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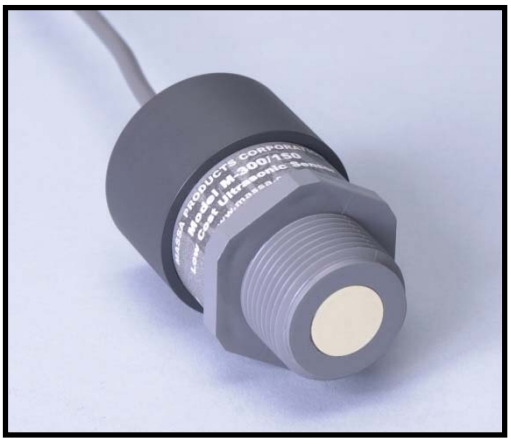
GENERATIONS AHEAD IN SONAR & ULTRASONIC TECHNOLOGY

M-300 & M-320 Family of Low Cost Ultrasonic Sensors



Installation and Operation Guide

December 23, 2014

RoHS COMPLIANT

TABLE OF CONTENTS

1 Introduction

The M-300/M-320 Family of Low Cost Ultrasonic Sensors combines Massa's 60 years of experience in electroacoustics 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. The M-300 Family, listed in the following table, consists of sensors that operate at different frequencies and have different beam angles for their acoustic radiation pattern.

Current Family of Massa M-300 Low Cost Ultrasonic Sensors				
Model	**Nominal Ultrasonic Frequency**	**System Beam Angle**	**Output Type**	**Massa Part Number**
M-300/150	150 kHz	8 º	0-10V	300419-501
M-300/95	95 kHz	8 º	0-10V	300420-501
M-300/150	150 kHz	8 º	0-20mA	300445-501
M-300/95	95 kHz	8 º	0-20mA	300444-501

In operation, an M-300/M-320 Sensors generates a high frequency ultrasonic pulse, measures the time it takes for the reflected echo to return from a target, and then calculates the target distance using the speed of sound. The value of the speed of sound, which is a function of temperature, is determined by the sensor using its internal temperature probe. The distance to a target can be obtained from an M-300 Sensor in a variety of ways. For example, the sensor output can be a DC voltage, the value of which is proportional to the target distance, or the sensor can be programmed to produce a switched voltage output at a user-determined target distance. Information regarding the target can be sent by an RS-485 communication link to a computer and displayed using the M-300/M-320 Software, or another host device can be used (see the M-300 "Serial Communications Guide" at www.massa.com).

Key Features of M-300/M-320 Sensors include:

- Analog or Setpoint Switched Output
- Plug & Play Setup - *No Targets Needed*
- Software Set Span and Zero - *No Pots or Pushbuttons*
- Easy to use Setup Software using Windows® 8, 7, NT 2000, and XP Systems
- Built-in Temperature/Sound Speed Compensation
- Up to 32 Sensors on RS-485 Multi-drop Loop

2 Quick Guide on Getting Started

Mounting the M-300/M-320 Sensor

The M-300/M-320 Family of Low Cost Sensors is designed to be easily mounted by using the 1″ NPT threaded shaft that is part of the housing of each sensor. The M-300/M-320 can be screwed into a 1″ NPT tapped hole in a mounting plate, or it can be mounted onto a flat plate by inserting the threaded shaft of the housing through a hole in the plate and securing the sensor using the locknut that is included with each sensor. An optional Mounting Bracket can also be purchased, as shown in Figure 1.

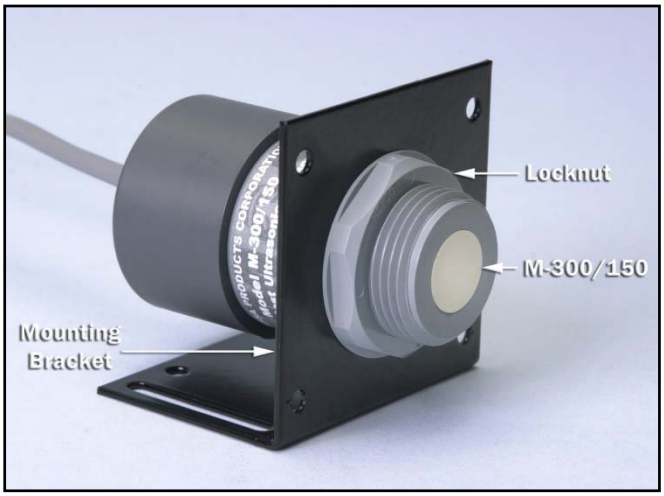


Figure 1

Photograph of a Massa M-300/150 Sensor Attached to an Optional Mounting Bracket

Operating an M-300/M-320 Sensor Without a Computer

- With the 12-24 V DC Power Supply turned OFF, connect it to the red and black leads of the M-300 Sensor, as shown in Figure 2. The output for model M-320 is a current output (Iout).

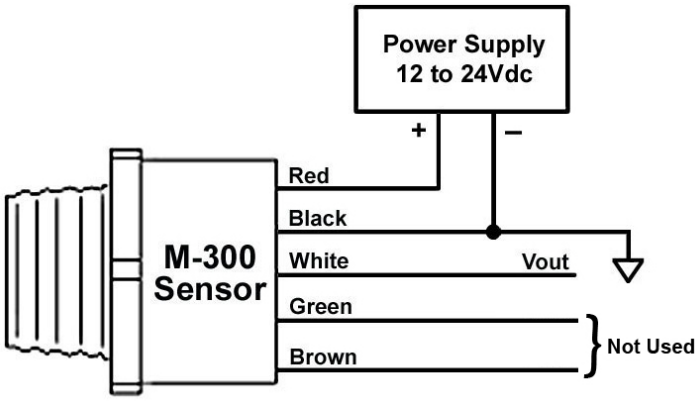


Figure 2

Wiring Diagram for an M-300 Sensor Used Without a Computer

2 Quick Guide on Getting Started *(continued)*

- Turn the Power Supply ON.
- The DC voltage on the white lead of the M-300 Sensor will be proportional to the distance to the target.

Operating an M-300/M-320 Sensor Connected to a Computer

- Download the M-300 Software into the computer from the Massa website at www.massa.com. (If a CD version of the M-300 Software is needed, consult the factory at 800-962-7543.)
- With the 12-24 V DC Power Supply turned OFF, connect it to the red and black leads of the M-300 Sensor, as shown in Figure 3.

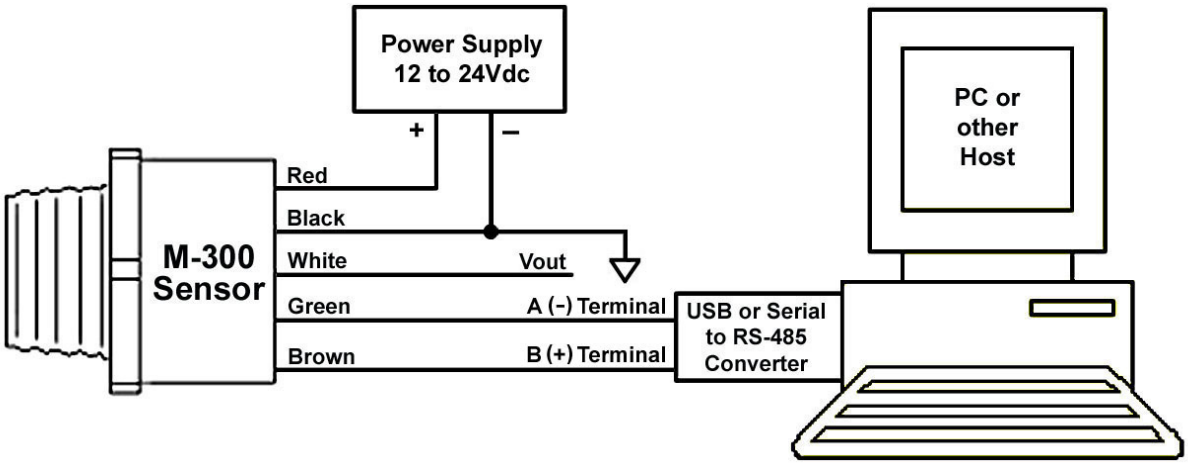


Figure 3

Wiring Diagram for an M-300 Sensor Used With a Computer

- For the M-300 Sensor to communicate with a computer, either an RS-232/RS-485 converter is required when connecting to a serial port, or a USB/RS-485 converter is required when connecting to a USB port.
- Connect the sensor's green lead to the converter's A (-) terminal [the TDA (-) terminal on a USB converter], and the brown lead to the converter's B (+) terminal [the TDB (+) terminal on USB converter].

NOTE: Use of termination resistors on the RS-485 network is not required.

- Plug the Communication Converter into the appropriate serial or USB port on the Computer.
- Turn the Power Supply ON.
- Execute the M-300 program.

2 Quick Guide on Getting Started *(continued)*

- The Status and Setup Screen will appear, as shown in Figure 4, and an indication that the sensor was "found" will appear in the 'Messages' box at the bottom of the screen.

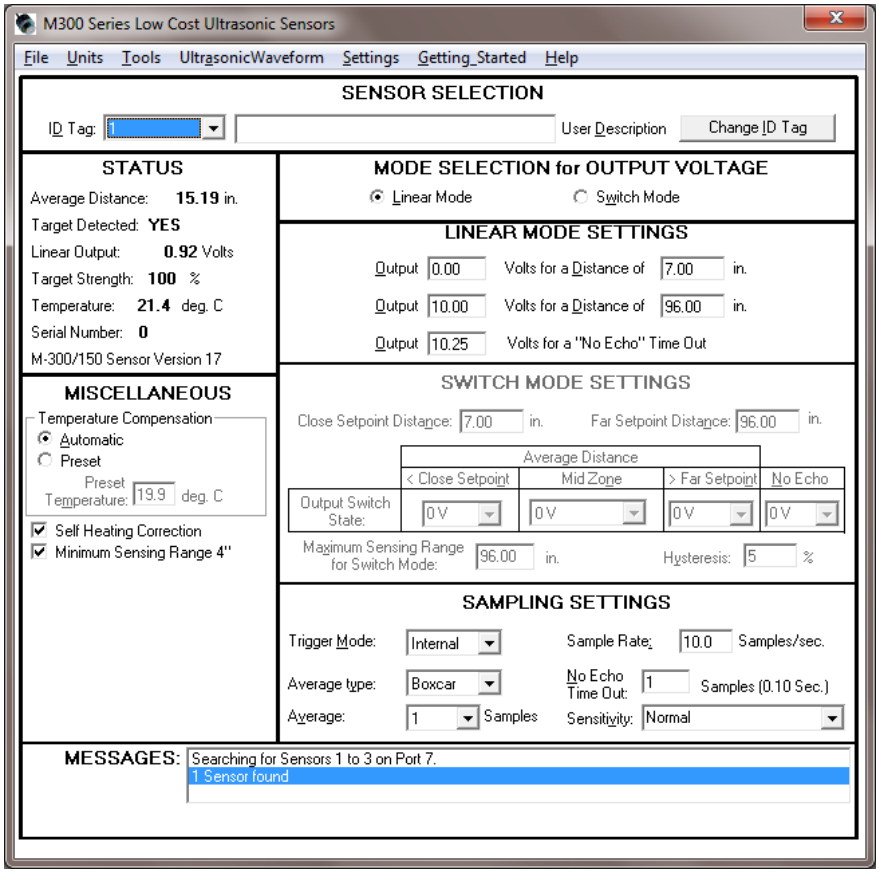


Figure 4

Example of the Status and Setup Screen for an M-300 Sensor

NOTE: If the sensor is not "found", you may have to select another communications port. Use the drop-down menu 'Settings' then 'Communications Port' to select another port. Use the 'Tools' drop-down menu and then 'Search for Sensors' to establish communications on the new port.

- Point the M-300 towards a target, such as a wall, to obtain a distance measurement.
- To change any of the M-300 or M-320 settings, 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. The Sensor's settings are non-volatile and the programmed values will be retained even if power is lost.
- The M-300/M-320 Sensor can be adjusted for optimum performance in each application by adjusting its settings. (See Section 5 for detailed information regarding utilization of these adjustment features.)

2 Quick Guide on Getting Started *(continued)*

Operating Up to 32 M-300 Sensors Simultaneously Using a Multi-Drop Configuration

- Download the M-300 Software into the Computer from the Massa website at www.massa.com (if a CD version of the M-300 Software is needed, consult the factory at 800-962-7543.)
- With the 12-24 V DC Power Supply turned OFF, connect it to the red and black leads of the M-300 Sensor, as shown in Figure 5.

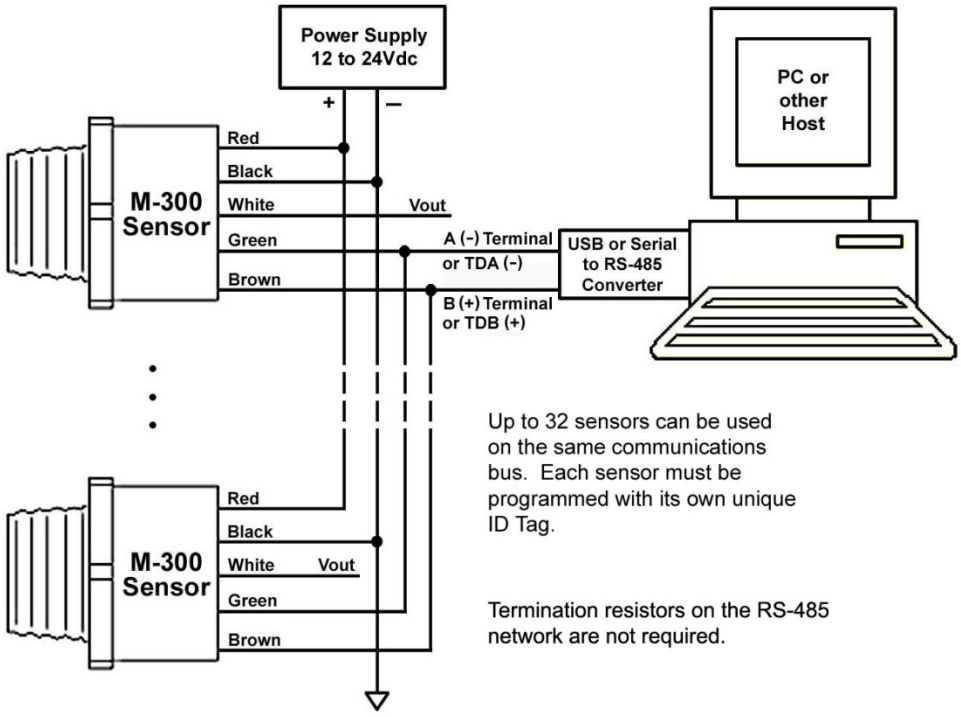


Figure 5

Wiring Diagram for M-300 Sensors Using a Multi-Drop Configuration

- Connect the first M-300 or M-320 Sensor to the Computer using the steps shown in the subsection entitled "Operating an M-300/M-320 Sensor Connected to a Computer", and insert a unique ID Tag from 1 to 32 into the Sensor.
- Disconnect the sensor and then sequentially connect to the computer, by themselves one at a time, each of the remaining multiple M-300 Sensors that are going to be placed on the communications bus, and insert a unique ID Tag from 1 to 32 into each of them. Once this has been done, all the sensors can be wired in parallel to the RS-485 communications bus, as illustrated in Figure 5.
- Restart the M-300 program. Any sensor can now be selected from the drop down list next to the ID Tag and its status viewed.
- Any sensor can be reprogrammed, including changing its ID Tag, by selecting it and making the desired changes.

3 Product Description

This section contains a general overview of the M-300/M-320 Family of Low Cost Ultrasonic Sensors. For detailed information on any specific model of M-300/M-320 Sensors, refer to the datasheet located on the Massa website (www.massa.com) for the particular model.

DC Power Requirements

M-300/M-320 Sensors are powered from 12 to 24 V DC sources, either batteries or power supplies, that are capable of supplying currents of approximately 30 ma (M-300) and up to 50mA (M-320). The red and black wires of an M-300 Sensor must be connected to the DC power, as shown in Figures 2, 3, and 5 in Section 2.

Voltage Output (Vout) of an M-300 Sensor

The white lead of an M-300 Sensor produces a DC analog Output Voltage, Vout, as shown in Figure 2, 3, and 5 in Section 2. The value of Vout provides information regarding the Target Distance, which is the distance from the sensor to a target. M-300 Sensors have two modes of operation. In the Proportional Voltage Output Mode, Vout is an analog DC voltage that is directly proportional to the Target Distance. In the Switched Setpoint Output Mode, Vout switches between two different voltage levels based on the Target Distance falling within specific distance zones that are programmed into the M-300 Sensor as Setpoints. More detailed information regarding the use of these two operational modes is contained in Section 5.

Proportional Voltage Output Mode ('Linear Mode')

Figure 6 is a schematic illustration of the Proportional Voltage Output Mode ('Linear Mode') of Vout for an M-300 Sensor. A Zero distance and a Span distance that are anywhere within the Minimum Sensing Range and Maximum Sensing Range of the sensor can be programmed into the M-300. The values of Vout will then be proportional to the Target Distance in the zone between the distances set for Zero and Span. If a target is any closer than the Zero distance, Vout will be the voltage value that was programmed into the M-300 Sensor for the Zero distance. If the target is further away than the Span distance, Vout will be the voltage value that was programmed into the Sensor for the Span distance. If target is not detected, than Vout will be a third voltage setting named "Loss of Echo Voltage".

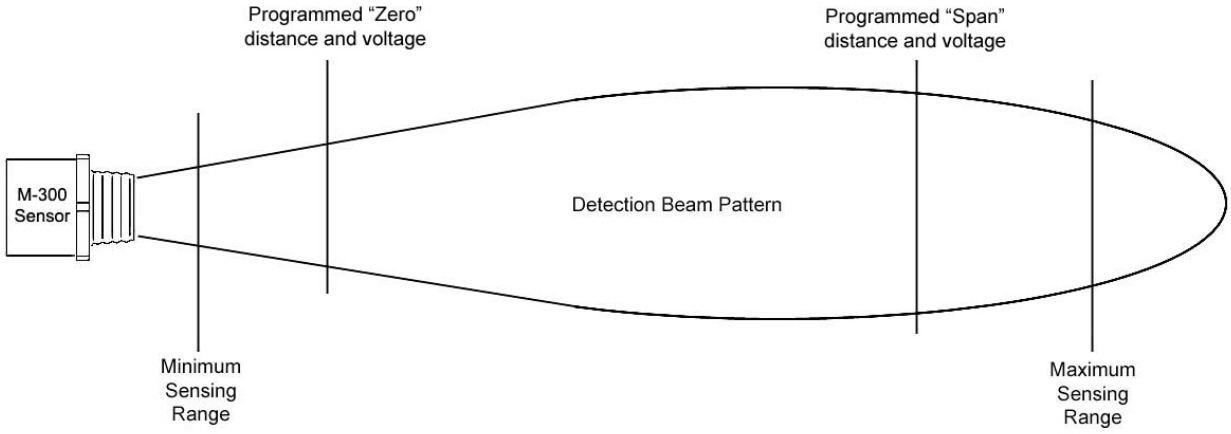


Figure 6

Schematic Illustration of the Proportional Voltage Output Mode of Vout for an M-300 Sensor

3 Product Description *(continued)*

In the 'Linear Mode', the user can set the values for the following programming options using the Status and Setup Screen shown in Figure 4 in Section 2 on Page 4.

1) Set any Output Voltage value from 0 V DC to 10.25 V DC for the Zero Distance

2) Set any Output Voltage value from 0 V DC to 10.25 V DC for the Span Distance

3) Set any Output Voltage value from 0 V DC to 10.25 V DC for the No Echo Time Out to indicate that the target is "lost", which occurs after the preset number of samples that were programmed into the 'No Echo Time Out' in the 'Sampling Settings'.

With this flexibility, positive or negative slopes can be programmed, along with any start and end voltage value. Targets within the detection zone, established by the Zero and Span distances, will produce an output voltage that is proportional to the Target Distance between the Zero Output Voltage and the Span Output Voltage. Targets detected beyond the endpoints of the selected distance zone will produce output voltages equal to the nearer endpoint. Targets detected closer than the minimum specified Sensing Range will produce a Vout equal to the Outpoint Voltage programmed for the Zero distance. Targets detected at distances greater than the programmed Span distance will produce a Vout equal to the Output Voltage programmed for the Span distance. If no target is detected, Vout will be the Output Voltage programmed for 'No Echo Time Out'.

Switched Setpoint Output Mode ('Switch Mode')

Figure 7 is a schematic illustration of the Switched Setpoint Output Mode ('Switch Mode') of Vout for an M-300 Sensor. In this Switch Mode, a Close Setpoint Distance and a Far Setpoint Distance, that are anywhere within the Minimum and Maximum Sensing Range, can be programmed into the M-300. These two setpoint distances will then establish three distance zones, which are the Close Zone for Target Distances less than the Close Setpoint Distance, the Mid Zone for target distances between the Close Setpoint Distance and the Far Setpoint Distance, and the Far Zone for Target Distances greater than the Far Setpoint Distance. Different value of Vout can be selected to be produced for when the target is located in each of the three zones.

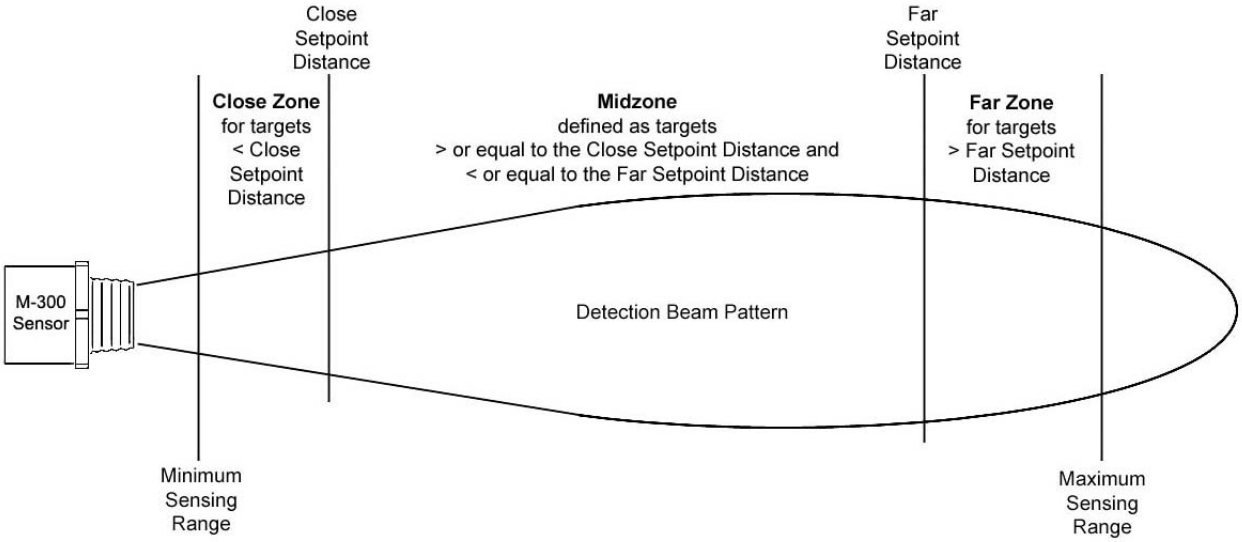


Figure 7

Schematic Illustration of the Switched Setpoint Output Mode of Vout for an M-300 Sensor

3 Product Description *(continued)*

In the 'Switch Mode', the user can set the value of the following programming options using the Status and Setup Screen shown in Figure 4 in Section 2 on Page 4.

1) Set a value for the Close Setpoint Distance.
2) Set a value for the Far Setpoint Distance.
3) Set a value of 0 V DC or 10.25 V DC for Vout when the Target Distance is in the Close Zone (<Close Setpoint Distance).
4) Set a value of 0 V DC or 10.25 V DC for Vout when the Target Distance is in the Mid Zone (>Close Setpoint Distance and <Far Setpoint Distance).
5) Set a value of 0 V DC or 10.25 V DC for Vout when the Target Distance is in the Far Zone (>Far Setpoint Distance).
6) Set a value of 0 V DC or 10.25 V DC for when No Echo has been detected after a preset timeout.
7) The Mid Zone also has a 'No Change' programmable option where the value of Vout will not charge when a target enters this zone from another zone.
8) Hysteresis around the setpoints can be programmed from 0% to 75%.
9) Vout for targets detected closer than the minimum specified Sensing Range of the specific model of M-300 Sensor used will be the same as the value for Vout set for the Close Zone.

Current Output (Iout) of an M-320 Sensor

The white lead of an M-320 Sensor produces a DC analog Output Current, Iout. The value of Iout provides information regarding the Target Distance, which is the distance from the sensor to a target. M-320 Sensors have two modes of operation. In the Proportional Current Output Mode, Iout is an analog DC current that is directly proportional to the Target Distance. In the Switched Setpoint Output Mode, Iout switches between two different current levels based on the Target Distance falling within specific distance zones that are programmed into the M-320 Sensor as Setpoints. More detailed information regarding the use of these two operational modes is contained in Section 5.

3 Product Description *(continued)*

RS-485 Port

Monitoring and programming the M-300/M-320 Sensor occurs through the RS-485 serial communications port. The advantages of an RS-485 based system include the ability to have long cable lengths while 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. When communicating with a PC, a communications converter will be required (either a USB or RS-232 to RS-485). *(To learn more about the specific operational details of this communication port, see the "M-300 Serial Communications Guide" located on the Massa website at www.massa.com.)*

Wire the M-300/M-320 Sensor to the RS-485 Communication Converter as shown in Figure 3 in Section 2. The converter's terminal for the green wire of the sensor will be marked as TDA, A (-), or some combination for the A terminal wiring. The converter's terminal for the brown wire of the sensor will be marked as TDB, B (+), or some combination for the B terminal wiring. If the converter has any of the switches shown below, set to the following positions:

- TD 422 or TD 485, set to TD 485 position
- ECHO ON or ECHO OFF, set to ECHO OFF position
- 4 Wire or 2 Wire, set to 2 Wire position

The M-300/M-320 Sensor is now ready to communicate using the Massa Model M-300 Software Program.

Multi-drop Operation

When planning to connect more than one M-300/M-320 Sensor on the same communications bus, each must be programmed with its own unique 'ID Tag' from 1 to 32. To do this, only *one* M-300 Sensor at a time must be placed and each is then programmed with its own unique 'ID Tag'. The available 'ID Tag' numbers are 1 to 32. Repeat this procedure for all the sensors on the communications port.

The software will now allow the monitoring and editing of any sensor on-line. To monitor any sensor, simply go to the 'ID Tag' field in the 'Sensor Selection' box and select a sensor by using the 'ID Tag' drop down menu and highlighting the numbering of the sensor that is to be monitored. (See Fig. 14 in Section 5 on Page 13 for more details.)

Note 1: The RS-485 Converter must have automatic send data control for proper operation. The M-300/M-320 Sensor is configured for half-duplex operation (2-wire), which allows only one device to communicate at a time. In normal operation a host device (typically a PC) requests data or sends a command to a particular sensor resulting in a response. Signal ground should be connected between the sensor and the RS-485 Converter to keep the common mode voltage between the devices within safe limits. Not wiring the RS-485 Converter ground may sacrifice reliability and noise immunity. Termination of the network is not recommended on port powered converters, and is not necessary for the M-300 Sensors due to the use of slew rate limited components.

Note 2: M-300/M-320 Sensors continuously monitor themselves for system integrity. If a fault occurs, the sensor and its outputs will be placed into the No Echo state. The fault can be identified via the serial communications port. Some faults are self-correcting, but some may require user intervention to "Reset" the software of the sensor.

4 Installing M-300 Software

The minimum requirements to run the M-300 Software program is a PC operating under Windows® 8, 7, NT 2000, and XP operating systems. This software can be downloaded it from the Massa website (www.massa.com), or a CD (P/N 8224-1) can be purchased by contacting the factory.

Start by running 'setup.exe', and the screen shown in Figure 8 will be displayed.

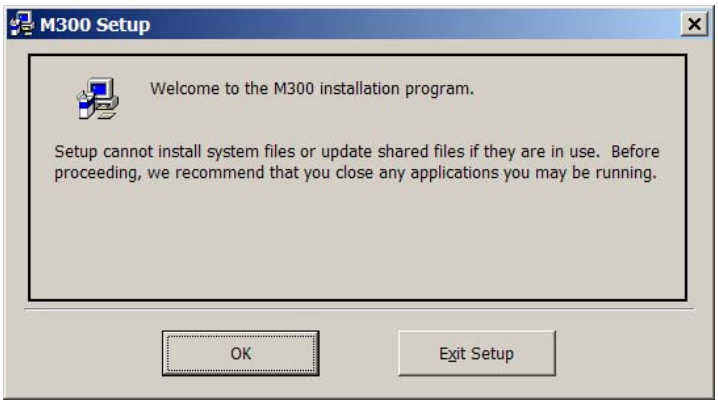


Figure 8

First Screen that is Displayed After Running 'Setup.exe' During Installation of the M-300 Software

Click on 'OK' and the screen shown in Figure 9 will be displayed. Continue with the installation by clicking the 'Install M300 Software' button and proceed with the rest of the installation.

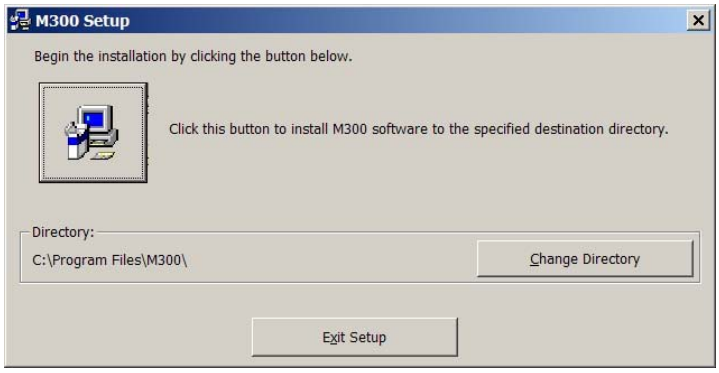


Figure 9

Screen That Is Displayed After the 'OK' Button in Figure 8 is Clicked

Once the software has been installed, connect the M-300/M-320 to the computer, as shown in Figure 3 of Section 2, and then execute the M300.exe program.

5 Status and Setup Screen

Establishing Communication between a PC and the M-300/M-320 Sensor

Once the M-300 Software has been installed and program executed, the comm port assigned for the USB to RS-485 Converter must be determined. Use the drop down menu item *Getting_Started* and follow instructions on this page. The USB/RS-485 Converter must be first unplugged from your PC's USB port followed by plugging it back in when requested to determine port assignment. See Figures 10, 11 and 12 below.

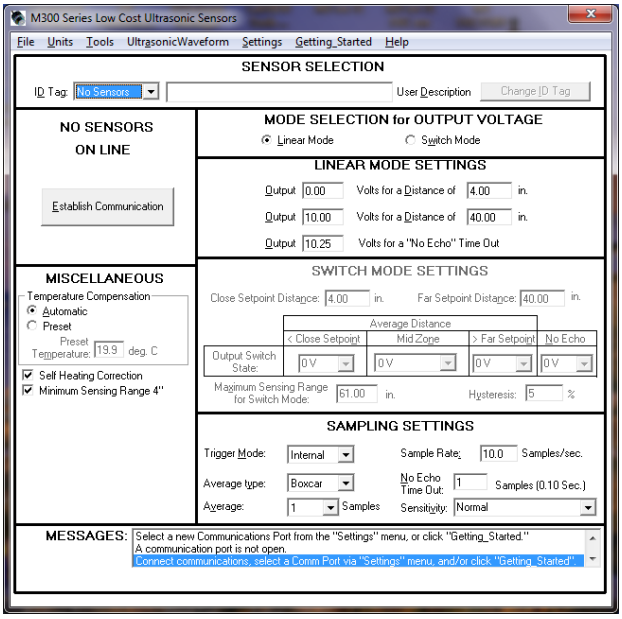


Figure 10
Main M-300 Software Screen Without USB Port Assigned

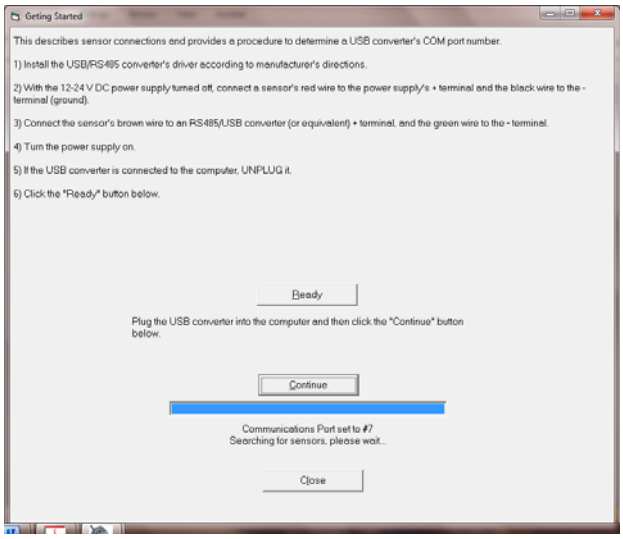
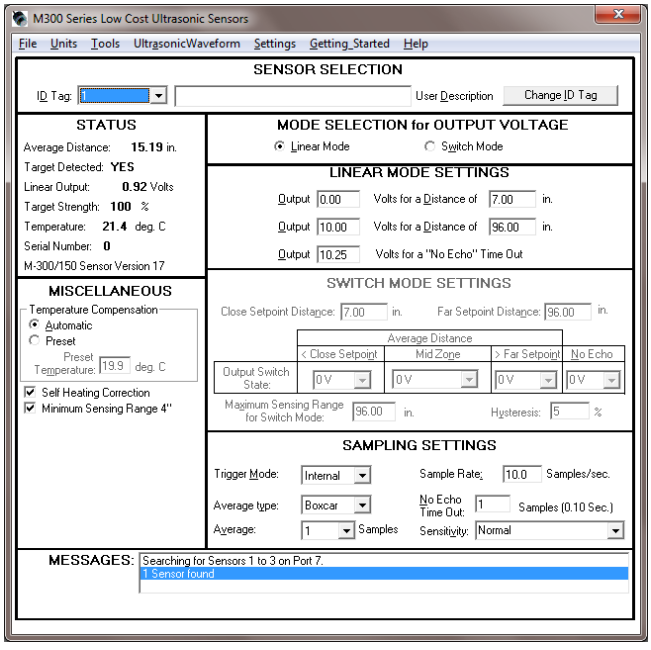


Figure 11
Getting Started Instructions to Find USB Port

Figure 12
After the *Getting Started* Page is Closed, the Sensor Will Be Reporting Status Information



5 Status and Setup Screen *(continued)*

Figure 12 shows the main operating screen of the M-300/M-320 System which provides status information, ID Tag and all the operating parameters of the sensor. If sensor is not found, then the screen shown in Figure 13 will be displayed, and the 'Messages' box at the bottom will indicate '0 Sensor found'. Verify if the sensor is powered and RS-485 wires are properly connected. Click the *Established Communications* to retry finding the sensor.

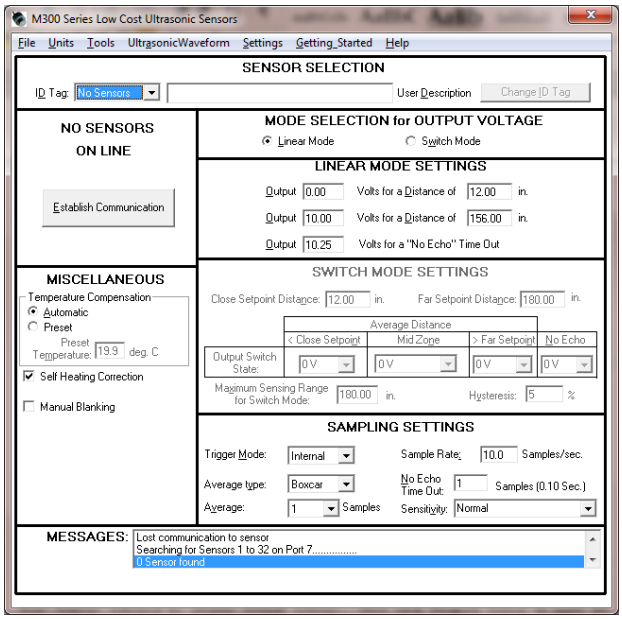


Figure 13

Main M-300 Software Screen that Does Not Detect a Sensor

Editing the M-300/M-320 Sensor Parameters

The Status and Setup Screen provides status information and all the operating parameters for the sensor. Editing is performed using standard Windows® text editing or by drop down menus. When a field is changed, the 'Editing' box, shown in Figure 14, will replace the 'Status' box in the Status and Setup Screen.

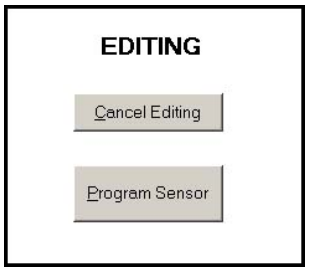


Figure 14

'Editing' Box

Make the desired changes to the various M-300/M-320 parameters and then click the 'Program Sensor' button. It is possible to recall previously saved settings by using the drop down menu item 'File' then 'Recall Settings…'. If it is preferred to defer to the sensors default settings, use the drop down menu item 'Settings' followed by 'Display Default Settings'. Then click 'Program Sensor' to apply the defaults to the sensor.

5 Status and Setup Screen *(continued)*

If a value of a parameter is entered that is invalid for the operation of the sensor, the M-300 Software will highlight the invalid value in red and will display a red error message in the 'Messages' box, as illustrated in Figure 15.

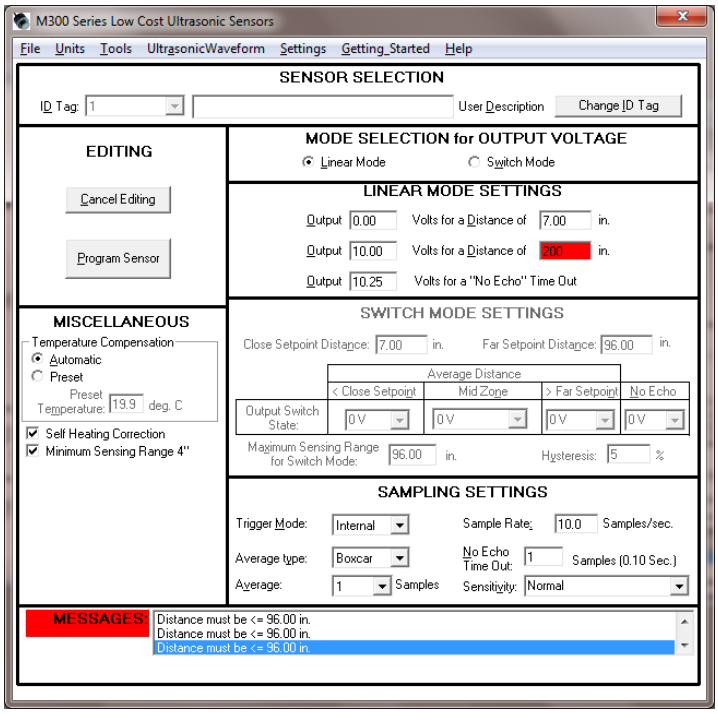


Figure 15

M-300 Software Status and Setup Screen When an Invalid Parameter Has Been Entered

Sensor Selection Box of the Status and Setup Screen

'ID TAG"

The ID Tag is a programmable sensor address that allows multiple sensors to be connected to the same pair of wires of a communications bus. Figure 16 shows the 'Sensor Selection' box of the Status and Setup Screen. The sensor being monitored is identified by the number displayed in the 'ID Tag'. There are two methods of programming multiple sensors placed on the same network. The first method is to program each sensor by itself on the bus with its own unique 'ID Tag'. Once this has been completed, place all the sensors on the bus in parallel. To change the 'ID Tag' of a sensor, click the 'Change ID Tag' button and the 'Change ID Tag' box shown in Figure 15 will appear. Select a new 'ID Tag' from the drop down menu and then click the 'OK' button.

Figure 16

Sensor Selection Box of the Status and Setup Screen

5 Status and Setup Screen *(continued)*

Sensor Selection Box of the Status and Setup Screen

'ID TAG''

The ID Tag is a programmable sensor address that allows multiple sensors to be connected to the same pair of wires of a communications bus. Figure 17 shows the 'Sensor Selection' box of the Status and Setup Screen. The sensor being monitored is identified by the number displayed in the 'ID Tag'. There are two methods of programming multiple sensors placed on the same network. The first method is to program each sensor by itself on the bus with its own unique 'ID Tag'. Once this has been completed, place all the sensors on the bus in parallel. To change the 'ID Tag' of a sensor, click the 'Change ID Tag' button and the 'Change ID Tag' box shown in Figure 18 will appear. Select a new 'ID Tag' from the drop down menu and then click the 'OK' button.

Figure 17

Sensor Selection Box of the Status and Setup Screen

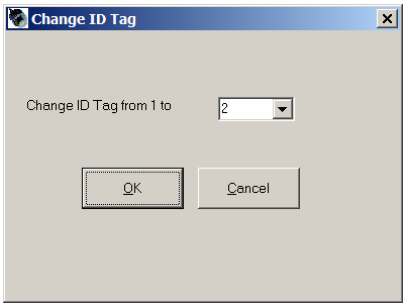


Figure 18

Change ID Tag Box

The second method of placing multiple sensors on the same network is to place only the 1st sensor on the network and assign 2 or greater for its 'ID Tag'. Disconnect power and connect another sensor on the network. Reconnect power to the sensors and restart the M-300 Software Program or re-establish communications. The new sensor will have 1 for its 'ID Tag 1'. Using the 'Change ID Tag' button, select the next available 'ID Tag' from the drop down list. Repeat this procedure until all the sensors are placed on the network. This method should only be used with new sensors that have been assigned 1 for their 'ID Tag' at the factory.

User Description

Each sensor can be identified with up to 32 ACSII characters of descriptive information, such as "Process Tank #3", that can be entered into the 'User Description' box. Once editing of the User Description box has begun, then the 'Editing' box shown in Figure 14 will replace the "Status" box. To save the information, click the 'Program Sensor' button in the 'Editing' box.

5 Status and Setup Screen *(continued)*

Status Box of the Status and Setup Screen

The 'Status' box displays the various parameters for the particular M-300 Sensor whose 'ID Tag' is displayed in the 'Sensor Selection' box of the Status and Setup Screen. This field is updated approximately every ¼ of a second. An example is shown in Figure 19.

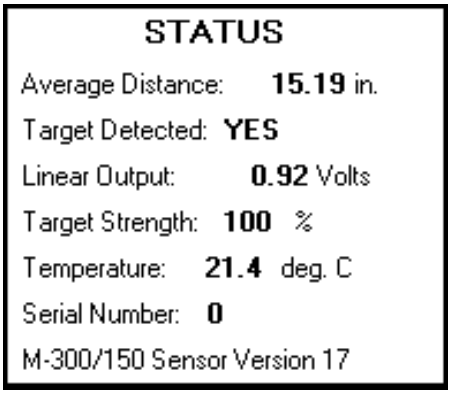


Figure 19

Example of the Status Box of the Status and Setup Screen

'Average Distance': Measured average Target Distance to target. Number of samples in the average and the average type is programmable by using the 'Sampling Settings' box.

'Target Detected': Indicates that a target is detected. If the sensor is in the 'Switch Mode' and if the target is beyond the programmed 'Maximum Sensing Range' for 'Switch Mode', the 'Target Detected' indication will be 'NO'.

'Linear Output' or **'Switch Output':** Indicates the value of Vout, which is proportional to the Target Distance if the M-300's voltage output is programmed in the 'Linear Mode. If the M-300's voltage output is programmed for 'Switch Mode' operation, it will indicate either 0V or 10V. For the M-320, it will indicate 0mA or 20mA.

'Target Strength': Measure of the relative strength of the received ultrasonic echo signal and can be used to align either the target or the M-300/M-320 Sensor to produce the optimum echo.

'Temperature': Temperature reading of the internal probe of the M-300 Sensor when 'Automatic' is selected in the 'Temperature Compensation' box. If 'Preset' is selected in the 'Temperature Compensation' box, then the preset temperature that was entered will be displayed.

'Serial Number': The serial number of the M-300/M-320 Sensor that was assigned at the factory.

The last line in the 'Status' box indicates the particular model of the M-300/M-320 Sensor that is being used and the Version number of its firmware.

5 Status and Setup Screen *(continued)*

Mode Selection for Output Voltage Box of the Status and Setup Screen

The 'MODE SELECTION for OUTPUT VOLTAGE' box of the Status and Setup Screen allows the M-300 Sensor to operate in either the 'Linear Mode' or the 'Switch Mode'. If model M-320 Sensor is detected, then display will indicate 'MODE SELECTION for OUTPUT CURRENT'.

'Linear Mode Settings' Box of the Status and Setup Screen

When the M-300 Sensor is programmed to operate in the Proportional Voltage Output Mode ('Linear Mode'), Vout is an analog voltage that is proportional to the Target Distance. To enable this mode of operation, click on the 'Linear Mode' radio button in the 'Mode Selection for Output Voltage' box of the Status and Setup Screen, as shown in Figure 20. 'Switch Mode Settings' parameters are disabled when the sensor is in the Linear Output Mode. For Model M-320 Sensors, the output represents Proportional Current Output Mode.

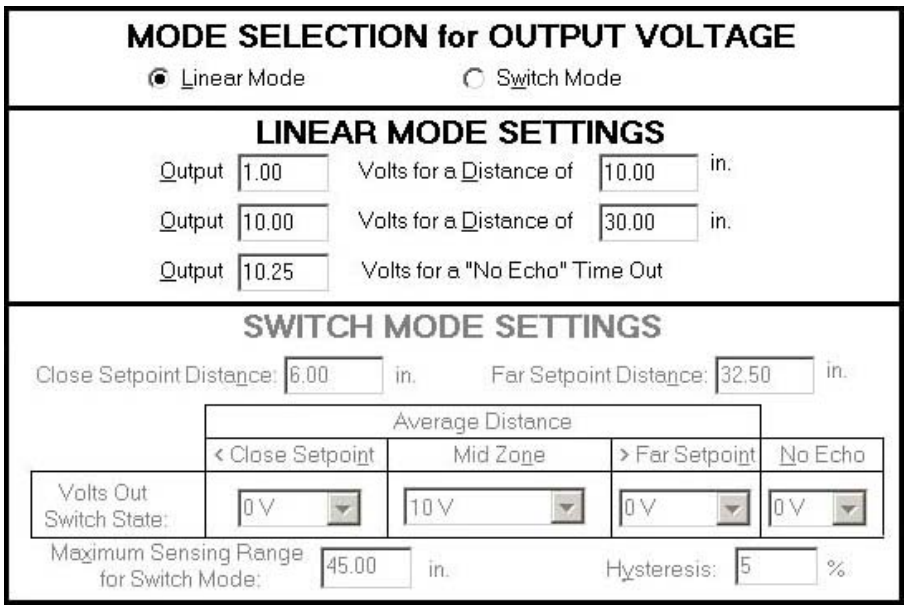


Figure 20

M-300 Mode Selection for Output Voltage Box of the Status and Setup Screen

Programming options in the 'Linear Mode' allow any voltage to be entered into the 'Output' box from 0 to 10.25 V DC for the 1st programmed distance (Zero), and any voltage from 0 V DC to 10.25 V DC for the 2nd programmed distance (Span). With this flexibility, positive or negative slopes can be realized along with any start and end voltage. (See Figure 6 in Section 3 for an explanation of Zero and Span Distance.) In the example shown in Figure 17, the 'Output' is programmed for 1.00 V DC for a 'Zero Distance' of 10.00 inches. The Span is programmed for an 'Output' of 10.00 V DC at a 'Distance of' 30.00 inches. Targets detected between the Zero and Span distances will produce a linear value of Vout between the programmed Zero and Span Voltage values. Targets detected closer than the Zero distance will produce a value for Vout equal to the Zero distance voltage (1.00 V DC in this example). Targets detected greater than the Span distance will produce a value for Vout equal to the Span distance voltage (10.00 V DC in this example). If targets are not detected, Vout will be equal to the ' "No Echo" Time Out ' voltage (10.25 V DC in this example).

For model M-320 Sensors, the linear mode selection is 0 to 20.5mA.

5 Status and Setup Screen *(continued)*

'Switch Mode Settings' Box of the Status and Setup Screen

The Switched Setpoint Outpoint Mode ('Switch Mode') allows the state of Vout to switch between 0 and 10.25 V DC based on the relationship of the measured Target Distance to the 'Close Setpoint Distance' and the 'Far Setpoint Distance' programmed into the M-300 Sensor. Figure 7 in Section 3 shows how three zones are created; the Close Zone where the Target Distance is < the 'Close Setpoint Distance', the Mid Zone where the Target Distance is between the 'Close and the Far Setpoint Distances', and the Far Zone where the Target Distance is greater than the 'Far Setpoint Distance'.

To enable this mode, click on the 'Switch Mode' radio button in the 'Mode Selection for Output Voltage' box of the Status and Setup Screen, as shown in Figure 21. Enter values for the 'Close Setpoint Distance' and the 'Far Setpoint Distance' within the allowable distances specified in the datasheet for the particular M-300/M-320 Sensor. Use the drop down menu to set the values of Vout for when the Target Distance is within each of the three zones. These values can be 0 V DC or 10 V DC. (In the 10 V DC settings, the actual value of Vout is 10.25 V DC). A value for Vout of 0 V DC or 10 V DC can also be set for a 'No Echo' condition.

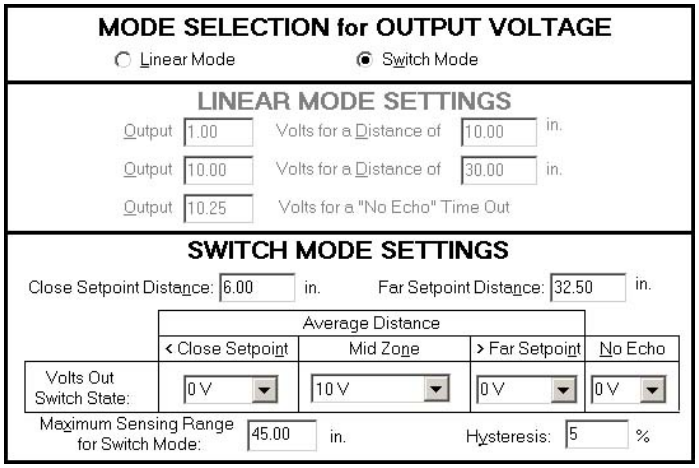


Figure 21

Switch Mode Setting Box

A 'No Change' condition can also be chosen for the voltage setting for the Mid Zone. In this state, Vout would not change as a target transitioned into the Mid Zone. For example, if the '<Close Setpoint' voltage was set at 0 V and the '>Far Setpoint' voltage was set at 10 V, Vout would stay at 0 V when the target moved from the Close Zone into the Mid Zone, and would change to 10 V when it moved into the Far Zone. If the target started moving closer, Vout would stay at 10 V as it moved from the Far Zone into the Mid Zone, and would change to 0 V as it moved into the Close Zone.

A percentage between 0 and 75% can also be entered in the 'Hysteresis' section of the 'Switch Mode Settings' box. This creates a guard zone around each Setpoint Distance to keep Vout from switching back and forth between two states when the Target Distance equals the Setpoint distance. This is explained in more detail in Section 9 on Page 29.

A Maximum Sensing Range for 'Switch Mode' can also be entered into the 'Switch Mode Settings' box. If the Target Distance is greater than the maximum range entered, the M-300 will consider it to be a 'No Echo' condition and Vout will be the programmed 'No Echo' voltage.

For the M-320 Sensor, the Switch Mode will be displayed in current of 0mA and 20.5mA.

5 Status and Setup Screen *(continued)*

Sampling Settings Box of the Status and Setup Screen

The 'Sampling Setting' box shown, in Figure 22, allows the tailoring of the M-300 / M-320 Sensor's filter parameters to optimize operation.

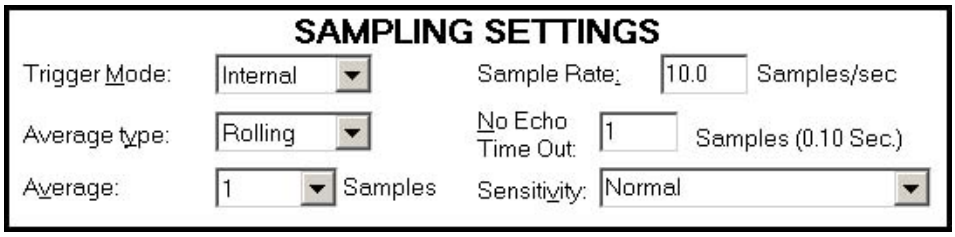


Figure 22

Sampling Settings Box of the Status and Setup Screen

'Trigger Mode': Use the pull down menu to select the 'Trigger Mode'. Options are 'Internal' (self trigger) or 'Manual'. If 'Internal' is selected, the M-300/M-320 Sensor will measure the Target Distance as many times per second as is entered for the 'Sample Rate'. If 'Manual' is selected, the sensor will wait for serial communications to send a software trigger signal before the sensor transmits an acoustic pulse. The screen will display a 'Manual Trigger' button that causes the M-300 Sensor to transmit an acoustic pulse each time it is clicked.

'Average Type': The Target Distance displayed, and the value of Vout, are determined by averaging a number of measured Target Distances. The pull down menu allows the selection of either 'Rolling' or 'Boxcar' for the type of averaging to be used by the sensor. If 'Rolling' is selected, the sensor stores the number of sequential Target Distance measurement entered for 'Average', and then computes the average. Each new sample then replaces the oldest sample in memory, and the average is recomputed and displayed. If 'Boxcar' is selected, the number of measurements entered for 'average' are stored with the average computed and displayed. These samples are then discarded and the process starts over again.

'Average': This drop down menu selects the number of samples to be used to obtain the average Target Distance. If 'Rolling' is selected for the 'Average Type', 'Average' is limited to 32 samples. For 'Boxcar', the maximum number of samples is 1024.

'Sample Rate': When 'Internal' is selected for the 'Trigger Mode', the number of times per second the M-300 Sensor will measure the Target Distance can be entered for the 'Sample Rate'. This rate can be between 0.1 samples/sec up to the sensor's maximum specified rate. (This is model dependent. Refer to the datasheet located on the Massa website at www.massa.com for the particular sensor being used.) In general, the faster the target is moving, the higher the sample rate required.

'No Echo Time Out': The number entered is the number of consecutive samples for which an echo is not detected that must occur before the sensor enters the 'No Echo' state. The displayed 'Target Distance' and Vout will hold these last values until the 'Time Out' occurs.

'Sensitivity': This parameter, which is set by a drop down menu, allows the sensor's target detection ability to be adjusted. Most applications should be set to 'Normal'. Applications with poor reflecting targets may require a 'High' setting. If unwanted reflections are detected by the sensor a 'Low' setting may be required.

5 Status and Setup Screen *(continued)*

Miscellaneous Box of the Status and Setup Screen

The 'Miscellaneous' box, shown in Figures 23 and 24, is used to select different methods of 'Temperature Compensation' to be used by the M-300 Sensor to calculate the speed of sound in order to obtain an accurate Target Distance measurement. This box is also used to display error messages.

The radio buttons under 'Temperature Compensation' can be used to select either 'Automatic' or 'Preset'. If 'Automatic' is selected, the M-300 Sensor uses its internal temperature probe to calculate the speed of sound. This calculation assumes that the Target Distance measurement is being conducted in air. The factory default setting is 'Automatic', and it is recommended that this setting is used for most applications. If a specific speed of sound is desired to be used for the Target Distance measurement, 'Preset' can be selected, which overrides the internal temperature probe. The desired speed of sound to be used by the M-300 is set by entering the temperature that produce this sound speed based on the following:

$$c(T) = 13,044\sqrt{1+\frac{T}{273}}$$

Where: $c(T)$ is the Speed of Sound in Inches per Second
T is the Temperature in °C

Certain error conditions will be displayed in the lower portion of the 'Miscellaneous' box as shown in Figure 24. They include invalid operating parameters that may have been programmed outside the acceptable range of the M-300 Setup Software, internal temperature sensor faults, low supply voltage, and the echo detector fault.

The 'Invalid Operating Parameter' error is considered a fatal error since it could affect the operational settings of the sensor. After entering new settings, the values should be validated by clicking 'Reset Error(s)'. The sensor will not operate (transmit ultrasonic pulses) while in this error mode.

The 'Low Supply Voltage Occurred' error is non-fatal and simply indicates that the sensor went into reset at some point due to a low power supply or glitch. The sensor will continue to transmit ultrasonic pulses.

The 'Temperature Sensor' and 'Echo Detector' error messages cannot be cleared. If these errors occur, the sensor will attempt to fix the problem and will self-clear once they have been corrected. If the errors do not clear after a period of time, the sensor may have a serious fault. While in these error modes, the sensor will not transmit ultrasonic pulses and the output voltage will default to the programmed 'No Echo' voltage.

Figure 23
Miscellaneous Box of the Status and Setup Screen

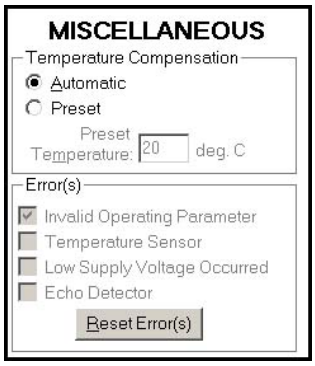


Figure 24
Miscellaneous Box Showing Error Message

5 Status and Setup Screen *(continued)*

Messages Box of the Status and Setup Screen

Messages will be displayed in this box, such as "Searching for Sensors on Port 1…" as shown in Figure 25, errors, such as user inputs that are out of parameter limits, are also displayed, as shown in Figure 15.

Figure 25

Example of Messages in the Messages Box of the Status Setup Screen

Self Heating Correction

When in operation, the temperature of the M-300/M-320 Sensor becomes slightly higher than the ambient temperature of the air. The sensor firmware corrects the reading of the temperature probe to obtain the actual temperature of the air outside of the sensor. The adjustment if found in the MISCELLANEOUS box. It is recommended that if sensor is continuously powered, then check the Self Heating Correction box. If the sensor is briefly being turned on then off for long periods, then uncheck the Self Heating Correction box as sensor self-heating does not occur. See Figure 26.

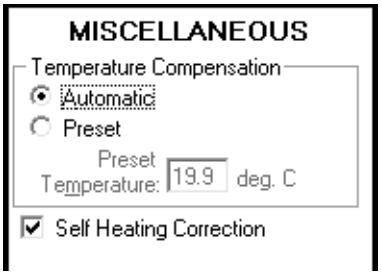


Figure 26

Example Showing 'Self Heating Correction' in the 'MISCELLANEOUS' box

5 Status and Setup Screen *(continued)*

File Tab

Sensor register settings can be saved and recalled using the *File* drop down menu tab. This function allows the convenience of programming numerous sensors with the same settings. See Figure 27.

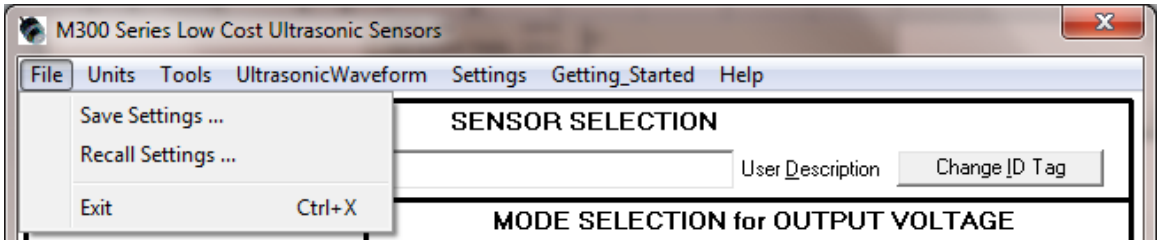


Figure 27

Example Showing 'Save Data' and 'Recall Data' in the 'File'
Drop Down Menu of the Status and Setup Screen

'Save Settings…': Allows all the sensor settings displayed to be saved to a PC. This facilitates the transfer of settings to other sensors.

'Recall Settings…': Allows restoration of previously saved values. Only data sets that were saved for the same specific M-300 Sensor model as the selected sensor are allowed to be recalled. Click 'Program Sensor' to apply the settings to the selected on-line sensor.

'Exit': Exits the M-300 Setup Software while the sensor continues to operate normally.

Units Tab

The *Units* dropdown menu allows the selection of units for distance and temperature, see Figure 28 below.

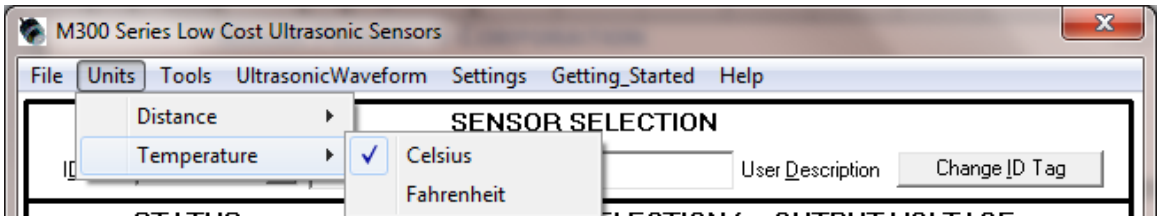


Figure 28

The 'Units' Drop Down Menu Selections of the Status and Setup Screen

'Distance': Allows the user to select the distance units to be displayed. The available selections include inches, centimeters, feet, and meters.

'Temperature': Allows the user to select the temperature units to be displayed. Select either Celsius or Fahrenheit.

5 Status and Setup Screen *(continued)*

Tools Tab

The *Tools* dropdown menu contains the menu item to calibrate the Voltage Output for M-300 Sensors or Current Output for M-320 Sensors. Each sensor is calibrated at the factory for 10.00V or 20.00mA so in most instances, the sensor does not need to be calibrated. The second menu item allows the program to search for sensors if communications was lost. See Figure 29 below.

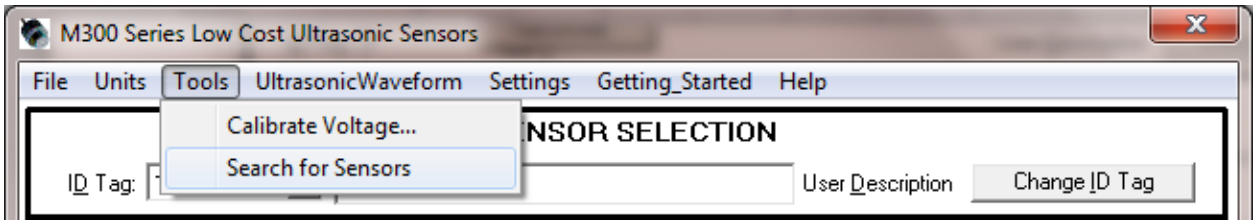


Figure 29

The 'Tools' Drop Down Menu Selections of Sensor Calibration and Setup Screen

'Calibrate Voltage…': Allows the user to calibrate the Vout to 10.00 V DC for the M-300 Sensor or Iout to 20.00mA for M-320 Sensors. A warning page will appear acknowledging you want to continue as this will change the output for calibration which could disrupt a process when the sensor is connected to an application. See Figure 30.

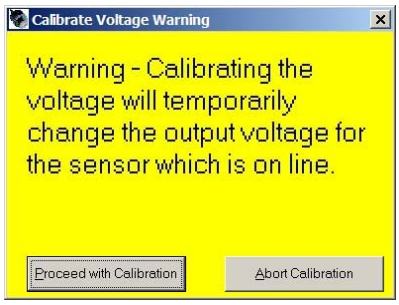


Figure 30

The 'Calibrate Voltage Warning' (or Current for M-320 Sensors)

Attach a volt meter attached to the white lead of the M-300 Sensor (Vout), adjust the voltage by using the 'Increase Voltage' or 'Decrease Voltage' buttons to 10.00V. See Figure 31. Allow several seconds each time the button is clicked for Vout to adjust since this is a filtered output. Click 'Exit and resume normal sensor operation' button when done. For M-320 Sensors, wire to current meter and adjust for 20.00mA.

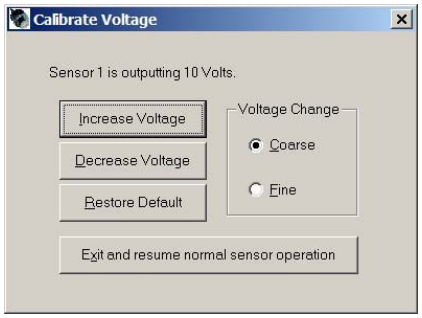


Figure 31

The 'Calibrate Voltage' Screen of the Status and Setup Screen

5 Status and Setup Screen *(continued)*

'Search for Sensors': Allows the user to re-establish communications with the sensor(s) if lost or not initially obtained.

Note: If communications to sensors are lost, the 'Status' box area will be replaced with a 'No Sensors On Line' box as shown in Figure 32. Clicking on the 'Establish Communication' button in this box will produce the same results as clicking on 'Search for Sensors' as seen in Figure 29.

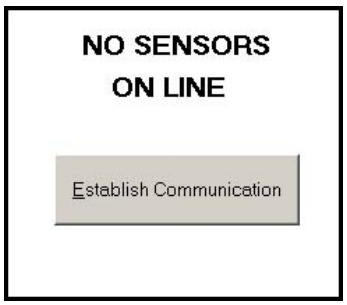


Figure 32
'Establish Communications' Box

UltrasonicWaveform Tab

The M-300/M-320 Sensor has a unique feature that will allow the M-300 Software to obtain and display an ultrasonic waveform, similar to an oscilloscope. This can be used as a valuable aid in diagnosing difficult applications. Waveforms can be saved and recalled for future review. To access this feature, click on the UltrasonicWaveform tab shown in Figure 33.

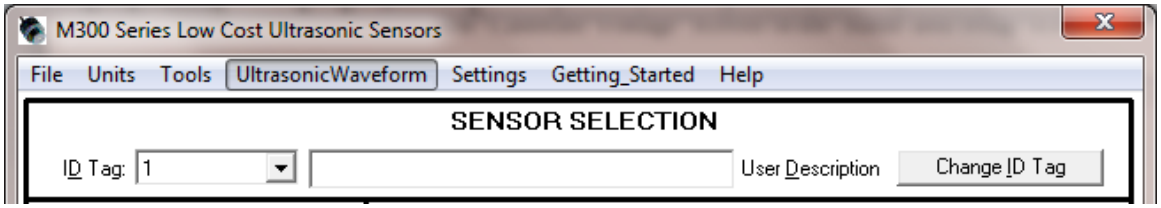


Figure 33
Ultrasonic Waveform Menu Item

A warning display will appear as shown here in Figure 34. If the M-300/M-320 Sensor is actively controlling a process, then the operation of the process may be affected since the sensors output voltage or current will be operating in the No Echo programmed value. Click *Continue* to obtain an ultrasonic waveform.

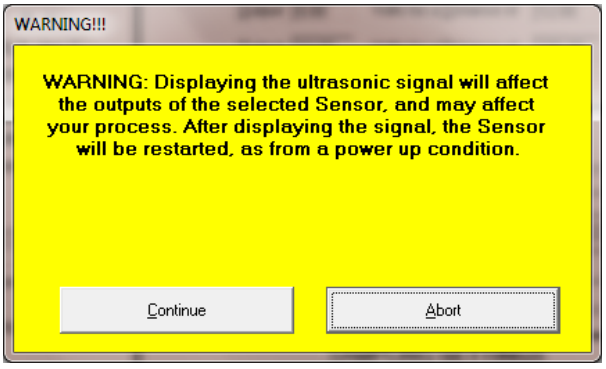


Figure 34
Warning Page the Sensor Output Will Change

5 Status and Setup Screen *(continued)*

After clicking *Continue* in the Warning Display page, the sensor will obtain ultrasonic waveform and display it as shown if Figure 35. The "Signal" trace, in black, represents the peak detected waveform from the received ultrasonic signals. The first peak is the sensor's transmit pulse, followed by a second peak at 30" that is the target. Subsequent reflections may follow the target signal, but they are ignored by the sensor. The 2nd waveform, in red, is the 'Threshold' trace. This represents the signal detection level as determined by the "Sensitivity" setting. A reflected signal that crosses over this 'Threshold' level is captured and used to calculate the Target Distance. Most applications will have the "Sensitivity" adjustment set to "Normal". However, if the target's reflection is marginal, setting the "Sensitivity" setting to "High" (which lowers the threshold level) will improve target detection. On the other hand, if there are unwanted reflections in the application arriving before the target echo, setting the "Sensitivity" setting to "Low" (which raises the "Threshold" level) may be required. This valuable display tool will help to analyze and validate the M-300 Sensor's operation in the particular application. Certain applications may require custom sensitivity adjustments. Consult Massa Products for additional information.

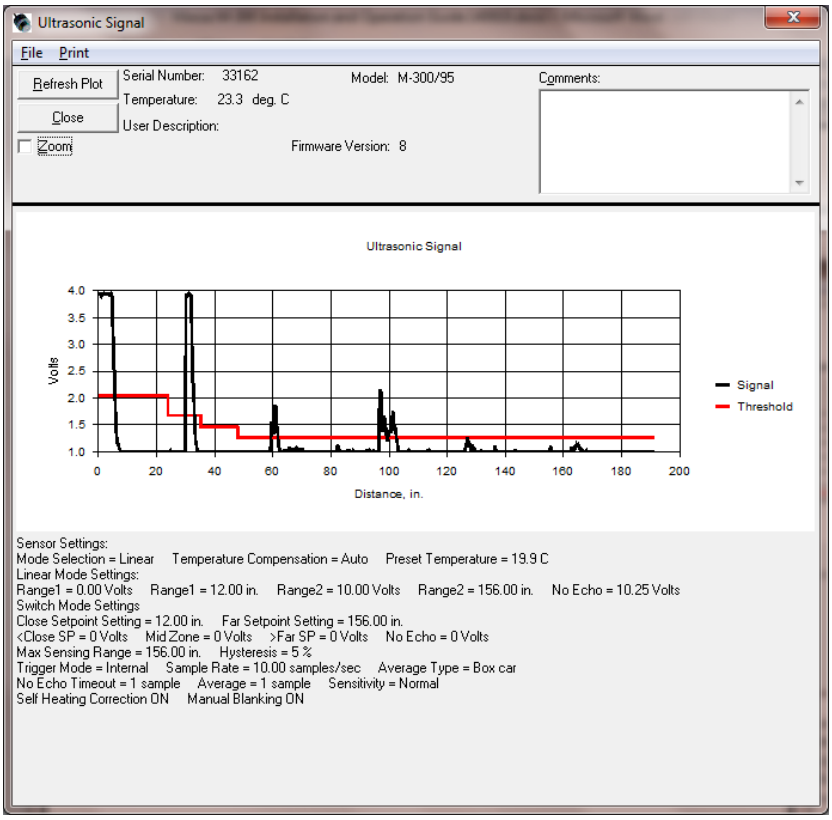


Figure 35
Ultrasonic Waveform
& Sensor Register Settings

5 Status and Setup Screen *(continued)*

Settings Tab

Figure 36 shows the selection options for the 'Setting' drop down menu

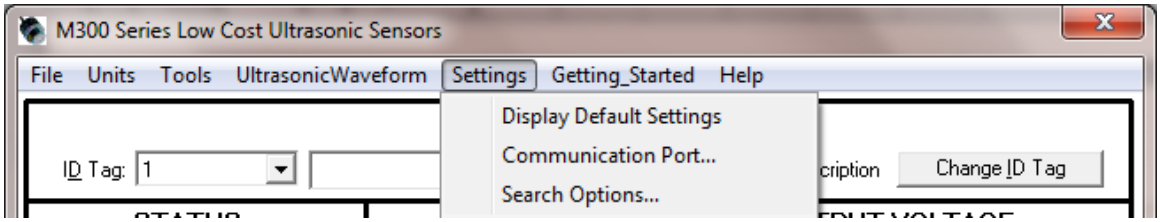


Figure 36

The 'Settings' Drop Down Menu Selections of the Status and Setup Screen

'Display Default Settings': Displays the M-300 Factory Default values. Either cancel or program these values into your sensor. You may change settings before programming the sensor.

'Communications Port…': Allows for selection of the PC port the USB Converter is assigned to. If it has not yet been determined, then use the *Getting Started* menu to have it automatically found.

'Search Options…': If 'Search Options…' is selected, the screen shown in Figure 37 is displayed. The M-300 Software will only search for sensors with ID Tag numbers between those listed in 'Start Search ID Tag' and 'End Search ID Tag'. To change the search limits, click on the 'Start Search ID Tag' and 'End Search ID Tag' boxes and enter ID Tag values from 1 to 32 and click 'OK'. To search for the new ID Tag search limits just entered, go to the 'Tools' drop down menu and then select 'Search for Sensors - Options'. If all the sensors on line are not found, then revert back to searching from 1 to 32.

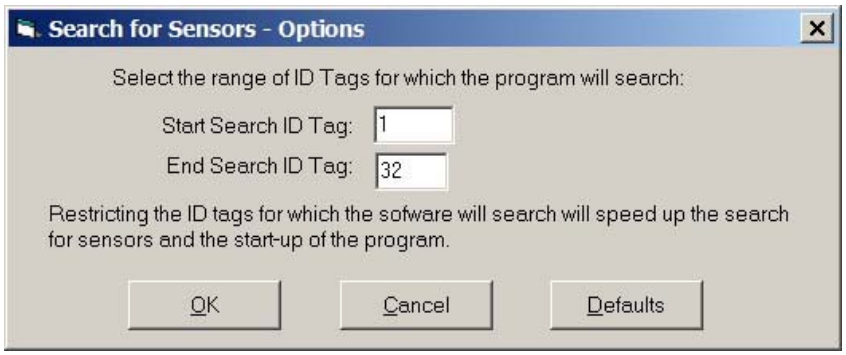


Figure 37

Example Showing the 'Search for Sensors - Options' Screen

5 Status and Setup Screen *(continued)*

Getting Started Tab

The *Getting Started* tab allows the USB port being used to be found easily. See page 11 for more details.

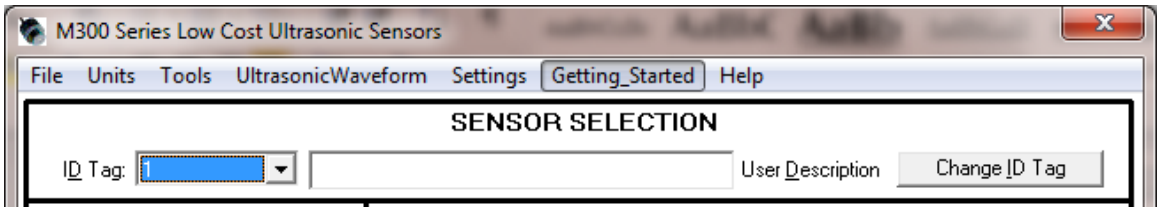


Figure 38

'Getting Started' Drop Down Menu Selections

Help Tab

Figure 39 shows the selection options for the 'Help' drop down menu.

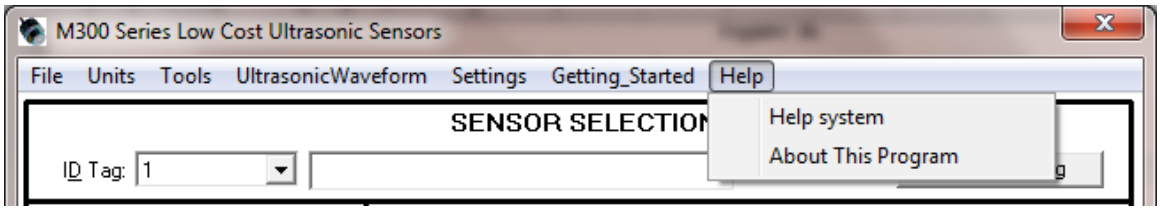


Figure 39

'Help' Drop Down Menu Selections

'Help system': Help menu is under construction. Please check the Massa website (www.massa.com) for updates.

'About This Program': If this option is selected the M-300 Software version number will be displayed, as shown in Figure 40.

Figure 40

The 'About this Program' Screen

6 Factory Default Programmed Settings

The M-300 Sensor is factory programmed with the default values listed below. All of the values can be reprogrammed if required by the application. The factory defaults are as follows:

ID Tag = 1

User Description Field = 32 ASCII spaces

Mode Selection for Voltage Output = Linear

Voltage Output Linear Mode Settings:
1st Output Setpoint: Voltage = 1.00V; Distance = *minimum specified sensing range
2nd Output Setpoint: Voltage = 10.00V; Distance = *maximum specified sensing range
No Echo Voltage = 10.25V

Voltage Output Switch Mode Settings:
Close Setpoint Distance = *minimum sensing range
Far Setpoint Distance = *maximum sensing range
Volts Out Switch State = 0 V DC for all zones
Maximum Sensing Range for Switch Mode = *maximum sensing range
Hysteresis = 5%

Sampling Settings:
Trigger Mode = Internal
Average type = boxcar
Average = 1 sample
Sample Rate = 10 Samples/sec (Hz)
No Echo Time Out = 1 Sample (0.10 Sec.)
Sensitivity = Normal

Miscellaneous:
Temperature compensation = automatic (internal probe)

Other parameters:
Self-heating correction = enabled (checked)

* Minimum and Maximum sensing ranges are different for each model in the M-300 Sensor Family. Consult the Datasheet located on the Massa website (www.massa.com) for the specific model M-300 Sensor to obtain its minimum and maximum sensing ranges.

7 Specifications

There are several different models in the M-300 Family of Low Cost Ultrasonic Sensors. The latest specifications for each sensor are posted on the Massa website (www.massa.com).

8 Troubleshooting

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

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

Cannot find all sensors that are connected in a multi-drop network:

Verify the communications adapter is wired properly. Verify that unique ID tags were assigned for each M-300 on line. Verify that range of 'ID Tags' entered in the 'Search for Sensors' screen is 1 to 32 (see Figure 31 on Page 23).

The Voltage Output does not respond:

Verify that power is connected to the sensor. Verify that the sensor in *not* in the Manual trigger mode.

Sensor reports 'zero' range and 'No Target' when the target should be detected:

If the M-300 is programmed for 'Switch Mode' operation the target could be beyond the Far Zone. Under these circumstances, the sensor will report 'Zero' range and 'No Target'. Adjust the parameter 'Maximum Sensing Range for Switch Mode'.

The sensor seems to respond slowly or erratically:

The 'Average' may be set to a high value and/or the 'Sample Rate' may be set to a slow rate. There is a balance required for adjusting these parameters. Each sensor must 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').

9 Terminology

Beam: The projection, usually conical, of useable ultrasonic energy radiating from the sensor that extends axially from the face of the transducer in the sensor.

Beam Diameter: The diameter, *dia (D)*, as a function of distance, *D*, of the cross-sectional area insonified by a sensor with an acoustic system beam angle of θ, computed as follows (for value of θ, see Table in Section 1 or the datasheet for the specific model of sensor on the Massa website at www.massa.com):

$$dia\,(D) = 2D\tan\left(\frac{\theta}{2}\right)$$

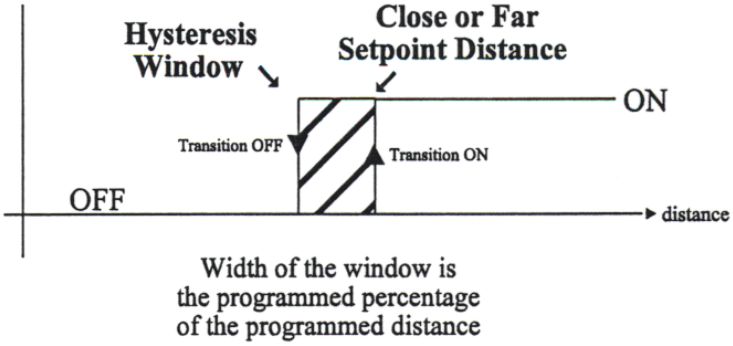
Close Setpoint Distance A position in space within the sonar's beam that is closer than the Far Setpoint Distance, and between the Minimum Sensing Range and the Maximum Sensing Range. (See Figure 7 in Section 3 on Page 7.)

Far Setpoint Distance: A position in space beyond the Close Setpoint Distance, and between the Maximum Sensing Range and the Minimum Sensing Range. (See Figure 7 in Section 3 on Page 7.)

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. This is the operation of the M-300 Software with the M-300 Sensors.

Terminology *(continued)*

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.



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 are detected after the initial reflected target may be multiple bounce echoes. This is the result of having a good reflective target and may require you to limit the sample rate of your system. All ultrasonic signals must subside before the next transmit burst is to occur, otherwise spurious output values may result.

Sample Rate: The rate at which an M-300 Sensor transmits an ultrasonic pulse of energy.

Speed of Sound in Air:

$$c(T) = 13,044\sqrt{1+\frac{T}{273}}$$

Where: $c(T)$ is the Speed of Sound in Inches per Second
T is the Temperature in °C

Temperature Compensation: The technique for determining the speed of sound, which is a formation of temperature, used to calculate the Target Distance.

Transducer: A device capable of efficiently converting one form of energy (in this case ultrasonic sound) back and forth into another form of energy (in this case electricity).

10 Wire Color Code

Wire Color Code for Standard M-300 Sensors (and M-320 Sensors):

RED:	Positive Power in (12-24V DC)
BLACK:	Ground
WHITE:	Vout (M-300) and Iout (M-320)
GREEN:	RS-485 communications port, A (-) or TDA (-) terminal
BROWN:	RS-485 communications port, B (+) or TDB (+) terminal

11 Customer Support

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12 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.

Appendix A

Sensor Start up Timing

The sensor power up time ready to report a valid output is based on several sensor settings and target conditions. These include Sample Rate, Average, and No Echo Timeout. The following are formulas based on these settings and conditions:

Model M-300/150 with 4″ min enabled:

Sensor Startup Time (valid target): 0.25seconds + (2 x Average x Sample Rate in seconds)

Sensor Startup Time (no target): 0.25seconds + (2 x No Echo x Sample Rate in seconds)

Model M-300/150 with 4″ min disabled and M-300/95:

Sensor Startup Time (valid target): 0.25seconds + (Average Setting x Sample Rate in seconds)

Sensor Startup Time (no target): 0.25seconds + (No Echo Setting x Sample Rate in seconds)