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# Communication Protocol Specification

## SE2L-H05LP



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## Revision history

Symbol	Revision Detail	Page	Date	Drafted
-	Initial	-	2015/12/10	N.Ohsugi
B	Continuous data output commands (AR02, AR03, AR04, AR05) added.	4, 7, 8, 11, 12	2016/3/29	N.Ohsugi
C	Commands (XR, YR) added. Laser off State added in AR commands. B Protocol commands added.	4, 7, 9 - 29	2017/1/17	N.Ohsugi
D	Warning message added. New parameter added in sensing commands and status command. Area data of parameter details in YR command added. Detection log commands added.	4, 9 - 17	2017/10/19	N.Ohsugi

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## 1. Introduction

This document describes the communication protocol specification for the safety laser scanner, SE2L-H05LP (henceforth SE2L).

Communication protocol is a predefined format of ASCII strings used for data transmission between host computer and SE2L referred as, “Command” and “Reply”. Commands are sent from the host computer to SE2L which will then reply with the data corresponding to the type of command. Protocol should be strictly followed in order to obtain the appropriate data. Set of such commands and their responses are explained in this document.

**This specification is compatible with firmware version 2.1.1o (and later) of SE2L.**

### Note:

- This specification is intended for the developers who have sufficient knowledge on the product and software programming.
- Read this document carefully before programming the communication software.
- Read user’s manual of SE2L before programming the communication software.

### Danger!

- Sending commands other than those specified in this document can permanently damage the SE2L.
- Sending commands other than those specified in this document can lead to unintended performance of SE2L causing critical injury or death.
- Sending commands in sequence other than those specified in this document can lead to unintended performance of SE2L causing critical injury or death.
- Data integrity (size, CRC, status etc.) shall be sufficiently checked before using the data for the intended purpose.
- Data obtained through communication should not be used for controlling the safety device.
- Verification shall be done to ensure that the data output does not hamper the safety operation of either SE2L or the controlled device.
- Do not perform Ethernet and USB communication simultaneously. If Ethernet is connected, stop the Ethernet transmission when configuring the SE2L with USB device or SD card.

## 2. Abbreviations and Descriptions

CRC: Cyclic Redundancy Check

STX: Start of Text

ETX: End of Text

OSSD: Output Signal Switching Device

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### 3. Communication Format

General communication format and terms used in it are explained below.

#### Command

Host » SE2L

STX	Command Size	Header	Sub Header	CRC	ETX
1 char	4 char	2 char	2 char	4 char	1 char

#### Reply

Host « SE2L

STX	Reply Size	Header	Sub Header	Data*	Status	CRC	ETX
1 char	4 char	2 char	2 char	N char	2 char	4 char	1 char

\* Some of the replies may not contain this field.

#### Command:

It is the data transmitted from the host computer to SE2L. It is enclosed between STX and ETX and contains Command Size, Header, Sub-Header and CRC.

#### Command Size:

It is the total length of ASCII characters in a command. Command size is encoded to hexadecimal strings (refer to section 4).

#### Header:

It is a unique code to differentiate the type of command.

#### Sub-Header:

It is an additional parameter to differentiate the same command having multiple replies.

#### CRC:

It is a 16-Bit code for checking the data integrity. Command size, header, sub-header and data are included in CRC calculation (refer to section 5). CRC is encoded to hexadecimal strings (refer to section 4)

#### Reply:

It is the data transmitted from SE2L to host computer upon receiving a command. It is enclosed between STX and ETX and contains Reply size, Header, Sub-Header, Data, Status and CRC. Reply is unique for each command.

#### Reply Size:

It is the total length of ASCII characters in a reply. Reply size is encoded to hexadecimal strings (refer to section 4).

#### Data:

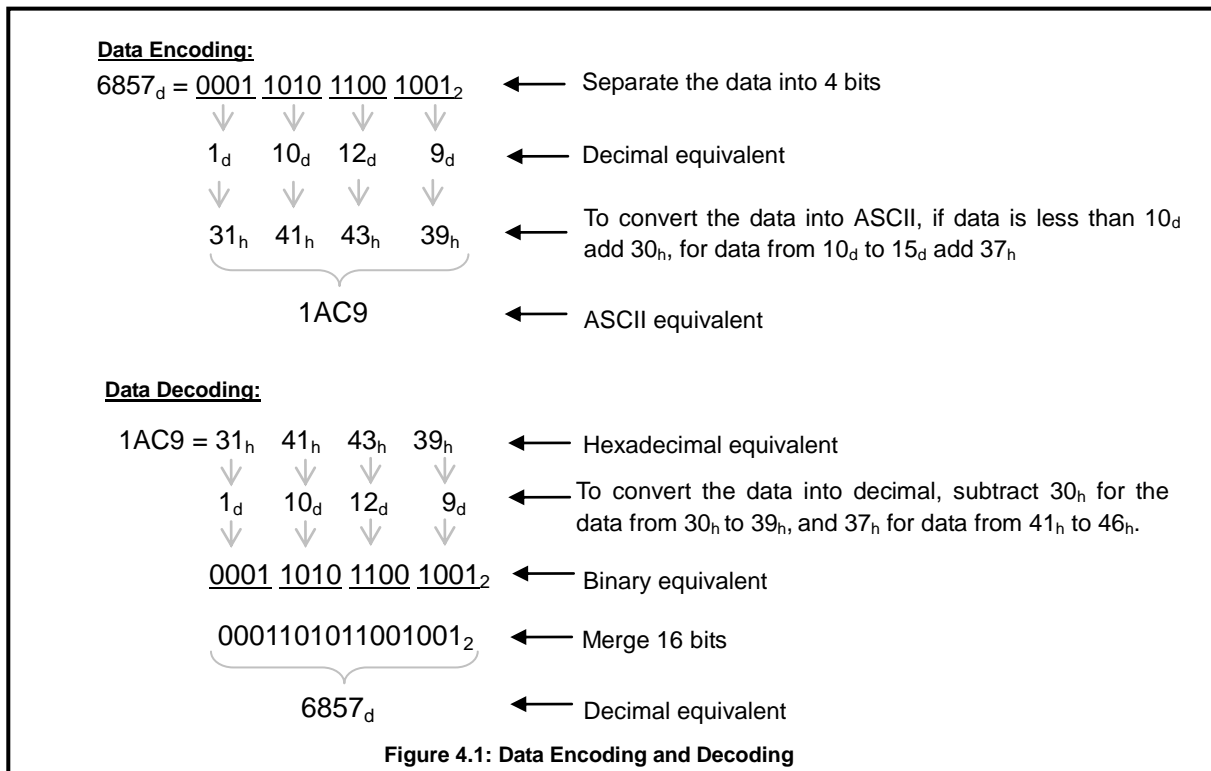
Data is SE2L's internal state and/or measurement values. It is encoded in ASCII strings and transmitted from SE2L. Some of the replies may not contain the data.

#### Status:

It is a code to inform the success or failure of the command execution. Status other than "00" is error code. Refer to section 7 for details.

#### 4. Data Encoding and Decoding

Data encoding is applied in the communication protocol. Host computer should convert all the numerical values into ASCII characters before transmitting them to SE2L. For encoding, the data should be first divided into 4 bits, and then depending on its value, either 30<sub>h</sub> or 37<sub>h</sub> is added to convert into ASCII characters (Figure 4.1). Values received from SE2L are also in the same format therefore, program on the host computer should decode it before using. Decoding is exactly the opposite of encoding process where, depending on the value of each received ASCII characters, either 30<sub>h</sub> or 37<sub>h</sub> is subtracted and merged to generate the original value.



#### 5. CRC Calculation

CRC is a 16 bit code to check the data integrity at the receiving end. It serves as a mean to detect corruption or loss during transmission that may occur due noise in the communication channel. When SE2L receives data from the host computer, it recalculates the CRC and compares it with the CRC value in the command. SE2L will reply with the requested data only if both CRCs match otherwise, it will reply with an error code in the status. Data integrity check should be also applied on the host computer before using the received data. Discard the data if verification fails data and try again by resending the command.

CRC is calculated using the polynomial  $X^{16} + X^{12} + X^5 + 1$ . CRC value is encoded into 4 ASCII characters (see section 4) before the transmission. STX and ETX are not included when calculating the CRC value.

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CRC Standard: Kermit  
Polynomial: 0x1021  
Shift Direction: Right  
Initial Value: 0x0000  
Byte Swap: Yes  
Reverse CRC Result: Yes

**CRC Example:**

Data → "000EVR00" : 0x3492 ← CRC

## 6. Commands

Commands recognized by SE2L are described in this section. SE2L will respond with the corresponding data when it receives these commands. Format should be strictly followed in order to obtain the appropriate data. SE2L will reply with error status (refer to section 7) if length, CRC or header string validation fails.

SE2L performs communication routine once in every sensing cycle (one sensing cycle of SE2L is 29 to 30ms) and sends the reply to any command received during this period. Therefore, if commands are not received completely in once cycle it will take another cycle to send the reply. Further, reply can be delayed depending on the communication speed of the host system. Allow sufficient timeout period by considering all possible delays that can occur in the system before resending the command when reply is not received from SE2L. Avoid continuously sending the commands to SE2L without waiting for the reply. It will affect the performance and becomes a cause of error.

Some of the commands can set SE2L to supply the measurement data continuously. When SE2L is in continuous transmission mode, it will supply the data at every 30ms (approx.). Continuous mode can be terminated by sending the appropriate stop commands. In continuous transmission mode, avoid sending additional commands to acquire the same data. However, commands to request other information such as, sensor version can be sent to SE2L.

### **Important Note:**

When the scan skip function is active, device will reply only during the measurement cycles. For example, if the scan skip function is configured as 2, reply of AR02 and AR04 (refer to sections 6.2.3 and 6.2.4) commands will be provided at every 90msec. However, if the device is in the error state, the reply will be sent at every cycle. In such case, the values of measurement data when the sensor is skipping the measurement will be 0xFFFE. Further, scan skip function is temporarily suspended when the device is in setting mode and the communication cycle is 30msec.

## 6.1 Version Details (VR Command)

When SE2L receives this command, it replies with its version details. Version details include serial number, firmware version among other information. Data in the version command are not encoded except the length and CRC.

Before acquiring sensing data using AR commands, send the VR command to confirm the connection with intended SE2L.

Host » SE2L

STX	Length	V	R	0	0	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

Host « SE2L

STX	Length	V	R	0	0	Status
1 char	4 char	1 char	1 char	1 char	1 char	2 char
Sensor model		,				
29 char		1 char				
Firmware version		,				
29 char		1 char				
Reserved		,				
37 char		1 char				
Serial Number		,	CRC	ETX		
8 char		1 char	4 char	1 char		

## 6.2 Sensing Data (AR Commands)

There are 6 variations of this command differentiated by sub-header. Function of commands will vary depending on it (Table 6.2.1). When SE2L receives this command, it replies with its sensing data (Table 6.2.2).

After sending a command to acquire data in continuous transmission mode, avoid sending additional commands to get the same data. However, commands to request other information such as, sensor version, can be sent to SE2L even in continuous mode.

SE2L will supply the data at every 30ms (approx.) in continuous transmission mode. Even if SE2L can not perform the measurement due to internal error or goes to lockout state, it will continue to send the reply but the measurement values are not updated.

**Important: Before acquiring sensing data using AR commands, send the VR command to check the serial number for verifying the connection with an intended SE2L.**

Table 6.2.1: Function of AR Commands Based on Sub-header Parameter

Command	Function
"AR00"	Acquire sensing data with measured distance
"AR01"	Acquire sensing data with measured distance and intensity
"AR02"	Acquire sensing data with measured distance in continuous mode
"AR03"	Stop continuous mode initiated by "AR02"
"AR04"	Acquire sensing data with measured distance and intensity in continuous mode
"AR05"	Stop continuous mode initiated by "AR04"



**Table 6.2.2: Details of Sensing Data**

Item	Data	Remarks
Operating Mode	0: Normal 1: Setting	
Area Number	00 ~ 1F	Offset the number by 1 to match with 7-seg display of SE2L
Error State	0: No error 1: Error is detected	Use this information with Error Code to show the error status. Also check the Lockout State.
Error Code	1 ~ BF	Use this information with Error Status to show the error number. Offset the number by 0x40 to match with 7-seg display of SE2L. Refer to SE2L user's manual for error details.
Lockout State	0: Normal 1: Lockout	Use this information with Error Code to show the error status. Also check the Error State.
OSSD 1 State	0: Off (No detection) 1: On (Detection)	Always 1 in setting mode
OSSD 2 Status	0: Off (No detection) 1: On (Detection)	Always 1 in setting mode
Warning 1 State	0: Off (No detection) 1: On (Detection)	Always 0 when SE2L is operating without warning zone1. Always 1 in setting mode when operating with warning zone1.
Warning 2 State	0: Off (No detection) 1: On (Detection)	Always 0 when SE2L is operating without warning zone2. Always 1 in setting mode when operating with warning zone2.
OSSD 3 State	0: Off (No detection) 1: On (Detection)	Always 0 when SE2L is operating without protection zone2. Always 1 in setting mode when operating with protection zone2.
OSSD 4 State	0: Off (No detection) 1: On (Detection)	Always 0 when SE2L is operating without protection zone2. Always 1 in setting mode when operating with protection zone2.
Muting/override State1	0: Not Active 1: Active	Always 0 when SE2L is operating without muting function.
Muting/override State2	0: Not active 1: Active	Always 0 when SE2L is operating without muting function and/or without protection zone2.
Reset Request1	0: Off 1: On	Always 0 when SE2L is operating without interlock1 function.
Reset Request2	0: Off 1: On	Always 0 when SE2L is operating without interlock2 function and/or without protection zone2.
Encoder Speed	0~FFFF	Always 0 when SE2L is operating without encoder Input function.
Time Stamp	0 ~ FFFFFFFF	Unit is millisecond.
Laser off State	0: Laser is emitted 1: Laser is stopped	Always 0 when operating without Laser off function Always 0 in setting mode
Optical Window contamination warning	0: Off (Not contaminated) 1: On (Contaminated)	Data will be 1 when optical window starts to accumulate dust. Use this information to clean the optical window before it becomes severe leading the device to error state (error 85, b1 ~ c1).
Distance Data	0000 ~ FFFF	1081 Steps data Note: 1. Values more than 40000 are error code (0xFFFF). 2. If object is not detected value will be 65534 (0xFFFE). 3. If object is at a very close range value will be 65533 (0xFFFD). 4. When the device is in laser off state or lockout state the value will be 65532 (0xFFFC)
Intensity Data	0000 ~ FFFF	1081 Steps data Note: 1. If object is not detected the value will be 0. 2. Do not use the value if distance of the corresponding step has error. 3. When the device is in laser off state or lockout state the value will be 65532 (0xFFFC).

### 6.2.1 AR00 Command

When SE2L receives this command, it provides sensing data with measured distance. Refer to Table 6.2.2 for details on the data.

Host » SE2L

STX	Length	A	R	0	0	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

Host « SE2L

STX	Length	A	R	0	0	Status	
1 char	4 char	1 char	1 char	1 char	1 char	2 char	
Operating Mode		Area Number		Error Status	Error Code	Lockout State	
1 char		2 char		1 char	2 char	1 char	
OSSD 1 State		OSSD 2 State		Warning 1 State	Warning 2 State		
1 char		1 char		1 char	1 char		
OSSD 3 State		OSSD 4 State		Reserved (0)	Reserved (0)		
1 char		1 char		1 char	1 char		
Muting/Override State 1		Muting/Override State 2					
1 char		1 char					
Reset Request 1		Reset Request 2		Encoder Speed			
1 char		1 char		4 char			
Time Stamp		Laser off State		Optical Window Contamination Warning		Reserved	
8 char		1 char		1 char		6 char	
Distance Data		CRC		ETX			
4324 char		4 char		1 char			

### 6.2.2 AR01 Command

When SE2L receives this command, it provides sensing data with measured distance and intensity. Refer to Table 6.2.2 for details on the data.

Host » SE2L

STX	Length	A	R	0	1	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

Host « SE2L

STX	Length	A	R	0	1	Status	
1 char	4 char	1 char	1 char	1 char	1 char	2 char	
Operating Mode		Area Number		Error State	Error Code	Lockout State	
1 char		2 char		1 char	2 char	1 char	
OSSD 1 State		OSSD 2 State		Warning 1 State	Warning 2 State		
1 char		1 char		1 char	1 char		
OSSD 3 State		OSSD 4 State		Reserved (0)	Reserved (0)		
1 char		1 char		1 char	1 char		
Muting/Override State 1		Muting/Override State 2					
1 char		1 char					
Reset Request 1		Reset Request 2		Encoder Speed			
1 char		1 char		4 char			
Time Stamp		Laser off State		Optical Window Contamination Warning		Reserved	
8 char		1 char		1 char		6 char	

Distance Data 4324 char	Intensity Data 4324 char	CRC 4 char	ETX 1 char
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### 6.2.3 AR02 Command

When SE2L receives this command, it provides sensing data with measured distance in continuous mode. Data is supplied at every 30ms (approx.) after completing the scan. Send “AR03 Command” (refer to section 6.2.4) to stop the continuous data output.

Host » SE2L

STX 1 char	Length 4 char	A 1 char	R 1 char	0 1 char	2 1 char	CRC 4 char	ETX 1 char
---------------	------------------	-------------	-------------	-------------	-------------	---------------	---------------

Host « SE2L

• First response of SE2L (contains only the status without any data)

STX 1 char	Length 4 char	A 1 char	R 1 char	0 1 char	2 1 char	Status 2 char	CRC 4 char	ETX 1 char
---------------	------------------	-------------	-------------	-------------	-------------	------------------	---------------	---------------

• Scan data response of SE2L (provides the same data as in “AR00 command” (refer to section 6.2.1) with continuous mode)

STX 1 char	Length 4 char	A 1 char	R 1 char	0 1 char	2 1 char	Status 2 char		
Operating Mode 1 char		Area Number 2 char		Error Status 1 char	Error Code 2 char		Lockout State 1 char	
OSSD 1 State 1 char		OSSD 2 State 1 char		Warning 1 State 1 char		Warning 2 State 1 char		
OSSD 3 State 1 char		OSSD 4 State 1 char		Reserved (0) 1 char		Reserved (0) 1 char		
Muting/Override State 1 1 char			Muting/Override State 2 1 char					
Reset Request 1 1 char		Reset Request 2 1 char		Encoder Speed 4 char				
Time Stamp 8 char		Laser off State 1 char		Optical Window Contamination Warning 1 char				Reserved 6 char
Distance Data 4324 char		CRC 4 char	ETX 1 char					

### 6.2.4 AR03 Command

SE2L stops the continuous data output initiated by “AR02 Command” (refer to section 6.2.3) on receiving this command.

Host » SE2L

STX 1 char	Length 4 char	A 1 char	R 1 char	0 1 char	3 1 char	CRC 4 char	ETX 1 char
---------------	------------------	-------------	-------------	-------------	-------------	---------------	---------------

Host « SE2L

STX 1 char	Length 4 char	A 1 char	R 1 char	0 1 char	3 1 char	Status 2 char	CRC 4 char	ETX 1 char
---------------	------------------	-------------	-------------	-------------	-------------	------------------	---------------	---------------

### 6.2.5 AR04 Command

When SE2L receives this command, it provides sensing data with measured distance and intensity in continuous mode. Data is supplied at every 30ms (approx.) after completing the scan. Send “AR04 Command” (refer to section 6.2.6) to stop the continuous data output.

Host » SE2L

STX	Length	A	R	0	4	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

Host « SE2L

• First response of SE2L (contains only the status without any data)

STX	Length	A	R	0	4	Status	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	2 char	4 char	1 char

• Scan data response of SE2L (provides the same data as in “AR01 command” (refer to section 6.2.2) with continuous mode)

STX 1 char	Length 4 char	A 1 char	R 1 char	0 1 char	4 1 char	Status 2 char		
Operating Mode 1 char		Area Number 2 char		Error Status 1 char		Error Code 2 char	Lockout State 1 char	
OSSD 1 State 1 char		OSSD 2 State 1 char		Warning 1 State 1 char		Warning 2 State 1 char		
OSSD 3 State 1 char		OSSD 4 State 1 char		Reserved (0) 1 char		Reserved (0) 1 char		
Muting/Override State 1 1 char			Muting/Override State 2 1 char					
Reset Request 1 1 char		Reset Request 2 1 char		Encoder Speed 4 char				
Time Stamp 8 char		Laser off State 1 char		Optical window contamination warning 1 char			Reserved 6 char	
Distance Data 4324 char		Intensity Data 4324 char		CRC 4 char		ETX 1 char		

### 6.2.6 AR05 Command

SE2L stops the continuous data output initiated by “AR04 Command” (refer to section 6.2.5) on receiving this command.

Host » SE2L

STX	Length	A	R	0	5	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

Host « SE2L

STX	Length	A	R	0	5	Status	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	2 char	4 char	1 char

### 6.3 Status Data (XR Commands)

When SE2L receives this command, it provides the status data. Refer to Table 6.2.2 for details on the data.

Host » SE2L

STX	Length	X	R	0	0	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

Host « SE2L

STX	Length	X	R	0	0	Status		
1 char	4 char	1 char	1 char	1 char	1 char	2 char		
Operating Mode		Area Number		Error State		Error Code		Lockout State
1 char		2 char		1 char		2 char		1 char
OSSD 1 State		OSSD 2 State		Warning 1 State		Warning 2 State		
1 char		1 char		1 char		1 char		
OSSD 3 State		OSSD 4 State		Reserved (0)		Reserved (0)		
1 char		1 char		1 char		1 char		
Muting/Override State 1		Muting/Override State 2						
1 char		1 char						
Reset Request 1		Reset Request 2		Encoder Speed		Laser Off State		
1 char		1 char		4 char		1 char		
Slave1 OSSD1,2 State		Slave2 OSSD1,2 State		Slave3 OSSD1,2 State				
1 char		1 char		1 char				
Slave1 OSSD3,4 State		Slave2 OSSD3,4 State		Slave3 OSSD3,4 State				
1 char		1 char		1 char				
Slave1 Warning1 State		Slave2 Warning1 State		Slave3 Warning1 State				
1 char		1 char		1 char				
Slave1 Warning2 State		Slave2 Warning2 State		Slave3 Warning2 State				
1 char		1 char		1 char				
Slave1 Error State		Slave2 Error State		Slave3 Error State				
1 char		1 char		1 char				
Slave1 Laser Off State		Slave2 Laser Off State		Slave3 Laser Off State				
1 char		1 char		1 char				
Time Stamp		Optical window contamination Warning		Reserved		CRC	ETX	
8 char		1 char		39 char		4 char	1 char	

Note:

- Slave status data are obtained only when the device is configured to operate in master-slave mode.
- When the command is transmitted to master device, status of the master will be provided on the first part of the reply followed by the status of the slaves in the second part.
- When the command is transmitted to slave device, its own status will be provided on the first part of the reply and second part will be all 0.

## 6.4 Area Data (YR Commands)

When SE2L receives this command, it provides the area configuration data. Refer to Table 6.4.1 for details on the parameters to be provided on the command. Parameters should be sent in the hexadecimal equivalent characters. Status codes for YR command are shown in Table 7.2.

**Table 6.4.1 Parameter details in YR command**

Parameter	Size	Details	Note
Area type	2	00: Protection Zone 1 01: Protection Zone 2 02: Warning Zone 1 03: Warning Zone 2 04: Muting Area 1 05: Muting Area 2 06: Reference Area (Centre) 07: Reference Area (Max value) 08: Reference Area (Min Value)	Device should be configured with the corresponding function to obtain the correct data.
Area Number	2	00: Area 1 01: Area 2 ... 1F: Area 32	Provide the area numbers in hexadecimal equivalent characters (0 to 1F). Area number should not exceed the configured active area count
Start Step	4	0000: Step 0 0001: Step 1 ... 0438: Step 1080	Provide the step values in hexadecimal equivalent characters Step values should not exceed the maximum range 0438 (1081 in decimal). Start step should not be greater than the end step.
End Step	4	0000: Step 0 0001: Step 1 ... 0438: Step 1080	
Grouping	2	00/01: No grouping 02: Grouping two data 03: Group three data ... 09: Group nine data	Parameter 00 and 01 are treated in the same way (no grouping). Steps with the specified count are treated as one group and a single value is supplied from each group in order to reduce the data volume. Data with the maximum value in the group is provided when the grouping is more than 2.
Area Data	4n	0 ~ 7FFF (15 bit data)	Uppermost bit of the area data is reserved. If the data exceeds 7FFF, ignore the first bit and only use the remaining 15 bit data.

Host » SE2L

STX 1 char	Length 4 char	Y 1 char	R 1 char	Area Type 2 char	Area Number 2 char
Start Step 4 char	End Step 4 char	Resolution 2 char	CRC 4 char	ETX 1 char	

Host « SE2L

STX 1 char	Length 4 char	Y 1 char	R 1 char	Area Type 2 char	Area Number 2 char
Start Step 4 char	End Step 4 char	Resolution 2 char	Status 2 char		
Area Data 4n* char	CRC 4 char	ETX 1 char			

\*n = (End Step – Start Step) / Resolution

If n is not a whole number, one data from the remaining steps will be supplied.

## 6.5 Detection Log Command

When SE2L detects obstacle in the protection area it records the information such as, operating area number, distance and step (position) of the obstacle. If obstacles are present at multiple steps, SE2L records the data of the step having the shortest range. In master-slave mode, master unit records the detection log of all the slaves however, slave units don't record the master or other slaves detection information. There are two commands related to detection log function, one to obtain the log and the other to clear it.

### 6.5.1 Detection Log Read (DL00 Command)

When SE2L receives this command, it provides detection log data. SE2L stores maximum 29 sets of log information in a ring buffer in its RAM. Contents of the log data is given in Table 6.5.1.1. When log count exceeds 29, old records are overwritten by the new ones in the ring buffer. A set of log data is 64 characters long (Figure 6.5.1.1). Value "FFFF" of the first 4 data, indicates the end position of the ring buffer therefore, ignore the 64 characters in this line. Data above the indicator are new and below it are the old logs. Since the data are stored in the RAM, they are erased whenever the device is switched off.

Table 6.5.1.1: Details of Detection Log

Item	Data	Remarks
Input/Output <sup>*1</sup>	0 ~ FFFF	Input and output states of the connected device. Bit15 ~ Bit8 represents the operating area number when the log was recorded. Value is from 0x00 to 0x1F which represents area 1 to area 32. Bit1 represents detection state of Protection zone 1. Bit0 represents detection state of Protection zone 2. Note: 1. Value FFFF of this data indicates the end position of the ring buffer therefore, ignore 64 characters in this set. Data above the indicator are new and below it are the old logs (Figure 6.5.1.1). 2. Bit 0 is always 0 when SE2L is operating without protection zone2.
Protection1 Min dist	0 ~ FFFF	Minimum distance measured inside the protection zone1.
Protection1 Min dist step	0 ~ FFFF	Position where the minimum distance was detected inside the protection zone1. Note: Data is provided in detection resolution (0 to 2160). Divide the number by 2 to match with area resolution (0 to 1080).
Protection2 Min dist	0 ~ FFFF	Minimum distance measured inside the protection zone2 Note: Always 0 when SE2L is operating without protection zone2.
Protection2 Min dist step	0 ~ FFFF	Position where the minimum distance was detected inside the protection zone2. Note: 1. Data is provided in detection resolution (0 to 2160). Divide the number by 2 to match with area resolution (0 to 1080). 2. Always 0 when SE2L is operating without protection zone2.
Slave1 Input/Output	0 ~ FFFF	If SE2L is operating in Master-Slave mode and connected unit is Master, this is an input and output states of Slave unit 1. Note: 1. Details are same as input output states (see *1) of connected device. 2. Always 0 when the device is slave unit.

Slave2 Input/Output	0 ~ FFFF	If SE2L is operating in Master-Slave mode and connected unit is Master, this is an input and output states Slave unit 2. Note: 1. Details are same as input output states (see *1) of connected device. 2. Always 0 when the device is slave unit.
Slave3 Input/Output	0 ~ FFFF	If SE2L is operating in Master-Slave mode and connected unit is Master, this is an input and output states Slave unit 3. Note: 1. Details are same as input output states (see *1) of connected device. 2. Always 0 when the device is slave unit.
Log Lapsed time	0 ~ FFFFFFFF	It is the duration that has lapsed since the data was recorded and the log command was received. Unit is 30ms. For example, if the vale is 0000007A, then the log was recorded 3660ms ago.
Reserved	0 ~ FFFF	Note: Ignore the data.

#### Host » SE2L

STX	Length	D	L	0	0	CRC	ETX
1 char	4 char	1 char	1 char	1 char	1 char	4 char	1 char

#### Host « SE2L

STX	Length	D	L	0	0	Status
1 char	4 char	1 char	1 char	1 char	1 char	2 char
Log Data	CRC	ETX				
1920 char	4 char	1 char				

#### Log details:

Log1	Input /Output*	Protection1 Min dist.	Protection1 Min dist step	Protection2 Min dist	Protection2 Min dist step
	4 byte	4 byte	4 byte	4 byte	4 byte
	Slave1 Input /Output*	Reserved	Reserved		
	4 byte	4 byte	4 byte		
Log30	Slave2 Input /Output*	Reserved	Reserved		
	4 byte	4 byte	4 byte		
	Slave3 Input /Output*	Reserved	Reserved	Log lapsed time	
	4 byte	4 byte	4 byte	8 byte	
..					
..					
Log30	Input /Output	Protection1 Min dist.	Protection1 Min dist step	Protection2 Min dist	Protection2 Min dist step
	4 byte	4 byte	4 byte	4 byte	4 byte
	Slave1 Input /Output	Reserved	Reserved		
	4 byte	4 byte	4 byte		
Log30	Slave2 Input /Output	Reserved	Reserved		
	4 byte	4 byte	4 byte		
	Slave3 Input /Output	Reserved	Reserved	Log lapsed time	
	4 byte	4 byte	4 byte	8 byte	

#### \*Input/Output bit details

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Area number								Reserved				Protection1 state		Protection2 state	



[illegible]

### 6.5.2 Detection Log Clear (DC00 Command)

Host » SE2L

Host « SE2L

## 7. Reply Status

### Table 7.1 Detail of Status Code

---

**Table 7.2 Detail of Status Code for YR command**

Status	Detail
0x00	No Error
0x44	➤ Grouping count exceed the maximum value ➤ Area type exceeds the maximum value.
0x52	➤ Start and/or end step exceeds the maximum value ➤ Start step is greater than end step
0x54	Area number exceeds the maximum value
0x55	Area number exceeds the active area count in the sensor
0x81	Protection2 data is requested (YR01) without activating the Protection2 area.
0x82	Warning1 data is requested (YR02) without activating the Warning1 area.
0x83	Warning2 data is requested (YR03) without activating the Warning2 area.
0x84	Muting1 data is requested (YR04) without activating the muting1 area.
0x85	Muting2 data is requested (YR05) without activating the muting2 area.
0x86	Reference data is requested (YR06) without activating the reference area.
0x87	Reference max data is requested (YR07) without activating the reference area.
0x88	Reference min data is requested (YR08) without activating the reference area.

---

## 8. B Protocol Mode Communication

List of supported B Protocol commands are shown in Table 8.1.

**Table 8.1 B Protocol Commands**

Command	Function
BM	Acquire state of the laser
GD	Acquire measured distance
GE	Acquire measured distance and intensity
MD	Acquire measured distance in continuous mode
ME	Acquire measured distance and intensity in continuous mode
QT	Stop the continuous mode
RS	Stop the continuous mode
RT	Stop the continuous mode
VV	Acquire version detail of SE2L
PP	Acquire parameters of SE2L
II	Acquire state of SE2L

### 8.1 B Protocol Format

#### 8.1.1 Request Message

Request Message is sent from the host computer to SE2L. It contains command code, parameters, user specified strings and request terminator (Figure 8.1.1.1).

Command code is expressed in two upper case alphabets. SE2L uses this code to differentiate the command and provides the corresponding response.

Parameters are command specific values expressed in integers. Values should be filled with zero if integer digits are less than parameter's size, for example, if the value is 4, it must be represented as 4, 04, or 004 respectively if parameter size is one, two, or three. Encoding is not applied for the parameters.

User specified string is sequence of characters starting with a semicolon (Figure 8.1.1.2). Characters that can be used are all the alphabets and numbers along with special characters ' ', '!', ' \_ ', '+', '-' and '@'. Avoid using any other characters in the string and limit the size to maximum 16 characters. User specified string is an optional field therefore it can be excluded from the request message. However when same request is issued in succession with separate strings it can serve as a means to differentiate the response message from SE2L.

Request terminator can be a Line feed (LF) character, a Carriage Return (CR) character or both CR and LF in succession.

---

## Request Message

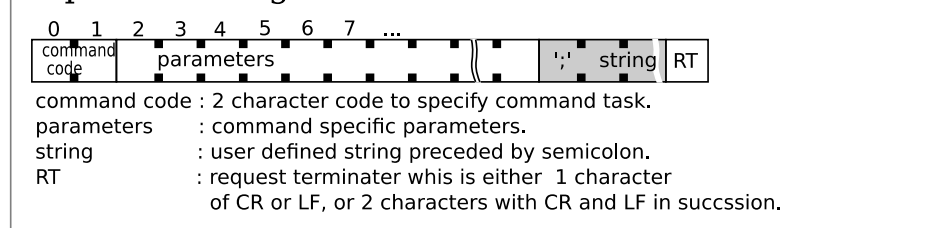


Figure 8.1.1.1: B Protocol Request Message Format

## User String

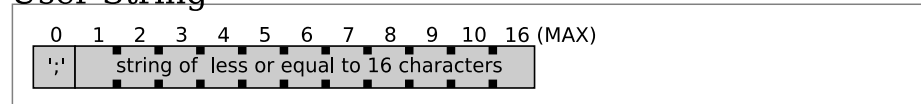


Figure 8.1.1.2: User String Format

### 8.1.2 Response Message

Response Message is sent from SE2L to host computer after receiving a request. It contains echo back of request message, status, check code, data corresponding to the command code and response delimiter (Figure 8.1.2.1).

Echo back is the retransmission of request message by SE2L excluding the request terminator.

Status is a two character alpha-numeric code to inform the success or failure of the command execution.

Check code is a one character code generated for the data enclosed between response delimiter (refer to section 8.3).

Data is SE2L's internal state or measurement values. Some of the data are encoded before transmission. See the corresponding commands in section 8.7 for the type of data sent by SE2L and encoding applied to them.

Response delimiter is a line feed character inserted between the data and at the end of the response message. Check the two consecutive RD in the response message or empty line to confirm the response termination.

#### **Important Note:**

When the scan skip function is active, device will reply only during the measurement cycles. For example, if the scan skip function is configured as 2, reply of commands will be provided at every 90ms. However, if the device is in the error state, the reply will be sent at every cycle. In such case, the values of measurement data when the sensor is skipping the measurement will be 0xFFFE. Further, scan skip function is temporarily suspended when the device is in setting mode and the communication cycle is 30ms.

## Response Message

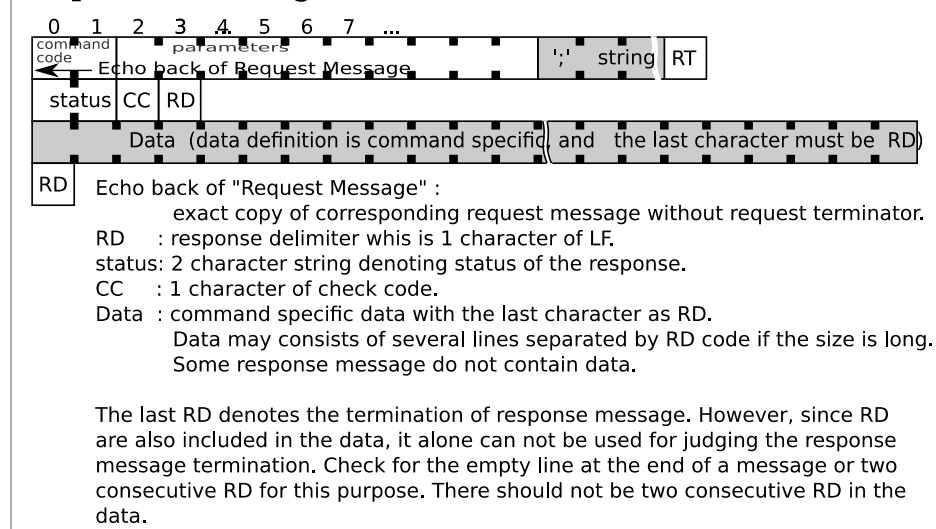


Figure 8.1.2.1: Response Message Format

### 8.1.3 Scan Response Message

Apart from general response format (refer to section 8.1.2), SE2L provides the data in an additional format called, scan response message, when request message is sent to obtain data in continuous mode (Figure 8.1.3.1). Echo back in such message is not exactly the same as request message. They are partially changed. Further, status of such response reflects the current state of SE2L.

## Scan Response Message

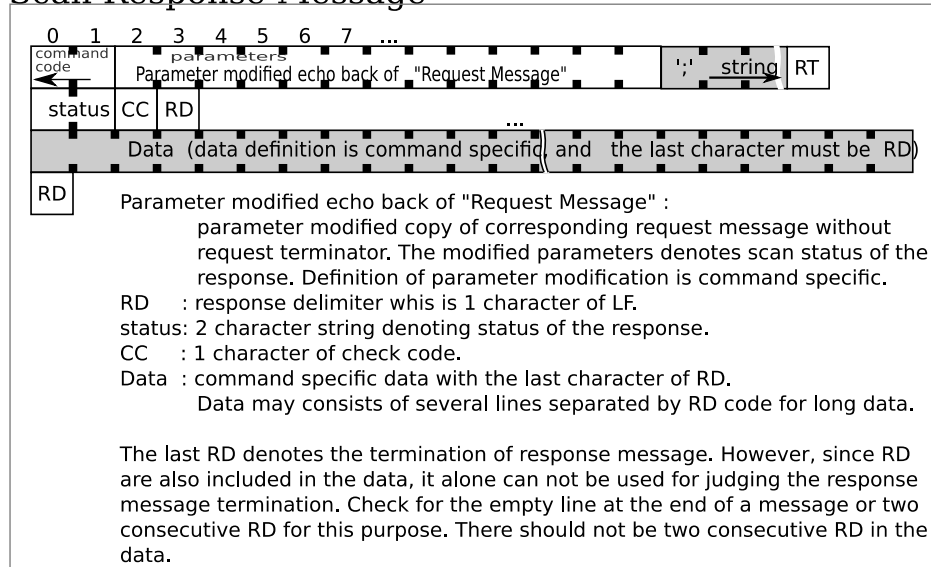


Figure 8.1.3.1: Scan Response Message Format

## 8.2 B Protocol Encoding and Decoding

B protocol encodes the decimal values into ASCII characters in order to compress the data and reduce the transmission time.

Encoding process involve dividing a number into groups of 6 bits. For each 6 bit data, 0x30 is added to convert them into ASCII characters.

Example of encoding 1234 (0x4d2) in B protocol:

Step 1: Expressing the data in binary with incomplete upper bits padded with zero.

1234: 00 0000 0100 1101 0010

Step 2: Separate into three groups with 6 bits each

000000 010011 010010

0x00    0x13    0x12

Step 3: Add 0x30 to convert them into ASCII

0x00 + 0x30 = 0x30 = '0'

0x13 + 0x30 = 0x43 = 'C'

0x12 + 0x30 = 0x42 = 'B'

Data are encoded to either three or four characters. Host computer should appropriately decode the data before using them. Figure 8.2.1 shows the general expression of encoded data.

#### Character Encoded Data

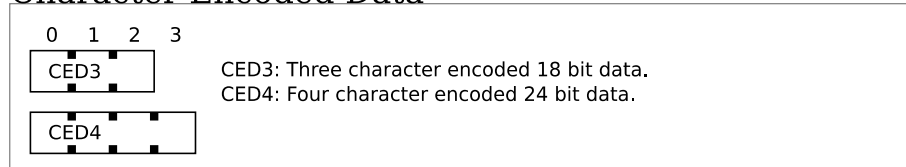


Figure 8.2.1: Representation of Encoded Data

### 8.3 Check Code

Check code is a value obtained by adding all character in a target string. Size of the check code is reduced to 6 bits and applied B Protocol encoding (refer to section 8.2) to convert into ASCII character. Check code should be used for validating the received data by the host computer.

Example of obtaining check code for string "ABC01" in B protocol:

Step 1: Calculate the sum of all characters in the string

'A'    'B'    'C'    '0'    '1'    '2'

0x41 + 0x42 + 0x43 + 0x30 + 0x31 + 0x32 = 0x159

Step 2: Truncate the value to lower 6 bits and add 0x30 to convert into ASCII character.

0x19 + 0x30 = 0x49 = 'I'

## 8.4 Timestamp

Timestamp is a 24 bit counter value of internal timer. It is included in the response message of data request commands. 24 bit data is converted into 4 ASCII characters by B Protocol encoding (refer to section 8.2) before transmission. Value will reset to 0 when counter overflows therefore, host computer should handle this with appropriate measure. Timestamp comes as a set with timer value, check code and response delimiter called as, Time Data (Figure 8.4.1).

### Time Data

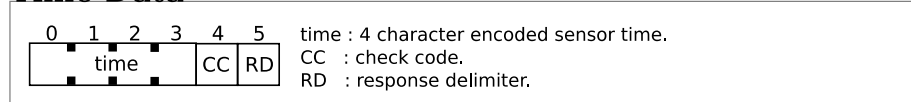


Figure 8.4.1: Representation of Timestamp

## 8.5 Data Splitting

When response message contains a large volume of data they are split into number of blocks each containing 64 characters with its check code and response delimiter (Figure 8.5.1). However, as data may not be always in exact multiple of 64, the last block may contain less than 64 characters with its check code and response delimiter.

### Dividing into Blocks

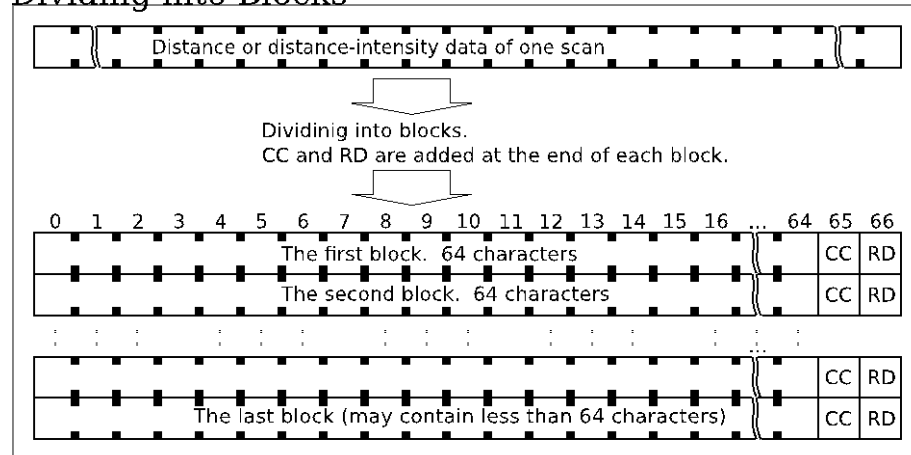


Figure 8.5.1: Separation of Measurement Data into Blocks

## 8.6 Common B Protocol Status Codes

When request message format is wrong or when device is unable to send the desired response due to internal errors, it sends the reply with error status. Status that is common for all commands are shown in Table 8.6.1. Command specific status codes are explained in the respective command in section 8.7.

**Table 8.6.1 Common B Protocol Status Codes**

Code	Detail
00	No error
01 ~ 07	Error in the command parameter
0D	Request message is longer than specified
0E	Undefined command
0G	User specified string is longer than allowed.
0H	User specified string has error
0N	SE2L is in lockout state due to error

## 8.7 B Protocol Commands

### 8.7.1 BM Command

Request and response messages of BM command are shown in Figure 8.7.1.1 and Table 8.7.1.1 shows the status code detail. Generally the status is always 02, but when the device is in the lockout state due to error or if it is switched to laser off mode, the status will be 01.

**Table 8.7.1.1 Details of Status Code**

Code	Detail
01	Laser emission is stopped due to internal error or the device is switched to laser off mode .
02	Laser is on

#### BM request message



#### BM response message



**Figure 8.7.1.1: BM command Request and Response**

### 8.7.2 Measurement Data (GD and GE Command)

When SE2L receives this command, it replies with measurement data. There are 2 variations of this command. GD Command provides only the distance and GE command provides both the distance and intensity. Parameters in the request message are listed in Table 8.7.2.1. SE2L's response depends on these parameters. Measurement data in the response message are encoded to 3 ASCII characters with B Protocol encoding technique (refer to section 8.2). Further, the data is also split into number of blocks during transmission (refer to section 8.5). Format of request and response message are respectively shown in Figure 8.7.2.1, and 8.7.2.2.

If parameters are not received in the correct format, SE2L will send the reply with error



status (refer to Table 8.7.2.2). Refer to section 8.1 for details on terminology used in the message.

**Important:** Before acquiring sensing data using GD, GE command, send the VV command to check the serial number for verifying the connection with an intended SE2L.

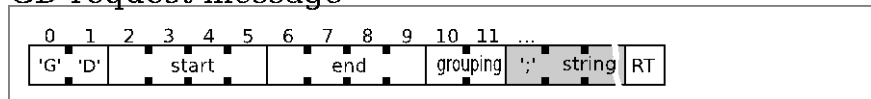
**Table 8.7.2.1 Parameters of GD and GE request message**

Parameters	Size	Detail	Remarks
Start	4	Position of first measurement data to send	SE2L has a total of 1081 steps (numbered from 0 to 1080). Value should not exceed this range.
End	4	Position of the last measurement data to send	
Grouping	2	Number of adjacent steps among which SE2L is requested to send only the minimum measurement value	Grouping parameter 0 is treated as 1.

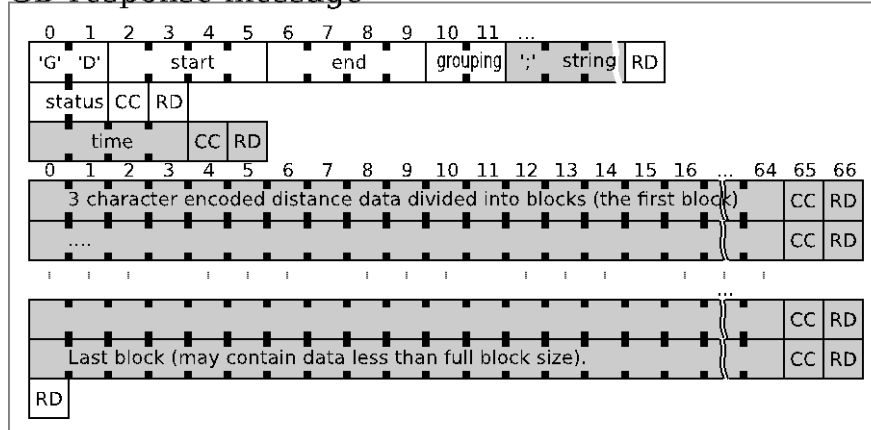
**Table 8.7.2.2 Details of Status Code**

Code	Detail
00	No error
01	Start parameter contains non numeric character
02	End parameter contains non numeric character
03	Grouping parameter contains non numeric character
04	End parameter exceeds the measurement step
05	End parameter is smaller than start parameter
06	Skips parameter contains non numeric character

#### GD request message



#### GD response message



**Figure 8.7.2.1: GD command Request and Response**

0	1	2	3	4	5	6	7	8	9	10	11	...			
'G'	'E'			start				end		grouping	','	string			RT

Diagram illustrating the structure of a compressed data block. The block is divided into several sections:

- Header Section (0-11):** Contains metadata fields: 'G', 'E', 'start', 'end', 'grouping', and 'string'. The 'start' field is split across indices 2, 3, and 4. The 'end' field is split across indices 7, 8, and 9. The 'grouping' field is split across indices 10 and 11. The 'string' field is split across indices 12 and 13. The 'RD' field is at index 14.
- Status Section (12-15):** Contains 'status', 'CC', and 'RD' fields. 'status' is at index 12, 'CC' is at index 13, and 'RD' is at index 14.
- Time Section (16-19):** Contains 'time', 'CC', and 'RD' fields. 'time' is at index 16, 'CC' is at index 17, and 'RD' is at index 18.
- Main Data Section (20-66):** Contains '3 character encoded distance and intensity data divided into blocks'. This section is further divided into blocks of 3 character encoded distance and intensity data. The last block may contain data less than the full block size. The 'RD' field is at index 66.

### Figure 8.7.2.2: GE command Request and Response

### 8.7.3 Measurement Data (MD and ME Command)

When SE2L receives this command, it replies with measurement data. There are 2 variations of this command. MD Command provides the distance only and ME command provides both the distance and intensity. Parameters in the request message are listed in Table 8.7.3.1. SE2L's response depends on these parameters. Measurement data in the response message are encoded to 3 ASCII characters with B Protocol encoding technique (refer to section 8.2). Further, the data is also split into number of blocks during transmission (refer to section 8.5). Format of request and response message are respectively shown in Figure 8.7.3.1, and 8.7.3.2.

If parameters are not received in the correct format, SE2L will send the reply with error status (refer to Table 8.7.3.2). Refer to section 8.1 for details on terminology used in the message.

**Important: Before acquiring sensing data using MD, ME command, send the VV command to check the serial number for verifying the connection with an intended SE2L.**

**Table 8.7.3.1 Parameters of MD and ME request message**

Parameters	Size	Detail	Remarks
Start	4	Position of first measurement data to send	SE2L has a total of 1081 steps (numbered from 0 to 1080). Value should not exceed this range.
End	4	Position of the last measurement data to send	
Grouping	2	Number of adjacent steps among which SE2L is requested to send only the minimum measurement value	Grouping parameter 0 is treated as 1.
Skips	1	Interval to send the data	SE2L skips sending the data for number of cycles provided in this field when it is in continuous transmission mode. One measurement cycle of SE2L is 29 ~ 30ms.
Scans	2	Number of scan cycles SE2L is requested to provide the data continuously	In the echo back from SE2L, original value in this field is replaced by number of remaining scans. If the parameter is set to "00", SE2L will continue to send the data until it is stopped by sending stop commands. Status in the response message in such case will be "99". Continuous transmission will stop if connection between host computer and SE2L is lost.

**Table 8.7.3.2 Details of Status Code**

Code	Detail
00	No error
01	Start parameter contains non numeric character
02	End parameter contains non numeric character
03	Grouping parameter contains non numeric character
04	End parameter exceeds the measurement step
05	End parameter is smaller than start parameter
06	Skips parameter contains non numeric character
07	Scan parameter contains non numeric character

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...
'M'	'D'			start				end		grouping	skips	scans	';	string	RT

[illegible]

The diagram illustrates the structure of a compressed data block, showing the layout of various fields and their sizes. The fields are arranged in a sequence, with their sizes indicated by the number of bits or bytes they occupy.

**Fields and their sizes:**

- 'M' 'D' start end grouping skips pending scans string RD**: This row contains fields with sizes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ..., 64, 65, 66. The fields are: 'M' (0), 'D' (1), start (2), end (3), grouping (4), skips (5), pending (6), scans (7), string (8), RD (9), RD (10), RD (11), RD (12), RD (13), RD (14), RD (...), RD (64), RD (65), RD (66).
- status CC RD**: This row contains fields with sizes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ..., 64, 65, 66. The fields are: status (0), CC (1), RD (2), RD (3), RD (4), RD (5), RD (6), RD (7), RD (8), RD (9), RD (10), RD (11), RD (12), RD (13), RD (14), RD (...), RD (64), RD (65), RD (66).
- time CC RD**: This row contains fields with sizes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ..., 64, 65, 66. The fields are: time (0), CC (1), RD (2), RD (3), RD (4), RD (5), RD (6), RD (7), RD (8), RD (9), RD (10), RD (11), RD (12), RD (13), RD (14), RD (...), RD (64), RD (65), RD (66).
- 3 character encoded distance data divided into blocks.**: This row contains fields with sizes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ..., 64, 65, 66. The fields are: 3 character encoded distance data divided into blocks. (0), RD (1), RD (2), RD (3), RD (4), RD (5), RD (6), RD (7), RD (8), RD (9), RD (10), RD (11), RD (12), RD (13), RD (14), RD (...), RD (64), RD (65), RD (66).
- Last block (may contain data less than full block size).**: This row contains fields with sizes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ..., 64, 65, 66. The fields are: Last block (may contain data less than full block size.) (0), RD (1), RD (2), RD (3), RD (4), RD (5), RD (6), RD (7), RD (8), RD (9), RD (10), RD (11), RD (12), RD (13), RD (14), RD (...), RD (64), RD (65), RD (66).
- RD**: This row contains fields with sizes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ..., 64, 65, 66. The fields are: RD (0), RD (1), RD (2), RD (3), RD (4), RD (5), RD (6), RD (7), RD (8), RD (9), RD (10), RD (11), RD (12), RD (13), RD (14), RD (...), RD (64), RD (65), RD (66).

### Figure 8.7.3.1: MD command Request and Response

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...
'M'	'E'			start				end		grouping	skips	scans	';	string	RT

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 ...  
 'M' 'E' start end grouping skips scans ';' string RD  
 status CC RD  
 RD

### ML scan response message

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...							
'M'		'E'		start					end		grouping		skips		pending scans		';'		string		RD	
status		CC		RD																		
time		CC		RD																		

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	...	64	65	66	
3 character encoded distance and intensity data divided into blocks.																		CC		RD	
																		CC		RD	
																		CC		RD	

																		CC		RD	
Last block (may contain data less than the full block size).																		CC		RD	

RD	
----	--

**Figure 8.7.3.2: ME command Request and Response**

### 8.7.4 Continuous Transmission Terminate (QT, RS and RT Command)

These commands stop the continuous transmission mode initiated by MD or ME command. Request message has no command specific parameter and response does not contain any data. Format of request and response message are respectively shown in Figure 8.7.4.1, 8.7.4.2 and 8.7.4.3 for QT, RS and RT commands.

Table 8.7.4.1 Details of Status Code

Code	Detail
00	No error. SE2L stops the continuous data transmission

#### QT request message



#### QT response message



Figure 8.7.4.1: QT command Request and Response

#### RS request message



#### RS response message



Figure 8.7.4.2: RS command Request and Response

#### RT request message



#### RT response message



Figure 8.7.4.3: RT command Request and Response

### 8.7.5 Sensor Information (VV, PP and II Commands)

When SE2L receives this command, it replies with sensor information. Request messages have no command specific parameter. Response message contains number of fields separated by a semicolon. Therefore, they should not be treated as a check code. Request and response messages are respectively shown in Figure 8.7.5.1, Figure 8.7.5.2 and Figure 8.7.5.3 for VV, PP and II commands. Information included in response of each command is shown in Table 8.7.5.2, Table 8.7.5.3 and Table 8.7.5.4.

**Table 8.7.5.1 Details of Status Code**

Code	Detail
00	No error.

**Table 8.7.5.2 Information in VV Command**

Description	String Sample
Vendor information	VEND:IDEC Corporation
Product model	PROD:SE2L-H05LP
Firmware version	FIRM:02.00.00o
B protocol version	PROT:S 2.0 for Safety
Product serial number	SERI:H0123456

**Table 8.7.5.3 Information in PP Command**

Description	String Sample
Product model	MODL:SE2L-H05LP
Minimum measurable distance (mm)	DMIN:0000
Maximum measurable distance (mm)	DMAX:40000
Angular resolution (Number of divisions in 360°)	ARES:1440
First measurement step	AMIN:0000
Last measurement step	AMAX:1080
Front measurement step	AFRT:0540
Standard scanning speed (rpm)	SCAN:2000

**Table 8.7.5.4 Information in II Command**

Description	String Sample
Product model	MODL:SE2L-H05LP
Laser status	LASR:ON
Scanning speed	SCSP: 2000[rpm]<-Fixed
Sensing mode	MESM: Measuring by Sensitive Mode
Communication speed	SBPS: Ethernet 100[Mbps]<- Fixed
Time	TIME:012345
Device status	STAT: Sensor works well.

## VV request message



## VV response message

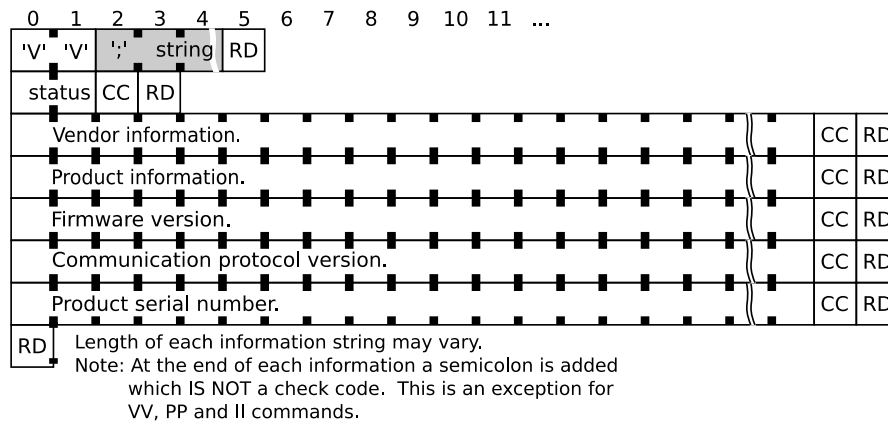
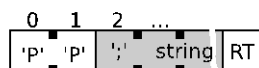


Figure 8.7.5.1: VV command Request and Response

## PP request message



## PP response message

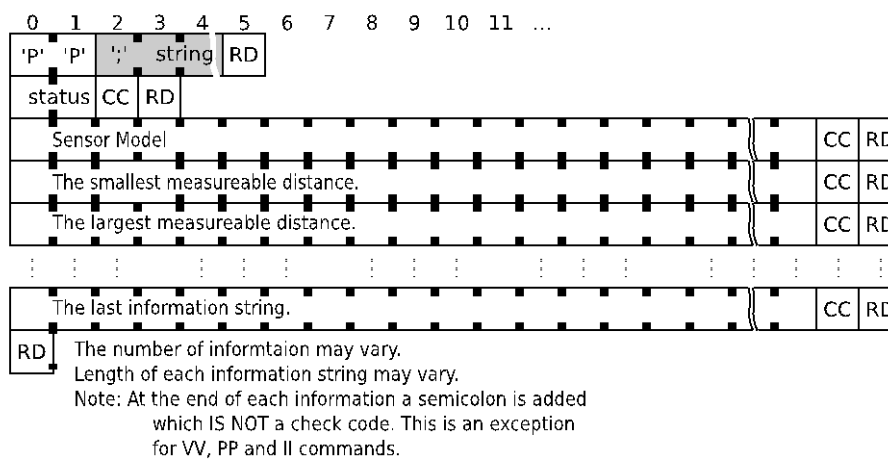


Figure 8.7.5.2: PP command Request and Response

II request message



II response message

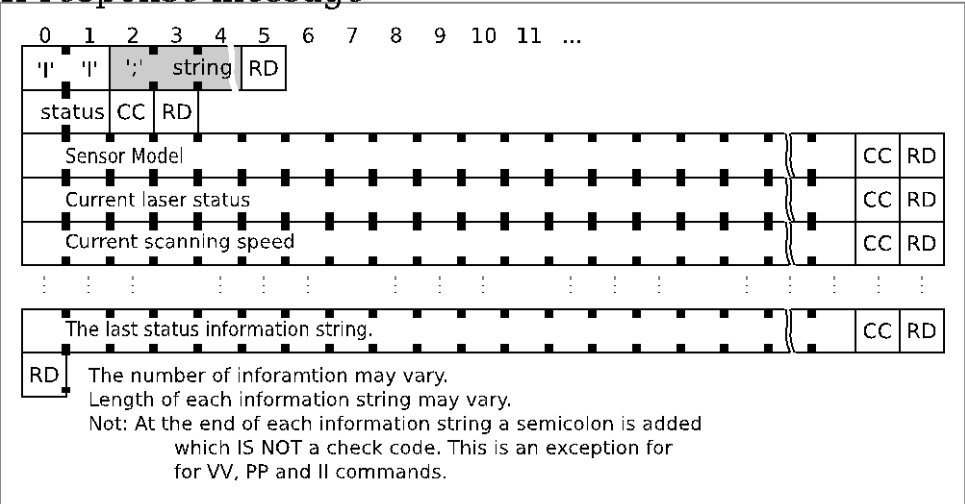


Figure 8.7.5.3: II command Request and Response