at a later time, the user must save the modified settings in one of the setup locations. Refer page 88 for more information on setups.*

7.1 Display Views



Digits

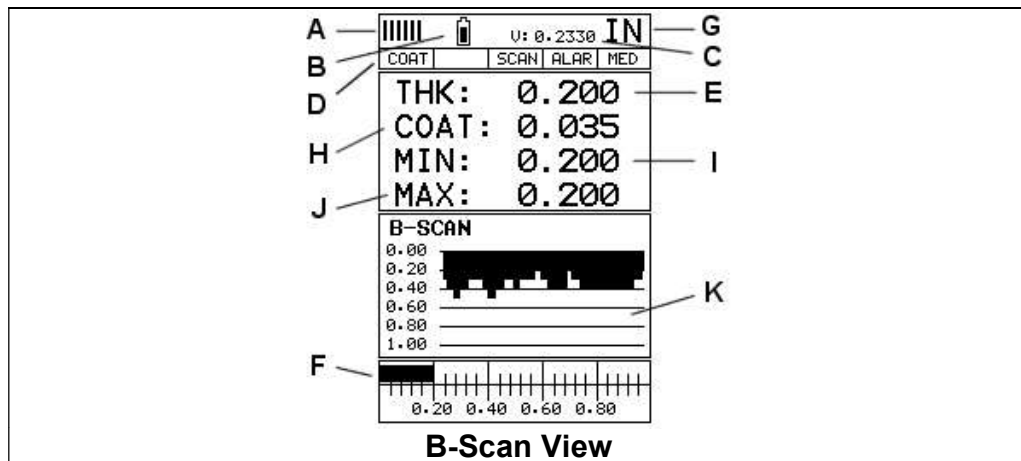
The Digits view is a basic digital thickness gauge look and feel. The larger digits make it much easier for the operator to monitor the thickness readings. The Scan Bar has also been added to the Digits view to provide the user with yet another visual

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tool for easily monitoring changes in thickness readings due to internal flaws or defects.

The following is a list of the viewable features on the display:

- A. **Repeatability/Stability Indicator** – This indicator should be commonly used in conjunction with the digital thickness values displayed. When all the vertical bars are fully illuminated and the last digit on the digital thickness value is stable, the **TI-CMX** is reliably measuring the same value 3 to 200 times per second, depending on which measurement mode and features are enabled.
- B. **Battery Icon** – Indicates the amount of battery life the **TI-CMX** has remaining.
- C. **Velocity** – The material velocity value the **TI-CMX** is currently using or calibrated for. Displayed in both English or Metric units, depending on the what units the gauge is set for.
- D. **Feature Status Bar** – Indicates the features currently enabled and in use in the following order:
 - Measurement Mode
 - Differential Mode
 - High Speed Scan Mode
 - Alarm Mode
 - Gain Setting
- E. **Digital Material Thickness Value** – Extra large font size for viewing ease.
- F. **Scan Bar** – Another view of material thickness in a deflection style horizontal bar. This is another visual tool that would enable the user the ability to see thickness changes during high speed scans from flaws and pits.
- G. **Units** – The current measurement units being used (English, Metric).
- H. **Coating Thickness Value** – Displays the actual thickness of any coating adhered to a metallic material surface (PECT Mode), or a coating adhered to a non-metallic surface (CT Mode).
- I. **Minimum Material Thickness** – Part of the Alarm feature. Displays the minimum thickness value found during a scan.
- J. **Maximum Material Thickness** – Part of the Alarm feature. Displays the maximum thickness value found during a scan.



B-Scan

The B-Scan displays a time based cross section view of test material. This view is commonly used to display the contour of the blind, or underside, surface of a pipe or tank application. It is very similar to a fish finder. If a flaw or pit is located during a scan, the B-Scan will draw the pit on the screen. The solid black rectangle in the diagram at location K represents the cross section, or side view of the material. The B-Scan view draws at a rate of 7 seconds per screen from right to left. Also notice at location K, the pits and corroded bottom surface of the material.

It's important to note that the measurement range on the display be set wide enough, so that the maximum thickness of the material can be viewed on the display. Using the diagram above, if the material thickness was actually 1.75", the underside of the material would not be viewable according to the current range at 0.00" – 1.00". All the user would see is a black screen from 0.00" – 1.00" with no view of the bottom contour at 1.75".

The following is a list of the viewable features on the display:

- A. **Repeatability/Stability Indicator** – This indicator should be commonly used in conjunction with the digital thickness values displayed. When all the vertical bars are fully illuminated and the last digit on the digital thickness value is stable, the **TI-CMX** is reliably measuring the same value 3 to 200 times per second, depending on which measurement mode and features are enabled.
- B. **Battery Icon** – Indicates the amount of battery life the **TI-CMX** has remaining.
- C. **Velocity** – The material velocity value the **TI-CMX** is currently using or calibrated for. Displayed in either English or Metric units, depending on the what units the gauge is set for.
- D. **Feature Status Bar** – Indicates the features currently enabled and in use in the following order:
 - Measurement Mode (P-E, PECT, PETP, E-E, COAT)
 - Differential Mode (ON/OFF)

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- High Speed Scan Mode (ON/OFF)
 - Alarm Mode (ON/OFF/AUDIBLE)
 - Gain Setting (VLOW, LOW, MED, HI, VHI)
- E. **Digital Material Thickness Value** – Smaller font size when the B-Scan display view is enabled.
- F. **Scan Bar** – Another view of material thickness in a deflection style horizontal bar. This is another visual tool that would enable the user the ability to see thickness changes during high speed scans from flaws and pits.
- G. **Units** – The current measurement units being used (English, Metric).
- H. **Coating Thickness Value** – Displays the actual thickness of any coating adhered to a metallic material surface (PECT Mode), or a coating adhered to a non-metallic surface (CT Mode).
- I. **Minimum Material Thickness** – Part of the Alarm feature. Displays the minimum thickness value found during a scan.
- J. **Maximum Material Thickness** – Part of the Alarm feature. Displays the maximum thickness value found during a scan.
- K. **B-Scan Display** – Cross section view of the material. Provides the user with graphical view of the opposite/blind surface (i.e. inside pipe wall surface), to give the user some idea of the condition, or integrity of the material being tested.

7.2 Activating B-Scan View

To use the B-Scan feature it must be enabled in the display menu. The following steps will help you do just that:

Enabling the B-Scan Feature

| SET DISPLAY | |
|-------------|--------------|
| VIEW | BSCAN |
| B-START | 0.000 |
| B-DEPTH | 0.400 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL |
| DISP | TUNE |

- 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) Press the **LEFT** and **RIGHT** arrow keys to toggle **DIGITS** or **BSCAN**. When the correct view is being displayed continue on to setting the **B-START** or **B-DEPTH** values, or press the **MEAS** key to return to the measurement screen and begin taking readings.

7.3 Adjusting the B-Scan Start (B-START) & Depth (B-DEPTH)

In order to use the B-Scan and Scan Bar features of the **TI-CMX** effectively, the starting depth and overall depth must be setup correctly. This can be adjusted using the **B-START** and the **B-DEPTH** features of the **TI-CMX**. The **B-START** refers to the starting depth or thickness value displayed. Example: If you want your B-Scan or Scan Bar to start at a zero thickness value, then **B-START** must be set to 0.000". If you want the B-Scan and Scan Bar to start displaying at .125", then **B-START** must be set to .125". **B-DEPTH** represents overall viewable thickness range being tested. Example: If your measuring tank walls with a total thickness of .300", and your **B-START** has been set to 0.000", you might consider setting your **B-DEPTH** value to something like 0.400" to cover the entire thickness range being tested. You might also consider **B-DEPTH** as a zoom feature for both the B-Scan and Scan Bar. Why? Because the larger the overall thickness range view (**B-DEPTH**), the smaller the noticeable shifts in the Scan Bar and B-Scan presentation. Therefore, it's best to set the **B-START** and **B-DEPTH** to reasonable values that zoom in and optimize your graphic presentation.

Starting depth (B-START)

The starting **B-START**, or starting depth, is the starting thickness value. Often times this value will simply be set to zero in order to start measuring at 0.000". The only time this value will be set to something other than zero, is if the user needs to zoom in even closer. When will this be the case? If the user is testing a material that's 1 inch in thickness and knows that the potential corrosion is only on the back surface of the material and not possibly deeper than .200". In this case, the user may wish to set the B-ST at .700" to zoom in closer to the actual area being tested. In turn, the B-DEP might be set at 1.100" in order to cover the entire range respectively. This will offer the user better resolution for both the B-Scan and Scan Bar graphical presentations.

Note: *Once the range is set, it will remain the same for all the views respectively.*

The procedures to adjust the starting depth (**B-START**) are outlined below:

Adjusting the Starting Depth (B-START)

| SET DISPLAY | |
|----------------|---------------|
| VIEW | DIGITS |
| B-START | 0.000 |
| B-DEPTH | 1.000 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL DISP TUNE |

- 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 **B-START** is highlighted.
- 3) Press the **LEFT** and **RIGHT** arrow keys to scroll the value. When the correct **B-Start** value is being displayed, **proceed to step 8.**

| B-START | |
|---------|-----|
| 0.000 | |
| OK | ESC |

- 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.

Checkline

- 7) Repeat steps **5 & 6** until the **B-Start** value is correctly displayed.
- 8) Press the **OK** key to set the **B-Start** value and return to the menu screen, or **ESC** to cancel entering the **B-Start**.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

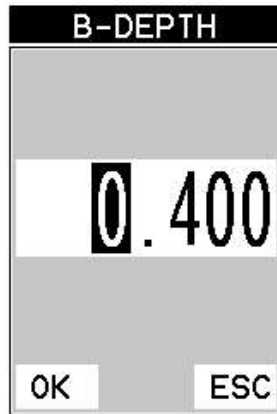
Overall range (B-DEPTH)

Once again, just to reiterate, **B-DEPTH** is the overall viewable thickness range being tested. This should be set to a value slightly larger than the expected maximum range being measured. The procedures to adjust the overall thickness range viewed (**B-DEPTH**) are outlined below:

Adjusting the Overall Depth (B-DEPTH)

| SET DISPLAY | |
|----------------|--------------|
| VIEW | DIGITS |
| B-START | 0.000 |
| B-DEPTH | 1.000 |
| UNITS | IN |
| BACKLIGHT | OFF |
| CONTRAST | 10 |
| PRB | CAL |
| DISP | TUNE |

- 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 **B-DEPTH** 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**.

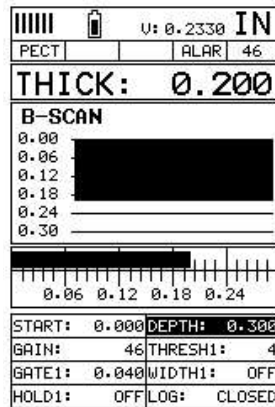


- 4) **Alternatively**, press the **ENTER** key to display the **Digits Edit Box**.
- 5) Press the **UP** and **DOWN** arrow keys to scroll the highlighted value.
- 6) Press the **LEFT** and **RIGHT** arrow keys to scroll the digit locations.
- 7) Repeat steps **5 & 6** until the **B-Depth** value is correctly displayed.
- 8) Press the **OK** key to set the **B-Depth** and return to the menu screen, or **ESC** to cancel entering the **B-Depth**.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Adjusting the B-Scan Speed

The **TI-CMX** has the capability to adjust the the scrolling speed of the time based B-Scan displayed in the gauge. The procedures to adjust the speed are outlined below:

Adjusting the B-Scan Speed



- 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 **B-SCAN SPEED** is highlighted.
- 3) Use the **LEFT** and **RIGHT** arrow keys to scroll the speed from 0-10. Note: 10 representing the fastest scroll time. Once the appropriate speed is displayed, press the **MEAS** key to return to the measurement screen and begin the B-Scan process.
- 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 **SPEED** is correctly displayed.
- 8) Press the **OK** key to set the speed and return to the **DISP** menu., followed by pressing the **MEAS** key to begin the B-Scan process.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin the scanning process.

7.4 Gain

The gain, or amplification of the return echoes, can be adjusted in the **TI-CMX** to accommodate a variety of applications. 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 actual material back wall itself. Not enough gain may result in intermittent detection. It may also result in lack of detection on internal flaws, pits, or porosity. 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.

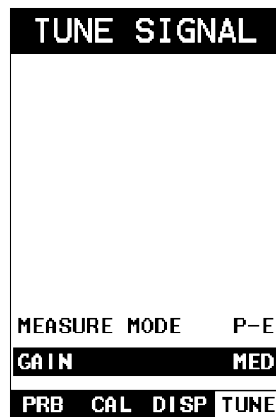
The **TI-CMX** has three gain settings (**VLOW, LOW, MED, HI, VHI**). The gain range is 42dB – 50dB in 2dB increments. **Note:** *The **TI-CMX** has been optimized for the **MED** gain setting for all common applications. It should be operated in this mode as standard. However, some applications may require the lower or higher gain settings.* When? The low settings may be necessary for noisy or granular cast materials. How do I know when to lower the gain? If the reading becomes sporadic and won't settle down or resolve on a thickness value, the user can assume that the material is either very noisy aluminum, or granular cast iron. This would be a good time to change the **TI-CMX** to lower gain setting and see if the reading settles down and become stable.

How do I know when to increase the gain? Often times the user will be trying to measure a material that is hard to penetrate or pass sound through. This may be due to the material type, or overall thickness of the material. When a material is hard to pass sound through because of the thickness or general make-up, it would be a good time to consider switching the **TI-CMX** into a higher gain setting. Another example might be the need to increase overall sensitivity for locating fine pits or flaws. In any case, the selectable gain settings offer the user some additional options to resolve and overcome application issues.

Note: *When the echo-echo thru-paint measurement mode is selected, the manual gain feature is disabled and grayed out in the menu items. In this mode, the **TI-CMX** switches to an automatic gain mode (**AGC**) that optimizes the gain setting automatically in the hardware of the **TI-CMX**.*

The procedures to adjust the **Gain** are outlined below:

Adjusting the Gain



- 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, press the **MEAS** key to return to the measurement screen and begin taking readings.

CHAPTER EIGHT THRU PAINT MEASUREMENT TECHNIQUE

8.1 Introduction to Thru Paint Measurement

The principle behind thru paint measurement is by measuring the time between two backwall echoes returning from the test material. Since both of these backwall echoes travel the same path through the paint or coating, the thickness of the coating is subtracted out of the measurement so that only the actual material thickness can be measured. This feature saves the user a great deal of time scraping and removing the coating from tanks and pipes during the inspection process.

The primary purpose of thru paint measurement is to determine actual or overall material thickness by eliminating the coating thickness. Thru paint mode cannot be used for flaw or pit detection. Therefore, inspectors may need to use echo-echo thru paint mode in conjunction with the standard pulse-echo flaw detection mode for some applications. Chassis tubing inspectors and sanctioning bodies will use the echo-echo mode for tubing with powder coatings, and pulse-echo mode for tubing without coating. The combination of using both modes is ideal for the advanced inspectors needs.

8.2 Using Thru Paint Mode

The first thing to note in this section, is that by selecting the transducer type from the list of probes stored in the **TI-CMX**, a basic echo-echo thru paint configuration is recalled from memory. Each of the transducers in the list contains pre-configured echo-echo settings. The standard transducer that will be used for common steel applications $\frac{1}{4}$ " 5MHz high damped transducer (**1/4IN – 5.0MHZ HD**). This is the recommended transducer for this industry and should be used for thru paint applications. Any of the auto recognition coating transducers are also high damped transducers and will work in echo-echo mode as well.

Note: *When a transducer is selected for use, all of the measurement modes available for use with this transducer can easily be determined by pressing the multi-mode button on the keypad. The **TI-CMX** has been programmed to identify the modes available to a specific transducer.*

Once the transducer type has been selected and the appropriate calibration procedure completed, the **TI-CMX** can toggle between **pulse-echo** (flaws & pits), and **echo-echo** (thru paint) modes by simply pressing the **MULTI MODE** key located on the keypad. Refer to page 38 for additional information.

The **TI-CMX** can also be configured for thru paint applications by selecting a factory setup stored in the list of setups in the **TI-CMX**. Refer to page 88 for information on recalling a setup. Once either the transducer type or setup has been selected, the inspector is ready to begin making measurements.

CHAPTER NINE

PULSE-ECHO COATING & COATING TECHNIQUES

9.1 Introduction to Pulse-Echo Coating Measurement (PECT)

In the previous sections we've discussed the need for detecting pits and flaws (pulse-echo) in materials, along with the requirement to measure through and eliminate errors caused by coated materials (echo-echo). Until now, both modes were needed in order accomplish both tasks. Pulse-echo mode was used for flaw detection, and echo-echo mode was used to eliminate the coating thickness and provide a nominal material thickness only. With this in mind, it often became cumbersome toggling between both modes respectively.

In a majority of applications involving coated materials, inspectors are often interested in monitoring both the thickness of the material, as well as the thickness of the coating. Therefore, the **TI-CMX** has been designed to provide the user with the ability to measure the material and coating thicknesses simultaneously, while maintaining the ability to detect flaws and pits all in a single mode called **Pulse-Echo Coating (PECT)**. This is accomplished by using a custom hybrid combination mode utilizing properties from the basic modes along with a group of special techniques and theoretical wave phenomena's.

The **TI-CMX** is preset to a coating velocity of 0.0850 in/ μ sec (2159 m/sec) from the factory. This velocity is a very close approximation of the common coating velocities found in the field. However, the **TI-CMX** also has a built-in one and two point calibration options to calibrate to coating samples with a known thicknesses.

There are two coating modes built into the **TI-CMX**:

- 1) **Pulse-Echo Coating (PECT)** – used during inspections where both the material and coating thicknesses are required.
- 2) **Coating Only (CT)** – used during inspections where only the coating thickness is required.

9.2 Enabling Pulse-Echo Coating Mode (PECT) & Coating (CT)

When the **TI-CMX** is initially powered up, the gauge will automatically check to see if the transducer plugged into the gauge can be recognized. All Checkline coating enabled transducers are equipped with the auto recognition feature. If the **TI-CMX** doesn't recognize that a special coating enabled transducer is plugged into the gauge, the coating feature will be disabled entirely. There are a number of coating enabled transducers available from Checkline. Please contact us with your application requirements for additional information on frequencies and diameters currently offered.

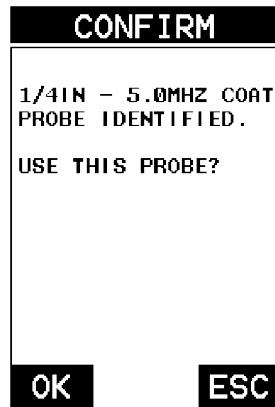
The coating modes can be enabled in three different ways:

- 1) On Power up and probe recognition.
- 2) By pressing **MULTI MODE** keypad.

3) From the tabbed menus under **TUNE, MEASURE MODE**.

The steps that follow will demonstrate all three methods in the order listed above:

Probe Automatically Recognized (PECT only)



1) Press the **OK** key once to use the identified probe, or **ESC** to display a list of optional transducers.

Note: *If the **TI-CMX** recognizes a specific transducer, the user should always select **OK** to use the identified probe. The only time an alternative probe should be selected from a list is if the user switched probes following initial power up and recognition.*

2) Assuming the **TI-CMX** recognized the probe and the **OK** key was pressed, the **TI-CMX** will advance to a Zero Probe menu. If the transducer was identified as a special transducer capable of measuring coating thickness, a menu will be displayed allowing the user the ability to toggle the coating thickness display on/off as follows:

ZERO PROBE

COATING: ON

COATING: OFF

SELECT COATING
ON/OFF – REMOVE
COUPLANT FROM
PROBE AND PRESS
OK KEY TO PERFORM
THE ZERO.

OK

ESC

3) Press the **UP** and **DOWN** arrow keys to toggle the coating option on/off.

Multi Mode Key Pressed (PECT & CT)

| MEASURE MODE | |
|--------------|------|
| COATING OFF | P-E |
| COATING ON | PECT |
| TEMP COMP | PETP |
| THRU COAT | E-E |
| THRU VERIFY | E-EV |
| COATING ONLY | CT |

| MEASURE MODE | |
|--------------|------|
| COATING OFF | P-E |
| COATING ON | PECT |
| TEMP COMP | PETP |
| THRU COAT | E-E |
| THRU VERIFY | E-EV |
| COATING ONLY | CT |

Applied to Metals

Not Applied to Metals

- 1) Press the **MULTI MODE** key located on bottom left of the keypad to display the **MEASURE MODE** options menu.
- 2) Press the **UP** and **DOWN** arrow keys to highlight the **COATING ON (PECT)** or **COATING ONLY (CT)** menu option.
- 3) Press the **ENTER** key to enable the coating option, or **ESC** to cancel changing the measure mode, and return to the main measurement screen.

Measure Mode (Tabbed Menus) – (PECT & CT)

| | |
|--------------|---------------|
| TUNE SIGNAL | |
| | |
| MEASURE MODE | PECT |
| GAIN | MED |
| PRB | CAL DISP TUNE |

Applied to Metals

| | |
|--------------|---------------|
| TUNE SIGNAL | |
| | |
| MEASURE MODE | CT |
| GAIN | MED |
| PRB | CAL DISP TUNE |

Not Applied to Metals

- 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 **MEASURE MODE** is highlighted.
- 3) Press the **LEFT** and **RIGHT** arrow keys to scroll the modes.
- 4) When the correct **MODE** is being displayed, press the **MEAS** key to return to the measurement screen and begin taking readings.

9.3 Zero Coating

In order to account for very slight electronic differences in transducers of the same type, frequency, and diameter, the **TI-CMX^{DL+}** has been equipped with a “zero coating” feature. This enables the **TI-CMX^{DL+}** to obtain very accurate readings on coatings, eliminating potential errors incurred from slight differences in the manufacturing processes. The procedure is outlined below:

Performing a Coating Zero

| MEASURE MODE | |
|---------------------|-----------|
| COATING OFF | P-E |
| COATING ON | PECT |
| TEMP COMP | PETP |
| THRU COAT | E-E |
| THRU VERIFY | E-EV |
| COATING ONLY | CT |
| | |

- 1) Press the **MULTI MODE** key once to activate the measurement mode options.
- 2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **Coating Only (CT)** mode is highlighted.
- 3) Press the **ENTER** key to select the measurement mode and return to the measurement screen.
- 4) Apply a drop of couplant on the transducer and place the transducer in steady contact with the probe zero disk (battery cover) and obtain a steady reading.

Note: *The coating measurement displayed will potentially be a value greater or less than 0.*

- 5) 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 **PRB** menu is highlighted and displaying the submenu items.

| SETUP PROBE | |
|--------------|---------------|
| ZERO PROBE | AUTO |
| ZERO COATING | |
| TYPE | 11 |
| FLAW MODE | OFF |
| PRB | CAL DISP TUNE |

- 6) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ZERO COATING** is highlighted.
- 7) Press the **ENTER** key to display the confirmation screen.
- 8) Press the **OK** key to zero the coating and return to the **PRB** menu, or **ESC** to cancel the coating zero process.
- 9) Press the **MULTI MODE** key once to activate the measurement mode options.
- 10) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **Coating On (PECT)** is highlighted.
- 11) Press the **ENTER** key to select the measurement mode and return to the measurement screen, and begin taking readings. Proceed to the coating calibration section.

9.4 Coating Calibration (PECT)

Known Velocity

If the coating velocity is known, the user may wish to simply enter the velocity number into the *TI-CMX*, rather than have the *TI-CMX* calculate the velocity value using a known thickness on a coating sample(s). The steps for entering the velocity are outlined below:

Using a Known Material Velocity

| CALIBRATE | |
|-------------|---------------|
| MAT | STEEL <4340> |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | 0.050 |
| COATING 2PT | UNCAL |
| COATING VEL | 0.1166 |
| PRB | CAL DISP TUNE |

- 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 **COATING VEL** is highlighted.

| COATING VEL | |
|-------------|-----|
| 0.1166 | |
| OK | ESC |

- 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 velocity number is correctly displayed.
- 7) Press the **OK** key to set the velocity and return to the menu screen, or **ESC** to cancel entering the velocity.
- 8) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Known Thickness

Sometimes the sound velocity of a coating material is unknown. In this case a sample with a known thickness can be used to determine the sound velocity of the coating. As previously discussed, the **TI-CMX** offers a one point calibration option for coating in **PECT** measurement mode. It is also important to reiterate that the coating sample must be coupled to a metallic material in order to perform the calibration. The calibration should also consider calibrating on high side of the intended measurement range, when using the one point option, minimize overall error. For example, if the measurement range of the coating will be from .040" - .080" (1.0mm - 2.3mm), a coating closest to .080 (2.0mm) should be used.

Note: *It's always handy to carry a set of mechanical calipers to use in conjunction with the **TI-CMX** for calibration in the field:*

One Point Calibration

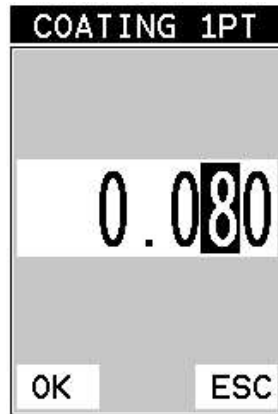
| CALIBRATE | |
|-------------|---------------|
| MAT | STEEL <4340> |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | 0.080 |
| COATING 2PT | UNCAL |
| COATING VEL | 0.1866 |
| PRB | CAL DISP TUNE |

Note: *Be sure that the probe zero procedure has been performed prior to performing this calibration procedure.*

- 1) Physically measure an exact sample of the coating using a set of calipers or a digital micrometer.

Note: *The coating sample must be coupled to a metallic material in order to be calibrated.*

- 2) Apply a drop of couplant on a piece of metal and place the coating sample on the metal over the couplant. Apply a drop of couplant on the transducer and place the transducer in steady contact with the coating and sample or actual test material. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.
- 3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **COATING 1PT** is highlighted.



- 4) 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 known thickness value is correctly displayed.
- 8) Press the **OK** key to calculate the velocity and return to the menu screen, or **ESC** to cancel the coating one point calibration.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Note: ***CHECK YOUR CALIBRATION!** Place the transducer back on the calibration point. The coating thickness reading should now match the known thickness. If the thickness is not correct, repeat the steps above.*

9.5 Introduction to Coating Measurement (CT)

In the previous sections we've discussed how to setup and use the coating feature for use in conjunction with material thickness and flaw and pit detection. The **TI-CMX** also has the capability to be used for general coating measurements. This measurement mode is called Coating (CT) and can be enabled using the same methods as described in a previous section above.

When the Coating Only (CT) mode is enabled, a two point calibration on the coating samples **must** be performed. This is to ensure linearity over the coating measurement range will be achieved.

Note: *If coating measurements will be made with the coating applied to a metal surface, the calibration must be done in the same manner, with the samples coupled to a metal surface. However, if the coating will be measured as a stand alone material, the calibration must be performed the same way.*

9.6 Two Point Coating Calibration (CT)

Known Thickness

The following section will demonstrate the two point coating calibration procedure. This example demonstrates a coating thickness range of .040" - .120" (1 – 3 mm) as follows:

Note: *It's always handy to carry a set of mechanical calipers to use in conjunction with the **TI-CMX** for calibration in the field:*

One Point Calibration

| CALIBRATE | |
|-------------|--------|
| MAT | CUSTOM |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | 0.1200 |
| COATING 2PT | 0.0400 |
| COATING VEL | 0.0933 |
| PRB | CAL |
| DISP | TUNE |

Note: *Use the maximum coating sample for the one point calibration first.*

- 1) Physically measure the thicker of the two samples of coating, as close as possible to the maximum expected coating measurement range, using a set of calipers or a digital micrometer.

Very Important: *If coating measurements will be made with the coating applied to a metal surface, the calibration must be done in the same manner, with the samples coupled to a metal surface. However, if the coating will be*

measured as a stand alone material, the calibration must be performed the same way.

- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the thicker of the two coating and samples fist. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.
- 3) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **COATING 1PT** is highlighted.



- 4) 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 known thickness value is correctly displayed.
- 8) Press the **OK** key to calculate the velocity and return to the menu screen, or **ESC** to cancel the coating one point calibration.

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

Two Point Calibration

| CALIBRATE | |
|-------------|---------------|
| MAT | CUSTOM |
| MATL 1PT | UNCAL |
| MATL 2PT | UNCAL |
| VELOCITY | 0.2330 |
| COATING 1PT | 0.1200 |
| COATING 2PT | 0.0400 |
| COATING VEL | 0.0933 |
| PRB | CAL DISP TUNE |

Note: Use the minimum coating sample for the two point calibration.

- 1) Physically measure the thinnest of the two samples of the coating, as close as possible to the minimum expected coating measurement range, using a set of calipers or a digital micrometer.

Very Important: If coating measurements will be made with the coating applied to a metal surface, the calibration must be done in the same manner, with the samples coupled to a metal surface. However, if the coating will be measured as a stand alone material, the calibration must be performed the same way.

- 2) Apply a drop of couplant on the transducer and place the transducer in steady contact with the thinner of the two coating and samples. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable. 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.

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



- 4) 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 known thickness value is correctly displayed.
- 8) Press the **OK** key to calculate the velocity and return to the menu screen, or **ESC** to cancel the coating one point calibration.
- 9) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

Note: ***CHECK YOUR CALIBRATION!** Place the transducer back on both calibration points. The coating thickness readings should now match the known thickness values of each sample. If the thickness is not correct, repeat the steps above.*

CHAPTER TEN ADDITIONAL FEATURES OF THE TI-CMX

10.1 High Speed Scan

The High Speed Scan feature of the **TI-CMX** increases the overall repetition rate to a maximum of 140Hz with a high speed screen refresh rate of 25 times a second. This feature enables a user to make scanned passes over an arbitrary length of the test material, while still maintaining a reasonable representation of thickness over the scanned area or region. This feature can be used in conjunction with High and Low alarm limits features to dynamically keep track of both values. The feature is typically used to provide a better representation of the area scanned, by taking more readings at a faster rate repetition rate.

The procedure to use the **SCAN MODE** feature is outlined below:

Using the Scan Mode

| UTILITIES | |
|--------------------|-------|
| SCAN MODE | ON |
| ALARM | ON |
| ALARM HIGH | 0.700 |
| ALARM LOW | 0.210 |
| DIFFERENTIAL | OFF |
| SET DATA UTIL XFER | |

- 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 **SCAN MODE** is highlighted.
- 3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **SCAN MODE** on/off.
- 4) Press the **MEAS** key to return to the measurement screen.

10.2 Alarm Mode

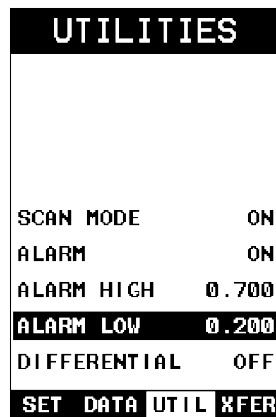
The **Alarm Mode** feature of the **TI-CMX** provides the user with a method of setting tolerances, or limits, for a particular application requirement. This feature may be used for a variety of applications to verify the material is within the manufacturer specifications. There are two limits, or alarm values, that can be setup in the **TI-CMX** – **ALARM LOW** and **ALARM HIGH** limits. 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:

Toggle Alarm (on/off)

| UTILITIES | |
|--------------|-----------|
| SCAN MODE | ON |
| ALARM | ON |
| ALARM HIGH | 0.700 |
| ALARM LOW | 0.200 |
| DIFFERENTIAL | OFF |
| SET DATA | UTIL XFER |

- 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** is highlighted.
- 3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **ALARM** on/off/audible.
- 4) Continue on to the next section “**Setting the Alarm Low Limit**”.

Setting the Alarm Low Limit



- 1) Assuming the **ALARM** is **ON**, use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **ALARM LOW** 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 LOW** 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 HIGH** limit.

10.3 Differential Mode

The **Differential Mode** of the **TI-CMX** provides the user with the ability to set a nominal value, according to what the expected thickness should be, and measure the +/- difference from the nominal value entered. This feature is typically used in QA incoming inspections on pipes, plate stock, coils, etc. The steps below outline how to enable and enter the nominal value to use this feature:

Toggle Differential (on/off)

UTILITIES

| | |
|---------------------|--------------|
| SCAN MODE | OFF |
| ALARM | ON |
| ALARM HIGH | 0.700 |
| ALARM LOW | 0.210 |
| DIFFERENTIAL | 0.250 |

SET DATA UTIL XFER

- 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 **DIFFERENTIAL** is highlighted.
- 3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **DIFFERENTIAL** on. A value will appear to the right of **DIFFERENTIAL**.
- 4) Continue on to the next section "**Setting the Differential Value**".

Setting the Differential Value



- 1) Assuming **DIFFERENTIAL** has been enabled and a value is being displayed to the right of the **DIFFERENTIAL** label, 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 **DIFFERENTIAL** value is correctly displayed.
- 5) Press the **OK** key to set the **DIFFERENTIAL** value and return to the menu screen.
- 6) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

10.4 Key Click

When a key is pressed on the **TI-CMX** keypad, the user can control whether or not an audible beep is sounded and at what volume level, if any. The procedure for this feature/preference is outlined below:

Setting the Key Click

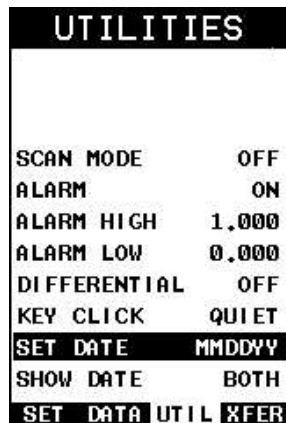
| UTILITIES | |
|--------------|-----------|
| SCAN MODE | OFF |
| ALARM | ON |
| ALARM HIGH | 1.000 |
| ALARM LOW | 0.000 |
| DIFFERENTIAL | OFF |
| KEY CLICK | QUIET |
| SET DATE | MMDDYY |
| SHOW DATE | BOTH |
| SET DATA | UTIL XFER |

- 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 **KEY CLICK** is highlighted.
- 3) Use the **LEFT** and **RIGHT** arrow keys to toggle the **KEY CLICK** loud/quiet/off.
- 4) Press the **MEAS** key to return to the measurement screen.

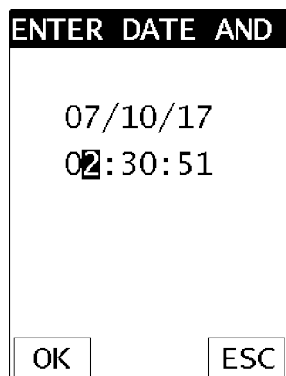
10.5 Set Date

The **TI-CMX** is equipped with an internal clock to time and date stamp the log, setup and screen capture files for reporting/documentation purposes. The procedures for setting the time and date are outlined below:

Setting Date & 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 **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 **SET DATE** is highlighted.



- 3) Press the **ENTER** key to display the **Digits Edit Box**.
- 4) Press the **UP, DOWN, LEFT, & RIGHT** arrow keys to scroll the field locations.
- 5) Press the **LEFT** and **RIGHT** arrow keys multiple times to scroll the value.
- 6) Repeat steps **4 & 5** until the **Time & Date** is correctly displayed.
- 7) Press the **OK** key to set the **Time & Date** and return to the menu screen, or **ESC** to cancel entering the **Time & Date**.

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

10.6 Show Date & Time

The **TI-CMXDL** can be configured to show the date & time in the active A-Scan window as needed or preferred (off/date/time/both). The procedure for activating and displaying the above options are outlined below:

Live Time & Date

| UTILITIES | |
|--------------|-----------|
| SCAN MODE | OFF |
| ALARM | ON |
| ALARM HIGH | 1.000 |
| ALARM LOW | 0.000 |
| DIFFERENTIAL | OFF |
| KEY CLICK | QUIET |
| SET DATE | MMDDYY |
| SHOW DATE | BOTH |
| SET DATA | UTIL XFER |

- 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 **SHOW DATE** is highlighted.
- 3) Press the **LEFT** and **RIGHT** arrow keys multiple times to scroll the options (Date, Time, Both, Off).
- 4) Finally, press the **MEAS** key to return to the measurement screen and begin taking readings.

CHAPTER ELEVEN SETUPS – CREATE, STORE, EDIT, & RECALL

11.1 Introduction to Setups

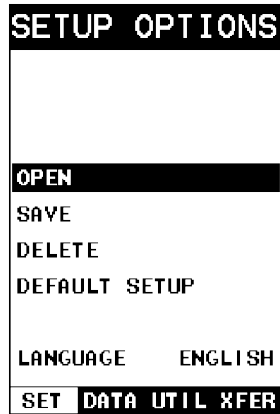
Often times, users are faced with a variety of tasks and applications that are sometimes similar, but often times very different. With a standard thickness gauge, the user would have to recalibrate for each individual application respectively. With all the features of the **TI-CMX**, the number of potential applications also increases based on ability alone. This is primarily in reference to the addition of those very difficult applications, where a standard thickness gauge would not be feasible, or capable of accomplishing the tasks.

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 **TI-CMX** has been equipped with the ability to save these setups to memory and be recalled at any time. The **TI-CMX** can store up to **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 their individual applications requirements. 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 and calibration process.

11.2 Opening a Setup

The **TI-CMX** is loaded with a number of setups from the factory. These setups can be opened, edited, and saved to any one of **64 setup locations**. If a factory setup is written over, the user can simply reload the default factory setups at anytime using the utility software included with the **TI-CMX**. The factory setups are general setups **Only**. However, they may serve as an excellent starting point, requiring only minor adjustments to work for custom applications. It is recommended that user customized setups be saved to an empty location, and save the factory setups for the purpose of a general starting point. The following procedures outline how to open factory and custom setups:

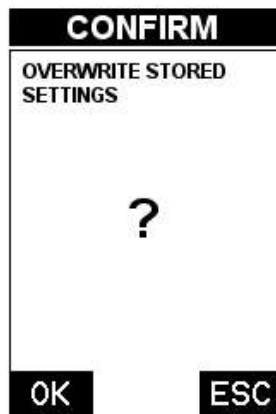
Opening a Setup



- 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.



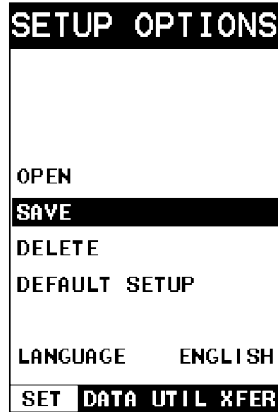
- 5) Press the **ENTER** key to activate the confirmation screen.
- 6) Press the **OK** key to load the setup from memory.
- 7) Press the **MEAS** key to return to the measure screen.

11.3 Saving a Setup

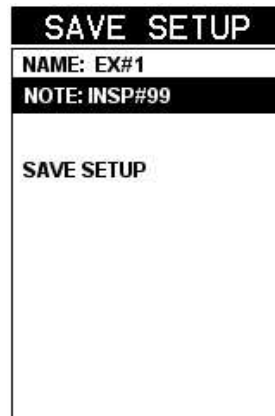
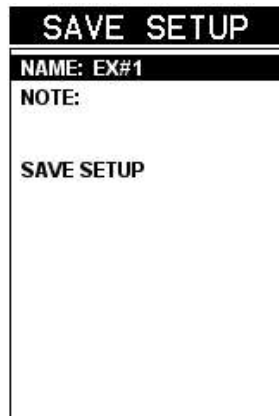
Once the **TI-CMX** parameters and features have been adjusted for an application, the user may elect to save these settings to a specific setup location for future use. This can potentially save time and reduce error between users.

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 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 **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.

| SETUP NAME |
|---------------------|
| 0123456789 |
| ! ' _ # █ / . - () |
| ABCDEFGHIJ |
| KLMNOPQRST |
| UVWXYZ |
| EX#1 █ |

| SETUP NOTE |
|---------------------|
| 0123456789 |
| ! ' _ # █ / . - () |
| ABCDEFGHIJ |
| KLMNOPQRST |
| UVWXYZ |
| INSP#99 █ |

OK

ESC

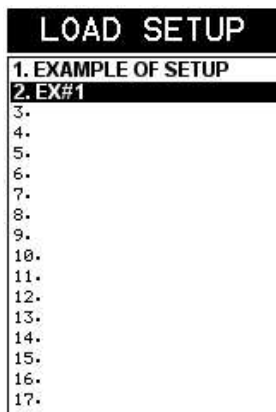
OK

ESC

- 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**.

| SAVE SETUP |
|---------------|
| NAME: EX#1 |
| NOTE: INSP#99 |
| SAVE SETUP |
| |

- 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**.*

11.4 Deleting a Saved Setup

This option allows a user to delete setup files that were previously saved and no longer needed. It's a simple feature to allow the user to do a bit of "house cleaning".

Deleting a Setup

SETUP OPTIONS

OPEN
SAVE
DELETE
DEFAULT SETUP
LANGUAGE ENGLISH
SET DATA UTIL XFER

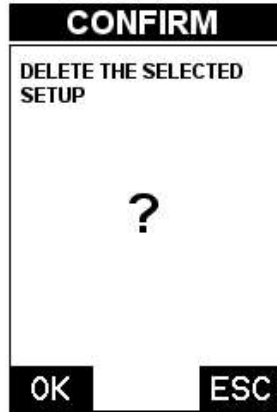
- 1) Press the **MENU** key once to activate the menu items tab. Press the **MENU** key multiple times to tab right and the **ESC** key multiple times to tab left until the **SETUP** menu is highlighted and displaying the submenu items.
- 2) Use the **UP** and **DOWN** arrow keys to scroll through the sub menu items until **DELETE** is highlighted.

DELETE SETUP

1. EXAMPLE OF SETUP
2. EX#1
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.

- 3) Press the **ENTER** key to display the **Setups List**.
- 4) Press the **UP** and **DOWN** arrow keys to scroll to the **Setup Name**.

- 5) When the **Setup Name** is highlighted, press the **ENTER** key to display the confirmation screen.



- 6) Press the **OK** key to delete the **Setup File**.
- 7) Finally, press the **MEAS** key to return to the measurement screen.

11.5 Using the Default Setup

The default setup feature was added to the **TI-CMX** 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 **TI-CMX** was somehow corrupted, and the user does not have access to a computer to re-load the factory setups back into the **TI-CMX**. This gives the user the ability to load and modify a basic setup as follows:

Using the Default Setup

```
SETUP OPTIONS
OPEN
SAVE
DELETE
DEFAULT SETUP
LANGUAGE    ENGLISH
SET DATA UTIL XFER
```

- 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.

11.6 Selecting a Language

The **TI-CMX** is equipped with a language option. Currently, the only languages supported are English, Spanish, German, French, Hungarian, Czech, however the list continues to grow. The steps to select one of these languages are outlined as follows:

Selecting a Language

SETUP OPTIONS

OPEN

SAVE

DELETE

DEFAULT SETUP

LANGUAGE ENGLISH

SET DATA UTIL XFER

- 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 **LANGUAGE** is highlighted.
- 3) Press the **LEFT** and **RIGHT** arrow keys to toggle the language options.
- 4) Once the desired language is displayed, press the **MEAS** key to return to the measurement screen.

CHAPTER TWELVE USING THE UTILITY SOFTWARE

12.1 Computer System Requirements

DakView will run on many different operating systems: Windows XP, Windows 2000 Professional, Windows 2000 Server, Windows 2000, Vista, Windows 7, 8, 10, or advanced Server operating systems running on Intel or AMD hardware. Additionally there is a version for the Mac OSX platform.

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 **DakView**.

DakView requires an available communications port in order to transfer data to and from the **TI-CMX**. **DakView** 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 Checkline (pt# N-402-0510).

12.2 Installing DakView

DakView is available directly from our website for download free of charge. Stay current by periodically checking the website for the latest version. Simply download the .exe file from our website to your computer, and double click the icon to begin installation.

Refer to the online help section in **DakView** for operating instructions.

12.3 Communicating with the **TI-CMX**

DakView will not directly communicate with the **TI-CMX** series gauges. The **TI-CMX** is equipped with USB, acting as a Thumb Drive (external storage device) when connected to a computer and powered on. Therefore, the SD memory card can be opened as a drive with *directory structure, similar to the C: on your computer*. The files stored on the internal SD can be simply copied (dragged) into any folder on your PC and opened using **DakView**. The PC software will function as a file viewer for the **TI-CMX** series gauges.

12.4 Line Power

The **TI-CMX** can be powered using the standard USB-C to USB-A data cable (N-003-0330), by connecting directly to a USB port on your computer, or using a standard cell phone power adapter directly to an outlet. This is a convenient way to power the gauge for specific bench top applications in a factory line environment.

12.5 Upgrading the **TI-CMX**

The **TI-CMX** can be upgraded to the latest revision of firmware at any time. Simply download the latest version posted on the Checkline website, copy the upgrade file to the main drive directory **TI-CMX**, and use the upgrade utility located in the **XFER** menu. The process is very easy and convenient, allowing our users to stay current with updated feature additions and bug fixes. The procedure to upgrade your **TI-CMX** is outlined below:

Upgrading the Firmware

| |
|--|
| UPGRADE GAUGE |
| LOAD FILE CMXDLPV3_00Q.BCH TO FLASH |
| ? |
| <input type="button" value="OK"/> <input type="button" value="ESC"/> |

| |
|-----------------------|
| UPGRADE GAUGE |
| ABOUT DEV 0.50I |
| DATA UTIL XFER |

- 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 **XFER** menu is highlighted and displaying the submenu items.
Alternatively, press the **LEFT** and **RIGHT** arrow keys multiple times using the left button wheel.
- 2) Press the **ENTER** key to display the upgrade confirmation screen, followed by pressing **OK** key to start the upgrade process. Note: The **TI-CMX** will power down and the alarm lights will flash during the upgrade process.

APPENDIX A - VELOCITY TABLE

| Material | sound velocity in/us | | sound velocity m/s |
|--------------------------|-------------------------|-----------------|-----------------------|
| | | | |
| Aluminum | 0.2510 | | 6375 |
| Beryllium | 0.5080 | | 12903 |
| Brass | 0.1730 | | 4394 |
| Bronze | 0.1390 | | 3531 |
| Cadmium | 0.1090 | | 2769 |
| Columbium | 0.1940 | | 4928 |
| Copper | 0.1830 | | 4648 |
| Glass (plate) | 0.2270 | | 5766 |
| Glycerine | 0.0760 | | 1930 |
| Gold | 0.1280 | | 3251 |
| Inconel | 0.2290 | | 5817 |
| Iron | 0.2320 | | 5893 |
| Cast Iron | 0.1800 | (approx) | 4572 |
| Lead | 0.0850 | | 2159 |
| Magnesium | 0.2300 | | 5842 |
| Mercury | 0.0570 | | 1448 |
| Molybdenum | 0.2460 | | 6248 |
| Monel | 0.2110 | | 5359 |
| Nickel | 0.2220 | | 5639 |
| Nylon | 0.1060 | (approx) | 2692 |
| Platinum | 0.1560 | | 3962 |
| Plexiglas | 0.1060 | | 2692 |
| Polystyrene | 0.0920 | | 2337 |
| PVC | 0.0940 | | 2388 |
| Quartz glass | 0.2260 | | 5740 |
| Rubber vulcanized | 0.0910 | | 2311 |
| Silver | 0.1420 | | 3607 |
| Steel (1020) | 0.2320 | | 5893 |
| Steel (4340) | 0.2330 | | 5918 |
| Steel Stainless" | 0.2230 | | 5664 |
| Teflon | 0.0540 | | 1372 |

TI-CMX High Performance Material & Coating Thickness Gauge

| | | | |
|------------------|---------------|--|-------------|
| Tin | 0.1310 | | 3327 |
| Titanium | 0.2400 | | 6096 |
| Tungsten | 0.2040 | | 5182 |
| Uranium | 0.1330 | | 3378 |
| Water | 0.0580 | | 1473 |
| Zinc | 0.1660 | | 4216 |
| Zirconium | 0.1830 | | 4648 |

WARRANTY INFORMATION

• Warranty Statement •

Checkline warrants the *TI-CMX* against defects in materials and workmanship for a period of two years from receipt by the end user. Additionally, Checkline warrants transducers and accessories against such defects for a period of 90 days from receipt by the end user. If Checkline receives notice of such defects during the warranty period, Checkline will either, at its option, repair or replace products that prove to be defective.

Should Checkline be unable to repair or replace the product within a reasonable amount of time, the customer's alternative exclusive remedy shall be refund of the purchase price upon return of the product.

• Exclusions •

The above warranty shall not apply to defects resulting from: improper or inadequate maintenance by the customer; unauthorized modification or misuse; or operation outside the environmental specifications for the product.

Checkline makes no other warranty, either express or implied, with respect to this product. Checkline specifically disclaims any implied warranties of merchantability or fitness for a particular purpose. Some states or provinces do not allow limitations on the duration of an implied warranty, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the five-year duration of this written warranty.

This warranty gives you specific legal rights, and you may also have other rights which may vary from state to state or province to province.

• Obtaining Service During Warranty Period •

If your hardware should fail during the warranty period, contact Checkline and arrange for servicing of the product. Retain proof of purchase in order to obtain warranty service.

For products that require servicing, Checkline may use one of the following methods:

- Repair the product
- Replace the product with a re-manufactured unit
- Replace the product with a product of equal or greater performance
- Refund the purchase price.

• After the Warranty Period •

If your hardware should fail after the warranty period, contact Checkline for details of the services available, and to arrange for non-warranty service.