



## camera module datasheet

PRELIMINARY SPECIFICATION

1/4" color CMOS QSXGA (5 megapixel) MIPI camera module  
with OmniBSI™ technology and auto focus control

OV5640-MRSL-A00A



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#### **color CMOS QSXGA (5 megapixel) MIPI camera module with OmniBSI™ technology and auto focus control**

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version 1.0  
july 2010

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# OV5640MRSL

color CMOS QXGA (5 megapixel) MIPI camera module with OmniBSI™ technology and auto focus control

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## applications

- cellular phones
- toys
- PC multimedia
- digital still cameras

## ordering information

- **OV05640-MRSL-A00A** (color, auto focus)  
8.5 x 8.5 x 5.10 mm flex cable

## features

- 1.4  $\mu\text{m}$  x 1.4  $\mu\text{m}$  pixel with OmniBSI technology for high performance (high sensitivity, low crosstalk, low noise, improved quantum efficiency)
- optical size of 1/4"
- automatic image control functions: automatic exposure/ gain control (AEC/AGC), automatic white balance (AWB), automatic band filter (ABF), automatic 50/60 Hz luminance detection, and automatic black level calibration (ABLC)
- programmable controls for frame rate, AEC/AGC 16-zone size/position/weight control, mirror and flip, cropping, windowing, and panning
- image quality controls: color saturation, hue, gamma, sharpness (edge enhancement), lens correction, defective pixel canceling, and noise canceling
- support for output formats: RAW RGB, RGB565/555/444, CCIR656, YUV422/420, YCbCr422, and compression
- support for video or snapshot operations
- support for LED and flash strobe mode
- support for internal and external frame synchronization for frame exposure mode
- support for horizontal and vertical sub-sampling, binning
- support for minimizing artifacts on binned image
- support for data compression output
- support for anti-shake
- standard serial SCCB interface
- digital video port (DVP) parallel output interface and dual lane MIPI output interface
- embedded 1.5V regulator for core power
- programmable I/O drive capability, I/O tri-state configurability
- support for black sun cancellation
- support for image sizes: 5 megapixel, and any arbitrary size scaling down from 5 megapixel
- support for auto focus control (AFC) with embedded AF VCM driver
- embedded microcontroller

## key specifications

- **active array size:** 2592 x 1944
- **power supply:**  
core: 1.5V  $\pm$  5% (with embedded 1.5V regulator)  
analog: 2.6 ~ 3.0V (2.8V typical)  
I/O: 1.8V / 2.8V
- **power requirements:**  
active: TBD  
standby: TBD
- **temperature range:**  
operating: -30°C to 70°C  
stable image: 0°C to 50°C
- **output formats:** 8-/10-bit RGB RAW output
- **lens size:** 1/4"
- **lens chief ray angle:** 24°
- **input clock frequency:** 6~27 MHz
- **S/N ratio:** TBD
- **dynamic range:** TBD
- **maximum image transfer rate:**  
QSXGA (2592x1944): 15 fps  
1080p: 30 fps  
1280x960: 45 fps  
720p: 60 fps  
VGA (640x480): 90 fps  
QVGA (320x240): 120 fps
- **sensitivity:** TBD
- **shutter:** rolling shutter / frame exposure
- **maximum exposure interval:** 1964 x  $t_{\text{ROW}}$
- **pixel size:** 1.4  $\mu\text{m}$  x 1.4  $\mu\text{m}$
- **well capacity:** TBD
- **dark current:** TBD
- **fixed pattern noise (FPN):** TBD
- **image area:** 3673.6  $\mu\text{m}$  x 2738.4  $\mu\text{m}$
- **package dimensions:** 8.5mm x 8.5mm x 5.10mm

**OV5640MRSL**

color CMOS QSXGA (5 megapixel) MIPI camera module with OmniBSI™ technology and auto focus control

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color CMOS QSXGA (5 megapixel) MIPI camera module with OmniBSI™ technology and auto focus control

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# 1 pin descriptions

**table 1-1** lists the pin descriptions and their corresponding numbers for the OV5640MRSL camera module. The package information is shown in **section 4**.

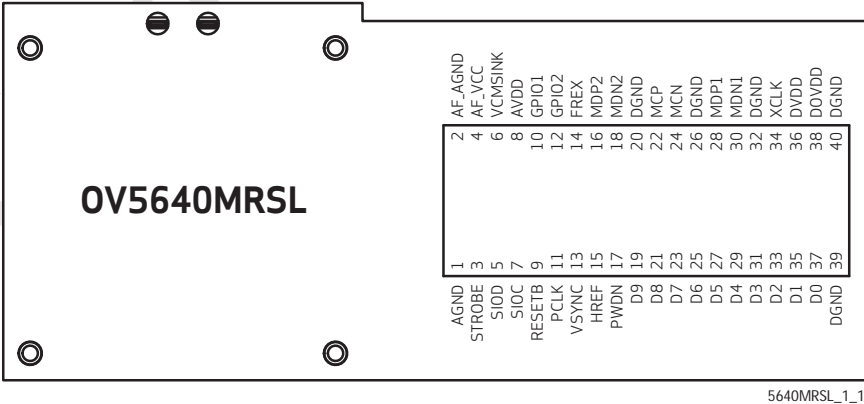
**table 1-1** pin descriptions (sheet 1 of 2)

pin number	signal name	pin type	description
01	AGND	ground	ground for analog circuit
02	AF_AGND	ground	autofocus ground
03	STROBE	I/O	strobe output
04	AF_VCC	power	autofocus power
05	SIOD	I/O	SCCB serial interface data I/O
06	VCMSINK	I/O	output current sink for VCM
07	SIOC	input	SCCB serial interface clock input
08	AVDD	power	2.8V supply for sensor analog
09	RESETB	input (0)	reset (active low with internal pull-up resistor)
10	GPIO1	I/O	GPIO port 1
11	PCLK	output	pixel clock output
12	GPIO0	I/O	GPIO port 0
13	VSYNC	output	vertical synchronization output
14	FREX	I/O	frame exposure control
15	HREF	output	horizontal reference output
16	MDP2	output	MIPI second data lane positive output
17	PWDN	input (0)	power down mode enable (active high with internal pull-down resistor)
18	MDN2	output	MIPI second data lane negative output
19	D9	output	video port output bit[9]
20	DGND	ground	ground for digital circuit
21	D8	output	video port output bit[8]
22	MCP	output	MIPI clock lane positive output
23	D7	output	video port output bit[7]
24	MCN	output	MIPI clock lane negative output
25	D6	output	video port output bit[6]

table 1-1 pin descriptions (sheet 2 of 2)

pin number	signal name	pin type	description
26	DGND	ground	ground for digital circuit
27	D5	output	video port output bit[5]
28	MDP1	output	MIPI first data lane positive output
29	D4	output	video port output bit[4]
30	MDN1	output	MIPI first data lane negative output
31	D3	output	video port output bit[3]
32	DGND	ground	ground for digital circuit
33	D2	output	video port output bit[2]
34	XCLK	input	system clock input
35	D1	output	video port output bit[1]
36	DVDD	power	1.5V supply for digital
37	D0	output	video port output bit[0]
38	DOVDD	power	1.8V supply for I/O circuit
39	DGND	ground	ground for digital circuit
40	DGND	ground	ground for digital circuit

figure 1-1 OV5640MRSL pinout diagram



## 2 system level description

### 2.1 overview

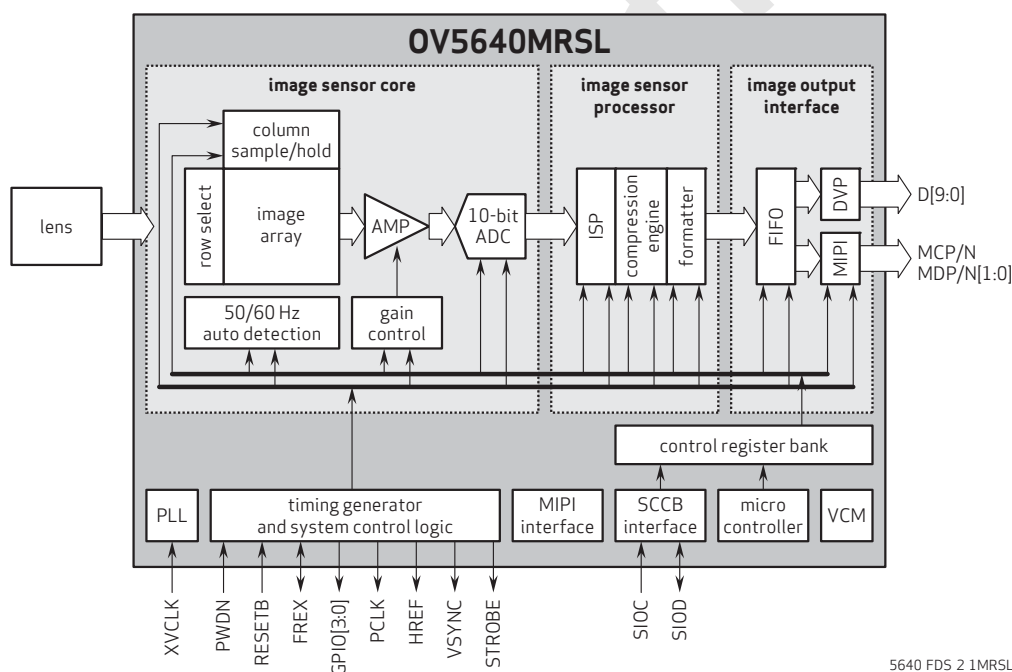
The OV5640MRSL is a sensor on-board camera with a lens and module designed for mobile applications where low power consumption and small size are of utmost importance.

Proprietary sensor technology utilizes advanced algorithms to cancel Fixed Pattern Noise (FPN), eliminate smearing, and drastically reduce blooming. All required camera functions are programmable through the serial SCCB interface.

The device can be programmed to provide image output in various fully processed and encoded formats.

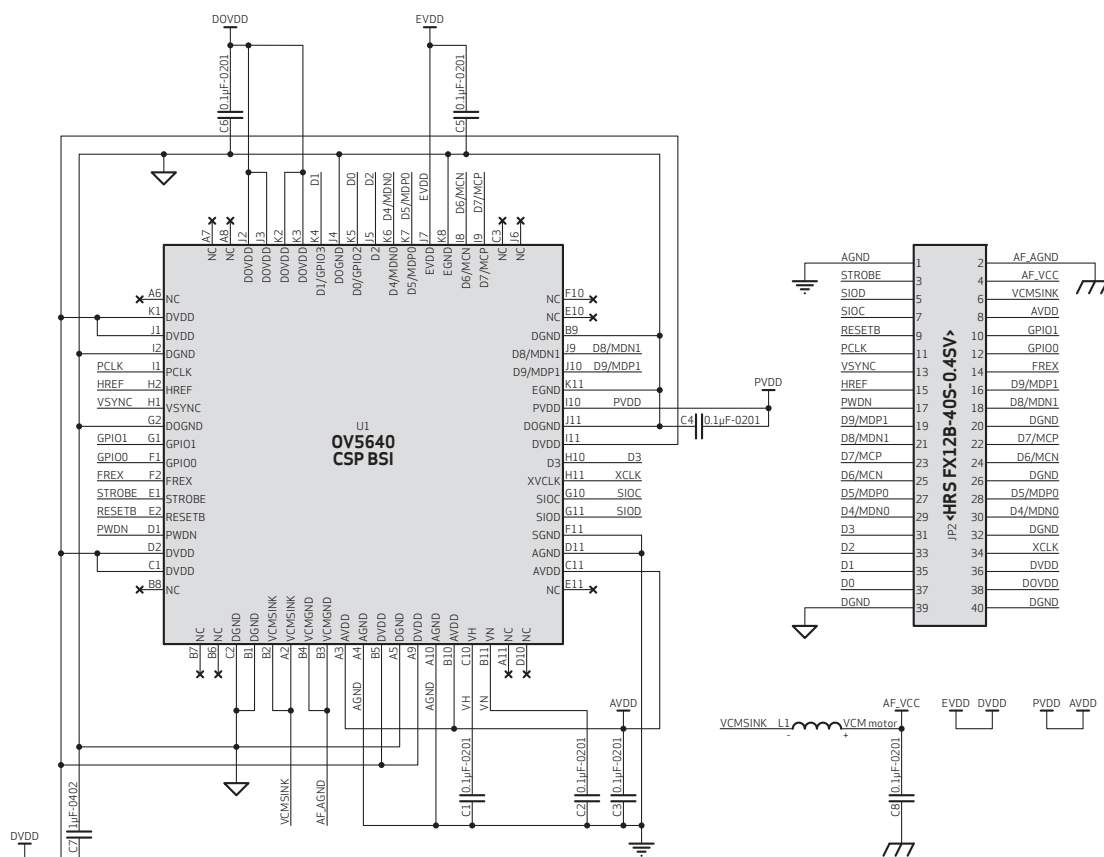
The OV5640MRSL features the OV5640 image sensor. Refer to the OV5640 Product Specification for chip-specific information.

figure 2-1 OV5640MRSL block diagram



5640\_FDS\_2\_1MRSL

figure 2-2 module schematic



**note 1** RESETB should be connected to DOVDD outside of module if unused.

**note 2** FREX should be connected to DGND outside of module if unused.

**note 3** AVDD is 2.6-3.0 V of sensor analog power (clean).  
During OTP programming, an AVDD voltage range of 2.5 V  $\pm$  10% is required.  
OTP read may use normal AVDD voltage range.

**note 4** DOVDD is 1.7-3.0 V of sensor digital IO power (clean). 1.8 V is recommended.

**note 5** DVDD is 1.5 V of sensor core power (clean).  
The sensor internal regulator (no external 1.5 V DVDD is needed) is recommended for 1.8 V DOVDD.  
External 1.5 V DVDD is recommended for 2.8 V DOVDD.

**note 6** sensor AGND and DGND should be separated and connected to a single point outside PCB  
(do not connect inside module).

**note 7** DGND and EGND should be two separated nets, and only connected at a single point inside the module.

**note 8** capacitors should be close to the related sensor pins.

**note 9** if more space available, use capacitor of 1  $\mu$ F-0402 between DVDD and DGND.

**note 10** D9:0 (D9:MSB, D0:LSB) is sensor RGB RAW 10-bit output. D9:2 (D9:MSB, D2:LSB) is 8-bit output.

**note 11** EVDD/EGND are power/ground for MIPI core.  
MCP and MCN are MIPI clock lane positive and negative output.  
MDP0 and MDN0 are MIPI 1st data lane positive and negative output.  
MDP1 and MDN1 are MIPI 2nd data lane positive and negative output.

**note 12** traces of MCP, MCN, MDP0, MDN0, MDP1, and MDN1 should have the same or similar length.  
The differential impedance of these transmission lines should be controlled at 100 Ohm.

**note 13** traces from AF\_VCC to L1+ and L1- to pin VCM\_SINK,  
and the trace of AF\_AGN need to be paid extra attention because of high electrical current.

**note 14** VCM driver built in the sensor could be controlled by the micro-controller inside the sensor.

5640MRSL\_FDS\_2\_2



## 3 operating specifications

### 3.1 absolute maximum ratings

**table 3-1** absolute maximum ratings

parameter		absolute maximum rating <sup>a</sup>
ambient storage temperature		-40°C to +95°C
supply voltage (with respect to ground)	$V_{DD-A}$	4.5V
	$V_{DD-D}$	3V
	$V_{DD-IO}$	4.5V
electro-static discharge (ESD)	human body model	2000V
	machine model	200V
all input/output voltages (with respect to ground)		-0.3V to $V_{DD-IO} + 1V$
I/O current on any input or output pin		±200 mA

- a. exceeding the absolute maximum ratings shown above invalidates all AC and DC electrical specifications and may result in permanent damage to the device. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

### 3.2 functional temperature

**table 3-2** functional temperature

parameter	range
operating temperature range <sup>a</sup>	-30°C to +70°C
stable image temperature range <sup>b</sup>	0°C to +50°C

- a. sensor functions but image quality may be noticeably different at temperatures outside of stable image range
- b. image quality remains stable throughout this temperature range

### 3.3 DC characteristics

**table 3-3** DC characteristics ( $-30^{\circ}\text{C} < T_A < 70^{\circ}\text{C}$ ) (sheet 1 of 2)

symbol	parameter	min	typ	max	unit
power supply					
V <sub>DD-A</sub>	supply voltage (analog)	2.6	2.8	3.0	V
V <sub>DD-D</sub> <sup>a</sup>	supply voltage (digital core)	1.425	1.5	1.575	V
V <sub>DD-IO</sub>	supply voltage (digital I/O)	1.7	1.8	3.0	V
internal DVDD, DOVDD=1.8V					
I <sub>DD-A</sub>	active (operating) current	TBD	TBD	TBD	mA
I <sub>DD-IO</sub> <sup>b, c</sup>		TBD	TBD	TBD	mA
I <sub>DDS-SCCB</sub> <sup>d</sup>	standby current	TBD	TBD	TBD	μA
I <sub>DDS-PWDN</sub> <sup>d</sup>		TBD	TBD	TBD	μA
P <sub>O</sub>	active (operating) power consumption	TBD	TBD	TBD	mW
P <sub>DDS-SCCB</sub>	standby power consumption	TBD	TBD	TBD	μW
P <sub>DDS-PWDN</sub>		TBD	TBD	TBD	μW
external DVDD, DOVDD=2.8V					
I <sub>DD-A</sub>	active (operating) current	TBD	TBD	TBD	mA
I <sub>DD-D</sub> <sup>b, c</sup>		TBD	TBD	TBD	mA
I <sub>DD-IO</sub>	standby current	TBD	TBD	TBD	mA
I <sub>DDS-SCCB</sub>		TBD	TBD	TBD	μA
I <sub>DDS-PWDN</sub>	standby current	TBD	TBD	TBD	μA
P <sub>O</sub>		active (operating) power consumption	TBD	TBD	TBD
P <sub>DDS-SCCB</sub>	standby power consumption	TBD	TBD	TBD	μW
P <sub>DDS-PWDN</sub>		TBD	TBD	TBD	μW
external DVDD, DOVDD=1.8V					
I <sub>DD-A</sub>	active (operating) current	TBD	TBD	TBD	mA
I <sub>DD-D</sub> <sup>b, c</sup>		TBD	TBD	TBD	mA
I <sub>DD-IO</sub>	standby current	TBD	TBD	TBD	mA
I <sub>DDS-SCCB</sub>		TBD	TBD	TBD	μA
I <sub>DDS-PWDN</sub>	standby current	TBD	TBD	TBD	μA
P <sub>O</sub>		active (operating) power consumption	TBD	TBD	TBD
P <sub>DDS-SCCB</sub>	standby power consumption	TBD	TBD	TBD	μW
P <sub>DDS-PWDN</sub>		TBD	TBD	TBD	μW

**table 3-3** DC characteristics ( $-30^{\circ}\text{C} < T_A < 70^{\circ}\text{C}$ ) (sheet 2 of 2)

symbol	parameter	min	typ	max	unit
digital inputs (typical conditions: AVDD = 2.8V, DVDD = 1.5V, DOVDD = 1.8V)					
$V_{IL}$	input voltage LOW			0.54	V
$V_{IH}$	input voltage HIGH	1.26			V
$C_{IN}$	input capacitor			10	pF
digital outputs (standard loading 25 pF)					
$V_{OH}$	output voltage HIGH	1.62			V
$V_{OL}$	output voltage LOW			0.18	V
serial interface inputs <sup>e</sup>					
$V_{IL}$	SIOC and SIOD	-0.5	0	0.54	V
$V_{IH}$	SIOC and SIOD	1.26	1.8	3.0	V

- using the internal DVDD regulator is strongly recommended for minimum power down current
- active current is based on sensor resolution at full size and at full speed in compression format. For smaller sizes such as 720p or below preview, the total active current will be about half.
- DOVDD active current is based on loading of 10pF and typical compression format output PCLK (48MHz). For YUV output with higher PCLK, or higher loading, DOVDD current can go up.
- at room temperature and typical supply voltages
- based on DOVDD = 1.8V.

### 3.4 AC characteristics

**table 3-4** AC characteristics ( $T_A = 25^\circ\text{C}$ ,  $V_{DD-A} = 2.8\text{V}$ )

symbol	parameter	min	typ	max	unit
ADC parameters					
B	analog bandwidth		30		MHz
DLE	DC differential linearity error		0.5		LSB
ILE	DC integral linearity error		1		LSB
	settling time for hardware reset			<1	ms
	settling time for software reset			<1	ms
	settling time for resolution mode change			<1	ms
	settling time for register setting			<300	ms

**table 3-5** timing characteristics

symbol	parameter	min	typ	max	unit
oscillator and clock input					
$f_{\text{OSC}}$	frequency (XVCLK) <sup>a</sup>	6	24	54	MHz
$t_r, t_f$	clock input rise/fall time <sup>b</sup>			5 (10 <sup>c</sup> )	ns
$f_{\text{PCLK}}$	parallel port output pixel clock		48 <sup>d</sup>	96 <sup>e</sup>	MHz

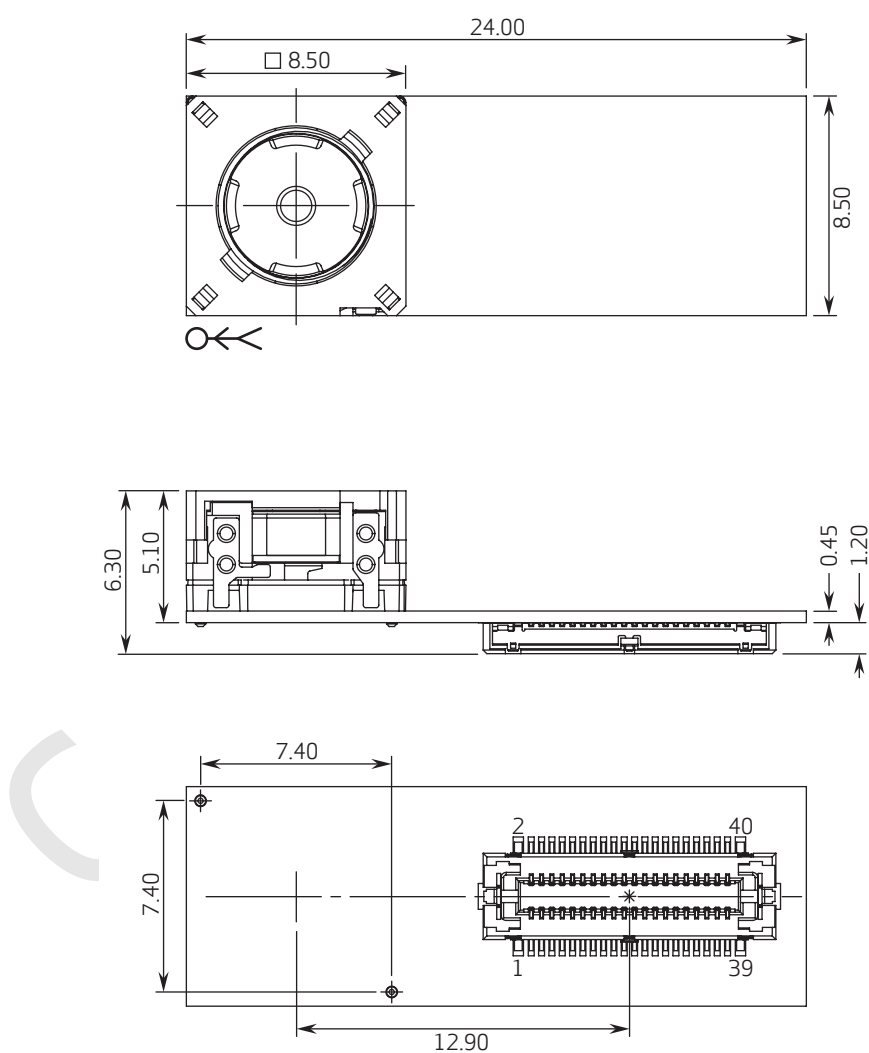
- for input clock range 6~27MHz, the OV5640MRSL can tolerate input clock jitter up to 1ns, for input clock range to 54MHz, the OV5640MRSL can tolerate input clock jitter up to 500ps
- if the PLL is bypassed, the delay from input clock to output clock is approximately 4~5ns
- if using the internal PLL
- typical PCLK is 48 MHz when sensor output is smaller size (VGA YUV or below) or full size compression
- 96 MHz is for sensor RAW data output at 15fps or YUV output at 7.5fps. For higher speeds such as 5 megapixel YUV @ 15fps, OmniVision recommends using the MIPI two-lane interface.

## 4 module specifications

### 4.1 package specifications

Refer to **figure 4-1** for package information on the OV5640MRSL module.

**figure 4-1** package specifications



**note** all dimensions are in millimeters.

5640MRSL\_FDS\_4\_1

## 4.2 mechanical specifications

Refer to **table 4-1** for mechanical information on the OV5640MRSL module.

**table 4-1** mechanical dimensions

parameter	specification	comments
sensor	QSXGA	CMOS in housing
lens	plastic	
connection type	0.4mm pitch board-to-board	
housing	8.5 mm x 8.5 mm x 5.10 mm	

## 4.3 connector information

The OV5640MRSL uses a 40-pin, 0.4 mm pitch flex cable connector. **table 4-2** shows a listing of some recommended connectors.

**table 4-2** recommended connectors

manufacturer	part number	description
Hirose	FX12B - 40S - 0.4SV	receptacle on camera module
Hirose	FX12B - 40P - 0.4SV	plug mating connector

## 4.4 optical specifications

Refer to **table 4-3** for mechanical information on the OV5640MRSL module.

**table 4-3** optical specifications

parameter	specification	comments
lens elements	(4P) +1IR	
viewing angle	67.5° diagonal	
focal length	3.42 mm	
f stop	f/2.8	
focus range	10 cm → ∞	
mount description	M6 x 0.35P	
TV distortion	<1%	

## 4.5 VCM general specifications

Refer to **table 4-4** for VCM information on the OV5640MRSL module.

**table 4-4** VCM specifications

parameter	specification
lens diameter	M 6 x 0.35mm
rated load current	100 mA max
working range	0 ~ 0.2mm (min)

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## revision history

version 1.0      07.23.2010

- initial release

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# OV5640MRSL

color CMOS QXGA (5 megapixel) MIPI camera module with OmniBSI™ technology and auto focus control

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