

Programmable System Frequency Generator for PII/III™

Recommended Application:

440BX/VIA Apollo Pro133/ ALI 1631 style chipset.

Output Features:

- 2 - CPUs @2.5V
- 1 - IOAPIC @ 2.5V
- 13 - SDRAM @ 3.3V
- 6 - PCI @3.3V,
- 1 - 48MHz, @3.3V
- 1 - 24MHz @ 3.3V
- 2 - REF @3.3V, 14.318MHz.

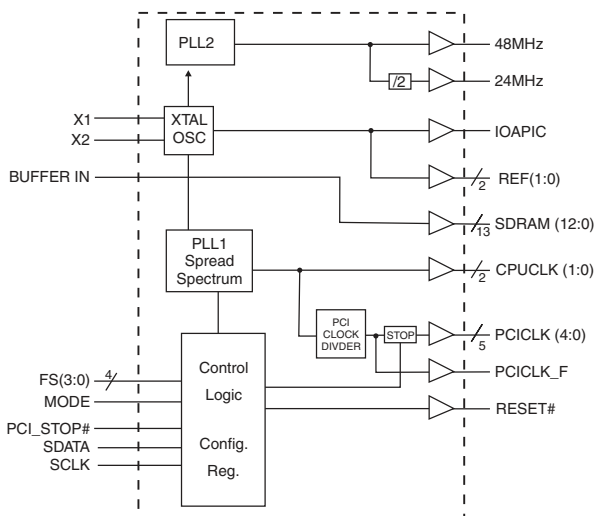
Features:

- Programmable output frequency.
- Programmable output rise/fall time.
- Programmable PCICLK, PCICLK_F, SDRAM skew.
- Real time system reset output
- 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

Key Specifications:

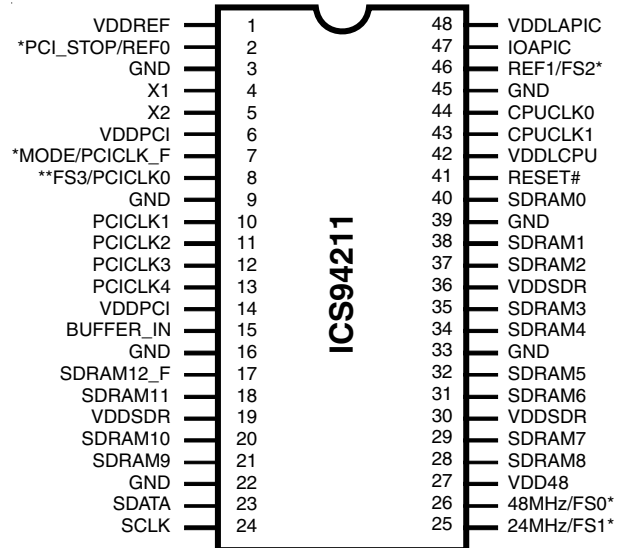
- CPU – CPU: <175ps
- SDRAM - SDRAM: <500ps
- PCI – PCI: <500ps
- CPU(early)-PCI: Min=1.0ns, Typ=2.0ns, Max=4.0ns

Block Diagram



0441F—08/24/05

Pin Configuration



48-Pin 300mil SSOP

- * Internal Pull-up Resistor of 120K to VDD
- ** Internal Pull-down resistor of 120K to GND

Functionality

| FS3 | FS2 | FS1 | FS0 | CPU (MHz) | PCICLK (MHz) |
|-----|-----|-----|-----|-----------|--------------|
| 0 | 0 | 0 | 0 | 80.00 | 40.00 |
| 0 | 0 | 0 | 1 | 75.00 | 37.50 |
| 0 | 0 | 1 | 0 | 83.31 | 41.65 |
| 0 | 0 | 1 | 1 | 66.82 | 33.41 |
| 0 | 1 | 0 | 0 | 103.00 | 34.33 |
| 0 | 1 | 0 | 1 | 112.01 | 37.34 |
| 0 | 1 | 1 | 0 | 68.01 | 34.01 |
| 0 | 1 | 1 | 1 | 100.23 | 33.41 |
| 1 | 0 | 0 | 0 | 120.00 | 40.00 |
| 1 | 0 | 0 | 1 | 114.99 | 38.33 |
| 1 | 0 | 1 | 0 | 109.99 | 36.66 |
| 1 | 0 | 1 | 1 | 105.00 | 35.00 |
| 1 | 1 | 0 | 0 | 140.00 | 35.00 |
| 1 | 1 | 0 | 1 | 150.00 | 37.50 |
| 1 | 1 | 1 | 0 | 124.00 | 31.00 |
| 1 | 1 | 1 | 1 | 132.99 | 33.25 |

General Description

The **ICS94211** is a single chip clock solution for desktop designs using the BX/Apollo Pro133/ALI 1631 style chipset. It provides all necessary clock signals for such a system.

The **ICS94211** belongs to ICS new generation of programmable system clock generators. It employs serial programming I²C 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 become unstable from over clocking.

Pin Configuration

| PIN NUMBER | PIN NAME | TYPE | DESCRIPTION |
|--|------------------------|------|--|
| 1 | VDDREF | PWR | Ref, XTAL power supply, nominal 3.3V |
| 2 | REF0 | OUT | 14.318 Mhz reference clock. |
| | PCI_STOP# ¹ | IN | Halts PCICLK(0:4) clocks at logic 0 level, when input low (In mobile mode, MODE=0) |
| 3, 9, 16, 22, 33, 39, 45 | GND | PWR | Ground |
| 4 | X1 | IN | Crystal input, has internal load cap (36pF) and feedback resistor from X2 |
| 5 | X2 | OUT | Crystal output, nominally 14.318MHz. Has internal load cap (36pF) |
| 6, 14 | VDDPCI | PWR | Supply for PCICLK_F and PCICLK (0:4), nominal 3.3V |
| 7 | PCICLK_F | OUT | Free running PCI clock not affected by PCI_STOP# for power management. |
| | MODE ^{1,2} | IN | Pin 7 function select pin, 1=Desktop Mode, 0=Mobile Mode. Latched Input. |
| 8 | FS3 | IN | Frequency select pin. Latched Input. Internal Pull-down to GND |
| | PCICLK0 | OUT | PCI clock outputs. Syncheronous to CPU clocks with 1-48ns skew (CPU early) |
| 13, 12, 11, 10 | PCICLK (4:1) | OUT | PCI clock outputs. Syncheronous to CPU clocks with 1-48ns skew (CPU early) |
| 15 | BUFFER IN | IN | Input to Fanout Buffers for SDRAM outputs. |
| 17, 18, 20, 21, 28, 29, 31, 32, 34, 35, 37, 38, 40 | SDRAM (12:0) | OUT | SDRAM clock outputs, Fanout Buffer outputs from BUFFER IN pin (controlled by chipset) |
| 19, 30, 36 | VDDSDR | PWR | Supply for SDRAM (0:12) and CPU PLL Core, nominal 3.3V. |
| 23 | SDATA | I/O | Data input for I ² C serial input, 5V tolerant input |
| 24 | SCLK | IN | Clock input of I ² C input, 5V tolerant input |
| 25 | 24MHz | OUT | 24MHz output clock |
| | FS1 ^{1,2} | IN | Frequency select pin. Latched Input. |
| 26 | 48MHz | OUT | 48MHz output clock |
| | FS0 ^{1,2} | IN | Frequency select pin. Latched Input |
| 27 | VDD48 | PWR | Power for 24 & 48MHz output buffers and fixed PLL core. |
| 41 | RESET | OUT | Real time system reset signal for frequency ratio change or watchdog timer timeout. This signal is active low. |
| 42 | VDDLCPU | PWR | Supply for CPU clocks, 2.5V nominal |
| 43 | CPUCLK1 | OUT | CPU clock outputs, powered by VDDL2. Low if CPU_STOP#=Low |
| 44 | CPUCLK0 | OUT | Free running CPU clock. Not affected by the CPU_STOP# |
| 46 | REF1 | OUT | 14.318 MHz reference clock. |
| | FS2 ^{1,2} | IN | Frequency select pin. Latched Input |
| 47 | IOAPIC | OUT | IOAPIC clock output. 14.318 MHz Powered by VDDL. |
| 48 | VDDLAPIC | PWR | Power pin for the IOAPIC outputs. 2.5V. |

Notes:

- 1: Internal Pull-up Resistor of 120K to 3.3V on indicated inputs
- 2: Bidirectional input/output pins, input logic levels are latched at internal power-on-reset. Use 10Kohm resistor to program logic Hi to VDD or GND for logic low.

General I²C serial interface information for the ICS94211

How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address D2_(H)
- 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 20** (see Note)
- 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 _(H) | |
| | ACK |
| Dummy Command Code | |
| | ACK |
| Dummy Byte Count | |
| | ACK |
| Byte 0 | |
| | ACK |
| Byte 1 | |
| | ACK |
| Byte 2 | |
| | ACK |
| Byte 3 | |
| | ACK |
| Byte 4 | |
| | ACK |
| Byte 5 | |
| | ACK |
| Byte 6 | |
| | ACK |
| ○ | |
| ○ | ○ |
| ○ | ○ |
| ○ | ○ |
| Byte 18 | |
| | ACK |
| Byte 19 | |
| | ACK |
| Byte 20 | |
| | ACK |
| Stop Bit | |

*See notes on the following page.

How to Read:

- Controller (host) will send start bit.
- Controller (host) sends the read address D3_(H)
- ICS clock will **acknowledge**
- ICS clock will send the **byte count**
- Controller (host) acknowledges
- ICS clock sends **Byte 0 through byte 8 (default)**
- ICS clock sends **Byte 0 through byte X (if X_(H) was written to byte 8)**.
- 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 _(H) | |
| | ACK |
| | Byte Count |
| ACK | |
| | Byte 0 |
| ACK | |
| | Byte 1 |
| ACK | |
| | Byte 2 |
| ACK | |
| | Byte 3 |
| ACK | |
| | Byte 4 |
| ACK | |
| | Byte 5 |
| ACK | |
| | Byte 6 |
| ACK | |
| If 7 _H has been written to B6 | Byte 7 |
| ACK | |
| ○ | ○ |
| ○ | ○ |
| ○ | ○ |
| | |
| If 12 _H has been written to B6 | Byte 18 |
| ACK | |
| If 13 _H has been written to B6 | Byte 19 |
| ACK | |
| If 14 _H has been written to B6 | Byte 20 |
| ACK | |
| Stop Bit | |

Brief I²C registers description for ICS94211 Programmable System Frequency Generator

| Register Name | Byte | Description | PWD Default |
|---|--------------|--|---|
| Functionality & Frequency Select Register | 0 | Output frequency, hardware / I ² 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 _H to this byte. | 08 _H |
| Watchdog Timer Count Register | 9 | Writing to this register will configure the number of seconds for the watchdog timer to reset. | 10 _H |
| 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, I²C 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 I²C 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.

Byte 0: Functionality and frequency select register (Default=0)

| Bit | Description | | | | | | | | | PWD |
|----------------|---|------|------|------|--------|--------------------|------------|---------------|---------------|--------|
| Bit (2,7:4) | Bit2 | Bit7 | Bit6 | Bit5 | Bit4 | VCO/REF Divider | VCO MHz | CPUCLK MHz | PCICLK MHz | Note 1 |
| | | FS3 | FS2 | FS1 | FS0 | | | | | |
| | 0 | 0 | 0 | 0 | 0 | 447/40 | 160.01 | 80.00 | 40.00 | |
| | 0 | 0 | 0 | 0 | 1 | 440/42 | 150.00 | 75.00 | 37.50 | |
| | 0 | 0 | 0 | 1 | 0 | 512/44 | 166.61 | 83.31 | 41.65 | |
| | 0 | 0 | 0 | 1 | 1 | 392/42 | 133.64 | 66.82 | 33.41 | |
| | 0 | 0 | 1 | 0 | 0 | 446/31 | 206.00 | 103.00 | 34.33 | |
| | 0 | 0 | 1 | 0 | 1 | 485/31 | 224.01 | 112.01 | 37.34 | |
| | 0 | 0 | 1 | 1 | 0 | 513/54 | 136.02 | 68.01 | 34.01 | |
| | 0 | 0 | 1 | 1 | 1 | 518/37 | 200.45 | 100.23 | 33.41 | |
| | 0 | 1 | 0 | 0 | 0 | 352/21 | 240.00 | 120.00 | 40.00 | |
| | 0 | 1 | 0 | 0 | 1 | 514/32 | 229.99 | 114.99 | 38.33 | |
| | 0 | 1 | 0 | 1 | 0 | 507/33 | 219.98 | 109.99 | 36.66 | |
| | 0 | 1 | 0 | 1 | 1 | 484/33 | 210.00 | 105.00 | 35.00 | |
| | 0 | 1 | 1 | 0 | 0 | 352/18 | 280.00 | 140.00 | 35.00 | |
| | 0 | 1 | 1 | 0 | 1 | 440/21 | 300.00 | 150.00 | 37.50 | |
| | 0 | 1 | 1 | 1 | 0 | 433/25 | 247.99 | 124.00 | 31.00 | |
| | 0 | 1 | 1 | 1 | 1 | 483/26 | 265.99 | 132.99 | 33.25 | |
| | 1 | 0 | 0 | 0 | 0 | 396/21 | 270.00 | 135.00 | 33.75 | |
| | 1 | 0 | 0 | 0 | 1 | 345/19 | 259.99 | 129.99 | 32.50 | |
| | 1 | 0 | 0 | 1 | 0 | 440/25 | 252.00 | 126.00 | 31.50 | |
| | 1 | 0 | 0 | 1 | 1 | 478/29 | 236.00 | 118.00 | 39.33 | |
| | 1 | 0 | 1 | 0 | 0 | 486/30 | 231.95 | 115.98 | 38.66 | |
| | 1 | 0 | 1 | 0 | 1 | 491/37 | 190.01 | 95.00 | 31.67 | |
| | 1 | 0 | 1 | 1 | 0 | 440/35 | 180.00 | 90.00 | 30.00 | |
| | 1 | 0 | 1 | 1 | 1 | 463/39 | 169.98 | 85.01 | 28.34 | |
| | 1 | 1 | 0 | 0 | 0 | 371/16 | 332.00 | 166.00 | 41.50 | |
| | 1 | 1 | 0 | 0 | 1 | 447/20 | 320.01 | 160.01 | 40.00 | |
| 1 | 1 | 0 | 1 | 0 | 433/20 | 309.99 | 154.99 | 38.75 | | |
| 1 | 1 | 0 | 1 | 1 | 310/15 | 295.91 | 147.95 | 36.99 | | |
| 1 | 1 | 1 | 0 | 0 | 469/23 | 291.97 | 145.98 | 36.50 | | |
| 1 | 1 | 1 | 0 | 1 | 362/18 | 287.95 | 143.98 | 35.99 | | |
| 1 | 1 | 1 | 1 | 0 | 476/24 | 283.98 | 141.99 | 35.50 | | |
| 1 | 1 | 1 | 1 | 1 | 347/18 | 276.02 | 138.01 | 34.50 | | |
| Bit 3 | 0-Frequency is selected by hardware select, latched inputs 1- Frequency is selected by Bit 2,7:4 | | | | | | | | | 0 |
| Bit 1 | 0- Normal 1- Spread spectrum enable $\pm 0.35\%$ Center Spread | | | | | | | | | 1 |
| Bit 0 | 0- Running 1- Tristate all outputs | | | | | | | | | 0 |

Notes:

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

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

| BIT | PIN# | PWD | DESCRIPTION |
|-------|------|-----|--------------|
| Bit 7 | - | X | Latched FS2# |
| Bit 6 | - | 1 | (Reserved) |
| Bit 5 | - | 1 | (Reserved) |
| Bit 4 | - | 1 | (Reserved) |
| Bit 3 | 40 | 1 | SDRAM0 |
| Bit 2 | - | 1 | (Reserved) |
| Bit 1 | 43 | 1 | CPUCLK1 |
| Bit 0 | 44 | 1 | CPUCLK0 |

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

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

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

| BIT | PIN# | PWD | DESCRIPTION |
|-------|--------------------|-----|--------------|
| Bit 7 | - | 1 | (Reserved) |
| Bit 6 | - | X | Latched FS0# |
| Bit 5 | 26 | 1 | 48MHz |
| Bit 4 | 25 | 1 | 24 MHz |
| Bit 3 | - | 1 | (Reserved) |
| Bit 2 | 17, 21, 20, 18 | 1 | SDRAM (9:12) |
| Bit 1 | 28, 32, 31, 29, | 1 | SDRAM (5:8) |
| Bit 0 | 34, 38, 37, 35 | 1 | SDRAM (1:4) |

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

| BIT | PIN# | PWD | DESCRIPTION |
|-------|------|-----|--------------|
| Bit 7 | - | 1 | (Reserved) |
| Bit 6 | - | 1 | (Reserved) |
| Bit 5 | - | 1 | (Reserved) |
| Bit 4 | - | 1 | (Reserved) |
| Bit 3 | - | X | Latched FS1# |
| Bit 2 | - | 1 | (Reserved) |
| Bit 1 | - | X | Latched FS3# |
| Bit 0 | - | 1 | (Reserved) |

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

| BIT | PIN# | PWD | DESCRIPTION |
|-------|------|-----|-------------|
| Bit 7 | - | 1 | (Reserved) |
| Bit 6 | - | 1 | (Reserved) |
| Bit 5 | - | 1 | (Reserved) |
| Bit 4 | 47 | 1 | IOAPIC |
| Bit 3 | - | 1 | (Reserved) |
| Bit 2 | - | 1 | (Reserved) |
| Bit 1 | 46 | 1 | REF1 |
| Bit 0 | 2 | 1 | REF0 |

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

| BIT | PIN# | PWD | DESCRIPTION |
|------|------|-----|-----------------|
| Bit7 | - | 0 | Reserved (Note) |
| Bit6 | - | 0 | Reserved (Note) |
| Bit5 | - | 0 | Reserved (Note) |
| Bit4 | - | 0 | Reserved (Note) |
| Bit3 | - | 0 | Reserved (Note) |
| Bit2 | - | 1 | Reserved (Note) |
| Bit1 | - | 1 | Reserved (Note) |
| Bit0 | - | 0 | Reserved (Note) |

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.

Note: This is an unused register writing to this register will not affect device performance or functionality.

Byte 7: Vendor ID and Revision ID Register

| Bit | PWD | Description |
|-------|-----|-------------|
| Bit 7 | 0 | Vendor ID |
| Bit 6 | 0 | Vendor ID |
| Bit 5 | 1 | Vendor ID |
| Bit 4 | X | Revision ID |
| Bit 3 | X | Revision ID |
| Bit 2 | X | Revision ID |
| Bit 1 | X | Revision ID |
| Bit 0 | X | Revision ID |

Byte 8: Byte Count and Read Back Register

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

Byte 9: VCO Control Selection Bit & Watchdog Timer Control Register

| Bit | PWD | Description |
|-------|-----|---------------------------------|
| Bit 7 | 0 | 0=Hw/B0 freq / 1=B14&15 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 10: 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 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 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 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 | | PCICLK_F Skew Control |
| Bit 6 | | |
| Bit 5 | | PCICLK [0:4] Skew Control |
| Bit 4 | | |
| Bit 3 | | SDRAM_F Skew Control |
| Bit 2 | | |
| Bit 1 | | SDRAM [0:7] Skew Control |
| Bit 0 | | |

Byte 17: Output Rise/FallTime Select Register

| Bit | PWD | Description |
|-------|-----|--------------------------------|
| Bit 7 | | CPUCLK_F: Slew Rate Control |
| Bit 6 | | |
| Bit 5 | | CPUCLK1: Slew Rate Control |
| Bit 4 | | |
| Bit 3 | | SDRAM [0:11] Slew Rate Control |
| Bit 2 | | |
| Bit 1 | | SDRAM_F: Slew Rate Control |
| Bit 0 | | |

Notes:

1. PWD = Power on Default
2. The power on default for byte 13-20 depends on the hardware (latch inputs FS[0:4]) or I²C (Byte 0 bit [1:7]) setting. Be sure to read back and re-write the values of these 8 registers when VCO frequency change is desired for the first pass.

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 Bi 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 | | SDRAM [8:11] Skew Control |
| Bit 6 | | |
| 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 18: Output Rise/Fall Time Select Register

| Bit | PWD | Description |
|-------|-----|------------------------------|
| Bit 7 | | PCI {0:4}: Slew Rate Control |
| Bit 6 | | |
| Bit 5 | | PCI_F Slew Rate Control |
| Bit 4 | | |
| Bit 3 | | 48MHz: Slew Rate Control |
| Bit 2 | | |
| Bit 1 | | 24MHz: Slew Rate Control |
| Bit 0 | | |

Byte 19: Reserved Register

| 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 20: Reserved Register

| 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 |

Note: Byte 19 and 20 are reserved registers, these are unused registers writing to these registers will not affect device performance or functionality.

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 Stability = 14.038 x (VCO divider value)^{-0.5}

To program the VCO frequency for over-clocking.

0. Before trying to program our clock manually, consider using ICS provided software utilities for easy programming.
1. 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.
2. Write 0001, 1001 (19_H) to byte 8 for readback of 21 bytes (byte 0-20).
3. Read back byte 11-20 and copy values in these registers.
4. Re-initialize the write sequence.
5. Write a '1' to byte 9 bit 7 and write to byte 11 & 12 with the desired VCO & REF divider values.
6. Write to byte 13 to 20 with the values you copy from step 3. This maintains the output spread, skew and slew rate.
7. 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.

Note:

1. User needs to ensure step 3 & 7 is carried out. Systems with wrong spread percentage and/or group to group skew relation programmed into bytes 13-16 could be unstable. Step 3 & 7 assure the correct spread and skew relationship.
2. If VCO, REF divider values or phase detector stability are out of range, the device may fail to function correctly.
3. Follow min and max VCO frequency range provided. Internal PLL could be unstable if VCO frequency is too fast or too slow. Use 14.31818MHz x VCO/REF divider values to calculate the VCO frequency (MHz).
4. ICS recommends users, to utilize the software utility provided by ICS Application Engineering to program the VCO frequency.
5. Spread percent needs to be calculated based on VCO frequency, spread modulation frequency and spread amount desired. See Application note for software support.

Absolute Maximum Ratings

| | |
|-------------------------------|--------------------------------|
| Supply Voltage | 7.0 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

$T_A = 0 - 70^\circ\text{C}$; Supply Voltage $V_{DD} = 3.3$ V +/-5%, $V_{DDL} = 2.5$ 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 |
| Input High Current | I_{IH} | $V_{IN} = V_{DD}$ | -5 | | 5 | mA |
| Input Low Current | I_{IL1} | $V_{IN} = 0$ V; Inputs with no pull-up resistors | -5 | | | mA |
| | I_{IL2} | $V_{IN} = 0$ V; Inputs with pull-up resistors | -200 | | | |
| Operating Supply Current | $I_{DD3.3OP}$ | $C_L = \text{max cap loads}$; CPU=66-133 MHz, SDRAM=100 MHz | | 124 | 350 | mA |
| | | CPU=133 MHz, SDRAM=133 MHz | | 135 | 500 | |
| | $I_{DD2.5OP}$ | $C_L = \text{max cap loads}$; | | 18 | 70 | |
| Powerdown Current | $I_{DD3.3PD}$ | $C_L = 0$ pF; Input address to VDD or GND | | | 600 | mA |
| Input Frequency | F_i | $V_{DD} = 3.3$ V | | 14.318 | | MHz |
| Pin Inductance | L_{pin} | | | | 7 | nH |
| Input Capacitance ¹ | C_{IN} | Logic Inputs | | | 5 | pF |
| | C_{OUT} | Output pin capacitance | | | 6 | pF |
| | C_{INX} | X1 & X2 pins | 27 | | 45 | pF |
| Transition time ¹ | T_{trans} | To 1st crossing of target frequency | | | 3 | ms |
| Settling time ¹ | T_s | From 1st crossing to 1% target frequency | | | 3 | ms |
| Clk Stabilization ¹ | T_{STAB} | From $V_{DD} = 3.3$ V to 1% target frequency | | | 3 | ms |
| Delay ¹ | t_{PZH}, t_{PZL} | Output enable delay (all outputs) | 1 | | 10 | ns |
| | t_{PHZ}, t_{PLZ} | Output disable delay (all outputs) | 1 | | 10 | ns |
| Skew ¹ | tcpu-pci | $V_T = 1.5$ V; $V_{TL} = 1.25$ V | | 2.45 | 4 | ns |

¹Guaranteed by design, not 100% tested in production.

Electrical Characteristics - CPU

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

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------------|-------------------------|--|------|------|-----|----------|
| Output Impedance ¹ | R_{DSP2B} | $V_O = V_{DD} * (0.5)$ | 13.5 | 15 | 45 | Ω |
| Output Impedance ¹ | R_{DSN2B} | $V_O = V_{DD} * (0.5)$ | 13.5 | 16.5 | 45 | Ω |
| Output High Voltage | V_{OH2B} | $I_{OH} = -1\text{ mA}$ | 2 | 2.48 | | V |
| Output Low Voltage | V_{OL2B} | $I_{OL} = 1\text{ mA}$ | | 0.04 | 0.4 | V |
| Output High Current | I_{OH2B} | $V_{OH@MIN} = 1\text{ V}$ | | -60 | -27 | mA |
| | | $V_{OH@MAX} = 2.375\text{V}$ | -27 | -7 | | |
| Output Low Current | I_{OL2B} | $V_{OL@MIN} = 1.2\text{ V}$ | 27 | 63 | | mA |
| | | $V_{OL@MAX} = 0.3\text{V}$ | | 20 | 30 | |
| Rise Time ¹ | t_{r2B} | $V_{OL} = 0.4\text{ V}, V_{OH} = 2.0\text{ V}$ | 0.4 | 1.2 | 1.6 | ns |
| Fall Time ¹ | t_{f2B} | $V_{OH} = 2.0\text{ V}, V_{OL} = 0.4\text{ V}$ | 0.4 | 0.9 | 1.6 | ns |
| Duty Cycle ¹ | d_{t2B} | $V_T = 1.25\text{ V}$ | 45 | 46.9 | 55 | % |
| Skew ¹ | t_{sk2B} | $V_T = 1.25\text{ V}$ | | 12.7 | 175 | ps |
| Jitter, Cycle-to-cycle ¹ | $t_{j\text{cyc-cyc}2B}$ | $V_T = 1.25\text{ V}, \text{ CPU } 66, \text{ SDRAM } 100$ | | 150 | 250 | ps |

¹Guaranteed by design, not 100% tested in production.

Electrical Characteristics - PCI

$T_A = 0 - 70^\circ\text{C}$; $V_{DD} = 3.3\text{ V} \pm 5\%$, $C_L = 40\text{ pF}$ for PCI0-1, $C_L = 10 - 30\text{ pF}$ for other PCIs (unless otherwise stated)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------------|------------------------|--|-----|------|------|----------|
| Output Impedance ¹ | R_{DSP1} | $V_O = V_{DD} * (0.5)$ | 12 | | 55 | Ω |
| Output Impedance ¹ | R_{DSN1} | $V_O = V_{DD} * (0.5)$ | 12 | | 55 | Ω |
| 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} | $V_{OH@MIN} = 1\text{ V}$ | | | -33 | mA |
| | | $V_{OH@MAX} = 3.135\text{V}$ | -33 | | | |
| Output Low Current | I_{OL1} | $V_{OL@MIN} = 1.95\text{ V}$ | 30 | | | mA |
| | | $V_{OL@MAX} = 0.4\text{V}$ | | | 38 | |
| Rise Time ¹ | t_{r1} | $V_{OL} = 0.4\text{ V}, V_{OH} = 2.4\text{ V},$ | 0.5 | 1.5 | 2 | ns |
| Fall Time ¹ | t_{f1} | $V_{OL} = 2.4\text{ V}, V_{OH} = 0.4\text{ V}, \text{ PCI0-3}$ | 0.5 | 1.5 | 2 | ns |
| Duty Cycle ¹ | d_{t1} | $V_T = 1.5\text{ V}$ | 45 | 52.5 | 55 | % |
| Skew ¹ | t_{sk1} | $V_T = 1.5\text{ V}$ | | 49 | 500 | ps |
| Jitter, cycle-to-cycle ¹ | $t_{j\text{cyc-cyc}1}$ | $V_T = 1.5\text{ V}$ | | 200 | 500 | ps |

¹Guaranteed by design, not 100% tested in production.

Electrical Characteristics - IOAPIC

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

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------|-------------|--|-----|------|-----|----------|
| Output Impedance ¹ | R_{DSP4B} | $V_O = V_{DD} * (0.5)$ | 9 | | 3 | Ω |
| Output Impedance ¹ | R_{DSN4B} | $V_O = V_{DD} * (0.5)$ | 9 | | 30 | Ω |
| Output High Voltage | V_{OH4B} | $I_{OH} = -5.5\text{ mA}$ | 2 | | | V |
| Output Low Voltage | V_{OL4B} | $I_{OL} = 9\text{ mA}$ | | | 0.4 | V |
| Output High Current | I_{OH4B} | $V_{OH@MIN} = 1.4\text{ V}$ | | | -21 | mA |
| | | $V_{OH@MAX} = 2.5\text{ V}$ | -36 | | | |
| Output Low Current | I_{OL4B} | $V_{OL@MIN} = 1.0\text{ V}$ | 36 | | | mA |
| | | $V_{OL@MAX} = 0.2\text{ V}$ | | | 31 | |
| Rise Time ¹ | t_{r4B} | $V_{OL} = 0.4\text{ V}, V_{OH} = 2.0\text{ V}$ | 0.4 | 0.7 | 1.6 | ns |
| Fall Time ¹ | t_{f4B} | $V_{OH} = 2.0\text{ V}, V_{OL} = 0.4\text{ V}$ | 0.4 | 1.1 | 1.6 | ns |
| Duty Cycle ¹ | d_{t4B} | $V_T = 1.25\text{ V}$ | 45 | 53.7 | 55 | % |

¹Guaranteed by design, not 100% tested in production.

Electrical Characteristics - SDRAM

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

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------|------------|--|-----|------|-----|----------|
| Output Impedance ¹ | R_{DSP3} | $V_O = V_{DD} * (0.5)$ | 10 | | 24 | Ω |
| Output Impedance ¹ | R_{DSN3} | $V_O = V_{DD} * (0.5)$ | 10 | | 24 | Ω |
| Output High Voltage | V_{OH3} | $I_{OH} = -1\text{ mA}$ | 2.4 | | | V |
| Output Low Voltage | V_{OL3} | $I_{OL} = 1\text{ mA}$ | | | 0.4 | V |
| Output High Current | I_{OH3} | $V_{OH@MIN} = 2\text{ V}$ | | | -46 | mA |
| | | $V_{OH@MAX} = 3.135\text{ V}$ | -54 | | | |
| Output Low Current | I_{OL3} | $V_{OL@MIN} = 1\text{ V}$ | 54 | | | mA |
| | | $V_{OL@MAX} = 0.4\text{ V}$ | | | 53 | |
| Rise Time ¹ | t_{r3} | $V_{OL} = 0.4\text{ V}, V_{OH} = 2.4\text{ V}$ | 0.4 | 0.8 | 1.6 | ns |
| Fall Time ¹ | t_{f3} | $V_{OH} = 2.4\text{ V}, V_{OL} = 0.4\text{ V}$ | 0.4 | 0.8 | 1.6 | ns |
| Duty Cycle ¹ | d_{t3} | $V_T = 1.5\text{ V}$ | 45 | 51.7 | 55 | % |
| Skew ¹ | t_{sk3} | $V_T = 1.5\text{ V}$ | | 166 | 250 | ps |
| Propagation Delay | T_{prop} | $V_T = 1.5\text{ V}$ | | 3.1 | 5 | ns |

¹Guaranteed by design, not 100% tested in production.

Electrical Characteristics - REF, 24_48MHz, 48MHz

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

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------------------|------------------------|--|-----|------|------|----------|
| Output Impedance ¹ | R_{DSP5} | $V_O = V_{DD} * (0.5)$ | 20 | | 60 | Ω |
| Output Impedance ¹ | R_{DSN5} | $V_O = V_{DD} * (0.5)$ | 20 | | 60 | Ω |
| Output High Voltage | V_{OH5} | $I_{OH} = -1\text{ mA}$ | 2.4 | | | V |
| Output Low Voltage | V_{OL5} | $I_{OL} = 1\text{ mA}$ | | | 0.4 | V |
| Output High Current | I_{OH5} | $V_{OH @ MIN} = 1.0\text{ V}$ | | | -23 | mA |
| | | $V_{OH @ MAX} = 3.135\text{ V}$ | -29 | | | |
| Output Low Current | I_{OL5} | $V_{OL @ MIN} = 1.95\text{ V}$ | 29 | | | mA |
| | | $V_{OL @ MAX} = 0.4\text{ V}$ | | | 27 | |
| Rise Time ¹ | t_{r5} | $V_{OL} = 0.4\text{ V}, V_{OH} = 2.4\text{ V}$ | 0.4 | 2 | 4 | ns |
| Fall Time ¹ | t_{f5} | $V_{OH} = 2.4\text{ V}, V_{OL} = 0.4\text{ V}$ | 0.4 | 2 | 4 | ns |
| Duty Cycle ¹ | d_{t5} | $V_T = 1.5\text{ V}$ | 45 | 53 | 55 | % |
| Jitter, cycle-to-cycle ¹ | $t_{j\text{cyc-cyc}5}$ | $V_T = 1.5\text{ V}, \text{Fixed clocks}$ | | 200 | 500 | ps |
| | | $V_T = 1.5\text{ V}, \text{Ref clocks}$ | | 1032 | 1250 | |

¹Guaranteed by design, not 100% tested in production.

Shared Pin Operation - Input/Output Pins

The I/O pins designated by (input/output) on the ICS94211 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.

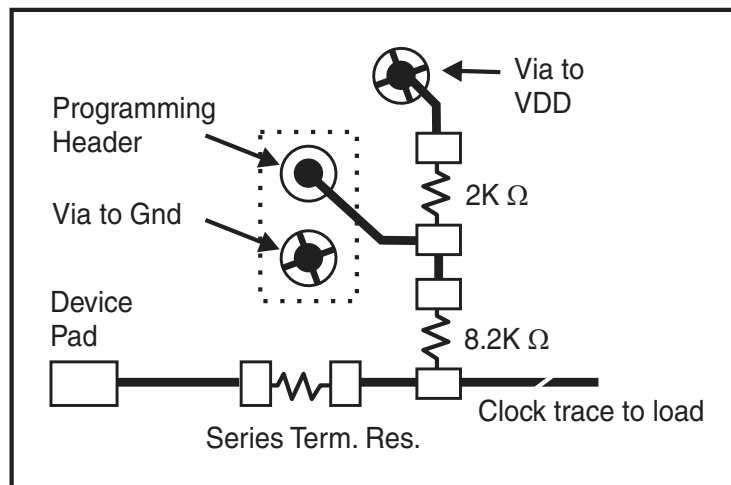
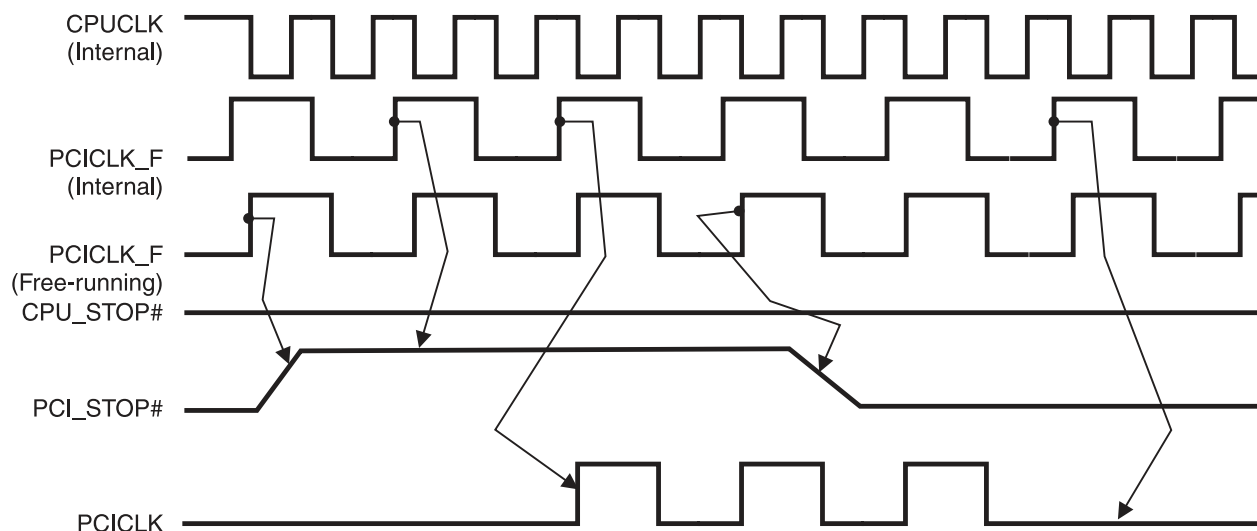


Fig. 1

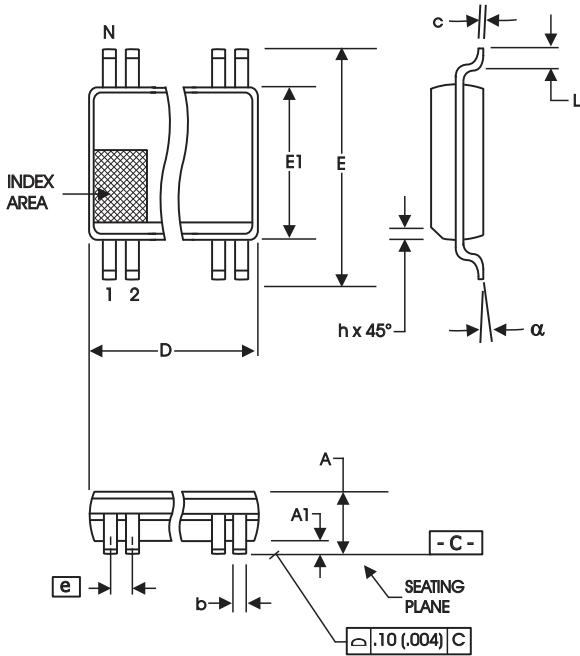
PCI_STOP# Timing Diagram

PCI_STOP# is an asynchronous input to the **ICS94211**. It is used to turn off the PCICLK clocks for low power operation. PCI_STOP# is synchronized by the **ICS94211** 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 ICS94211 device.)
2. PCI_STOP# is an asynchronous input, and metastable conditions may exist. This signal is required to be synchronized inside the ICS94211.
3. All other clocks continue to run undisturbed.
4. CPU_STOP# is shown in a high (true) state.



| SYMBOL | In Millimeters COMMON DIMENSIONS | | In Inches 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° |

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

Reference Doc.: JEDEC Publication 95, MO-118

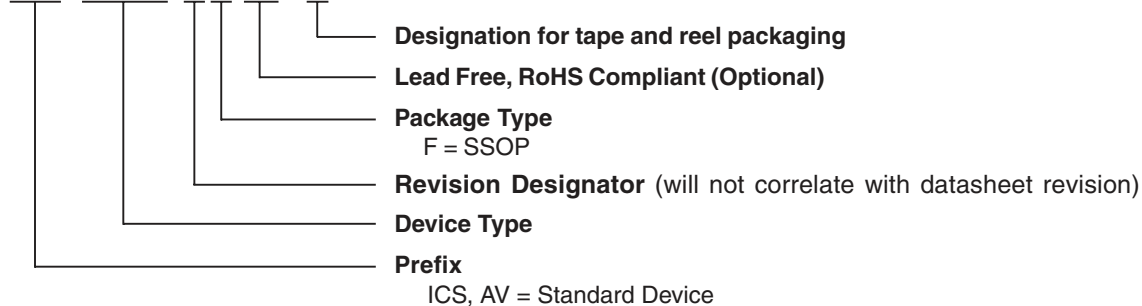
10-0034

Ordering Information

ICS94211yFLF-T

Example:

ICS XXXX y F LF -T



Revision History

| Rev. | Issue Date | Description | Page # |
|-------------|-------------------|--------------------------------|---------------|
| F | 8/24/2005 | Added LF Ordering Information. | 16 |
| | | | |
| | | | |

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