

IPM650 Product Manual



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1 Receiving & Unpacking

1.1 Unpacking

Check all parts to ensure no damage occurred during transit. If you suspect that your product is damaged, contact FUTEK at futek@futek.com for immediate support.

1.2 Storage

If the device is to be stored for a prolonged period, take the following safety precautions:

- The storage temperature should be between 0°C and +70°C (32°F to 158°F)
- Store in a dry environment
- If possible, store the instrument in its original packaging when not in use

1.3 Accessories Supplied

- Power supply adapter
- 8 pin connector plug
- 6 pin connector plug
- 4 pin connector plug (2)
- Bumpons (4)

Caution

FUTEK is not responsible for any damage or injury caused by misuse, misunderstanding, or abuse of this product.

2 Safety Considerations & Care for Your Device

- Do not disassemble for modifications or repair
- Make sure to disconnect the power adapter and turn the device off when connecting or disconnecting any of the connectors
- Do not operate the device in the following environments:
 - Direct sunlight
 - Where the product will be splashed with water, oil, and chemicals
- Do not throw, drop, or scratch with any sharp objects

3 Important Information for IPM650

3.1 Performance

The IPM650 is a microcontroller based digital panel meter that monitors the activity of a vast range of sensors. This includes Wheatstone bridge strain gauge and amplified output Torque/ Force/ Pressure/ Displacement sensors. All of the measurements are based on a high accuracy, low noise, 24 bit resolution, Analog to Digital Converter with a non-linearity of 0.001%, and a temperature coefficient factor of less than 5 PPM (zero and span drift). All analog components, not only the ones that provide the requirements for ADC, such as reference voltage, but also the ones which are employed for analog output, excitation voltage, and input/output buffers are low noise, low distortion, low temperature coefficient, and high precision/accuracy parts. The combination of these components, along with a high speed micro-controller integrated with a precision DAC controller has provided a high accuracy instrument, which is able to measure the activity of a 2 mV/V sensor with up to a 500,000 count (total) noise free base! The high precision DAC controller has been exploited to provide a ± 5 V output with 100 μ V resolution and/or (0-25mA) current output with a 0.5 μ A resolution. A wide range of bridge resistances and input/output impedances of external instruments can be applied to this device without any lack of performance.

The IPM650 accepts amplified voltage input (± 12 VDC), current input (up to 30 mA), and bridge input (up to 500 mV/V), and has the capability to provide power to FUTEK rotary torque sensors (24 VDC/ 1 W and 5 VDC/ 0.05 W).

3.2 Product Introduction

- TEDS IEEE 1451.4 compliant with template 30 for High level voltage output sensors and template 33 for bridge sensors
- Ability to interact with TEDS data by using the SENSIT Test and Measurement software.
- Selectable calibration method
 - Live calibration: Applying an actual load
 - Manipulating method: Entering the sensitivity
- Ability to measure bridge resistance
- Automated sensitivity calculation based on calibration value
- Dual scaling calculation for bi-directional sensors
- Selectable units of measure for Force, Torque, Pressure, and Displacement with automatic conversion of units between readings
- Selectable sampling rate from 5 samples per second to an ultra-fast signal sampling rate of 4800 samples per second with 16 different speeds
- Selectable moving average method for software filtering
- Peak/ Valley and First Peak/ First Valley functions
- Manual and auto peak/valley reset functions
- Tare/ Gross functions with indicator
- Tracking/Hold functions with indicator

- Built-in shunt calibration features with indicator
- Lockout feature to prevent inadvertent changes
- Data logging with up to 21,000 points
- Supports USB link port
- Built-in load cell excitation voltage
- Selectable automatic display shutoff for period of inactivity (up to 15 minutes)
- Selectable latched or non-latched alarm configuration
- ASCII Stream Output.
- Two independently isolated solid state alarm relays, each one able to be disabled or enabled individually, with normally open or closed operations and protected at 110mA/110V
- Selectable voltage output as bipolar (± 5 V) or uni-polar (0-5 V) with 2.5V offset
- Selectable current output as bidirectional and unidirectional
- Selectable 0-20mA, 0-25mA, 4-20mA, 5-25mA current output
- Selectable alarm configuration (Latched or non-Latched)
- Provides a +5.000 V (± 1 mV) excitation voltage to bridge resistances as low as 30 Ohms and as high as 30k Ohms with a limited current to 160 mA
- Default channel calibrated to 0-4 mV/V using precision BLH
- Back lit 4x16 character LCD with selectable brightness, contrast, and auto shut off
- Selectable digit height size (4.75 mm and 12.55 mm)
- Selectable number of digits to be displayed, excluding the decimal point (3, 4, 5, or 6)
- Equipped with the diagnostic mode to measure bridge resistance, sensitivity, internal voltage (Analog and digital), and temperature
- User friendly navigation menu directs users to enable/disable or select/unselect various features with easy to follow instructions
- Ability to store 14+1 sensor profiles including calibration values such as Offset, Full scale, Loading point(s), Engineering unit, Serial number, Sensor type (Bridge, Voltage, Current), Sensitivity, Alarm limits (High and Low), and all Peak/ Valley (First, Hold, Auto reset) Threshold values
- Active channel number indicator
- Black powder coated aluminum enclosure
- Lead free/ RoHS compliant parts
- ESD, EMI, EFT and short circuit protected input and output, which covers the CE approval

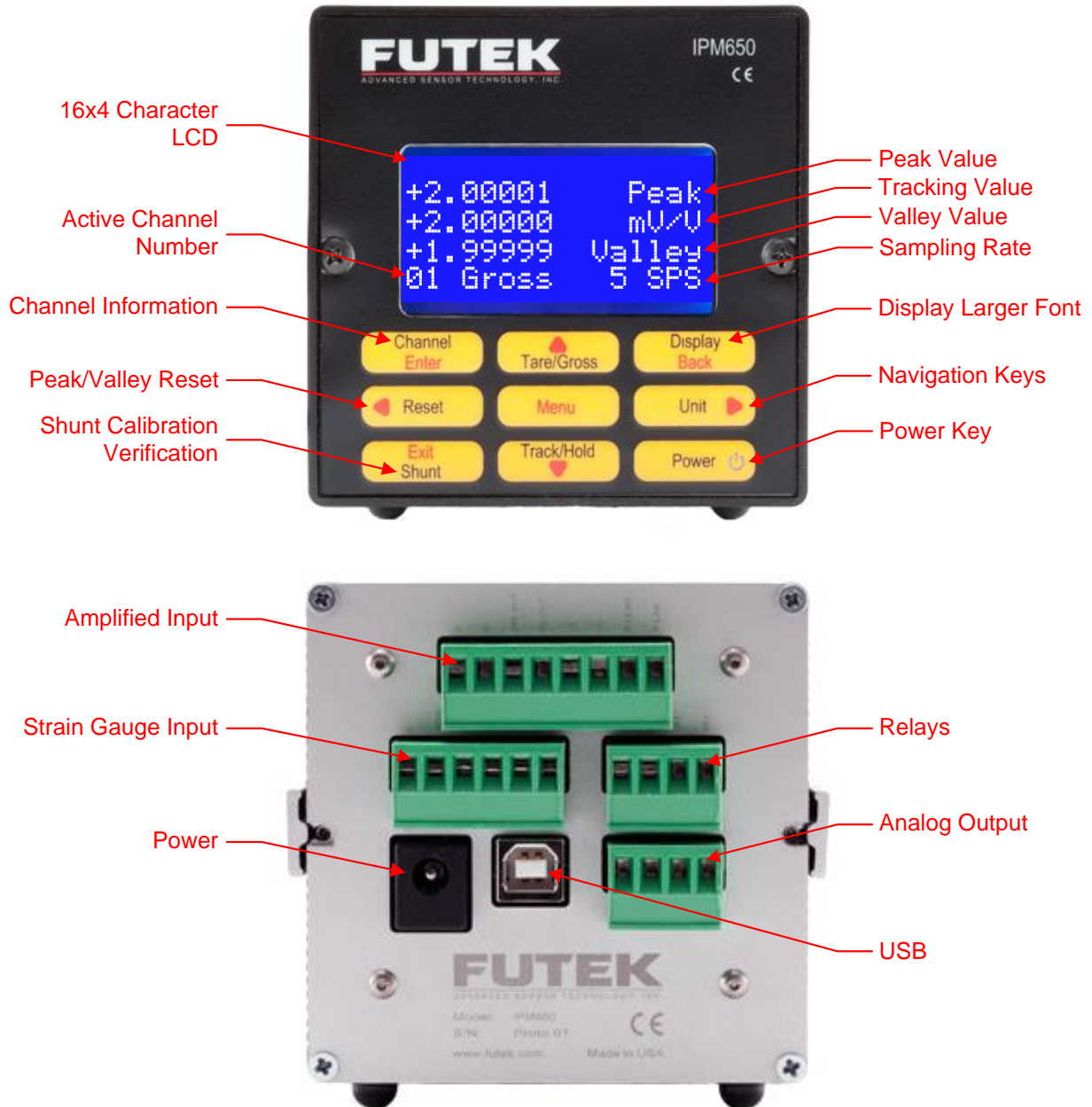
4 Connector & Wiring Diagram

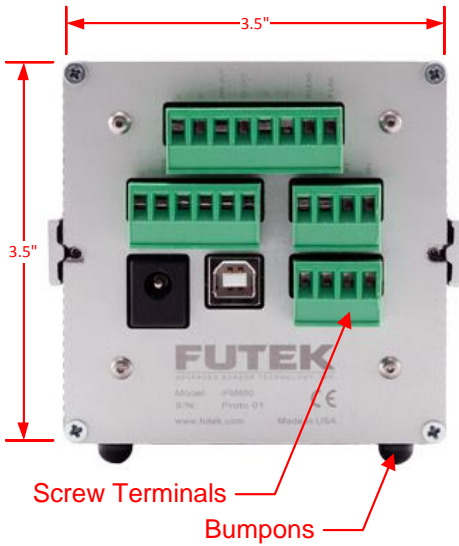





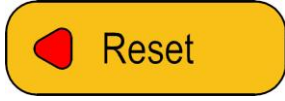





Connectors	Description			Diagram
Amplified Input	<u>Pin</u>	<u>Symbol</u>	<u>Description</u>	
	1	G	Ground	
	2	G	Ground	
	3	24V OUT	24VDC Output	
	4	5V OUT	5VDC Output	
	5	-V	-V from sensor	
	6	+V	+V from sensor	
	7	PLEAD	n/a	
8	PLAG	n/a		
Strain Gauge Input	<u>Pin</u>	<u>Symbol</u>	<u>Description</u>	
	1	G	Ground	
	2	TEDS	TEDS Data	
	3	-S	-Signal	
	4	+S	+Signal	
	5	-E	-Excitation	
Relays	<u>Pin</u>	<u>Symbol</u>	<u>Description</u>	
	1	-R2	Solid state relay 2	
	2	+R2	Solid state relay 2	
	3	-R1	Solid state relay 1	
Analog Output	<u>Pin</u>	<u>Symbol</u>	<u>Description</u>	
	1	-VOUT	Voltage output (-)	
	2	+VOUT	Voltage output (-)	
	3	G	Ground (current)	
	4	IOUT	Current output	

5 Features

5.1 IPM650 Overview





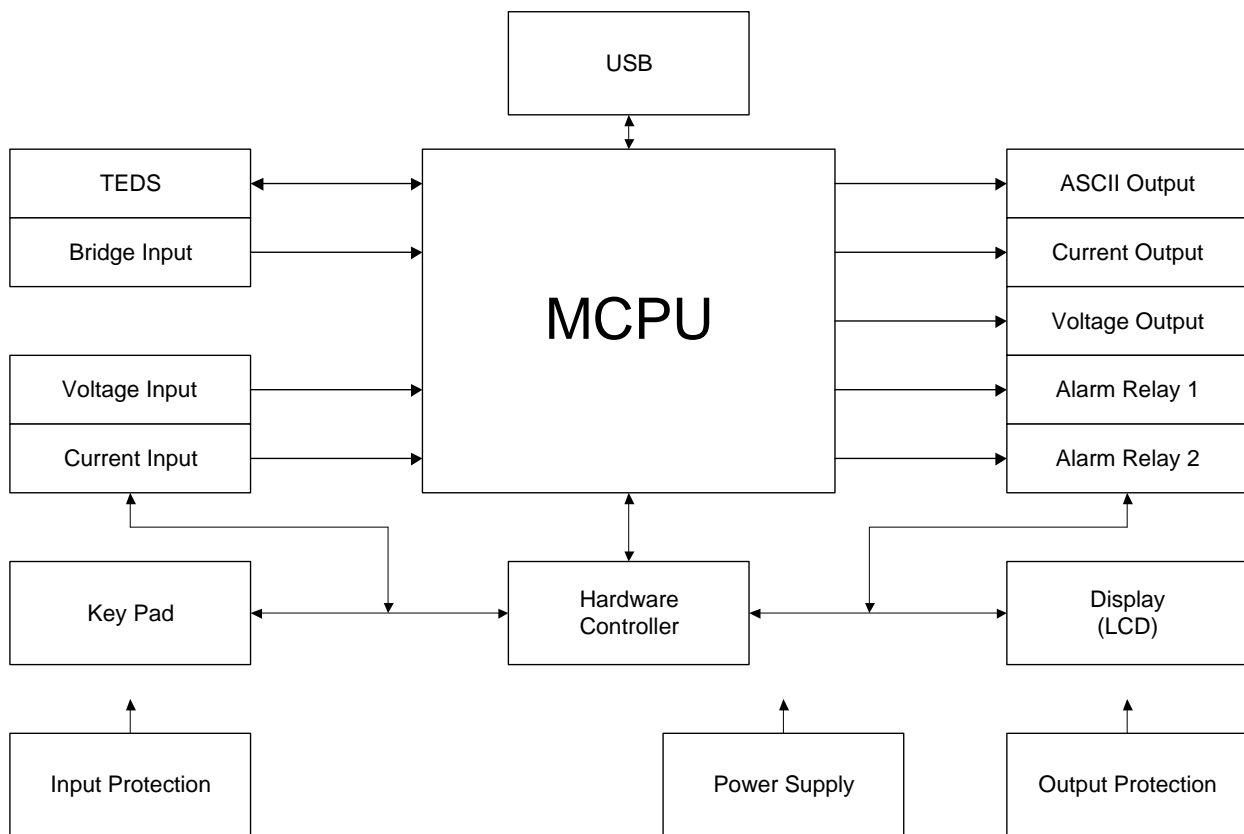
Front Panel Button	Function in Menu Mode	Function in Normal Mode
	Enter	Displays channel information
	▲ Arrow	Allows the user to toggle between displaying the tare and gross values. This can be used to remove any fixture weights.
	Back	Allows the user to toggle between two different size fonts. This key selects one of four different states in normal mode (peak, tracking, valley, and normal)
	◀ Arrow	Allows the user to reset the peak/valley
	N/A	Start navigation
	▶ Arrow	Allows the user to toggle between four groups of engineering units (Force, Torque, Pressure, and Displacement) and the standard mV/V. ¹
	Exit	Allows the user to shunt the current reading. The device shunts a resistor across the -Excitation and -Signal connections. ²
	▼ Arrow	Allows the user to freeze the current reading. HOLD will be displayed on the LCD showing that it has been held. When the button or any other key is pressed, the hold command will be cancelled. ²
	ON/OFF	ON/OFF

¹Engineering units can only be converted within its own category.

Force (Mass): μg , mg, g, kg, M- tone, dyn, kdyn, Mdyn, N, kN, oz, lb, klb, ton (US), ton (UK)
Torque: g-mm, g-cm, kg-cm, kg-m, N-mm, N-cm, N-m, KN-m, in-oz, in-lb, ft-lb
Pressure: Pa, kPa, mbar, bar, MPa, kg/cm², atm (standard atmosphere), mm-HG, in-H₂O, ft-H₂O, psi, kpsi
Displacement: mm, cm, dm, m, km, in, ft, yd, mile

²Pressing SHUNT will disable the HOLD function, but pressing HOLD will not disable the SHUNT function.

5.2 IPM650 Structure



5.3 Main Display

```
FUTEK ADVANCED
SENSOR TECH INC.
IPM650-PRO
MADE IN USA
```

Welcome message will be displayed at power on

```
AUTO CALIBRATION
IN PROGRESS
PLEASE WAIT 11
.....
```

Auto calibration will be applied when device is turned on. The calibration will minimize any effects of the temperature drift for either zero (offset) or span. During the auto calibration process the key pad is locked out and inaccessible. Brief information about the active channel will be displayed when calibration is complete.

Depending on whether TEDS detect is enabled or not (see section 6.8.4), the following Sensor Profile will be displayed for 10 seconds: TEDS enabled (left), TEDS disabled (right).

```
TEMPLATE          33
SERIAL            123456
20.0000           LBS
1.98765           mV/V
```

```
CHANNEL           01
SERIAL            1
SENSOR            BRIDGE
+2.00000          mV/V
```

After 10 seconds the following message will be displayed.

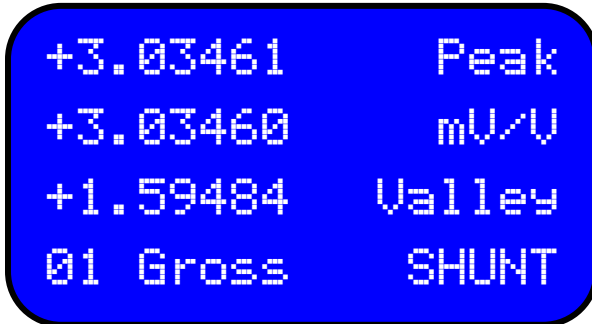


Pressing the display key will change the reading to a larger font. Pressing it again will switch between modes while still in the large font. The tare and gross modes can also be used while in the larger font mode.



After displaying the Valley, the next change will direct you to the main page again.

The shunt key can be pressed any time after the device has been calibrated and a new sensor profile has been loaded. The simulated value is to be used as a calibration reference. SHUNT will blink on the display.

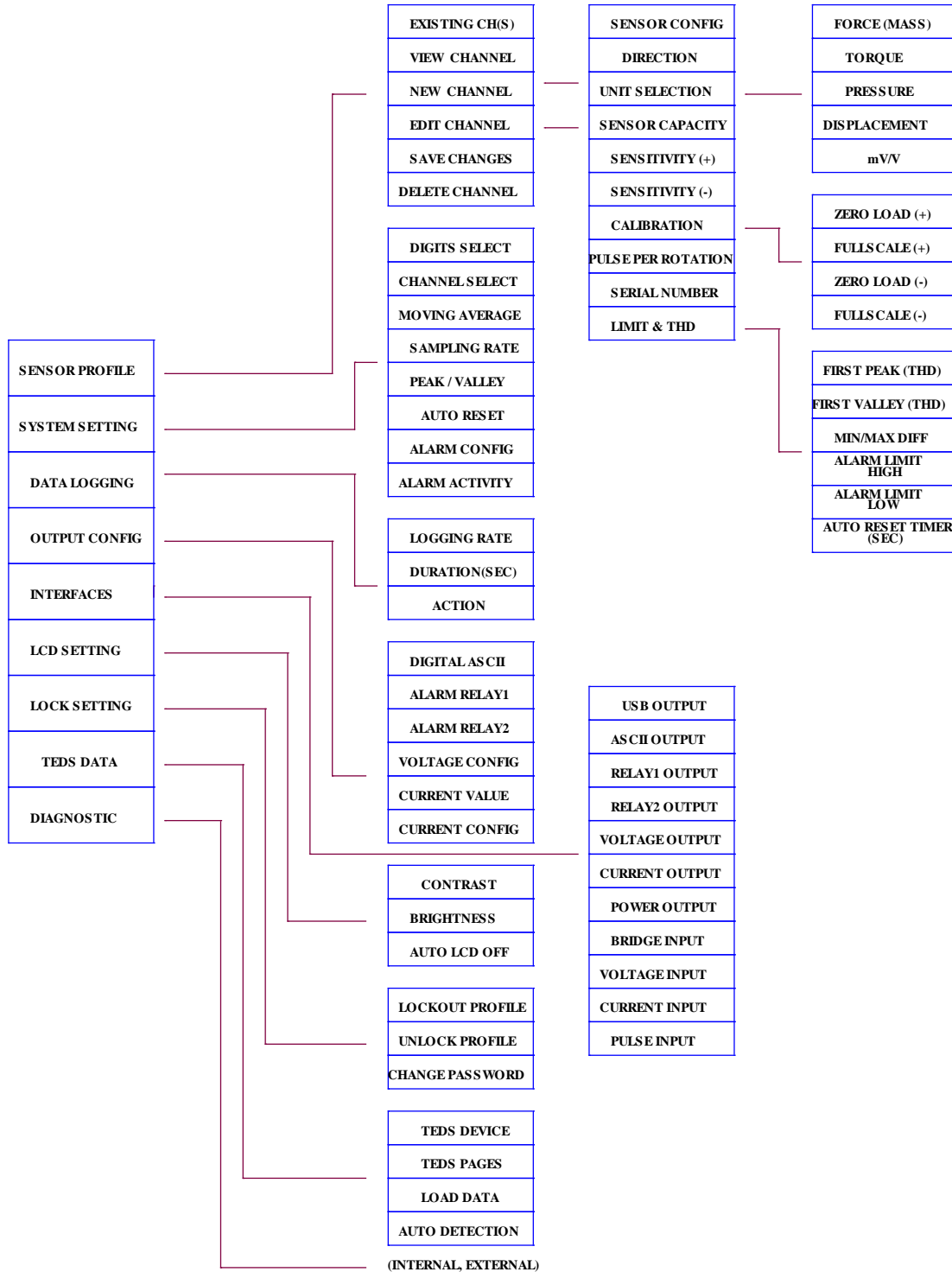


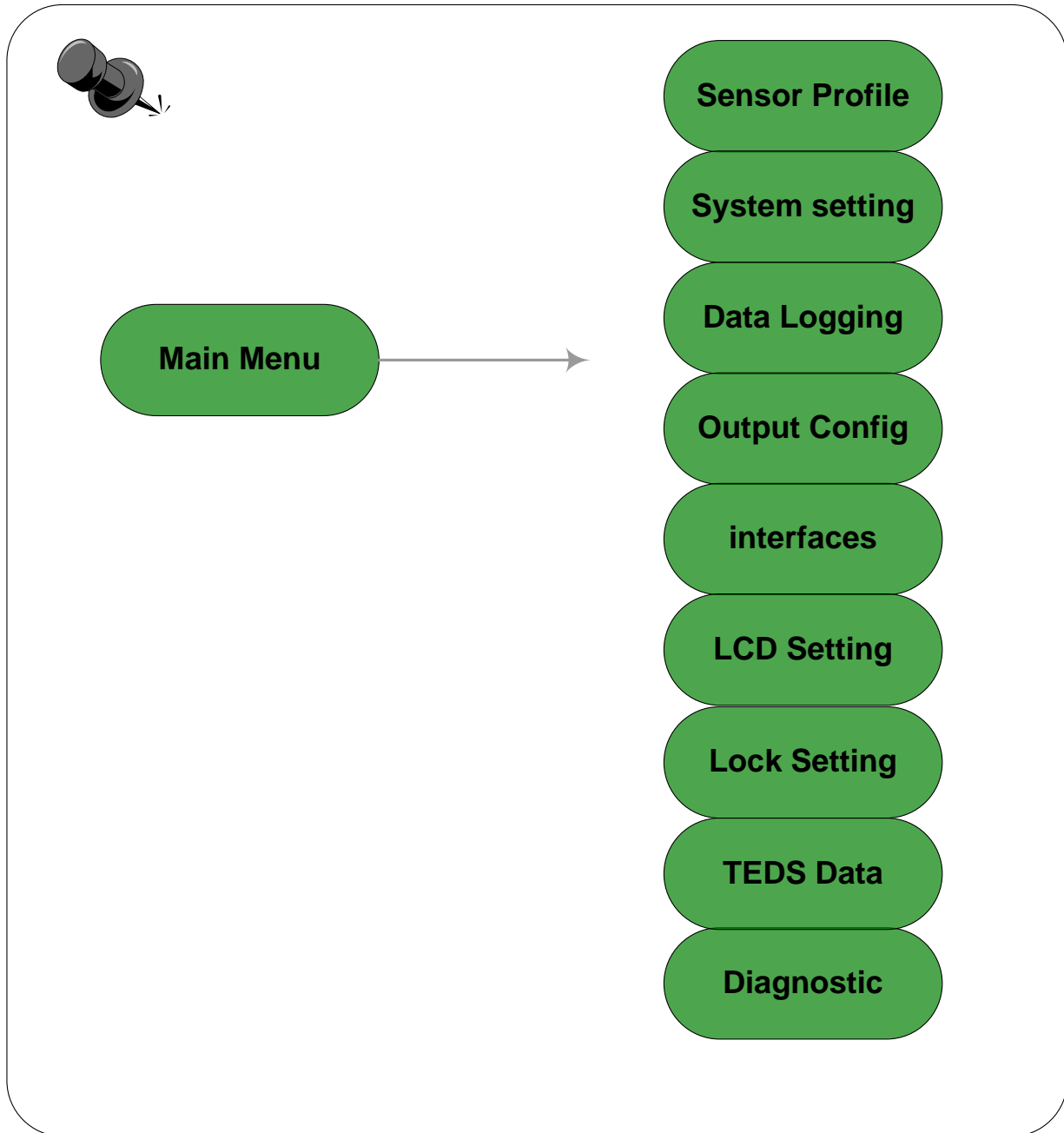
When both SHUNT and HOLD are active on the last row, the display will switch between blinking SHUNT and blinking HOLD.



The Channel Key will allow you to view the channel information.

6 Main Menu Overview





```
SENSOR PROFILE
SYSTEM SETTING
▶ DATA LOGGING
OUTPUT CONFIG
```

```
INTERFACES
LCD SETTING
▶ LOCK SETTING
TEDS DATA
```

```
LOCK SETTINGS
TEDS DATA
▶ DIAGNOSTIC
-----
```

Press the MENU key to enter the main menu.

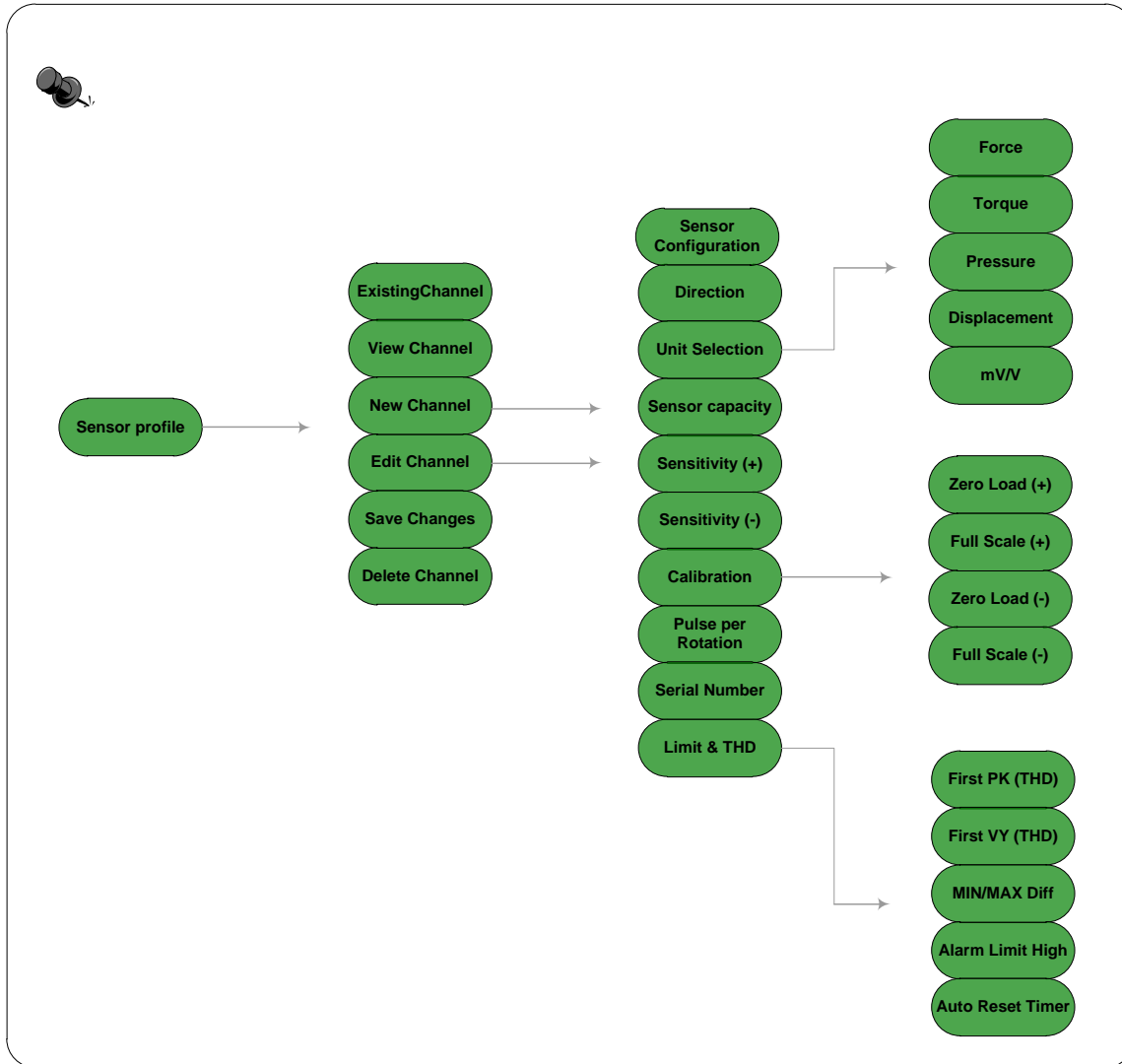
Use ▲▼ keys to select the desired menu option.

Press ENTER to navigate to the submenu.

The EXIT button can be used at any time to exit any menu or sub menu and return to the display page.

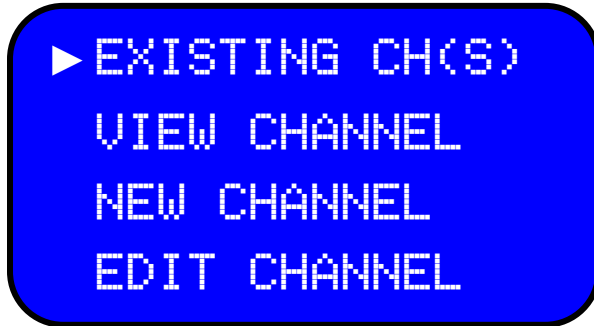
The BACK button can be used at any time to step back from any sub menu.

6.1 Sensor Profile



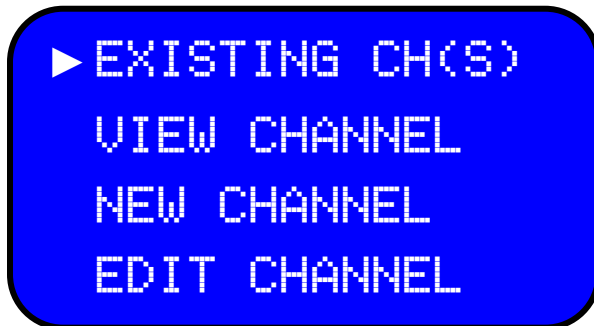
▶ SENSOR PROFILE
SYSTEM SETTING
DATA LOGGING
OUTPUT CONFIG

Select “**SENSOR PROFILE**” from the main menu options and press **ENTER**. The following options are available: **EXISTING CH(S)**, **VIEW CHANNEL**, **NEW CHANNEL**, **EDIT CHANNEL**, **SAVE CHANGES** and **DELETE CHANNEL**.

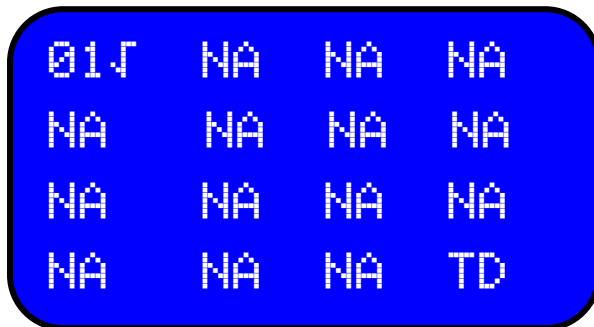


6.1.1 Existing Channels

Scroll to “**EXISTING CH(S)**” using the **▲▼** keys and press **ENTER** to view the different sensor profiles. The IPM650 is able to store up to 15 different sensor profiles.

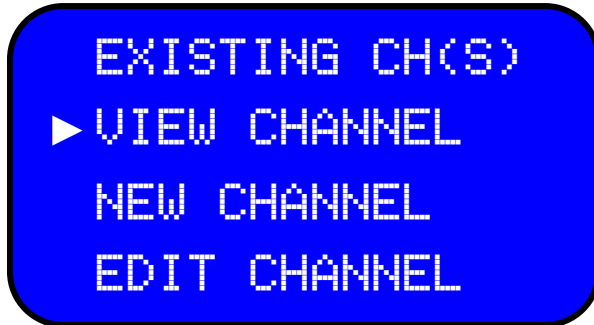


This function is useful to have a quick view of the number of channels (sensor profile) that have been stored in the internal memory and whether they are active or not. The active channel has a check mark next to it. For example, in this specific figure only channel 01 exists and is active. TEDS activity is shown separately. If TEDS is present it will be shown in the bottom right area. **BACK** can be pressed at any time to return to other sensor profile options.



6.1.2 View Channel

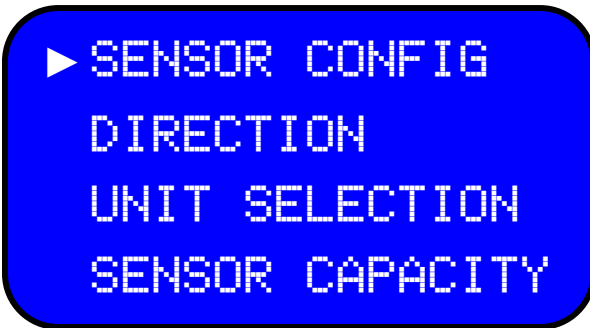
Scroll to select “VIEW CHANNEL” from the “SENSOR PROFILE” using the ▲ ▼ keys and press ENTER to view: channel number, sensor type, serial number, capacity and engineering unit. If currently more than one channel exists, pressing the arrow ◀ ▶ keys on the keypad will cycle through the existing channels.



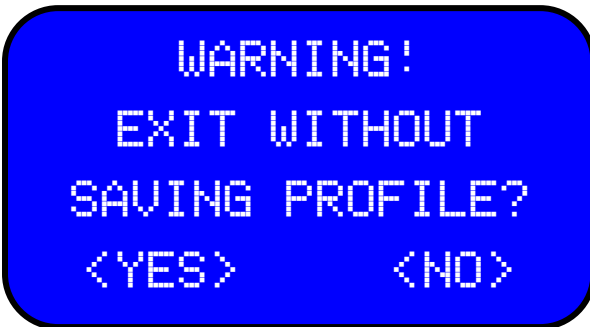
6.1.3 New Channel

Scroll to "NEW CHANNEL" from the "SENSOR PROFILE" using the ▲▼ keys and press ENTER. Use the ◀▶ to select the remaining 2 to 15 channels. Press ENTER to set the data for desired channel.

Note: The first channel is already set as default and will be displayed on the screen if no other channel has been set.



In order to set the new channel data the following steps must be taken exactly in the order in which it is shown on the screen, the ▼ key cannot be used to skip the steps. If EXIT is pressed while setting the new channel or editing an existing channel, following warning message will be displayed:



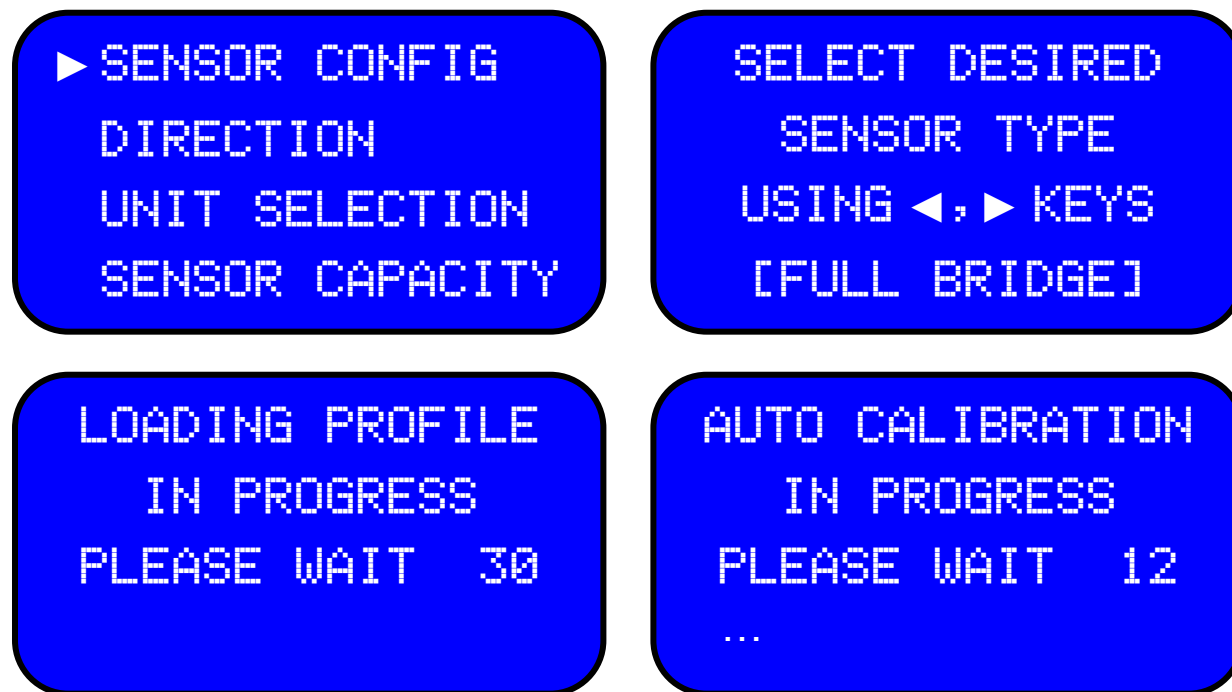
This function is not available if lockout option is enabled. See section 6.7 for further information how to enable or disable lock settings. If this device is being used for the first time, it has not been locked yet. If this device is already locked, the following message will appear if “NEW CHANNEL” is selected:



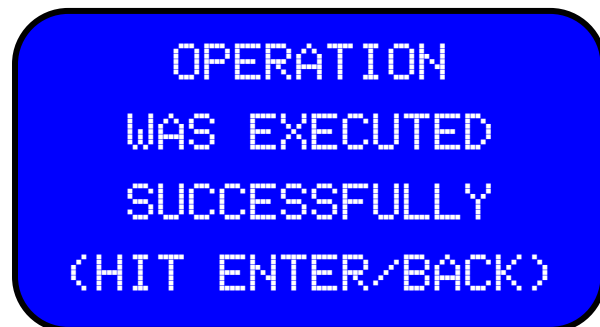
6.1.3.1 Sensor Configuration

Scroll to "SENSOR CONFIG" from "NEW CHANNEL" using ▲▼ keys and press ENTER to set a new channel. "SENSOR CONFIG" can also be selected from "EDIT CHANNEL" to make modifications on the existing channels except channel 1. Use the ◀▶ keys to select the sensor type as either "FULL BRIDGE", "VOLTAGE OUTPUT", or "CURRENT OUTPUT".

Any time a new sensor type is selected, which was not defined before, the device will automatically calibrate itself after it loads the new profile. The following messages will be seen on the screen.



The following message may be seen if the sensor type is the same as current profile.



6.1.3.2 Direction

Scroll to “**DIRECTION**” from “**NEW CHANNEL**” using the ▲ ▼ keys and press ENTER. “**DIRECTION**” can also be selected from “**EDIT CHANNEL**” to make modifications on the existing channels except channel one.

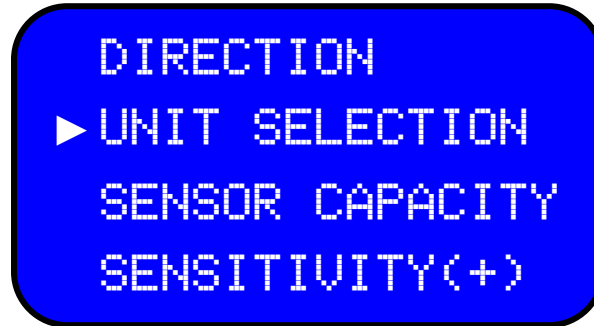
Using the ◀ ▶ keys on the keypad select either uni-direction or bi-direction.

```
▶ DIRECTION
UNIT SELECTION
SENSOR CAPACITY
SENSITIVITY(+)
```

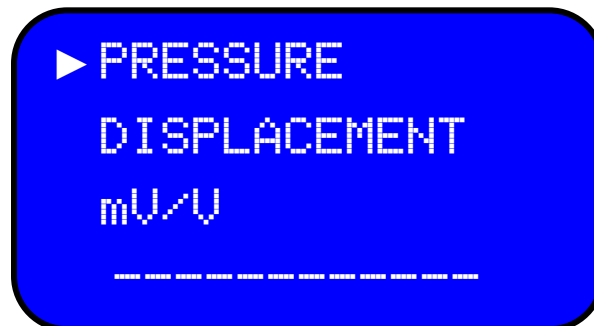
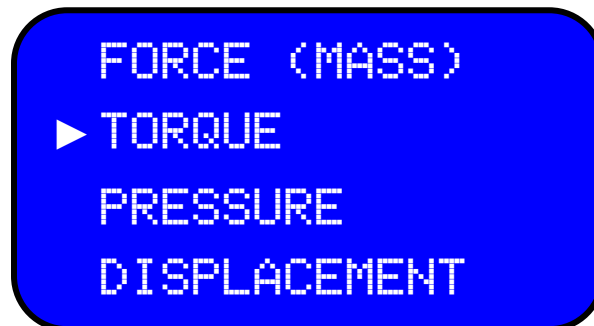
```
SELECT DESIRED
DIRECTION TYPE
USING ◀, ▶ KEYS
[UNI-DIRECTION]
```

```
OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)
```

6.1.3.3 Unit selection



Scroll to “UNIT SELECTION” from “NEW CHANNEL” using the ▲▼ keys and press ENTER. It can also be selected from “EDIT CHANNEL” to make modifications on the existing channel except channel one. Using the ▲▼ keys select one of the following four groups of Engineering Units: FORCE, TORQUE, PRESSURE, and DISPLACEMENT and standard mV/V for the new channel.



6.1.3.3.1 Force (MASS)

Scroll to “**FORCE (MASS)**” from “**UNIT SELECTION**” using the ▲ ▼ keys and press **ENTER**. The following options can be selected for force: **μg, mg, g, kg, M-tone, dyn, kdyn, Mdyn, N, kN, oz, lbs, klb, ton (US)** and **ton (UK)**. Once the desired force unit is selected, the following message will appear.

```
▶ FORCE (MASS)
TORQUE
PRESSURE
DISPLACEMENT
```

```
SELECT DESIRED
ENGINEERING UNIT
USING ◀, ▶ KEYS
[μg]
```

```
OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)
```

6.1.3.3.2 Torque

Scroll to "TORQUE" from "UNIT SELECTION" using the ▲▼ keys and press ENTER. The following options for torque can be selected: **g-mm**, **g-cm**, **g-m**, **kg-cm**, **kg-m**, **N-mm**, **N-cm**, **N-m**, **kN-m**, **in-oz**, **in-lb**, and **ft-lb**. Once the desired torque unit is selected, the following message will be shown.

```
FORCE (MASS)
▶ TORQUE
PRESSURE
DISPLACEMENT
```

```
SELECT DESIRED
ENGINEERING UNIT
USING ◀, ▶ KEYS
[g-mm]
```

```
OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)
```

6.1.3.3.3 Pressure

Scroll to “**PRESSURE**” from “**UNIT SELECTION**” using the ▲ ▼ keys and press ENTER. The following options can be selected for pressure: Pa, kPa, mbar, bar, MPa, kg/cm², atm (standard atmosphere), mm-HG, in-H₂O, ft-H₂O, psi, and kpsi. Once the desired pressure unit is selected, the following message will be shown.

```
FORCE (MASS)
TORQUE
▶ PRESSURE
DISPLACEMENT
```

```
SELECT DESIRED
ENGINEERING UNIT
USING ◀, ▶ KEYS
[Pa]
```

```
OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)
```

6.1.3.3.4 Displacement

Scroll to “**DISPLACEMENT**” from “**UNIT SELECTION**” using the ▲ ▼ keys and press ENTER. The following units can be selected for displacement: **mm, cm, dm, m, km, in, ft, yd**, and **mi**. Once the desired displacement unit is selected, the following message will be shown.

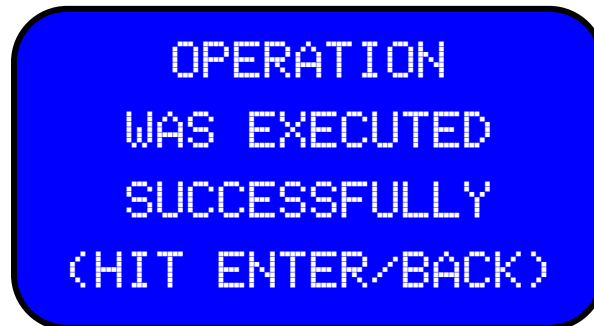
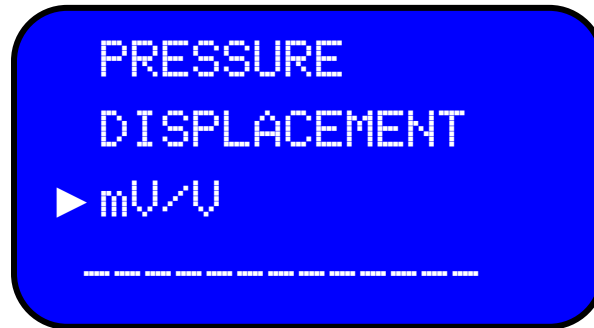
```
PRESSURE
▶ DISPLACEMENT
mU/V
-----
```

```
SELECT DESIRED
ENGINEERING UNIT
USING ◀, ▶ KEYS
[mm]
```

```
OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)
```


6.1.3.3.5 mV/V

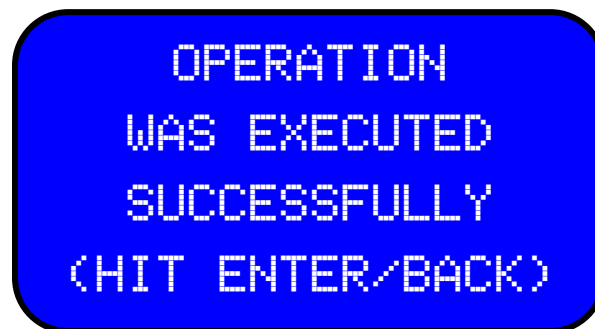
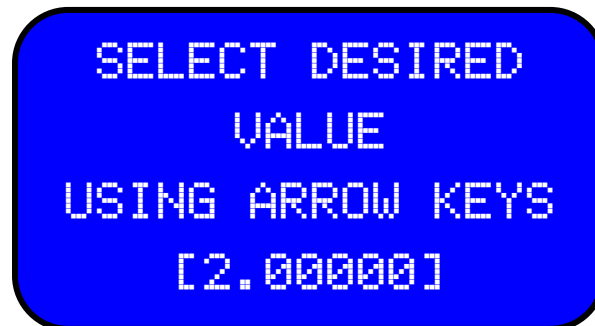
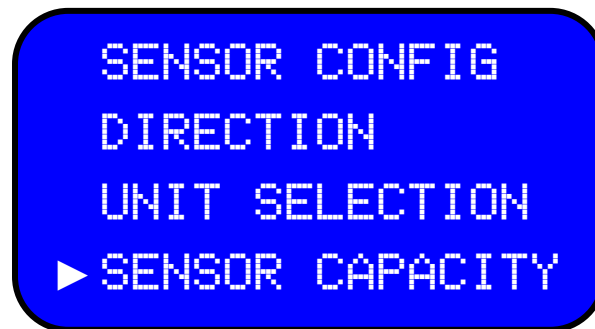
Scroll to “mV/V” from “UNIT SELECTION” using the ▲▼ keys and press ENTER. Once the desired displacement unit is selected, the following message will be shown.



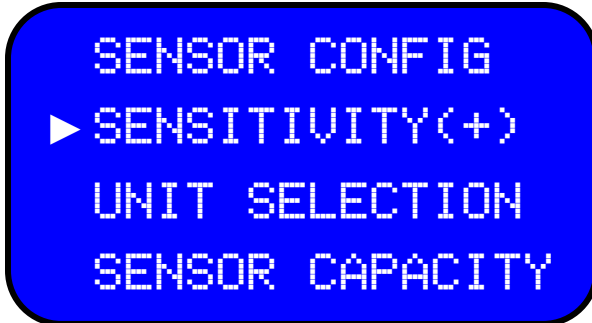
6.1.3.4 Sensor Capacity

Scroll to "SENSOR CAPACITY" from "NEW CHANNEL" using the ▲ ▼ keys and press ENTER. "SENSOR CAPACITY" can also be selected from "EDIT CHANNEL" to make modifications on the existing channels except channel one.

Using the ◀ ▶ keys move the cursor to the desired placement and use the ▲ ▼ keys to select the desired number or decimal position. The capacity can be selected from 0.00001 to 9999999.



6.1.3.5 Sensitivity (+)

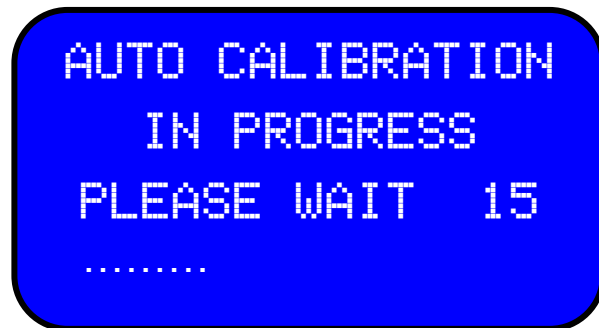
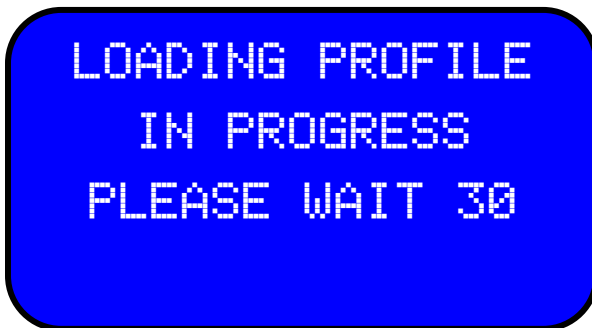


Scroll to “SENSITIVITY (+)” from “NEW CHANNEL” using the ▲ ▼ keys and press ENTER to set the sensitivity for a new channel. “SENSITIVITY” can also be selected from “EDIT CHANNEL” to make modifications on the existing channel except channel one. Sensitivity of the channel can be selected in mV/V using the ◀ ▶ and the ▲ ▼ keys.

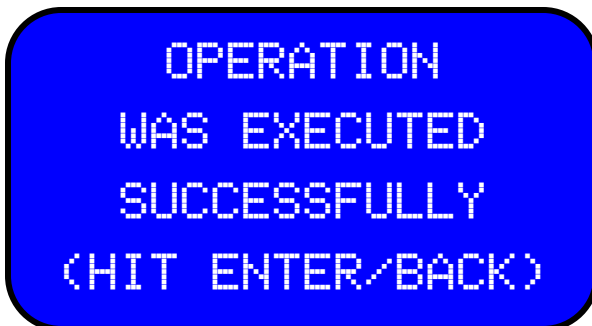
If the actual sensitivity is not known, but the specific range is known, use the larger number. For example if the sensitivity of the sensor is between 2 mV/V and 3 mV/V, 3mV/V should be entered. A live calibration would then be needed to find the actual mV/V. Any time a new sensor sensitivity is set, the device may do an auto calibration after it loads the new profile.

The following messages will be seen on the screen.

Note: Sensitivity can be defined for bridge sensors and voltage sensors. This option is disabled for current sensors.

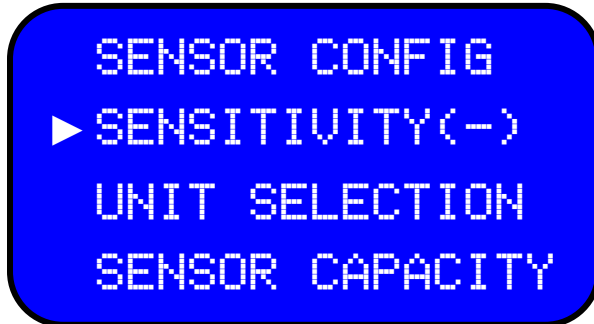


The following message will be seen if the sensor sensitivity is the same as current profile.



Note: For voltage sensor device asks for voltage output.

6.1.3.6 Sensitivity (-)

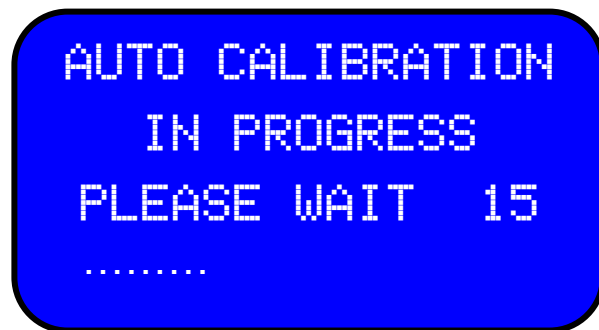
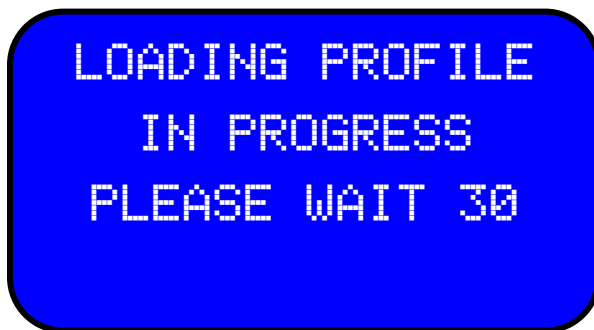


Scroll to “SENSITIVITY (-)” from “NEW CHANNEL” using the ▲▼ keys and press ENTER to set the sensitivity for a new channel. “SENSITIVITY” can also be selected from “EDIT CHANNEL” if to make modifications on the existing channels except channel one. Sensitivity of the channel can be selected in mV/V using the ◀▶ and the ▲▼ keys.

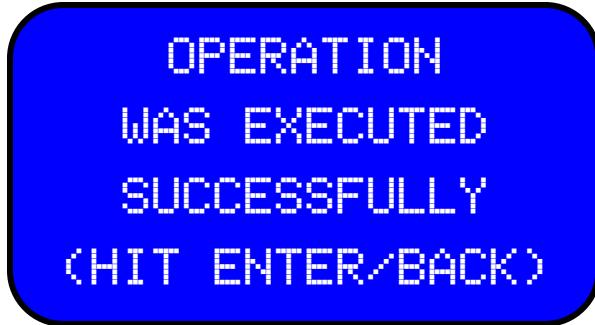
If the actual sensitivity is not known, but the specific range is known, use the larger number. For example if the sensitivity of the sensor is between 2 mV/V and 3 mV/V, 3mV/V should be entered. A live calibration would then be needed to find the actual mV/V. Any time a new sensor sensitivity is set, the device may do an auto calibration after it loads the new profile.

Note that sensitivity can be defined for *bridge sensors and voltage sensors*. This option is disabled for *current sensors*.

Note: If a Uni-directional sensor is configured in “DIRECTION” the section is not available, otherwise if the sensor is Bi-directional configured and the following step shall be taken for the negative values:



The following message will be seen if the sensor sensitivity is the same as current profile.



6.1.3.7 Calibration

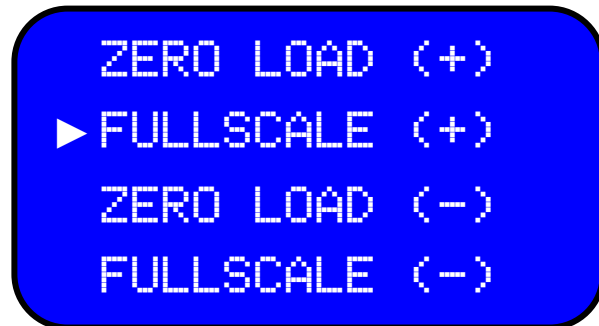
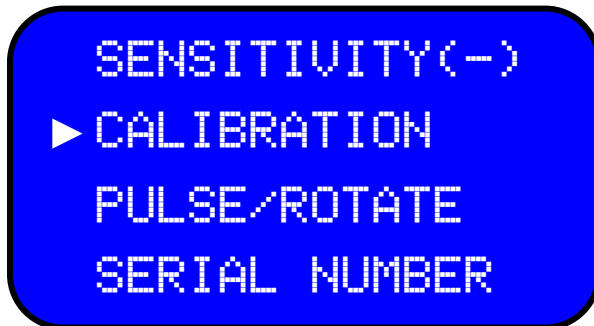
Scroll to “**CALIBRATION**” from “**NEW CHANNEL**” using ▲▼ keys and press ENTER to set it for the new channel. “**CALIBRATION**” can also be selected from “**EDIT CHANNEL**” to make modifications on the existing channels except channel one.

Note: This function is dedicated for precise calibration (live calibration), however if the user would not like to apply the load, in the sensitivity selection (6.1.3.5 & 6.1.3.6) manipulating method **must** be done accurately otherwise the calculation is not correct.

For example: Using a calibration certification with the sensitivity, the number must be entered in the sensitivity selection (6.1.3.5 & 6.1.3.6) and this step can be skipped. However it is recommended to use this step and manually live calibrate the sensor.

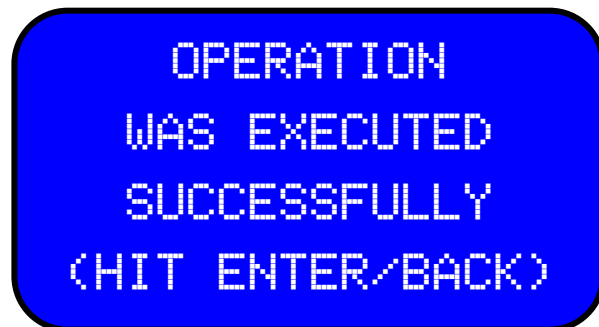
If user does not have actual sensitivity and has already entered an estimated value in Sensitivity Section (6.1.3.5 & 6.1.3.6) this step must be executed carefully.

After performing all calibration steps and entering zero load and full scale, device is able to calculate the actual SENSITIVITY value and update it. SENSOR CONFIGURATION menu will now contain the actual value.



6.1.3.7.1 Zero Load (+)

Scroll to “**ZERO LOAD (+)**” from “**CALIBRATION**” using the ▲▼ keys and press ENTER.



6.1.3.7.2 Full Scale (+)

Scroll to "FULL SCALE (+)" from "CALIBRATION" using the ▲▼ keys and press ENTER.

APPLY
FULL SCALE(+)
CALIBRATION
THEN PRESS ENTER

OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)

If the channel "DIRECTION" is defined as "BI-DIRECTION" it will be prompt to apply the full scale calibration (-) as well as zero load (-) for the reverse direction.

6.1.3.7.3 Zero Load (-)

Scroll to "ZERO LOAD (-)" from "CALIBRATION" using the ▲▼ keys and press ENTER.

APPLY
ZERO LOAD(-)
CALIBRATION
THEN PRESS ENTER

OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)

6.1.3.7.4 Full Scale (-)

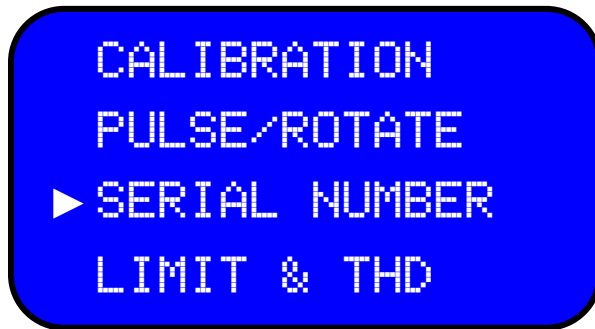
Scroll to "FULL SCALE (-)" from "CALIBRATION" using the ▲▼ keys and press ENTER.

APPLY
FULL SCALE(-)
CALIBRATION
THEN PRESS ENTER

OPERATION
WAS EXECUTED
SUCCESSFULLY
(HIT ENTER/BACK)

6.1.3.8 Serial number

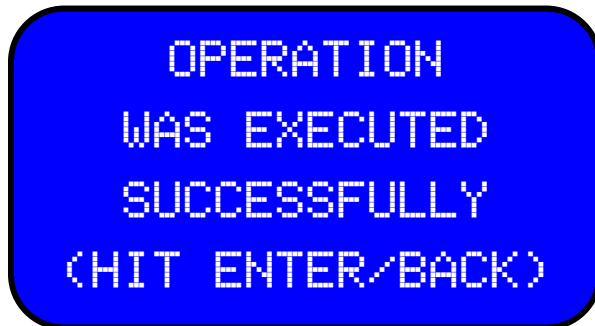
Scroll to “SERIAL NUMBER” from “NEW CHANNEL” using the ▲▼ keys and press ENTER. “SERIAL NUMBER” can also be selected from “EDIT CHANNEL” to make modifications on the existing channels except channel one.



Using the ◀▶ keys, the cursor can be moved among the seven digits and use the ▲▼ keys to select the desired serial number.

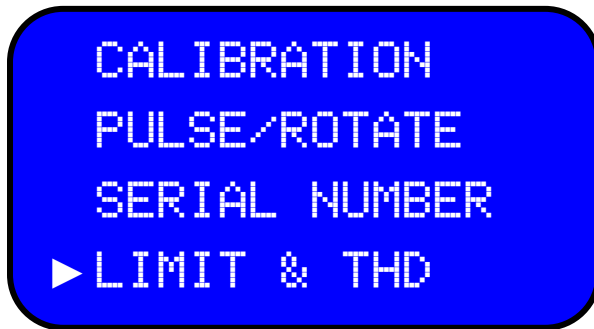


A confirmation message will be displayed confirming operation was successfully executed.



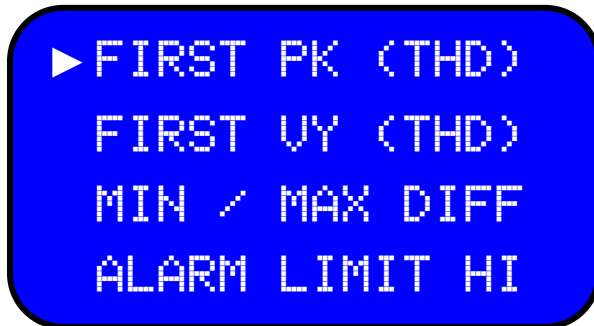
6.1.3.9 Limit & THD

Scroll to **LIMIT & THD** from **“NEW CHANNEL”** using the ▲ ▼ keys and press **ENTER.** **LIMIT & THD** can also be selected from **“EDIT CHANNEL”** to make modifications on the existing channels except channel one.



6.1.3.9.1 First Peak THD

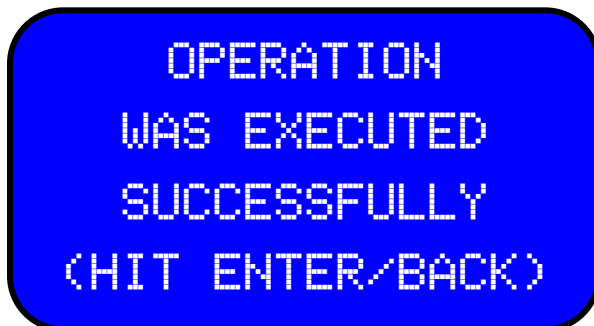
Scroll to “FIRST PK THD” from “LIMIT & THD” using the ▲ ▼ keys and press ENTER.



Use the arrow keys to move the cursor among the digits and select the desired number for the First Peak. The sign value can also be changed from positive to negative in case a bi-directional sensor is configured.



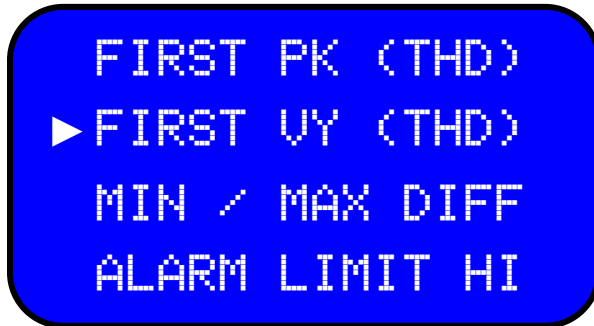
A confirmation message will be displayed confirming operation was successfully executed.



(See Figures no.1 and 2 on page 44 for examples of threshold levels on one directional and two directional sensors).

6.1.3.9.2 First Valley THD

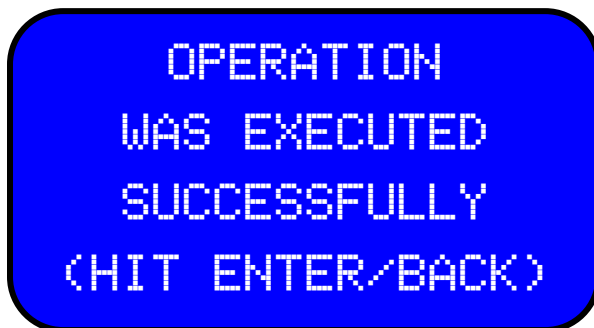
Scroll to “FIRST VY (THD)” from “LIMIT & THD” using the ▲▼ keys and press ENTER.



Use the arrow keys to move the cursor among the digits and select the desired number for the First Valley. The sign value can also be changed from positive to negative in case a bi-directional sensor is configured.



A confirmation message will be displayed confirming operation was successfully executed.



(See Figures no.1 and 2 on page 44 for examples of threshold levels on one directional and two directional sensors).

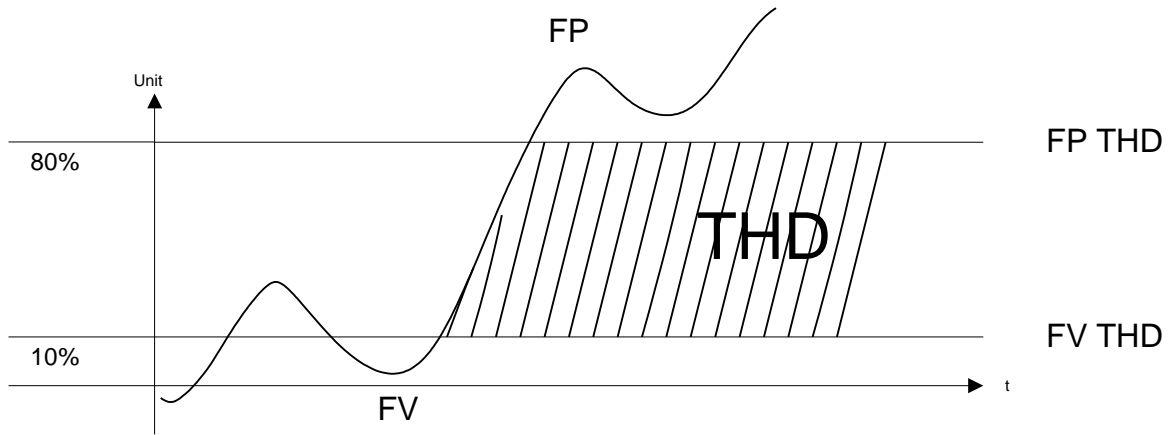


Figure No.1
 Example of One Directional Sensor

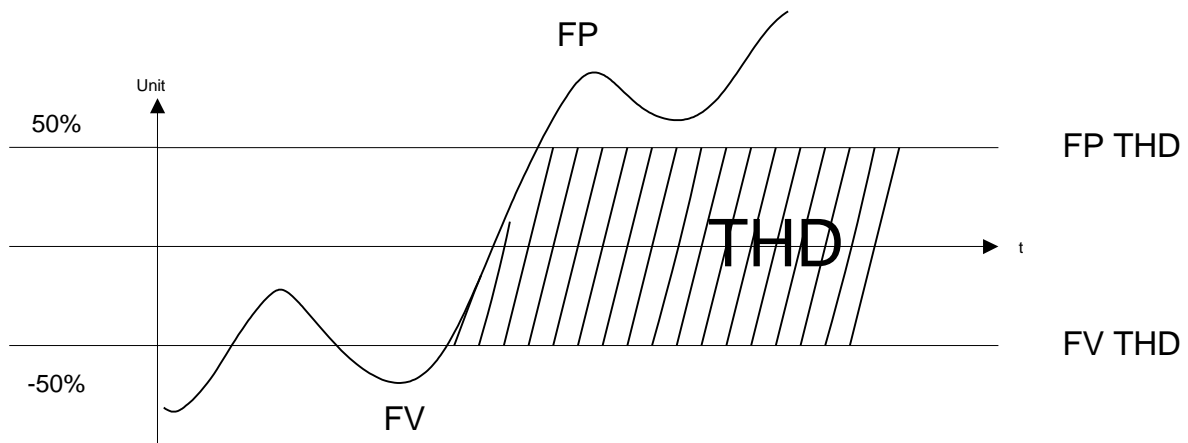
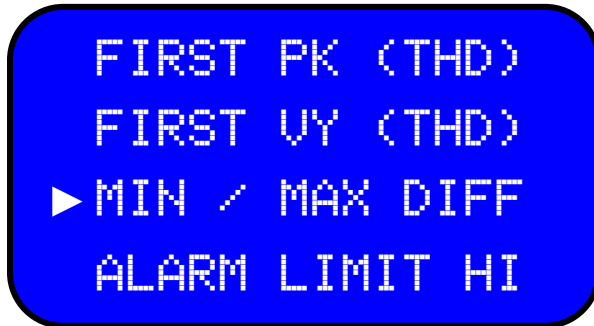


Figure No.2
 Example of Two Directional Sensor

6.1.3.9.3 MIN/MAX Differentiation

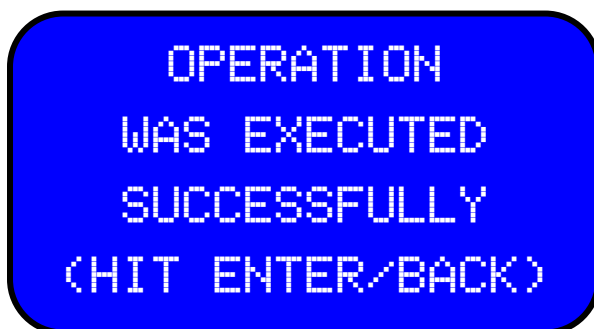
Scroll to “MIN / MAX DIFF” from “LIMIT & THD” using the ▲ ▼ keys and press ENTER.



Use the arrow keys to move the cursor among the digits and select the desired number for the Min/Max Differentiations. The sign value can also be changed from positive to negative in case a bi-directional sensor is configured.



A confirmation message will be displayed confirming operation was successfully executed.



(See Figure no.3 on page 46 for examples of Min/Max Differentiation).

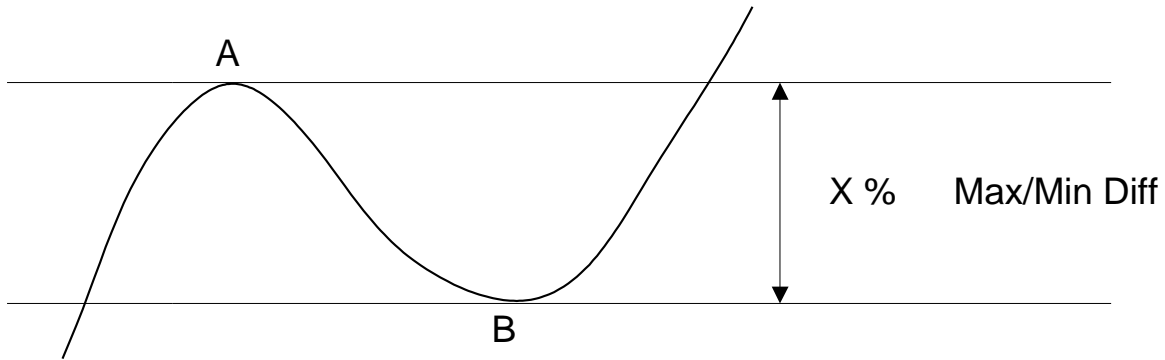


Figure No.3
Max/ Min Differentiation

Caution should be taken in defining X, for the Max/Min Diff.
For example:

Consider the following data at points A and B:

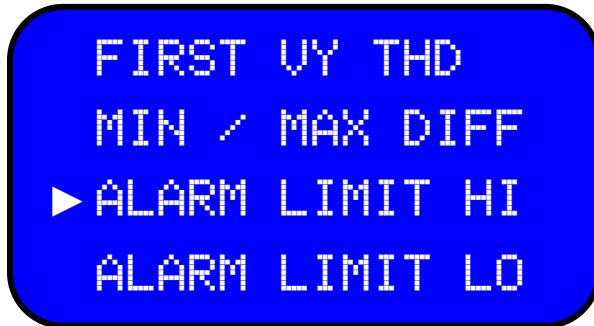
A: 100 IL

B: 90IL

If X is considered less than 10%, A would not be considered as first peak, or B would not be considered as first valley.

6.1.3.9.4 Alarm Limit High

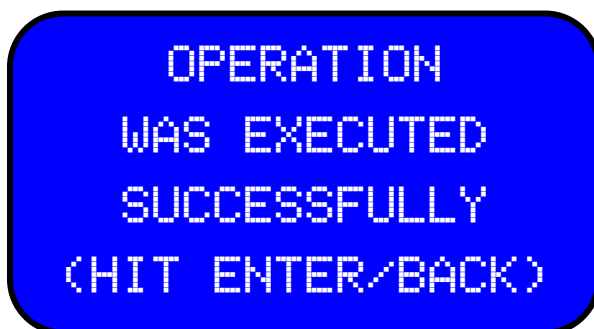
Scroll to "ALARM LIMIT HI" from "LIMIT(S) & THD(S)" using the ▲ ▼ keys and press ENTER.



Use the arrow keys to move the cursor among the digits and select the desired number for the Alarm Limit High. The sign value can also be changed from positive to negative in case a bi-directional sensor is configured.



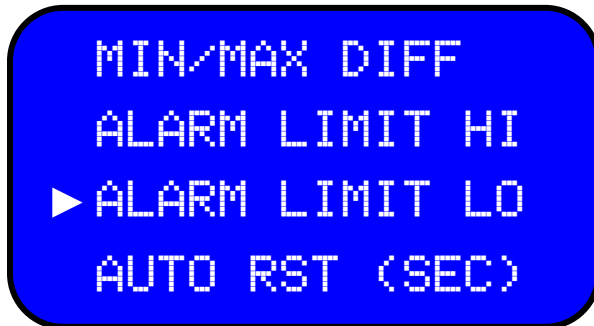
A confirmation message will be displayed confirming operation was successfully executed.



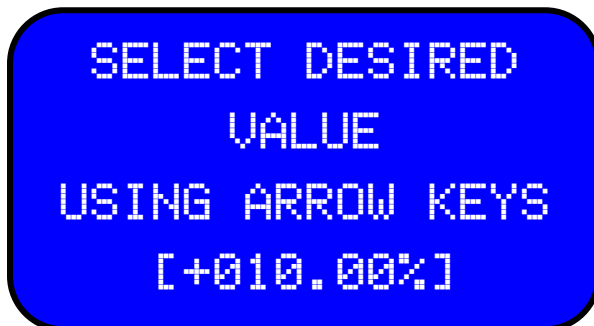
(See Figures no. 4 and 5 on page 49 for examples of alarm threshold levels for one directional and two directional sensors).

6.1.3.9.5 Alarm Limit Low

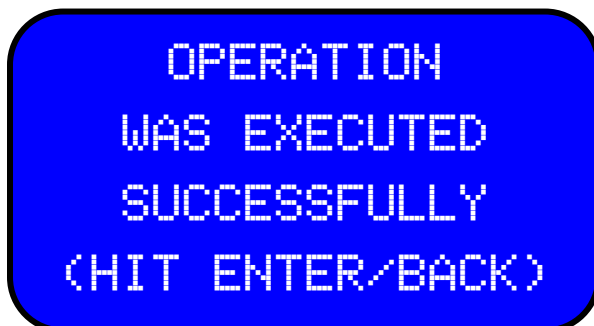
Scroll to "ALARM LIMIT LO" from "LIMIT & THD" using the ▲▼ keys and press ENTER.



Use the arrow keys to move the cursor among the digits and select the desired number for the Alarm Limit Low. The sign value can also be changed from positive to negative in case a bi-directional sensor is configured.



A confirmation message will be displayed confirming operation was successfully executed.



(See Figures no. 4 and 5 on page 49 for examples of alarm threshold levels for one directional and two directional sensors).

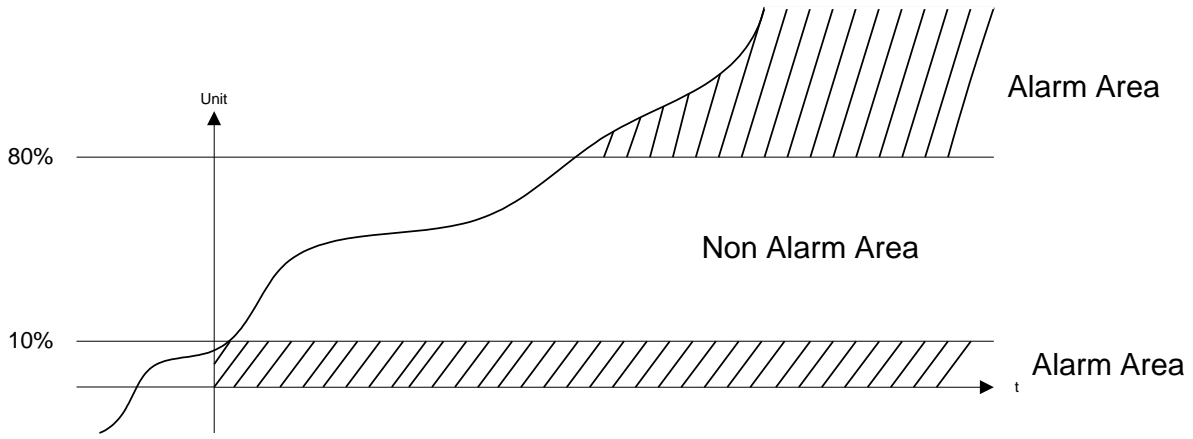


Figure No.4
 Example of One Directional Sensor

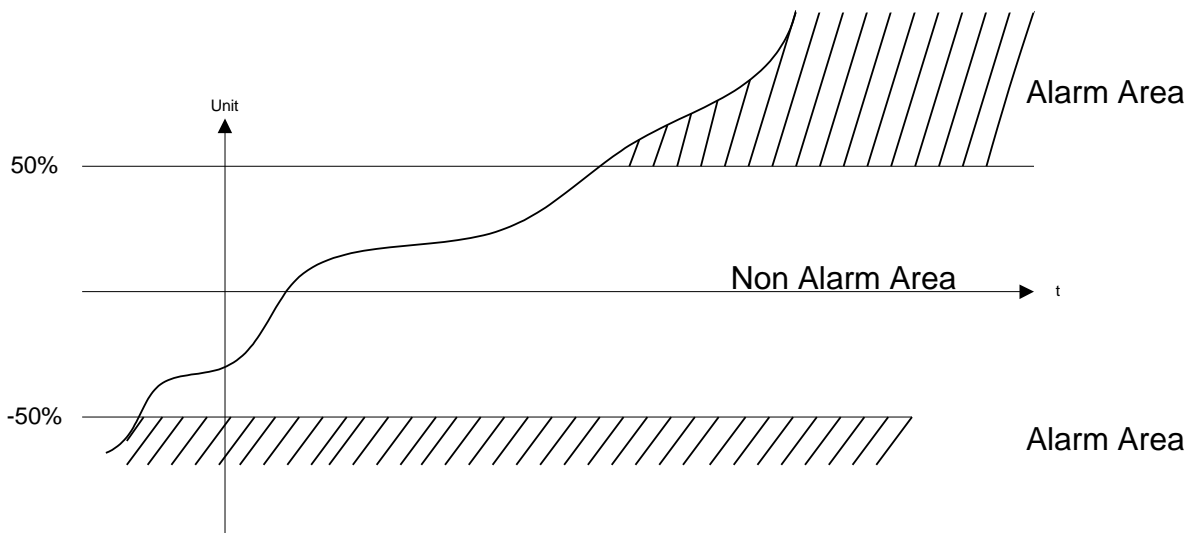


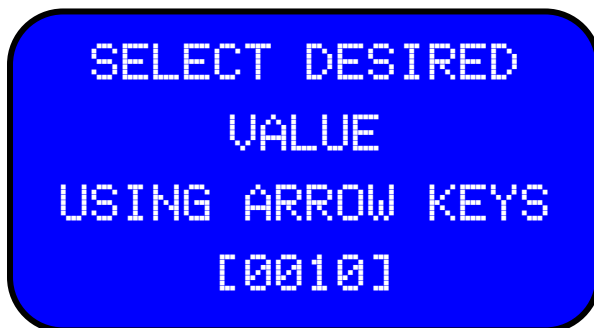
Figure No.5
 Example of Two Directional Sensor

6.1.3.9.6 Auto Reset Timer

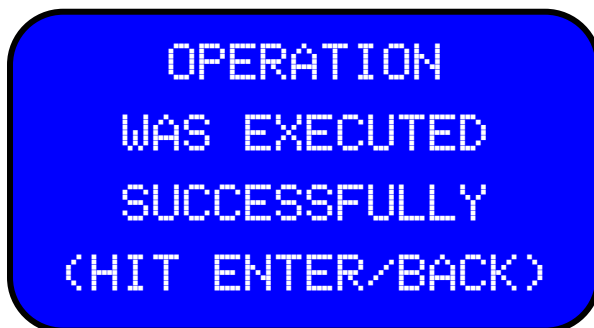
Scroll to "AUTO RST (SEC)" from "LIMIT & THD" using the ▲ ▼ keys and press ENTER.



Use the arrow keys to move the cursor among the digits and select the desired number.



A confirmation message will be displayed confirming operation was successfully executed.

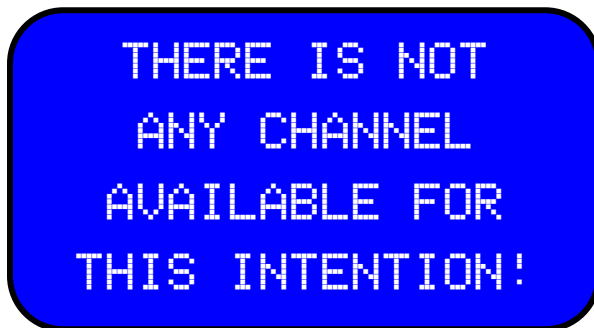


6.1.4 Edit Channel

Scroll to “**EDIT CHANNEL**” from “**SENSOR PROFILE**” using the ▲▼ keys and press ENTER.



Attempting to edit channels when no channel has been set beside channel one, which was set by default, will result in the following warning:



The edit channel option is not available if the lockout option is enabled. See section 6.7 for further information on lock settings how to enable or disable lock.

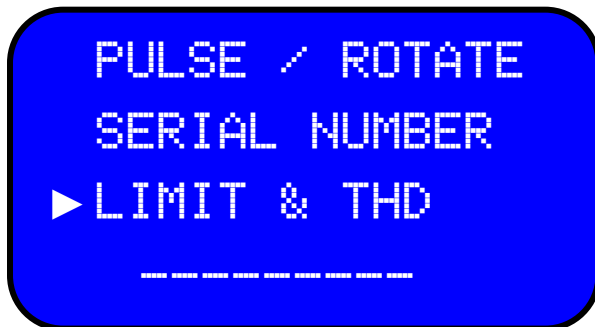
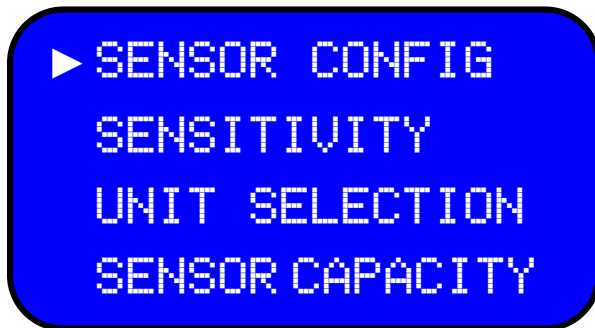
If this device is already locked the following message will be displayed “**EDIT CHANNEL**”:



Use the ◀▶ to select the channel to edit.



All the features that are accessible in the “New CHANNEL” option, applies to the Edit Channel option as well.



6.1.4.1 Sensor Configuration

See the details mentioned in section 6.1.3.1.

6.1.4.2 Direction

See the details mentioned in section 6.1.3.2.

6.1.4.3 Unit selection

See the details mentioned in section 6.1.3.3.

6.1.4.3.1 Force (MASS)

See the details mentioned in section 6.1.3.3.1.

6.1.4.3.2 Torque

See the details mentioned in section 6.1.3.3.2.

6.1.4.3.3 Pressure

See the details mentioned in section 6.1.3.3.3.

6.1.4.3.4 Displacement

See the details mentioned in section 6.1.3.3.4.

6.1.4.3.5 mV/V

See the details mentioned in section 6.1.3.3.5.

6.1.4.4 Sensor Capacity

See the details mentioned in section 6.1.3.4.

6.1.4.5 Sensitivity (+)

See the details mentioned in section 6.1.3.5.

6.1.4.6 Sensitivity (-)

See the details mentioned in section 6.1.3.6.

6.1.4.7 Calibration

See the details mentioned in section 6.1.3.7.

6.1.4.7.1 Zero Load (+)

See the details mentioned in section 6.1.3.7.1

6.1.4.7.2 Full Scale (+)

See the details mentioned in section 6.1.3.7.2

6.1.4.7.3 Zero Load (-)

See the details mentioned in section 6.1.3.7.3

6.1.4.7.4 Full Scale (-)

See the details mentioned in section 6.1.3.7.4

6.1.4.8 Serial number

See the details mentioned in section 6.1.3.8.

6.1.4.9 Limit & THD

See the details mentioned in section 6.1.3.9.

6.1.4.9.1 First Peak (THD)

See the details mentioned in section 6.1.3.9.1.

6.1.4.9.2 First Valley (THD)

See the details mentioned in section 6.1.3.9.2.

6.1.4.9.3 MIN/MAX Differentiation

See the details mentioned in section 6.1.3.9.3.

6.1.4.9.4 Alarm Limit High

See the details mentioned in section 6.1.3.9.4.

6.1.4.9.5 Alarm Limit Low

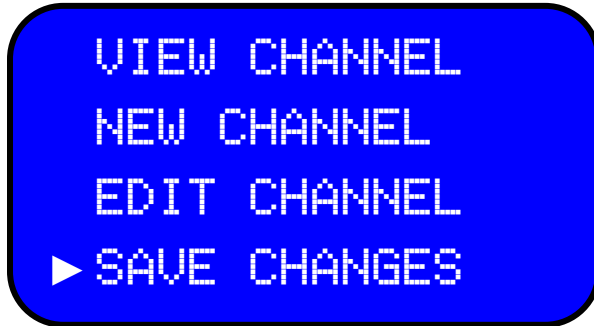
See the details mentioned in section 6.1.3.9.5.

6.1.4.9.6 Auto Reset Timer

See the details mentioned in section 6.1.3.9.6.

6.1.5 Save Changes

Scroll to “**SAVE CHANGES**” from “**SENSOR PROFILE**” using the ▲▼ keys and press **ENTER** to save the modifications that are made under the Edit Channel or New Channel menu.

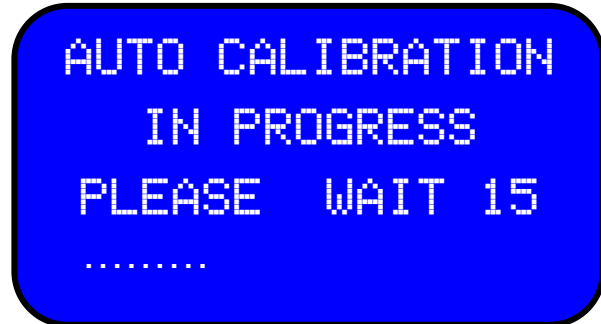
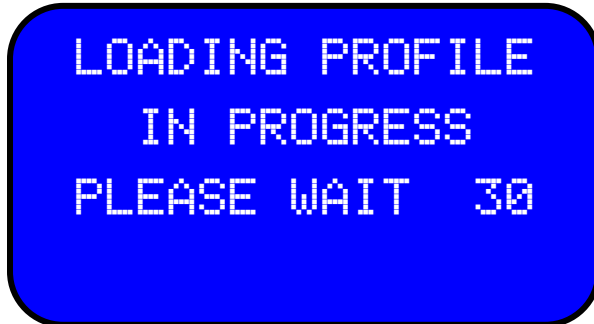


The Save Changes option is not available if the lockout option is enabled. See section 6.7 for further information on lock settings. If this device is already locked the following message will be displayed.

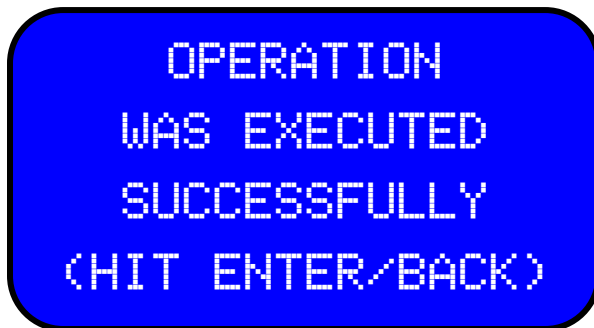


Once a new channel or modifications to the existing channel are saved, the new profile will be loaded. The previous profile cannot be re loaded.

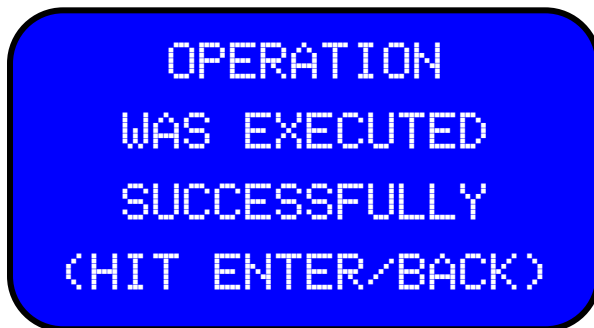
Anytime that new sensor sensitivity is set or the sampling rate is changed, the device may do an auto calibration after it loads the new profile.



The following confirmation message will be displayed:



If the sensitivity of the new channel configuration or the modification is unchanged, a message confirming that the desired operation was successfully executed will be given.



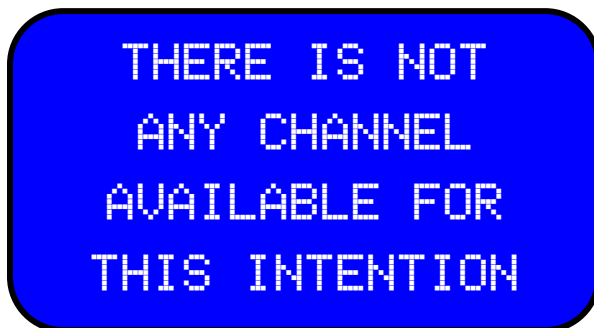
6.1.6 Delete Channel

Scroll to “**DELETE CHANNEL**” from “**SENSOR PROFILE**” using the ▲▼ keys and press ENTER. Use the ◀▶ keys to select the channel to delete. Choose Accept or Cancel to confirm or cancel the operation.

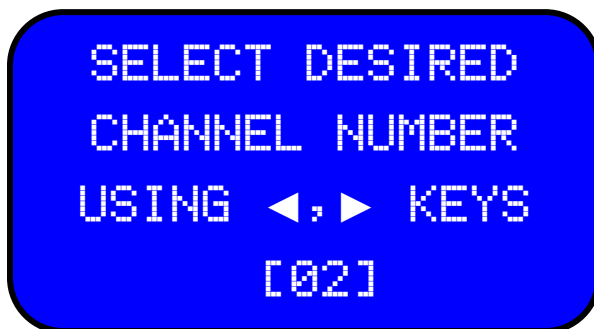
Note: Any channel other than the first channel can be deleted.

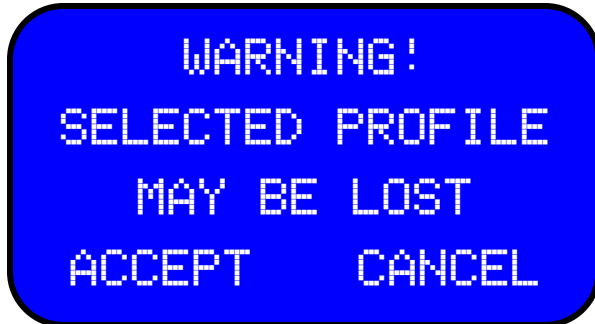


Attempting to delete channels when no channel has been set, besides channel one, which is set by default, will result in the following warning message.

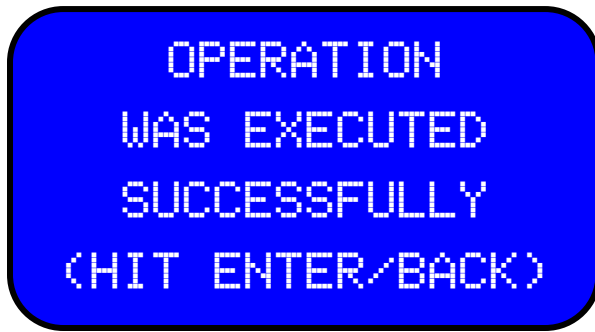


If the channel chosen to be deleted is already set as active channel, the following message will be given:

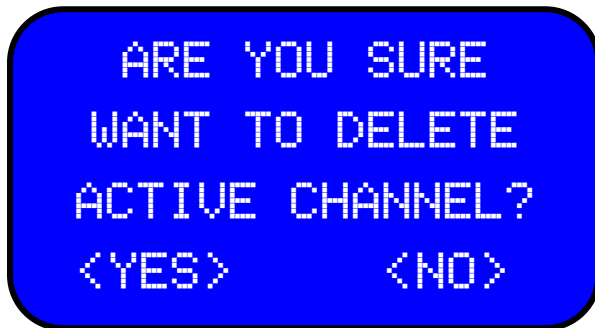




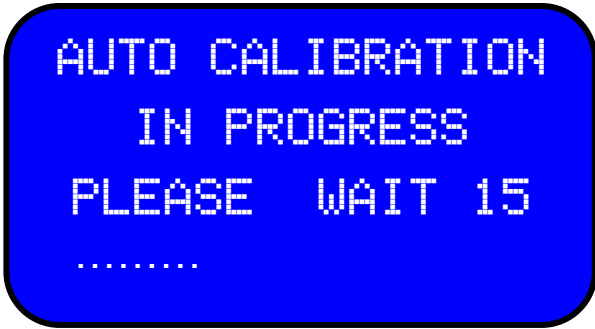
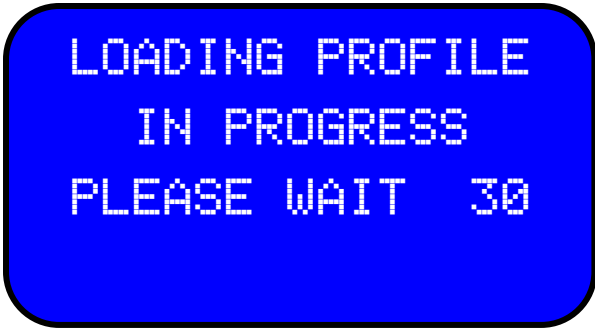
A message confirming the desired operation was successfully executed will be displayed.



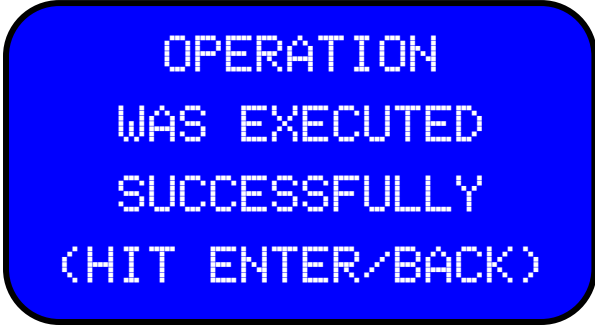
If the channel attempting to delete is the active channel, the following message will be displayed:



If the active channel is deleted, profile one will be automatically loaded, and an auto calibration will take place.



BACK can be applied to cancel or **ENTER** can be used to delete the selected channel. Once accepted to delete, a message confirming the desired operation was successfully executed will be given:

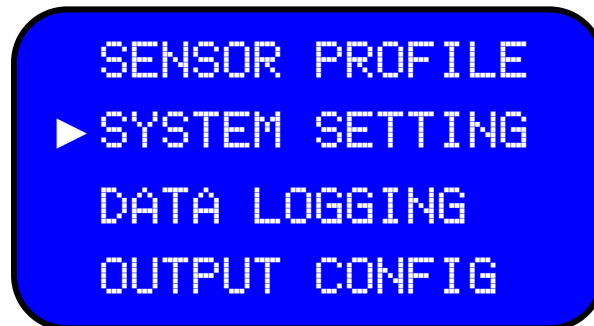
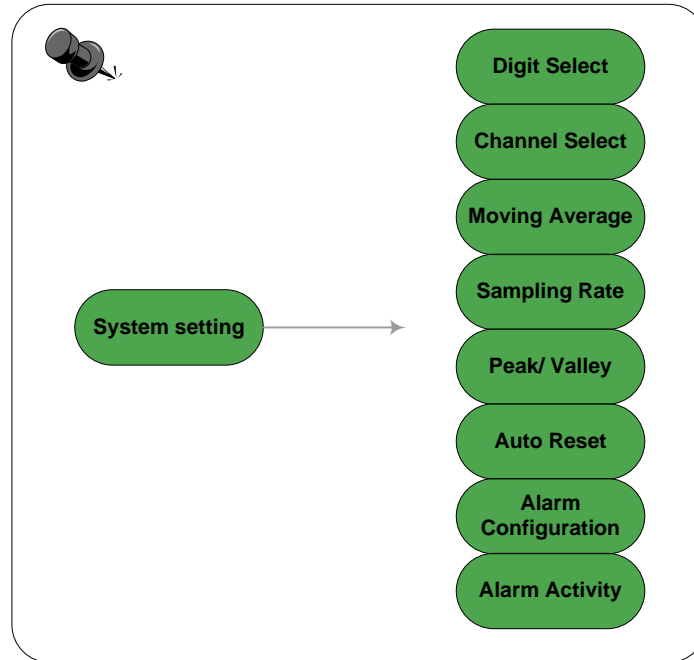


The delete function is not available if the lockout option is enabled. If this device is already locked, attempting to select "**DELETE CHANNEL**" will produce the following message:



Refer to section 6.7 for lock settings and for further information how to set it enable or disable.

6.2 System Setting



6.2.1 Digit Select

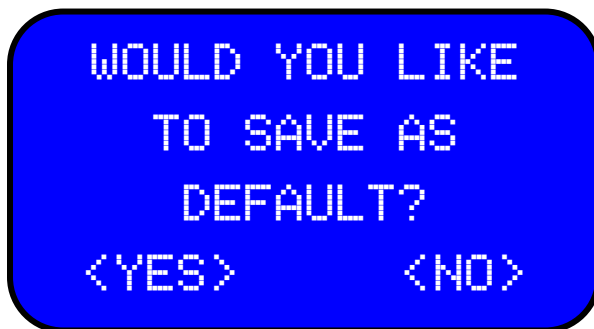
Scroll to "DIGIT SELECT" from "SYSTEM SETTING" using the ▲▼ keys and press ENTER.



Use the ◀▶ keys to select the number of digits from 3 to 6.



Once the desired number of digits has been selected, a prompt will appear prompting to set the value as a default value.



Select EXIT to return to the main page at any time.
Press BACK to go to the previous options at any time.

6.2.2 Channel Select

Scroll to “**CHANNEL SELECT**” from “**SYSTEM SETTING**” using the ▲ ▼ keys and press ENTER. Use the ◀ ▶ keys to select the desired number. If no other channels have been added, only channel 01 can be selected, which is the default channel.

```
DIGIT SELECT
▶ CHANNEL SELECT
MOVING AVERAGE
SAMPLING RATE
```

```
SELECT DESIRED
CHANNEL NUMBER
USING ◀, ▶ KEYS
[01]
```

```
LOADING PROFILE
IN PROGRESS
PLEASE WAIT 30
```

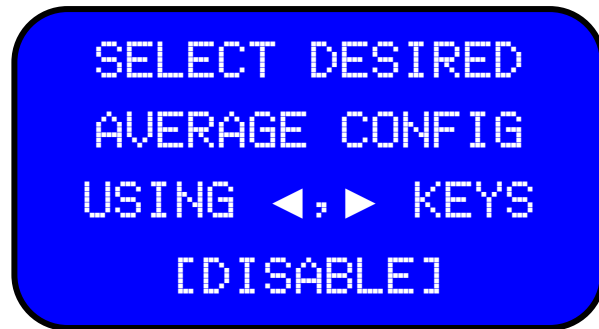
```
AUTO CALIBRATION
IN PROGRESS
PLEASE WAIT 15
.....
```

After selecting the desired channel, there is the option of setting it as the default channel. Use **BACK** to select NO and return to the system setting option. By selecting YES, the selected channel will be set as the default channel.

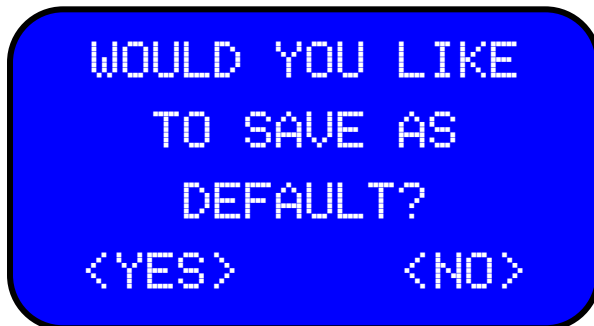
```
WOULD YOU LIKE
TO SAVE AS
DEFAULT?
<YES> <NO>
```

6.2.3 Moving Average

Scroll to “**MOVING AVERAGE**” from “**SYSTEM SETTING**” using the ▲ ▼ keys and press ENTER. Using the ◀ ▶ keys: **disable, 2, 4, 8, 16, 32, 64, or 128** can be selected.



After selecting the desired moving average settings, a prompt will be shown with the option of setting it as default. Use **BACK** to select NO and return to the system setting option. By selecting YES, the selected channel will be set as the default channel.



Average Measurements:

An average (Ave_n) is defined as the summation of n samples divided by n.

$$Ave_n = \frac{\sum_{i=1}^n \text{Sample}_i}{n} \quad (1)$$

For the kth average, we have the following:

$$Ave_k = \frac{\sum_{i=1+k-n}^k \text{Sample}_i}{n} \quad (2)$$

This is known as a moving average because the average at each k^{th} instant is based on the most recent set of n values. In other words, it is a moving window of n values that are used to calculate the average of the data sequence (see Figure 1).

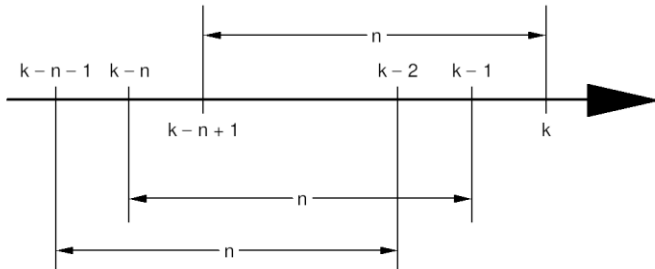


Figure 1: Moving Average of n Data Points

The averaging process can be improved if the calculations can be performed in a recursive fashion. Equation 1 can also be represented as the previous total of $n - 1$ samples plus the new sample, and then divided by n .

$$Ave_n = \frac{\sum_{i=1}^{n-1} \text{Sample}_i + \text{Sample}_n}{n} \quad (3)$$

Using Equation 1, we can derive the equation for Ave_{n-1}

$$Ave_{n-1} = \frac{\sum_{i=1}^{n-1} \text{Sample}_i}{n-1} \quad (4)$$

This can be rearranged as shown in Equation 5:

$$(n-1) \cdot Ave_{n-1} = \sum_{i=1}^{n-1} \text{Sample}_i \quad (5)$$

Using Equation 5, we can replace the value of $\sum_{i=1}^n \text{Sample}_i$ in equation 3 with $(n-1) \times Ave_{n-1} + \text{Sample}_n$. This yields Equation 6:

$$Ave_n = \frac{(n-1) \cdot Ave_{n-1} + \text{Sample}_n}{n} = \frac{n \cdot Ave_{n-1}}{n} - \frac{Ave_{n-1}}{n} + \frac{\text{Sample}_n}{n} \quad (6)$$

Equation 6 can be simplified to equation 7:

$$Ave_n = Ave_{n-1} + \frac{\text{Sample}_n - Ave_{n-1}}{n} \quad (7)$$

6.2.4 Sampling Rate

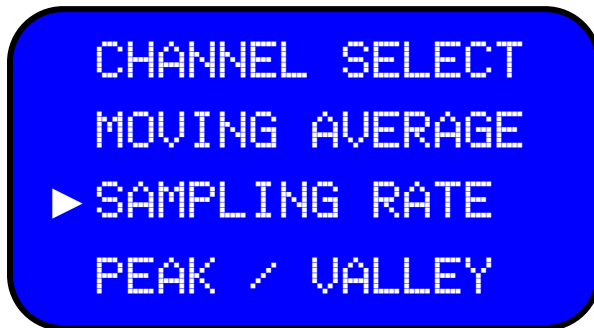
Scroll to “**SAMPLING RATE**” from “**SYSTEM SETTING**” using the ▲▼ keys and press ENTER. Using the ◀▶ keys, 16 different sampling rates can be selected in two different levels as listed below:

LOW SPEED: 5, 10, 25, 30, 50, 60, 100, 200, 400

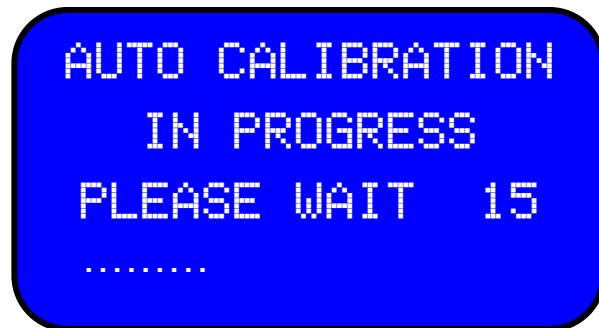
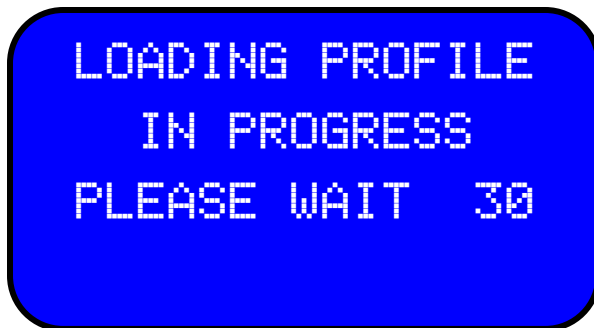
HIGH SPEED: 600, 800, 960, 1200, 1600, 2400, 4800

Note: During the data logging, *Voltage output*, *Current output*, and *ASCII output* are disabled to get the maximum data.

See section 6.3 for more information about data logging.



Whenever the sampling rate is changed the system will automatically load the active channel and perform an auto calibration followed by loading the active channel information.



For bandwidth clarification, see APPENDIX C (DEVICE SPECIFICATIONS).

6.2.5 Peak/ Valley

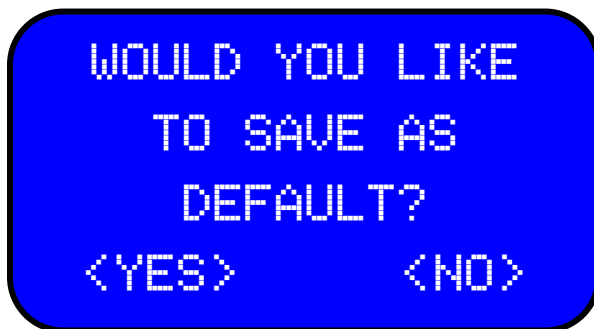
Scroll to "PEAK/ VALLEY" from "SYSTEM SETTING" using the ▲▼ keys and press ENTER.



Using the ◀▶ keys select to display the First Peak/Valley or Hold Peak/Valley values.



A prompt will be shown to set this value as a default setting.



First Peak/First Valley mode will capture the first peak or valley and disregard the future inputs peak or valleys.

Peak Hold/Valley Hold mode will "Hold" on to the maximum (peak) and minimum (valley) values.

First peak and first valley will be captured based on the specified threshold values defined in the sensor profile. Refer to sections (6.1.3.10.1), (6.1.3.10.2), and (6.1.3.10.3) for more details.

Valley is the maximum absolute value in the negative direction.

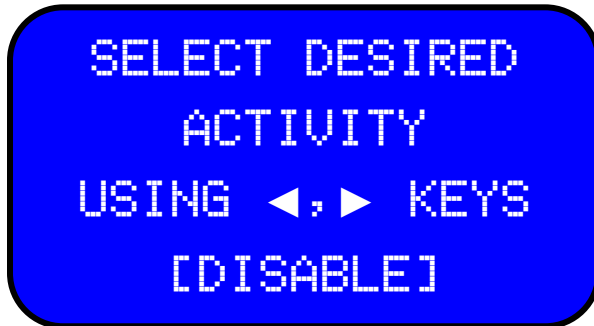
6.2.6 Auto Reset

Scroll to "AUTO RESET" from "SYSTEM SETTING" using the ▲▼ and press ENTER.

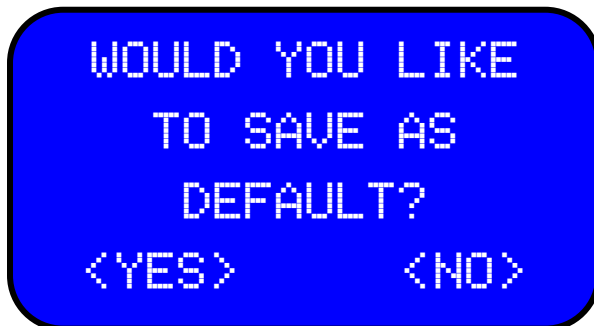
Auto Reset will reset the peak and valley values when the timer is expired. The time, in seconds, is defined in the sensor profile. Refer to section (6.1.3.9.6) for more detail.



Using the ◀▶ keys select to enable or disable the Auto Reset function.



A prompt will be shown to set this value as a default setting.



6.2.7 Alarm Configuration

Scroll to “ALARM CONFIGURATION” in “SYSTEM SETTING” using the ▲ ▼ keys and press ENTER.

The Alarm threshold levels are set in the sensor profile (Refer to section 6.1.3.9), Refer to the drawings on page 44 for examples regarding alarm THD levels.

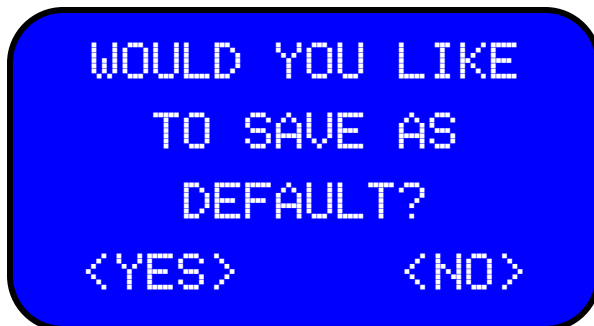


Using the ◀▶ keys set the Alarm Configuration to Latched or Non-Latched.

Definitions:

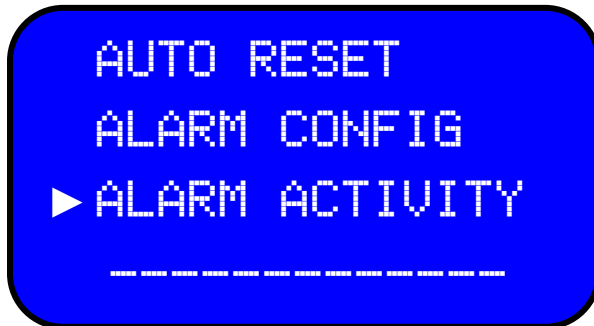
Latched alarm: Holds the alarm activated until a reset function (manual reset or auto reset) is performed.

Non-Latched alarm: The alarm will turn OFF if the current value goes outside the alarm operating range (enters none alarm area).

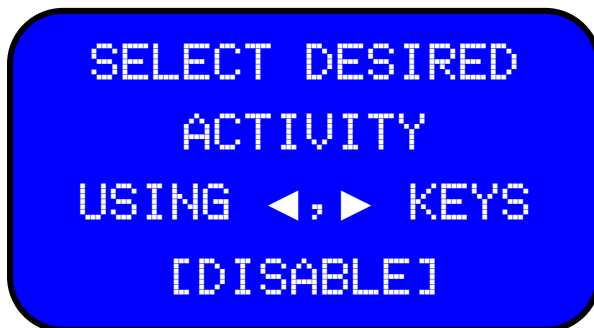


6.2.8 Alarm Activity

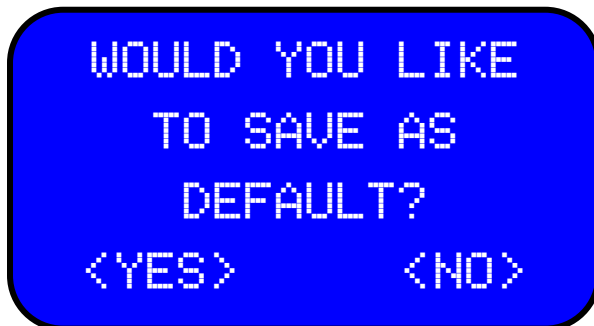
Scroll to "ALARM ACTIVITY" from "SYSTEM SETTING" using the ▲▼ keys and press ENTER.



Using the ◀▶ keys different alarm activities including System Alarm or Relay Alarm can be either enabled or disabled.

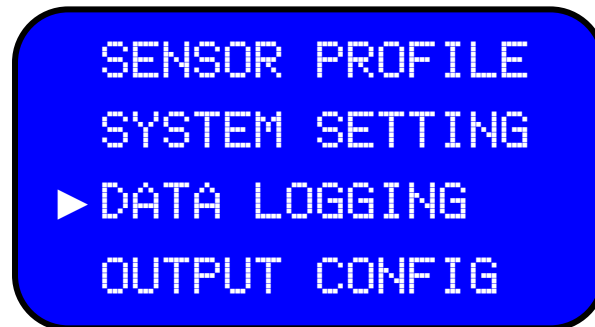
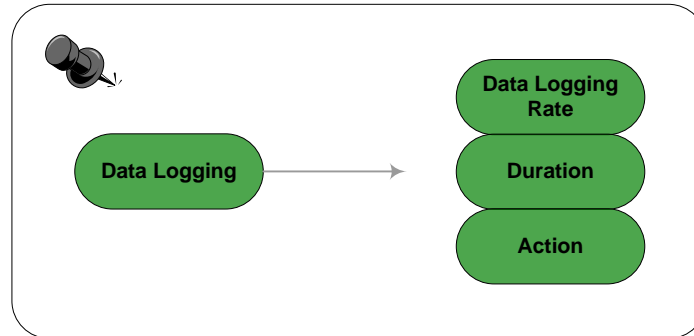


A prompt will be shown to set this value as a default setting.



The Peak values will blink in intervals of 2.5 seconds if the current value exceeds the alarm high limit.
The Valley values will blink in intervals of 2.5 seconds if the current value is below the alarm low limit.

6.3 Data Logging



This menu option allows the user to log the data. Data logging is a useful feature to monitor the performance of sensor during a specific time. In order to take advantage of this feature the following factors should be considered before:

The Data Logging feature is not available if the timer has been expired or there is not enough memory location to support the defined time. Also if there is an attempt to try to use the Tare key while using this feature, a warning message will notify the user that this function is not available at this time.

IPM650 has 128 Kbytes internal buffer to log the data. This buffer has been partitioned to two areas for Tracking and Time values and each category has 24 bit data (3 bytes) allocated to it; which means that each one has capacity of 21,845 pieces of data. The final data packet time, is measured in millisecond. After data logging is completed, while the device is on and another data logging has not been established, the logged data is accessible by FUTEK data logging software, SENSIT Test and Measurement.

6.3.1 Logging Rate

Scroll to “**LOGGING RATE**” from “**DATA LOGGING**” using the ▲ ▼ keys and press ENTER. Using the ◀ ▶ keys select either **HALF SPEED**, **FULL SPEED**. This setting can be set as a default setting.

SELECT DESIRED
LOGGING RATE
USING ◀, ▶ KEYS
[HALF SPEED]

▶ LOGGING RATE
DURATION (SEC)
ACTION

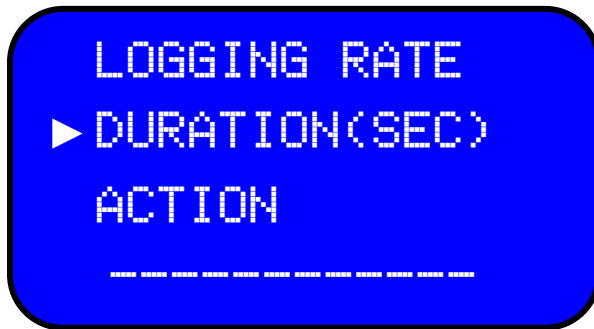
WOULD YOU LIKE
TO SAVE AS
DEFAULT?
<YES> <NO>

At full speed the IPM650 will use the current set sampling rate in the data logging session. At half speed, ½ of the current set sampling rate will be using in the data logging session.

6.3.2 Duration (SEC)

Scroll to “**DURATION**” from “**DATA LOGGING**” using the ▲▼ keys and press ENTER.

Use the ◀▶ and the ▲▼ keys to select the desired duration in seconds; therefore, from 0 to 9999 seconds can be selected.



Note: The duration that can be set is limited by the following formula:

$$\text{Max Duration (sec)} = \text{Integer} (21845 / \text{sampling rate})$$

SPS	5	10	25	30	50	60	100	200
Max D	4369	2184	873	728	436	364	218	109

SPS	400	600	800	960	1200	1600	2400	4800
Max D	54	36	27	22	18	13	9	4

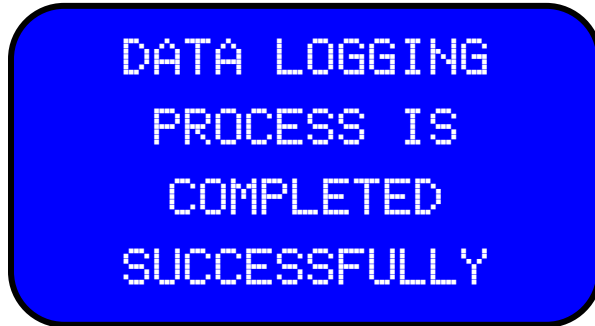
For example:

If the sampling rate has been set to 10 Samples per Second (SPS) the duration, in second, can be selected up to 2184.

In the case of HALF SPEED the duration time can be twice as long.

If the device has been set to 10 Samples per Second (SPC) and HALF SPEED logging rate is selected, the duration, in second, can be selected up to 4368.

Although any other numbers can be selected, after the actual maximum duration time, the internal buffer will hit full capacity and the following message will appear:

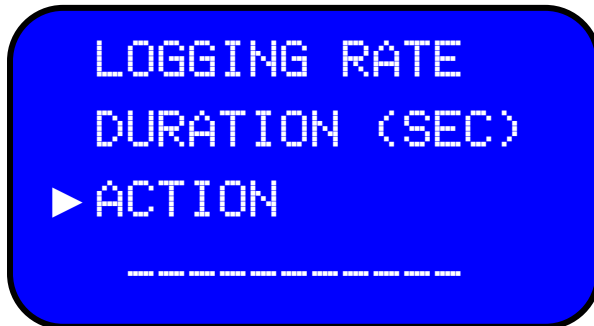


6.3.3 Action

Scroll to "ACTION" from "DATA LOGGING" using the ▲▼ keys and press ENTER.

Using the ◀▶ keys, the data logging session either can be started or stopped.

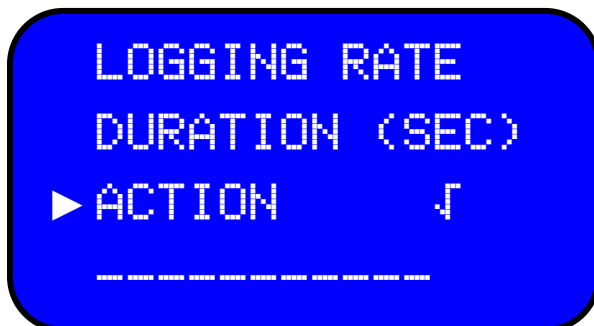
This sub menu allows the user to Stop or Start data logging process. As soon as the Start option is selected, the data logging process starts.



By pressing the ENTER key you can select to stop or start the data logging test.



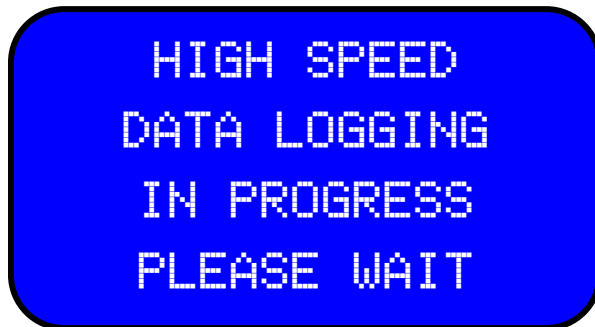
The following check mark will be displayed when the data logging session has begun.



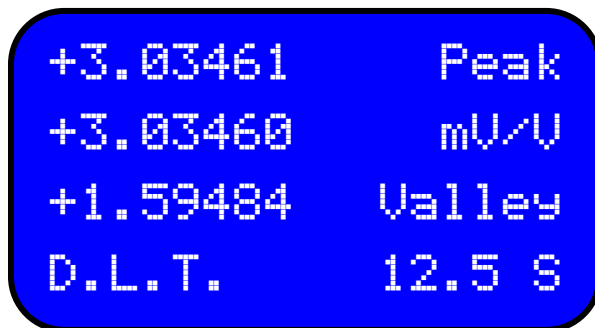
It is important to know that IPM650 is equipped by a high speed Processor.

This processor is responsible to control every single feature of device and dedicates the specific time frame for internal operation and Interfaces.

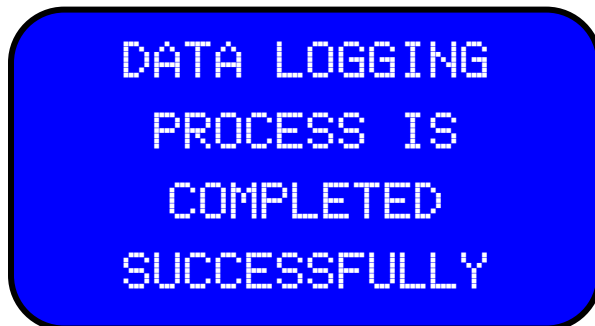
During a high speed data logging session (600, 800, 960, 1200, 1600, 2400 and 4800) the *Voltage output*, *Current output*, and *ASCII output* are internally disabled and the data logging menu cannot be left until the timer expires. This will force the processor to allocate more time frames to process the data from ADC, perform the calculation, and save the data into the internal buffer, however after completing the data logging session, the initial conditions will be restored.



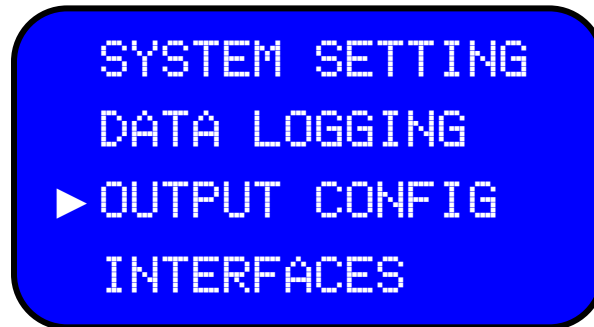
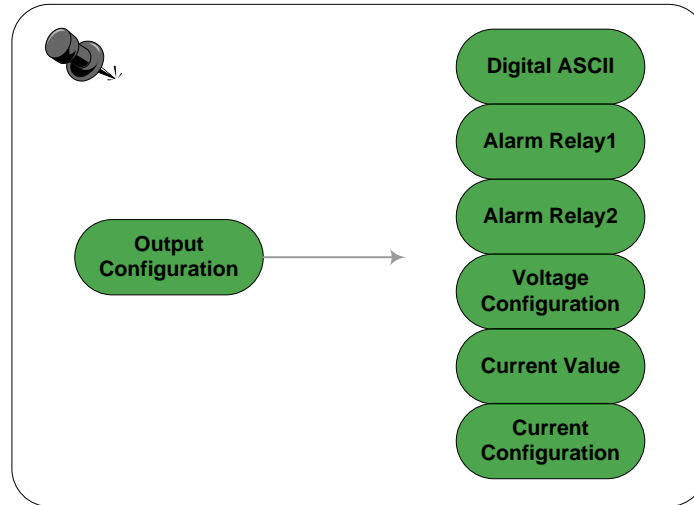
When performing data logging session at lower speed sampling rates below 600 sps, there is an option to exit the data logging screen and return to the main screen where the countdown timer shows the elapsed time.



The following message will be displayed as soon as the data logging session has been completed.



6.4 Output Configuration



6.4.1 Digital ASCII

Scroll to “**DIGITAL ASCII**” from “**OUTPUT CONFIG**” using the ▲▼ keys and press ENTER. ASCII output consists of four rows of data. Each row can be separated using following options:

- Carriage Return: carriage return (CR) is one of the control characters in ASCII code which moves the position of the cursor to the first position on the same line
- Line feed: moves the cursor on a display screen down one line.
- Carriage Return and line feed: moves to the next line, while carriage return precedes line feed to indicate a new line.
- Line feed and Carriage Return

```
▶ DIGITAL ASCII
ALARM RELAY1
ALARM RELAY2
VOLTAGE CONFIG
```

Use the ◀▶ keys and press ENTER to select CR, LF, LF & CR or LF & CR.

```
SELECT DESIRED
TERMINATION CHAR
USING ◀, ▶ KEYS
[CR+LF]
```

```
WOULD YOU LIKE
TO SAVE AS
DEFAULT?
<YES>      <NO>
```

6.4.2 Alarm Relay 1

Alarm relay 1 is a solid state relay with a voltage / current rating of 110V/100mA. Alarm relay 1 has been mapped to alarm high.

Scroll to “ALARM RELAY1” from “OUTPUT CONFIG” using the ▲▼ keys and press ENTER.
Use the ◀▶ keys to set the alarm relay 1 either to be normally open or normally close.

```
DIGITAL ASCII
▶ ALARM RELAY1
ALARM RELAY2
VOLTAGE CONFIG
```

```
SELECT DESIRED
RELAY CONFIG
USING ◀, ▶ KEYS
[NORMALLY OPEN]
```

A prompt will be shown to set this value as a default setting.

```
WOULD YOU LIKE
TO SAVE AS
DEFAULT?
<YES>      <NO>
```

6.4.3 Alarm Relay 2

Alarm relay 2 is a solid state relay with a voltage / current rating of 110V/100mA. Alarm relay 2 has been mapped to alarm low.

Scroll to “ALARM RELAY2” from “OUTPUT CONFIG” using the ▲▼ keys and press ENTER.
Use the ◀▶ keys to set the alarm relay 2 either to be normally open or normally close.

```
DIGITAL ASCII
ALARM RELAY1
▶ALARM RELAY2
VOLTAGE CONFIG
```

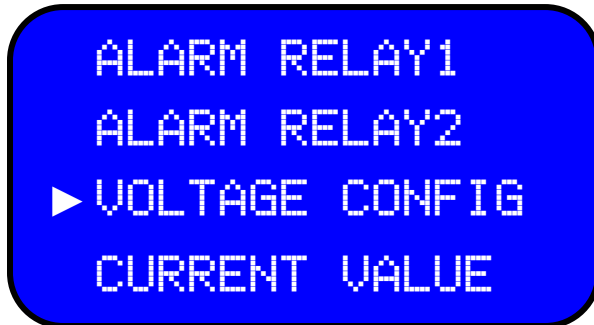
```
SELECT DESIRED
RELAY CONFIG
USING ◀, ▶ KEYS
[NORMALLY OPEN]
```

A prompt will be shown to set this value as a default setting.

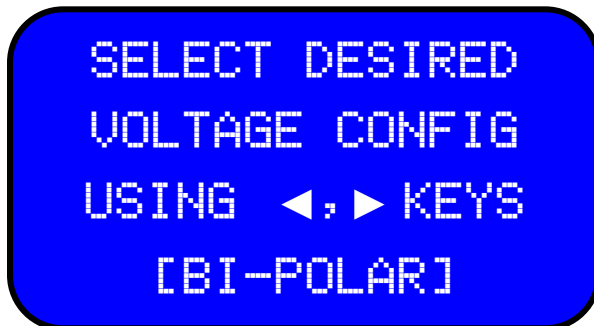
```
WOULD YOU LIKE
TO SAVE AS
DEFAULT?
<YES>      <NO>
```


6.4.4 Voltage Configuration

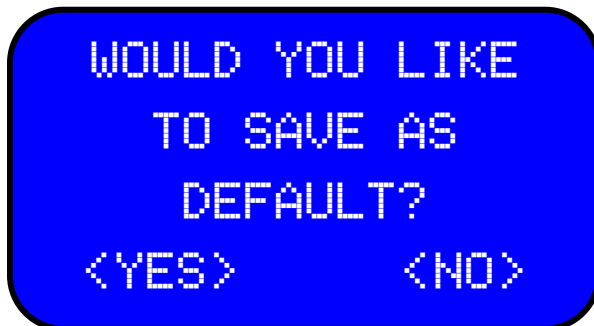
Scroll to “VOLTAGE CONFIG” from “OUTPUT CONFIG” using the ▲ ▼ keys and press ENTER.



Use the ◀ ▶ keys to select uni-polar which is 0 to 5 volts (negative full scale is mapped to 0 VDC, zero load is mapped to 2.5 VDC and plus full scale is mapped to +5V) or bipolar which is -5 VDC to 5 VDC (negative full scale is mapped to -5 VDC, zero load is mapped to 0 VDC and plus full scale is mapped to +5VDC).

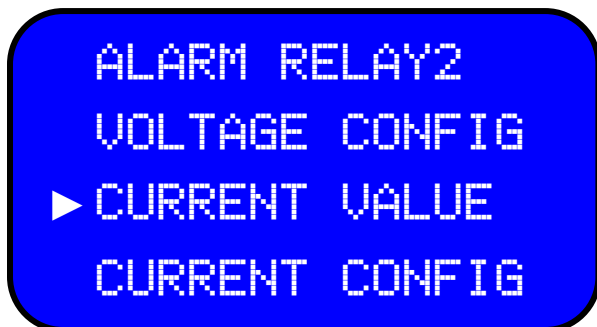


A prompt will be shown to set this value as a default setting.



6.4.5 Current Value

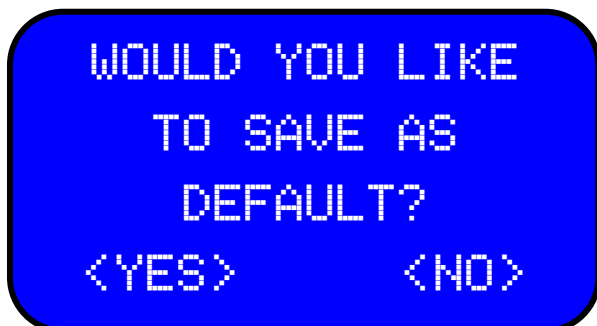
Scroll to “CURRENT VALUE” from “OUTPUT CONFIGURATION” using the ▲ ▼ keys and press ENTER to define the current value.



Use the ◀ ▶ keys and press ENTER to select any of the following Ranges: 0-20 mA, 4-20 mA, 0-25 mA or 5-25 mA.



A prompt will be shown to set this value as a default setting.



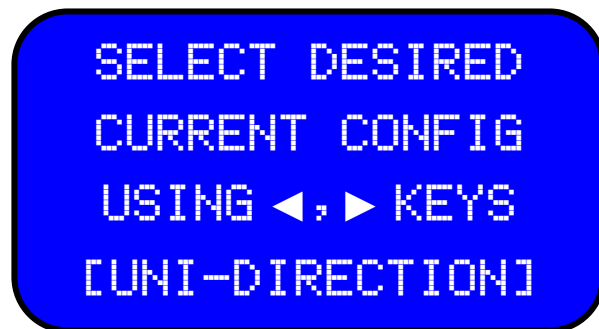
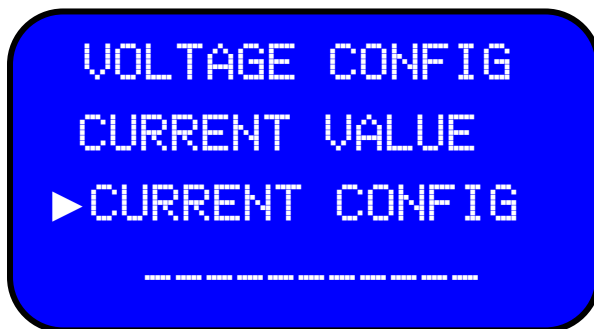
6.4.6 Current Configuration

Scroll to “CURRENT CONFIG” from “OUTPUT CONFIG” using the ▲▼ keys and press ENTER. Use the ◀▶ keys to select either UNIDIRECTIONAL or BIDIRECTIONAL

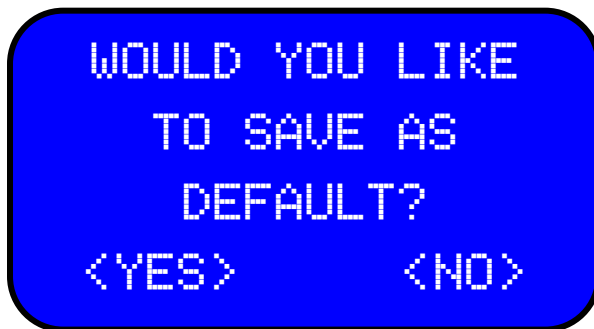
- For a Bi-Directional configuration the, negative full scale output from the sensor is mapped to the lowest value of current. A zero load output from the sensor is mapped to the middle value and the positive full scale output from the sensor is mapped to the highest value of current. For example if 4-20 mA is selected, the sensor’s negative full scale output is mapped to 4 mA, the zero load output from the sensor is mapped to 12 mA, and the sensor positive full scale output is mapped to 20 mA.

This configuration is recommended for bidirectional sensors.

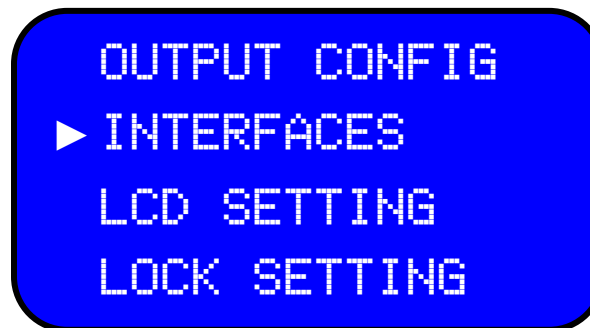
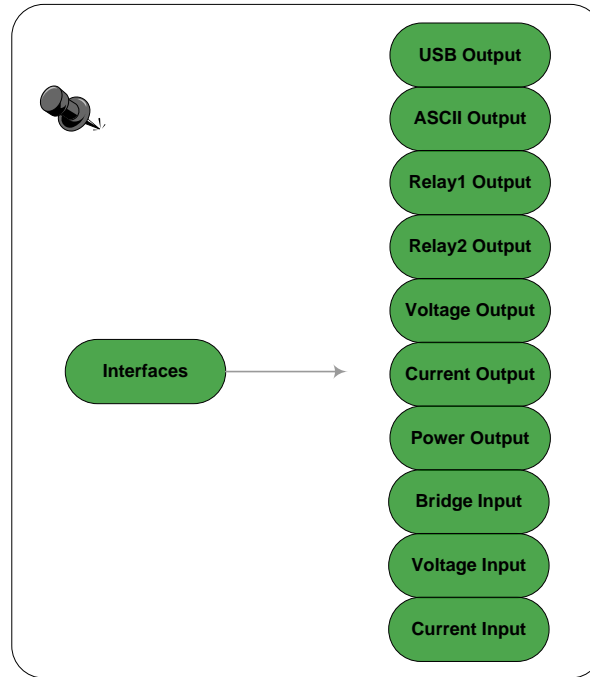
- For a Unidirectional configuration, the zero load output from the sensor is mapped to the lowest value of current and the sensor’s positive full scale output is mapped to the highest value of current. For example if 4-20 mA is selected, the zero load output from the sensor is mapped to 4 mA, and sensor’s positive full scale output is mapped to 20 mA. For negative values of load, output current decreases until reach 0 mA.
- This configuration is recommended for unidirectional sensors in order to obtain more resolution.



A prompt will be shown to set this value as a default setting.



6.5 Interfaces



The following can be either enabled or disabled under the Interfaces menu:

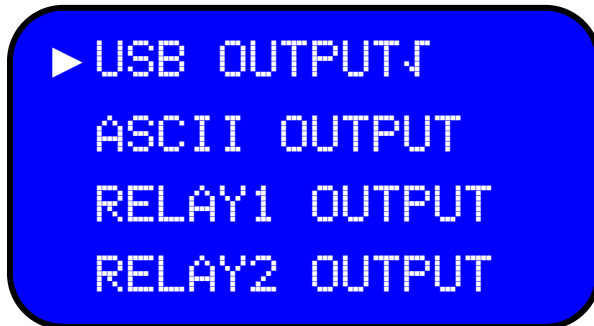
USB output, ASCII output, Relay 1 output, Relay 2 output, Voltage output, Current output, Power output, Bridge input, Voltage input, and Current input. A check mark next to the item indicates that item has been activated.

Output enable: This feature enables a 24 V/1W power supply to be used as an excitation voltage (power supply) for an amplified sensor which requires an external power supply. It is highly recommended to disable this feature when a bridge type sensor is connected to the IPM650.

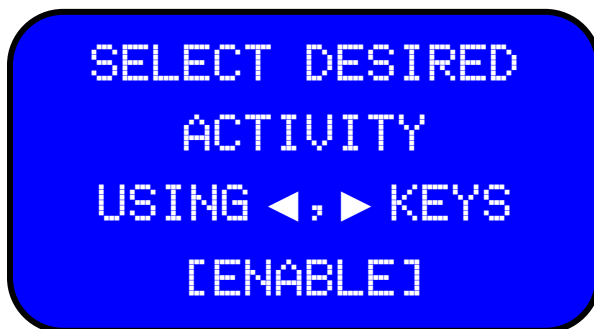
Using this feature will enable the internal DC-DC converter, thus providing high voltage.

6.5.1 USB Output

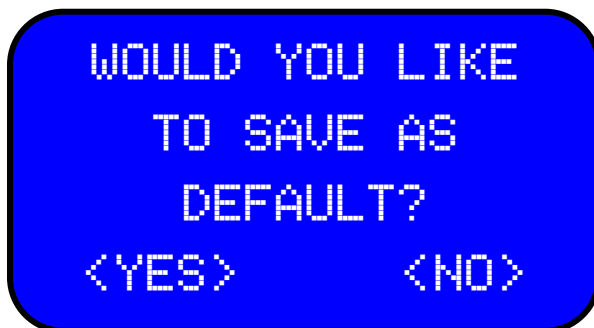
Scroll to "USB OUTPUT" from "INTERFACE" using the ▲ ▼ keys and press ENTER.



Use the ◀ ▶ keys to either enable or disable the USB output activity.



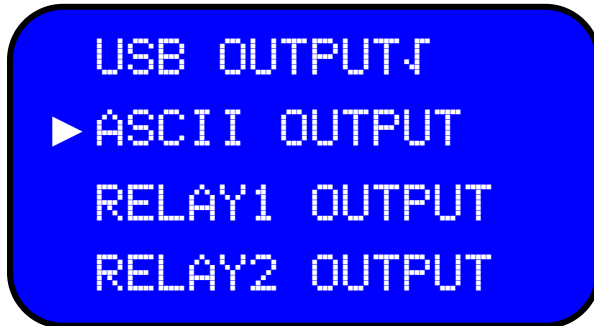
A prompt will be shown to set this value as a default setting.



Whenever the USB Output is enabled a check mark showing that this feature is enabled will be seen on the display.

6.5.2 ASCII output

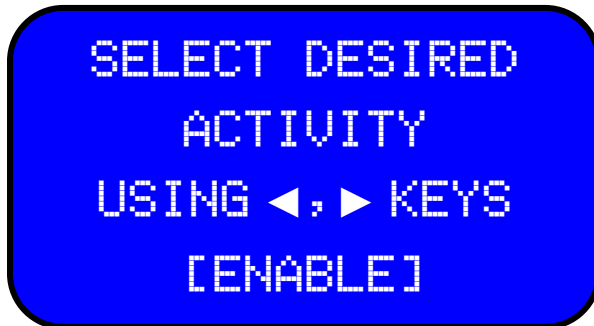
Scroll to "ASCII OUTPUT" from "INTERFACE" using the ▲▼ keys and press ENTER.



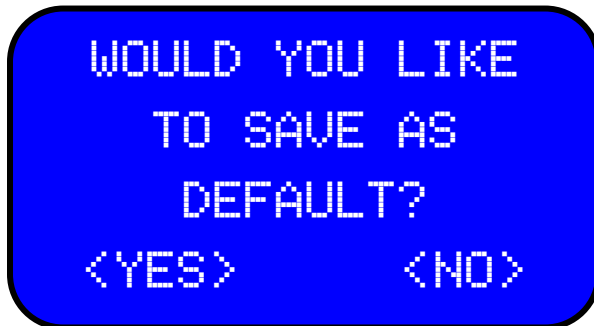
Use the ◀▶ keys to either enable or disable the ASCII output.

The termination character configuration should be set in the Digital ASCII menu within the Output Config menu. Refer to section (6.4.1) for more details.

The ASCII output is disabled when the IPM650 sends and receives packet information from the computer.



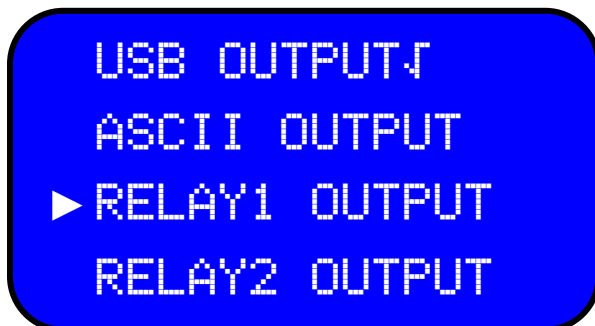
A prompt will be shown to set this value as a default setting.



Whenever the ASCII Output is enabled a check mark showing that this feature is enabled will be seen on the display.

6.5.3 Relay 1 Output

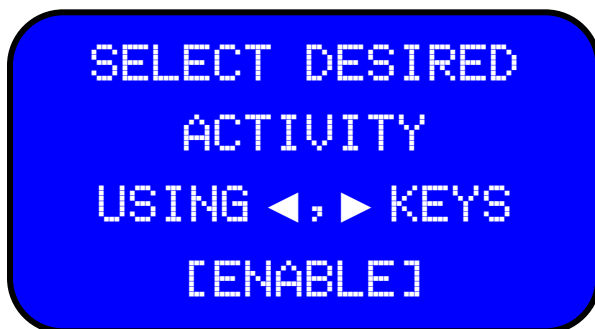
Scroll to “RELAY1 OUTPUT” from “INTERFACE” using the ▲ ▼ keys and press ENTER.



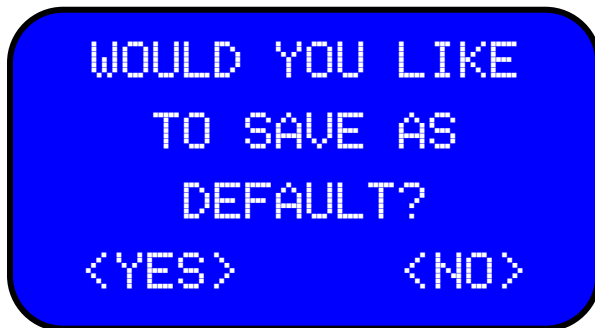
Use the ◀ ▶ keys to enable or disable Relay 1 output.

The configuration of the Relay 1 Output should be set under the output configuration menu. Refer to section (6.4.2) for more details.

Relay 1 is mapped to alarm high and will be affected by the alarm settings under the system setting menu. Refer to section (6.2.8) for more details on alarm activity.



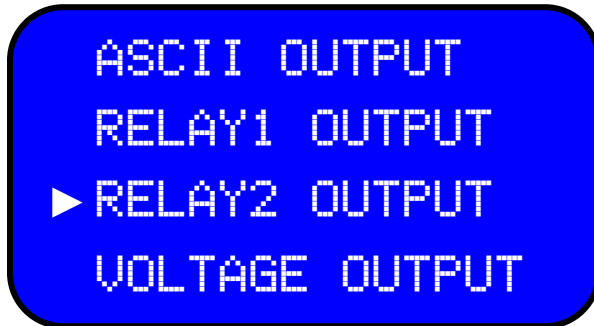
A prompt will be shown to set this value as a default setting.



Whenever the Relay 1 Output is enabled a check mark showing that this feature is enabled will be seen on the display.

6.5.4 Relay 2 Output

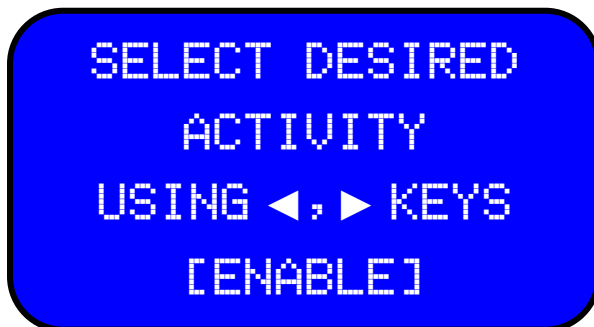
Scroll to “RELAY OUTPUT2” from “INTERFACE” using the ▲▼ keys and press ENTER.



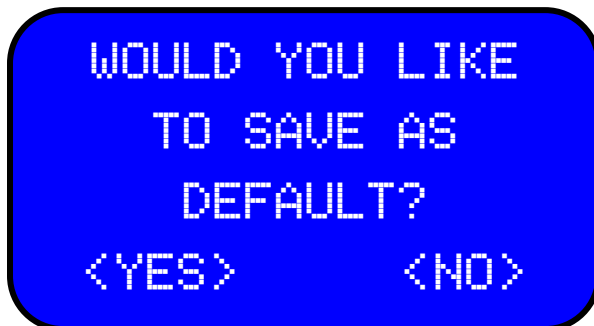
Use the ◀▶ keys to either disable or enable the Relay 2.

The configuration of the Relay 2 Output should be set under the output config menu. Refer to section (6.4.3) for more details.

Relay 2 is mapped to alarm low and will be affected by the alarm settings under the system settings menu. Refer to section (6.2.8) for more details.



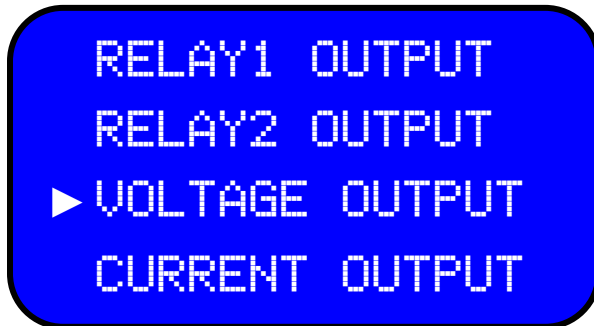
A prompt will be shown to set this value as a default setting.



Whenever the Relay 2 Output is enabled a check mark showing that this feature is enabled will be seen on the display.

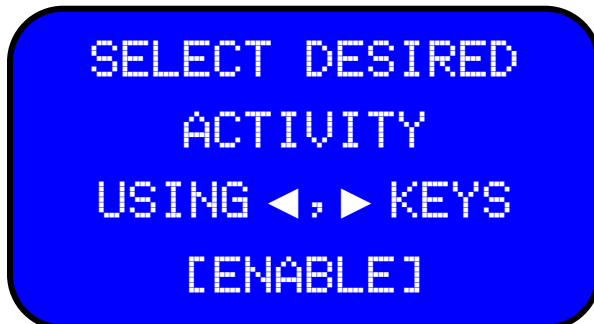
6.5.5 Voltage Output

Scroll to “VOLTAGE OUTPUT” from “INTERFACE” using the ▲▼ keys and press ENTER.

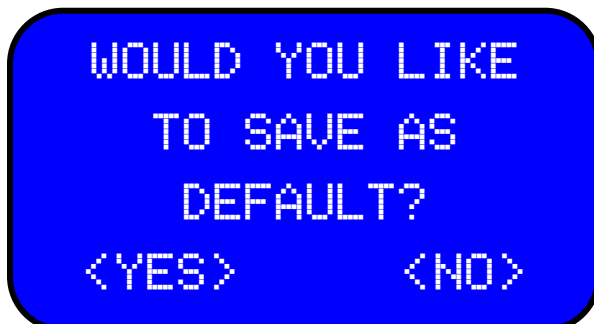


Use the ◀▶ keys to either disable or enable the Voltage Output activity.

The configuration of the Voltage Output should be set under the output config menu. Refer to section (6.4.4) for more details.



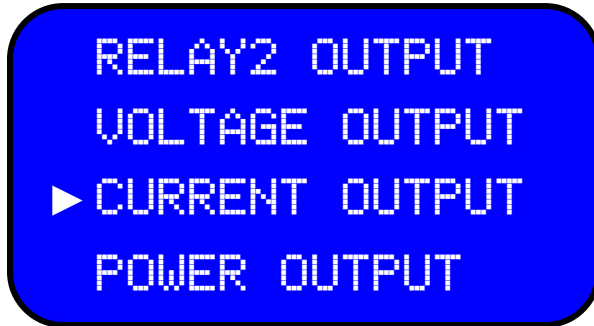
A prompt will be shown to set this value as a default setting.



Whenever the Voltage Output is enabled a check mark showing that this feature is enabled will be seen on the display.

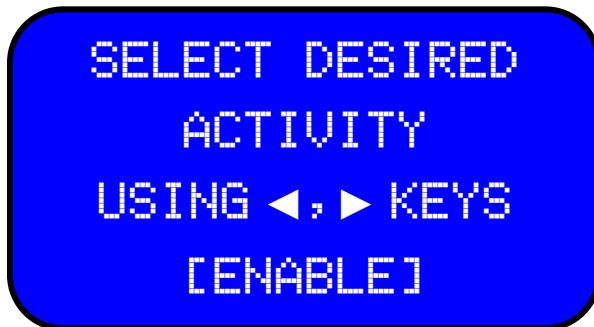
6.5.6 Current Output

Scroll to “CURRENT OUTPUT” from “INTERFACE” options using the ▲ ▼ keys and press ENTER.

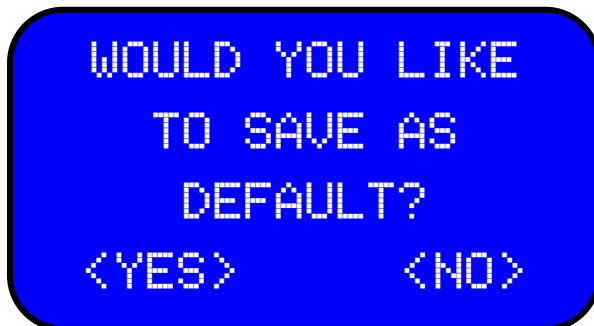


Use the ◀ ▶ keys on to either disable or enable the Current Output.

The configuration of the Current Output should be set under the output config menu. Refer to section (6.4.5) for more details.



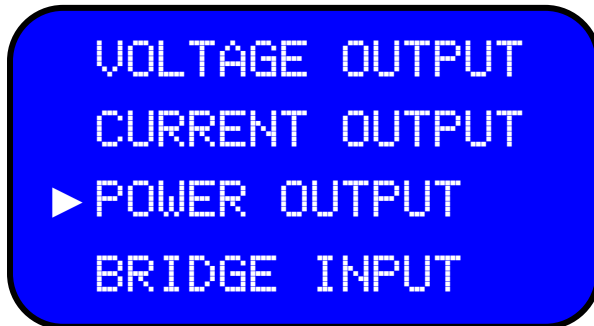
A prompt will be shown to set this value as a default setting.



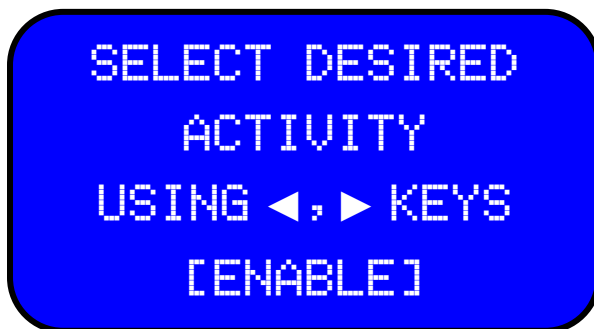
Whenever the Current Output is enabled a check mark showing that this feature is enabled will be seen on the display.

6.5.7 Power Output

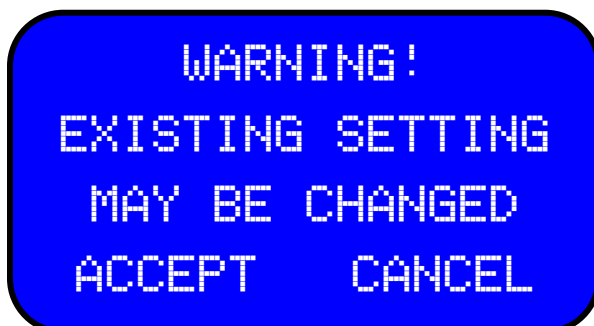
Scroll to “POWER OUTPUT” from “INTERFACE” options using the ▲ ▼ keys and press ENTER.



Use the ◀ ▶ keys to either disable or enable the Power Output.



Depending on the type of sensor that has already defined in the current sensor profile, a warning message will be displayed when attempting to enable an input type which is not matched with the sensor configuration. For example, if the active channel 2 is defined as a bridge input the following warning message will appear on the screen when activating the Power Output:

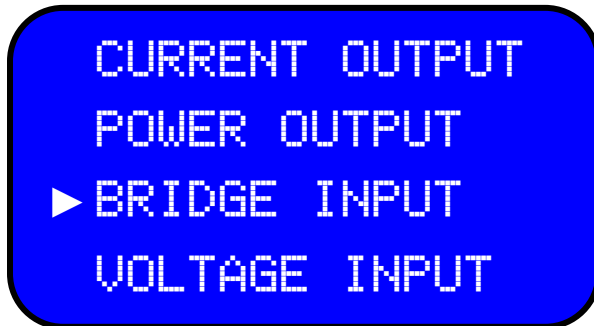


Whenever the Power Output is enabled a check mark showing that this feature is enabled will be seen on the display.

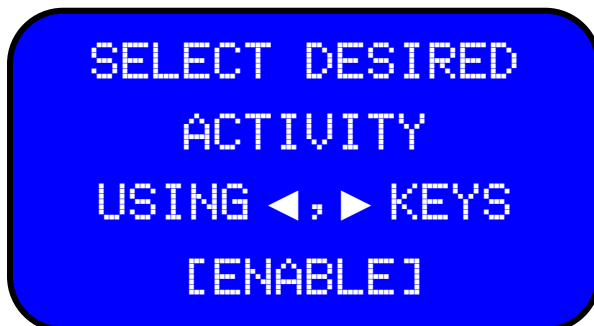
Important notice: Bridge sensors are internally connected to input number 1, current sensors are connected to input number 2 and voltage sensors are connected to input number 3. Enabling a different type of input can result in incorrect measurements.

6.5.8 Bridge Input

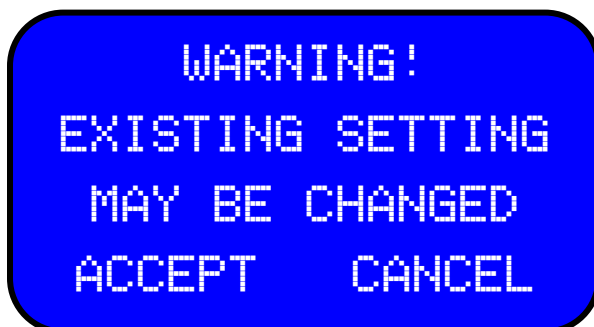
Scroll to “**BRIDGE INPUT**” from “**INTERFACE**” using the ▲ ▼ keys and press **ENTER**.



Use the ◀ ▶ keys to either enable or disable the Bridge Input.



Depending on the type of sensor defined in the current sensor profile, a warning message will be displayed when attempting to enable an input type which is not matched with the sensor configuration. *For example*, if the active channel is defined as a bridge input the following warning message will appear on the screen when activating a different input setting:

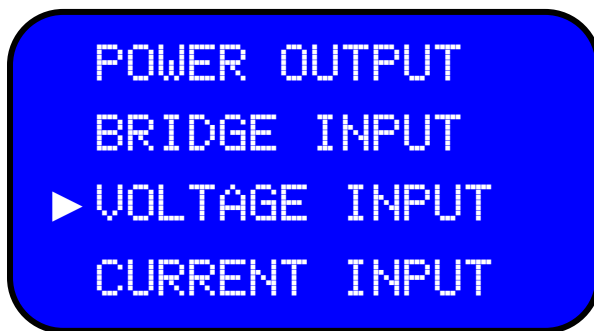


Whenever the Bridge Input is enabled a check mark showing that this feature is enabled will be seen on the display.

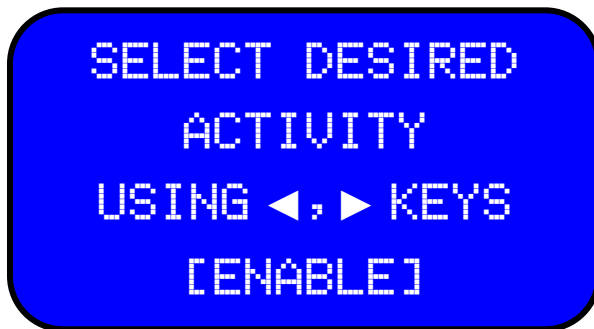
Important notice: Bridge sensors are internally connected to input number 1, current sensors are connected to input number 2 and voltage sensors are connected to input number 3. Enabling a different type of input can result in incorrect measurements.

6.5.9 Voltage Input

Scroll to “**VOLTAGE INPUT**” from “**INTERFACE**” using the ▲▼ keys and press **ENTER**.



Use the ◀▶ keys to either disable or enable the voltage input.



Depending on the type of sensor defined in the current sensor profile, a warning message will be displayed when attempting to enable an input type which is not matched with the sensor configuration. *For example*, if the active channel is defined as a bridge input the following warning message will appear on the screen when activating a different input setting:

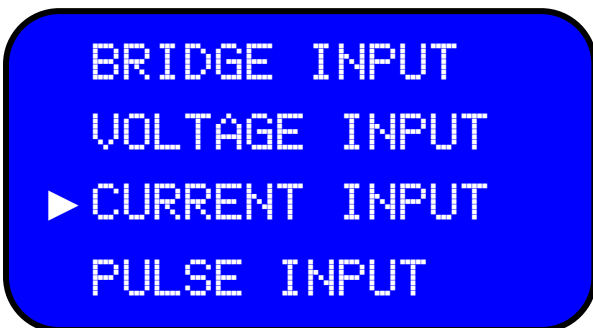


Whenever the Voltage Input is enabled a check mark showing that this feature is enabled will be seen on the display.

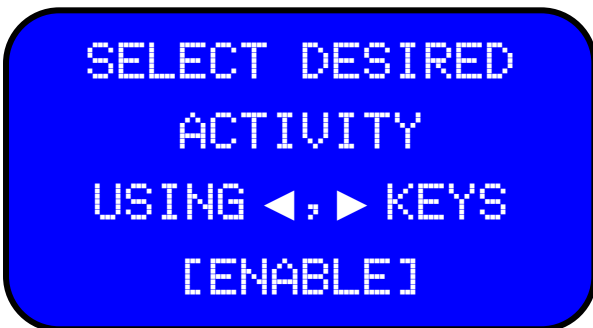
Important notice: Bridge sensors are internally connected to input number 1, current sensors are connected to input number 2 and voltage sensors are connected to input number 3. Enabling a different type of input can result in incorrect measurements.

6.5.10 Current Input

Scroll to "CURRENT INPUT" from "INTERFACE" using the ▲▼ keys and press ENTER.



Use the ◀▶ keys to either disable or enable the Current Input.



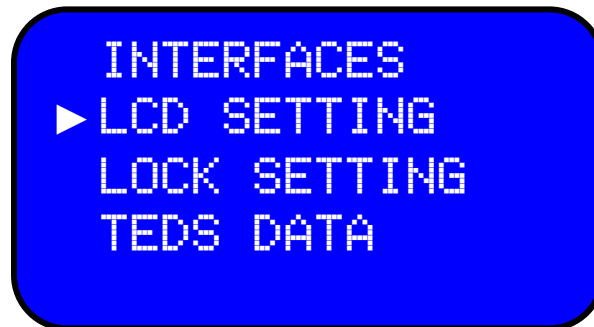
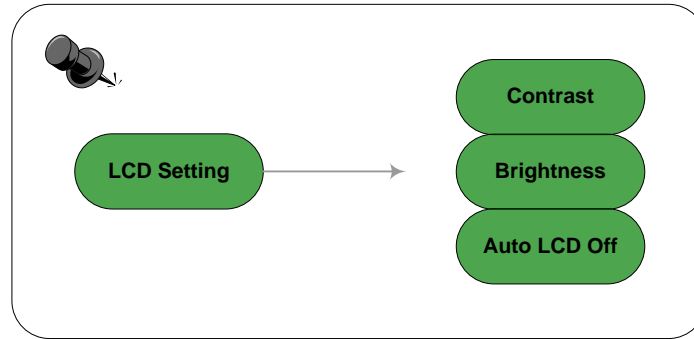
Depending on the type of sensor defined in the current sensor profile, a warning message will be displayed when attempting to enable an input type which is not matched with the sensor configuration.

For example, if the active channel is defined as a bridge input the following warning message will appear on the screen when activating a different input setting:



Whenever the Current Input is enabled a check mark showing that this feature is enabled will be seen on the display.

6.6 LCD Setting



6.6.1 Contrast

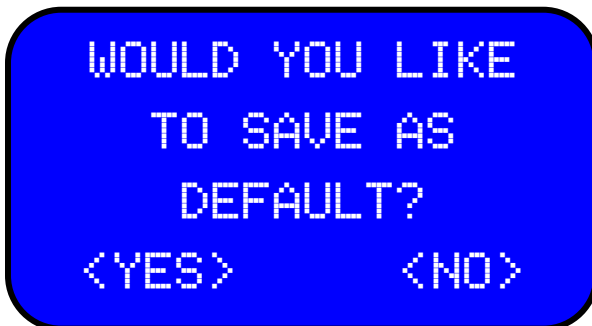
Scroll to "CONTRAST" from "LCD SETTING" using the ▲ ▼ keys and press ENTER.



Use the ◀ ▶ keys to select the desired LCD contrast level.



A prompt will be shown to set this value as a default setting.



6.6.2 Brightness

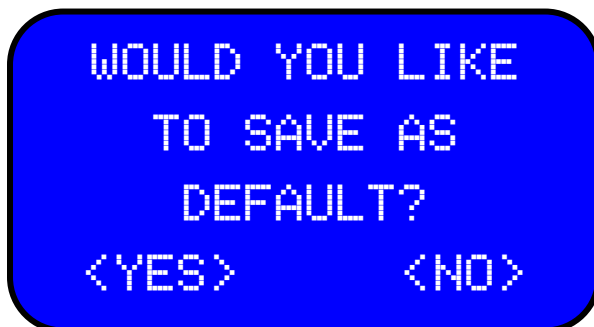
Scroll to "BRIGHTNESS" from "LCD SETTING" using the ▲▼ keys and press ENTER.



Use the ◀▶ keys to select the desired LCD brightness level.



The desired Brightness can be saved as default.

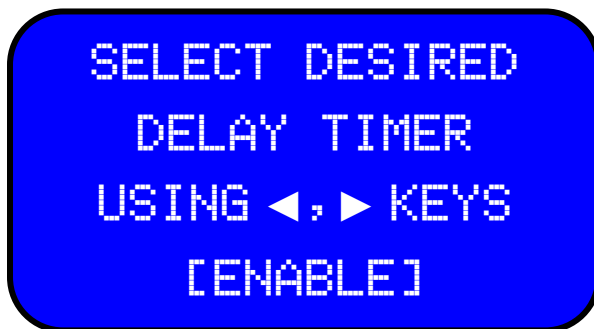


6.6.3 Auto LCD off

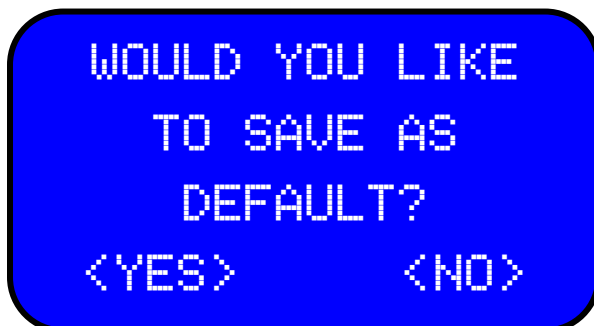
Scroll to "AUTO LCD OFF" from the "LCD SETTING" using the ▲ ▼ keys and press ENTER.



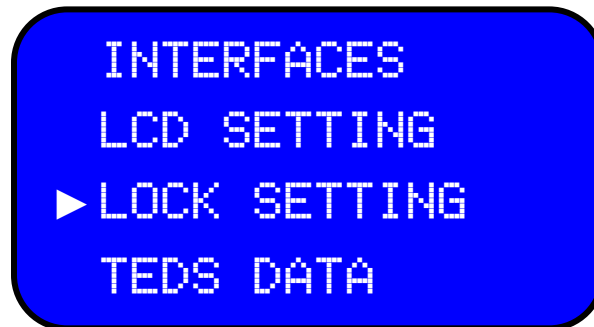
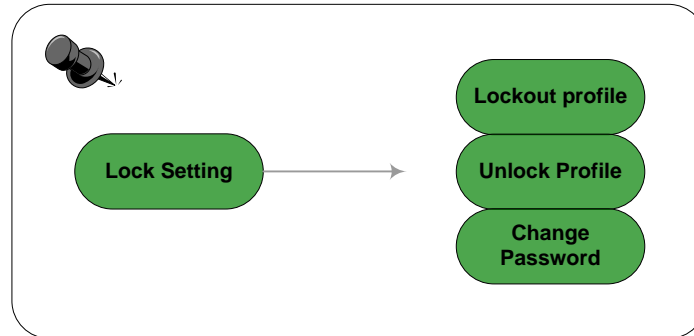
Use the ◀ ▶ keys to Enable or Disable the Auto LCD Off feature. The Auto LCD Off timer can be set for 1-15min, after which the LCD will turn off if left unattended.



A prompt will be shown to set this value as a default setting.



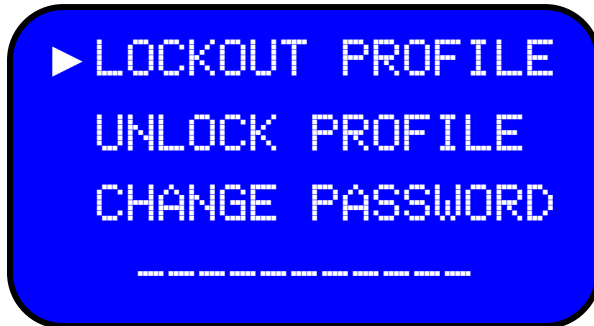
6.7 Lock Settings



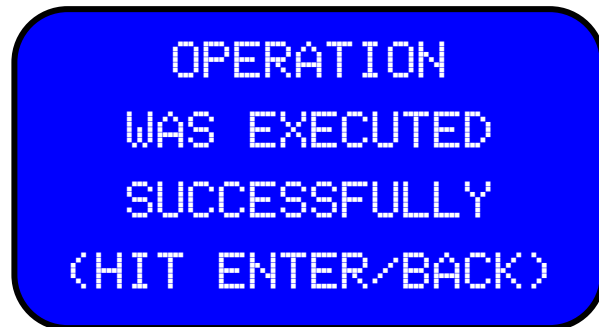
The Lock Setting menu is used to control access to the Sensor Profile settings and data information that have been stored in internal non-volatile memory (6.1.3.x and 6.1.4.x). Additionally, the Lock Setting menu is used to control the following submenus in Sensor Profile menu: New, Edit, Save, Delete.

6.7.1 Lockout Profile

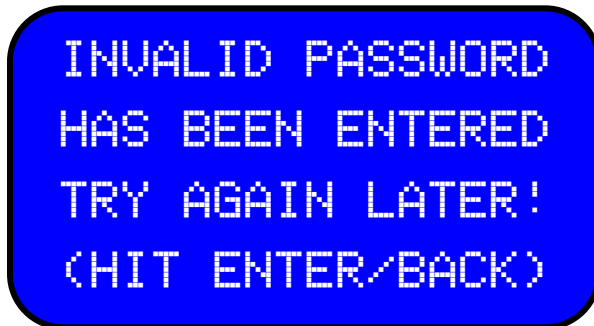
Scroll to “**LOCKOUT PROFILE**” from “**LOCK SETTING**” using the ▲▼ keys and press ENTER. Once pressed ENTER, this feature will lockout the Edit, New, Save, and Delete of **SENSOR PROFILE** menu. However the Existing Channel(s) and the View Channel(s) options are still accessible.



Enter the current password to lockout the sensor profile. If the correct password is entered the following success message will be displayed.

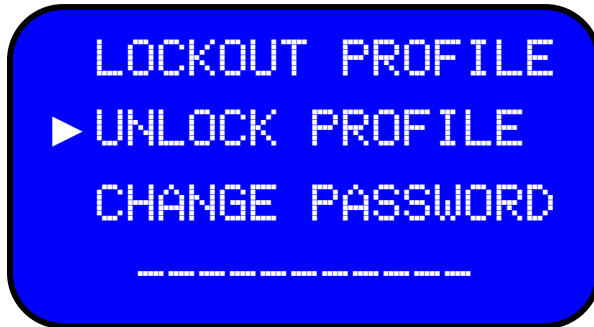


If the password is entered incorrectly, an invalid password message will appear:

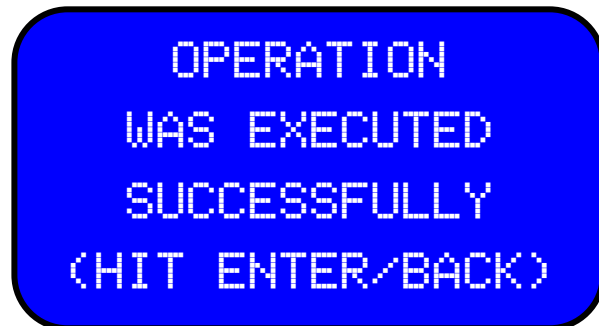


6.7.2 Unlock profile

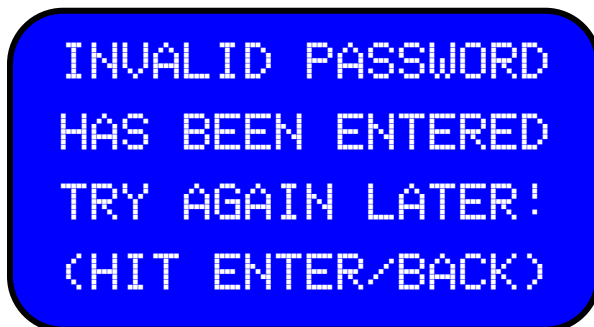
Scroll to “UNLOCK PROFILE” from “LOCK SETTING” using the ▲▼ and press ENTER. Once pressed the ENTER, this feature unlocks the sensor profile menu and full access to sensor profile will be gained.



Enter the current password to unlock the sensor profile. If the correct password is entered, the following success message will be displayed.

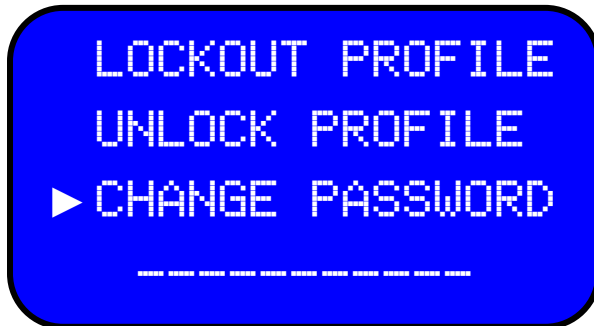


If the password is entered incorrectly, an invalid password message will appear:



6.7.3 Change Password

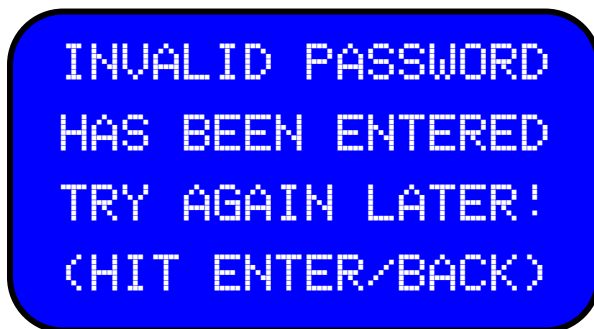
Scroll to “CHANGE PASSWORD” from “LOCK SETTING” using the ▲▼ keys and press ENTER.



Use the ◀▶ and ▲▼ keys to select the current password.



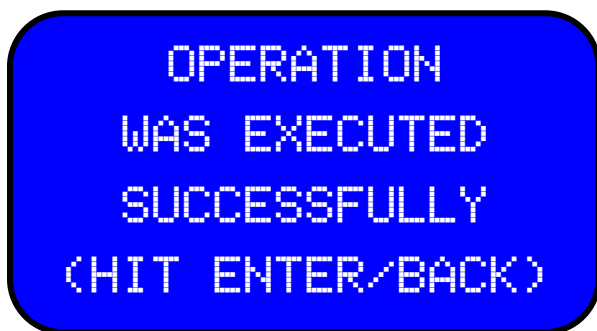
The current password shall be entered in order to be able to change the password. Once an incorrect password is entered, the following message will appear:



Use the ◀▶ and ▲▼ keys to set the desired password. Any combination of seven digits can be chosen. Press ENTER to save the new password.



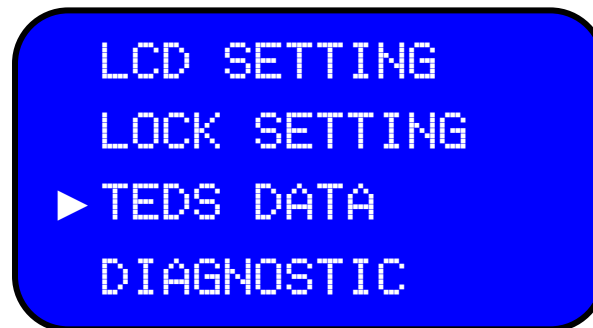
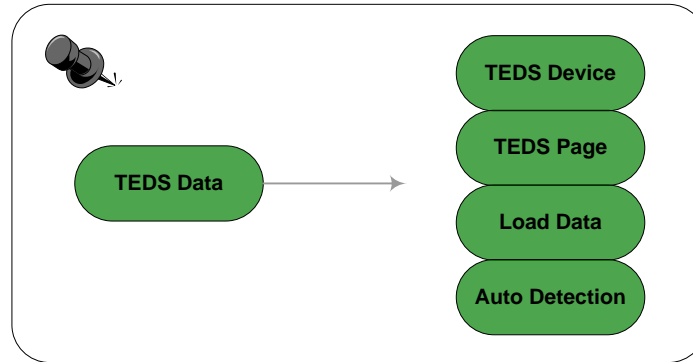
The following success message will appear on the screen once the desired password has been entered.



NOTE:

The IPM650 has a default password ([0000000]) mentioned in Appendix C. This password can be updated with desired password. Additionally there is an alternative permanent (please see Appendix C). In case the assigned password is forgotten, the alternative password can be used as the current password to lock/unlock /change the setting submenus.

6.8 TEDS Data



The mentioned IEEE 1451.4 standard defines a collection of templates for common class transducer. The templates provide the means for the measurement system to convert the binary data stored on a smart TEDS sensor EEPROM.

The IPM650 supports Template 30 for High level voltage output sensors and template 33 for bridge type sensors.

Transducers with stated template for different chip devices (DS2430, DS2431, DS2432 and DS2433) are supported with IPM650.

List of probable error while using TEDS:

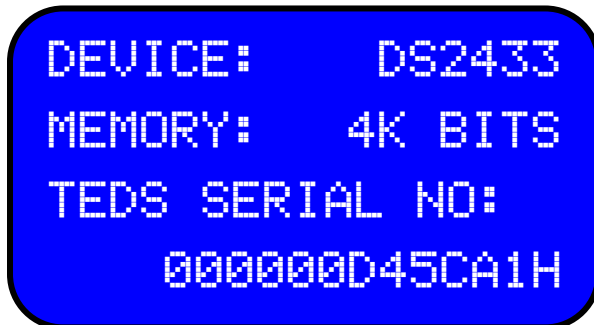
Please see Appendix A

6.8.1 TEDS Device

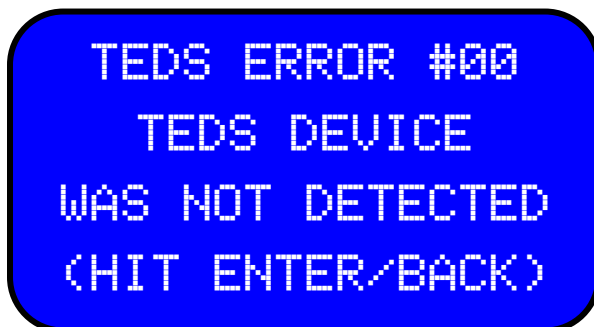
Scroll to "TEDS DEVICE" from "TEDS DATA" using the ▲ ▼ keys and press ENTER.



If a TEDS device is connected, the TEDS information will be displayed as shown below:

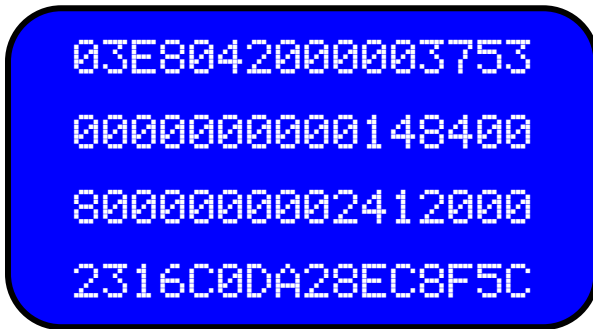


If the TEDS DEVICE is selected without a connected TEDS device, an error message will be displayed.



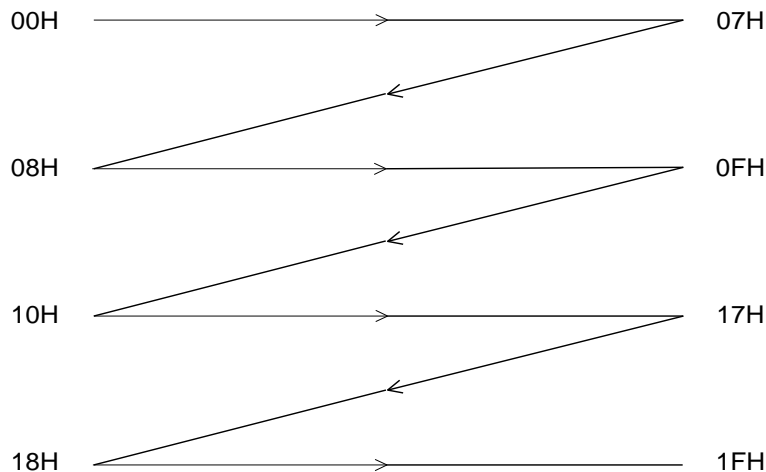
6.8.2 TEDS Page

Scroll “**TEDS PAGE**” from “**TEDS DATA**” using THE ▲ ▼ keys and press ENTER.
 A total of sixteen pages (0 – 15) can be selected



If **TEDS PAGE** is selected, without a connected TEDS device, an error message will be displayed.

Each TEDS page is 32 bytes and is mapped as below:

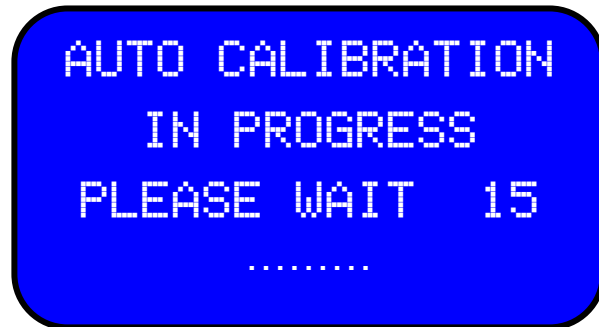
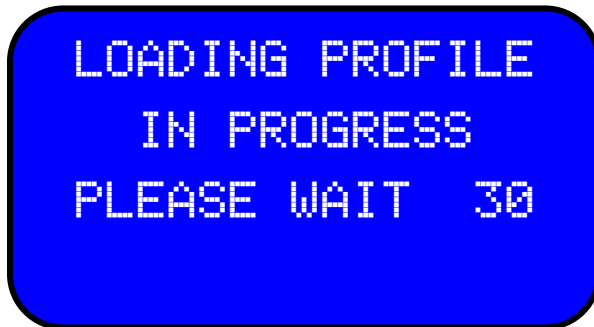


6.8.3 Load Data

Scroll to "LOAD DATA" from "TEDS DATA" using the ▲ ▼ keys and press ENTER.



The load data option loads the new profile, based on the TEDS data, and performs an auto calibration.



If **Load Data** is selected, without a connected TEDS device, an error message will be displayed.

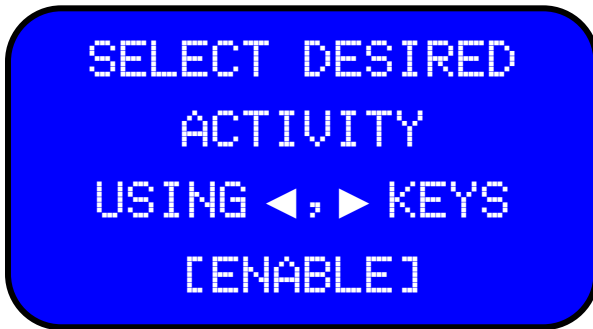
6.8.4 Auto Detection

Scroll to “**AUTO DETECTION**” from “**TEDS DATA**” using the ▲ ▼ keys and press ENTER.

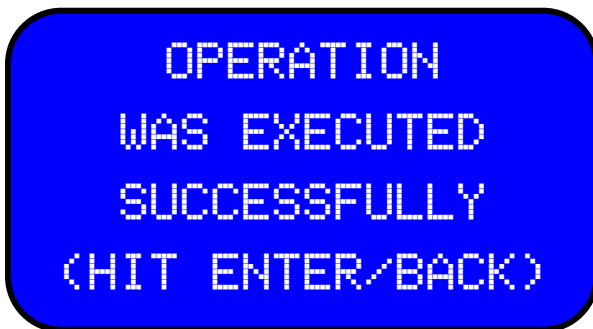
If “**AUTO DETECTION**” is enabled, the IPM650 will search for a TEDS device during power up. If TEDS information exists, its information will be loaded; otherwise the IPM650 will load the active channel. If “**AUTO DETECTION**” is disabled, the IPM650 will load the active channel during power up.



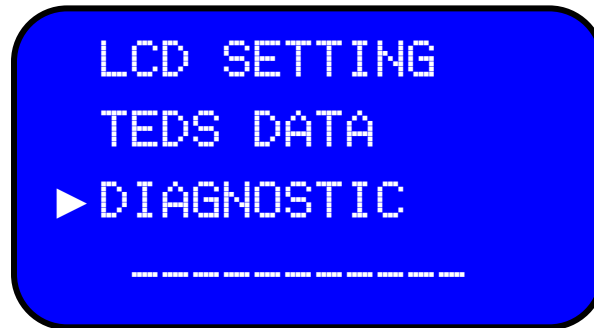
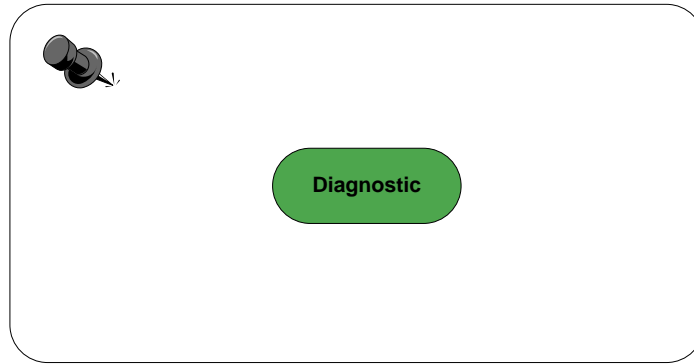
Use the ◀ ▶ keys to Enable or Disable the TEDS Auto Detection feature



The following message will be displayed confirming the operation was executed successfully.



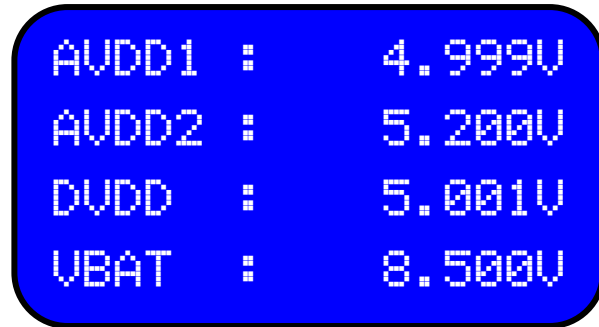
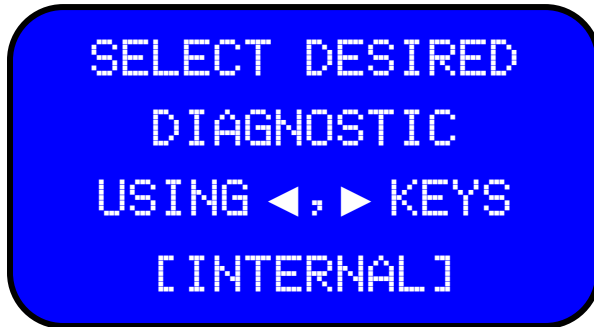
6.9 Diagnostic



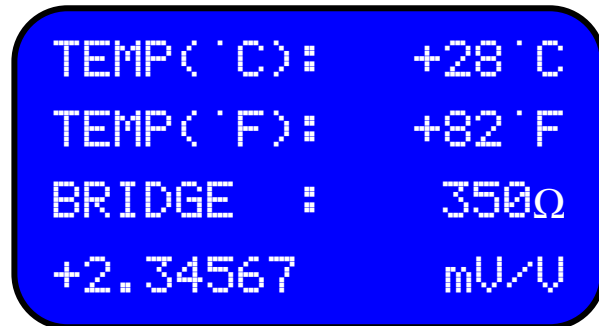
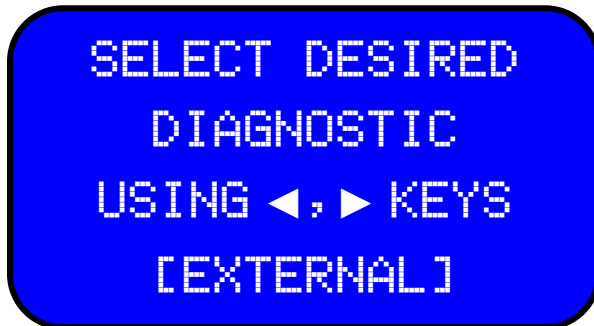
6.9.1 Internal or External

Scroll to “DIAGNOSTIC” using the ▲▼ keys and press ENTER.

Use the ◀▶ keys to select either INTERNAL or EXTERNAL diagnostic.



The internal diagnostic shows the analog VDD1, analog VDD2, digital VDD, and VBAT values.



The external diagnostic shows the sensor sensitivity, Temp, and bridge resistance.

NOTE:

The external diagnostic page can only show the information of a Strain gage with the sensitivity of less than 4mV/V. If the sensor is amplified voltage output or current output or has a sensitivity more than 4 mV/V, when trying to display External Diagnostic, an error message will appear stating that this function is not available.

7 Appendix A (List of Probable Errors)

Error No.	Error Description on the LCD
Error #1	TEDS DEVICE WAS NOT DETECTED
Error #2	UNKNOWN DEVICE WAS DETECTED
Error #3	UNKNOWN TEMPLATE WAS DETECTED
Error #4	UNKNOWN UNIT WAS DETECTED
Error #5	ELECTRICAL VALUE IS INVALID
Error #6	TEDS DATA IS INVALID
Error #7	BRIDGE TYPE IS INVALID

Error #1: TEDS DEVICE WAS NOT DETECTED

If any non TEDS sensor is connected or if TEDS is not connected properly the mentioned error will occur.

Error #2: UNKNOWN DEVICE WAS DETECTED

The IPM650 supports chip number DS2430, DS2431, DS2432 and DS2433. Any other TEDS device with a different data sheet numbers will not be able to interact with the IPM650.

Error #3: UNKNOWN TEMPLATE WAS DETECTED

The IPM650 supports template numbers 30 and 33; any other TEDS device with different template numbers will not be able to interact information with the IPM650.

Error #4: UNKNOWN UNIT WAS DETECTED

If the sensor's TEDS has been defined with units other than IEEE standard units, the mentioned error will occur.

Error #5: ELECTRICAL VALUE IS INVALID

This error occurs when the electrical values are more than defined values.

Error #6: TEDS DATA IS INVALID

The defined TEDS information is invalid.

Error #7: BRIDGE TYPE IS INVALID

The IPM650 supports full bridge only configurations, therefore any other bridge type transducers like quarter or half plugged to this device will not recognized and the mentioned error to occur.

8 Appendix B (List of Messages)

Message No.	Message Description on the LCD	pages
Welcome Message	FUTEK ADVANCED SENSOR TECH INC. IPM650-PRO MADE IN USA	14
Delete Message	WARNING! SELECTED PROFILE MAY BE LOST! ACCEPT CANCEL	56
Delete Confirmation	ARE YOU SURE WANT TO DELETE ACTIVE CHANNEL? YES NO	56
Interface Warning	WARNING! EXISTING SETTING MAY BE CHANGED ACCEPT CANCEL	87, 88, 89, 90
Unsaved Data Warning	WARNING! EXIT WITHOUT SAVING PROFILE? YES NO	24
Success Message	OPERATION WAS EXECUTED SUCCESSFULLY HIT ENTER / BACK	25, 26, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40, 41, 43, 45, 46, , 48, 54, 56, 57, 96, 97, 99, 104
Confirmation Message	WOULD YOU LIKE TO SAVE AS DEFAULT? YES NO	59, 60, 61, 64, 65, 66, 67, 69, 74, 75, 76, 77, 78, 79, 81, 82, 83, 84, 85, 86, 92, 93, 94
Edit/ delete Warning	THERE IS NOT ANY CHANNEL AVAILABLE FOR THIS INTENTION	49, 55
(+)No Load Calibration	APPLY ZERO LOAD(+) CALIBRATION THEN PRESS ENTER	36

(+)Full Load Calibration	APPLY FULL SCALE(+) CALIBRATION THEN PRESS ENTER	37
(-)Full Load Calibration	APPLY FULL SCALE(-) CALIBRATION THEN PRESS ENTER	37
(-)No Load Calibration	APPLY ZERO LOAD(-) CALIBRATION THEN PRESS ENTER	37
Unavailable Feature	SELECTED FEATURE IS NOT AVAILABLE AT THIS TIME HIT ENTER / BACK	24, 49, 53, 57
Incorrect password Warning	INVALID PASSWORD HAS BEEN ENTERED TRY AGAIN LATER! (HIT ENTER/ BACK)	96, 97, 98
Data Logging Confirmation	DATA LOGGING PROGRESS COMPLETED SUCCESSFULLY	70, 72

9 Appendix C (Device Specifications)

Main Control Processor Unit (MCPU)

Part #: MSC1214
Internal ADC Resolution: 24 bits
Sampling Rate: 60 SPS
Application: Diagnostic mode

DAC Resolution: * 16 bits
DAC Accuracy: * 0.02% of FSR (Factory Calibrated)
DAC Non linearity:* 0.1% of FSR (Factory Calibrated)
Application:* Voltage output/ Current output

Analog to Digital Converter (ADC)

Part #: AD7190
Recommended Load: 30 to 30000 Ω
Bridge Excitation: 5.000 V \pm 1 mV (limited current to 160 mA)
Input Range: \pm 2.5V (0-500 mV/V) Channel 1 for bridge
Input Range: \pm 12 V Channel 2 for Voltage/Current input
Sampling rate: up to 4800 SPS
Non linearity: \pm 5 PPM for FSR
Offset Drift vs. temperature: \pm 5 PPM/ $^{\circ}$ C
Span Drift vs. temperature: \pm 5 PPM/ $^{\circ}$ C
Application: Signal measurement

Voltage Reference

Part #: MAX6126AASA25+
Accuracy: \pm 0.02%
Nominal Voltage: 2.5 V
Temperature Shift: \pm 3 PPM/ $^{\circ}$ C
Application: Reference Voltage / Excitation voltage

Power Requirement

Power Supply Adapter: 12 VDC/ 1 A

Solid State Relays

Part #: G3VM-2F
Application: Alarm relay 1, 2
Maximum Output Voltage: 250 V (AC or DC)
Maximum Output Current: 120 mA
Note: Internally limited and protected to 110 V/100 mA

Liquid Crystal Display (LCD)

Part #:	CFAH1604B-TMI-ET
Brand:	Crystalfontz America, Inc.
Number of Characters (Width):	16 Characters
No. of Lines (Lines):	4 Lines
Backlight Type & Color:	T-LED, white
Fluid Type, Image (Positive or Negative), & LCD glass Color:	M-STN, Negative, blue
Polarizer Film Type, Wide (WT) Temperature Range, & Viewing Angle (O'clock):	I-Transmissive, WT, 6:00
Character Set (CGROM):	English and European fonts
Controller:	T-Sitronix ST7066U

Connector Plugs

4 Pin Connector Plug	20020007-H041B01LF
6 Pin Connector Plug	20020007-H061B01LF
8 Pin Connector Plug	20020007-H081B01LF

Power Output

Part#:	DCP020515DU, LM2671
Nominal Output1:	24 V / 50 mA
Nominal Output2:	5 V / 50 mA
Application:	Excitation for amplified sensors

Response Times

Conversion capture rate:	every sample
Peak capture rate:	every sample
Valley capture rate:	every sample
Conversion display update rate:	5 times per second
Peak display update rate:	5 times per second
Valley display update rate:	5 times per second

Bandwidth

The digital output bandwidth has been specified as **SPS/4**.

The analog output bandwidth has been specified as **SPS/4** for sampling rates **less than 1200 SPS** and has been specified as **SPS/5** for sampling rates **more than 1200 SPS** if:

- ASCII stream output is deactivated,
- IPM650 is not connected to computer,
- All relays are disabled
- Display is in menu mode (Peak, Valley, Tracking and data display are main display mode).

Default Password:	0000000
Alternative Password:	Device's Serial Number
Instrument Weight:	1.9 lbs. (862 g)
Dimensions:	3.8" (L) x 3.8" (W) x 6.5" (D)

10 Appendix D TEDS IEEE 1451.4 Introduction

10.1 What is TEDS?

Plug and play sensor hardware and software makes configuring a smart TEDS sensor as easy as plugging a mouse into a PC. Efficiency and productivity has greatly improved due to the elimination of manual sensor configuration.

10.2 Basic Concept

TEDS is at the heart of the new universally accepted IEEE1451.4 standard for delivering plug and play capabilities to analog measurements and test instruments. In essence, information in a Transducer Electronic Data Sheet, (TEDS), provides instruments with critical sensor calibration information allowing for accurate and precise measurements every time.

- TEDS works in a similar way in which USB computer peripherals immediately work when a USB device is connected.
- TEDS enabled equipment may be swapped out without a recalibration, saving time and money.
- TEDS holds information such as sensor manufacturer, model and serial numbers, and more importantly, all of the calibration settings determined by the manufacturer.

10.3 How it works

Plug and play is a data acquisition technology that can simplify the configuration of automated measuring systems by making a sensor's unique identification data available electronically. As implemented according to IEEE P1451.4, data in the form of a transducer electronic data sheet (TEDS) is burned on an electrically erasable programmable read only memory (EEPROM) chip located on the sensor, so when a properly adapted signal conditioner interrogates the sensor, it can interpret the self identification data. This technology provides a great benefit by eliminating the need for a traditional paper calibration sheets. In addition, it can simplify labeling and cabling problems, as well as inventory control; by letting you burn the location data onto the chip when installing a sensor. Finally, because all sensors that are produced according to the standard will carry the same basic identically formatted self-identification information, you will be able to use the sensors and applicable signal conditioners interchangeably across manufacturers.

11 Appendix E (System Performance)

Specifications:

Parameter	ADC	Unit
Output Data Rate	5 to 4800	Hz nom
No Missing Codes	24	Bits min
Resolution	See the following RMS Noise and Resolution Table	
RMS Noise and Output Data Rates	See the following RMS Noise and Resolution Table	
Integral Nonlinearity	±5 (Current or Voltage Input) ±15 (Bridge Input)	ppm of FSR max ppm of FSR max
Offset Error	±0.58	µV/ typ
Offset Error Drift vs. Temperature	±0.78	nV/°C typ
Offset Error drift vs. Time	25	nV/1000 hours typ
Gain Error	±0.005 (Current or Voltage Input) ±0.0075 (Bridge input)	% max %typ
Gain Drift vs. Temperature	±1	ppm/°C typ
Gain Drift vs. Time	10 (Current or Voltage Input)	ppm/1000 hours typ
Power Supply Rejection	95 (Current or Voltage Input) 100 (Bridge input)	dB typ dB min
Common Mode rejection @ DC	100 (Current or Voltage Input) 110 (Bridge input)	dB min dB min
@50Hz, 60Hz	120	dB min
@50Hz, 60Hz	120	dB min
Normal Mode Rejection	120 (10 Hz output data rate) 82 (50 Hz output data rate)	dB min dB min
Normal Mode Rejection Common Mode Rejection Reference Detect Levels	Same as for analog inputs 95 0.3 0.6	dB typ V min V max

RMS Noise (μV):

Output data Rate (Hz)	Settling Time (ms)	$S \leq 500\text{mV/V}^*$	$S \leq 7.5\text{mV/V}$	$S \leq 3.5\text{mV/V}$
5	818	0.256	0.640	1.152
10	400	0.330	0.896	1.472
25	160	0.544	1.344	2.304
30	133.4	0.615	1.472	2.560
50	80	0.900	2.112	3.584
60	66.7	0.970	2.304	3.968
100	40	1.161	2.816	4.864
200	20	1.567	3.968	6.900
400	10	2.067	5.440	9.600
600	6.66	2.400	6.656	11.648
800	5	2.734	7.936	13.824
960	4.17	3.000	8.960	15.488
1200	3.33	3.334	9.856	17.152
1600	2.5	3.8889	11.264	19.8826
2400	1.67	5.000	14.080	25.344
4800	0.83	14.300	24.320	337.760

* The same specification will be applied to current and voltage input channel.

Effective Resolution (peak to Peak Resolution):

Output data Rate (Hz)	Settling Time (ms)	$S \leq 500\text{mV/V}^{**}$	$S \leq 7.5\text{mV/V}$	$S \leq 3.5\text{mV/V}$
5	800	23 (21.5)	23 (20)	22 (19.5)
10	400	23 (21)	22.5 (19.5)	21.5 (19)
25	160	22 (19)	22 (19)	21 (18)
30	133.3	23 (20.5)	22 (19)	21 (18)
50	80	22.5 (19.5)	21 (18.5)	20.5 (17.5)
60	66.7	22.5 (19.5)	21 (18.5)	20.5 (17.5)
100	40	23 (19.5)	21 (19)	21 (17.5)
200	20	21.5 (19)	20 (17.5)	19 (17)
400	10	21 (18.5)	20 (17)	19 (16)
600	6.7	21 (18)	19.5 (17)	19 (16)
800	5	21 (18)	19.5 (17)	18.5 (16)
960	4.17	20.5 (19)	20 (17.5)	18.5 (15.5)
1200	3.33	20.5 (18)	19 (16)	18 (15.5)
1600	2.5	20 (17.5)	18.5 (15.5)	18 (15)
2400	1.67	20 (17)	18.5 (15.5)	17.5 (15)
4800	0.83	18.5 (15.5)	17.5 (15)	17 (14.5)

** The same specification will be applied to current and voltage input channel.