

## Programmable Frequency Generator & Integrated Buffers for Pentium III Processor

### Recommended Application:

Single chip clock solution for IA platform.

### Output Features:

- 3 - CPU @ 2.5V
- 13 - SDRAM @ 3.3V
- 6 - PCI @ 3.3V,
- 2 - AGP @ 3.3V
- 1 - 48MHz, @3.3V fixed.
- 1 - 24/48MHz, @3.3V selectable by I<sup>2</sup>C (Default is 24MHz)
- 2 - REF @3.3V, 14.318MHz.

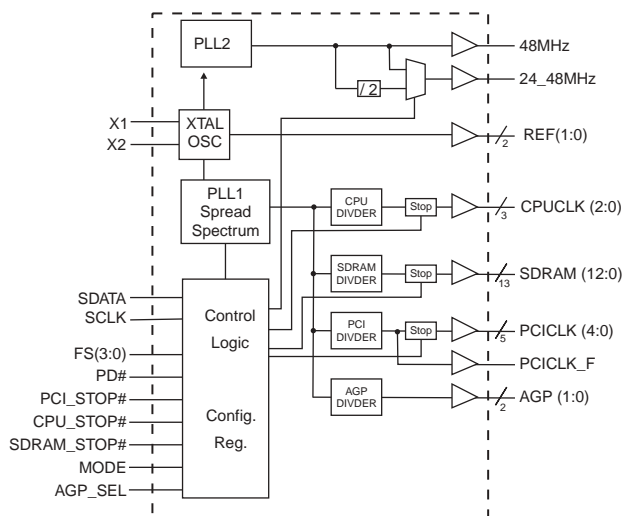
### Features:

- Programmable output frequency.
- Programmable output rise/fall time.
- Programmable SDRAM and CPU skew.
- Spread spectrum for EMI control typically by 7dB to 8dB, with programmable spread percentage.
- Watchdog timer technology to reset system if over-clocking causes malfunction.
- Uses external 14.318MHz crystal.
- FS pins for frequency select

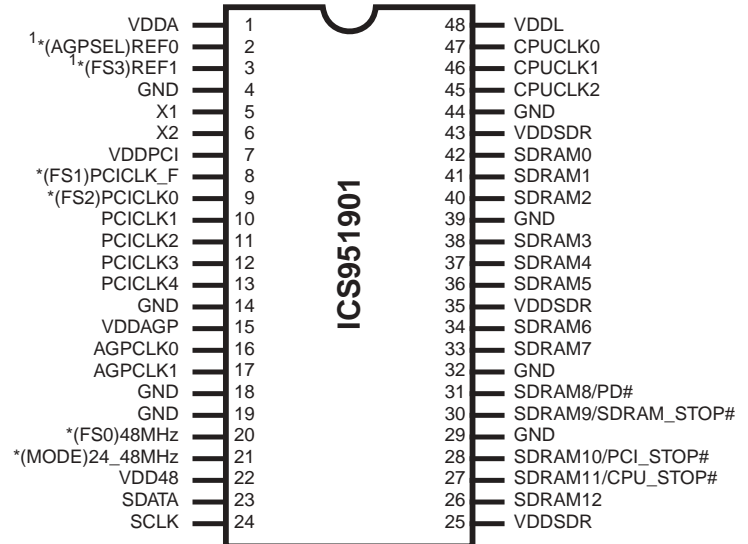
### Skew Specifications:

- CPU - CPU: < 175ps
- SDRAM - SDRAM < 250ps (except SDRAM12)
- PCI - PCI: < 500ps
- CPU (early) - PCI: 1-4ns (typ. 2ns)

### Block Diagram



### Pin Configuration



### 48-Pin 300mil SSOP

\* These inputs have a 120K pull down to GND.

<sup>1</sup> These are double strength.

### Functionality

| Bit2 | FS3<br>Bit7 | FS2<br>Bit6 | FS1<br>Bit5 | FS0<br>Bit4 | CPU<br>MHz | SDRAM<br>MHz | PCI<br>MHz | AGP1<br>SEL=1 | AGP0<br>SEL=0 |
|------|-------------|-------------|-------------|-------------|------------|--------------|------------|---------------|---------------|
| 0    | 0           | 0           | 0           | 0           | 66.67      | 66.67        | 33.33      | 66.67         | 64            |
| 0    | 0           | 0           | 0           | 1           | 66.67      | 100.00       | 33.33      | 66.67         | 64            |
| 0    | 0           | 0           | 1           | 0           | 66.67      | 133.34       | 33.33      | 66.67         | 64            |
| 0    | 0           | 0           | 1           | 1           | 75.00      | 75.00        | 37.50      | 75.00         | 64            |
| 0    | 0           | 1           | 0           | 0           | 83.31      | 83.31        | 33.32      | 66.64         | 64            |
| 0    | 0           | 1           | 0           | 1           | 90.00      | 90.00        | 30.00      | 60.00         | 64            |
| 0    | 0           | 1           | 1           | 0           | 95.00      | 95.00        | 31.67      | 63.33         | 64            |
| 0    | 0           | 1           | 1           | 1           | 100.00     | 66.67        | 33.33      | 66.67         | 64            |
| 0    | 1           | 0           | 0           | 0           | 100.00     | 100.00       | 33.33      | 66.67         | 64            |
| 0    | 1           | 0           | 0           | 1           | 100.00     | 133.34       | 33.33      | 66.67         | 64            |
| 0    | 1           | 0           | 1           | 0           | 105.00     | 105.00       | 35.00      | 70.00         | 64            |
| 0    | 1           | 0           | 1           | 1           | 112.00     | 112.00       | 33.60      | 67.20         | 64            |
| 0    | 1           | 1           | 0           | 0           | 117.99     | 117.99       | 35.40      | 70.80         | 64            |
| 0    | 1           | 1           | 0           | 1           | 124.09     | 124.09       | 31.02      | 62.05         | 64            |
| 0    | 1           | 1           | 1           | 0           | 133.34     | 100.00       | 33.33      | 66.67         | 64            |
| 0    | 1           | 1           | 1           | 1           | 133.34     | 133.34       | 33.33      | 66.67         | 64            |

## General Description

The **ICS951901** is a single chip clock solution for desktop designs using 630S chipsets. It provides all necessary clock signals for such a system.

The **ICS951901** belongs to ICS new generation of programmable system clock generators. It employs serial programming I<sup>2</sup>C interface as a vehicle for changing output functions, changing output frequency, configuring output strength, configuring output to output skew, changing spread spectrum amount, changing group divider ratio and dis/enabling individual clocks. This device also has ICS propriety 'Watchdog Timer' technology which will reset the frequency to a safe setting if the system becomes unstable from over clocking.

## Power Groups

### Analog

VDDA = X1, X2, Core, PLL  
VDD48 = 48MHz, 24MHz, fixed PLL

### Digital

VDDPCI = PCICLK\_F, PCICLK  
VDDSDR = SDRAM  
VDDAGP=AGP, REF

## MODE Pin Power Management Control Input

| MODE<br>Pin 21 | Pin 27    | Pin 28    | Pin 30      | Pin 31 |
|----------------|-----------|-----------|-------------|--------|
| 0              | SDRAM11   | SDRAM10   | SDRAM9      | SDRAM8 |
| 1              | CPU_STOP# | PCI_STOP# | SDRAM_STOP# | PD#    |

## Pin Configuration

| PIN NUMBER                        | PIN NAME        | TYPE | DESCRIPTION  |
|-----------------------------------|-----------------|------|--|
| 1, 7, 15, 22, 25, 35, 43          | VDD             | PWR  | 3.3V Power supply for SDRAM output buffers, PCI output buffers, reference output buffers and 48MHz output  |
| 2                                 | AGPSEL          | IN   | AGP frequency select pin.  |
|                                   | REF0            | OUT  | 14.318 MHz reference clock.  |
| 3                                 | FS3             | IN   | Frequency select pin.  |
|                                   | REF1            | OUT  | 14.318 MHz reference clock.  |
| 4, 14, 18, 19, 29, 32, 39, 44     | GND             | PWR  | Ground pin for 3V outputs.   |
| 5                                 | X1              | IN   | Crystal input, nominally 14.318MHz.  |
| 6                                 | X2              | OUT  | Crystal output, nominally 14.318MHz.   |
| 8                                 | FS1             | IN   | Frequency select pin.  |
|                                   | PCICLK_F        | OUT  | PCI clock output, not affected by PCI_STOP#  |
| 9                                 | FS2             | IN   | Frequency select pin.  |
|                                   | PCICLK0         | OUT  | PCI clock output.  |
| 13, 12, 11, 10                    | PCICLK (4:1)    | OUT  | PCI clock outputs.   |
| 17, 16,                           | AGP (1:0)       | OUT  | AGP outputs defined as 2X PCI. These may not be stopped.   |
| 20                                | FS0             | IN   | Frequency select pin.  |
|                                   | 48MHz           | OUT  | 48MHz output clock   |
| 21                                | MODE            | IN   | Pin 27, 28, 30, & 31 function select pin<br>0=Desktop 1=Mobile mode  |
|                                   | 24_48MHz        | OUT  | Clock output for super I/O/USB default is 24MHz  |
| 23                                | SDATA           | I/O  | Data pin for I <sup>2</sup> C circuitry 5V tolerant  |
| 24                                | SCLK            | IN   | Clock pin of I <sup>2</sup> C circuitry 5V tolerant  |
| 27                                | CPU_STOP#       | IN   | Stops all PCICLKs besides the PCICLK_F clocks at logic 0 level, when input is low and MODE pin is in Mobile mode   |
|                                   | SDRAM11         | OUT  | SDRAM clock output   |
| 28                                | PCI_STOP#       | IN   | Stops all CPUCLKs clocks at logic 0 level, when input is low and MODE pin is in Mobile mode  |
|                                   | SDRAM10         | OUT  | SDRAM clock output   |
| 30                                | SDRAM9          | OUT  | SDRAM clock output   |
|                                   | SDRAM_STOP#     | IN   | Stops all SDRAM clocks at logic 0 level, when input is low and MODE pin is in Mobile mode  |
| 31                                | PD#             | IN   | Asynchronous active low input pin used to power down the device into a low power state. The internal clocks are disabled and the VCO and the crystal are stopped. The latency of the power down will not be greater than 2ms |
|                                   | SDRAM8          | OUT  | SDRAM clock output   |
| 26 33, 34, 36, 37, 38, 40, 41, 42 | SDRAM (12, 7:0) | OUT  | SDRAM clock outputs  |
| 45, 46, 47                        | CPUCCLK (2:0)   | OUT  | CPU clock outputs.   |
| 48                                | VDDL            | PWR  | Power pin for the CPUCLKs. 2.5V  |

## Serial Configuration Command Bitmap

Byte0: Functionality and Frequency Select Register (default = 0)

| Bit   | Bit2 | Description |             |             |             |            |              |            |               |               |                       | PWD            |
|---|------|-------------|-------------|-------------|-------------|------------|--------------|------------|---------------|---------------|-----------------------|----------------|
|   |      | FS3<br>Bit7 | FS2<br>Bit6 | FS1<br>Bit5 | FS0<br>Bit4 | CPU<br>MHz | SDRAM<br>MHz | PCI<br>MHz | AGP1<br>SEL=1 | AGP0<br>SEL=0 | Spread %              |                |
| Bit 2<br>Bit 7:4  | 0    | 0           | 0           | 0           | 0           | 66.67      | 66.67        | 33.33      | 66.67         | 64            | ± 0.35% center spread | 00000<br>Note1 |
|   | 0    | 0           | 0           | 0           | 1           | 66.67      | 100.00       | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 0    | 0           | 0           | 1           | 0           | 66.67      | 133.34       | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 0    | 0           | 0           | 1           | 1           | 75.00      | 75.00        | 37.50      | 75.00         | 64            | ± 0.35% center spread |                |
|   | 0    | 0           | 1           | 0           | 0           | 83.31      | 83.31        | 33.32      | 66.64         | 64            | ± 0.35% center spread |                |
|   | 0    | 0           | 1           | 0           | 1           | 90.00      | 90.00        | 30.00      | 60.00         | 64            | ± 0.35% center spread |                |
|   | 0    | 0           | 1           | 1           | 0           | 95.00      | 95.00        | 31.67      | 63.33         | 64            | ± 0.35% center spread |                |
|   | 0    | 0           | 1           | 1           | 1           | 100.00     | 66.67        | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 0           | 0           | 0           | 100.00     | 100.00       | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 0           | 0           | 1           | 100.00     | 133.34       | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 0           | 1           | 0           | 105.00     | 105.00       | 35.00      | 70.00         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 0           | 1           | 1           | 112.00     | 112.00       | 33.60      | 67.20         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 1           | 0           | 0           | 117.99     | 117.99       | 35.40      | 70.80         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 1           | 0           | 1           | 124.09     | 124.09       | 31.02      | 62.05         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 1           | 1           | 0           | 133.34     | 100.00       | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 0    | 1           | 1           | 1           | 1           | 133.34     | 133.34       | 33.33      | 66.67         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 0           | 0           | 0           | 75.00      | 100.00       | 37.50      | 75.00         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 0           | 0           | 1           | 75.00      | 112.50       | 32.14      | 64.29         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 0           | 1           | 0           | 75.00      | 150.00       | 32.14      | 64.29         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 0           | 1           | 1           | 83.31      | 111.07       | 33.32      | 66.64         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 1           | 0           | 0           | 83.32      | 166.65       | 31.25      | 62.49         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 1           | 0           | 1           | 90.00      | 60.00        | 30.00      | 60.00         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 1           | 1           | 0           | 90.00      | 120.00       | 30.00      | 60.00         | 64            | ± 0.35% center spread |                |
|   | 1    | 0           | 1           | 1           | 1           | 95.00      | 63.33        | 31.67      | 63.33         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 0           | 0           | 0           | 95.00      | 126.66       | 31.67      | 63.33         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 0           | 0           | 1           | 105.00     | 70.00        | 35.00      | 70.00         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 0           | 1           | 0           | 105.00     | 140.00       | 35.00      | 70.00         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 0           | 1           | 1           | 112.00     | 84.00        | 33.60      | 67.20         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 1           | 0           | 0           | 117.99     | 88.49        | 35.40      | 70.80         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 1           | 0           | 1           | 124.09     | 93.07        | 31.02      | 62.05         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 1           | 1           | 0           | 129.99     | 97.49        | 32.50      | 64.99         | 64            | ± 0.35% center spread |                |
|   | 1    | 1           | 1           | 1           | 1           | 140.00     | 105.00       | 35.00      | 70.00         | 64            | ± 0.35% center spread |                |
| Bit 3 0 - Frequency is selected by hardware select, Latched inputs<br>1 - Frequency is selected by Bit, 2 7:4 |      |             |             |             |             |            |              |            |               |               |                       | 0              |
| Bit 1 0 - Normal<br>1 - Spread Spectrum Enabled   |      |             |             |             |             |            |              |            |               |               |                       | 1              |
| Bit 0 0 - Running<br>1 - Tristate all outputs   |      |             |             |             |             |            |              |            |               |               |                       | 0              |

**Note1:**

Default at power-up will be for latched logic inputs to define frequency, as displayed by Bit 3.

**Note:** PWD = Power-Up Default

**Byte 1: CPU, Active/Inactive Register**  
 (1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION                    |
|-------|------|-----|--------------------------------|
| Bit 7 | -    | 1   | Sel24_48<br>(1:24MHz, 0:48MHz) |
| Bit 6 | -    | 1   | Reserved                       |
| Bit 5 | -    | 1   | Reserved                       |
| Bit 4 | -    | 1   | Reserved                       |
| Bit 3 | 47   | 1   | CPUCLK0                        |
| Bit 2 | 46   | 1   | CPUCLK1                        |
| Bit 1 | 45   | 1   | CPUCLK2                        |
| Bit 0 | -    | 1   | Reserved                       |

**Byte 2: PCI, Active/Inactive Register**  
 (1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION |
|-------|------|-----|-------------|
| Bit 7 | -    | 1   | Reserved    |
| Bit 6 | -    | 1   | Reserved    |
| Bit 5 | 13   | 1   | PCICLK4     |
| Bit 4 | 12   | 1   | PCICLK3     |
| Bit 3 | 11   | 1   | PCICLK2     |
| Bit 2 | 10   | 1   | PCICLK1     |
| Bit 1 | 9    | 1   | PCICLK0     |
| Bit 0 | 8    | 1   | PCICLK_F    |

**Byte 3: SDRAM, Active/Inactive Register**  
 (1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION |
|-------|------|-----|-------------|
| Bit 7 | 33   | 1   | SDRAM7      |
| Bit 6 | 34   | 1   | SDRAM6      |
| Bit 5 | 36   | 1   | SDRAM5      |
| Bit 4 | 37   | 1   | SDRAM4      |
| Bit 3 | 38   | 1   | SDRAM3      |
| Bit 2 | 40   | 1   | SDRAM2      |
| Bit 1 | 41   | 1   | SDRAM1      |
| Bit 0 | 42   | 1   | SDRAM0      |

**Byte 4: SDRAM , Active/Inactive Register**  
 (1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION |
|-------|------|-----|-------------|
| Bit 7 | -    | 1   | Reserved    |
| Bit 6 | 21   | 1   | 24_48MHz    |
| Bit 5 | 20   | 1   | 48MHz       |
| Bit 4 | 26   | 1   | SDRAM12     |
| Bit 3 | 27   | 1   | SDRAM11     |
| Bit 2 | 28   | 1   | SDRAM10     |
| Bit 1 | 30   | 1   | SDRAM9      |
| Bit 0 | 31   | 1   | SDRAM8      |

**Byte 5: AGP, Active/Inactive Register**  
 (1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION    |
|-------|------|-----|----------------|
| Bit 7 | -    | X   | FS3 (Readback) |
| Bit 6 | -    | X   | FS2 (Readback) |
| Bit 5 | -    | X   | FS1 (Readback) |
| Bit 4 | -    | X   | FS0 (Readback) |
| Bit 3 | 3    | 1   | REF0           |
| Bit 2 | 2    | 1   | REF1           |
| Bit 1 | 17   | 1   | AGPCLK1        |
| Bit 0 | 16   | 1   | AGPCLK0        |

**Notes:**

1. Inactive means outputs are held LOW and are disabled from switching.
2. Latched Frequency Selects (FS#) will be inverted logic load of the input frequency select pin conditions.

**Byte 6: Control , Active/Inactive Register**  
(1= enable, 0 = disable)

| BIT  | PIN# | PWD | DESCRIPTION  |
|------|------|-----|--|
| Bit7 | 2,3  | 0   | REF strength 0=1X, 1=2X  |
| Bit6 | 45   | 0   | CPUCLK2 - Stop - Control<br>0=CPU_STOP# will control CPUCLK2,<br>1=CPUCLK2 is free running even if CPU_STOP# is low                |
| Bit5 | -    | X   | AGPSEL (Readback)  |
| Bit4 | -    | X   | MODE (Readback)  |
| Bit3 | -    | X   | CPU_STOP# (Readback)   |
| Bit2 | -    | X   | PCI_STOP# (Readback)   |
| Bit1 | -    | X   | SDRAM_STOP# (Readback)   |
| Bit0 | -    | 0   | AGP Speed Toggle<br>0=AGPSEL (pin2) will be determined by latch input setting,<br>1=AGPSEL will be opposite of latch input setting |

**Byte 7: Vendor ID Register**  
(1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION |
|-------|------|-----|-------------|
| Bit 7 | -    | 0   | Reserved    |
| Bit 6 | -    | 0   | Reserved    |
| Bit 5 | -    | 1   | Reserved    |
| Bit 4 | -    | 0   | Reserved    |
| Bit 3 | -    | 1   | Reserved    |
| Bit 2 | -    | 0   | Reserved    |
| Bit 1 | -    | 0   | Reserved    |
| Bit 0 | -    | 1   | Reserved    |

**Byte 8: Byte Count and Read Back Register**  
(1= enable, 0 = disable)

| BIT   | PIN# | PWD | DESCRIPTION |
|-------|------|-----|-------------|
| Bit 7 | -    | 0   | Reserved    |
| Bit 6 | -    | 0   | Reserved    |
| Bit 5 | -    | 0   | Reserved    |
| Bit 4 | -    | 0   | Reserved    |
| Bit 3 | -    | 0   | Reserved    |
| Bit 2 | -    | 1   | Reserved    |
| Bit 1 | -    | 0   | Reserved    |
| Bit 0 | -    | 0   | Reserved    |

**Byte 9: Watchdog Timer Count Register**

| Bit   | PWD | Description  |
|-------|-----|--|
| Bit 7 | 0   | The decimal representation of these 8 bits correspond to 290ms or 1ms the watchdog timer will wait before it goes to alarm mode and reset the frequency to the safe setting. Default at power up is 16X 290ms = 4.6 seconds. |
| Bit 6 | 0   |  |
| Bit 5 | 0   |  |
| Bit 4 | 1   |  |
| Bit 3 | 0   |  |
| Bit 2 | 0   |  |
| Bit 1 | 0   |  |
| Bit 0 | 0   |  |

**Byte 10: VCO Control Selection Bit & Watchdog Timer Control Register**

| Bit   | PWD | Description                     |
|-------|-----|---------------------------------|
| Bit 7 | 0   | 0=Hw/B0 freq / 1=B11 & 12 freq  |
| Bit 6 | 0   | WD Enable 0=disable / 1=enable  |
| Bit 5 | 0   | WD Status 0=normal / 1=alarm    |
| Bit 4 | 0   | WD Safe Frequency, Byte 0 bit 2 |
| Bit 3 | 0   | WD Safe Frequency, FS3          |
| Bit 2 | 0   | WD Safe Frequency, FS2          |
| Bit 1 | 0   | WD Safe Frequency, FS1          |
| Bit 0 | 0   | WD Safe Frequency, FS0          |

Note: FS values in bit [0:4] will correspond to Byte 0 FS values. Default safe frequency is same as 00000 entry in byte0.

#### Byte 11: VCO Frequency Control Register

| Bit   | PWD | Description      |
|-------|-----|------------------|
| Bit 7 | X   | VCO Divider Bit0 |
| Bit 6 | X   | REF Divider Bit6 |
| Bit 5 | X   | REF Divider Bit5 |
| Bit 4 | X   | REF Divider Bit4 |
| Bit 3 | X   | REF Divider Bit3 |
| Bit 2 | X   | REF Divider Bit2 |
| Bit 1 | X   | REF Divider Bit1 |
| Bit 0 | X   | REF Divider Bit0 |

Note: The decimal representation of these 7 bits (Byte 11 [6:0]) + 2 is equal to the REF divider value .

#### Notes:

1. PWD = Power on Default

#### Byte 13: Spread Sectrum Control Register

| Bit   | PWD | Description          |
|-------|-----|----------------------|
| Bit 7 | X   | Spread Spectrum Bit7 |
| Bit 6 | X   | Spread Spectrum Bit6 |
| Bit 5 | X   | Spread Spectrum Bit5 |
| Bit 4 | X   | Spread Spectrum Bit4 |
| Bit 3 | X   | Spread Spectrum Bit3 |
| Bit 2 | X   | Spread Spectrum Bit2 |
| Bit 1 | X   | Spread Spectrum Bit1 |
| Bit 0 | X   | Spread Spectrum Bit0 |

Note: Please utilize software utility provided by ICS Application Engineering to configure spread spectrum. Incorrect spread percentage may cause system failure.

#### Byte 15: Output Skew Control

| Bit   | PWD | Description               |
|-------|-----|---------------------------|
| Bit 7 | 1   | SDRAM 12 Skew Control     |
| Bit 6 | 0   |                           |
| Bit 5 | 0   | SDRAM (11:0) Skew Control |
| Bit 4 | 1   |                           |
| Bit 3 | 1   | CPUCLK2 Skew Control      |
| Bit 2 | 1   |                           |
| Bit 1 | 1   | CPUCLK (1:0) Skew Control |
| Bit 0 | 0   |                           |

#### Byte 12: VCO Frequency Control Register

| Bit   | PWD | Description      |
|-------|-----|------------------|
| Bit 7 | X   | VCO Divider Bit8 |
| Bit 6 | X   | VCO Divider Bit7 |
| Bit 5 | X   | VCO Divider Bit6 |
| Bit 4 | X   | VCO Divider Bit5 |
| Bit 3 | X   | VCO Divider Bit4 |
| Bit 2 | X   | VCO Divider Bit3 |
| Bit 1 | X   | VCO Divider Bit2 |
| Bit 0 | X   | VCO Divider Bit1 |

Note: The decimal representation of these 9 bits (Byte 12 bit [7:0] & Byte 11 bit [7] ) + 8 is equal to the VCO divider value. For example if VCO divider value of 36 is desired, user need to program  $36 - 8 = 28$ , namely, 0, 00011100 into byte 12 bit & byte 11 bit 7.

#### Byte 14: Spread Sectrum Control Register

| Bit   | PWD | Description           |
|-------|-----|-----------------------|
| Bit 7 | X   | Reserved              |
| Bit 6 | X   | Reserved              |
| Bit 5 | X   | Reserved              |
| Bit 4 | X   | Spread Spectrum Bit12 |
| Bit 3 | X   | Spread Spectrum Bit11 |
| Bit 2 | X   | Spread Spectrum Bit10 |
| Bit 1 | X   | Spread Spectrum Bit 9 |
| Bit 0 | X   | Spread Spectrum Bit8  |

Note: Please utilize software utility provided by ICS Application Engineering to configure spread spectrum. Incorrect spread percentage may cause system failure.

#### Byte 16: Output Skew Control

| Bit   | PWD | Description |
|-------|-----|-------------|
| Bit 7 | X   | Reserved    |
| Bit 6 | X   | Reserved    |
| Bit 5 | X   | Reserved    |
| Bit 4 | X   | Reserved    |
| Bit 3 | X   | Reserved    |
| Bit 2 | X   | Reserved    |
| Bit 1 | X   | Reserved    |
| Bit 0 | X   | Reserved    |

#### Byte 17: Output Rise/Fall Time Select Register

| Bit   | PWD | Description                 |
|-------|-----|-----------------------------|
| Bit 7 | 1   | PCI (3:0) Slew Rate Control |
| Bit 6 | 0   |                             |
| Bit 5 | 1   | PCI_F Slew Rate Control     |
| Bit 4 | 0   |                             |
| Bit 3 | 1   | CPUCLK2 Slew Rate Control   |
| Bit 2 | 0   |                             |
| Bit 1 | 0   | CPUCLK1 Slew rate Control   |
| Bit 0 |     |                             |

#### Byte 18: Output Rise/Fall Time Select Register

| Bit   | PWD | Description                |
|-------|-----|----------------------------|
| Bit 7 | 1   | SDRAM12: Slew Rate Control |
| Bit 6 | 0   |                            |
| Bit 5 | 1   | AGPCLK1: Slew Rate Control |
| Bit 4 | 0   |                            |
| Bit 3 | 1   | AGPCLK0: Slew Rate Control |
| Bit 2 | 0   |                            |
| Bit 1 | 1   | PCICLK4: Slew Rate Control |
| Bit 0 | 0   |                            |

#### Byte 19: Output Rise/Fall Time Select Register

| Bit   | PWD | Description                     |
|-------|-----|---------------------------------|
| Bit 7 | 1   | 48MHz: Slew Rate Control        |
| Bit 6 | 0   |                                 |
| Bit 5 | 1   | 24_48MHz: Slew Rate Control     |
| Bit 4 | 0   |                                 |
| Bit 3 | 1   | REF1: Slew Rate Control         |
| Bit 2 | 0   | REF0: Slew Rate Control         |
| Bit 1 | 1   | SDRAM (11:0): Slew Rate Control |
| Bit 0 | 0   |                                 |

#### Byte 20: Output Rise/Fall Time Select Register

| Bit   | PWD | Description               |
|-------|-----|---------------------------|
| Bit 7 | 0   | Reserved                  |
| Bit 6 | 0   | Reserved                  |
| Bit 5 | 0   | Reserved                  |
| Bit 4 | 0   | Reserved                  |
| Bit 3 | 0   | Reserved                  |
| Bit 2 | 0   | Reserved                  |
| Bit 1 | 0   | CPUCLK0 Slew Rate Control |
| Bit 0 |     |                           |

#### VCO Programming Constrains

VCO Frequency ..... 150MHz to 500MHz

VCO Divider Range ..... 8 to 519

REF Divider Range ..... 2 to 129

Phase Detector Stability ..... 0.3536 to 1.4142

#### Useful Formula

VCO Frequency = 14.31818 x VCO/REF divider value

Phase Detector Stabiliy = 14.038 x (VCO divider value)<sup>-0.5</sup>

#### To program the VCO frequency for over-clocking.

- Before trying to program our clock manually, consider using ICS provided software utilities for easy programming.
- Select the frequency you want to over-clock from with the desire gear ratio (i.e. CPU:SDRAM:3V66:PCI ratio) by writing to byte 0, or using initial hardware power up frequency.
- Write 0001, 1001 (19<sub>H</sub>) to byte 8 for readback of 21 bytes (byte 0-20).
- Read back byte 11-20 and copy values in these registers.
- Re-initialize the write sequence.
- Write a '1' to byte 9 bit 7 and write to byte 11 & 12 with the desired VCO & REF divider values.
- Write to byte 13 to 20 with the values you copy from step 3. This maintains the output spread, skew and slew rate.
- The above procedure is only needed when changing the VCO for the 1st pass. If VCO frequency needed to be changed again, user only needs to write to byte 11 and 12 unless the system is to reboot.

## Absolute Maximum Ratings

|                               |                                |
|-------------------------------|--------------------------------|
| Supply Voltage                | 5.5 V                          |
| Logic Inputs                  | GND –0.5 V to $V_{DD} + 0.5$ V |
| Ambient Operating Temperature | 0°C to +70°C                   |
| Case Temperature              | 115°C                          |
| Storage Temperature           | –65°C to +150°C                |

Stresses above those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only and functional operation of the device at these or any other conditions above those listed in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

## Electrical Characteristics - Input/Supply/Common Output Parameters

TA = 0 - 70°C; Supply Voltage VDD = 3.3 V +/-5% VDDL = 2.5 V +/-5% (unless otherwise stated)

| PARAMETER                      | SYMBOL          | CONDITIONS                               | MIN            | TYP   | MAX            | UNITS |
|--------------------------------|-----------------|--|----------------|-------|----------------|-------|
| Input High Voltage             | $V_{IH}$        |  | 2              |       | $V_{DD} + 0.3$ | V     |
| Input Low Voltage              | $V_{IL}$        |  | $V_{SS} - 0.3$ |       | 0.8            | V     |
| Supply Current                 | $I_{DD}$        | $C_L = 30$ pF, CPU @ 66, 100 MHz         |                | 390   | 400            | mA    |
| Power Down                     | PD              |  |                | 300   | 600            | mA    |
| Input frequency                | $F_i$           | $V_{DD} = 3.3$ V;                        | 12             | 14.32 | 16             | MHz   |
| Input Capacitance <sup>1</sup> | $C_{IN}$        | Logic Inputs                             |                |       | 5              | pF    |
|                                | $C_{INX}$       | X1 & X2 pins                             | 27             |       | 45             | pF    |
| Transition Time                | $T_{trans}$     | To 1st crossing of target Freq.          |                |       | 3              |       |
| Settling Time                  | $T_S$           | From 1st crossing to 1% target Freq.     |                |       |                |       |
| Clk Stabilization <sup>1</sup> | $T_{STAB}$      | From $V_{DD} = 3.3$ V to 1% target Freq. |                |       | 3              | ms    |
| Skew                           | $T_{CPU-PCI}$   | CPU $V_T = 1.5$ V PCI $V_T = 1.25$ V     | 1              | 1.9   | 4              | ns    |
| Skew                           | $T_{CPU-SDRAM}$ | CPU $V_T = 1.5$ V SDRAM $V_T = 1.25$ V   | -500           | -300  | 0              | ps    |

<sup>1</sup> Guaranteed by design, not 100% tested in production.



## Electrical Characteristics - CPU

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DDL} = 2.5 \text{ V} \pm 5\%$ ;  $V_{DDL} = 2.5 \text{ V} \pm 5\%$ ;  $C_L = 10\text{-}20 \text{ pF}$  (unless otherwise specified)

| PARAMETER                           | SYMBOL        | CONDITIONS  | MIN | TYP  | MAX | UNITS |
|-------------------------------------|---------------|---|-----|------|-----|-------|
| Output Impedance <sup>1</sup>       | $R_{DSP2B}$   | $V_O = V_{DD}^*(0.5)$                               | 10  |      | 20  |       |
| Output Impedance <sup>1</sup>       | $R_{DSN2B}$   | $V_O = V_{DD}^*(0.5)$                               | 10  |      | 20  |       |
| Output High Voltage                 | $V_{OH2B}$    | $I_{OH} = -12.0 \text{ mA}$                         | 2   |      |     | V     |
| Output Low Voltage                  | $V_{OL2B}$    | $I_{OL} = 12 \text{ mA}$                            |     |      | 0.4 | V     |
| Output High Current                 | $I_{OH2B}$    | $V_{OH} = 1.7 \text{ V}$                            |     |      | -19 | mA    |
| Output Low Current                  | $I_{OL2B}$    | $V_{OL} = 0.7 \text{ V}$                            | 19  |      |     | mA    |
| Rise Time <sup>1</sup>              | $t_{r2B}$     | $V_{OL} = 0.4 \text{ V}$ , $V_{OH} = 2.0 \text{ V}$ | 0.4 | 1.2  | 1.6 | ns    |
| Fall Time <sup>1</sup>              | $t_{f2B}$     | $V_{OH} = 2.0 \text{ V}$ , $V_{OL} = 0.4 \text{ V}$ | 0.4 | 1.1  | 1.6 | ns    |
| Duty Cycle <sup>1</sup>             | $d_{t2B}$     | $V_T = 1.25 \text{ V}$                              | 45  | 46.9 | 55  | %     |
| Skew window <sup>0:1</sup>          | $t_{sk2B}$    | $V_T = 1.25 \text{ V}$                              |     | 43   | 175 | ps    |
| Skew window <sup>0:2</sup>          | $t_{sk2B}$    | $V_T = 1.25 \text{ V}$                              |     | 142  | 375 | ps    |
| Jitter, Cycle-to-cycle <sup>1</sup> | $t_{jcy-cyc}$ | $V_T = 1.25 \text{ V}$ , CPU=66 MHz                 |     | 177  | 250 | ps    |

<sup>1</sup>Guaranteed by design, not 100% tested in production.

## Electrical Characteristics - 24-48MHz

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3 \text{ V} \pm 5\%$ ;  $V_{DDL} = 2.5 \text{ V} \pm 5\%$ ;  $C_L = 10\text{-}20 \text{ pF}$  (unless otherwise specified)

| PARAMETER               | SYMBOL                       | CONDITIONS  | MIN | TYP  | MAX | UNITS |
|-------------------------|------------------------------|---|-----|------|-----|-------|
| Output Impedance        | $R_{DSP5B}^1$                | $V_O = V_{DD}^*(0.5)$                               | 20  |      | 60  |       |
| Output Impedance        | $R_{DSN5B}^1$                | $V_O = V_{DD}^*(0.5)$                               | 20  |      | 60  |       |
| Output High Voltage     | $V_{OH15}$                   | $I_{OH} = -14 \text{ mA}$                           | 2.4 |      |     | V     |
| Output Low Voltage      | $V_{OL5}$                    | $I_{OL} = 6.0 \text{ mA}$                           |     |      | 0.4 | V     |
| Output High Current     | $I_{OH5}$                    | $V_{OH} = 2.0 \text{ V}$                            |     |      | -20 | mA    |
| Output Low Current      | $I_{OL5}$                    | $V_{OL} = 0.8 \text{ V}$                            | 10  |      |     | mA    |
| Rise Time <sup>1</sup>  | $t_{r5}$                     | $V_{OL} = 0.4 \text{ V}$ , $V_{OH} = 2.4 \text{ V}$ | 0.4 | 1.45 | 4   | ns    |
| Fall Time <sup>1</sup>  | $t_{f5}$                     | $V_{OH} = 2.4 \text{ V}$ , $V_{OL} = 0.4 \text{ V}$ | 0.4 | 1.5  | 4   | ns    |
| Duty Cycle <sup>1</sup> | $d_{t5}$                     | $V_T = 1.5 \text{ V}$                               | 45  | 52.5 | 55  | %     |
| Jitter                  | $t_{cycle \text{ to cycle}}$ | $V_T = 1.5 \text{ V}$                               |     | 210  | 500 | ps    |

<sup>1</sup>Guaranteed by design, not 100% tested in production.

## Electrical Characteristics - PCI

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $V_{DDL} = 2.5\text{ V} \pm 5\%$ ;  $C_L = 10\text{-}30\text{ pF}$  (unless otherwise specified)

| PARAMETER                           | SYMBOL         | CONDITIONS  | MIN | TYP  | MAX  | UNITS |
|-------------------------------------|----------------|---|-----|------|------|-------|
| Output Impedance                    | $R_{DSP1B}^1$  | $V_O = V_{DD}^*(0.5)$                             | 12  |      | 55   |       |
| Output Impedance                    | $R_{DSN1B}^1$  | $V_O = V_{DD}^*(0.5)$                             | 12  |      | 55   |       |
| Output High Voltage                 | $V_{OH1}$      | $I_{OH} = -1\text{ mA}$                           | 2.4 |      |      | V     |
| Output Low Voltage                  | $V_{OL1}$      | $I_{OL} = 1\text{ mA}$                            |     |      | 0.55 | V     |
| Output High Current                 | $I_{OH1}$      | $V_{OH} @ \text{MIN} = 1.0\text{ V}$              |     |      | -29  | mA    |
| Output Low Current                  | $I_{OL1}$      | $V_{OL} @ \text{MIN} = 1.95\text{ V}$             | 29  |      |      | mA    |
| Rise Time <sup>1</sup>              | $t_{r1}$       | $V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$ | 0.5 | 2.3  | 2.5  | ns    |
| Fall Time <sup>1</sup>              | $t_{f1}$       | $V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$ | 0.5 | 2.3  | 2.5  | ns    |
| Duty Cycle <sup>1</sup>             | $d_{t1}$       | $V_T = 1.5\text{ V}$                              | 45  | 51.2 | 55   | %     |
| Skew window <sup>1</sup>            | $t_{sk1}$      | $V_T = 1.5\text{ V}$                              |     | 108  | 500  | ps    |
| Jitter, Cycle-to-cycle <sup>1</sup> | $t_{jcy-cyc1}$ | $V_T = 1.5\text{ V}$                              |     | 353  | 500  | ps    |

<sup>1</sup>Guaranteed by design, not 100% tested in production.

## Electrical Characteristics - SDRAM

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $V_{DDL} = 2.5\text{ V} \pm 5\%$ ;  $C_L = 20\text{-}30\text{ pF}$  (unless otherwise specified)

| PARAMETER                           | SYMBOL         | CONDITIONS  | MIN | TYP  | MAX | UNITS |
|-------------------------------------|----------------|---|-----|------|-----|-------|
| Output Impedance                    | $R_{DSP3B}^1$  | $V_O = V_{DD}^*(0.5)$                             | 10  |      | 24  |       |
| Output Impedance                    | $R_{DSN3B}^1$  | $V_O = V_{DD}^*(0.5)$                             | 10  |      | 24  |       |
| Output High Voltage                 | $V_{OH3}$      | $I_{OH} = -18\text{ mA}$                          | 2.4 |      |     | V     |
| Output Low Voltage                  | $V_{OL3}$      | $I_{OL} = 9.4\text{ mA}$                          |     |      | 0.4 | V     |
| Output High Current                 | $I_{OH3}$      | $V_{OH} = 2.0\text{ V}$                           |     |      | -46 | mA    |
| Output Low Current                  | $I_{OL3}$      | $V_{OL} = 0.8\text{ V}$                           |     |      |     | mA    |
| Rise Time <sup>1</sup>              | $t_{r3}$       | $V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$ |     | 0.8  | 1.6 | ns    |
| Fall Time <sup>1</sup>              | $t_{f3}$       | $V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$ |     | 0.8  | 1.6 | ns    |
| Duty Cycle <sup>1</sup>             | $d_{t3}$       | $V_T = 1.5\text{ V}$                              | 45  | 48.5 | 55  | %     |
| Skew window <sup>1(0:11)</sup>      | $t_{sk3}$      | $V_T = 1.5\text{ V}$                              |     | 192  | 250 | ps    |
| Skew window <sup>1(0:12)</sup>      | $t_{sk3}$      | $V_T = 1.5\text{ V}$                              |     | 290  | 500 | ps    |
| Jitter, Cycle-to-cycle <sup>1</sup> | $t_{jcy-cyc3}$ | $V_T = 1.5\text{ V}$ , CPU=66,100,133 MHz         |     | 173  | 250 | ps    |

<sup>1</sup>Guaranteed by design, not 100% tested in production.

## Electrical Characteristics - AGP

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD}=3.3\text{V} \pm 5\%$ ;  $C_L = 20\text{ pF}$  (unless otherwise specified)

| PARAMETER                | SYMBOL           | CONDITIONS  | MIN | TYP  | MAX | UNITS |
|--------------------------|------------------|---|-----|------|-----|-------|
| Output Impedance         | $R_{DSP4B}^1$    | $V_O = V_{DD} \cdot (0.5)$                        | 12  |      | 55  |       |
| Output Impedance         | $R_{DSN4B}^1$    | $V_O = V_{DD} \cdot (0.5)$                        | 12  |      | 55  |       |
| Output High Voltage      | $V_{OH4B}$       | $I_{OH} = -18\text{ mA}$                          | 2   |      |     | V     |
| Output Low Voltage       | $V_{OL4B}$       | $I_{OL} = 18\text{ mA}$                           |     |      | 0.4 | V     |
| Output High Current      | $I_{OH4B}$       | $V_{OH} = 2.0\text{ V}$                           |     |      | -19 | mA    |
| Output Low Current       | $I_{OL4B}$       | $V_{OL} = 0.8\text{ V}$                           | 19  |      |     | mA    |
| Rise Time <sup>1</sup>   | $t_{r4B}$        | $V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$ | 0.5 | 1.5  | 2   | ns    |
| Fall Time <sup>1</sup>   | $t_{f4B}$        | $V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$ | 0.5 | 1.6  | 2   | ns    |
| Duty Cycle <sup>1</sup>  | $d_{t4B}$        | $V_T = 1.5\text{ V}$                              | 45  | 52.3 | 55  | %     |
| Skew window <sup>1</sup> | $t_{sk}^1$       | $V_T = 1.5\text{ V}$                              |     | 55.5 | 175 | ps    |
| Jitter Cyc-Cyc           | $t_{jcyc-cyc}^1$ | $V_T = 1.5\text{ V}$                              |     | 239  | 500 | ps    |

<sup>1</sup>Guaranteed by design, not 100% tested in production.

## Electrical Characteristics - REF

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $V_{DDL} = 2.5\text{ V} \pm 5\%$ ;  $C_L = 20\text{ pF}$  (unless otherwise stated)

| PARAMETER               | SYMBOL    | CONDITIONS  | MIN | TYP  | MAX | UNITS |
|-------------------------|-----------|---|-----|------|-----|-------|
| Output High Voltage     | $V_{OH5}$ | $I_{OH} = -12\text{ mA}$                          | 2.4 |      |     | V     |
| Output Low Voltage      | $V_{OL5}$ | $I_{OL} = 9\text{ mA}$                            |     |      | 0.4 | V     |
| Output High Current     | $I_{OH5}$ | $V_{OH} = 2.0\text{ V}$                           |     |      | -22 | mA    |
| Output Low Current      | $I_{OL5}$ | $V_{OL} = 0.8\text{ V}$                           | 16  |      |     | mA    |
| Rise Time <sup>1</sup>  | $t_{r5}$  | $V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$ |     | 1.8  | 4   | ns    |
| Fall Time <sup>1</sup>  | $t_{f5}$  | $V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$ |     | 1.9  | 4   | ns    |
| Duty Cycle <sup>1</sup> | $d_{t5}$  | $V_T = 50\%$                                      | 45  | 54.5 | 55  | %     |

<sup>1</sup>Guaranteed by design, not 100% tested in production.

## General I<sup>2</sup>C serial interface information for the ICS951901

### How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address D2<sub>(H)</sub>
- ICS clock will **acknowledge**
- Controller (host) sends a dummy command code
- ICS clock will **acknowledge**
- Controller (host) sends a dummy byte count
- ICS clock will **acknowledge**
- Controller (host) starts sending **Byte 0 through Byte 28** (see Note 2)
- ICS clock will **acknowledge** each byte **one at a time**
- Controller (host) sends a Stop bit

| How to Write:             |                      |
|---------------------------|----------------------|
| Controller (Host)         | ICS (Slave/Receiver) |
| Start Bit                 |                      |
| Address D2 <sub>(H)</sub> |                      |
|                           | <b>ACK</b>           |
| Dummy Command Code        |                      |
|                           | <b>ACK</b>           |
| Dummy Byte Count          |                      |
|                           | <b>ACK</b>           |
| Byte 0                    |                      |
|                           | <b>ACK</b>           |
| Byte 1                    |                      |
|                           | <b>ACK</b>           |
| Byte 2                    |                      |
|                           | <b>ACK</b>           |
| Byte 3                    |                      |
|                           | <b>ACK</b>           |
| Byte 4                    |                      |
|                           | <b>ACK</b>           |
| Byte 5                    |                      |
|                           | <b>ACK</b>           |
| Byte 6                    |                      |
|                           | <b>ACK</b>           |
| ○                         | ○                    |
| ○                         | ○                    |
| ○                         | ○                    |
| Byte 18                   |                      |
|                           | <b>ACK</b>           |
| Byte 19                   |                      |
|                           | <b>ACK</b>           |
| Byte 20                   |                      |
|                           | <b>ACK</b>           |
| Stop Bit                  |                      |

### How to Read:

- Controller (host) will send start bit.
- Controller (host) sends the read address D3<sub>(H)</sub>
- ICS clock will **acknowledge**
- ICS clock will send the **byte count**
- Controller (host) acknowledges
- ICS clock sends **Byte 0 through byte 6 (default)**
- ICS clock sends **Byte 0 through byte X (if X<sub>(H)</sub> was written to byte 6).**
- Controller (host) will need to acknowledge each byte
- Controller (host) will send a stop bit

| How to Read:                              |                      |
|---|----------------------|
| Controller (Host)                         | ICS (Slave/Receiver) |
| Start Bit                                 |                      |
| Address D3 <sub>(H)</sub>                 |                      |
|   | <b>ACK</b>           |
|   | <b>Byte Count</b>    |
| ACK                                       |                      |
|   | <b>Byte 0</b>        |
| ACK                                       |                      |
|   | <b>Byte 1</b>        |
| ACK                                       |                      |
|   | <b>Byte 2</b>        |
| ACK                                       |                      |
|   | <b>Byte 3</b>        |
| ACK                                       |                      |
|   | <b>Byte 4</b>        |
| ACK                                       |                      |
|   | <b>Byte 5</b>        |
| ACK                                       |                      |
|   | <b>Byte 6</b>        |
| ACK                                       |                      |
| If 7 <sub>H</sub> has been written to B6  | <b>Byte 7</b>        |
| ACK                                       |                      |
| ○   | ○                    |
| ○   | ○                    |
| ○   | ○                    |
|   |                      |
| If 1A <sub>H</sub> has been written to B6 | <b>Byte 18</b>       |
| ACK                                       |                      |
| If 1B <sub>H</sub> has been written to B6 | <b>Byte 19</b>       |
| ACK                                       |                      |
| If 1C <sub>H</sub> has been written to B6 | <b>Byte 20</b>       |
| ACK                                       |                      |
| Stop Bit                                  |                      |

\*See notes on the following page.

## Brief I<sup>2</sup>C registers description for ICS951901 Programmable System Frequency Generator

| Register Name                             | Byte         | Description  | PWD Default                               |
|---|--------------|--|---|
| Functionality & Frequency Select Register | 0            | Output frequency, hardware / I <sup>2</sup> C frequency select, spread spectrum & output enable control register.                  | See individual byte description           |
| Output Control Registers                  | 1-6          | Active / inactive output control registers/latch inputs read back.   | See individual byte description           |
| Vendor ID & Revision ID Registers         | 7            | Byte 11 bit[7:4] is ICS vendor id - 1001. Other bits in this register designate device revision ID of this part.                   | See individual byte description           |
| Byte Count Read Back Register             | 8            | Writing to this register will configure byte count and how many byte will be read back. Do not write 00 <sub>H</sub> to this byte. | 08 <sub>H</sub>                           |
| Watchdog Timer Count Register             | 9            | Writing to this register will configure the number of seconds for the watchdog timer to reset.                                     | 10 <sub>H</sub>                           |
| Watchdog Control Registers                | 10 Bit [6:0] | Watchdog enable, watchdog status and programmable 'safe' frequency' can be configured in this register.                            | 000,0000                                  |
| VCO Control Selection Bit                 | 10 Bit [7]   | This bit select whether the output frequency is control by hardware/byte 0 configurations or byte 11&12 programming.               | 0   |
| VCO Frequency Control Registers           | 11-12        | These registers control the dividers ratio into the phase detector and thus control the VCO output frequency.                      | Depended on hardware/byte 0 configuration |
| Spread Spectrum Control Registers         | 13-14        | These registers control the spread percentage amount.  | Depended on hardware/byte 0 configuration |
| Group Skews Control Registers             | 15-16        | Increment or decrement the group skew amount as compared to the initial skew.  | See individual byte description           |
| Output Rise/Fall Time Select Registers    | 17-20        | These registers will control the output rise and fall time.  | See individual byte description           |

### Notes:

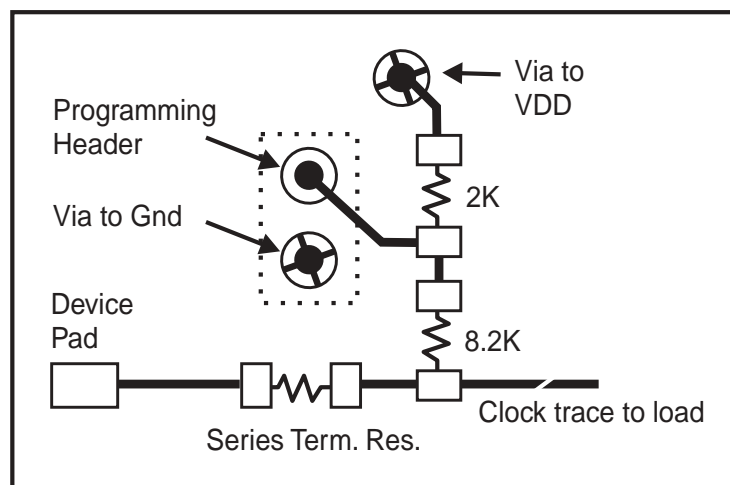
- The ICS clock generator is a slave/receiver, I<sup>2</sup>C component. It can read back the data stored in the latches for verification. Readback will support standard SMBUS controller protocol. **The number of bytes to readback is defined by writing to byte 8.**
- When writing to byte 11 - 12, and byte 13 - 14, they must be written as a set.** If for example, only byte 14 is written but not 15, neither byte 14 or 15 will load into the receiver.
- The data transfer rate supported by this clock generator is 100K bits/sec or less (standard mode)
- The input is operating at 3.3V logic levels.
- The data byte format is 8 bit bytes.
- To simplify the clock generator I<sup>2</sup>C interface, the protocol is set to use only Block-Writes from the controller. The bytes must be accessed in sequential order from lowest to highest byte with the ability to stop after any complete byte has been transferred. The Command code and Byte count shown above must be sent, but the data is ignored for those two bytes. The data is loaded until a Stop sequence is issued.
- At power-on, all registers are set to a default condition, as shown.

## Shared Pin Operation - Input/Output Pins

The I/O pins designated by (input/output) on the ICS951901 serve as dual signal functions to the device. During initial power-up, they act as input pins. The logic level (voltage) that is present on these pins at this time is read and stored into a 5-bit internal data latch. At the end of Power-On reset, (see AC characteristics for timing values), the device changes the mode of operations for these pins to an output function. In this mode the pins produce the specified buffered clocks to external loads.

To program (load) the internal configuration register for these pins, a resistor is connected to either the VDD (logic 1) power supply or the GND (logic 0) voltage potential. A 10 Kilohm (10K) resistor is used to provide both the solid CMOS programming voltage needed during the power-up programming period and to provide an insignificant load on the output clock during the subsequent operating period.

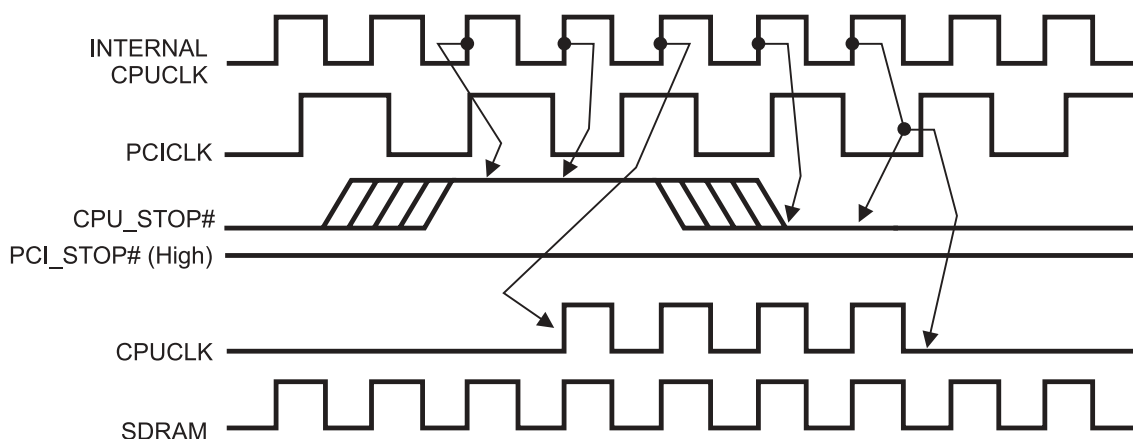
Figure 1 shows a means of implementing this function when a switch or 2 pin header is used. With no jumper is installed the pin will be pulled high. With the jumper in place the pin will be pulled low. If programmability is not necessary, than only a single resistor is necessary. The programming resistors should be located close to the series termination resistor to minimize the current loop area. It is more important to locate the series termination resistor close to the driver than the programming resistor.



**Fig. 1**

## CPU\_STOP# Timing Diagram

CPU\_STOP# is an asynchronous input to the clock synthesizer. It is used to turn off the CPU clocks for low power operation. CPU\_STOP# is synchronized by the **ICS94209**. The minimum that the CPU clock is enabled (CPU\_STOP# high pulse) is 100 CPU clocks. All other clocks will continue to run while the CPU clocks are disabled. The CPU clocks will always be stopped in a low state and start in such a manner that guarantees the high pulse width is a full pulse. CPU clock on latency is less than 4 CPU clocks and CPU clock off latency is less than 4 CPU clocks.

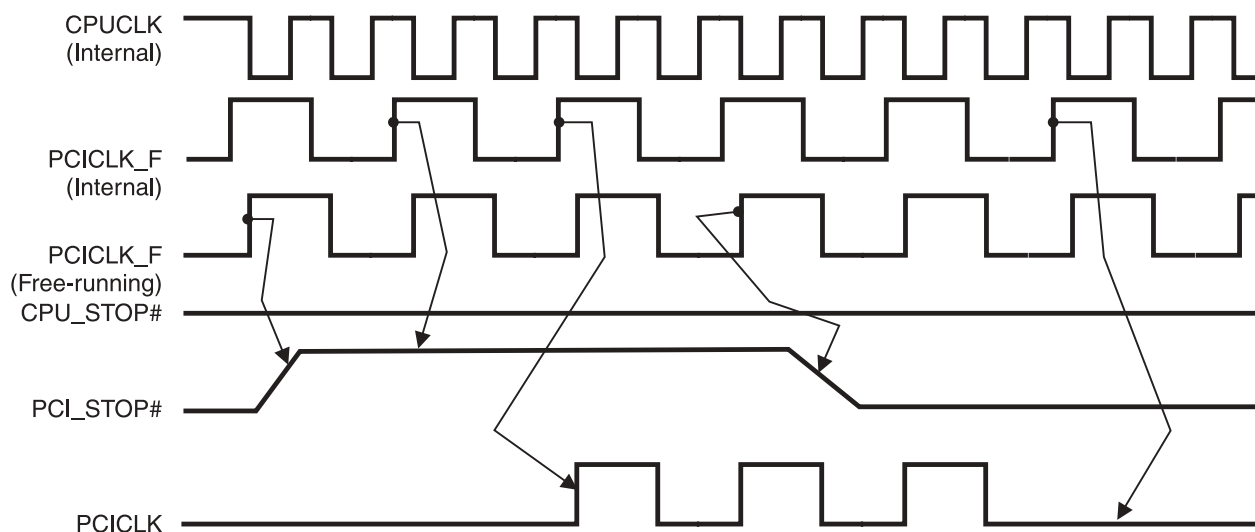


### Notes:

1. All timing is referenced to the internal CPU clock.
2. CPU\_STOP# is an asynchronous input and metastable conditions may exist. This signal is synchronized to the CPU clocks inside the ICS94209.
3. All other clocks continue to run undisturbed. (including SDRAM outputs).

## PCI\_STOP# Timing Diagram

PCI\_STOP# is an asynchronous input to the **ICS94209**. It is used to turn off the PCICLK clocks for low power operation. PCI\_STOP# is synchronized by the **ICS94209** internally. The minimum that the PCICLK clocks are enabled (PCI\_STOP# high pulse) is at least 10 PCICLK clocks. PCICLK clocks are stopped in a low state and started with a full high pulse width guaranteed. PCICLK clock on latency cycles are only one rising PCICLK clock off latency is one PCICLK clock.



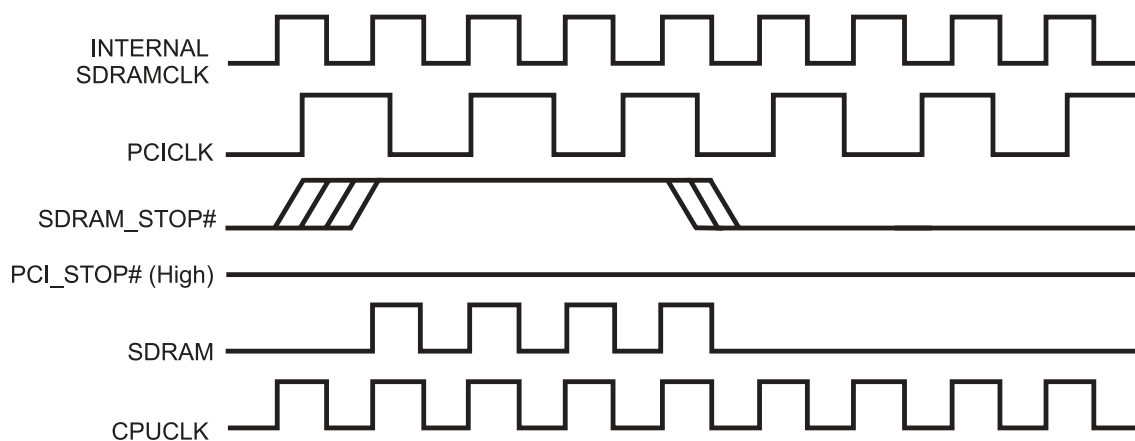
### Notes:

1. All timing is referenced to the Internal CPUCLK (defined as inside the ICS94209 device.)
2. PCI\_STOP# is an asynchronous input, and metastable conditions may exist. This signal is required to be synchronized inside the ICS94209.
3. All other clocks continue to run undisturbed.
4. CPU\_STOP# is shown in a high (true) state.



## SDRAM\_STOP# Timing Diagram

SDRAM\_STOP# is an asynchronous input to the clock synthesizer. It is used to stop SDRAM clocks for low power operation. SDRAM\_STOP# is synchronized to complete its current cycle, by the **ICS94209**. All other clocks will continue to run while the SDRAM clocks are disabled. The SDRAM clocks will always be stopped in a low state and start in such a manner that guarantees the high pulse width is a full pulse.



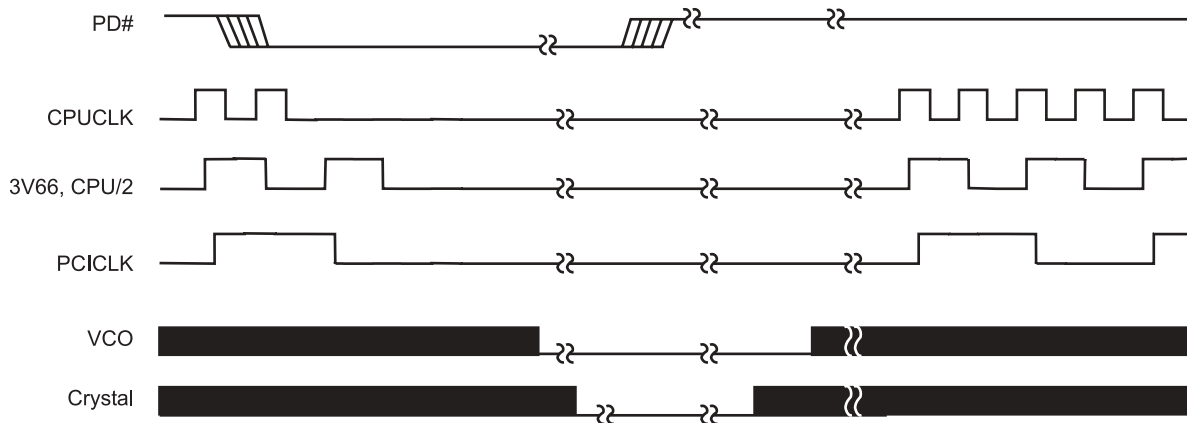
### Notes:

1. All timing is referenced to the internal CPU clock.
2. SDRAM is an asynchronous input and metastable conditions may exist. This signal is synchronized to the SDRAM clocks inside the ICS94209.
3. All other clocks continue to run undisturbed.

## PD# Timing Diagram

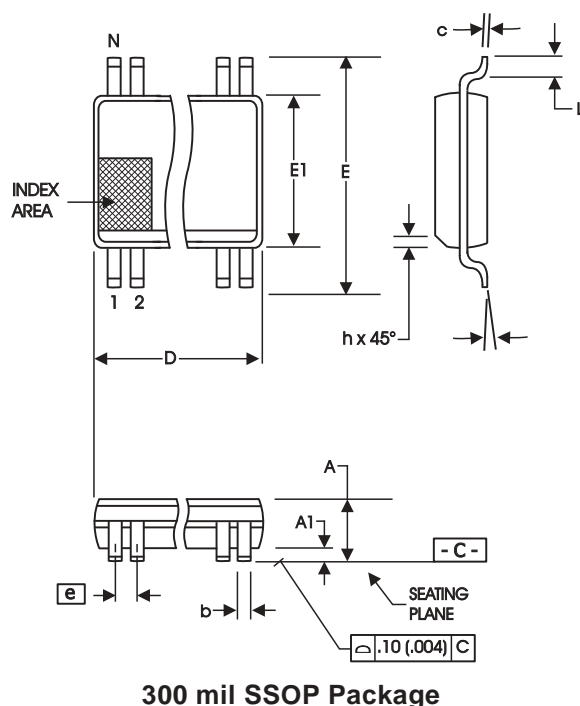
The power down selection is used to put the part into a very low power state without turning off the power to the part. PD# is an asynchronous active low input. This signal needs to be synchronized internal to the device prior to powering down the clock synthesizer.

Internal clocks are not running after the device is put in power down. When PD# is active low all clocks need to be driven to a low value and held prior to turning off the VCOs and crystal. The power up latency needs to be less than 3 mS. The power down latency should be as short as possible but conforming to the sequence requirements shown below. PCI\_STOP# and CPU\_STOP# are considered to be don't cares during the power down operations. The REF and 48MHz clocks are expected to be stopped in the LOW state as soon as possible. Due to the state of the internal logic, stopping and holding the REF clock outputs in the LOW state may require more than one clock cycle to complete.



### Notes:

1. All timing is referenced to the Internal CPUCLK (defined as inside the ICS94209 device).
2. As shown, the outputs Stop Low on the next falling edge after PD# goes low.
3. PD# is an asynchronous input and metastable conditions may exist. This signal is synchronized inside this part.
4. The shaded sections on the VCO and the Crystal signals indicate an active clock.
5. Diagrams shown with respect to 133MHz. Similar operation when CPU is 100MHz.



300 mil SSOP Package

| SYMBOL   | In Millimeters<br>COMMON DIMENSIONS |       | In Inches<br>COMMON DIMENSIONS |       |
|----------|-------------------------------------|-------|--------------------------------|-------|
|          | MIN                                 | MAX   | MIN                            | MAX   |
| A        | 2.41                                | 2.80  | .095                           | .110  |
| A1       | 0.20                                | 0.40  | .008                           | .016  |
| b        | 0.20                                | 0.34  | .008                           | .0135 |
| c        | 0.13                                | 0.25  | .005                           | .010  |
| D        | SEE VARIATIONS                      |       | SEE VARIATIONS                 |       |
| E        | 10.03                               | 10.68 | .395                           | .420  |
| E1       | 7.40                                | 7.60  | .291                           | .299  |
| e        | 0.635 BASIC                         |       | 0.025 BASIC                    |       |
| h        | 0.38                                | 0.64  | .015                           | .025  |
| L        | 0.50                                | 1.02  | .020                           | .040  |
| N        | SEE VARIATIONS                      |       | SEE VARIATIONS                 |       |
| $\alpha$ | 0°                                  | 8°    | 0°                             | 8°    |

VARIATIONS

| N  | D mm. |       | D (inch) |      |
|----|-------|-------|----------|------|
|    | MIN   | MAX   | MIN      | MAX  |
| 48 | 15.75 | 16.00 | .620     | .630 |

Reference Doc.: JEDEC Publication 95, MO-118

10-0034

## Ordering Information

ICS951901yFLF-T

Example:

ICS XXXXXX y F LF-T

Designation for tape and reel packaging

Lead Free (Optional)

Package Type

F = SSOP

Revision Designator (will not correlate with datasheet revision)

Device Type

Prefix

ICS = Standard Device

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