Himax Imaging, Ltd.

DATA SHEET

(DOC No. HM01B0-ANA-00FT870-DS)

HM01B0-ANA-00FT870

Compact Camera Module

Preliminary version 01 July, 2021

Himax Imaging, Ltd.

Revision History

July, 2021

Version	Date	Description of changes
01	2021/07/30	New setup.

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1. Sensor Specification

The HM01B0 is an Ultra Low Power Image Sensor **(ULPIS)** that enables the integration of an "Always-on" camera for computer vision applications such as gestures, intelligent ambient light and proximity sensing, tracking and object identification. The unique architecture of the sensor enables the sensor to consume very low power of <4mW at QVGA 60FPS, <2mW at QVGA 30FPS, and <1.1mW at QQVGA 30FPS.

The HM01B0 contains 324 x 324 pixel resolutions and supports a 324 x 244 window mode which can be readout at a maximum frame rate of 60FPS, and a 2x2 monochrome binning mode with a maximum frame rate of 120FPS. The video data is transferred over a configurable 1-bit, 4-bit or 8-bit video interface with support for frame and line synchronization. The sensor integrates a black level calibration circuit, automatic exposure and gain control loop, self-oscillator and motion detection circuit with interrupt output to reduce host computation and commands to the sensor to optimize the system power consumption.

The sensor is available in a Chip Scale Package **(CSP)** or Bare Die and measures less than 5mm^2. The sensor supports single, dual or triple power supply configuration and requires only 3 passive components enabling a highly compact camera module design for devices such as IoT, wearable, smart building, smart phone, tablets and slim notebooks.

1.1 Features

- Ultra Low Power Image Sensor designed for Always-on vision devices and applications
- High sensitivity 3.6µ BrightSense™ pixel technology
- 324 x 324 active pixel resolution with support for QVGA window, vertical flip and horizontal mirror readout
- <1.1mW QQVGA resolution at 30FPS,
  < 2mW QVGA resolution at 30FPS
- Programmable black level calibration target, frame size, frame rate, exposure, analog gain **(up to 8x)** and digital gain **(up to 4x)**
- Automatic exposure and gain control loop with support for 50Hz / 60Hz flicker avoidance
- Flexible 1-bit, 4-bit and 8-bit video data interface with video frame and line sync
- Motion Detection circuit with programmable ROI and detection threshold with digital output to serve as an interrupt
- On-chip self oscillator
- I2C 2-Wire serial interface for register access
- CSP and Bare Die sensor package option
- High CRA for low profile module design

1.2 Application

- Cellular and mobile phones
- Digital video camcorders
- PC multimedia
- Tablets

1.3 Key parameters

Module Parameters		Value
Image sensor part number		HM01B0-ANA
Pixel Array (Active/ Effective)		324 x 324 / 320 x 320
Pixel Size		3.6μm x 3.6μm
Image Diagonal		1.63mm
Optical Format		Full frame 1/11"; QVGA 1/13"
Color Filter Array		Monochrome
Shutter Type		Electronic Rolling Shutter
Frame Rate (Max.) (8-bit interface)		8-bit, 320p 45FPS @ 6MHz
		8-bit, QVGA 60FPS @ 6MHz
Frame Rate MAX (4-bit interface)		8-bit, 320p 45FPS @ 12MHz
		8-bit, QVGA 60FPS @ 12MHz
Frame Rate MAX (1-bit interface)		8-bit, 320p 30FPS@ 36MHz
		8-bit, QVGA 45FPS @ 36MHz
S/N Ratio MAX		38.7dB
Dynamic Range (1x / 8x)		64dB / 70dB
Sensitivity @ 530nm		5.6 V / Lux-sec
Pixel CRA MAX		30°
Supply Voltage (Typ.)	AVDD	2.8V
	DVDD	1.5V (Internal LDO)
	IOVDD	1.8V / 2.8V
Input Reference Clock		3 – 36MHz
Serial Interface		I2C, 400kHz max.
Video Data Interface		8-bit, 4-bit, 1-bit data output FVLD, LVLD, PCLK
Pixel Clock (PCLK) (MAX.)		36MHz
Output Format		6-bit / 8-bit RAW
Digital Output		Motion Interrupt (Active High)
Control Loop		Black Level, Exposure / Gain
Power Consumption (Typ.)		8-bit, QQVGA 30FPS 1.1mW
		8-bit, QVGA 30FPS <2mW
		8-bit, QVGA 60FPS <4mW
		Standby 200μW
Temperature		Operating -20 ºC to 85 ºC
		Stable Image 0 ºC to 60 ºC
Construction		3P+ IRCF
EFL		0.66 mm ± 5%
BFL		1.04 mm
Image circle		1.83 mm
Focus distance		35 cm
Depth of Field		30 cm ~ infinite
F/No		2.4
TV distortion		under 4.3%
Field of view	Horizontal	87°
	Vertical	87°
	Diagonal	115°
Relative illumination		Over 35%: y=1.0d
Chief ray angle		30°
Barrel size		M3.5 x P0.20
Holder size		5.0mm x 5.0mm
Total track (Barrel to image)		Y=2.80 ± 0.1 (at inf.)

1.4 QVGA window readout

The QVGA sensor window with an active resolution of 324 x 244 pixels is programmed by setting register 0x3010[0] to 1. The location of the windows fixed such that the coordinate of the first pixel read out location is 0, 0.

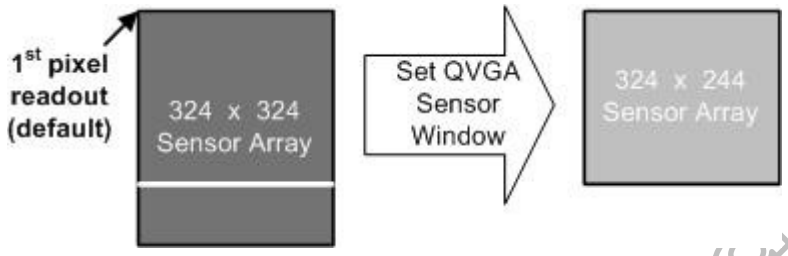


Figure 1.1: QVGA resolution pixel readout

1.5 Electrical specification

1.5.1 Operating ratings

Parameter	Symbol	Spec.			Unit
		Min.	Typ.	Max.	
Analog supply voltage	V_{DD-A}	2.6	2.8	3.0	V
Digital supply voltage	V_{DD-D}	1.35	1.5	1.65	V
IO supply voltage	V_{DD-IO}	1.7	1.8	3.0	V

Table 1.1: Operating ratings

1.5.2 DC characteristics

The power consumptions are measured in sense **(C_L = 5pF)**.

Parameter	Symbol	Condition	Spec.			Unit
			Min.	Typ.	Max.	
Average Current Consumption						
Active current 1	$I_{DD-AVDD1}$	External Internal LDO Mode, 8-bit RAW, QVGA @ 60FPS, PCLKO gated, V_{DD-A} = 2.8V,V_{DD-D} = 1.5V, V_{DD-IO} = 1.8V	-	271	-	µA
	$I_{DD-DVDD1}$		-	1201	-	µA
	$I_{DD-IOVDD1}$		-	287	-	µA
Active current 2	$I_{DD-AVDD2}$	Internal LDO Mode, 8-bit RAW, QVGA @ 60FPS, PCLKO gated, V_{DD-A} = 2.8V, V_{DD-IO} = 2.8V	-	278	-	µA
	$I_{DD-IOVDD2}$		-	1746	-	µA
Standby current 1	$I_{DD-STANDBY1}$	External Internal LDO Mode, V_{DD-A} = 2.8V, V_{DD-D} = 1.5V, V_{DD-IO} = 1.8V, MCLK on	-	105.7	-	µA
Standby current 2	$I_{DD-STANDBY2}$	External Internal LDO Mode, V_{DD-A} = 2.8V, V_{DD-D} = 1.5V, V_{DD-IO} = 1.8V, MCLK off	-	3	-	µA
Standby current 3	$I_{DD-STANDBY3}$	Internal LDO Mode, V_{DD-A} = 2.8V, V_{DD-IO} = 2.8V, MCLK on	-	142.3	-	µA
Standby current 4	$I_{DD-STANDBY4}$	Internal LDO Mode, V_{DD-A} = 2.8V, V_{DD-IO} = 2.8V, MCLK off	-	25.1	-	µA
Digital Inputs (MCLK, TRIG, SCL)						
Input voltage low	V_{IL}	-	GND – 0.3	-	$0.3V_{DD-IO}$	V
Input voltage high	V_{IH}	-	$0.7V_{DD-IO}$	-	V_{DD-IO} + 0.3	V
Input capacitance	C_{IN}	-		4	-	pF
Digital Output						
Output voltage low	V_{OL}	-	-	-	$0.2V_{DD-IO}$	V
Output voltage high	V_{OH}	-	$0.8V_{DD-IO}$	-	-	V
Output capacitance	C_{OUT}	-	-	4	-	pF
Output resistance	R_{OUT}	-	-	1	-	Ω
Tri-state leakage current	I_{OZ}	-	-	-	10	µA

Table 1.2: DC characteristics

1.5.3 Master clock input (MCLK)

Parameter	Symbol	Condition	Spec.			Unit
			Min.	Typ.	Max.	
Input frequency	MCLK	-	3	-	36	MHz
Input clock duty cycle	$MCLK_{DUTY}$	-	45	-	55	%

Table 1.3: Master Clock (MCLK) timing

1.6 Power up sequence

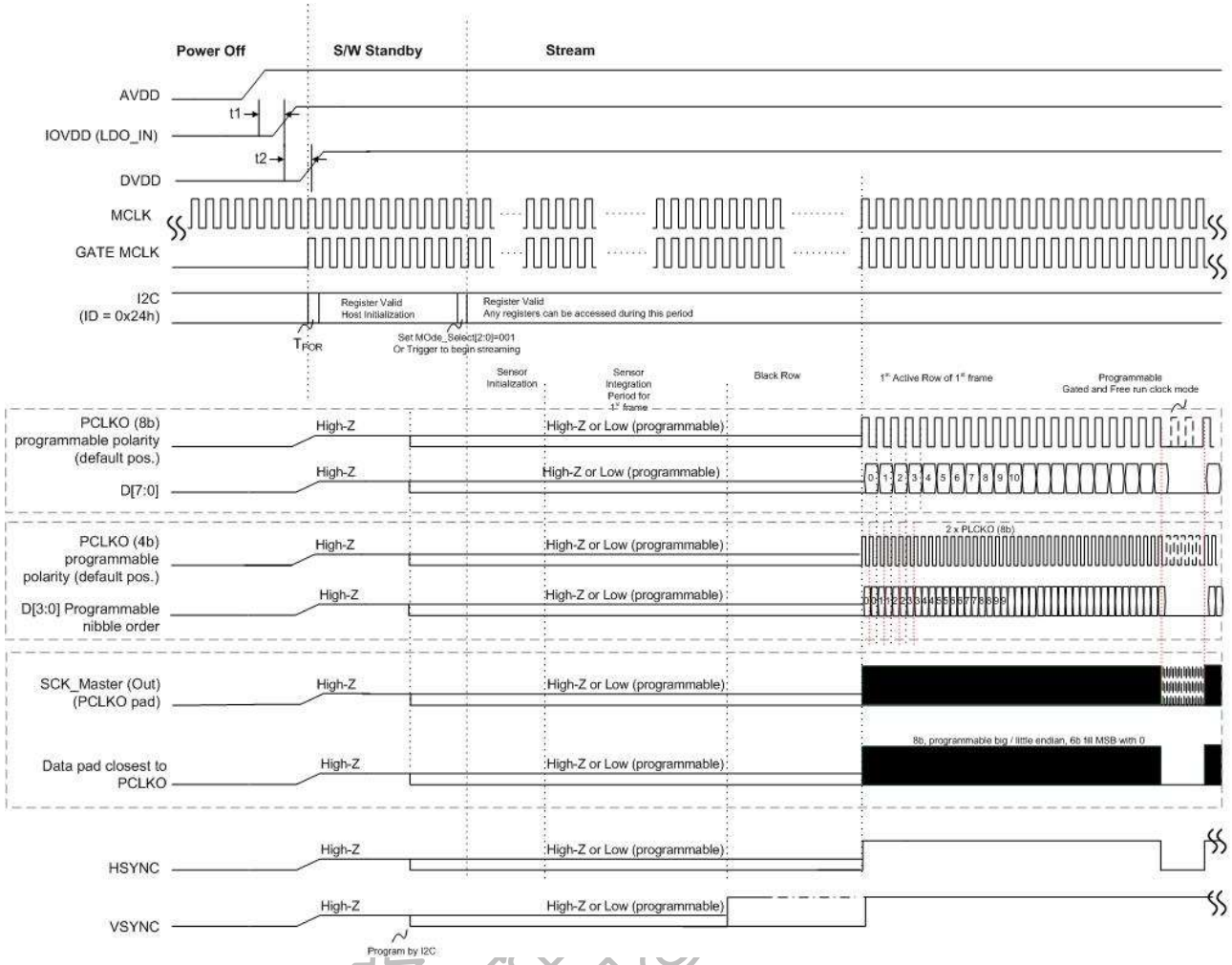


Figure 1.2: Power up sequence

Parameter	Symbol	Spec.			Unit
		Min.	Typ.	Max.	
AVDD to IOVDD	t1	0	-	∞	s
IOVDD to DVDD	t2	0	-	∞	s
Power On Reset time	t_{POR}	50	-	-	µs

Table 1.4: Power up sequence timing

2. Camera Module Specification

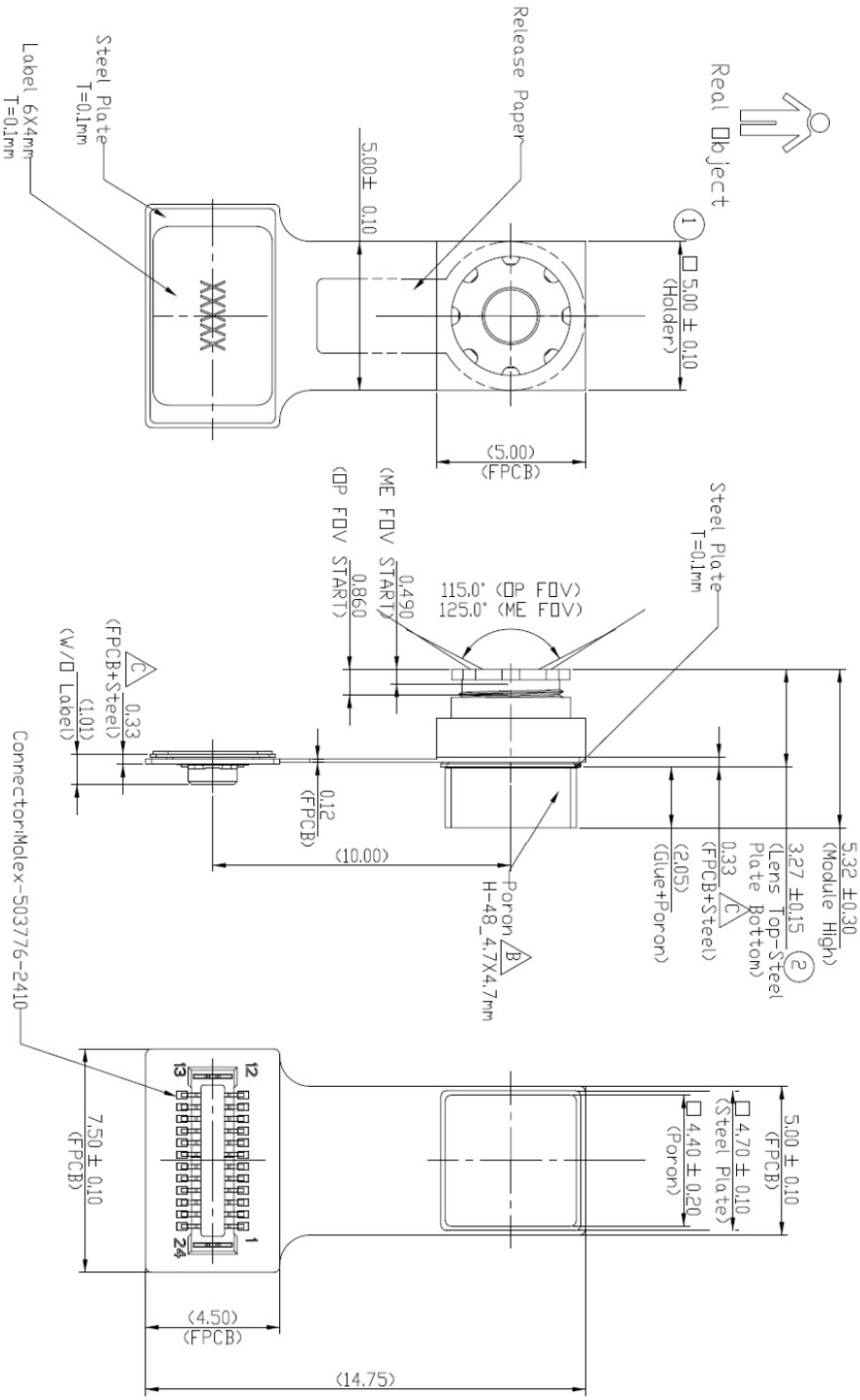
2.1 Pin map and description of camera module

Pin no.	Pin name	Type	Description
1	AGND	Ground	Analog ground.
2	AVDD	Power	Analog power. **(2.8V)**
3	DGND	Ground	Digital ground.
4	TRIG	In	Frame trigger input. **(Internal pull down / Active high)**
5	FLVD	Out	Frame valid output.
6	LVLD	Out	Line valid output.
7	SCL	In	I2C serial clock.
8	SDA	In/Out	Serial data I/O. **(Open drain)**
9	INT	Out	Interrupt output. **(Active high)**
10	DGND	Ground	Digital ground.
11	IOVDD	Power	IO power. **(1.8V)**
12	DVDD	Power	Core digital power. **(1.5V)**
13	DGND	Ground	Digital ground.
14	MCLK	In	Master clock input.
15	DGND	Ground	Digital ground.
16	PCLK	Out	Pixel clock
17	D0	Out	Data 0 output.
18	D1	Out	Data 1 output.
19	D2	Out	Data 2 output.
20	D3	Out	Data 3 output.
21	D4	Out	Data 4 output.
22	D5	Out	Data 5 output.
23	D6	Out	Data 6 output.
24	D7	Out	Data 7 output.

Note: (1) HM01B0 sensor default slave address: 0x24.

Table 2.1: Pin map and description of camera module

2.2 Mechanical drawing of camera module



No.	Pin Define
1	AGND
2	AVDD28
3	DGND
4	TRIG
5	FVLD
6	LVLD
7	SCL
8	SDA
9	INT
10	DGND
11	IOVDD18
12	DVDD15
13	DGND
14	MCLK
15	DGND
16	PCLK
17	D0
18	D1
19	D2
20	D3
21	D4
22	D5
23	D6
24	D7

Figure 2.1: Mechanical drawing of camera module

2.3 Application schematic of camera module

2.3.1 Reference circuit

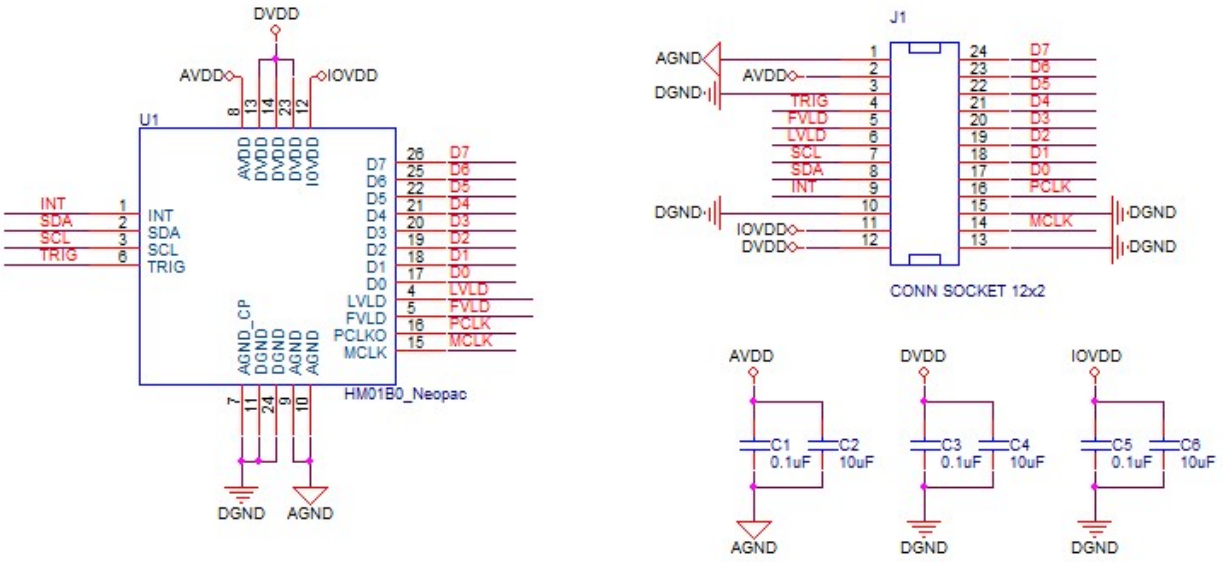


Figure 2.2: Reference circuit of camera module

2.3.2 Layout consideration

A. In order to reduce power noise to the camera module, it is suggested that a 0.1μF capacitor and a high value decoupling capacitor **(10μF or above)** be placed across every power line **(AVDD & DVDD & IOVDD)** and corresponding ground pin. Try to place these capacitors close to the module connector. The power noise will contribute to image noise and it is necessary to reduce them as much as possible.

B. In order to reduce interference and noise caused by the high frequency clocks. It is suggested that the master and pixel clocks be surrounded with ground shielding pins.

C. In order to avoid the ground loop, it is recommended that the sensor analog ground be connected to sensor digital ground through a point or 0ohm resistor. Then the sensor digital ground should be connected to system ground through a point or a 0 ohm resistor.

D. In order to reduce EM radiation, it is recommended that ground pins be assigned to the edge of the module connector.

3. Optical Lens Specification

3.1 Mechanical drawing of optical lens

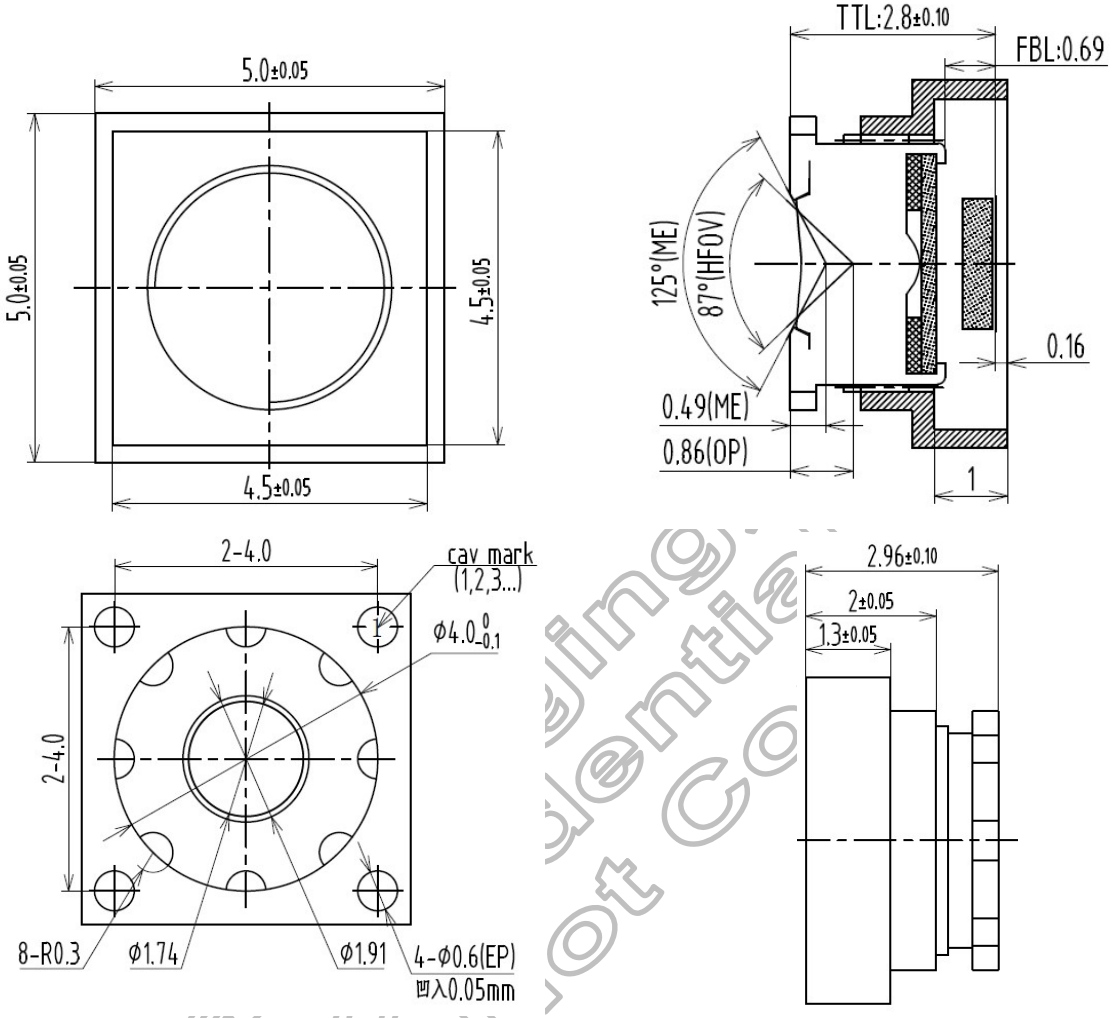
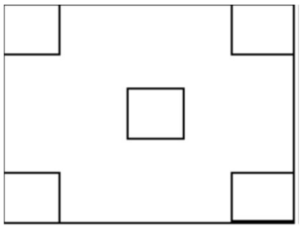
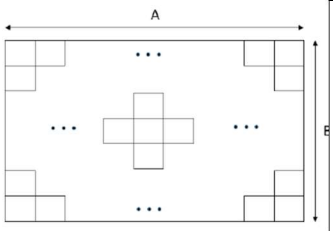


Figure 3.1: Mechanical drawing of optical lens

Module Parameters		Value
Construction		3P+ IRCF
EFL		0.66 mm ± 5%
BFL		1.04 mm
Image circle		1.83 mm
Focus distance		35 cm
Depth of Field		30 cm ~ infinite
F/No		2.4
TV distortion		under 4.3%
Field of view	Horizontal	87°
	Vertical	87°
	Diagonal	115°
Relative illumination		Over 35%: y=1.0d
Chief ray angle		30°
Barrel size		M3.5 x P0.20
Holder size		5.0mm x 5.0mm
Total track (Barrel to image)		Y=2.80 ± 0.1 (at inf.)

Table 3.1: Lens optical specification

4. Image Quality Specification

No.	Test Item	Diagram	Test Condition	Standard
1	MTF		Test Chart : 1/8 N Pattern Chart Distance : 35cm Full Image Size	Center(0% field) : >=0.8 Corner(65% field) : >=0.6
2	Shading	 AOI:32x32 pixel Shading Ratio= Ycorner(min) / Ycenter	Without ISP (raw image) Distance : 1cm Light condition : 1500 +/- 300 lux , 5100+/-300K	>=30%
3	Blemish	 A : 324pixel B : 324pixel Block Size : 9x9 pixel	Without ISP (raw image) Distance : 1cm Light condition : 1500 +/- 300 lux , 5100+/-300K	The liminance difference between each block and the adjacent block should be less than 3%
4	Defect pixel	Dark Pixel Defect	The sensor is illuminated to midlevel : ~ 400 LSBs to 700 LSBs.	Within a color plane, each pixel is compared to the mean of the neighboring 40 x 40 pixels. If the pixel value is 40 percent or more below the mean, it is considered a dark pixel defect.
		Bright Pixel Defect	The sensor is illuminated to midlevel : ~ 400 LSBs to 700 LSBs. (Analog gain = 1; exposure time = 10ms)	Within a color plane, each pixel is compared to the mean of the neighboring 40 x 40 pixels. If the pixel value is 40 percent or more above the mean, it is considered a dark pixel defect.
		Bright Cluster Defect No. : 10	By "Bright Pixel Defect" Result	The defects within each color plane are examined. If any two adjacent pixels that are considered bright pixel defects are detected, they are then defined as a bright cluster.
		Dark Cluster Defect No. : 10	By "Dark Pixel Defect" Result	The defects within a color plane are examined. If any two

				adjacent pixels that are considered dark pixel defects are detected, they are then defined as a dark cluster.

Table 4.1: Image Quality Specification

5. Reliability Test Conditions

5.1 Test Unit :

Reliability test Q'ty : 35 pcs

5.2 Test Condition

No.	Test Item	Test Conditions	Judgement
1	High Temperature test	60℃ / 48 hrs	The difference of MTF(%) Center <=5 Corner(0.7f) <=10
2	High Temperature & Humidity test	60℃ / 90%RH 48hrs	
3	Low Temperature test	-20℃ / 48 hrs	
4	Thermal Shock test (No-Operating)	-20℃ / 30min～60℃ / 30min 32 cycles	
5	ESD test (No-Operating)	Contact discharge: ±2.0 KV / 10 times, to USB connector Human Body Mode	
6	Mechanical Vibration test (No-Operating,No packaging)	5Hz～350Hz～500Hz 0.21 Grms. Vibrate X,Y, and Z axis, 60min per axis.	
7	Mechanical Vibration test (No-Operating, packaging)	5Hz～55Hz; -6dB; Acc 3G, Vibrate X,Y, and Z axis, 60min per axis.	
8	Drop test (No-Operating, No packaging)	80cm height free fall for 10 times per unit base material: concrete floor	
9	Drop test (No-Operating, packaging)	100cm height free fall for 10 impacts per unit (1 corner, 3 edges, 6 faces) base material: concrete floor	

Table 5.1: Reliability test condition