

VGA Output using TV-Out Extension Solution

i.MX21

by: Tatiana Orofino

1 Abstract

Freescale first thought of a TV-Out Extension solution that'd be able to provide image output in S-Video or Composite Video formats. A PC-to-TV encoder chip from Focus was chosen for implementation, so that now Freescale offers a complete demo board tho connect in any of our i.MX ADS. Software is also provided, for Linux-based systems. This Linux driver is implemented and ready to be used by any application.

It might be useful, however, for some customers to have an VGA output format, so that video can be displayed in any computer monitor plugged to it by a 15-pin connector. Although i.MX21 reaches only QVGA resolution, this new solution is very satisfactory for single user interface applications that require VGA output.

2 Objectives

This document was written in order to add information to the existing Application Note that describes a TV-Out

Contents

1 Abstract	1
2 Objectives	1
3 About FS453/454 Chip	2
4 Original TV Encoder Board	3
5 Hardware Modifications	3
6 Software Implementation	3
7 Reference Documents	4



Extension for the i.MX family. Therefore, all initial settings for PLL and timing are described in that document. Please refer to Freescale’s online AN2639 for more information.

This solution has been developed in order to accomplish i.MX21 projects requests. User interface applications may require different video solutions, from a very simple and cost-effective monochromatic display to bigger and coloured touch screen LCDs. The FS453/454 chip is able to output VGA images, just by using its VGA Mode settings. Freescale’s TV Encoder board contains a Focus FS453 chip, and it will be described next how to implement a complete VGA output solution.

3 About FS453/454 Chip

The FS453/4 is a video scan converter. It accepts computer graphics, in HD (High Definition) and SD (Standard Definition) input resolutions and different rates. It converts them to broadcast quality video compliant with industry standards as shown:

Table 1.

Format	Standard
NTSC (SD)	SMPTE-170M
PAL (SD)	ITU-R 624
480p (HD)	EIA-770.2-A
720p (HD)	SMPTE 296
1080i (HD)	SMPTE 274

The FS453/4 can be used both as TV encoder and as 75MHz DACs for VGA through XGA output. In SDTV mode the FS453 converts, scales, removes flicker, interlaces and encodes the data into NTSC or PAL formats. In HDTV mode, it performs color space conversions and then inserts the required syncs for output.

The digital video encoder generates Y/C, CVBS, RGB and YPrPb output signals. These signals can be combined to support RGB + CVBS for SCART, YPrPb + CVBS or multiple CVBS and Y/C DAC outputs. All parameters can be read and written via the I2C compatible serial port. The flexibility of the FS453/4 allows a glueless digital interface to most graphic display chips.

The FS453/4 requires power from +1.8V digital and +3.3V analog supplies. For external components, the parts only need a 27 MHz clock and passive components.

3.1 VGA Pass-Through Mode

The FS453 supports a DAC-only mode referred to as VGA pass-through. The VGA mode is compatible with VESA standard or any VGA timing that requested by customers. This mode routes the incoming digital RGB video data directly to the DAC, so that the device can be used to directly drive the RGB signals to a monitor. The HSync and VSync signals driven to the monitor must come directly from the graphics controller.

4 Original TV Encoder Board

The demo board was first designed for YUV inputs, so that the pull-up resistors are populated for this configuration. It also provides only S-video and Composite video images. There's a reserved space for a VGA connector but it is not populated by the original implementation.

5 Hardware Modifications

The documentation of Freescale's TV Encoder demo board clarifies the changes to be made in order to get a RGB input. This input passes through the TV Encoder and it's output with both HSync and VSync to any VGA-format monitor.

The demo board provides two input implementation options: RGB and YUV. There are 00hm resistors that must be populated in which case. The odd resistors must be populated for a RGB input.

Besides, it is also necessary to populate the VGA 15-pin connector on the board.

6 Software Implementation

As most of projects with i.MX are OS-based, the developed software solution requires an OS driver modification. In this case, the solution presented was implemented for Linux-based applications. Freescale's BSP already contains a driver that interfaces with FS453 but it implements only PAL and NTSC outputs. Thus, the VGA pass-through mode must be implemented.

The VGA mode must be inserted in the `pre_program()` function in `fs453.c`. The VGA pass-through mode can be set by writing 9030h to the QPR register. The communication to the FS453/4 chip is done via I2C. The initialization is already implemented except by QPR register that must be set correctly. The changes are highlighted in the code source.

Example 1.

```
PRINT_INFO("Program FS453.....");

if (standard == TVOUT_MODE_PAL)
    tvMode = PAL_OFFSET; //Offset to the PAL settings
else if (standard == TVOUT_MODE_VGA)
    tvMode = VGA_OFFSET;
else
    tvMode = NTSC_OFFSET;

i2c_read(0x0C, &data, 2); // Clear NCO_EN and SRESET
data &= ~0x0003;
i2c_write(0x0C, data, 2);

    i2c_write(0xC4, 0x9E30, 2); // set QPR in VGA mode
    i2c_write(0x0A, 0x0000, 2); // Patch QPR VGA mode no Clock out bug

fs453_soft_reset();

i2c_write(0xC4, timingRegs[tvMode + selection][0], 2); // QPR
```

Using this implementation, images will be output directly to the TV Encoder board in VGA format. An alternate but much more complicated solution would be adapting the time, resolution and screen size settings to a VGA output. This settings were implemented for other output types, such as NTSC and PAL, and are placed in the /drivers folder for Freescale's Linux BSP.

7 Reference Documents

Documents from Focus Enhancements Inc.:

- FS453/FS454 Product Brief
- FS453/FS454 Hardware Reference
- FS453/FS454 Software/Firmware Reference
- FS453/FS454 VGA Pass-Through Mode

Documents from Freescale Semiconductor Inc.:

- AN2639: *TV-Out Extension for i.MX1/L* (order number: AN2639)
- AN2639SW: *Software to accompany AN2639* (order number: AN2639SW)
- MC9328MX21 *Applications Processor Reference Manual* (order number: MC9328MX21RM)
- MC9328MX21 *Applications Processor Technical Data* (order number: MC9328MX21)
- M9328MX21ADS Schematics

NOTES

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
<http://www.freescale.com/support>

USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064, Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© Freescale Semiconductor, Inc. 2006. All rights reserved.