



# Bx Notebook System Frequency Synthesizer

## Features

- Maximized EMI suppression using Cypress's Spread Spectrum Technology
- Two copies of CPU output
- Six copies of PCI output (Synchronous w/CPU output)
- One 48-MHz output for USB support
- One selectable 24-/48-MHz output
- Two Buffered copies of 14.318-MHz input reference signal
- Supports 100-MHz or 66-MHz CPU operation
- Power management control input pins
- Available in 28-pin SSOP (209 mils)
- SS function can be disabled
- See W40S11-02 for 2 SDRAM DIMM support

## Key Specifications

Supply Voltages: .....  $V_{DDQ3} = 3.3V \pm 5\%$   
 $V_{DDQ2} = 2.5V \pm 5\%$   
 CPU0:1 Output to Output Skew: ..... 175 ps  
 CPU0:1 Cycle to Cycle Jitter: ..... 200 ps

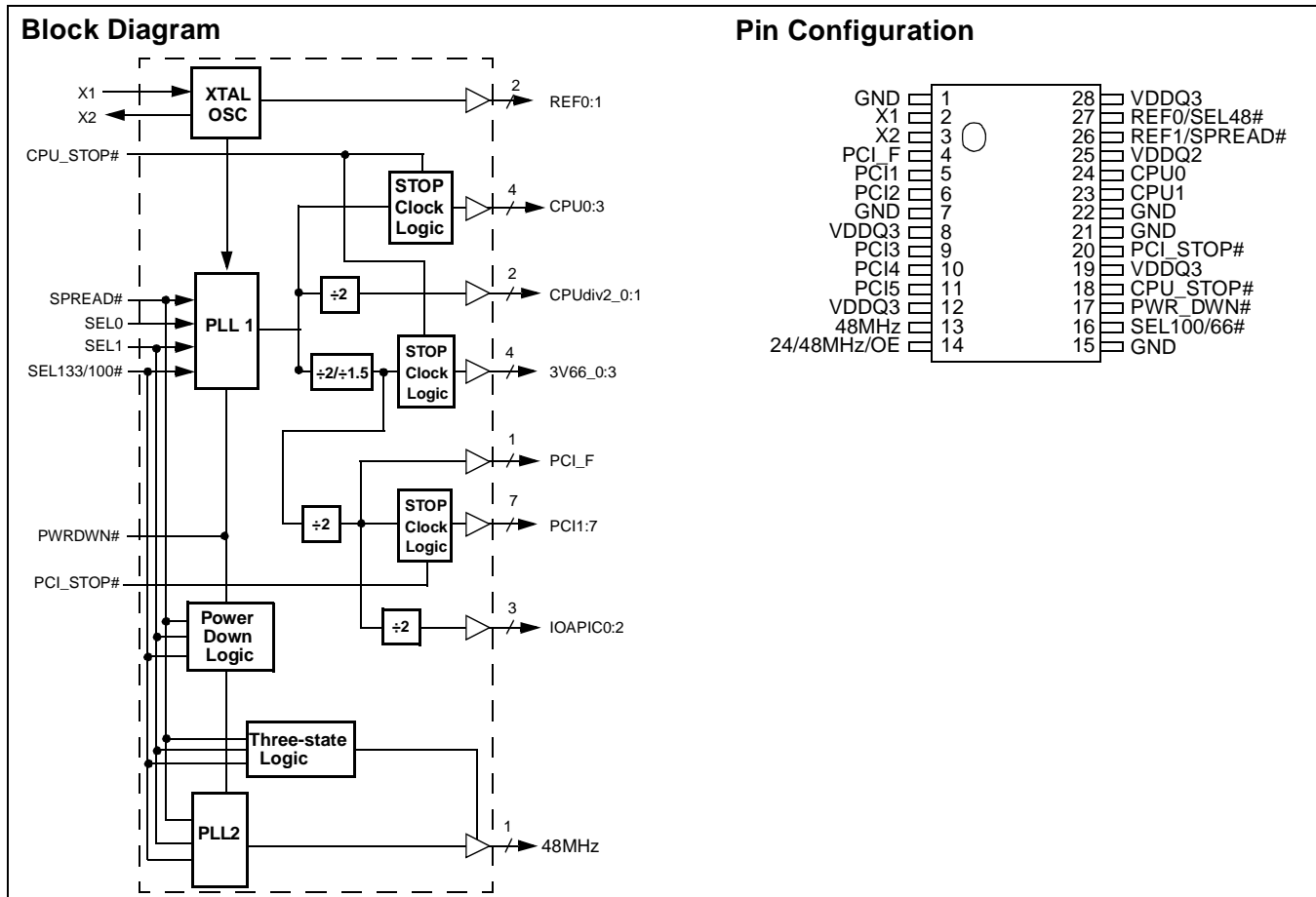
PCI\_F, PCI1:5 Output to Output Skew:..... 500 ps  
 PCI\_F, PCI1:5 Cycle to Cycle Jitter:..... 250 ps  
 CPU to PCI Output Skew: ..... 1.5–4.0 ns (CPU Leads)  
 Output Duty Cycle: ..... 45/55%  
 PCI\_F, PCI Edge Rate:.....  $\geq 1$  V/ns  
 CPU\_STOP#, OE, SPREAD#, SEL48#, PCI\_STOP#, PWR\_DWN# all have a 250-k $\Omega$  pull-up resistor.

Table 1. Pin Selectable Frequency

| SEL100/66# | OE | CPU      | PCI  | Spread%     |
|------------|----|----------|------|-------------|
| 0/1        | 0  | HI-Z     | HI-Z | Don't Care  |
| 0          | 1  | 66.6 MHz | 33.3 | See Table 2 |
| 1          | 1  | 100 MHz  | 33.3 | See Table 2 |

Table 2. Spread Spectrum Feature

| SPREAD# | Spread Profile       |
|---------|----------------------|
| 0       | -0.5% (down spread)  |
| 1       | 0% (spread disabled) |



**Pin Definitions**

| Pin Name     | Pin No.          | Pin Type | Pin Description   |
|--------------|------------------|----------|---|
| CPU0:1       | 24, 23           | O        | <b>CPU Clock Outputs 0 and 1:</b> These two CPU clock outputs are controlled by the CPU_STOP# control pin. Output voltage swing is controlled by voltage applied to VDDQ2. Frequency is selected per <i>Table 1</i> .   |
| PCI1:5       | 5, 6, 9, 10, 11  | O        | <b>PCI Bus Clock Outputs 1 through 5:</b> These five PCI clock outputs are controlled by the PCI_STOP# control pin. Output voltage swing is controlled by voltage applied to VDDQ3. Frequency is selected per <i>Table 1</i> .  |
| PCI_F        | 4                | O        | <b>Fixed PCI Clock Output:</b> Unlike PCI1:5 outputs, this output is not controlled by the PCI_STOP# control pin; it cannot be forced LOW by PCI_STOP#. Output voltage swing is controlled by voltage applied to VDDQ3. Frequency is selected per <i>Table 1</i> .  |
| CPU_STOP#    | 18               | I        | <b>CPU_STOP# Input:</b> When brought LOW, clock outputs CPU0:1 are stopped LOW after completing a full clock cycle (2–3 CPU clock latency). When brought HIGH, clock outputs CPU0:1 start with a full clock cycle (2–3 CPU clock latency).  |
| PCI_STOP#    | 20               | I        | <b>PCI_STOP# Input:</b> The PCI_STOP# input enables the PCI1:5 outputs when HIGH and causes them to remain at logic 0 when LOW. The PCI_STOP# signal is latched on the rising edge of PCI_F. Its effect takes place on the next PCI_F clock cycle.  |
| REF0/SEL48#  | 27               | I/O      | <b>I/O Dual-Function REF0 and SEL48# Pin:</b> Upon power-up, the state of SEL48# is latched. The state is set by either a 10K resistor to GND or to V <sub>DD</sub> . A 10K resistor to GND causes pin 14 to provide a 48-MHz clock. If the pin is strapped to V <sub>DD</sub> , pin 14 will provide a 24-MHz clock. After 2 ms, the pin becomes a high-drive output that produces a copy of 14.318 MHz.  |
| REF1/SPREAD# | 26               | I/O      | <b>I/O Dual-Function REF1 and SPREAD# Pin:</b> Upon power-up, the state of SPREAD# is latched. The state is set by either a 10K resistor to GND or to V <sub>DD</sub> . A 10K resistor to GND enables Spread Spectrum function. If the pin is strapped to V <sub>DD</sub> , Spread Spectrum is disabled. After 2 ms, the pin becomes a high-drive output that produces a copy of 14.318 MHz.  |
| 24/48MHz/OE  | 14               | I/O      | <b>I/O Dual-Function 24-MHz or 48-MHz Output and Output Enable Input:</b> Upon power-up, the state of pin 14 is latched. The state is set by either a 10K resistor to GND or to V <sub>DD</sub> . A 10K resistor to GND latches OE LOW, and all outputs are three-stated. If the pin is strapped to V <sub>DD</sub> , OE is latched HIGH and all outputs are active. After 2 ms, the pin becomes an output whose frequency is set by the state of pin 27 on power-up. |
| 48MHz        | 13               | O        | <b>48-MHz Output:</b> Fixed 48-MHz USB output. Output voltage swing is controlled by voltage applied to VDDQ3.  |
| SEL100/66#   | 16               | I        | <b>Frequency Selection Input:</b> Select power-up default CPU clock frequency as shown in <i>Table 1</i> .  |
| X1           | 2                | I        | <b>Crystal Connection or External Reference Frequency Input:</b> This pin can either be used as a connection to a crystal or to a reference signal.   |
| X2           | 3                | I        | <b>Crystal Connection:</b> An input connection for an external 14.318-MHz crystal. If using an external reference, this pin must be left unconnected.   |
| PWR_DWN#     | 17               | I        | <b>Power Down Control:</b> When this input is LOW, device goes into a low-power standby condition. All outputs are held LOW. CPU and PCI clock outputs are stopped LOW after completing a full clock cycle (2–3 CPU clock cycle latency). When brought HIGH, CPU and PCI outputs start with a full clock cycle at full operating frequency (3 ms maximum latency).  |
| VDDQ3        | 8, 12, 19, 28    | P        | <b>Power Connection:</b> Connected to 3.3V.   |
| VDDQ2        | 25               | P        | <b>Power Connection:</b> Power supply for CPU0:1 output buffers. Connected to 2.5V.   |
| GND          | 1, 7, 15, 21, 22 | G        | <b>Ground Connection:</b> Connect all ground pins to the common system ground plane.  |

## Overview

The W137 was developed to meet the Intel® Mobile Clock specification for the BX chipset, including Super I/O and USB support. The W40S11-02 is the Intel-defined companion part used for driving 2 SDRAM DIMM modules. Please see that data sheet for additional information.

Cypress's proprietary spread spectrum frequency synthesis technique is a feature of the CPU and PCI outputs. When enabled, this feature reduces the peak EMI measurements of not only the output signals and their harmonics, but also of any other clock signals that are properly synchronized to them. The -0.5% modulation profile matches that defined as acceptable in Intel's clock specification.

## Functional Description

### I/O Pin Operation

Pins 14, 26, and 27 are dual-purpose I/O pins. Upon power-up these pins act as logic inputs, allowing the determination of assigned device functions. A short time after power-up, the logic state of each pin is latched and the pins then become clock outputs. This feature reduces device pin count by combining clock outputs with input select pins.

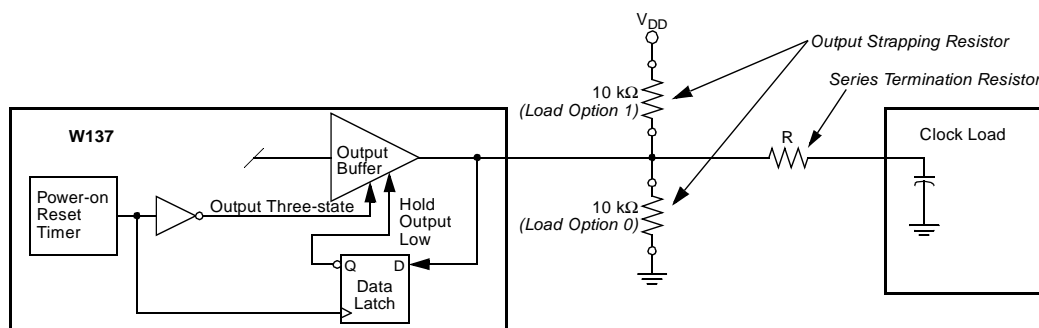
An external 10-k $\Omega$  "strapping" resistor is connected between each I/O pin and ground or  $V_{DD}$ . Connection to ground sets a latch to "0", connection to  $V_{DD}$  sets a latch to "1". *Figure 1* and

*Figure 2* show two suggested methods for strapping resistor connection.

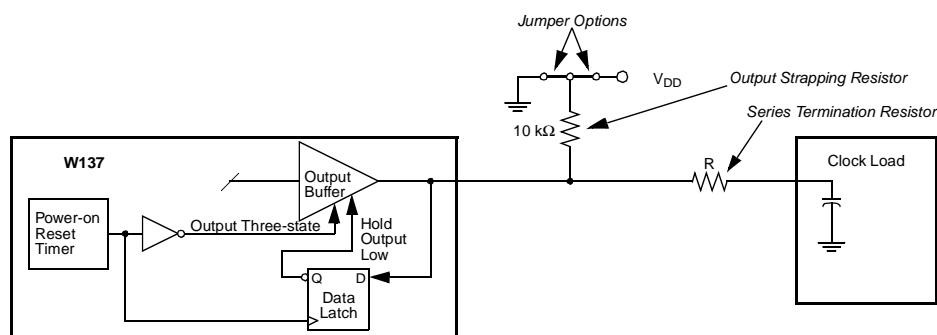
Upon W137 power-up, the first 2 ms of operation is used for input logic selection. During this period, the output buffers are three-stated, allowing the output strapping resistor on each I/O pin to pull the pin and its associated capacitive clock load to either a logic HIGH or logic LOW state. At the end of the 2-ms period, the established logic 0 or 1 condition of each I/O pin is then latched. Next, the output buffers are enabled, which converts both I/O pins into operating clock outputs. The 2-ms timer is started when  $V_{DD}$  reaches 2.0V. The input latches can only be reset by turning  $V_{DD}$  off and then back on again.

It should be noted that the strapping resistors have no significant effect on clock output signal integrity. The drive impedance of the clock output is  $\leq 40\Omega$  (nominal) which is minimally affected by the 10-k $\Omega$  strap to ground or  $V_{DD}$ . As with the series termination resistor, the output strapping resistor should be placed as close to the I/O pin as possible in order to keep the interconnecting trace short. The trace from the resistor to ground or  $V_{DD}$  should be kept less than two inches in length to prevent system noise coupling during input logic sampling.

When the clock outputs are enabled following the 2-ms input period, target (normal) output frequency is delivered assuming that  $V_{DD}$  has stabilized. If  $V_{DD}$  has not yet reached full value, output frequency initially may be below target but will increase to target once  $V_{DD}$  voltage has stabilized. In either case, a short output clock cycle may be produced from the CPU clock outputs when the outputs are enabled.



**Figure 1. Input Logic Selection Through Resistor Load Option**



**Figure 2. Input Logic Selection Through Jumper Option**

### Spread Spectrum Clocking

The device generates a clock that is frequency modulated in order to increase the bandwidth that it occupies. By increasing the bandwidth of the fundamental and its harmonics, the amplitudes of the radiated electromagnetic emissions are reduced. This effect is depicted in *Figure 3*.

As shown in *Figure 3*, a harmonic of a modulated clock has a much lower amplitude than that of an unmodulated signal. The reduction in amplitude is dependent on the harmonic number and the frequency deviation or spread. The equation for the reduction is

$$dB = 6.5 + 9 \cdot \log_{10}(P) + 9 \cdot \log_{10}(F)$$

Where *P* is the percentage of deviation and *F* is the frequency in MHz where the reduction is measured.

The output clock is modulated with a waveform depicted in *Figure 4*. This waveform, as discussed in “Spread Spectrum Clock Generation for the Reduction of Radiated Emissions” by Bush, Fessler, and Hardin produces the maximum reduction in the amplitude of radiated electromagnetic emissions. The deviation selected for this chip is -0.5% of the selected frequency. *Figure 4* details the Cypress spreading pattern. Cypress does offer options with more spread and greater EMI reduction. Contact your local Sales representative for details on these devices.

Spread Spectrum clocking is activated or deactivated through I/O pin #26.

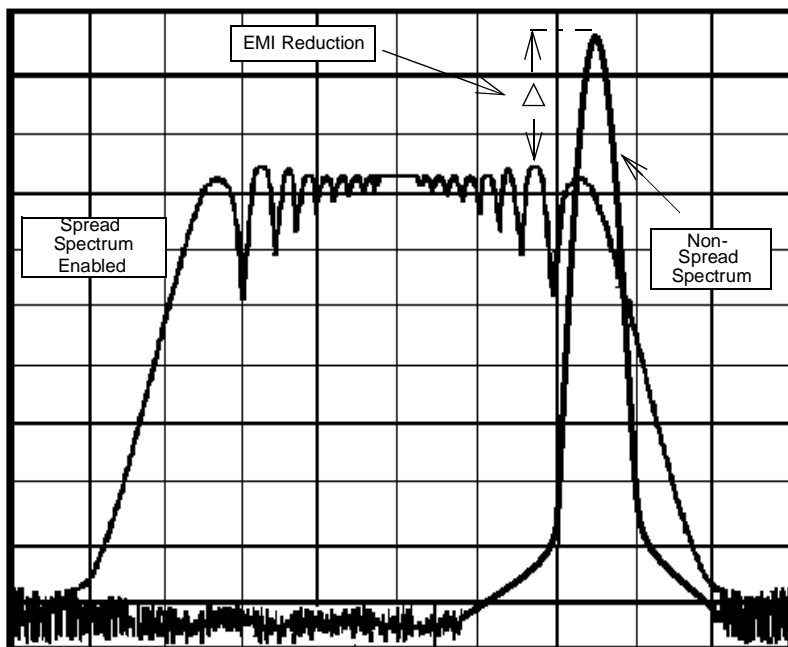


Figure 3. Clock Harmonic with and without SSCG Modulation Frequency Domain Representation

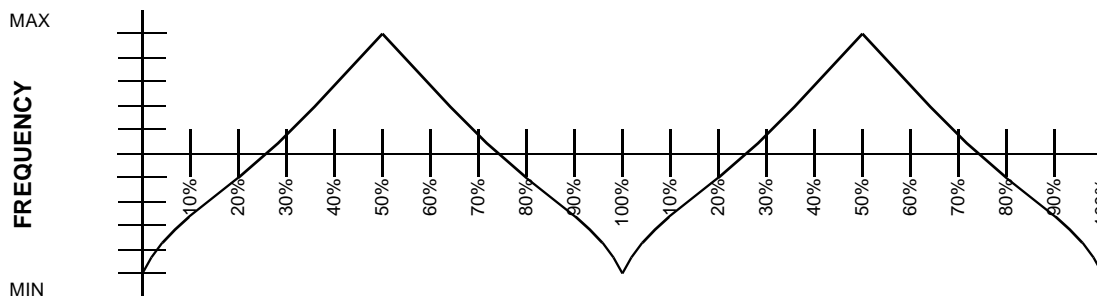


Figure 4. Typical Modulation Profile

## Absolute Maximum Ratings

Stresses greater than those listed in this table may cause permanent damage to the device. These represent a stress rating only. Operation of the device at these or any other conditions

above those specified in the operating sections of this specification is not implied. Maximum conditions for extended periods may affect reliability.

| Parameter        | Description                            | Rating       | Unit |
|------------------|--|--------------|------|
| $V_{DD}, V_{IN}$ | Voltage on any pin with respect to GND | -0.5 to +7.0 | V    |
| $T_{STG}$        | Storage Temperature                    | -65 to +150  | °C   |
| $T_A$            | Operating Temperature                  | 0 to +70     | °C   |
| $T_B$            | Ambient Temperature under Bias         | -55 to +125  | °C   |
| $ESD_{PROT}$     | Input ESD Protection                   | 2 (min.)     | kV   |

## DC Electrical Characteristics:

$T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ;  $V_{DDQ3} = 3.3\text{V} \pm 5\%$ ;  $V_{DDQ2} = 2.5\text{V} \pm 5\%$ ; CPU0:1 = 66.6/100 MHz

| Parameter                 | Description  | Test Condition                                    | Min.      | Typ.              | Max.           | Unit          |
|---------------------------|--|---|-----------|-------------------|----------------|---------------|
| <b>Supply Current</b>     |  |   |           |                   |                |               |
| $I_{DD3PD}$               | 3.3V Supply Current in Power-down mode                       | PWR_DWN# = 0                                      |           | 1                 | 5              | mA            |
| $I_{DD3}$                 | 3.3V Supply Current  | Outputs Loaded <sup>[1]</sup>                     |           | 80                | 100            | mA            |
| $I_{DD2}$                 | 2.5V Supply Current  | Outputs Loaded <sup>[1]</sup>                     |           | 30                | 45             | mA            |
| $I_{DD2PD}$               | 2.5V Supply Current in Power-down mode                       | PWR_DWN# = 0                                      |           | 0.2 $\mu\text{A}$ | 1              | mA            |
| <b>Logic Inputs</b>       |  |   |           |                   |                |               |
| $V_{IL}$                  | Input Low Voltage  |   | GND - 0.3 |                   | 0.8            | V             |
| $V_{IH}$                  | Input High Voltage   |   | 2.0       |                   | $V_{DD} + 0.3$ | V             |
| $I_{IL}$                  | Input Low Current <sup>[2]</sup>                             |   |           |                   | -25            | $\mu\text{A}$ |
| $I_{IH}$                  | Input High Current <sup>[2]</sup>                            |   |           |                   | 10             | $\mu\text{A}$ |
| $I_{IL}$                  | Input Low Current (SEL100/66#)                               |   |           |                   | -5             | $\mu\text{A}$ |
| $I_{IH}$                  | Input High Current (SEL100/66#)                              |   |           |                   | +5             | $\mu\text{A}$ |
| <b>Clock Outputs</b>      |  |   |           |                   |                |               |
| $V_{OL}$                  | Output Low Voltage   | $I_{OL} = 1 \text{ mA}$                           |           |                   | 50             | mV            |
| $V_{OH}$                  | Output High Voltage  | PCI_F, PCI1:5, REF0:1<br>$I_{OH} = -1 \text{ mA}$ | 3.1       |                   |                | V             |
| $V_{OH}$                  | Output High Voltage  | CPU0:1<br>$I_{OH} = -1 \text{ mA}$                | 2.2       |                   |                | V             |
| $I_{OL}$                  | Output Low Current:  | CPU0:1<br>$V_{OL} = 1.25\text{V}$                 | 80        | 120               | 180            | mA            |
|                           |  | PCI_F, PCI1:5<br>$V_{OL} = 1.5\text{V}$           | 70        | 110               | 140            | mA            |
|                           |  | REF0:1<br>$V_{OL} = 1.5\text{V}$                  | 50        | 70                | 90             | mA            |
| $I_{OH}$                  | Output High Current  | CPU0:1<br>$V_{OH} = 1.25\text{V}$                 | 80        | 120               | 180            | mA            |
|                           |  | PCI_F, PCI1:5<br>$V_{OH} = 1.5\text{V}$           | 70        | 110               | 140            | mA            |
|                           |  | REF0:1<br>$V_{OH} = 1.5\text{V}$                  | 50        | 70                | 90             | mA            |
| <b>Crystal Oscillator</b> |  |   |           |                   |                |               |
| $V_{TH}$                  | X1 Input Threshold Voltage <sup>[3]</sup>                    | $V_{DDQ3} = 3.3\text{V}$                          |           | 1.65              |                | V             |
| $C_{LOAD}$                | Load Capacitance, As Seen by External Crystal <sup>[4]</sup> |   |           | 14                |                | pF            |
| $C_{IN,X1}$               | X1 Input Capacitance <sup>[5]</sup>                          | Pin X2 unconnected                                |           | 28                |                | pF            |

### Notes:

- All clock outputs loaded with 6" 60 $\Omega$  transmission lines with 20-pF capacitors.
- CPU\_STOP#, PCI\_STOP#, PWR\_DWN#, SPREAD#, and SEL48# logic inputs have internal pull-up resistors (not CMOS level).
- X1 input threshold voltage (typical) is  $V_{DD}/2$ .
- The W137 contains an internal crystal load capacitor between pin X1 and ground and another between pin X2 and ground. Total load placed on crystal is 14 pF; this includes typical stray capacitance of short PCB traces to crystal.
- X1 input capacitance is applicable when driving X1 with an external clock source (X2 is left unconnected).

**DC Electrical Characteristics:** (continued)

 $T_A = 0^{\circ}\text{C to } +70^{\circ}\text{C}; V_{DDQ3} = 3.3\text{V}\pm 5\%; V_{DDQ2} = 2.5\text{V}\pm 5\%; \text{CPU0:1} = 66.6/100 \text{ MHz}$ 

| Parameter                         | Description            | Test Condition   | Min. | Typ. | Max. | Unit |
|-----------------------------------|------------------------|------------------|------|------|------|------|
| <b>Pin Capacitance/Inductance</b> |                        |                  |      |      |      |      |
| $C_{IN}$                          | Input Pin Capacitance  | Except X1 and X2 |      |      | 5    | pF   |
| $C_{OUT}$                         | Output Pin Capacitance |                  |      |      | 6    | pF   |
| $L_{IN}$                          | Input Pin Inductance   |                  |      |      | 7    | nH   |

**AC Electrical Characteristics**
 $T_A = 0^{\circ}\text{C to } +70^{\circ}\text{C}; V_{DDQ3} = 3.3\text{V}\pm 5\%; V_{DDQ2} = 2.5\text{V}\pm 5\%; f_{XTL} = 14.31818 \text{ MHz}$ 

AC clock parameters are tested and guaranteed over stated operating conditions using the stated lump capacitive load at the clock output.

**CPU Clock Outputs, CPU0:1 (Lump Capacitance Test Load = 20 pF)**

| Parameter | Description  | Test Condition/Comments   | CPU = 66.6 MHz |      |      | CPU = 100 MHz |      |      | Unit     |
|-----------|--|---|----------------|------|------|---------------|------|------|----------|
|           |  |   | Min.           | Typ. | Max. | Min.          | Typ. | Max. |          |
| $t_P$     | Period   | Measured on rising edge at 1.25V  | 15             |      | 15.5 | 10            |      | 10.5 | ns       |
| $t_H$     | High Time  | Duration of clock cycle above 2.0V  | 5.2            |      |      | 3.0           |      |      | ns       |
| $t_L$     | Low Time   | Duration of clock cycle below 0.4V  | 5.0            |      |      | 2.8           |      |      | ns       |
| $t_R$     | Output Rise Edge Rate                              | Measured from 0.4V to 2.0V  | 1              |      | 4    | 1             |      | 4    | V/ns     |
| $t_F$     | Output Fall Edge Rate                              | Measured from 2.0V to 0.4V  | 1              |      | 4    | 1             |      | 4    | V/ns     |
| $t_D$     | Duty Cycle   | Measured on rising and falling edge at 1.25V  | 45             |      | 55   | 45            |      | 55   | %        |
| $t_{JC}$  | Jitter, Cycle-to-Cycle                             | Measured on rising edge at 1.25V. Maximum difference of cycle time between two adjacent cycles.                     |                |      | 200  |               |      | 200  | ps       |
| $t_{SK}$  | Output Skew  | Measured on rising edge at 1.25V  |                |      | 175  |               |      | 175  | ps       |
| $f_{ST}$  | Frequency Stabilization from Power-up (cold start) | Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization. |                |      | 3    |               |      | 3    | ms       |
| $Z_O$     | AC Output Impedance                                | Average value during switching transition. Used for determining series termination value.                           |                | 13.5 |      |               | 13.5 |      | $\Omega$ |

**PCI Clock Outputs, PCI1:5 and PCI\_F (Lump Capacitance Test Load = 30 pF)**

| Parameter       | Description  | Test Condition/Comments   | CPU = 66.6/100 MHz |      |      | Unit |
|-----------------|--|---|--------------------|------|------|------|
|                 |  |   | Min.               | Typ. | Max. |      |
| t <sub>P</sub>  | Period   | Measured on rising edge at 1.5V   | 30                 |      |      | ns   |
| t <sub>H</sub>  | High Time  | Duration of clock cycle above 2.4V  | 12.0               |      |      | ns   |
| t <sub>L</sub>  | Low Time   | Duration of clock cycle below 0.4V  | 12.0               |      |      | ns   |
| t <sub>R</sub>  | Output Rise Edge Rate                              | Measured from 0.4V to 2.4V  | 1                  |      | 4    | V/ns |
| t <sub>F</sub>  | Output Fall Edge Rate                              | Measured from 2.4V to 0.4V  | 1                  |      | 4    | V/ns |
| t <sub>D</sub>  | Duty Cycle   | Measured on rising and falling edge at 1.5V   | 45                 |      | 55   | %    |
| t <sub>JC</sub> | Jitter, Cycle-to-Cycle                             | Measured on rising edge at 1.5V. Maximum difference of cycle time between two adjacent cycles.                      |                    |      | 250  | ps   |
| t <sub>SK</sub> | Output Skew  | Measured on rising edge at 1.5V   |                    |      | 500  | ps   |
| t <sub>O</sub>  | CPU to PCI Clock Offset                            | Covers all CPU/PCI outputs. Measured on rising edge at 1.5V. CPU leads PCI output.                                  | 1.5                |      | 4.0  | ns   |
| f <sub>ST</sub> | Frequency Stabilization from Power-up (cold start) | Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization. |                    |      | 3    | ms   |
| Z <sub>O</sub>  | AC Output Impedance                                | Average value during switching transition. Used for determining series termination value.                           |                    | 20   |      | Ω    |

**REF0:1 Clock Output (Lump Capacitance Test Load = 20 pF)**

| Parameter       | Description  | Test Condition/Comments   | CPU = 66.6/100 MHz |      |      | Unit |
|-----------------|--|---|--------------------|------|------|------|
|                 |  |   | Min.               | Typ. | Max. |      |
| f               | Frequency, Actual                                  | Determined by crystal oscillator frequency  | 14.318             |      |      | MHz  |
| t <sub>R</sub>  | Output Rise Edge Rate                              | Measured from 0.4V to 2.4V  | 0.5                |      | 2    | V/ns |
| t <sub>F</sub>  | Output Fall Edge Rate                              | Measured from 2.4V to 0.4V  | 0.5                |      | 2    | V/ns |
| t <sub>D</sub>  | Duty Cycle   | Measured on rising and falling edge at 1.5V   | 45                 |      | 55   | %    |
| f <sub>ST</sub> | Frequency Stabilization from Power-up (cold start) | Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization. |                    |      | 3    | ms   |
| Z <sub>O</sub>  | AC Output Impedance                                | Average value during switching transition. Used for determining series termination value.                           |                    | 25   |      | Ω    |

**48-MHz and 24-MHz Clock Outputs (Lump Capacitance Test Load = 20 pF)**

| Parameter       | Description  | Test Condition/Comments   | CPU = 66.6/100 MHz |      |      | Unit |
|-----------------|--|---|--------------------|------|------|------|
|                 |  |   | Min.               | Typ. | Max. |      |
| f               | Frequency, Actual                                  | Determined by PLL divider ratio (see n/m below)   | 48.008<br>24.004   |      |      | MHz  |
| f <sub>D</sub>  | Deviation from 48 MHz                              | (48.008 – 48)/48  | +167               |      |      | ppm  |
| m/n             | PLL Ratio  | (14.31818 MHz x 57/17 = 48.008 MHz)   | 57/17, 57/34       |      |      |      |
| t <sub>R</sub>  | Output Rise Edge Rate                              | Measured from 0.4V to 2.4V  | 0.5                |      | 2    | V/ns |
| t <sub>F</sub>  | Output Fall Edge Rate                              | Measured from 2.4V to 0.4V  | 0.5                |      | 2    | V/ns |
| t <sub>D</sub>  | Duty Cycle   | Measured on rising and falling edge at 1.5V   | 45                 |      | 55   | %    |
| f <sub>ST</sub> | Frequency Stabilization from Power-up (cold start) | Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization. |                    |      | 3    | ms   |
| Z <sub>O</sub>  | AC Output Impedance                                | Average value during switching transition. Used for determining series termination value.                           |                    | 25   |      | Ω    |

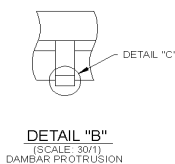
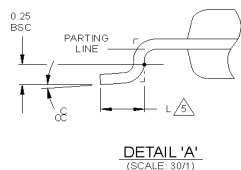
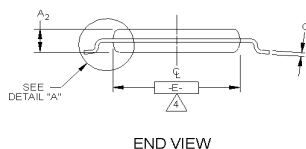
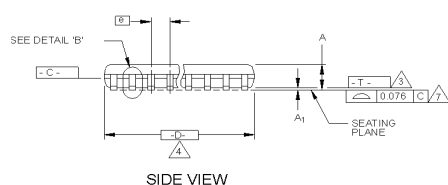
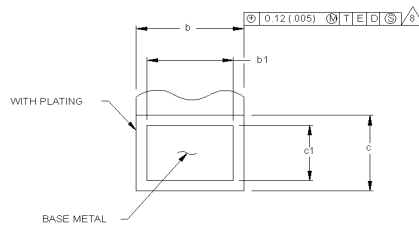
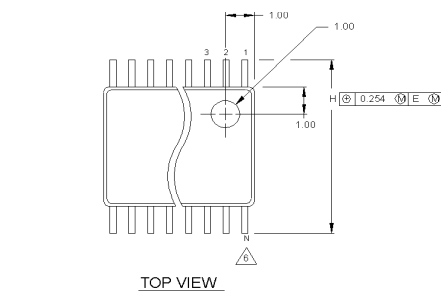
**Ordering Information**

| Ordering Code | Package Name | Package Type            |
|---------------|--------------|-------------------------|
| W137          | H            | 28-pin SSOP (209 mils)  |
|               | X            | 28-pin TSSOP (173 mils) |

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Document #: 38-00821



**Package Diagrams**
**28-Pin Thin Small Shrink Outline Package (TSSOP, 173 mils)**


- NOTES:**
- DIE THICKNESS ALLOWABLE IS 0.279±0.0127 (0.110±0.005 INCHES)
  - DIMENSIONING & TOLERANCES PER ANSI Y14.5M-1982.
  - "T" IS A REFERENCE DATUM.
  - "D" & "E" ARE REFERENCE DATUMS AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS, AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15mm PER SIDE. DIMENSION IS THE LENGTH OF TERMINAL FOR SOLDERING TO A SUBSTRATE.
  - TERMINAL POSITIONS ARE SHOWN FOR REFERENCE ONLY.
  - FORMED LEADS SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITHIN 0.076mm AT SEATING PLANE.
  - THE LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08mm TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND AN ADJACENT LEAD TO BE 0.14mm SEE DETAILS "B" AND "C".
  - DETAIL "C" TO BE DETERMINED AT 0.10 TO 0.25 MM FROM THE LEAD TIP.
  - CONTROLLING DIMENSION: MILLIMETERS.
  - THIS PART IS COMPLIANT WITH JEDEC SPECIFICATION MO-153. VARIATIONS AA, AB, AC, AD AND AE.

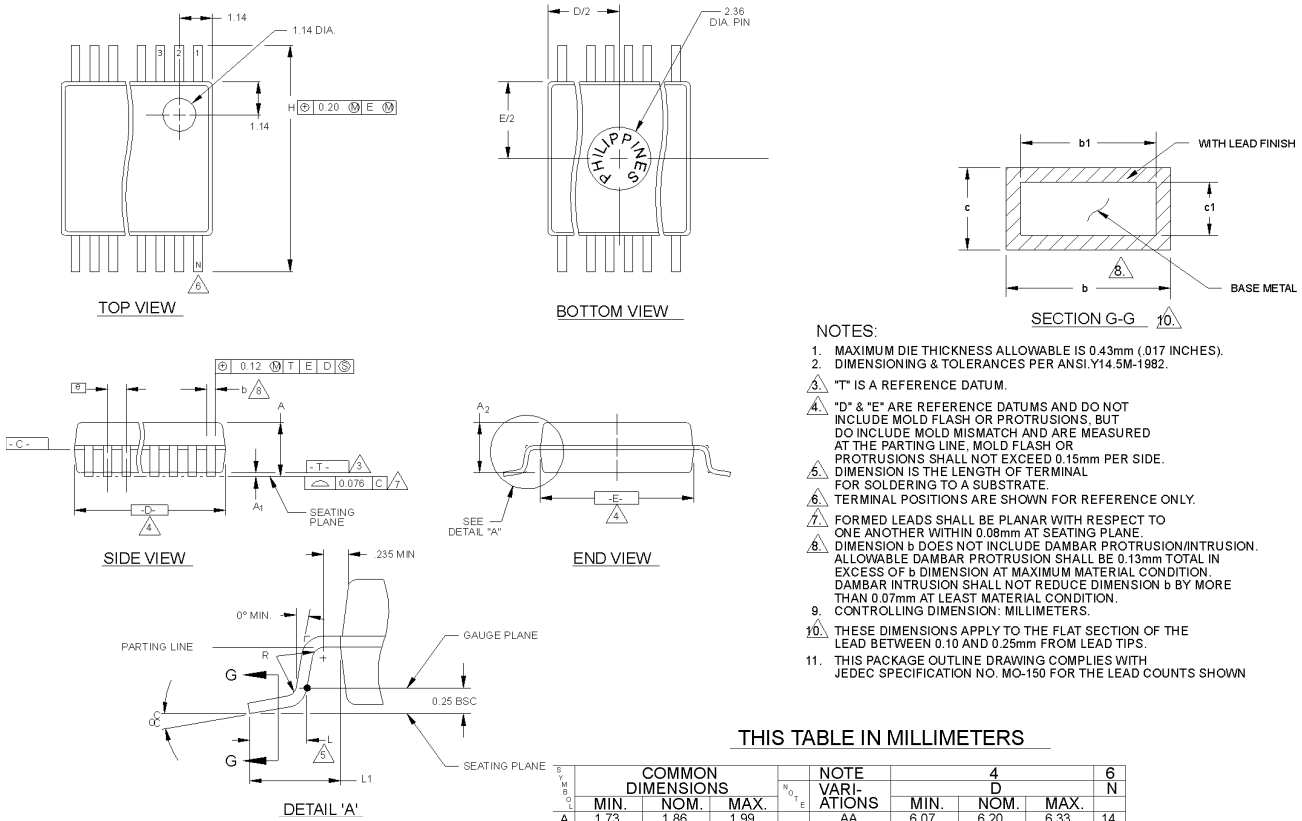
**THIS TABLE IN MILLIMETERS**

| S<br>V<br>M<br>B<br>O<br>L | COMMON DIMENSIONS |       |       | N<br>O<br>T<br>E | 4<br>D |      |      | 6<br>N |
|----------------------------|-------------------|-------|-------|------------------|--------|------|------|--------|
|                            | MIN.              | NOM.  | MAX.  |                  | MIN.   | NOM. | MAX. |        |
| A                          |                   |       | 1.10  | AA               | 2.90   | 3.00 | 3.10 | 8      |
| A <sub>1</sub>             | 0.05              | 0.10  | 0.15  | AB               | 4.90   | 5.00 | 5.10 | 14     |
| A <sub>2</sub>             | 0.85              | 0.90  | 0.95  | AC               | 4.90   | 5.00 | 5.10 | 16     |
| b                          | 0.19              | -     | 0.30  | AD               | 6.40   | 6.50 | 6.60 | 20     |
| b1                         | 0.19              | 0.22  | 0.25  | AE               | 7.70   | 7.80 | 7.90 | 24     |
| c                          | 0.090             | -     | 0.20  | AF               | 9.60   | 9.70 | 9.80 | 28     |
| c1                         |                   | 0.127 | 0.135 |                  |        |      |      |        |
| D                          | SEE VARIATIONS    |       |       | 4                |        |      |      |        |
| E                          | 4.30              | 4.40  | 4.50  | 4                |        |      |      |        |
| e                          | 0.65 BSC          |       |       |                  |        |      |      |        |
| H                          | 6.25              | 6.40  | 6.50  |                  |        |      |      |        |
| L                          | 0.50              | 0.60  | 0.70  | 5                |        |      |      |        |
| N                          | SEE VARIATIONS    |       |       | 6                |        |      |      |        |
| ∠                          | 0°                | 4°    | 8°    |                  |        |      |      |        |

**THIS TABLE IN INCHES**

| S<br>V<br>M<br>B<br>O<br>L | COMMON DIMENSIONS |       |       | N<br>O<br>T<br>E | 4<br>D |      |      | 6<br>N |
|----------------------------|-------------------|-------|-------|------------------|--------|------|------|--------|
|                            | MIN.              | NOM.  | MAX.  |                  | MIN.   | NOM. | MAX. |        |
| A                          |                   |       | .0433 | AA               | .114   | .118 | .122 | 8      |
| A <sub>1</sub>             | .002              | .004  | .006  | AB               | .193   | .197 | .201 | 14     |
| A <sub>2</sub>             | .0335             | .0354 | .0374 | AC               | .193   | .197 | .201 | 16     |
| b                          | .0075             | -     | .0118 | AD               | .252   | .256 | .260 | 20     |
| b1                         | .0075             | .0087 | .0098 | AE               | .303   | .307 | .311 | 24     |
| c                          | .0035             | -     | .0079 | AF               | .378   | .382 | .386 | 28     |
| c1                         | .0035             | .0050 | .0053 |                  |        |      |      |        |
| D                          | SEE VARIATIONS    |       |       | 4                |        |      |      |        |
| E                          | .169              | .173  | .177  | 4                |        |      |      |        |
| e                          | .0256 BSC         |       |       |                  |        |      |      |        |
| H                          | .246              | .252  | .256  |                  |        |      |      |        |
| L                          | .020              | .024  | .028  | 5                |        |      |      |        |
| N                          | SEE VARIATIONS    |       |       | 6                |        |      |      |        |
| ∠                          | 0°                | 4°    | 8°    |                  |        |      |      |        |

\*VARIATION AF IS DESIGNED BUT NOT TOOLED\*

**Package Diagrams (continued)**
**28-Pin Small Shrink Outline Package (SSOP, 209 mils)**


- NOTES:**
1. MAXIMUM DIE THICKNESS ALLOWABLE IS 0.43mm (.017 INCHES).
  2. DIMENSIONING & TOLERANCES PER ANSI.Y14.5M-1982.
  3. "T" IS A REFERENCE DATUM.
  4. "D" & "E" ARE REFERENCE DATUMS AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS, BUT DO INCLUDE MOLD MISMATCH AND ARE MEASURED AT THE PARTING LINE, MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15mm PER SIDE.
  5. DIMENSION IS THE LENGTH OF TERMINAL FOR SOLDERING TO A SUBSTRATE.
  6. TERMINAL POSITIONS ARE SHOWN FOR REFERENCE ONLY.
  7. FORMED LEADS SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITHIN 0.08mm AT SEATING PLANE.
  8. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION/INTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13mm TOTAL IN EXCESS OF b DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR INTRUSION SHALL NOT REDUCE DIMENSION b BY MORE THAN 0.07mm AT LEAST MATERIAL CONDITION. CONTROLLING DIMENSION: MILLIMETERS.
  - 9.
  10. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10 AND 0.25mm FROM LEAD TIPS.
  11. THIS PACKAGE OUTLINE DRAWING COMPLIES WITH JEDEC SPECIFICATION NO. MO-150 FOR THE LEAD COUNTS SHOWN

**THIS TABLE IN MILLIMETERS**

| SYMBOL         | COMMON DIMENSIONS |      |      | NOTE VARIATIONS | 4 D   |       |       | 6 N |
|----------------|-------------------|------|------|-----------------|-------|-------|-------|-----|
|                | MIN.              | NOM. | MAX. |                 | MIN.  | NOM.  | MAX.  |     |
| A              | 1.73              | 1.86 | 1.99 | AA              | 6.07  | 6.20  | 6.33  | 14  |
| A <sub>1</sub> | 0.05              | 0.13 | 0.21 | AB              | 6.07  | 6.20  | 6.33  | 16  |
| A <sub>2</sub> | 1.68              | 1.73 | 1.78 | AC              | 7.07  | 7.20  | 7.33  | 20  |
| b              | 0.25              | -    | 0.38 | AD              | 8.07  | 8.20  | 8.33  | 24  |
| b <sub>1</sub> | 0.25              | 0.30 | 0.33 | AE              | 10.07 | 10.20 | 10.33 | 28  |
| c              | 0.09              | -    | 0.20 | AF              | 10.07 | 10.20 | 10.33 | 30  |
| c <sub>1</sub> | 0.09              | 0.15 | 0.16 |                 |       |       |       |     |
| D              | SEE VARIATIONS    |      |      |                 |       |       |       | 4   |
| E              | 5.20              | 5.30 | 5.38 |                 |       |       |       | 4   |
| e              | 0.65 BSC          |      |      |                 |       |       |       |     |
| H              | 7.65              | 7.80 | 7.90 |                 |       |       |       |     |
| L              | 0.63              | 0.75 | 0.95 |                 |       |       |       | 5   |
| L <sub>1</sub> | 1.25 REF          |      |      |                 |       |       |       |     |
| N              | SEE VARIATIONS    |      |      |                 |       |       |       | 6   |
| 0°             | 0°                | 4°   | 8°   |                 |       |       |       |     |
| R              | 0.09              | 0.15 |      |                 |       |       |       |     |

**VARIATION AF IS DESIGNED BUT NOT TOOLED**

**THIS TABLE IN INCHES**

| SYMBOL         | COMMON DIMENSIONS |      |      | NOTE VARIATIONS | 4 D  |      |      | 6 N |
|----------------|-------------------|------|------|-----------------|------|------|------|-----|
|                | MIN.              | NOM. | MAX. |                 | MIN. | NOM. | MAX. |     |
| A              | .068              | .073 | .078 | AA              | .239 | .244 | .249 | 14  |
| A <sub>1</sub> | .002              | .005 | .008 | AB              | .239 | .244 | .249 | 16  |
| A <sub>2</sub> | .066              | .068 | .070 | AC              | .278 | .284 | .289 | 20  |
| b              | .010              | -    | .015 | AD              | .318 | .323 | .328 | 24  |
| b <sub>1</sub> | .010              | .012 | .013 | AE              | .397 | .402 | .407 | 28  |
| c              | .004              | -    | .008 | AF              | .397 | .402 | .407 | 30  |
| c <sub>1</sub> | .004              | .006 | .006 |                 |      |      |      |     |
| D              | SEE VARIATIONS    |      |      |                 |      |      |      | 4   |
| E              | .205              | .209 | .212 |                 |      |      |      | 4   |
| e              | .0256 BSC         |      |      |                 |      |      |      |     |
| H              | .301              | .307 | .311 |                 |      |      |      |     |
| L              | .025              | .030 | .037 |                 |      |      |      | 5   |
| L <sub>1</sub> | .049 REF          |      |      |                 |      |      |      |     |
| N              | SEE VARIATIONS    |      |      |                 |      |      |      | 6   |
| 0°             | 0°                | 4°   | 8°   |                 |      |      |      |     |
| R              | .004              | .006 |      |                 |      |      |      |     |