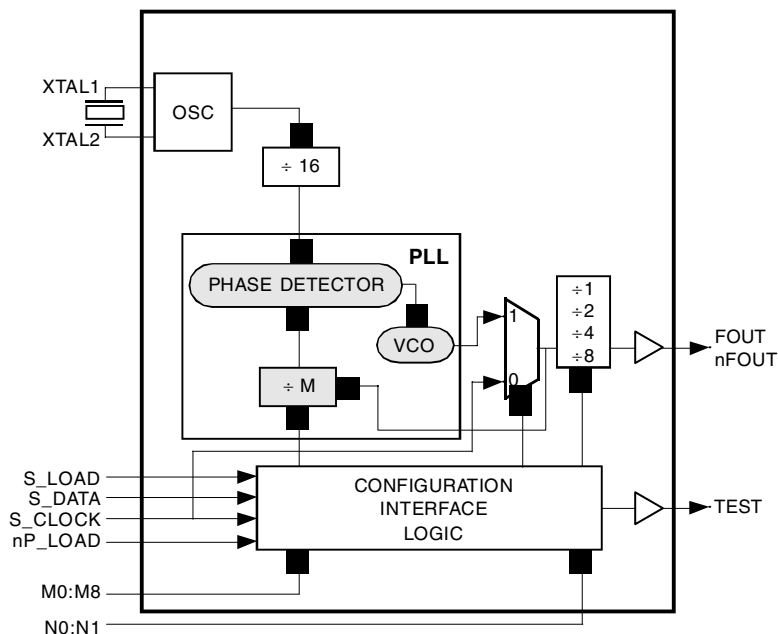


General Description

The 84329-01 is a general purpose, single output high frequency synthesizer. The VCO operates at a frequency range of 200MHz to 700MHz. The VCO frequency is programmed in steps equal to the value of the crystal frequency divided by 16. The VCO and output frequency can be programmed using the serial or parallel interfaces to the configuration logic. The output can be configured to divide the VCO frequency by 1, 2, 4, and 8. Output frequency steps as small as 125kHz to 1MHz can be achieved using a 16MHz crystal depending on the output dividers.

Block Diagram



FEATURES

- Fully integrated PLL, no external loop filter requirements
- 1 differential 3.3V LVPECL output
- Crystal oscillator interface
- Output frequency range: 25MHz to 700MHz
- VCO range: 200MHz to 700MHz
- Parallel interface for programming counter and output dividers during power-up
- Serial 3 wire interface
- RMS Period jitter: 5.5ps (maximum)
- Cycle-to-cycle jitter: 35ps (maximum)
- 3.3V supply voltage
- 0°C to 70°C ambient operating temperature
- Available in both standard (RoHS 5) and lead-free (RoHS 6) packages

PIN ASSIGNMENT

| | | | |
|------|----|----|---------|
| M0 | 1 | 28 | nP_LOAD |
| M1 | 2 | 27 | VCC |
| M2 | 3 | 26 | XTAL2 |
| M3 | 4 | 25 | XTAL1 |
| M4 | 5 | 24 | nc |
| M5 | 6 | 23 | nc |
| M6 | 7 | 22 | VCCA |
| M7 | 8 | 21 | S_LOAD |
| M8 | 9 | 20 | S_DATA |
| N0 | 10 | 19 | S_CLOCK |
| N1 | 11 | 18 | VCC |
| VEE | 12 | 17 | FOUT |
| TEST | 13 | 16 | nFOUT |
| VCC | 14 | 15 | VEE |

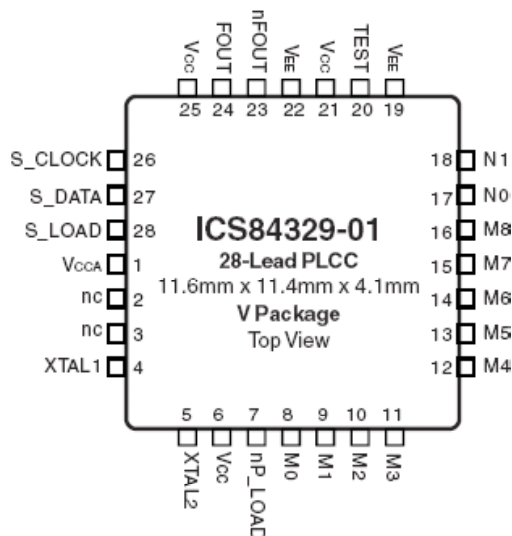
84329-01

28-Lead SOIC

7.5mm x 18.05mm x 2.25mm package body

M Package

Top View



FUNCTIONAL DESCRIPTION

NOTE: The functional description that follows describes operation using a 16MHz crystal. Valid PLL loop divider values for different crystal or input frequencies are defined in the Input Frequency Characteristics, Table 6, NOTE 1.

The 84329-01 features a fully integrated PLL and therefore requires no external components for setting the loop bandwidth. A series-resonant, fundamental crystal is used as the input to the on-chip oscillator. The output of the oscillator is divided by 16 prior to the phase detector. With a 16MHz crystal this provides a 1MHz reference frequency. The VCO of the PLL operates over a range of 200MHz to 700MHz. The output of the M divider is also applied to the phase detector.

The phase detector and the M divider force the VCO output frequency to be M times the reference frequency ÷ 16 by adjusting the VCO control voltage. Note that for some values of M (either too high or too low), the PLL will not achieve lock. The output of the VCO is scaled by a divider prior to being sent to each of the LVPECL output buffers. The divider provides a 50% output duty cycle.

The programmable features of the ICS84329-01 support two input modes to program the M divider and N output divider. The two input operational modes are parallel and serial. Figure 1 shows the timing diagram for each mode. In parallel mode the nP_LOAD input is LOW. The data on inputs M0 through M8 and N0 through N1 is passed directly

to the M divider and N output divider. On the LOW-to-HIGH transition of the nP_LOAD input, the data is latched and the M divider remains loaded until the next LOW transition on nP_LOAD or until a serial event occurs. The TEST output is Mode 000 (shift register out) when operating in the parallel input mode. The relationship between the VCO frequency, the crystal frequency and the M divider is defined as follows:

$$f_{VCO} = \frac{f_{xtal}}{16} \times M$$

The M value and the required values of M0 through M8 are shown in Table 3B, Programmable VCO Frequency Function Table. Valid M values for which the PLL will achieve lock are defined as $200 \leq M \leq 511$. The frequency out is defined as follows:

$$f_{out} = \frac{f_{VCO}}{N} = \frac{f_{xtal}}{16} \times \frac{M}{N}$$

Serial operation occurs when nP_LOAD is HIGH and S_LOAD is LOW. The shift register is loaded by sampling the S_DATA bits with the rising edge of S_CLOCK. The contents of the shift register are loaded into the M divider when S_LOAD transitions from LOW-to-HIGH. The M divide and N output divide values are latched on the HIGH-to-LOW transition of S_LOAD. If S_LOAD is held HIGH, data at the S_DATA input is passed directly to the M divider on each rising edge of S_CLOCK. The serial mode can be used to program the M and N bits and test bits T2:T0. The internal registers T2:T0 determine the state of the TEST output as follows:

| T2 | T1 | T0 | TEST Output | fOUT |
|----|----|----|---|---------------------|
| 0 | 0 | 0 | Shift Register Out | fOUT |
| 0 | 0 | 1 | High | fOUT |
| 0 | 1 | 0 | PLL Reference Xtal ÷ 16 | fOUT |
| 0 | 1 | 1 | VCO ÷ M (non 50% Duty M divider) | fOUT |
| 1 | 0 | 0 | fOUT LVCMOS Output Frequency < 200MHz | fOUT |
| 1 | 0 | 1 | Low | fOUT |
| 1 | 1 | 0 | S_CLOCK ÷ M (non 50% Duty Cycle M divider) | S_CLOCK ÷ N divider |
| 1 | 1 | 1 | fOUT ÷ 4 | fOUT |

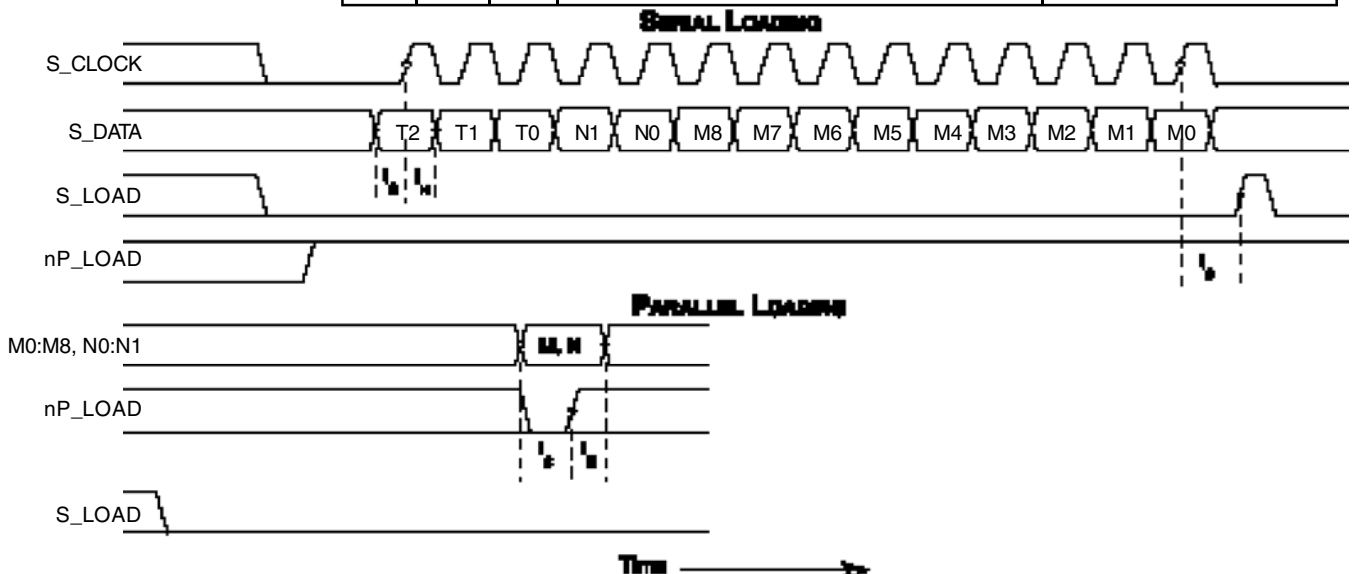


FIGURE 1. PARALLEL & SERIAL LOAD OPERATIONS

TABLE 1. PIN DESCRIPTIONS

| Name | Type | | Description |
|------------------------------------|--------|----------|--|
| M0, M1, M2, M3, M4, M5, M6, M7, M8 | Input | Pullup | M divider inputs. Data latched on LOW-to-HIGH transistion of nP_LOAD input. LVCMOS / LVTTTL interface levels. |
| N0, N1 | Input | Pullup | Determines N output divider value as defined in Table 3C Function Table. LVCMOS / LVTTTL interface levels. |
| V _{EE} | Power | | Negative supply pins. |
| TEST | Output | | Test output which is used in the serial mode of operation. LVCMOS / LVTTTL interface levels. |
| V _{CC} | Power | | Core supply pins. |
| nFOUT, FOUT | Output | | Differential output for the synthesizer. 3.3V LVPECL interface levels. |
| S_CLOCK | Input | Pulldown | Clocks the serial data present at S_DATA input into the shift register on the rising edge of S_CLOCK. LVCMOS / LVTTTL interface levels. |
| S_DATA | Input | Pulldown | Shift register serial input. Data sampled on the rising edge of S_CLOCK. LVCMOS / LVTTTL interface levels. |
| S_LOAD | Input | Pulldown | Controls transition of data from shift register into the M divider. LVCMOS / LVTTTL interface levels. |
| V _{CCA} | Power | | Analog supply pin. |
| nc | Unused | | No connect. |
| XTAL1, XTAL2 | Input | | Crystal oscillator interface. XTAL1 is the input. XTAL2 is the output. |
| nP_LOAD | Input | Pullup | Parallel load input. Determines when data present at M8:M0 is loaded into the M divider, and when data present at N1:N0 sets the N output divider value. LVCMOS / LVTTTL interface levels. |

NOTE: *Pullup* and *Pulldown* refer to internal input resistors. See Table 2, Pin Characteristics, for typical values.

TABLE 2. PIN CHARACTERISTICS

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------------------|-------------------------|-----------------|---------|---------|---------|-------|
| C _{IN} | Input Capacitance | | | 4 | | pF |
| R _{PULLUP} | Input Pullup Resistor | | | 51 | | kΩ |
| R _{PULLDOWN} | Input Pulldown Resistor | | | 51 | | kΩ |

TABLE 3A. PARALLEL AND SERIAL MODE FUNCTION TABLE

| Inputs | | | | | | Conditions |
|---------|------|------|--------|---------|--------|---|
| nP_LOAD | M | N | S_LOAD | S_CLOCK | S_DATA | |
| X | X | X | X | X | X | Reset. M and N bits are all set HIGH. |
| L | Data | Data | X | X | X | Data on M and N inputs passed directly to M divider and N output divider. TEST mode 000. |
| ↑ | Data | Data | L | X | X | Data is latched into input registers and remains loaded until next LOW transition or until a serial event occurs. |
| H | X | X | L | ↑ | Data | Serial input mode. Shift register is loaded with data on S_DATA on each rising edge of S_CLOCK. |
| H | X | X | ↑ | L | Data | Contents of the shift register are passed to the M divider and N output divider. |
| H | X | X | ↓ | L | Data | M divide and N output divide values are latched. |
| H | X | X | L | X | X | Parallel or serial input do not affect shift registers. |

NOTE: L = LOW
H = HIGH
X = Don't care
↑ = Rising edge transition
↓ = Falling edge transition

TABLE 3B. PROGRAMMABLE VCO FREQUENCY FUNCTION TABLE

| VCO Frequency (MHz) | M Divider | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---------------------|-----------|-----|-----|----|----|----|----|----|----|----|
| | | M8 | M7 | M6 | M5 | M4 | M3 | M2 | M1 | M0 |
| 200 | 200 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 201 | 201 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 202 | 202 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 203 | 203 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| • | • | • | • | • | • | • | • | • | • | • |
| • | • | • | • | • | • | • | • | • | • | • |
| 509 | 509 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 510 | 510 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 511 | 511 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

NOTE 1: These M divide values and the resulting frequencies correspond to a crystal frequency of 16MHz.

TABLE 3C. PROGRAMMABLE OUTPUT DIVIDER FUNCTION TABLE

| Inputs | | N Divider Value | Output Frequency (MHz) | |
|--------|----|-----------------|------------------------|---------|
| N1 | N0 | | Minimum | Maximum |
| 0 | 0 | 1 | 200 | 700 |
| 0 | 1 | 2 | 100 | 350 |
| 1 | 0 | 4 | 50 | 175 |
| 1 | 1 | 8 | 25 | 87.5 |

ABSOLUTE MAXIMUM RATINGS

| | |
|--|--------------------------|
| Supply Voltage, V_{CC} | 4.6V |
| Inputs, V_I | -0.5V to $V_{CC} + 0.5V$ |
| Outputs, V_O | -0.5V to $V_{CC} + 0.5V$ |
| Package Thermal Impedance, θ_{JA} | 46.2°C/W (0 lfpm) |
| Storage Temperature, T_{STG} | -65°C to 150°C |

NOTE: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

TABLE 4A. DC POWER SUPPLY CHARACTERISTICS, $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A = 0^\circ\text{C}$ TO 70°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| V_{CC} | Core Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{CCA} | Analog Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| I_{EE} | Power Supply Current | | | | 110 | mA |
| I_{CCA} | Analog Supply Current | | | | 15 | mA |

TABLE 4B. LVCMOS / LVTTTL DC CHARACTERISTICS, $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A = 0^\circ\text{C}$ TO 70°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-----------------------------|---|---------|---------|----------------|---------------|
| V_{IH} | Input High Voltage | S_LOAD, nP_LOAD, S_DATA, S_CLOCK, M0:M8, N0:N1 | 2 | | $V_{CC} + 0.3$ | V |
| V_{IL} | Input Low Voltage | S_LOAD, nP_LOAD, S_DATA, S_CLOCK, M0:M8, N0:N1 | -0.3 | | 0.8 | V |
| I_{IH} | Input High Current | M0-M8, N0, N1, nP_LOAD $V_{CC} = V_{IN} = 3.465V$ | | | 5 | μA |
| | | S_LOAD, S_DATA, S_CLOCK $V_{CC} = V_{IN} = 3.465V$ | | | 150 | μA |
| I_{IL} | Input Low Current | M0-M8, N0, N1, nP_LOAD $V_{CC} = 3.465V, V_{IN} = 0V$ | -150 | | | μA |
| | | S_LOAD, S_DATA, S_CLOCK $V_{CC} = 3.465V, V_{IN} = 0V$ | -5 | | | μA |
| V_{OH} | Output High Voltage; NOTE 1 | | 2.6 | | | V |
| V_{OL} | Output Low Voltage; NOTE 1 | | | | 0.5 | V |

NOTE 1: Outputs terminated with 50Ω to $V_{CC}/2$. See figure "3.3V Output Load Test Circuit" in the "Parameter Measurement Information" section.

TABLE 4C. LVPECL DC CHARACTERISTICS, $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A = 0^\circ\text{C}$ TO 70°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|----------------|---------|----------------|-------|
| V_{OH} | Output High Voltage; NOTE 1 | | $V_{CC} - 1.4$ | | $V_{CC} - 0.9$ | V |
| V_{OL} | Output Low Voltage; NOTE 1 | | $V_{CC} - 2.0$ | | $V_{CC} - 1.7$ | V |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | 0.6 | | 1.0 | V |

NOTE 1: Outputs terminated with 50Ω to $V_{CC} - 2V$.

TABLE 5. CRYSTAL CHARACTERISTICS

| Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|------------------------------------|-----------------|-------------|---------|---------|----------|
| Mode of Oscillation | | Fundamental | | | |
| Frequency | | 10 | | 25 | MHz |
| Equivalent Series Resistance (ESR) | | | | 70 | Ω |
| Shunt Capacitance | | | | 7 | pF |

TABLE 6. INPUT FREQUENCY CHARACTERISTICS, $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|-----------------|-----------------|---------|---------|---------|-------|
| f_{IN} | Input Frequency | XTAL; NOTE 1 | 10 | | 17 | MHz |
| | | XTAL; NOTE 1, 2 | 17 | | 25 | MHz |
| | | S_CLOCK | | | 50 | MHz |

NOTE 1: For the crystal frequency range the M value must be set to achieve the minimum or maximum VCO frequency range of 200MHz or 700MHz. Using the minimum frequency of 10MHz valid values of M are $320 \leq M \leq 511$.

Using the maximum frequency of 25MHz valid values of M are $128 \leq M \leq 448$.

NOTE 2: For crystal frequencies greater than 17MHz, a series tuning capacitor is required for proper operation. For more information, please refer to the Application Information, "Crystal Input and Oscillator Interface".

TABLE 7. AC CHARACTERISTICS, $V_{CC} = V_{CCA} = 3.3V \pm 5\%$, $T_A = 0^\circ C$ TO $70^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------------|----------------------------------|----------------------|---------|---------|---------|-------|
| F_{OUT} | Output Frequency | | | | 700 | MHz |
| $f_{jit(per)}$ | Period Jitter, RMS; NOTE 1, 2 | $f_{OUT} \geq 65MHz$ | | | 5.5 | ps |
| | | $f_{OUT} < 65MHz$ | | | 12 | ps |
| $f_{jit(cc)}$ | Cycle-to-Cycle Jitter; NOTE 1, 2 | $f_{OUT} \geq 50MHz$ | | | 35 | ps |
| | | $f_{OUT} < 50MHz$ | | | 50 | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 300 | | 800 | ps |
| t_S | Setup Time | | 5 | | | ns |
| t_H | Hold Time | | 5 | | | ns |
| t_L | PLL Lock Time | | | | 10 | ms |
| odc | Output Duty Cycle | | 45 | 50 | 55 | % |

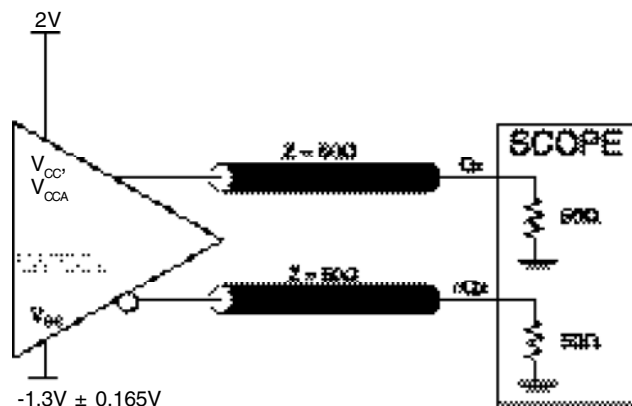
See Parameter Measurement Information section.

Characterized using a 16MHz XTAL.

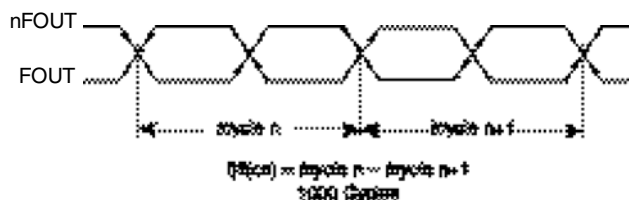
NOTE 1: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 2: See Applications section.

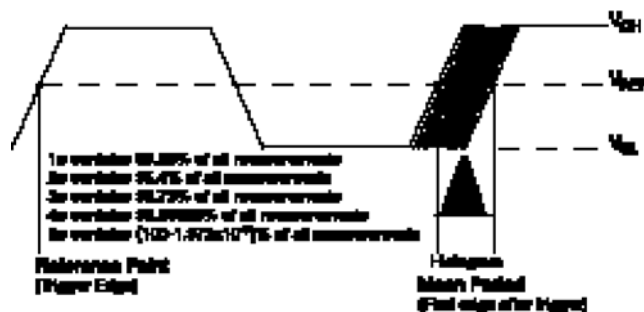
PARAMETER MEASUREMENT INFORMATION



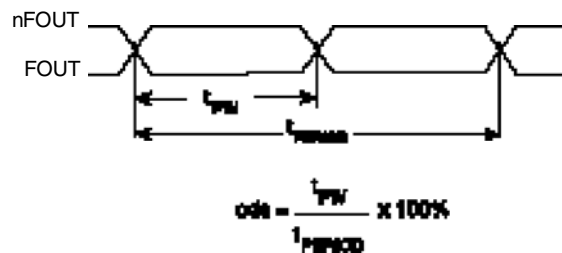
3.3V OUTPUT LOAD AC TEST CIRCUIT



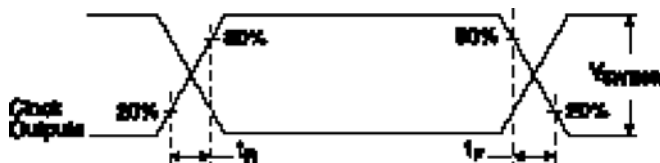
CYCLE-TO-CYCLE JITTER



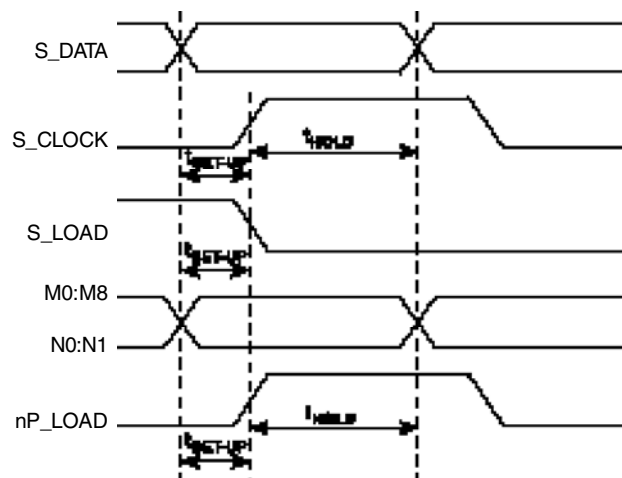
PERIOD JITTER



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



OUTPUT RISE/FALL TIME



SETUP AND HOLD

APPLICATION INFORMATION

POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The 84329-01 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL. V_{CC} and V_{CCA} should be individually connected to the power supply plane through vias, and bypass capacitors should be used for each pin. To achieve optimum jitter performance, power supply isolation is required. *Figure 2* illustrates how a 10Ω resistor along with a $10\mu F$ and a $.01\mu F$ bypass capacitor should be connected to each V_{CCA} pin.

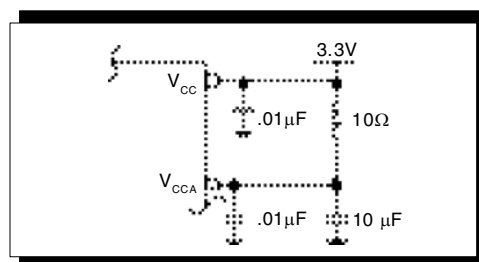


FIGURE 2. POWER SUPPLY FILTERING

TERMINATION FOR LVPECL OUTPUTS

The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

FOUT and nFOUT are low impedance follower outputs that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to

drive 50Ω transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion. *Figures 3A and 3B* show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.

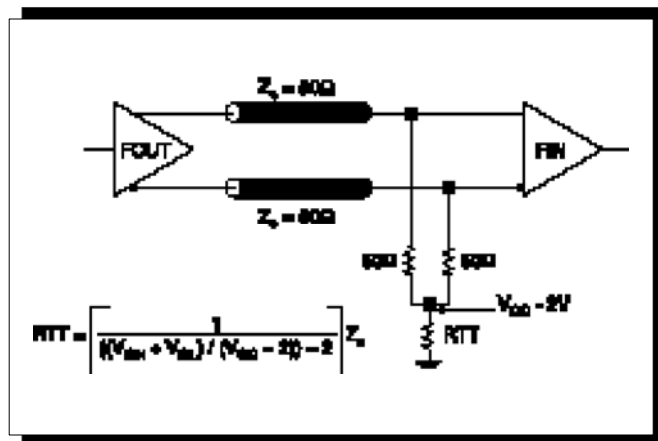


FIGURE 3A. LVPECL OUTPUT TERMINATION

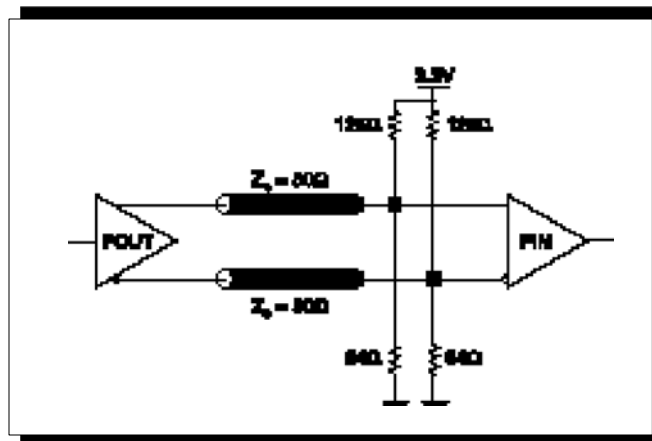


FIGURE 3B. LVPECL OUTPUT TERMINATION

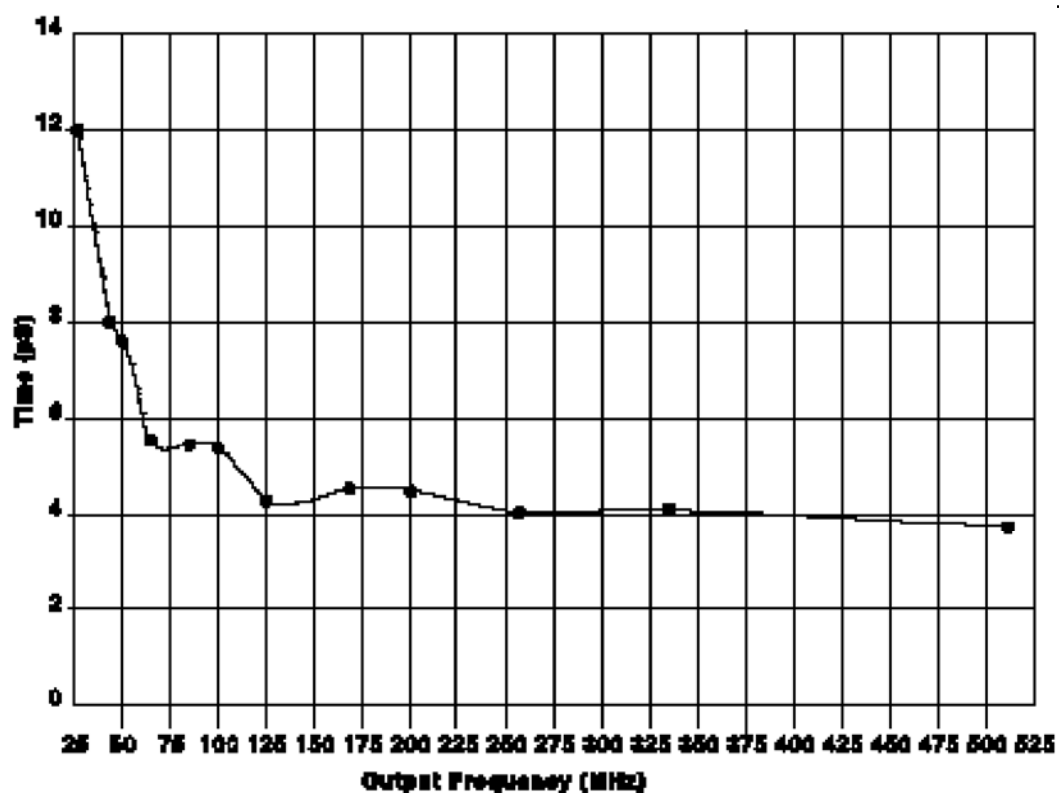


FIGURE 4A. RMS JITTER VS. f_{OUT} (USING A 16MHz XTAL)

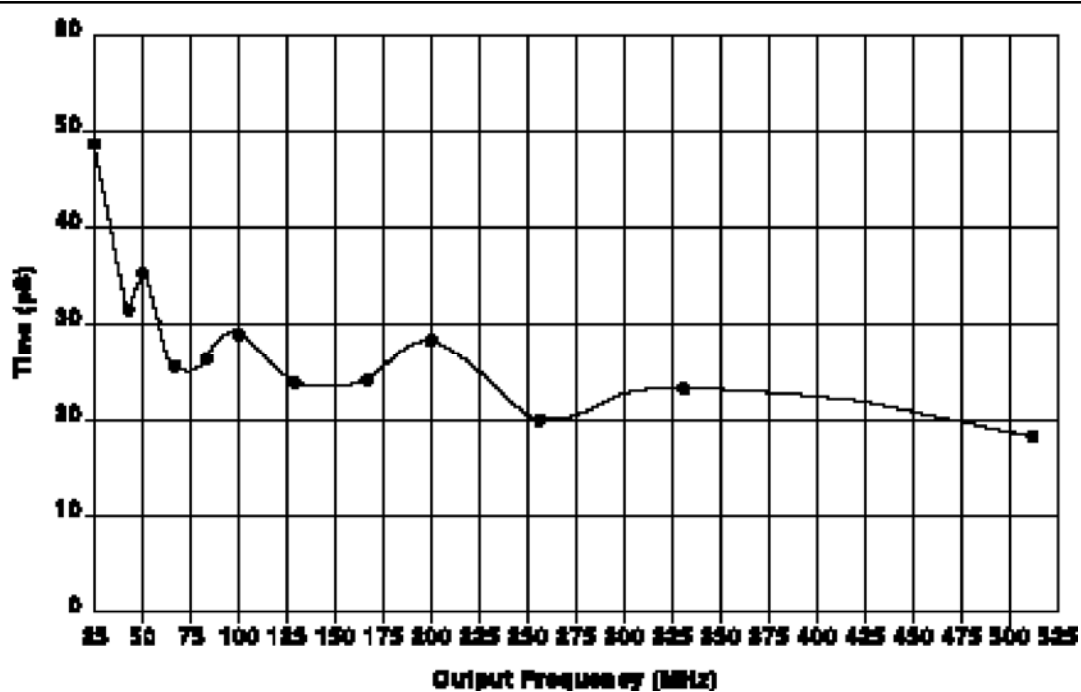


FIGURE 4B. CYCLE-TO-CYCLE JITTER VS. f_{OUT} (USING A 16MHz XTAL)

CRYSTAL INPUT AND OSCILLATOR INTERFACE

The 84329-01 features an internal oscillator that uses an external quartz crystal as the source of its reference frequency. The oscillator is a series resonant, multi-vibrator type design. This design provides better stability and eliminates the need for large on chip capacitors. Though a series resonant crystal is preferred, a parallel resonant crystal can be used. A parallel resonant mode crystal used in a series resonant circuit will exhibit a frequency of oscillation a few hundred ppm lower than specified. A few hundred ppm translates to KHz inaccuracy. In general computing applications, this level of inaccuracy is irrelevant. If better ppm accuracy is required, an external capacitor can be added to a quartz crystal in series to XTAL1. *Figure 5A* shows how to interface with a crystal.

Figures 5A and 5B show various crystal parameters which are recommended only as guidelines. *Figure 5A* shows how to inter-face a capacitor with a parallel resonant crystal. *Figure 5B* shows the capacitor value needed for the optimum ppm performance over various series resonant crystal frequencies. For IA64/32 platforms which required a Raltron Parallel Resonant Quartz crystal part #AS-16.66-18-SMD-T-M1, a 7pF series capacitor can be used to better the ppm accuracy.

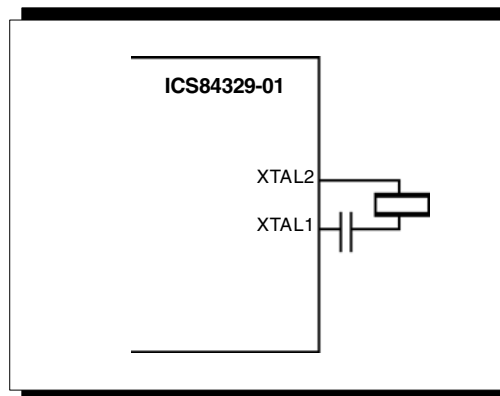
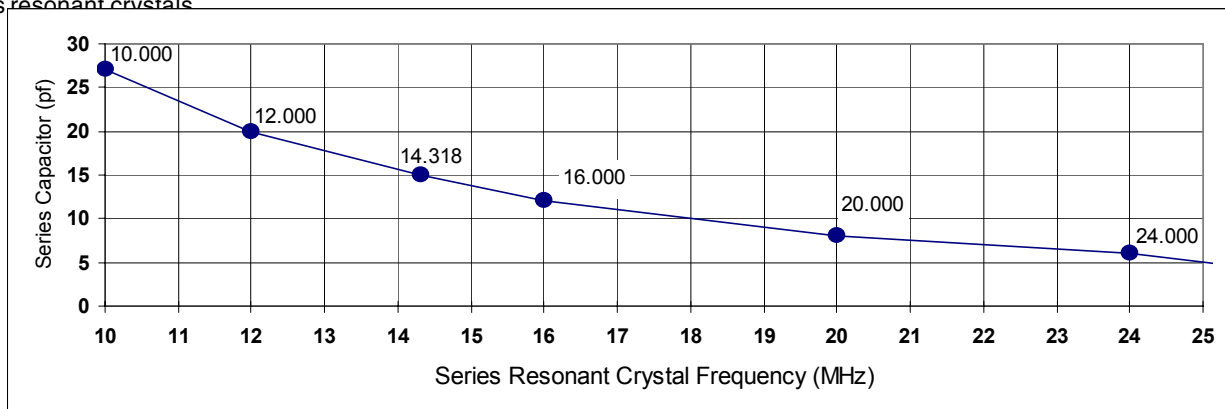


FIGURE 5A. CRYSTAL INTERFACE

NOTE: For crystal frequencies higher than 17MHz, a series tuning capacitor is required for proper operation.

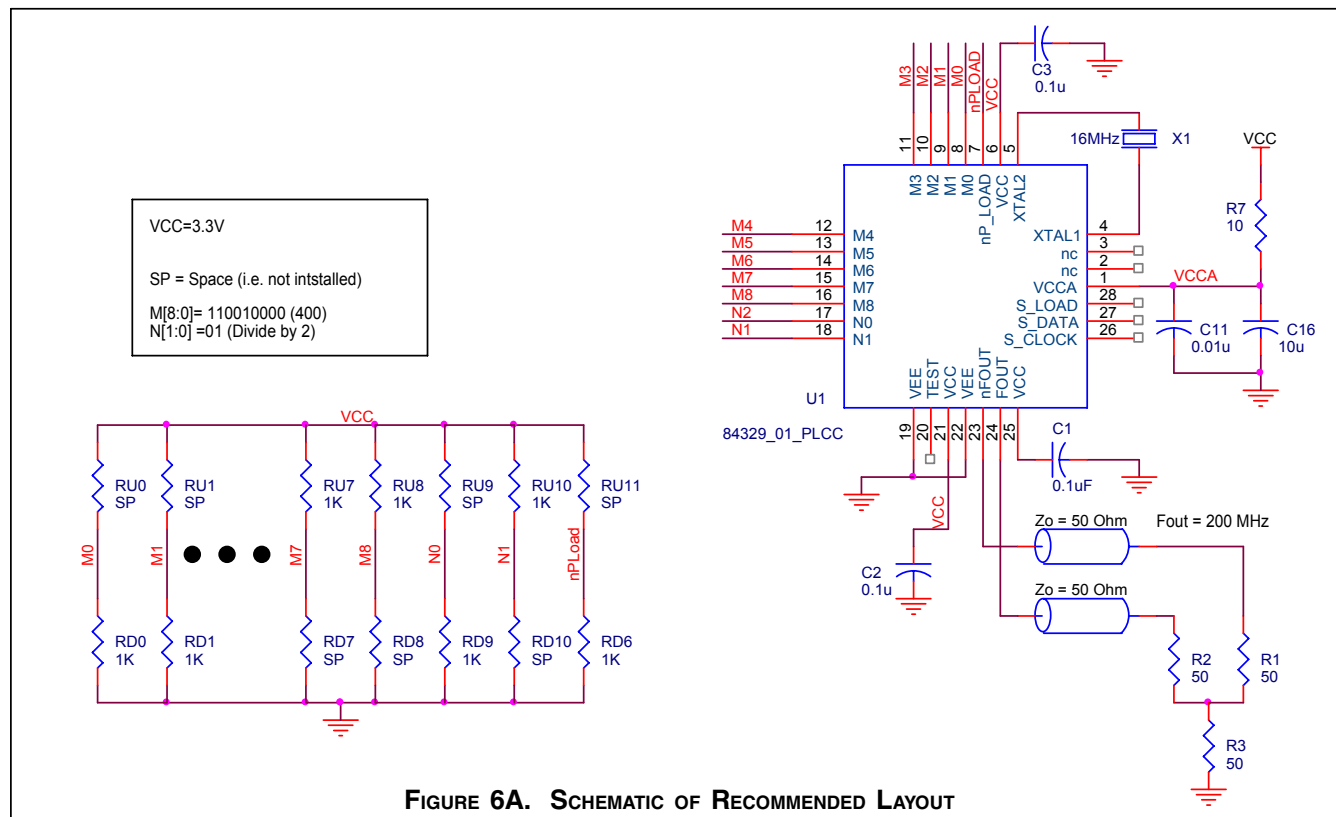
FIGURE 5B. Recommended tuning capacitance for various series resonant crystals



LAYOUT GUIDELINE

The schematic of the 84329-01 layout example used in this layout guideline is shown in *Figure 6A*. The ICS84329-01 recommended PCB board layout for this example is shown in *Figure 6B*. This layout example is used as a general guideline.

The layout in the actual system will depend on the selected component types, the density of the components, the density of the traces, and the stack up of the P.C. board.



The following component footprints are used in this layout example:

All the resistors and capacitors are size 0603.

POWER AND GROUNDING

Place the decoupling capacitors C1, C2 and C3, as close as possible to the power pins. If space allows, placement of the decoupling capacitor on the component side is preferred. This can reduce unwanted inductance between the decoupling capacitor and the power pin caused by the via.

Maximize the power and ground pad sizes and number of vias capacitors. This can reduce the inductance between the power and ground planes and the component power and ground pins.

The RC filter consisting of R7, C11, and C16 should be placed as close to the V_{CCA} pin as possible.

CLOCK TRACES AND TERMINATION

Poor signal integrity can degrade the system performance or cause system failure. In synchronous high-speed digital systems, the clock signal is less tolerant to poor signal integrity than other signals. Any ringing on the rising or falling edge or excessive ring back can cause system failure. The shape of the trace and the trace delay might be restricted by the available space on the board and the component location. While routing the traces, the clock signal traces should be routed first and should be locked prior to routing other signal traces.

- The differential 50Ω output traces should have the same length.
- Avoid sharp angles on the clock trace. Sharp angle turns cause the characteristic impedance to change on the transmission lines.
- Keep the clock traces on the same layer. Whenever possible, avoid placing vias on the clock traces. Placement of vias on the traces can affect the trace characteristic impedance and hence degrade signal integrity.
- To prevent cross talk, avoid routing other signal traces in parallel with the clock traces. If running parallel traces is unavoidable, allow a separation of at least three trace widths between the differential clock trace and the other signal trace.
- Make sure no other signal traces are routed between the clock trace pair.
- The matching termination resistors should be located as close to the receiver input pins as possible.

CRYSTAL

The crystal X1 should be located as close as possible to the pins 24 (XTAL1) and 25 (XTAL2). The trace length between the X1 and U1 should be kept to a minimum to avoid unwanted parasitic inductance and capacitance. Other signal traces should not be routed near the crystal traces.

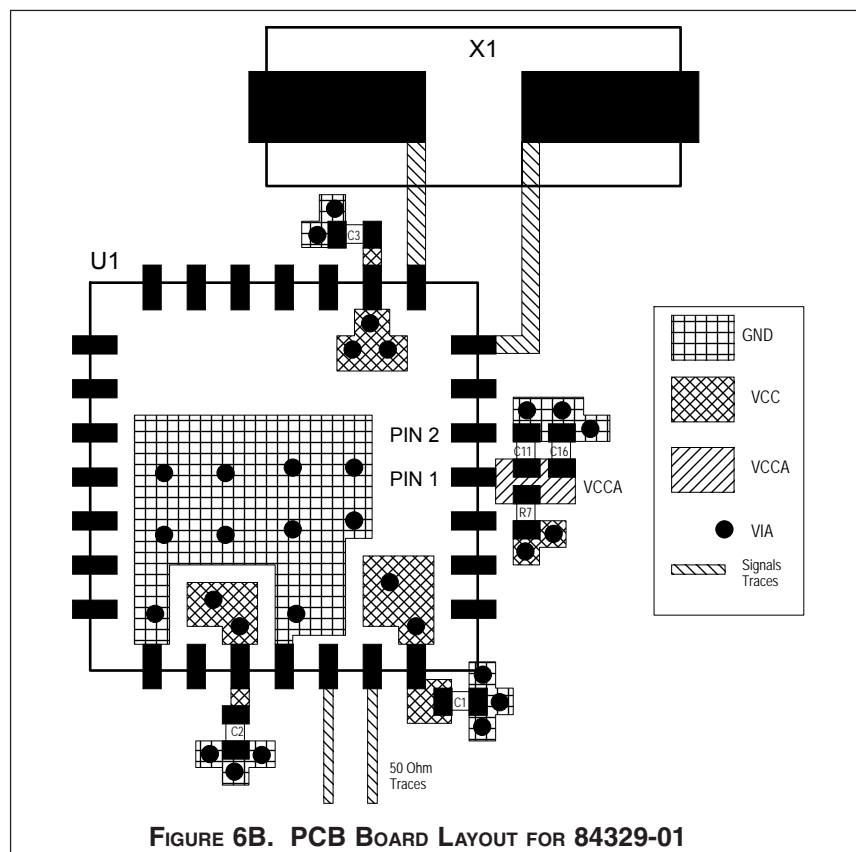


FIGURE 6B. PCB BOARD LAYOUT FOR 84329-01

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 84329-01. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 84329-01 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{CC} = 3.3V + 5\% = 3.465V$, which gives worst case results.

NOTE: Please refer to Section 3 for details on calculating power dissipated in the load.

- Power (core)_{MAX} = $V_{CC_MAX} * I_{EE_MAX} = 3.465V * 110mA = 381.2mW$
- Power (outputs)_{MAX} = **30mW/Loaded Output pair**

$$\text{Total Power}_{MAX} (3.465V, \text{ with all outputs switching}) = 381.2mW + 30mW = 411.2mW$$

2. Junction Temperature.

Junction temperature, T_j , is the temperature at the junction of the bond wire and bond pad and directly affects the reliability of the device. The maximum recommended junction temperature for the devices is 125°C.

The equation for T_j is as follows: $T_j = \theta_{JA} * Pd_total + T_A$

T_j = Junction Temperature

θ_{JA} = Junction-to-Ambient Thermal Resistance

Pd_total = Total Device Power Dissipation (example calculation is in section 1 above)

T_A = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance θ_{JA} must be used. Assuming a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 39.7°C/W per Table 8A below.

Therefore, T_j for an ambient temperature of 70°C with all outputs switching is:

$$70^\circ C + 0.411W * 39.7^\circ C/W = 86.3^\circ C. \text{ This is well below the limit of } 125^\circ C.$$

This calculation is only an example. T_j will obviously vary depending on the number of loaded outputs, supply voltage, air flow, and the type of board (single layer or multi-layer).

TABLE 8A. THERMAL RESISTANCE θ_{JA} FOR 28-PIN SOIC, FORCED CONVECTION

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|---|----------|----------|----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 76.2°C/W | 60.8°C/W | 53.2°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 46.2°C/W | 39.7°C/W | 36.8°C/W |
| NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs. | | | |

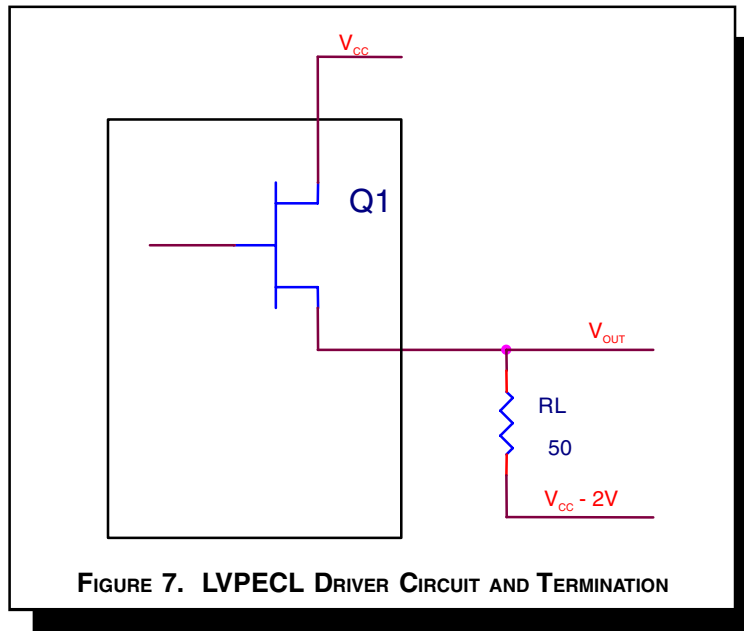
TABLE 8B. THERMAL RESISTANCE θ_{JA} FOR 28-PIN PLCC, FORCED CONVECTION

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|--|----------|----------|----------|
| | 0 | 200 | 500 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 37.8°C/W | 31.1°C/W | 28.3°C/W |

3. Calculations and Equations.

The purpose of this section is to derive the power dissipated into the load.

LVPECL output driver circuit and termination are shown in the Figure 7.



To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination voltage of $V_{CC} - 2V$.

- For logic high, $V_{OUT} = V_{OH_MAX} = V_{CC_MAX} - 0.9V$

$$(V_{CC_MAX} - V_{OH_MAX}) = 0.9V$$

- For logic low, $V_{OUT} = V_{OL_MAX} = V_{CC_MAX} - 1.7V$

$$(V_{CC_MAX} - V_{OL_MAX}) = 1.7V$$

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$$Pd_H = [(V_{OH_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - (V_{CC_MAX} - V_{OH_MAX}))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = 19.8mW$$

$$Pd_L = [(V_{OL_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - (V_{CC_MAX} - V_{OL_MAX}))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = 10.2mW$$

Total Power Dissipation per output pair = Pd_H + Pd_L = **30mW**

RELIABILITY INFORMATION

TABLE 9A. θ_{JA} VS. AIR FLOW SOIC TABLE

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|---|----------|----------|----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 76.2°C/W | 60.8°C/W | 53.2°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 46.2°C/W | 39.7°C/W | 36.8°C/W |
| NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs. | | | |

TABLE 9B. θ_{JA} VS. AIR FLOW PLCC TABLE

| θ_{JA} by Velocity (Linear Feet per Minute) | | | |
|---|----------|----------|----------|
| | 0 | 200 | 500 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 37.8°C/W | 31.1°C/W | 28.3°C/W |
| NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs. | | | |

TRANSISTOR COUNT

The transistor count for 84329-01 is: 4408

PACKAGE OUTLINE - M SUFFIX FOR 28 LEAD SOIC

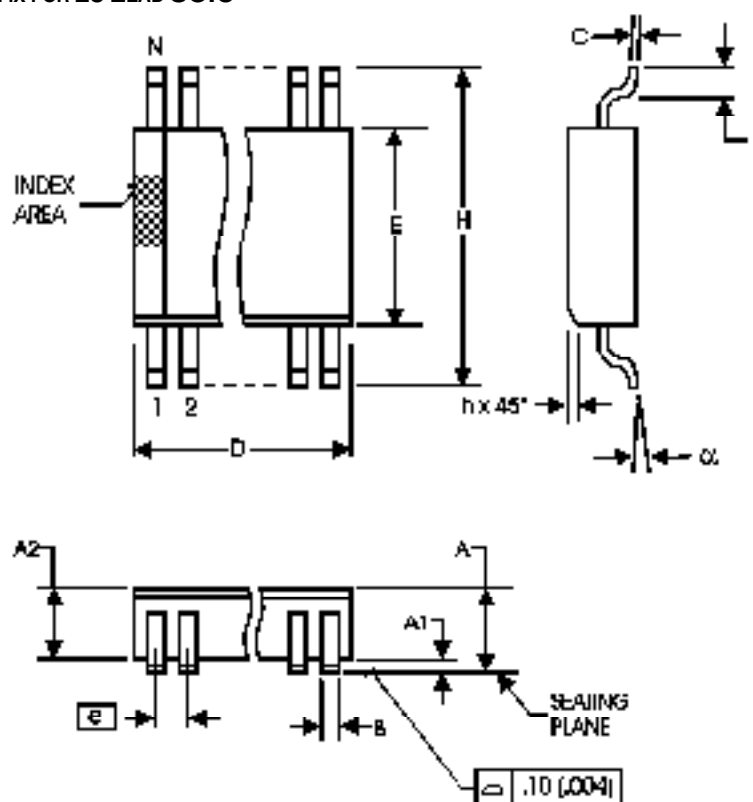


TABLE 10A. PACKAGE DIMENSIONS

| SYMBOL | Millimeters | |
|--------|-------------|---------|
| | MINIMUM | MAXIMUM |
| N | 28 | |
| A | -- | 2.65 |
| A1 | 0.10 | -- |
| A2 | 2.05 | 2.55 |
| B | 0.33 | 0.51 |
| C | 0.18 | 0.32 |
| D | 17.70 | 18.40 |
| E | 7.40 | 7.60 |
| e | 1.27 BASIC | |
| H | 10.00 | 10.65 |
| h | 0.25 | 0.75 |
| L | 0.40 | 1.27 |
| α | 0° | 8° |

Reference Document: JEDEC Publication 95, MS-013, MO-119

TABLE 11. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|-----------------|-------------------------|--------------------|-------------|
| 84329AM-01LF | ICS84329AM-01LF | Lead-Free, 28 Lead SOIC | Tube | 0°C to 70°C |
| 84329AM-01LFT | ICS84329AM-01LF | Lead-Free, 28 Lead SOIC | 1000 Tape & Reel | 0°C to 70°C |
| 84329AV-01LF | ICS84329A01L | Lead-Free, 28 Lead PLCC | Tube | 0°C to 70°C |
| 84329AV-01LFT | ICS84329A01L | Lead-Free, 28 Lead PLCC | 500 Tape & Reel | 0°C to 70°C |

NOTE: Parts that are ordered with an "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

| REVISION HISTORY SHEET | | | | |
|------------------------|-----------|---------|--|----------|
| Rev | Table | Page | Description of Change | Date |
| B | T6 | 6 | Input Frequency Characteristics Table - • updated XTAL from 25MHz Max. to 20MHz Max. • added another XTAL row to include Notes 1 and 2 | 02/14/02 |
| | | 12 | Added Crystal Input and Oscillator Interface section. | |
| B | T1 | 2 | Updated Parallel & Serial Load Operations diagram. | 12/18/02 |
| | | 3 | Changed V_{CC} and crystal descriptions. Updated format. | |
| C | T6 | 1 | Block Diagram, replaced $\div N$ with dividers. | 4/3/03 |
| | | 6 | Changed 20MHz max. limit to 17MHz max. and changed 20MHz min. limit to 17MHz min. Revised Note 2. | |
| | | 10 | Crystal Input & Oscillator Interface section, added same crystal frequency note. | |
| D | T2 T4C | 1 | Features Section - added lead-free bullet. | 4/10/07 |
| | | 2 | Corrected Figure 1, Parallel & Serial Load Operations Diagram. | |
| | | 3 | Pin Characteristics - changed CIN from 4pF max. to 4pF typical. | |
| | | 5 | LVPECL DC Characteristics Table -corrected V_{OH} max. from $V_{CC} - 1.0V$ to $V_{CC} - 0.9V$. | |
| D | T11 | 13 - 14 | Power Considerations - corrected power dissipation to reflect V_{OH} max in Table 4C. | 8/7/10 |
| | | 18 | Ordering Information Table - added lead-free part number for ICS84329AM-01, and added lead-free part number and marking for ICS84329AV-01. Added lead-free note. | |
| D | T11 | 18 | Ordering Information Table - removed ICS prefix from Part/Order Number column. Added lead-free marking for 28 lead SOIC package. | 8/21/12 |
| | | 20 | Added Contact Page. Updated datasheet's header/footer with IDT from ICS. | |
| D | | 1 | Corrected typo: put space between 'the crystal' | 8/21/12 |
| D | T11 | 1 | Updated replacement part number | 4/9/14 |
| | | 18 | Ordering Information Table - removed leaded devices | |

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