General Description

The 84330C is a general purpose, single output high frequency synthesizer. The VCO operates at a frequency range of 250MHz to 700MHz. 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 250kHz to 2MHz can be achieved using a 16MHz crystal depending on the output divider settings.

Features

- Fully integrated PLL, no external loop filter requirements
- One differential 3.3V LVPECL output
- Crystal oscillator interface: 10MHz to 25MHz
- Output frequency range: 31.25MHz to 700MHz
- VCO range: 250MHz to 700MHz
- Parallel or serial interface for programming M and N dividers during power-up
- RMS period jitter: 5ps (maximum)
- Cycle-to-cycle jitter: 40ps (maximum)
- 3.3V supply voltage
- 0°C to 70°C ambient operating temperature
- Available in lead-free (RoHS 6) package

Pin Assignments

Block Diagram

Pin Assignments
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 84330C features a fully integrated PLL and therefore requires no external components for setting the loop bandwidth. A quartz 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 250MHz 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 2M times the reference frequency 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 84330C 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:

\[ f_{VCO} = \frac{f_{XTAL} \times 2M}{16} \]

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 \(125 \leq M \leq 350\). The frequency out is defined as follows:

\[ f_{out} = \frac{f_{VCO}}{N} = \frac{f_{XTAL} \times 2M}{N \times 16} \]

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 in the table below:

<table>
<thead>
<tr>
<th>T2</th>
<th>T1</th>
<th>T0</th>
<th>TEST Output</th>
<th>( f_{OUT} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Shift Register Out</td>
<td>( f_{OUT} )</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>HIGH</td>
<td>( f_{OUT} )</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>PLL Reference XTAL ÷16</td>
<td>( f_{OUT} )</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>((VCO ÷ M)/2) (non 50% Duty Cycle M Divider)</td>
<td>( f_{OUT} )</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>( f_{OUT} ), LVCMOS Output Frequency &lt; 200MHz</td>
<td>( f_{OUT} )</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>LOW</td>
<td>( f_{OUT} )</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>((S_CLOCK ÷ M)/2) (non 50% Duty Cycle M Divider)</td>
<td>( S_CLOCK ÷ N ) Divider</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>( f_{OUT} ÷ 4 )</td>
<td>( f_{OUT} )</td>
</tr>
</tbody>
</table>

![Figure 1. Parallel & Serial Load Operations](image)
### Table 1. Pin Descriptions

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CCA}$</td>
<td>Power</td>
<td>Analog supply pin.</td>
</tr>
<tr>
<td>XTAL1, XTAL2</td>
<td></td>
<td>Crystal oscillator interface. XTAL1 is an oscillator input, XTAL2 is an oscillator output.</td>
</tr>
<tr>
<td>XTAL_SEL</td>
<td>Input</td>
<td>Pullup selects between the crystal oscillator or FREF_EXT inputs as the PLL reference source. Selects XTAL inputs when HIGH. Selects FREF_EXT when LOW. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>OE</td>
<td>Input</td>
<td>Pullup Output enable. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>nP_LOAD</td>
<td>Input</td>
<td>Pullup Parallel load input. Determines when data present at M8:M0 is loaded into M divider, and when data present at N1:N0 sets the N output divide value. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>M0, M1, M2</td>
<td>Input</td>
<td>Pullup M divider inputs. Data latched on LOW-to-HIGH transition of nP_LOAD input. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>M3, M4, M5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M6, M7, M8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N0, N1</td>
<td>Input</td>
<td>Pullup Determines N output divider value as defined in Table 3C Function Table. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>$V_{EE}$</td>
<td>Power</td>
<td>Negative supply pins.</td>
</tr>
<tr>
<td>TEST</td>
<td>Output</td>
<td>Test output which is used in the serial mode of operation. Single-ended LVPECL interface levels.</td>
</tr>
<tr>
<td>$V_{CC}$</td>
<td>Power</td>
<td>Core supply pins.</td>
</tr>
<tr>
<td>nFOUT, FOUT</td>
<td>Output</td>
<td>Differential output for the synthesizer. 3.3V LVPECL interface levels.</td>
</tr>
<tr>
<td>nc</td>
<td>Unused</td>
<td>No connect.</td>
</tr>
<tr>
<td>FREF_EXT</td>
<td>Input</td>
<td>Pulldown PLL reference input. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>S_CLOCK</td>
<td>Input</td>
<td>Pulldown Clocks the serial data present at S_DATA input into the shift register on the rising edge of S_CLOCK. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>S_DATA</td>
<td>Input</td>
<td>Pulldown Shift register serial input. Data sampled on the rising edge of S_CLOCK. LVCMOS / LVTTL interface levels.</td>
</tr>
<tr>
<td>S_LOAD</td>
<td>Input</td>
<td>Pulldown Controls transition of data from shift register into the M divider. LVCMOS / LVTTL interface levels.</td>
</tr>
</tbody>
</table>

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

### Table 2. Pin Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{IN}$</td>
<td>Input Capacitance</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>$R_{PULLUP}$</td>
<td>Input Pullup Resistor</td>
<td></td>
<td>51</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>$R_{PULLDOWN}$</td>
<td>Input Pulldown Resistor</td>
<td></td>
<td>51</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
</tbody>
</table>
Function Tables

Table 3A. Parallel and Serial Mode Function Table

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>nP_LOAD</td>
<td>M</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>Data</td>
</tr>
<tr>
<td>↑</td>
<td>Data</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
</tbody>
</table>

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

Table 3B. Programmable VCO Frequency Function Table

<table>
<thead>
<tr>
<th>VCO Frequency (MHz)</th>
<th>M Divide</th>
<th>256</th>
<th>128</th>
<th>64</th>
<th>32</th>
<th>16</th>
<th>8</th>
<th>4</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>125</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>252</td>
<td>126</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>254</td>
<td>127</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>256</td>
<td>128</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>696</td>
<td>348</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>698</td>
<td>349</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>700</td>
<td>350</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

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

Table 3C. Programmable Output Divider Function Table

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output Frequency (MHz)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 N0</td>
<td>N Divider Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 0</td>
<td>2</td>
<td>125</td>
<td>350</td>
</tr>
<tr>
<td>0 1</td>
<td>4</td>
<td>62.5</td>
<td>175</td>
</tr>
<tr>
<td>1 0</td>
<td>8</td>
<td>31.25</td>
<td>87.5</td>
</tr>
<tr>
<td>1 1</td>
<td>1</td>
<td>250</td>
<td>700</td>
</tr>
</tbody>
</table>
Absolute Maximum Ratings

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>
<thead>
<tr>
<th>Item</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage, ( V_{CC} )</td>
<td>4.6V</td>
</tr>
<tr>
<td>Inputs, ( V_I )</td>
<td>-0.5V to ( V_{CC} + 0.5V )</td>
</tr>
<tr>
<td>Outputs, ( IO )</td>
<td>50mA</td>
</tr>
<tr>
<td>Continuous Current</td>
<td></td>
</tr>
<tr>
<td>Surge Current</td>
<td>100mA</td>
</tr>
<tr>
<td>Package Thermal Impedance, ( \theta_{JA} )</td>
<td></td>
</tr>
<tr>
<td>28 Lead PLCC</td>
<td>37.8°C/W (0 lpm)</td>
</tr>
<tr>
<td>32 Lead LFQFP</td>
<td>47.9°C/W (0 lpm)</td>
</tr>
<tr>
<td>32 Lead VFQFN</td>
<td>37.0°C/W (0 mps)</td>
</tr>
<tr>
<td>Storage Temperature, ( T_{STG} )</td>
<td>-65°C to 150°C</td>
</tr>
</tbody>
</table>

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, \( V_{CC} = 3.3V \pm 5\% \), \( V_{EE} = 0V \), \( T_A = 0°C \) to 70°C

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CC} )</td>
<td>Core Supply Voltage</td>
<td></td>
<td>3.135</td>
<td>3.3</td>
<td>3.465</td>
<td>V</td>
</tr>
<tr>
<td>( V_{CC}A )</td>
<td>Analog Supply Voltage</td>
<td></td>
<td>3.135</td>
<td>3.3</td>
<td>3.465</td>
<td>V</td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Power Supply Current</td>
<td></td>
<td></td>
<td>160</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>( I_{CCA} )</td>
<td>Analog Supply Current</td>
<td></td>
<td></td>
<td>16</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

Table 4B. LVCMOS/LVTTL DC Characteristics, \( V_{CC} = 3.3V \pm 5\% \), \( V_{EE} = 0V \), \( T_A = 0°C \) to 70°C

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IH} )</td>
<td>Input High Voltage</td>
<td>( V_{CC} = V_{IN} = 3.465V )</td>
<td>2</td>
<td>( V_{CC} + 0.3 )</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( V_{IL} )</td>
<td>Input Low Voltage</td>
<td></td>
<td>-0.3</td>
<td>0.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( I_{IH} )</td>
<td>Input High Current</td>
<td>( V_{CC} = V_{IN} = 3.465V )</td>
<td>5</td>
<td>( \mu A )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{IL} )</td>
<td>Input Low Current</td>
<td>( V_{CC} = 3.465V, V_{IN} = 0V )</td>
<td>-150</td>
<td>( \mu A )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4C. LVPECL DC Characteristics, \( V_{CC} = 3.3V \pm 5\% \), \( V_{EE} = 0V \), \( T_A = 0°C \) to 70°C

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{OH} )</td>
<td>Output High Voltage; ( \text{NOTE 1} )</td>
<td>( V_{CC} - 1.4 )</td>
<td>( V_{CC} - 0.9 )</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{OL} )</td>
<td>Output Low Voltage; ( \text{NOTE 1} )</td>
<td>( V_{CC} - 2.0 )</td>
<td>( V_{CC} - 1.7 )</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{SWING} )</td>
<td>Peak-to-Peak Output Voltage Swing</td>
<td>0.8</td>
<td>1.0</td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE 1: Outputs terminated with 50Ω to \( V_{CC} - 2V \).
Table 5. Crystal Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode of Oscillation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
<td>10</td>
<td>25</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Equivalent Series Resistance (ESR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>Shunt Capacitance</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

NOTE 1: For the crystal frequency range, the M value must be set to achieve the minimum or maximum VCO frequency range of 250MHz to 700MHz. Using the minimum input frequency of 10MHz, valid values of M are $200 \leq M \leq 511$. Using the maximum input frequency of 25MHz, valid values of M are $80 \leq M \leq 224$.

NOTE 2: Maximum frequency on FREF_EXT is dependent on the internal M counter limitations. See Application Information Section for recommendations on optimizing the performance using the FREF_EXT input.

Table 6. Input Frequency Characteristics, $V_{CC} = 3V\pm5\%$, $V_{EE} = 0V$, $T_A = 0\degree C$ to 70°C

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_{IN}$</td>
<td>Input Frequency</td>
<td>XTAL; NOTE 1</td>
<td>10</td>
<td></td>
<td>25</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td>S_CLOCK</td>
<td></td>
<td>10</td>
<td></td>
<td>50</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td>FREF_EXT; NOTE 2</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
</tbody>
</table>

Table 7. AC Characteristics, $V_{CC} = 3.3V\pm5\%$, $V_{EE} = 0V$, $T_A = 0\degree C$ to 70°C

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_{OUT}$</td>
<td>Output Frequency</td>
<td></td>
<td></td>
<td></td>
<td>700</td>
<td>MHz</td>
</tr>
<tr>
<td>$\Delta f_\text{per}$</td>
<td>Period Jitter, RMS; NOTE 1, 2</td>
<td></td>
<td>5</td>
<td></td>
<td>ps</td>
<td></td>
</tr>
<tr>
<td>$\Delta f_\text{cc}$</td>
<td>Cycle-to-Cycle Jitter; NOTE 1, 2</td>
<td></td>
<td>40</td>
<td></td>
<td>ps</td>
<td></td>
</tr>
<tr>
<td>$t_R / t_F$</td>
<td>Output Rise/Fall Time</td>
<td>20% to 80%</td>
<td>200</td>
<td></td>
<td>600</td>
<td>ns</td>
</tr>
<tr>
<td>$t_S$</td>
<td>Setup Time</td>
<td>S_DATA to S_CLOCK</td>
<td>20</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S_CLOCK to S_LOAD</td>
<td></td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M, N to nP_LOAD</td>
<td></td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_H$</td>
<td>Hold Time</td>
<td>S_DATA to S_CLOCK</td>
<td>20</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M, N to nP_LOAD</td>
<td></td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_L$</td>
<td>PLL Lock Time</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td>ms</td>
</tr>
<tr>
<td>$\text{odc}$</td>
<td>Output Duty Cycle</td>
<td></td>
<td>45</td>
<td></td>
<td>55</td>
<td>%</td>
</tr>
</tbody>
</table>

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

See Parameter Measurement Information section.

NOTE: Characterized using 16MHz XTAL.

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

NOTE 2: See Applications section.
Parameter Measurement Information

3.3/3.3V LVPECL Output Load AC Test Circuit

Cycle-to-Cycle Jitter

Output Duty Cycle/Pulse Width/Period

Output Rise/Fall Time
Application Information

Power Supply Filtering Technique

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. To achieve optimum jitter performance, power supply isolation is required. The 84330C 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 0.01\( \mu \)F bypass capacitors should be used for each pin. *Figure 2* illustrates this for a generic \( V_{CC} \) pin and also shows that \( V_{CCA} \) requires that an additional 10\( \Omega \) resistor along with a 10\( \mu \)F bypass capacitor be connected to the \( V_{CCA} \) pin.

![Figure 2. Power Supply Filtering](image)

Recommendations for Unused Input and Output Pins

**Inputs:**

**LVCMOS Control Pins**

All control pins have internal pullups or pulldowns; additional resistance is not required but can be added for additional protection. A 1k\( \Omega \) resistor can be used.

**Outputs:**

**TEST Output**

The unused TEST output can be left floating. There should be no trace attached.

**LVPECL Outputs**

The unused LVPECL output pair can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.
The XTAL\_IN input can accept a single-ended LVCMOS signal through an AC coupling capacitor. A general interface diagram is shown in Figure 3. The XTAL\_OUT pin can be left floating. The input edge rate can be as slow as 10ns. For LVCMOS signals, it is recommended that the amplitude be reduced from full swing to half swing in order to prevent signal interference with the power rail and to reduce noise. This configuration requires that the output impedance of the driver (Ro) plus the series resistance (Rs) equals the transmission line impedance. In addition, matched termination at the crystal input will attenuate the signal in half. This can be done in one of two ways. First, R1 and R2 in parallel should equal the transmission line impedance. For most 50Ω applications, R1 and R2 can be 100Ω. This can also be accomplished by removing R1 and making R2 50Ω. By overdriving the crystal oscillator, the device will be functional, but note, the device performance is guaranteed by using a quartz crystal.

![Figure 3. General Diagram for LVCMOS Driver to XTAL Input Interface](image)

![Figure 4. Cycle-to-Cycle Jitter vs. fOUT (using a 16MHz crystal)](image)
Termination for 3.3V 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 5A and 5B 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 5A. 3.3V LVPECL Output Termination](image)
![Figure 5B. 3.3V LVPECL Output Termination](image)
Layout Guideline

The schematic of the 84330C layout example used in this layout guideline is shown in Figure 6A. The 84330C 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.

Figure 6A. 84330C Schematic of Recommended Layout
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 C3 and C4, 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 VCCA 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 4 (XTAL1) and 5 (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. 84330C PCB Board Layout for 84330C](image-url)
Power Considerations

This section provides information on power dissipation and junction temperature for the 84330C. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 84330C 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)\(_{\text{MAX}}\) = \( V_{CC,\text{MAX}} \times I_{EE,\text{MAX}} = 3.465V \times 176mA = 609.8\text{mW} \)
- Power (outputs)\(_{\text{MAX}}\) = \( 30\text{mW/Loaded Output Pair} \)

Total Power\(_{\text{MAX}}\) (3.465V, with all outputs switching) = 609.8mW + 30mW = 639.8mW

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 HiPerClockS devices is 125°C.

The equation for \( T_J \) is as follows:

\[
T_J = \theta_{JA} \times P_{d\_total} + T_A
\]

- \( \theta_{JA} \) = Junction-to-Ambient Thermal Resistance
- \( P_{d\_total} \) = 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 \( \theta_{JA} \) must be used. Assuming a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 31.1°C/W per Table 8A below.

Therefore, \( T_J \) for an ambient temperature of 70°C with all outputs switching is:

\[
70^\circ C + 0.640W \times 31.1^\circ C/W = 98.9^\circ C.
\]

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 \( \theta_{JA} \) for 28 Lead PLCC, Forced Convection

<table>
<thead>
<tr>
<th>( \theta_{JA} ) by Velocity</th>
<th>Linear Feet per Minute</th>
<th>0</th>
<th>200</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Layer PCB, JEDEC Standard Test Boards</td>
<td>( \theta_{JA} )</td>
<td>37.8°C/W</td>
<td>31.1°C/W</td>
<td>28.3°C/W</td>
</tr>
</tbody>
</table>

### Table 8B. Thermal Resistance \( \theta_{JA} \) for 32 Lead LQFP, Forced Convection

<table>
<thead>
<tr>
<th>( \theta_{JA} ) by Velocity</th>
<th>Linear Feet per Minute</th>
<th>0</th>
<th>200</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Layer PCB, JEDEC Standard Test Boards</td>
<td>( \theta_{JA} )</td>
<td>67.8°C/W</td>
<td>55.9°C/W</td>
<td>50.1°C/W</td>
</tr>
<tr>
<td>Multi-Layer PCB, JEDEC Standard Test Boards</td>
<td>( \theta_{JA} )</td>
<td>47.9°C/W</td>
<td>42.1°C/W</td>
<td>39.4°C/W</td>
</tr>
</tbody>
</table>

NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.
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 Figure 7.

Table 8C. Thermal Resistance $\theta_{JA}$ for 32 Lead VFQFN

<table>
<thead>
<tr>
<th>Meters per Second</th>
<th>0</th>
<th>1</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Layer PCB, JEDEC Standard Test Boards</td>
<td>37.0°C/W</td>
<td>32.4°C/W</td>
<td>29.0°C/W</td>
</tr>
</tbody>
</table>

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

- For logic high, $V_{OUT} = V_{OH,\text{MAX}} = V_{CC,\text{MAX}} - 0.9V$
  
  $(V_{CC,\text{MAX}} - V_{OH,\text{MAX}}) = 0.9V$

- For logic low, $V_{OUT} = V_{OL,\text{MAX}} = V_{CC,\text{MAX}} - 1.7V$
  
  $(V_{CC,\text{MAX}} - V_{OL,\text{MAX}}) = 1.7V$

$P_{d,H}$ is power dissipation when the output drives high.
$P_{d,L}$ is the power dissipation when the output drives low.

\[
P_{d,H} = \left[\frac{(V_{OH,\text{MAX}} - (V_{CC,\text{MAX}} - 2V))/R_L}{V_{CC,\text{MAX}} - V_{OH,\text{MAX}}}\right] \times \left(\frac{V_{CC,\text{MAX}} - V_{OL,\text{MAX}}}{(2V - (V_{CC,\text{MAX}} - V_{OH,\text{MAX}}))/R_L}\right) \times (V_{CC,\text{MAX}} - V_{OH,\text{MAX}}) = \left(\frac{2V - 0.9V}{50\Omega}\right) \times 0.9V = 19.8mW
\]

\[
P_{d,L} = \left[\frac{(V_{OL,\text{MAX}} - (V_{CC,\text{MAX}} - 2V))/R_L}{V_{CC,\text{MAX}} - V_{OL,\text{MAX}}}\right] \times \left(\frac{V_{CC,\text{MAX}} - V_{OL,\text{MAX}}}{(2V - (V_{CC,\text{MAX}} - V_{OL,\text{MAX}}))/R_L}\right) \times (V_{CC,\text{MAX}} - V_{OL,\text{MAX}}) = \left(\frac{2V - 1.7V}{50\Omega}\right) \times 1.7V = 10.2mW
\]

Total Power Dissipation per output pair = $P_{d,H} + P_{d,L} = 30mW$
Reliability Information

Table 9A. $\theta_{JA}$ vs. Air Flow Table for a 28 Lead PLCC

<table>
<thead>
<tr>
<th>Linear Feet per Minute</th>
<th>0</th>
<th>200</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Layer PCB, JEDEC Standard Test Boards</td>
<td>37.8°C/W</td>
<td>31.1°C/W</td>
<td>28.3°C/W</td>
</tr>
</tbody>
</table>

Table 9B. $\theta_{JA}$ vs. Air Flow Table for a 32 Lead LQFP

<table>
<thead>
<tr>
<th>Linear Feet per Minute</th>
<th>0</th>
<th>200</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Layer PCB, JEDEC Standard Test Boards</td>
<td>67.8°C/W</td>
<td>55.9°C/W</td>
<td>50.1°C/W</td>
</tr>
<tr>
<td>Multi-Layer PCB, JEDEC Standard Test Boards</td>
<td>47.9°C/W</td>
<td>42.1°C/W</td>
<td>39.4°C/W</td>
</tr>
</tbody>
</table>

NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

Table 9C. $\theta_{JA}$ vs. Air Flow Table for a 32 Lead VFQFN

<table>
<thead>
<tr>
<th>Meters per Second</th>
<th>0</th>
<th>1</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Layer PCB, JEDEC Standard Test Boards</td>
<td>37.0°C/W</td>
<td>32.4°C/W</td>
<td>29.0°C/W</td>
</tr>
</tbody>
</table>

Transistor Count

The transistor count for 84330C is: 4498
Pin compatible with the MC12430
Package Outline and Package Dimensions

Package Outline - V Suffix for 28 Lead PLCC

Table 10A. Package Dimensions for 28 Lead PLCC

<table>
<thead>
<tr>
<th>JEDEC Variation</th>
<th>All Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Minimum</td>
</tr>
<tr>
<td>N</td>
<td>28</td>
</tr>
<tr>
<td>A</td>
<td>4.19</td>
</tr>
<tr>
<td>A1</td>
<td>2.29</td>
</tr>
<tr>
<td>A2</td>
<td>1.57</td>
</tr>
<tr>
<td>b</td>
<td>0.33</td>
</tr>
<tr>
<td>c</td>
<td>0.19</td>
</tr>
<tr>
<td>D/E</td>
<td>12.32</td>
</tr>
<tr>
<td>D1/E1</td>
<td>11.43</td>
</tr>
<tr>
<td>D2/E2</td>
<td>5.21</td>
</tr>
</tbody>
</table>

Reference Document: JEDEC Publication 95, MS-018
Table 10B. Package Dimensions for 32 Lead LQFP

<table>
<thead>
<tr>
<th>JEDEC Variation: BBA</th>
<th>All Dimensions in Millimeters</th>
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</thead>
<tbody>
<tr>
<td>Symbol</td>
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<td>N</td>
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<td>A</td>
<td>0.05</td>
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<td>A1</td>
<td>1.35</td>
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<td>A2</td>
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<td>b</td>
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<td>c</td>
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</tr>
<tr>
<td>D &amp; E</td>
<td>9.00 Basic</td>
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<tr>
<td>D1 &amp; E1</td>
<td>7.00 Basic</td>
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<tr>
<td>D2 &amp; E2</td>
<td>5.60 Ref.</td>
</tr>
<tr>
<td>e</td>
<td>0.80 Basic</td>
</tr>
<tr>
<td>L</td>
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<tr>
<td>θ</td>
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<tr>
<td>ccc</td>
<td>0.10</td>
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Reference Document: JEDEC Publication 95, MS-026
### Ordering Information

Table 11. Ordering Information

<table>
<thead>
<tr>
<th>Part/Order Number</th>
<th>Marking</th>
<th>Package</th>
<th>Shipping Packaging</th>
<th>Temperature</th>
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<tr>
<td>84330CVLN</td>
<td>ICS84330CVLN</td>
<td>“Lead-Free” 28 Lead PLCC</td>
<td>Tube</td>
<td>0°C to 70°C</td>
</tr>
<tr>
<td>84330CVLNT</td>
<td>ICS84330CVLN</td>
<td>“Lead-Free” 28 Lead PLCC</td>
<td>500 Tape &amp; Reel</td>
<td>0°C to 70°C</td>
</tr>
<tr>
<td>84330CYLN</td>
<td>ICS84330CYLN</td>
<td>“Lead-Free/Annealed” 32 Lead LQFP</td>
<td>Tube</td>
<td>0°C to 70°C</td>
</tr>
<tr>
<td>84330CYLNT</td>
<td>ICS84330CYLN</td>
<td>“Lead-Free/Annealed” 32 Lead LQFP</td>
<td>1000 Tape &amp; Reel</td>
<td>0°C to 70°C</td>
</tr>
</tbody>
</table>

NOTE: Parts that are ordered with an "LN" suffix to the part number are the Pb-Free configuration and are RoHS compliant.
# Revision History Sheet

<table>
<thead>
<tr>
<th>Rev</th>
<th>Table</th>
<th>Page</th>
<th>Description of Change</th>
<th>Date</th>
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<tbody>
<tr>
<td>B</td>
<td>T1</td>
<td>2</td>
<td>Updated Parallel &amp; Serial Load Operations Diagram.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3</td>
<td>Pin Description Table - description to TEST output should read Single-ended LVPECL</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>interface levels instead of LVCMOS/LVTTL interface levels.</td>
<td></td>
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<tr>
<td></td>
<td>T4B</td>
<td>5</td>
<td>LVCMOS Table - $V_{OH}/V_{OL}$ levels added TEST pin and changed $V_{OH}$ min. from 2.6V</td>
<td>8/28/03</td>
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<tr>
<td></td>
<td></td>
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<td>to $V_{CC}$ - 1.4V; changed $V_{OL}$ max. from 0.5V to $V_{CC}$ - 1.7V.</td>
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<td></td>
<td>T5</td>
<td>6</td>
<td>Crystal Characteristics Table - changed ESR from 70$\Omega$ max. to 50$\Omega$ max.</td>
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<td></td>
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<td>8</td>
<td>Updated LVPECL Output Termination diagrams.</td>
<td></td>
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<tr>
<td>B</td>
<td>T4B</td>
<td>5</td>
<td>Deleted $V_{OH}$ &amp; $V_{OL}$ row entries from LVCMOS Table.</td>
<td>9/10/03</td>
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<tr>
<td>B</td>
<td>T12</td>
<td>18</td>
<td>Added Lead-Free/Annealed to the Part Ordering Information Table.</td>
<td>6/1/04</td>
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<tr>
<td>B</td>
<td>T12</td>
<td>1</td>
<td>Features Section added Lead-Free bullet.</td>
<td>10/5/04</td>
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<tr>
<td></td>
<td></td>
<td>18</td>
<td>Ordering Information Table - added PLCC Lead-Free part number.</td>
<td></td>
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<tr>
<td>B</td>
<td></td>
<td>1</td>
<td>Features Section - corrected Output Frequency Range from 25MHz to 31.25MHz</td>
<td>12/7/04</td>
</tr>
<tr>
<td>C</td>
<td>T3A</td>
<td>4</td>
<td>Parallel &amp; Serial Mode Function Table - corrected 3rd line in $S_{LOAD}$ column from</td>
<td>4/10/07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>“X” to “L”.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T4C</td>
<td>13</td>
<td>LVPECL DC Characteristics Table - corrected $V_{OH}$ max. from $V_{CC}$ -1.0V to $V_{CC}$</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
<td>-0.9V.</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Power Considerations - corrected power dissipation to reflect $V_{OH}$ max. in Table 4C</td>
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<tr>
<td>C</td>
<td>T10A</td>
<td>8</td>
<td>Added Recommendations for Unused Input and Output Pins.</td>
<td>1/28/09</td>
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<td></td>
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<td>17</td>
<td>Package Dimension Table - D2/E2 changed the min. from 4.85 to 5.21 and the max. from</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5.56 to 5.46.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>T10C</td>
<td>1</td>
<td>Added 32 VFQFN Pin Assignment.</td>
<td>7/17/09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>Absolute Maximum Ratings - add 32 VFQFN Package Thermal Impedance.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T11</td>
<td>18</td>
<td>Added 32 VFQFN Package Dimensions and Diagram.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td>Ordering Information Table - added 32 VFQFN ordering information.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>T11</td>
<td>19</td>
<td>Ordering Information - removed leaded devices and the CKLF package.</td>
<td>4/22/15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Updated data sheet format.</td>
<td></td>
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</tbody>
</table>
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