OV9655MFSL Color CMOS SXGA (1.3 MegaPixel) Concept Camera Module with OmniPixel® Technology

General Description

The OV9655MFSL is a sensor on-board camera and lens 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 OV9655MFSL features the OV9655 CAMERACHIP™ sensor. Refer to the *OV9655 Datasheet* for chip-specific information.

Caution: READ THIS FIRST!
Prior to finalizing any mechanical or electrical design for production, consult with OmniVision to confirm any final dimensional or electrical pinout data.

Features

- 1,310,720 pixels, SXGA/VGA format, 1/4" lens
- 8mm x 8mm x 7.38mm module size, flex cable
- Flex cable connector
- 2.5V operation, low power dissipation
- Serial Camera Control Bus (SCCB) interface
- Function controls:
  - Exposure control
  - Gamma
  - Gain
  - White balance
  - Color matrix
  - Color saturation
  - Hue control
  - Windowing

Ordering Information

Product	Package
OV09655-MFSL	8mm x 8mm x 7.38mm Flex Cable

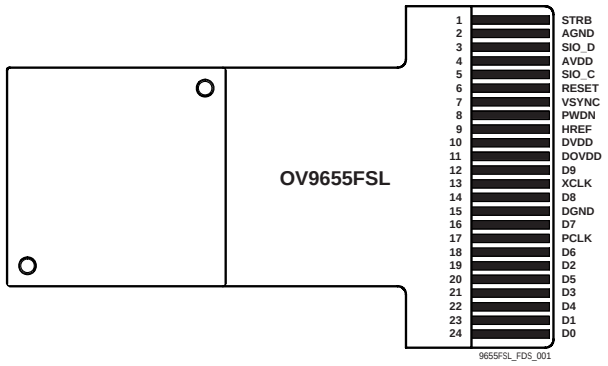
Applications

- Cellular and Picture Phones
- Toys
- PC Multimedia
- Digital Still Cameras

Key Specifications

Active Array Size		1280 x 1024
Power Supply	**Core**	1.8VDC ± 10%
	Analog	2.45 to 2.8VDC
	I/O	1.7V to 3.3V
Power Requirements	**Active**	TBD
	Standby	<20 µA
Temperature Range	**Operation**	-30°C to 70°C
	Stable Image	0°C to 50°C
Output Formats (8-bit)		• YUV/YCbCr 4:2:2 • RGB565/555 • GRB 4:2:2 • Raw RGB Data
Lens Size		1/4"
Chief Ray Angle		TBD
Maximum Image Transfer Rate	**SXGA**	15 fps
	VGA and down scaling	30 fps
Sensitivity		TBD
S/N Ratio		TBD
Dynamic Range		TBD
Scan Mode		Progressive
Maximum Exposure Interval		1050 x t_{ROW}
Gamma Correction		Programmable
Pixel Size		3.18 µm x 3.18 µm
Dark Current		TBD
Well Capacity		TBD
Fixed Pattern Noise		<0.03% of $V_{PEAK-TO-PEAK}$
Image Area		4.17 mm x 3.29 mm
Package Dimensions		8mm x 8mm x 7.38mm

Figure 1 OV9655MFSL Pin Diagram



Functional Description

Figure 2 shows the functional block diagram of the OV9655MFSL Camera Module. The OV9655MFSL includes:

- 1/4" lens
- OV9655 CAMERACHIP image sensor
- Flex cable

Figure 2 Functional Block Diagram

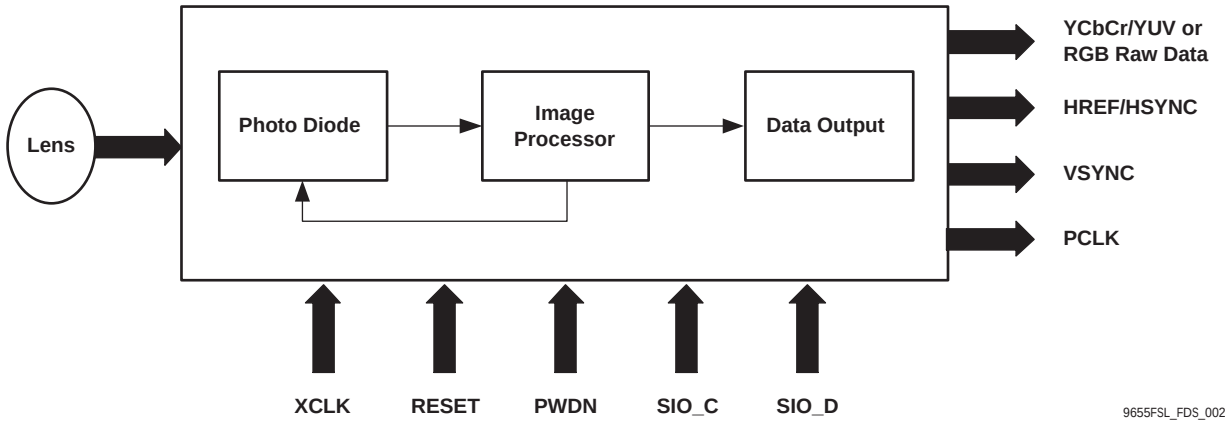
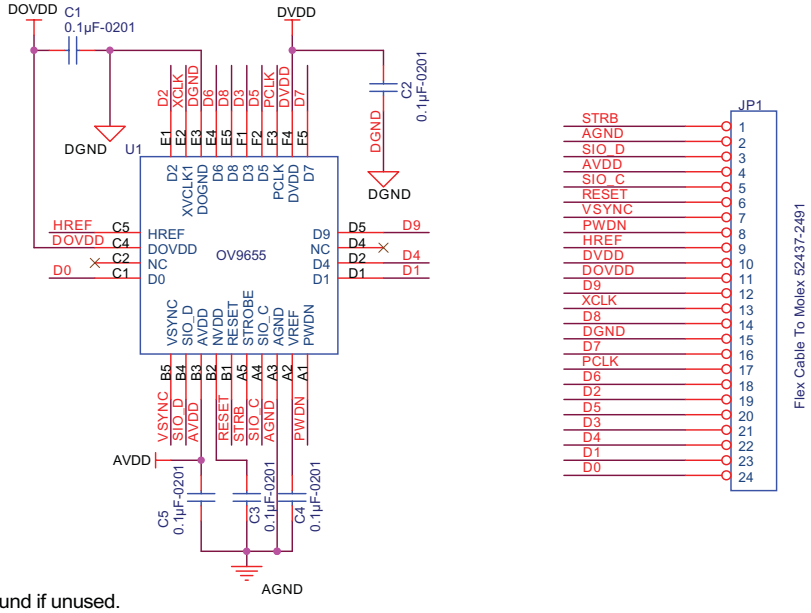


Figure 3 Module Schematic



Note:
Connector PWDN and RESET should be connected to ground if unused.
AVDD is 2.5V sensor analog power.
DVDD is 1.8V sensor digital power.
DOVDD is 1.7V to 3.0V sensor digital IO power.
Sensor AGND and DGND should be separated and connected to a single point outside PCB (DO NOT connect inside module).
C1 should be close to sensor DOVDD and DOGND.
C2 should be close to sensor DVDD and DOGND.
C3 should be close to sensor NVDD and AGND.
C4 should be close to sensor VREF and AGND.
C5 should be close to sensor AVDD and AGND.
D[9:2] is module YUV and RGB 8-bit output (D9: MSB, D2: LSB).
D[9:0] is module raw RGB 10-bit output (D9: MSB, D0: LSB).

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Imaging Specifications

Table 1 Sensor Image Functions

Sensor Imaging Functions	Description
Auto Exposure	Module automatically sets correct exposure time.
Auto Exposure ON/OFF	Auto exposure can be turned off so the exposure can be set manually.
Auto White Balance (AWB)	AWB without companion processor interaction.
Auto White Balance OFF	AWB can be turned off.
Color Correction	It is possible to adjust for the color filter response of the image sensor as well as for human eye sensitivity.
Bayer Pattern Interpolation	(Mosaic or equivalent) The interpolation must be done prior to downsizing the image to avoid artifacts due to incorrect interpolation.
Electrical Illumination Flicker Elimination	Interference from 50Hz or 60Hz illumination can be suppressed with manually set frame rate divider.
Gamma Correction	Built-in 0.45/1.0
Color Space Conversion	Bayer raw RGB is converted to YCbCr/YUV color space.
Image Size Decimation	Size can be altered using the windowing registers. Quarter-format sub-sampling is also provided.
Image ON/OFF	Image ON/OFF can be controlled by register settings.
RGB Output	RGB raw data output available.
AGC Gain	Automatic Gain Control (AGC)
White Balance	Automatic White Balance

NOTE: OV9655MFSL features the OV9655 CAMERACHIP sensor. Refer to the *OV9655 Datasheet* for chip-specific information.

Table 2 Output Specifications

Output Image Formats	Description
Output Formats	SXGA (1280 x 1024 pixels)
	VGA (640 x 480 pixels)
YUV Format	4:2:2 compliant with CCIR656
YUV Order	YUYV or UYVY
Embedded Sync Codes	Sync signals coded in with data output (CCIR656) or output separately.
Data Clipping	According to CCIR656 or no clipping.
Format in Decimation Mode	PCLK verifies whether or not there is data on every cycle.

Pin Description

Table 3 Pin Description

Pin Number	Name	Pin Type	Function/Description
01	STRB	Output	LED/strobe control output
02	AGND	Power	Analog ground
03	SIO_D	I/O	SCCB serial interface data I/O
04	AVDD	Power	Analog power supply (V_{DD-A} = 2.45 to 2.8 VDC)
05	SIO_C	Input	SCCB serial interface clock input
06	RESET	Function (default = 0)	Clears all registers and resets them to their default values. Active high, internal pull-down resistor.
07	VSYNC	Output	Vertical sync output
08	PWDN	Function (default = 0)	Power Down Mode Selection - active high, internal pull-down resistor. 0: Normal mode 1: Power down mode
09	HREF	Output	HREF output
10	DVDD	Power	Power supply (V_{DD-C} = 1.8 VDC $\pm$ 10%) for digital core logic
11	DOVDD	Power	Digital power supply for I/O (V_{DD-IO} = 1.7V to 3.3V)
12	D9	Output	Output bit[9] - MSB for 10-bit RGB and 8-bit YUV
13	XCLK	Input	Crystal clock input
14	D8	Output	Output bit[8]
15	DGND	Power	Digital ground
16	D7	Output	Output bit[7]
17	PCLK	Output	Pixel clock output
18	D6	Output	Output bit[6]
19	D2	Output	Output bit[2] - LSB for 8-bit YUV
20	D5	Output	Output bit[5]
21	D3	Output	Output bit[3]
22	D4	Output	Output bit[4]
23	D1	Output	Output bit[1] - for 10-bit RGB only
24	D0	Output	Output bit[0] - LSB for 10-bit RGB only

NOTE:

D[9:2] for 8-bit YUV or RGB (D9 MSB, D2 LSB)

D[9:0] for 10-bit RGB (D9 MSB, D0 LSB)

Electrical Characteristics

Table 4 Absolute Maximum Ratings

Ambient Storage Temperature		-40ºC to +95ºC
Supply Voltages (with respect to Ground)	**V_{DD-A}**	4.5 V
	V_{DD-C}	3 V
	V_{DD-IO}	4.5 V
All Input/Output Voltages (with respect to Ground)		-0.3V to V_{DD-IO}+1V

NOTE: Exceeding the Absolute Maximum ratings shown above invalidates all AC and DC electrical specifications and may result in permanent device damage.

Table 5 DC Characteristics (-20°C < T_A < 70°C)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{DD-A}	DC supply voltage – Analog	–	2.45	2.5	2.8	V
V_{DD-C}	DC supply voltage – Core	–	1.62	1.8	1.98	V
V_{DD-IO}	DC supply voltage – I/O power	–	1.7	–	3.3	V
I_{DDA}	Active (Operating) Current	See Note [a]		20		mA
$I_{DDS-SCCB}$	Standby Current	See Note [b]		1		mA
$I_{DDS-PWDN}$	Standby Current			10	20	µA
V_{IH}	Input voltage HIGH	CMOS	0.7 x V_{DD-IO}			V
V_{IL}	Input voltage LOW				0.3 x V_{DD-IO}	V
V_{OH}	Output voltage HIGH	CMOS	0.9 x V_{DD-IO}			V
V_{OL}	Output voltage LOW				0.1 x V_{DD-IO}	V
I_{OH}	Output current HIGH	See Note [c]	8			mA
I_{OL}	Output current LOW		15			mA
I_L	Input/Output Leakage	GND to V_{DD-IO}			± 1	µA

a. V_{DD-A} = 2.5V, V_{DD-C} = 1.8V, V_{DD-IO} = 2.5V
$I_{DDA} = \Sigma\{I_{DD-IO} + I_{DD-C} + I_{DD-A}\}$, f_{CLK} = 24MHz at 7.5 fps YUV output, no I/O loading

b. V_{DD-A} = 2.5V, V_{DD-C} = 1.8V, V_{DD-IO} = 2.5V
$I_{DDS-SCCB}$ refers to a SCCB-initiated Standby, while $I_{DDS-PWDN}$ refers to a PWDN pin-initiated Standby

c. Standard Output Loading = 25pF, 1.2KΩ

Table 6 Functional and AC Characteristics (-20°C < T_A < 70°C)

Symbol	Parameter	Min	Typ	Max	Unit
Functional Characteristics					
	A/D Differential Non-Linearity		± 1/2		LSB
	A/D Integral Non-Linearity		± 1		LSB
	AGC Range			18	dB
	Red/Blue Adjustment Range		12		dB
Inputs (PWDN, CLK, RESET)					
f_{CLK}	Input Clock Frequency	10	24	48	MHz
t_{CLK}	Input Clock Period	21	42	100	ns
$t_{CLK:DC}$	Clock Duty Cycle	45	50	55	%
$t_{S:RESET}$	Setting time after software/hardware reset			1	ms
$t_{S:REG}$	Settling time for register change (10 frames required)			300	ms
SCCB Timing (see Figure 4)					
f_{SIO_C}	Clock Frequency			400	KHz
t_{LOW}	Clock Low Period	1.3			µs
t_{HIGH}	Clock High Period	600			ns
t_{AA}	SIO_C low to Data Out valid	100		900	ns
t_{BUF}	Bus free time before new START	1.3			µs
$t_{HD:STA}$	START condition Hold time	600			ns
$t_{SU:STA}$	START condition Setup time	600			ns
$t_{HD:DAT}$	Data-in Hold time	0			µs
$t_{SU:DAT}$	Data-in Setup time	100			ns
$t_{SU:STO}$	STOP condition Setup time	600			ns
t_R, t_F	SCCB Rise/Fall times			300	ns
t_{DH}	Data-out Hold time	50			ns
Outputs (VSYNC, HREF, PCLK, and D[9:0] (see Figure 5, Figure 6, and Figure 7)					
t_{PDV}	PCLK[↓] to Data-out Valid			5	ns
t_{SU}	D[9:0] Setup time	15			ns
t_{HD}	D[9:0] Hold time	8			ns
t_{PHH}	PCLK[↓] to HREF[↑]	0		5	ns
t_{PHL}	PCLK[↓] to HREF[↓]	0		5	ns
AC Conditions:	• V_{DD}: V_{DD-C} = 1.8V, V_{DD-A} = 2.5V, V_{DD-IO} = 2.5V • Rise/Fall Times: I/O: 5ns, Maximum SCCB: 300ns, Maximum • Input Capacitance: 10pf • Output Loading: 25pF, 1.2KΩ to 2.5V • f_{CLK}: 24MHz				

Timing Specifications

Figure 4 SCCB Timing Diagram

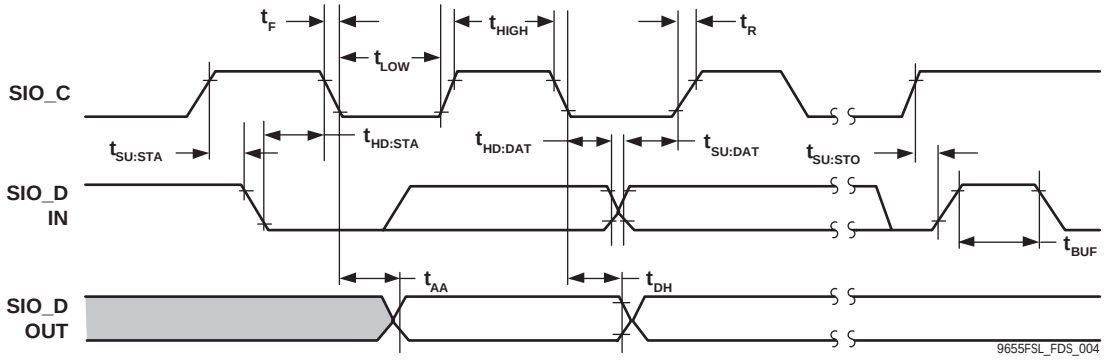


Figure 5 Horizontal Timing

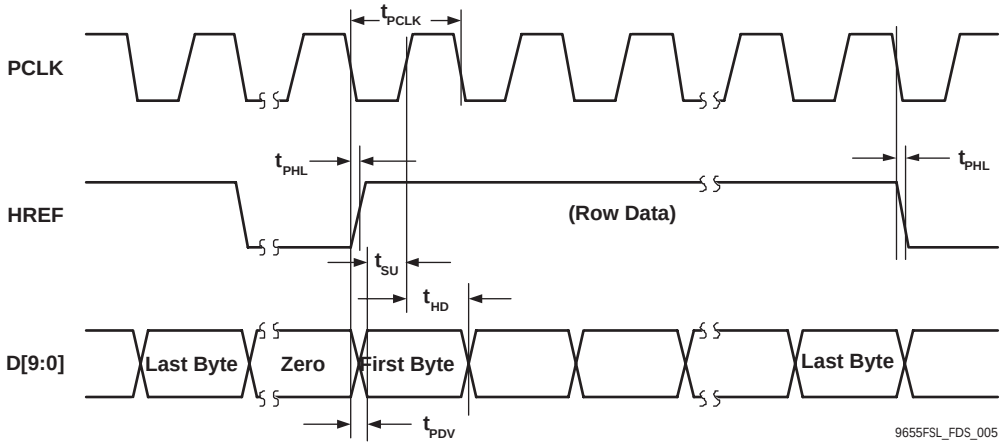
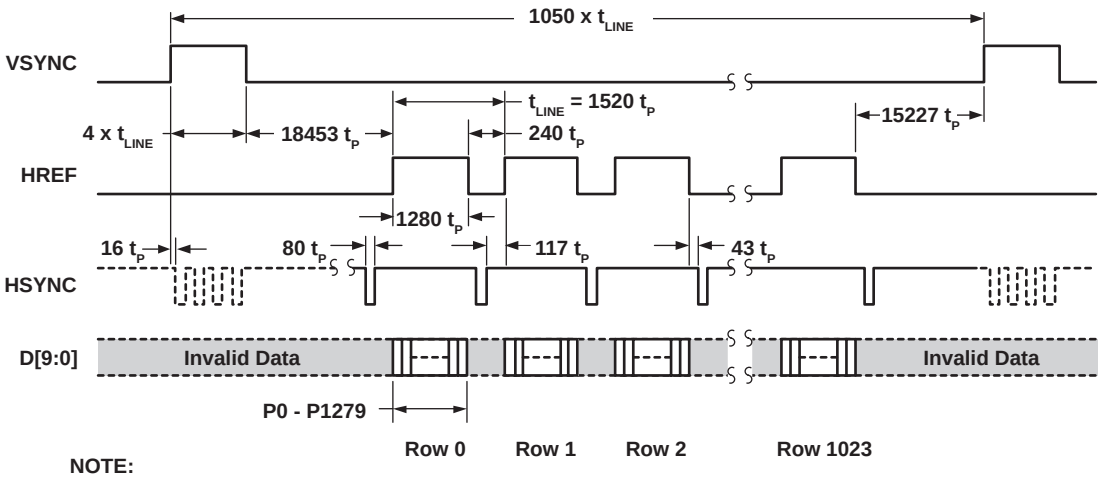


Figure 6 SXGA Frame Timing



NOTE:
For Raw data, t_P = internal pixel clock
For YUV/RGB, t_P = 2 x internal pixel clock

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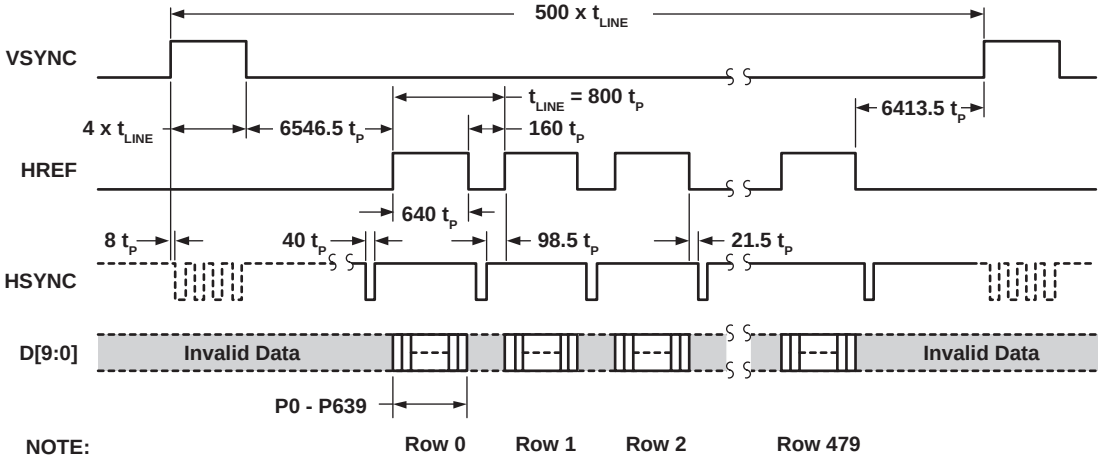
Figure 7 VGA Frame Timing



NOTE:
For Raw data, t_P = internal pixel clock
For YUV/RGB, t_P = 2 x internal pixel clock

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Figure 8 RGB 565 Output Timing Diagram

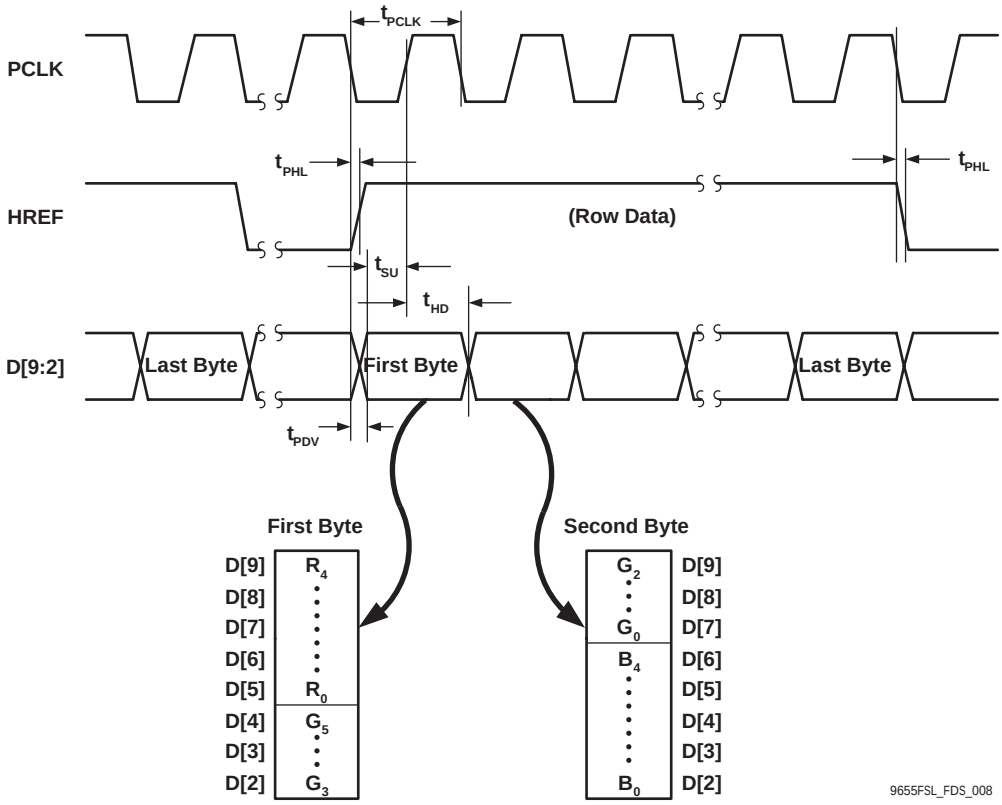
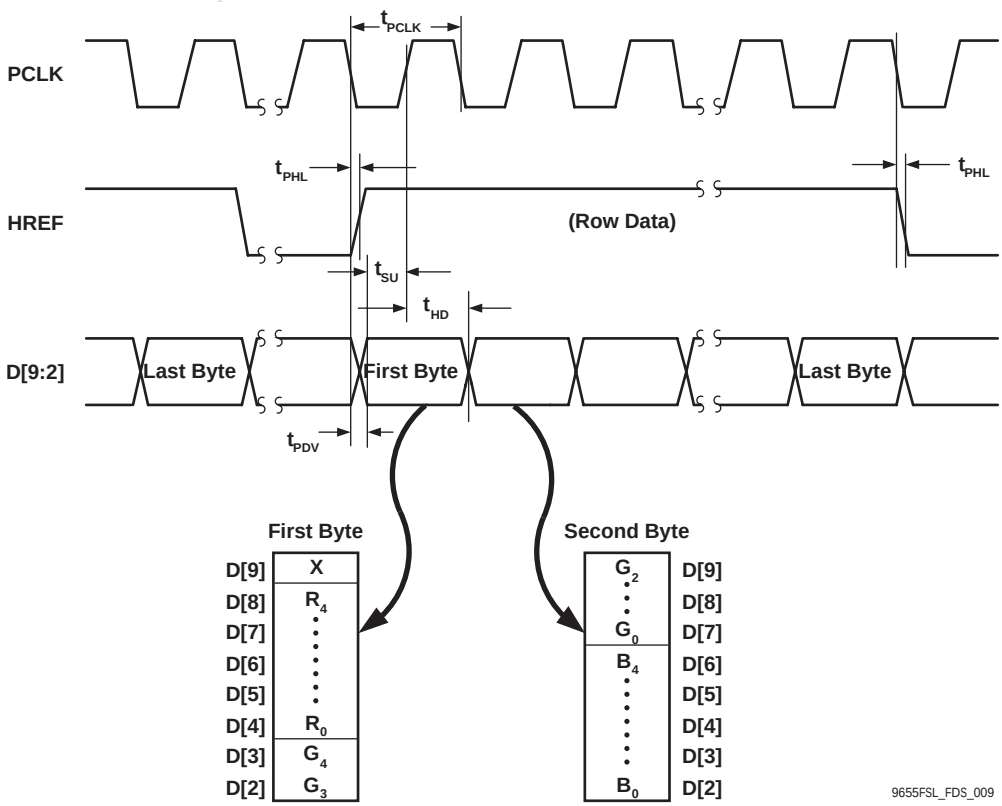


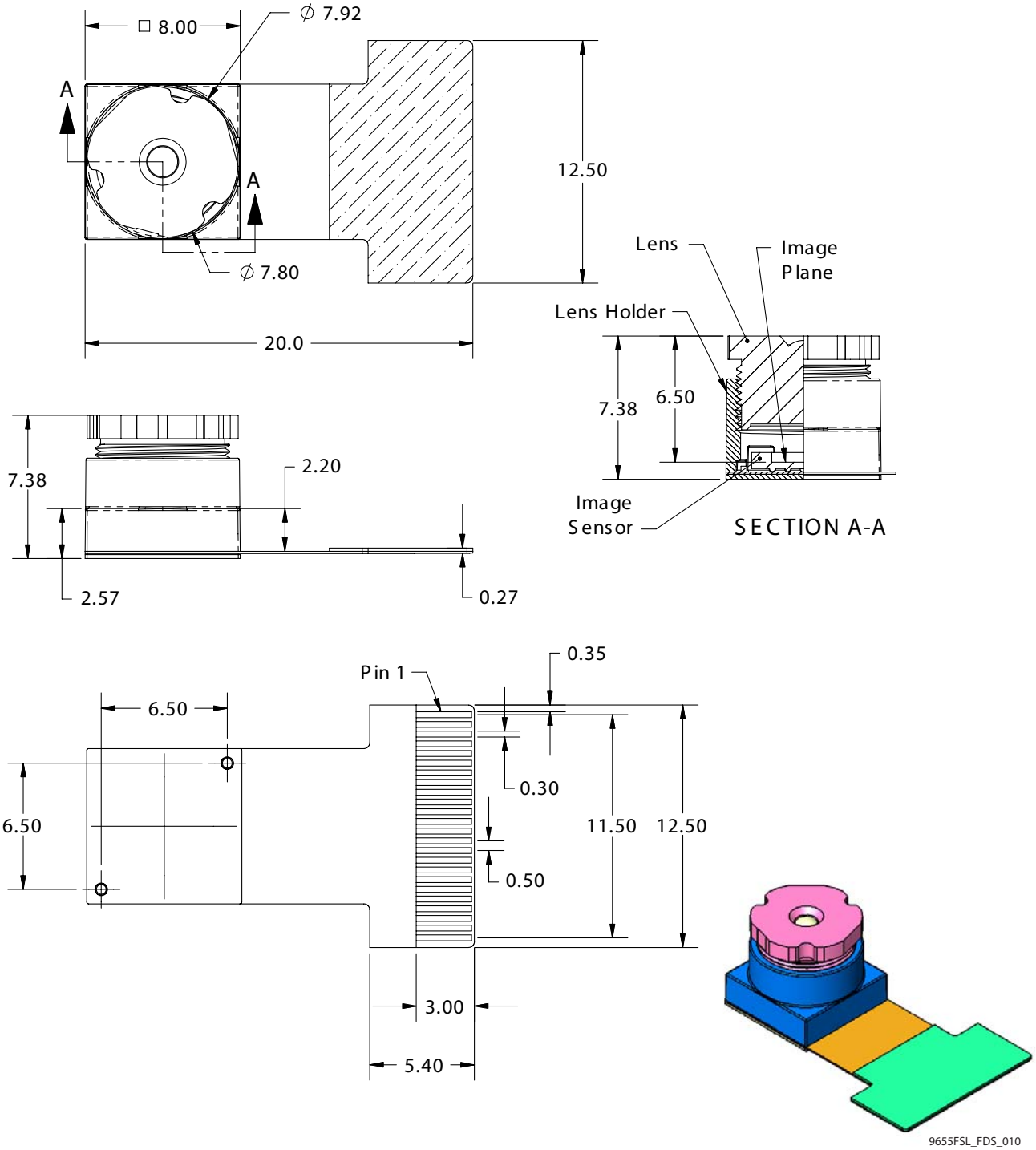
Figure 9 RGB 555 Output Timing Diagram



Package Specifications

Refer to Figure 10 for package information on the OV9655MFSL module.

Figure 10 OV9655MFSL Package Specifications



Mechanical Specifications

Table 7 Mechanical Dimensions

Parameter	Specification	Comments
Sensor	5.1 mm x 5.72 mm	CMOS in housing
Lens	Glass/Plastic	
Connection Type	24 x 0.5 mm	Flex cable
Housing	8 mm x 8 mm x 7.38 mm	Excluding mushroom

Connector Information

The OV9655MFSL uses a 24-pin, 0.5 mm pitch flex cable connector. Table 8 shows a listing of some recommended connectors.

Table 8 Recommended Connectors

Manufacturer	Part No.	Description
Molex	52437-2427 (Bulk) 52437-2491 (Tape reel)	0.5 FPC connector, ZIF for SMT, R/A (bottom contact)

Optical Specifications

Table 9 Lens Specifications

Parameter	Specification	Comments
Lens Elements	1 Glass, 2 Plastic	3-element
Viewing Angle	55.74° diagonal	
Focal Length	4.85 mm	
F Number	2.8	
Focus Range	40 cm → ∞	
Filter	IR cut	Included in barrel
Mount Description	M7 x 0.35P	
TV Distortion	<1%	
Focus Adjustment	Fixed	at 80 cm

Handling Precautions

WARNING: READ THIS FIRST!
Prior to handling any OmniVision flex camera module, read the following precautions.

- DO NOT try to open the unit enclosure as there is no user-serviceable component inside.
- To prevent damage to the camera module by electrostatic discharge, handle the camera module ONLY after discharging ALL static electricity from yourself and ensuring a static-free environment for the camera module.
- DO NOT touch the top surface of the lens.
- DO NOT press down on the lens.
- DO NOT try to focus the lens.
- DO NOT put the camera module in a dusty environment.
- To reduce the risk of electrical shock and damage to the camera module, turn OFF the power before connect and disconnect the camera module.
- DO NOT bend the flex cable in a sharp angle.
- DO NOT twist the flex cable.
- DO NOT peel the flex cable when you install and uninstall the camera module.
- DO NOT drop the camera module more than 60 cm onto any hard surface.
- To prevent fire or shock hazard, DO NOT expose camera module to rain or moisture.
- DO NOT expose camera module to direct sunlight.
- DO NOT put camera module in a high temperature environment.
- DO NOT use liquid or aerosol cleaners to clean the lens.
- DO NOT make any changes or modifications to camera module.
- DO NOT subject camera module to strong electromagnetic field.
- DO NOT subject the camera module to excessive vibration or shock.