

FS8864-SME-A40

MultiPixel 3D ToF Micro Sensor Module

Rev 9 Preliminary

Product Description

FS8864-SME-A40 series products are 3D ToF micro sensor module which 4x4 16 pixels 3D ToF (Time of Flight) sensors, microprocessors and optional PMU (Power Management Unit).

The module provides depth and intensity information on each pixel for measurement up to 4m min. (refer to detailed part number description), and can be used either indoor or outdoor environment.

The products meet the eye-safety standard and varies of international safety standards.

Product Highlight

- 3D depth and intensity measurement by ToF
- 4x4 pixels
- 16° FOV-D typ.
- Micro module size
- Eye safe, IEC60825-1 Class 1

Product Application

- 3D Sensor
- Gesture recognition
- Human-Machine Interaction
- Robot navigation and obstacle avoidance

Part Number

FS8864-SME-A40

-SME:

-SME, with microprocessor and PMU

-A40:

-A40, 4.0m min. measurement range, 4X4 pixels

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Parameters

(Under 25°C typ unless otherwise stated. All parameters are based upon measurements from a Luminwave approved evaluation system, including hardware, firmware with an appropriate calibration, and GUI.)

Parameter	Note	Value	Unit
Working Distance	90% Reflectance -A40:	0.1-4m min.	m
Ambient Light Suppression		TBD	klx
Field Of Angle, FOV	4x4 FOV-D 4x4 FOV-H/V	16 typ. 10 typ.	°
Distance Resolution* ¹	0.1-0.5m: 0.5-1.5m: >1.5m:	1 2 4	cm
Distance Accuracy* ¹	0.1-1m: >1m:	4 4%	cm
Distance Repeatability* ²	0.1-0.5m: >0.5m:	1 2%	cm
Emitter Wavelength		940	nm
Acquisition		10 typ.	fps
Supply Voltage		+5	V
Average Power Consumption* ³		360 typ. 420 max.	mW
Operation temperature		-10—55	°C
Storage temperature		-20—80	°C

Note:

1. Based upon the average of 50 measurements. 2. Based upon 50 measurements, 1 σ . 3. Based upon 10fps typ. measured by –SMD.

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Pixel area

ToF Sensor Pixel Area

Pixels are identified as (Row, Col), examples of 4x4, 6x6 and 8x8 are shown below. The size of the pixels are identified by part numbers.

0,0	0,1	0,2	0,3
1,0	1,1	1,2	1,3
2,0	2,1	2,2	2,3
3,0	3,1	3,2	3,3

4x4 pixels, e.g. -A40

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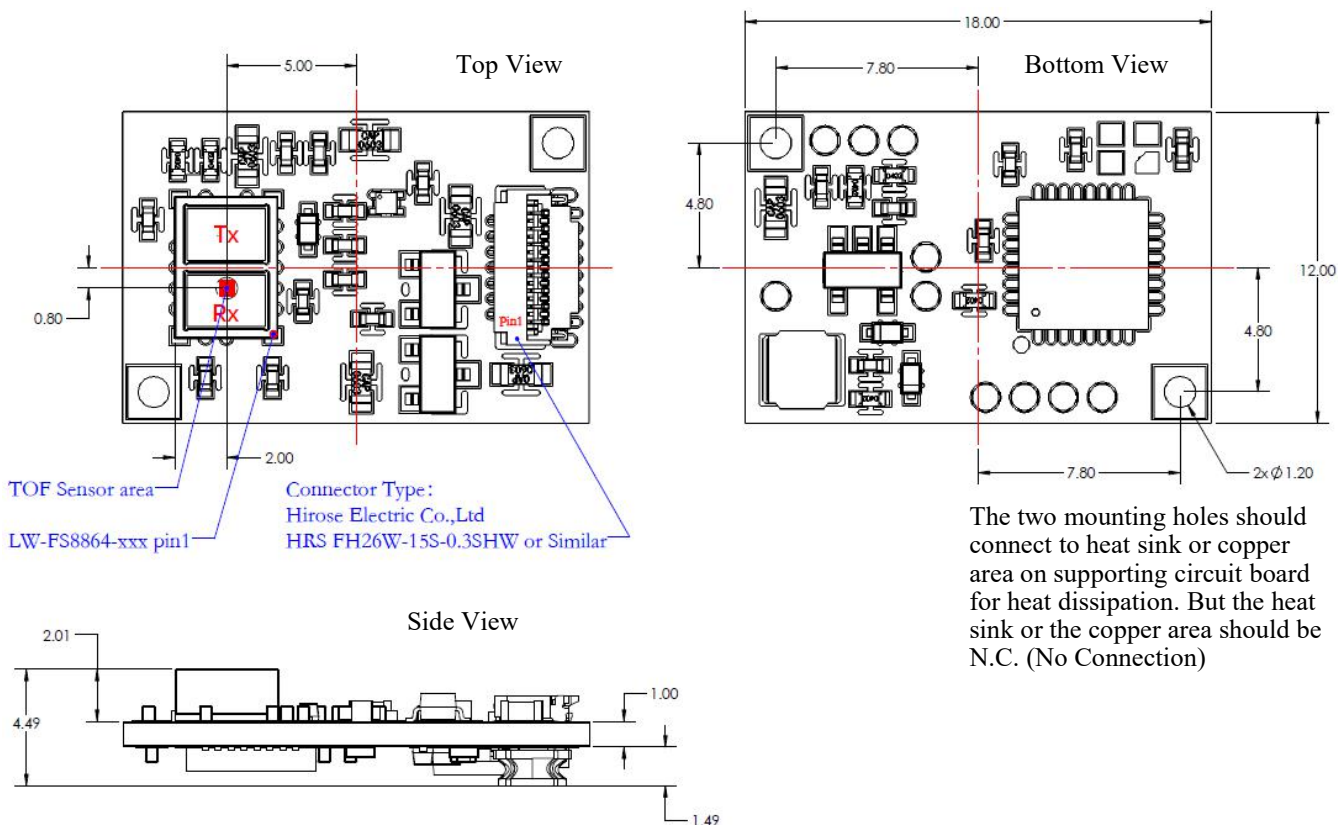
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Dimension

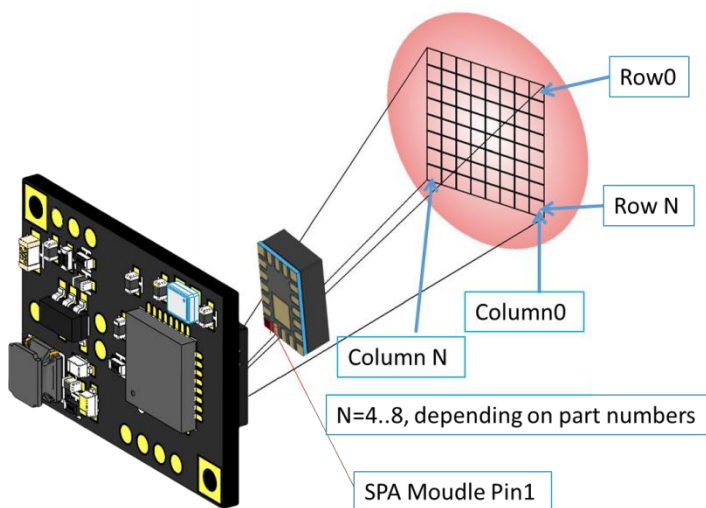
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18mm L x 12mm W x 4.49mm H

Unit mm



The two mounting holes should connect to heat sink or copper area on supporting circuit board for heat dissipation. But the heat sink or the copper area should be N.C. (No Connection)



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Pin Definition

Pin #	-SME
	Pin Definition
1	Reserved, NC
2	GND
3	GND
4	Reserved, NC
5	NC
6	GND
7	NC
8	NC
9	GND
10	UART RXD
11	GND
12	UART TXD
13	+5V
14	+5V
15	NC
NC: No Connection	

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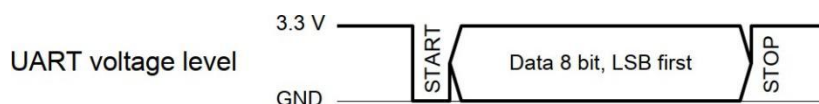
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UART Communication

The communication interface uses 8 bit UART standard on LVTTTL levels (3.3V) It operates with following parameters:

Parameter	Value	Unit	Comment
Baud rate	921'600	Bit/s	1 bit = 1.085μs
Start bits	1	Bit	low active
Data	8	Bit	
Stop bits	1	Bit	high active
Parity	No		



The UART operates in a master-slave mode with the application as the master and the sensor module as the slave.

Command Format:

The command packet has a fixed length of 14 Bytes: A start byte (value 0xF5), followed by 1 byte command ID (CMD), 8 bytes of parameters corresponding to the command and 4 closing bytes with a 32bit CRC.

1 byte	1 byte	8 bytes						4 bytes			
0xF5	CMD	Parameters, fix length						32 bit CRC			
		LSB					MSB	LSB			MSB

Response Format:

The answer packet has variable length: A start byte (value 0xFA), followed by 1 byte type definition, 2 byte length definition n, n bytes data and 4 closing bytes with a 32bit CRC.

1 byte	1 byte	2 bytes		n bytes				4 bytes			
0xFA	Type	Length n		Data				32 bit CRC			
		LSB	MSB	LSB			MSB	LSB			MSB

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CRC32:

The Cyclic Redundancy Check (CRC) calculation includes all bytes of the packet except the CRC itself. Examples are listed in the command list.

CRC specification:

- Bitwise CRC32
- Init value: 0xFFFFFFFF
- Xor value: 0x00000000
- Polynom: 0x04C11DB7

CRC calculation function:

```
uint32_t CrcCalc::calcCrc32(const uint8_t *data, const uint32_t size)
```

```
{
    uint32_t crc = initValue;
    for(uint32_t i = 0; i < size; i++)
    {
        crc = calcCrc32Uint8(crc, data[i]);
    }
    return crc ^ xorValue;
}
```

```
uint32_t CrcCalc::calcCrc32Uint8(uint32_t crc, uint8_t data)
```

```
{
    int32_t i;
    //This shift is done to make it compatible to the STM32 hardware CRC
    crc = crc ^ (data << 24);
    for (i = 0; i < 8; i++)
    {
        if (crc & 0x80000000)
        {
            crc = (crc << 1) ^ polynom;
        }
        else
        {
            crc = (crc << 1);
        }
    }
    return (crc);
}
```

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Command List note*:

SET_POWER [0x40]

Put the sensor module in power-up or power-down mode and returns after t_{PROC} acknowledge. Before any acquisition commands, power must be enabled.

Parameter byte 0: 0x00 disables power, 0x01 enables power
 others: 0x00

Command e.g. | 0xF5 | 0x40 | 0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0x9C 0xD7 0xD6 0x91 | (power enable)

Response type 0x00, Acknowledge

Response data 0 bytes

Response time power up t_{PROC} : < 200 ms

Response time power down t_{PROC} : < 30 μ s

Response e.g. | 0xFA | 0x00 | 0x00 0x00 | (0 bytes) | 0xB2 0xAB 0xFC 0xE8 |

GET_REGION_LENGTH_WIDTH[0x57]

Get the length and width of the ToF sensor pixel area.

Parameter no, all bytes 0x00

Command e.g. | 0xF5 | 0x57 | 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0xD7 0x7C 0xB3 0x05 |

Response type 0x0C, Data

Response data 2bytes: length and width of the ToF sensor pixel area ,8 bit unsigned integer.

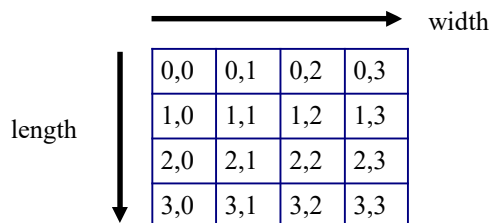
Response time t_{PROC} : ~ 40 μ s

Response e.g. | 0xFA | 0x0C | 0x02 0x00 | 0x08 0x08 | 0x7B 0xA5 0x60 0x0F |

(8x8 pixels, length = 8 and width = 8)

| 0xFA | 0x0C | 0x02 0x00 | 0x04 0x04 | 0xE4 0x5C 0x00 0xF5 |

(4x4 pixels, length = 4 and width = 4)



Note *: Still under development, the command list could be changed in the future version

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Command List:

GET_REGION_DISTANCE_AMPLITUDE [0X29]

Starts a new distance and ToF amplitude acquisition and returns the result or status of the ToF sensor pixel area after t_{PROC} . The amplitude is a quality indicator for the distance result.

Parameter no, all bytes 0x00

Command e.g. | 0xF5 | 0x29 | 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0xCB 0xFA 0xAB 0xE7 |

Response type 0x0B, Data

Response data length x width x 4 bytes distance followed by length x width x 4 bytes amplitude, total: 2x length x width x 4 bytes. For example, the size of the ToF sensor pixel area is 4x4 (16 pixels), the data are 16 x 4 bytes distance followed by 16 x 4 bytes amplitude, total 128 bytes.

Readout order each: Starts at (0,0), (0,1),, (0, n), (1,0),, and ends with (n,n).

Distance byte 0..3 each: Distance, 0.1mm/LSB or status, 32 bit unsigned integer.

Amplitude byte 0..3 each: ToF amplitude or status, 32 bit unsigned integer.

Below distance data indicate an "error" on the pixel (not a distance data).

Status: 16'001'000d: Low ToF amplitude

16'002'000d: overflow

16'003'000d: Saturation

16'004'000d: Reserved

16'005'000d: underflow

16'006'000d: High ToF amplitude

Below ToF amplitude data indicate the pixel is too "dark" or too "bright", then the distance data of this pixel may not be accurate.

Values < 100 LSB, distance noise is significant;

Values > 1900 LSB, the distance can contain considerable error.

ToF amplitude between 100 to 1900 indicates a good distance data.

Response time t_{PROC} : <25ms

Response e.g. | 0xFA | 0x0B | 0x80 0x00 | 0x24 0x0F 0x00 0x00 ... 0xE8 0x04 0x00 0x00 ... (128 bytes total) |

CRC (4 bytes) | (128 bytes) (distance 387.6mm ... amplitude 1256 LSB)

| 0xFA | 0x0B | 0x00 0x02 | 0x24 0x0F 0x00 0x00 ... 0xE8 0x04 0x00 0x00 ... (512 bytes total) |

CRC (4 bytes) | (512 bytes) (distance 387.6mm ... amplitude 1256 LSB)

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Command List:

SET_ADAPTIVE_INTEGRATION [0X55]

Turn on the adaptive integration time function. The integration time will be determined automatically during the measurement. Each measurement could have a different integration time depending on the object being measured. After turning on the module, the default enables the adaptive integration time function. When the adaptive integration time function is enabled, the module won't respond to the SET_INTEGRATION_TIME_DIS [0x00] command. By turning on the adaptive integration time function, the typical acquisition speed is about 12fps, which means the module can respond about 12 acquisition commands, like GET_REGION_DISTANCE_AMPLITUDE [0x29], in a second.

Parameter byte 0: 0x00 = enables adaptive integration time, 0x01 = disables adaptive integration time
others: 0x00

Command e.g. | 0xF5 | 0x55 | 0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0x66 0xE9 0XD2 0xBE | (disables adaptive time function)

| 0xF5 | 0x55 | 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0xAC 0X35 0X73 0xE5 | (enables adaptive time function)

Response type 0x00, Acknowledge

Response data 0 bytes

Response time t_{PROC} : ~ 40 μ s

Response e.g. | 0xFA | 0x00 | 0x00 0x00 | (0 bytes) | 0xB2 0xAB 0xFC 0xE8 |

SET_PERIOD_FREQUENCY [0X58]

Determine the acquisitions in between two adaptive integration times. The purpose of this command is increasing fps in some applications. By default, SET_ADAPTIVE_INTEGRATION [0x55] enables adaptive integration time function on each measurement. If a higher fps is desired, SET_PERIOD_FREQUENCY [0x58] can be used to add a few acquisitions without updating the integration time. Ex., if the parameter is 5, the integration time is adaptively updated on the first acquisition and being kept in the next four acquisitions, then the integration time is adaptively updated again on the sixth acquisition and being kept in the next four acquisitions, and so on. By choosing an approximate parameter, the fps could be up to 30fps depending on the application. The parameter can be an unsigned int from 1 to 9.

Parameter byte 0: acquisitions in an adaptive integration timeperiod
others: 0x00

Command e.g. | 0xF5 | 0x58 | 0x05 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0xEB 0XA1 0X97 0x6D | (Period=5, one acquisition with an adaptive integration time then four acquisitions without changing the integration time)

Response type 0x00, Acknowledge

Response data 0 bytes

Response time t_{PROC} : ~ 40 μ s

Response e.g. | 0xFA | 0x00 | 0x00 0x00 | (0 bytes) | 0xB2 0xAB 0xFC 0xE8 |

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Command List:

SET_INTEGRATION_TIME_DIS [0x00]

Set the integration time manually for distance measurements and returns after t_{PROC} acknowledge. The integration time is stored and used as long power is on or until a new time is set. Range: 1 ... 1'600 μ s. 0 is not a valid value. To manually set the integration time, the adaptive integration function has to be disabled first.

Parameter byte 0, 1: Integration time in microseconds, 16 bit unsigned integer

others: 0x00

Command e.g. | 0xF5 | 0x00 | 0x00 0x1E 0x00 0x00 0x00 0x00 0x00 0x00 | 0xD9 0x85 0x1A 0x99 |
(30 μ s integration time)

Response type 0x00, Acknowledge

Response data 0 bytes

Response time t_{PROC} : ~ 40 μ s

Response e.g. | 0xFA | 0x00 | 0x00 0x00 | (0 bytes) | 0xB2 0xAB 0xFC 0xE8 |

GET_TEMPERATURE [0x4A]

Get the chip temperature during last distance acquisition.

Parameter no, all bytes 0x00

Command e.g. | 0xF5 | 0x4A | 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0x18 0x41 0xF5 0xA4 |

Response type 0xFC, Data

Response data 2 bytes: Temperature, 0.01 $^{\circ}$ C / LSB, 16 bit 2's complement signed integer.

Response time t_{PROC} : ~ 40 μ s

Response e.g. | 0xFA | 0xFC | 0x02 0x00 | 0x47 0x13 | 0x4F 0xEE 0x12 0x1F |
(temperature 49.35 $^{\circ}$ C)

GET_FIRMWARE_VERSION[0x49]

Get the firmware version (V.S.S).

Parameter no, all bytes 0x00

Command e.g. | 0xF5 | 0x49 | 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 | 0x05 0xA2 0x35 0xB6 |

Response type 0xFE, Data

Response data 4 bytes

byte 0, 1: Subversion S, 16 bit unsigned integer

byte 2,: Sensor type S, 8 bit unsigned integer

byte 3,: Version V, 8 bit unsigned integer

Response e.g. | 0xFA | 0xFE | 0x04 0x00 | 0x01 0x00 0x08 0x03 | 0x35 0x33 0x03 0x46 |
(Version 3.8.1)

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Command List:

DATA_NACK

System response only: Command not accepted or unknown.

Response type 0x01, Not acknowledged

Response data 0 bytes

Response e.g. | 0xFA | 0x01 | 0x00 0x00 | (0 bytes) | 0x35 0x07 0x24 0xE9 |

DATA_ERROR

System response only: Error occurred during the execution of the command. Response instead of the required data

Response type 0xFF, Error

Response data 2 bytes:

bit 0..14: Error number. Try it again. If the error remains, contact your sales responsible.

bit 15: 0

Response e.g. | 0xFA | 0xFF | 0x02 0x00 | 0x03 0x00 | 0x94 0xF6 0x35 0x81 |

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Revision History

Revision	Changes
Rev1 Preliminary	Initial Release, limited usage
Rev2 Preliminary	Update format
Rev3 Preliminary	Add UART Communication sections
Rev4 Preliminary	Update spec, update mechanical drawings, update UART Communication
Rev5 Preliminary	Update parameters and the test condition
Rev6 Preliminary	Update CRC32 example
Rev7 Preliminary	Add –SMD, update UART Communication
Rev8 Preliminary	Add –SME, update parameters, update UART Communication
Rev9 Preliminary	Add –B15, remove SMA/B, update parameters, update UART Communication

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CAUTION

ELECTROSTATIC SENSITIVE DEVICES

DO NOT OPEN PACKAGES OR HANDLE EXCEPT AT A STATIC-FREE WORKSTATION

