Intelligent Rain Detection Module Datasheet

1. Introduction

This intelligent rain detection module is mainly intended for automatic wiper control of security cameras. When installed inside a camera windshield, the module is capable of sensing precise rainfall status on the glass surface of the windshield and feeds back information(no rain, light rain, moderate rain, or heavy rain) to a host by UART, then the host can control the wiper to get rid of the raindrops on the windshield to ensure a clear view for the camera in rainy conditions.

1.1 Features

- Based on optical sensing system, accurately detects rainfall status on glass and sends information to host via UART;
- HALIOS®-SD measurement method, high robustness against strong sunlight;
- Less environmental interference and longer service life since the product is used inside windshields without direct exposure to external natural environment;
- Tiny body with a diameter of 12.5±0.15mm, suitable for cameras of all kinds;
- CRC-8 check for improving anti-interference ability in communication;
- Partial parameters setup can be changed by UART configuration;
- Error self-diagnostic, actively sends error status to host via UART;
- Optical system self-calibration;
- Ambient light detection, providing cameras with more auxiliary parameters;
- On-board temperature detection, excellent temperature linearity to ensure accurate measurements;
- Supporting optical sleep mode to extend the service life of the optic components.

1.2 Ordering Information

Table 1.1 Ordering Information

Type	Voltage(V)	Temperature	Encapsulation	Packaging	MSL
RS200 V2.00	3.3V	-40°C~85°C	-	EPE (pcs/layer)	3

2. Function Description

The module interacts with the host via UART, and the serial port setup is shown in Table 2.1. The implementation of all functions depends on UART transmitting and receiving commands.

<p align="center">Table 2.1 Serial Port Setup</p>

Baud Rate	115200
Data Bit	8bit
Stop Bit	1bit
Check Bit	NONE

The format of each frame data is shown in Table 2.2. The frame header is 0x3A, as shown in Table 2.3; the frame flags and frame data represent one frame data, as shown in Table 2.4. Both the module and the host have to pass a CRC-8 checksum when transmitting or receiving one frame data, and FCS represents the CRC-8 checksum value of the frame flag and the frame data, as shown in Table 2.5.

<p align="center">Table 2.2 Serial Data Frame Structure</p>

Frame Header	Frame Flag	Frame Data	FCS CRC-8
1Byte	1Byte	2Byte (hexadecimal, little-endian format)	1Byte

<p align="center">Table 2.3   Frame Header Definition</p>

Frame Header[7:0]	Frame Header Definition
0x3A	Each frame of 5 Byte data must start with 0x3A (colon character ":" in ASCII)

Table 2.4 Definition of Frame Flag & Frame Data

Frame Flag[7]: Data Read & Write Property	Frame Flag[6:0]: Data Number	Frame Data [15:0]: Data Value	Description
0 (Read) 1 (Write)	0 (Firmware Version)	X	Frame Data [15:8] major version number, Frame data [7:0] backup version number
	1 (Rainfall Status)	0	No rain
		1	Light rain
		2	Moderate rain
		3	Heavy rain
	2 (System Status)	0	Normal
		1	RS200 Internal communication error
		2	LEDA damaged
		3	LEDB damaged
		4	Optical system calibration not good
		5	Parameter configuration failure
		6	Serial communication error (serial port check error)
		7	Low voltage warning (low voltage threshold 2.8V)
	3 (Optical System)	0	Perform optical system calibration
		1	Send optical system calibration value
	4 (Enter Real-time Rainfall Mode)	0	Exit real-time rainfall mode
		1	Enter real-time rainfall mode

Frame Flag[7]: Data Read & Write Property	Frame Flag[6:0]: Data Number	Frame Data [15:0]: Data Value	Description
0 (Read) 1 (Write)	5 (Rainfall status output frequency or enabling status)	0~9	Rainfall status output frequency, the default is 1, representing 50ms; modifiable. Increasing or reducing 1 represents an increase or decrease of 50ms (output is disabled when it's 0)
	6 (No-rain/light-rain threshold V1)	0~65535	No-rain/light-rain threshold V1
	7 (Light-rain/moderate-rain threshold V2)	0~65535	Light-rain/moderate-rain threshold V2
	8 (Moderate-rain/heavy-rain threshold V3)	0~65535	Moderate-rain/heavy-rain threshold V3
	9 (No-rain/light-rain threshold S1)	0~65535	No-rain/light-rain threshold S1
	10 (Light-rain/moderate-rain threshold S2)	0~65535	Light-rain/moderate-rain threshold S2
	11 (Moderate-rain/heavy-rain threshold S3)	0~65535	Moderate-rain/heavy-rain threshold S3
	12 (Threshold of the number of times determined to be heavy rain in 10 measurements N1)	1~10	Threshold of the number of times determined to be heavy rain in 10 measurements N1
	13 (Threshold of the number of times determined to be moderate rain in 10 measurements N2)	1~10	Threshold of the number of times determined to be moderate rain in 10 measurements N2
	14 (Threshold of the number of times determined to be light rain in 10 measurements N3)	1~10	Threshold of the number of times determined to be light rain in 10 measurements N3

		0	Exit ambient light detection mode Continued
15 (Ambient light detection mode)		1	Enter ambient light detection mode
16 (Host reads module temperature)		0	Host reads module temperature once
17 (Module optical sleep mode)		0	Exit sleep mode and enter rainfall detection
		1	Enter sleep mode

Table 2.5 FCS Definition

FCS[7:0]	Polynomial (HEX)	Data Reverse	Initial Value (HEX)	XOR Value (HEX)
CRC-8	x8+x5+x4+1 (0x31)	MSB First	0xFF	0x00

Examples of most frame data with different functions are shown in Table 2.6, xx indicates that the data varies with the frame data.

Table 2.6   Examples of Frame Data with Different Functions

Frame Flag[7]	Frame Flag [6:0]	Frame Data [15:0]	Description	Command Codes in Hex format
0	0	X	The host commands the module to send firmware version	3A 00 00 00 4B
1	0	X	The module sends firmware version to host	3A 80 xx xx xx
1	1	1	The module sends rainfall status to host: light rain	3A 81 01 00 2C
1	1	2	The module sends rainfall status to host: moderate rain	3A 81 02 00 01
1	1	0	The module sends rainfall status to host: no rain	3A 81 00 00 D8
1	1	3	The module sends rainfall status to host: heavy rain	3A 81 03 00 F5
0	1	X	The host reads rainfall status from the module	3A 01 00 00 0D
1	2	0	The module sends system status to host: system normal	3A 82 00 00 12
1	2	1	The module sends system status to host: module communication error	3A 82 01 00 E6
1	2	2	The module sends system status to host: LEDA damaged	3A 82 02 00 CB

Continued

Frame Flag[7]	Frame Flag [6:0]	Frame Data [15:0]	Description	Command Codes in Hex format		
1	2	3	The module sends system status to host: LEDB damaged	3A 00	82 3F	03
1	2	4	The module sends system status to host: optical system calibration is not good	3A 00	82 91	04
1	2	5	The module sends status to host: fail to write optical system parameter	3A 00	82 65	05
1	2	6	The module sends status to host: check error of the received serial data	3A 00	82 48	06
1	2	7	The module sends status to the host: the current voltage of the module is no more than 2.8 V	3A 00	82 BC	07
0	2	X	The host reads system status from module	3A 00	02 C7	00
1	3	X	The host commands module to perform optical system calibration	3A 00	83 54	00
0	3	X	The host reads the optical system calibration value from the module	3A 00	03 81	00
1	3	X	The module sends the optical system calibration value to the host	3A xx	83 xx	xx
1	4	0	The host commands the module to exit real-time rainfall mode	3A 00	84 B7	00
1	4	1	The host commands the module to enter real-time rainfall mode	3A 00	84 43	01
1	5	X	The host commands the module to set rainfall status output frequency as X	3A xx	85 xx	xx
0	5	X	The host reads the rainfall status output frequency from the module	3A 00	05 24	00

Frame Flag[7]	Frame Flag [6:0]	Frame Data [15:0]	Description	Command Codes in Hex format
1	5	X	The module sends the rainfall status output frequency to the host	3A 85 xx xx xx
1	6	X	The host commands module to set no-rain/light-rain threshold V1	3A 86 xx xx xx
0	6	X	The host reads no-rain/light-rain threshold V1 from module	3A 06 00 00 EE
1	6	X	The module sends no-rain/light-rain threshold V1 to the host	3A 86 xx xx xx
1	7	X	The host commands module to set light-rain/moderate-rain threshold V2	3A 87 xx xx xx
0	7	X	The host reads light-rain/moderate-rain threshold V2 from module	3A 07 00 00 A8
1	7	X	The module sends light-rain/moderate-rain threshold V2 to the host	3A 87 xx xx xx
1	8	X	The host commands module to set moderate-rain/heavy-rain threshold V3	3A 88 xx xx xx
0	8	X	The host reads moderate-rain/heavy-rain threshold V3 from module	3A 08 00 00 19
1	8	X	The module sends moderate-rain/heavy-rain threshold V3 to the host	3A 88 xx xx xx
1	9	X	The host commands module to set no-rain/light-rain threshold S1	3A 89 xx xx xx
0	9	X	The host reads no-rain/light-rain threshold S1 from module	3A 09 00 00 5F
1	9	X	The module sends no-rain/light-rain threshold S1 to the host	3A 89 xx xx xx
0	10	X	The host reads light-rain/moderate-rain threshold S2 from module	3A 0A 00 00 95
1	10	X	The module sends light-rain/moderate-rain threshold S2 to the host	3A 8A xx xx xx
1	11	X	The host commands module to set moderate-rain/heavy-rain threshold S3	3A 8B xx xx xx
1	10	X	The host commands module to set light-	3A 8A xx

			rain/moderate-rain threshold S2	xx	xx	
0	11	X	The host reads moderate-rain/heavy-rain threshold S3 from module	3A 00	0B D3	00
1	11	X	The module sends moderate-rain/heavy-rain threshold S3 to the host	3A xx	8B xx	xx
1	12	X	The host commands module to set the threshold N1 for the number of times of heavy rain in 10 measurements	3A xx	8C xx	xx
0	12	X	The host reads the threshold N1 for the number of times of heavy rain in 10 measurements from module	3A 00	0C 30	00
1	12	X	The module sends the threshold N1 for the number of times of heavy rain in 10 measurements to the host	3A xx	8C xx	xx
1	13	X	The host commands module to set the threshold N2 for the number of times of moderate rain in 10 measurements	3A xx	8D xx	xx
0	13	X	The host reads the threshold N2 for the number of times of moderate rain in 10 measurements from module	3A 00	0D 76	00

Frame Flag[7]	Frame Flag[6:0]	Frame Data[15:0]	Description	Command Codes in Hex format
1	13	X	The module sends the threshold N2 for the number of times of moderate rain in 10 measurements to the host	3A 8D xx xx xx
1	14	X	The host commands module to set the threshold N3 for the number of times of light rain in 10 measurements	3A 8E xx xx xx
0	14	X	The host reads the threshold N3 for the number of times of light rain in 10 measurements from module	3A 0E 00 00 BC
1	14	X	The module sends the threshold N3 for the number of times of light rain in 10 measurements to the host	3A 8E xx xx xx
1	15	0	The host commands the module to exit ambient light detection mode	3A 8F 00 00 2F
1	15	1	The host commands the module to enter ambient light detection mode	3A 8F 01 00 DB
1	15	X	The module sends ambient light value to the host	3A 8F xx xx xx
0	16	X	The host commands the module to send chip temperature	3A 10 00 00 EF
1	16	X	The module sends chip temperature to the host	3A 90 xx xx xx
1	17	0	The host commands module optical system to exit sleep mode	3A 91 00 00 7C
1	17	1	The host commands module optical system to enter sleep mode	3A 91 01 00 88

2.1 Rainfall Detection Function

The module classifies rainfall states into four types: no rain, light rain, moderate and heavy rain. Refer to the command list for details. Meanwhile, it also supports parameter settings of the four rainfall states to meet various sensitivity and other practical needs. The relevant factory parameter ranges are shown in Table 2.7.

Parameter V: the active degree of the dynamic raindrop flowing on the glass surface, the faster the raindrop flow, the larger the parameter V.

Parameter S: the "unevenness" of the static raindrop distributed on the glass surface, the higher the unevenness degree, the larger the parameter S.

Parameter N: The module will obtain the real-time rainfall status first according to the

parameter V and S, and then determine the rainfall status as light rain, moderate rain, or heavy rain in 10 measurements, and finally output the rainfall status with most times through UART.

Note: Parameters V, S, N, frequency and calibration will be saved to internal Flash during configuration, so it is necessary to ensure stable power supply.

Table 2.7 Parameter Range

Parameters	Factory/Reset Value (Decimal)	Adjustable Range	Relationship
No-rain/light-rain threshold V1	30	0~65535	V3>V2>V1
Light-rain/moderate-rain threshold V2	255	0~65535	
Moderate-rain/heavy-rain threshold V3	1535	0~65535	
No-rain/light-rain threshold S1	30	0~65535	S3>S2>S1
Light-rain/moderate-rain threshold S2	255	0~65535	
Moderate-rain/heavy-rain threshold S3	1535	0~65535	
Threshold N1 for heavy rain	2	1~10	N3>=N1
Threshold N2 for moderate rain	2	1~10	N3>=N2
Threshold N3 for light rain	2	1~10	

2.2 Environmental Detection Function

The module supports ambient light (white light) detection, which can be used with rainfall detection function. This function is enabled by commands. When enabled, the ambient light value will be output at a fixed frequency. The Ambient light feedback value range(decimal) is 0 ~ 1024. And the higher the light intensity, the lower the feedback value, or vice versa. Currently, there is no correlation curve for light intensity-vs.-feedback value .

2.3 Temperature Detection Function

The module supports ambient temperature detection function, which is implemented by the integrated on-chip temperature sensor. As shown in Figure 2.1, the measured ambient temperatures range from -40°C to 85°C with a stepping of 5°C and they have good linearity. In the calculation formula, y represents the temperature value from RS200 feedback(it's hexadecimal in RS200 feedback, and decimal in the calculation formula); x represents the ambient temperature.
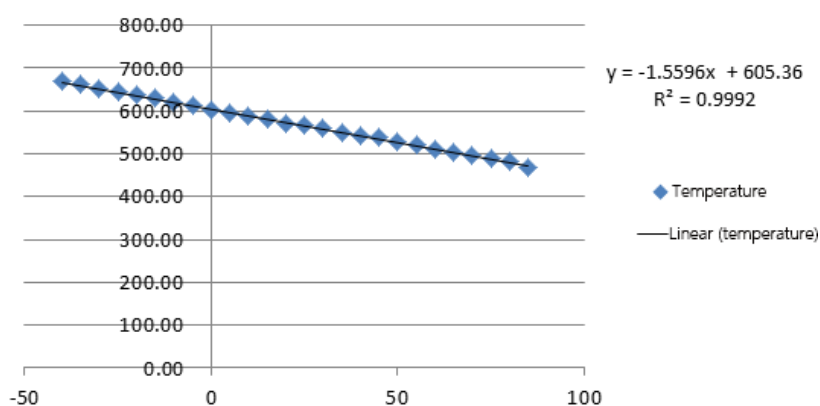

$$y = -1.5596x + 605.36$$
$$R^2 = 0.9992$$

Figure 2.1 Temperature Detection Linearity Analysis

2.4 System State Description

The module will automatically monitor the system status during operation, and if there is any abnormality in the system, the module will send the system status to the host. The descriptions of various abnormalities are shown in Table 2.8.

Table 2.8 Descriptions of Abnormal Phenomena：

Abnormal Phenomena	Description
Module internal communication error	The chips of the module can't communication normally.
LEDA damaged	Indicates the current rainfall data is invalid. When 10 consecutive sets of invalid data are detected, LEDA error indication will be given once and the internal error count will increase by 1; when 10 consecutive sets of valid data are detected, the internal error count will decrease by 1. If the error count reaches 3, the module will restart after 5s.
LEDB damaged	Indicates that the current rainfall data and values are invalid. When 10 consecutive sets of invalid rainfall data and values are detected, LEDB error indication will be given once and the internal error count will increase by 1; when 10 consecutive sets of valid rainfall data and

	values are detected, the internal error count will decrease by 1. If the error count reaches 3, the module will restart after 5s.
Optical system calibration not good	After calibration, the absolute value of no-rain rainfall value minus 255 is too larger
Optical system parameter writing failure	An error occurred while writing non-volatile memory to Flash of MCU
Check error of received serial data	The module received a host command check error, and the command will not be executed by RS200
Low voltage warning	Module voltage is no more than 2.8V

3. Pin Function

3.1 Pinout

The module uses a 0.8mm wire-to-board socket to lead out the power supply and communication pins for easy use, as shown in Figure 3.1. The communication pins are 2-wire serial ports that can communicate with the host directly and send rainfall status data, and the pin definition is shown in Table 3.1.
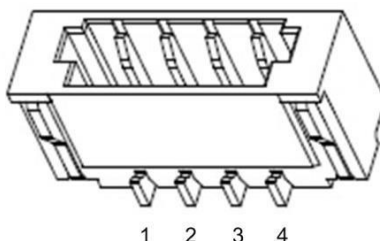
Figure 3.1 Wire-to-Board Socket

3.2 Pin Description

Table 3.1 Pin Definition

NO.	Signal Name	Function	Remarks
1	VCC	3.3V Power Supply	-
2	UART_TX	UART Receiving	Connected to the pin TX of the host UART
3	UART_RX	UART Transmitting	Connected to the pin RX of the host UART
4	GND	Ground	-

4. Electrical Characteristics

4.1 Electrical Features

Power supply features: DC: 3.3V~31mA, the range is shown in Table 4.1.

Table 4.1 Power Supply Features

Parameter	Symbol	Specification			
		Minimum	Typical	Maximum	Unit
Operating Voltage	VCC	3.00	3.3	3.5	V
Operating Current	I	-	31	-	mA

4.2 Communication Parameter

The UART communication parameter is shown in Table 4.2. The UART level standard

is TTL-3.3V.

Table 4.2 Serial Communication Parameter

Parameter	Symbol	Specification			
		Minimum	Typical	Maximum	Unit
Serial Communication Rate	--	Not support	115200	Not support	bps

4.3 Temperature Parameter

The temperature parameter is shown in Table 4.3.

Table 4.3 Temperature Parameter

Parameter	Symbol	Specification			
		Minimum	Typical	Maximum	Unit
Operating Temperature	Tamb	-40	——	+85	℃
Humidity	——	5	——	95	%RH

4.4 Power Consumption Parameter

The power consumption parameter test is shown in Table 4.4. The test carried out at room temperature and the RS200 module is powered at 5V.

Table 4.4 Power Consumption Parameter

Parameter	Symbol	Specification			
		Optical Sleep Mode	Rainfall Detection Mode	Ambient Light Detection Mode	Unit
Power Consumption	——	8	31	10	mA

5. Mechanical Dimensions

The mechanical dimensions of the module are shown in Figure 5.1, Figure 5.2, and Figure 5.3. It is a circular PCB with a diameter of 12.5 ± 0.15 mm. The inner circle with a diameter of 12 mm is the electricity distribution area and the circular area with a diameter of 11.5 mm is distributed with components. The highest component height on the front side is 1.10mm, and it's 2.7mm on the back side.

Please note that the electricity area with a diameter of 12mm can't be in contact with metal structures.
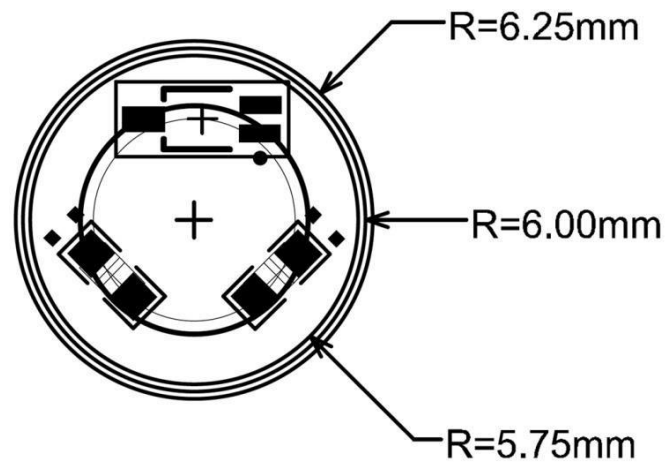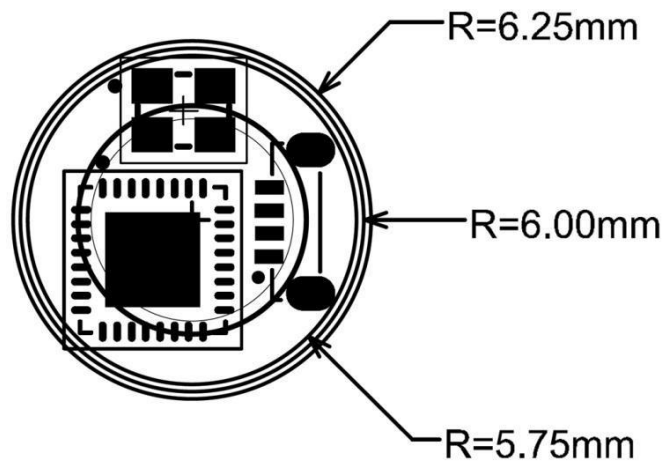

Figure 5.1   Dimensions on the Front Side

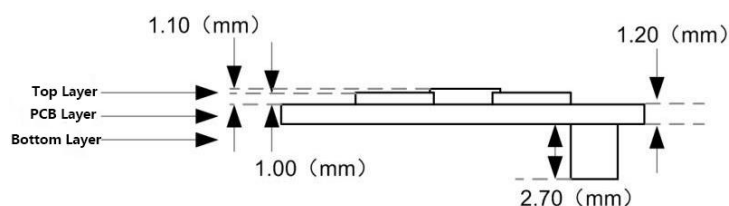Figure 5.2   Dimensions on the Back Side

Figure 5.3   The Heights

6. Notice

6.1 Storage

1. The module can't be stored under the following conditions

      a. Corrosive gases, such as CI2, H2S, NH3, SO2, and other NOx

      b. Saline environment, extremely humid environment

      c. Exposure to sunlight for a long time

      d. Environments with overhigh temperature and humidity

2. Avoid dropping, vibration and mechanical pressure

3. Avoid high voltage, and electrostatic contact to prevent the device from damage

4. The device has a moisture sensitivity class of MSL:3, please keep it from moisture.