Centris 610 & 650, Quadra 800: Video Architecture (7/94)

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TOPIC -----

This article describes the video capabilities of the Macintosh Centris 610 and 650, and the Quadra 800, and includes:

- A discussion of a few general video topics
- Details on how to wire the video connector sense pins to access all the supported video modes of these computers, and
- Description of the memory configurations necessary to support each of the video modes at specific pixel depths.

The information in this article relative to the Centris 610 and Centris 650 is also relevant to the Quadra 610 and Quadra 650.

DISCUSSION -----

General Video Design Philosophy

The video hardware design of the Centris 610 and 650 and the Quadra 800 is very similar to the earlier Quadra computers. However, one of the main goals of these CPUs was to reduce the cost of the computers relative to the Quadra 700 and 950, while still providing the same or better performance. While it wasn't possible to significantly reduce cost while maintaining the exact feature set of the earlier Quadras, most of the Quadra video features were carried through to the Centris 610 and 650 and Quadra 800. The main exceptions are:

- No support for Apple convolution (flicker reduction) for NTSC and PAL, and
- No support for 24 bits per pixel (bpp).

The video hardware for all three CPUs, the Centris 610, Centris 650, and Quadra 800, is virtually identical. The only exception is that the Centris 610 only requires 100 ns VRAM, while the Centris 650 and Quadra 800 require 80 ns VRAM.

The maximum supported pixel depth is 16 bpp. This isn't a matter of the amount of VRAM in the computer -- it's a hardware limitation. The RAM or DAC used by all three computers simply doesn't include the hardware required to do 24 bpp on any display. The same is true for the lack of support for Apple convolution -- the hardware necessary to do this isn't present in the computer.

24 bpp support was dropped for a number of reasons:

- Cost reduction. It's still relatively expensive to provide the 24 bpp support offered by the Quadra 700 and 950.

- Marketing research data has shown that a very large percentage of Quadra users don't use the onboard video, but rather use an accelerated video card capable of driving a 2-page display at 24 bpp. It wasn't reasonable to burden the price of every Centris 610, 650 and Quadra 800 with the cost of a 2-page 24-bpp frame buffer.

- 16 bpp offers most of the advantages of 24 bpp, without much of the cost and at a higher level of performance. QuickTime MooV playback is optimized for 16 bpp. Also, for casual browsing of image data (for example, scanned images or Photo CD pictures), 16 bpp is quite adequate and offers better performance with fewer system resource requirements than 24 bpp.

Convolution support was dropped primarily for cost reasons, and also because it's very rarely used. NTSC and PAL timing support are still offered, however. The Centris 610, 650 and Quadra 800 do support all the monitor types supported by the Quadra 950. This includes support for a 1024 x 768 resolution on 19-inch displays (which wasn't provided by the Quadra 700).

The design changes made a positive impact on performance. At the same processor clock speed, the video section of these new computers outperforms the video section of the older Quadras. That is, video performance on the Centris 650 is better than the Quadra 700, and on the Quadra 800 is better than the Quadra 950. Due to an improved video memory controller design, one wait state was removed from many of the frame buffer access cycles. This results in reduced memory access time overall, and therefore improved performance. The graphics tests in Speedometer (version 3.11) show an improvement of roughly 6-10% over the earlier Quadra computers (each running System 7.1).

Supported Display Configurations and Monitor ID Codes
---------- The Centris and Quadra frame buffer determines what type of display is attached to the video connector by examining the state of 3 sense line pins. The following chart details how these three pins must be wired for each of the supported display types. For each supported display it lists the screen resolution (horizontal pixels X vertical pixels), dot clock frequency, and the vertical and horizontal scan rates.

Basically, the Centris 610 and 650 and Quadra 800 support any display, whether from Apple or from another vendor, that meets one of the following specifications:

Standard Sense Codes:

Display	Sense pins 10	7	4	Hor x Vert Pixels	Dot Clock	Vert Refrsh	Horiz Refrsh
Apple 21 Color	0	0	0	1152 x 870	100	75	68.7
Apple Portrait	0	0	1	640 x 870	57.2832	75	68.9
12" Apple RGB	0	1	0	512 x 384	15.6672	60.15	24.48
Apple 2-Page Mono.	0	1	1	1152 x 870	100	75	68.7
NTSC	1	0	0	underscan-512x384	12.2727	59.94	15.7
	1	0	0	overscan- 640x480	12.2727	59.94	15.7
(To produce a color NTSC signal, a RGB-to-NTSC converter is required.)							
12" AppleMonochrome	1	1	0	640 x 480	30.24	66.7	35.0
13" Apple RGB	1	1	0	640 x 480	30.24	66.7	35.0

Extended sense codes will be examined if the following sense code is detected:

1	1	1

Notes on above monitors:

- A sense pin value of 0 means that the pin should be grounded to the C&VSYNC.GND signal; a value of 1 means don't connect the pin.

- Sense pins 4, 7, and 10 are referred to as SENSE0, SENSE1, and SENSE2 in pinout tables for the video connectors.

- The terms "underscan" and "overscan" are used to describe the active video resolution for NTSC and PAL modes. Underscan means that the active video area appears in a rectangle centered on the screen with a black surrounding area. This ensures that the entire active video area always is displayed on all monitors. Overscan uses the entire possible video area for NTSC or PAL. However, most monitors or televisions will cause some of this video to be lost beyond the edges of the display, so the entire image won't be seen.

Extended Sense Codes:

Note for extended sense codes: A sense pin pair value of 0 means those pins should be tied together (as opposed to grounding the pins to pin 11); a value of 1 means don't connect the pins. DON'T wire any of these pins to ground.

Display	Sense pins 4-10	10-7	7-4	Hor x Vert Pixels	Dot Clock	Vert Refrsh	Horiz Refrsh

16" Color	0	1	1	832 x 624	57.2832	75	49.7

PAL

PAL has two wiring options, using the extended sense pin configuration. To produce a color PAL signal, an RGB-to-PAL converter is required.

PAL Option 1	0	0	0	underscan-640x480	14.75	50	15.625
				overscan-768x576	14.75	50	15.625
PAL Option 2	1	1	0	underscan-640x480	14.75	50	15.625
				overscan-768x576	14.75	50	15.625

Note: This sense code also requires a diode between sense pins 10 and 7, with anode towards pin 7, cathode towards pin 10.

VGA	1	0	1	640 x 480	25.175	59.95	31.47
SVGA	1	0	1	800 x 600	36	56	35.16

To enable SVGA, after configuring and connecting the monitor for VGA, open the Monitors control panel and select Options. Choose Super VGA from the dialog and reboot your system.

19" Color	1	1	0	1024 x 768	80	75	60.24

No external monitor (video halted)

	1	1	1

Here are the video connector pinouts:

Pin	Signal	Description
1	RED.GND	Red Video Ground
2	RED.VID	Red Video
3	CYSNC~	Composite Sync
4	MON.ID1	Monitor ID, Bit 1 (also known as SENSE0)
5	GRN.VID	Green Video
6	GRN.GND	Green Video Ground
7	MON.ID2	Monitor ID, Bit 2 (also known as SENSE1)
8	nc	(no connection)
9	BLU.VID	Blue Video
10	MON.ID3	Monitor ID, Bit 3 (also known as SENSE2)
11	C&VSYNC.GND	CSYNC & VSYNC Ground
12	VSYNC~	Vertical Sync
13	BLU.GND	Blue Video Ground
14	HSYNC.GND	HSYNC Ground
15	HSYNC~	Horizontal Sync
Shell	CHASSIS.GND	Chassis Ground

If your monitor is a VGA type, you can try the following cable pinouts:

```
Macintosh Video                          VGA Connector
DB-15
-------------                            --------------

2  ------------------- Red Video ------------ 1
1  ------------------- Red Ground ----------- 6
9  ------------------- Blue Video ----------- 3
13 ------------------- Blue Ground ---------- 8
5  ------------------- Green Video ---------- 2
6  ------------------- Green Ground --------- 7
15 ------------------- Hsync ---------------- 13
12 ------------------- Vsync ---------------- 14
14 ------------------- Sync Ground ---------- 10
10 -------------------|
7  -------------------| Connect 7 and 10 so the sense pin ID will equal VGA
```

There are a few issues to keep in mind with VGA monitors:

- VGA monitors will vary depending on the vendor. Check with the vendor about Macintosh Centris and Quadra compatibility before buying. Or better yet, actually try the monitor with a Quadra to see if it works and if the quality is acceptable.

- Vendors have different image quality specifications. There may be significant differences between Apple monitors and the wide range of VGA monitors. Do a side-by-side comparison of the monitors you are considering before buying.

- Many third-party cable vendors have off-the-shelf cables that should work.

Most NTSC devices use an RCA-type phono-connector and the following diagram uses that as a reference point. A cable wired as follows may allow many different brands of NTSC monitors to work on a Macintosh Centris or Quadra. We advise that you test the monitor on one of these computers prior to purchase, to see if it meets your expectations.

Adjust the phono-connector side to whatever type of connector is used (RCA, BNC, and so on). "Tip" is the pin in the center of the connector (the signal); the sleeve is flange around the outer edges of the connector (the chassis ground).

```
   Card Connector                    RCA-Type Phono-Connector
   --------------                    ------------------------
   4      MON.ID1  (sense0) --|
   7      MON.ID2  (sense1) --|
   11     C&VSYNC.GND --------|

   5      GRN.VID  -----------------> Tip (signal)
   Shell  CHASSIS.GND --------------> Sleeve (ground)
```

By grounding pin 4 and pin 7 to pin 11, the Macintosh Centris and Quadra CPUs are told that an NTSC monitor is attached. The actual black and white video

signal is on pin 5 and connects to the center (Tip) of the phono-plug. The shell of the card connector connects to the sleeve of the phono-plug.

To acquire a color NTSC signal from a Centris or Quadra (or any Apple Macintosh display card), an RGB-to-composite video converter is required.

VRAM Requirements for Supported Display Configurations

The frame buffers on the new Centris and Quadra computers support a variety of pixel depths, from 1 to 16 bits per pixel (bpp). The supported pixel depths (1, 2, 4, 8, or 16 bpp) depend on the display resolution and the amount of VRAM present. The fully expanded capability of all three computers is the same -- 1MB of VRAM. As with the Quadra 950, these computers can be expanded using 256K (that is, 128K x 16) 80 ns VRAM SIMMs (although the Centris 610 only requires 100 ns VRAM).

The following chart lists the Centris 610 and 650 and Quadra 800 built-in video's maximum pixel depth supported depending upon the VRAM configuration:

Display size	512K VRAM	1MB VRAM
12-inch landscape 384 x 512	16 bpp	16 bpp
12-inch Monochrome 640 x 480	8 bpp	8 bpp
13-inch RGB & VGA 640 x 480	8 bpp	16 bpp
SVGA 800 x 600	8 bpp	16 bpp
15-inch Portrait (b/w) 640 x 870	4 bpp	8 bpp
16" Color, 832 x 624	8 bpp	16 bpp
19" Color, 1024 x 768	4 bpp	8 bpp
2-Page Display (b/w) 1152 x 870	4 bpp	8 bpp
21" Color 1152 x 870	4 bpp	8 bpp
PAL underscan-640x480	8 bpp	16 bpp
overscan-768x576	8 bpp	16 bpp
NTSC		

underscan-512x384	8 bpp	16 bpp
overscan- 640x480	8 bpp	16 bpp

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