

MassaSonic™ M-5000 Smart Ultrasonic Sensor



Installation & Operation Guide

This guide covers the installation and operation of the MassaSonic™ M-5000 Smart Ultrasonic Sensor and options:

P/N 200504-501 M-5000/220 Full Sensor Kit

which includes:

p/n 300280-501	MassaSonic M-5000/220 Smart Ultrasonic Sensor 220 kHz, 12° Beam
p/n 7873-1	Locknuts (Qty 2)
p/n 7875-1	User's Manual
p/n 200511-1	Mounting Bracket
p/n 7868-1	Communications Converter
p/n 7876-1	Installation & Setup Software (1 CD)

P/N 200547-501 M-5000/95 Full Sensor Kit

which includes:

p/n 300306-501	MassaSonic M-5000/220 Smart Ultrasonic Sensor 95 kHz, 12° Beam
p/n 7873-1	Locknuts (Qty 2)
p/n 7875-1	User's Manual
p/n 200511-1	Mounting Bracket
p/n 7868-1	Communications Converter
p/n 7876-1	Installation & Setup Software (1 CD)

Windows® 3.1, 95, 98, 2000 or XP operating system is required to run the installation setup software.

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Manual Version: 5

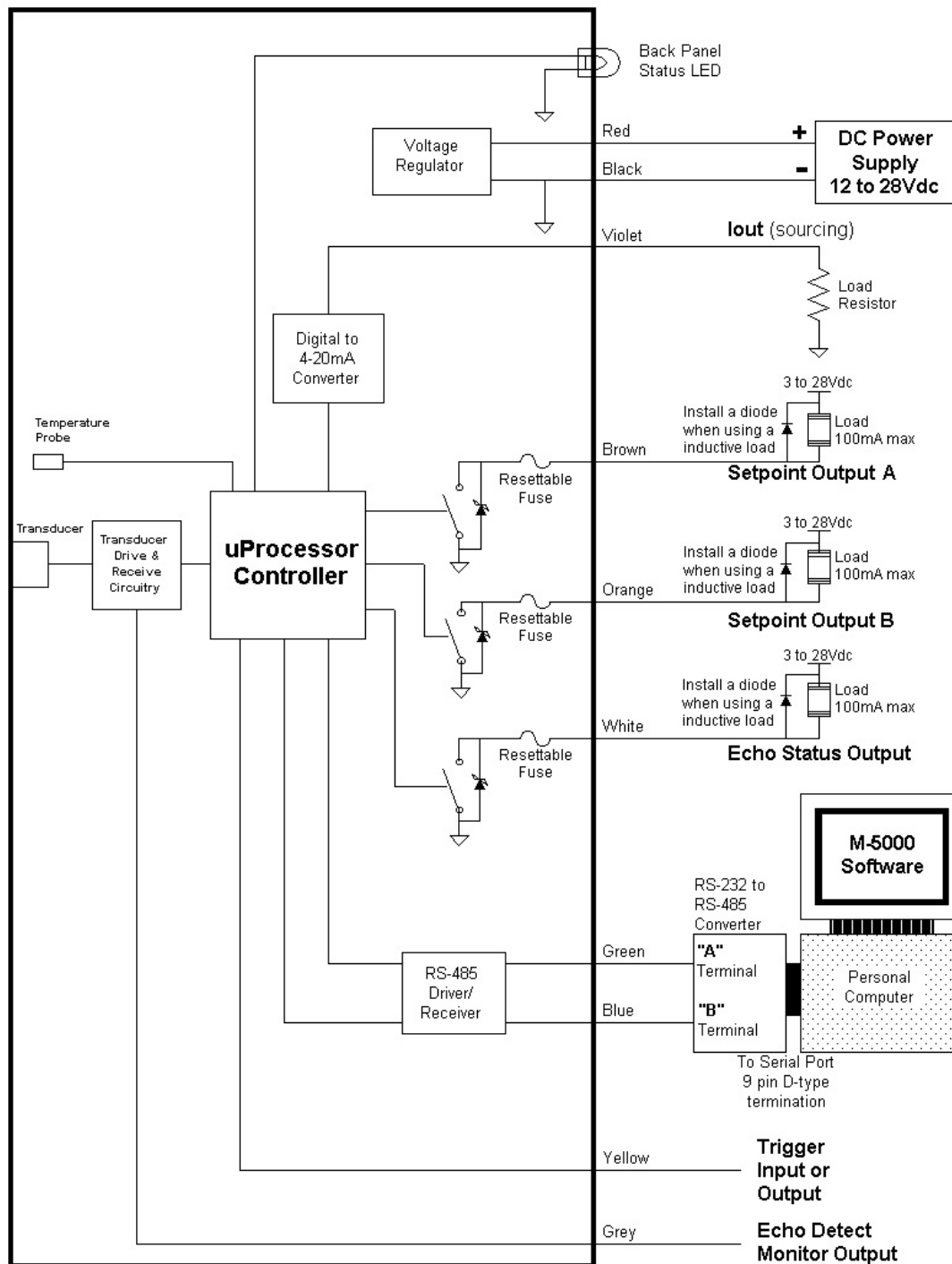
Massa Products Corporation
280 Lincoln Street
Hingham, MA 02043-1796
U.S.A.

Tel: 781-749-4800 Toll Free: 800-962-7543 (USA) Fax: 781-740-2045

Web Site: www.massa.com E-mail: sales@massa.com

M-5000 Functional Block Diagram

Figure 1



M-5000 Status and Setup Screen

M-5000 Smart Ultrasonic Sensor

File Tools Units Temperature Compensation Info

M-5000 STATUS

Average Distance: **11.95** in
 Temperature: **22.0** Deg. C
 Current OUTPUT: **7.53** mA
 Setpoint OUTPUT A: **OFF**
 Setpoint OUTPUT B: **ON**
 Echo Status OUTPUT: **ON**
 Target Strength: **100** %
 Serial Number: **101003**
 Sensor: 220 kHz 12 degree beam

ID Tag:

User Description:

CURRENT LOOP OUTPUT SETTINGS

4 mA Distance: in 20 mA Distance: in
 OUTPUT Span: No Echo OUTPUT Current: mA

SETPOINT OUTPUT SETTINGS

Close Setpoint Distance: in Far Setpoint Distance: in

	Average Distance			
	< Close Setpoint	Mid Zone	> Far Setpoint	No Echo
Setpoint OUTPUT A:	ON	No Change	OFF	OFF
Setpoint OUTPUT B:	OFF	ON	ON	OFF

Hysteresis for OUTPUT B: %

ECHO STATUS OUTPUT SETTINGS

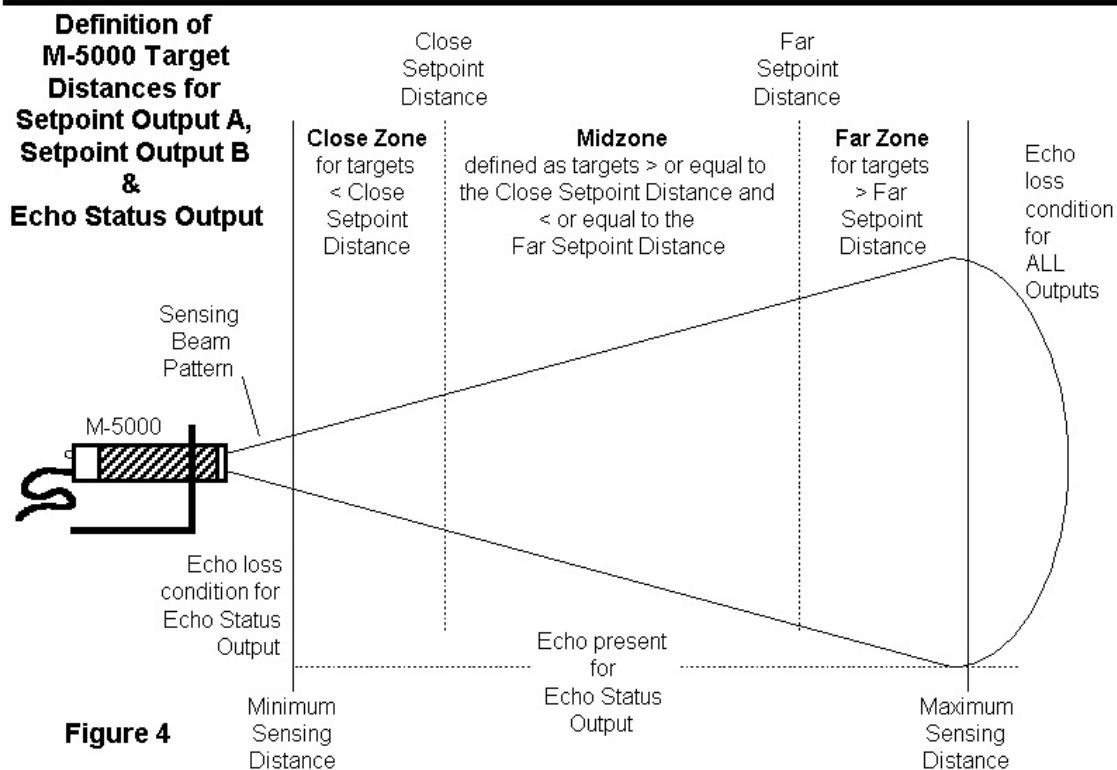
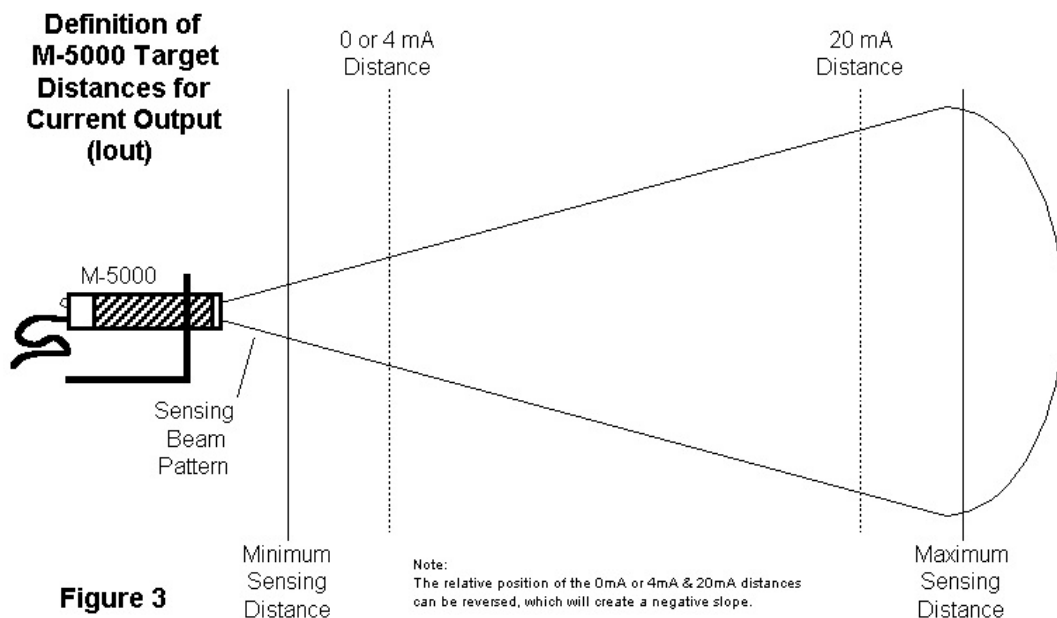
Echo Status OUTPUT with No Echo: No Echo Time Out: Samples (.500 Sec.)

SAMPLING SETTINGS

Trigger Mode: Sample Rate: Samples/sec.
 Average type: Average: Samples

Figure 2

M-5000 Smart Ultrasonic Sensor Terminology



Note:

- 1.) The value of all outputs are based on the average target distance.
- 2.) Iout, Setpoint Output A and Setpoint Output B indeterminate when targets are within the Minimum Sensing Distance.

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1 Introduction

The MassaSonic M-5000 Smart Ultrasonic Sensor combines Massa's 50 years of experience in electro acoustics with state-of-the-art analog and microprocessor hardware and software design. The result is the most versatile, easiest to use ultrasonic sensor on the market.

Operation: The M-5000 generates a high frequency ultrasonic pulse, measures the time it takes for the echo to return and calculates the target distance. The temperature effects on the speed of sound are compensated for by means of an internal temperature sensor. This distance information is outputted as a 4 to 20 ma current (optionally programmable to 0 to 20mA). It is also outputted on an RS-485 communication port to be displayed on a PC screen controlled by an easy to use M-5000 Status and Setup program. Two independent Setpoint Outputs and an Echo Status Output allow multi-functional control.

Key Features include:

- Analog & Setpoint Outputs
- Plug & Play Setup - *No Targets Needed*
- Software Set Span and Zero - *No Pots or Pushbuttons, Tamperproof Settings*
- Easy to Use Setup Software - Windows® 3.1, 95, 98, 2000, or XP
- Built-in Temperature/Sound Speed Compensation
- Up to 32 Sensors on RS-485 Multi-drop Loop



MassaSonic™ M-5000/220 Smart Ultrasonic Sensor
Full Sensor Kit (Installation & Operation Guide not shown)

2 Quick Guide on Getting Started

To become familiar with the operation and programming features of the M-5000, unpack the components from the Full Sensor Kit and proceed as follows:

1. Secure the sensor onto the Mounting Bracket using the two mounting nuts .
2. With the power supply off, wire the sensor's red and black leads to a power supply as shown in Figure 1 (page iii).
3. Wire the sensor's green lead to the **A** terminal and blue lead to the **B** terminal on the Communications Converter. At this time it is not necessary to connect the other wires.
4. Plug the Communications Converter into one of the serial ports of the PC (com1, com2, etc.).
5. Apply power to the sensor (12-28VDC).
6. Install the software into the PC as described on the supplied diskettes.
7. Execute the M-5000 program.
8. The first time the program is executed, the communications port used (step 4 above) must be selected. See Figure 7 (page 7).
9. After the program accesses the sensor, the Status and Setup Screen as shown in Figure 2 (page iv) will appear.
10. Point the M-5000 towards a target such as a wall. Make sure that the target is between 4" and 40" from the sensor and the front face of the M-5000 containing the transducer is aimed perpendicular to the target.
11. Observe the "Average Distance" (located in the M-5000 Status Box). This is the distance between the target and the face of the sensor.
12. To change any of the M-5000 settings of the M-5000 Status and Setup Screen, move the mouse pointer and click on the field to be modified. After all changes have been made, click on the Program button. There is no limit to the number of times the sensor can be reprogrammed.
13. Turn off DC power and wire the remaining connections as shown in Figure 1 (page iii).
14. The M-5000 sensor has a variety of different outputs and operating modes, and should be optimized for the best performance in each sensing application. Continue to read this Operation Guide for more detailed information.

quick guide quick guide quick guide quick guide quick guide quick guide

3 Product Description

Referring to Figure 1, the following describes the key functions and connection hook-ups for the M-5000:

DC Power Input:

The unit is powered from a 12 to 28Vdc source with approximately 60 ma current drain (not including the Current Output).

Current Output:

This is the analog current output which is proportional to the target distance. Programming options include:

- 4-20 mA or 0-20 mA spans. Corresponding target distances must be within allowable sensing distances. Slope is based on the programmed setting for the 4mA Distance (or 0mA Distance) and 20mA Distance.
- After the 4mA Distance (or 0mA Distance) and the 20mA distance are programmed, the current will be linear as the target distance varies between them.
- If the target echo signal is lost (after a preset timeout), the Current Output will go to a preselected value (0, 3.5, 4.0, 20 or 20.5 mA). See "No Echo Time Out" under the ECHO STATUS SETTING for timeout information.

Setpoint Output A and Setpoint Output B:

These are multi functional, independent open drain N-Channel MOSFET switches to ground (over-voltage and over-current protected). As shown in Figure 5, three zones are established by the user selecting a **Close Setpoint Target Distance** and a **Far Setpoint Target Distance**. The zones are defined as shown in Figure 5. Setpoint OUTPUT A & B can also be programmed to ON or OFF when a "No Echo" condition occurs. The state of these outputs is based on the average target distance.

Example of one possible matrix of the states of Setpoint Output A & Setpoint Output B.

	Close Zone < Close SP Distance	Mid Zone	Far Zone > Far SP Distance
Setpoint Output A	OFF	ON	OFF
Setpoint Output B	OFF	OFF	ON

Hysteresis for OUTPUT A and OUTPUT B [5%]

Figure 5

In the example above, Setpoint Output A will turn ON (MOSFET switch closed to ground) when the target distance is in the Mid Zone between the Close and Far Setpoint Distances. Otherwise it will be OFF.

3 Product Description (cont.)

Setpoint Output A and Setpoint Output B: (cont.)

In the Figure 5 example, Setpoint Output B will turn ON when the target distance is greater than the Far Setpoint Distance.

Hysteresis can be set as a percent of Close and Far Setpoint Distances (any valid value between 0% and 90%) to reduce the effects of noise or to implement a control function.

The **Mid Zone** has programming states of ON or OFF and includes a 3rd programmable state of **No Change**. Targets in this zone will not change state when in this zone. This feature creates a variable hysteresis around the CLOSE and FAR Setpoint Distances. Power up default for the **Mid Zone** when programmed to "No Change" is the state for the **Close Zone**.

If both Setpoint Outputs are programmed for NO CHANGE in the **Mid Zone**, it is recommended that Hysteresis be set to 0%. This can be done by temporarily changing a **Mid Zone** to ON or OFF and setting the Hysteresis to 0%, then returning that **Mid Zone** to NO CHANGE.

If the other Setpoint OUTPUT has the **Mid Zone** programmed to either ON or OFF, then the hysteresis selection still applies for that OUTPUT only.

In the example shown in Figure 6, Setpoint Output A will not turn ON until target distance increases beyond the **Far SP Distance**. It will not turn OFF until the target distance decreases to less than the **Close SP Distance**.

	Close Zone < Close SP Distance	Mid Zone	Far Zone > Far SP Distance
Setpoint Output A	OFF	No Change	ON
Setpoint Output B	ON	OFF	OFF

Hysteresis for OUTPUT B [10%]

Figure 6

Echo Status Output:

This is a third independent open drain N-Channel Mosfet to ground whose state can be programmed to be either ON or OFF if no target is present. The number of echo samples which must be missed consecutively to trigger this output to a "No Echo" state is programmable (see No Echo Timeout under Echo Status Settings). Programming the "No Echo Time Out" to a value other than 1 will reduce the "No Echo" state caused by spurious missing echos.

NOTE: For this Echo Status Output ONLY, targets within approximately 0.2" of the minimum sensing distance will cause the output to switch to the "No Echo" condition. The back panel LED will also indicate a loss of echo "Flash".

The M-5000 continuously monitors itself for system integrity. Upon a fault, this Echo Status Output will go to its programmed "No Echo" state. The error will be reported on the serial communications port. Some errors may be restored by pressing the "Reset Error" button located in the message box (appears when a system error is detected).

3 Product Description (cont.)

Trigger I/O:

There are 5 Trigger Modes from simple, automatic INTERNAL triggering, to triggering which assures that there will be no crosstalk in applications involving multiple M-5000s in close proximity to each other. Remember, ultrasonic sensors are active; that is, one unit's transmission can be picked up by a second unit's receiver (if within each others sensing beam), giving false readings. Multiple units in the same area should be synchronized. The following describes the 5 Trigger Modes:

Internal: The ultrasonic pulse is triggered by unsynchronized internal timing. The SAMPLE RATE is selected on the PC screen. In this mode, the TRIGGER I/O line is an inactive input.

Internal with TRIGGER Out: Same as INTERNAL, but with a TRIGGER pulse (0 to 5V, 150 μ sec) appearing at the TRIGGER I/O line at the start of the ultrasonic transmit pulse. This can be used to TRIGGER a scope or other M-5000's.

External: This line becomes an input for an external TRIGGER pulse (5V, 150 μ sec). This allows the user to control when an ultrasonic transmit pulse is generated (sample rate).

External with Delay: Same as EXTERNAL, except the ultrasonic pulse will be delayed an amount specified by the user (this will appear next to the Trigger Mode field under the SAMPLING SETTING). This can be used in multiple M-5000 applications to prevent crosstalk. A "master" M-5000 will be programmed for INTERNAL WITH TRIGGER OUT and connected to all other M-5000 TRIGGER I/O lines. Each of the "slave" M-5000's will be programmed for EXTERNAL WITH DELAY and have different DELAY TIMES selected. The sample rate of the master should allow all ultrasonic signals to subside before another "master" pulse is generated.

Manual: If MANUAL trigger is selected, a TRIGGER button appears on the PC screen. Clicking the cursor on this button will produce a single ultrasonic pulse. No signal will appear on the TRIGGER I/O LINE. This should be used for diagnostics only.

RS485 Port:

Monitoring and programming the M-5000 Smart Ultrasonic Sensor occurs through the RS-485 serial communications port. The advantages of an RS-485 based system are longer cable lengths (specified to 1,500 ft.) and wiring up to 32 sensors on just one pair of wires (multi-drop). This method allows for access to all sensors from any convenient location. Since your computer is an RS-232 based system, a converter between the two systems is required.

The Massa Model M-5000/RS485 Interface Converter provides a method of interfacing your computer's RS-232 based system to Massa Smart Ultrasonic Sensor RS-485 based system.

Wire the M-5000's RS485 green wire (A terminal) to the "A" input of the M-5000/RS485 and the RS485 blue wire to the "B" input of the M-5000/RS485. Plug the M-5000/RS485 to your PC's serial 9 pin port.

The M-5000 is now ready to communicate with the Massa Model M-5000/SW Status & Setup software program.

Multi-drop Operation: When you expect to wire more than one M-5000 on the same communications line, each sensor will have to be programmed with its own unique **ID Tag**. To do this, you must place only one M-5000 sensor on line at a time. Wire the M-5000's RS485 green wire (A terminal) to the "A"

3 Product Description (cont.)

RS485 Port: (cont.)

input of the M-5000/RS485 and the RS485 blue wire to the "B" input of the M-5000/RS485. Plug the M-5000/RS485 to your PC's serial 9 pin port.

Start the M-5000/SW Status and Setup software program by executing M5000.exe or the M-5000 icon. Edit the **ID Tag** field. Make note and label each sensor with the ID. See "Installing M-5000 Status & Setup Software" (Section 3) of this operation guide for more detail.

Available **ID Tag** numbers are from 1 to 32. Repeat this exercise for all the sensors you plan on placing on the communications port. Once all the sensors contain their own unique ID Tag, then and only then can you wire all the sensors on the RS-485 communications port. The software will then allow you to monitor and edit any sensor on-line. To monitor another sensor, simply go to the **ID Tag** field and select another sensor by pulling down **ID Tag** Menu and highlight the sensor you prefer. When more than one sensor is on-line, the ID Tag field cannot be edited.

Echo Detect Monitor Output:

This output is a peak detection of the ultrasonic signals produced by the M-5000. It includes the transmit burst at the beginning of the waveform followed by the reflected signal from the target. Other signals after the first return echo may also be present. These are called multiple echoes and are reflections to and from the target and the sensor. Only the first target signal is used.

This signal can best be observed on a scope by using the TRIGGER pulse provided at the TRIGGER I/O line (TRIGGER mode programmed for INTERNAL WITH TRIGGER OUT).

The duration of the multiple echo signals can be used to determine the Sample Rate in a multi M-5000 applications. Cable length for this signal is limited to 10 feet.

LED Operation/Diagnostics:

There are three operating modes indicated by the LED on the status of the M-5000 sensor:

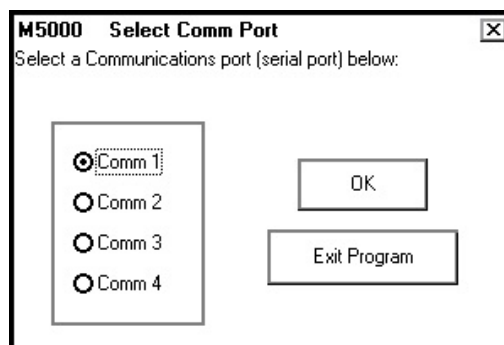
1. Continuously **ON** - Normal operation when an echo is detected within the specified sensing distances.
2. **ON** with short blink **OFF** - Normal operation when no echo is detected within the specified sensing distances and after the expiration of No Echo Time Out.
3. Equal rapid **ON** and **OFF** - System fault. Source of fault will be communicated to the PC and displayed in the message area of the M-5000 Status and Setup Screen.

4 Installing M-5000 Status & Setup Software:

The requirements for the PC to run this program are a 386 processor or better with a Windows 3.1 or better operating system. A mouse or pointing device and a minimum monitor size is 640 x 480 are also required.

This software can be installed by either using the diskettes (p/n 7876-1) or downloading it off the Internet. Follow the instructions on the diskettes or on the Internet.

Attach the M-5000 Smart Ultrasonic Sensor to the communications port and 12 to 28VDC to the power pins (as described in Section 2). Execute the program M-5000.exe or the M-5000 icon. The first time the M-5000 program is executed, it will ask to have the communications port that is connected identified.



This screen will only be displayed the first time the M-5000 Program is executed.

Figure 7

The program will then look for all M-5000's on line:



Figure 8

If the indicator gauge keeps scrolling repeatedly, then the M-5000 program is not communicating with the MassaSonic M-5000 Smart Ultrasonic Sensor. Check for proper wiring on power and communications, then verify that you are connected to the communications port selected. You may select another communications port by hitting the "Select New Comm Port" button and changing it in that control box.

Once it finds all sensors on-line, it will download all sensor information from the lowest numbered ID Tag Sensor on-line.

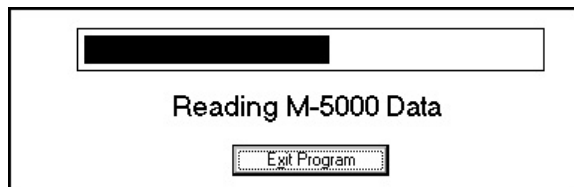


Figure 9

Once the download is complete, the main screen will appear as shown on Figure 2.

5 M-5000 Status and Setup Screen:

With a single M-5000 attached to the M-5000/RS485 Interface Adapter and PC including any monitoring equipment on the I/O lines, apply DC power to the M-5000 and execute the M-5000.exe Program. The M-5000 Smart Ultrasonic Sensor screen will be displayed on the monitor.

This screen provides status information on the M-5000, unit identification, program control, and setting selections for all operating parameters. **Editing** is done by drop-down menus or standard Windows text editing. Example values and settings are used for illustration.

When any field gets edited, the M-5000 Status display will disappear and “**EDIT MODE**” will appear along with “**Cancel Edit**” and “**Program M-5000**” buttons in place of it. Once you have completed all adjustments and are ready to upload the information to the M-5000, hit the “**Program M-5000**” button. To negate the programming session, hit the “**Cancel Edit**” button and you will return to the M-5000 Status screen.

M-5000 Status Box:

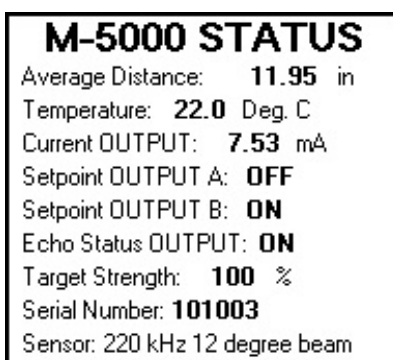


Figure 10

Average Distance: Measured distance to target. Number of samples in the average is programmable by using the SAMPLING SETTINGS box.

Temperature: Temperature reading of internal probe.

Current Output: Commanded current output in mA.

Setpoint OUTPUT A: State of Setpoint Output A - function of target distance and programmed SETTINGS for SETPOINT OUTPUT A.

Setpoint OUTPUT B: State of Setpoint Output B - Function of target distance and programmed SETTINGS for SETPOINT OUTPUT B.

Echo Status Output: This indicates whether a valid target echo is detected. The ON/OFF state of the Echo Status Output line (white wire) is programmable.

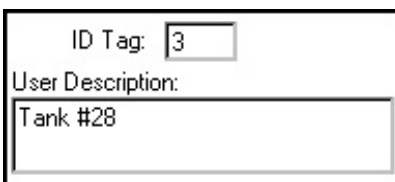
Target Strength: This is a measure of the relative strength of the acoustic echo signal. It can be used to align the target or the M-5000 to produce the best echo.

Serial Number: This is M-5000 unit identification.

Sensor Description: This is M-5000's transducer description.

5 M-5000 Status and Setup Screen: (cont.)

ID Tag/ User Identification:

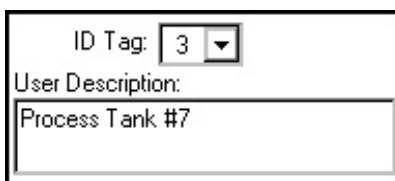


The screenshot shows a window with two fields. The first field is labeled "ID Tag:" and contains the number "3". The second field is labeled "User Description:" and contains the text "Tank #28".

Display with only
one sensor on-line.

Figure 11

ID TAG: Standard units from the factory will show an ID Tag of number 1. When you expect to wire more than one M-5000 on the same communications line, each sensor will have to be programmed with its own unique **ID Tag**. To do this, you must place *only one* M-5000 sensor on line at a time and program each sensor with a different **ID Tag**. For your convenience, the label on the sensor has a location for you to write in the ID Tag.



The screenshot shows a window with two fields. The first field is labeled "ID Tag:" and contains a pull-down menu with the number "3" and a downward arrow. The second field is labeled "User Description:" and contains the text "Process Tank #7".

Display with multiple
sensors on-line.

Figure 12

If the M-5000 Status & Setup program identifies more than one sensor on the communications loop, then the **ID Tag** field can not be edited. This field will then turn into a pull-down menu which will allow you to choose another sensor on line. Once you select another sensor, all the information from the sensor will be downloaded to the PC. The status will then be displayed.

User Description: This field allows you to identify the sensor with up to 32 ASCII characters. This can be such descriptions as "Process tank 123" or "Ink Tank #2".

5 M-5000 Status and Setup Screen: (cont.)

The following describes the **SETTINGS** boxes which allow the user to reprogram the operation of the M-5000 Smart Ultrasonic Sensor:

CURRENT LOOP OUTPUT SETTINGS:

CURRENT LOOP OUTPUT SETTINGS	
4 mA Distance: 4.00 in	20 mA Distance: 40.00 in
OUTPUT Span: 4-20 mA ▼	No Echo OUTPUT Current: 20.5 mA

Figure 13

4 (OR 0) mA Distance: Target distance that will produce 4 (or 0) mA. Normally this corresponds to the closest distance, resulting in a positive slope on the current vs distance curve. However, the far target distance could be set here so that the 4-20 ma current would increase as the target proceeded from the far to the near distance points. To enter or edit the value, simply highlight the field and enter new values.

20 mA Distance: Target distance that will produce 20 mA. As above, this 20 mA distance can be set for the far distance (normal) or the near distance for a negative slope.

Output Span: This is a drop-down menu to select 0-20 mA or 4-20 mA span.

No Echo Output Current: If there is no echo detected (after No Echo Time Out has occurred) the Output Current will go to this programmed value. This level is chosen by this pull-down menu. Choices are 0.0, 3.5, 4.0, 20.0 and 20.5 mA.

SETPOINT OUTPUT SETTINGS:

SETPOINT OUTPUT SETTINGS				
Close Setpoint Distance: 6.00 in		Far Setpoint Distance: 12.00 in		
	Average Distance			
	< Close Setpoint	Mid Zone	> Far Setpoint	No Echo
Setpoint OUTPUT A:	☐ ON	No Change ▼	☐ OFF	☐ OFF
Setpoint OUTPUT B:	☐ OFF	ON ▼	☐ ON	☐ OFF
Hysteresis for OUTPUT B: 5 %				

Figure 14

5 M-5000 Status and Setup Screen: (cont.)

SETPOINT OUTPUT SETTINGS: (cont.)

Within the allowable sensing distance, two setpoint distances can be selected to implement setpoint monitoring or control. As shown in Fig. 14, three zones are defined and the ON/OFF condition of each setpoint can be programmed for each zone. The **Mid Zone** also includes a **No Change** function. See Product Description section (Section 2) for more details. Note, editing fields will automatically place the program in EDIT mode. When finished editing, click PROGRAM M-5000 button to upload.

Close Setpoint Distance: Selects the distance of the CLOSE SETPOINT.

Far Setpoint Distance: Selects the distance of the FAR SETPOINT.

Setpoint OUTPUT A: Select ON or OFF for the three zones (**Mid Zone** includes No Change state). Put the cursor on the field and click your mouse button to select ON, OFF or No Change.

Setpoint OUTPUT B: Same as above.

No Echo: If no echo signals are detected for a given number of samples (programmed under ECHO STATUS SETTINGS), the SETPOINT OUTPUT A and B outputs will go to the state selected in these two boxes. Click the cursor in each box to toggle between ON and OFF.

Hysteresis: Type in a value between 0 to 90% hysteresis as a % of the setpoint distance. Thus, if the hysteresis was selected for 10% and the FAR SETPOINT DISTANCE was set at 30", the SETPOINT OUTPUTS will switch at 30" if the target is moving away from the M-5000, and will switch at 27" if the target is moving toward the M-5000.

Note that values are only accepted if the hysteresis points are within the CLOSE and FAR Setpoint Distances.

ECHO STATUS SETTINGS:

ECHO STATUS OUTPUT SETTINGS	
Echo Status OUTPUT with No Echo:	OFF
No Echo Time Out:	15 Samples (.500 Sec.)

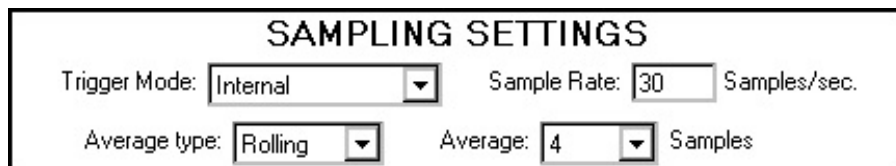
Figure 15

Echo Status OUTPUT with No Echo: This programs the state of the Echo Status OUTPUT Mosfet with No Echo detected (after the No Echo Time Out has expired). It also represents the state when a detected echo is outside the specified sensing distance. Select ON or OFF

No Echo Timeout: This is the number of consecutive target echoes that must be lost before the Echo Status OUTPUT Mosfet goes to its programmed state. The **average target distance** will hold its last measured distance until this timeout occurs.

5 M-5000 Status and Setup Screen: (cont.)

SAMPLING SETTINGS:



SAMPLING SETTINGS	
Trigger Mode:	Internal
Sample Rate:	30 Samples/sec.
Average type:	Rolling
Average:	4 Samples

Figure 16

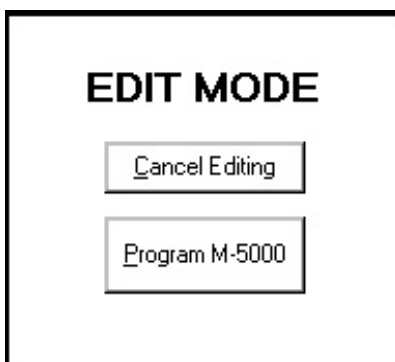
Trigger Mode: Pull down menu to select mode. See TRIGGER I/O in the PRODUCT DESCRIPTION section.

Sample Rate: Type in values between 0.1 samples/sec to the maximum specified rate. In general, the faster the target is moving, the higher the sample rate.

Average Type: The distance reading and the associated 0/4-20 mA Output Current and condition of Setpoint Outputs A & B are based on the average target distance. ROLLING average uses the latest samples (number of samples user selected) where each new sample replaces the oldest sample. BOXCAR takes a selected number of samples before outputting the average reading.

Average: This drop down menu selects the number of samples to be used in the average. The Rolling Average selection limits the average to 32 samples.

When any field gets edited, the M-5000 Status display will disappear and **"EDIT MODE"** will appear along with **"Cancel Edit"** and **"Program M-5000"** buttons in place of it. Once you have completed all adjustments and are ready to upload the information to the M-5000, hit the **"Program M-5000"** button. To negate the programming session, hit the **"Cancel Edit"** button and you will return to the M-5000 Status screen.



EDIT MODE
Cancel Editing
Program M-5000

Figure 17

5 M-5000 Status and Setup Screen: (cont.)

Message Area:



Figure 18

This box will display messages starting on the top line. Error messages from a sensor will also be displayed here.

The Preset Temperature selection will appear at the bottom of the box only when in Preset Temperature Mode. Otherwise, a clear Message box denotes Automatic Temperature compensation mode.

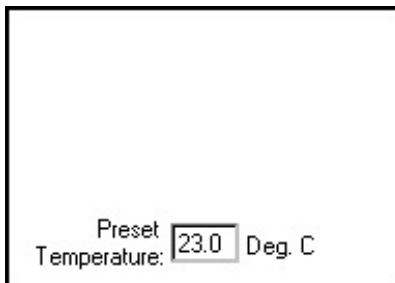


Figure 19

5 M-5000 Status and Setup Screen: (cont.)

Calibration of the Current Output:

The calibration of the CURRENT OUTPUT can be performed by pulling down the **Tools** menu item and selecting **Calibrate Current**. The box below will appear.

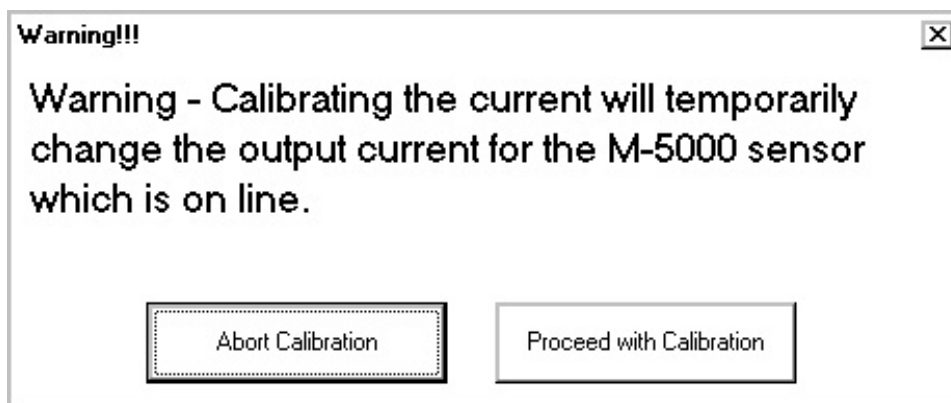


Figure 20

This warning is displayed to verify that you want to make this adjustment. A M-5000 Smart Sensor current output may be connected in a process loop which may disrupt that process.

Hit the "Proceed with Calibration" button and the box below will appear.

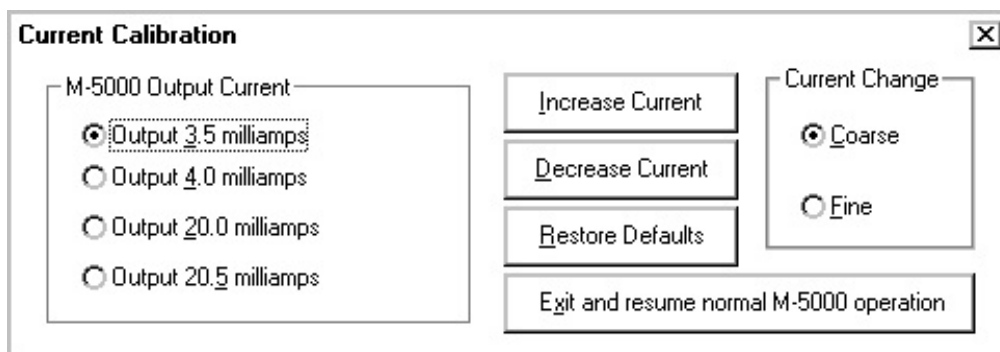


Figure 21

The Current Output can be trimmed to your hardware. Massa Products calibrates these values at the factory.

When you enter this screen, the Current Output will be outputted to the value highlighted. This will override the normal sensing operation (again, this will temporarily interfere with your process loop).

Exit will return you to normal sensing operation.

5 M-5000 Status and Setup Screen: (cont.)

File Menu drop down selections:

Save...	Allows the values selected for the Current Loop Output, Setpoint Output, Sampling Settings, Echo Status Settings and User Description to be saved onto floppy or hard disk. This allows you to mirror your selections to other M-5000.
Recall...	Allows you to restore values previous selected to the Current Loop Output, Setpoint Output, Sampling Settings, Echo Status Settings and User Description.
Print...	The M-5000 monitor and programming screen will be printed as displayed. Keep it for your record hardcopy.
Exit	Exits the M-5000 program. The MassaSonic M-5000 Smart Sensor continues to operate normally.

Tools Menu drop down selections:

Calibrate Current	This feature allows the trimming of the current loop output. The values that can be trimmed include: 3.5mA, 4.0mA, 20.0mA and 20.5mA points. See the previous page for more details.
--------------------------	--

Units Menu drop down selections:

Distance	Allows the user to select the distance units to be displayed on the M-5000 Status & Setup Screen. The selection includes: inches, feet, centimeters and meters.
Temperature	Allows the user to select the temperature units to be displayed on the M-5000 Status & Setup Screen. Selection either °F or °C.

Temperature Compensation Menu drop down selections:

Automatic	Internal temperature probe is used to compensate for changes in speed of sound versus temperature. The probe is near the face of the unit and its temperature is close to the ambient. Reading resolution is 0.5°C.
Preset	This selection opens a window allowing the user to enter a temperature value that is, for example, more representative of his measurement environment. This PRESET temperature will also be displayed in the M-5000 STATUS box. This is typically used for diagnostics only.

Info Menu drop down selections:

About This Program	Displays the M-5000 Status and Setup program version.
M-5000 Version	Displays the M-5000 version.

6 Standard Factory Default Programmed Settings

The M-5000 sensor comes factory programmed with the defaults listed below. Applications may require the M-5000 to be reprogrammed. The factory defaults are as follows:

Current Loop Output Settings

4mA Distance = minimum specified sensing distance
 20mA Distance = maximum specified sensing distance
 Output Span = 4-20mA
 Loss of echo Output Current = 20.0mA

Setpoint Output Setting

Close Setpoint Distance = minimum specified sensing distance
 Far Setpoint Distance = maximum specified sensing distance

	Near Zone <Close Setpoint	Mid Zone	Far Zone >Far Setpoint	No Echo
Setpoint OUTPUT A	OFF	OFF	OFF	OFF
Setpoint OUTPUT B	OFF	OFF	OFF	OFF

Hysteresis for OUTPUT A & OUTPUT B= 5%

Sampling Settings

Trigger Mode = Internal
 Sample Rate = 1/2 of maximum sample rate
 Average type = none
 Average = 1 sample

Echo Status Settings

Echo Status Output with No Echo = OFF
 No Echo Timeout = 1 Sample

Miscellaneous

ID Tag = 1
 Temperature compensation = internal
 Units = inches
 Temperature units = °C
 Comm Port = Port 1
 User Description = empty

The factory can customize each sensor for you. Use the M-5000 Setup Form at the end of this guide to have a custom system developed for you.

7 Specifications (Typical at 24Vdc and 22 degrees C)

Ultrasonic Frequency:	220 kHz @ 22°C
Beam Angle:	12°
Minimum Sensing Distance:	4 inches (10cm)
Maximum Sensing Distance:	up to 40 inches (100 cm)
Power Required:	12 - 28 Vdc (reverse polarity protected)
Current Consumption:	80 mA max
Operating Temperature:	-20° C to 65° C
Storage Temperature:	-40° C to 85° C
Humidity:	0-95%, non condensing
Transducer Material:	MassaPlast 102 (special blend of PPA)
Housing Material:	CPVC
Housing Dimension:	30 mm diameter M-30X1.5 threaded tube, 100mm long
Cable:	10 conductor PVC jacket 24 AWG (pigtail termination) 10 ft (3 m), user-extendable 1500ft.
Current Loop Output:	0 to 20 mA or 4 to 20mA sourcing, 12-bit resolution, invertible
Span & Zero Distances:	Programmable from 4 to 40 inches
Current Loop Loss of Echo Current options:	0 mA, 3.5 mA, 4.0 mA, 20 mA or 20.5 mA
Setpoint & Echo Status Outputs:	Current Sink, open drain MOSFETS, 28 Vdc, 100 mA maximum, protected for over-voltage and fused for overcurrent (resettable)
Hysteresis on Setpoint Outputs:	0% to 89% in 1% increments
Setpoint Distances:	Programmable from 4 to 40 inches
Communication Port:	RS485 output (transient protected)
Trigger I/O:	5 Vdc (5.6 Vmax positive pulse, 100uS min) when programmed as an input (to trigger externally), 5.3 Vdc trigger pulse (150uS) as an output or inactive line.
LED operation:	ON - echo present Slow Blink - no echo present Fast Blink - system error OFF - no power
Sample Rate:	0.1 Hz to 100 Hz in 0.1Hz increments
Accuracy:	±0.25% of maximum distance (± 0.1") in homogeneous environment
Measurement Resolution:	0.01 inches (0.025 cm)
Temperature Compensation:	Internal probe
Temperature Probe Resolution:	0.5° C
Digital Filtering:	Rolling averaging: 1, 2, 4, 8, 16 or 32 samples Boxcar averaging: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 or 1024 samples Outputs hold on Loss-of-Echo (timeout): up to 255 consecutive samples
Environmental Seal:	IEC IP67 (submersible for short periods), NEMA 6

Monitor & Programming Requirements

Communications Converter:	RS-485 to RS232 with automatic send data control
Operating System:	Windows® 3.1, 95, 98, 2000 or XP.

8 Troubleshooting

The LED is slowly blinking:

If the LED is normally ON and blinks OFF momentarily, then the M-5000 is not picking up a target because either the target is off angle, not a good reflector or is too close to the face of the sensor (within minimum sensing distance).

The LED is blinking fast:

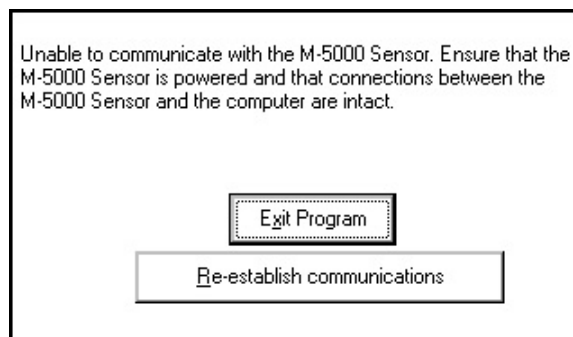
This indicates a fault in the sensor. The communications port will report the error to the M-5000 Status and Calibration display. If the error "Cannot program M-5000" is displayed, 1st try to test the M-5000 under the **Tools** menu. If it fails again, the M-5000 is permanently damaged.

Other conditions which can cause a fault is shorting out the **Monitor** line (white wire) or **Trigger** I/O (yellow wire). These outputs can be restored by fixing the short and powering down then restoring power to the M-5000.

The Setpoint Output is erratic when the target is at the programmed setpoint

Set the **Hysteresis** to a nominal value of **5%**.

The error message shown below comes up when trying to read the M-5000 when in multi-drop operation



Verify the wiring of the communications adapter properly. Verify that unique ID tags were assigned for each M-5000 on line.

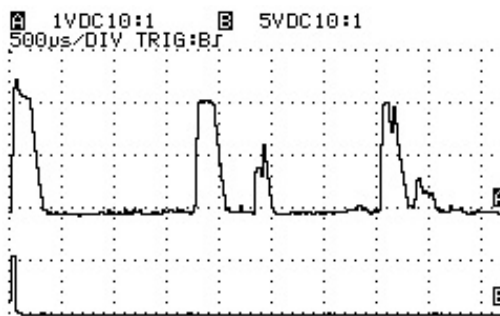
There is no response to any outputs:

Verify that the sensor is powered. Verify that the sensor is not in the **Manual** trigger mode.

The sensor seems to response slowly or erratically:

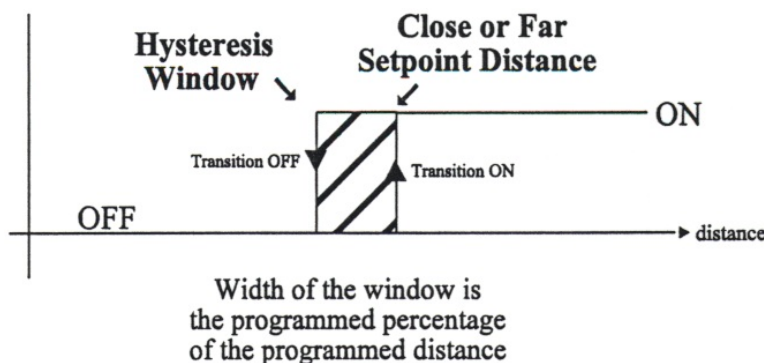
The **Average** may be set to a high value and/or **Sample Rate** may be set to a slow rate. There is a balance required for adjusting these parameters. Each sensor will require to be adjusted to each application based on process speed (**Sample Rate**), the smoothness required of the outputs (**Average**) and occasional loss of echo filtering (**No Echo Time Out**).

Here are typical waveforms you can expect from the Monitor Detect Output (**A** trace) and the Trigger I/O line (**B** trace) which is programmed as a trigger output. The beginning of the Monitor Detect Output is the transmit burst and associated ringing of the sensor followed by the 1st receive echo from a target (placed at 12 inches). Any other echoes following the first return echo from the target can be ignored. Evaluating certain applications may require you to observe these signals for target integrity.



9 M-5000 Terminology

0mA Distance	The position in space, within the beam path and sensor distance, which is defined by a programmed distance. Current loop output will be at its minimum value when a target is at this distance.
4mA Distance	The position in space, within the beam path and sensor distance, which is defined by a programmed distance. Current loop output will be at its minimum value when a target is at this distance.
20mA Distance	The position in space, within the beam path and sensor distance, which is defined by a programmed distance. Current loop output will be at its maximum value when a target is at this distance.
Beam Path	The conical projection of useable ultrasonic energy extending axially from the face of the transducer with a total included angle (θ) in degrees.
Beam Width	The diameter (dia) in inches of a transducer's useable beam at a distance D in inches. $\text{dia} = 2 \times D \times \text{TAN} \left(\frac{1}{2} \times \theta \right)$
Close Setpoint Distance	A near position in space, within the beam path and sensor distance.
Current Loop	A method of transmitting an analog signal, in which the value of the signal is represented by the current source of the sensors Current Loop Output.
Current Sourcing	Loads are connected between the output and the ground (-) of the power supply.
Far Setpoint Distance	A position in space beyond the Close Setpoint Distance, but within the beam path and sensor distance.
Half Duplex	Operation of a communication network in which access on the line only occurs one at a time (due to a 2 wire system). This requires full software control on the line, typically the PC or host controls the data flow.
Hysteresis	The distance between the operating point when a target approaches a setpoint and the release point when the target moves away from a setpoint towards its original position.



9 M-5000 Terminology

ID Tag	A unique sensor programmed value (address) from 1 to 32 which identifies the sensor in a multi-drop communications loop.
Multi-drop	A communication network based on a pair of twisted wires which operates at half-duplex. This system simplifies wiring at the expense of a rigid software protocol. Up to 32 sensors (with their own unique ID) can be wired on the same pair of wires.
Multiple bounce	Ultrasonic signals that can occur after the initial reflected target are multiple bounce echoes. This is result of having a good reflective target and would require you to limit the sample rate of your system. All ultrasonic signals must subside before the next transmit burst can occur, otherwise spurious output values would result.
Peak Detect	This is the Monitor (gray) line which outputs the full wave peak detect signal. It will include the transmit burst at the beginning of the waveform followed by the return echo from a target (if any). See "Echo Detect Monitor Output" in the Installation section of this manual to properly observe this line.
Sample Rate	The rate at which the M-5000 transmits an ultrasonic pulse of energy.
Setpoint ON	The closure of these N-Channel MOSFET outputs.
Setpoint OFF	The open state of these N-Channel MOSFET outputs.
Speed of Sound Formula (in air)	$c = 789.9147 \sqrt{^{\circ}\text{C} + 273} \text{ inches/sec}$ $^{\circ}\text{C} = \text{degrees centigrade}$
Temperature	The technique of correcting for the sensing distance data due to Compensation temperature variations which change the speed of sound.
Transducer	A device capable of efficiently converting one form of energy (in this case sound) back and forth into another form of energy (in this case electrical).
Trigger	A voltage pulse from Trigger I/O that indicate the start and end of the ultrasonic burst.

10 Customer Support

Massa Products Corporation

280 Lincoln Street
Hingham, MA 02043 USA

Tel: (781) 749-4800

Fax: (781) 740-2045

Hours: 8:00am to 4:30pm (Eastern Standard Time)

Website: <http://www.massa.com>

Email: sales@massa.com

If you are having trouble or just need help setting up, please have the following questions ready to be answered before you call:

- 1.) What is the minimum and maximum sensing distance your target is going to travel?
- 2.) What type of target is it? Size of target? Shape of target? Material of target?
- 3.) Are there unwanted targets (obstructions, random events, etc.) which may potentially pose a problem?
- 4.) What is the velocity of your target?
- 5.) What are your resolution requirements?
- 6.) What is the typical temperature? What are the temperature extremes for your application?

11 Appendix

A: Wire Color Code of Standard M-5000 sensor:

RED :	Positive Power In (12-28Vdc)
BLACK :	Ground
BROWN :	Setpoint Output A
ORANGE :	Setpoint Output B
WHITE :	Echo Status Output
VIOLET :	Current Loop Output
GREEN :	RS485 communications port, A terminal
BLUE :	RS485 communications port, B terminal
YELLOW :	Trigger I/O
GRAY :	Echo Detect Monitor Output

The M-5000 comes with a standard 3 meter cable length terminated with pigtails.

11 Appendix

B: M-5000 Set Up Form

M-5000 Set Up Form & Checklist

Company _____

ID Tag (1-32) _____ Serial Number (factory assigned) _____

User Description (up to 32 characters) _____

Current Loop Output Settings:

0mA/4mA Distance _____ 20mA Distance _____

Output Span (select one) 0-20mA 4-20mA

Loss of Echo OUTPUT Current (select one) 0.0mA 3.5mA 4.0mA 20.0mA 20.5mA

Setpoint Output Settings:

Close Setpoint Distance _____ Far Setpoint Distance _____

	<u><Close Setpoint</u>	<u>Mid Zone</u>	<u>>Far Setpoint</u>	<u>No Echo</u>
Setpoint Output A	ON/OFF	ON/OFF/No Change	ON/OFF	ON/OFF
Setpoint Output B	ON/OFF	ON/OFF/No Change	ON/OFF	ON/OFF

(select either ON, OFF or No Change)

Hysteresis (0 to 90%) _____ % (not valid for OUTPUTS programmed for *No Change*)

Sampling Settings:

Trigger Mode (select one) Internal Internal w/trig out External trig in Manual

External Trigger Mode delay _____ mS

Sample Rate (0.1 to maximum specified sample rate) _____ Hz

Average Type (select one) boxcar rolling

Average (select one) 1 2 4 8 16 32 64 128 256 512 1024 samples (rolling limited 32 samples)

Echo Status Settings:

Echo Status OUTPUT with No Echo (select one) ON OFF

No Echo Time Out (0-255 samples) _____ (consecutive samples before timeout)

Miscellaneous Settings:

Temperature Compensation (select one) Automatic Preset

Preset Temperature _____

Distance Units (select one) inches feet millimeters centimeters meters

Temperature units (circle one) °F °C

Communications Port (select one) COM1 COM2 COM3 COM4

Warranty

MASSA PRODUCTS CORPORATION, hereinafter called MASSA, warrants each of its products to be free from defects in material and workmanship for a period of one year commencing on the date of delivery to the original Purchaser. The obligation under this warranty is limited to the repair or replacement at MASSA'S sole discretion of any MASSA product returned to MASSA or to an authorized field service station. OTHER THAN AS SET FORTH ABOVE, MASSA MAKES NO WARRANTY REGARDING ITS PRODUCTS (INCLUDING, WITHOUT LIMITATION, WARRANTIES AS TO MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) EITHER EXPRESS OR IMPLIED. MASSA SPECIFICALLY MAKES NO WARRANTIES AS TO THE SUITABILITY OF THE PRODUCTS FOR ANY PARTICULAR APPLICATION, WHETHER FOR PURCHASER OR PURCHASER'S CUSTOMERS.

Massa Products Corporation reserves the right to change system and performance specifications without notice.