CS20-Product Specifications

Revision History Version			
Date	Revision	Description	Editor
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1. Description and Features

Product Description

CS20 is a solid-state laser radar, equipped with a 640 * 480 resolution ToF image sensor, which uses ToF technology to obtain three-dimensional information of objects and space. It has excellent performance such as long-distance, low power consumption, and provides users with convenient and efficient 3D perception capabilities.

The product is powered through the Type C interface and simultaneously outputs depth image phase information. Users can obtain depth, IR, point cloud and other data through the SDK.

Features

- Millimeter measurement accuracy
- Measuring range: 0.1-5m@90% Ref
- High dynamic measuring range
- Support depth and signal amplitude timing synchronization
- Adjustable range and resolution

Applicable scene

- Robot SLAM
- Industrial Vision
- Volume measurement
- Liveness detection
- Somatosensory interaction
- 3D modeling

Figure 1-1. CS20 External view of solid-state lidar

2. Introduction

2.1 Urpose of this document

This document describes the specifications and parameters of the solid-state laser radar CS20 in detail, and provides users with relevant information required for understanding and using the CS20 solid-state laser radar.

2.2 ToF Technology overview

ToF technology calculates the distance between an object and the camera through the time-of-flight of light. Firstly, the ToF sensor sends a modulation signal to the light source driving chip, and then the modulation signal sends out high-frequency modulated near-infrared light by controlling the laser. When the light encounters the object to be measured and diffuse reflection back to the receiving end of the sensor, through the time difference between emitted and received light to calculate depth information.

CS20 solid-state lidar adopts the continuous wave modulation technology (CW iToF) in i-ToF (indirect ToF). Through the proportional relationship of the energy values collected by the sensor in different time windows, the signal phase is analyzed, and the time difference between the transmitted signal and the received signal is indirectly measured to obtain the depth.

Continuous wave modulation (CW-iToF)

Usually sine wave modulation is used, phase offset of sine waves at receiver and emitter is proportional to the distance of the object from the camera, and measure distance vis phase offset.

$$\varphi_{TOF} = \operatorname{atan}\left(\frac{C_1 - C_3}{C_2 - C_4}\right)$$
$$D = \frac{c}{2} * \frac{\varphi_{TOF}}{2\pi * f_m} + D_{offset}$$

Formula 2-1. distance calculation

The phase offset (φ) and depth (D) are obtained by the integral energy values from the above formulas C1, C2, C3, and C4. These values are the energy collected by four receiving windows with different phase delays, and corresponding to sampling at 0°, 90°, 180°, and 270° at the phase sampling points. As:

$$C_1 = Asin(\varphi)$$
$$C_2 = Asin(\varphi + 90°) = Acos(\varphi)$$
$$C_3 = Asin(\varphi + 180°) = -Asin(\varphi)$$
$$C_4 = Asin(\varphi + 270°) = -Acos(\varphi)$$

Formula 2-2. 能量值与相位

A is the amplitude of the received sinusoidal signal

In terms of precision, the precision of CW-iToF is mainly subject to random noise and quantization noise. The former is inversely proportional to the signal-to-noise ratio (SNR) of the received optical signal, and the latter is inversely proportional to the sine wave modulation frequency. Therefore, in order to improve the precision, CW-iToF generally adopts high-power short integration time sampling to improve the SNR of the received optical signal; at the same time, the modulation frequency is increased to suppress quantization noise.

In terms of range, the phase range that can be resolved by CW-iToF is [0~2π], its maximum range is Dmax=c/(2fm). Therefore, the higher the frequency, the higher precision and the smaller range. If the depth of the range is exceeded, the periodic phase wrap (Phase wrap) measurement value will erroneously fall within [0~Dmax].

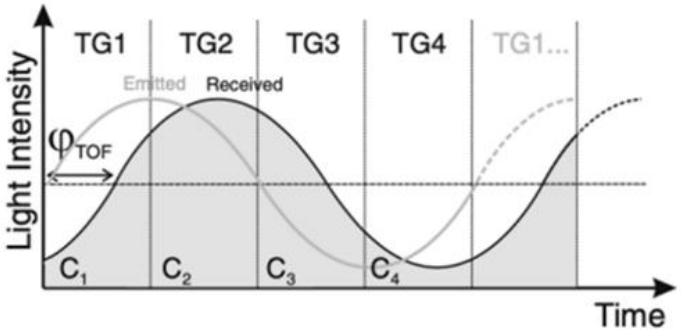

Figure 2-1. Light time of flight and light intensity

2.3 Block Diagram of Solid State Lidar System

CS20 solid state lidar hardware system includes two main components, ISP processor and Depth module. The ISP processor is located on the motherboard, and the ToF module is connected to the motherboard through a connector.

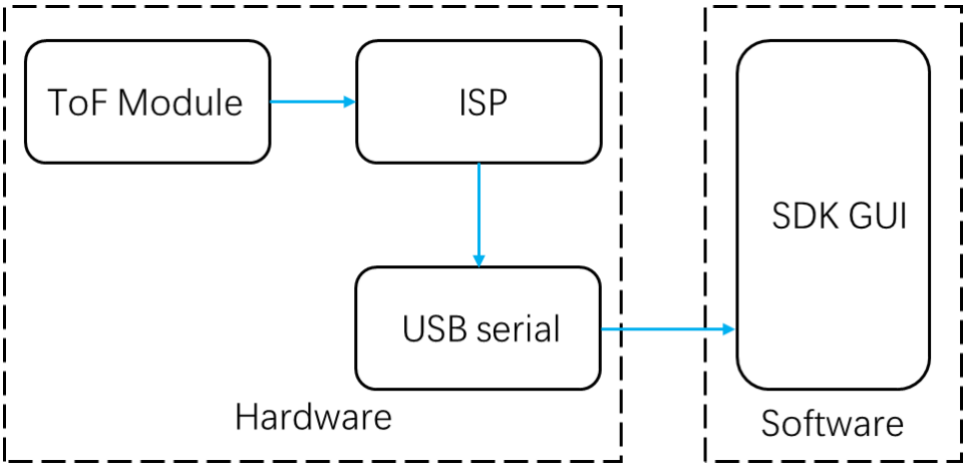

Figure 2-2. CS20 Block Diagram of Solid State Lidar System

2.4 Technical parameter

Technical parameter		
depth image	Resolution	640*480/320*240
	FOV	H60°xV45°
Basic parameters	Working distance	0.1-5m, indoor
	VCSEL wavelength	940nm
	precision	0.1~0.5m: ±2.5cm; 0.5~5m: ±1% @ 90% reflectivity
	Size	48mm x 34mm x 12mm
	data transmission	USB 2.0 Agreement ， Type C Interface
	Power supply	5V, average 0.5A
	Power consumption	average 1.2W
	operating system	Win 10，Linux，ROS
	Operating temperature	-10 ~ 50℃
	safety	Laser CLASS1

3. Component Specifications

3.1 ToF module

ToF 模组组件如表所示：

Component	Description
ToF imager	Time of light image sensor
ToF emitter	Class 1 laser compliant (optional)
Other Components	Laser Driver, EEPROM, Voltage Regulators, FPC, Connector etc.

Table 3-1. ToF module components

3.1.1 ToF Module Image Sensor

Component	Description
Active Pixels	640*480/320*240
Sensor Aspect Ration	4：3
Format	10-bit RAW
Shutter Type	Global shutter
Signal Interface	MIPI CSI-2, 2X Lanes
F Number	1.4
Effect Focal Length	3.90mm
Focus	Fixed
Horizontal Field of View	59.2
Vertical Field of View	46.0
Diagonal Field of View	71.0
TV Distortion（Trad.*2)	<1.5%

Table 3-2. ToF Image sensor parameters

3.1.2 ToF Module Laser Emitter

The ToF laser emitter emits uniform near-infrared (940nm) light to the object, and the laser emitter meets Class 1 laser safety requirements under normal operation.

Items	Test Condition	Min	Typical	Max	Unit
Optical Output power	Pulse=3.5A，50℃	2.3	2.7	-	W
Threshold current	Pulse 50℃	0.3	0.45	0.7	A
Operating Current	Pulse 50℃	-	3.5	-	A
Operating voltage	Pulse=3.5A，50℃	-	2.14	2.6	V
Slope efficient	Pulse=3.5A，50℃	0.8	1	-	mW/mA

Power conversion efficiency	Pulse=3.5A，50℃	33	36	-	%
Angle	Pulse=3.5A，50℃	-	72	-	°
	Pulse=3.5A，50℃	-	58	-	
Wavelength	If=6A，50℃	930	940	950	nm
Wavelength coefficient	Pulse=3.5A	-	0.07	-	nm/℃

Table 3-3. ToF Module Laser Emitter Parameters

3.2 ISP Mainboard

Components	Description
ISP Processor	PC Camera Controller
8 MB Flash	PC Camera Controller firmware storage and ToF firmware storage
24 MHz Crystal	Clock source for Vision Processor
Depth Module Receptacle	(36+10)pin receptacle for connection to Depth Module
USB Type-C	USB peripheral connector for connection to Host USB 2.0 port
Voltage Regulators	DC to DC and LDO converters powering Vision Processor Board and depth module
Mounting holes	Vision Processor Board secure mounting

Table 3-5.ISP Motherboard components

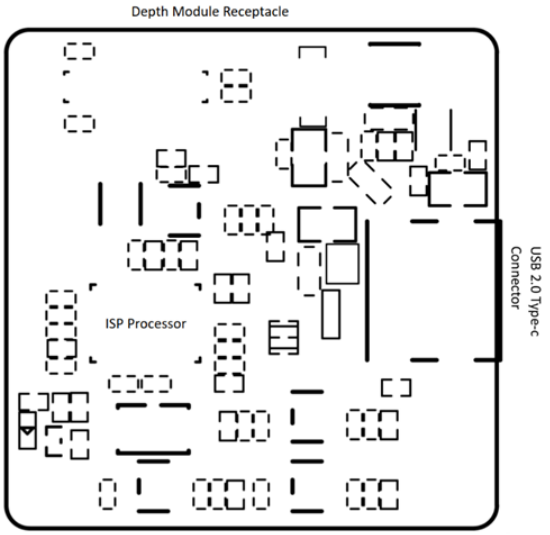

Figure 3-1. CS20 ISP mainboard Schematic diagram

Dimension	Min	Nominal	Max	Unit
Width	30.3	30.5	30.7	mm

Height	30.08	31.0	31.2	mm
Depth	4.85	4.90	4.95	mm
Weight	4.45	4.50	4.55	g

Table 3-6. ISP Mainboard size

3.3.1 Type C Explain

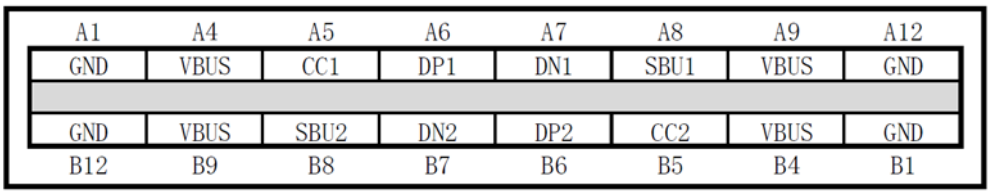

Figure 3-2. USB Type-C Receptacle Pin Map

Pin	Signal	Function	Pin	Signal	Function
A1	GND	接地	B12	GND	接地
A4	VBUS	总线电源	B9	VBUS	总线电源
A5	CC1	Configuration channel	B8	SBU2	NC
A6	DP1	USB 2.0差分信号，position 1，正	B7	DN2	USB 2.0差分信号，position 2，负
A7	DN1	USB 2.0差分信号，position 1，负	B6	DP2	USB 2.0差分信号，position 2，正
A8	SBU1	NC	B5	CC2	Configuration channel
A9	VBUS	总线电源	B4	VBUS	总线电源
A12	GND	接地	B1	GND	接地

Figure 3-3. USB Peripheral Connector Pin List

3.3 power waste

状态	Imin（mA)	Iavg（mA)	Ipp（mA)
Standby(complete machine)	91	195	1896
Standby	5	5	5
Supply voltage：VBUS=5V，The measured data is based on the exposure time =1500us。			

Table 3-7. CS20 Power consumption index of solid-state lidar

4. Performance evaluation

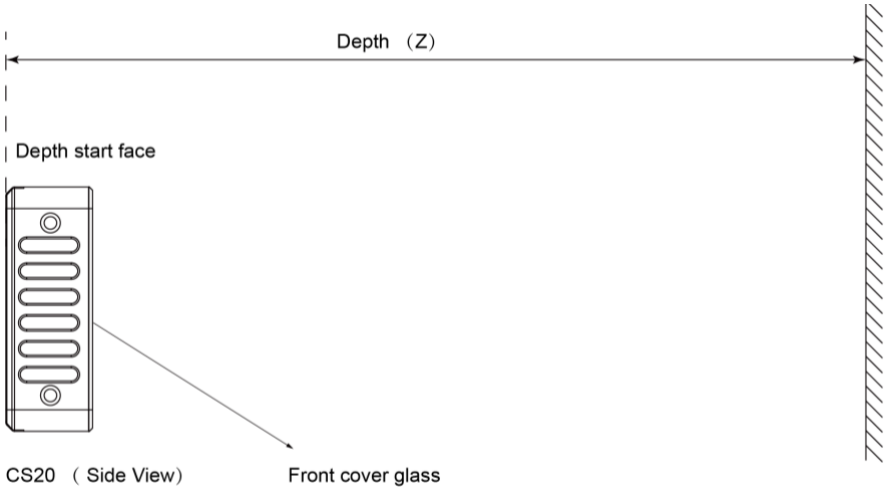

Figure 4-1 CS20 Evaluation starting point

1) Absolute accuracy: refers to the difference between the measurement result and the real data, it is used to characterize the closeness of the measurement result to the real data, The formula is defined as follows:

$$Accuracy = \left| \frac{\sum_i depth_i}{N} - D \right|$$

2) Inter frame noise: used to evaluate the stability of depth data between multiple frames. The formula of inter frame noise is defined as follows:

$$Temporal\ noise = \frac{1}{N} \sum_i \sqrt{\frac{\sum_j \left(depth_j - \frac{\sum_j depth_j}{M} \right)^2}{M}}$$

3) Point cloud thickness: shoot the white wall and test the point cloud thickness of the white wall at different distances.

5. Mechanical structure

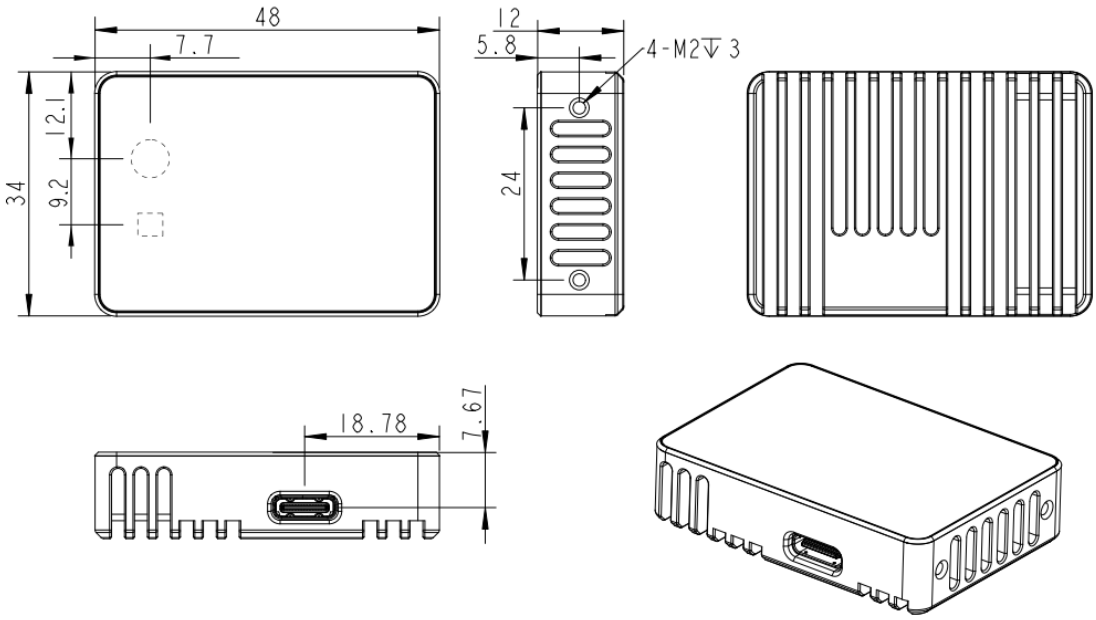

Figure 5-1 CS20 Structure Diagram of Solid State Lidar

Dimension	Min	Nominal	Max	Unit
Width	47.74	47.94	48.14	mm
Height	33.8	34	34.2	mm
Depth	11.8	12	12.2	mm
Weight	32.5	33	33.5	g

Table 5-1. structure size

6. Storage conditions

Condition	Description	Min	Max	Unit
Storage Temperature		-15	60	°C
	Humidity	Temperature/RH: 40°C/90%		
Work Temperature		-10	50	°C

7． Camera Cleaning Steps

1. Do not spill any chemicals or water on the camera lens
2. Remove dust and dirt from the lens with a lens blower
3. Wipe with a dry, clean microfiber cloth

8. Software

- Windows ---Credimension Viewer

The windows demo GUI tool of the Credential Viewer CS20 series. This tool is mainly used to obtain the depth, IR, and point cloud information displayed and saved. It also supports the functions of viewing the basic information of the device, setting the resolution integration time, and so on.

- SDK---CSAPI

Customers can use the CS20 SDK for secondary development. The SDK supports Windows/Linux (Ubuntu/ARMv7/ARMv8)/ROS platforms, and has made specific performance optimization for the embedded architecture. For detailed usage methods, please refer to the supporting documentation in the SDK.

9. Compliance regulations

“ ROHS、CE、FCC、CLASS 1 ”

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