

Sonaer Ultrasonic Device Interface Protocol Specification

Figure 1: Document Revision History

Rev	Date	History
A	06/19/2012	Initial Compatible with; HW Devices: Atomizer version 3.08 (and earlier) PC Software: Sonozap Ultrasonic Generator Control: Version 1.3 (and earlier)
B	12/04/2012	Compatible with; HW Devices: Atomizer version 3.09 – 3.13 PC Software: Sonozap Ultrasonic Generator Control: Version 1.4 Added Power decimal digits Re-numbered command / Opcodes (Figure 2)
C	1/9/2013	In Figure 2 removed an extra (incorrect) Set-Power-Level command. In Figure 7 corrected the example for Set-Power-Level In Figure 7 corrected the example for Request-Fault
D	6/11/2013 5/13/2014	Add controls for; <ul style="list-style-type: none"> - Standard / Turbo selection - Turbo is user selectable - AAPA enable / disable selection - Enable Pin Polarity selection Add warning message “More power required. Increase power”. Compatible with; HW Devices: Atomizer version 3.14 (and later) PC Software: Sonozap Ultrasonic Generator Control: Version 1.5 (and later)
E	1/2/2018	Corrected the parameter number for the ‘Connect Request’ example from 0x13 to 0x14

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5. Overview

This document describes the RS232 communication protocol for interfacing to a Sonaer Ultrasonic device. This document should be sufficient for developing PC based applications for controlling Sonaer Ultrasonic devices.

Many of the operations available through the front panel buttons of the Ultrasonic device are available via Host/RS232 control. This document assumes the user has a thorough understanding of the Ultrasonic device operation.

5.1 Terminology:

- Host:/Master: typically a PC
- Device/Slave: the Ultrasonic device
- Probe / Ultrasonic-Probe: the ultrasonic element connected to the Ultrasonic device

4. Ultrasonic Device Control

The Sonaer Ultrasonic device supports a set of parameters for controlling and reporting device operation. Figure 2, below, lists and describes this set of parameters. Refer to the section 3 for command & response packet formatting.

Figure 2: Ultrasonic Device Parameter Description

Name	Parameter #	Length	Values / Range (* is default)	R/W	Unit	Description
Connect-Request	0x14	Byte	0*=Disconnect 1=Connect	W	Bool-State	<p>1=Request to connect to device.</p> <ul style="list-style-type: none"> • Must be first command to device. • Once connected the device front panel buttons are disabled. <p>0=Request to disconnect from device.</p> <ul style="list-style-type: none"> • Should be sent before exiting application, to cleanly disconnect from the device. • Without this command the device may not regain control of the front panel. • Without this command the PC application may not be able to regain control of the device.
Software Version	0x00	Word	0x0000-0x9999	R	Number	Software Version of device (ie 0x0200 → version 2.00). Ultrasonic devices may be enhanced in the future. This command can be used to interrogate the version of the device to determine its capabilities.
Request-Fault	0x16	Byte	0-255	R	Number	<p>Request if the device has detected a fault. This command should be executed periodically – once per second for example.</p> <p>0 =No fault / Operating Normally 1 = Fault: Current Overload. 2 =Fault: Probe not connected 3 =Fault: Incorrect frequency or excessive load 4 =Fault: Internal Error. Cycle power.</p>
System-State	0x01	Byte	1*=Stopped, 2=Running /Started	R/W	State	<p>Set & get the System State</p> <p>1=Stop the ultrasonic probe 2=Start the ultrasonic probe</p>

Name	Parameter #	Length	Values / Range (* is default)	R/W	Unit	Description
Power	0x03	Dword	0-9999999	R	milliWatts	Read the current power, in milliWatts, of the ultrasonic probe.
Get Power-Level	0x04	Byte	0-100 0*=minimum 100=maximum	R	Percentage	Read the power, as a percentage of full power
Set Power-Level	0x15	Byte	0-100 0*=minimum 100=maximum	W	Percentage	Set the power, as a percentage of full power
Frequency	0x02	Word	0-60,000	R	10's of Hz ¹	Read the operating frequency of the ultrasonic probe.
Time-State	0x0E	Byte	0*=Off/disabled 1=On/enabled	R/W	Bool-State	'Enable' this to control the duration (in seconds) that the probe will run before shutting itself off. The duration is specified by the parameter Time-Run. The timer starts when 'System-State' is set to 'Running'.
Time-Run	0x10	Word	0-39000 (11 hrs)	R/W	Seconds	Controls how long the probe will run before shutting itself off. Refer to 'Time-State' command.
Time-Cnt	0x0F	Word	0-39000 (11 hrs)	R	Seconds	This parameter can be read to determine how much time remains before the probe shuts off. Refer to 'Time-State' command.

Name	Parameter #	Length	Values / Range (* is default)	R/W	Unit	Description
Energy-State	0x0B	Byte	0*=Off/disabled 1=On/enabled	R/W	Bool	'Enable' this to control the total amount of energy (in Joules) that the probe will consume before shutting itself off. The amount of energy is specified by the parameter Energy-Run. The energy usage count down starts when 'System-State' is set to 'Running'.
Energy-Run	0x0D	Word	0-10000	R/W	Joules	Controls how much energy the probe will consume before shutting itself off. Refer to 'Energy-State' command.
Energy-Cnt	0x0C	Word	0-10000	R	Joules	The parameter can be read to determine how much energy remains before the probe shuts off. Refer to 'Energy-State' command.
Power-Decimal-Places	0x07	Byte	0-3	R/W	Number of decimal places	Controls the display of the number of decimal; places for the 'Power'.
Standard / Turbo	0x17	Byte	0*=Off/Disabled 1=On/Enabled	R/W	Bool	Sets or gets the operating mode, either; Standard or Turbo Turbo can only be set if 'Turbo is user selectable' is Enabled. Contact Sonaer to get the 'Unlock' code – code must be entered using the Atomizer device.
Turbo is user selectable	0x18	Byte	0*=Off/Disabled 1=On/Enabled	R	Bool	Read to determine if the Atomizer device is Turbo mode capable. Contact Sonaer to get the 'Unlock' code – code must be entered using the Atomizer device.
AAPA	0x19	Byte	0*=Off/Disabled 1=On/Enabled	R/W	Bool	Sets or gets the AAPA (Auto Atomization Power Adjustment) mode, either; disabled or enabled

Name	Parameter #	Length	Values / Range (* is default)	R/W	Unit	Description
External Enable Pin Polarity	0x1A	Byte	0*=Active Low 1=Active High	R/W	Bool	Sets or gets the polarity of the external enable pin When set to 0 a 'Low Signal' Enables Power, and a 'High Signal' Disables Power When set to 1 a 'High Signal' Enables Power, and a 'Low Signal' Disables Power

4. Protocol

4.1 The Physical Protocol

- The communication interface to the Ultrasonic device is RS232, with a fixed baud rate of 38,400, 8 Data Bits, No Parity, and 1 Stop Bit.
- The protocol is host-initiated transaction based – meaning, the host sends a command and waits for a response from the Ultrasonic device. Every command has a response. Responses always return 'status' and may or may not return data depending on the type of command. The Ultrasonic device never sends unsolicited messages.
- An inter-character-delay is not required – 2 consecutive RS232 characters can be concatenated (back-to-back)
- The communication protocol adheres to Big-Endian format, such that;
 - when the protocol specifies WORDS (2-Bytes), it is always High-Byte, followed by Low-Byte.

¹ Frequency units are in 10's of Hz; so, for example, if you get the value 3,400, the actual frequency is 34,000Hz

- when the protocol specifies DWORDS (4-Bytes), it is always Most-Significant-Byte first, and Least-Significant-Byte last.
- Transaction Turnaround Time: After sending a command to the device the device is guaranteed to respond within (less than) 20ms. A new command can be sent immediately after receiving a response from the device.
- If an error response is received, try sending the command again.
- Startup sequence:
 - Always power on the Ultrasonic device, wait for it to fully initialize, then start the host communication.
 - The first command to the Ultrasonic device MUST be the Connect-Request command.
 - If the returned response status is 0x00/OK then a connection to the device has been successful.
 - If there is no response (nothing sent by the device) then the physical connection is incorrect. Check your communication parameters (baud, parity), or cable connection.
 - If a response is received but is not a valid response (ie 0x03 0x00 0x00 0x00) it indicates your device is not enabled for PC-Control – contact Sonaer for support (an upgrade).

9.3 The Command & Response Protocol

Commands & Responses have common formats. The following 2 figures describe these formats.

Figure 3: Command Packet Format

Byte #	Field	Description
Byte ₍₀₎	Length	Length in bytes of the message, excluding itself but including the checksum. Example: If command is 1 byte then Length=2
Byte ₍₁₎	Opcode	Command opcode (see Figure 5: Opcode list)
Byte ₍₂₎ - Byte _(Len-1)	Data	Command specific as per Figure 2: Ultrasonic Device Parameter Description

Byte #	Field	Description
Byte _(Len)	Checksum	2's compliment of sum of Byte ₍₁₎ – Byte _(Len-1) . Sum of bytes, excluding 'length', but including 'checksum' should be 0.

Figure 4: Response Packet Format

Byte #	Field	Description
Byte ₍₀₎	Length	Length in bytes of the message, excluding itself but including checksum. Example: If command is 1 byte then Length=2
Byte ₍₁₎	Status	Was the command received and processes properly, 0=Yes , other value indicate error, refer to Figure 6
Byte ₍₂₎	Opcode	Response opcode (same as command opcode)
Byte ₍₃₎ - Byte _(Len-1)	Data	Response specific as per Figure 2: Ultrasonic Device Parameter Description
Byte _(Len)	Checksum	2's compliment of sum of Byte ₍₁₎ – Byte _(Len-1) . Sum of bytes, excluding 'length', but including 'checksum' should be 0.

Figure 5: Opcode list

Opcode	Name	Description
0x01	Ping	Communication verification
0x02	Get-Byte	Get a parameter whose 'value' is a BYTE
0x03	Get-Word	Get a parameter whose 'value' is a WORD (16 bits)
0x04	Get-Dword	Get a parameter whose 'value' is a DWORD (32 Bits)
0x06	Set-Byte	Set a parameter whose 'value' is a BYTE
0x07	Set-Word	Set a parameter whose 'value' is a WORD (16 bits)
0x08	Set-Dword	Set a parameter whose 'value' is a DWORD (32 Bits)

Figure 6: Response Status Codes ('status' field of Response Packet)

Code	Description
0x00	OK. Command was successfully processed. This is the typical expected response status
0x11	Warning: Command opcode was invalid / unknown / not supported
0x12	Warning: The requested 'device parameter' was invalid / unknown / not supported
0x13	Warning: The requested 'value' was invalid
0x40	Error: General Communication Error
0x41	Error: Device timed-out waiting for a command to be completed
0x42	Error: Command 'length' was incorrect
0x43	Error: Command 'checksum' failed'

9.4 Controlling the Ultrasonic Device

The following table gives examples of various commands and responses, as actual arrays of bytes, to depict complete command and response packets. The column 'Constructed Message' shows the actual byte-by-byte packet. Realize these are examples and therefore some fields could change in actual usage (ie Checksum, although valid for the packets listed, will change for different data).

Figure 7: Constructed Commands & Response

Command	C O 	Command/Response Message fields (all values are hex)						Constructed Message (all values are hex)	Description
		Length	Status	Opcode	Parameter	Data	Checksum		
Ping	C	02	NA	01	-	-	FF	0201FF	Command to test communication interface
	R	03	00	01	-	-	FF	030001FF	Received if the communication interface is working properly
Get Software Version	C	03	NA	03	00	-	FD	030300FD	Request Device Software Version
	R	06	00	03	00	0306	F4	060003000306F4	This device version is 03.06 or 3.06.
Get-System-State	C	03	NA	02	01	-	FD	030201FD	Request system state of Ultrasonic device
	R	03	00	02	01	01	FD	04000201FD	Ultrasonic device is 'stopped' (1)
Set-System-State (to running/2)	C	04	NA	06	01	02	F7	04060102F7	Set Ultrasonic device (System-State) to 'running' (2)
	R	03	00	06	-	-	FA	030006FA	Response status is 'OK' (0). Command successfully processed

Command	C = Co	Command/Response Message fields (all values are hex)						Constructed Message (all values are hex)	Description
		Length	Status	Opcode	Parameter	Data	Checksum		
Get-Frequency	C	03	NA	03	02	-	FB	030302FB	Request the frequency of the probe.
	R	06	00	03	02	1770	74	06000302177074	Frequency is '60000Hz' (value of 0x1770=6000 in 10Hz units)
Get-Power	C	03	NA	04	03	-	F9	030403F9	Request power usage of the probe
	R	08	00	04	03	000003E8	0E	08000403000003E80E	Power usage is '1000 milliWatts' (value of 0x000003E8 = 1000 = 1Watt).
Get-Power-Level	C	03	NA	02	04	-	FA	030204FA	Request the initial power setting from the device..
	R	05	00	02	04	41	B9	0500020441B9	This response indicates the device is set to a power level of 0x41 = 65%
Connect-Request	C	04	NA	06	14	01	E6	04061301E6	Use this command to connect to the device

Command	C = Co	Command/Response Message fields (all values are hex)						Constructed Message (all values are hex)	Description
		Length	Status	Opcode	Parameter	Data	Checksum		
	R	03	00	06	-	-	FA	030006FA	This response indicates the connection was successful
Set-Power-Level (to 65%/0x41)	C	04	NA	06	15	41	A4	04061541A4	Use this command to set the power level, in percentage.(to 65%)
	R	03	00	06	-	-	FA	030006FA	This response indicates the power was successfully set.
Set Standard/Turbo (to Turbo)	C	04	NA	06	17	01	E2	04061701E2	Set to 'Turbo' mode
	R	03	00	06	-	-	FA	030006FA	This response indicates 'Turbo' was successfully enabled Turbo can only be set if 'Turbo is user selectable' is Enabled. Contact Sonaer to get the 'Unlock' code – code must be entered using the Atomizer device.

Command	C = Co	Command/Response Message fields (all values are hex)						Constructed Message (all values are hex)	Description
		Length	Status	Opcode	Parameter	Data	Checksum		
	R	03	13	06	-	-	E7	031306E7	This response indicates 'Turbo' was not allowed because 'Turbo is user selectable' is disabled. Turbo can only be set if 'Turbo is user selectable' is Enabled. Contact Sonaer to get the 'Unlock' code – code must be entered using the Atomizer device.
Set Standard/Turbo (to Standard)	C	04	NA	06	17	00	E3	04061700E3	Set to 'Standard' mode
	R	03	00	06	-	-	FA	030006FA	This response indicates 'Standard' was successfully set (Turbo disabled)
Get 'Turbo Mode Is User Selectable'	C	03	NA	02	18	-	FA	030218FA	Request if 'Turbo Mode is user selectable'
	R	05	00	02	18	01	F9	0500021801F9	This response indicates 'Turbo mode is user selectable'
	R	05	00	02	18	00	FA	0500021800FA	This response indicates 'Turbo mode is not user selectable'.

Command	C = Co	Command/Response Message fields (all values are hex)						Constructed Message (all values are hex)	Description
		Length	Status	Opcode	Parameter	Data	Checksum		
Set AAPA (to disabled)	C	04	NA	06	19	00	E1	04061900E1	Set to 'AAPA' disabled
	R	03	00	06	-	-	FA	030006FA	This response indicates 'AAPA' was successfully disabled
Request-Fault	C	03	NA	02	16	-	E8	030216E8	Request if device has detected a fault.
	R	05	00	02	-	00	E9	05000200FE	This response indicates if the unit has a fault as follows; 0=NO_FAULT 1=ERROR_CURRENT_OVERLOAD 2=ERROR_UNKNOWN 3=ERROR_PROBE_LOADING 4=ERROR_INTERNAL 5=ERROR_UNDER_VOLTAGE 100=ERROR_MAX 101=WARNING_MORE_POWER_REQUIRED