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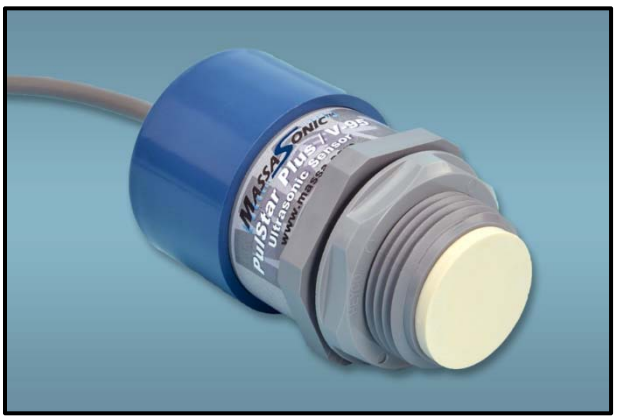
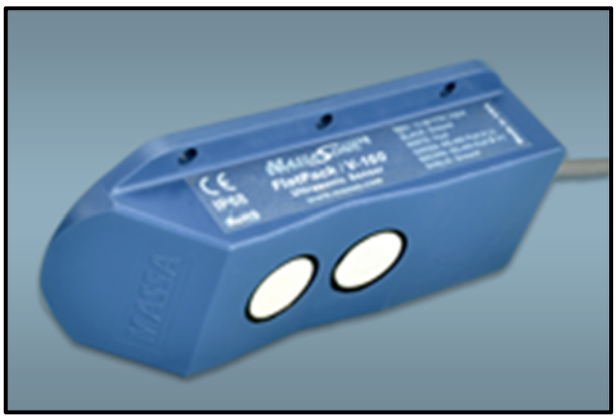
MassaSonic® PulStar® and FlatPack® Series Ultrasonic Level Sensors

Serial Communications Guide





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RoHS COMPLIANT

Table of Contents

1.0 Introduction 3

2.0 Sensor Wiring 3

3.0 Communications Protocol 3

4.0 Sensor Commands 4-9

- 4.1 Request for STATUS 4
- 4.2 Response when STATUS information is requested 4
- 4.3 Request to WRITE to Data Memory 5
- 4.4 Request to READ from Data Memory 6
- 4.5 Response from a READ request of Data Memory 6
- 4.6 Request to SOFTWARE TRIGGER 7
- 4.7 Request for MODEL TYPE and FIRMWARE REVISION LEVEL 8
- 4.8 Response from requesting MODEL TYPE & FIRMWARE REV. LEVEL 8
- 4.9 Response from a SENSOR ERROR 8
- 4.10 Resetting an ERROR 9
- 4.11 Request to REBOOT 9

5.0 Data Memory 10-17

- 5.1 Data Memory (General) 10-12
- 5.2 Data Memory (Linear Mode Parameters) 13
- 5.3 Data Memory (Switch Mode Parameters) 14
- 5.4 Data Memory (Sensitivity Adjustment Parameters) 15-17

6.0 Ultrasonic Diagnostic Waveform 18-22

7.0 MassaSonic™ Ultrasonic Sensor Software Save/Recall Format 23

8.0 Flowcharts 24-27

- Flowchart for Status Information on Multiple Sensors 24
- Flowchart for Writing to Data Memory 25
- Flowchart for Reading Data Memory 26
- Flowchart for Error Processing 27

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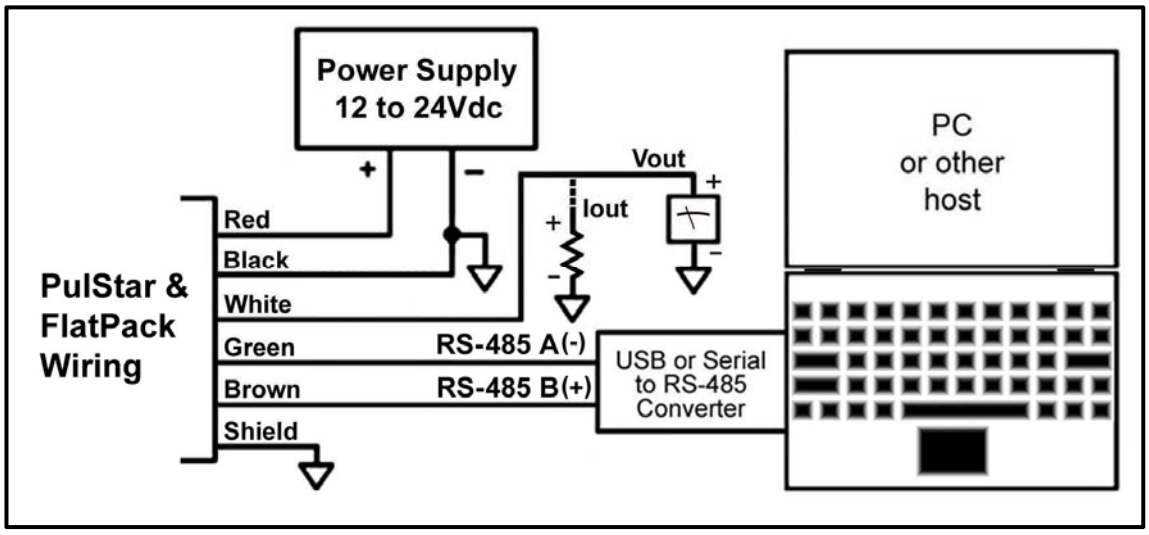
1.0 Introduction

This document was developed for users who want to communicate and control the PulStar® and FlatPack® Series of Smart Ultrasonic Sensors with their own host device. The following pages describe how to obtain Sensor Status information and how to access Data Memory, which controls the sensors operation. Flowcharts in the back of the guide include how to develop routines to implement up to 32 sensors on line and error handling.

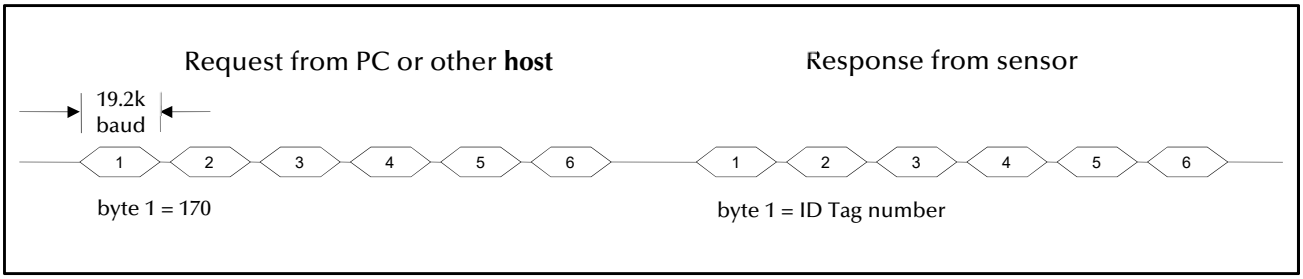
2.0 Sensor Wiring

A wiring diagram using an RS-232 (DB9) to RS-485 Converter is shown below. You can also use a USB to RS-485 Converter if your PC does not have a RS-232 communications port.



3.0 Communications Protocol

The data rate is set at 19.2 kbaud. Each byte contains 10 bits that include a start bit, 8 bit data, and 1 stop bit and no parity bit. There are a total of 6 bytes required to access the PulStar and FlatPack Sensors. The sensor will respond back with 6 bytes that include status (range to target, temperature, target strength, etc.), Data Memory read requests, and sensor error messages on the RS-485 bus. Transmitted values are in binary.



4.0 Sensor Commands

4.1 Request for STATUS

There are a total of 6 bytes required to obtain the status information that will include target range, temperature, target strength, error condition and other information. The data format of the Status Request from host to sensor is as follows:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	3 (status)
4	Placeholder byte	0
5	Placeholder byte	0
6	Checksum	sum of bytes 1 to 5, modulo 256

4.2 Response when STATUS information is requested

Upon receiving the Status request, the sensor will respond back with 6 bytes of Status data with the format defined as:

Byte	Description	Value
1	Sensor ID Tag No.	1 to 32
2	Response Code	8 bits parsed, see below
3	Range data byte (LSB)	see Notes 1, 2, 3, and 6
4	Range data byte (MSB)	see Notes 1, 2, 3, and 6
5	Temperature data	5 to 254, see Notes 4 and 6
6	Checksum byte	Sum of bytes 1 to 5, modulo 256

Response Code data byte 2 parsed:

bit	7 6 5 4	Description	bit	Description
	0 0 0 0	0% target strength	3	Target Detected: **0**=NO **1**=YES
	0 0 0 1	25% target strength	2	Vout operating mode: **0**=Linear **1**=Switch
	0 0 1 0	50% target strength	1	If Switch Mode operation Vout: **0**=0 Vout **1**=10 Vout
	0 0 1 1	75% target strength		else Linear Mode = **0**
	0 1 0 0	100% target strength	0	Set if sensor error, see Data Memory address 104, on Page 11 for the error description

Notes:

1) Range to target (average): Byte 3 (LSB) combined with byte 4 (MSB) to form 2 bytes, then divided by 128 (inches).
2) No target detected will be indicated as 0000 range and 0% target strength.
3) If responding to Status Request Code 2, Byte 3 is MSB and Byte 4 is LSB.
4) Temperature data is defined as deg C = (byte 5 * 0.48876) – 50.
   *Model PulStar® TTL only: Temperature data is defined as deg C = (byte 5 * 0.58651) – 50*
5) See Page 8 for the response if there is a sensor error.
6) If sensor does not have application firmware, its response is IDTag, 0x84, 0xFC, 0xFD, 0xFE, checksum byte. Use latest version Massa Sensor Software to upload application firmware.

4.3 Request to WRITE to Data Memory

There are a total of 6 bytes required to write to the sensor's Data Memory. These locations affect operation of the sensor including sample rate, averaging, loss of echo timeout, Voltage Output operating mode, Sensor ID tag, etc. The description to each Data Memory location is on Pages 10-17. The data format is as follows:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	103 (write to Data Memory)
4	Address of Data Memory	8 to 128
5	Data to be stored in memory	0 - 255 (limits indicated in Data Memory section of this guide)
6	Checksum	sum of bytes 1 to 5, modulo 256

There is no response from the sensor after a write request. Good design practice is to read back the Data Memory for verification (see next page). The sensor will verify that the Data Memory is within specified values as described in the Data Memory description section. Any invalid data will be replaced with the factory default value and will indicate a Data Memory replacement error (see Page 8).

When a write command is initiated, the sensor will stop its normal operation and remain idle waiting for additional writing to the Data Memory. The sensor will only return to normal operation (with the new parameters in Data Memory) when a re-boot command is initiated (see Page 8) or if it is re-powered.

SPECIAL CASE: The ID Tag memory address 40 must be unlocked by the command shown here prior to requesting the change. Note that any other command request other than the ID Tag change request will re-lock the ID Tag memory location.

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	105 (unlock ID Tag location 40)
4	Unlock value	12
5	Unlock value	234
6	Checksum	sum of bytes 1 to 5, modulo 256

This command must immediately follow with the standard write to Data Memory:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32 (Sensor ID Tag you are requesting to change)
3	Request Code	103 (write to Data Memory)
4	Address of data memory	40
5	New ID Tag	1 to 32
6	Checksum	sum of bytes 1 to 5, modulo 256

The new ID Tag will take affect after a re-boot command (or power cycle).

4.4 Request to READ from Data Memory

There are a total of 6 bytes required to access and read the Data Memory from the sensor. The data format is as follows:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	104 (read)
4	Address of Data Memory	8 to 128
5	Placeholder byte	0
6	Checksum	sum of bytes 1 to 5, modulo 256

4.5 Response to a READ request of Data Memory

Upon the sensor receiving the read request for the specific Data Memory location, it will respond back with 6 bytes of data with the format defined below:

Byte	Description	Value
1	Sensor ID Tag No.	1 to 32
2	Response Code	128 (read)
3	Address	address of Data Memory
4	Data Memory	data from address in byte 3
5	Data Memory	data from next higher address
6	Checksum	sum of bytes 1 to 5, modulo 256

See Pages 10-17 for details on all the Data Memory locations.

4.6 Software Trigger the Sensor

4.6.1 Request for a Software Trigger 1 Command will initiate the sensor to transmit an ultrasonic pulse and acquire the range to target when sensor is in the *Software Trigger* mode (memory address 94=1, see section 5.1.7). However, if the sensor is enabled for minimum sensing processing (Reg 105=1), a second Software Trigger command will be required to complete a set of pulses so that the range report is updated (when Average Reg 91=0). More Software Trigger 1 commands will be necessary when the Average register 91 is greater than an average of 1 (Reg 91>0). It is recommended that sensors with FW versions ≥ 60 to use the new command listed in section 4.6.2 which will transmit a set of ultrasonic pulses so that the status report will be updated with just one command (when Ave Reg91=0).

See Note 1 below on how long to wait before you request the status information from the sensor. You may also trigger all the sensors wired to the communication bus simultaneously by setting the sensor ID to 0 (zero). This is recommended when sensors are placed in close proximity to each other thus avoiding acoustic cross-talk and erroneous operation. The data format to trigger the sensor is as follows:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32 (including 0, see Note 2)
3	Request Code	1 (trigger sensor to transmit)
4	Placeholder byte	0
5	Placeholder byte	0
6	Checksum	sum of bytes 1 to 5, modulo 256

Notes:

1) After you request this software trigger command, you must wait a finite amount of time before you request for status information from the sensor so it can acquire targets. The wait time is model dependent. For 150 & 160 models wait at least 15mS. For 95 models, wait at least 40mS.
2) If the Sensor ID Tag (byte 2) is zero, then all sensors on the communications bus will transmit at approximately the same time.
3) If enabling Min Sensing Distance, send this software trigger command twice to obtain a valid range (ave=1). See Section 5.1.13.
4) When powering up the sensor, wait at least 100mS before this command is executed.

4.6.2 Request for a Software Trigger 2 Command will initiate the sensor to transmit a set ultrasonic pulses and acquire the range to target when sensor is in the *Software Trigger* mode (memory address 94 = 1, see section 5.1.7).

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32 (including 0, see Note 2)
3	Request Code	4 (trigger sensor to transmit set of pings)
4	Placeholder byte	0
5	Placeholder byte	0
6	Checksum	sum of bytes 1 to 5, modulo 256

Notes:

1) After you request this software trigger command, you must wait a finite amount of time before you request for status information from the sensor so it can acquire targets. The wait time is model dependent. For model 150 & 160 wait at least 30mS. For model 95 wait at least 110mS.

4.7 Request for Sensor MODEL TYPE and FIRMWARE REVISION LEVEL

There are a total of 6 bytes required to access the sensor's model type and firmware revision level. Shown below is the data format required to receive this information:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	123 (model type /firmware revision request code)
4	Placeholder byte	0
5	Placeholder byte	0
6	Checksum	sum of bytes 1 to 5, modulo 256

4.8 Response from requesting MODEL TYPE and FIRMWARE REVISION LEVEL

Upon the sensor receiving the request for Model Type and Firmware Revision Level request, it will respond back with 6 bytes of data with the format defined below:

Byte	Description	Value
1	Sensor ID Tag No.	1 to 32
2	Response Code	131 (model type /firmware revision response code)
3	Sensor Model Code	*see below
4	Firmware Revision	data
5	Model Type	0 = standard, 1 = Plus
6	Checksum	sum of bytes 1 to 5, modulo 256

*Sensor model codes: 101 = PulStar-95-V, 102 = PulStar-150-V, 142 = PulStar-150-I, 141 = PulStar-95-I, 106 = FlatPack-160-V, 107 = FlatPack-95-V, 146 = FlatPack-160-I, 147 = FlatPack-95-I, 104 = PulStar-150-TTL, 105 = PulStar-95-TTL

4.9 Response on a SENSOR ERROR

An error is indicated in the Sensor Status response if byte 2 bit 0 = **1**. The Data Memory address 104 will have at least a bit set indicating the source of the error (see Error Flags in the Data Memory Section, Page 11). The sensor will respond back to the normal Status request with 6 bytes as defined below:

Byte	Description	Value
1	Sensor ID Tag No.	1 to 32
2	Response Code	bit 0 is set on error, other bits undetermined
3	Range data byte (LSB)	see note below
4	Range data byte (MSB)	see note below
5	Temperature data	5 to 255 (probe fault if less than 5)
6	Checksum	sum of bytes 1 to 5, modulo 256

Note: Range data bytes will be zero if Data Memory was replaced. Other errors may or may not have valid range. For example, a temperature probe fault error will still try to attempt to obtain a range and report it. An Internal Signal Detect error will report the range as zero and attempts to self-correct. A Brown Out error may operate properly, but users should verify their power supply for minimum requirements.

Data Memory address 104 error flags (see Page 11):

If bit 0 set:	A Data Memory location was replaced with a factory default value. Sensor sampling operation stops until user clears bit and re-boots the sensor.
If bit 1 set:	Brown out error. Sensor will attempt to self-correct. Verify supply voltage.
If bit 2 set:	Temperature Probe error. Sensor will attempt to self-correct.
If bit 3 set:	Internal Signal Detect error. Sensor will attempt to self-correct

4.10 Resetting an ERROR

The only two errors that can be reset are the Data Memory replacement and Brown Out errors. This can be done by writing a zero to the memory address **104**. After clearing the error, the sensor must be re-booted (see below). The sensor will attempt to self-clear both the Internal Signal detect and Temperature Probe faults. The user cannot clear these errors.

4.11 Request to REBOOT

There are a total of 6 bytes required to reboot a sensor. This command must be sent after you have completed writing to any or all sensor Data Memory locations to activate the changes (however re-powering the sensor will also activate the changes). The data structure is as follows:

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	119 (reboot)
4	Placeholder byte	0
5	Placeholder byte	0
6	Checksum	sum of bytes 1 to 5, modulo 256

The latter pages contain flowcharts to be used as guides in developing your code.

5.0 PulStar® and FlatPack® Sensors Data Memory

The Data Memory locations described below may be changed to tailor the sensor's operation to your particular application. The sensor will verify that you stay within product limits for proper operation. If you write invalid data to any location, the sensor will replace the invalid data with the product default values after a re-boot command or next power up. Common practice is to verify the location you written to with the Read command (see page 6).

5.1 Data Memory (General)

5.1.1 ID Tag is in Data Memory address **40**. Values in this location must be between **1** and **32**. This location requires a special unlock command to enable writing to this location. See page 5 for details. The default value is **1**.

5.1.2 User Description Field is in Data Memory address **41** thru **72**. These values must be ASCII codes from **32** through **126**. The default values are **32** (ASCII spaces).

5.1.3 Voltage Output Operating Mode is in Data Memory address **85**. This location defines the operating mode of the Sensor's Voltage Output (or Iout for current output versions). A "**0**" in this location operates the Voltage Output in a linear mode. The parameters that control the slope and min/max voltage values of the voltage output are located in data memory locations *Zero Setpoint Distance*, *Zero Setpoint Voltage Value*, *Span Setpoint Distance*, and *Span Setpoint Voltage Value* (see page 13). A "**1**" in this location operates the Voltage Output as switch. The parameters that control the switch points are located in data memory *Close Setpoint Distance*, *Far Setpoint Distance*, and *Switch Mode Output Operation* and *Setpoint Output Hysteresis* (see page 14). If application firmware is not present, the voltage (or current) output oscillates at 5Hz.

5.1.4 Average is in Data Memory address **91**. This location is defined as follows: **0**=ave. of 1, **1**=ave. of 2, **2**=ave. of 4, **3**=ave. of 8, **4**=ave. of 16, **5**=ave. of 32, **6**=ave. of 64, **7**=ave. of 128, **8**=ave. of 256, **9**=ave. of 512, and **10**=ave. of 1024. The maximum average for the "Rolling" average type is 32 (or index value of **5**). The default value is **0**.

5.1.5 Average Type is in Data Memory address **92**. This location is defined as follows: "**0**" = Rolling and "**1**" = Boxcar. By definition, a Rolling average uses the latest samples where each new sample replaces the oldest sample. A Boxcar average takes the selected number of samples before outputting the average reading, then starts a new average. The default value is **0** (Rolling).

5.1.6 No Echo Time Out is in Data Memory address **93**. This location is programmable from **1** to **254** representing the amount of consecutive missed echoes before the sensor reaches a loss of echo condition. This parameter is independent of the Average parameter. The default value is **1**.

5.1.7 Trigger Mode is in Data Memory address **94**. This location is defined as follows: "**0**" establishes normal operation or internal self triggering at a rate programmed by the Sample Rate (data memory location **100-103**). A "**1**" in this location places the sensor in a software trigger mode where a computer or other host is required to initiate the sensor to transmit (see Software Trigger command on page 7). The default value is **0** (internal).

5.1.8 Sample Rate is in Data Memory address 100 thru 103. This 4 byte location represents the sampling time for which the sensor transmits its ultrasonic pulse. Address 100 is the LSB thru 103 being the MSB. Resolution for models /150 & /160 is 400nS/bit, and for model /95 is 800nS/bit. The default value for all models is 10Hz. ***NOTE:*** *The response rate for the output is half of this programmed sample rate when the sensor is programmed for min sensing range (see section 5.1.13).*

5.1.9 Temperature Compensation is in Data Memory address **95**. This location is defined as follows: "**0**" = internal probe or "**1**" = manual temperature (see location 96). The default value is **0** (internal probe). The formula for the speed of sound compensation is:

c = (789.9147 * SQRT (temperature in °C + 273)) / 2 inches/sec (to target)

5.1.10 Manual Temperature Override is in Data Memory address **96**. When address **95** is set to 1, Manual Temperature operation is in effect and the value in this location (**96**) is used in calculating the target distance. The temperature is defined as:

Temp °C = (data memory **96** * 0.48876) – 50

Temp °C = (data memory **96** * 0.58651) – 50 (PulStar™ TTL models)

5.1.11 Self Heating Correction is in Data Memory address **24**. This location is defined as follows: "**0**" corrects for a self-heating error immediately at power up and is based on the input power supply voltage. The sensor's self-heating time is approximately 30 minutes where the sensor's temperature probe will measure slightly low and will correct in time (30 min). This will give a slight error in reporting the range during this initial power up period (worst case error at power up). In most processes, the sensor is powered continuously, so it only affects the initial power up cycle. Subsequent power cycles (low off duty cycle) will report the temperature accurately.

When applications requires a sensor to be occasionally powered (very low ON duty cycles), setting this location to "**1**" disables self-heating correction and will properly measure the ambient temperature. Note that if self-heating is disabled and the sensor it powered continuously, then an error in reading the temperature will occur. The default value is **0** (self-heating correction enabled).

5.1.12 Error Flags is in Data Memory address **104**. These are set when the sensor is in a fault condition. If **bit 0** is set, then at least one Data Memory location was programmed beyond the sensor limits and a factory default value replaced the data in error. The user should validate all Data Memory locations since more than one location could have been replaced. This particular error requires user intervention to clear by writing a "**0**" to this location.

Other errors indicators are **bit1** for a Brown Out error due to a low power supply. **Bit 2** for an internal Temperature Probe Fault. And **bit 3** for an internal Signal Detect Error. Errors indicated by bits 2 and 3 are self-clearing and the sensor will try to recover on its own. The Brown Out error flag can be cleared by writing a zero to its location. It is possible for the sensor to continue to operate, even with this Brown Out flag set. However, users should check the power supply if this continues to be set.

5.1.13 Enable Min Sensing Distance is in Data Memory address **105**. This enables closer sensing range. This location is defined as follows: "**0**" = disabled or "**1**" = enabled (4" min PulStar 150 and 8" min PulStar 95). Enabling this feature requires 2 ping cycles to obtain target range.

Notes:

1) If sensor is set up for Manual trigger, sensor must be requested for at least 2 Software Trigger 1 commands to obtain a valid range report (if average=1). Disabling this setting will update the range report on every ping (average=1).
2) Use Software Trigger 2 command for FW ver ≥ 60.
3) Enabling this feature will reduce the response rate for the output in half by the programmed Sample Rate (see section 5.1.8).

5.1.14 Sensor LED Operating Mode (Sensor's with LED) is in Data Memory address **120**.

When set to 0, the LED is ON when sensor detects target at any range and is OFF after No Echo Timeout has expired.

When set to 1, the LED is OFF when sensor detects target at any range and is ON after No Echo Timeout has expired.

When set to 2, the LED will operate based on Data Memory register 85. If register 85=0, the LED will be ON when target is detected and OFF after No Echo Timeout as expired (like reg 120=0). When register 85=1, then the LED will operate based on the settings from the Switch Mode Output Switch State and the Close and Far Setpoint Distances (See section 5.3). If the target is in the zone with the setting set to 10V, then the LED will be ON, otherwise it is OFF.

Notes:

1) The LED function is limited to sensor specific model
2) Overriding the above operation, the LED behaves as if a No Echo Timeout has occurred for either a sensor rebooted, an invalid operating parameter error has occurred, or an echo detect error has occurred.
3) LED operates at 5 Hz when no application firmware is present

5.1.15 Sensor Transmit Power Control (PLUS models only) is in Data Memory address **121**. This control provides standard transmit power when set to **0** and high power level when set to **1**.

5.1.16 Serial Number is in Data Memory address **1-4**. This 4 byte value is stored with LSB in address **1** and MSB in **4**. The serial number registers are read only.

5.1.17 Waveform Start Time (1-cycle ping) is in Data Memory address **130-131**. This 2 byte value is stored with LSB in address **130** and MSB in **131**. Units are in 400nS for sensor models 150 & 160 and 800nS for 95. These registers are updated after a waveform is requested. See section 6.0 for more details on use.

5.1.18 Waveform End Time (1-cycle ping) is in Data Memory address **132-133**. This 2 byte value is stored with LSB in address **132** and MSB in **133**. Units are in 400nS for sensor models 150 & 160 and 800nS for 95. These registers are updated after a waveform is requested. See section 6.0 for more details on use.

5.1.19 Waveform Start Time (10-cycle ping) is in Data Memory address **134-135**. This 2 byte value is stored with LSB in address **134** and MSB in **135**. Units are in 400nS for sensor models 150 & 160 and 800nS for 95. These registers are updated after a waveform is requested. See section 6.0 for more details on use.

5.1.20 Waveform End Time (10-cycle ping) is in Data Memory address **136-137**. This 2 byte value is stored with LSB in address **135** and MSB in **137**. Units are in 400nS for sensor models 150 & 160 and 800nS for 95. These registers are updated after a waveform is requested. See section 6.0 for more details on use.

5.2 Data Memory (Linear Mode Parameters)

5.2.1 Zero Setpoint Distance is in Data Memory address **73-74**. This 2 byte memory location represents the distance for the *Zero Setpoint Voltage Value* for the voltage output operating in the Linear Mode. The Voltage Output will operate linearly when a target is detected between this Zero Setpoint Distance and the Span Setpoint Distance. These 2 bytes are defined as **74** being the MSB and **73** being the LSB having a value of 128 times the range in inches[1]. The default value is the Sensor's minimum specified distance and the limits are the sensors minimum and maximum specified ranges and must not equal the *Span Setpoint Distance*. Not applicable for TTL models.

5.2.2 Zero Setpoint Voltage Value is in Data Memory address **77-78**. This 2 byte memory location is the voltage value for the *Zero Setpoint Distance* and is used when operating in the Linear Mode. The resolution for this 2 byte value is 1mV/bit with address **78** being MSB and **77** being LSB. The default value is **0** (0V) for Vout models and is **4000** (4.0mA) for Iout models. Not applicable for TTL models.

5.2.3 Span Setpoint Distance is in Data Memory address **75-76**. This 2 byte memory location represents the distance for the *Span Setpoint Voltage Value* for the voltage output operating in the Linear Mode. The Voltage Output will operate linearly when a target is detected between the Zero Setpoint Distance and this Span Setpoint Distance. These 2 bytes are defined as **76** being the MSB and **75** being the LSB having a value of 128 times the range in inches[1]. The default value is the Sensor's maximum specified distance and the limits are the sensors minimum and maximum specified ranges and must not equal the *Zero Setpoint Distance*. Not applicable for TTL models.

5.2.4 Span Setpoint Voltage Value is in Data Memory address **79-80**. This 2 byte memory location is the voltage value for the *Span Setpoint Distance* and is used when operating in the Linear Mode. The resolution for this 2 byte value is 1mV/bit with address **80** being MSB and **79** being LSB. The default value is **10,000** (10.00V) for Vout models and is **20000** (20.0mA) for Iout models. Not applicable for TTL models.

5.2.5 Loss of Echo Voltage Value is in Data Memory address **86-87**. This value represents the voltage output when the sensor is in the *No Echo Condition* (see No Echo Timeout address 93 on page 10). The resolution for this 2 byte value is 1mV/bit with address **87** being MSB and **86** being LSB. The default value is **10250** (10.25 V) for Vout models and is **20500** (20.5mA) for Iout models. Not applicable for TTL models.

5.2.6 Voltage Output Calibration is in Data Memory address **22-23**. This 2 byte location represents the 10.00V calibration value (or 20.00mA for Iout models). The factory calibrates this parameter, but it may be adjusted to your instrument. The limits are from **900** to **1023**. Not applicable for TTL models.

Note 1: Example for a range value of 37.75" saved in data memory would be $37.75 \times 128 = 4832_{10}$ or $12E0_{16}$. Thus in data memory store MSB=12_{16} and LSB=$E0_{16}$ (MSB=18_{10} and LSB=224_{10})

5.3 Data Memory (Switch Mode Parameters)

5.3.1 Close Setpoint Distance is in Data Memory address **81-82**. This 2 byte memory location is the distance used to establish a zone for the Voltage Output when operating in the Switch Mode. The 2nd setpoint used to create these zones is the *Far Setpoint Distance*. See *Switch Mode Output Operation* below for details on how the voltage output will operate. These 2 bytes are defined as **82** being the MSB and **81** being the LSB having a value of 128 times the range in inches (see note 1 previous page). This value must be less than the *Far Setpoint Distance*. The default value is the Sensor's minimum specified distance. Not applicable for TTL models.

5.3.2 Far Setpoint Distance is in Data Memory address **83-84**. This 2 byte memory location is the distance used to establish a zone for the Voltage Output when operating in the Switch Mode. The 1st setpoint used to create these zones is the *Close Setpoint Distance*. See *Switch Mode Output Operation* below for details on how the voltage output will operate. These 2 bytes are defined as **84** being the MSB and **83** being the LSB having a value of 128 times the range in inches (see note 1 previous page). This value must be greater than the *Close Setpoint Distance*. The default value is the Sensor's maximum specified distance. Not applicable for TTL models.

5.3.3 Switch Mode Output Operation is in Data Memory address **88**. This data location is used to establish what state the voltage output will be in when a target is detected within a particular zone created by the Close and Far Setpoint Distances (subject to Hysteresis, see below) when operating in the Switch Mode. The default value is **0**. The data byte is parsed as follows. Not applicable for TTL models.

bit 0: No Echo
- **0** = No Echo Vout=0 V , Echo present Vout=10 V
- **1** = No Echo Vout=10 V, Echo present Vout=0 V

bit 1: Target > Far Setpoint Distance
- **0** = If Target > Far Setpoint Distance, then Vout = 0 V
- **1** = If Target > Far Setpoint Distance, then Vout = 10 V

bit 2*: Target between Close and Far Setpoint Distances (* bit 3 = 0 for this function, else see bit 3)
- **0** = Target Present between Close and Far Setpoint Distances, Vout=0 V
- **1** = Target Present between Close and Far Setpoint Distances, Vout=10 V

bit 3: No Change for Target between Close and Far Setpoint Distances
- **0** = See bit 2 for operation of targets between Close and Far Setpoint Distances
- **1** = No change in voltage output when targets enter between Close & Far Setpoint Distances (setting this to 1 will disable function of bit 2)

bit 4: Target < Close Setpoint Distance
- **0** = If Target < Close Setpoint Distance, then Vout = 0 V
- **1** = If Target < Close Setpoint Distance, then Vout = 10 V

5.3.4 Setpoint Output Hysteresis is in Data Memory address **90**. This location specifies the amount of hysteresis in %. The Close Setpoint Distance, Far Setpoint Distance, and Hysteresis must be chosen so that the Far Setpoint Distance with hysteresis applied is greater than the Close Setpoint Distance. This parameter is used when operating in the Switch Mode. The limits are **0** to **75**%. Hysteresis is defined as the distance between the operating point when a target approaches a setpoint and the release point when the target moves away from the setpoint towards its original position. The default value is **5** (percent). Not applicable for TTL models.

5.3.5 Maximum Sensing Range is in Data Memory address **98-99**. This programmed value limits how far the sensor detects objects. These 2 bytes are defined as **99** being the MSB and **98** being the LSB having a value of 128 times the range in inches (see note 1 previous page). This parameter can be useful if you would like to eliminate a fixed background target and have the sensor indicate it as "No Echo". The default value is the Sensor model maximum specified sensing range. Not applicable for TTL models.

5.4 Data Memory (Sensitivity Adjustment Parameters)

Sensors have a sensitivity (threshold) adjustment that can set both in amplitude and in time where it occurs. Massa has developed a series of adjustments as seen the in Massa Sensor Software drop down menu. This includes *Normal, Normal High-Temperature, Low, Very Low, High* and *Very High*. Most applications should use the *Normal* setting. However applications such as the sensor being in a very hot environment (over 130ºF) may want to select *Normal High-Temperature*. *High* settings improve acquiring a weak target, but may have other issues like detecting unwanted targets, so use these *High* settings with care. In applications such as a sensor aiming down a narrow pipe, the *Low* setting may be selected to avoid side reflections. Described below are the Data Memory locations that affect the sensitivity adjustment of the sensor. However it is highly recommended that if you change from the *Normal* setting that you fully evaluate operation of the sensor in your application. The Massa Sensor Software has a menu item that displays the ultrasonic signals and will show the threshold levels as programmed.

These registers are enabled for use when Min Sensing Range is enabled (register 105=1).

5.4.1 1-Cycle Pulse Blanking Range is in Data Memory address **8**. This provides the time after a 1-cycle ultrasonic pulse when targets are ignored and not used for detection for temperatures <35C. Register value represents 10uS units.

5.4.2 1-Cycle Pulse Blanking Range is in Data Memory address **9**. This provides the time after a 1-cycle ultrasonic pulse when targets are ignored and not used for detection for temperatures 35C to 55C. Register value represents 10uS units.

5.4.3 1-Cycle Pulse Blanking Range is in Data Memory address **10**. This provides the time after a 1-cycle ultrasonic pulse when targets are ignored and not used for detection for temperatures >55C. Register value represents 10uS units.

5.4.4 Gain Control Switch Time for 1-Cycle Pulses is in Data Memory address **117-118**. This adjusts the time the gain switches from low to high after the sensor has transmitted an ultrasonic pulse. Unit value is in µS.

5.4.5 1-Cycle Pulse Threshold Voltage #1 is in Data Memory address **11**. This is the initial voltage level set. The value is indexed from **1** to **19** and is defined as:

1=1.25V, **2**=1.41V, **3**=1.46V, **4**=1.56V, **5**=1.67V, **6**=1.72V, **7**=1.88V, **8**=2.03V, **9**=2.08V, **10**=2.19V, **11**=2.29V, **12**=2.34V, **13**=2.50V, **14**=2.66V, **15**=2.71V, **16**=2.81V, **17**=2.92V, **18**=2.97V, **19**=3.40V.

TTL Models: **1**=0.75V, **2**=0.84V, **3**=0.88V, **4**=0.94V, **5**=1.00V, **6**=1.03V, **7**=1.13V, **8**=1.22V, **9**=1.25V, **10**=1.31V, **11**=1.38V, **12**=1.41V, **13**=1.50V, **14**=1.59V, **15**=1.63V, **16**=1.69V, **17**=1.75V, **18**=1.78V, **19**=2.06V.

5.4.6 1-Cycle Pulse Threshold Voltage #2 is in Data Memory address **12**. This is the next level change that can be set and will occur at the timing parameter *Switch time for 1-Cycle Threshold #2*. The value is indexed from **1** to **18** and as described in *1-Cycle Threshold Voltage #1*. However, programming this location to **0** will turn off this voltage level change.

5.4.7 1-Cycle Pulse Threshold Voltage #3 is in Data Memory address **13**. This is the next level change that can be set and will occur at the timing parameter *Switch time for 1-Cycle Threshold #3*. The value is indexed from **1** to **18** and as described in *1-Cycle Threshold Voltage #1*. However, programming this location to **0** will turn off this voltage level change.

5.4.8 1-Cycle Pulse Threshold Voltage #4 is in Data Memory address **14**. This is the next level change that can be set and will occur at the timing parameter *Switch time for 1-Cycle Threshold #4*. The value is indexed from **1** to **18** and as described in *1-Cycle Threshold Voltage #1*. However, programming this location to **0** will turn off this voltage level change.

5.4.9 1-Cycle Pulse Switch Time for Threshold Voltage #2 is in Data Memory address **15-16**. This 2 byte value represents the time from when the sensor sends it ultrasonic pulse to where the voltage level changes to *Threshold Voltage #2* value. The MSB is stored in **16** and the LSB is in **15**. See note below for the defined unit value.

5.4.10 1-Cycle Pulse Switch Time for Threshold Voltage #3 is in Data Memory address **17-18**. This 2 byte value represents the time from when the sensor sends it ultrasonic pulse to where the voltage level changes to *Threshold Voltage #3* value. The MSB is stored in **18** and the LSB is in **17**. See note below for the defined unit value.

5.4.11 1-Cycle Pulse Switch Time for Threshold Voltage #4 is in Data Memory address **19-20**. This 2 byte value represents the time from when the sensor sends it ultrasonic pulse to where the voltage level changes to *Threshold Voltage #4* value. The MSB is stored in **20** and the LSB is in **19**. See note below for the defined unit value.

Note: The Switch Time for Threshold Voltage is model dependent. The PulStar-150 and FlatPack-160 are 400nS per bit, and the PulStar-95 and FlatPack 95 are 800nS per bit.

5.4.12 End of Detection for 1-Cycle Pulses is in Data Memory address **108**. This allows end of detection range to be adjusted for the low power pulse. For model 150 & 160: 0=10″, 1=30″, 2=60″ and 3=use any low power pulse capture. For models 95: 0=10″, 1=60″, 2=120″ and 3=use any low power pulse capture.

The controls below are for high power 10-cycle transmit pulse.

5.4.13 10-Cycle Pulse Blanking Range is in Data Memory address **28-29**. This 2 byte value represents the time after a 10-cycle ultrasonic pulse when targets are ignored and not used for detection. Typically this register is used to ignore the transmit pulse but can be used to include additional time due to mounting configuration. Register value in µS units.

5.4.14 Gain Control Switch Time for 10-Cycle Pulses is in Data Memory address **125-126**. This adjusts the time the gain switches from low to high after the sensor has transmitted an ultrasonic pulse. Unit value is in µS.

5.4.15 10-Cycle Pulse Threshold Voltage #1 is in Data Memory address **30**. This is the initial voltage level set. The value is indexed from **1** to **18** and is defined as:

1=1.25V, **2**=1.41V, **3**=1.46V, **4**=1.56V, **5**=1.67V, **6**=1.72V, **7**=1.88V, **8**=2.03V, **9**=2.08V, **10**=2.19V, **11**=2.29V, **12**=2.34V, **13**=2.50V, **14**=2.66V, **15**=2.71V, **16**=2.81V, **17**=2.92V, **18**=2.97V.

TTL Models: **1**=0.75V, **2**=0.84V, **3**=0.88V, **4**=0.94V, **5**=1.00V, **6**=1.03V, **7**=1.13V, **8**=1.22V, **9**=1.25V, **10**=1.31V, **11**=1.38V, **12**=1.41V, **13**=1.50V, **14**=1.59V, **15**=1.63V, **16**=1.69V, **17**=1.75V, **18**=1.78V, **19**=2.06V.

5.4.16 10-Cycle Pulse Threshold Voltage #2 is in Data Memory address **31**. This is the next level change that can be set and will occur at the timing parameter *Switch time for 10-Cycle Threshold #2*. The value is indexed from **1** to **18** and as described in *10-Cycle Threshold Voltage #1*. However, programming this location to a **0** will turn off this voltage level change.

5.4.17 10-Cycle Pulse Threshold Voltage #3 is in Data Memory address **32**. This is the next level change that can be set and will occur at the timing parameter *Switch time for 10-Cycle Threshold #3*. The value is indexed from **1** to **18** and as described in *10-Cycle Threshold Voltage #1*. However, programming this location to a **0** will turn off this voltage level change.

5.4.18 10-Cycle Pulse Threshold Voltage #4 is in Data Memory address **33**. This is the next level change that can be set and will occur at the timing parameter *Switch time for 10-Cycle Threshold #4*. The value is indexed from **1** to **18** and as described in *10-Cycle Threshold Voltage #1*. However, programming this location to a **0** will turn off this voltage level change.

5.4.19 10-Cycle Pulse Switch Time for Threshold Voltage #2 is in Data Memory address **34-35**. This 2 byte value represents the time from when the sensor sends it ultrasonic pulse to where the voltage level changes to *10-Cycle Threshold Voltage #2* value. The MSB is stored in **35** and the LSB is in **34**. See note below for the defined unit value.

5.4.20 10-Cycle Pulse Switch Time for Threshold Voltage #3 is in Data Memory address **36-37**. This 2 byte value represents the time from when the sensor sends it ultrasonic pulse to where the voltage level changes to *10-Cycle Threshold Voltage #3* value. The MSB is stored in **37** and the LSB is in **36**. See note below for the defined unit value.

5.4.21 10-Cycle Pulse Switch Time for Threshold Voltage #4 is in Data Memory address **38-39**. This 2 byte value represents the time from when the sensor sends it ultrasonic pulse to where the voltage level changes to *10-Cycle Threshold Voltage #4* value. The MSB is stored in **39** and the LSB is in **38**. See note below for the defined unit value.

Note: The Switch Time for Threshold Voltage is model dependent. 400nS for PulStar-150 and FlatPack-160, and 800nS for PulStar-95 & FlatPack-95.

6.0 PulStar & FlatPack Sensors Ultrasonic Diagnostic Waveform

6.1 Description

Massa's Ultrasonic Sensors have the ability to retrieve ultrasonic waveforms for application record keeping and evaluating any measurement issues. The MassaSonic Sensor Software will obtain, save, and retrieve previously saved waveforms.

6.2 General Operation

Acquiring the waveform from a sensor is performed using the 'Ultrasonic Waveform' command seen in Section 6.4. This valuable tool can be used for record keeping when starting a new application and more importantly, to diagnose incorrect range reporting (due to obstructions or missing echoes). In such cases, it will allow custom sensor sensitivity settings to be confidently implemented to solve the issue. Since the sensor's memory is limited, it cannot collect all the waveform data using just one pulse. It requires numerous pulses to obtain the entire waveform in which data will be sent in consecutive blocks of 80 bytes until all the bytes are sent. The table in section 6.4 indicates the total amount waveform bytes for a given sensor model. For proper analysis, 4 requests for waveforms are required for proper analysis. If more than one sensor is on-line, then the 'Disable Communications' command is required so that other sensors will ignore all the communication bus traffic.

6.3 Disable Communications Command

If only one sensor is wired to the bus, then disabling communications is not required, skip to Section 6.4. If there is more than one sensor on the bus, then it is imperative to temporarily disable communications for the sensors that are not sending waveform data followed by a longer disable communications to all other sensors. The first step is to send a 15mS 'Disable Communications' command to the sensor from which you want to retrieve the waveform as shown below.

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32 (sensor acquiring waveform)
3	Request Code	110 (Disable Communications)
4	Delay amount (LSB)	44
5	Delay amount (MSB)	1
6	Checksum	sum of bytes 1 to 5, modulo 256

Follow the above command with a much longer global 'Disable Communications' command to all other sensors with the time based on the model from which you are acquiring the waveform from.

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	0 (global, all sensors)
3	Request Code	110 (Disable Communications)
4	Delay amount (LSB)	see table below
5	Delay amount (MSB)	see table below
6	Checksum	sum of bytes 1 to 5, modulo 256

Sensor Model Request for Waveform	Disable time to all Other Sensors	Byte 4	Byte 5
150 & 160	650mS	151	49
95	1600mS	18	122

The resolution of the 'Disable Communications' time is approximately 51.2uS.

6.4 Request Ultrasonic Waveform (all sensor models)

The request for ultrasonic waveform command includes 2 controls, one for selecting the transmit pulse type (1-cycle for short range and 10-cycles for long range) and another control for gain control (low and high).

Byte	Description	Value
1	Sensor Request	170
2	Sensor ID Tag No.	1 to 32
3	Request Code	100 (Ultrasonic Waveform Request)
4	Ping Type	0=high power (10-cycle), 0=low power (1-cycle)
5	Gain	0=low gain, 1=high gain
6	Checksum	sum of bytes 1 to 5, modulo 256

The response from the sensor will be waveform data only without header or checksum information. The total number of bytes of the waveform is model dependent as shown in the table below. The 'Pulses Req.' column represents how many times the sensor has to send a transmit burst, which is done automatically until all waveform data bytes are sent (per waveform request). For proper analysis, 4 requests for waveforms are required which must include 1-cycle low & high gain and 10-cycles low gain & high gain.
When more than one sensor is on the bus, use the 'Disable Communications' command so other sensors will ignore bus traffic (prior to the use of this command), see Section 6.3. This command must be issued before each waveform request.

Sensor Model	Total Waveform Bytes (per request)	Pulses	Acquisition Time	Maximum time to acquire all 4 waveforms
150 & 160	800	10	650mS	3.5 sec
95	1680	21	1600mS	7 sec

For proper evaluation of one sample period in time of a sensor signal capture, it is necessary to obtain 4 waveform types. They are 1-cyle low gain, 1-cycle high gain, 10-cycles low gain and 10-cycles high gain. After obtaining all 4 waveform types, the low and high gain data (for each ping type) must be stitched together to represent the actual waveform in operation. The beginning of the data starts with the low gain data and then stops with the gain control switch time registers (section 5.4.4 and 5.4.14). The rest of the waveform continues using the high gain data from the gain switch time to the end of file. The resolution of the waveform in time is approximately 25.6uS and is fixed over temperature.

Each waveform data byte represents the amplitude information and its formula is:

Amplitude (in volts) = 0.0195 * waveform byte

For TTL models only: Amplitude (in volts) = 0.0117 * waveform byte

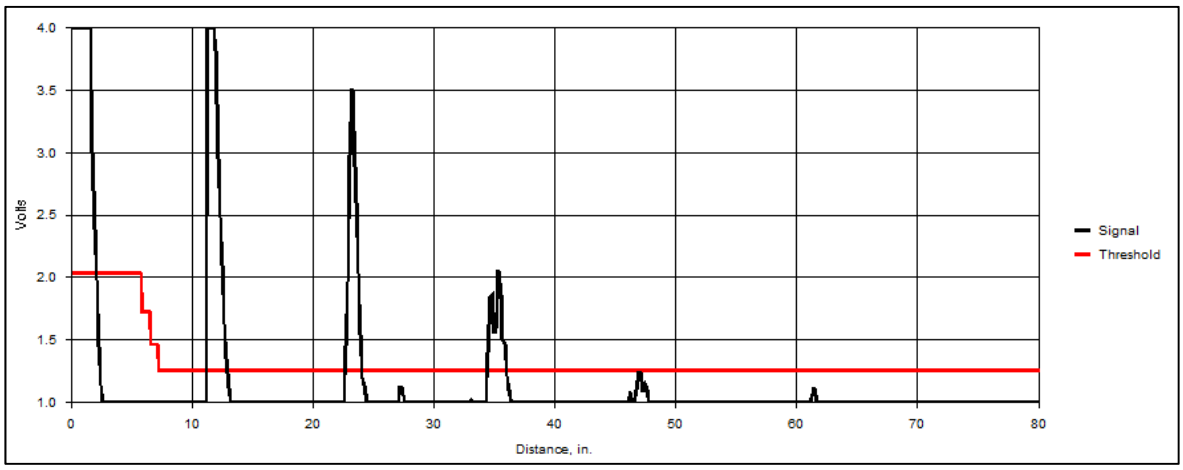
Speed of sound formula to convert time to distance in inches:

Distance (inches) = (Time (sec) * 789.9 * SQRT (Temperature °C + 273)) / 2

See next page of example waveform.

The figure below is an example waveform plot from the MassaSonic Software using a PulStar 150 Sensor. The waveform has been stitched together using the 1-cycle ping low gain & high gain data and gain control switching time registers 117-118. The plot also includes a red detection line based on the threshold adjust registers 11-20.

Example ultrasonic waveform with a target at 12″



The ultrasonic waveform shown above starts with a transmit pulse followed by a reflection peak from an object 12″ away. Subsequent reflections may or may not follow the 1st reflection. In normal operation, the reported detection occurs after the blanking range time has expired (section 5.4.1 - 5.4.3) and when a reflected signal has crossed the detection line. Any subsequent reflections (due to sound bouncing back and forth) are ignored by the sensor. The waveform represents a single shot in time. Sensor settings such as averaging and other filter controls are independent of waveform operation. To gain slightly more resolution of each byte in time, accurate start and stop times are available in registers seen in section 5.1.17 - 5.1.20. These registers are updated after the reception of each waveform.

Summary and notes on waveform operation:

1) Waveform data is not temperature compensated. It is raw digitized data of the reflections fixed as a resolution of 25.6uS per byte.
2) It is not possible to perform a single waveform capture with gain switching, thus the need to obtain 4 waveforms and stitch them together.
3) To gain additional accuracy in resolution, use the start and end times of a waveform seen in sections 5.1.17 - 5.1.20.
4) Other sensor registers such as Average don't have any effect on waveform data.
5) If end user is developing tools to obtain waveforms and would like to observe them using the MassaSonic Software, it should follow the data format as seen in Section 6.5.
6) Status reporting of range provides much higher accuracy in distance measurement. The waveform tool is used simply to observe and diagnose any issues an application may have.
7) In normal operation, the sensor performs a 1-cycle pulse for obtaining target that are close and 10-cycle pulse for longer range targets.

6.5 Massa Sensor Software Ultrasonic Waveform Format

This data format saved and recalled by the Massa Sensor Software (ver ≥ 3.0) is specified below and is in binary format. The MassaSonic™ Ultrasonic Sensor Software also has the ability to convert and save it to a human readable text file.

Waveform file details:

The Massa Sensor Software will save and recall waveform files in binary format. File sizes vary based on sensor model type, see below. When a waveform is obtained or recalled, it can be saved using the *SaveAsText* drop down menu item. Format for each model is indicated below:

Models: PulStar 150 (V, I, or TTL) and FlatPack 160 (V or I) waveform file format #5 (binary version):

'byte(s)	Description
'1	Data Format (= 5)
'2	Sensor Model Code (see below)
'3	Sensor firmware version
'4-259	Sensor registers 0 to 255
'260	Temperature (a/d units) at time of waveform (from a status request response, byte 5)
'261-1060	Waveform short ping - low gain. 800 bytes
'1061-1860	Waveform short ping - high gain. 800 bytes
'1861-2660	Waveform long ping - low gain. 800 bytes
'2661-3460	Waveform long ping - high gain. 800 bytes
'3461-	Comments (optional) - ASCII. Suggested to place time/date stamp

Sensor model codes: 102 = PulStar-150-V, 142 = PulStar-150-I, 106 = FlatPack-160-V, 146 = FlatPack-160-I

Models: PulStar 95 (V, I, or TTL) and FlatPack 95 (V or I) waveform file format #5 (binary version):

'byte(s)	Description
'1	Data Format (= 5)
'2	Sensor Model Code (see below)
'3	Sensor firmware version
'4-259	Sensor registers 0 to 255
'260	Temperature (a/d units) at time of waveform (from a status request response, byte 5)
'261-1940	Waveform short ping - low gain. 1680 bytes
'1941-3620	Waveform short ping - high gain. 1680 bytes
'3621-5300	Waveform long ping - low gain. 1680 bytes
'5301-6980	Waveform long ping - high gain. 1680 bytes
'6981-	Comments (optional) - ASCII. Suggested to place time/date stamp

Sensor model codes: 101 = PulStar-95-V, 141 = PulStar-95-I, 107 = FlatPack-95-V, 147 = FlatPack-95-I, 105 = PulStar-95-TTL

Temperature byte formula in deg °C = (register 132 * 0.48876) – 50
Temperature byte formula in deg °C = (register 132 * 0. 58651) – 50 (TTL models)

Procedure for creating a waveform file

1) First byte is the data format type
2) Sensor model code is obtained from Command 123 (see sections 4.7 & 4.8)
3) Sensor firmware version from Command 123
4) Read 256 sensor registers using Command 104 (see section 4.4 & 4.5)
5) Request status and retain temperature using Command 3 (see section 4.1 & 4.2)
6) Request waveform short ping low gain using Command 100 (see section 6.4)
7) Request waveform short ping high gain using Command 100 (see section 6.4)
8) Request waveform long ping low gain using Command 100 (see section 6.4)
9) Request waveform long ping high gain using Command 100 (see section 6.4)
10) Add any comments. Time/date stamp as an option
11) Convert file to binary format

Temperature formula in [deg] ºC = (register 132 * 0.48876) - 50

Temperature formula in [deg] ºC (TTL models) = (register 132 * 0.58651) – 50

Speed of Sound (round trip) = 1 / (789.9147 * SQRT (T+273.15) / 2) inches/sec (T = deg C)

Distance of sample point = (Sample #) * (Sample timing / Speed of sound) + Delay of waveform start

Sample number starts at 1 found in the binary file line 133
Sample timing value is from "Sampling to Sample Timing" as seen above
Speed of sound from formula above
Delay of waveform start: see Table on Page 19

When the signal amplitude is above what you set for your software detection level, this sample point distance value is used for the target range. The waveform time resolution approximates to 0.157" (temperature dependent).

Waveform Amplitude (volts) = Sample value * 5/255 (i.e. 200 represents 3.92V)

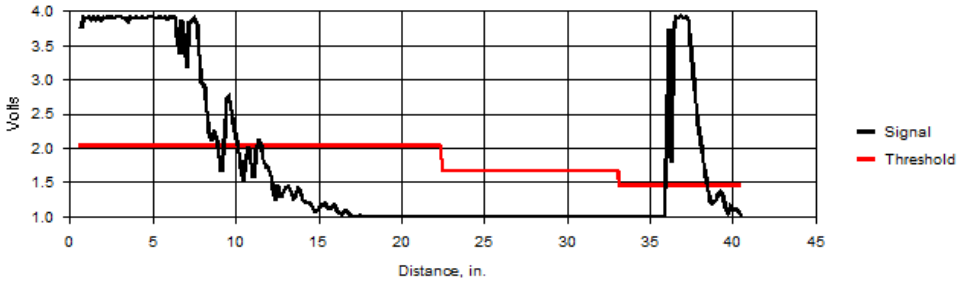
Waveform Amplitude, model TTL only (volts) = Sample value * 3/255 (i.e. 200 represents 2.35V)

Detection Threshold Levels:

1=1.25V, **2**=1.41V, **3**=1.46V, **4**=1.56V, **5**=1.67V, **6**=1.72V, **7**=1.88V, **8**=2.03V, **9**=2.08V, **10**=2.19V, **11**=2.29V, **12**=2.34V, **13**=2.50V, **14**=2.66V, **15**=2.71V, **16**=2.81V, **17**=2.92V, **18**=2.97V.

TTL Models: **1**=0.75V, **2**=0.84V, **3**=0.88V, **4**=0.94V, **5**=1.00V, **6**=1.03V, **7**=1.13V, **8**=1.22V, **9**=1.25V, **10**=1.31V, **11**=1.38V, **12**=1.41V, **13**=1.50V, **14**=1.59V, **15**=1.63V, **16**=1.69V, **17**=1.75V, **18**=1.78V, **19**=2.06V.

Sample waveform

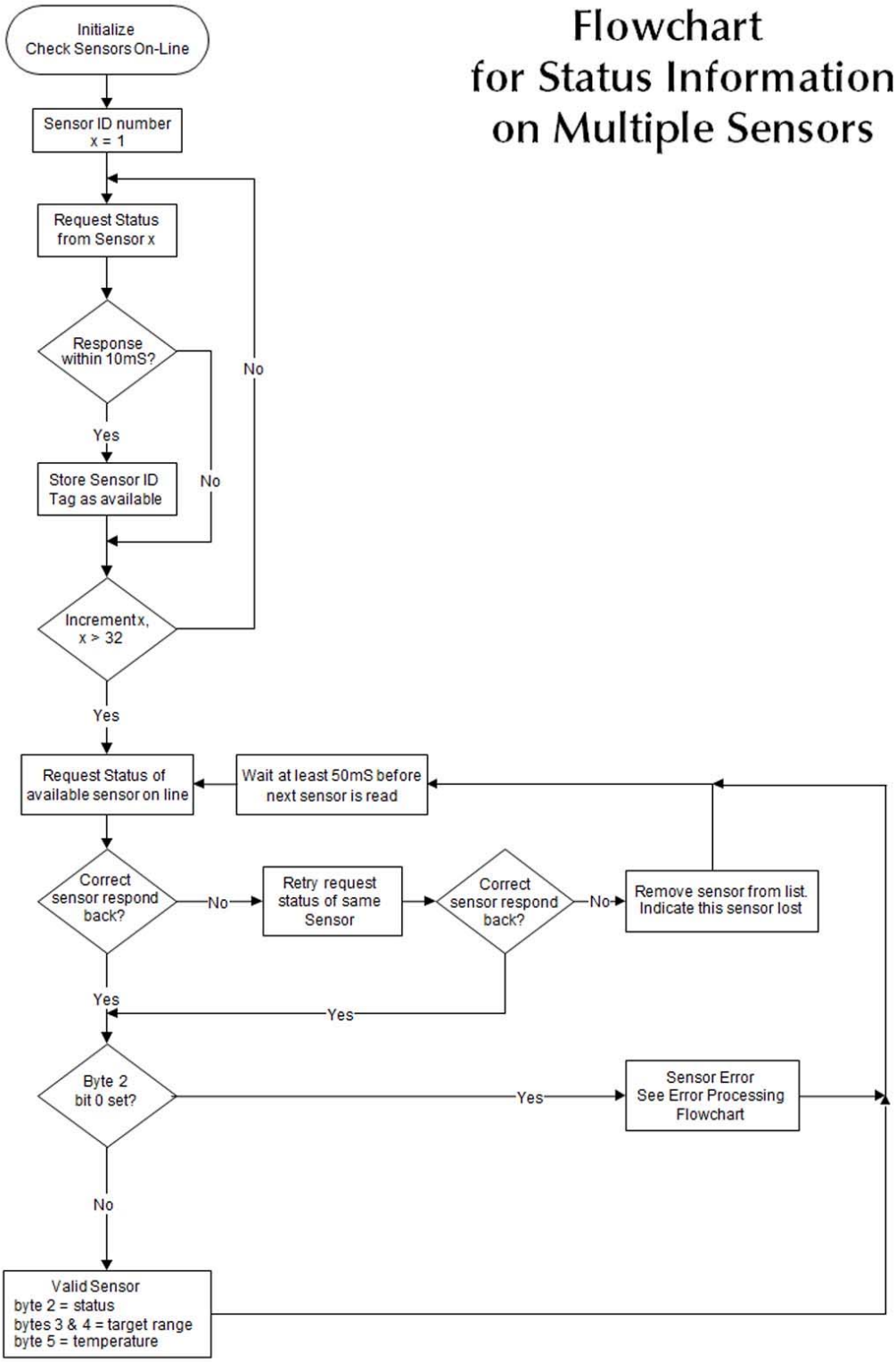


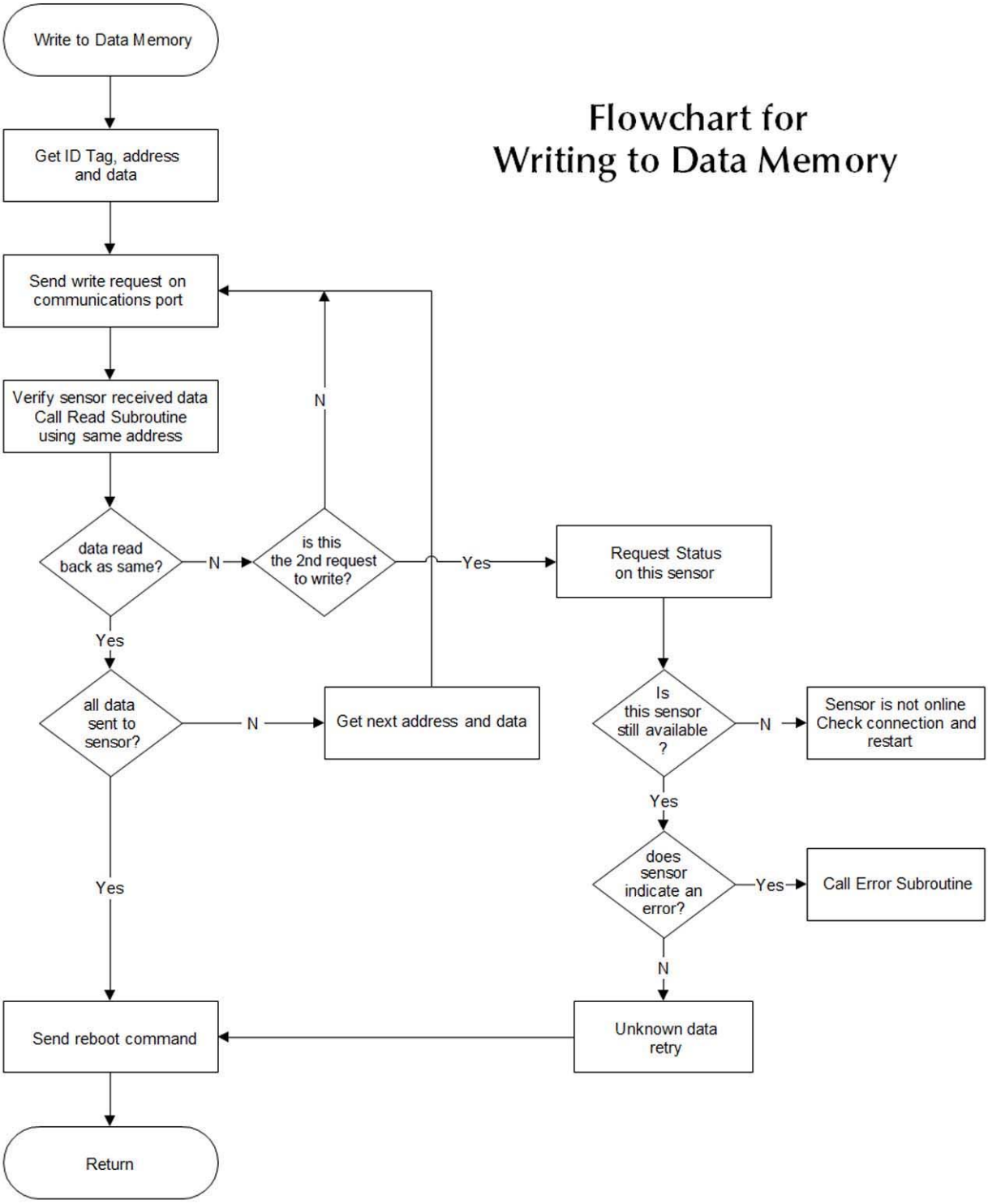
7.0 MassaSonic™ Ultrasonic Sensor Software Save/Recall File Format

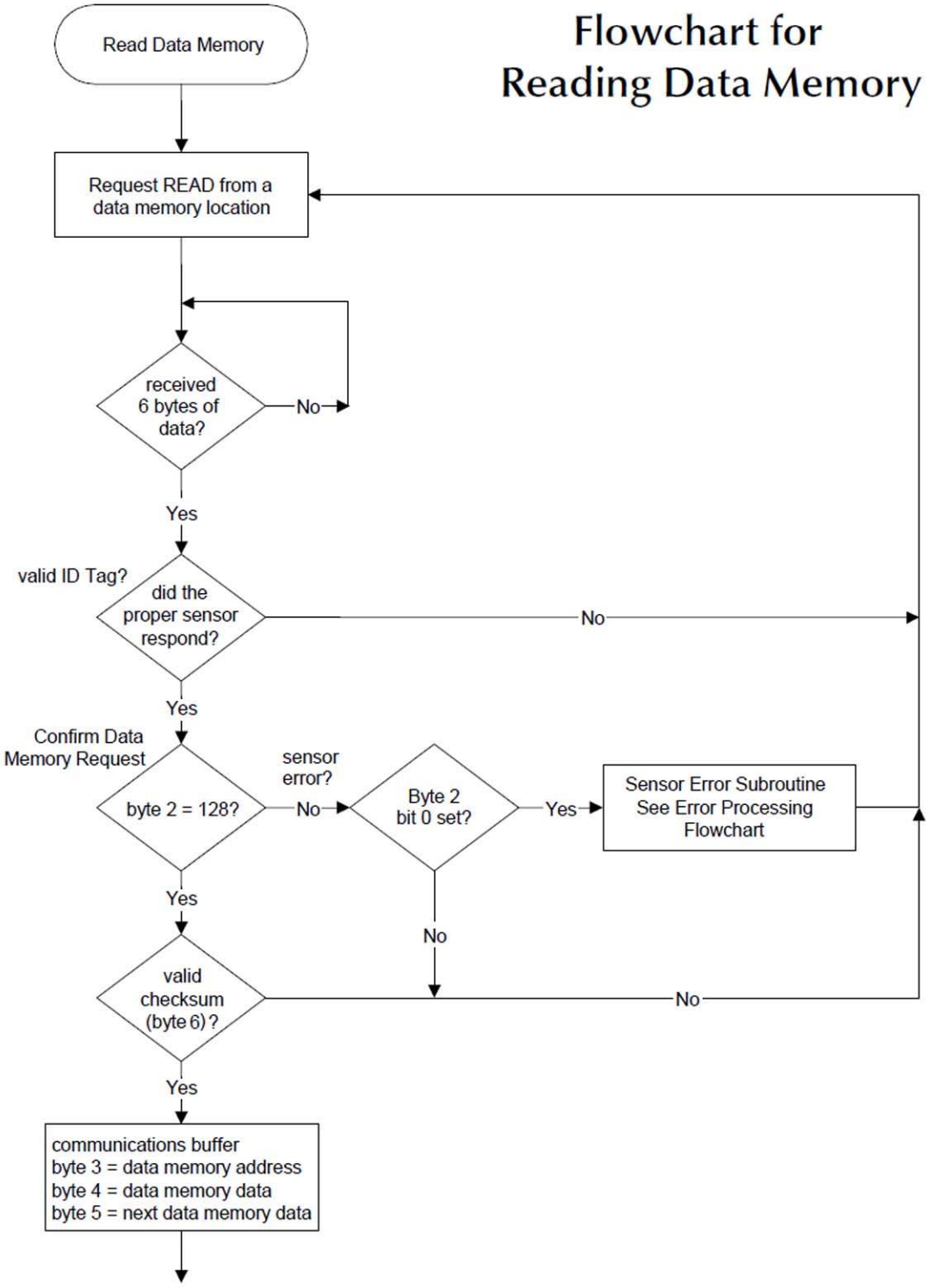
Below is an example of a settings configuration file from the MassaSonic™ Ultrasonic Sensor Software. The brackets contain the register addresses.

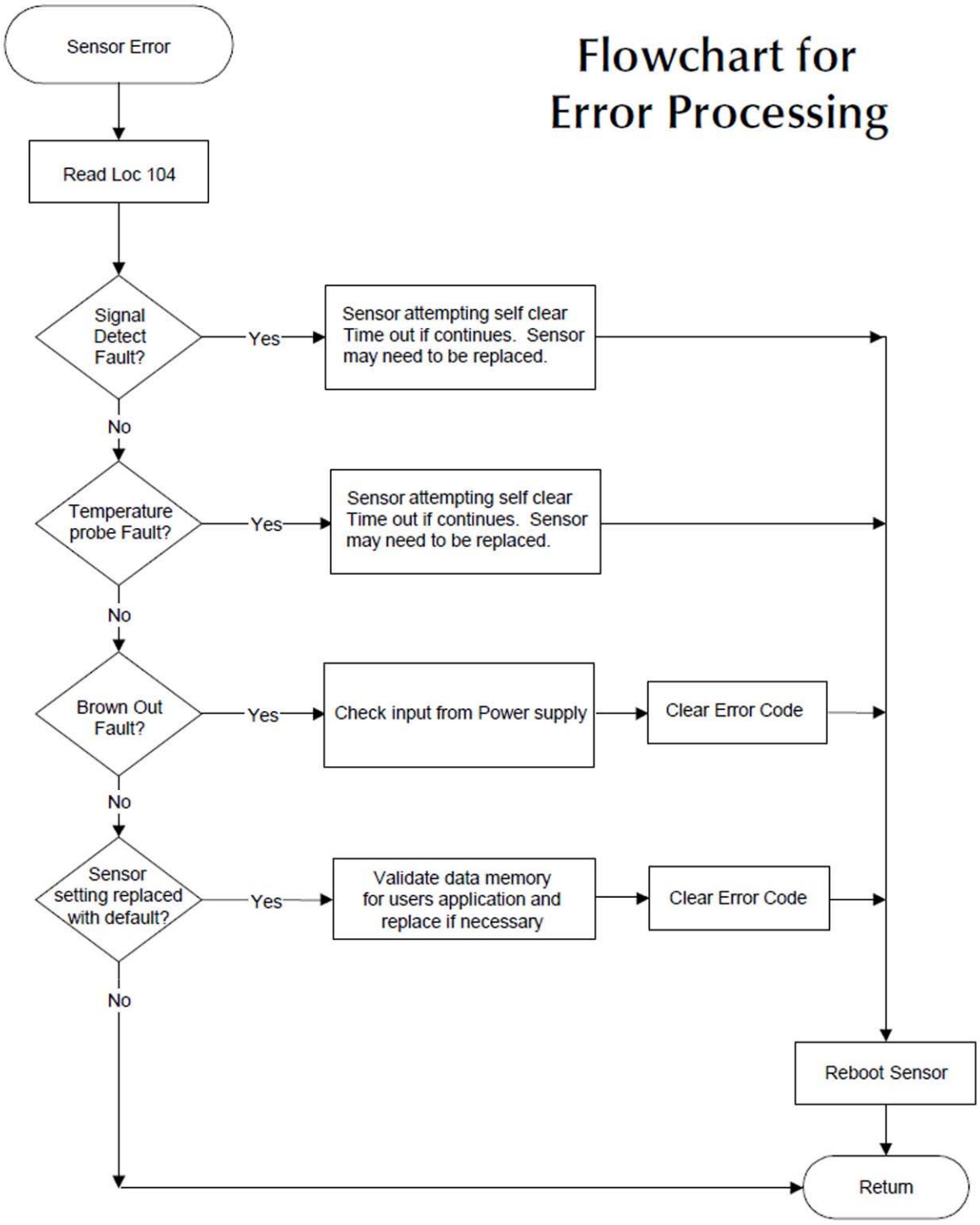
C:\MassaSonicSoftware\PulStar-150.cfg
SettingsFormat = 1
SoftwareVersion = 3.00
FirmwareVersion = 70
Model = PulStar/150 V Plus
PartNumber = - 0
SerialNumber = 0
IDTag = 1
SensorCode = 102
ErrorCode = 0
HeatingCorrections = -2.9,-3.4,-3.9,-4.4,-4.9,-5.4,-5.9,-6.4 Deg C
OutputMode [85] = 0
LinearModeRange1 [73:74] = 512
LinearModeRange2 [75:76] = 10752
LinearModeRange1Output [77:78] = 0
LinearModeRange2Output [79:80] = 10000
LinearModeNoEchoOutput [86:87] = 10250
CloseSetpointDistance [81:82] = 512
FarSetpointDistance [83:84] = 10752
<CloseSetpoint [88.4] = 0
MidZone [88.2:88.3] = 0
>FarSetpoint [88.1] = 0
SwitchModeNoEchoOutput [88.0] = 0
SwitchModeUserMaxRange [98:99] = 10752
Hysteresis [90] = 5
PingInterval [100:103] = 250000
AverageType [92] = 1
AverageSamplesIndex [91] = 0
NoEchoTimeout [93] = 1
TriggerMode [94] = 0
TempComp [95] = 0
ManualPresetTemp [96] = 143
UserDescription [41:72] =
SelfHeatingCorrection [24] = 0
MinSensingRangeEnabled [105] = 1
LEDMode [120] = 0
TransformerPower [121] = 0
MasterSlave [122] = 0
EnableErrorReport [21] = 1
ShortPingBlankingTime1 [8] = 55
ShortPingBlankingTime2 [9] = 57
ShortPingBlankingTime3 [10] = 59
ShortPingThresh1 [11] = 8
ShortPingThresh2 [12] = 6
ShortPingThresh3 [13] = 3
ShortPingThresh4 [14] = 1
ShortPingThreshSwitchTime2 [15:16] = 2250
ShortPingThreshSwitchTime3 [17:18] = 2500
ShortPingThreshSwitchTime4 [19:20] = 2750
ShortPingGainSwitchTime [117:118] = 800
ShortPingEndOfDetectionIndex [108] = 2
LongPingBlankingTime [28:29] = 1000
LongPingThresh1 [30] = 8
LongPingThresh2 [31] = 6
LongPingThresh3 [32] = 3
LongPingThresh4 [33] = 1
LongPingThreshSwitchTime2 [34:35] = 3000
LongPingThreshSwitchTime3 [36:37] = 4000
LongPingThreshSwitchTime4 [38:39] = 5000
LongPingGainSwitchTime [125:126] = 2000

8.0 Flowcharts




Flowchart for
Writing to Data Memory
Write to Data Memory
Get ID Tag, address and data
Send write request on communications port
Verify sensor received data Call Read Subroutine using same address
data read back as same?
N
is this the 2nd request to write?
N
Yes
Request Status on this sensor
Yes
all data sent to sensor?
N
Get next address and data
Is this sensor still available ?
N
Sensor is not online Check connection and restart
Yes
does sensor indicate an error?
Yes
Call Error Subroutine
N
Yes
Send reboot command
Unknown data retry
Return


Flowchart for
Reading Data Memory
Read Data Memory
Request READ from a data memory location
received 6 bytes of data?
No
Yes
valid ID Tag?
did the proper sensor respond?
No
Yes
Confirm Data Memory Request
byte 2 = 128?
sensor error?
No
Byte 2 bit 0 set?
Yes
Sensor Error Subroutine See Error Processing Flowchart
Yes
No
valid checksum (byte 6)?
No
Yes
communications buffer
byte 3 = data memory address
byte 4 = data memory data
byte 5 = next data memory data


Flowchart for
Error Processing
Sensor Error
Read Loc 104
Signal Detect Fault?
Yes
Sensor attempting self clear Time out if continues. Sensor may need to be replaced.
No
Temperature probe Fault?
Yes
Sensor attempting self clear Time out if continues. Sensor may need to be replaced.
No
Brown Out Fault?
Yes
Check input from Power supply
Clear Error Code
No
Sensor setting replaced with default?
Yes
Validate data memory for users application and replace if necessary
Clear Error Code
No
Reboot Sensor
Return

Document Revision History

February 19, 2019 Correction to Waveform Command Ping Type page 19 Section 6.4. Was incorrectly shown as 0=low power & 1=hi power.