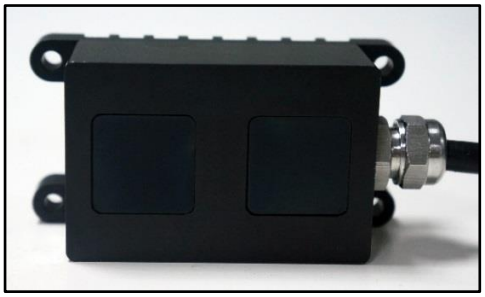
HPS-3D160

Solid-State LiDAR Sensor



Features

- Full field of view frame up to 35 fps
- Field of View: 76° x 32°， Resolution: 160 x 60
- Support 16 group of users customize region of interest setting, each group support 8 regions of interest
- Various communication ports, support USB, RS-232, RS-485, CAN and GPIO Optocoupler isolation port.
- Support GPIO input measurement simultaneously.
- Measures range up to 12m
- Range accuracy: points cloud in centimeter
- Excellent ambient light suppression ability
- Embedded anti-interference algorithm, support multi-machine work
- Total solid structure, industrial IP67 anti-water design
- Support Simple-HDR mode, Auto-HDR mode and Super-HDR mode, with fine scene adaptability.

Applications

- Robotics & AGV automatic navigated robot （obstacle detection，SLAM application）
- Drone collision avoidance，altitude hold
- Industrial safety area protection and proximity protection
- Safety surveillance
- 3D movement recognition
- 3D modeling

Description

HPS-3D160 is a new generation high-performance solid-state LiDAR sensor based on the principle of ToF, with optimized lighting system and low distortion infrared optical lens, measure distance up to 12m on 90% reflective rate white target. Flexible customize ROI setting function, Simple-HDR, Auto-HDR, and Super-HDR mode, make HPS-3D160 widely used in all reflectivity scenes HPS-3D160 integrates a high-power 850nm infrared VCSEL emitter and a high-sensitivity photosensitive device, embedded high-performance processor and advanced data process, filter and compensation algorithm, enables very stable and simultaneous measure data output. Full solid structure, industrial IP67 waterproof design and strong aerospace aluminum housing allows the HPS-3D160 to be used in a variety of complex environments

Ordering information

HPS- 3 D 1 6 0 - □

Hypersen product designator

3D： Solid-State LiDAR series

Resolution:
160: 160*60
320: 320*240
640: 640*480

Communication interface:
U: USB
C: CAN
D: RS-485
S: RS-232

CE FC RoHS

Overview

1.1 Technical specification

Table 1. 1.1 Technical specification

Parameter	Values	Unit
Size	78（L）x 40（W）x 30（H）	mm
Weight	110 *1	g
Power supply	9 ~ 12	V
Maximum power consumption	6	W
Quiescent power consumption	0.7	W
Storage temperature	-40 ~ 85	℃
Operating temperature	-10 ~ 55	℃
Infrared VCSEL emitter	850	nm
Emitting angle	76（horizontal）x 32（vertical）	°
Maximum measuring distance	12 *2	m
Minimum measuring distance	0.25	m
Maximum output frame rate	Full field of view 35	fps
Output data	Depth data, average distance, signal strength, weak signal pixels quantity, saturated pixels quantity, maximum distance, minimum distance	-
Operating mode	Normal mode, Auto-HDR mode Super-HDR mode, Simple-HDR mode	-
Power-on initialization time	1500	ms
Interface	Option：USB，RS232，RS485 or CAN	-
Optocoupler isolation IO	standard：input x 1，output x 1	-
Cable length	200	cm

Note: *1 Not include cable

*2 Tested on 90% reflectance white target

1.2 Dimensions and pin definitions

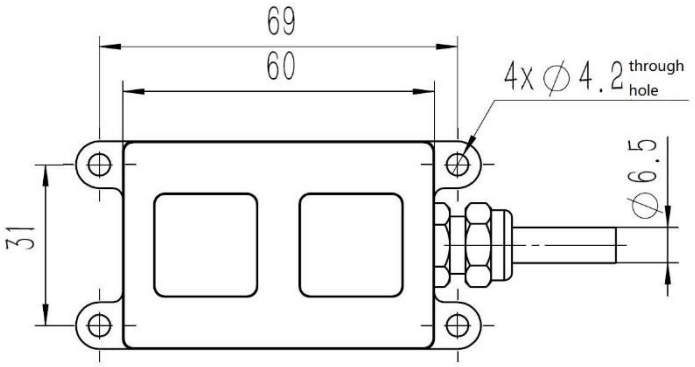


Figure 1. HPS-3D160 front view

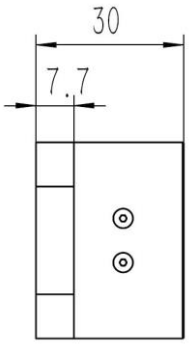


Figure 2. HPS-3D160 left view

Table 2. **HPS-3D160** cable definition

Cable color	Signal name	Signal type	Description	Remark
Red	VCC	Power	Power, connect to DC +9 ~ 12V	Products with different communication ports, DATA+ and DATA- cables have different signal definitions.
Black	GND	Power	Power ground	
Blue	OUT	I/O	Optocoupler isolation I/O output terminal	
Blue/White	IN	I/O	Optocoupler isolation I/O input terminal	
Purple/White	COM	I/O	Optocoupler isolation I/O public terminal	
Purple	GND	Digital	Signal ground	
Orange	DATA+	Digital	USB D+ / CAN D+ / RS-485 D+ / RS-232 TX	
Orange/white	DATA-	Digital	USB D- / CAN D- / RS-485 D- / RS-232 RX	
Shield layer	SHIELD	-	Cable shield layer，internal part connects to product outer shell	

2.1 Communication ports

HPS-3D160 could communicate with host through USB，RS232，RS485 or CAN, and HPS-3D160 also comes standard with an optocoupler isolation input and an optocoupler isolation output, which can be connected with PLC and other devices.

2.2 USB, RS232, RS485 and CAN communication protocol

2.2.1 Communication protocol

In sensor, each command includes 2 headers, 1 message length bytes, 1 command byte, 1 device address byte, parameter field, 2 CRC16-CCITT check bytes; every return data includes 2 headers, 2 message length bytes, 1 device address byte, 1 RID byte (Return ID, normally same as command byte), data field, 2 CRC16-CCITT check byte, 2 message ends. command packet and return data packet is little endian, that is, the low memory address stores the low byte data.

2.2.2 Multi-sensor support

Each sensor has a programmable device address (Default address is 0x00, broadcast address is 0xFF), users can change it to achieve multi-machine work on the same bus.

2.2.3 Command data packet is indefinite length format, defined as the following table:

byte number	Description
0	0xF5，Header 1
1	0x0A，Header 2
2	Length byte，indicates byte number 3 starting number of data bytes
3	Command byte
4	device address，specify answering device, factory address default 0x00, broadcast address 0xFF
N	Parameter field
5+N	CRC16 Low byte
5+N+1	CRC16 High byte

Note: The byte participating in the CRC check in the command packet is byte number 3-N.

Return data packet is changeable length format, defined as the following table:

byte number	Description
0	0xF5，Header 1
1	0x5F，Header 2
2	Remaining valid data length low byte
3	Remaining valid data length high byte
4	Device address
5	RID，return packet type ID
N	String
6+N	CRC16 Low byte
6+N+1	CRC16 High byte
6+N+2	0x5F，Message end 1
6+N+3	0xF5，Message end 2

Note：The byte participating in the CRC check in the return packet is byte number4~N。

Command #1 Achieve sensor device address

This command can broadcast achieve sensor device address。

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x05	Message length
3	0xBA	Command byte
4	0xFF	Broadcast address
5	0x02	Fixed parameter
6	0x1F	CRC16 Low byte
7	0xD6	CRC16 High byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2
2	Message length Low byte	……	Message length low byte
3	Message length High byte	……	Message length high byte
4	device address	……	Current responding device address
5	RID	0xBA	RID，return packet type ID
6	device address	……	Current responding device address
7	CRC16 LSB	……	CRC16 low byte
8	CRC16 MSB	……	CRC16 high byte
9	Message end 1	0x5F	Message end 1
10	Message end 2	0xF5	Message end 2

Command #2 Set sensor's device address

This command can set sensor's device address, after setting sensor's device address succeed and sending return data packet, the new address will come into effect.

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x06	Message length
3	0xBA	Command byte
4	Target device address	Target device address，0x00 ~ 0xFE
5	0x01	Fixed parameter
6	0x00 ~ 0xFE	New device address
7	……	CRC16 Low byte
8	……	CRC16 High byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2
2	Message length low byte	0x07	Message length low byte

3	Message length high byte	0x00	Message length high byte
4	device address	……	Current responding device address（set device address before taking effect）
5	RID	0xBA	RID, Return packet type: ID
6	Confirmation byte	……	0x01: succeed，0x00: fail
7	CRC16 LSB	……	CRC16 low byte
8	CRC16 MSB	……	CRC16 high byte
9	Message end 1	0x5F	Message end 1
10	Message end 2	0xF5	Message end 2

Command #3 Achieve sensor's hardware version number.

This command can achieve sensor's hardware version number.

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x04	Message length
3	0xA0	Command byte
4	Target device address	Target device address，0x00 ~ 0xFE
5	……	CRC16 low byte
6	……	CRC16 high byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2
2	Message length Low byte	0x0C	Message length low byte
3	Message length High byte	0x00	Message length high byte
4	device address	……	Current responding device address
5	RID	0xA0	RID，return packet type ID
6	Year	……	Example：2018-09-19 V1.3 Rev3 [6]: 0x12, [7]: 0x09, [8]: 0x13, [9]: 0x01, [10]: 0x03, [11]: 0x03
7	Month	……	
8	Day	……	
9	Main version	……	
10	Minor version	……	
11	Revisions	……	
12	CRC16 LSB	……	CRC 16 low byte

13	CRC16 MSB	……	CRC 16 high byte
14	Message end 1	0x5F	Message end 1
15	Message end 2	0xF5	Message end 2

Command#4 Get sensor serial number

This command can get sensor serial number, each sensor serial number is unique, can be used as the unique identification code.

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x05	Message length
3	0xA1	Command
4	Target device address	Target device address，0x00 ~ 0xFE
5	0x02	Stable parameter
6	……	CRC16 low byte
7	……	CRC16 high byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2
2	Message length low byte	0x44	Message length low byte
3	Message length high byte	0x00	Message length high byte
4	device address	……	Current responding device address
5	RID	0xa0	RID，return packet type ID
6~67	Sensor serial number	ASCII string	ASCII string, string is end up with'\0', that is ASCII value is 0 Example：HPS-3D160-U-1810130 [6]: 'H', [7]: 'P', [8]: 'S', [9]: '-', [10]: '3', [11]: 'D', [12]: '1', [13]: '6', [14]: '0', [15]: '-', [16]: 'U', [17]: '-', [18]: '1', [19]: '8', [20]: 1, [21]: '0', [22]: '1', [23]: '3', [24]: '0', [25]: '\0' Other data can be neglected.
68	CRC16 LSB	……	CRC16 low byte
69	CRC16 MSB	……	CRC16 high byte
70	Message end 1	0x5F	Message end 1
71	Message end 2	0xF5	Message end 2

Command #5 Set sensor working mode

This command can set sensor's working mode.

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x06	Message length
3	0xA3	Command byte
4	Target device address	Target device address，0x00 ~ 0xFE
5	0x01	Fixed parameter
6	……	0x00: Standby mode, 0x01: Single measurement mode, 0x02: Continuous measurement mode
7	……	CRC16 low byte
8	……	CRC16 high byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2
2	Message length Low byte	0x07	Message length low byte
3	Message length High byte	0x00	Message length high byte
4	Device address	……	Current responding device address
5	RID	0xA3	RID，return packet type ID
6	Confirmation byte	……	0x01: succeed，0x00: fail
7	CRC16 LSB	……	CRC16 low byte
8	CRC16 MSB	……	CRC16 high byte
9	Message end 1	0x5F	Message end 1
10	Message end 2	0xF5	Message end 2

Command #6 Select user customize region of interest setting group

User can customize 16 groups region of interest setting, each group support 8 region of interest, through this command can select sensor's region of interest setting group.

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x06	Message length
3	0xAC	Command byte
4	Target device address	Target device address，0x00 ~ 0xFE
5	0xA9	Fixed parameter
6	0x00 ~ 0x0F	Region of interest setting group ID

7	……	CRC16 low byte
8	……	CRC16 high byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2
2	Message length low byte	0x07	Message length low byte
3	Message length high byte	0x00	Message length high byte
4	device address	……	Current responding device address
5	RID	0xAC	RID，return packet type ID
6	Confirmation byte	……	0x01: succeed，0x00: fail
7	CRC16 LSB	……	CRC16 low byte
8	CRC16 MSB	……	CRC16 high byte
9	Message end 1	0x5F	Message end 1
10	Message end 2	0xF5	Message end 2

Command#7 Achieve current region of interest setting group ID

This command can achieve region of interest setting group ID number。

byte number	Value	Description
0	0xF5	Header 1
1	0x0A	Header 2
2	0x05	Message length
3	0xAC	Command byte
4	Target device address	Target device address，0x00 ~ 0xFE
5	0xAA	Fixed parameter
6	……	CRC16 low byte
7	……	CRC16 high byte

Return data:

byte number	Name	Value	Description
0	Header 1	0xF5	Header 1
1	Header 2	0x5F	Header 2

2	Message length low byte	0x07	Message length low byte
3	Message length high byte	0x00	Message length high byte
4	Device address	……	Current responding device address
5	RID	0xAC	RID，return packet type ID
6	Region of interest setting group ID	0x00 ~ 0x0F	Region of interest setting group ID
7	CRC16 LSB	……	CRC16 low byte
8	CRC16 MSB	……	CRC16 high byte
9	Message end 1	0x5F	Message end 1
10	Message end 2	0xF5	Message end 2

2.2.4 Measure packet data analysis:

Measure packet can be divided into following 4 types:

1. Complete data packet: Contains critical measurement data and full-view depth data. It is suitable for applications requiring secondary data with full-view depth for secondary development, but requires high data processing capability for terminal devices. The packet data field is defined as follows:

Header	Message length	Device address	RID	Measure data	CRC16 value	Message end

Among these, measuring data field detailed format is as followed:

byte number	Name	Value	Description
0 ~ 1	Dummy	Arbitrary value	This value can be neglected
2	Average distance	Low byte	Full view of field average distance, unit: mm
3		High byte	
4	Effective signal strength	Low byte	Effective signal strength, this value has no units
5		High byte	
6	Average signal strength	Low byte	Average signal strength in region of interest, this value has no unit, the higher the value ,the stronger the reflective signal strength, specified definition is: Average signal strength < 150: Signal strength is weak 150 <= Average signal strength <= 800: Signal strength is well Average signal strength > 800: Signal is too strong
7		High byte	
8	Number of low signal pixels	Low byte	Number of low signal pixels
9		High byte	

10	Number of saturated pixels	Low byte	Number of saturated pixels
11		High byte	
12	Maximum distance value	Low byte	Maximum distance value of region of interest，if the value is 0，it represents invalid data
13		High byte	
14	Minimum distance value	Low byte	Minimum distance value of region of interest，if the value is 65535，it represents invalid data
15		High byte	
16	Data frame counter	Lowest byte	Measuring data frame counter data，convenient for configuring data transport, and check whether frame is lost
17		Secondary lowest byte	
18		Secondary highest byte	
19		Highest byte	
20	Reserved byte	……	Reserved byte
21			
22			
23			
19200 bytes	Depth data	Every pixel point distance value is shown by 2 bytes，Low byte number is stored in low byte data	Data is arranged as: Pixel point 1…Pixel point 160 Pixel point 161…Pixel point 320 …… Pixel point 9440…Pixel point 9600

2. Streamlined measurement data packets: Only critical measurement data is included, which is suitable for applications requiring only critical measurement data of full viewing angle, and requires less data processing capability and communication rate for terminal devices. The packet data field is defined as follows:

byte number	Name	Value	Description
0 ~ 1	Dummy	Arbitrary value	This value can be neglected
2	Average distance	Low byte	Average distance of full view of field，unit: mm
3		High byte	
4	Effective signal strength	Low byte	Effective signal strength, this value has no unit
5		High byte	
6	Average signal strength	Low byte	Average signal strength in region of interest，this value has no unit, the higher the value ,the stronger the reflective signal strength, specified definition is: Average signal strength < 150: Signal strength
7		High byte	

			is weak 150 <= Average signal strength <= 800: Signal strength is well Average signal strength > 800: Signal is too strong
8	Number of low signal pixel point	Low byte	Number of low signal pixel point
9		High byte	
10	Number of saturated pixel point	Low byte	Number of saturated pixel point
11		High byte	
12	Maximum distance value	Low byte	Maximum distance value of region of interest, if the value is 0, it represents invalid data
13		High byte	
14	Minimum distance value	Low byte	Minimum distance value of region of interest, if the value is 65535, it represents invalid data
15		High byte	
16	Data frame counter	Lowest byte	Measuring data frame counter data, convenient for configuring data transport, and check whether frame is lost
17		Secondary lowest byte	
18		Secondary highest byte	
19		Highest byte	
20 ~ 23	Reserved byte	……	Reserved byte

3. Complete data packet of region of interest: Contains the critical measurement data and region of interest data for each region of interest. It is suitable for applications that only need a specific region of Interest information in the perspective. The data processing capability of the terminal device is moderate. The packet data field is defined as follows:

Header	Message length	device address	RID	Region of interest information	Region of interest measuring data 1	……	Region of interest measuring data N	CRC16	Message end

Among these, region of interest information's data field is defined as follow:

byte number	Name	Value	Description
0	Enable number of regions of interest	0x00~0x07	Decide based on enable number of regions of interest
1	Region of interest group ID	0x00~0x0F	Current used region of interest group's ID number
2	Data frame counter	Lowest byte	Measuring data frame counter data, convenient for configuring data transport, and check whether frame is lost
3		Secondary lowest byte	
4		Secondary highest byte	

5		Highest byte	
6 ~ 23	Reserved byte	……	Reserved byte

Region of interest measuring data field is defined as follow:

byte number	Name	Value	Description
0	Region of interest ID	Low byte	Current region of interest ID number
1		High byte	
2	Region of interest upper left corner X coordinate	Low byte	Current region of interest upper left corner X coordinate
3		High byte	
4	Region of interest upper left corner Y coordinate	Low byte	Current region of interest upper left corner Y coordinate
5		High byte	
6	Region of interest lower right corner X coordinate	Low byte	Current region of interest lower right corner X coordinate
7		High byte	
8	Region of interest lower right corner Y coordinate	Low byte	Current region of interest lower right corner Y coordinate
9		High byte	
10	Average signal strength	Low byte	Average signal strength in region of interest, this value has no unit, the higher the value ,the stronger the reflective signal strength, specified definition is: Average signal strength < 150: Signal strength is weak 150 <= Average signal strength <= 800: Signal strength is well Average signal strength > 800: Signal is too strong
11		High byte	
12	Effective signal strength	Low byte	In region of interest, after removing weak signal and too strong signal, the effective signal value of pixel point, this value has no unit, the higher the value, the stronger the reflective strength
13		High byte	
14	Average distance	Low byte	Average measured distance of pixel in region of interest
15		High byte	
16	Maximum distance value	Low byte	Maximum distance value of region of interest, if the value is 0, it represents invalid data
17		High byte	
18	Minimum distance value	Low byte	Minimum distance value of region of interest, if the value is 65535, it represents invalid data
19		High byte	
20	Number of saturated pixel	Low byte	Number of saturated pixel point
21		High byte	

	point		
22	Threshold comparison result	Low byte	Bit0 ~ Bit2: threshold 0，threshold 1，threshold 2，trigger alarm or when alarm release it respond threshold position automatically set 1 or 0 Bit3~Bit15: reserve
23		High byte	
24	Maximum distance value X coordinate	Low byte	Maximum distance value pixel relative to full view of field, X coordinate in region of interest
25		High byte	
26	Maximum distance value Y coordinate	Low byte	Maximum distance value pixel relative to full view of field, Y coordinate in region of interest
27		High byte	
28	Minimum distance value X coordinate	Low byte	Minimum distance value pixel relative to full view of field X coordinate in region of interest
29		High byte	
30	Minimum distance value Y coordinate	Low byte	Minimum distance value pixel relative to full view of field Y coordinate in region of interest
31		High byte	
……	Depth data of region of interest	Each pixel point distance value is shown by 2 bytes，low byte number is stored in low byte data	The initial data is the first pixel on left upper corner, remaining data outputs in line order.

4. Region of interest simple data packet：Only contain each region of interest's critical measuring data, The data processing capability and communication rate requirements of the terminal device are low. The packet data field is defined as follows：

Header	Message length	device address	RID	Region of interest information	Region of interest measuring data1	……	Region of interest measuring data N	CRC16	Message end

Among these，region of interest information data field definition as followed:

byte number	Name	Value	Description
0	Number of enabled regions of interest	0x00~0x07	Decide based on enable number of regions of interest
1	Region of interest group ID	0x00~0x0F	Current used region of interest group's ID number
2	Data frame counter	Lowest byte	Measuring data frame counter data，convenient for configuring data transport, and check whether frame is lost
3		Secondary lowest byte	

4		Secondary highest byte	
5		Highest byte	
6 ~ 23	Reserved byte	……	Reserved byte

Region of interest measuring data field:

byte number	Name	Value	Description
0	Region of interest ID	Low byte	Current region of interest ID number
1		High byte	
2	Average signal strength	Low byte	Average signal strength in region of interest, this value has no unit, the higher the value ,the stronger the reflective signal strength, specified definition is: Average signal strength < 150: Signal strength is weak 150 <= Average signal strength <= 800: Signal strength is well Average signal strength > 800: Signal is too strong
3		High byte	
4	Effective signal strength	Low byte	In region of interest, after removing weak signal and too strong signal, the effective signal value of pixel point, this value has no unit, the higher the value, the stronger the reflective strength
5		High byte	
6	Average distance	Low byte	Pixel's average distance measurement in region of interest
7		High byte	
8	Maximum distance value	Low byte	Maximum distance value of region of interest, if the value is 0, it represents invalid data
9		High byte	
10	Minimum distance value	Low byte	Minimum distance value of region of interest, if the value is 65535, it represents invalid data
11		High byte	
12	Number of saturated pixel point	Low byte	Number of saturated pixel point
13		High byte	
14	Threshold comparison result	Low byte	Bit0 ~ Bit2: threshold 0, threshold 1, threshold 2, trigger alarm or when alarm release it respond threshold position automatically set 1 or 0 Bit3~Bit15: reserve
15		High byte	
16	Maximum distance value X coordinate	Low byte	Maximum distance value pixel relative to full view of field, X coordinate in region of interest
17		High byte	
18	Maximum distance value Y coordinate	Low byte	Maximum distance value pixel relative to full view of field, Y coordinate in region of interest
19		High byte	
20		Low byte	

21	Minimum distance value X coordinate	High byte	Minimum distance value pixel relative to full view of field X coordinate in region of interest
22	Minimum distance value Y coordinate	Low byte	Minimum distance value pixel relative to full view of field Y coordinate in region of interest
23		High byte	
24 ~ 32	Reserved byte	……	Reserved byte

Packet information

Type	HPS-3D160
Dimension	78（L）x 40（W）x 30（H）
Weight	110g / piece （not include cable）
Packet box	1 pcs / box

Revision history

Date	Revision	Description
2018/10/15	1.0	Initial version

Appendix

CRC16's C language complementation

```
static const USIGN16 crc16_tab[] = {
    0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50a5, 0x60c6, 0x70e7,
    0x8108, 0x9129, 0xa14a, 0xb16b, 0xc18c, 0xd1ad, 0xe1ce, 0xf1ef,
    0x1231, 0x0210, 0x3273, 0x2252, 0x52b5, 0x4294, 0x72f7, 0x62d6,
    0x9339, 0x8318, 0xb37b, 0xa35a, 0xd3bd, 0xc39c, 0xf3ff, 0xe3de,
    0x2462, 0x3443, 0x0420, 0x1401, 0x64e6, 0x74c7, 0x44a4, 0x5485,
    0xa56a, 0xb54b, 0x8528, 0x9509, 0xe5ee, 0xf5cf, 0xc5ac, 0xd58d,
    0x3653, 0x2672, 0x1611, 0x0630, 0x76d7, 0x66f6, 0x5695, 0x46b4,
    0xb75b, 0xa77a, 0x9719, 0x8738, 0xf7df, 0xe7fe, 0xd79d, 0xc7bc,
    0x48c4, 0x58e5, 0x6886, 0x78a7, 0x0840, 0x1861, 0x2802, 0x3823,
    0xc9cc, 0xd9ed, 0xe98e, 0xf9af, 0x8948, 0x9969, 0xa90a, 0xb92b,
    0x5af5, 0x4ad4, 0x7ab7, 0x6a96, 0x1a71, 0x0a50, 0x3a33, 0x2a12,
    0xdbfd, 0xcbdc, 0xfbbf, 0xeb9e, 0x9b79, 0x8b58, 0xbb3b, 0xab1a,
    0x6ca6, 0x7c87, 0x4ce4, 0x5cc5, 0x2c22, 0x3c03, 0x0c60, 0x1c41,
    0xedae, 0xfd8f, 0xcdec, 0xddcd, 0xad2a, 0xbd0b, 0x8d68, 0x9d49,
    0x7e97, 0x6eb6, 0x5ed5, 0x4ef4, 0x3e13, 0x2e32, 0x1e51, 0x0e70,
    0xff9f, 0xefbe, 0xdfdd, 0xcffc, 0xbf1b, 0xaf3a, 0x9f59, 0x8f78,
    0x9188, 0x81a9, 0xb1ca, 0xa1eb, 0xd10c, 0xc12d, 0xf14e, 0xe16f,
    0x1080, 0x00a1, 0x30c2, 0x20e3, 0x5004, 0x4025, 0x7046, 0x6067,
    0x83b9, 0x9398, 0xa3fb, 0xb3da, 0xc33d, 0xd31c, 0xe37f, 0xf35e,
    0x02b1, 0x1290, 0x22f3, 0x32d2, 0x4235, 0x5214, 0x6277, 0x7256,
    0xb5ea, 0xa5cb, 0x95a8, 0x8589, 0xf56e, 0xe54f, 0xd52c, 0xc50d,
    0x34e2, 0x24c3, 0x14a0, 0x0481, 0x7466, 0x6447, 0x5424, 0x4405,
    0xa7db, 0xb7fa, 0x8799, 0x97b8, 0xe75f, 0xf77e, 0xc71d, 0xd73c,
    0x26d3, 0x36f2, 0x0691, 0x16b0, 0x6657, 0x7676, 0x4615, 0x5634,
    0xd94c, 0xc96d, 0xf90e, 0xe92f, 0x99c8, 0x89e9, 0xb98a, 0xa9ab,
    0x5844, 0x4865, 0x7806, 0x6827, 0x18c0, 0x08e1, 0x3882, 0x28a3,
    0xcb7d, 0xdb5c, 0xeb3f, 0xfb1e, 0x8bf9, 0x9bd8, 0xabbb, 0xbb9a,
    0x4a75, 0x5a54, 0x6a37, 0x7a16, 0x0af1, 0x1ad0, 0x2ab3, 0x3a92,
    0xfd2e, 0xed0f, 0xdd6c, 0xcd4d, 0xbdaa, 0xad8b, 0x9de8, 0x8dc9,
    0x7c26, 0x6c07, 0x5c64, 0x4c45, 0x3ca2, 0x2c83, 0x1ce0, 0x0cc1,
    0xef1f, 0xff3e, 0xcf5d, 0xdf7c, 0xaf9b, 0xbfba, 0x8fd9, 0x9ff8,
    0x6e17, 0x7e36, 0x4e55, 0x5e74, 0x2e93, 0x3eb2, 0x0ed1, 0x1ef0,
};

/*---------------------------------------------------------------------------*/
// @USIGN16 Calc_CRC16(const USIGN8 *buf, const int len)
// @brief Calculate 2 bytes 16 bit CRC check value
// @param buf- Data buffer pointer to be calculated
// @param len- Data length to be calculated
// @return 16bit CRC check value
/*---------------------------------------------------------------------------*/
```

```
USIGN16 Calc_CRC16(const USIGN8 *buf, const USIGN32 len)
{
    USIGN32 i;
    USIGN16 cksum;

    cksum = 0;
    for (i = 0;  i < len;  i++) {
        cksum = crc16_tab[((cksum>>8) ^ *buf++) & 0xFF] ^ (cksum << 8);
    }
    return cksum;
}

/*--------------------------------The End of File-------------------------------*/
```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