Plug & Test™ Technology

Model 5i

DIGITAL FORCE / TORQUE INDICATOR

User's Guide

Thank you…

Thank you for purchasing a Mark-10 Model 5i digital force / torque indicator, designed for use with interchangeable remote force and torque sensors. A 5i-sensor combination can be used with some Mark-10 test stands grips, and data collection software.

With proper usage, we are confident that you will get many years of great service with this product. Mark-10 instruments are ruggedly built for many years of service in laboratory and industrial environments.

This User's Guide provides setup, safety, and operation instructions. Dimensions and specifications are also provided. For additional information or answers to your questions, please do not hesitate to contact us. Our technical support and engineering teams are eager to assist you.

Before use, each person who is to use a Model 5i indicator should be fully trained in appropriate operation and safety procedures.

TABLE OF CONTENTS

1 OVERVIEW

1.1 List of included items

Qty.	Part No.	Description
1	12-1049	Carrying Case
1	08-1022	AC adapter body with US, EU, or UK prong
1	08-1026	Battery (inside the indicator)
1	-	Certificate of calibration
1	09-1165	USB cable
1	-	Resource CD (USB driver, user's guides, MESUR™ Lite software, MESUR™gauge DEMO software, User's Guide)

1.2 General Overview

From left to right: Model 3i indicator with Series R03 force sensor, and Model 5i indicator with Series R50 torque sensor

The 5i is a universal indicator designed for displaying measurements from interchangeable mark-10 Plug & Test™ sensors. Sensor capacities are available from 0.25 to 10,000 lbF (1 N to 50 kN) of force, and from 10 ozFin to 5,000 lbFin (7 Ncm to 550 Nm) of torque. These sensors can be handheld or mounted to a fixture or test stand for more sophisticated testing requirements.

Plug & Test™ sensors are used with either the 5i or 3i indicator. They may be disconnected from one indicator and connected to another without the need for re-calibration or re-configuration. All such data is saved within a PCB located inside the smart connector.

The model number, serial number, and capacity of the sensor are identified in the rectangular label located on the Plug & Test™ connector. The model and serial numbers are also identified in the **Information** screen of the indicator.

1.3 Accuracy and Resolution

Indicator accuracy must be combined with sensor accuracy to determine the total accuracy of the system. Since sensors may be used with either the 5i or 3i indicator, the accuracy of the indicator being used must be identified and taken into account, as follows:

Indicator Model	Accuracy
5i	±0.1% of full scale ±1 digit
3i	±0.2% of full scale ±1 digit

The addition of "±1 digit" refers to the least significant digit shown on the indicator display. This is equivalent to one increment of resolution. The resolution may be different for some sensors depending on whether a 5i or 3i indicator is being used. For example, a Series R01 force sensor will display finer resolution when connected to a 5i indicator than when connected to a 3i indicator. Resolution information is shown in the sensors' user's guides.

The total system accuracy can be calculated by adding the sensor accuracy, indicator accuracy, and one count of resolution. Refer to the following examples:

Example 1
Model MR01-100 sensor with Model M5i Indicator

MR01-100 ±0.15% of full scale	+	**M5i** ±0.1% of full scale ±1 digit	=	**Total** ±0.25% of full scale ±1 digit

This translates into a fixed error of up to:
0.25% x 100 lbF = 0.25 lbF + 0.05 lbF = 0.30 lbF

Example 2
Model MR50-50Z sensor with Model M3i Indicator

MR50-50Z ±0.35% of full scale	+	**M3i** ±0.2% of full scale ±1 digit	=	**Total** ±0.55% of full scale ±1 digit

This translates into a fixed error of up to:
0.55% x 50 ozFin = 0.275 ozFin + 0.02 ozFin = 0.295 ozFin

Because accuracy is defined as a *percentage of full scale*, the fixed error is possible anywhere on the scale from 0 to the capacity. As such, this value represents an increasingly large error as *percentage of reading* towards the low end of the scale. It is, therefore, recommended that a sensor is selected with capacity as close as possible to the expected load.

1.4 Safety / Proper Usage

Read through the following safety instructions thoroughly before using the 5i with a sensor:

1. Note the sensor's capacity before use and ensure that the capacity is not exceeded. Producing a load greater than the indicated safe overload value can damage the sensor. An overload can occur whether the sensor's indicator is powered on or off.

2. In order to extend the life of the sensor, avoid repetitive shock and impact loading.

3. When moving the sensor to another location, never lift from the cable or strain relief. This can cause damage to the sensor. Always lift the sensor housing itself.

4. Always ensure that load is applied axially with respect to the sensor.

5. Ensure that the sensor is kept away from water or any other electrically conductive liquids at all times.

6. The sensor and indicator should be serviced by a trained technician only. AC power must be disconnected and the indicator must be powered off before the housing is opened.

7. Always consider the characteristics of the sample being tested before initiating a test. A risk assessment should be carried out beforehand to ensure that all safety measures have been addressed and implemented.

8. Typical materials able to be tested include many manufactured items, such as springs, electronic components, fasteners, caps, films, mechanical assemblies, and many others. Items that should not be used with the sensor include potentially flammable substances or products, items that can shatter in an unsafe manner, and any other components that can present an exceedingly hazardous situation when acted upon by a force. Always wear eye and face protection when

testing, especially in aforementioned hazardous cases. Extra bodily protection should be worn if a destructive failure of a test sample is possible.

9. In aforementioned hazardous situations, it is strongly recommended that a machine guarding system be employed to protect the operator and others in the vicinity from shards or debris.

10. Sensors have threaded holes or chucks, designed for the mounting of grips, fixtures, or attachments. If any such accessories are used, ensure they are mounted firmly to prevent a potential safety risk to the operator and others in the vicinity. If using an accessory from a supplier other than Mark-10, ensure that it is constructed of suitably rugged materials and components. Similar precautions should be taken when mounting the sensor to a test stand, work bench, or other piece of equipment.

2 POWER

The 5i is powered either by an 8.4V NiMH rechargeable battery or by an AC adapter. Since these batteries are subject to self discharge, it may be necessary to recharge the unit after a prolonged period of storage. Plug the accompanying charger into the AC outlet and insert the charger plug into the receptacle on the indicator (refer to the illustration below). The battery will fully charge in approximately 8 hours.

Caution!

Do not use chargers or batteries other than supplied or instrument damage may occur.

If the AC adapter is plugged in, an icon appears in the lower left corner of the display, as follows: 

If the AC adapter is not plugged in, battery power drainage is denoted in a five-step process:

1. When battery life is greater than 75%, the following indicator is present: 
2. When battery life is between 50% and 75%, the following indicator is present: 
3. When battery life is between 25% and 50%, the following indicator is present: 
4. When battery life is less than 25%, the following indicator is present: 
5. When battery life drops to approximately 2%, the indicator from step 4 will be flashing. Several minutes after (timing depends on usage and whether the backlight is turned on or off), a message will appear, "BATTERY VOLTAGE TOO LOW. POWERING OFF". A 4-tone audio indicator will sound and the indicator will power off.

The indicator can be configured to automatically power off following a period of inactivity. Refer to the **Other Settings** section for details.

If battery replacement is necessary, the battery may be accessed by loosening the two captive screws in the rear half of the housing and separating the two halves of the housing.

3 MECHANICAL SETUP

3.1 Connecting a sensor

The Plug & Test™ connector must be inserted into the receptacle of the 5i or 3i indicator with the side marked "Plug & Test™ Technology" facing up (see Fig. 3.1). When fully inserted, the connector will lock into place with a "click".

Fig. 3.1
Appropriate orientation of Plug & Test™ connector. Sensor model number, serial number, and load capacity may be found on the labels affixed to the connector.

To release the connector, press both buttons on either side of the indicator housing to release the sensor (see Fig. 3.2). Pull the connector completely out of the indicator by holding the curved aluminum section. **DO NOT** pull on the cable or strain relief.

Fig. 3.2
Press both buttons on either side of the indicator housing to release the Plug & Test™ connector.

3.2 Sensor connector orientation

In order to accommodate a variety of testing requirements, the orientation of the Plug & Test™ connector may be set up in either of the two positions shown below. To change the orientation, loosen the two captive screws on the back side of the housing, separate the two housing halves, rotate one half 180 degrees, and reassemble. Contact between the two halves is made by the spring pins and contact pads on the printed circuit boards.

Sensor connector oriented up

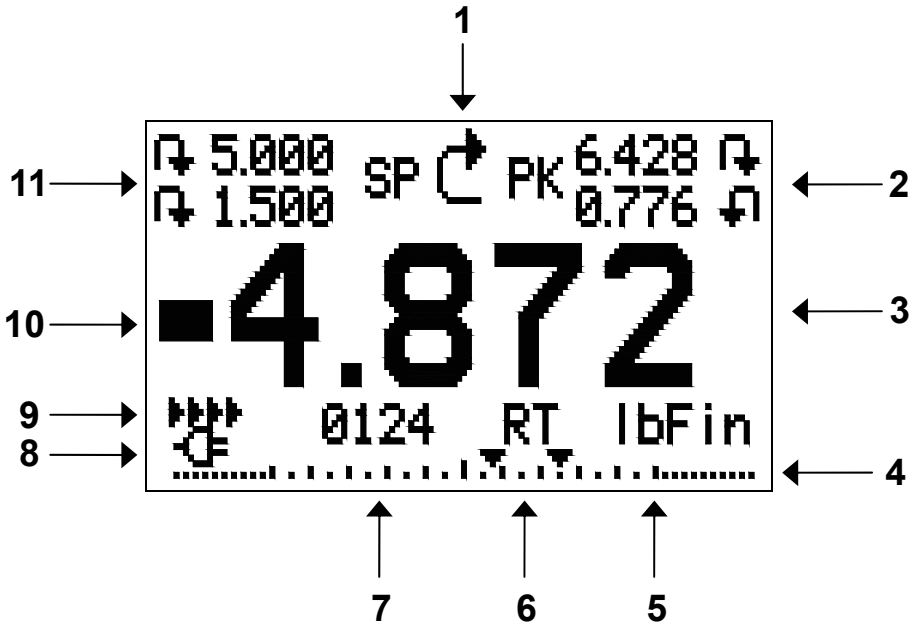
Sensor connector oriented down

3.3 Mounting to a plate

The 5i can be mounted to a plate with four thumb screws fastened into the appropriate holes in the rear half of the housing. Refer to the **Dimensions** section for detailed hole information and locations.

4 HOME SCREEN AND CONTROLS

4.1 Home Screen



No.	Name	Description
1	**Measurement direction indicator**	– indicates compression direction (for force sensors) – indicates tension direction (for force sensors) – indicates clockwise direction (for torque sensors) – indicates counter-clockwise direction (for torque sensors) These indicators are used throughout the display and menu.
2	**Peaks**	The maximum measured compression/tension or clockwise/counter-clockwise readings. These readings are reset by pressing **ZERO** or by powering the indicator off and on.
3	**Primary reading**	The current displayed load reading. See **Operating Modes** section for details. If a sensor is not plugged in, this value will be replaced by a message, as follows: SENSOR NOT CONNECTED
4	**Load bar**	Analog indicator to help identify when an overload condition is imminent. The bar increases either to the right or to the left from the midpoint of the graph. Increasing to the right indicates compression or clockwise load, increasing to the left indicates tension or counter-clockwise load. If set points are enabled, triangular markers are displayed for visual convenience. This indicator reflects the actual load, which may not correspond to the primary reading (depends on operating mode). The **ZERO** key does not reset the load bar. See **Operating Modes** section for details.
5	**Units**	The current measurement unit. Abbreviations are as follows: **Force units:** lbF – Pound-force ozF – Ounce-force kgF – Kilogram-force gF – Gram-force N – Newton kN – Kilonewton mN – Millinewton

		Torque units: lbFft – Pound-foot lbFin – Pound-inch ozFin – Ounce-inch kgFm – Kilogram-meter kgFmm – Kilogram-millimeter gFcm – Gram-centimeter Nm – Newton-meter Ncm – Newton-centimeter Nmm – Newton-millimeter **Note:** not all sensor models display all the above units. Refer to the capacity / resolution table for the respective sensor series for details.
6	**Mode**	The current measurement mode. Abbreviations are as follows: RT – Real Time PC – Peak Compression (for force sensors) PT – Peak Tension (for force sensors) PCW – Peak Clockwise (for torque sensors) PCCW – Peak Counter-clockwise (for torque sensors) A – Average Mode ET – External Trigger Mode See **Operating Modes** section for details about each of these modes
7	**Number of stored data points**	The number of stored data points in memory, up to 1000. Displayed only if **Memory Storage** is enabled for the **DATA** key.
8	**Battery / AC adapter indicator**	Either the AC adapter icon or battery power icon will be shown, depending on power conditions. Refer to the **Power** section for details.
9	**Automatic data output indicator**	If **Auto Output** has been enabled under **Serial / USB Settings**, this indicator is displayed. When automatic data output is occurring, the icon becomes animated. See **Communications** section for details.
10	**High / low limit indicators**	Correspond to the programmed set points. Indicator definitions are as follows: ▲ – the displayed value is greater than the upper load limit ■ – the displayed value is between the load limits ▼ – the displayed value is less than the lower load limit
11	**Set points**	The programmed load limit values. Typically used for pass/fail type testing. One, two, or no indicators may be present, depending on the configuration shown in the **Set Points** menu item.

4.2 Controls

Primary Label	Primary Function	Secondary Label	Secondary Function
⏻	Powers the indicator on and off. Press briefly to power on, press and hold to power off. Active only when the home screen is displayed.	**ENTER**	Various uses, as described in the following sections.
ZERO	Zeroes the primary reading and peaks.	▲ *(UP)*	Navigates up through the menu and sub-menus.
MENU	Enters the main menu.	**ESCAPE**	Reverts one step backwards through the menu hierarchy.
MODE	Toggles between measurement modes.	▼ *(DOWN)*	Navigates down through the menu and sub-menus.
DATA	Stores a value to memory, transmits the current reading to an external device, and/or initiates automatic	**DELETE**	Enables and disables **Delete** mode while viewing stored data.

	data output, depending on setup.		
UNITS	Toggles between measurement units.	**DIRECTION**	Toggles between tension and compression (or clockwise and counter-clockwise) directions while configuring set points and other menu functions.
☀	Turns the LCD backlight on and off.	**N/A**	N/A

4.3 Menu navigation basics

Most of the indicator's various functions and parameters are configured through the main menu. To access the menu press **MENU**. Use the **UP** and **DOWN** keys to scroll through the items. The current selection is denoted with clear text over a dark background. Press **ENTER** to select a menu item, then use **UP** and **DOWN** again to scroll through the sub-menus. Press **ENTER** again to select the sub-menu item.

For parameters that may be either selected or deselected, press **ENTER** to toggle between selecting and deselecting. An asterisk (*) to the left of the parameter label is used to indicate when the parameter has been selected.

For parameters requiring the input of a numerical value, use the **UP** and **DOWN** keys to increment or decrement the value. Press and hold either key to auto-increment at a gradually increasing rate. When the desired value has been reached, press **ENTER** to save the change and revert back to the sub-menu item, or press **ESCAPE** to revert back to the sub-menu item without saving. Press **ESCAPE** to revert one step back in the menu hierarchy until back into normal operating mode.

Refer to the following sections for details about setting up particular functions and parameters.

Note: As described above, the Plug & Test™ smart connector retains all configuration and calibration data for the sensor, which includes menu settings. As such, a sensor must be connected in order for menu changes to be saved with that particular sensor. If a sensor is not connected and the **MENU** key is pressed, it is possible to browse through the menu parameters and make changes, but changes will not be saved.

5 OPERATING MODES

Caution!

In any operating mode, if the capacity of the instrument has been exceeded by more than 110%, the display will show "OVER" to indicate an overload. A continuous audible tone will be sounded until the MENU key has been pressed or the load has been reduced to a safe level.

Five operating modes are possible with the 5i indicator. To cycle between the modes, press **MODE** while in the home screen.

5.1 Real time (RT)

The primary reading corresponds to the live measured reading.

5.2 Peak Compression (PC) / Peak Clockwise (PCW) - *for force / torque sensors, respectively*

The primary reading corresponds to the peak compression or clockwise reading observed. If the actual load decreases from the peak value, the peak will still be retained in the primary reading area of the display. Pressing **ZERO** will reset the value.

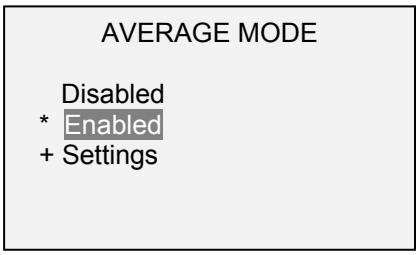
5.3 Peak Tension (PT) / Peak Counter-clockwise (PCCW) – *for force / torque sensors, respectively*

Same as above, but for tension / counter-clockwise readings.

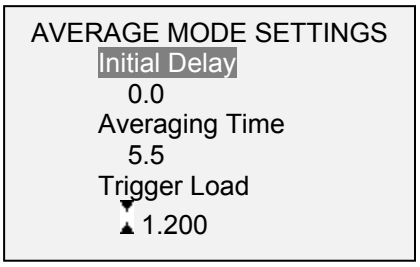
5.4 Average Mode (AVG)

Average mode is used to obtain an average load reading over a specified period of time. Applications include measurement of peel force, bearing torque, muscle strength, frictional force, and other tests requiring time-averaged readings.

Before the parameters of Average Mode can be configured, it must be enabled. To do so, select **Average Mode** from the menu, scroll to **Enable** and press **ENTER**. The display appears as follows:



Then, scroll to **Settings**, and press **ENTER** to configure the parameters. The parameters are as follows:



Parameter	Description
Initial Delay	The time delay, in seconds, before the averaging sequence commences.
Averaging Time	The time duration, in seconds, of the averaging sequence.
Trigger Load	The minimum load required to start the averaging sequence. Toggle between compression and tension (or clockwise and counter-clockwise) directions by pressing the **DIRECTION** key. Initial delay follows the trigger load.

After the parameters have been configured and the menu has been exited, press **MODE** until **AVG** is displayed. Then press **ZERO**. Average mode is now armed, and the averaging sequence will commence when the trigger load has occurred. The current status of the average sequence is displayed below the primary reading, as follows:

Step	Status Abbreviation	Description
1	TRIG WAIT	The trigger load has not yet occurred.
2	INIT DLY	The initial delay is currently taking place.
3	AVERAGING	The indicator is collecting readings. The status will be flashing until averaging has been completed.
4	AVRG DONE	Averaging has been completed. The average load is displayed in the primary reading.

At the completion of the averaging sequence, the peak values are retained until **ZERO** is pressed. Another averaging sequence may be started after **ZERO** has been pressed. To exit Average mode, press **MODE** and select the desired measuring mode.

5.5 External Trigger (ET)

This mode of operation is useful for measuring electrical contact activation load as well as synchronization of multiple instruments for a "snapshot" view of applied loads. It is possible to capture the

reading with a normally open contact (high to low transition of the trigger signal) or a normally closed contact (low to high transition).

Before the parameters of External Trigger Mode can be configured, it must be enabled. To do so, enter the main menu, select **External Trigger**, scroll to one of the four available options and press **ENTER**. The options are as follows:

EXTERNAL TRIGGER

* Disabled
Momentary Hi->Lo
Momentary Lo->Hi
Maintained High
Maintained Low

Option	Description
Momentary High → Low	The display will freeze the captured reading until **ZERO** is pressed. Applies to a high to low transition of the trigger signal.
Momentary Low → High	The display will freeze the captured reading until **ZERO** is pressed. Applies to a low to high transition of the trigger signal.
Maintained High	The display will show the captured reading only for as long as a high signal is maintained.
Maintained Low	The display will show the captured reading only for as long as a low signal is maintained.

After the selection has been made and the menu has been exited, press **MODE** until **ET** is displayed. External Trigger mode is now armed. Refer to the pin diagram in the **Communications** section for connection information.

To exit External Trigger mode, press **MODE** and select the desired measuring mode.

Note: As long as external trigger has been enabled, it is still active even if the indicator is in **Real Time** mode. After the display freezes, any programmed set points will be active. However, if the indicator is in **External Trigger** mode, any programmed set points will be inactive.

6 DIGITAL FILTERS

Digital filters are provided to help smooth out the readings in situations where there is mechanical interference in the work area or test sample. These filters utilize the moving average technique in which consecutive readings are pushed through a buffer and the displayed reading is the average of the buffer contents. By varying the length of the buffer, a variable smoothing effect can be achieved. The selection of 1 will disable the filter since the average of a single value is the value itself.

To access digital filter settings, select **Filters** from the menu. The display will appear as follows:

DIGITAL FILTERS
(1 = Fastest)

Current Reading
1
Displayed Reading
1

Two filters are available:

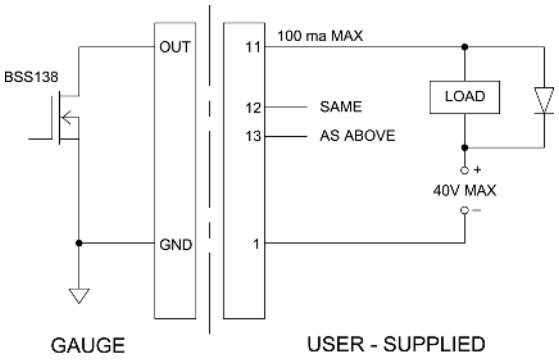
Current Reading – Applies to the peak capture rate of the instrument.

Displayed Reading – Applies to the primary reading on the display.

Available settings: *1,2,4,8,16,32,64,128,256,512,1024.* It is recommended to keep the current reading filter at its lowest value for best performance, and the displayed reading filter at its highest value for best stability.

7 SET POINTS

7.1 General Information



Set points are useful for tolerance checking (pass/fail), triggering an external device such as a motorized test stand, or alarm indication in process control applications. Two limits, high and low, are specified and stored in the non-volatile memory of the instrument and the primary reading is compared to these limits. The results of the comparisons are indicated through the three outputs provided on the 15-pin connector, thus providing "under", "in range", and "over" signaling. These outputs can be connected to indicators, buzzers, or relays as required for the application.

7.2 Configuration

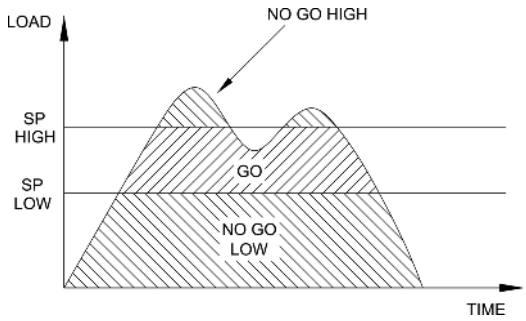
To configure set points, select **Set Points** from the menu. The screen will appear as follows:

SET POINTS
Upper Disabled
* Upper Enabled
5.000
Lower Disabled
* Lower Enabled
3.500

Either one, two, or none of the set points may be enabled. To toggle between the tension and compression (or clockwise and counter-clockwise) directions, press the **DIRECTION** key.

If two set points have been enabled, they are displayed in the upper left corner of the display. If only one set point has been enabled, the word "OFF" will appear in place of the value. If no set points have been enabled, the upper left corner of the display will be blank.

When set points are enabled, the following indicators are shown to the left of the primary reading:



▲ – the displayed value is greater than the upper load limit (NO GO HIGH)

■ – the displayed value is between the limits (GO)

▼ – the displayed value is less than the lower load limit (NO GO LOW)

Set point indicators and outputs reference the displayed reading, not necessarily the current live load.

Interactions with External Trigger Mode
Even if set points have been enabled, they are inactive when the indicator is in **External Trigger** mode.

7.3 Using Set Points to Control Mark-10 Motorized Test Stands

When using set points to stop/cycle a Mark-10 motorized test stand, both set points must be enabled, and each set point must be set to **opposite** measurement directions. For example, if a test requires the test stand to stop at 20 lbFin of clockwise torque, program the upper set point to 20 lbFin clockwise, and the lower set point to a counter-clockwise value such as 10 lbFin, or any other value in the counter-clockwise direction that will not be triggered during the course of the test.

8 DATA MEMORY AND STATISTICS

The 5i has a storage capacity of 1,000 data points. Readings may be stored, viewed, and output to an external device. Individual, or all, data points may be deleted. Statistics are calculated for the data presently in memory.

To enable memory storage, select **DATA Key** from the menu, then scroll to **Memory Storage** and press **ENTER**. Then exit the menu. In the home screen, the data record number **0000** will appear below the primary reading. Press **DATA** at any time to save the displayed reading. The record number will increment each time **DATA** is pressed. If **DATA** is pressed when memory is full the message "MEMORY FULL" will be flashed at the bottom of the display and a double audio tone will be sounded.

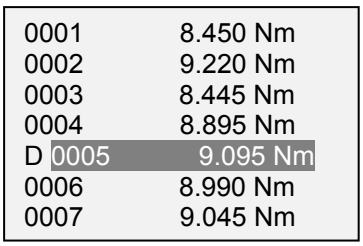
To view, edit, and output stored readings and statistics, select **Memory** from the menu. The screen appears as follows:

MEMORY
View Data
View Statistics
Output Data
Output Statistics
Output Data & Stats
Clear All Data

8.1 View Data

All the saved data points may be viewed. The record number is displayed, along with the corresponding value and presently set unit of measurement. Any readings may be deleted individually. To do so, scroll

to the desired reading and press **DELETE**. The letter "D" will appear to the left of the record number, indicating that the indicator is in **Delete** mode, as follows:



Press **ENTER** to delete the value. To exit **Delete** mode, press **DELETE** again. Any number of readings may be individually deleted, however, all readings may also be cleared simultaneously. Refer to the **Clear All Data** section for details.

8.2 Statistics
Statistical calculations are performed for the saved values. Calculations include number of readings, minimum, maximum, mean, and standard deviation.

8.3 Output Data
Press **ENTER** to output data to an external device. The display will show, "SENDING DATA…", then "DATA SENT". If there was a problem with communication, the display will show, "DATA NOT SENT". Saved data can be downloaded by some Mark-10 data collection programs. Refer to their respective user's guides for details.

8.4 Output Statistics
Press **ENTER** to output statistics to an external device. The display will show, "SENDING STATS…", then "STATS SENT". If there was a problem with communication, the display will show, "STATS NOT SENT".

8.5 Output Data & Stats
Press **ENTER** to output data and statistics to an external device. The display will show, "SENDING DATA", then "SENDING STATS…", then "DATA SENT", then "STATS SENT". If there was a problem with communication, the display will show, "DATA NOT SENT" and/or "STATS NOT SENT".

8.6 Clear All Data
Press **ENTER** to clear all data from the memory. A prompt will be shown, "CLEAR ALL DATA?". Select **Yes** to clear all the data, or **No** to return to the sub-menu.

For output of data and/or statistics, RS-232 or USB output must be enabled. Data formatting is <CR><LF> following each value. Units can be either included or excluded. Output of data via the Mitutoyo output is possible, however, output of statistics is not. Refer to the **Communications** section for details.

Note: Data is not retained while the indicator is powered off.

9 COMMUNICATIONS

Communication with the 5i indicator is achieved through the micro USB or 15-pin serial ports located at the bottom of the instrument, as shown in the illustration in the **Power** section. Communication is possible only when the indicator is in the main operating screen (i.e. not in a menu or configuration area).

9.1 Installing the USB driver

It is recommended that the USB driver be installed before physically connecting the indicator to the PC with a USB cable.

1. Insert the *Resource CD* supplied with the indicator into the CD/DVD drive in the computer. Then, navigate in *Windows Explorer* or *My Computer* to one of the following folders on the CD:

Windows 2000 through Vista - "Win_2K_XP_S2K3_Vista"

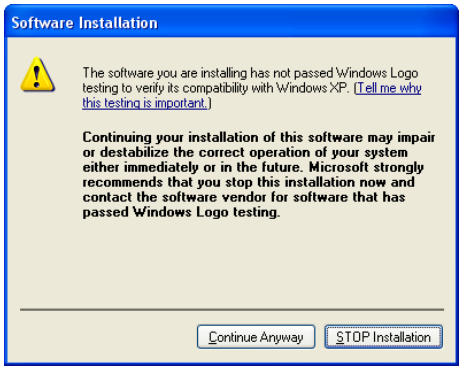
Windows 7 - "Windows_7"

2. Execute the installer application "Mark-10USBInstaller.exe" by double-clicking it. When the program launches, one of the following windows will appear, depending on the operating system:

or

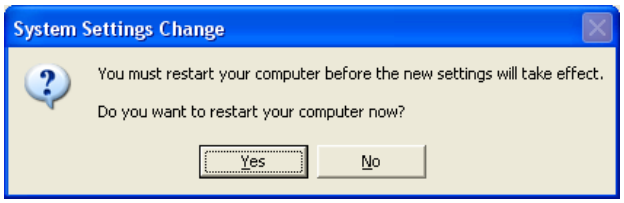
Click "Install".

3. The next screen appears as follows:



Click "Continue Anyway".

4. After installation completes the following screen may appear in non-Windows 7 operating systems.



Restart the computer before connecting a Mark-10 USB device.

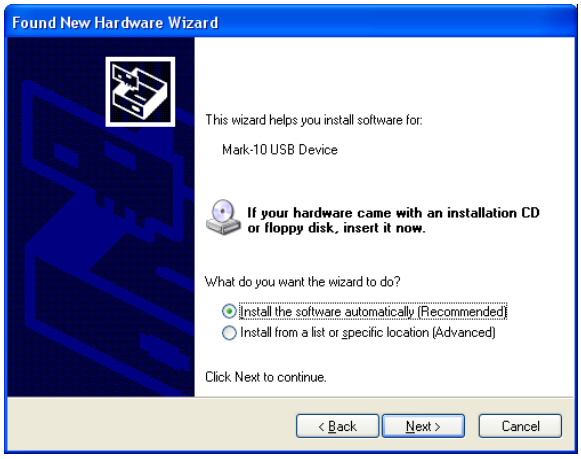
5. After Windows as restarted, plug in the device. The following will occur:

Windows 7 Operating Systems – When the Mark-10 USB device has been plugged into a USB port, the driver will automatically be found. When the driver installation is complete, a message will appear as follows: "The MARK-10 USB DEVICE driver is now installed and ready to use".

Non-Windows 7 Operating Systems – When the Mark-10 USB device has been plugged into a USB port, the following screen appears:

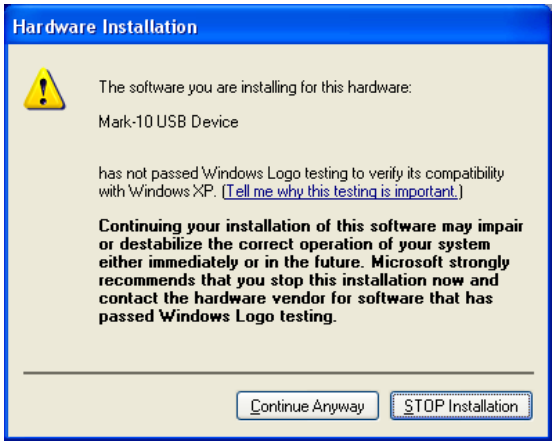
Select "No, not this time", then click "Next".

6. The next screen appears as follows:



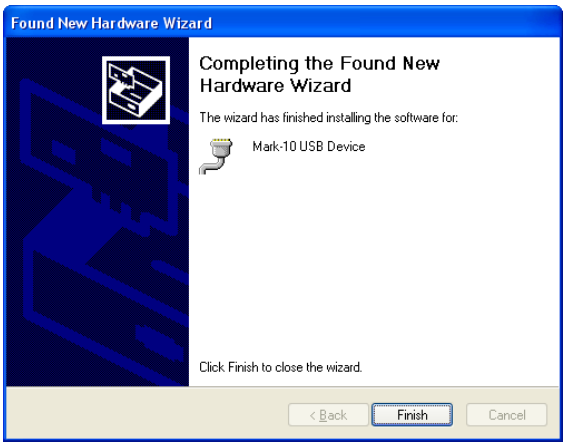
Select "Install the software automatically (Recommended)", then click "Next".

7. The next screen appears as follows:



Click "Continue Anyway".

8. The next, and final, screen appears as follows:



Click "Finish". The Mark-10 USB device is now installed and ready to use. The COM port number assigned by *Windows* may be identified in *Device Manager*, or in the communication application being used, such as *MESURgauge* or *HyperTerminal*.

9.2 Serial / USB

To set up RS-232 and USB communication, select **Serial/USB Settings** from the menu. The screen appears as follows:

```
SERIAL/USB SETTINGS
*   RS232 Selected
    USB Selected
  + Baud Rate
  + Data Format
  + Auto Output
```

Select either RS-232 or USB input (output is always simultaneous through both the USB and RS-232 ports). RS-232 must be selected when communicating through a Mark-10 test stand controller. When communicating from the indicator directly to a PC or data collector, either RS-232 or USB can be selected as required. Configure the baud rate and data format as required for the application. Default values are as follows:

Baud Rate: **9,600**
Data Format: **Numeric + units**
Auto Output: **Disabled**

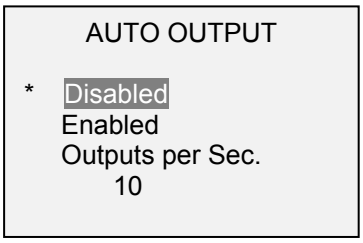
Other communication settings are permanently set to the following:

Data Bits: **8**
Stop Bits: **1**
Parity: **None**

Individual data points may be transmitted by pressing **DATA** or by requesting the appropriate ASCII command from an external device (see **Command Set** sub-section for details).

9.3 Automatic Output

The indicator has the ability to output data continuously and automatically via RS-232 or USB. To enable automatic output, select **Auto Output** from the **Serial/USB Settings** sub-menu. The screen appears as follows:

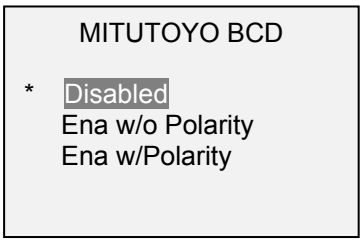


Select **Enabled** to activate automatic output. The number of outputs per second can be set to 1, 2, 5, 10, 25, 50, 125, or 250. The capabilities of the receiving device should be considered when selecting the data output rate.

After the settings have been saved, revert to the home screen. An icon will appear in the lower left corner of the display, as follows: ▶▶▶ This indicates that automatic data output has been armed. Automatic output of data may be initiated by pressing **DATA** or by sending the appropriate ASCII command from an external device (see **Command Set** sub-section for details). The icon will become animated, signaling that automatic output is occurring. Press **DATA** again to end the data transmission.

9.4 Mitutoyo BCD settings

This output is useful for connection to data collectors, printers, multiplexers, or any other device capable of accepting Mitutoyo BCD data. Individual data points may be transmitted by pressing **DATA** or by requesting it from the Mitutoyo communication device (if available). To enable Mitutoyo output, select the desired format – either with polarity or without polarity. The screen appears as follows:

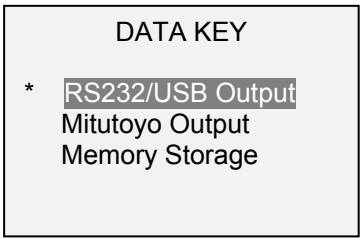


9.5 Analog Output

This output can be used for chart recorders, oscilloscopes, data acquisition systems, or any other compatible devices with analog inputs. The output produces ±1 volt at full scale of the sensor. The polarity of the signal is positive for compression/clockwise and negative for tension/counter-clockwise.

9.6 DATA Key Functions

The **DATA** key can be configured to perform several functions. To configure the **DATA** key, select **DATA Key** from the menu. The display will appear as follows:

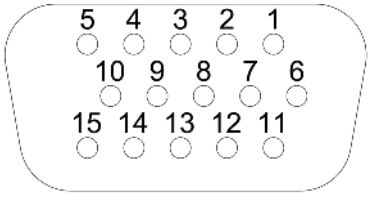


Three options are available:

Selection	Function when pressing DATA
RS232/USB Output	Outputs data via the serial and USB ports
Mitutoyo Output	Outputs data via Mitutoyo (Digimatic) through the serial port
Memory Storage	Stores a reading to memory (refer to the **Memory** section for details)

Any combination of the above functions may be selected.

9.7 I/O Connector Pin Diagram (female)



DB-9HD-15

Pin No.	Description	Input / Output
1	Signal Ground	---
2	Tension/Counter-clockwise Overload	Output
3	RS-232 Receive	Input
4	RS-232 Transmit	Output
5	+12V DC	Output
6	Analog Output	Output
7	Compression/Clockwise Overload	Output
8	Mitutoyo Clock Output Bit 2	Output
9	Mitutoyo Data Output Bit 0	Output
10	Mitutoyo Request Input Bit 3	Input
11	"Under" Set Point	Output
12	"Over" Set Point	Output
13	"Within" Set Point	Output
14	External Trigger	Input
15	Mitutoyo Ready Output Bit 1	Output

9.8 Command Set / Gauge Control Language 2 (GCL2)

The 5i may be controlled by an external device through the RS-232 or USB channel. The following is a list of supported commands and their explanations. All commands must be terminated with a Carriage Return character or with a Carriage Return/Line Feed combination. The indicator responses are always terminated with a Carriage Return/Line Feed.

Request Readings

?	Request the displayed reading (dependant on operating mode)
?C	Request the current (real time) reading
?PT	Request the peak tension reading
?PC	Request the peak compression reading
?CW	Request the peak clockwise reading
?CCW	Request the peak counter-clockwise reading
?ET	Request the reading obtained during the External trigger mode

?A	Request the average reading obtained during the Average mode

Units (available units depend on the sensor used)

LB	Switch unit to pound-force
OZ	Switch unit to ounce-force
KG	Switch unit to kilogram-force
G	Switch unit to gram-force
N	Switch unit to Newton
MN	Switch unit to milli-Newton
KN	Switch unit to kilo-Newton
LBFT	Switch unit to pound-foot
LBIN	Switch unit to pound-inch
OZIN	Switch unit to ounce-inch
KGM	Switch unit to kilogram-meter
KGMM	Switch unit to kilogram-millimeter
GCM	Switch unit to gram-centimeter
NM	Switch unit to Newton-meter
NCM	Switch unit to Newton-centimeter
NMM	Switch unit to Newton-millimeter

Basic Functions (available measurement directions depend on the sensor used)

CUR	Current mode (real time mode) for primary reading
PT	Peak Tension mode for primary reading
PC	Peak Compression mode for primary reading
PCW	Peak Clockwise mode for primary reading
PCCW	Peak Counter-clockwise mode for primary reading
CLR	Clear peaks
Z	Zero display and perform the CLR function

Filters

FLTCn	Digital filter for displayed readings
FLTPn	Digital filter for current readings n= 0-10, filter = 2^n, ex: n=0= no filter, n=10=1024 samples averaged

Memory & Statistics

MEM	Transmit all stored readings
STA	Transmit statistics

Set Points

SPHD	Disable high set point
SPLD	Disable low set point
SPHn	High set point. n=value (+ for compression, - for tension)
SPLn	Low set point. n=value (+ for compression, - for tension) **Note:** High set point value must be greater than low set point value if both values are set to the same polarity.

USB/RS-232 Communication

FULL	USB/RS-232 transmission with units
NUM	USB/RS-232 transmission without units (only numeric values)
AOUTn	Auto-transmit n times per second n=1,2,5,10,25,50,125,250. 0=disabled **Note:** n = 1 = yields 50 times per second. This is provided for backward compatibility with the legacy indicator model BGI.

Mitutoyo Communication

MIT	Enable Mitutoyo output
MITD	Disable Mitutoyo output

POL	Mitutoyo output with polarity (+ for compression, - for tension)
NPOL	Mitutoyo output without polarity (absolute value)
PM	Print/send data to a Mitutoyo-compatible device

Averaging

A	Enable Average mode
AD	Disable Average mode
AM	Select Average mode (if enabled) for primary reading
ATn	Average time. n=0.1-300.0 seconds
DELn	Initial delay. n=0.1-300.0 seconds
TRFn	Trigger force. n=value (+ for compression/clockwise, - for tension/counter-clockwise)

External Trigger

ETH	Enable high level-triggered External trigger mode
ETL	Enable low level-triggered External trigger mode
ETHL	Enable reading captured on a high to low transition
ETLH	Enable reading captured on a low to high transition
ETD	Disable External trigger mode

Input / Output Bits

Sn	Set output bit (open drain, pull to ground). n=0,1,2
Cn	Clear output bit. n=0,1,2
Rn	Read current status of output bit or level of input pin. n=0,1,2,3

Personality

RN	Read product name
RM	Read model number
RV	Read firmware version number
RS	Read serial number

Other Commands

AOFFn	Auto-shutoff. n=0-30 minutes. 0=auto shutoff disabled
SAVE	Save current settings in nonvolatile memory
LIST	List current settings and status

Following is an example LIST output: V1.00;LBF;CUR;FLTC8;FLTP1;AOUT00;AOFF5;FULL;MIT;POL;B0

All fields are separated by ";". The first field shows the firmware version, the last field shows the remaining battery power (B0=full charge, B3=minimum power). All other fields show the status of settings and features using the same abbreviations as the commands to set them.

Any detected errors are reported back by means of the following error codes:

*10	Illegal command
*11	Not applicable
*12	Invalid specifier
*22	Value too large

10 CALIBRATION

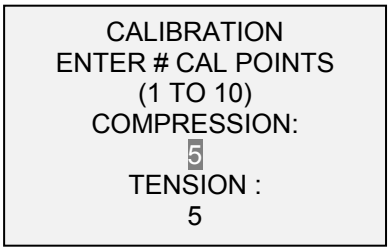
10.1 Initial Physical Setup

The sensor should be mounted vertically to a test stand or fixture rugged enough to withstand a load equal to the full capacity of the sensor. Certified deadweights, torque arms/wheels, and/or master load cells should be used, along with appropriate mounting brackets and fixtures. Caution should be taken while handling such equipment.

10.2 Calibration Procedure

In the interests of simplicity and brevity, the following instructions use force terminology only. Such wording is displayed only when a force sensor is being calibrated. When a torque sensor is being calibrated, the terms **COMPRESSION** and **TENSION** are replaced by **CLOCKWISE** and **COUNTER-CLOCKWISE**, respectively.

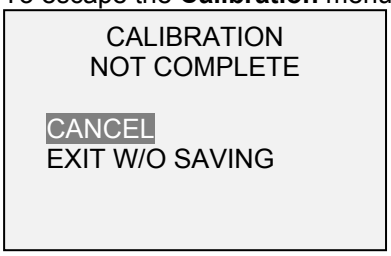
1. Select **Calibration** from the menu. The display will appear as follows:



   The sensor can be calibrated at up to 10 points in each direction. Enter the number of calibration points for each direction (compression and tension or clockwise and counter-clockwise). At least one point must be selected for each direction.

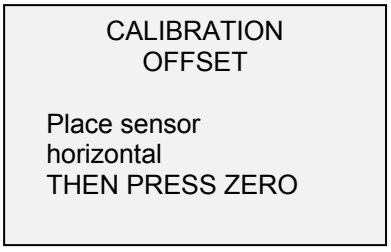
   Note: To achieve the accuracy specification of ±0.1% ±1 digit + sensor, it is recommended to calibrate the sensor at 5 or more even increments in both the tension and compression directions. For example, a sensor with capacity of 10 lbF should be calibrated at 2, 4, 6, 8, and 10 lb loads in each direction.

2. To escape the **Calibration** menu at any time, press **ESCAPE**. The display will appear as follows:



   Selecting "CANCEL" will revert back to the Calibration setup. Selecting "EXIT W/O SAVING" will return to the menu without saving changes.

3. After the number of calibration points has been entered, press **ENTER**. The display will appear as follows:



4. Place the sensor horizontally on a level surface free from vibration, then press **ZERO**. The indicator will calculate offsets, and the display will appear as follows:

```
CALIBRATION
OFFSET

Please wait…
```

```
CALIBRATION
OFFSET

Sen.Offset Adj.Passed
Ana.Offset Adj.Passed
```

If failed:

```
CALIBRATION
OFFSET

Sen.Offset Adj.Failed
Ana.Offset Adj.Failed
```

5. The following screen appears after the offsets have been calculated:

```
CALIBRATION
COMPRESSION

Attach necessary
weight fixtures.

THEN PRESS ENTER
```

Attach weight fixtures (brackets, hooks, etc), as required. Do not yet attach any weights or apply any calibration loads. Then press **ENTER**.

6. The display will appear as follows:

```
CALIBRATION
COMPRESSION

Optionally exercise
load cell a few times.

THEN PRESS ENTER
```

Optionally exercise the sensor several times (at full scale, if possible), then press **ENTER**.

7. The display will appear as follows:

```
CALIBRATION
COMPRESSION
GAIN ADJUST
APPLY FULL SCALE LOAD
10.000 LBF +/-20%
THEN PRESS ENTER
```

Apply a weight equal to the full scale of the instrument, then press **ENTER**.

8. After displaying "PLEASE WAIT…" the display will appear as follows:

CALIBRATION COMPRESSION ENSURE NO LOAD THEN PRESS ZERO

Remove the load applied in Step 8, leave the fixtures in place, then press **ZERO**.

9. The display will appear as follows:

CALIBRATION COMPRESSION APPLY LOAD 1 OF 5 ENTER LOAD: 2.000 LBF THEN PRESS ENTER

Use the **UP** and **DOWN** keys to adjust the load value as required. The load values default to even increments, as indicated by the previously entered number of data points (even increments are recommended for best results). For example, if a 50 lbF capacity sensor is calibrated, and 5 data points were selected, the load values will default to 10, 20, 30, 40, and 50 lb. Apply the calibration load. Then press **ENTER**.

Repeat the above step for the number of data points selected.

10. After all the compression calibration points have been completed, the display will appear as follows:

CALIBRATION COMPRESSION COMPLETE REVERSE DIRECTION FOR TENSION Attach necessary weight fixtures. THEN PRESS ENTER

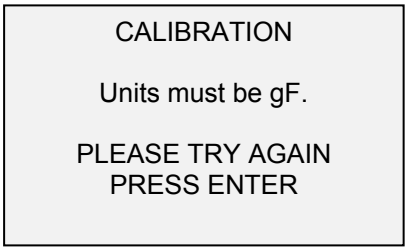
Press **ENTER**.

11. At the completion of the tension calibration, the display will appear as follows:

CALIBRATION COMPLETE SAVE & EXIT EXIT W/O SAVING

To save the calibration information, select "SAVE & EXIT". To exit without saving the data select "EXIT W/O SAVING".

12. Any errors are reported by the following screens:



Displayed at the start of calibration if a disallowed unit is selected.

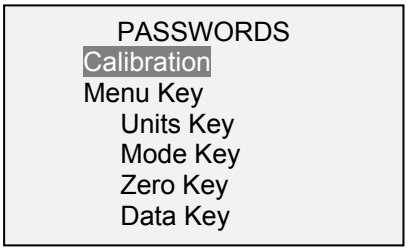
Ensure that the load is not swinging, oscillating, or vibrating in any manner. Then try again.

The calibration weight does not match the set value.

The entered calibration point is too close to the previous point.

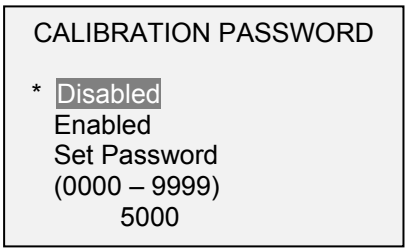
11 PASSWORDS

Two separate passwords may be set to control access to the Calibration section and to the menu and other keys. To access the passwords setup screen, select **Passwords** from the menu. The display will appear as follows:



11.1 Calibration Password

Select **Calibration** from the sub-menu. The display will appear as follows:



To set the password, select **Enabled** , then **Set Password**. Use the **UP** and **DOWN** keys to increment and decrement the value, from 0 to 9999. When the desired value has been selected, press **ENTER**, then **ESC** to exit the sub-menu.

11.2 Menu Key Password

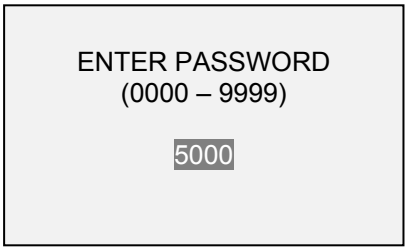
If enabled, every time the **MENU** key is selected, a password must be provided. Select **Menu Key** from the sub-menu. Follow the same procedure as described in section 10.1.

11.3 Locking Out Other Keys

Other keys may be locked out individually. Select any combination of keys (**UNITS**, **MODE**, **ZERO**, **DATA**) by pressing **ENTER** in the **Passwords** sub-menu. Pressing a locked key will prompt the message "KEY PROTECTED" and then revert to the previous screen.

11.4 Password Prompts

If passwords have been enabled, the following will be displayed when pressing the **MENU** key or accessing the **Calibration** section:



Use the **UP** and **DOWN** keys to select the correct password, then press **ENTER** to continue.

If the incorrect password has been entered, the display will appear as follows:

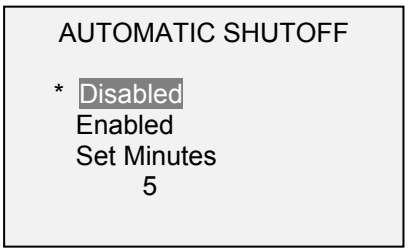
To re-enter the password, press ESC to exit to the home screen. Then, access the desired function and enter the password again when prompted.

If the password has been misplaced, it can be reset. Press **ENTER** to generate a *request code*. The *request code* must be supplied to Mark-10 or a distributor, who will then provide a corresponding *authorization code*. Enter the *activation code* to disable the password.

12 OTHER SETTINGS

12.1 Automatic Shutoff

The indicator may be configured to automatically power off following a period of inactivity while on battery power. Inactivity is defined as the absence of any key presses or load changes of 100 counts or less. To access these settings, select **Automatic Shutoff** from the menu. The display will appear as follows:

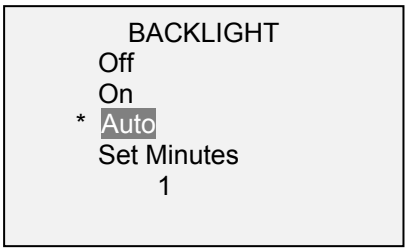


Select **Disabled** to disable automatic shutoff. Select **Enabled** to enable it. The length of time of inactivity is programmed in minutes via the **Set Minutes** parameter. Available settings: 5-30, in 5 minute increments.

Note: If the AC adapter is plugged in, the indicator will ignore these settings and remain powered on until the **POWER** key is pressed.

12.2 Backlight

Although the backlight may be turned on and off at any time by pressing the **BACKLIGHT** key, there are several available initial settings (applicable upon powering on the indicator). To access these settings, select **Backlight** from the menu. The display will appear as follows:



Select **Off** for the backlight to be off upon powering on the indicator.

Select **On** for the backlight to be on upon powering on the indicator.

Select **Auto** for the backlight to be on upon powering indicator, but will shut off after a period of inactivity (as defined in the **Automatic Shutoff** sub-section). The backlight will turn on again when activity resumes. The length of time of inactivity is programmed in minutes via the **Set Minutes** parameter. Available settings: *1-10*, in 1 minute increments.

Note: If the AC adapter is plugged in, the indicator will ignore these settings and keep the backlight on, unless the **BACKLIGHT** key is pressed. Selecting the **On** or **Off** setting in the **Backlight** menu will manually turn the backlight on or off as if the Backlight button were pressed.

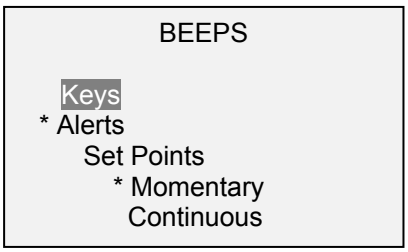
12.3 LCD Contrast

The contrast of the display may be adjusted. Select **LCD Contrast** from the menu. The screen will appear as follows:

Press **ENTER** to modify the contrast. Select a value from 0 to 25, 25 producing the most contrast.

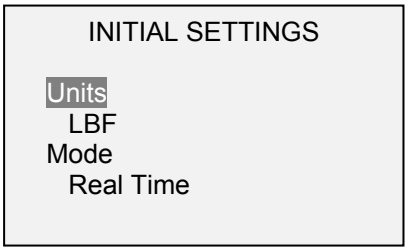
12.4 Beeps

Audible tones can be enabled for all key presses and alerts, such as overload, set point value reached, etc. The Set Point alert can be configured to be either a momentary tone or a continuous tone (until the load is restored to a value between the set points). To configure the functions for which audible tones will apply, select **Beeps** from the menu. The screen will appear as follows:



12.5 Initial settings

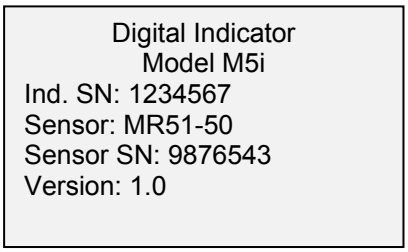
This section is used to configure the initial settings upon powering on the indicator. The initial units of measurement and the primary reading measurement mode may be configured. To access these settings, select **Initial Settings** from the menu. The screen will appear as follows:



The default unit of measure depends on the sensor series. The default mode is Real Time, regardless of sensor.

12.6 Information / Welcome Screen

The following screen is displayed at power up and can be accessed at any time by selecting **Information** from the menu:



13 SPECIFICATIONS

13.1 General

Accuracy:	±0.1% of full scale ±1 digit + sensor
Sampling rate:	7,000 Hz
Power:	AC or rechargeable battery. Low battery indicator appears when battery level is low, and indicator powers off automatically when power reaches critical stage.
Battery life:	**Backlight on:** up to 7 hours of continuous use **Backlight off:** up to 24 hours of continuous use
Measurement units:	lbF, ozF, gF, kgF, N, kN, mN, lbFft, lbFin, ozFin, kgFm, kgFmm, gFcm, Nm, Ncm, Nmm (depending on sensor)
Outputs:	**USB / RS-232:** Fully configurable up to 115,200 baud. Includes Gauge Control Language 2 for full computer control. **Mitutoyo (Digimatic):** Serial BCD suitable for all Mitutoyo SPC-compatible devices. **Analog:** ±1 VCD, ±0.25% of full scale at capacity, **General purpose:** Three open drain outputs, one input. **Set points:** Three open drain lines.
Configurable settings:	Digital filters, outputs, automatic output (via USB/RS-232), automatic shutoff, default settings, averaging mode, external trigger, passwords, key tones, audio alarms, backlight, calibration
Weight:	0.7 lb [0.3 kg]
Included accessories:	Carrying case, AC adapter, battery, USB cable, resource CD (USB driver, MESUR™ Lite software, MESUR™gauge DEMO software, and user's guide), NIST-traceable certificate of calibration
Warranty:	3 years (see individual statement for further details)

13.2 Factory Settings

Parameter	Setting
Set points	
Upper	Disabled (defaults to 80% of full scale, compression, when enabled)
Lower	Disabled (defaults to 40% of full scale, compression, when enabled)
Filters	
Current	8
Displayed	1024
Average mode	Disabled
Initial Delay	0
Trigger Force / Torque	10% of full scale
Averaging Time (sec.)	5.0
External Trigger	Disabled
DATA Key Functions	
RS-232/USB Output	Enabled
Mitutoyo Output	Disabled
Memory Storage	Enabled
Backlight	Auto
Minutes	1
Serial/USB	
RS-232 Output Selected	Enabled
USB Output Selected	Disabled
Baud Rate	9,600
Data Format	Numeric + units
Auto Output	Disabled
Outputs per Sec.	125
Mitutoyo BCD Output	Disabled
Automatic Shutoff	Enabled
Minutes	5
Beeps	
Keys	Enabled
Alerts	Enabled
Set Points	Momentary
LCD Contrast	10
Initial Settings	
Units	Depends on sensor
Mode	Real Time
Passwords	All passwords disabled