

# Ten LVCMOS Output Low Additive Jitter Fanout Buffer

## Features

- 3 to 1 input Multiplexer: Two inputs accept any differential (LVPECL, HCSSL, LVDS, SSTL, CML, LVCMOS) or a single ended signal and the third input accepts a crystal or a single ended signal
- Ten 1.5V/1.8V/2.5V/3.3V LVCMOS outputs
- Supports frequencies from 0 to 200MHz
- Supports crystals from 8MHz to 60MHz
- Ultra-low additive jitter: 17fs (12kHz to 20MHz)
- Ultra-low noise floor of -170dBc/Hz
- Supports 2.5V or 3.3V power supplies
- Output to output skew of 30ps (typical)
- Input to output delay of 2ns (typical)

## Ordering Information

|             |            |               |
|-------------|------------|---------------|
| ZL40241LDG1 | 32 Pin QFN | Trays         |
| ZL40241LDF1 | 32 pin QFN | Tape and Reel |

Package size: 5 x 5 mm  
-40°C to +85°C

## Applications

- General purpose clock distribution
- Low jitter clock trees
- Logic translation
- Clock and data signal restoration
- Wired and Wireless communications
- High performance microprocessor clock distribution
- Medical Imaging
- Test equipment

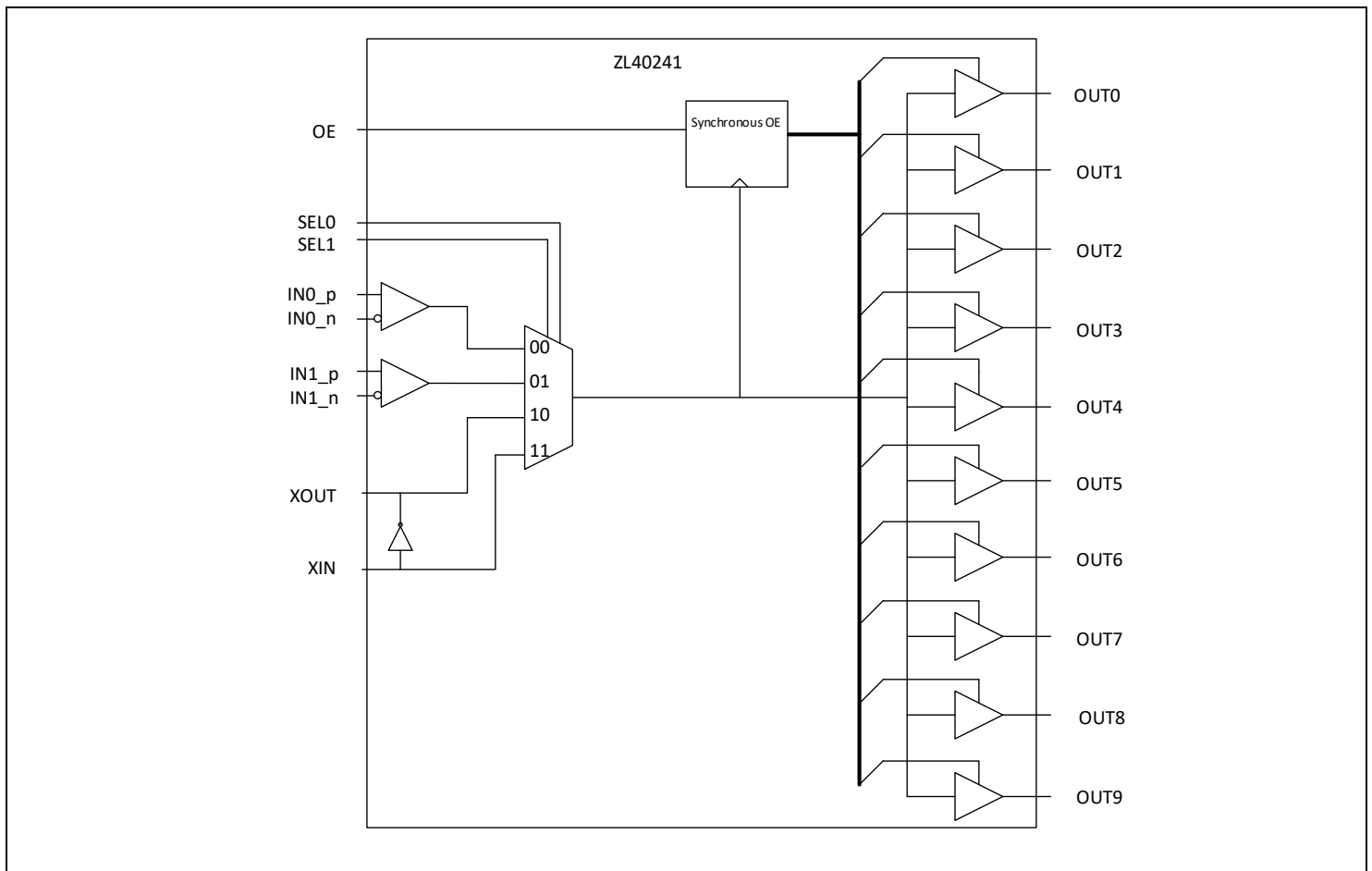


Figure 1. Functional Block Diagram

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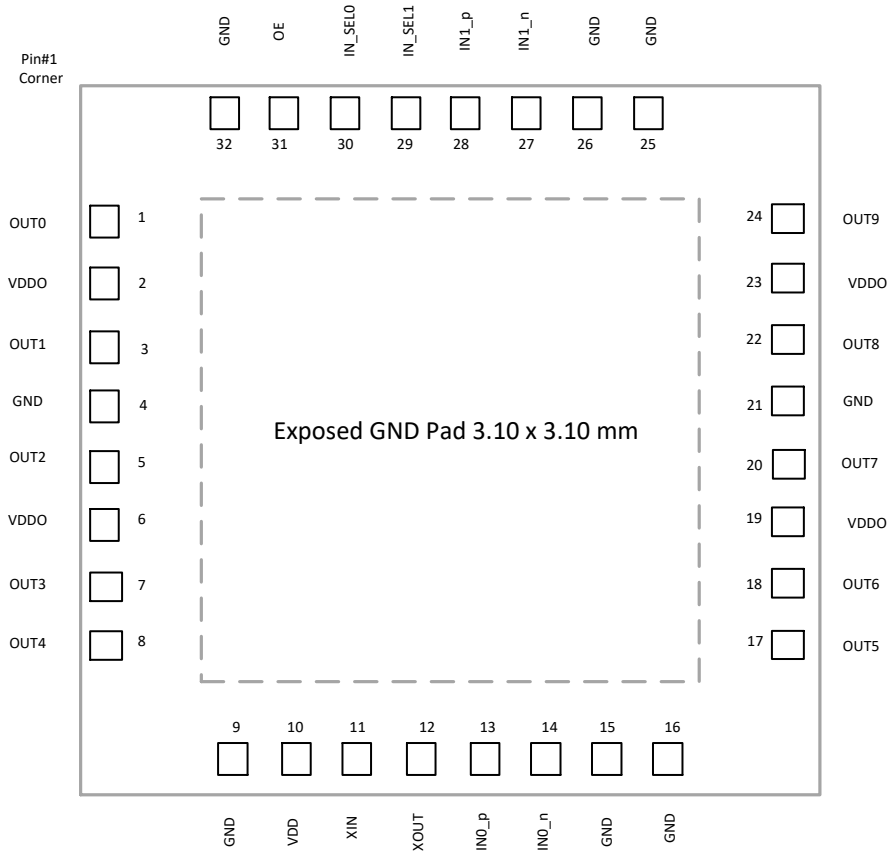
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## Pin Diagram

The device is packaged in a 5x5mm 32-pin QFN.



**Figure 2. Pin Diagram**

## Pin Descriptions

All device inputs and outputs are LVPECL unless described otherwise. The I/O column uses the following symbols: I – input, I<sub>PU</sub> – input with 300kΩ internal pull-up resistor, I<sub>PD</sub> – input with 300kΩ internal pull-down resistor, I<sub>APU</sub> – input with 30kΩ internal pull-up resistor, I<sub>APD</sub> – input with 30kΩ internal pull-down resistor, I<sub>APU/APD</sub> – input biased at VDD/2 with 60kΩ internal pull-up and 60kΩ pull-down resistors, O – output, I/O – Input/Output pin, P – power supply pin.

**Table 1 - Pin Descriptions**

| #   | Name   | I/O  | Description  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
|---|--|--|--|---------|---------|------|---|---|---------------|---|---|---------------|---|---|---------------------------------|---|---|----------------|
| <b>Input Reference</b>                              |  |  |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 13<br>14<br>28<br>27                                | IN0_p<br>IN0_n<br>IN1_p<br>IN1_n   | I <sub>APD</sub><br>I <sub>APU/APD</sub><br>I <sub>APD</sub><br>I <sub>APU/APD</sub> | <p><b>Input Differential or Single Ended References 0 and 1</b></p> <p>Input frequency range 0Hz to 200MHz.</p> <p>Non-inverting inputs (_p) are pulled down with internal 30kΩ pull-down resistors. Inverting inputs (_n) are biased at VDD/2 with 60kΩ pull-up and pull-down resistors to keep inverting input voltages at VDD/2 when inverting inputs are left floating (device fed with a single ended reference).</p>   |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| <b>Output Clocks</b>                                |  |  |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 1<br>3<br>5<br>7<br>8<br>17<br>18<br>20<br>22<br>24 | OUT0<br>OUT1<br>OUT2<br>OUT3<br>OUT4<br>OUT5<br>OUT6<br>OUT7<br>OUT8<br>OUT9 | O  | <p><b>Ultra-Low Additive Jitter LVCMOS Outputs 0 to 9</b></p> <p>Output frequency range 0 to 200MHz</p>  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| <b>Control</b>                                      |  |  |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 30<br>29  | IN_SEL0<br>IN_SEL1   | I <sub>PD</sub>  | <p><b>Input select pins.</b> Logic level on these pins selects which input will be passed to the output.</p> <table border="1"> <thead> <tr> <th>IN_SEL1</th> <th>IN_SEL0</th> <th>OUTN</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Input 0 (IN0)</td> </tr> <tr> <td>0</td> <td>1</td> <td>Input 1 (IN1)</td> </tr> <tr> <td>1</td> <td>0</td> <td>Crystal Oscillator or overdrive</td> </tr> <tr> <td>1</td> <td>1</td> <td>Crystal Bypass</td> </tr> </tbody> </table> | IN_SEL1 | IN_SEL0 | OUTN | 0 | 0 | Input 0 (IN0) | 0 | 1 | Input 1 (IN1) | 1 | 0 | Crystal Oscillator or overdrive | 1 | 1 | Crystal Bypass |
| IN_SEL1   | IN_SEL0  | OUTN   |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 0   | 0  | Input 0 (IN0)  |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 0   | 1  | Input 1 (IN1)  |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 1   | 0  | Crystal Oscillator or overdrive  |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |
| 1   | 1  | Crystal Bypass   |  |         |         |      |   |   |               |   |   |               |   |   |                                 |   |   |                |

|  |      |                 |   |
|--|------|-----------------|---|
| 31   | OE   | I <sub>PD</sub> | <b>Output Enable</b> When high outputs are enabled. When low outputs are high-Z.  |
| <b>Crystal Oscillator</b>                  |      |                 |   |
| 11   | XIN  | I               | <b>Crystal Oscillator Input or crystal bypass mode or crystal overdrive mode</b><br>If crystal oscillator is not used pull down this pin or connect it to ground. |
| 12   | XOUT | O               | <b>Crystal Oscillator Output</b>  |
| <b>Power and Ground</b>                    |      |                 |   |
| 10   | VDD  | P               | <b>Positive Supply Voltage.</b> Connect to 3.3V or 2.5V supply. VDD voltage must be higher or equal to VDDO.  |
| 2<br>6<br>19<br>23                         | VDDO | P               | <b>Positive Supply Voltage for LVC MOS Outputs</b> Connect 3.3V, 2.5V, 1.8V or 1.5V power supply  |
| 4<br>9<br>15<br>16<br>21<br>25<br>26<br>32 | GND  | P               | <b>Ground</b> Connect to ground   |
| E-Pad                                      | GND  | P               | <b>Ground.</b> Connect to ground  |

### Functional Description

The ZL40241 is a pin controlled low additive jitter, low power 3 x 10 LVCMOS fanout buffer.

Two inputs can accept signal in differential (LVPECL, SSTL, LVDS, HSTL, CML) or single ended (LVPECL or LVCMOS) format and the third input can accept a single ended signal or it can be used to build a crystal oscillator by connecting an external crystal resonator between its XIN and XOUT pins.

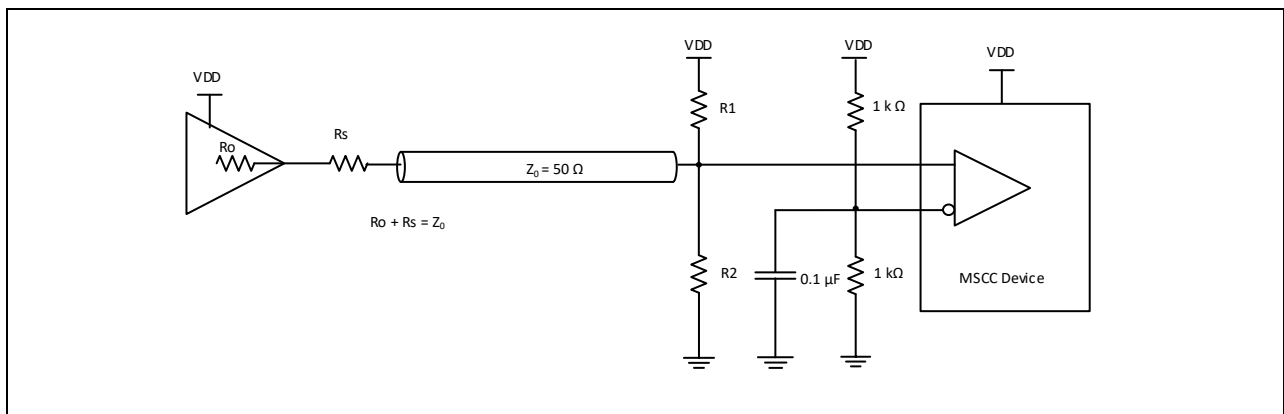
The ZL40241 has ten LVCMOS outputs which can be powered from 3.3V, 2.5V, 1.8V or 1.5V supply. Output can be synchronously enabled/disabled via OE pin.

The device operates from 2.5V+/-5% or 3.3V+/-5% supply. Its operation is guaranteed over the industrial temperature range -40°C to +85°C.

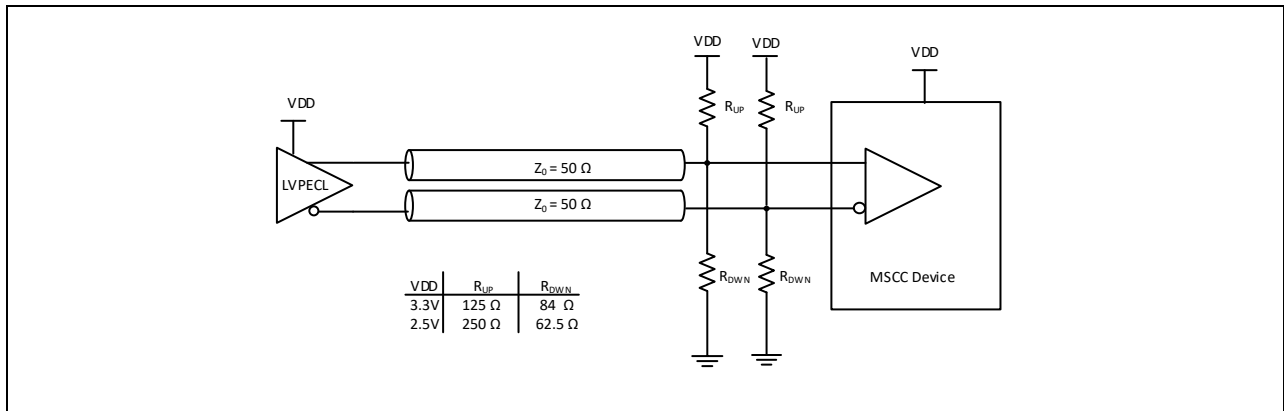
### Clock Inputs

The following blocks diagram shows how to terminate different signals fed to the ZL40241 inputs.

Figure 3 shows how to terminate a single ended output such as LVCMOS. Ideally, resistors R1 and R2 should be 100Ω each so that the transmission line is terminated with matched impedance (50Ω). However, if the driving strength of the output driver is not sufficient resistor values should be increased



**Figure 3. Input driven by a single ended output**



**Figure 4. Input driven by DC coupled LVPEVCL output**



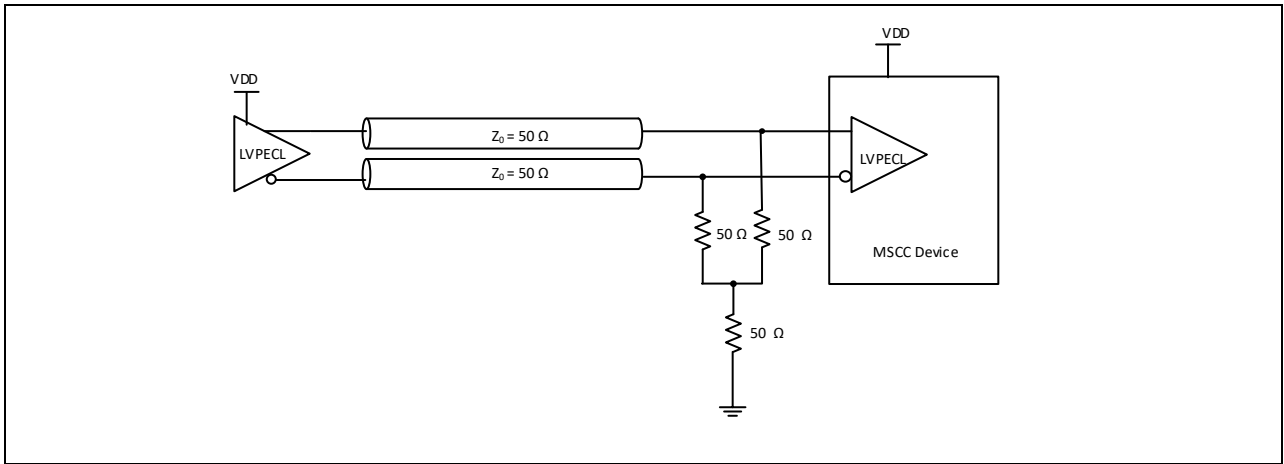


Figure 5. Input driven by DC coupled LVPEVCL output (alternative termination)

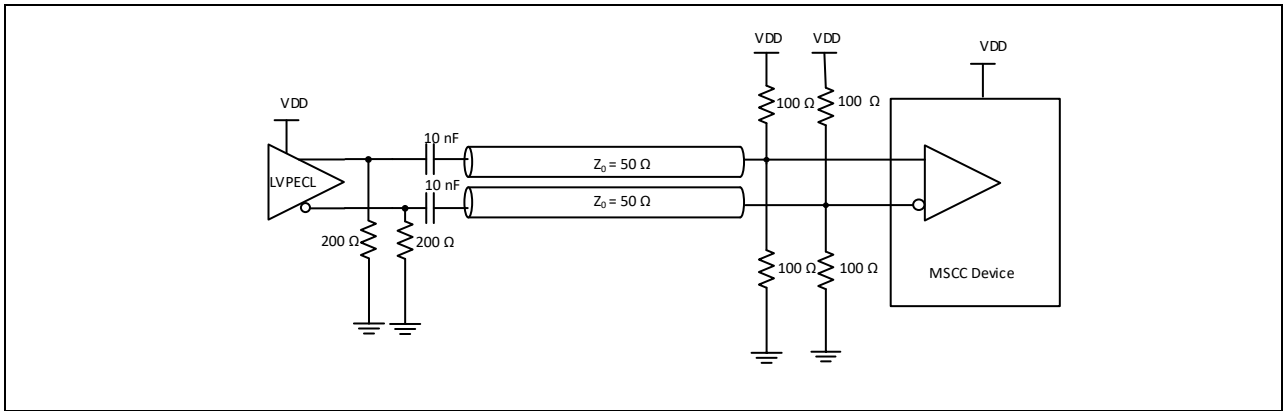


Figure 6. Input driven by AC coupled LVPECL output

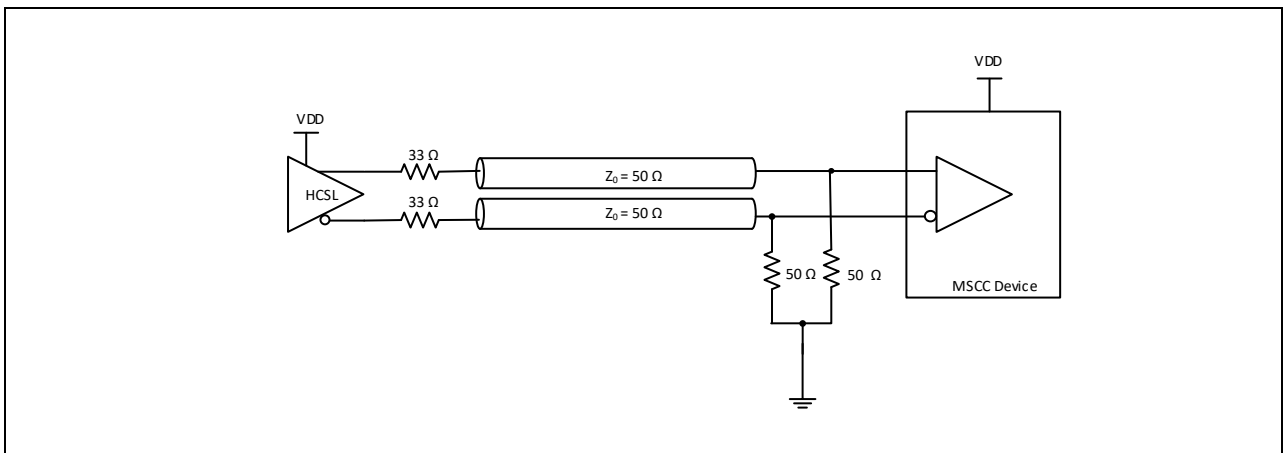


Figure 7. Input driven by HCSL output

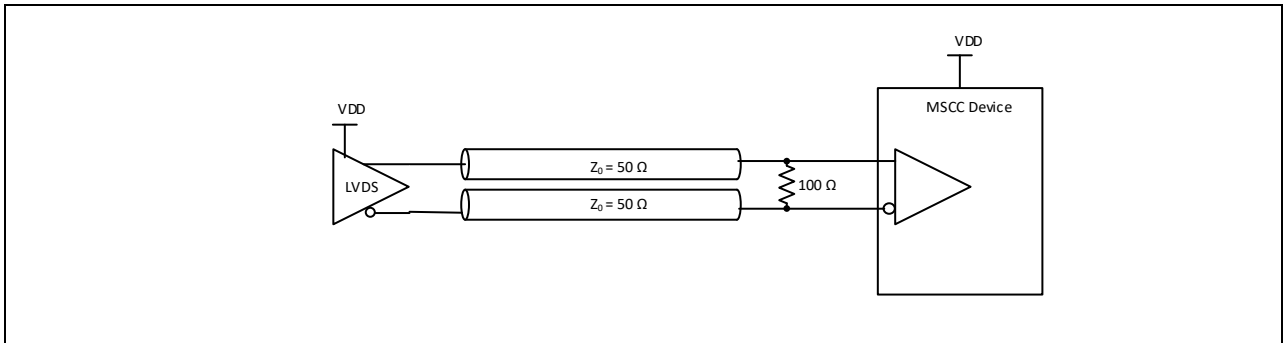


Figure 8. Input driven by LVDS output

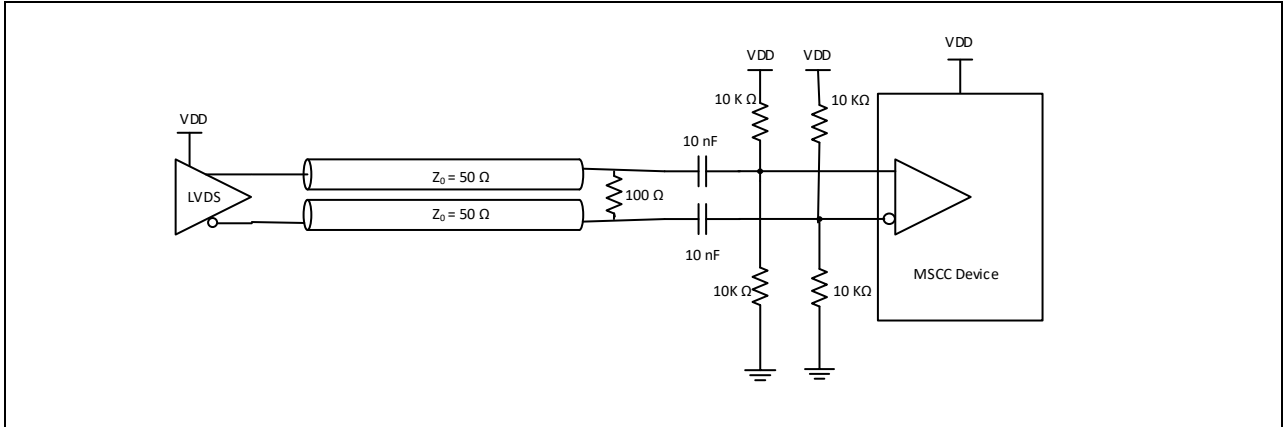


Figure 9. Input driven by AC coupled LVDS

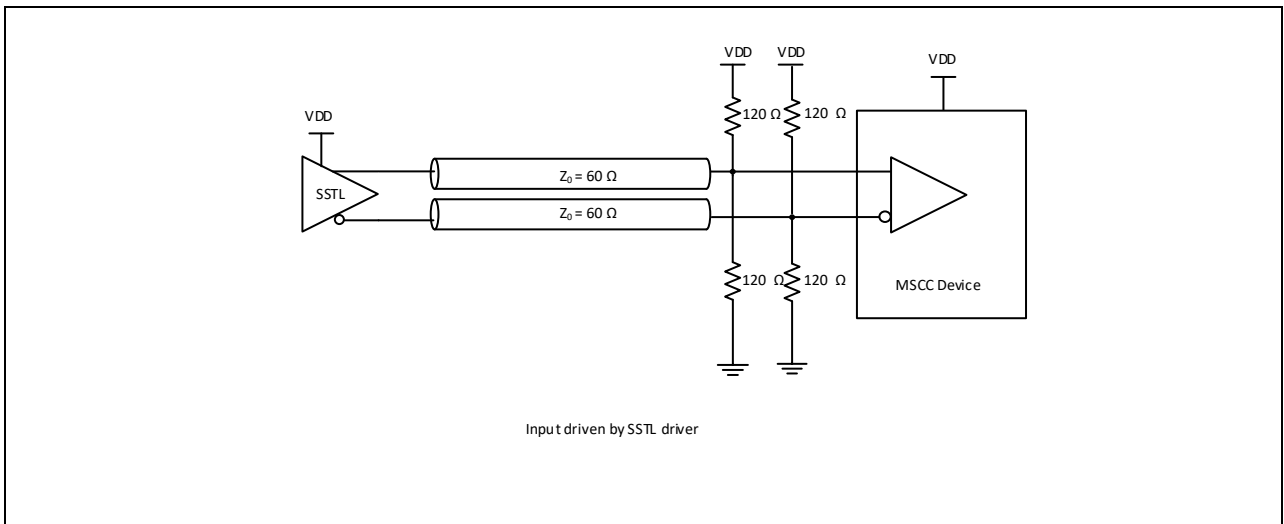
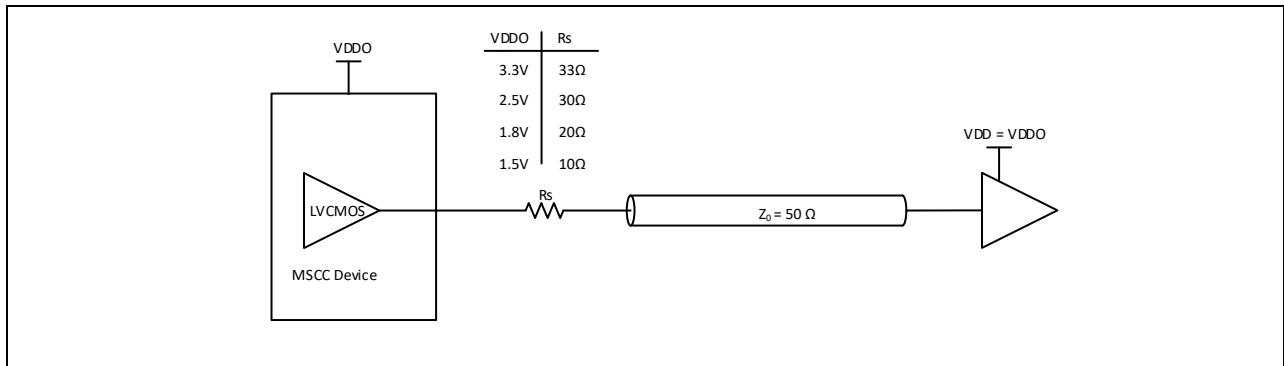


Figure 10. Input driven by an SSTL output

## Clock Outputs

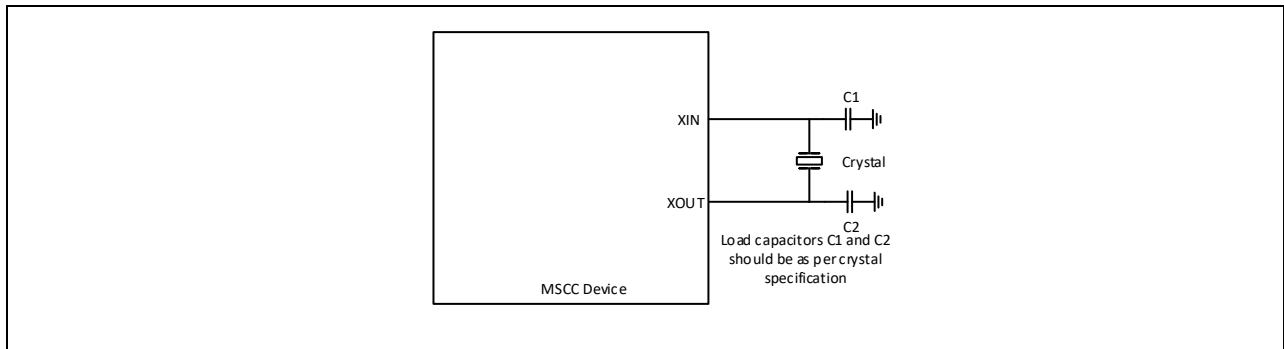
LVC MOS outputs require only series termination resistor whose value is depending on LVC MOS output voltage as shown in Figure 11.



**Figure 11. Termination for 3.3V LVPECL outputs**

## Crystal Oscillator Input

The crystal oscillator circuit can work with crystal resonators from 8MHz to 60MHz. Load capacitors C1 and C2 shall be selected as per crystal vendor recommendation. Shunt resistor is implemented inside the device. If the crystal is not used, connect XIN pin to ground.



**Figure 12. Crystal Oscillator Circuit**

The phase noise plot for 25MHz crystal is shown in Figure 13. The phase noise floor of the device is below -170dBc/Hz as can be seen on the figure.

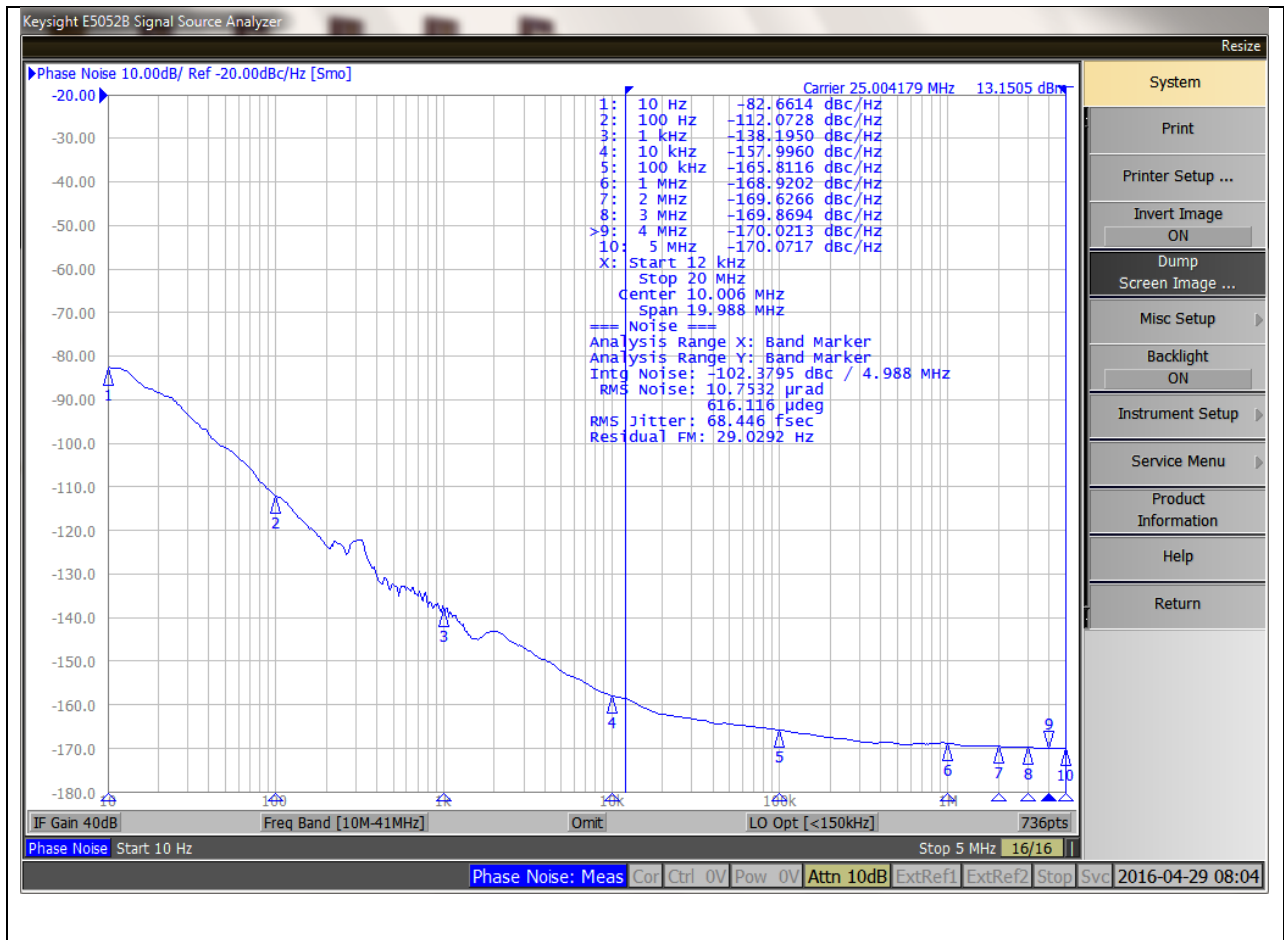


Figure 13. Phase Noise Plot with 25MHz Crystal

### Termination of unused inputs and outputs

Unused inputs can be left unconnected or alternatively IN\_0/1 can be pulled-down by 1kΩ resistor. Unused outputs should be left unconnected.

## Power Consumption

The total device power consumption can be calculated as:

$$P_T = P_S + P_{XTAL} + P_C + P_D$$

Where:

$$P_S = V_{DD} \times I_S$$

is static power consumed by input buffers. If XTAL is running this power should be set to zero. where the static current ( $I_S$ ) is specified in Table 4 .

$$P_{XTAL} = V_{DD} \times I_{DD\_XTAL}$$

is power consumption of XTAL circuit. The current of the XTAL circuit is provided in Table 4 . If XTAL is not used the power consumption is equal to zero.

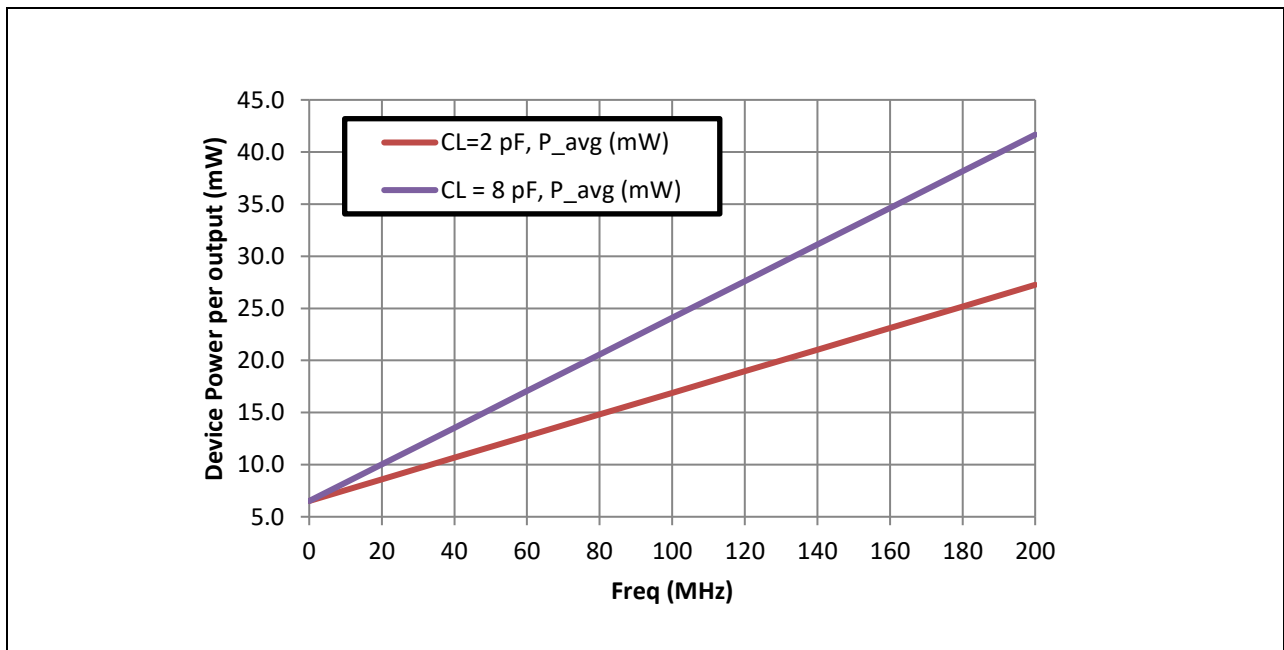
$$P_C = V_{DDO} \times I_{DDC}$$

Common output power shared among all ten outputs. The current ( $I_{DDC}$ ) is specified in Table 4 . ,

$$P_D = V_{DDO} \times (I_{DD} \times n \times f / 100MHz + V_{DDO} \times C_{LOAD} \times f \times n)$$

Dynamic power where dynamic current ( $I_{DD}$ ) is specified in Table 4 . ,  $C_{LOAD}$  is capacitive load driven by an output,  $f$  is frequency of the output clock and  $n$  is number of active outputs.

The power consumption for different clock frequencies and power supply voltages can be quickly estimated from Figure 14, Figure 15 and Figure 15.



**Figure 14. Device power consumption per output for  $V_{DD} = V_{DDO} = 3.465V$**

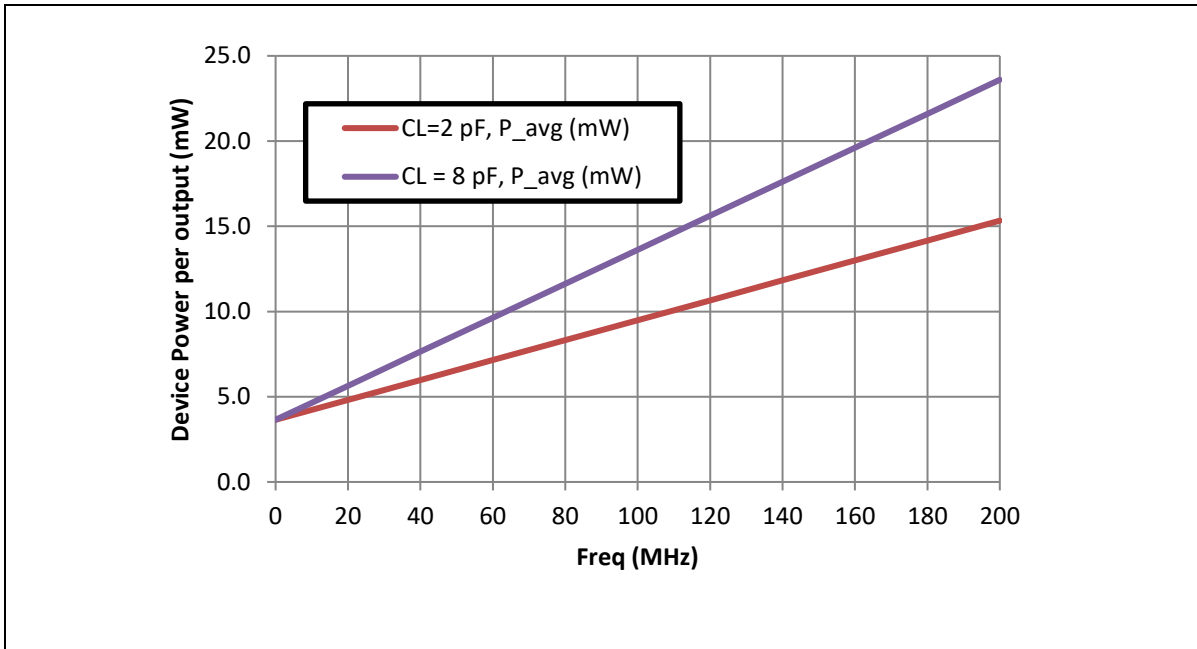


Figure 15. Device power consumption per output for  $V_{DD} = V_{DDO} = 2.625V$

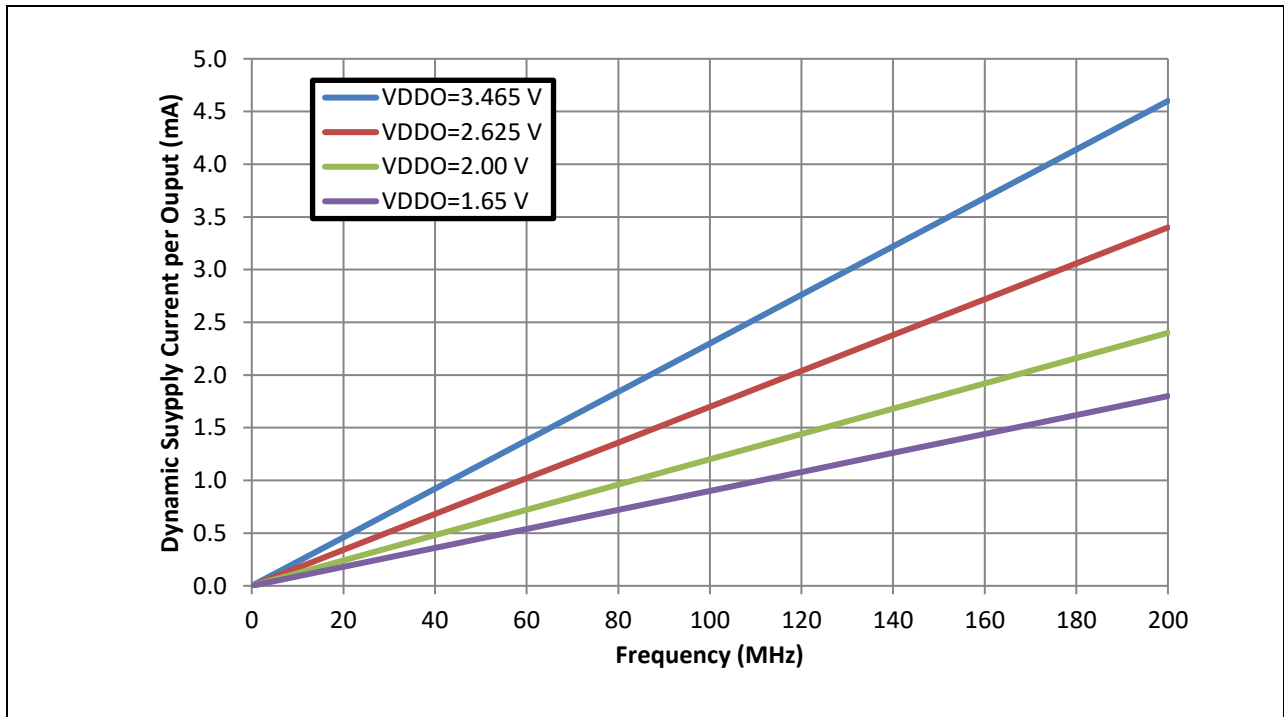
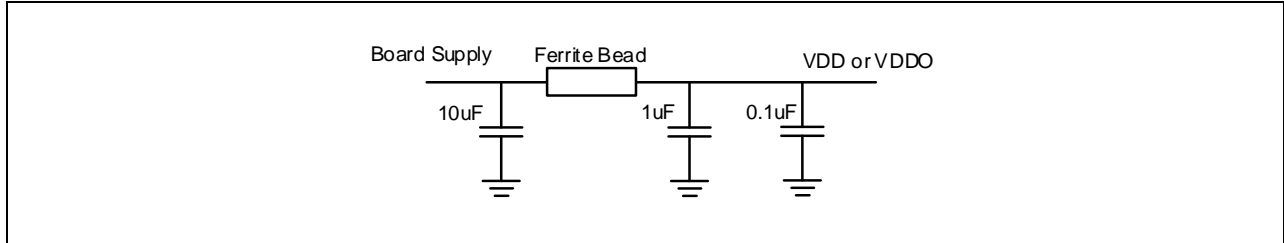


Figure 16. Dynamic supply current per output for different output supply voltages

### Power Supply Filtering

Each power pin (VDD and VDDO) should be decoupled with 0.1 $\mu$ F capacitor with minimum equivalent series resistance (ESR) and minimum series inductance (ESL). For example, 0402 X5R Ceramic Capacitors with 6.3V minimum rating could be used. These capacitors should be placed as close as possible to the power pins. To reduce the power noise from adjacent digital components on the board each power supply could be further insulated with low resistance ferrite bead with two capacitors. The ferrite bead will also insulate adjacent component from the noise generated from the device. Following figure shows recommended decoupling for each power pin.



**Figure 17. Power Supply Filtering**

### Device Control

ZL40241 is controlled via Output Enable (OE) and Input Select (SEL0/1) input pins

## AC and DC Electrical Characteristics

### Absolute Maximum Ratings

**Table 2 - Absolute Maximum Ratings\***

|   | Parameter             | Sym.                              | Min. | Typ. | Max. | Units | Notes |
|---|-----------------------|-----------------------------------|------|------|------|-------|-------|
| 1 | Supply voltage (3.3V) | V <sub>DD</sub> /V <sub>DDO</sub> | -0.5 |      | 4.6  | V     |       |
| 2 | Supply voltage (2.5V) | V <sub>DD</sub> /V <sub>DDO</sub> | -0.5 |      | 4.6  | V     |       |
| 3 | Supply voltage (1.8V) | V <sub>DDO</sub>                  | -0.5 |      | 2.5  | V     |       |
| 4 | Supply voltage (1.5V) | V <sub>DDO</sub>                  | -0.5 |      | 2.0  | V     |       |
| 5 | Storage temperature   | T <sub>ST</sub>                   | -55  |      | 125  | °C    |       |

- \* Exceeding these values may cause permanent damage
- \* Functional operation under these conditions is not implied
- \* Voltages are with respect to ground (GND) unless otherwise stated

### Recommended Operating Conditions

**Table 3 - Recommended Operating Conditions\***

|   | Characteristics       | Sym.                              | Min.  | Typ. | Max.                  | Units | Notes |
|---|-----------------------|-----------------------------------|-------|------|-----------------------|-------|-------|
| 1 | Supply voltage 3.3V   | V <sub>DD</sub> /V <sub>DDO</sub> | 3.135 | 3.30 | 3.465                 | V     |       |
| 2 | Supply voltage 2.5V   | V <sub>DD</sub> /V <sub>DDO</sub> | 2.375 | 2.50 | 2.625                 | V     |       |
| 3 | Supply voltage 1.8V   | V <sub>DDO</sub>                  | 1.6   | 1.8V | 2                     | V     |       |
| 4 | Supply voltage 1.5V   | V <sub>DDO</sub>                  | 1.35  | 1.5  | 1.65                  |       |       |
| 5 | Operating temperature | T <sub>A</sub>                    | -40   | 25   | 85                    | °C    |       |
| 6 | Input voltage         | V <sub>DD-IN</sub>                | - 0.3 |      | V <sub>DD</sub> + 0.3 | V     |       |

- \* Voltages are with respect to ground (GND) unless otherwise stated
- \* The device supports two power supply modes (3.3V and 2.5V)

**Table 4 - Current consumption**

|   | Characteristics  | Sym.                      | Min. | Typ. | Max. | Units | Notes        |
|---|--|---------------------------|------|------|------|-------|--------------|
| 1 | Static device current  | I <sub>s_3.3V</sub>       |      | 15   | 18   | mA    | VDD= 3.465V  |
|   |  | I <sub>s_2.5V</sub>       |      | 12   | 15   | mA    | VDD = 2.625V |
| 2 | Device current with 25MHz XTAL input   | I <sub>DD_XTAL_3.3V</sub> |      | 24   | 27   | mA    | VDD= 3.465V  |
|   |  | I <sub>DD_XTAL_2.5V</sub> |      | 18   | 20   | mA    | VDD= 2.625V  |
| 3 | Dynamic current per output (f = 100MHz) <sup>(1)(2)</sup><br>Needs to be scaled for different frequencies by f/100MHz, Driving Strength = 1 (registers 0x09, 0x0A) | I <sub>DD_3.3V</sub>      |      | 4.2  | 4.7  | mA    | VDDO= 3.465V |
|   |  | I <sub>DD_2.5V</sub>      |      | 3.0  | 3.5  | mA    | VDDO= 2.625V |
|   |  | I <sub>DD_1.8V</sub>      |      | 2.1  | 2.4  | mA    | VDDO= 2V     |
|   |  | I <sub>DD_1.5V</sub>      |      | 1.6  | 1.8  | mA    | VDDO= 1.65V  |
| 4 | Dynamic current per output (f = 100MHz) <sup>(1)(2)</sup><br>Needs to be scaled for different frequencies by f/100MHz, Driving Strength = 0 (registers 0x09, 0x0A) | I <sub>DD_3.3V</sub>      |      | 2.3  | 3.0  | mA    | VDDO= 3.465V |
|   |  | I <sub>DD_2.5V</sub>      |      | 1.7  | 1.8  | mA    | VDDO= 2.625V |
|   |  | I <sub>DD_1.8V</sub>      |      | 1.2  | 1.3  | mA    | VDDO= 2V     |
|   |  | I <sub>DD_1.5V</sub>      |      | 0.9  | 1.0  | mA    | VDDO= 1.65V  |
| 5 | Common output current <sup>(3)</sup>   | I <sub>DDC_3.3V</sub>     |      | 3.8  | 8.0  | mA    | VDDO= 3.465V |
|   |  | I <sub>DDC_2.5V</sub>     |      | 1.9  | 3.3  | mA    | VDDO= 2.625V |
|   |  | I <sub>DDC_1.8V</sub>     |      | 1.2  | 1.7  | mA    | VDDO= 2V     |
|   |  | I <sub>DDC_1.5V</sub>     |      | 1    | 1.4  | mA    | VDDO= 1.65V  |

- (1) Needs to be scaled for different frequencies by f/100MHz
- (2) To calculate total power consumption use following formula: P = (I<sub>s</sub> + I<sub>DD\_XTAL</sub>) \* VDD + (I<sub>DDC</sub> + I<sub>DD</sub> \* n \* f/100MHz + VDDO \* C<sub>LOAD</sub> \* f \* n) \* VDDO, where I<sub>DD\_XTAL</sub>: should be set to zero if XTAL is not used or I<sub>s</sub> should be set to zero if XTAL is used.  
n: number of active outputs  
f: frequency of the clock  
C<sub>LOAD</sub>: is capacitive load driven by an output.
- (3) This current is consumed by device whenever one or more outputs are enabled. It is independent of the number of active outputs



**Table 5 - Input Characteristics\***

|    | Characteristics   | Sym.            | Min. | Typ.         | Max.            | Units   | Notes  |
|----|---|-----------------|------|--------------|-----------------|---------|--|
| 1  | CMOS high-level input voltage for SEL0/1 and OE                           | $V_{CH}$        | 1.20 |              |                 | V       |  |
| 2  | CMOS low-level input voltage for SEL0/1 and OE                            | $V_{CIL}$       |      |              | 0.45            | V       |  |
| 3  | CMOS input leakage current for SEL0/1 and OE <sup>(1)</sup>               | $I_{IL}$        | -40  |              | 10              | $\mu$ A | $V_I = V_{DD}$ or 0 V  |
| 4  | Differential input common mode voltage for IN0_p/n and IN1_p/n            | $V_{CM}$        | 0.5  |              | $V_{DD} - 0.85$ | V       |  |
| 5  | Differential input voltage difference for IN0_p/n and IN1_p/n             | $V_{ID}$        | 0.15 |              | 1.3             | V       |  |
| 6  | Differential input leakage current for IN0_p/n and IN1_p/n <sup>(2)</sup> | $I_{IL}$        | -200 |              | 100             | $\mu$ A | $V_I = V_{DD}$ or 0 V  |
| 7  | Single ended input high voltage for IN_0_p and IN_1_p                     | $V_{SIH}$       | 2    |              | $V_{DD} + 0.3V$ | V       | $V_{DD} = 3.3V \pm 5\%$  |
|    |   | $V_{SIH}$       | 1.6  |              | $V_{DD} + 0.3V$ | V       | $V_{DD} = 2.5V \pm 5\%$  |
| 8  | Single ended input high voltage for IN_0_p and IN_1_p                     | $V_{SIL}$       | -0.3 |              | 1.3             | V       | $V_{DD} = 3.3V \pm 5\%$  |
|    |   | $V_{SIL}$       | -0.3 |              | 0.9             | V       | $V_{DD} = 2.5V \pm 5\%$  |
| 9  | Input frequency   | $f_{IN}$        | 0    |              | 200             | MHz     |  |
| 10 | Input duty cycle  | dc              | 35%  |              | 65%             |         | @200MHz; for lower frequencies duty cycle can be scaled proportionally |
| 11 | Input slew rate   | slew            |      | 2            |                 | V/ns    |  |
| 12 | Input pull-up/ pull-down resistance (INx_n)                               | $R_{PU}/R_{PD}$ |      | 60k $\Omega$ |                 |         |  |
| 13 | Input pull-down resistance (INx_p)  | $R_{PD}$        |      | 30k $\Omega$ |                 |         |  |

\* Values are over Recommended Operating Conditions

\* Values are over all two power supply modes ( $V_{DD} = 3.3V$  and  $V_{DD} = 2.5V$ )

(1) CMOS input leakage is due to 300k $\Omega$  pull-up/pull-down resistors

(2) Differential Input leakage is due to 60k $\Omega$  pull-up/pull-down resistors INx\_n and due to 30k $\Omega$  pull-down resistor for INx\_p

**Table 6 - Crystal Oscillator Characteristics\***

|   | Characteristics                            | Sym.     | Min.        | Typ. | Max. | Units      | Notes   |
|---|--|----------|-------------|------|------|------------|---|
| 1 | Mode of oscillation                        | mode     | Fundamental |      |      |            |   |
| 2 | Frequency                                  | f        | 8           |      | 60   | MHz        |   |
| 3 | On chip shunt resistor                     | R        |             | 0.5  |      | M $\Omega$ |   |
| 4 | On chip capacitance                        | C        |             | 12   |      | pF         |   |
| 5 | Frequency in overdrive mode <sup>(1)</sup> | $f_{OV}$ | 0.1         |      | 200  | MHz        | Functional but may not meet AC parameters<br>Minimum depends on AC coupling Capacitor (0.1 $\mu$ F assumed) |
| 6 | Frequency in bypass mode <sup>(2)</sup>    | $f_{BP}$ |             |      | 200  | MHz        | Functional but may not meet AC parameters   |

\* Values are over Recommended Operating Conditions

\* Values are over all two power supply modes ( $V_{DD} = 3.3V$  and  $V_{DD} = 2.5V$ )

(1) Maximum input level is 2V

(2) Maximum output level is VDD

**Table 7 - LVCMOS Output Characteristics\***

|    | Characteristics                              | Sym.                            | Min.     | Typ. | Max.     | Units | Notes                     |
|----|--|---------------------------------|----------|------|----------|-------|---------------------------|
| 1  | Output high voltage                          | V <sub>OH</sub>                 | 0.8*VDDO |      |          | V     | VDDO = 3.3V±5%            |
|    |  | V <sub>OH</sub>                 | 0.8*VDDO |      |          | V     | VDDO = 2.5V±5%            |
|    |  | V <sub>OH</sub>                 | 0.7*VDDO |      |          | V     | VDDO = 1.8V±10%           |
|    |  | V <sub>OH</sub>                 | 0.7*VDDO |      |          | V     | VDDO = 1.5V±10%           |
| 2  | Output low voltage                           | V <sub>OL</sub>                 |          |      | 0.2*VDDO | V     | VDDO = 3.3V±5%            |
|    |  | V <sub>OL</sub>                 |          |      | 0.2*VDDO | V     | VDDO = 2.5V±5%            |
|    |  | V <sub>OL</sub>                 |          |      | 0.3*VDDO | V     | VDDO = 1.8V±10%           |
|    |  | V <sub>OL</sub>                 |          |      | 0.3*VDDO | V     | VDDO = 1.5V±10%           |
| 3  | Output impedance                             | R <sub>O</sub>                  |          | 17   |          | Ω     | VDDO = 3.3V               |
|    |  | R <sub>O</sub>                  |          | 21   |          | Ω     | VDDO = 2.5V               |
|    |  | R <sub>O</sub>                  |          | 30   |          | Ω     | VDDO = 1.8V               |
|    |  | R <sub>O</sub>                  |          | 42   |          | Ω     | VDDO = 1.5V               |
| 4  | Output slew rate-- rise or fall (20% to 80%) | t <sub>r</sub> , t <sub>f</sub> | 3.19     | 5.14 | 6.33     | V/ns  | VDDO = 3.3V±5%            |
|    |  | t <sub>r</sub> , t <sub>f</sub> | 1.72     | 3.74 | 4.61     | V/ns  | VDDO = 2.5V±5%            |
|    |  | t <sub>r</sub> , t <sub>f</sub> | 1.64     | 2.52 | 3.32     | V/ns  | VDDO = 1.8V±10%           |
|    |  | t <sub>r</sub> , t <sub>f</sub> | 1.20     | 1.96 | 2.54     | V/ns  | VDDO = 1.5V±10%           |
| 5  | Output frequency                             | F <sub>O</sub>                  | 0        |      | 200      | MHz   |                           |
| 6  | Output Duty Cycle                            |                                 | 50.26%   |      | 53.18%   |       | Input. duty-cycle 50%     |
| 7  | Output enable or disable time                |                                 |          |      | 2        | Cycle |                           |
| 8  | Output to output skew                        | t <sub>oosk</sub>               |          |      | 27       | ps    |                           |
| 9  | Device to device output skew                 | t <sub>boosk</sub>              |          |      | 1.6      | ns    |                           |
| 10 | Input to output delay                        | t <sub>iOD</sub>                | 1.15     | 2.09 | 2.54     | ns    | VDD = 3.3V                |
|    |  | t <sub>iOD</sub>                | 1.57     | 2.27 | 2.77     | ns    | VDD = 2.5V                |
| 11 | Input multiplexer isolation                  | i <sub>so</sub>                 | 75       |      |          | dB    | tested with 125MHz clocks |

\* Values are over Recommended Operating Conditions

\* Values are over all two power supply modes (V<sub>DD</sub> = 3.3V and V<sub>DD</sub> = 2.5V)

\* Load 50 Ohm to VDDO/2

**Table 8 - LVCMOS Output Additive Jitter and Phase Noise\***

|   | Characteristics                                | Min.    | Typ.    | Max.   | Units  | Notes   |
|---|--|---------|---------|--|--------|---|
| 1 | System level additive jitter <sup>(1)</sup>    |         | 17      |  | fs-RMS | VDD = 3.3V, VDDO = 3.3V<br>f <sub>in</sub> = 125MHz, single ended input         |
|   |  |         | 31      |  | fs-RMS | VDD = 2.5V, VDDO = 1.5V to 2.5V<br>f <sub>in</sub> = 125MHz, single ended input |
|   |  |         | 22      |  | fs-RMS | VDD = 3.3V, VDDO = 3.3V<br>f <sub>in</sub> = 125MHz, differential input         |
|   |  |         | 37      |  | fs-RMS | VDD = 2.5V, VDDO = 1.5V to 2.5V<br>f <sub>in</sub> = 125MHz, differential input |
| 2 | Additive jitter <sup>(2) (3)</sup>             |         | 45.18   | 93.11  | fs-RMS | VDD = 3.3V, VDDO = 3.3V<br>f <sub>in</sub> = 125MHz, single ended input         |
|   |  |         | 80.46   | 126.92   | fs-RMS | VDD = 2.5V, VDDO = 1.5V to 2.5V<br>f <sub>in</sub> = 125MHz, single ended input |
|   |  |         | 39.95   | 68.98  | fs-RMS | VDD = 3.3V, VDDO = 3.3V<br>f <sub>in</sub> = 125MHz, differential input         |
|   |  |         | 67.18   | 117.26   | fs-RMS | VDD = 2.5V, VDDO = 1.5V to 2.5V<br>f <sub>in</sub> = 125MHz, differential input |
| 3 | Phase Noise floor<br>(VDD = 3.3V, VDDO = 3.3V) |         | -145.08 | -138.67  | dBc/Hz | @10kHz, f <sub>in</sub> = 125MHz, single ended input                            |
|   |  |         | -152.46 | -145.82  | dBc/Hz | @100kHz, f <sub>in</sub> = 125MHz, single ended input                           |
|   |  |         | -160.67 | -155.66  | dBc/Hz | @1MHz, f <sub>in</sub> = 125MHz, single ended input                             |
|   |  |         | -162.66 | -160.55  | dBc/Hz | @10MHz, f <sub>in</sub> = 125MHz, single ended input                            |
|   |  |         | -162.71 | -160.19  | dBc/Hz | @20MHz, f <sub>in</sub> = 125MHz, single ended input                            |
|   |  |         | -145.34 | -137.83  | dBc/Hz | @10kHz, f <sub>in</sub> = 125MHz, differential input                            |
|   |  |         | -152.60 | -146.93  | dBc/Hz | @100kHz, f <sub>in</sub> = 125MHz, differential input                           |
|   |  |         | -161.06 | -156.99  | dBc/Hz | @1MHz, f <sub>in</sub> = 125MHz, differential input                             |
|   |  |         | -163.22 | -160.84  | dBc/Hz | @10MHz, f <sub>in</sub> = 125MHz, differential input                            |
| 4 | Phase Noise floor<br>(VDD = 2.5V, VDDO = 2.5V) |         | -139.93 | -134.59  | dBc/Hz | @10kHz, f <sub>in</sub> = 125MHz, single ended input                            |
|   |  |         | -147.22 | -144.21  | dBc/Hz | @100kHz, f <sub>in</sub> = 125MHz, single ended input                           |
|   |  |         | -157.11 | -154.78  | dBc/Hz | @1MHz, f <sub>in</sub> = 125MHz, single ended input                             |
|   |  |         | -160.58 | -158.21  | dBc/Hz | @10MHz, f <sub>in</sub> = 125MHz, single ended input                            |
|   |  |         | -160.78 | -158.19  | dBc/Hz | @20MHz, f <sub>in</sub> = 125MHz, single ended input                            |
|   |  |         | -141.69 | -134.26  | dBc/Hz | @10kHz, f <sub>in</sub> = 125MHz, differential input                            |
|   |  |         | -149.19 | -144.73  | dBc/Hz | @100kHz, f <sub>in</sub> = 125MHz, differential input                           |
|   |  |         | -158.66 | -156.22  | dBc/Hz | @1MHz, f <sub>in</sub> = 125MHz, differential input                             |
|   |  |         | -161.60 | -159.32  | dBc/Hz | @10MHz, f <sub>in</sub> = 125MHz, differential input                            |
|   | -161.85  | -159.36 | dBc/Hz  | @20MHz, f <sub>in</sub> = 125MHz, differential input |        |   |

\* Values are over Recommended Operating Conditions

\* Values are over all two power supply modes (V<sub>DD</sub> = 3.3V and V<sub>DD</sub> = 2.5V)

(1) System level additive jitter is calculated as  $J_{RMS\_SYS\_AJ} = J_{RMS\_OUT} - J_{RMS\_IN}$

(2) Additive jitter is calculated as  $J_{RMS\_AJ} = \sqrt{J_{RMS\_OUT}^2 - J_{RMS\_IN}^2}$  where jitter is integrated in 12 kHz to 20 MHz band

Tester measures jitter at 156.25MHz. Since this freq won't appear in the data sheet, it should be removed from the PPGT. Data sheet jitter is guaranteed by lab char. The ATE jitter measurement will be used to screen outliers only, with limits based on ATE distribution

**Table 9 - LVCMOS Output Jitter Phase Noise with 25MHz XTAL\***

|   | Characteristics                   | Min. | Typ.    | Max. | Units  | Notes                            |
|---|-----------------------------------|------|---------|------|--------|----------------------------------|
| 1 | Jitter RMS in 12kHz to 20MHz band |      | 72.63   |      | fs     | VDD = 3.3V, VDDO = 3.3V          |
|   |                                   |      | 87.59   |      | fs     | VDD = 2.5V; VDDO = 2.5V          |
| 2 | Phase Noise floor                 |      | -75.96  |      | dBc/Hz | @10Hz, VDD = 3.3V, VDDO = 3.3V   |
|   |                                   |      | -107.50 |      | dBc/Hz | @100Hz, VDD = 3.3V, VDDO = 3.3V  |
|   |                                   |      | -132.34 |      | dBc/Hz | @1kHz, VDD = 3.3V, VDDO = 3.3V   |
|   |                                   |      | -157.36 |      | dBc/Hz | @10kHz, VDD = 3.3V, VDDO = 3.3V  |
|   |                                   |      | -165.82 |      | dBc/Hz | @100kHz, VDD = 3.3V, VDDO = 3.3V |
|   |                                   |      | -168.85 |      | dBc/Hz | @1MHz, VDD = 3.3V, VDDO = 3.3V   |
|   |                                   |      | -168.88 |      | dBc/Hz | @5MHz, VDD = 3.3V, VDDO = 3.3V   |
|   |                                   |      | -70.52  |      | dBc/Hz | @10Hz, VDD = 2.5V; VDDO = 2.5V   |
|   |                                   |      | -102.60 |      | dBc/Hz | @100Hz, VDD = 2.5V; VDDO = 2.5V  |
|   |                                   |      | -129.14 |      | dBc/Hz | @1kHz, VDD = 2.5V; VDDO = 2.5V   |
|   |                                   |      | -153.93 |      | dBc/Hz | @10kHz, VDD = 2.5V; VDDO = 2.5V  |
|   |                                   |      | -164.00 |      | dBc/Hz | @100kHz, VDD = 2.5V; VDDO = 2.5V |
|   |                                   |      | -167.34 |      | dBc/Hz | @1MHz, VDD = 2.5V; VDDO = 2.5V   |
|   |                                   |      | -167.41 |      | dBc/Hz | @5MHz, VDD = 2.5V; VDDO = 2.5V   |

\* Values are over Recommended Operating Conditions

\* Values are over all two power supply modes (V<sub>DD</sub> = 3.3V and V<sub>DD</sub> = 2.5V)

\* Xtal frequency is 25 MHz

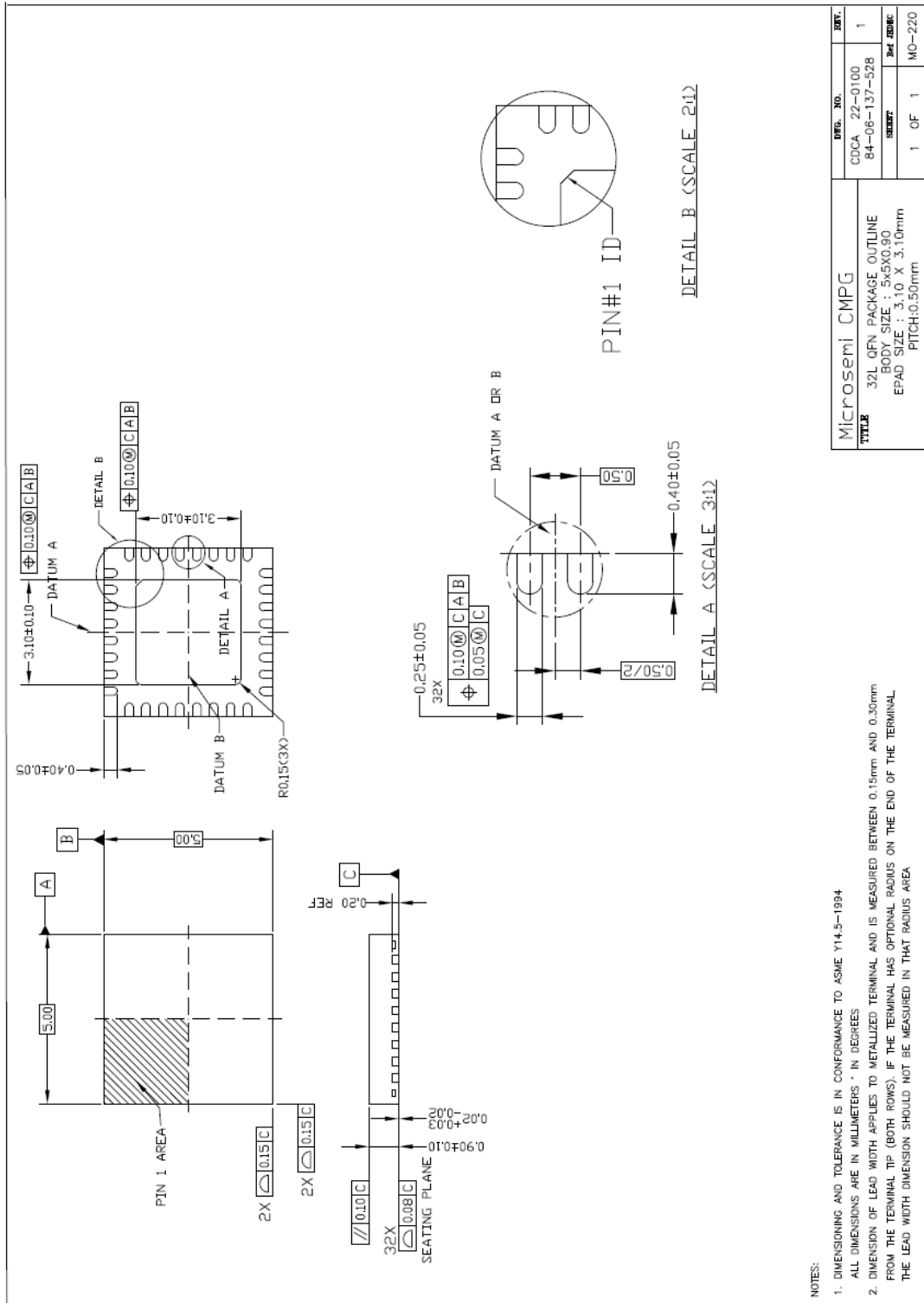
**Table 10 - 5x5mm QFN Package Thermal Properties**

| Parameter  | Symbol            | Conditions     | Value | Units |
|--|-------------------|----------------|-------|-------|
| Maximum Ambient Temperature                                    | T <sub>A</sub>    |                | 85    | °C    |
| Maximum Junction Temperature                                   | T <sub>JMAX</sub> |                | 125   | °C    |
| Junction to Ambient Thermal Resistance <sup>(1)</sup> (Note 1) | θ <sub>JA</sub>   | still air      | 26.8  | °C/W  |
|  |                   | 1m/s airflow   | 21.8  |       |
|  |                   | 2.5m/s airflow | 19.9  |       |
| Junction to Board Thermal Resistance                           | θ <sub>JB</sub>   |                | 10.8  | °C/W  |
| Junction to Case Thermal Resistance                            | θ <sub>JC</sub>   |                | 19.5  | °C/W  |
| Junction to Pad Thermal Resistance <sup>(2)</sup>              | θ <sub>JP</sub>   | Still air      | 6.5   | °C/W  |
| Junction to Top-Center Thermal Characterization Parameter      | ψ <sub>JT</sub>   | Still air      | 0.6   | °C/W  |

(1) Theta-JA (θ<sub>JA</sub>) is the thermal resistance from junction to ambient when the package is mounted on an 4-layer JEDEC standard test board and dissipating maximum power

(2) Theta-JP (θ<sub>JP</sub>) is the thermal resistance from junction to the center exposed pad on the bottom of the package)

Package Outline



## Revision History

February 2017: Initial Release

July 2018: Release changes:

- Added note in pinout to tie XIN pin when crystal circuit is not used
- Fixed several typographical errors.

October 2018: Release changes:

- Removed Figures 18, and 19 due to inaccuracy



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