

Integrating QuickLogic® ArcticLink® III VX Solution Platform Software into an Android System



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ArcticLink III VX Solution Platform Overview

The QuickLogic ArcticLink III VX solution platform provides the following functions for an Android-based mobile platform:

- **Display bridging between the application processor and the display panel controller**
The ArcticLink III VX solution platform provides display bridging for the following variants:
 - MIPI DSI or RGB input
 - MIPI DSI, LVDS, and/or RGB output
- **Visual Enhancement Engine (VEE) and Display Power Optimizer (DPO)**
The ArcticLink III VX solution platform dynamically adjusts the local contrast ratio and dynamic range of display content according to the viewer's ambient light level. During the run-time, VEE/DPO is controlled by the software using a single parameter: *vee_strength*.
- **Panel backlight brightness control**
The ArcticLink III VX solution platform provides a Pulse Width Monitor (PWM) functional block. The software can dynamically control the brightness of the backlight by configuring the duty-cycle of the PWM block.

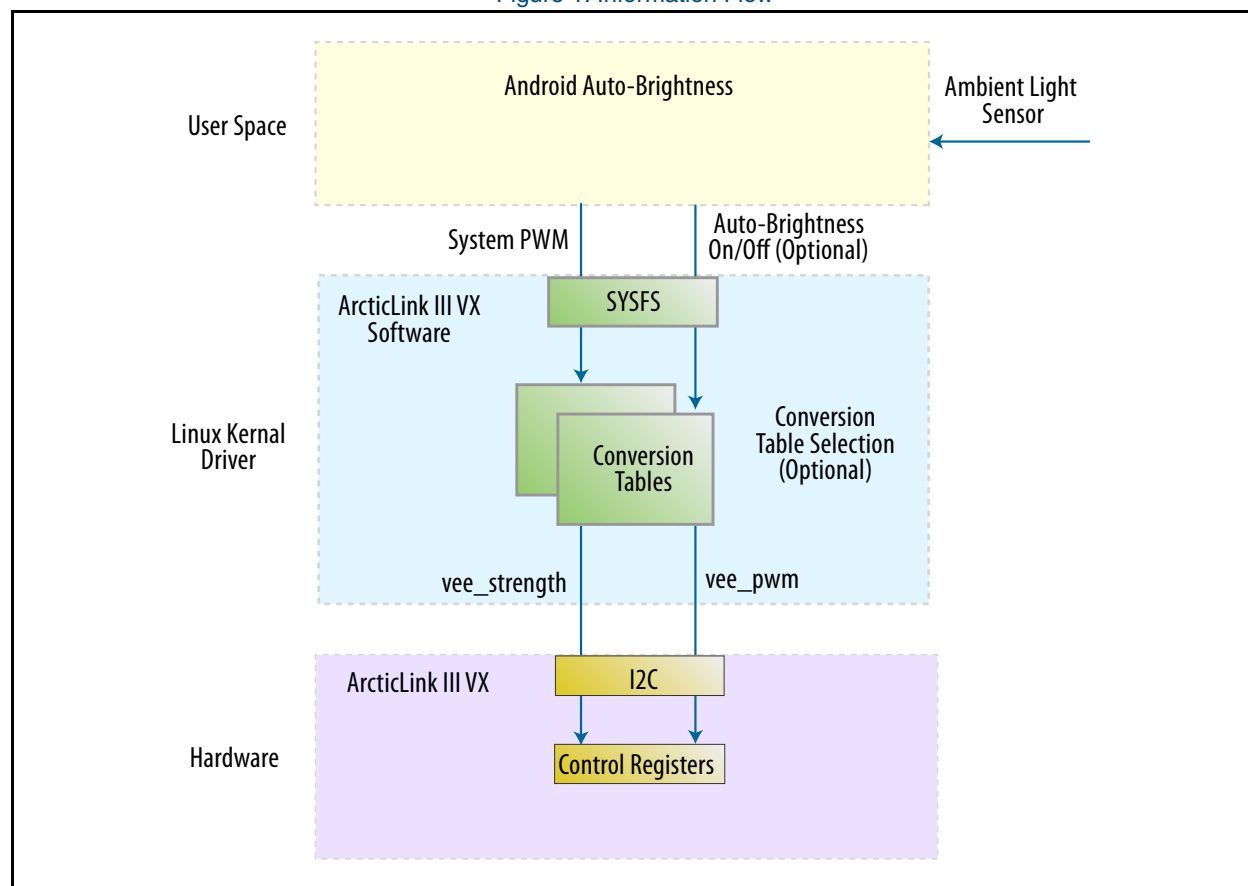
The ArcticLink III VX solution platform software provides the following functions:

- **Configures the display-bridge functions**
The software configures the ArcticLink III VX solution platform by writing the configuration registers via I²C or MIPI. The contents of the configuration registers are calculated off-line for the target system by using system parameters such as: *system_clock*, panel parameters (such as HSYNC, HBP, HSAA, HFP, VFP, VSYNC, VBP, and VSAA) and other system information.
- **Controls *vee_strength* and backlight *PWM_duty_cycle***
The software interfaces with the Android auto-brightness function via standard brightness SYSFS. Based on the inputs from auto-brightness, the software dynamically calculates the optimal values for *vee_strength* and *pwm_duty_cycle*, and writes the values to the registers of ArcticLink III VX solution platform via the I²C interface. Off-line calibration may be necessary for optimizing the matrices used by the calculation to achieve the optimal power-saving and visual enhancements.

Interactions with Android Auto-Brightness and Generation of Control Parameters

Figure 1 describes the information flows and interactions between the ArcticLink III VX solution platform software, standard Android auto-brightness, and ArcticLink III VX solution platform hardware.

Figure 1: Information Flow



As shown in **Figure 1**, Android auto-brightness sends two types of information to the ArcticLink III VX solution platform driver via SYSFS:

- System PWM (0-255): for controlling the perceived brightness of the screen from system perspective. The system PWM may not be the same as the real PWM (*vx_pwm*) actually applied for the display panel.
- Auto-brightness on/off information.

The ArcticLink III VX solution platform software is implemented as a kernel-level driver. During the initialization, the driver configures the static parameters for initializing the ArcticLink III VX solution platform hardware.

During the run-time, the driver converts the *system_pwm* from auto-brightness into two parameters: *vx_pwm* and *vee_strength*. With VEE/DPO, *vx_pwm* is typically lower than *system_pwm* for the same perceived brightness. Since the display power consumption is directly related to *vx_pwm*, the power saving can be achieved with the same perceived display quality.

Optionally, different conversion tables can be used with auto-brightness on or off.

- When the auto-brightness is off, make *vx_pwm* closer to *system_pwm* with lower *vee_strength* value.
- When the auto-brightness is on, make *vx_pwm* < *system_pwm* with high *vee_strength* to save the power consumption.

Table 1 shows an example of the conversion tables:

Table 1: Example Conversions

Steps	Auto-Brightness On			Auto-Brightness Off	
	System	VX	VEE	VX	Adjust VX
	PWM	PWM	Strength	PWM	Weight
	(0~255)	(0~235)	(0~31)	(0~235)	(0~31)
0	0	7	10	9	6
1	27	13	10	18	6
2	39	20	10	26	6
3	51	27	10	35	6
4	63	34	10	44	6
5	75	40	11	53	6
6	87	47	11	61	6
7	99	54	11	70	6
8	111	60	11	79	6
9	123	67	11	88	6
10	135	74	11	96	6
11	147	81	11	105	6
12	159	88	11	104	6
13	171	94	11	123	6
14	183	101	11	131	6
15	195	110	11	140	6
16	207	124	11	156	6
17	220	138	11	172	6
18	230	152	11	187	6
19	235	166	12	203	6
20	240	180	12	219	6
21	255	194	12	235	6

Description of ArcticLink III VX Software

An example of the ArcticLink III VX solution platform software is in reference source code *lcd_DISPLAY_boeot_wsvga_mipi.c* and *DISPLAY.c*. for the Marvell PXA986_LT02 platform. Note this reference code supports the modified Android auto-brightness control with Content Adaptive Backlight Control (CABC) and additional functionalities. For using standard Android auto-brightness control, the source code can be modified slightly.

lcd_DISPLAY_boeot_wsvga_mipi.c

This file contains the module for VX5B3D. The module provides initialization function of VX5B3D, supports brightness control and power saving functions provided by VX5B3D, and supports debug and tuning functions for VX5B3D.

The module provides three SYSFSs:

- Auto-brightness control: *dev_attr_auto_brightness* CABC on/off, *brightness*, *auto_brightness* on/off
- VEE tuning with ADB shell: *dev_attr_vee_strenght*
- Debug: *dev_attr_vx5b3d_Regread*

DISPLAY.c

This file provides supporting functions used in *lcd_DISPLAY_boeot_wsvga_mipi.c*. The supporting functions include:

- *vx5b3d_mipi_write*: write to the registers of VX5B3D through the MIPI interface
- *vx5b3d_i2c_read*: read the registers of VX5B3D through the I²C interface
- *DISPLAY_write3*: write to the registers of VX5B3D through the I²C interface

Contact Information

Phone: (408) 990-4000 (US)
(647) 367-1014 (Canada)
+(44) 1932-21-3160 (Europe)
+(886) 26-603-8948 (Taiwan)
+(86) 21-5179-8474 (China)

E-mail: info@quicklogic.com

Sales: America-sales@quicklogic.com

Europe-sales@quicklogic.com

Asia-sales@quicklogic.com

Japan-sales@quicklogic.com

Support: www.quicklogic.com/support

Internet: www.quicklogic.com

Revision History

Revision	Date	Originator and Comments
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