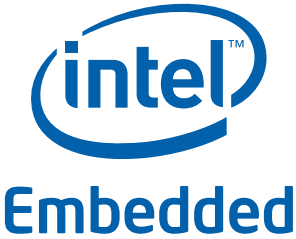


Embedded Customization to Support VBIOS Startup Screen on Portrait Panels for XP

Application Note

November 2010

Order Number: 324639-001US

Contents

Revision History

Date	Revision	Description
November 2010	001	Initial release

1.0 Introduction

Native, portrait orientation panels are fast becoming a common display device in embedded systems. These portrait panels, with their height dimensions much larger than their widths, are already commonly found in cell phones, smartphones and PDAs. In certain embedded devices, these same kinds of displays are now becoming more popular, such as in RFID scanners, handheld barcode readers, and tablet PCs. But, because these displays use native portrait display timings, an incompatibility can exist with legacy VBIOS. This application note describes the technical methods implemented by Intel to enable US15W-based platforms using Intel Embedded Graphics Drivers (IEGD) to boot with splash screens successfully in portrait orientation into a Windows XP based operating system. Intel customers should be able to follow the guidelines contained herein to enable portrait mode during boot within their Windows XP, IEGD-based US15W system as well.

As ECG ventures into the world of “truly embedded” devices, Intel’s embedded division faces competition from companies such as TI* and Freescale*. Intel continues to showcase its own strength in the embedded processor and graphics market by bringing over the large expanse of legacy x86 software as free or low-cost content to these new embedded customers. This application note intends to convert more slates, tablets, web books and other devices requiring portrait display mode to Intel-based platforms by providing support of displays whereby there are more vertical lines than horizontal pixels from boot through post-boot transition and into the Windows* operating system.

During the process of implementing portrait display mode for several US15W-based Atom customer systems using IEGD and Windows XP, Intel faced many challenges. One challenge is the tightly coupled dependency of certain x86-based software on more native PC-like hardware. For example, the older x86 legacy System BIOS and Video BIOS that depend on standard PC display resolutions and timings are configured to work only with landscape modes by default. This application note focuses on overcoming that issue: using native, portrait oriented panels to display centered and full screen content with legacy System BIOS and Video BIOS firmware as the Windows XP OS boots, displaying each splash screen in an acceptable format.

1.1 Glossary

Abbreviation	Definition
BIOS	Basic Input Output System
CPU	Central Processing Unit
CRT	Cathode Ray Tube monitor
DTD	Detailed Timing Descriptor
ECG	Embedded Communication Group
EDID	Extended Display Identification Data
EMGD	(Intel) Embedded Media and Graphics Driver
FAE	Field Applications Engineer
IEGD	Intel Embedded Graphics Drivers
OS	Operating System
PLL	Phase-Locked Loop
RFID	Radio Frequency IDentification
SysBIOS	System BIOS
TI	Texas Instruments

Abbreviation	Definition
TME	Technical Marketing Engineer
VBE	VESA BIOS Extensions
VBIOS	Video BIOS
VESA	Video Electronics Standards Association
VGA	Video Graphics Array
VSYNC	Vertical Synchronization

1.2 Purpose of This Document

This document was written for four target audiences.

- Intel® Embedded Media and Graphics Driver (Intel® EMGD)/IEGD TMEs:
  TMEs working with conversion customer projects may use this document to identify whether this usage model represents the same opportunity they face with their customer. This lets them use the same resolution for their customers.
- Intel® EMGD/IEGD Developers:
  From this document, developers may gain the technical details of the changes in the software source code, or configuration changes to Windows XP, to the customer's System BIOS firmware, or to ECG's IEGD/ Intel® EMGD Video BIOS firmware.
- Intel FAEs and Distributor FAEs:
  Field Applications Engineers who are engaged with US15W - Atom platform makers who require support for displays with more vertical lines than horizontal pixels.
- Customers – specifically their SysBIOS providers:
  As with Intel developers and support personnel, also describe technical information about the requirements for customers to solve these problems through their non-Intel software and firmware support structure, including changes to the customer's System BIOS.

1.3 Background: VBIOS Mode Setting

When introduced, the VBIOS supported only a handful of VGA modes. After color CRTs became standard, this list expanded. However, all VGA modes' timings are defined in the VGA specs, and none includes native portrait modes. The results for customers needing portrait mode are boot screens that are displayed as uncentered and/or chopped, which detract from the overall user experience.

With the introduction of VBE, the VBIOS could support VESA modes and custom CRT modes accessible by the VBIOS using the EDID standard. However, because those specs never included any display mode timings with native portrait aspect ratios customers requiring a greater V x H display were left with boot screens that were visually undesirable.

VBE infrastructure makes it possible to define a custom mode with a native portrait mode. This does not resolve the business challenge caused by the Windows XP boot-up logo.

Note: This application note focuses almost entirely on the BIOS and boot screens because after control is passed to the Windows XP* OS, the operating system renders portrait mode satisfactorily using modern flexible display driver capabilities.

1.4 Background: Intel Embedded SOC's Display Pipeline

1.4.1 VGA and VESA Graphics Modes Use Different Engines

In current Intel embedded SOCs (Systems On a Chip) such as Intel® System Controller Hub US15W chipset and Intel® Atom™ processor E6xx, the display pipeline hardware is based on the Gen3 or Gen4 display pipelines, such as the 940/945 or 960/965. These display engines use two completely different modes of operation when they are programmed for VGA vs. VESA mode support.

1.4.2 VGA Display Hardware Flexibility to Fit Portrait Timings

The VGA mode of operation uses a dedicated VGA plane with dedicated VGA PLLs representing the display pipe. The flexibility of the VGA plane and the VGA PLLs only go as far as the VGA standard. This limits using any form of clipping or centering with the VGA mode of operations, severely hampering the ability to make the VBIOS enable VGA modes on a native portrait panel.

1.4.3 Graphics Mode Hardware Fits Landscape into Portrait Timings

Alternatively, when programming the hardware for graphics modes, like VESA modes, a separate Display Plane A and Display Pipe A are used. This combination allows horizontal clipping and vertical panning that could be used to fit a VESA mode into native portrait timing.

Also, not all currently supported display ports support simultaneous upscale and downscale depending on the aspect ratio, such as upscaling the vertical and downscaling the horizontal – a hardware feature that could have been used to overcome this problem.

1.5 Background: Windows XP Bootup Logo

1.5.1 Windows XP Bootup Logo Uses VGA Mode 0x12

Contrary to visual perception, the standard Windows XP bootup logo is actually displayed using VGA mode 0x12 (640 horizontal active x 480 vertical active x 4 chained 256 color planes). Although the mode may look like a graphics VESA mode, it is still a VGA mode that does not use the modern pixel framebuffer layout to draw the contents of the screen. This means VGA mode 0x12 requires the Intel SOC display pipeline to use the VGA plane and the dedicated VGA PLLs. This combination prevents clipping the horizontal timing while centering the vertical. Although, some experimentation remains in this area, all prior effort trying to horizontal clip and vertical center using the VGA pipeline has failed.

1.5.2 Windows XP Bootup Executes Multiple Mode Resets

During the OS bootup process, due to the various screen switches, the OS itself does four to six different VBIOS mode setting operations. The majority of these operations are requests to set VGA Text-Mode 0x03 (720 (H) x 400 (V) x 8 bpp but based on ASCII text codes not graphics pixels), which is globally recognized as the de facto default or reset state of the VBIOS. These mode sets precede the VGA mode 0x12 request used to display the splash screen.

1.5.3 Windows XP Bootup Accesses the Framebuffer

Between some of these VBIOS mode reset requests (VGA Text-Mode 0x03), the OS also accesses the VGA framebuffer via the legacy 0xA000 segment address. During this time the OS has been observed trying to clear several leading scan lines of the framebuffer.

2.0 Business Challenge

The customer wants to boot Windows XP and have the boot screen display full screen and centered on an LVDS panel in Native Portrait Mode (e.g. 480x640, 480x800, or 600x800). Due to the VBIOS specs, the Intel display hardware, and the OS bootup sequence, it is very difficult to make this work. The default behavior of IEGD/EMGD VBIOS, when trying to display VGA modes with original VGA spec'd timings, causes the display output to wrap horizontally and repeat vertically on the customer's panel. Configuring the IEGD/EMGD VBIOS with the native portrait mode timings results in a corrupted VGA mode 0x12 image output that the OS uses for the splash screen. Unfortunately, Windows XP depends on the legacy System BIOS and VBIOS.

2.1 Exact Use Case

Customers want to boot Windows XP on an Intel embedded SOC with a native portrait panel while ensuring that the bootup logo is displayed properly.

2.2 Technical Challenge

The Windows XP OS bootup logo uses VGA mode 0x12 and Intel's embedded SOC's display engines' VGA plane and pipe does not accommodate modifying the pipe timings to horizontally clip and vertically center the VGA mode. Similarly, Intel's display ports do not support panels fitting landscape timings into portrait timings.

2.3 Expected Customer Experience

The customer expects to have some form of bootup logo and system information screen that remains static and displays fully and centered on the native portrait panel until the OS display driver takes over and displays the framebuffer properly in portrait mode, which occurs post-boot automatically via Windows XP.

3.0 Solution: Locking Portrait-fitted VESA Mode Displacing the Windows XP Bootup Logo

Due to the technical challenges cited in the "Business Challenge" section, the solution Intel created to solve this problem was to modify some of the rules of how the VBIOS and the System BIOS should behave in order to meet the expected customer experience.

The idea is to make the System BIOS and VBIOS work together to prepare a splash screen before beginning Windows XP bootup and then ensuring that any VBIOS requests from Windows XP do not change the contents of the framebuffer. When IEGD or EMGD takes over the display, it will control the programming of the display device and will be able to continue normally. The System BIOS will draw the splash screen based on an existing VESA standard mode, and the VBIOS would center-pan according to the mode to fit into the native portrait panel timings.

This way, the System BIOS draws a centered splash screen. Meanwhile the VBIOS can be "disabled" by System BIOS to not entertain/process future mode setting operations. That way, the same splash screen continues to display until the Windows XP IEGD takes over and continues to draw the desktop in the portrait mode first seen during the boot sequence.

The technical tasks that are required to make this idea work are discussed in the following sections.

4.0 Requirements

1. The customer must use a legacy System BIOS and VBIOS combination to boot Windows XP. Without a legacy combination, it would be better to use more flexible firmware and an OS such as EFI/BLDK and Linux. That combination solves this problem with even better results by using already existing features of the firmware and OS.
2. The customer or his chosen System BIOS vendor must be able to modify the system BIOS to accommodate the custom VBIOS prepared by Intel.
   a. If a customer cannot modify the System BIOS, that customer cannot use this solution.
   b. The customer must choose which VESA mode to draw a splash screen replacement with center-panning into the native portrait timing. The tighter the fit the better. For example, for a native portrait panel of 480x800, choose 640x480 as the tightest VESA mode.
3. The customer must use the production hardware portrait panel for VBIOS-SBIOS integration and prototype testing.
   This solution clips the horizontal lines and centers the vertical frame into native portrait timings. Centering behaves differently from panel to panel. Test only with the required production panel since LVDS panels vary significantly from model to model and manufacturer to manufacturer.

5.0 Enablement Process for Windows

Microsoft has confirmed that a bootup splash screen is NOT required for Windows XP-based embedded systems. So, do the following to modify the Windows XP configuration so NO bootup splash screen is displayed at all. Please follow these steps:

1. Click on **Start**, and then **Run**.
2. In the search box type the command `msconfig` and then press **Enter**.
   This command loads the `System Configuration Utility` program.
3. Click the BOOT.INI tab located at the top of the System Configuration Utility window.
4. Under Boot Options, check the box next to `/NOGUIBOOT` and then click **OK**.
   You will be prompted to either Restart, which will restart immediately, or Exit without restart, which will close the window and allow you to restart manually.
5. After the restart, the PC will boot into Windows XP without showing the splash screen. This will result in a slightly faster boot time.

Note: Windows XP will continue to boot in this manner until the System Configuration Utility is configured to again boot normally.

6.0 Enablement Process for VBIOS

The following changes are required to the IEGD/EMGD VBIOS.

1. Modify the VBIOS to handle centering vertically and clipping horizontally.
2. Ensure that a custom user DTD could be programmed into the VBIOS that has native portrait timings, but with implicit hint information to handle clipping of the horizontal total and centering of the vertical total for a chosen VESA mode.

   For example, you could use a custom DTD specifically for center-pan VESA 0x101 (640x480) into a 480x640 panel. Following is an example of original native portrait panel timings vs. the custom DTD that includes the hints to center-pan into an existing VESA mode – notice the VSYNC change where it was shifted up (pulled in earlier) by ½ of the difference of (VBLANK_START – VACTIVE):

```
static igd_display_info_t
    nativr_potrait_4x8 = {
    {
     480,   /* Width */
     640,   /* Height */
     0, /* Refresh Rate */
     23760, /* Dot Clock */
     599,   /* HTotal (horizontal synch end) */
     479,   /* HBlank Start (h_active-1) */
     599,   /* HBlank End (start + h_blank) */
     580,   /* HSync Start (h_active+h_synch-1)
     588,   /* HSync End (start + h_syncp) */
     659,   /* VTotal (Vertical synch end) */
     639,   /* VBlank Start (v_active-1) */
     659,   /* VBlank End (start + v_blank) */
     657,   /* VSync Start (v_active+v_synch-1)
     659,   /* VSync End (start + v_synchp) */
     0, /* Mode Number */
     0x20000,   /* Flags */
     0, /* X Offset */
     0, /* Y Offset */
     NULL,  /* pd extension pointer */
     NULL,  /* mode extension pointer */
    },
};
```

```
static igd_display_info_t
    centerpan_6x4in4x8_portrait[] = {
    {
     640,   /* Width */
     480,   /* Height */
     0, /* Refresh Rate */
     52000, /* Dot Clock */
     599,   /* HTotal (horizontal synch end) */
     479,   /* HBlank Start (h_active-1) */
     599,   /* HBlank End (start + h_blank) */
     580,   /* HSync Start (h_active+h_synch-1)
     588,   /* HSync End (start + h_syncp) */
     659,   /* VTotal (Vertical synch end) */
     639,   /* VBlank Start (v_active-1) */
     659,   /* VBlank End (start + v_blank) */
     577,   /* VSync Start (v_active+v_synch-1)
     579,   /* VSync End (start + v_synchp) */
     0, /* Mode Number */
     0x20000,   /* Flags */
     0, /* X Offset */
     0, /* Y Offset */
     NULL,  /* pd extension pointer */
     NULL,  /* mode extension pointer */
    },
};
```

3. Modify the VBIOS to ensure that the IALs dependency on VESA mode numbers with specific width and height is not disrupted by this “center-pan” solution that fits the VESA mode into native portrait timings that the HAL needs to handle.
4. Modify the VBIOS to export a new interface for the System BIOS to be able to signal the VBIOS to lock or free the framebuffer.

   When in locked state, the VBIOS must not allow any mode setting operation to be serviced and ensure that the 0xA000 CPU access of the framebuffer is disabled.

   When in locked state, the VBIOS must ensure that Int 10 0x0A to WriteChar is also not serviced.

Notes:

1. Customers needing graphics driver and VBIOS support of portrait orientation panels must submit a sales request through your local Intel FAE or sales representative. DTD timing data along with a full panel datasheet for each [HORIZ_ACTIVE] < [VERTICAL_ACTIVE] LVDS panel needed for production should be submitted with the sales request.
2. IEGD developers should reference the IEGD_10_3_1_package#1723 and VBIOS_10_3_1_package#1723 which already contain a custom VBIOS Int 10 0x5f70 interface along with VBIOS hard-coded panel size modifications to implement full screen boot support of several specific 480x640 and 480x800 LVDS panels.

3. IEGD developers and customers should expect modifications to the IEGD_10_3_1_package#1723 and VBIOS_10_3_1_package#1723 will be required by Intel software engineers to support other 480x640, 480x800, 480x800, 600x800 or other LVDS panels where the [number of active horizontal pixels] is < [number of active vertical lines].
4. Customers needing graphics driver and VBIOS support of portrait orientation panels must be willing to perform co-validation of any Engineering Candidate driver(s) furnished by Intel for this purpose.

6.1 New VBIOS Interface to Lock Framebuffer – Intel Interrupt 10 0x5F70

A new IEGD VBIOS Int 10 0x5F70 interface is defined for the customer's System BIOS to use as part of this solution. This feature allows the System BIOS to control disabling or enabling subsequent mode setting operations by the IEGD VBIOS. It also disallows CPU access to the framebuffer.

Per VBE spec, Int 10 with register "AX = 0x5FXX" is a vendor specific interface. For the new IEGD 10.3.X HotFix "Disable Mode Setting" interface:

AX = 0x5F70.

BH = 0x1 → Disables subsequent mode setting operations

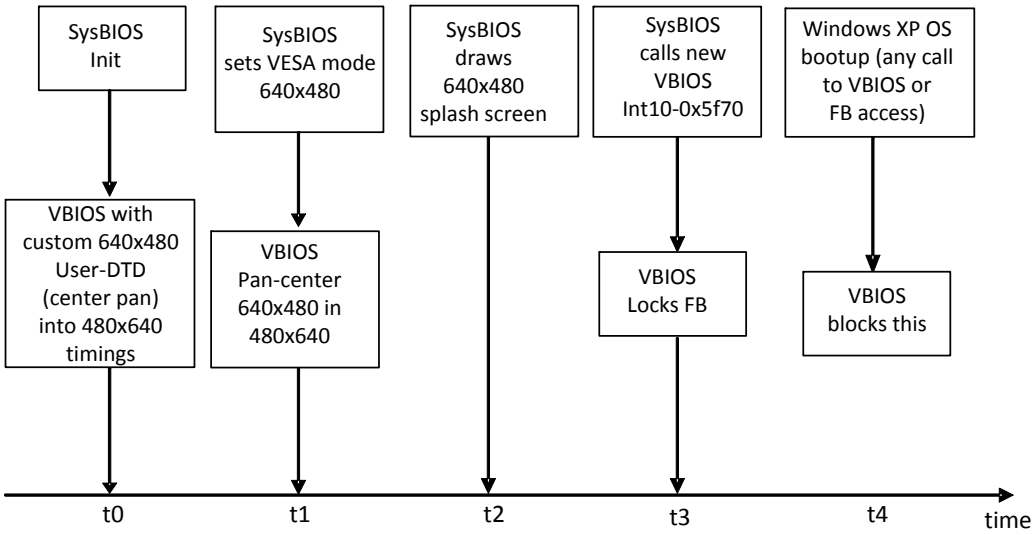
BH = 0x0 → Enables subsequent mode setting operations

7.0 Enablement Process for SysBIOS Modifications

1. After POST completion, modify the System BIOS to request for the VBIOS to set mode to the chosen VESA mode.
2. After the mode setting operation, System BIOS should draw the splash screen that replaces the Windows bootup logo.

   Because this logo would be center-panned into a native portrait panel, Intel recommends strongly that customers display a splash screen that has a black background around the left and right edges with content in its center. The black of the splash screen will mix seamlessly into the black-colored blank regions giving the impression that the boot screen(s) with logo are one screen and encompass the entire active region of the panel.
3. After drawing the splash screen, modify the System BIOS to call the new VBIOS Int 10 0x5F70 to lock the framebuffer content.

8.0 Functional Flow of Events



The following example assumes centering mode 0x101, 640x480, into a 480x640 portrait panel.

Event 1: Initialization of customized System BIOS including the VBIOS Option ROM.

Event 2: Legacy Int 10 mode setting call is triggered by System BIOS requesting for the targeted VESA mode 0x101.

Event 3: The customized VBIOS will respond with setting up a 640x480 framebuffer into a 480x640 portrait display timing (horizontally clipped and vertically centered).

Event 4: VBIOS will continue to expose standard 0x101 (640x480) width and height and framebuffer access like normal landscape mode.

Event 5: Eventual startup splash screen pixels are drawn by System BIOS into the framebuffer.

Event 6: Prior to handing off control to the boot loader, the System BIOS will call the new VBIOS interface (Int 10 0x5F70) to lock the framebuffer contents.

Event 7: Subsequently, the VBIOS will lock the framebuffer access and will not service any subsequent mode setting or pixel population operations. Windows XP OS boots with the bootup screen untouched until the IEGD/Intel® EMGD driver takes over.

9.0 Limitations of IEGD-Implemented Portrait Mode During Boot

Full screen DOS under Windows XP will not work. The display will remain blank until the user presses **Alt+Enter** a second time to come back to the OS desktop.

10.0 Conclusion

Because portrait-oriented panels are getting a lot of traction in the embedded market, previously many customers were left with only the choice of using an open source operating system to achieve full-screen display during boot in portrait mode. However, as this application note illustrates, locking the portrait-fitted VESA mode by displacing the Windows XP bootup logo feature coupled with omitting other non-critical boot screens now enables more embedded customers to implement the Windows operating system for their solutions without detracting from the overall display experience.

Embedded customers can now achieve this solution with the latest Intel chipsets incorporating integrated graphics, e.g., US15W series. For additional design assistance or technical resources related to this topic please refer to http://intel.com/embedded/edc.