



Logic PD Development Kit Camera Module Selection and Integration

Application Note 596

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Abstract

This application note provides options that customers can consider when interfacing a camera module to a Logic PD Development Kit.

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Revision History

REV	EDITOR	DESCRIPTION	APPROVAL	DATE
A	BSB	-Initial release	SO, AF	08/15/14
B	BSB	- Updated Section 2.1 to include additional information concerning coding for 8-bit configuration.	AF, CT	06/22/17

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1 Introduction

Logic PD has been integrating camera modules with Texas Instruments (TI) OMAP products for many years. This application note provides information that will give developers a jump start on their camera module integration development efforts when interfacing to a Logic PD Development Kit.

2 DM3730 Torpedo Development Kit

The DM3730 Torpedo Development Kit provides a 26-pin female camera connector (J6) that allows connection of 8-bit, 10-bit, and 12-bit cameras. Any of the 26-pin cameras listed below can be connected without hardware modification. Typically, 2.8V and 3.3V systems are close enough to be functional, but the signal levels on J6 can be adjusted through R194 and R195 if needed.

For 8-bit cameras (pins 1-8 of J6):

1. Place a jumper across pins 1-2 of JP5 on the baseboard.

NOTE: 10-bit and 12-bit cameras can also be used in this mode - the least significant 2-4 data bits will be dropped.

For 12-bit cameras (pins 1-10, 14, and 15 of J6):

1. Place a jumper across pins 2-3 of JP5 on the baseboard.
2. Move R90 to R91 on the DM3730/AM3703 Torpedo and Torpedo + Wireless SOM and populate R108-R111 on the SOM.

NOTE: 8-bit cameras can also be used in this mode if pins 9, 10, 14, and 15 of J6 are grounded. Additionally, 10-bit cameras can be used in this mode if pins 14 and 15 of J6 are grounded.

Logic PD offers custom SOMs for customers needing to make changes as described above. Customers whom choose to make these changes themselves will void their warranty. [Contact Logic PD Sales](#)¹ for additional information on custom SOMs.

2.1 Software

The Logic PD DM37x Linux Board Support Package (BSP) 2.4-2 and newer include a driver to support use of the 5 megapixel LI-5M04 module (Aptina MT9P011 sensor) out of the box. The default MT9P031 driver was modified to add support for white balance using the gain available in the sensor. Since most users will not have moved R90 to enable 12-bit cameras, the MT9P031 driver was also modified to report that it is an 8-bit camera (search for MT9P031_8MSB_ONLY in *drivers/media/video/mt9p031.c*). Since the camera data is aligned to the least significant bits of the parallel interface on the Camera Image Signal Processor (ISP), this tells the omap3isp driver to drop the most significant data bits (keeping the least significant bits that have valid data on them). The board configuration file configures the pin muxing for 8-bit camera support (search for 'muxing 8-bit interface' in *arch/arm/mach-omap2/board-omap3logic.c*).

¹ <http://www.logicpd.com/contact/inquiry/>

The DM37x Linux BSP 2.4-2 and newer include additional drivers for a number of camera sensors besides the MT9P031. Use of other sensors can be enabled by simply selecting them in the Linux kernel *menuconfig* and adding them to the board configuration file (search for CONFIG_VIDEO_MT9P031 in *arch/arm/mach-omap2/board-omap3logic.c*). The camera driver will then need to be modified to report that it is an 8-bit camera, unless R90 is moved to enable 12-bit input (see previous paragraph).

12-Bit changes to mt9p031.c:

Comment out the #define as seen below.

```
/* Indicates that only 8 of the 12 data signals are connected */
// #define MT9P031_8MSB_ONLY
```

12-Bit changes to board-omap3logic.c:

Change the `#if 1` to `#if 0` as seen below.

```
#if 0
    printk("%s: muxing 8-bit interface (cam_d0-cam_d7)\n", __FUNCTION__);
#else
    printk("%s: muxing 12-bit interface (cam_d0-cam_d11)\n", __FUNCTION__);
    omap_mux_init_signal("cam_d8.cam_d8", OMAP_PIN_INPUT);
    omap_mux_init_signal("cam_d9.cam_d9", OMAP_PIN_INPUT);
    omap_mux_init_signal("cam_d10.cam_d10", OMAP_PIN_INPUT);
    omap_mux_init_signal("cam_d11.cam_d11", OMAP_PIN_INPUT);
#endif
```

2.2 Data Bus Alignment

TI recommends (and Linux expects) that camera data is connected to the least significant bits of the parallel interface. However, the 26-pin interface expects that data is connected to the most significant bits of the connector. To compensate, JP5 can be used to properly align 8-bit and 12-bit data using level-shifters. 10-bit data can be routed as 8-bit or 12-bit data, but the Linux sensor driver will need to be modified to match.

Also note that the Camera ISP modules that deal with RAW (Bayer RGB) data only operate on 10-bit data. For 12-bit RAW cameras, the Linux driver automatically enables the CCDL lane-shifter to right-shift by 2. Any 10-bit RAW camera data (e.g., on a custom baseboard) can be used as-is. Any 8-bit RAW camera data needs to be left-shifted by 2, but the CCDL lane-shifter can only right-shift. Instead, Logic PD has modified the omap3isp driver to set the DGAIN in the previewer to 4x (0x3FF) in this case, essentially the same as a left-shift by 2. If this is not done, the two most significant bits are not used, so the image is very dark. As long as 8-bit YUV and JPEG cameras are connected properly, there should be no internal alignment issues (the 8-bit data is sent directly to the Camera ISP resizer module or to RAM).

3 **DM3730 SOM-LV Development Kit**

The DM3730 SOM-LV Development Kit does not have a dedicated camera input connector. However, a camera can be connected to the 240-pin expansion connectors (J13-J14) if a custom adapter board is created.

4 **OMAP35x Torpedo Development Kit**

The OMAP35x Torpedo Development Kit provides a 26-pin female camera connector (J6) that allows connection of 8- to 12-bit cameras if a custom adapter board is designed. The original DM3730 Torpedo Development Kit has the same connector as the OMAP35x Torpedo Development Kit, but the newer -30 DM3730 Torpedo Development Kit includes an improved connector (see above).

5 **OMAP35X SOM-LV Development Kit**

The OMAP35x SOM-LV Development Kit does not have a dedicated camera input connector. However, a camera can be connected to the 240-pin expansion connectors (J13-J14) if a custom adapter board is created.

6 **OMAP-L138 EVM Development Kit**

The OMAP-L138 EVM Development Kit includes a 26-pin female camera connector on the UI board that accepts a number of types of existing camera boards. Level shifters are provided to allow adjustment as needed. The Platform Support Package (PSP) includes a driver for the Aptina MT9V032 Camera Headboard that is used during functional test.

TI includes a driver for the Aptina MT9T031 Camera Headboard in the 2.6.37 Linux source code.

Logic PD has connected an Aptina MT9P111 to the OMAP-L138 EVM Development Kit using a custom adapter board with some power supplies and connectors on it. This board had a 26-pin connector and a flex connector connected to a LI-CAM board. In order to make this work, Logic PD had to modify the EVM UI board to use 2.8V IO signal levels instead of 3.3V IO signal levels. A Linux 2.6.37 driver is also available for this module.

7 **26-pin Camera Boards**

The boards in and below have a 26-pin connector on them and are targeted for use with an Aptina demo kit board or a TI/Mistral EVM kit. They should also be usable with some Logic PD Development Kits (see development kit-specific sections above for details).

Table 1: Camera Boards with 26-pin Male Connector

Board	Included Sensor	Resolution	IO Levels	Data Bits	Additional Information
Aptina Demo Kits²	Various Aptina Sensors	VGA - 5 MP	3.3V	10	Order "Headboard Only" Search for MT9 sensors, select the sensor and look for evaluation/development tool. Acquired by OnSemi
LI-5M04	LI-5M04CM³ (Aptina MT9P011)	5 MP	2.8V	10	Adapter Board⁴ , Camera Module⁵ , Board+Module⁶
LI-3M02	LI-3M02CM⁷ (Aptina MT9T111)	3 MP	2.8V	8	Adapter Board⁸ , Camera Module⁹ , Board+Module¹⁰
LI-2M01	LI-2M01CM (Aptina MT9D112)	2 MP	2.8V	10	Adapter Board¹¹ , Camera Module¹² , Board+Module¹³
LI-1M01	LI-1M01CM (Aptina MT9M112)	1.3 MP	2.8V	10	Adapter Board¹⁴ , Camera Module¹⁵ , Board+Module¹⁶
LI-VM01	LI-VM01CM (Aptina MT9V113)	VGA	2.8V	10	Adapter Board¹⁷ , Camera Module¹⁸ , Board+Module¹⁹
LI-5M01	Aptina MT9P031	5M	3.3V	10	Board²⁰ , User Guide²¹
LI-3M01	Aptina MT9T001	3M	3.3V	10	Board²² , User Guide²³
Leopard Imaging IPCamera Boards²⁴	Various Aptina, Sony, and OmniVision Sensors		3.3V		Required Adapter Board²⁵

Table 2: Camera Boards with 26-pin Female Connector (Ribbon Cable Needed)

Board	Included Sensor	Resolution	IO Levels	Data Bits	Additional Information
e-CAM50_DM37x	e-CAM50_5642_MOD (OV5642)	5 MP		8	Auto-focus, LED flash
e-CAM52_35x	e-CAM52_5640_MOD (OV5640)	5 MP	2.8V	10	Auto-focus
e-CAM50_CU5642_MOD	e-CAM50_CU35x (OV5642)	5 MP	3.3V	10	
e-CAM1M_CU10630_MOD	e-CAM50_CU35x	1 MP	3.3V	10	WDR/HDR,

² <http://www.onsemi.com/PowerSolutions/parametrics.do?id=101682>

³ <http://shop.leopardimaging.com/product.sc?productId=45>

⁴ https://www.leopardimaging.com/uploads/LI-MOD01_Camera_Module_Adapter.pdf

⁵ https://www.leopardimaging.com/uploads/LI-5M04CM_Camera_Module_Flyer.pdf

⁶ https://www.leopardimaging.com/uploads/LI-5M04_Camera_Module_Board.pdf

⁷ <https://www.leopardimaging.com/LI-3M02CM.html>

⁸ https://www.leopardimaging.com/uploads/LI-MOD01_Camera_Module_Adapter.pdf

⁹ https://www.leopardimaging.com/uploads/LI-3M02CM_Camera_Module_Flyer.pdf

¹⁰ https://www.leopardimaging.com/uploads/LI-3M02_Camera_Module_Board.pdf

¹¹ https://www.leopardimaging.com/uploads/LI-MOD01_Camera_Module_Adapter.pdf

¹² https://www.leopardimaging.com/uploads/LI-2M01CM_Camera_Module_Flyer.pdf

¹³ https://www.leopardimaging.com/uploads/LI-2M01_Camera_Module_Board.pdf

¹⁴ https://www.leopardimaging.com/uploads/LI-MOD01_Camera_Module_Adapter.pdf

¹⁵ https://www.leopardimaging.com/uploads/LI-1M01CM_Camera_Module_Flyer.pdf

¹⁶ https://www.leopardimaging.com/uploads/LI-1M01_Camera_Module_Board.pdf

¹⁷ https://www.leopardimaging.com/uploads/LI-MOD01_Camera_Module_Adapter.pdf

¹⁸ https://www.leopardimaging.com/uploads/LI-VM01CM_Camera_Module_Flyer.pdf

¹⁹ https://www.leopardimaging.com/uploads/LI-VM01_Camera_Module_Board.pdf

²⁰ https://www.leopardimaging.com/uploads/LI-5M01_HD_Camera_Board.pdf

²¹ https://www.leopardimaging.com/uploads/LI-5M01_User_Guide_v1.23.pdf

²² https://www.leopardimaging.com/uploads/LI-3M01_HD_Camera_Board.pdf

²³ https://www.leopardimaging.com/uploads/LI-3M01_User_Guide_v1.62.pdf

²⁴ <http://shop.leopardimaging.com/category.sc?categoryId=14>

²⁵ <http://shop.leopardimaging.com/product.sc?productId=142>

Board	Included Sensor	Resolution	IO Levels	Data Bits	Additional Information
	(OV10633)				16:9

7.1 Aptina Demo Kit Board

The Aptina demo kit board and TI EVM both run at 3.3V IO levels, so it seems odd that some of the cameras have 2.8V IO levels. From all reports, it appears these cameras are still functional when connected to a system using 3.3V IO levels.

7.2 Omnivision OV7690

Logic PD has also connected an Omnivision OV7690 development board to a DM3730 Torpedo Development Kit using a custom adapter board with some power supplies and connectors on it. In order to do this, the OV7690 board required modification to power the digital IO on 1.8V instead of 2.8V. A driver does exist for the OV7690 in the DM37x Linux 2.4-2 BSP using Linux 3.0.

8 Potential Issues

The camera connector may not be used with 26-pin off-the-shelf camera boards for the following reasons:

- The development kits use 1.8V signal levels, while the available adapter boards use 2.8 or 3.3V signaling.
- CSI_D8-CSI_D11 (the most significant data bits) on the OMAP35x/DM3730 Torpedo & Torpedo + Wireless can only be used if you move R90 to R91 on the SOM. On the DM3730 Torpedo, you may also want to populate R108-R111.
- The most significant camera data bits are used for other purposes on the development kit baseboards:
 - OMAP35x Torpedo Development Kit - CONFIG8-11/CSI_D8-11 are used for power measurements.
 - DM3730 Torpedo and Torpedo + Wireless Development Kit - R133 on the baseboard grounds CONFIG10/CSI_D10.

9 Summary

The information in this document has been provided to assist Logic PD customers when selecting and integrating a camera module with a TI OMAP platform.

Logic PD has interfaced the DM3730/AM3703 Torpedo and Torpedo + Wireless modules to camera sensors for a number of customers' camera modules. For some of these projects, custom camera boards were developed to connect the camera sensor to the DM3730 Torpedo Development Kit on J6. Designers looking for assistance in integrating their camera module into a TI OMAP design are encouraged to contact Logic PD through their dedicated sale representative or by posting a question to the Logic PD [Technical Discussion Group \(TDG\) forum](http://support.logicpd.com/TDGForum.aspx).²⁶

²⁶ <http://support.logicpd.com/TDGForum.aspx>