Communication Protocol Specification
UAM-05LPA



HOKUYO AUTOMATIC CO.,LTD.

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1. Introduction

This document describes the communication protocol specification for the safety laser scanner, UAM-05LPA (henceforth UAM).

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

This specification is compatible with firmware version 1.0.0.

Notes:

- 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 UAM before programming the communication software.

Danger!

- Sending commands other than those specified in this document can permanently damage the UAM.
- Sending commands other than those specified in this document can lead to unintended performance of UAM causing critical injury or death.
- Sending commands in sequence other than those specified in this document can lead to unintended performance of UAM 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 UAM or the controlled device.
- Do not perform Ethernet and USB communication simultaneously. If Ethernet is connected, stop the Ethernet transmission when configuring the UAM with USB device or SD card.
- As a measure to avoid the effect of electric noise, UAM resets the Ethernet PHY every 10 seconds when it is not connected to the host. Connection fails to establish during the reset process. Therefore, try to connect multiple times with the sufficient timeout when connecting with the UAM.
- When UAM detects error, it saves the information in the ROM. During this period communication may stop briefly.

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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 » UAM

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

Reply

Host « UAM

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

*Some of the replies may not contain this field.

Command:

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

Status:

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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 UAM. For encoding, the data should be first divided into 4 bits, and then depending on its value, either 30_h or 37_h is added to convert into ASCII characters (Figure 4.1). Values received from UAM 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_h or 37_h is subtracted and merged to generate the original value.

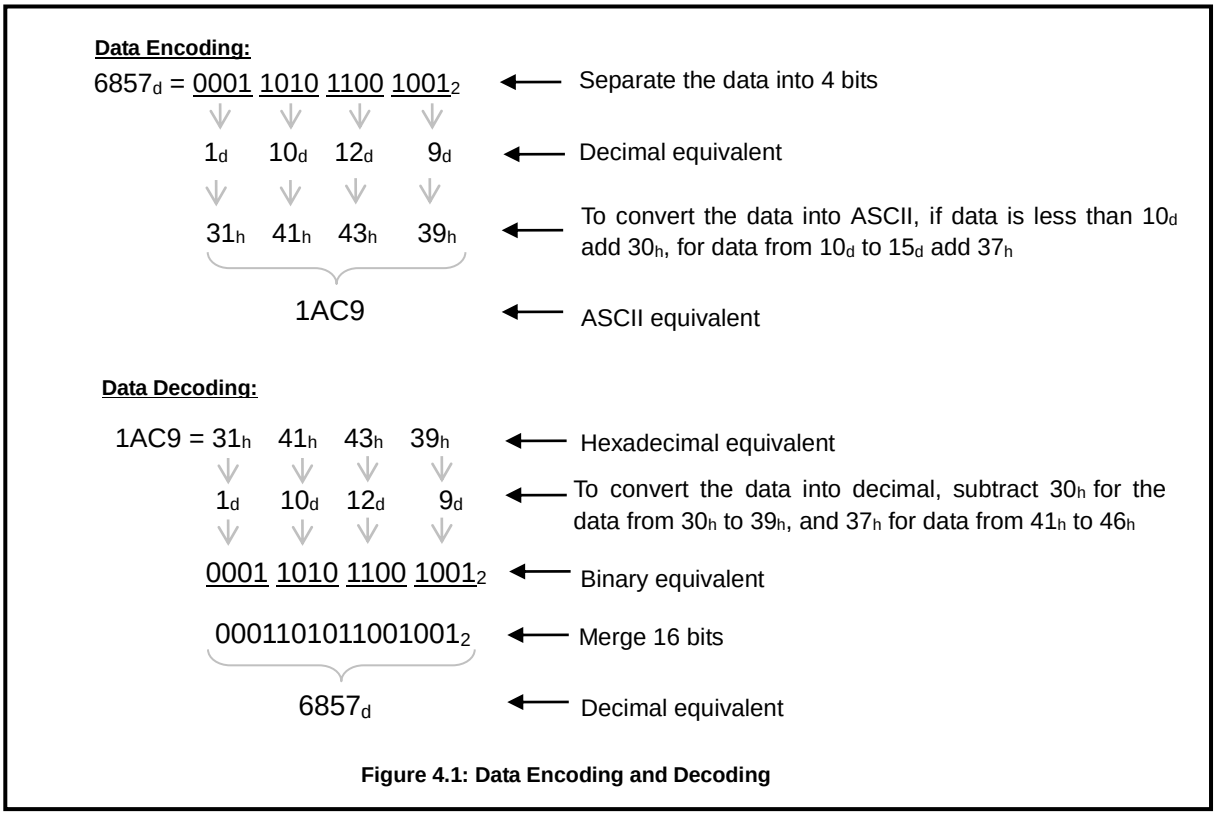


Figure 4.1: Data Encoding and Decoding

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 UAM receives data from the host computer, it recalculates the CRC and compares it with the CRC value in the command. UAM 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 $\mathbf{X^{16} + X^{12} + X^5 + 1}$. CRC value is encoded into 4 ASCII

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characters (see section 4) before the transmission. STX and ETX are not included when calculating the CRC value.

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

UAM performs communication routine once in every sensing cycle (one sensing cycle of UAM is 29 to 30ms) and sends the reply of the command received during this period. Therefore, if command is not received completely in once cycle, it will take another cycle to send the reply. Further, the 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 the reply is not received from UAM. Avoid continuously sending commands to UAM without waiting for the reply. It will affect the performance and becomes a cause of error.

Some of the commands can set UAM to supply the measurement data continuously. When UAM 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 UAM.

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, AR04 and AR07 (refer to sections 6.2.3, 6.2.4, 6.2.8) 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 suspended when the device is in setting mode.

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6.1 Version Details (VR Command)

When UAM 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 UAM.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"VR"	2	0x56, 0x52	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"VR"	2	0x56, 0x52	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
Sensor Model Number*1	29	ASCII Char	Sensor model number
Separator	1	0x2C	Comma (,)
Firmware Version*1	29	ASCII Char	Firmware version
Separator	1	0x2C	Comma (,)
Reserved	29	ASCII Char	Reserved
Separator	1	0x2C	Comma (,)
Reserved	2	0x00 ~ 0xFF	Reserved
Separator	1	0x2C	Comma (,)
Reserved	4	ASCII Char	Hokuyo Model
Separator	1	0x2C	Comma (,)
Serial Number*1	16	ASCII Char	Serial number of the device
Separator	1	0x2C	Comma (,)
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	131		

*1: If the information is less than 29 char, it is filled with ASCII code for space (0x20).

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6.2 Sensing Data (AR Commands)

There are 9 variations of this command differentiated by sub-header. Function of commands will vary depending on it (Table 6.2.1). When UAM receives this command, it replies with its sensing and measurement data. After sending a command to acquire data in the 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 UAM even in the continuous mode.

UAM will supply the data at every 30ms (approx.) in continuous transmission mode. Even if UAM 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 UAM.

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”
“AR06”	Acquire sensing data with high resolution measured distance
“AR07”	Acquire sensing data with high resolution measured distance in continuous mode
“AR08”	Stop continuous mode initiated by “AR07”

6.2.1 AR00 Command

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

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
Operating Mode	1	0x0	Normal operation mode
		0x1	Setting mode
Area Number	2	0x00 ~ 0x7F	Operating area number from 1 to 128

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Error Status	1	0x0	No error
		0x1	Error is detected. Note: Use this information with Last Error Number to show the error status.
Last Error Number	2	0x00 ~ 0xBF	Use this information with Error Status to show the error number. Offset the number by 0x40 to match with 7-seg display of the device.
Lockout Status	1	0x0	Device is not in lockout state
		0x1	Device is in lockout state
OSSD1/1 Status	1	0x0	Off: No detection
		0x1	On: Detection
OSSD1/2 Status	1	0x0	Off: No detection
		0x1	On: Detection
Warning1 Status	1	0x0	Off: No detection or Warning1 not used
		0x1	On: Detection
Warning2 Status	1	0x0	Off: No detection or Warning2 not used
		0x1	On: Detection
OSSD2/1 Status	1	0x0	Off: No detection or Protection2 not used
		0x1	On: Detection
OSSD2/2 Status	1	0x0	Off: No detection or Protection2 not used
		0x1	On: Detection
Reserved	2	0x00	Reserved
Muting/Override State Protection Zone1	1	0x0	Not active or not used
		0x1	Active
Muting/Override State Protection Zone2	1	0x0	Not active or not used
		0x1	Active
Reset Request Protection Zone1	1	0x0	Not active or not used
		0x1	Active
Reset Request Protection Zone2	1	0x0	Not active or not used
		0x1	Active
Encoder Velocity	4	0x000 ~ 0xFFFF	Encoder velocity Note: Always 0 if encoder function is not used
Timestamp	8	0x00000000 ~ 0xxFFFFFFFF	Message timestamp
Laser off Status	1	0x0	Not active or not used
		0x1	Active
Contamination Warning	1	0x0	No Warning
		0x1	Warning (When the device detects objects near the optical window in the predefined warning range (number of steps) or contamination sensors detects the optical window contamination in the predefined warning range (signal level)).
Encoder Input Pattern Number	1	0x0 ~ 0x7	Operating input pattern number. Always 0 when encoder function is not used.
Encoder Angle Velocity	4	0x0000 ~ 0xFFFF	Encoder angle velocity Always 0 when angular velocity function is not used.
Reserved	1	0x0	-
Protection Zone1 Detection Start Step	4	0x0000 ~ 0x0870	First step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Protection Zone1 Detection End Step	4	0x0000 ~ 0x0870	Last step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected

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Protection Zone2 Detection Start Step	4	0x0000 ~ 0x0870	First step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Protection Zone2 Detection End Step	4	0x0000 ~ 0x0870	Last step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Warning Zone1 Detection Start Step	4	0x0000 ~ 0x0870	First step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Warning Zone1 Detection End Step	4	0x0000 ~ 0x0870	Last step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Warning Zone2 Detection Start Step	4	0x0000 ~ 0x0870	First step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Warning Zone2 Detection End Step	4	0x0000 ~ 0x0870	Last step number where the obstacle is detected (0 to 1081)
		0xFFFF	No obstacle is detected
Distance Data	4324	0x0000 ~ 0xFFFF	Distance data of 1081 steps
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	4411		

6.2.2 AR01 Command

When UAM receives this command, it provides sensing data with measured distance and intensity.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"01"	2	0x30, 0x31	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"01"	2	0x30, 0x31	Command sub header
Same as AR00 Command	4397	Same as AR00 command	
Intensity Data	4324	0x0000 ~ 0xFFFF	Intensity level of 1081 steps
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	8735		

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6.2.3 AR02 Command

When UAM 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 » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"02"	2	0x30, 0x32	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

The first response of UAM is shown below. It contains only the status without any data.

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"02"	2	0x30, 0x32	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Thereafter, UAM provides the same reply as in “AR00 command” (refer to section 6.2.1) at every cycle until it is stopped by sending the AR03 command (refer to section 6.2.4).

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"01"	2	0x30, 0x31	Command sub header
Same as AR00 Command	4397	Same as AR00 command	
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	4411		

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6.2.4 AR03 Command

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

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"03"	2	0x30, 0x33	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"03"	2	0x30, 0x33	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	16		

6.2.5 AR04 Command

When UAM 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 » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"04"	2	0x30, 0x34	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

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Host « UAM

The first response of UAM is shown below. It contains only the status without any data.

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"04"	2	0x30, 0x32	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Thereafter, UAM provides the same reply as in “AR01 command” (refer to section 6.2.2) at every cycle until it is stopped by sending the AR05 command (refer to section 6.2.6).

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"04"	2	0x30, 0x31	Command sub header
Same as AR01 Command	4397	Same as AR01 command	
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	4411		

6.2.6 AR05 Command

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

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"05"	2	0x30, 0x35	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"03"	2	0x30, 0x35	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	16		

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6.2.7 AR06 Command

When UAM receives this command, it provides sensing data with high resolution measured distance.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"06"	2	0x30, 0x36	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"06"	2	0x30, 0x36	Command sub header
Same as AR00 Command	73	Same as AR00 command	
Distance Data	8644	0x0000 ~ 0xFFFF	Distance of 2161 steps
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	8731		

6.2.8 AR07 Command

When UAM receives this command, it provides sensing data with high definition measured distance in continuous mode. Data is supplied at every 30ms (approx.) after completing the scan. Send “AR08 Command” (refer to section 6.2.6) to stop the continuous data output.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"07"	2	0x30, 0x36	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

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Host « UAM

The first response of UAM is shown below. It contains only the status without any data.

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"07"	2	0x30, 0x32	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Thereafter, UAM provides the same reply as in “AR06 command” (refer to section 6.2.7) at every cycle until it is stopped by sending the AR08 command (refer to section 6.2.9).

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"07"	2	0x30, 0x36	Command sub header
Same as AR06 Command	8717	Same as AR06 command	
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	8731		

6.2.9 AR08 Command

UAM stops the continuous data output initiated by “AR07 Command” (refer to section 6.2.5) on receiving this command.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"08"	2	0x30, 0x38	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"AR"	2	0x41, 0x52	Command header
"08"	2	0x30, 0x35	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	16		

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6.3 Status Data (XR Command)

When UAM receives this command, it provides the status data.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"XR"	2	0x58, 0x52	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"XR"	2	0x58, 0x52	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
Operating Mode	1	0x0	Normal operation mode
		0x1	Setting mode
Area Number	2	0x00 ~ 0x7F	Operating area number from 1 to 128
Error Status	1	0x0	No error
		0x1	Error is detected. Note: Use this information with Last Error Number to show the error status.
Last Error Number	2	0x00 ~ 0xBF	Use this information with Error Status to show the error number. Offset the number by 0x40 to match with 7-seg display of the device.
Lockout Status	1	0x0	Device is not in lockout state
		0x1	Device is in lockout state
OSSD1/1 Status	1	0x0	Off: No detection
		0x1	On: Detection
OSSD1/2 Status	1	0x0	Off: No detection
		0x1	On: Detection
Warning1 Status	1	0x0	Off: No detection or Warning1 not used
		0x1	On: Detection
Warning2 Status	1	0x0	Off: No detection or Warning2 not used
		0x1	On: Detection
OSSD2/1 Status	1	0x0	Off: No detection or Protection2 not used
		0x1	On: Detection
OSSD2/2 Status	1	0x0	Off: No detection or Protection2 not used
		0x1	On: Detection
Reserved	2	0x00	Reserved
Muting/Override State Protection Zone1	1	0x0	Not active or not used
		0x1	Active
Muting/Override State Protection Zone2	1	0x0	Not active or not used
		0x1	Active
Reset Request Protection Zone1	1	0x0	Not active or not used
		0x1	Active
Reset Request Protection Zone2	1	0x0	Not active or not used

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		0x1	Active
Encoder Velocity	4	0x000 ~ 0xFFFF	Encoder velocity Note: Always 0 if encoder function is not used
Laser Off Status	1	0x0	Not active or not used
		0x1	Active
Slave OSSD1 and 2 Status (3 Slaves)	3	0x0	Off: No detection or device is slave unit
		0x1	On: Detection
Slave OSSD3 and 4 Status (3 Slaves)	3	0x0	Off: No detection or Protection2 not used or device is slave unit
		0x1	On: Detection
Slave Warning1 Status (3 Slaves)	3	0x0	Off: No detection or Warning1 not used or device is slave unit
		0x1	On: Detection
Slave Warning2 Status (3 Slaves)	3	0x0	Off: No detection or Warning2 not used or device is slave unit
		0x1	On: Detection
Slave Error Status (3 Slaves)	3	0x0	No error
		0x1	Error is detected. Note: Use this information with Last Error Number to show the error status.
Slave Laser Off Status (3 Slaves)	3	0x0	Not active or not used
		0x1	Active
Timestamp	8	0x00000000 ~ 0xxFFFFFFFF	Message timestamp
Contamination Warning	1	0x0	No Warning
		0x1	Warning (When the device detects objects near the optical window or contamination sensors detect the optical window contamination).
Encoder Input Pattern Number	1	0x0 ~ 0x7	Operating input pattern number. Always 0 when encoder function is not used.
Encoder Angle Velocity	4	0x0000 ~ 0xFFFF	Encoder angle velocity Always 0 when angular velocity function is not used.
Reserved	34	0x0	-
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	106		

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6.4 Area Data (YR Command)

When UAM receives this command, it provides the area configuration data.. Status codes for YR command are shown in Table 7.2.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"YR"	2	0x59, 0x52	Command header
Area Type*1	2	0x00	Protection1 area
		0x01	Protection2 area
		0x02	Warning1 area
		0x03	Warning2 area
		0x04	Muting1 area
		0x05	Muting2 area
		0x06	Reference area
		0x07	Reference area- minimum
		0x08	Reference area- maximum
Area Number+2	2	0x00 ~ 0x7F	Area1 to 128
Area Start Step	4	0x0000 ~ 0x439	Step number of first data requested (0 ~ 1080)
Area End Step	4	0x0000 ~ 0x439	Step number of last data requested (0 ~ 1080)
Resolution	2	0x00 ~ 0x09	Number of steps to be combined to reduce the data. For example, if data is requested from step 0 to 9 with resolution 2, two consecutive steps are compared and the data with higher value is selected resulting in only 5 data from the total 10 data which is then sent in the reply message.
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	26		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"YR"	2	0x59, 0x52	Command header
Same as in Command	14	Same as in Command	
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
Area Data	n	0x0000 ~ 0xFFFF	Area data of the requested steps. Note: 1: n = ((End Step – Start Step) / Resolution) x 4 2: 1 extra data is supplied if n is not a whole number.
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	5 + n		

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6.5 Detection Log Command

When UAM 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, UAM 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 slave's 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 UAM receives this command, it provides detection log data. UAM 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 is 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*1	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 is the old logs (Figure 6.5.1.1). 2. Bit 0 is always 0 when UAM 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 high resolution (0.125°/step) step number (0 to 2160). Divide the number by 2 to match with lower resolution (0.25°/step) step number (0 to 1080).
Protection2 Min dist	0 ~ FFFF	Minimum distance measured inside the protection zone2 Note: Always 0 when UAM 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 high resolution (0.125°/step) step number (0 to 2160). Divide the number by 2 to match with lower resolution (0.25°/step) step number (0 to 1080). 2. Always 0 when UAM is operating without protection zone2.
Slave1 Input/Output	0 ~ FFFF	If UAM is operating in Master-Slave mode and connected unit is Master, this is an input and output states of Slave unit 1. Note:

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		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 UAM 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 UAM 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 salve 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 second. For example, if the vale is 0000007A, then the log was recorded 122 seconds ago.
Reserved	0 ~ FFFF	Note: Ignore the data.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"DL"	2	0x45, 0x4C	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"DL"	2	0x45, 0x4C	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
Detection Log*1	1920	See details below	30 object detection log data
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	1936		

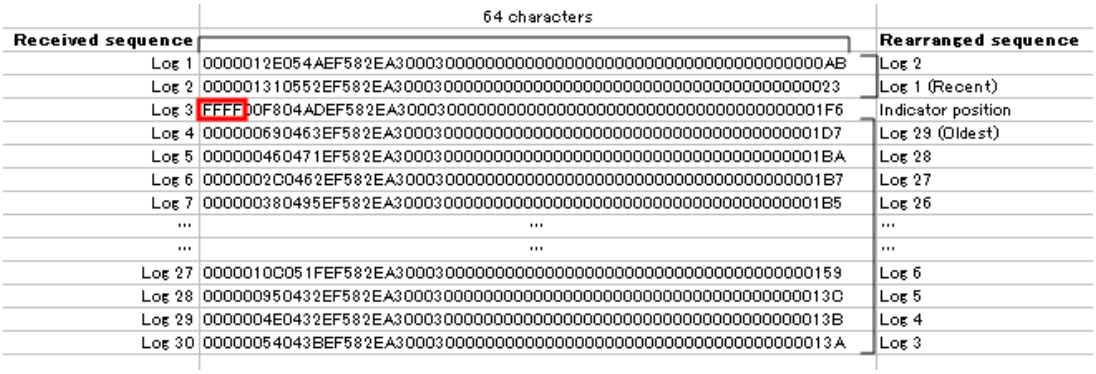
*1: Log details:

	Input /Output* 4 char	Protection1 Min dist. 4 char	Protection1 Min dist step 4 char	Protection2 Min dist 4 char	Protection2 Min dist step 4 char
Log1 ~ 30	Slave1 Input /Output* 4 char	Reserved 4 char	Reserved 4 char		
	Slave2 Input /Output* 4 char	Reserved 4 char	Reserved 4 char		
	Slave3 Input /Output* 4 char	Reserved 4 char	Reserved 4 char	Log lapsed time 8 char	

*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

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	64 characters	
Received sequence		**Rearranged sequence**
Log 1	0000012E054AEF582EA3000300000000000000000000000000000000000000000AB	Log 2
Log 2	000001310552EF582EA30003000000000000000000000000000000000000000023	Log 1 (Recent)
Log 3	FFFF00F804ADEF582EA3000300000000000000000000000000000000000000001F6	Indicator position
Log 4	000000690463EF582EA3000300000000000000000000000000000000000000001D7	Log 29 (Oldest)
Log 5	000000460471EF582EA3000300000000000000000000000000000000000000001BA	Log 28
Log 6	0000002C0462EF582EA3000300000000000000000000000000000000000000001B7	Log 27
Log 7	000000380495EF582EA3000300000000000000000000000000000000000000001B5	Log 26
...	...	...
...	...	...
Log 27	0000010C051FEF582EA30003000000000000000000000000000000000000000000159	Log 6
Log 28	000000950432EF582EA3000300000000000000000000000000000000000000000013C	Log 5
Log 29	0000004E0432EF582EA3000300000000000000000000000000000000000000000013B	Log 4
Log 30	00000054043BEF582EA3000300000000000000000000000000000000000000000013A	Log 3

Figure 6.5.1.1: Example of log data received form UAM

6.5.2 Detection Log Clear (DC00 Command)

When UAM receives this command, it clears detection log data stored in its RAM. Since the data are stored in the RAM, they are automatically erased whenever the device is switched off.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"DC"	2	0x44, 0x43	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"DC"	2	0x44, 0x43	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	16		

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6.6 Configuration ID (ID Command)

This is a command to read the 32-bit configuration ID of the setting data stored in the device. It is calculated and saved in the device during the device configuration. The value will be 0 if the device is not configured or the settings are initialized.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"ID"	2	0x49, 0x44	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"ID"	2	0x49, 0x44	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error
		0x01 ~ 0xFF	Error
Configuration ID1	8	0x00000000	Device not configured
		0x000000001 ~ 0xFFFFFFFF	32-bit CRC of configuration data with configured date and IP address.
Configuration ID2	8	0x00000000	Device not configured
		0x000000001 ~ 0xFFFFFFFF	32-bit CRC of configuration data without configured date and IP address.
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	32		

6.7 Reboot Device (SB Command)

This is a command to reboot the device. This command is accepted only when the device is in error state. There must be 2 consecutive RB command within 1sec for the device to reboot. The sensor will restart after approximately 1 sec on receiving the second command.

Host » UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"SB"	2	0x53, 0x42	Command header
"00"	2	0x30, 0x30	Command sub header
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	14		

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Host « UAM

Content	Size	Value	Detail
STX	1	0x02	Start of text
Length	4	0x0000 ~ 0xFFFF	Total number of characters in the message
"SB"	2	0x53, 0x42	Command header
"00"	2	0x30, 0x30	Command sub header
Status	2	0x00	No error (Second SB command received successfully)
		0x01	No error (First SB command received successfully).
		0x02 ~ 0xFF	Error
CRC	4	0x0000 ~ 0xFFFF	CRC of the message excluding STX and ETX
ETX	1	0x03	End of text
Total Size	16		

Note: It takes approx. 30s for the device to resume normal operation after reboot.

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7. Reply Status

UAM validates the received command by conducting number of checks. If they are successful UAM replies with the corresponding data with the status code “00”. On the other hand, it will reply with error status if verification fails. Details of status codes are shown in table 7.1.

Table 7.1 Detail of Status Code

Status	Detail
0x00	No Error
0x12	Received command does not contain the minimum required fields or received data size exceeds the maximum size of internal buffer.
0x31	Command is received without STX
0x34	Command header contains unspecified characters
0x35	Data contains unspecified characters
0x36	Data size is not equal to the size mentioned in the command
0x37	CRC of received data is not equal to CRC in the command
0x41, 0x42	Unspecified command is received
0x44	Sub header is out-of-range
0x45	Sub header is not a number
0x66,	Configuration of UAM is incomplete
0x73	Unable to process commands (AR02 and AR04) as the device is in setting mode (Continuous data output mode can not be started when the device is in setting mode).
Others	Internal error (See table 7.2 if the transmitted command is status command YR)

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.

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8. SCIP Mode Communication

UAM also supports commands of Sensor Communication Interface Protocol (SCIP). List of supported SCIP commands is shown in Table 8.1.

Table 8.1 SCIP Commands Supported by UAM

Command	Function
BM*	Switch on the laser for measurement.
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 UAM
PP	Acquire parameters of UAM
II	Acquire state of UAM
RB	Reboots UAM

*: Laser is always emitted in UAM therefore, it is not necessary to send the “BM Command” to switch-on the laser before starting the measurement. It is supported for maintaining the compatibility with the SCIP protocol and SCIP library.

For more details on SCIP commands refer to SCIP specification.

8.1 SCIP Format

8.1.1 Request Message

Request Message is sent from the host computer to UAM. 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. UAM 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 UAM.

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

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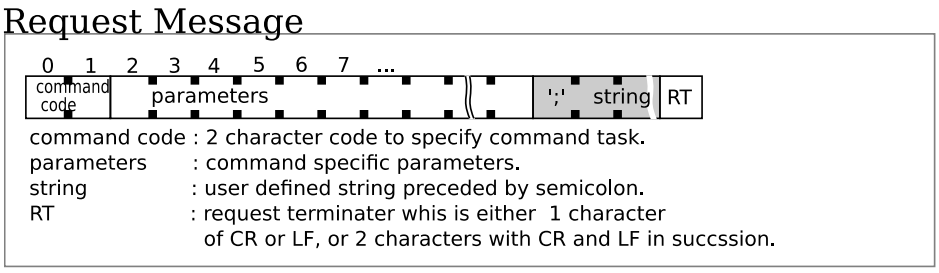


Figure 8.1.1.1: SCIP Request Message Format

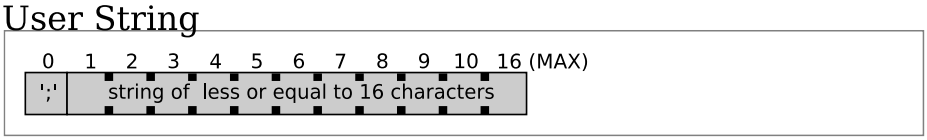


Figure 8.1.1.2: User String format

8.1.2 Response Message

Response Message is sent from UAM 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 UAM 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 UAM'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 UAM 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 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.

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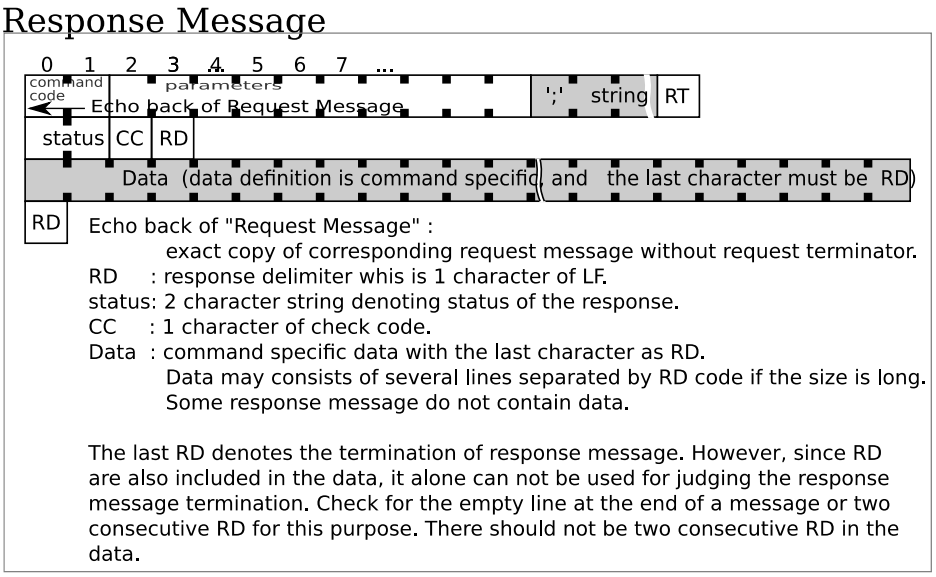


Figure 8.1.2.1: Response Message Format

8.1.3 Scan Response Message

Apart from general response format (refer to section 8.1.2), UAM 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 sate of UAM.

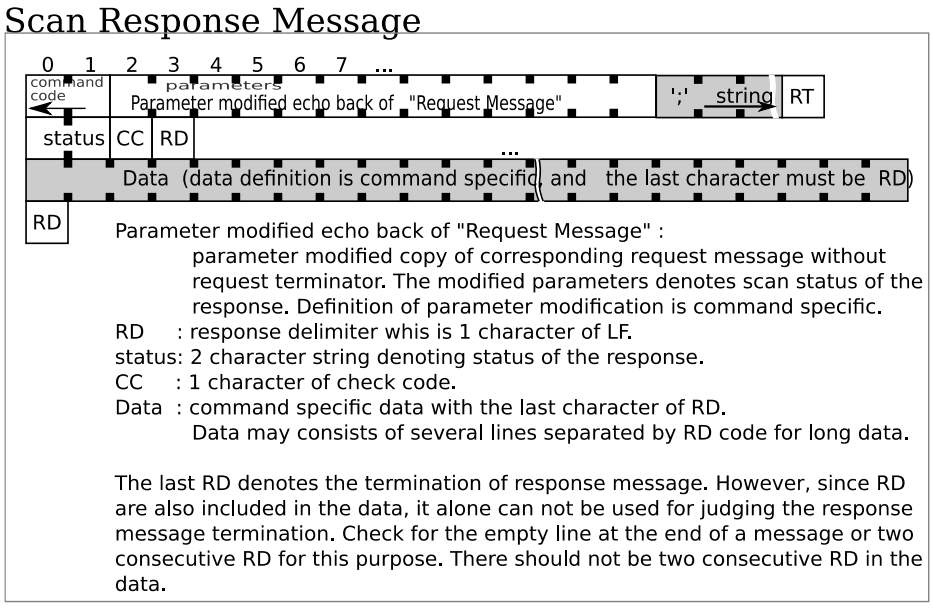


Figure 8.1.3.1: Scan Response Message Format

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8.2 SCIP Encoding and Decoding

SCIP 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 SCIP 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.

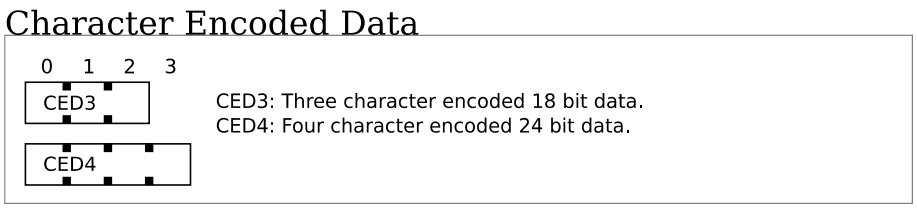


Figure 8.2.1: Representation of Encoded Data

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 SCIP 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 SCIP 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'

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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 SCIP 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).

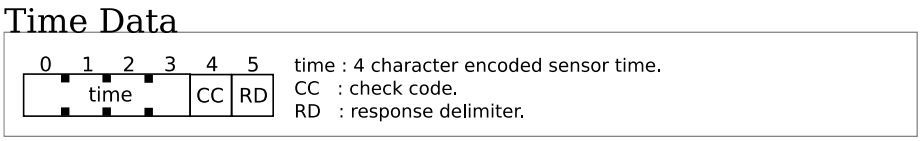


Figure 8.4.1: Representation of Timestamp

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.

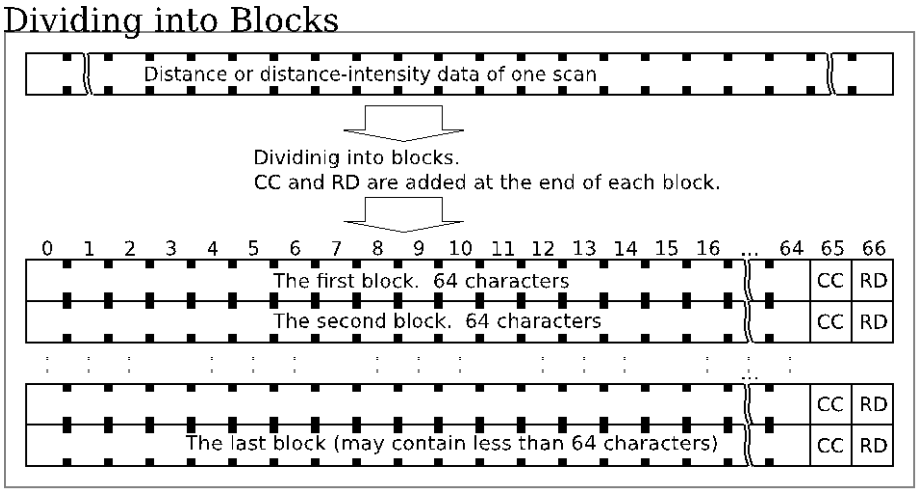


Figure 8.5.1: Separation of Measurement Data into Blocks

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8.6 Common SCIP 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 SCIP 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	UAM is in lockout state due to error

8.7 SCIP Commands

8.7.1 BM Command

In SCIP specification, it is required to send BM command to switch-on the laser to start the measurement before sending the GD or GE command. However, in UAM laser is always on therefore, sending this command is unnecessary. This command is supported to maintain the compatibility with the SCIP protocol and the SCIP library.

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



Figure 8.7.1.1: BM command Request and Response

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8.7.2 Measurement Data (GD and GE Command)

When UAM 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. UAM's response depends on these parameters. Measurement data in the response message are encoded to 3 ASCII characters with SCIP 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, UAM 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 UAM.

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	UAM 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 UAM 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

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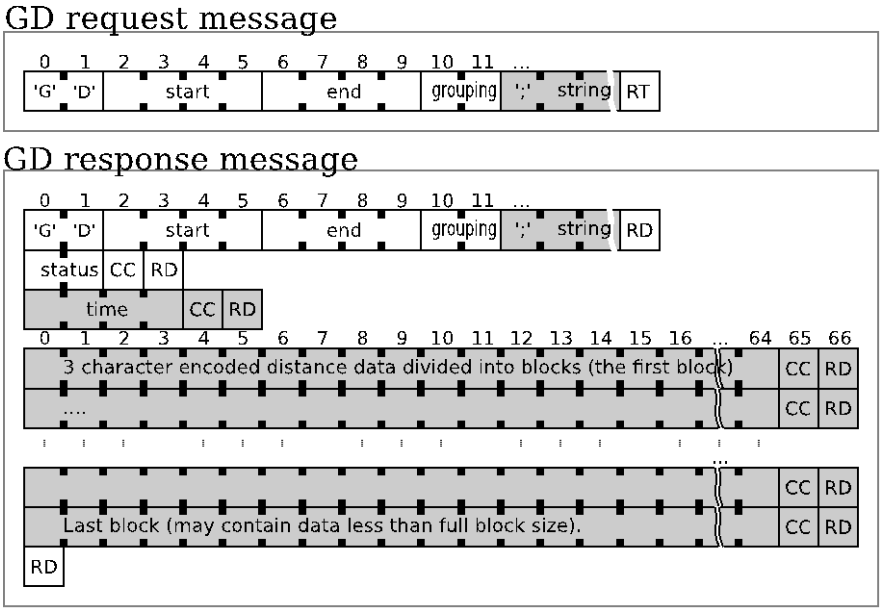


Figure 8.7.2.1: GD command Request and Response

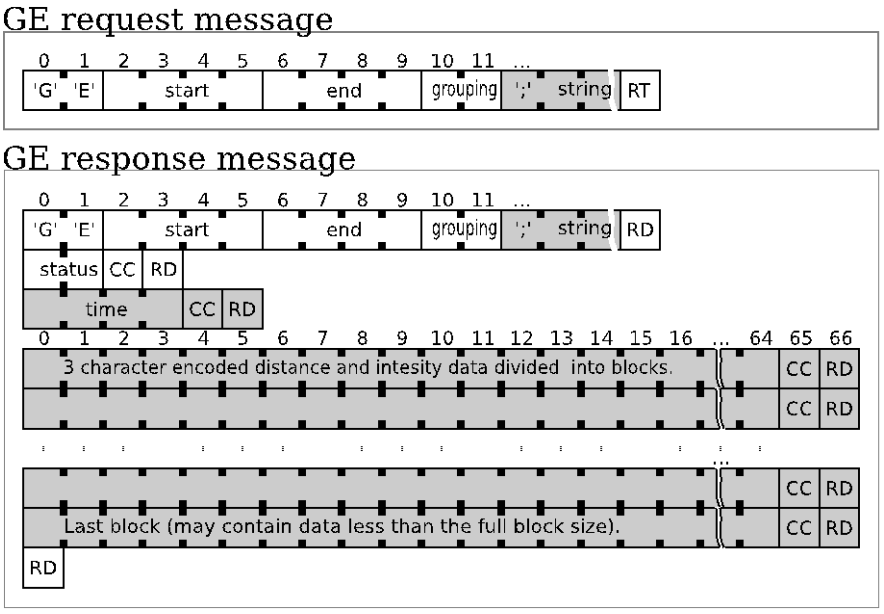


Figure 8.7.2.2: GE command Request and Response

8.7.3 Measurement Data (MD and ME Command)

When UAM 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. UAM's response depends on these parameters. Measurement data in the response message are encoded to 3 ASCII characters with SCIP 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, UAM will send the reply with error status (refer

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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 UAM.**
- **Continuous data transmission initiated using the MD, ME command will be terminated if UAM detects error and goes to lockout state.**

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	UAM 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 UAM is requested to send only the minimum measurement value	Grouping parameter 0 is treated as 1.
Skips	1	Interval to send the data	UAM skips sending the data for number of cycles provided in this field when it is in continuous transmission mode. One measurement cycle of UAM is 29 ~ 30ms.
Scans	2	Number of scan cycles UAM is requested to provide the data continuously	In the echo back from UAM, original value in this field is replaced by number of remaining scans. If the parameter is set to “00”, UAM 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 UAM 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

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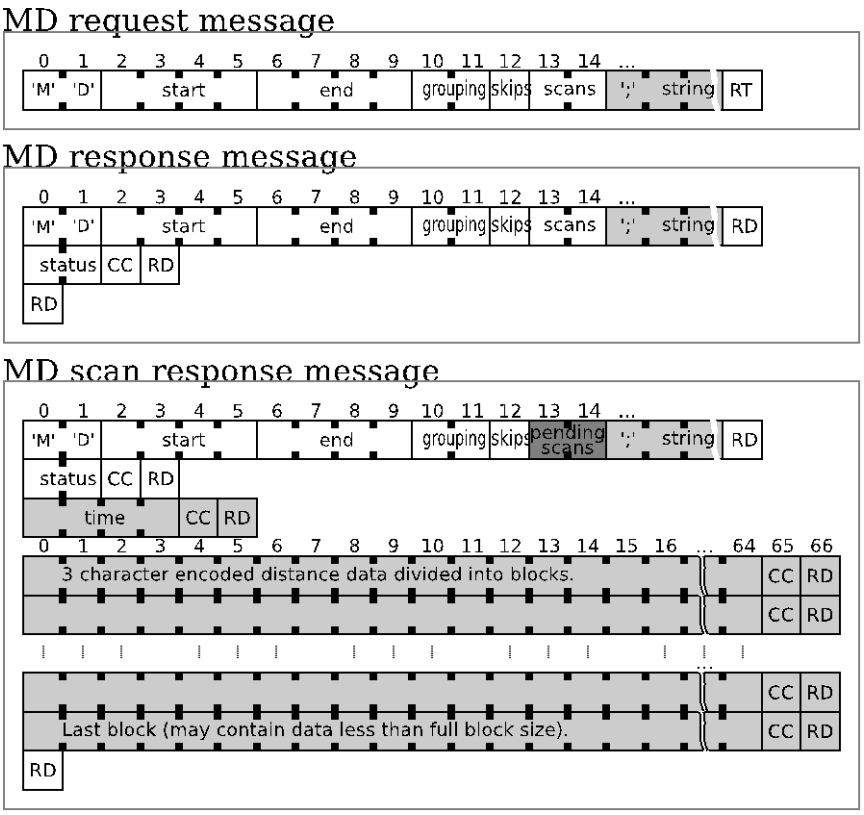


Figure 8.7.3.1: MD command Request and Response

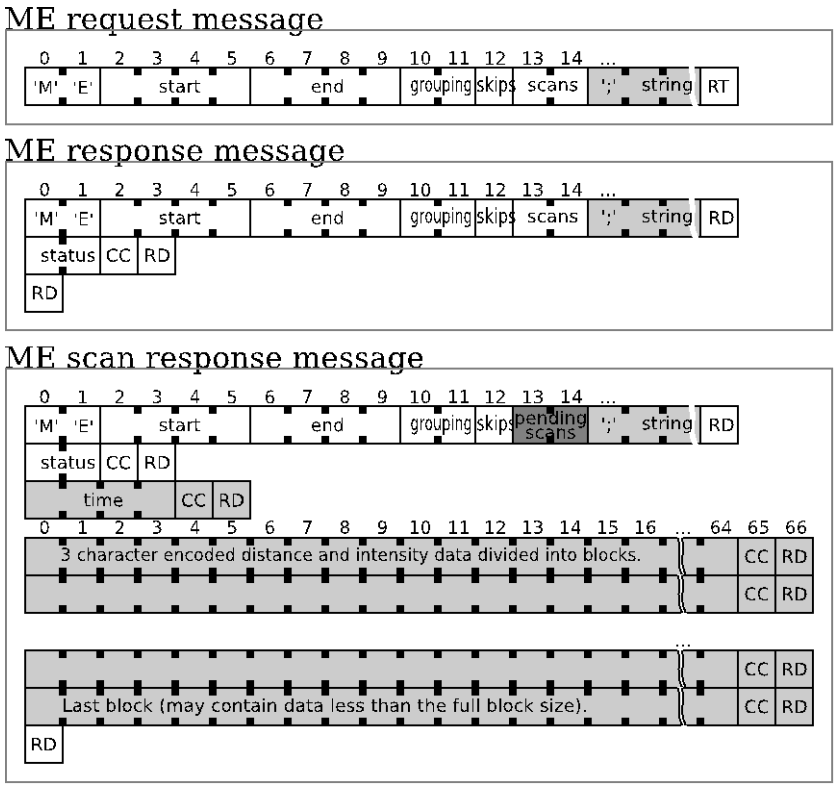


Figure 8.7.3.2: ME command Request and Response

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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. UAM stops the continuous data transmission



Figure 8.7.4.1: QT command Request and Response



Figure 8.7.4.2: RS command Request and Response

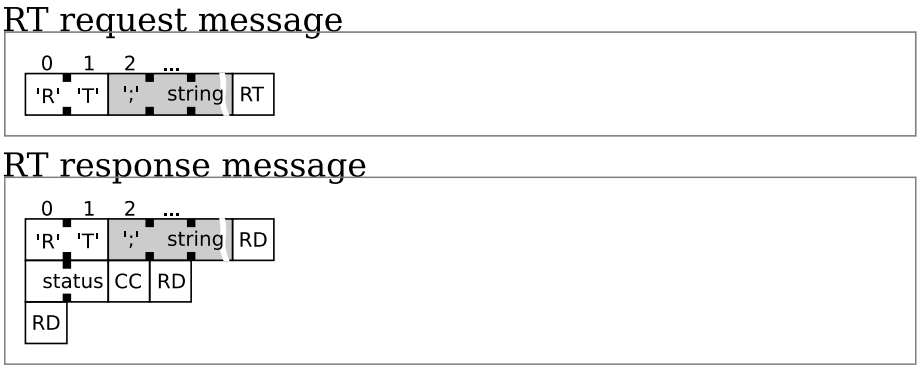


Figure 8.7.4.3: RT command Request and Response

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8.7.5 Sensor Information (VV, PP and II Commands)

When UAM 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:Hokuyo Automatic Co.,Ltd.
Product model	PROD:UAM-05LPA
Firmware version	FIRM:01.00.00
SCIP protocol version	PROT: SCIP 2.0 for Safety
Product serial number	SERI:H0123456

Table 8.7.5.3 Information in PP Command

Description	String Sample
Product model	MODL:UAM-05LPA
Minimum measurable distance (mm)	DMIN:20
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:UAM-05LPA
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.

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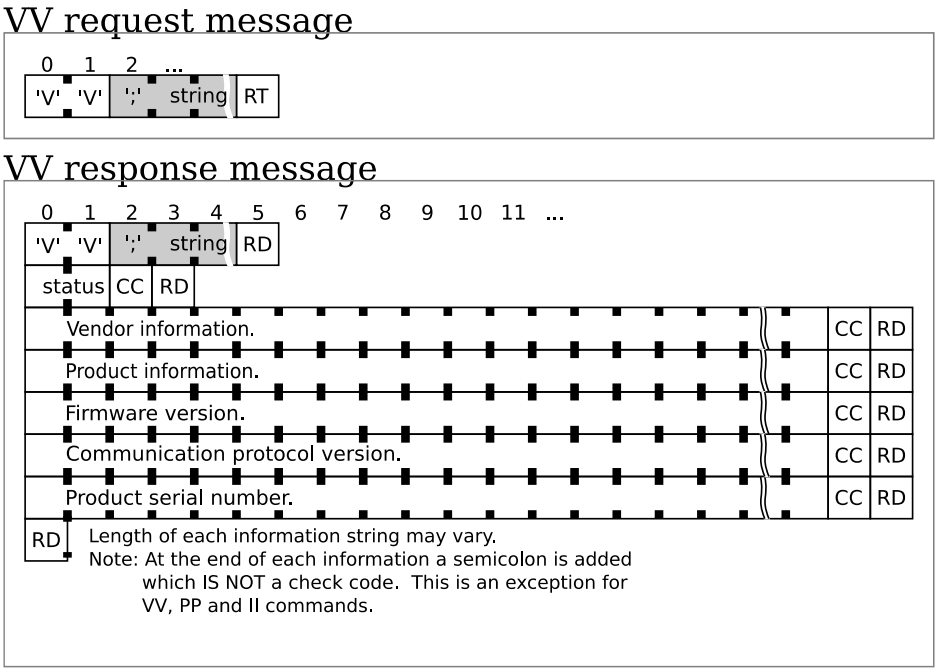


Figure 8.7.5.1: VV command Request and Response

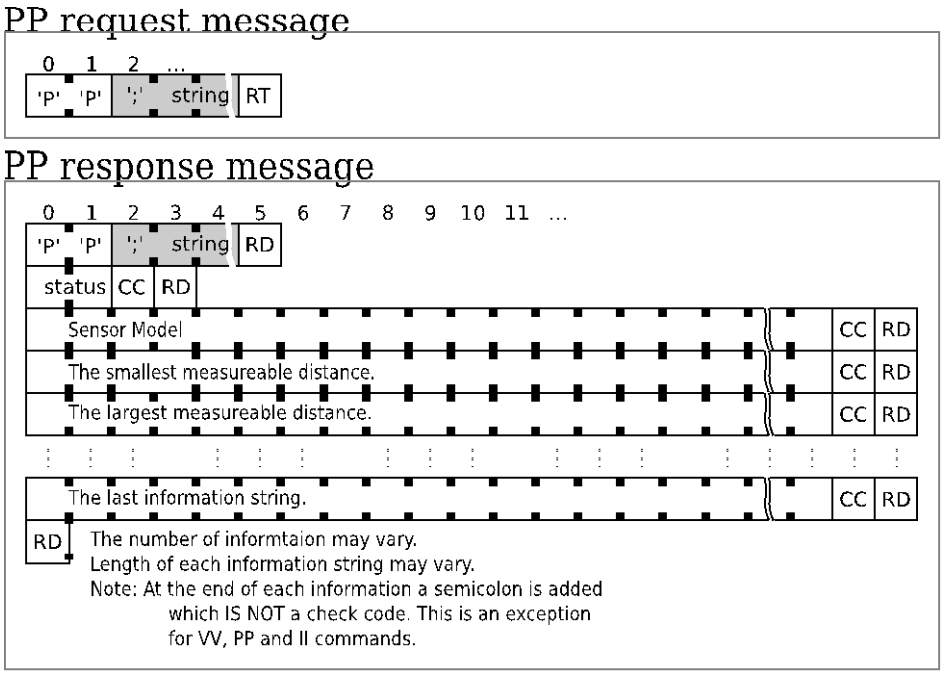


Figure 8.7.5.2: PP command Request and Response

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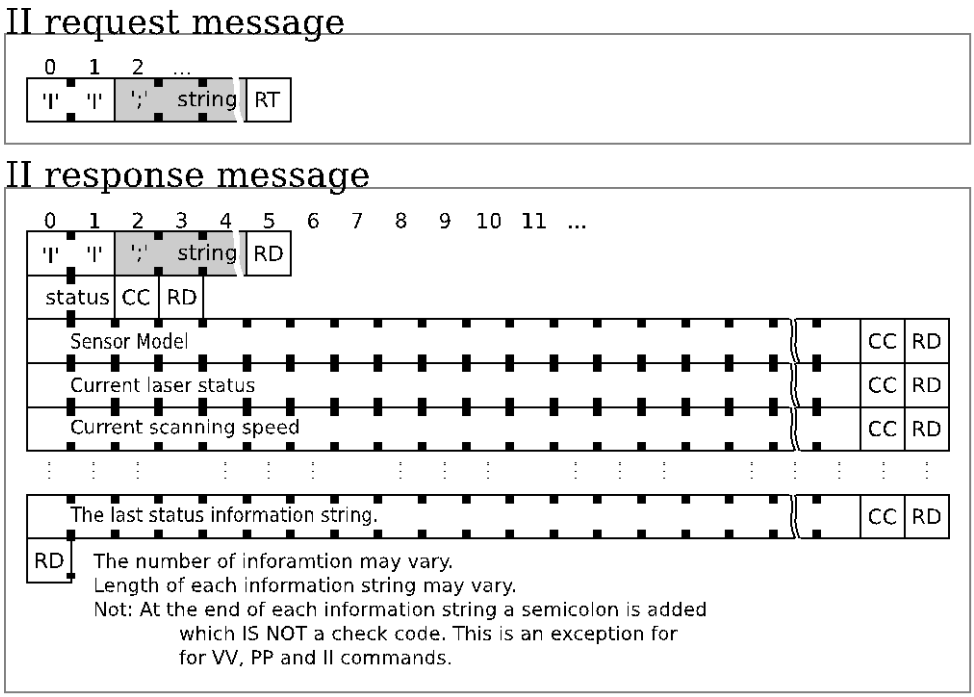


Figure 8.7.5.3: II command Request and Response

8.7.6 Reboot Device (RB Command)

This RB command is to reboot (restart) the sensor when it is in error state. It requires a special procedure to use it. Within 1 second, 2 request messages of the RB command must be sent and their corresponding response messages must be received (2 roundtrips of the RB command) to restart the sensor, otherwise the current sensor state is kept, and no reboot is performed. When the sensor receives the RB command, the sensor behaves as if it has just been powered up.

Table 8.7.6.1 Details of Status Code

Code	Detail
00	Normal. Received the 2nd RB command request.
01	Normal. Received the 1st RB command request.



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