NOTES

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1.0   INTRODUCTION

The Electromatic Model TI-007DL is a precision Ultrasonic Micrometer. Based on the same operating principles as sonar, the TI-007DL is capable of measuring the thickness of various materials with accuracy as high as ± 0.0001 inches, or ± 0.001 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.

This manual is presented in three sections. The first section covers operation of the TI-007DL, and explains the keypad controls and display. The second section provides guidelines in selecting a transducer for a specific application. The last section provides application notes and a table of sound velocity values for various materials.

Electromatic 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:

Electromatic Equipment Company
600 Oakland Avenue,
Cedarhurst, NY 11516 – USA

Telephone: (516)295-4300
Facsimile: (516) 295-4399

Online: www.checkline.com
Email: sales@checkline.com

10.0 WARRANTY

ELECTROMATIC Equipment Co., Inc. (ELECTROMATIC) warrants to the original purchaser that this product is of merchantable quality and confirms in kind and quality with the descriptions and specifications thereof. Product failure or malfunction arising out of any defect in workmanship or material in the product existing at the time of delivery thereof which manifests itself within one year from the sale of such product, shall be remedied by repair or replacement of such product, at ELECTROMATIC's option, except where unauthorized repair, disassembly, tampering, abuse or misapplications has taken place, as determined by ELECTROMATIC. All returns for warranty or non-warranty repairs and/or replacement must be authorized by ELECTROMATIC, in advance, with all repacking and shipping expenses to the address below to be borne by the purchaser.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE OR APPLICATION. ELECTROMATIC SHALL NOT BE RESPONSIBLE NOR LIABLE FOR ANY CONSEQUENTIAL DAMAGE, OF ANY KIND OR NATURE, RESULTING FROM THE USE OF SUPPLIED EQUIPMENT, WHETHER SUCH DAMAGE OCCURS OR IS DISCOVERED BEFORE, UPON OR AFTER REPLACEMENT OR REPAIR, AND WHETHER OR NOT SUCH DAMAGE IS CAUSED BY MANUFACTURER'S OR SUPPLIER'S NEGLIGENCE WITHIN ONE YEAR FROM INVOICE DATE.

Some State jurisdictions or States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. The duration of any implied warranty, including, without limitation, fitness for any particular purpose and merchantability with respect to this product, is limited to the duration of the foregoing warranty. Some states do not allow limitations on how long an implied warranty lasts but, not withstanding, this warranty, in the absence of such limitations, shall extend for one year from the date of invoice.

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9.0 APPENDIX C — SOUND VELOCITIES OF SOME COMMON MATERIALS

Material	in/µs	m/s
Aluminum	0.250	6350
Bismuth	0.086	2184
Brass	0.173	4394
Cadmium	0.109	2769
Cast Iron	0.180 (approx.)	4572
Constantan	0.206	5232
Copper	0.184	4674
Epoxy Resin	0.100 (approx.)	2540
German Silver	0.187	4750
Glass, crown	0.223	5664
Glass, flint	0.168	4267
Gold	0.128	3251
Ice	0.157	3988
Iron	0.232	5893
Lead	0.085	2159
Magnesium	0.228	5791
Mercury	0.057	1448
Nickel	0.222	5639
Nylon	0.102 (approx.)	2591
Paraffin	0.087	2210
Platinum	0.156	3962
Plexiglass	0.106	2692
Polystyrene	0.092	2337
Porcelain	0.230 (approx.)	5842
PVC	0.094	2388
Quartz, glass	0.222	5639
Rubber, vulcanized	0.091	2311
Silver	0.142	3607
Steel, common	0.233	5918
Steel, stainless	0.223	5664
Stellite	0.275 (approx.)	6985
Teflon	0.056	1422
Tin	0.131	3327
Titanium	0.240	6096
Tungsten	0.210	5334
Zinc	0.166	4216
Water	0.058	1473

2.0 OPERATION

The TI-007DL interacts with the operator through the membrane keypad and the LCD display. The functions of the various keys on the keypad are detailed below, followed by an explanation of the display and its various symbols.
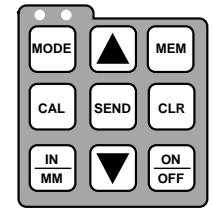
The Keypad

ON/OFF This key is used to turn the TI-007DL on and off. **When the TI-007DL is turned ON**, it will first perform a brief display test by illuminating all of the segments in the display. After one second, the tool will display the internal software version number. After displaying the version number, the display will show "0.0000" (or "0.000" if using metric units), indicating the tool is ready for use.

The TI-007DL is turned OFF by pressing the **ON/OFF** key. The tool has a special memory that retains all of its settings even when the power is off. An auto-powerdown mode conserves battery life. If the tool is idle for 5 minutes, it turns off.

IN/MM **The IN/MM key** is used to switch back and forth between English and metric units. This key may be used at any time, whether the tool is displaying a thickness (IN or MM) or a velocity value (IN/µs or M/s).

CAL **The CAL key** is used to enter and exit the TI-007DL's calibration mode. This mode is used to adjust the sound-velocity value that the TI-007DL will use when calculating thickness. The tool will either calculate the sound-velocity from a sample of the material being measured, or allow a known velocity value to be entered directly. Refer to page 6 for an explanation of the two CAL functions available.

MODE **The MODE key** is used to toggle through features and settings of the TI-007DL (alarm, diff, scan, gate, back light, and beeper). The **MODE** key is used in conjunction with the arrow and send keys to enable/disable the features and settings. Refer to page 8 for a further explanation of the different modes.

The UP arrow key has three functions. When the TI-007DL is in calibration mode, this key is used to increase numeric values on the display. An auto-repeat function is built in, so that when the key is held down, numeric values will increment at an increasing rate. When MODE is activated, the UP arrow key scrolls through the various features and settings of the TI-007DL. When the data logging feature has been activated by pressing the MEM key, the UP arrow is used to scroll through the various fields, storage locations, and functions for the data logger. Refer to page 11 for further information regarding the use of the UP arrow key and the data logger.

The DOWN arrow key has three functions. When the TI-007DL is in the CAL mode, this key is used to decrease numeric values on the display. An auto-repeat function is built in, so that when the key is held down, numeric values will decrement at an increasing rate. When MODE is activated, the DOWN arrow key scrolls through the various features and settings of the TI-007DL. When the data logging feature has been activated by pressing the MEM key, the UP arrow is used to scroll through the various fields, storage locations, and functions for the data logger. Refer to page 11 for further information regarding the use of the UP arrow key and the data logger.

MEM

The MEM key enables /disables the data logging feature of the TI-007DL. This key is used in conjunction with the UP/DOWN arrows, SEND, and CLR keys (hi-lighted in green). The combination of these keys control the data logging features of the TI-007DL. Refer to the data logging section on page 11.

CLR

The CLR key is specifically used with the data logging feature of the TI-007DL. This key clears the contents of an entire file, or individual storage locations. The CLR key is also used to send an obstruct (ObSt) to an individual storage location. The ObSt symbol would indicate that the user was unable to take a reading at a particular locations, see data logging section on page 12.

SEND

The SEND key is used for sending data to internal storage locations and external peripheral devices (serial printer/computer) The SEND key is also used to select data logging functions in the TI-007DL, page 12.

The Display

The numeric portion of the display consists of 4 complete digits preceded by a leading "1", and is used to display numeric values, as well as occasional simple words, to indicate the status of various settings. When the TI-007DL is displaying thickness measurements, the display will hold the last value measured, until a new measurement is made. Additionally, when the battery voltage is low, the entire display will begin to flash. When this occurs, the batteries should be replaced.

These eight vertical bars form the Stability Indicator. When the TI-007DL is idle, only the left-most bar and the underline will be on. While the gauge is taking a measurement, six or seven of the bars should be on. If fewer than five bars are on, the TI-007DL is having difficulty achieving a stable measurement, and the thickness value displayed will most likely be erroneous.

When the IN symbol is on, the TI-007DL is displaying a thickness value in inches. The maximum thickness that can be displayed is 1.999 inches.

When the MM symbol is on, the TI-007DL is displaying a thickness value in millimeters. If the displayed thickness exceeds 19.999 millimeters, the decimal point will shift automatically to the right, allowing values up to 99.99 millimeters to be displayed.

When the IN symbol is on, in conjunction with the /μs symbol, the TI-007DL is displaying a sound-velocity value in inches-per-microsecond.

When the M symbol is on, in conjunction with the /s symbol, the TI-007DL is displaying a sound-velocity value in meters-per-second.
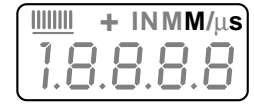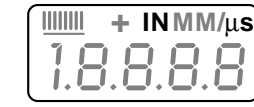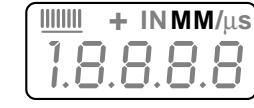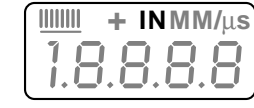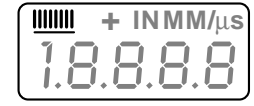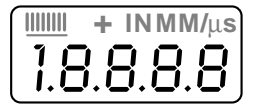
Measuring tubing

When measuring a piece of tubing for wall thickness, it may prove beneficial to have multiple delay lines with different radiuses for different tubing diameters. The delay lines can be easily radiused by placing a piece of emery cloth around the tubing and moving the transducer back and forth until a radius has formed on the tip of the delay line.

Measuring hot surfaces

The velocity of sound through a substance is dependent upon its temperature. As materials heat up, the velocity of sound through them decreases. In most applications with surface temperatures less than about 200 °F (100 °C), no special procedures must be observed. At temperatures above this point, the change in sound velocity of the material being measured starts to have a noticeable effect upon ultrasonic measurement.

At such elevated temperatures, it is recommended that the user perform a calibration procedure (refer to page 6) on a sample piece of known thickness, which is at or near the temperature of the material to be measured. This will allow the TI-007DL to correctly calculate the velocity of sound through the hot material.

When performing measurements on hot surfaces, it may also be necessary to use a specially constructed high-temperature delay line. It is recommended that the probe be left in contact with the surface for as short a time as needed to acquire a stable measurement. While the transducer is in contact with a hot surface, it will begin to heat up, and through thermal expansion and other effects, may begin to adversely affect the accuracy of measurements.

Measuring laminated materials

Laminated materials are unique in that their density (and therefore sound-velocity) may vary considerably from one piece to another. Some laminated materials may even exhibit noticeable changes in sound-velocity across a single surface. The only way to reliably measure such materials is by performing a calibration procedure on a sample piece of known thickness. Ideally, this sample material should be a part of the same piece being measured, or at least from the same lamination batch. By calibrating to each test piece individually, the effects of variation of sound-velocity will be minimized.

An additional important consideration when measuring laminates, is that any included air gaps or pockets will cause an early reflection of the ultrasound beam. This effect will be noticed as a sudden decrease in thickness in an otherwise regular surface. While this may impede accurate measurement of total material thickness, it does provide the user with positive indication of air gaps in the laminate.

7.0   APPENDIX A — PRODUCT SPECIFICATIONS

Weight:	10 ounces (with batteries).
Size:	2.5W x 4.5 H x 1.24 D inches (*63.5W x 114.3 H x 31.5 D mm*).
Operating Temp.:	–20 to 120 °F *(–30 to 50 °C)*
Case:	Extruded aluminum body/nickel plated aluminum end caps.
Keypad:	Sealed membrane, resistant to water and petroleum products.
Power Source:	Two "AA" size, 1.5 volt alkaline or 1.2 volt NiCad cells. 150 hours typical operating time on alkaline, 100 hours on NiCad.
Display:	Liquid-Crystal-Display, 4.5 digits, 0.500 inch high numerals. LED backlight.
Measuring Range:	0.0060 to 1.0000 inches *(0.15 to 25.40mm)* — Steel
Resolution:	0.0001 inch *(0.001mm)*
Accuracy:	±0.0001 inch *(0.001mm)*, depends on material and conditions
Sound Velocity Range:	0.0492 to 0.3937 in/µs (*1250 to 10000m/s*)

The Transducer

The transducer is the "business end" of the TI-007DL. It transmits and receives ultrasonic sound waves that the TI-007DL uses to calculate the thickness of the material being measured. The transducer connects to the TI-007DL via the attached cable, and one coaxial connector.

The transducer must be used correctly in order for the TI-007DL to produce accurate, reliable measurements. Below is a short description of the transducer, followed by instructions for its use.

The photo below shows a typical single element delay line transducer. This delay line is fastened to the transducer with a retainer ring. A drop of couplant is applied between the delay line and transducer body. The transducer body contains one crystal element that is responsible for conducting ultrasonic sound into and back from the material being measured. When the transducer is placed against the material being measured, it is the area directly beneath the delay line that is being measured.
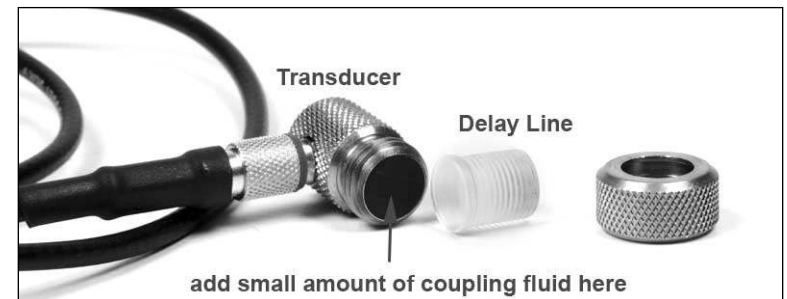
When measuring, press against the top of the transducer with the thumb or index finger to hold the transducer in place. Moderate pressure is sufficient, as it is only necessary to keep the transducer stationary, and the delay line seated flat against the surface of the material being measured.

Making Measurements

In order for the transducer to do its job, there must be no air gaps between the wearface and the surface of the material being measured. This is accomplished with the use of a "coupling" fluid, commonly called "couplant". This fluid serves to "couple", or transfer, the ultrasonic sound waves from the transducer, into the material, and back again. Before attempting to make a measurement, a small amount of couplant should be applied to the surface of the material being measured. Typically, a single droplet of couplant is sufficient.

After applying couplant, press the transducer (wearface down) firmly against the area to be measured. The Stability Indicator should have six or seven bars darkened, and a number should appear in the display. If the TI-007DL has been set to the correct sound velocity (see page 6), the number in the display will indicate the actual thickness of the material directly beneath the transducer.

If the Stability Indicator has fewer than five bars darkened, or the numbers on the display seem erratic, first check to make sure that there is an adequate film of couplant beneath the transducer, and that the transducer is seated flat against the material. If

the condition persists, it may be necessary to select a different transducer (size or frequency) for the material being measured. See page 15 for information on Transducer selection.

While the transducer is in contact with the material that is being measured, the TI-007DL will perform four measurements every second, updating its display as it does so. When the transducer is removed from the surface, the display will hold the last measurement made.

IMPORTANT

Occasionally, a small film of couplant will be drawn out between the transducer and the surface as the transducer is removed. When this happens, the TI-007DL may perform a measurement through this couplant film, resulting in a measurement that is larger or smaller than it should be. This phenomenon is obvious when one thickness value is observed while the transducer is in place, and another value is observed after the transducer is removed.

Condition and Preparation of Surfaces

In any ultrasonic measurement scenario, the shape and roughness of the test surface are of paramount importance. Rough, uneven surfaces may limit the penetration of ultrasound through the material, and result in unstable, and therefore unreliable, measurements. The surface being measured should be clean, and free of any small particulate matter, rust, or scale. The presence of such obstructions will prevent the transducer from seating properly against the surface. Often, a wire brush or scraper will be helpful in cleaning surfaces. In more extreme cases, rotary sanders or grinding wheels may be used, though care must be taken to prevent surface gouging, which will inhibit proper transducer coupling.

Extremely rough surfaces, such as the pebble-like finish of some cast iron, will prove most difficult to measure. These kinds of surfaces act on the sound beam like frosted glass on light:, the beam becomes diffused and scattered in all directions.

In addition to posing obstacles to measurement, rough surfaces contribute to excessive wear of the transducer, particularly in situations where the transducer is "scrubbed" along the surface.

Calibration

In order for the TI-007DL to make accurate measurements, it must be set to the correct sound-velocity for the material being measured. Different types of material 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 tool is not set to the correct sound-velocity, all of the measurements the tool makes will be erroneous by some fixed percentage. The one point calibration is the simplest and most commonly used calibration procedure for optimizing linearity over large ranges. The TI-007DL provides two simple methods for setting the sound-velocity, described in the following pages

6.0 TRANSDUCER SELECTION

The TI-007DL is inherently capable of performing measurements on a wide range of materials, from various metals to glass and plastics. Different types of material, however, will require the use of different transducers. Choosing the correct transducer for a job is critical to being able to easily perform accurate and reliable measurements. The following paragraphs highlight the important properties of transducers, which should be considered when selecting a transducer for a specific job.

Generally speaking, the best transducer for a job is one that sends sufficient ultrasonic energy into the material being measured such that a strong, stable echo is received by the TI-007DL. Several factors affect the strength of ultrasound as it travels. These are outlined below:

Initial Signal Strength

The stronger a signal is to begin with, the stronger its return echo will be. Initial signal strength is largely a factor of the size of the ultrasound emitter in the transducer. A large emitting area will send more energy into the material being measured than a small emitting area. Thus, a so-called "1/4-inch" transducer will emit a stronger signal than a "1/8-inch" transducer.

Absorption and Scattering

As ultrasound travels through any material, it is partly absorbed. If the material through which the sound travels has any grain structure, the sound waves will experience scattering. Both of these effects reduce the strength of the waves, and thus, the TI-007DL's ability to detect the returning echo.

Higher frequency ultrasound is absorbed and scattered more than ultrasound of a lower frequency. While it may seem that using a lower frequency transducer might be better in every instance, low frequencies are less directional than high frequencies.

Geometry of the Transducer

The physical constraints of the measuring environment sometimes determine a transducer's suitability for a given job. Some transducers may simply be too large to be used in tightly confined areas. Also, the surface area available for contacting with the transducer may be limited, requiring the use of a transducer with a small cone tipped delay line. Measuring on a curved surface, may require the use of a transducer with a matching curved wearface.

Temperature of the Material

When it is necessary to measure on surfaces that are exceedingly hot, special delay lines may be necessary. Additionally, care must be taken when performing a "Calibration to Known Thickness" with a high temperature application. See Appendix B for more information on measuring materials with a high temperatures.

Selection of the proper transducer is often a matter of tradeoffs between various characteristics. It may be necessary to experiment with a variety of transducers in order to find one that works well for a given job. ELECTROMATIC can provide assistance in choosing a transducer, and offers a broad selection of transducers for evaluation in specialized applications.

7. Press the **UP/DOWN** arrow keys to scroll to the flashing **Prnt/F-05** (the file chosen), or **LISt** (tape printer) symbol.

8. Press the **SEND** key to print the contents of the file.

9. Press the **MEM** key at any time to exit the data logging functions and return to measurement mode.

Calibration to a known thickness

NOTE: This procedure requires a sample piece of the specific material to be measured, the exact thickness of which is known, e.g. from having been measured by some other means.

1. Make sure the TI-007DL is **ON**.

2. Apply couplant to the sample piece.

3. Press the transducer against the sample piece, making sure that the transducer sits flat against the surface of the sample. The display should show some (probably incorrect) thickness value, and the Stability Indicator should have nearly all its bars on.

4. Having achieved a stable reading, remove the transducer. If the displayed thickness changes from the value shown while the transducer was coupled, repeat step 3.

5. Press the **CAL** key. The **IN** (or **MM**) symbol should begin flashing.

6. Use the **UP** and **DOWN** arrow keys to adjust the displayed thickness up or down, until it matches the thickness of the sample piece.

7. Press the **CAL** key again. The **IN/μs (or M/s)** symbols should begin flashing. The TI-007DL is now displaying the sound velocity value it has calculated based on the thickness value that was entered in step 6.

8. Press the **CAL** key once more to exit the calibration mode. The TI-007DL is now ready to perform measurements.

Calibration to a known velocity

NOTE: This procedure requires that the operator know the sound-velocity of the material to be measured. A table of common materials and their sound-velocities can be found in Appendix C.

1. Make sure the TI-007DL is **ON**.

2. Press the **CAL** key to enter calibration mode. If the IN (or MM) symbol is flashing, press the **CAL** key again, so that the IN/μs (or M/s) symbols are flashing.

3. Use the **UP** and **DOWN** arrow keys to adjust the displayed velocity up or down, until it matches the sound-velocity of the material to be measured.

4. Press the **CAL** key once more to exit the calibration mode. The TI-007DL is now ready to perform measurements.

NOTE: At any time during the calibration procedure (IN, MM, IN/μs, or M/s flashing in the display), pressing the SCAN key will restore the tool to the factory default sound-velocity for steel (0.233 IN/μs).

To achieve the most accurate measurements possible, it is generally advisable to always calibrate the TI-007DL to a sample piece of known thickness. Material composition (and thus, its sound-velocity) sometimes varies from lot to lot and from manufacturer to manufacturer. Calibration to a sample of known thickness will ensure that the tool is set as closely as possible to the sound velocity of the material to be measured.

3.0 TI-007DL MODES AND FEATURES

The Back Light

The back light of the TI-007DL can be set to three different positions on/off/auto. The following steps outline the procedure for changing the settings of the back light:

1. Press **ON/OFF** key to power up the TI-007DL.

2. Press the **MODE** key to activate features and settings.

3. Press the **UP/DOWN** arrow keys to scroll to the LItE symbol.

4. Press the **SEND** key to toggle the status of the back light on/off/auto.

5. Press the **MODE** key once again to return to measurement mode.

Scan Mode

While the TI-007DL excels at making single point measurements, it is sometimes desirable to examine a larger region, searching for the thinnest point. The TI-007DL includes a feature, called Scan Mode, which allows it to do just that.

In normal operation, the TI-007DL performs and displays four measurements every second, which is quite adequate for single measurements. In Scan Mode, however, the tool performs eight measurements every second, but does not display them. While the transducer is in contact with the material being measured, the TI-007DL is keeping track of the lowest measurement it finds. The transducer may be "scrubbed" across a surface, and any brief interruptions in the signal will be ignored. When the transducer loses contact with the surface for more than a second, the TI-007DL will display the smallest measurement it found.

When the TI-007DL is in measurement mode, press the MODE key to activate the features and settings. The display will begin flashing ALAr (alarm), followed by the status - on/off. Use the UP and DOWN arrow keys to scroll to SCAn mode. Press the SEND key to toggle scan mode on/off. While scanning, the display will show a moving series of dashes instead of a thickness value. When the transducer is removed from the material being scanned, the TI-007DL will (after a brief pause) display the smallest measurement it found.

Alarm Mode

The Alarm Mode feature of the TI-007DL allows the user to set an audible and visual Hi /Lo parameter when taking measurements. If the measurement falls below or above the Hi /Lo limits, set by the user, a red light will be illuminated on the front panel of the gauge and an audible indication (beep) will sound. This improves the speed and efficiency of the inspection process by eliminating constant viewing of the actual reading displayed. The following procedure outlines how to enable and set up this feature:

Using the Beeper

1. Press **ON/OFF** key to power up the unit

2. Press **MODE** key to activate features and settings.

3. Press the **UP** and **DOWN** arrow keys to scroll to **bEEP**.

6. Press the **UP/DOWN** arrow keys to scroll to the flashing **CLr/F-05** (the file selected by the user) symbol.

7. Press the **SEND** key to select the clear file option. The symbol (**CLr?**) will be displayed.

8. Press the **CLR** key to confirm and clear the contents of the entire file.

9. Press the **MEM** key, at any time, to exit the data logging functions and return to measurement mode.

Clearing all Files

1. Press the **ON/OFF** key to power up the TI-007DL.

2. Immediately press the **CLR** key. **CLr?** will be displayed.

3. Press the **CLR** key once again to clear all files.

Sending All Files to a Computer

At the end of the inspection process, or end of the day, the user may require the readings be transferred to a computer. The following steps outline this procedure:

1. Refer to the section on Connecting to a Computer, page 11, before proceeding.

2. Press the **ON/OFF** key to power up the TI-007DL.

3. Press the **MEM** key to activate the data logging functions and settings.

4. Press the **UP/DOWN** arrow keys to scroll to the **SEND/ALL** symbol flashing on the display.

5. Press the **SEND** key to send all data files to the computer.

6. Press the **MEM** key to exit the data logging functions and return to measurement mode.

Printing a File

The user may wish to print an individual file to a serial printer or computer. A file can, very simply, be printed to a communications program on a PC (i.e., Windows 3.1 - Terminal, Window 95/98 - HyperTerminal), and then printed. The procedure for printing a file is outlined below:

1. Refer to the section on Connecting to a Computer, page 11, before proceeding.

2. Press the **ON/OFF** key to power up the TI-007DL.

3. Press the **MEM** key to activate the data logging functions and settings.

4. Press the **SEND** key to enter file setup.

5. Press the **UP/DOWN** arrow keys to scroll to the file to be printed (F-01, F-05, etc.).

6. Press **SEND**, once again, to select the file to be printed. The display will flash the **FILE/F-05** (The file selected) symbol.

5. Press the **SEND** key once again to select the file.

Note: The display will flash the **FILE/F-04** (The selected file) symbol.

6. Press the **MEM** key, once again, to advance to the storage locations in the file selected.

Note: The display will flash the current storage location (L007, L039, etc), followed by the status of the location. The storage location can contain one of three possible things:

        a. A measurement that was previously stored.
        b. A clear location, indicated by the CLr symbol.
        c. Obstruct (ObSt), indicating that a measurement could not be obtained.

7. Press the **UP/DOWN** arrow keys to advance to the desired cell location.

8. Take a measurement and press the **SEND** key to store a reading in the desired location.

   The data logger will automatically advance to the next storage location in sequential order.

9. Repeat step 8 as required.

Clearing a Storage Location

The user may require a storage location, that is currently full, be over written. This procedure is outlined in the following steps:

Note: Assuming the steps in **Using The Data Logge**r have been completed, and step 8 is being repeated.

1. Press the **UP/DOWN** arrow keys to move to the location to be over written.

Note: If the user attempts to write to a location that is currently full, the display will flash the **FuLL** symbol.

2. Press the **CLR** key to delete the contents of the storage location. The display will flash the storage location (L011, L099, etc.) and the **CLr** symbol.

3. Take another measurement, and press the **SEND** key to write to the same storage location just cleared.

Clearing an Entire File

The user may require the contents of an entire file be completely cleared of all measurements. This would allow the user to start a new list of measurements starting at storage location L001. The procedure is outlined in the following steps:

1. Press the **ON/OFF** key to power up the TI-007DL.
2. Press the **MEM** key to activate the data logging functions and settings.
3. Press the **SEND** key to enter file setup.
4. Press the **UP/DOWN** arrow keys to scroll to the file that will be cleared of all measurements.
5. Press the **SEND** key once again to select the file.

Note: The display will flash the **FILE/F-05** (The file selected by the user) symbol.

4. Press the **SEND** key to toggle the status of the beeper on/off.

5. Press the **MODE** key once again to return to measurement mode.

Alarm Mode

1. Press the **ON/OFF** key to power up the TI-007DL
2. Press the **MODE** key to activate features and settings
3. Mode will start with **ALAr** feature and current status
4. Press send key to toggle ALAr status on/off
5. **Status ON** – A nominal value will be displayed with the units IN/MM flashing.
6. Press the **UP** or **DOWN** arrow keys to scroll to the desired nominal thickness value.
7. Press **SEND** key to select the desired nominal value and return to mode menu.
8. Press **MODE** key once to return to measurement mode.

4.0 MEASUREMENT MODES

The TI-007DL is equipped with four measurement mode options (echo-echo, interface-echo, plastic, auto). In echo-echo mode, the gauge has the ability to read thin metals down to .006 inches (.15 millimeters). The echo-echo mode also allows the user to measure the thickness of metals that have been previously coated or painted on the surface. This enables the user to determine the thickness of the metal without having to remove the paint. In interface-echo mode, the gauge has the ability to read plastics and thicker materials. The TI-007DL 's auto mode will automatically switch between modes according to the different materials being measured. The following section outlines how to switch between measurement modes:

Measurement Modes

1. Press **ON/OFF** key to power up the TI-007DL .

2. Press the **MODE** key to activate features and settings.

3. Press the **UP** or **DOWN** arrow keys to scroll to **PLAS**.

4. Press the **SEND** key to toggle between the different measurement modes:
    E-E (Echo-Echo), I-E (Interface-Echo), PLAS (Plastic), AutO (Auto).

5. Press the **MODE** key once again to return to measurement mode.

Differential Mode

In the Quality Control environment, it is sometimes necessary to know the difference between a nominal (target) thickness value and an actual thickness value.This feature is also included in the TI-007DL. With the Differential Mode enabled, the TI-007DL will display the positive or negative difference from an entered nominal value. The following steps outline the procedure for setting up this feature:

Differential Mode

6. Press **ON/OFF** key to power up the TI-007DL.

7. Press the **MODE** key to activate features and settings.

8. Press the UP or DOWN arrow keys to scroll to **dIFF**.

9. Press the **SEND** key to toggle the status of the differential mode on/off.

10. **Status ON** - A nominal value will be displayed with the units **IN/MM** flashing.

11. Press the **UP** or **DOWN** arrow keys to scroll to the desired nominal thickness value.

12. Press the **SEND** key to select the desired nominal value and return to mode menu.

13. Press the **MODE** key once again to return to measurement mode.

5.0 RS232 SERIAL PORT & THE DATA LOGGER

The TI-007DL is equipped with an RS232 serial port. Using the accessory cable (part# N-306-0010), the TI-007DL has the ability to connect to a computer, or external storage device. The following section outlines the procedure for connecting the TI-007DL to a computer, and how to collect data using any standard communications program:

Connecting To a Computer

1. Connect the accessory cable (part# N-306-0010) to the 2 pin jack located on the bottom of the TI-007DL, and the 9 pin connector to a serial port on the computer.

2. Start the communications software that will be used to collect the measurements (i.e., Microsoft Windows 3.1 -Terminal, or 95/98 - HyperTerminal).

3. Setup the communications software using the following parameters:
    Data Bits - 8, Parity - None, Stop Bits - 1, Baud Rate 1200 (to print a report), or 9600 to transfer data file.

    Note: A report can be printed to a communications program (i.e. HyperTerminal), or printed to a serial printer using 8.5" x 11" paper.

4. Set the communications software COMM port to the port number that the TI-007DL is connected - direct comm1, comm 2, etc.

5. Proceed to the section USING THE DATA LOGGER.

Note: Communications software packages generally have the ability to capture the screen data to a common text file. This text file, containing the measurements, can then be imported into any common spreadsheet program (i.e. Excel, Quattro Pro, Lotus123) for further reporting requirements.

Using The Data Logger

The TI-007DL is equipped with an on board data logging feature. This will prove to be a valuable reporting tool for inspection purposes. It will increase efficiency by reducing the time it takes to manually record the measurements during the inspection process. The TI-007DL can then be connected to a computer or serial printer to save and print the results of the inspection.

The TI-007DL has a storage capacity of 1000 measurements. The TI-007DL has 10 files consisting of 100 sequential storage locations in each file. The procedure for using the data logger is outlined in the following steps:

1. Press **ON/OFF** key to power up the TI-007DL.

2. Press the **MEM** key to activate the data logger.

Note: The display will flash **FILE / F-01** (or the last file used) symbol. Remember, there are 10 files F-01 thru F-10.

3. Press the **SEND** key to enter file setup.
   The current file will be displayed (F-01, F-03, etc.)

4. Press the **UP / DOWN** arrow keys to scroll to the file (1-10) that will be used to record the measurements.

MODEL TI-007DL

ULTRASONIC MICROMETER

OPERATING INSTRUCTIONS