

# *ChromaCast*

**82C205**

**LCD Monitor Controller**

**Preliminary Programmer's Guide**

**CONFIDENTIAL**

Revision 1.0

915-2000-084

11/22/99

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### **OPTi Inc.**

1440 McCarthy Blvd.

Milpitas, CA 95035

Tel: (408) 486-8000

Fax: (408) 486-8001WWW:

<http://www.opti.com>

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## Introduction

This is the programmer's guide for the ChromaCast 82C205 LCD Monitor Controller. It is an application note for the ChromaCast 82C205 Databook that contains detailed register descriptions. This guide will walk the programmer through the various programming sequences necessary in order to build a customized LCD monitor control application.

The ChromaCast 82C205 Monitor Controller is a controller for LCD Flat Panel Monitors. The 82C205 performs several functions including:

- clock generation for the display, and memory,
- scaling,
- frame rate conversion,
- television mode support,
- on screen display menu overlay,
- dithering,
- power management.

The 8051 compatible micro-controller interfaces to the ChromaCast 82C205 LCD Monitor Controller and assists in the configuration process so the 82C205 can be enabled to perform the above functions. The 8051 will be referred to hereafter as the CPU or micro-controller.

The CPU initializes the registers of the 82C205, enabling the 82C205 to accept different incoming resolutions and refresh rates, and allows the 82C205 to interface with many different types of flat panels. In addition, the CPU provides the on-screen display (OSD) bitmap data to the 82C205, as well as the EDID data used in the Display Data Channel (DDC). The objective of this programmer's guide is to present a logical description of each major function of ChromaCast 82C205 and a methodology for programming these functions. Suggested programming procedures and values will be included.

This guide is divided into the following sections:

### ❑ **Configuring ChromaCast 82C205 for a Specific Panel**

This section details how to configure ChromaCast 82C205 for a particular panel. Issues such as the number of bits per pixel that the panel supports, number of pixels per clock, panel resolution, and the timing of the panel synchronization signals are discussed. In order to configure the ChromaCast 82C205 properly, the programmer must have a copy of the panel timing specification.

### ❑ **VGA Video Input Interface**

This section details how to detect the incoming resolution and synchronization timing from the VGA, as well as how to program the ChromaCast 82C205 to accept the incoming VGA signal.

### ❑ **Scaling**

This section details how to program the ChromaCast 82C205 Scaler. The 82C205 can display the incoming video at its original resolution, or it can scale the video up or down to match the panel size. The video can be displayed full scale on the panel, or in a "centered" mode at its original resolution surrounded by a black border.

### ❑ **On Screen Display**

This section details how to overlay an on screen display on top of the video path. Issues such as size and location of the OSD, color depth, attributes, and other tradeoffs are discussed.

### ❑ **Memory Configuration and Allocation**

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This section details how to program the 82C205 so it can interface with the DRAM. This section also allocates the DRAM to buffers for use by the ChromaCast 82C205.

### ❑ **Testing**

This section indicates what sort of testing and debug options are available on the ChromaCast 82C205.

### ❑ **TV Mode**

This section details how to operate the TV mode on the 82C205. The ChromaCast 82C205 interfaces with an NTSC/PAL decoder and accepts YUV 4:2:2 format. ChromaCast 82C205 performs a YUV to RGB color space transform and then performs interlace-to-progressive (IP) scan conversion. Discussions of different interlace-to-progressive conversion options are included.

### ❑ **CPU Interface**

This section explains the CPU interface to the ChromaCast 82C205, including addressing for the registers, and the DRAM buffer. The interrupt sources are also explained.

### ❑ **Power Management**

This section explains how to operate the general purpose timer on the 82C205, as it is an integral part of the power management system. Power sequencing for power-up and power-down on the panels is explained, as well as policies for DPMS power management.

### ❑ **Example Register Values for ChromaCast 82C205**

Appendix A offers a snapshot of the register values during operation of the 82C205. The setup is for a 1024x768, 60 Hz panel accepting a 1024x768, 70 Hz VGA input.

### ❑ **Common VGA Timing Values**

Appendix B includes some common VGA Timing values that describe the incoming VGA signal.

### ❑ **Memory and Display Clock Programming Table**

Appendix C includes the programming settings for the internal PLLs for memory clock and display clock frequencies.

### ❑ **On-Screen Display (OSD) User's Guide**

Appendix D provides a preliminary user's guide for the use of the On-Screen (OSD) to configure ChromaCast to provide the most satisfactory image.

## Nomenclature

Numbers representing different bases will be denoted as follows: A hexadecimal number will be followed by a lower case "h", as in A5h. A number without an "h" appended to it will be assumed to be a decimal value.

### Choosing ChromaCast 82C205 Hardware Configuration

ChromaCast 82C205 has a 24-bit digital interface that can be used with a Panellink or LVDS receiver or external A/D converters. In addition to an external A/D converter, ChromaCast 82C205 supports external clock sources.

It is recommended that the system uses an external Reference Clock source and shares the Reference Clock (14.318 MHz) with the CPU system clock.

Internal/External Hardware Selection	
Internal/External Memory Clock Select	Register FCh, Bit[3]
Internal/External Display Clock Select	Register FCh, Bit[2] 1 = internal clock 0 = external clock

### Configuring ChromaCast 82C205 for a Specific Panel

Before beginning, the programmer will need a specification for the panel. The following information should be extracted from the specification:

- Total Number of Data Lines to Panel
- Bits Per Pixel
- Pixels Per Clock
- Power Sequencing Timing
- Timing for the Horizontal and Vertical Syncs, and Display Enable (DE)

ChromaCast 82C205 uses a resistor strap option at power up to specify some of the above parameters. VESA naming conventions as referenced in FPD1-1 are used. The following naming conventions are used:

- A = Active, i.e. TFT display
- S = Single Scan. STN and TFT displays are single scan.

For instance, a TFT display with 12-bit color and a 24-bit data interface would be referred to as A-444-S24. The "444" term indicates 4 bits red, 4 bits green, and 4 bits blue. Using this nomenclature, select the panel type that is applicable and set the strapping resistors appropriately. Refer to the databook for details on the strapping options. The strapped panel type can be read from a register.

Panel Type	
Panel Type (Read only)	Register A0h

In addition to the strap option, bits per pixel (per color component) must be specified. For example, if the panel supports 18 bits per pixel (bpp), then the dither "Primary Bits" value should be programmed to 6. (The RGB data is digitized into 24-bpp values, hence to display 18-bpp, a dithering algorithm must be utilized.) For reasons of

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bandwidth or other tradeoffs, the captured data can be also be dithered to a bpp value that is smaller than the panel supports. The panel drive reformat module will then automatically “scale” the bpp up to the panel specification. So at the expense of some color depth, an 18 bpp panel could be driven with only 9 bpp captured, and the 82C205 will automatically format the data to 18 bpp; however, the resultant image will actually only display  $2^9$  colors, instead of the desired  $2^{18}$ . There are other dither options, but these will be discussed later. For very large OSDs or high refresh, high resolution VGA modes, bandwidth can become critical.

Primary Color Bits	
Primary Bits	Register 38h, Bits[7:4]

### Display CRTC Programming

The following parameters for the Display CRTC timing, including pixel clock frequency, horizontal and vertical sync timings, timing for DE, and polarities of the horizontal and vertical syncs are determined by the specification for the panel that the ChromaCast 82C205 is controlling.

#### Pixel Clock Frequency (in MHz):

The panel is driven by a pixel clock, which is the same clock that drives the display subsystem of the ChromaCast 82C205. This pixel clock frequency for a TFT panel is generally between 25 – 108 MHz. This clock can be generated by an internal PLL within the 82C205 or by an external crystal oscillator. On the panel specification, this clock is normally called FSHIFT or FPS. The frequency requirement for this panel must be read from the panel specification. Call this value  $FPS_F$ . Then program the VCLK2 PLL so that it outputs the  $FPS_F$  frequency: The reference clock for the VCLK2 PLL is 14.318 MHz. Program the N and M values of the PLL (the divider ratio) so the PLL will generate  $FPS_F$  frequency. The formula is  $FPS_F = 14.318 \text{ MHz} * N / M$ . A table of suggested values for M and N is included in the Appendix. Unless the display clock needs to be very low frequency, or the duty cycle needs to be adjusted, the divide by 2 option for the VCLK2 PLL can remain disabled.

One more detail about the pixel clock that needs to be determined is whether or not the clock is gated, i.e. is the clock continuously toggling, or is it gated so that it is only toggling when data is valid. Most DSTN displays require a gated clock, while TFT panels do not.

The last pixel clock specification that needs to be programmed is whether the panel data is stable on the falling edge of pixel clock or the rising edge.

Pixel Clock Frequency	
Gated Clock	Register A1h, Bit[2]
Clock Phase	Register A1h, Bit[3]
Divide Clock by 2	Register C6h, Bit[6]
M Values	Register C6h
N Values	Register C7h

#### Horizontal Sync Polarity:

This register sets the polarity of the horizontal sync to the panel. It has no relationship to the polarity of the incoming sync from the VGA.

Note: Polarity can be defined as follows: If the sync is high while data is active, then it is an active low sync. If the sync is low while data is active, then it is an active high sync.

Horizontal Sync Polarity	
Polarity	Register A1h, Bit[0]

### Horizontal Sync Width (in units of pixel clock)

The width of the active part of the sync (when data is not valid).

Horizontal Sync Width	
Sync Width	Register 82h, 83h

### Horizontal Display Start (in units of pixel clock)

This is the time between the start of the horizontal sync and the start of data valid. For TFT displays, special attention must be given to where the data ready line goes active (DRDY or DE) in order to determine this value. Hence, this timing specification refers to the time between the start of the horizontal sync and the first pixel clock following the horizontal sync. The value of the Horizontal Display Start must be an odd number

Horizontal Display Start	
Display Start	Register 84h, 85h

### Horizontal Display End (in units of pixel clock)

This is the time between the start of the horizontal sync and the end of data valid.

Horizontal Display End	
Display End	Register 86h, 87h

### Horizontal Total (in units of pixel clock)

This is the period of Horizontal Sync.

Horizontal Total	
Total	Register 80h, 81h

### Vertical Sync Polarity

This register sets the polarity of the vertical sync to the panel. It has no relationship to the polarity of the incoming sync from the VGA.

Note: Polarity can be defined as follows: If the sync is high while data is active, then it is an active low sync. If the sync is low while data is active, then it is an active high sync.

Vertical Sync Polarity	
Polarity	Register A1h, Bit[1]

### Vertical Sync Width (in units of video lines)

The width of the active part of the sync (when data is not valid).

Vertical Sync Width	
Sync Width	Register 8Ch, 8Dh

### Vertical Display Start (in units of video lines)

This is the time between the start of the vertical sync and the start of data valid.

Vertical Display Start	
Display Start	Register 8Eh, 8Fh

### Vertical Display End (in units of video lines)

This is the time between the start of the vertical sync and the end of data valid.

Vertical Display End	
Display End	Register 90h, 91h

### Vertical Total (in units of video lines)

This is the period of the vertical sync. For ALL panels, if the vertical total value does not differ between even and odd frames, enter the same value for vertical total in the even vertical total register as in the odd vertical total register.

Vertical Total	
Odd Total	Register 88h, 89h
Even Total	Register 8Ah, 8Bh

### Panel Window Default Settings

Later in this guide the centering option will be discussed, which allows a low resolution image to be displayed on a higher resolution panel, surrounded by a black border. Until that discussion, assume that the incoming image is scaled to the full panel size, hence the following Panel Window Registers should be set to the corresponding values in the Display CRTC as a default.

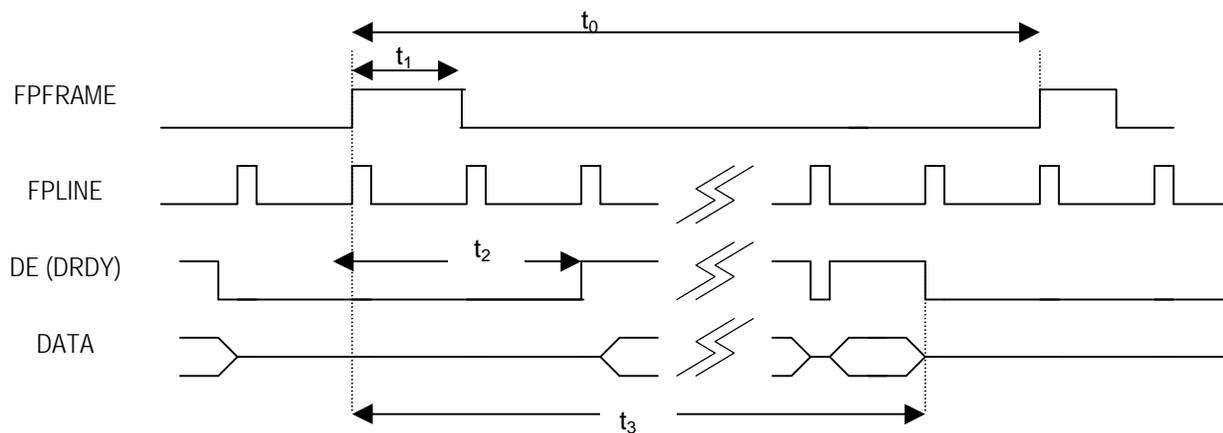
- Panel Window Horizontal Start = Display CRTC Horizontal Start (Registers 84h, 85h) + 11h
- Panel Window Horizontal End = Display CRTC Horizontal End (Registers 86h, 87h) + 11h
- Panel Window Vertical Start = Display CRTC Vertical Start (Registers 8Eh, 8Fh)
- Panel Window Vertical End = Display CRTC Vertical End (Registers 90h, 91h)

Panel Window Registers	
Panel Window Horizontal Start	Registers 98h, 99h
Panel Window Horizontal End	Registers 9Ah, 9Bh
Panel Window Vertical Start	Registers 9Ch, 9Dh
Panel Window Vertical End	Registers 9Eh, 9Fh

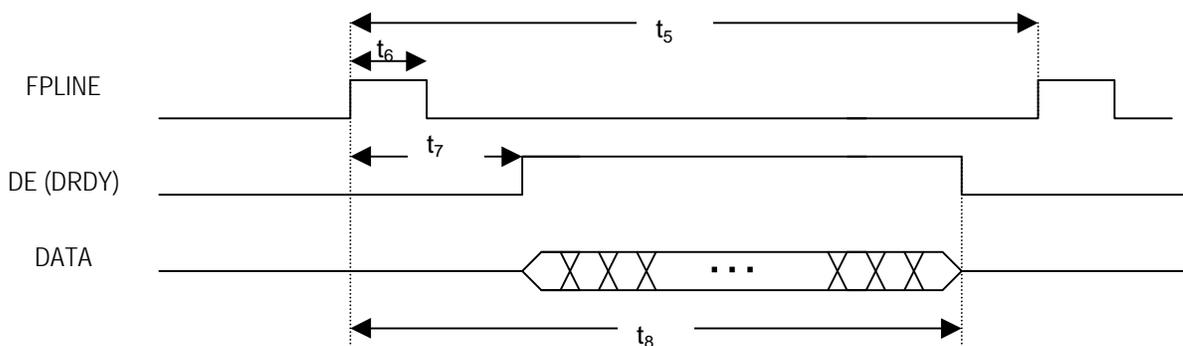
### Display Timing Waveforms

Signal	Description	Symbol	Min	Typical	Max	Unit
FPFRAME	Vertical Total	$t_0$	0		4095	Lines
	V Sync Width	$t_1$	0		4095	Lines
	Vertical Display Start	$t_2$	0		4095	Lines
	Vertical Display End	$t_3$	0		4095	Lines
FPLINE	Horizontal Total	$t_5$	0		4095	Pixel Clock
	H Sync Width	$t_6$	0		4095	Pixel Clock
	Horizontal Display Start	$t_7$	0		4095	Pixel Clock
	Horizontal Display End	$t_8$	0		4095	Pixel Clock
DE	Data Valid	$t_{10}$	0		4095	Pixel Clock
FPSHIFT	Pixel Clock Frequency	$t_{11}$	10		120	MHz

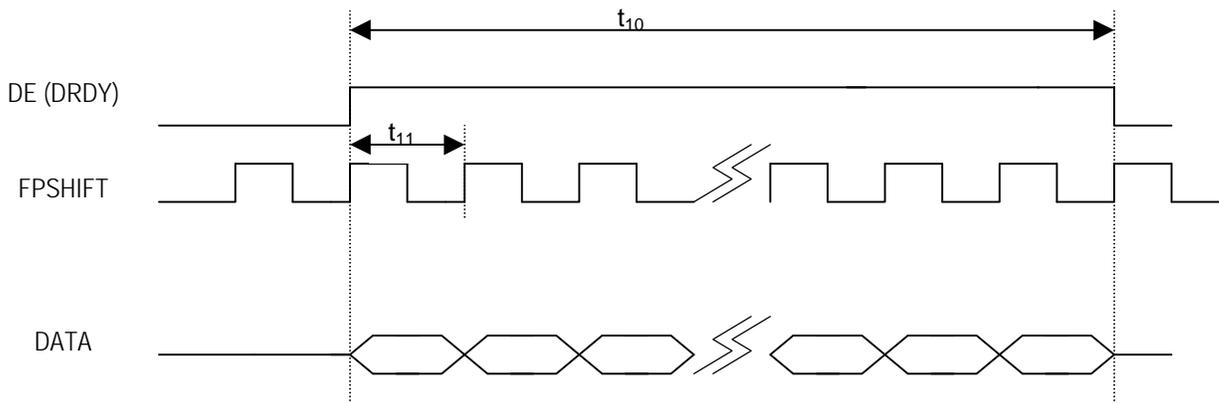
### Vertical Timing for TFT Panel



### Horizontal Timing for TFT Panel



### Detail of Pixel Clock Timing



\* Polarity of FPFAME, FPLINE, & FPSHIFT is programmable.

\* One and Two Pixels Per Clock are supported.

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## VGA Video Input Interface

The video data input interface includes a 24-bit digital input port which can be used to interface an external A/D converter or a PanelLink or LVDS receiver, and an 8/16 bit interface (actually shared with the 24-bit digital input port) for interfacing to a TV decoder.

Each resolution from the VGA controller has a refresh rate, horizontal sync frequency, and pixel clock frequency associated with it. The VESA document [VESA Monitor Timing Specifications](#) discusses this in depth. ChromaCast 82C205 provides feedback to the 8051 micro-controller specifying the refresh rate and horizontal sync frequency of the VGA input. The 8051 micro-controller must then update the capture clock divider word (for the line-locked PLL), the capture CRTC registers, and the scaler ratio.

**Sample VESA Table from VESA Monitor Timing Specifications**

Resolution	Refresh Rate	Horizontal Frequency	Pixel Frequency	Standard Type	Original Document#	Standard Date
1024x768	60 Hz	48.4 kHz	65 MHz	VESA Guidelines	VG901101A	8/9/91

### Calculating the Horizontal Sync Frequency ( $F_{HSYNC}$ ) of the Incoming VGA

The  $F_{HSYNC}$  value can be determined by the micro-controller by reading the horizontal sync frequency status register. This register gives the number of reference clock cycles (14.318 MHz or 70 ns) between horizontal sync i.e. the period of hsync in units of reference clocks. Then the micro-controller can calculate  $F_{HSYNC}$  by multiplying the number of reference clocks \* 70 ns and inverting the result:

$$F_{HSYNC} = 1 / (70 \text{ ns} * \text{number of reference clocks per hsync interval}).$$

Horizontal Sync Frequency Status	
Horizontal Sync Counter	Register 72h, 73h

### Calculating the Refresh Rate or Vertical Sync Frequency ( $F_{VSYNC}$ ) of the Incoming VGA

The  $F_{VSYNC}$  value can be determined by the micro-controller by reading the resolution counter status register. This register gives the number of horizontal syncs between vertical syncs, i.e. the period of vsync in units of incoming video lines. Then the micro-controller can calculate  $F_{VSYNC}$  by dividing the frequency of the horizontal sync,  $F_{HSYNC}$ , by the number of horizontal syncs in the vertical interval:

$$F_{VSYNC} = F_{HSYNC} / \text{Resolution counter register value}$$

Vertical Sync Frequency Status	
Vertical Sync Counter	Register 70h, 71h

### Determining the Resolution of the Incoming VGA

The resolution of the VGA can be determined by reading the resolution counter status register. This register gives the number of horizontal syncs between vertical syncs, i.e. the period of vsync in units of incoming video lines. Then the micro-controller can map this count to the most likely resolution by referencing VESA timing specifications in the form of a table. For instance, a reading of 810 (decimal) would most likely correspond to 768 active video lines, hence a 1024x768 resolution. The programmer then sets up a quantizer that maps the resolution counter's value to the most likely resolution. Blanking time causes the count to be greater than the number of active lines in a frame, but not significantly greater. Typical resolutions supported are 720x400, 640x480, 800x600, 1024x768, and 1280x1024, but this is a question of policy on how one wishes to define the quantizer. The resolution counter is the same value used to calculate  $F_{VSYNC}$ .

Vertical Sync Frequency Status	
Vertical Sync Counter	Register 70h, 71h

### Determining the frequency of the Pixel Clock used by the VGA

The pixel clock used by the VGA is not transmitted with the data, so it must be determined from the VESA standards definition. Once the resolution, refresh rate, and horizontal sync frequency are determined, the pixel clock from the VGA can be calculated by referencing a VESA table. Each resolution has several different refresh rates, and each rate has a certain recommended pixel clock associated with it. If one wishes to support non-VESA endorsed modes, then that can be accommodated by changing the table mapping.

### Determining the polarity of the horizontal and vertical incoming syncs

The 82C205 automatically detects the polarity of the incoming horizontal and vertical syncs from the VGA controller. The polarities of these incoming syncs are independent of the polarities of the syncs required by the panel. The incoming sync polarity information is available in a status register.

Capture Sync Polarity Status	
Hsync Polarity	Register 52h Bit[2]
Vsync Polarity	Register 52h Bit[3]

### Capture CRTC Programming

The Capture CRTC programming is independent of the Display CRTC programming (except in the case of memory bypass mode where frame rate conversion is not performed). Capture CRTC timing information can be obtained from reading the above mentioned status registers in the 82C205 and correlating this information with a VESA Monitor Timing table. The Appendix includes common Capture CRTC settings for certain VGA modes.

### Horizontal Sync Width (in units of VCLK1)

This register defines the width of the active part of the sync (when data is not valid). This is for internal use, so it can be set to any value greater than 1. As a rule of thumb, set this to 10.

Horizontal Sync Width	
H Sync Width	Register 40h, 41h

### Horizontal Display Start (in units of pixel clock)

This is the time between the start of the horizontal sync and the start of data valid. It can be calculated by first looking up the number of pixel clocks between the horizontal sync and the start of active data in the VESA Computer Monitor Timing Standard. (These values will have to be stored in a table in the CPU program ROM.)

Horizontal Display Start	
H Display Start	Register 42h, 43h

### Horizontal Display End (in units of pixel clock)

This is the time between the start of the horizontal sync and the end of data valid. This is calculated by adding the horizontal size of the incoming VGA to the Horizontal Display Start value (Registers 42h, 43h).

Horizontal Display End	
H Display End	Register 44h, 45h

### Horizontal Total (in units of pixel clock)

This is the period of Horizontal Sync. This can be determined by reading the Horizontal Frequency Count Register (Registers 72h, 73h) and performing the following calculation:

$$\text{Horizontal Total} = (\text{Horizontal Frequency Count} * \text{VCLK1}_f / 14.318 \text{ MHz}) - 1$$

Horizontal Total	
H Total	Register 46h, 47h

### Vertical Sync Width (in units of video lines)

The width of the active part of the sync (when data is not valid). This is for internal use, so it can be set to any value greater than 1. As a rule of thumb, set this the sync width to 1. The vertical sync width is specified by a start

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and end value for the Capture CRTIC, so in order to achieve a sync width of 1, the sync start should be programmed to be 1, and the sync end should be programmed to be 2.

Vertical Sync Width	
V Sync Start	Register 48h
V Sync End	Register 4Ah, 4Bh

### Vertical Display Start (in units of video lines)

This is the time between the start of the vertical sync and the start of data valid. It can be calculated by first looking up the number of lines between the vertical sync and the start of active data in the VESA Computer Monitor Timing Standard. (These values will have to be stored in a table in the CPU program ROM.) See the Appendix C for some suggested values for Vertical Display Start.

Vertical Display Start	
V Display Start	Register 4Ch, 4Dh

### Vertical Display End (in units of video lines)

This is the time between the start of the vertical sync and the end of data valid. This is calculated by adding the vertical size of the incoming VGA to the Vertical Display Start value (Registers 4Ch, 4Dh).

$$\text{Vertical Display End} = \text{Vertical Display Start} + \text{VGA Vertical Size}$$

Vertical Display End	
V Display End	Register 4Eh, 4Fh

### Vertical Total (in units of video lines)

This is the period of the vertical sync. This value is determined by reading the Resolution Detection register which indicates the number of lines per Vertical sync (Register 70h, 71h).

**Vertical Total = Resolution Detection Register Value (Register 70h, 71h)**

Vertical Total	
V Total	Register 50h, 51h

### Program the Capture CRTC to Synchronize to External Syncs

The Capture CRTC can be programmed to synchronize to the incoming horizontal and vertical syncs, or it can free-run by generating its own syncs according to the values in the Capture Horizontal Total and Capture Vertical Total registers. For normal VGA operation, the CRTC should be synchronized to the external syncs. For internal, built-in test pattern mode, the CRTC can be programmed to free run.

Capture CRTC Synchronization	
Synchronize or Free Run	Register 52h, Bits[1:0]

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## Dither

When the panel requires fewer than 24 bits per pixel (bpp) data, the dither must be enabled. The 24-bit data must be dithered down to the number of bits that the panel supports. The 24-bit data can also be dithered down to conserve bandwidth if the system has bandwidth issues. This causes a loss of the number of unique colors that can be represented, but in many cases, the degradation is not noticeable to the eye.

Earlier, the value for Primary Bits was selected in Register 38h. The dither function then has to be configured based upon this Primary Bits value. The dither uses an OPTi proprietary algorithm in order to give the user the perception of true color, even when 24 bits of color are not available to the panel. Due to the proprietary nature of this algorithm, OPTi provides values and formulas in order to set these registers

1. Set the Dither Frame Depth to 0.
2. Set the Dither Line Depth to  $(8 - \text{Primary Bits}) / 2$ .
3. Set the Dither Control Register to FAh.
4. Set the Dither Threshold to 0.
5. Set the Dither Algorithm Initializations to 03h.
6. Set the Dither Frame Offset Function Control to 0.
7. Set the Dither Line Offset Function Control to  $(8 - \text{Primary Bits} - \text{Dither Line Depth})$ .

Dither Registers	
Primary Bits	Register 38h, Bits[7:4]
Dither Frame Select	Register 38h, Bits[3:2]
Dither Line Select	Register 38h, Bits[1:0]
Dither Control	Register 39h
Dither Threshold	Register 3Ah
Dither Algorithm Initialization	Register 3Bh
Dither Frame Offset	Register 3Ch, Bits[7:4]
Dither Line Offset	Register 3Ch, Bits[3:0]

## Scaling

The ChromaCast 82C205 can scale an incoming video signal up to a larger panel resolution, or down to a smaller panel resolution. The programmer has to specify the incoming resolution, the outgoing resolution, and the scaling ratios in order for scaling to occur. The scale-down function can be performed without a DRAM frame buffer (assuming no frame rate conversion), but the scale-up function requires a frame buffer.

### Setting the Input Resolution for the Scaler

The incoming image resolution must be specified, whether from TV mode or from the VGA. This incoming resolution is specified in pixels for the horizontal direction, and in lines for the vertical direction.

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### VGA Example:

Assuming a 640 x 480 VGA signal, the Xsize = 640 and the Ysize = 480.

When scaling down, add 2Bh to Input Y size (Register 50h, 57h). Assuming a 1280x1024 VGA signal outputs to a 1024x768 panel, the Xsize=1280 and the Ysize=1024 + 2Bh.

Input Resolution for Scaler	
Xsize	Register 64h, 65h
Ysize	Register 56h, 57h

### TV Example:

Assuming a 640 x 240 TV signal (per field), the Xsize = 640 and the Ysize = 240.

Input Resolution for Scaler	
Xsize	Register 64h, 65h
Ysize	Register 56h, 57h

### Setting the Output Resolution

The outgoing resolution of the panel must be specified. The outgoing resolution is specified in pixels for the horizontal direction, and in lines for the vertical direction.

Assuming a 1024 x 768 VGA signal, the Xsize = 1024 and the Ysize = 768.

Output Resolution for Scaler	
Xsize	Register 62h, 63h
Ysize	Register 58h, 59h

### Setting the Scaling Ratios

The horizontal and vertical scaling ratios have to be set separately, and can be determined by the following formulas.

#### Vertical Ratio:

- If Scaling Up

$$Yratio = ((Capture Ysize - 1) * 1024) / (Display Ysize - 1)$$

- If Scaling Down or no Scaling:

$$Yratio = (((Display Ysize * 2048) / Capture Ysize) + 1) / 2$$

Vertical Ratio for Scaler	
Yratio	Register 54h, 55h

### Horizontal Ratio:

- $V_{in}$  Scaler:

If capture Xsize > display Xsize then,

$$Xratio = (( display Xsize * 8192 ) / ( capture Xsize + 1 )) / 2$$

Otherwise,

$$Xratio = 4096$$

- $V_{out}$  Scaler:

If capture Xsize > display Xsize then,

$$Xratio = 0$$

Otherwise,

$$Xratio = (( capture Xsize - 1 ) * 16384 ) / ((display Xsize - 1 ) + 32768 )$$

The horizontal ratio for the  $V_{out}$  scaler = Register 7Eh, 7Fh.

The VGA Frequency refers to the pixel clock of the incoming VGA signal. The VCLK1 Frequency refers to the Capture Clock for ChromaCast

Horizontal Ratio for $V_{in}$ Scaler	
Xratio	Register 60h, 61h

Horizontal Ratio for $V_{out}$ Scaler	
Xratio	Register 7Eh, 7Fh

### Fine Tuning the Scalers

The following registers need to be set in order to fine tune the scalers. These registers control the Differential Decision Analyzers (DDA) within the scalers.

1. Set the Vertical Scale-Down Random DDA Initialization to 0001h.
2. Set the Sign Seed Bit to 0h.
3. Set the DDA Field Compensation to 1h.
4. Set the DDA Reference to 1h.
5. Set the Horizontal Scale-Down Random DDA Initialization to 0001h.

Scaler Fine Tune
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Scaler Fine Tune	
Vertical Scale Down Random DDA Init	Register 5Ah, 5Bh
Vertical Scale Up Random DDA Init	Register 5Ch, 5Dh
Sign Seed Bit	Register 5Dh
DDA Field Compensation	Register 5Eh
DDA Reference	Register 5Eh
Horizontal Scale Down Random DDA Init	Register 66h, 67h

### Using the Anti-Alias Filter

ChromaCast 82C205 has an anti-alias filter that is used only for scale-down. If the 82C205 needs to scale down, enable this filter.

Antialias Filter Enable	
AntiAlias Enable	Register 6Eh

## “Centering”

Up to this point only scaling to the full panel resolution has been discussed. The 82C205 also offers a “centering” option which allows an image that is of lower resolution than the panel to be displayed in the center of the panel, surrounded by a black border that makes up the difference between the image resolution and the panel resolution. This feature is available for panels that support the DE only timing, i.e. horizontal and vertical syncs are not required.

The Display CRTC is programmed normally, then the Panel Window is programmed. By default, the panel window should be set to the same values as the corresponding values in the Display CRTC. However, when the programmer wants the black border to appear, the Panel Window registers should be programmed to reflect the portion of the display that should actually be displayed. The remainder will be filled in with a black border.

The panel window horizontal start and end registers are in units of VCLK2. The panel window vertical start and end registers are in units of display horizontal lines.

## How the Display Window Affects the Scaler

The window programming must work closely with the scaler, because the display window dimensions become the virtual panel size for the scaler. The scaler must scale up (or down) to the size of the panel window instead of the actual panel.

## Setting the Panel Window Register without “Centering”

If the 82C205 is not centering, set the Panel Window Registers as follows:

1. Panel Window Horizontal Start = Display CRTC Horizontal Start (Registers 84h, 85h) + 11h
2. Panel Window Horizontal End = Display CRTC Horizontal End (Registers 86h, 87h) + 11h
3. Panel Window Vertical Start = Display CRTC Vertical Start (Registers 8Eh, 8Fh)
4. Panel Window Vertical End = Display CRTC Vertical End (Registers 90h, 91h)

Panel Window Registers	
Panel Window Horizontal Start	Registers 98h, 99h
Panel Window Horizontal End	Registers 9Ah, 9Bh
Panel Window Vertical Start	Registers 9Ch, 9Dh
Panel Window Vertical End	Registers 9Eh, 9Fh

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## Contrast and Brightness Adjustment

There are two ways to change the contrast of the image. The first is through the analog gain adjustment on the external A/D converters. Usually this is adjusted once and then left alone. When the user adjusts the contrast and brightness through the user interface, the user will adjust the digital contrast and brightness levels.

### Digital Contrast

The digital contrast can be adjusted through the following registers. The contrast level can vary from 0 to 255. Unity gain is represented by the value of 128 (80h).

Digital Contrast	
Red Channel	Register 68h
Green Channel	Register 69h
Blue Channel	Register 6Ah

### Digital Brightness

The digital brightness can be adjusted through the following registers. The brightness level can vary from -128 to 127. A brightness adjustment value less than 0 will result in a displayed image that is darker than the original image. A brightness adjustment value greater than 0 will result in a displayed image that is lighter than the original image. If no adjustment to the image brightness is required, the brightness adjustment should be set to 0.

Digital Brightness Adjustment	
Red Channel	Register 6Bh
Green Channel	Register 6Ch
Blue Channel	Register 6Dh

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## The On Screen Display

The on screen display is bitmapped based in order to offer flexibility to support fonts of different languages, such as Chinese and Japanese. Company icons can also be displayed in order to give the OSD a custom feel. Some issues to decide when designing the OSD are:

### Determining OSD Size

The OSD size is programmable and can be as large as the whole screen or as small as a pixel. Even though the OSD region is rectangular, pixels within the rectangular region can be given transparent attributes to generate the appearance of a curved edge or any other shaped edge that is desired. One consideration in selecting the size of the OSD, however, is bandwidth. The larger the OSD, the more bandwidth will be occupied. The horizontal size of the OSD is specified in units of pixels (after scaling). The vertical size of the OSD is in units of video lines.

OSD Size	
Horizontal	Register 2Ch, 2Dh
Vertical	Register 30h, 31h

### Determining OSD Location on Screen

The OSD, which is a rectangular region, can be located anywhere on the display.

OSD Location	
Horizontal	Register 2Ah, 2Bh
Vertical	Register 2Eh, 2Fh

### Selecting OSD Attributes

ChromaCast 82C205 is full of useful attributes for the OSD, such as:

- transparent pixels – opt for a non-rectangular OSD shape
- blinking pixels - the 82C205 can blink to the underlying video, or to the color value in Index 0 of the register CLUT. The blink rate is programmable; for example, if this value is programmed 30 (decimal), the pixel will blink on for 30 capture frames, and off for 30 capture frames.

OSD Blinking Configuration	
Blink Background Select	Register 29h, Bit[2]
Blink Rate	Register 32h

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- inverted video - use the inverted video as the OSD background so it always stands out from the underlying display
- translucent pixels - with a programmable blend factor so the user can faintly “see” the underlying video through the OSD. Never have to worry about the OSD blocking the cursor again. Also one can choose to have one global blend value for all pixels that the OSD required to be translucent (by using the Register CLUT).

### Alpha Blend Operation

The alpha blend value in ChromaCast 82C205 is 5-bits wide. When the alpha blend value is set to 10h, the OSD overlay completely obscures the underlying video (this is full scale). When the alpha blend value is set to 00h, the OSD pixel is transparent. Values between 00h and 10h result in a translucent effect, the result of which is described by the following formula:

$$\text{Output} = \text{Video} * (1-\alpha) + \text{OSD} * (\alpha).$$

### Contents of the Register Color Look-Up Table

The Register color look-up table (CLUT) contains 16 entries. Only nibble mode can be for this implementation. Each entry contains a 3-bit color value (1-bit R,G,B), an alpha blend enable bit, and a 2-bit attribute value for a total of 6-bits. The two bit attribute value specifies normal, transparent, blinking, or video inversion. If enabling the alpha blend for a particular index, the global alpha blend value (from a register) is used. All indices with alpha blending use the same alpha value.

Register CLUT Programming	
Global Alpha Blend	CFh, Bits[4:0]
CLUT Index 0-F	Registers D0h – DFh

### Transferring Bitmap from CPU ROM to Display

So now that everything is configured, the programmer needs to generate a bitmap of indices that maps to the CLUT values stored in ChromaCast 82C205. Just write this bitmap to the OSD DRAM Buffer which is set up and explained in the Frame Buffer Allocation Section and whenever the programmers wants the OSD on the screen, enable it with the OSD Enable Register.

OSD Enable Register	
Enable OSD	Register 29h, Bit[1]

## Memory Configuration and Allocation

The ChromaCast 82C205 uses a 4 Mbyte DRAM buffer for a FRC (Frame Rate Conversion) frame buffer, as well as a buffer for the OSD bitmap. Frame Rate Conversion means that the 82C205 can accept video arriving at different refresh rates than the panel supports. The video capture systems will capture at the incoming video rate, and the display subsystem will read at the outgoing panel rate. If the system doesn't have to support FRC, then the system will be limited to supporting only the refresh rate specified by the panel. If the system does not need FRC and uses an external OSD alternative, the programmer will not need to program the memory subsystem beyond putting the 82C205 into memory bypass mode. If the system is not bypassing the memory subsystem, then the programmer will then need to configure the DRAM interface and allocate the frame buffer space.

## Bypassing the Memory Subsystem

A single register controls whether the memory subsystem will be bypassed. If the memory is bypassed, however, the Display CRTC needs to be programmed to synchronize with the Capture CRTC. An offset value for the vertical sync can also be programmed. This allows the Display Vertical Sync to synchronize to the Capture Vertical sync, but it will be generated X number of lines after the Capture Vertical Sync. A typical value for this is 5h.

Bypass Memory	
Bypass	Register A4h
Synchronize Display CRTC to Capture CRTC	Register 97h
Offset of Display Vertical Sync from Capture Vertical Sync	Register 92h, 93h

## Configuring the DRAM Interface

### Selecting DRAM speed

Program the Memory Clock Internal PLL to operate at the DRAM speed. For SDRAM, the typical speed is 100 MHz. The Memory Clock Internal PLL uses a 14.318 MHz clock as its reference. It then uses programmable M and N values that are configuration registers used to generate higher frequency clocks. Program the M and N values according to the following formula:

$$\text{Output Frequency for Memory Clock} = 14.318 \text{ MHz} * N / M$$

There is a divide by 2 option for the Memory Clock, but it is unlikely to be used. The divide by 2 option will divide the frequency of the Memory Clock output from the PLL by 2. The ChromaCast 82C205 also provides the option of not using the internal PLL if it is desired to provide the 82C205 with an external memory clock.

For a 100 MHz memory clock, program the M value to 0Fh and the N value to 69h. The divide by 2 option does not need to be exercised. The clock also passes through a programmable delay line on its way to the DRAM. This can be tweaked to obtain better performance. A typical value for the delay line when using the internal PLL is 08h. When using the external PLL, a typical value for the delay line is 0Eh. The delay line has an intrinsic delay of 0.6 – 0.7 ns (when the delay register is set to 00h), and each increment of the delay line register adds 0.3 – 0.4 ns.

Memory Clock	
Delay Line	Register 23h
Internal PLL Selection	Register FCh, Bit[[3]
Divide by 2	Register C4h, Bit[6][
N	Register C5h
M	Register C4h

Now the programmer needs to get some information from the DRAM specifications, such as refresh rate for the DRAM, burst type, and burst length.

### Programming the refresh rate

The refresh rate for DRAM is controlled by a counter inside of ChromaCast 82C205. The counter can be programmed and is clocked by a 14.318 MHz reference clock. Whenever the counter reaches the programmed terminal count, a refresh request will be generated. Program this rate to 1/3 of the value needed. For example, if the minimum refresh interval is 10  $\mu$ s, (which is 10  $\mu$ s \* 14.318 MHz which equals 143.180 reference clocks), then program the refresh rate to be  $143.180 \div 3 = 47.730$ , or in hexadecimal 002Fh.

Refresh Rate	
Refresh Rate	Register 1Eh, 1Fh

### Specifying the burst length and type, and CAS Latency

Interleaved and sequential burst types are supported. Only burst lengths of 8 are supported. CAS latencies of 2 and 3 memory clock cycles are supported. Register 22h, Bits[1:0] must be set to 1's.

SDRAM Control	
CAS Latency	Register 22h, Bit[3]
Burst Type	Register 22h, Bit[2]
Burst Length	Register 22h, Bit[1:0]

### Additional memory configuration settings

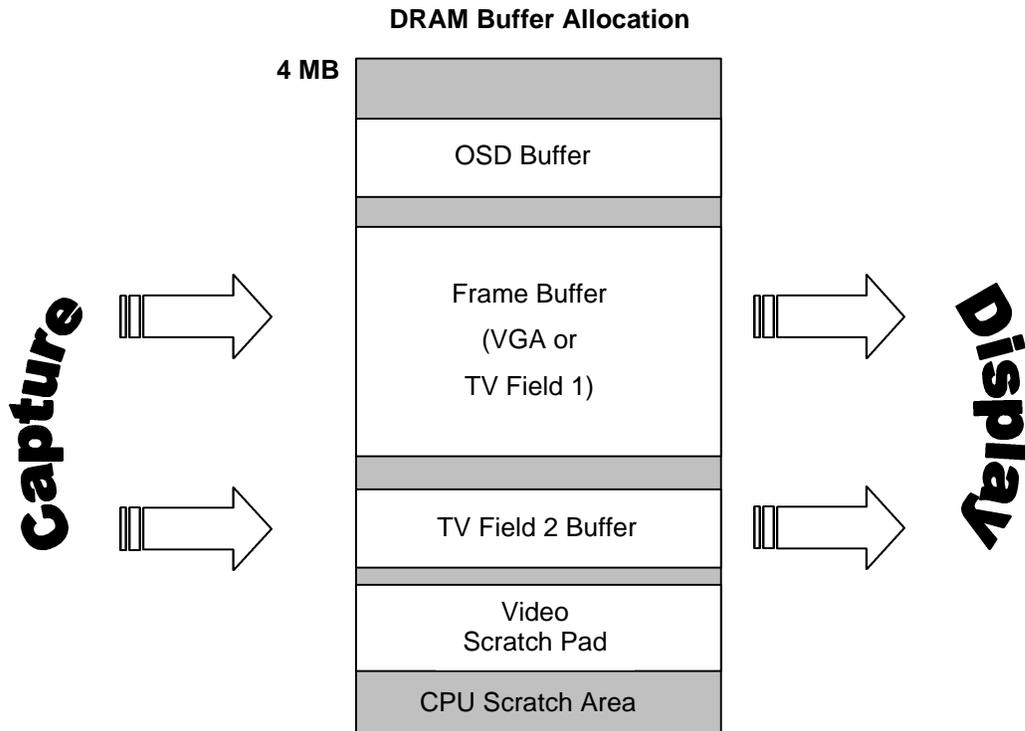
There is a register in 82C205 called "Arbiter Client Acknowledge Overlap". This bit should be set to "1" in order to achieve maximum performance.

Optimizing the Memory Subsystem	
Arbiter Overlap	Register 1Dh, Bit[5]

Now the DRAM interface is configured, and the next step is to allocate the DRAM address space to the various buffers.

### DRAM Buffer Allocation

The frame buffer is used to capture data, and then display it. When the 82C205 is in bypass mode, the frame buffer is not used. The frame buffer size will vary depending on the application. The larger the resolution of the display, the bigger the frame buffer that will be needed.



### Allocating the DRAM space to each buffer

Each buffer is defined by a start address and pitch. Pitch is the address difference between the start of two adjacent horizontal lines. An end address is not specified, so the programmer has to keep track of where each buffer ends, so the next buffer's start address doesn't collide with the end of the previous buffer. The end address is determined by the start address plus the size of the buffer. The start addresses must be on 64\*8 boundaries, i.e., the lowest 9 bits of the 22-bit start address must be all zero. Also, care must be taken to insure that the buffers do not overlap each other. The pitch should be programmed to the minimum amount of memory required by a line of that buffer, but it also has the restriction of being on a 64\*8 boundary. For instance, if the programmer was programming the pitch for the OSD buffer, assuming a 300x200 OSD using nibble mode, the pitch should be programmed to be:

$$\text{OSD Pitch (in bytes)} = [(300 \times 4) + (64 \times 8) - 1] / 8$$

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which is the number of pixels per lines to be accessed multiplied by the bits per pixel and divided by the word size which is 64\*8 for the DRAM configuration.

### VGA Frame Buffer

#### Calculating the pitch of the frame buffer

The pitch of the frame buffer can be calculated as follows:

$$\text{Video Pitch (bytes)} = \{[(\text{VGA Horizontal Size}_{[\text{in pixels}]} * \text{Primary Bits}_{\text{Register 38h}} * 3) + ((64*8)-1)] / 8$$

The pitch should be chosen to accommodate all the pixels captured in a horizontal line (after scale down) within a 64\*8 boundary.

#### Calculating the size of the frame buffer

The size of the frame buffer is calculated as follows:

$$\text{Frame Buffer Size (in bytes)} = \text{Video Pitch} * (\text{the incoming Vertical Size}_{[\text{in lines}]})$$

VGA Frame Buffer Start/Pitch	
Start Address for Capture (for Frame Buffer or TV Mode Field 1)	Register 04h, 05h, 06h
Pitch for Capture and Display Buffers (Video Pitch)	Registers 16h, 17h

### TV Frame Buffers

TV mode uses double buffering for the frame buffer, capturing one field in each buffer. Each stored field is 240 lines, so the size of each buffer is 240 lines \* the video pitch. In TV mode there are effectively 2 frame buffers, and in VGA mode only 1 frame buffer.

$$\text{TV Buffer Size (per field, in bytes)} = (\text{Video Pitch} * 240_{[\text{lines}]})$$

The TV Buffer space can be shared with the frame buffer space because VGA and TV are not active at the same time.

TV Buffer Start/Pitch	
Start Address for Capture (for Frame Buffer or TV Mode Field 1)	Register 04h, 05h, 06h
Start Address for TV Mode Field 2 Capture	Registers 07h, 08h, 09h
Pitch for Capture and Display Buffers (Video Pitch)	Registers 16h, 17h

### OSD Buffer

#### Calculating the OSD Pitch

The pitch of the OSD buffer can be calculated as follows:

$$\text{OSD Pitch (in bytes)} = [(\text{OSD Horizontal Size} \times 4) + ((64 \times 8) - 1)] / 8$$

#### Calculating the size of the OSD DRAM buffer

The pitch of the OSD determines the size of the OSD buffer required. The OSD DRAM buffer size can be calculated as follows:

$$\text{OSD Buffer Size (in bytes)} = \text{OSD Pitch} * \text{OSD Vertical Size}$$

OSD Buffer Start/Pitch	
Start Address for OSD Buffer	Registers 0Dh, 0Eh, 0Fh
Pitch for OSD	Register 1Ah, 1Bh

#### OSD FIFO Word Count

This value indicates how many DRAM read accesses that the FIFO will perform in one line. Use the following formula:

$$\text{OSD Bandwidth Limit Value} = (\text{OSD Horizontal Size} * 4) + ((64 * 8) - 1) / (64 * 8)$$

OSD FIFO Word Count	
FIFO Word Count	Registers B0h

### Display Read Out from Frame Buffers

#### Configuring the display buffers

There are two display buffers, one main one for the normal frame buffer, and one for the second field for TV mode. The display buffers start addresses should be programmed to match the capture buffer start addresses. The pitch for the display buffer is set to equal the pitch for the capture buffer, and is shared with the capture pitch (the register designated Video Pitch).

Display Buffer Setup	
Display Panel Start Address –Field 1	Register 10h, 11h, 12h
Display Panel Start Address for TV Mode Field 2 Capture	Registers 13h, 14h, 15h

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### Display FIFO Word Count

This value indicates how many DRAM read accesses that the FIFO will perform in one line. Use the following formula:

Display FIFO Word Count = [(Display Panel Horizontal Size

$$* \text{Primary Bits}_{\text{Register 38h}} * 3) + ((64*8)-1) ] / (64*8)$$

Display FIFO Word Count	
Display FIFO	Registers B2h

### CPU Scratch RAM

Any unallocated memory can be used by the micro-controller as scratch DRAM. After testing memory, the firmware will partition the whole memory for the hardware and firmware use.

Currently, the firmware is using the last three banks for the OSD window, tempory system configuration data, and some temporary data buffers.

During system boot, the firmware will copy any necessary fonts, numbers and bit maps from EPROM to the CPU scratch DRAM. Hardware will cache the OSD window, using the OSD Control Registers, then display it to the panel.

## Testing and Debugging

### Internal Test Patterns

There are internally generated test that can be used for system bring-up to test the memory and/or display subsystems. These patterns are available in VGA mode only (not TV mode). Instead of accepting data from the external A/D converters or the external digital video input port, the input data is generated internally. Several different test patterns are available, such as flat colors (red, green, or blue), horizontal and vertical ramps, checkerboards, and colorbars. An optional grid can be overlaid over the video to test scaling. The Capture CRTC can be programmed to free run for test pattern mode, so the programmer will not have to worry about supplying an external sync. The PLL 1 still needs an external sync however, unless the programmer switches over to a divided down reference clock that will emulate hsync.

Test Pattern Selection	
Free Run the Capture CRTC	Register 52h, Bits[[1:0]
Test Grid On	Register 6Fh, Bit[4]
Test Pattern Selection	Register 6Fh, Bits[3:0]

### Software Resets and Disables

The major subsystems of ChromaCast 82C205 are controlled by separate software resets.

Various hardware internals of ChromaCast 82C205 can be powered down by software for testing purposes. The video input subsystem can be disabled (stopping the capture), as can the video output subsystem (stopping the display).

Software Resets and Disables	
Video Subsystem Enables	Register 01h, Bits[1:0]
Hardware Enables	Register C9h
Software Resets	Register 02h

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### Revision Number

The Revision number of ChromaCast 82C205 is in a read-only register.

Revision Number	
Revision	Register 00h

### FIFO Status

The internal FIFOs within the 82C205 have flags that will trigger for overflow and underflow conditions. In order to clear these flags, the program must write a "1" and then a "0" to the Clear FIFO Error Register.

FIFO Status	
Clear FIFO Error	Register E9h
FIFO Overflow/ Underflow Status	Registers EAh, EBh

### Signature Analyzers

There are two signature analyzers built into the 82C205. One is in the capture data path, and the other is in the display data path. They are updated every vertical sync. If these registers read 0000h, there may indicate that the capture or display subsystem is locked.

Signature Analyzers	
Capture	Registers ECh, EDh
Display	Registers EEh, EFh

### CPU Memory Read Buffer

The 82C205 latches the data value from a CPU DRAM read into a register. This register is available for a "double

CPU Double Read Register	
Memory Read Value	Register 26h

### Memory Subsystem Status

The internal blocks of the memory subsystem have status registers that can be used to observe the state machines of the memory arbiter and sequencer. These registers can be used to detect a lock-up of the memory system.

Arbiter and Sequencer Status	
Arbiter	Register 27h
Sequencer	Register 28h

### Miscellaneous

The following registers are reserved for future applications and need to be set for appropriate operation.

- Display Sync Bi-directional Control = 0
- Capture Sync Bi-directional Control = 0
- Pull Down Function for Bi-directional Buffer = 0

Miscellaneous Registers	
Display Sync BiDirect	Register FCh, Bit[7]
Capture Sync BiDirect	Register FCh, Bit[6]
Pull Down for BiDirect	Register FDh, Bit[2]

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### TV Mode Setup

#### Selecting between 8-bit and 16-bit TV decoder interface

The ChromaCast 82C205 supports an 8-bit and a 16-bit interface to an NTSC/PAL decoder and accepts the digital YUV 4:2:2 format. In 8-bit mode, the Y, U, and V components are 1-byte wide, and are multiplexed on the bus. In 16-bit mode, the Y occupies 1 byte of the bus, and the U and V components are multiplexed on the other bytes. ChromaCast 82C205 de-multiplexes these components and performs YUV to RGB conversion.

TV Bus Width Selection	
Bus Width	Register 7Ch, Bit[1]

#### Determining if TV Phase is Correct

The first time the system is initialized, the phase counter offset may need to be adjusted for different decoders. The phase is incorrect if instead of seeing the correct colors for the TV image, an image that is composed primarily of purples and greens appears. Adjust the phase counter offset until the correct colors are visible. This tells ChromaCast 82C205 which component the decoder transmits first, the Y, U, or V.

Phase Counter Offset	
Offset	Register 7Ch, Bit[3:2]

#### Required Synchronization signals from the TV decoder

ChromaCast 82C205 requires an odd/even flag from the TV decoder instead of a vertical sync. The polarity for this flag is programmable, and will switch which field is considered odd and which is even, but this is not really a necessary distinction. The ChromaCast 82C205 also requires HREF from the TV decoder instead of a horizontal sync. HREF is a flag that indicates when video is active. Some decoders have different polarities for HREF, so this is programmable.

TV Sync Polarities	
Odd/Even	Register 7Dh, Bit[1]
HREF	Register 7Dh, Bit[0]

#### Enabling TV mode

There is a register that switches between VGA mode and TV mode. The program needs to update the capture CRTC and the scaling registers to the correct values. Also, the program needs to switch the datapath from the internal A/D converters to the external TV 24-bit input.

TV Mode Selection	
Enable TV Mode	Register 7Ch, Bit[0]

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### Programming the CRTC for TV Mode

The Capture CRTC does not need to be programmed for TV mode, except that the Capture CRTC must be programmed to synchronize to the incoming syncs.

### Programming the Scalers for TV Mode

See the section on Scaling. The scalars will have to be updated when TV mode is entered.

### IP Conversion

In order to convert the television signal from interlaced mode to progressive scan mode, IP conversion is necessary. Three types are implemented on ChromaCast 82C205: 1-Field Bob Mode, 2-Field Bob Mode, and Weave Mode.

#### Bob Mode

ChromaCast 82C205's 2-Field Bob Mode is the recommended interlaced-to-progressive method. Bob Mode involves capturing the odd fields (640x240 or 720x240) into their own buffer, and the even field (640x240 or 720x240) into their own buffer. The display then alternately switches which buffer to use based upon the field selection.

#### 1-Field Bob Mode

In 1-Field Bob Mode, only 1 Field is captured, so every other field is dropped. The captured field is scaled up to the panel size. In order to use this mode, use the following procedure:

1. Set the Display Field 2 Start = Display Field 1 Start.
2. Make sure the Capture Field 2 Buffer does not collide with the Capture Field 1 Buffer. Capture Field 1 & 2 both contain 240 lines.
3. Set the TV Weave Mode bit to 0h.
4. Set the DDA Field Compensation to 1h.
5. Set the DDA Reference to 0h.

#### 2-Field Bob Mode

In 2-Field Bob Mode, both fields are captured. This is the preferred mode of operation.

1. Set the Display Field 2 Start = Capture Field 2 Start.
2. Make sure the Capture Field 2 Buffer does not collide with the Capture Field 1 Buffer. Capture Field 1 & 2 both contain 240 lines.
3. Set the TV Weave Mode bit to 0h.
4. Set the DDA Field Compensation to 1h.
5. Set the DDA Reference to 1h.
6. Set TV Mode Even Field to 1h.

#### Weave Mode

In Weave mode, there are not two separate buffers for odd and even fields. Instead, they are captured into one buffer, but in an interlaced fashion. The odd field is captured into the buffer, skipping every other line. The even

field is then captured into those "skipped" lines. This method results in motion artifacts from the temporal inconsistencies.

1. Set the Display Field 2 Start = Display Field 1 Start.
2. Make sure the Capture Field 2 Buffer does not collide with the Capture Field 1 Buffer. Capture Field 1 must now hold 480 lines, and Field 2 should have 0.
3. Set the TV Weave Mode bit to 1h.
4. Set the DDA Field Compensation to 1h.
5. Set the DDA Reference to 0h.

TV IP Registers	
Capture Field 1 Start	Registers 04h, 05h, 06h
Capture Field 2 Start	Registers 07h, 08h, 09h
Display Field 1 Start	Registers 10h, 11h, 12h
Display Field 2 Start	Registers 13h, 14h, 15h
TV Weave Mode	Register 25h
TV Mode Even Field	Register 5Eh, Bit[2]
DDA Field Compensation	Register 5Eh, Bit[1]
DDA Reference	Register 5Eh, Bit[0]

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### CPU Interface

The ChromaCast 82C205 has an interface for an 8051 compatible micro-controller that can be used to program the 82C205's registers, and access the external DRAM. The CPU interface has a shared 16-bit address and data bus. The address is 16-bit and the lower byte of the bus is multiplexed with the 8-bit data bus. This CPU has various responsibilities that it performs in conjunction with the 82C205, including:

- Programming the Capture CRTC and Scalers for Incoming Video
- Managing the OSD
- Managing the Power Sequencing and Power Management
- Switching between TV Mode to VGA Mode
- Managing the DDC Transfer

The ChromaCast 82C205 can ask for service from the CPU by means of an active low interrupt line. This is how the 82C205 communicates events such as a change of resolution on the incoming video, a DDC service request, and a power management service request.

### CPU Access to the Registers

The CPU address bus is 16-bits wide. In order to access the registers, the REGISTER BASE value must be strapped from resistors on the board. This value by default is 00h. The REGISTER BASE value is 5-bits wide, and maps to Bits[13:8] of the CPU address bus. In order for the ChromaCast 82C205 to recognize a register access, Bit[15] must equal 1, Bit[14] must equal 0, and Bits[13:8] must match the REGISTER BASE value.

**CPU Address for Register Access**

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	REGISTER BASE					Index into Registers								

For example, if REGISTER BASE = 0, and the CPU wanted to access Register Index 30h, the CPU address would be 8030h.

### CPU Access to the DRAM Buffer

In order for the ChromaCast 82C205 to recognize a DRAM access, Bit[15] must equal 1, and Bit[14] must equal 1. The internal address to the DRAM is 22-bits wide in order to access 4 Mbytes. Since the CPU address cannot access such a wide memory address with only 16-bits available, a bank switching technique is used. A Bank register in the ChromaCast 82C205's registers is concatenated with the CPU address in order to create the internal 22-bit address to the DRAM.

**CPU Address for DRAM Access**

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	DRAM Address [13:0]													

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**Bank Register (Index 1Ch)**

7	6	5	4	3	2	1	0
DRAM Address[21:14]							

Another bit in the ChromaCast 82C205 will disable the memory accesses (reads and writes), so the 82C205 will ignore any memory reads and writes. For normal operation, this bit should be set to 0h.

For example, if one wanted to write to memory address 323456h, then the CPU address would be F456h, and the Bank Register would be programmed to be C8h.

**CPU DRAM Access Registers**

Enable DRAM Access	Register 01h
Bank Register	Register 1Ch

### Interrupts

ChromaCast 82C205 generates an active low interrupt whenever one or more pre-defined events. The events that can generate an interrupt are:

- A change in the frequency of the VGA Horizontal Sync
- A change in the frequency of the VGA Vertical Sync (Refresh Rate) or Sync(s) Lost
- Countdown Timer reaches terminal Count of Zero
- Start and End of the Capture Vertical Sync Active Time (used for testing)
- Start and End of the Display Vertical Sync Active Time (used for testing)

Each event has an interrupt enable, an interrupt clear, and a status register.

### Enabling an event to generate an interrupt

Enable the interrupt for that event by writing to the bit in the Interrupt Enable Register that corresponds to that event.

**Interrupt Enable**

Enables	Register B4h
---------	--------------

### The interrupt/event status register

Whether or not the event generates an interrupt, the event will occur internally and update the status register. If the event occurs, the status register will indicate a "1". The register will stay set until the interrupt clear bit has a "1" written to it. The Status register is read-only, but shares the same register index as the write-only Clear register.

Interrupt Status	
Status	Register B5h

### Clearing an interrupt/event

Write a "1" to the bit in the Interrupt Clear Register that corresponds to that event.

Interrupt Clear	
Clear	Register B5h

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## Power Management for ChromaCast 82C205

The ChromaCast 82C205 controls the power-up and power-down sequencing for the panel, as well as the DPMS Power Management for the system.

### Timer

ChromaCast 82C205 has a general purpose on-chip timer that can be used by the CPU to control power sequencing and power management time intervals. The timer is a 19-bit countdown timer that can count from 5 seconds down to 0 in 10  $\mu$ s intervals.

### Setting the timer interval

The timer can be set by writing to a 19-bit register. This 19-bit register requires 3 writes by the CPU. When the low byte of the timer value is written, the timer will latch the new value into its counter and will begin down-counting to 0. When the timer reaches 0, it will start over at the timer register value. Each time the timer reaches 0 it will generate an event which will cause an interrupt if the timer interrupt is enabled by the programmer.

Timer	
Timer	Register CAh, CBh, CCh

### Timer Operation Procedure

1. Decide the timer interval. Each increment is 10  $\mu$ s.
2. Write the high byte of the timer interval (actually 3 bits) to the timer register.
3. Write the middle byte of the timer interval.
4. Write the low byte of the timer interval. (When this word is written, the timer interval will be latched into the timer, and the timer will begin to count down.)
5. Enable the timer interrupt.
6. Disable the timer interrupt after it occurs unless the program is prepared to handle a continuous periodic timer interrupt.
7. Clear the interrupt and service the interrupt.

### Power Sequencing

The power-up/power-down panel sequencing is a critical application that ensures that the panel is not inadvertently damaged due to an improper power sequence.

Each panel has its own power sequencing specification. The discussion here applies to a TFT panel with a +5V input, and a +12V input for the backlight. This example is only meant to show the concept of power sequencing, and the programmer should check the specific panel specification for exact sequencing requirements. For this example, the CPU has three tasks to perform in order to power-up the panel:

1. Turn on the +5V
2. Enable the Clock and Data Lines

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3. Turn on the +12V

Inversely, for power-down, the CPU must:

1. Turn off the +12V
2. Disable the Clock and Data Lines to the Panel
3. Turn off the +5V

Each task has a specified minimum or maximum time interval before the next task has to be executed. These intervals can be found in the panel specification, and the CPU in combination with the internal timer can be used to meet the timing specification.

### DPMS Power Management

In addition to proper power sequencing for the panel, it is important to conserve power whenever possible. OPTi's ChromaCast 82C205 supports DPMS Power Management in conjunction with the CPU.

### Notifying the CPU of the DPMS state

The 82C205 monitors the activity of the vertical and horizontal syncs from the VGA controller and generates an interrupt whenever the syncs become inactive. The interrupt is shared with the "Change of Vertical Sync Rate" interrupt, so whenever that interrupt occurs, the sync lost status must be checked.

Sync Lost Status	
Sync Lost Bits	Register 52h, Bits[5:4]

### Monitor is disconnected from the VGA controller

The micro-controller can monitor the VGA connect/no-connect pin. If the VGA cable is disconnected, the CPU can switch to internal synchronization signals and an alternate horizontal sync source in order to display an internal pattern with an OSD overlay that indicates the cable is disconnected.

Operating without External Syncs	
Free Run Capture CRTC	Register 52h, Bits[1:0]

### ChromaCast 82C205 Power Conservation Techniques

The ChromaCast 82C205 can disable its on-chip PLLs and it can power down the panel backlight and panel power.

Hardware Enables	
Enables	Register C9h

### Example of Power Conservation Policy for DPMS

There are 4 states in the DPMS Power Management system. Below are these states are indicated, along with a possible power conservation policy. This is only one of many possible implementations.

**On**- All systems are operational

**Standby** – Backlight is powered off.

**Suspend** – Backlight is powered off.

**Off** – Backlight, PLLs and panel voltage off.

#### 1. Initialization

Initialize the hardware enables so that all internal hardware is on enabling all the bits in the Hardware Enables Register. Disable the timer interrupt. The Power Enables Register should be disabled so no power goes to the panel, and the clock and data lines are disabled.

#### 2. On

Assuming that the panel has a very simple power-up procedure (the individual panel spec should be consulted), the panel is powered up enabling the Panel Power bit of the Panel Enables Register. Immediately after this, enable the clock and data signals. Make sure the program performs a read-modify-write on this register so it doesn't accidentally turn off the power when enabling the clock and data lines. (Normally the time between VDD switching on and applying the data signals is  $t$ , where  $0 < t < 10$  ms, hence timers are not required).

Depending on the application, the program may delay the application of the backlight, but it is may not be necessary. The timer can be used to add this delay. If the backlight is turned on before the VDD to the panel, a white flash of the screen may occur. To turn on the backlight (assuming VDD is on and that data is enabled) enable the Panel Light bit of the Power Enables Register.

Now the panel is powered up. This sequence should be executed any time the panel is powered up. For more precise control of times, the timer feature can be used which gives 10  $\mu$ s precision +/- the delay in programming and interrupt handling.

When the panel is powered up, the timer interrupt should be disabled after its use is complete.

If the CPU receives an interrupt from the "Change of Resolution/Vertical Sync Frequency" source, check to make sure the syncs are not lost by reading the Sync Lost Bits. If the horizontal sync is lost, go to **standby**. If the vertical sync is lost, go to **suspend**.

#### 3. Standby

Turn off the backlight. Remember to perform this by reading, applying a mask, then re-writing, otherwise the program may accidentally power-down the whole panel.

Wait 1 second (using the timer).

Check the status of the Sync Lost Bits. If horizontal and vertical sync are now present, turn the backlight back on and return to the **on** state. Otherwise stay in **standby** and continue to poll the Sync Lost Bits.

### 4. Suspend

Now it is time to shut down most of the system. Power off the A/Ds and the backlight. The PLLs and the panel will still have power.

Wait for 5 s (using the timer).

Check the status of the Sync Lost Bits. If horizontal and vertical sync are now present, power the A/Ds and backlight back on, and return to the **on** state. Otherwise stay in **suspend** and continue to poll the Sync Lost Bits

### 5. Off

Start the power down sequence for the panel. Assuming only VDD is required by the panel (in addition to the backlight which is now off), disable the clock/data signals. Then, in a separate write, turn off the Panel Power (VDD) to the panel. Once the panel is powered down, power off the PLLs.

Wait 5 s (using the timer).

Check the status of the sync lost bits.

If both syncs are present, return to **on**. (Remember to turn all the internal hardware back on, power-on sequence the panel, and turn the backlight on once in the **on** state.) Otherwise, stay in this state which is really like a deep sleep.

Continue polling the sync lost bits register every 5 s until the syncs are present.

### Appendix A: Example Register Initialization Values

The following table shows initialization values for ChromaCast 82C205 registers for a 1024x768, 60 Hz TFT panel accepting 1024x768, 70 Hz VGA input. The ChromaCast 82C205 is using the DRAM frame buffer and an external line-locked PLL in this example.

Addr	Val														
00h	10h	20h	00h	40h	0Ah	60h	00h	80h	9Fh	A0h	0Ah	C0h	00h	E0h	04h
01h	03h	21h	00h	41h	00h	61h	10h	81h	02h	A1h	0Bh	C1h	00h	E1h	04h
02h	00h	22h	0Bh	42h	18h	62h	00h	82h	11h	A2h	00h	C2h	30h	E2h	04h
03h	00h	23h	01h	43h	01h	63h	04h	83h	00h	A3h	00h	C3h	0Ah	E3h	04h
04h	00h	24h	11h	44h	18h	64h	00h	84h	14h	A4h	00h	C4h	05h	E4h	04h
05h	C0h	25h	00h	45h	05h	65h	04h	85h	00h	A5h	00h	C5h	26h	E5h	04h
06h	00h	26h	EFh	46h	21h	66h	01h	86h	14h	A6h	00h	C6h	15h	E6h	04h
07h	00h	27h	00h	47h	05h	67h	00h	87h	02h	A7h	00h	C7h	30h	E7h	04h
08h	C0h	28h	13h	48h	01h	68h	80h	88h	27h	A8h	00h	C8h	23h	E8h	04h
09h	00h	29h	04h	49h	01h	69h	80h	89h	03h	A9h	00h	C9h	00h	E9h	00h
0Ah	00h	2Ah	40h	4Ah	02h	6Ah	80h	8Ah	27h	AAh	00h	CAh	5Bh	EAh	00h
0Bh	80h	2Bh	01h	4Bh	00h	6Bh	00h	8Bh	03h	ABh	00h	CBh	57h	EBh	00h
0Ch	2Dh	2Ch	80h	4Ch	23h	6Ch	00h	8Ch	06h	ACH	00h	CCh	01h	ECh	1Ah
0Dh	80h	2Dh	01h	4Dh	00h	6Dh	00h	8Dh	00h	ADh	00h	CDh	01h	EDh	F5h
0Eh	4Eh	2Eh	60h	4Eh	23h	6Eh	01h	8Eh	23h	AEh	00h	CEh	01h	EEh	2Ah
0Fh	3Fh	2Fh	00h	4Fh	03h	6Fh	00h	8Fh	00h	AFh	00h	CFh	28h	EFh	B0h
10h	00h	30h	7Fh	50h	26h	70h	26h	90h	23h	B0h	08h	D0h	30h	F0h	00h
11h	C0h	31h	00h	51h	03h	71h	03h	91h	03h	B1h	00h	D1h	0Ah	F1h	18h
12h	00h	32h	1Eh	52h	0Fh	72h	FBh	92h	18h	B2h	18h	D2h	10h	F2h	40h
13h	00h	33h	1Eh	53h	0Fh	73h	00h	93h	00h	B3h	18h	D3h	2Ah	F3h	1Fh
14h	C0h	34h	1Eh	54h	00h	74h	01h	94h	06h	B4h	85h	D4h	00h	F4h	00h
15h	00h	35h	1Eh	55h	00h	75h	00h	95h	0Ah	B5h	7Bh	D5h	24h	F5h	30h
16h	40h	36h	1Eh	56h	00h	76h	27h	96h	0Ah	B6h	00h	D6h	18h	F6h	41h
17h	0Bh	37h	1Eh	57h	03h	77h	03h	97h	00h	B7h	00h	D7h	1Ah	F7h	30h
18h	40h	38h	43h	58h	00h	78h	01h	98h	15h	B8h	19h	D8h	13h	F8h	38h
19h	01h	39h	FAh	59h	03h	79h	00h	99h	00h	B9h	19h	D9h	1Ch	F9h	04h
1Ah	C0h	3Ah	00h	5Ah	01h	7Ah	30h	9Ah	15h	BAh	19h	DAh	10h	FAh	00h
1Bh	00h	3Bh	01h	5Bh	00h	7Bh	05h	9Bh	02h	BBh	00h	DBh	14h	FBh	09h
1Ch	FDh	3Ch	01h	5Ch	01h	7Ch	00h	9Ch	23h	BCh	00h	DCh	1Ch	FCh	CCh
1Dh	12h	3Dh	00h	5Dh	00h	7Dh	01h	9Dh	00h	BDh	00h	DDh	1Fh	FDh	00h
1Eh	B8h	3Eh	00h	5Eh	03h	7Eh	01h	9Eh	23h	BEh	00h	DEh	32h	FEh	00h
1Fh	DFh	3Fh	00h	5Fh	03h	7Fh	01h	9Fh	03h	BFh	00h	DFh	04h	FFh	00h

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## Appendix B: Common VGA Timing Values

The following values are extracted from the VESA Computer Monitor Timing Standard. These are the values that a programmer may choose to include in a look-up table in order to properly program the Capture CRTC to accept different resolutions and refresh rates.

Resolution	HSIZE	VSIZE	VGA Pixel Clk (MHz)	Horizontal Display Start (in units of VGA Pixel Clk)	Vertical Display Start (in units of VGA Pixel Clk)
640x400 – 85 Hz	640	400	31.5	160	44
720x400 – 85 Hz	720	400	35.5	180	45
640x480 – 60 Hz	640	480	25.175	144	35
640x480 – 72 Hz	640	480	31.5	168	31
640x480 – 75 Hz	640	480	31.5	184	19
640x480 – 85 Hz	640	480	36	136	28
800x600 – 56 Hz	800	600	36	200	24
800x600 – 60 Hz	800	600	40	216	27
800x600 – 72 Hz	800	600	50	184	29
800x600 – 75 Hz	800	600	49.5	240	24
800x600 – 85 Hz	800	600	56.250	216	30
1024x768 – 43 Hz (I)	1024	384	44.9	232	24
1024x768 – 60 Hz	1024	768	65	296	35
1024x768 – 70 Hz	1024	768	75	280	35
1024x768 – 75 Hz	1024	768	78.750	272	31
1024x768 – 85 Hz	1024	768	94.5	304	39
1280x1024 – 60 Hz	1280	1024	108	360	41

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**Appendix C: VCLK2 PLL M & N Values**

This table indicates the M and N values for the Display PLL (VCLK2). These values can also be used for programming the memory clock (MCLK) PLL.

<u>M</u>	<u>N</u>	<u>Frequency(MHz)</u>	<u>M</u>	<u>N</u>	<u>Frequency(MHz)</u>	<u>M</u>	<u>N</u>	<u>Frequency(MHz)</u>
4	7	25.056815	5	11	31.499996	11	29	37.747929
13	23	25.332165	14	31	31.704541	14	37	37.840904
9	16	25.454542	9	20	31.818178	3	8	38.181813
14	25	25.568179	13	29	31.940555	13	35	38.548946
5	9	25.772724	4	9	32.215905	10	27	38.659086
11	20	26.033055	15	34	32.454541	7	19	38.863631
6	11	26.249997	11	25	32.541318	11	30	39.049582
13	24	26.433563	7	16	32.727269	15	41	39.136359
7	13	26.590906	10	23	32.931814	4	11	39.374995
15	28	26.727269	13	30	33.041954	13	36	39.650345
8	15	26.846587	3	7	33.409087	9	25	39.772722
9	17	27.045451	14	33	33.749996	14	39	39.886359
10	19	27.204542	11	26	33.842971	5	14	40.090904
11	21	27.334707	8	19	34.005677	11	31	40.351235
12	23	27.443178	13	31	34.143352	6	17	40.568177
13	25	27.534962	5	12	34.363632	13	37	40.751743
14	27	27.613633	12	29	34.602268	7	20	40.909086
15	29	27.681815	7	17	34.772723	15	43	41.045449
2	4	28.636360	9	22	34.999996	8	23	41.164767
15	31	29.590905	11	27	35.144624	9	26	41.363631
14	29	29.659087	13	32	35.244751	10	29	41.522722
13	27	29.737758	15	37	35.318177	11	32	41.652887
12	25	29.829542	2	5	35.795450	12	35	41.761358
11	23	29.938013	15	38	36.272723	13	38	41.853142
10	21	30.068178	13	33	36.346149	14	41	41.931813
9	19	30.227269	11	28	36.446276	15	44	41.999995
8	17	30.426133	9	23	36.590904	2	6	42.954540
15	32	30.545451	7	18	36.818177	15	46	43.909085
7	15	30.681814	12	31	36.988632	14	43	43.977267
13	28	30.839157	5	13	37.227268	13	40	44.055938
6	13	31.022723	13	34	37.447548	12	37	44.147722
12	26	31.022723	8	21	37.585223	11	34	44.256193
11	24	31.239665						

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10	31	44.386358	5	18	51.545448	15	62	59.181811
9	28	44.545449	13	47	51.765728	7	29	59.318174
8	25	44.744312	8	29	51.903402	13	54	59.475517
15	47	44.863631	11	40	52.066109	6	25	59.659083
7	22	44.999994	14	51	52.159084	11	46	59.876025
13	41	45.157337	15	55	52.499993	5	21	60.136356
6	19	45.340903	13	48	52.867126	14	59	60.340901
12	38	45.340903	10	37	52.977266	9	38	60.454538
11	35	45.557845	7	26	53.181811	13	55	60.576915
5	16	45.818176	11	41	53.367762	4	17	60.852265
14	45	46.022721	15	56	53.454539	15	64	61.090901
9	29	46.136358	12	45	53.693175	11	47	61.177678
13	42	46.258735	13	49	53.968525	7	30	61.363629
4	13	46.534085	9	34	54.090902	10	43	61.568174
15	49	46.772721	14	53	54.204539	13	56	61.678314
11	36	46.859498	5	19	54.409084	14	61	62.386356
7	23	47.045449	11	42	54.669415	11	48	62.479331
14	46	47.045449	6	23	54.886357	8	35	62.642038
10	33	47.249994	13	50	55.069923	13	57	62.779712
13	43	47.360134	7	27	55.227266	5	22	62.999992
3	10	47.727267	15	58	55.363629	12	53	63.238628
14	47	48.068176	8	31	55.482948	7	31	63.409083
11	37	48.161151	9	35	55.681811	9	40	63.636356
8	27	48.323858	10	39	55.840902	11	49	63.780984
13	44	48.461532	11	43	55.971067	13	58	63.881111
5	17	48.681812	12	47	56.079538	15	67	63.954537
12	41	48.920448	13	51	56.171322	2	9	64.431810
7	24	49.090903	14	55	56.249993	15	68	64.909083
9	31	49.318176	15	59	56.318175	13	59	64.982509
11	38	49.462804	2	8	57.272720	11	50	65.082636
13	45	49.562931	15	61	58.227265	9	41	65.227264
15	52	49.636357	14	57	58.295447	7	32	65.454537
2	7	50.113630	13	53	58.374118	14	64	65.454537
15	53	50.590903	12	49	58.465902	12	55	65.624992
13	46	50.664329	11	45	58.574373	5	23	65.863628
11	39	50.764456	10	41	58.704538	8	37	66.221582
9	32	50.909084	9	37	58.863629	11	51	66.384289
12	43	51.306812	8	33	59.062492	14	65	66.477264

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3	14	66.818173	5	26	74.454536	15	86	82.090899
13	61	67.185306	14	73	74.659081	4	23	82.329535
10	47	67.295446	9	47	74.772718	13	75	82.604885
7	33	67.499991	13	68	74.895095	9	52	82.727262
11	52	67.685942	4	21	75.170445	14	81	82.840899
15	71	67.772719	15	79	75.409081	5	29	83.045444
4	19	68.011355	11	58	75.495858	11	64	83.305775
13	62	68.286705	7	37	75.681809	6	35	83.522717
9	43	68.409082	10	53	75.886354	13	76	83.706283
14	67	68.522719	3	16	76.363627	7	41	83.863626
5	24	68.727264	14	75	76.704536	15	88	83.999989
11	53	68.987595	11	59	76.797511	8	47	84.119308
6	29	69.204537	8	43	76.960217	9	53	84.318171
13	63	69.388103	13	70	77.097892	10	59	84.477262
7	34	69.545446	5	27	77.318172	11	65	84.607427
15	73	69.681809	12	65	77.556808	12	71	84.715898
8	39	69.801127	7	38	77.727263	13	77	84.807682
9	44	69.999991	9	49	77.954536	14	83	84.886353
10	49	70.159082	11	60	78.099164	15	89	84.954535
11	54	70.289247	13	71	78.199291	2	12	85.909080
12	59	70.397718	15	82	78.272717	15	91	86.863625
13	64	70.489502	2	11	78.749990	14	85	86.931807
14	69	70.568173	15	83	79.227263	13	79	87.010478
15	74	70.636355	13	72	79.300689	12	73	87.102262
2	10	71.590900	11	61	79.400816	11	67	87.210733
15	76	72.545445	9	50	79.545444	10	61	87.340898
14	71	72.613627	7	39	79.772717	9	55	87.499989
13	66	72.692298	12	67	79.943172	8	49	87.698853
12	61	72.784082	5	28	80.181808	15	92	87.818171
11	56	72.892553	8	45	80.539762	7	43	87.954534
10	51	73.022718	11	62	80.702469	13	80	88.111877
9	46	73.181809	14	79	80.795444	6	37	88.295443
8	41	73.380673	3	17	81.136353	11	68	88.512385
15	77	73.499991	13	74	81.503486	10	62	88.772716
7	36	73.636354	10	57	81.613626	14	87	88.977261
13	67	73.793697	7	40	81.818171	9	56	89.090898
6	31	73.977263	14	80	81.818171	13	81	89.213275
11	57	74.194205	11	63	82.004122	4	25	89.488625

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15	94	89.727261	13	85	93.618869	14	95	97.159079
11	69	89.814038	11	72	93.718996	5	34	97.363624
7	44	89.999989	9	59	93.863624	11	75	97.623955
10	63	90.204534	7	46	94.090897	6	41	97.840897
13	82	90.314674	12	79	94.261352	13	89	98.024463
3	19	90.681807	5	33	94.499988	7	48	98.181806
14	89	91.022716	13	86	94.720268	15	103	98.318169
11	70	91.115691	8	53	94.857942	8	55	98.437488
8	51	91.278397	11	73	95.020649	9	62	98.636351
13	83	91.416072	14	93	95.113624	10	69	98.795442
5	32	91.636352	3	20	95.454533	11	76	98.925607
12	77	91.874988	13	87	95.821666	12	83	99.034078
7	45	92.045443	10	67	95.931806	13	90	99.125862
9	58	92.272716	7	47	96.136351	14	97	99.204533
11	71	92.417344	11	74	96.322302	15	104	99.272715
13	84	92.517471	15	101	96.409079	2	14	100.227260
15	97	92.590897	4	27	96.647715			
2	13	93.068170	13	88	96.923065			
15	98	93.545443	9	61	97.045442			

## Appendix D: ChromaCast OSD (On-Screen Display) User's Guide

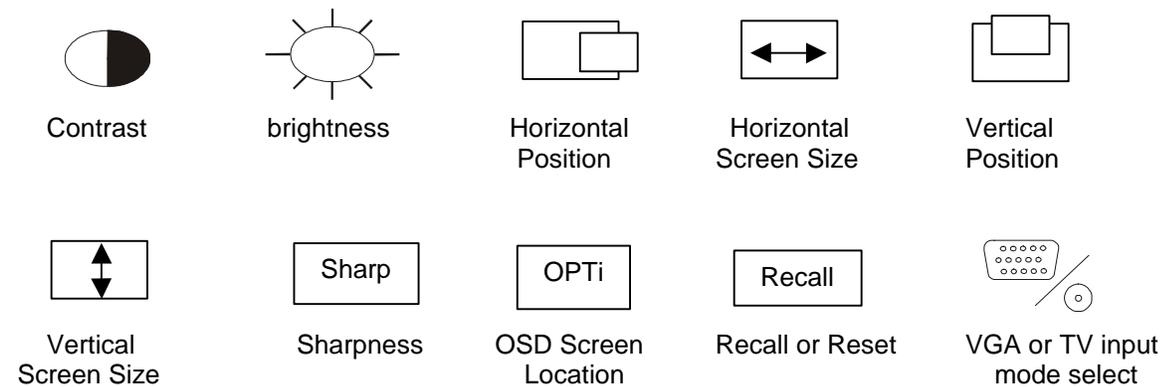
The ChromaCast On-Screen Display (or OSD) allows the user to alter the screen image appearance to suit their individual preferences

### Enabling OSD

The end user can enable OSD on the screen by pressing either the "Select" or the "Adjust" button on the front panel of the LCD. Two rows consisting of five icons will pop up. A brief description of each icon's function appears immediately below the icon.

### Supported Functions

The icons below represent the ten functions supported by ChromaCast. Each icon is accompanied by a brief description of the function printed immediately below it. Below the two rows of icons is a text line with a more complete description of whichever icon is currently highlighted and below that is a line of text showing the function's current level or value.



### Front Panel input buttons description

On the front of the LCD panel are several buttons that are used with the ChromaCast OSD to configure the image appearance. The buttons are represented below:

Reset	Select		Adjust		Mode
Reset button	down	Up	-	+	Mode button

**Reset Button:** For the normal operation, do not use this button. This is used for debugging purpose only.

**Select Button:** These buttons are used to select one of the ten icons. The selected icon will be either blinking or highlighted and its functional description will appear below the icon rows.

To change the toggle the language used in the OSD, press both Select buttons at the same time, release then press either of the Select buttons again.

**Adjust Button:** These buttons are used to either increase or decrease the value of the selected function or to execute the Icon command. The changed value will appear on the bottom row of the OSD display.

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**Mode Button:** This button is used to select one of the four input modes. Pressing the button once will initially display the current display mode. Pressing the button again will allow the user to toggle between the following four input modes:

1. Non scaling VGA input.
2. Scaled VGA input
3. S-video input
4. RCA-video input.

### Description of Supported Icons

#### Contrast Icon:

Use Adjust button; "+" will increase Contrast while "-" will decrease contrast.

#### Brightness Icon:

Use Adjust button; "+" will increase Brightness while "-" will decrease Brightness.

#### Horizontal position Icon:

Use Adjust button: "+" will move screen to right while "-" will move screen to left side of the screen.

#### Horizontal Screen size Icon:

Use Adjust button; "+" will increase the Horizontal screen sizes while "-" will decrease Horizontal screen size.

**Note:** In Bypass mode (1024x760 @ 60Hz.), this function is disabled and it will skip to next available Icon.

#### Vertical Position Icon:

Use Adjust button; "+" will move screen to upward while "-" will move screen downward.

#### Vertical Screen Size Icon:

Use Adjust button: "+" will increase vertical screen size while "-" will decrease Vertical screen size.

**Note:** In Bypass mode (1024x760 @ 60Hz.), this function is disabled and it will skip to next available Icon.

#### Focus Icon:

Use Select button to choose either "Auto-fine tune" mode or "VGA fine tune, Then use Adjust button "+" to value.

1. **Auto-fine tune mode** allows you to make the screen shaper and center it automatically by internal firmware.
2. **VGA fine tune mode** allow you to adjust clock input phase and this will make screen sharper.

#### OPTi Icon:

Using Adjust button can move CHROMACAST OSD display window around in screen: "+" will change OSD window position Horizontally while "-" will move OSD window position vertically. There are nine possible OSD window locations. Especially in nsc/ SXGA (Non scaling SXGA VGA input) mode, you could move OSD window to left hand side so that you could viewed the whole OSD window.

### Recall Icon:

Use Select button to choose either "USER Recall" mode or "Factory Recall, then use Adjust button to excute it (Your choice will be updated only when you executed Exit command).

### USER Recall mode

Allows you to reinstate all of ChromaCast Registers setting from previous value saved by user.

### Factory Recall mode

Allows you to reinstate all of ChromaCast Registers setting from the default value provided by manufacture.

### VGA or TV input Select mode Icon

First use the Select button to select one of input listed Below:

Input Type	OSD Message
Non scaling VGA input.	nsc/ VGA Input
Scaled VGA input	sc/ VGA Input
S-video input	bob Svd Input
RCA-video input.	bob RCA Input

Then use the Adjust button to enable the input mode.

In VGA input mode, the description section will show both the resolution and refresh rate of the current mode. At present, the following VGA capture modes are supported:

- 640x480 @ 60, 72, 75, 85Hz.
- 720x400 @ 70Hz.
- 800x600 @ 56, 60, 72, 75, 80Hz.
- 1024x768 @ 60, 70, 75, 85Hz
- 1280x1024 @ 60Hz

In TV mode, only NTSC: 720x480 @ 60Hz is supported.

### Exit menu

The OSD menu will disappear after a short period of activity. You can also exit the OSD when no icons are selected simply by pressing either Adjust button.

### OSD Description Language Select

Currently, we are supporting both English and Japanese fonts. By pressing both Select buttons ("down" and "up") at the same time, then pressing any one Select button will toggle fonts on OSD screen.

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### **Manufacture debugging mode**

This mode is provided for debugging only. Only engineers thoroughly familiar with the ChromaCast registers should ever attempt to use this mode.

Press both Adjust buttons (“+” and “-”) at the same time, then enter a ChromaCast Register number and its contents will be displayed on the OSD window. The Register number and its value adjustment are “count-up” only.

For a Register number selection, use Select buttons (“down” for tenth digit of the Register adjustment and “up” for ones digit of the Register value).

For a Register value Adjustment: Use Adjust buttons (“+” for tenth digit of the Register value and “-“ for ones digit of the Register value).

Upon completion of proper value for a Register have been selected, press “mode” button to write a value to a selected Register.