

32/64-BIT MULTIMEDIA PALETTE-DACS

- Multiple Visuals Supported
 - 4 bit indexed planar
 - 8 bit indexed
 - 15 bit direct color (corrected through LUT)
 - 15 bit true color
 - 30 bit direct color (corrected through LUT)
 - 30 bit true color
- 32 × 32, 2-plane user definable hardware cursor
- 8-channel analog/digital Game Port interface
- Deep pixel input FIFO
- 3 programmable Phase Lock Loops (memory, video and audio)
- Single Crystal (12.096MHz)
- Triple 10-bit DACs
- VESA feature connector port (STG1732 only)

- Intelligent power management
- PixMix™ pixel mode switching on 15 and 30-bit visuals
- Software selectable 16, 32, or 64-bit input pixel port width (64-bit on STG1764 only)
- 8:1, 4:1, 2:1, or 1:1 multiplexed pixel port
- Video rates up to 170MHz

DESCRIPTION

The STG1732 and STG1764 are 32-bit and 64-bit pixel port Palette-DACs compatible with the architecture of the STG2000 Multimedia Accelerator. The STG1732 and STG1764 feature integrated clock synthesizers, game port and hardware cursor. For support of DRAM based graphics memory the pixel port implements a pixel FIFO buffer which may be burst filled directly from a DRAM bus.

BLOCK DIAGRAM

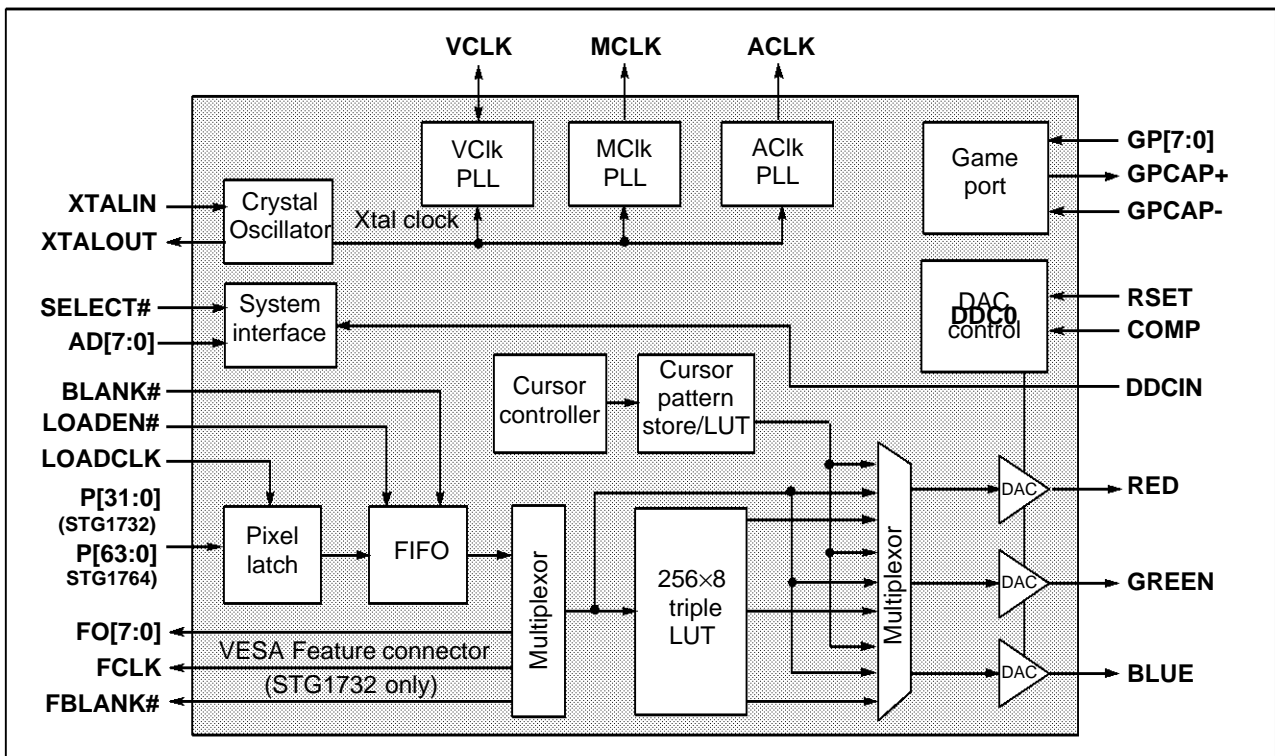
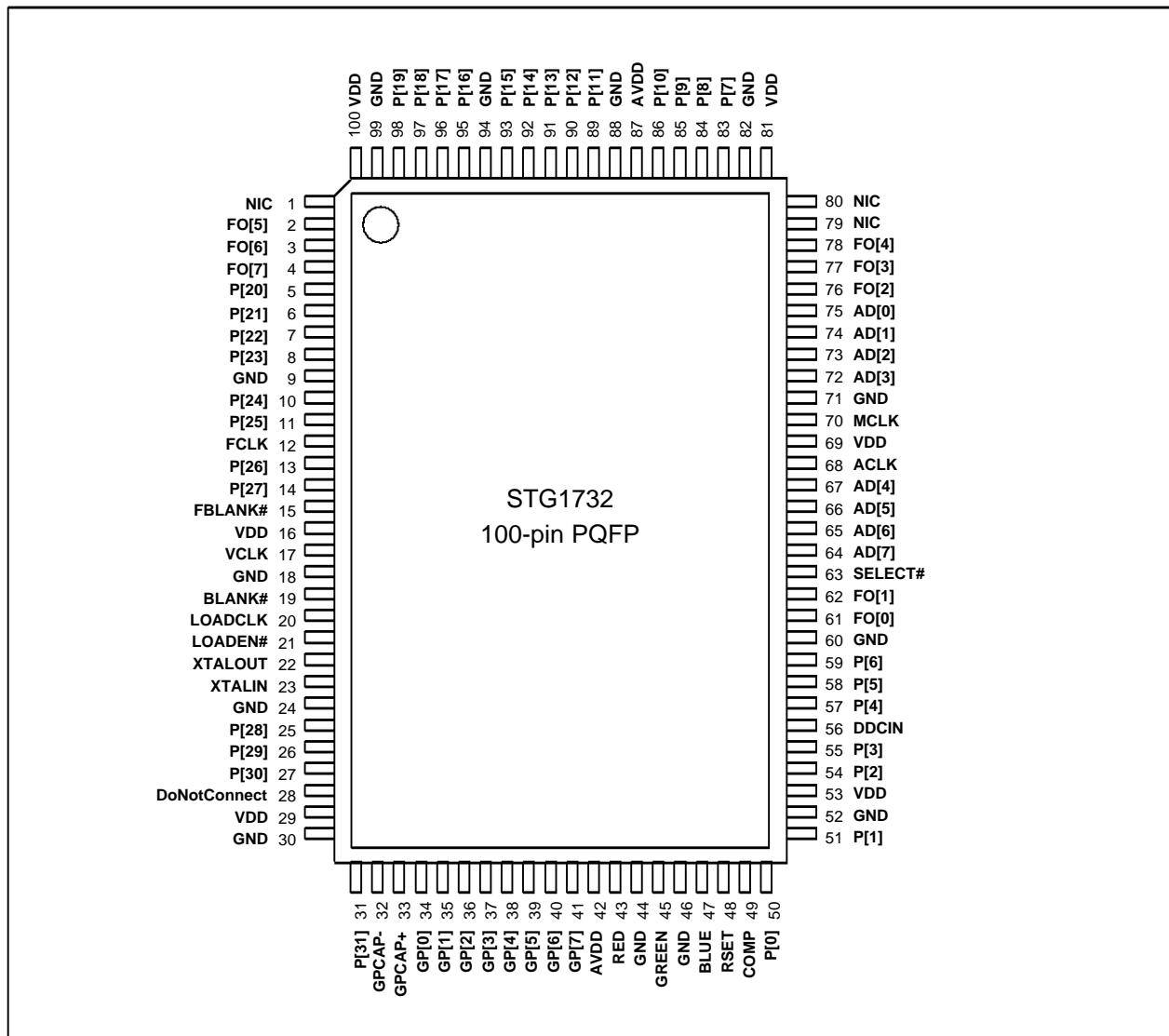


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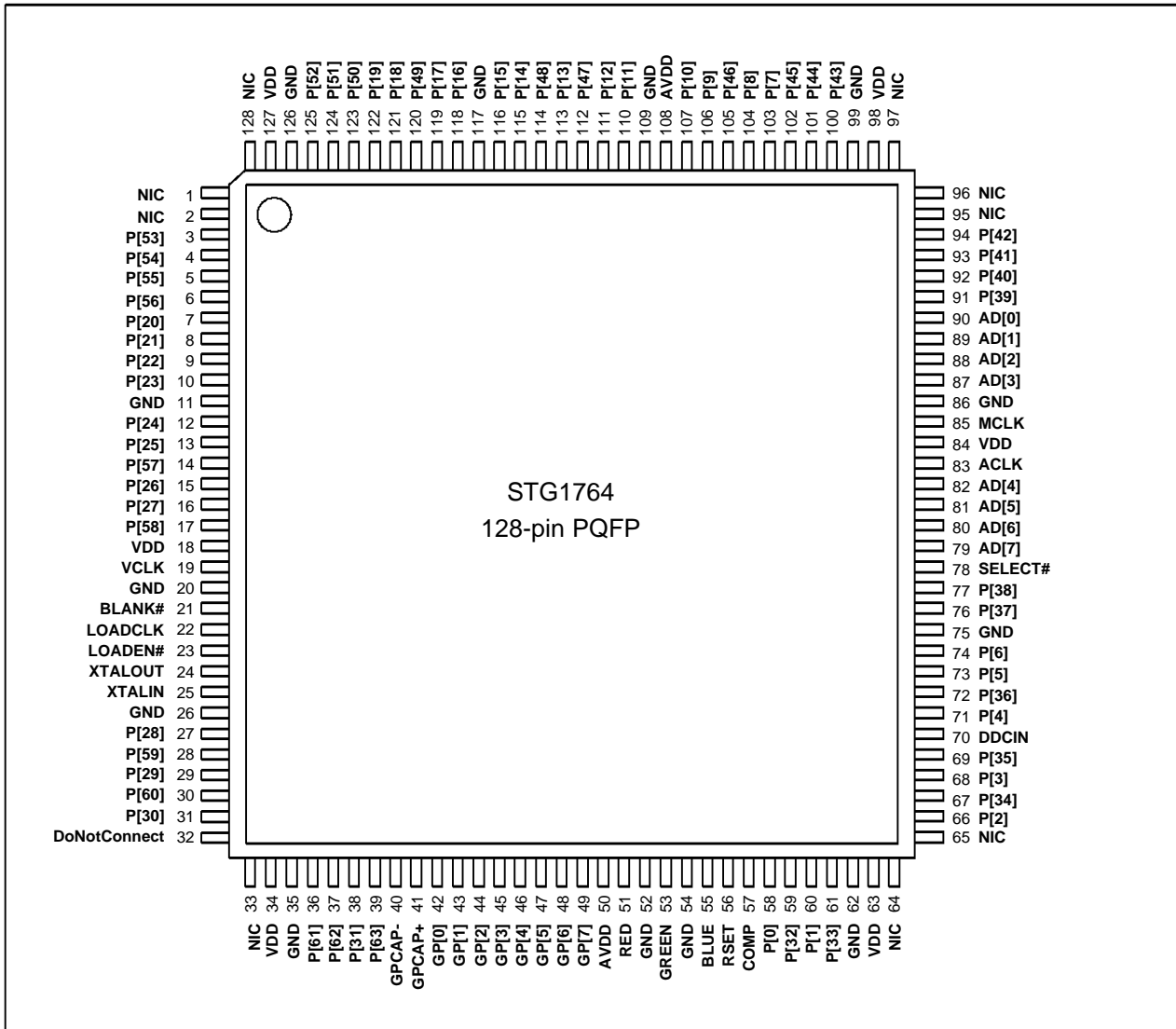
1 DEVICE PINOUTS

1.1 STG1732 PINOUT



STG1732, STG1764

1.2 STG1764 PINOUT



2 PIN DESCRIPTIONS

2.1 STG1732 PIXEL PORT

| Signal | I/O | Description |
|----------------|-----|--|
| P[31:0] | I | The pixel data word. The selected pixel mode determines how this data is interpreted. |
| LOADCLK | I | The rising edge of LOADCLK controls the sampling of pixel data on P[31:0] and LOADEN# in all modes. |
| LOADEN# | I | This signal qualifies the sampling of pixel data. When LOADEN# = 1, the data on P[31:0] on the rising edge of LOADCLK is ignored. |
| BLANK# | I | A '0' sampled on this pin on the rising edge of VCLK will, after the pipeline delay, turn the DAC outputs off. A special protocol on the BLANK# and VCLK pins enables VBLANK to reset various functions of the Palette-DAC at the start of frame flyback. |

2.2 STG1764 PIXEL PORT

| Signal | I/O | Description |
|----------------|-----|--|
| P[63:0] | I | The pixel data word. The selected pixel mode determines how this data is interpreted. |
| LOADCLK | I | The rising edge of LOADCLK controls the sampling of pixel data on P[63:0] and LOADEN# in all modes. |
| LOADEN# | I | This signal qualifies the sampling of pixel data. When LOADEN# = 1, the data on P[63:0] on the rising edge of LOADCLK is ignored. |
| BLANK# | I | A '0' sampled on this pin on the rising edge of VCLK will, after the pipeline delay, turn the DAC outputs off. A special protocol on the BLANK# and VCLK pins enables the STG2000 Multimedia Accelerator to reset various functions of the Palette-DAC at the start of frame flyback. |

2.3 VESA FEATURE CONNECTOR PORT (STG1732 ONLY)

| Signal | I/O | Description |
|----------------|-----|---|
| FO[7:0] | O | Feature connector pixel data outputs. |
| FCLK | O | The rising edge of FCLK validates the sampling of the FBLANK# signal and pixel data outputs on FO[7:0] . |
| FBLANK# | O | Feature connector blanking signal. |

2.4 SYSTEM INTERFACE

| Signal | I/O | Description |
|----------------|-----|---|
| SELECT# | I | This signal when '0' enables write or read accesses to and from the system interface. The falling edge latches a 4-bit address from AD[3:0] and samples AD[7] to identify whether the current cycle is a write (AD[7] = 0) or a read operation (AD[7] = 1). |
| AD[7:0] | I/O | This 8-bit bus is used to present the address and write/read information on the falling edge of SELECT# and to transfer data to and from the internal registers under the control of AD[7] . |

2.5 CLOCK SYNTHESIZERS

| Signal | I/O | Description |
|----------------|-----|---|
| MCLK | O | The Memory Clock synthesizer output. This signal connects to the STG2000 MCLKx2 pin. |
| VCLK | I/O | The Video Clock synthesizer output. This signal is the video frequency at the DACs divided by 1, 2, 4, 8, or 16, depending on the selected mode. In systems containing multiple Palette-DACs, VCLK can be configured as an input, enabling slave devices to be synchronized to the master clock. |
| ACLK | O | The Audio Clock synthesizer output. This signal is used to provide the timing reference to the subsystem audio codec. |
| XTALIN | I | A 12.096MHz series resonant crystal is connected between these two points to provide the reference clock for the synthesizers, see Figure 11, page 19. |
| XTALOUT | O | |

2.6 GAME PORT

| Signal | I/O | Description |
|----------------|-----|--|
| GP[7:0] | I | This 8-bit port interfaces with potentiometers up to 150K Ω and/or SPST switches, to support joysticks. |
| GPCAP+ | - | An external capacitor is connected between GPCAP- and GPCAP+ to contribute to an RC time constant, R being the variable joystick resistance. Example connections for an analog Game Port are given in Section 7. |
| GPCAP- | - | |

2.7 DACS

| Signal | I/O | Description |
|-------------------------|-----|--|
| RED, GREEN, BLUE | O | The DAC outputs. These are designed to drive a doubly terminated 75 Ω load. |
| COMP | - | External compensation capacitor for the DACs. This pin should be connected to AVDD via the compensation capacitor, see Figure 11, page 19. |
| RSET | - | A precision resistor placed between this pin and GND sets the full-scale DAC current, see Figure 11, page 19. |

2.8 VESA DISPLAY DATA CHANNEL PORT

| Signal | I/O | Description |
|--------------|-----|---|
| DDCIN | I | This bit is provided to allow a bitstream monitor ID to be sampled on successive VSync pulses to the display monitor, see Section 5, page 13. |

2.9 POWER SUPPLY

| Signal | I/O | Description |
|-------------|-----|---|
| AVDD | P | Analog power supply for the DACs and PLL. |
| VDD | P | Digital power supply. |
| GND | P | Common GND rail for all circuitry. |
| NIC | - | No internal connection; it is recommended these pins are tied to GND. |

3 SYSTEM INTERFACE

The STG1732 and STG1764 system interface comprises the **SELECT#** signal and an 8-bit multiplexed address and data bus, **AD[7:0]**.

SELECT# connects to pin **CS_DAC#** and **AD[7:0]** connect directly to pins **MDB[15:8]** of the STG2000 Multimedia Accelerator. The system interface pins are described in Section 2.4, page 5.

The register interface of the STG1732 and STG1764 is based on the standard SGS-THOMSON Palette-DAC interface. Four direct access registers are supported.

3.1 SYSTEM INTERFACE REGISTERS

Tables showing register contents include a column indicating if register fields are readable (**R**) or writable (**W**) and the initial power-on or soft reset value of the field (**I**). '-' indicates not readable / writable, X indicates not reset.

Table 1. STG1732 and STG1764 registers

| Address (AD[3:0]) | Register function |
|-------------------|----------------------------------|
| 0000 | Write Palette Address Register |
| 0001 | Color Data Register |
| 0010 | Pixel Mask Register ¹ |
| 0011 | Read Palette Address Register |
| 0100-0111 | Reserved |

NOTE

- 1 The Pixel Mask Register has a power-on and soft reset value of 0xFF

Writing to the Palette

Table 2. Write Palette Address Register 0x0

| Bits | Function | R W I |
|------|-----------------------|-------|
| 7:0 | Current Write Address | R W X |

Table 3. Color Data Register 0x1

| Bits | Function | R W I |
|------|-----------------------|-------|
| 7:0 | R, G or B color value | R W X |

To update the palette the required palette address is first written to the Write Palette Address Register. The R, G and B color values are then written in succession to the Color Data Register following which the Write Palette Address Register is automatically incremented.

Reading from the Palette

Table 4. Read Palette Address Register 0x3

| Bits | Function | R W I |
|------|----------------------|--------------------|
| 7:0 | Current Read Address | R ¹ W X |

NOTE

- 1 In VGA modes the STG2000 replaces these bits with a pair of bits indicating the last Palette Address Register written to. In non-VGA modes the current read address can be read from the STG1732 or STG1764.

To read from the palette the required palette address is first written to the Read Palette Address Register. The R, G and B color values are then read in succession from the Color Data Register following which the Read Palette Address Register is automatically incremented.

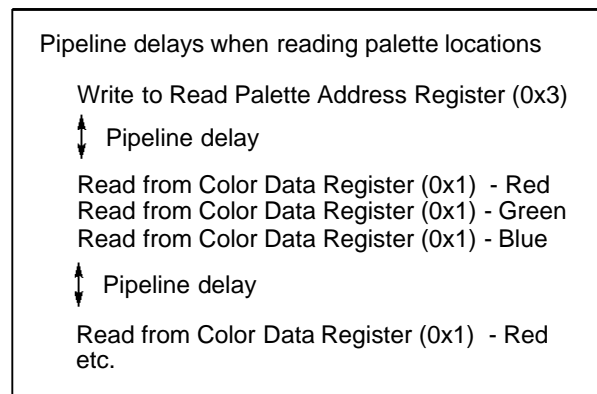
Pixel Mask Register (0x2)

This register provides a bitwise AND function of the Palette Address (8-bit indexed pixels only).

Pipelined registers

The registers used in accessing palette (LUT) locations are affected by read cycle pipeline delays. The position of these delays in a read sequence is shown in Figure 1.

Figure 1. Occurrence of pipeline delays



3.2 SYSTEM INTERFACE TIMING SPECIFICATION

Accesses to the pipelined RAMs - including the 256 location LUT must adhere to the cycle times tCP and tRP as specified below.

Figure 2. System interface read/write cycle

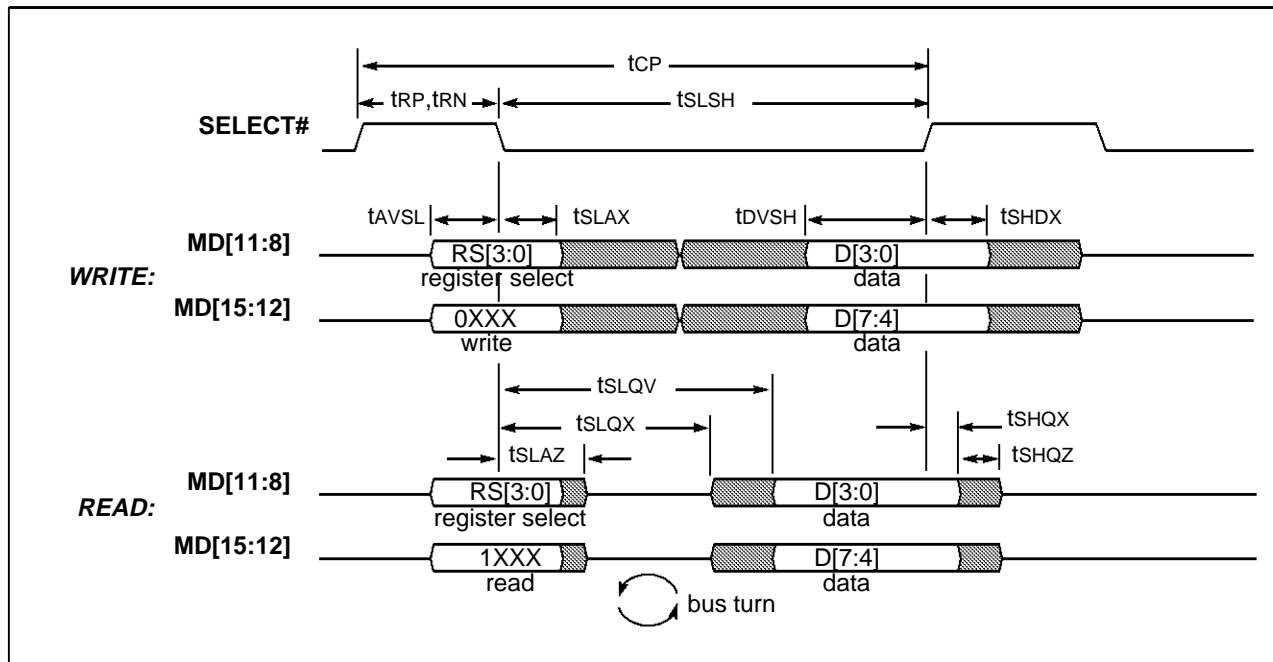


Table 5. System interface timing parameters

| Symbol | Parameter | Min. | Max. | Unit | Notes |
|--------|------------------------------------|------------|------|------|------------------|
| tCP | SELECT# pipeline cycle time | 2×TDCLK+10 | | ns | Write cycle, 1 |
| tRP | SELECT# pipeline recovery time | 6×TDCLK | | ns | Read cycle, 1, 2 |
| tRN | SELECT# non-pipeline recovery time | 30 | | ns | |
| tSLSH | SELECT# pulse time | 50 | | ns | |
| tAVSL | Address setup time | 8 | | ns | |
| tSLAX | Address hold time | 0 | | ns | |
| tDVSH | Write data setup time | 8 | | ns | Write cycle |
| tSHDX | Write data hold time | 0 | | ns | Write cycle |
| tSLAZ | Address tri-state time | | 10 | ns | Read cycle |
| tSLQX | Output turn-on delay | 10 | | ns | Read cycle, 3 |
| tSLQV | Read access time | | 40 | ns | Read cycle, 4 |
| tSHQX | Read data hold time | 5 | | ns | Read cycle, 3 |
| tSHQZ | Output turn-off delay | | 20 | ns | Read cycle |

NOTES

- 1 DCLK is the pixel dot clock period (undivided VCLK)
- 2 Access recovery times are specified as the time before a particular access, because the worst case access (reading a RED palette color value) can occur after either reading a BLUE palette color value or after writing to the Address Register (read mode). The occurrence of pipeline delays when reading palette locations is described on page 7.
- 3 Output load on AD[7:0] = 25pF
- 4 Output load on AD[7:0] = 80pF

4 PIXEL PORT

4.1 VISUALS (BITS PER PIXEL MODES) SUPPORTED

The following descriptions apply to 16 and 32-bit pixel ports. For a 64-bit port, data on pins **P[31:0]** is interpreted as described below for a 32-bit port. Data on pins **P[63:32]** is identical in format and displayed sequentially to that on **P[31:0]**.

4-bit indexed (VGA planar) visual

In the 4-bit indexed planar visual each 32-bit word contains four pixel planes. Each plane contains one bit of each of eight indexed color pixels (p0 to p7 in display order). The least significant bit of each pixel is contained in plane 0, the most significant bit in plane 3. This visual is not supported at pixel rates above 135MHz.

| Use of pixel input pins (32-bit port) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------------------|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| plane 3 | | | | | | | | plane 2 | | | | | | | | plane 1 | | | | | | | | plane 0 | | | | | | | |
| p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 |

For a 16-bit pixel port a 32-bit word is accumulated over two cycles as shown below.

| Use of pixel input pins (16-bit port, 2nd cycle) | | | | | | | | | | | | | | | | Use of pixel input pins (16-bit port, 1st cycle) | | | | | | | | | | | | | | | |
|--|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|--|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| plane 3 | | | | | | | | plane 2 | | | | | | | | plane 1 | | | | | | | | plane 0 | | | | | | | |
| p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p0 | p1 | p2 | p3 | p4 | p5 | p6 | p7 |

8-bit indexed visual

In the 8-bit indexed visual each 32-bit word contains four 8-bit indexed color pixels, each comprising bits b[7:0] as shown below. For a 16-bit port, pixels 0 and 1 are sampled on the 1st cycle and pixels 2 and 3 on the 2nd cycle of the port.

| Use of pixel input pins (32-bit port) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------------------|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|---------|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| pixel 3 | | | | | | | | pixel 2 | | | | | | | | pixel 1 | | | | | | | | pixel 0 | | | | | | | |
| b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |

16-bit visual

In 16-bit visuals, when PixMix mode is enabled, the PixMix bit (bit 15 of each pixel) selects whether pixel data bypasses the LUT, to feed the DACs directly, or indirectly, through the LUT, to allow pseudo color indexing or gamma correction to be applied. If PixMix mode is not enabled then the bypass mode will always be selected, and the LUT powered down. The LUT must therefore be reprogrammed if PixMix is re-enabled.

STG1732, STG1764

For a 16-bit port a single pixel is sampled for each cycle, for a 32-bit port two pixels are sampled for each cycle as shown below. This table indicates the effect of the PixMix bit when PixMix mode is enabled.

| Indexed or direct color mode | Use of pixel input pins (32-bit port) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------------|---------------------------------------|------------|----|----|----|----|--------------|----|---------------|----|----|-------------|----|----|----|----|---------|------------|----|----|----|----|--------------|---|---|---|---|-------------|---|---|---|---|---|---|---|---|---------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | Pixel 1 | | | | | | | | | | | | | | | | Pixel 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | | | | | | | | | | | |
| Direct | 0 | Red gamma | | | | | Green gamma | | | | | Blue gamma | | | | | 0 | Red gamma | | | | | Green gamma | | | | | Blue gamma | | | | | | | | | | | | | | | | | | | | | | | | |
| X | 1 | Red bypass | | | | | Green bypass | | | | | Blue bypass | | | | | 1 | Red bypass | | | | | Green bypass | | | | | Blue bypass | | | | | | | | | | | | | | | | | | | | | | | | |
| Indexed | 0 | X | X | X | X | X | X | X | Indexed color | | | | | | | | | | | | | | | | 0 | X | X | X | X | X | X | X | X | X | X | X | Indexed color | | | | | | | | | | | | | | | |

32-bit visual

In 32-bit visuals, when PixMix mode is enabled, the PixMix bit (bit 31 of each pixel) selects whether pixel data bypasses the LUT, to feed the DACs directly, or indirectly, through the LUT, to allow pseudo color indexing or gamma correction to be applied. If PixMix mode is not enabled then the bypass mode will always be selected, and the LUT powered down. The LUT must therefore be reprogrammed if PixMix is re-enabled.

For a 16-bit port bits [15:0] of each pixel are sampled on the first cycle and bits [31:16] on the second cycle of the port. This table indicates the effect of the PixMix bit when PixMix mode is enabled.

| Indexed or direct color mode | Use of pixel input pins (32-bit port) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------------|---------------------------------------|----|------------|----|----|----|----|----|----|----|--------------|----|-------------|----|----|----|----|----|-------------|----|----|----|------------|---|---|---|---------------|---|---|---|---|---|--|--|--|--|--|--|--|--|--|--|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | |
| Direct | 0 | X | Red gamma | | | | | | | | X | X | Green gamma | | | | | | | | X | X | Blue gamma | | | | | | | | X | X | | | | | | | | | | |
| X | 1 | X | Red bypass | | | | | | | | Green bypass | | | | | | | | Blue bypass | | | | | | | | | | | | | | | | | | | | | | | |
| Indexed | 0 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | Indexed color | | | | | | | | | | | | | | | |

Pixel mapping to the LUT and DACs

In the 16-bit visual, with gamma correction selected, each 5-bit color value is expanded to an 8-bit LUT address as shown below:

| | | | | | | | | |
|-------------------|---|---|---|---|---|---|---|---|
| Color value [4:0] | 4 | 3 | 2 | 1 | 0 | 4 | 3 | 2 |
| LUT input [7:0] | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

In indexed color and gamma corrected visuals, the LUT outputs an 8-bit color value mapping to the 10-bit DAC input as shown below:

| | | | | | | | | | | |
|-------------------|---|---|---|---|---|---|---|---|---|---|
| Color value [7:0] | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 7 | 6 |
| DAC input [9:0] | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

In the direct (LUT bypass) modes each 5-bit color value maps to the 10-bit DAC as shown below:

| | | | | | | | | | | |
|-------------------|---|---|---|---|---|---|---|---|---|---|
| Color value [4:0] | 4 | 3 | 2 | 1 | 0 | 4 | 3 | 2 | 1 | 0 |
| DAC input [9:0] | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Support for visuals at different pixel rates

| Visual (bpp) | Pixel rate (MHz) | | | |
|--------------|------------------|-----|-----|------|
| | 50 | 100 | 135 | 170* |
| 4 | ✓ | ✓ | ✓ | |
| 8 | ✓ | ✓ | ✓ | • |
| 16 | ✓ | ✓ | • | • |
| 32 | ✓ | • | | |

NOTES

✓ = Supported by STG1732 and STG1764

• = Supported by STG1764

* STG1764-170, preliminary only

4.2 PIXEL PORT TIMING SPECIFICATION

Figure 3. Pixel port timing diagram

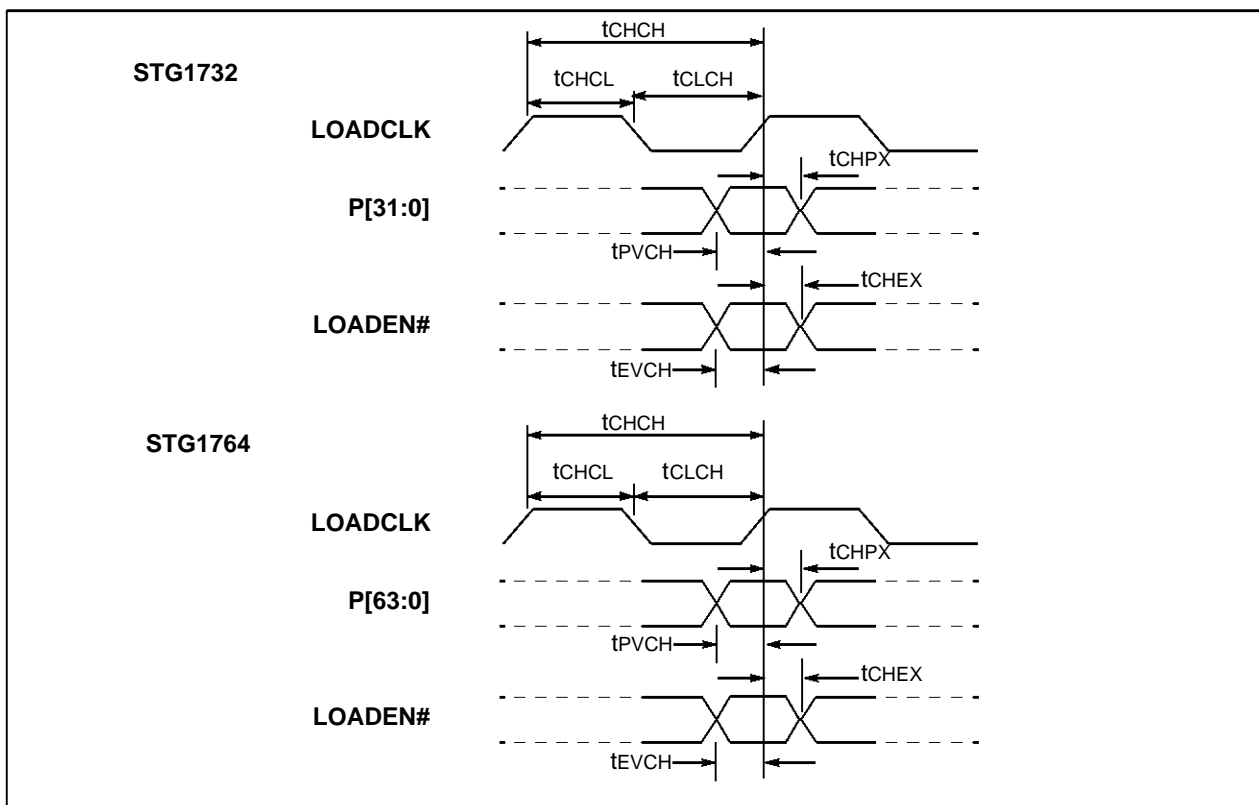


Table 6. Pixel port timing parameters

| Symbol | Parameter | Min. | Max. | Units | Notes |
|--------|------------------------|------|------|-------|-------|
| tCHCH | LOADCLK period | 20.0 | | ns | |
| tCLCH | LOADCLK low time | 6.0 | | ns | |
| tCHCL | LOADCLK high time | 5.0 | | ns | |
| tPVCH | Pixel data set-up time | 3.0 | | ns | |
| tCHPX | Pixel data hold time | 1.0 | | ns | |
| tEVCH | LOADEN# set-up time | 3.0 | | ns | |
| tCHEX | LOADEN# hold time | 1.0 | | ns | |

VBLANK detection

The start of frame flyback (VBLANK) is detected through a special protocol on the **BLANK#** pin. This protocol, shown in Figure 4, comprises the sequence 010, sampled on the **BLANK#** pin on successive rising edges of VCLK.

When VBLANK is detected the internal FIFO pointers and cursor position are reset. These actions can also be triggered through the VBLANK Control Register in extended register space.

Figure 4. VBLANK detection protocol

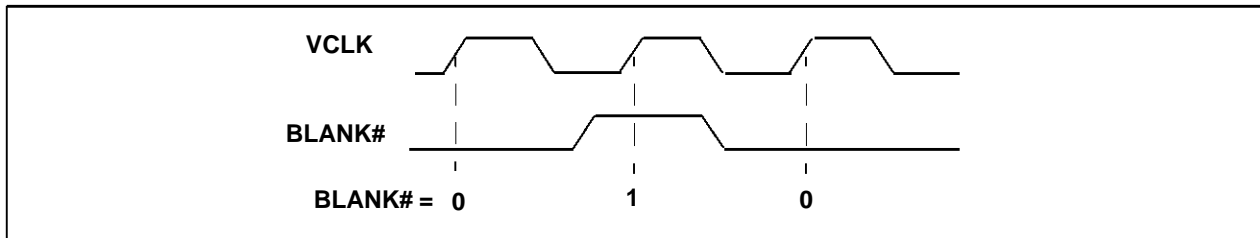


Figure 5. VBLANK detection timing diagram

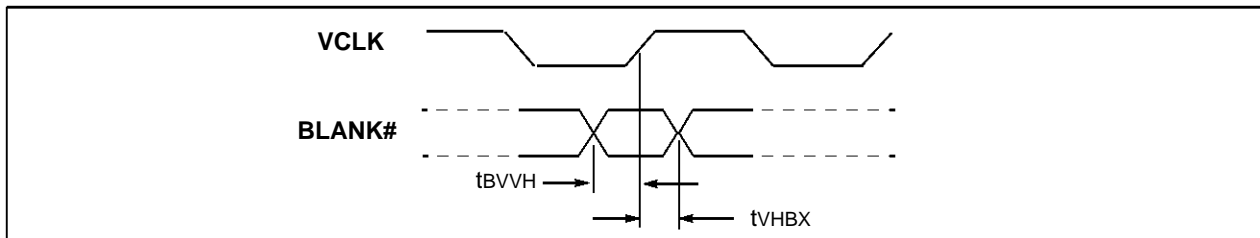


Table 7. VBlank detection timing parameters

| Symbol | Parameter | Min. | Max. | Units | Notes |
|--------|---------------------------|------|------|-------|-------|
| tBVVH | BLANK# set-up time | 2.0 | | ns | |
| tvHBX | BLANK# hold time | 2.0 | | ns | |

4.3 PIXEL FIFO

The FIFO provides buffering of pixel data latched in on **LOADCLK**, ready to be read out into the pixel pipeline under control of **BLANK#**. The internal core word width of the FIFO is 128 bits and therefore pixels are accumulated until 128 bits have been latched (2x64bits, 4x32 bits, or 8x16-bit pixel port load cycles) and then written into the core. The FIFO write is pipelined, so that to be able to read (display) all the required pixels from the FIFO, some extra 'dummy' **LOADCLK** cycles must be performed, after building the last complete 128-bit word, to flush the required data to be written into the core. A different number of extra **LOADCLK** cycles is required for each pixel port width mode, as shown in Table 8.

Table 8. Extra **LOADCLK** cycles required by the pixel FIFO

| Pixel port width | 16 | 32 | 64 |
|--------------------------------------|----|----|----|
| Extra LOADCLK cycles required | 5 | 3 | 2 |

Reading data from the FIFO is controlled by **BLANK#** and occurs in 32-bit words. This places a limitation on the resolution of the line length that **BLANK#** can control. If the VCLK is configured to be a divided ratio of the pixel dot clock then the resolution is further reduced by a factor of the divide ratio. Table 9 shows the number of pixels of which the displayed line length must be a multiple of for each of the visuals, for a VCLK divide ratio of 1.

Table 9. Permitted line length multiples

| Visual (width) | 4 | 8 | 16 | 32 |
|---|---|---|----|----|
| Number of pixels that the line length must be a multiple of | 8 | 4 | 2 | 1 |

5 SAMPLING OF DDCIN

Figure 6. DDCIN timing diagram

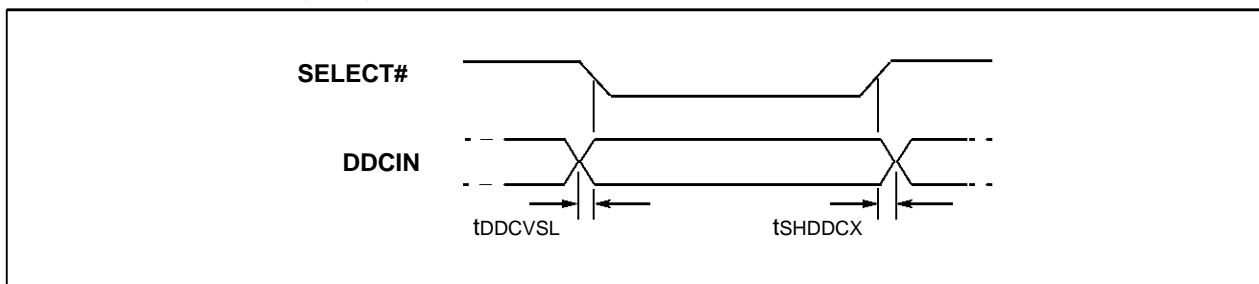


Table 10. DDCIN timing parameters

| Symbol | Parameter | Min. | Max. | Units | Notes |
|---------|------------------|------|------|-------|-------|
| tDDCVSL | DDCIN setup time | 0 | | ns | |
| tSHDDCX | DDCIN hold time | 0 | | ns | |

6 VESA FEATURE CONNECTOR PORT (STG1732 ONLY)

Figure 7. VESA Feature connector port timing diagram

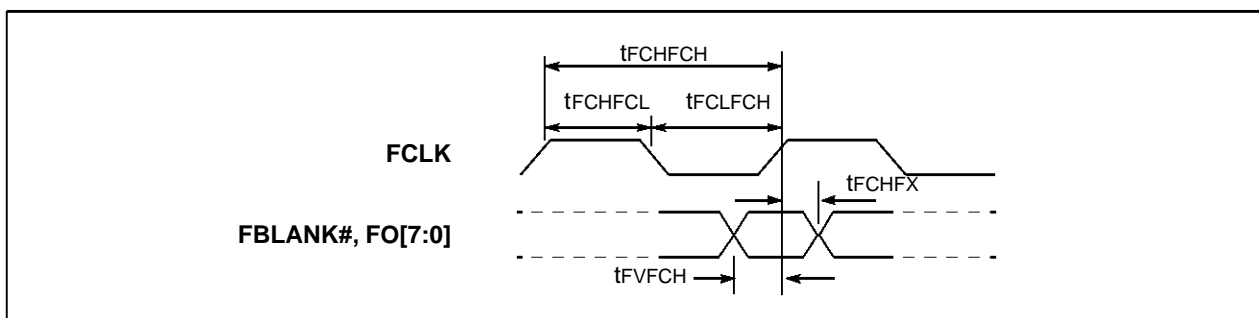


Table 11. VESA Feature connector port timing parameters

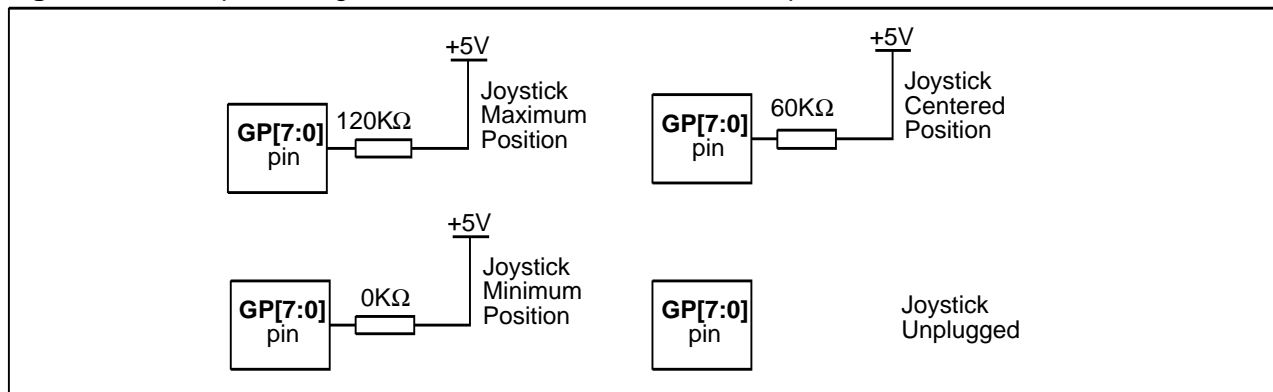
| Symbol | Parameter | Min. | Max. | Units | Notes |
|---------|------------------------|------|------|-------|-------|
| tFCHFCH | FCLK period | 35.0 | | ns | |
| tFCLFCH | FCLK low time | 14.0 | | ns | |
| tFCHFCL | FCLK high time | 14.0 | | ns | |
| tFVFCH | Pixel data set-up time | 10.0 | | ns | |
| tFCHFCH | Pixel data hold time | 2.0 | | ns | |

7 GAME PORT

The Game Port supports a high level of flexibility and accuracy when interfacing to external devices such as joysticks, throttle, pedals and/or switches. An external peripheral connected to any of the eight channels is capable of being measured as either an analog or digital device.

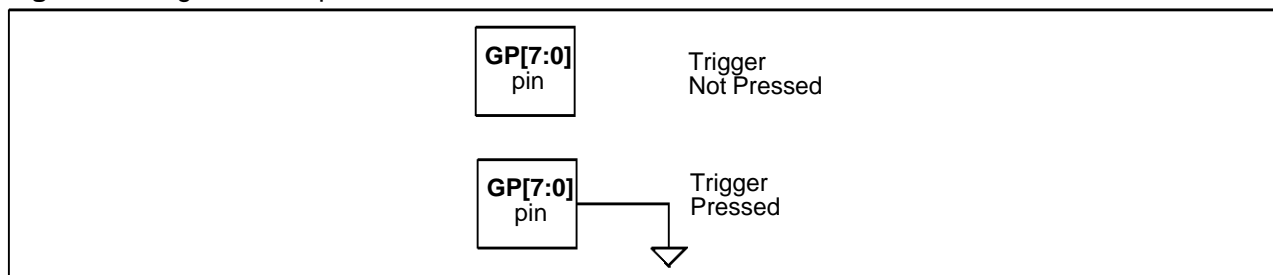
When a channel is an analog input, its pin is connected to the variable part of a joystick, throttle or pedals which are connected to VDD through a potentiometer (see Section 8.3). As the position changes, the potentiometer varies between its maximum resistance and zero ohms. An external capacitor connected between **GPCAP+** and **GPCAP-** is charged to VDD through the potentiometer. The varying resistance contributes to a variation in the RC time constant of the circuit.

Figure 8. Example analog Game Port conditions for a 120KΩ potentiometer



When a channel is a digital input, its pin is connected to a SPST switch to ground. If the trigger is not pressed the pin will be left floating. If the trigger is pressed the pin will be shorted to ground.

Figure 9. Digital Game port conditions



The ‘Joystick Unplugged’ and the ‘Trigger Not Pressed’ conditions are the same. When in this state the pin will be considered a digital input, since it is definitely known that a potentiometer is not connected, even though it is not known if a digital peripheral is attached.

The game port is accessible through two mechanisms known as the Real Mode Game Port or the High-Precision Game Port.

7.1 REAL MODE GAME PORT

The STG1732 and STG1764 Real Mode Game Port emulates and provides compatibility with the existing IBM Game Port standard. In this case the Palette-DAC Real Mode Game Port Register is mapped into I/O location 0x201 by the STG2000. This register allows existing DOS game applications to run with the STG2000 Multimedia Accelerator without modification. Details of the Real Mode Game Port Register are given in the STG2000 Datasheet [2].

7.2 HIGH-PRECISION GAME PORT

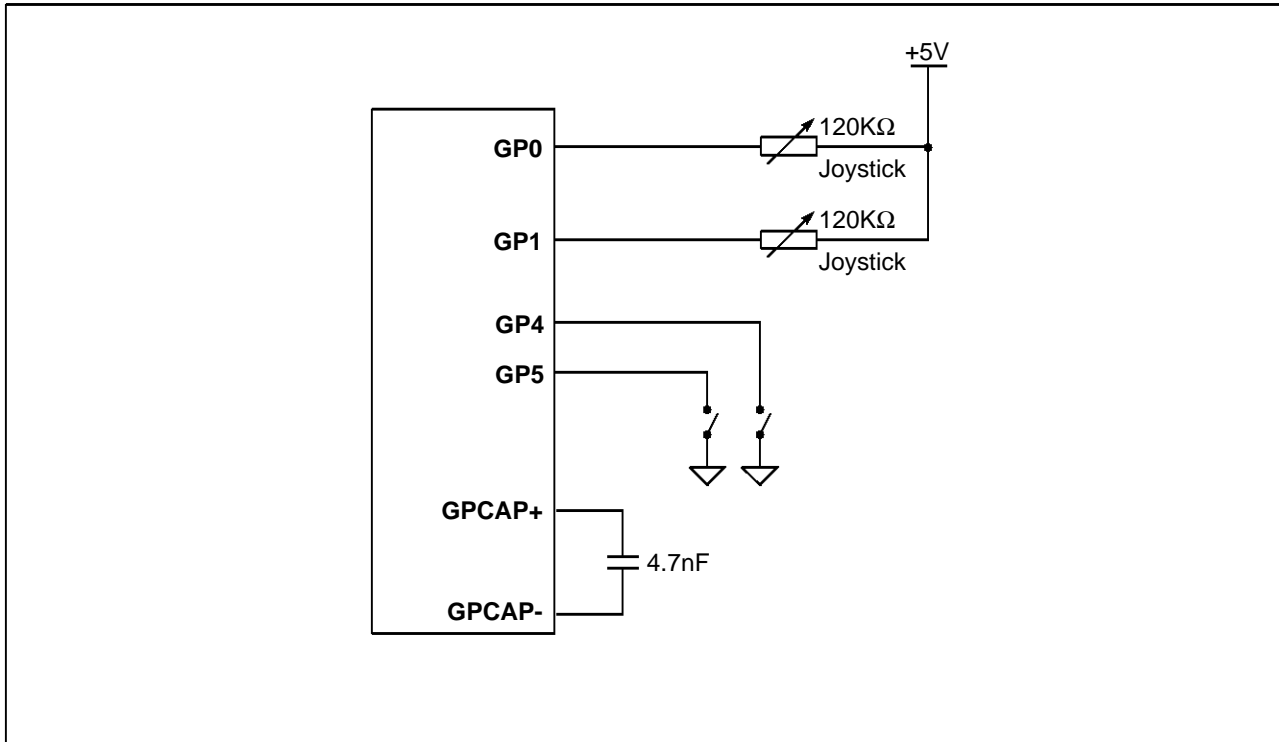
The High-Precision Game Port is accessed through the STG2000 programming interface (see [3] for details). It releases from the CPU the task of timing and polling the analog channels of the Real Mode Game Port. The capture logic in the Game Port continually updates all channels (up to 8 analog registers) with

new values. Additional flexibility is provided by allowing any of the 8 channels to be used for analog or digital measurement. The Game Port detects which channels are analog and which are digital and reports this to the application. The relevant values for each channel can then be read.

When the Game Port is capturing the analog input from a selected **GP[7:0]** pin, the crystal clock is used as a timing reference (see Section 8.3, page 17).

7.3 ANALOG GAME PORT CONNECTIONS

Figure 10. Example analog Game Port connections for a 120K Ω potentiometer (joystick)



8 ELECTRICAL SPECIFICATIONS
8.1 ABSOLUTE MAXIMUM RATINGS¹

| Symbol | Parameter | Min. | Max. | Units | Notes |
|----------|--|---------|---------|-------|-------|
| VDD/AVDD | DC supply voltage | | 7.0 | V | |
| | Voltage on input and output pins | GND-1.0 | VDD+0.5 | V | |
| TS | Storage temperature (ambient) | -55 | 125 | °C | |
| TA | Temperature under bias | 0 | 85 | °C | |
| PDmax | Power dissipation | | 2.5 | W | |
| | Analog output current (per output) | | 45 | mA | |
| | DC digital output current (per output) | | 25 | mA | |

NOTES

- 1 Stresses greater than those listed under 'Absolute maximum ratings' may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
- 2 For thermal management information on the STG1732 and STG1764 refer to [6].

8.2 DAC CHARACTERISTICS

| Parameter | Min. | Typ. | Max. | Units | Notes |
|---------------------------------|-------|-------|-------|------------------|---------|
| Resolution | | 10 | | bits | |
| DAC operating frequency | | | 135 | MHz | 1 |
| DAC operating frequency | | | 170 | MHz | 2 |
| White relative to Black current | 16.74 | 17.62 | 18.50 | mA | 3 |
| DAC to DAC matching | | ±1 | ±2.5 | % | 3,5 |
| Integral linearity | | ±0.5 | ±1.5 | LSB ₈ | 3,4,9 |
| Differential linearity | | ±0.25 | ±1 | LSB ₈ | 3,4,9 |
| DAC output voltage | | | 1.2 | V | 3 |
| DAC output impedance | | 20 | | kΩ | |
| Risetime (black to white level) | | 1 | 3 | ns | 3,6,7 |
| Settling time (black to white) | | | 7.4 | ns | 1,3,6,8 |
| Settling time (black to white) | | | 5.9 | ns | 2,3,6,8 |
| Glitch energy | | 50 | 100 | pVs | 3,6 |
| Comparator trip voltage | 280 | 335 | 420 | mV | |
| Comparator settling time | | | 100 | μs | |
| Internal Vref voltage | | 1.235 | | V | |
| Internal Vref voltage accuracy | | ±3 | ±5 | % | |

NOTES

- 1 STG1732-135 and STG 1764-135
- 2 STG1764-170, preliminary only
- 3 VREF = 1.235V, RSET = 147Ω
- 4 LSB₈ = 1 LSB of 8-bit resolution DAC
- 5 About the midpoint of the distribution of the three DACs
- 6 37.5ohm, 30pF load
- 7 10% to 90%
- 8 Settling to within 2% of full scale deflection
- 9 Monotonicity guaranteed

8.3 GAMEPORT CHARACTERISTICS

| Symbol | Parameter | Min | Typ. | Max | Units | Notes |
|------------------------------|---|--------|--------|--------|-------|---------|
| RPT_GP | Analog capture repeatability | 8 | 10 | | bits | 1, 2, 3 |
| VT_GP | Analog comparator switching threshold | 0.4VDD | 0.5VDD | 0.6VDD | V | |
| IIL_GP | GP[7:0] input leakage current | | | ±100 | µA | |
| IPULLUP_GP | GP[7:0] digital mode pullup current | 0.15 | | 5 | mA | |
| VIH_GP | GP[7:0] digital mode VIH | 0.8VDD | | | V | |
| VIL_GP | GP[7:0] digital mode VIL | | | 0.2VDD | V | |
| I _{CHARGE_GPCAP} | GPCAP+ / GPCAP- capacitor charge current | 0.5 | | 5 | mA | |
| I _{DISCHARGE_GPCAP} | GPCAP+ / GPCAP- capacitor discharge current | 0.2 | | 2 | mA | |

NOTES

- Each analog channel returns 16 bits, which may be read by software, of which 13-bits are updated by the Game Port capture logic.
- Crystal clock frequency = 12.096MHz (each channel captured once per frame at 90Hz).
- GPCAP+**/**GPCAP-** capacitor = 4.7nF

8.4 FREQUENCY SYNTHESIS CHARACTERISTICS

| Parameter | Min | Typ. | Max | Units | Notes |
|--|-----|------|-----|-------|-------|
| XTALIN crystal frequency range | 4 | | 20 | MHz | |
| Internal VCO frequency | 64 | | 135 | MHz | 1 |
| Internal VCO frequency | 64 | | 170 | MHz | 2 |
| VCLK output frequency | | | 50 | MHz | 3 |
| MCLK output frequency | | | 100 | MHz | 3 |
| ACLK output frequency | | | 25 | MHz | 3 |
| Synthesizer lock time | | | 500 | µs | |
| VCLK, MCLK, ACLK rise time | | | 4 | ns | 3 |
| VCLK, MCLK, ACLK fall time | | | 4 | ns | 3 |
| VCLK, MCLK, ACLK mark space ratio | | 50 | | % | |

NOTES

- STG1732-135 and STG1764-135
- STG1764-170, preliminary only
- C_{load}=15pF

8.5 VCLK INPUT CHARACTERISTICS

| Symbol | Parameter | Min. | Typ. | Max. | Units | Notes |
|-------------------|-----------------------------|------|------|------|-------|-------|
| tv _{VH} | VCLK input frequency | 20 | | | ns | 1 |
| t _{VLVH} | VCLK low time | 7 | | | ns | |
| t _{VHVL} | VCLK high time | 5 | | | ns | |

NOTE

- VCLK** assigned as an input

8.6 PIPELINE DELAYS

| Parameter | Typ. | Notes |
|-------------------------------|--|-------|
| Pipeline delay (4bpp, 8bpp) | $(3 \times \text{VCLK periods}) + (16 \times \text{Pixel clock periods}) + 7\text{ns}$ | 1 |
| Pipeline delay (16bpp, 32bpp) | $(3 \times \text{VCLK periods}) + (15 \times \text{Pixel clock periods}) + 7\text{ns}$ | 1 |

NOTE

- 1 Measured from the rising edge of VCLK (with **BLANK#** sampled high) to the occurrence of the related pixel data on the DACs.

8.7 DC CHARACTERISTICS

| Symbol | Parameter | Min. | Typ. | Max. | Units | Notes |
|--------|---|------|------|------|-------|-------|
| IDD | Average power supply current (135MHz) | | 270 | 340 | mA | 1 |
| IDD | Average power supply current (170MHz) | | 310 | 390 | mA | 2 |
| IDDP | Average power supply current (palette RAM powered down, 135MHz) | | 220 | | mA | 1 |
| IDDP | Average power supply current (palette RAM powered down, 170MHz) | | 260 | | mA | 2 |
| IDDS | Average power supply current (sleep mode) | | 60 | | mA | 3 |
| IIN | Digital input current | | | ±100 | µA | |
| IOZ | Off state digital output current | | | ±50 | µA | |
| VOH | Output logic 1 level | 2.4 | | | V | 4 |
| VOL | Output logic 0 level | | | 0.4 | V | 4 |

NOTES

- 1 Typ. and max. figures both measured at 135MHz, with differences due to VDD, pixel mode and part to part variations.
- 2 Typ. and max. figures both measured at 170MHz, with differences due to VDD, pixel mode and part to part variations. (STG1764-170, preliminary only)
- 3 Typ. figure measured at 35MHz, with differences due to VDD, pixel mode and part to part variations.
- 4 $I_{load} = 5\text{mA}$

8.8 OPERATING CONDITIONS

| Symbol | Parameter | Min. | Typ. | Max. | Units | Notes |
|--------|-------------------------------|------|------|---------|-------|-------|
| VDD | Positive supply voltage | 4.75 | 5.0 | 5.25 | V | 1 |
| VIH | Input logic 1 voltage | 2.2 | | VDD+0.5 | V | |
| VIL | Input logic 0 voltage | -0.5 | | 0.8 | V | |
| TA | Ambient operating temperature | | 25 | 70 | °C | |

NOTE

- 1 These voltage ranges apply equally for AVDD and VDD.

9 ANALOG INTERFACE

Figure 11. Recommended circuit

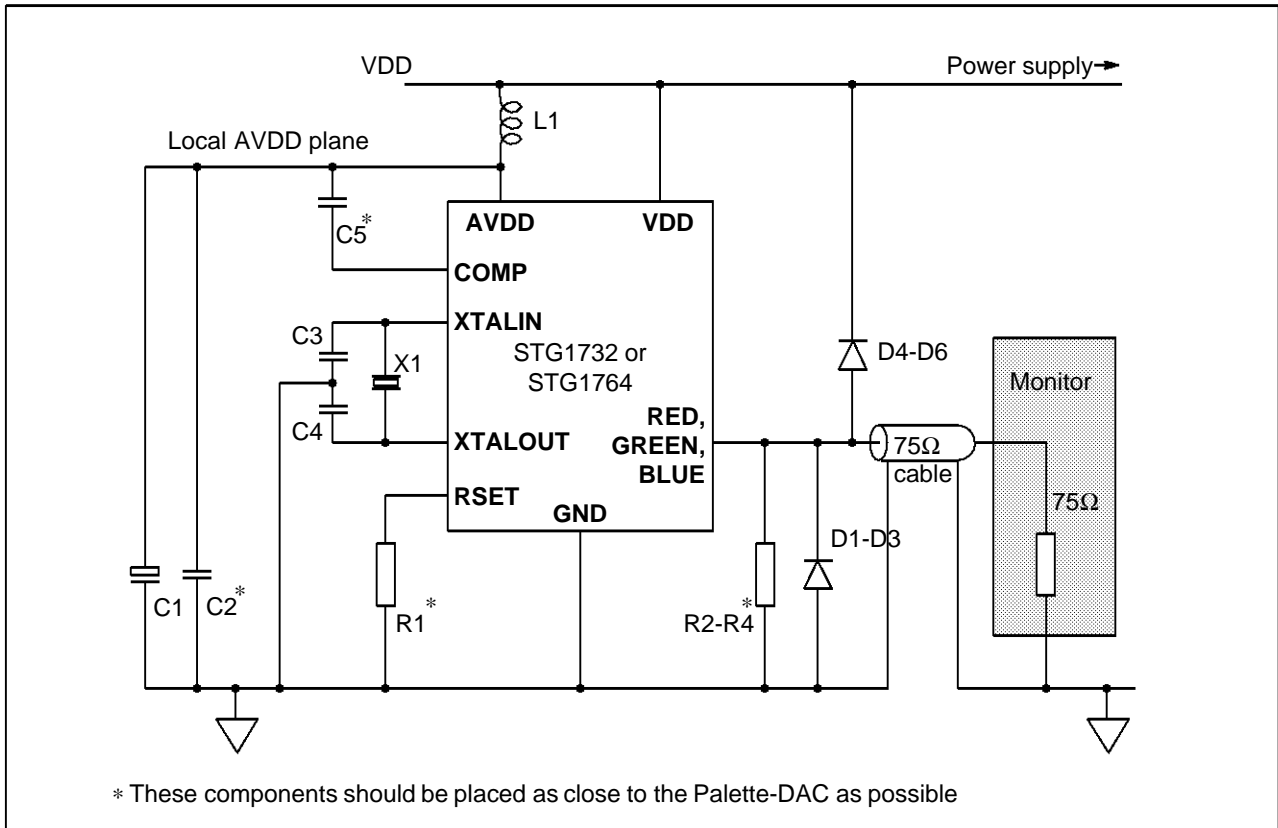


Table 12. Table of parts for recommended circuit (Figure 11)

| Part number | Value | Description |
|-------------|--------------|-------------------------|
| C1 | 22 μ F | tantalum capacitor |
| C2 | 100nF | surface mount capacitor |
| C3-C4 | 22pF | surface mount capacitor |
| C5 | 10nF | surface mount capacitor |
| R1 | 147 Ω | 1% resistor |
| R2-R4 | 75 Ω | 1% resistor |
| D1-D6 | 1N4148 | protection diodes |
| L1 | 1 μ H | inductor |
| X1 | 12.096MHz | series resonant crystal |

10 PACKAGE DIMENSIONS

Table 13. STG1732 100-pin Plastic Quad Flat Pack dimensions

| REF. (see Figure 12) | CONTROL DIMENSIONS - mm | | | ALTERNATIVE DIMENSIONS - inches | | | NOTES |
|----------------------------|-------------------------|--------|--------|---------------------------------|-------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| A | - | - | 3.400 | - | - | 0.134 | |
| A1 | 0.100 | - | - | 0.004 | - | - | |
| A2 | 2.540 | 2.800 | 3.050 | 0.096 | 0.110 | 0.120 | |
| B | 0.220 | - | 0.380 | 0.009 | - | 0.015 | |
| C | 0.130 | - | 0.230 | 0.005 | - | 0.009 | |
| D | 22.950 | - | 24.150 | 0.904 | - | 0.951 | |
| D1 | 19.900 | 20.000 | 20.100 | 0.783 | 0.787 | 0.791 | |
| D3 | - | 18.850 | - | - | 0.742 | - | REF |
| E | 16.950 | - | 18.150 | 0.667 | - | 0.715 | |
| E1 | 13.900 | 14.000 | 14.100 | 0.547 | 0.551 | 0.555 | |
| E3 | - | 12.350 | - | - | 0.486 | - | REF |
| e | - | 0.650 | - | - | 0.026 | - | BSC |
| G | - | - | 0.100 | - | - | 0.004 | |
| θ | 0° | - | 7° | 0° | - | 7° | |
| L | 0.650 | 0.800 | 0.950 | 0.026 | 0.031 | 0.037 | |
| Zd | - | 0.580 | - | - | 0.023 | - | REF |
| Ze | - | 0.830 | - | - | 0.033 | - | REF |

NOTES

- 1 Lead finish to be 85 Sn/15 Pb solder plate.
- 2 Maximum lead displacement from the notional center line will be no greater than ± 0.125 mm.

Figure 12. STG1732 100-pin Plastic Quad Flat Pack dimension reference

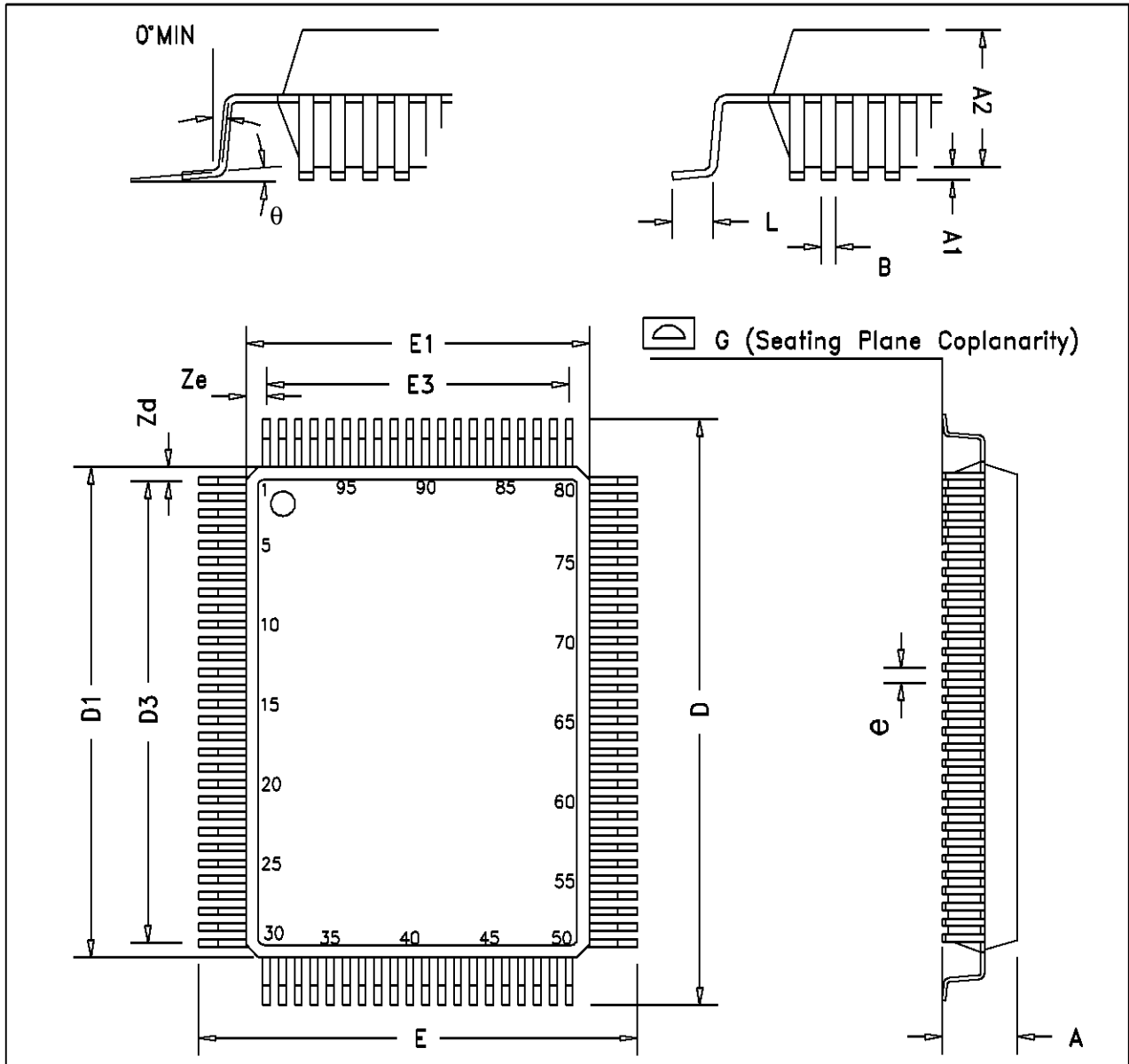


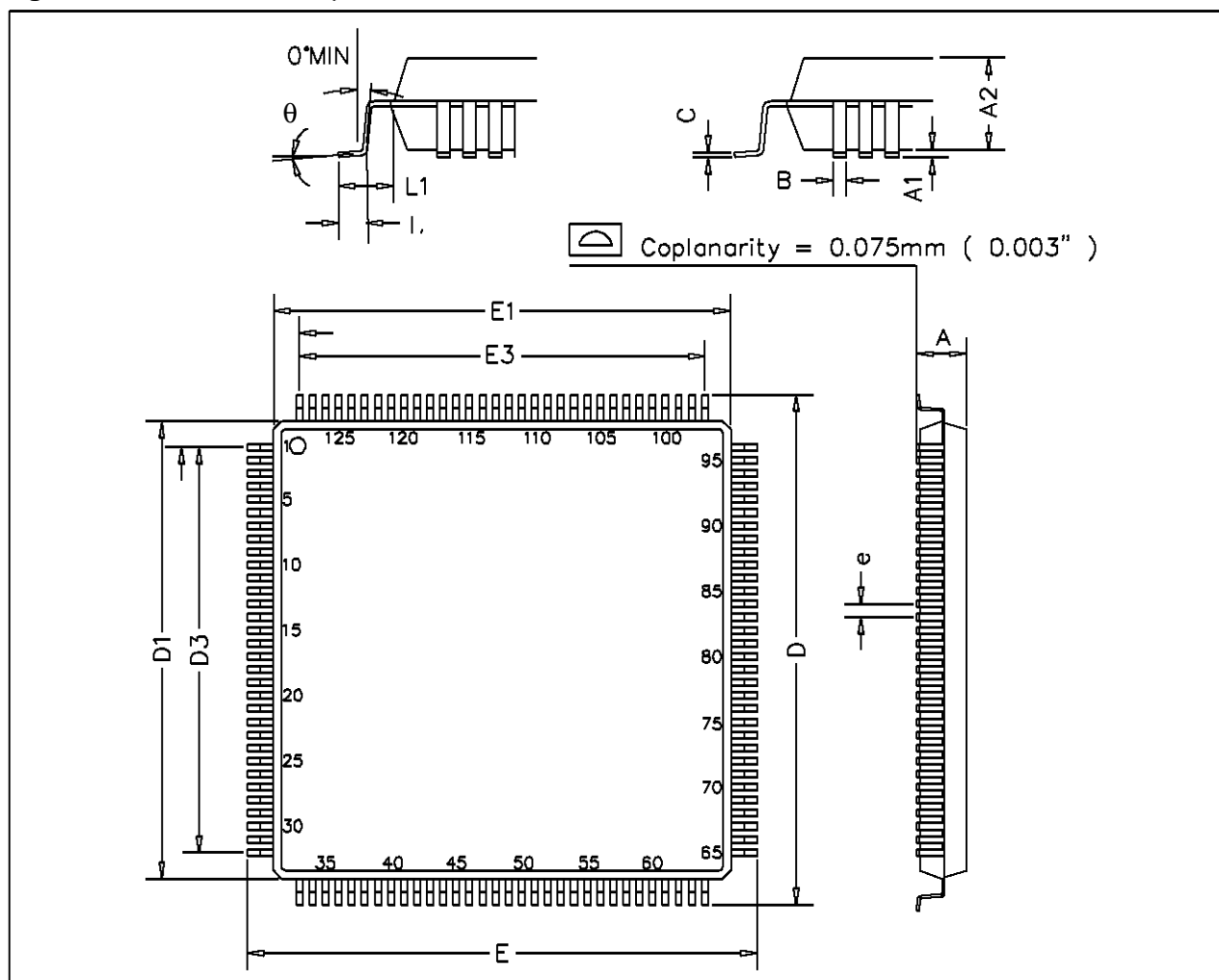
Table 14. STG1764 128-pin Plastic Quad Flat Pack dimensions

| REF. (see Figure 13) | CONTROL DIMENSIONS - mm | | | ALTERNATIVE DIMENSIONS - inches | | | NOTES |
|----------------------------|-------------------------|-------|-------|---------------------------------|-------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| A | - | - | 4.07 | - | - | 0.160 | |
| A1 | 0.25 | - | - | 0.010 | - | - | |
| A2 | 3.17 | 3.42 | 3.67 | 0.125 | 0.135 | 0.144 | |
| B | 0.30 | - | 0.45 | 0.012 | - | 0.018 | |
| c | 0.13 | - | 0.23 | 0.005 | - | 0.009 | |
| D | 30.95 | 31.20 | 31.45 | 1.219 | 1.228 | 1.238 | |
| D1 | 27.90 | 28.00 | 28.10 | 1.098 | 1.102 | 1.106 | |
| D3 | - | 24.80 | - | - | 0.976 | - | REF |
| e | - | 0.80 | - | - | 0.031 | - | BSC |
| E | 30.95 | 31.20 | 31.45 | 1.219 | 1.228 | 1.238 | |
| E1 | 27.90 | 28.00 | 28.10 | 1.098 | 1.102 | 1.106 | |
| E3 | - | 24.80 | - | - | 0.976 | - | REF |
| L | 0.65 | 0.80 | 0.95 | 0.026 | 0.031 | 0.037 | |
| L1 | - | 1.60 | -- | - | 0.063 | - | |
| θ | 0° | - | 7° | 0° | - | 7° | |

NOTES

- 1 Lead finish to be 85 Sn/15 Pb solder plate.
- 2 Maximum lead displacement from the notional center line will be no greater than ± 0.125 mm.

Figure 13. STG1764 128-pin Plastic Quad Flat Pack dimension reference



11 REFERENCES

- 1 STG1732 and STG1764 *Palette-DAC Datasheet*, SGS-THOMSON, June 1995, SGS-THOMSON Document Number: 42 1648 02 (this document)
- 2 STG2000 *Multimedia Accelerator Datasheet*, SGS-THOMSON Microelectronics, June 1995, SGS-THOMSON Document Number: 42 1653 02
- 3 *NVidia Technical Reference*, NVidia Corporation, June 1995, NVidia Document Number: DOC-03-STN
- 4 *NV Architecture Overview*, NVidia Corporation, June 1995, NVidia Document Number: DOC-03-SUN
- 5 *Programming NV*, NVidia Corporation, June 1995, NVidia Document Number: DOC-03-SPN
- 6 *Reference Design Kit (RDK), Design Guide*, SGS-THOMSON Microelectronics, June 1995, SGS-THOMSON Document Number: 72 OEK 290 00

12 ORDERING INFORMATION

| Device | Max. pixel rate | Package | Part number |
|---------|-----------------|--------------|--------------|
| STG1732 | 135MHz | 100 pin PQFP | STG1732X-13 |
| STG1764 | 135MHz | 128 pin PQFP | STG1764X-13 |
| STG1764 | 170MHz | 128 pin PQFP | STG1764X-17* |

* STG1764X-17 is preliminary only

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