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URG Series
Communication Protocol Specification

*1	Revise the explanation of L-Command	4	Nov/12th/09	W. Santosh	
SYMBOL	CORRECTIONS	PAGES	DATE	CORRECTED BY	NO

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Communication Specification

URG-X002 has provisions for RS-232C and USB interfaces. The real time monitoring of USB port enables the automatic switching, there is no need to restart the sensor or perform any other special task for connection. Priority is given for USB connection if USB port is connected to the host.

Standard of USB is Communication Device Class (CDC). Usages are identical to RS-232C. However USB connection will provide large amount of data with very high speed.

RS-232C.

Baud Rate: 19.2Kbps, 57.6Kbps, 115.2Kbps, 250Kbps, 500Kbps, 750Kbps
Parity: None
Data Bit: 8
Stop Bit: 1
Flow Control: None

USB

Version: 2.0
Communication Speed: Max. 12Mbps [Active 9Mbps]
Device Class: Communication Device Class
Caution: Access to the device from the application should be done only when the host-device configuration is complete and host recognizes the device. Port should be opened only after the OS assigns it to the device.

 # Communication Format #

Communication format from the host side is "Command", "Parameters" (if necessary) and "Termination Symbol" (ex. Line feed [$0a_{16}$] or carriage return [$0d_{16}$]) in succession. Reply from the device will echo back with the "Status", "Line feed" and depending upon the command "Data" and finally the "Termination Symbol". Termination symbol from the host is one byte while from the device is 2 byte data to differentiate them.

There are 4 types of command in SCIP 1.1

(1) Version Command
(2) Laser Illumination Command
(3) Communication Speed Setting Command for RS-232C
(4) Distance Data Acquisition Command

In the next version of the SCIP we are planning to add control command for data check and the other commands.

(HOST→SENSOR)

Command	Parameter	LF ($0a_{16}$) or CR ($0d_{16}$)

(SENSOR→HOST)

Command	Parameter	LF	Status	LF	Data	LF	LF

- Communication is initiated from the host side.
- There are no initiation codes. Termination code is either Line Feed ($0a_{16}$) or Carriage Return ($0d_{16}$).
- Command and the parameters will echo back with the status and data attached to it.
- The block check code does not have any type.
- Status other than '0' (30_{16}) is the error code.
- The LF separates the received data after every 64 bytes if the data size exceeds 64 bytes.
- Two LF appear continuously at the end of the received data.

 # Command Types #

[V-Command (Version Information)]

(HOST→SENSOR)

'V'(56_{16})	LF or CR

(SENSOR→HOST)

'V'(56_{16})	LF	
Status	LF	
Vendor Information	LF	
Product Information	LF	
Firmware Version	LF	
Protocol Version	LF	
Sensor Serial Number	LF	LF

Example:

V[LF]
0[LF]
VEND: Hokuyo Automatic Co., Ltd.[LF]
PROD: SOKUIKI Sensor URG-X002[LF]
FIRM: 0.01.22a,(2004/12/27)[LF]
PROT: 00001,(SCIP 1.0)[LF]
SERI: H0400000[LF][LF]

[L-Command (Laser Illumination Control)]

(HOST→SENSOR)

'L'($4c_{16}$)	Control Code (1 Byte)	LF or CR

(SENSOR→HOST)

'L'($4c_{16}$)	Control Code (1 Byte)	LF	Status	LF	LF

1) Laser is switched on when the control code is '1'[*1]. It will be switched off when the code is '0'[*1]. Control codes other than these return errors.
2) By default, whenever the sensor is switched on laser illuminates automatically even if it was switched off before.

[S-Command (Communication Settings)]

(HOST→SENSOR)

'S'(53_{16})	Baud Rate (6 Digits)	Reserved Area (7 Digits)	LF or CR

(SENSOR→HOST)

'S'(53_{16})	Baud Rate (6 Digits)	Reserved Area (7 Digits)	LF	Status	LF	LF

1) Default communication speed is set to 19.2 kbps. It can be changed to 57.6, 115.2, 250, 500 and 750 kbps by varying the settings.
   Example: 57.6Kpbs -> "057600" (ASCII 6Digits)
   115.2Kpbs -> "115200" (ASCII 6Digits)
2) Changes in the baud rate can be done only when the host gets the acceptance status '0'.
3) When the USB connection is used the command is accepted but it will not have any influence on the baud rate. Data in the reserved area are echoed without any influence in the sensor.

[G-Command (Distance Data Acquisition)]

The maximum measurable distance of the sensor is 4095 mm with 1mm resolution. Each data are expressed with 12 bits (0~4095 range). In order to reduce the data volume, 6-bit binary code is converted to 1-byte character codes. The encoding process is very simple where, the 12 bit data is separated into 6 bit each and 30_{16} added to them.

Example:
1234mm = 010011010010_2
↓ separation
(010011_2,010010_2) = (13_{16}, 12_{16})
↓ Add 30_{16}
(43_{16}, 42_{16}) = ('C', 'D')

Decoding process is the inverse of encoding where, 30_{16} is subtracted from the data and merged using the big-endian system.

Upon sending G-command the sensor will send back the distance data currently saved in the sensor memory. In the next SCIP version we are planning to introduce an option command upon receiving which the sensor will measure the distance and send the data to the host. The other option will be 1msec, 24bit "Time stamp".

(HOST→SENSOR)

'G'(47_{16})	Starting Point (3 Digits)	End Point (3 Digits)	Cluster Count (2 Digits)
LF or CR			

When the data is less than 64 bytes:

(SENSOR→HOST)

'G'(47_{16})	Starting Point (3 Digits)	End Point (3 Digits)	Cluster Count (2 Digits)	LF
Status	LF			
Data	LF	LF		

When the data is exactly 65 bytes (Full N Block):

(SENSOR→HOST)

'G'(47_{16})	Starting Point (3 Digits)	End Point (3 Digits)	Cluster Count (2 Digits)	LF
Status	LF			
Data Block 1 (64 Byte)	LF			
……..	LF			
Data Block N (64 Byte)	LF	LF		

When the data is more than 65 bytes (Full N Block with excess of n bytes):

(SENSOR→HOST)

'G'(47_{16})	Starting Point (3 Digits)	End Point (3 Digits)	Cluster Count (2 Digits)	LF
Status	LF			
Data Block 1 (64 Byte)	LF			
……..	LF			
Data Block N-1 (64 Byte)	LF			
Data Block N (n Byte)	LF	LF		

To obtain the data, assign the starting point, end point and cluster count. Sensor groups the multiple neighboring points assigned by the cluster count. The minimum value from each group is supplied as distance data to the host.

1) Starting Point (0~768): Point of the area from where the data reading starts.
   Example: "000" (30_{16}, 30_{16}, 30_{16}).
2) End Point (0~768): Point of the area where the data reading stops.
   Example: "768" (37_{16}, 36_{16}, 38_{16}).
3) Cluster Count (0~99): Number of neighboring points that are grouped as a cluster.
   Example: "01" (30_{16}, 31_{16}).

Angular detection range of the sensor is 240 degree.
Angular resolution per step is 360 degree/1024 = 0.3515625 degree. Step numbers “0”, “384” and ‘768” implies -135 degree, 0 degree and +135 degree respectively taking the front of the sensor as a reference point (Figure below).

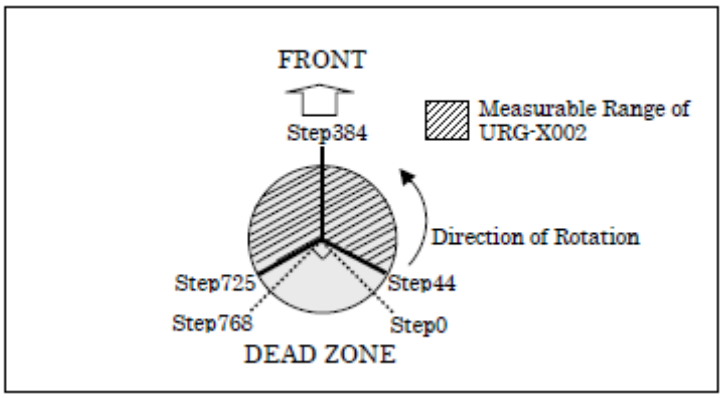

Figure: Top View

Sensor measures the distance in the range 20 mm to 4094 mm. If the distance is less than 20 mm, data will have error code.

Error Code	Error Type
0	Possibility of detected object is at 22m
1	Reflected light has low intensity
2	Reflected light has low intensity
3	Reflected light has low intensity
4	Reflected light has low intensity
5	Reflected light has low intensity
6	Possibility of detected object is at 5.7m
7	Distance data on the preceding and succeeding steps have errors
8	Others
9	The same step had error in the last two scan
10	Others
11	Others
12	Others
13	Others
14	Others
15	Others
16	Possibility of detected object is in the range 4096mm～5.6m
17	Others
18	Unspecified
19	Non-Measurable Distance

 # Response to the Invalid Commands #

- There will be no response to the undefined commands.
- If there are any miss in commands or the byte count doesn't match, it will echo with error status.
- Command will echo with error code if there are any invalid commands such as, sending distance acquisition command when the laser is off or if starting point is bigger than the end point etc.