MiniTest 405

Technical Reference and Operating Manual

Advancing with Technology ElektroPhysik

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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 rests solely with the user of the instrument.

Contents

1. Introduction

The ***MiniTest 405*** is a precision Ultrasonic Micrometer. capable of measuring the thickness of various materials with accuracy as high as ± 0.01mm or ± 0.001 inches. 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 ***MiniTest 405*** 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.

ElektroPhysik 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:

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1.2 Supply Schedule

- Plastics carrying case
- Gauge with transducer
- 1 bottle coupling fluid
- 2 x AA 1,5V alkaline batteries
- Instruction manual (English/German)
- Calibration certificate NIST 04-25-174-A and 04-28146-A

1.3 Accessories

- RS232 Interface cable
- MSoft 7000 Data transmission software
- Data printer (on request)

2. Operation

The ***MiniTest 405*** 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

2.1 Keypad

Switch ON/OFF

This key is used to turn the ***MiniTest 405*** on and off. When the gauge is turned ON, it will first perform a brief display test by illuminating all of the segments in the display.

After one second, the gauge will display the internal software version number. After displaying the version number, the display will show „0.000“ (or „0.00“ if using metric units), indicating the gauge is ready for use.

The ***MiniTest 405*** is turned OFF by pressing the **ON/ OFF** key.

The gauge has a special memory that retains all of its settings even when the power is off.

The gauge also features an auto-powerdown mode designed to conserve battery life. If the gauge is idle for 5 minutes, it will turn itself

PRB-0 Key

The **PRB-0** key is used to „zero“ the ***MiniTest 405*** in much the same way that a mechanical micrometer is zeroed. If the gauge is not zeroed correctly, all of the measurements that the gauge makes may be in error by some fixed value. Refer to Section „Performing a probe Zero“ for an explanation of this important procedure.

CAL Key

The **CAL** key is used to enter and exit the ***MiniTest 405***'s calibration mode. This mode is used to adjust the sound-velocity value that the ***MiniTest 405*** will use when calculating thickness. The gauge 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 section „Calibration“ for an explanation of the two **CAL** functions available.

Mode Key

The **MODE** key is used to toggle through the various features and settings of the ***MiniTest 405*** (alarm mode, beeper, back light, units, scan mode, and differential mode). The **MODE** key is used in conjunction with the arrow and send keys to enable/disable the features and settings

UP arrow key

The **UP** arrow key has three functions. When the ***MiniTest 405*** 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 ***MiniTest 405***. When the data logging feature has been activated by pressing the **MEM** key, the **UP** arrow is used to scroll through the various files, storage locations, and functions of the data logger. Refer to section „Using the Data Logger“ f for further information regarding the use of the **UP** arrow key and the data logger.

DOWN arrow key

The **DOWN** arrow key has three functions. When the ***MiniTest 405*** 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 scrolls through the various features and settings of the ***MiniTest 405***. When the data logging feature has been activated by pressing the **MEM** key, the **DOWN** arrow is used to scroll through the various files, storage locations, and functions of the data logger. Refer to page 24 for further information regarding the use of the **DOWN** arrow key and the data logger.

MEM key

The **MEM** key enables/disables the data logging feature of the MiniTest 405. This key is used in conjunction with the UP/DOWN arrows, SEND and CLR keys (hi-lighted in red). The combination of these keys control the data logging features of the ***MiniTest 405***. Refer to the section „Data Logger“ for further details.

Clear Key

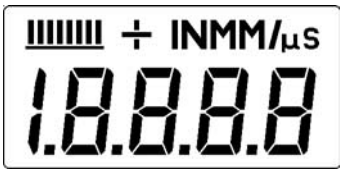
The **CLR** key is specifically used with the data logging feature of the ***MiniTest 405***. This key clears the contents of an entire file, or individual storage locations. The **CLR** key is also used to send an obstruct (**ObSt**) to an individual storage location.

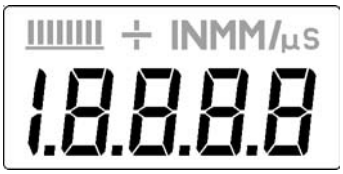
The **ObSt** symbol would indicate that a the user was unable to take a reading at a particular location. Refer to the section „Clearing a storage Location“ for further details.

Send Key

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 ***MiniTest 405***. Refer to section „Using the Data Logger“ for further details.

2.2 Display



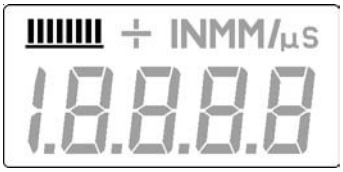


The numeric portion of the display consists of 4 complete digits preceded by a leading „1“, and is used to display numeric values, as well as occasional simple words, to indicate the status of various settings.

When the ***MiniTest 405*** is displaying thickness measurements, the display will hold the last value measured, until a new measurement is made.

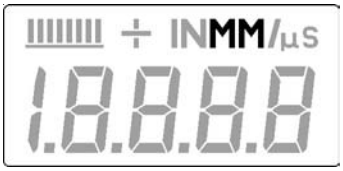
Note:

When the battery voltage is low, the entire display will begin to flash. When this occurs, the batteries should be replaced.

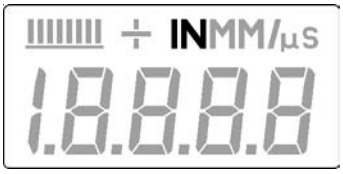


These eight vertical bars form the Stability Indicator. When the ***MiniTest 405*** is idle, only the left-most bar and the underline will be on. While the gauge is taking a measurement, six or seven of the bars should be on.

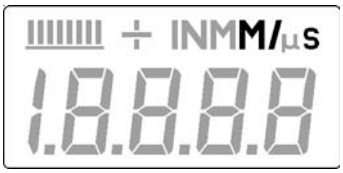
If fewer than five bars are on, the ***MiniTest 405*** is having difficulty achieving a stable measurement, and the thickness value displayed will most likely be erroneous.



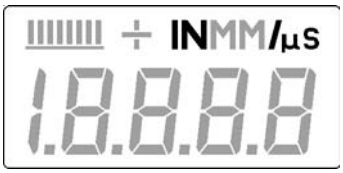
When the **MM** symbol is on, the ***MiniTest 405*** is displaying a thickness value in millimeters. If the displayed thickness exceeds 199.99 millimeters, the decimal point will shift automatically to the right, allowing values up to 1999.9 millimeters to be displayed.



When the **IN** symbol is on, the ***MiniTest 405*** is displaying a thickness value in inches. The maximum thickness that can be displayed is 19.999



When the **M** symbol is on, in conjunction with the **/s** symbol, the ***MiniTest 405*** is displaying a sound-velocity value in **meters-per-second**



When the **IN** symbol is on, in conjunction with the **/µs** symbol, the ***MiniTest 405*** is displaying a sound-velocity value in **inches-per-microsecond**

3. Transducer

The transducer is the „business end“ of the ***MiniTest 405***. It transmits and receives ultrasonic sound waves that the ***MiniTest 405*** uses to calculate the thickness of the material being measured. The transducer connects to the ***MiniTest 405*** via the attached cable, and two coaxial connectors. When using transducers manufactured by ElektroPhysik, the orientation of the dual coaxial connectors is not critical: either plug may be fitted to either socket in the ***MiniTest 405***.

The transducer must be used correctly in order for the ***MiniTest 405*** to produce accurate, reliable measurements. Below is a short description of the transducer, followed by instructions for its use.

This is a bottom view of a typical transducer. The two semicircles of the wearface are visible, as is the barrier separating them

One of the semicircles is responsible for conducting ultrasonic sound into the material being measured, and the other semicircle is responsible for conducting the echoed sound back into the transducer.

When the transducer is placed against the material being measured, it is the area directly beneath the center of the wearface that is being measured.

This is a top view of a typical transducer.

Press against the top 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 wearface seated flat against the surface of the material being measured.

4. Making Measurements

In order for the transducer to do its job, there must be no air gaps between the wear-face 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 transmit, 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 ***MiniTest 405*** has been properly „zeroed“ (see section „Probe Zero“) and set to the correct sound

velocity (see Sound Velecity Selection Table), 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 section „Transducer Selection“ for information on this issue.

While the transducer is in contact with the material being measured, the ***MiniTest 405*** 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 Note:

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 ***MiniTest 405*** 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.

4.1 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 irons, 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. Transducers should be inspected on a regular basis, for signs of uneven wear of the wearface. If the wearface is worn on one side more than another, the sound beam penetrating the test material may no longer be perpendicular to the material surface. In this case, it will be difficult to exactly locate tiny irregularities in the material being measured, as the focus of the soundbeam no longer lies directly beneath the transducer.

4.2 Probe Zero

Setting the Zero Point of the ***MiniTest 405*** is important for the same reason that setting the zero on a mechanical micrometer is important.If the gauge is not „zeroed“ correctly, all of the measurements the gauge makes will be in error by some fixed number.

When the ***MiniTest 405*** is „zeroed“, this fixed error value is measured and automatically corrected for in all subsequent measurements.

The ***MiniTest 405*** may be „zeroed“ by performing the following procedure:

1. Make sure the ***MiniTest 405*** is on.

2. Plug the transducer into the ***MiniTest 405***. Make sure that the connectors are fully engaged. Check that the wearface of the transducer is clean and free of any debris.

3. On the top of the ***MiniTest 405***, above the display, is the metal probe-disc. Apply a single droplet of ultrasonic couplant to the face of this disc.

4. Press the transducer against the probe-disc, making sure that the transducer sits flat against the surface of the probe-disc. The display should show some thickness value, and the Stability Indicator should have nearly all its bars illuminated. While the transducer is firmly coupled to the probe-disc, press the **PRB-0** key on the keypad. The ***MiniTest 405*** will display „Prb0“ while it is calculating its zero point.

5. Remove the transducer from the probe-disc.

At this point, the ***MiniTest 405*** has successfully calculated its internal error factor, and will compensate for this value in any subsequent measurements.

When performing a „probe-zero“, the ***MiniTest 405*** will always use the sound-velocity value of the built-in probe-disc, even if some other velocity value has been entered for making actual measurements.

Though the ***MiniTest 405*** will remember the last „probe-zero“ performed, it is generally a good idea to perform a „probe-zero“ whenever the gauge is turned on, as well as any time a different transducer is used. This will ensure that the instrument is always correctly zeroed.

5. Calibration

n order for the ***MiniTest 405*** 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 5920 m/s (0.233 inches-per-microsecond), versus that of aluminum, which is about 6350 m/s (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 procedure - optimizing linearity over large ranges.

The **two- point** calibration allows for greater accuracy over small ranges by calculating the probe zero and velocity.

The ***MiniTest 405*** provides three simple methods for setting the sound-velocity, described in the following pages.

5.1 Calibration to a known thickness

Note:

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 ***MiniTest 405*** is on.
2. Perform a Probe-Zero (see section „Probe Zero“)
3. Apply couplant to the sample piece.
4. 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.
5. Having achieved a stable reading, remove the transducer. If the displayed thickness changes from the value shown while the transducer was coupled, repeat step 4.
6. Press the **CAL** key. The **MM** (or **IN**) symbol should begin flashing.
7. Use the **UP** and **DOWN** arrow keys to adjust the displayed thickness up or down, until it matches the thickness of the sample piece.
8. Press the **CAL** key again. The **M/s** (or **IN/µs**) symbols should begin flashing. The ***MiniTest 405*** is now displaying the sound velocity value it has calculated based on the thickness value that was entered in step 7.
9. Press the **CAL** key once more to exit the calibration mode. The ***MiniTest 405*** is now ready to perform measurements.

5.2 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 **Section 11.**

1. Make sure the ***MiniTest 405*** is on.

2. Press the **CAL** key to enter calibration mode. If the **MM** (or **IN**) symbol is flashing, press the **CAL** key again, so that the **M/s** (or **IN/µs**) 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 ***MiniTest 405*** is now ready to perform measurements.

Note:

At any time during the calibration procedure (**MM, IN**, **M/s, or IN/µs** flashing in the display), pressing the **PRB-0** key will restore the gauge to the factory default sound-velocity for steel (5920m/s / 0.233 IN/µs).

To achieve the most accurate measurements possible, it is generally advisable to always calibrate the ***MiniTest 405*** to a sample piece of known thickness. Material composition (and thus, its sound-velocity) sometimes varies from lot to lot and from manufacturer. Calibration to a sample of known thickness will ensure that the gauge is set as closely as possible to the sound velocity of the material to be measured.

5.3 Two Point Calibration

Note:

This procedure requires that the operator has two known thickness points on the test piece that are representative of the range to be measured.

1. Make sure the ***MiniTest 405*** is on.

2. Perform a Probe-Zero (refer to section „Probe Zero“)

3. Apply couplant to the sample piece.

4. Press the transducer against the sample piece, at the first/second calibration point, 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.

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

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

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

8. Press the **Probe** key. The display will flash **1OF2**. **Repeat steps 3 through 8** on the second calibration point. The ***MiniTest 405*** will now display the sound velocity value it has calculated based on the thickness values that were entered in step 7.The ***MiniTest 405*** is now ready to perform measurements.

6. Settings

6.1 Changing Measuring Units MM / IN

The ***MiniTest 405*** has the ability to display measurements in both the English (IN) and Metric (MM) systems. The following steps outline the procedure for changing units:

1. Press **ON/OFF** key to power up the ***MiniTest 405***.

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

3. Press the **UP** or **Down** arrow keys to scroll to the **unIt** symbol.

4. Press the **SEND** key to toggle the status of the units - **IN** / **MM**.

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

6.2 Back Light

1. Press **ON/OFF** key to power up the ***MiniTest 405***.
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

6.3 Scan Mode

While the ***MiniTest 405*** excels at making single point measurements, it is sometimes desirable to examine a larger region, searching for the thinnest point. The ***MiniTest 405*** includes a feature, called Scan Mode, which allows it to do just that.In normal operation, the ***MiniTest 405*** performs and displays four measurements every second, which is quite adequate for single measurements. In Scan Mode, however, the tool performs sixteen measurements every second. While the transducer is in contact with the material being measured, the ***MiniTest 405*** 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 ***MiniTest 405*** will display the smallest measurement it found.

When the ***MiniTest 405*** 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 is updated faster than normal which may result in flickering of the values displayed. When the transducer is removed from the material being scanned, the ***MiniTest 405*** will (after a brief pause) display the smallest measurement it found.

6.4 Alarm Mode

The Alarm Mode feature of the ***MiniTest 405*** allows the user to set an audible and visual parameter when taking measurements. If the measurement falls below a nominal value, set by the user, a red light will be illuminated on the front panel of the gauge and the beeper sounded.

This improves the speed and efficiency of the inspection process by eliminating constant viewing of the actual reading displayed. The following procedures outline how to enable and set up this feature:

6.4.1 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** or **DOWN** arrow keys to scroll to **bEEP**.
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.

6.4.2 Alarm

1. Press **ON/OFF** key to power up the ***MiniTest 405***.
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 the **SEND** key to select the desired nominal value and return to **MODE** menu.
8. Press the **MODE** key once again to return to measurement mode.

6.5 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 *MiniTest 405*. With the Differential Mode enabled, the *MiniTest 405* will display the positive or negative difference from an entered nominal value. The following steps outline the procedure for setting up this feature:

1. Press **ON/OFF** key to power up.
2. Press the **MODE** key to activate features and settings.
3. Press **UP** or **DOWN** arrow keys to scroll to **dIFF**.
4. Press the **SEND** key to toggle the staus of the differential mode on/off.
5. **Status ON** - A nominal value will be displayed with the units IN/MM flashing.
6. Press **UP** or **DOWN** arrow keys to scroll to the desired nominal thickness value.
7. Press the **SEND** key to select the desired nominal value and return to mode menu.
8. Press the **MODE** key once again to return to measurement mode.

7. RS232 and Data Logger

MiniTest 405 is equiped with a serial port RS232. By means of the interface cable (available as an option) you can connect MiniTest 405 to a computer or to an external data printer. For connecting to a computer or to a data printer and for transmitting readings please proceed as follows:

Print-out a file: An individual file can be printed out on a serial printer or be transmitted to a computer.

1. First refer to section „Connect to a computer“. Note: **Baud rate 1200 (for protocol print-out)**
2. Press **ON/OFF** key to power up.
3. **Press MEM** key to activate features and settings.
4. **Press SEND** key to go to file set-up.
5. Use **UP or DOWN arrow keys** to scroll to the file to be printed out (F-01, F-05).

6. Press **SEND** key once again to select the file to be printed out. On display the symbol **FILE/F-05** (the selected file) flashes.

7. Press **UP / DOWN arrow keys** to go to the flashing symbol **Prnt/F-05** (selected filei) or **LISt** symbol (data printer).

7.1 Connecting to a computer

1. Connect the accessory cable to the 2 pin jack located on the bottom of the ***MiniTest 405***, 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 (e.g. MSoft 3. 7000).

3. Parameter setting in MSoft 7000

Manually:	
Data Bits:	8
Parity:	None
Stop Bits:	1
Baud Rate:	1200 (for protocol print-out) or 9600 for transmission of the data file

4. Note: A protocol print-out can be transmitted to the MSoft 7000 software or to a serial printer (8.5" x 1" paper).

5. In MSoft 7000 adjust the **COM** Port to the port number to which MiniTest 405 is connected - Com1, Com 2, etc.

6. Proceed as in section „Using the Data Logger“.

7. Note: The readings transferred to the MSoft 7000 software can be saved under a text file which can be imported into a spread sheet program such as Excel™, StarOffice Calc™, Lotus 1-2-3 ™ etc. for further documentation.

7.2 Using the Data Logger

The ***MiniTest 405*** 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 ***MiniTest 405*** can then be connected to a computer or serial printer to save and print the results of the inspection.

The *MiniTest 405* has a storage capacity of 1000 measurements. The *MiniTest 405* 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.

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 diplayed (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.

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.

Note:

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

9. Repeat **step 8** as required.

7.2.1 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 Logger** 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.

7.2.2 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.
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.

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.

7.2.3. Clearing all Files

1. Press the **ON/OFF** key to power up.
2. Immediately press the **CLR** key. CLr? Will be displayed.
3. Press the **CLR** key once again to clear all files.

7.2.4 Sendig 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**, before proceeding.
2. Press the **ON/OFF** key to power up the ***MiniTest 405***.
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.

7.2.5 Printing a File

The user may wish to print an individual file to a serial printer or computer. Please proceed as follows:

1. First refer to the sections 7 (Serial Port RS232 and Data Logger and Connecting to a computer)
2. Press the **ON/OFF** key to power up the ***MiniTest 405***.
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.
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.

8. Transducer Selection

The ***MiniTest 405*** 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 ***MiniTest 405***. 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 „1/2-inch“ transducer will emit a stronger signal than a „1/4-inch“ transducer.

· Absorption and Scattering

As ultrasound travels through any material, it is partly absorbed. If the material through which it travels has any grain structure, the sound waves will also experience scattering. Both of these effects reduce the strength of the waves, and thus, the ***MiniTest 405***'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. Thus, a higher frequency transducer would be a better choice for detecting the exact location of small pits or flaws in the material being measured.

· 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 wearface. Measuring on a curved surface, such as an engine cylinder wall, 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, high temperature transducers must be used. These transducers are built using special materials and techniques that allow them to withstand high temperatures without damage. Additionally, care must be taken when performing a „Probe Zero" or „Calibration to Known Thickness" with a high temperature transducer. See Section **„Application Notes"** for more information on measuring materials with a high temperature transducer.

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. ElektroPhysik can provide assistance in choosing a transducer, and offers a broad selection of transducers for evaluation in specialized applications.

9. Product Specifications

Product Specifications	
Weight of Gauge:	284 g / 10 ounces
Size of Gauge (W x H x D):	64 mm x 121 mm x 32 mm / 2.5 x 4.75 x 1.25"
Operating Temperature:	-20 to 50 °C (-20 to 120 °F)
Case:	Extruded aluminum body / nickel plated aluminum end caps.
Keypad:	Sealed mebrane, resistant to water and petroleum products.
Power Source:	2 x "AA", 1.5 Volt alcaline cells (typical operting time: 200 hours) or 2 x 1.2 Volt NiCad cells (typical operating time: 120 hours)
Display:	Liquid-Crystal-Display, 4.5-igits, 1.27cm / 0,500" high numerals, LED-backlight
Measuring Range:	0.63 to 500 mm (0.025 to 19.999")
Resolution:	0.01 mm (0.001")
Accuracy:	± 0.01 mm (0.001"), depends on material and conditions
Sound Velocity Range:	1250 to 10.000 m/s (0.0492 to 0.3930 in/µs)

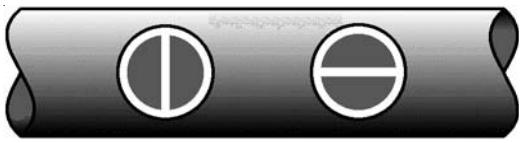
10. Application Notes

10.1 Measuring Pipe and Tubing

When measuring a piece of pipe to determine the thickness of the pipe wall, orientation of the transducers is important. If the diameter of the pipe is larger than approximately 100 mm/ 4 inches, measurements should be made with the transducer oriented so that the gap in the wearface is perpendicular (at right angle) to the long axis of the pipe.

For smaller pipe diameters, two measurements should be performed, one with the wearface gap perpendicular, another with the gap parallel to the long axis of the pipe.

The smaller of the two displayed values should then be taken as the thickness at that point



perpendicular parallel

10.2 Measuring Hot Surfaces

The velocity of sound through a substance is dependant upon its temperature. As materials heat up, the velocity of sound through them decreases. In most applications with surface temperatures less than about 100°C (200°F), 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 section „Calibration“) on a sample piece of known thickness, which is at or near the temperature of the material to be measured. This will allow the ***MiniTest 405*** 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 transducer. These transducers are built using materials which can withstand high temperatures. Even so, 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 itself and through thermal expansion and other effects, may begin to adversely affect the accuracy of measurements.

10.3 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.

11. Sound Velocities

Material		Sound Velocities	
		m/s	in/µs
Aluminum		6350	0,250
Bismuth		2180	0,086
Brass		4400	0,173
Cadmium		2770	0,109
Cast Iron	(approx.)	4570	0,180
Constantan		5230	0,206
Copper		4670	0,184
Epoxy resin	(approx.)	2540	0,100
German silver		4750	0,187
Glass, crown		5660	0,223
Glass, flint		4270	0,168

Material		Sound Velocity	
		m/s	in/µs
Gold		3240	0,128
Ice		3990	0,157
Iron		5890	0,232
Lead		2160	0,085
Magnesium		5800	0,228
Mercury		1450	0,057
Nickel		5630	0,222
Nylon	(approx.)	2590	0,102
Paraffin		2210	0,087
Platinum		3960	0,156
Plexiglass		2690	0,106

Material		Sound Velocity	
		m/s	in/µs
Polystyrene		2340	0,092
Porcelain	(approx.)	5890	0,230
PVC		2395	0,094
Quartz glass		5640	0,222
Rubber, vulcanized		2300	0,091
Silver		3600	0,142
Steel, common		5920	0,233
Steel, stainless		5660	0,223
Stellite	(approx.)	6985	0,275
Teflon		1420	0,056
Tin		3320	0,131

Material		Sound Velocity	
		m/s	in/µs
Titanium		6100	0,240
Tungsten		5330	0,210
Zinc		4190	0,166
Water		1480	0,058

12. After-Sales Service

State-of-the-art methods using high-quality components as well as a quality management system certified to DIN EN ISO 9001 ensure an optimum quality of the gauge.

Should you nevertheless detect an error or malfunction on your gauge, please inform the ElektroPhysik Service responsible for your products, giving the details including a description of the error or malfunction.

If there is anything specific you would like to know about the use, handling, operation or specifications of the gauges, please contact your nearest ElektroPhysik representative, or the following addresses direct:

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