LZR®-U90X
Protocol

1. Introduction

This application note contains useful information for communication with the LZR®-U90x family of raw data laser scanners from BEA/Sensorio.

This document is divided into two parts:

- Part 1 is an exhaustive list of all the characteristics and functions that are potentially available in laser scanners of the LZR®-U90x family. This list is established disregarding the specific type of sensor.
- Based on this, part 2 lists the availability of those features in the different laser scanners of the LZR®-U90x family.

2. Overview of all functions (part 1)

2.1 Reminder: The laser scanner platform LZR

The following picture (Figure 1) shows how the laser scanner (LZR) is generally installed when used vertically.

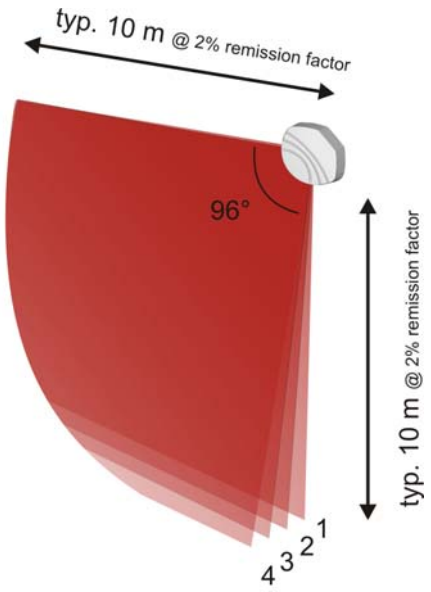


Figure 1

The LZR's main characteristics are:

Technology	TOF (Time Of Flight)
Number of curtains	4
Tilt angle shift between planes	approximately 2°
Number of measurement points per plane	274
Optical angular opening area	96,3281°
Angular resolution	96,3281°/274= 0,3516°
Speed of motor rotation	900 rpm

The following picture (Figure 2) shows the correlation between the spots and the angular scanning position.

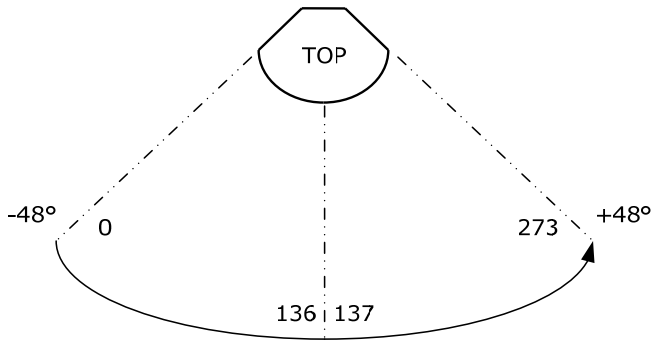


Figure 2

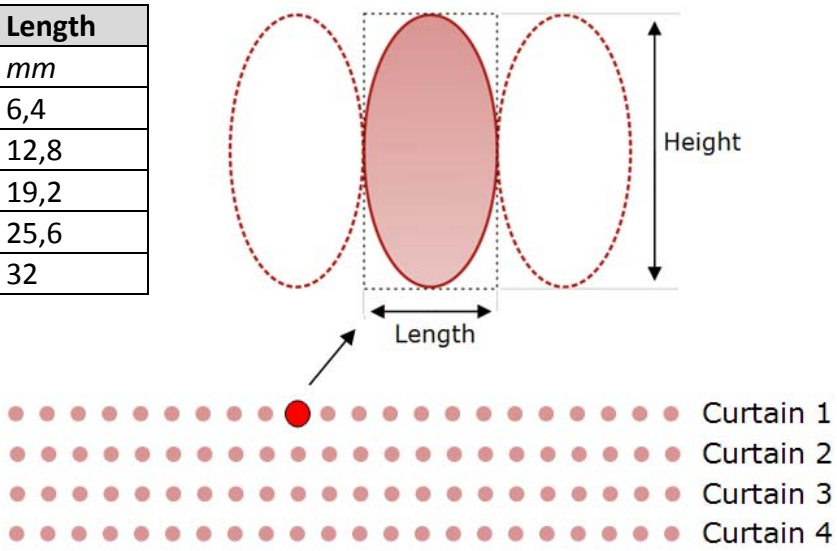
Distance measurement of spot 0	-48°
Distance measurement of spot 273	+48°

The distance information available through the serial link depends on the LZR version.

Characteristics of the laser spot:

Spot size depending on scanning distance:

Distance	Height	Length
m	*mm*	*mm*
1	16	6,4
2	32	12,8
3	48	19,2
4	64	25,6
5	80	32



Basic relation spot length vs spot height: 1 x 2,5 (length x height)

Characteristics of the distance measurement:

The maximum measurement capability of the LZR-U90x family is ensured until 10 m (min. target remission factor = 2%) with the gold coated drum mirror (0 m = centre of the drum). The versions with aluminum drum mirror and the LR version have a reduced capability (5 m x 5 m @ 2% remission factor).

Even if the LZR-U90x measurement capability is over this limit, every distance received greater than a defined maximum distance should be discarded.

2.2 Communication protocol

2.2 a) Serial communication

The main characteristics of the serial communication are:

Type	Asynchronous
Electrical interface	RS-485
Communication mode	Half-duplex
Data transmission speed	57600, 115200, 230400, 460800 or 921600
Topology	Point to point
Encoding	1 start bit, 1 stop bit, no parity bit
Data word length	8 bits

2.2 b) Basic symbols

The communication symbols used in a transmitted data stream are:

Synchronization

This symbol is used to allow the synchronization between the laser scanner and the door controller.

Size	2 bytes
Value	0xFEFE

Identification

This symbol is used to transmit the unique identification number of the LZR.

Size	4 bytes
Value	Serial number (hexadecimal value)
Structure	MSB first, LSB last

Data

This symbol is used to transmit any distance information to the door controller.

Size	2 bytes
Value	Distance (hexadecimal value)
Structure	MSB first, LSB last

NB: All distance measurements made by the LZR are expressed in mm

Control

This symbol is used to transmit the CRC.

Size	2 bytes
Principle	The calculation of the CRC is only performed on the data information.
Calculation	The CRC is encoded on 16 bits. The calculation is based on the division of the transmitted data bits by an polynomial such as: $X^{16} + X^{15} + X^2 + 1$
Structure	MSB first, LSB last

2.2 c) Structure of the data stream

The length of a data stream depends on the LZR version with a maximum of 1100 symbols, i.e. 2200 bytes.

2 Synchronization bytes

4 Identification bytes

2192 Data bytes:

- 2 bytes per distance measurement
- 4 planes
- 274 distance measurements per plane

2 Control bytes

The following figure shows the structure of the complete data stream:

SYNC	**ID**	**Distance information**												**Control**
		Curtain 2			*Curtain 4*			*Curtain 1*			*Curtain 3*			
0xFEFE	LZR ID	D0	...	Dn	D1	...	Dn	D1	...	Dn	D1	...	Dn	CRC
		2°			6°			0°			4°			

Please refer to the first picture concerning the curtains numbers

2.2 d) How does it work?

The laser scanner always works in “transmission” mode and sends out the measurement data as soon as he is powered and as soon as the data of a complete scanning cycle is available. The operator should always work in “reception” mode.

2.3 User interface

2.3 a) Relay signalling

In the LZR raw data versions, the two output relays are used as follows:

Relay 1	Relay 2	Description
ON (+V)	ON (+V)	LZR is switched ON, running and transmitting distance data
ON (+V)	OFF (0V)	LZR is switched ON, in standby mode and transmitting heartbeat message
OFF (0V)	ON (+V)	LZR is in error mode
OFF (0V)	OFF (0V)	LZR is switched OFF

2.4 Additional functions

2.4 a) Standby mode

The infrared laser diode that is pulsed in the distance measurement process can be switched ON/OFF in some versions of the LZR-U90x family by using the external input signal.

The input signal is de-bounced in a way that a pulse signal shorter than 100ms will not change the state of the laser diode.

Distance data frames are only sent on serial link when the infrared laser diode is pulsing.

When the infrared laser diode is switched OFF, no data is available, so no data frame is sent. In this standby mode, a "heartbeat" message is sent on the serial link informing the host system monitoring that the LZR is still alive but idle.

The “heartbeat” message follows the same structure as the data frame but with all data values set to 0.

SYNC	ID	Distance information												Control
		Curtain 2			*Curtain 4*			*Curtain 1*			*Curtain 3*			
0xFEFE	LZR ID	0	...	0	0	...	0	0	...	0	0	...	0	CRC
		2°			6°			0°			4°			

The repeat rate of the “heartbeat” transmission is 5 seconds.

3. LZR-U90X characteristics (part 2)

The following table summarizes the various characteristics available in the different versions of the raw data laser scanner family LZR-U90x.

Parameter	U901	U902	U903 LR	U903	U904
Colour					
Black	×		×	×	×
White		×			
Drum type					
Gold drum	×		×	×	×
Aluminium drum		×			
Detection Range					
10 m @ 2% remission factor	×			×	×
5 m @ 2% remission factor		×	×		
Serial link communication parameters					
Baud rate	460800	57600	460800	460800	57600
Data bits	8	8	8	8	8
Parity bit	None	None	None	None	None
Stop bit	1	1	1	1	1
Transmitted spots selection					
Number of plane	4	4	4	4	4
Number of distances	274	27	274	274	27
Start spot	0	0	0	0	0
Step between spots	1	10	1	1	10
Frame identification					
LZR Identification			×	×	×
Standby mode					
Standby mode			×	×	×
Heartbeat rate			5 sec	5 sec	5 sec
Input active state			Active Low (0V)	Active Low (0V)	Active Low (0V)

Annex A : CRC calculation source code

The following is an example of how the CRC could be calculated.

```
const unsigned char Tabcrcx[256] = {
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40,0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,
0x00,0xC1,0x81,0x40,0x01,0xC0,0x80,0x41,0x01,0xC0,0x80,0x41,0x00,0xC1,0x81,0x40} ;

const unsigned char Tabcrcy[256] = {
0x00,0xC0,0xC1,0x01,0xC3,0x03,0x02,0xC2,0xC6,0x06,0x07,0xC7,0x05,0xC5,0xC4,0x04,
0xCC,0x0C,0x0D,0xCD,0x0F,0xCF,0xCE,0x0E,0x0A,0xCA,0xCB,0x0B,0xC9,0x09,0x08,0xC8,
0xD8,0x18,0x19,0xD9,0x1B,0xDB,0xDA,0x1A,0x1E,0xDE,0xDF,0x1F,0xDD,0x1D,0x1C,0xDC,
0x14,0xD4,0xD5,0x15,0xD7,0x17,0x16,0xD6,0xD2,0x12,0x13,0xD3,0x11,0xD1,0xD0,0x10,
0xF0,0x30,0x31,0xF1,0x33,0xF3,0xF2,0x32,0x36,0xF6,0xF7,0x37,0xF5,0x35,0x34,0xF4,
0x3C,0xFC,0xFD,0x3D,0xFF,0x3F,0x3E,0xFE,0xFA,0x3A,0x3B,0xFB,0x39,0xF9,0xF8,0x38,
0x28,0xE8,0xE9,0x29,0xEB,0x2B,0x2A,0xEA,0xEE,0x2E,0x2F,0xEF,0x2D,0xED,0xEC,0x2C,
0xE4,0x24,0x25,0xE5,0x27,0xE7,0xE6,0x26,0x22,0xE2,0xE3,0x23,0xE1,0x21,0x20,0xE0,
0xA0,0x60,0x61,0xA1,0x63,0xA3,0xA2,0x62,0x66,0xA6,0xA7,0x67,0xA5,0x65,0x64,0xA4,
0x6C,0xAC,0xAD,0x6D,0xAF,0x6F,0x6E,0xAE,0xAA,0x6A,0x6B,0xAB,0x69,0xA9,0xA8,0x68,
0x78,0xB8,0xB9,0x79,0xBB,0x7B,0x7A,0xBA,0xBE,0x7E,0x7F,0xBF,0x7D,0xBD,0xBC,0x7C,
0xB4,0x74,0x75,0xB5,0x77,0xB7,0xB6,0x76,0x72,0xB2,0xB3,0x73,0xB1,0x71,0x70,0xB0,
0x50,0x90,0x91,0x51,0x93,0x53,0x52,0x92,0x96,0x56,0x57,0x97,0x55,0x95,0x94,0x54,
0x9C,0x5C,0x5D,0x9D,0x5F,0x9F,0x9E,0x5E,0x5A,0x9A,0x9B,0x5B,0x99,0x59,0x58,0x98,
0x88,0x48,0x49,0x89,0x4B,0x8B,0x8A,0x4A,0x4E,0x8E,0x8F,0x4F,0x8D,0x4D,0x4C,0x8C,
0x44,0x84,0x85,0x45,0x87,0x47,0x46,0x86,0x82,0x42,0x43,0x83,0x41,0x81,0x80,0x40} ;
```

```
unsigned short compute_crc16(unsigned char *adbuf, unsigned short nb_bytes)
{
 register unsigned char msb_crc=0, lsb_crc=0;
 register unsigned char tmp;
 register int i;

 for (i=0 ; i < nb_ bytes; i++)
 {
  tmp = msb_crc ^ (*adbuf++);
  msb_crc = lsb_crc ^ Tabcrcx[tmp];
  lsb_crc = Tabcrcy[tmp];
 }

 return ((unsigned short)lsb_crc + (msb_crc << 8));
}
```