

# Generating Grayscales on ICEBrite VGA Displays

*Application Note 119-01*

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*This Application Note describes several methods for displaying grayscales on Planar ICEBrite displays.*

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## Overview

Applications may benefit by using grayscales. Several video controllers have methods for generating grayscales on monochrome displays, including the ICEBrite™ family. This note addresses the *Chips and Technologies* (C&T) 65530 and 65535 controllers. Other video controller manufacturers, such as *SMOS* and *Cirrus Logic*, also provide methods to generate grayscales.

Planar's ICEBrite displays use a similar video interface to those used by many VGA-sized (640x480 addressability) monochrome LCDs. Planar's ICEBrite displays have a maximum frame rate frequency of 120 Hz, about double the maximum frame rate frequency of conventional VGA EL displays. Using the ICEBrite display's higher frame rate frequency, combined with flat panel controllers designed for this faster display, it is possible to generate a wider range of usable grays through frame rate control and dithering.

- ◆ *Frame Rate Control* (FRC) generates "true" grayscales by turning pixels on and off over several frames of time. The user's eye sees each individual pixel as gray. The potential problems with this method are brightness variations and shadowing, especially when used to shade larger areas.
- ◆ *Dithering* generates grayscales by patterning the area to be shaded. The tested C&T controllers use a pattern of 4 (2x2) pixels to generate the dithered grayscales. When the area is viewed from a distance, it appears to the user's eye as gray. When viewed up close, the different brightness of the individual pixels can be observed.

The response time of ICEBrite displays is much faster than LCDs, therefore not all possible grayscales are actually usable. Many of the grayscales may flicker or swim. Careful testing and selection is necessary to select appropriate grayscales for an application, especially when the ICEBrite displays are driven at their maximum frame rate frequency.

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Table 1 shows the register settings that were tested on the 65530 controller, and comments on the observed results.

**Table 1. Tested Register Settings for C&T 65530.**

Description	Register Settings	Comments
Three usable greyscales without dithering	XR4F=0 XR50=A3	These greyscales are 0%, 16% and 100% of full brightness <sup>1</sup> , and show no flickering (even at lower frame rate frequencies). Luminance non-conformity and shadowing are apparent if used to fill a large area.
Nine usable greyscales with dithering	XR4F=0 XR50=AB	
Five usable greyscales without dithering	XR4F=0 XR50=22	These greyscales are 0%, 8%, 16%, 60% and 100% of full brightness <sup>1</sup> . Flicker is apparent on the 8% and 60% greyscales from a short distance. The 0%, 16%, and 100% greyscales show no flickering.
Twelve usable greyscales with dithering	XR4F=0 XR50=2A	

<sup>1</sup> Percentages are approximate.

Table 2 is provided for your convenience. For the C&T 65530 with a 25 MHz dot clock, the register settings in Table 2 result in a frame rate of 120 Hz.

**Table 2. C&T 65530 Register Settings.**

XR00= 82	XR01= FF	XR02= 81	XR03= 00	XR04= A1	XR05= 00	XR06= 02
XR07= 00	XR08= 00	XR09= 00	XR0A= 00	XR0B= 00	XR0C= 00	XR0D= 00
XR0E= 00	XR0F= 51	XR10= 00	XR11= 00	XR12= 00	XR13= 00	XR14= 00
XR15= 00	XR16= 00	XR17= 00	XR18= FF	XR19= 5A	XR1A= 19	XR1B= 65
XR1C= 4F	XR1D= 7F	XR1E= FF	XR1F= 00	XR20= 00	XR21= 5A	XR22= 19
XR23= 59	XR24= 12	XR25= 59	XR26= 00	XR27= 00	XR28= 80	XR29= 00
XR2A= 00	XR2B= 03	XR2C= 04	XR2D= 50	XR2E= 50	XR2F= 00	XR30= 00
XR31= 00	XR32= 00	XR33= 00	XR34= 00	XR35= 00	XR36= 00	XR37= 00
XR38= 00	XR39= 00	XR3A= 00	XR3B= 00	XR3C= 00	XR3D= 00	XR3E= 00
XR3F= 00	XR40= 00	XR41= 00	XR42= 00	XR43= 00	XR44= 00	XR45= 00
XR46= 00	XR47= 00	XR48= 00	XR49= 00	XR4A= 00	XR4B= 00	XR4C= 00
XR4D= 00	XR4E= 00	XR4F= 00	XR50= **	XR51= 67	XR52= 41	XR53= 0C
XR54= 3A	XR55= E5	XR56= 00	XR57= 1B	XR58= 00	XR59= 0F	XR5A= 04
XR5B= 81	XR5C= 00	XR5D= 00	XR5E= 80	XR5F= 4E	XR60= 88	XR61= 6E
XR62= 07	XR63= 41	XR64= E4	XR65= 07	XR66= E0	XR67= 01	XR68= DF
XR69= 00	XR6A= 00	XR6B= 00	XR6C= 08	XR6D= 00	XR6E= 9A	XR6F= 1B
XR70= 80	XR71= 00	XR72= 00	XR73= 00	XR74= 00	XR75= 00	XR76= 00
XR77= 00	XR78= 00	XR79= 00	XR7A= 00	XR7B= 00	XR7C= 00	XR7D= 01
XR7E= 00	XR7F= 00					

\*\* Use the appropriate value from Table 1.

Table 3 shows the register settings that were tested on the 65535 controller.

**Table 3. Tested Register Settings for C&T 65535.**

Description	Register Settings	Comments
Three usable grayscales without dithering Nine usable grayscales with dithering	XR4F=42 XR50=22 XR4F=42 XR50=2A	These grayscales are 0%, 16% and 100% of full brightness. <sup>1</sup> Slight flicker is apparent from a short distance, especially when used to fill a large area. The dithering program is the same as in the C&T 65530.
Five grayscales (only three usable) without dithering <sup>2</sup>	XR4F=44 XR50=21	These grayscales are 0%, 8%, 16%, 60% and 100% of full brightness <sup>1</sup> . Flicker is apparent on the 8% and 60% grayscales from a short distance. The 0%, 16%, and 100% grayscales show no flickering.

<sup>1</sup> Percentages are approximate.

<sup>2</sup> Use this setting only if the colors are selected by the programmer. Not suitable for standard Windows applications.

For the C&T 65535 with a 25 MHz dot clock, the settings in Table 4 result in a frame rate of 120 Hz.

**Table 4. C&T 65535 Register Settings.**

XR00= C0	XR01= F7	XR02= 81	XR03= 00	XR04= 81	XR05= 00	XR06= 02
XR07= 00	XR08= 60	XR09= 00	XR0A= 00	XR0B= 00	XR0C= 00	XR0D= 00
XR0E= 80	XR0F= 41	XR10= 00	XR11= 00	XR12= 00	XR13= 00	XR14= 00
XR15= 00	XR16= 00	XR17= 00	XR18= FF	XR19= 53	XR1A= 01	XR1B= 6A
XR1C= 4F	XR1D= 7F	XR1E= FF	XR1F= 02	XR20= 00	XR21= 00	XR22= 00
XR23= 00	XR24= 12	XR25= 59	XR26= 00	XR27= 00	XR28= 80	XR29= 00
XR2A= 00	XR2B= 03	XR2C= 04	XR2D= 50	XR2E= 50	XR2F= 01	XR30= 03
XR31= 4E	XR32= 59	XR33= 00	XR34= 00	XR35= 00	XR36= 00	XR37= 00
XR38= 00	XR39= 00	XR3A= FF	XR3B= FF	XR3C= FF	XR3D= FF	XR3E= FF
XR3F= FF	XR40= 00	XR41= 00	XR42= 00	XR43= 00	XR44= 00	XR45= 00
XR46= 00	XR47= 00	XR48= 00	XR49= 00	XR4A= 00	XR4B= 00	XR4C= 00
XR4D= 00	XR4E= 00	XR4F= **	XR50= **	XR51= 67	XR52= 44	XR53= 4C
XR54= 3A	XR55= C5	XR56= 00	XR57= 03	XR58= 00	XR59= 0F	XR5A= 04
XR5B= 8F	XR5C= 02	XR5D= 10	XR5E= 80	XR5F= 06	XR60= 88	XR61= 6E
XR62= 07	XR63= 01	XR64= E4	XR65= 07	XR66= E0	XR67= 01	XR68= DF
XR69= 00	XR6A= 00	XR6B= 00	XR6C= 0B	XR6D= 00	XR6E= 00	XR6F= 1B
XR70= 80	XR71= 00	XR72= D8	XR73= 00	XR74= 00	XR75= 00	XR76= 00
XR77= 00	XR78= 00	XR79= 00	XR7A= 00	XR7B= 00	XR7C= 00	XR7D= 00
XR7E= 00	XR7F= 3C					

\*\* Use the appropriate value from Table 3.

## Grayscale Testing

Testing was performed with the Planar EL640.480-AM1 because it has the largest pixel dot pitch. Register settings were varied to generate a variety of grayscales. If a test pattern produced no noticeable flicker on the AM1, it is expected that flicker will not appear on other ICEBrite VGA displays that have a smaller dot pitch.

Grayscales were generated by changing the flat panel controller register settings. Additional grayscales were generated from each register setting using both dithered and non-dithered settings.

Register settings are dependent on the way the video controller and the display are embedded in the system. It is the application-manufacturers' responsibility to verify register settings are used to control the display within its specifications.

In small areas, or where small text is used (such as many Windows applications), the use of non-dithered grayscale is recommended. Not all grayscales are usable. Test and evaluate the various grayscales with your application.

## Additional Information

Planar Applications Engineering provides support to assist with ICEBrite display design related issues. Contact a Planar office, or visit the Planar web site.

Contact Intel to purchase the initialization routines used to write or load BIOS files as well as the utilities to load and save register settings. Intel: (800) 628-8686 or visit their website at [www.intel.com](http://www.intel.com). Another controller vendor that supports grayscale is Epson Electronics America (408) 922-0200 or visit their website at [www.epson.com](http://www.epson.com).

Planar Applications Engineering may be contacted at:

<b>North &amp; South America OEM Sales</b>	<b>Europe &amp; Asia-Pacific OEM Sales</b>
Planar America, Inc. 1400 NW Compton Drive Beaverton, Oregon 97006-1992 Tel. +1 (503) 690 1100 Fax +1 (503) 690 1493 <a href="mailto:sales@planar.com">sales@planar.com</a>	Planar International Ltd. Olarinluoma 9, P.O. Box 46 FIN-02201 Espoo, Finland Tel. +358 9 420 01 Fax +358 9 420 0200 <a href="mailto:intlsales@planar.com">intlsales@planar.com</a>

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