PHYTEC Messtechnik GmbH

Application Note

How to use phyCAM camera modules with the phyCARD-XL3 (i.MX6) SOM

Revision History

Version	Changes	Author	Date
A0	Initial Release	H. Fendrich	20.03.2014
A1	New block diagrams	H. Fendrich	01.07.2014
B0	Describe the settings for camera (in YOCTO PD15.3.0)	H. Fendrich	29.03.2016

Content

1 Overview

The i.MX6 Microcontroller supported more then 1 camera interface (see figure 1).

figure 1: Block Diagram Camera Interfaces of i.MX6 Controller (Quad / Dual) and i.MX6 Controller (Solo / Dual Lite)

On the phyCARD-XL3 (i.MX6) the CSI0/IPU#1 camera path (thru a serializer) go out as LVDS signal. Together with power signal and the I²C-Bus on the phyCARD - carrier board go it on teh phyCAM-S+ Camera interface (see figure 2).
Here you can connect one of the different phy-CAM-S camera modules. See the phyCAM-P/-S manual L-748 for more information.
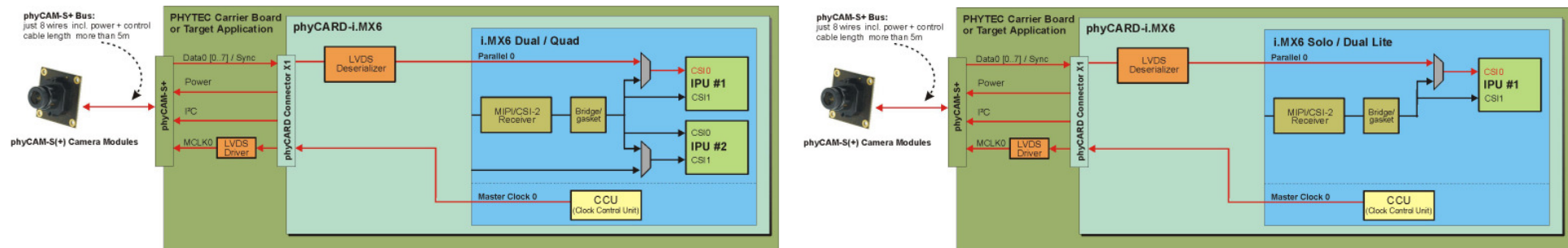

figure 2: Block Diagram of phyCAM-S(+) Camera Interfaces of phyCARD i.MX6 (Quad / Dual) and phyCARD i.MX6 (Solo / Dual Lite)

The BSP shipped with the Kit includes already the software drivers for the supported phyCAM camera modules. The drivers are compatible with v4l2. Also GStreamer scripts are included for the evaluation of the camera modules. If you need more then one camera interface or/and phyCAM-P support, please use the phyFLEX-i.MX6 Modul.

2   Camera Connectors on the Carrier Boards

The development kits for the phyCARD-XL3 (i.MX6) may contain either:
•   one carrier board
•   one phyCARD-XL3 (i.MX6) modul SOM

The carrier board connects to the phyCARD-connector, with the phyCARD-XL3 (i.MX6) modul.

The serial phyCAM-S+ camera input is available directly on the carrier board PBA-A-01 on a RJ45 (CAM) connector. See figure 3 for the location of the connectors on the carrier board.
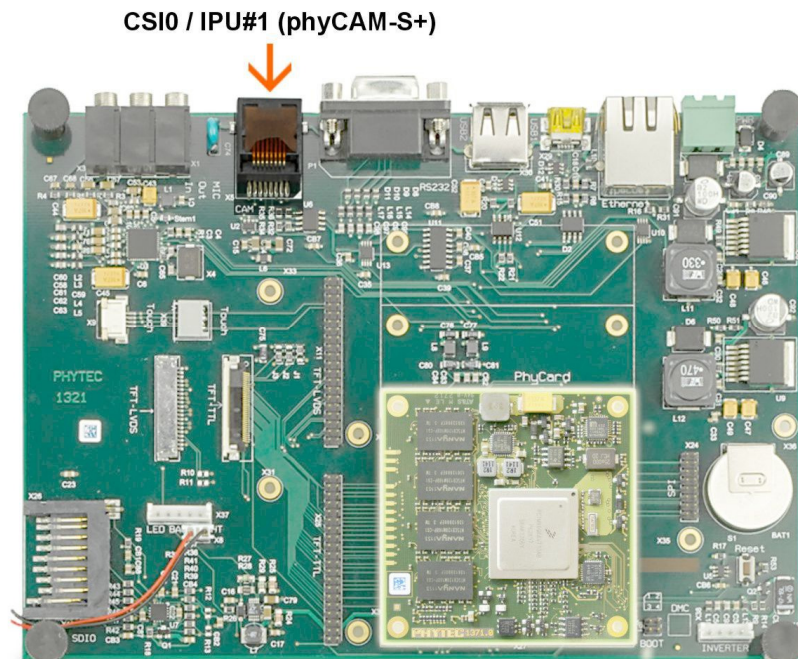
figure 3: Camera Interfaces on Carrier Board for the phyCard- XL3 (i.MX6) SOM

3 Set bootarg parameters in the *config*-file for cameras (Linux PD14.1.0 and higher)

The bootarg parameters are used to adapt the software environment to the hardware configuration and camera module(s) connected to the board.

The configuration in the config file must match with the camera models that are connected to the camera interfaces.
Note that model, interface type and I²C-addresses must be set correctly. Otherwise the camera(s) are not working.
Please check, if the correct camera model is set in the config file. If not, please follow the steps below to set the appropriate configuration.

Changing the setting of the bootarg parameters

To change the config-file (bootargs-cam), use the Barebox environment:
- 'cd env/bin' <enter>
- 'edit bootargs-cam' <enter>

The following settings in config-file are necessary:
- CSI0=<csi[X]_cam_type>,<csi[X]_cam_address>
- only for VM-010: bootargs="$bootargs mt9v022.sensor_type=<color or mono>"
- only for VM-011: bootargs="$bootargs mt9p031.mono=Y"

The parameters for the phyCAM – modules are shown in the table below (see next page).

After changing the settings with the editor:
- close the editor (CTRL D)
- type 'saveenv' <enter> to save
- restart PHYTEC module

After login, change into the directory: \gstreamer_examples\..
cd gstreamer_examples <ENTER>.

Now you can start working with the GStreamer demo-scripts.
Detailed information about the GStreamer examples can be found in the phyCAM-Manual L-748.

Hardware Configuration		Bootarg Parameters		Bootarg settings for default I²C-address (default jumper on camera and boards)
phyCAM camera model (part number)	connected to	csi[X]_cam_type	csi[X]_cam_address	
VM-006-BW-LVDS (-M12 / -H)	X5 on base board	VM-006	0x5D	CSI0=VM-006,0x5D
VM-008 (-M12/ -H)	X5 on base board	VM-008	0x44, 0x45	CSI0=VM-008,0x45
VM-009-LVDS (-M12 / -H)	X5 on base board	VM-009	0x48, 0x5D	CSI0=VM-009,0x48
VM-010-BW-LVDS (-M12 / -H)	X5 on base board	VM-010	0x48, 0x4C, 0x58, 0x5C	CSI0=VM-010,0x48 bootargs="$bootargs mt9v022.sensor_type=mono"
VM-010-COL-LVDS (-M12 / -H)	X5 on base board	VM-010	0x48, 0x4C, 0x58, 0x5C	CSI0=VM-010,0x48 bootargs="$bootargs mt9v022.sensor_type= color"
VM-011-BW-LVDS (-M12 / -H)	X5 on base board	VM-011	0x48, 0x5D	CSI0=VM-011,0x48 bootargs="$bootargs mt9p031.mono=Y"
VM-011-COL-LVDS (-M12 / -H)	X5 on base board	VM-011	0x48, 0x5D	CSI0=VM-011,0x48 #bootargs="$bootargs mt9p031.mono=Y"

Notes:
- I²C addresses of the camera are set by hardware configuration (jumper setting on the camera and / or on the baseboard. Please refer to the phyCAM-manual L-748 and the hardware manual of the kit.

4   Change the cameras or camera parameters (YOCTO Linux PD15.3.0)

Due to the change over to the new linux kernel version, the cameras and the camera interface are no longer supported as a SOC-device, but as sub-devices.
To configure is used the multimedia framework "media control".
The conversion of the formerly from PHYTEC supported camera driver, camera interface and the IPU and VPU support is not yet complete.

The Linux BSP PD15.1.0 and PD15.1.1 for these kits does support the camera VM-011-COL (phyCAM-P and phyCAM-S+) at CSI0/IPU#1. For support other PHYTEC phyCAM cameras or change the camera master clock or the I2C address of the cameras you have to compile a new device tree.
For more information see on FTP:
ftp://ftp.phytec.de/pub/ImageProcessing/phyCARD-i.MX6_linux_PD15.3.0/

The configuration in the config-expansions file must match with the camera models that are connected to the camera interfaces.
Note that model, interface type and I²C-addresses must be set correctly. Otherwise the camera(s) are not working.
Please check, if the correct camera model is set in the config file. If not, please follow the steps below to set the appropriate configuration.

Changing the setting of the config-expansions parameters

To change the config-file (config-expansions), use the Barebox environment:
- 'cd env' <enter>
- 'edit config-expansions' <enter>

The following settings in config-expansions - file are necessary:
of_camera_selection -p <csi_port> -b <csiX_cam_bus_type> -a <csiX_cam_i2c_address> <cam_type>
- csi_port = [0,1]
- csix_cam_bus_type = [phyCAM-P, phyCAM-S+]
- csix_cam_i2c_address = [0x41-0x5D] depend of camera typ/setings
- csix_cam_type = [VM-006, VM-008, VM-009, VM-010-BW, VM-010-COL, VM-011-BW, VM-011-COL]

Example: VM-010-BW-LVDS with i2C-address 0x48 on CSI0 (Camera_0) port
[of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-010-BW]

The parameters for the phyCAM – modules are shown in the table below (see next page).

After changing the settings with the editor:
- close the editor (CTRL D)
- type 'saveenv' <enter> to save
- restart PHYTEC module

After login, change into the directory: \gstreamer_examples\..
cd gstreamer_examples <ENTER>.

Now you can start working with the GStreamer demo-scripts. Detailed information about the GStreamer examples can be found in the phyCAM-Manual L-748.

Hardware Configuration		Bootarg Parameters				Bootarg settings for default I²C-address (default jumper on camera and boards)
phyCAM camera model (part number)	connected to	csi_port	csi[X]_cam_bus_type	csi[X]_cam_type	csi[X]_cam_i2c_address	
VM-006-BW (-M12 / -H)	Not on MIRA board	0	phyCAM-P	VM-006	0x5D, 0x41	of_camera_selection -p 0 -b phyCAM-P -a 0x5D VM-006
	Not on MIRA board	1	phyCAM-P	VM-006	0x5D, 0x41	of_camera_selection -p 1 -b phyCAM-P -a 0x5D VM-006
VM-006-BW-LVDS (-M12 / -H)	**X5 on base board**	0	phyCAM-S+	VM-006	0x5D, 0x41	of_camera_selection -p 0 -b phyCAM-S+ -a 0x5D VM-006
	Not on MIRA board	1	phyCAM-S+	VM-006	0x5D, 0x41	of_camera_selection -p 1 -b phyCAM-S+ -a 0x5D VM-006
VM-008	Not on MIRA board	0	phyCAM-P	VM-008	0x44, 0x45	of_camera_selection -p 0 -b phyCAM-P -a 0x45 VM-008
	Not on MIRA board	1	phyCAM-P	VM-008	0x44, 0x45	of_camera_selection -p 1 -b phyCAM-P -a 0x45 VM-008
	X5 on base board	0	phyCAM-S+	VM-008	0x44, 0x45	of_camera_selection -p 0 -b phyCAM-S+ -a 0x45 VM-008
	Not on MIRA board	1	phyCAM-S+	VM-008	0x44, 0x45	of_camera_selection -p 1 -b phyCAM-S+ -a 0x45 VM-008
VM-009 (-M12 / -H)	Not on MIRA board	0	phyCAM-P	VM-009	0x48, 0x5D	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-009
	Not on MIRA board	1	phyCAM-P	VM-009	0x48, 0x5D	of_camera_selection -p 1 -b phyCAM-P -a 0x5D VM-009
VM-009-LVDS (-M12 / -H)	**X5 on base board**	0	phyCAM-S+	VM-009	0x48, 0x5D	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-009
	Not on MIRA board	1	phyCAM-S+	VM-009	0x48, 0x5D	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-009
VM-010-BW (-M12 / -H)	Not on MIRA board	0	phyCAM-P	VM-010-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-010-BW
	Not on MIRA board	1	phyCAM-P	VM-010-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-P -a 0x4C VM-010-BW
VM-010-BW-LVDS (-M12 / -H)	**X5 on base board**	0	phyCAM-S+	VM-010-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-010-BW
	Not on MIRA board	1	phyCAM-S+	VM-010-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-010-BW
VM-010-COL (-M12 / -H)	Not on MIRA board	0	phyCAM-P	VM-010-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-010-COL
	Not on MIRA board	1	phyCAM-P	VM-010-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-P -a 0x4C VM-010-COL
VM-010-COL-LVDS (-M12 / -H)	**X5 on base board**	0	phyCAM-S+	VM-010-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-010-COL
	Not on MIRA board	1	phyCAM-S+	VM-010-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-010-COL
VM-011-BW (-M12 / -H)	Not on MIRA board	0	phyCAM-P	VM-011-BW	0x48,0x5D	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-011-BW
	Not on MIRA board	1	phyCAM-P	VM-011-BW	0x48,0x5D	of_camera_selection -p 1 -b phyCAM-P -a 0x5D VM-011-BW
VM-011-BW-LVDS (-M12 / -H)	**X5 on base board**	0	phyCAM-S+	VM-011-BW	0x48,0x5D	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-011-BW
	Not on MIRA board	1	phyCAM-S+	VM-011-BW	0x48,0x5D	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-011-BW
VM-011-COL (-M12 / -H)	Not on MIRA board	0	phyCAM-P	VM-011-COL	0x48,0x5D	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-011-COL
	Not on MIRA board	1	phyCAM-P	VM-011-COL	0x48,0x5D	of_camera_selection -p 1 -b phyCAM-P -a 0x5D VM-011-COL
VM-011-COL-LVDS (-M12 / -H)	**X5 on base board**	0	phyCAM-S+	VM-011-COL	0x48,0x5D	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-011-COL
	Not on MIRA board	1	phyCAM-S+	VM-011-COL	0x48,0x5D	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-011-COL

VM-012-BW (-M12 / -H) [1]	Not on MIRA board	0	phyCAM-P	VM-012-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-012-BW
	Not on MIRA board	1	phyCAM-P	VM-012-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-P -a 0x4C VM-012-BW
VM-012-BW-LVDS (-M12 / -H) [1]	**X5 on base board**	0	phyCAM-S+	VM-012-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-012-BW
	Not on MIRA board	1	phyCAM-S+	VM-012-BW	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-012-BW
VM-012-COL (-M12 / -H) [1]	Not on MIRA board	0	phyCAM-P	VM-012-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-P -a 0x48 VM-012-COL
	Not on MIRA board	1	phyCAM-P	VM-012-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-P -a 0x4C VM-012-COL
VM-012-COL-LVDS (-M12/-H) [1]	**X5 on base board**	0	phyCAM-S+	VM-012-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 0 -b phyCAM-S+ -a 0x48 VM-012-COL
	Not on MIRA board	1	phyCAM-S+	VM-012-COL	0x48, 0x4C, 0x58, 0x5C	of_camera_selection -p 1 -b phyCAM-S+ -a 0x48 VM-012-COL

Notes:
- csi[X]_cam address must be identical to the I²C-address of the corresponding camera. I²C addresses of the camera are set by hardware configuration (jumper setting on the camera and / or on the baseboard / mapper board. Please refer to the phyCAM-manual L-748 and the hardware manual of the kit.
- If two cameras are used at the same time, csi[X]_cam i2c address must be different for CAM0 and CAM1**.**
- If the CSI1 port not is used, please select "none" or the same camera as at CSI0 (with other I²C-adress).
- [1] in progress

5   GStreamer function for improved Tearing reduction (only up to PD14.1x)

Tearing is a visual artifact in video display where the display image shows information from two or more frames in a single screen draw.
It appears as a horizontal border or line. The image part beyond the line seems to be shifted horizontally when the image content or the camera is moved.
The tearing line(s) usually move(s) vertically across the image.
The artifact occurs when the camera framerate differs from the display frame or the camera readout cycle is not in sync with the display's refresh.
Definition and background information about the tearing effect can be found in http://en.wikipedia.org/wiki/Screen_tearing.

The Freescale i.MX-6 processor contains an anti-tearing mechanism in the IPU unit, which can reduce the tearing effect.
However, since - depending on camera settings and camera model - the frame rate might be very different from the display's refresh rate, tearing effects might still be visible even if the anti-tearing mechanism is active. For applications that are intended to display live camera images on the display, additional measures should be considered to obtain a perfect image quality. This measures can include frame rate control (trimming the camera frame rate to the display's refresh rate), multi-buffering of the camera image etc.

We recommend to activate the anti-tearing mechanism of the i.MX-6 when live camera images are shown on the display.
For evaluation purposes with the development kits, Phytec added GStreamer examples, that use a different fbsink – function, that activates the anti-tearing mechanism.

Please use the following GStreamer-examples with Freescale "mfw_isink" for evaluation of the i.MX-6 camera:

Camera Module	Standard GStreamer Script	GStreamer Script with Freescale mfw_isink
	No tearing reduction	Framebuffer tearing reduction
VM-006	/more_mt9m001_scripts/mt9m001_bw_fbdef_640x480-sensor-roi	/more_mt9m001_scripts/mt9m001_fs_bw_fbdef_640x480
VM-009	/more_mt9m131_scripts/skip/skip2_fbdev_640x512	/more_mt9m131_scripts/skip/skip2_fs_fbdev_640x512
VM-010-BW	/more_mt9v024_scripts/mt9v024_bw-fbdev_752x480	/more_mt9v024_scripts/mt9v024_bw-fs_fbdev_752x480
VM-010-COL	/more_mt9v024_scripts/mt9v024_col-fbdev_752x480	/more_mt9v024_scripts/mt9v024_col-fs_fbdev_752x480
VM-011-BW	/more_mt9p031_scripts/mt9p031_bw_different_res_to_fbdev	/more_mt9p031_scripts/mt9p031_bw_fs_different_res_to_fbdev
VM-011-COL	/more_mt9p031_scripts/mt9p006_col_different_res_to_fbdev	/more_mt9p031_scripts/mt9p006_col_fs_different_res_to_fbdev

Note: After use freescale, gstreamer-sink plug-in "mfw_isink " the standard-gstreamer-sink plug-in "fbdevsink" do not working. Please restart the modul.