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Precision 1:6 LVPECL Fanout Buffer

Data Sheet

February 2013

Features

Inputs/Outputs

- Accepts differential or single-ended input
  - LVPECL, LVDS, CML, HCSL, LVCMOS
- Six precision LVPECL outputs
- Operating frequency up to 750 MHz

Power

- Option for 2.5 V or 3.3 V power supply
- Core current consumption of 110 mA
- On-chip Low Drop Out (LDO) Regulator for superior power supply rejection

Performance

- Ultra low additive jitter of 38 fs RMS

Ordering Information

ZL40204LDG1	32 Pin QFN	Trays
ZL40204LDF1	32 Pin QFN	Tape and Reel

Matte Tin
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 communications: OTN, SONET/SDH, GE, 10 GE, FC and 10G FC
- Wireless communications
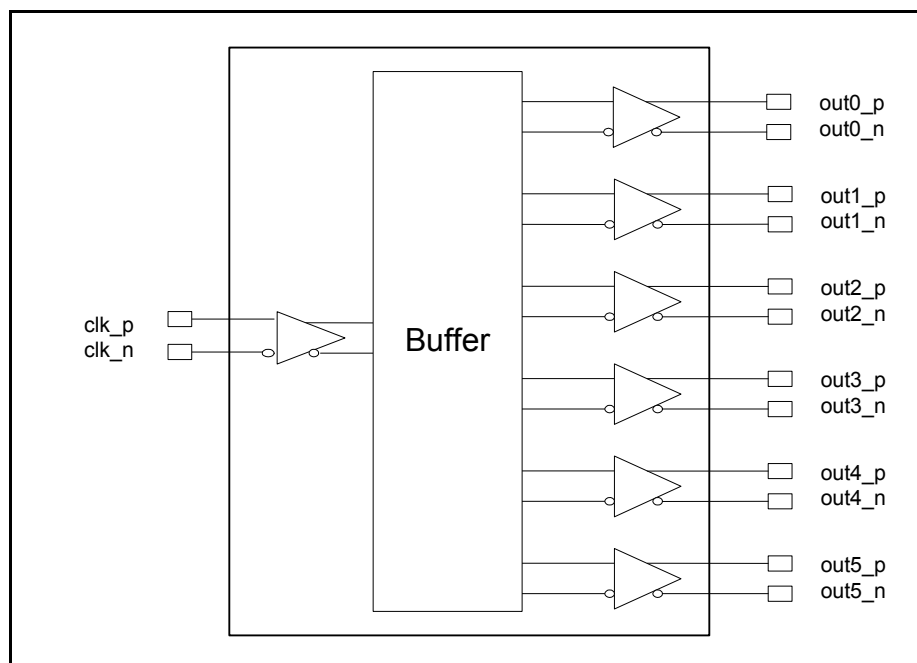- High performance microprocessor clock distribution

Figure 1 - Functional Block Diagram

Table of Contents

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List of Figures

Change Summary

Below are the changes from the November 2012 issue to the February 2013 issue:

Page	Item	Change
7	Figure 4	Changed text to indicate the circuit is not recommended for VDD_driver=2.5V.
7	Figure 5	Changed pull-up and pull-down resistors from 2kOhm to 100Ohm.
13	Figure 16	Corrected typo: changed R values from 143 and 82 to 120 and 60 to match other fanout buffer data sheets.

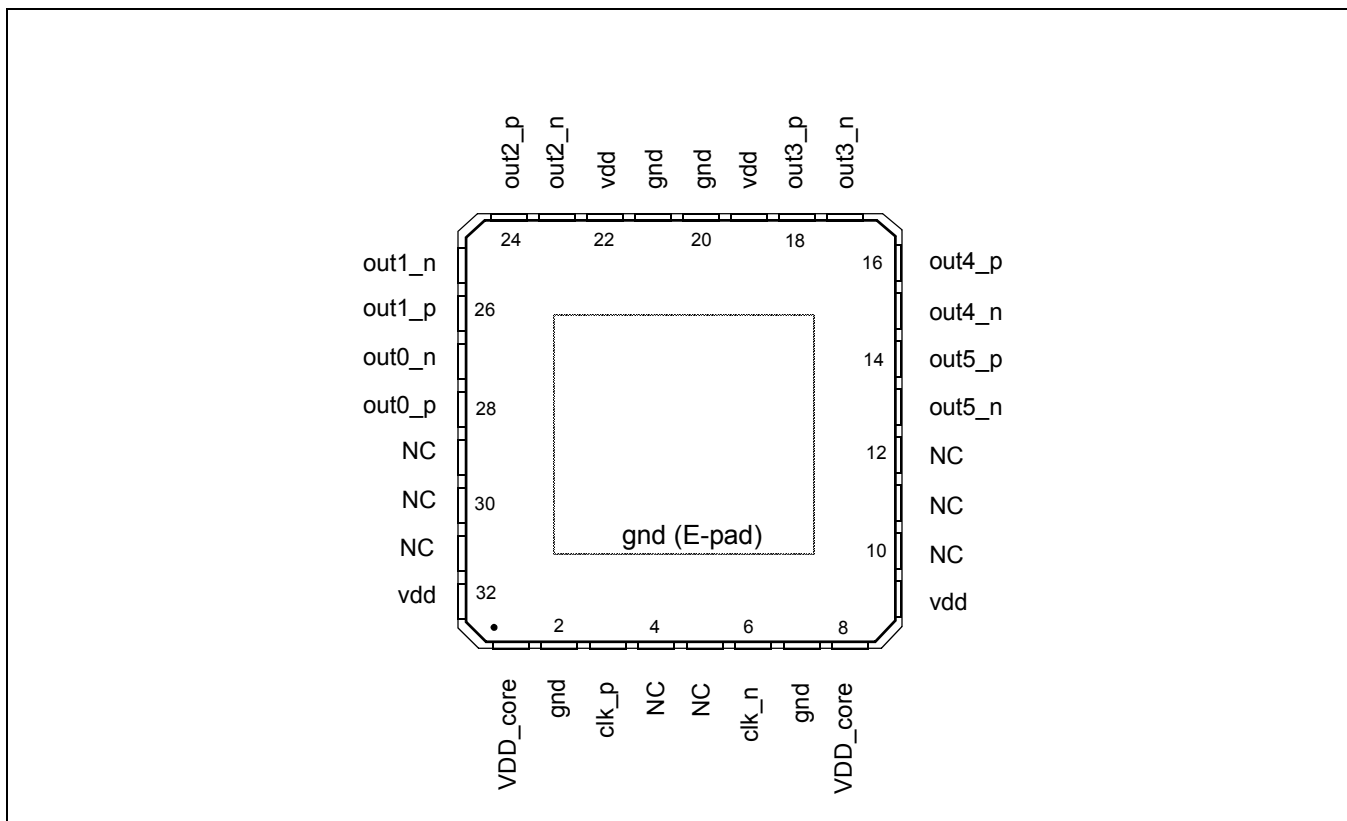# 1.0 Package Description

The device is packaged in a 32 pin QFN

Figure 2 - Pin Connections

2.0   Pin Description

Pin #	Name	Description
3, 6	clk_p, clk_n,	**Differential Input (Analog Input).** Differential (or singled ended) input signals. For all input signal configurations, see "Clock Inputs" on page 6
28, 27, 26, 25, 24, 23, 18, 17, 16, 15, 14, 13	out0_p, out0_n out1_p, out1_n out2_p, out2_n out3_p, out3_n out4_p, out4_n out5_p, out5_n	**Differential Output (Analog Output).** Differential outputs.
9, 19, 22, 32	vdd	**Positive Supply Voltage.** 2.5 V_{DC} or 3.3 V_{DC} nominal.
1, 8	vdd_core	**Positive Supply Voltage.** 2.5 V_{DC} or 3.3 V_{DC} nominal.
2, 7, 20, 21	gnd	**Ground.** 0 V.
4, 5 10, 11, 12, 29, 30, 31	NC	**No Connection.** Leave unconnected.

3.0   Functional Description

The ZL40204 is an LVPECL clock fanout buffer with six output clock drivers capable of operating at frequencies up to 750MHz.

Inputs to the ZL40204 are externally terminated to allow use of precision termination components and to allow full flexibility of input termination. The ZL40204 can accept DC coupled LVPECL or LVDS and AC coupled LVPECL, LVDS, CML or HCSL input signals; single ended input signals can also be accepted. A pin compatible device with internal termination is also available.

The ZL40204 is designed to fan out low-jitter reference clocks for wired or optical communications applications while adding minimal jitter to the clock signal. An internal linear power supply regulator and bulk capacitors minimize additive jitter due to power supply noise. 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.

The device block diagram is shown in Figure 1; its operation is described in the following sections.

3.1   Clock Inputs

The ZL40204 is adaptable to support different types of differential and singled-ened input signals depending on the passive components used in the input termination. The application diagrams in the following figures allow the ZL40204 to accept LVPECL, LVDS, CML, HCSL and single-ended inputs.
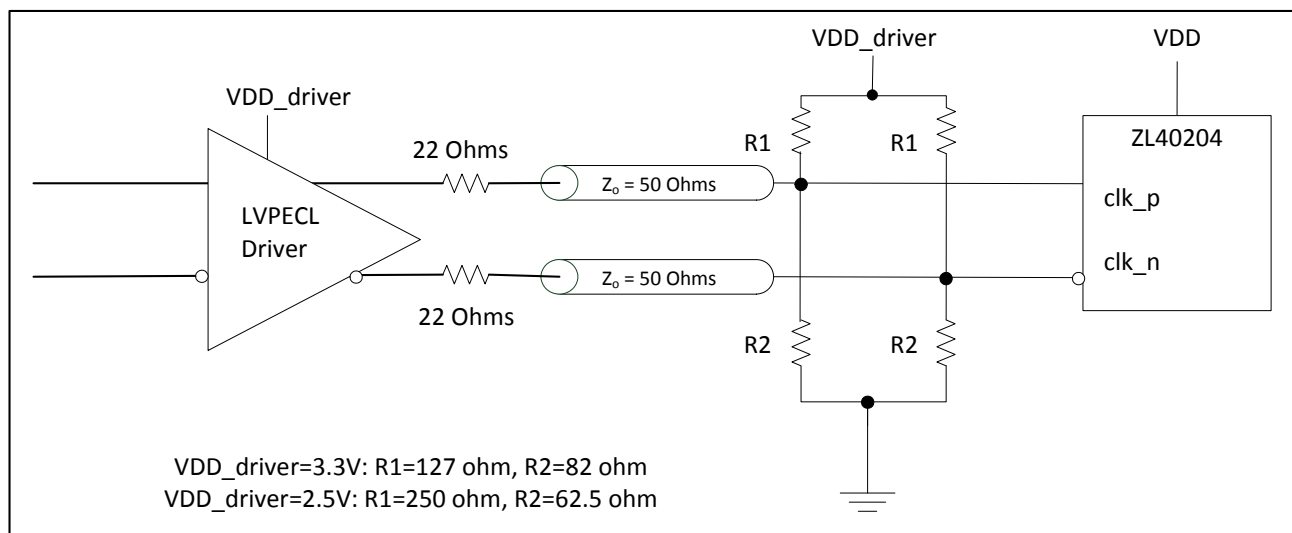

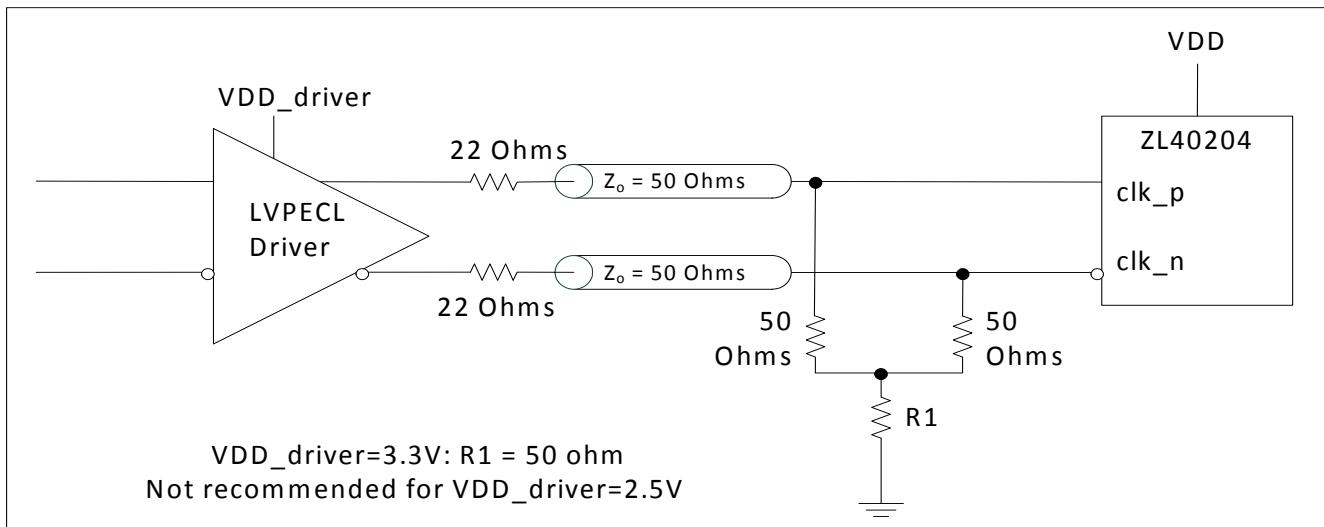**Figure 3 - LVPECL Input DC Coupled Thevenin Equivalent**

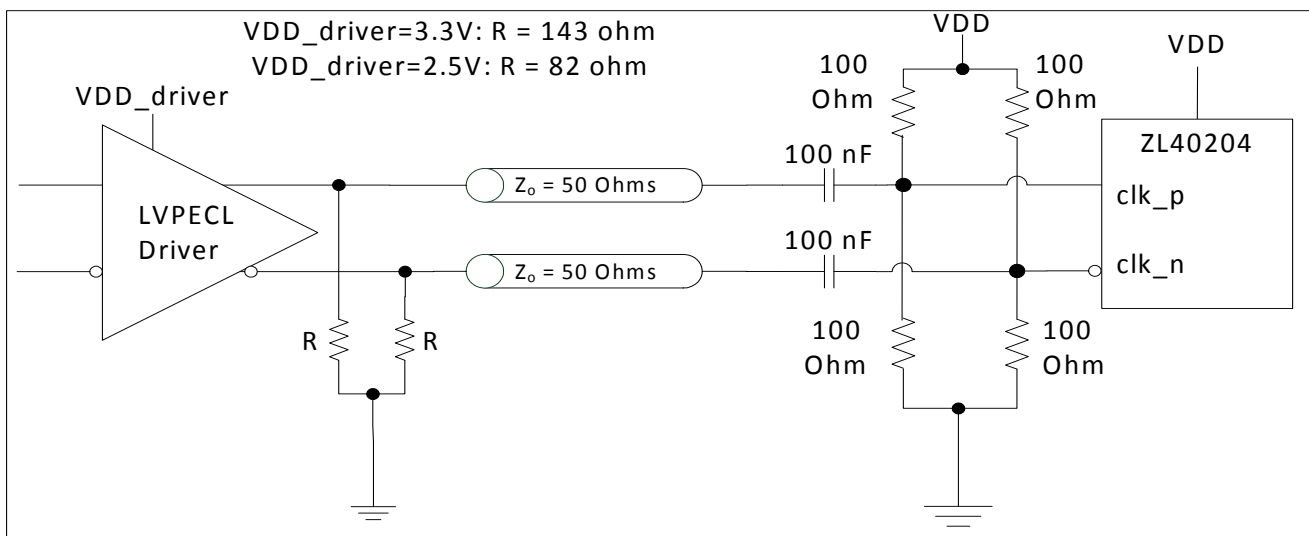**Figure 4 - LVPECL Input DC Coupled Parallel Termination**

Figure 5 - LVPECL Input AC Coupled Termination
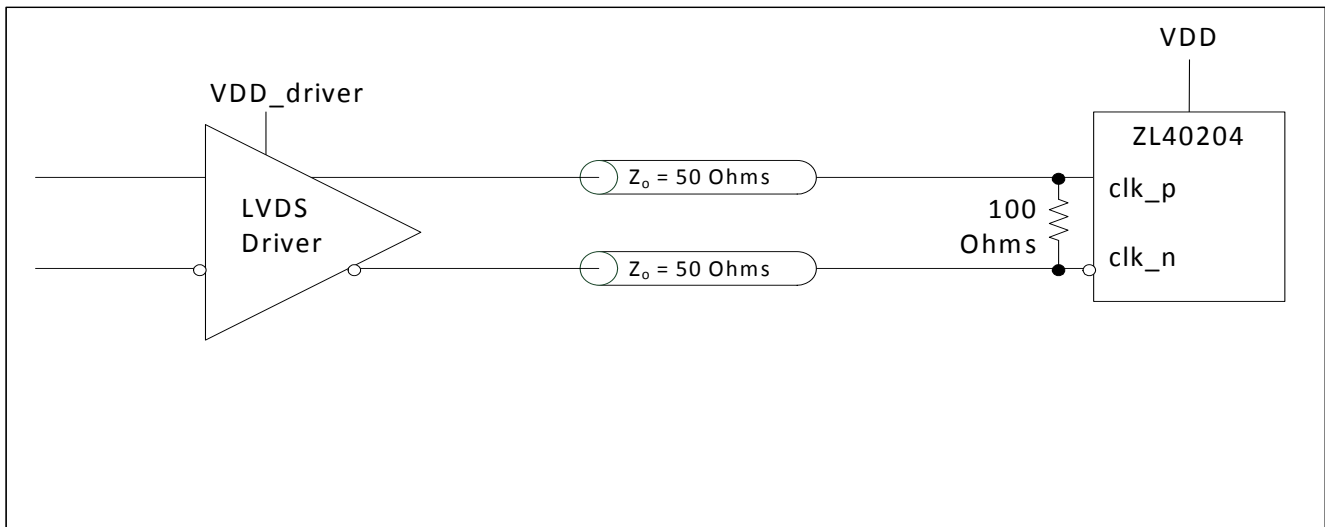
Figure 6 - LVDS Input DC Coupled
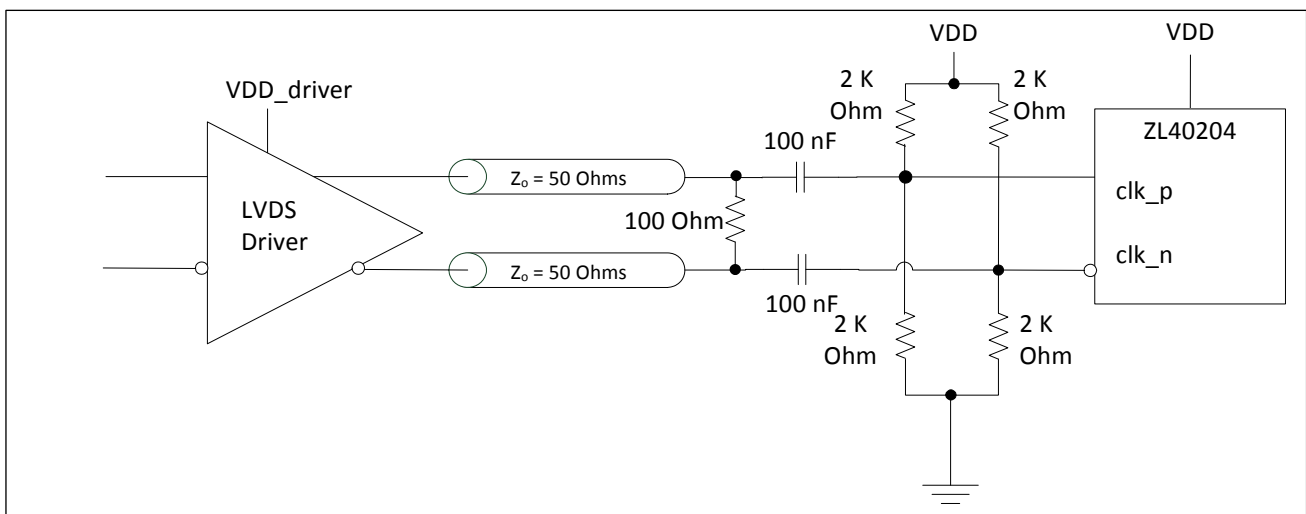
Figure 7 - LVDS Input AC Coupled
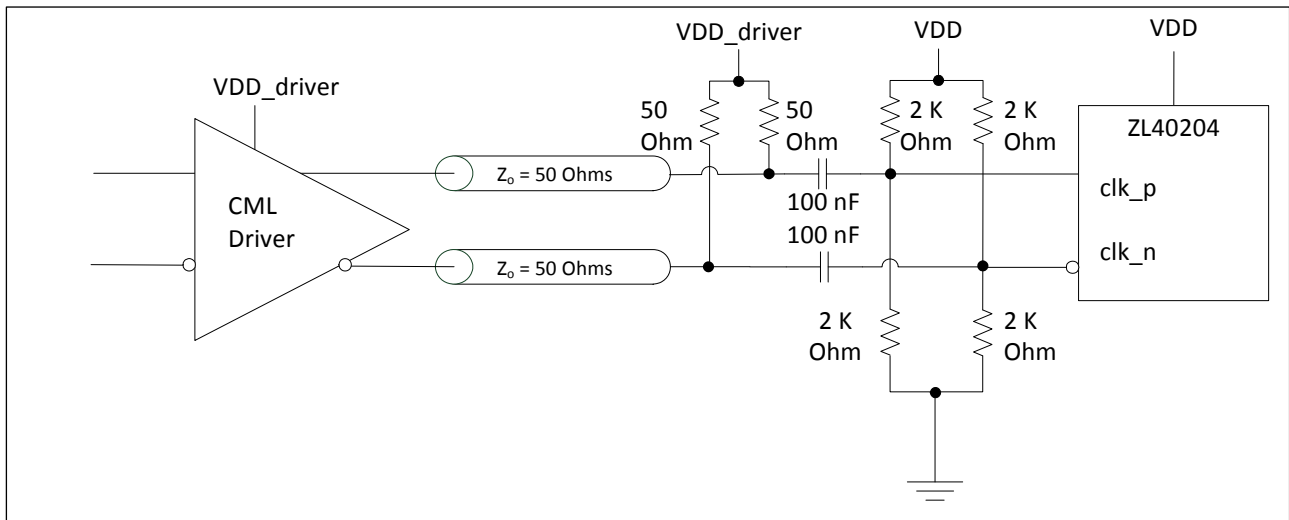
Figure 8 - CML Input AC Coupled
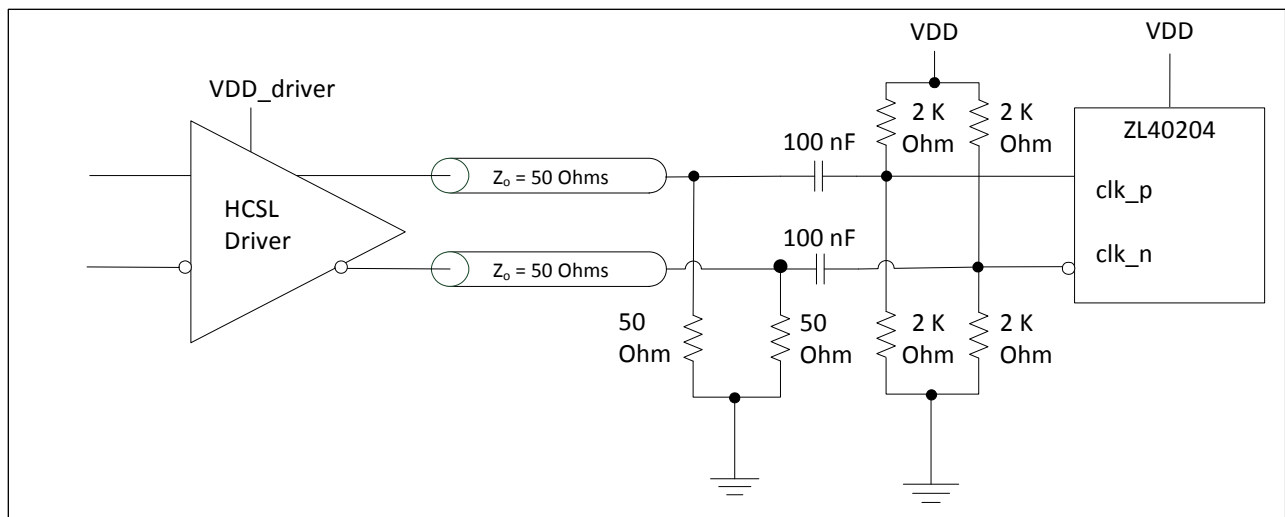
Figure 9 - HCSL Input AC Coupled
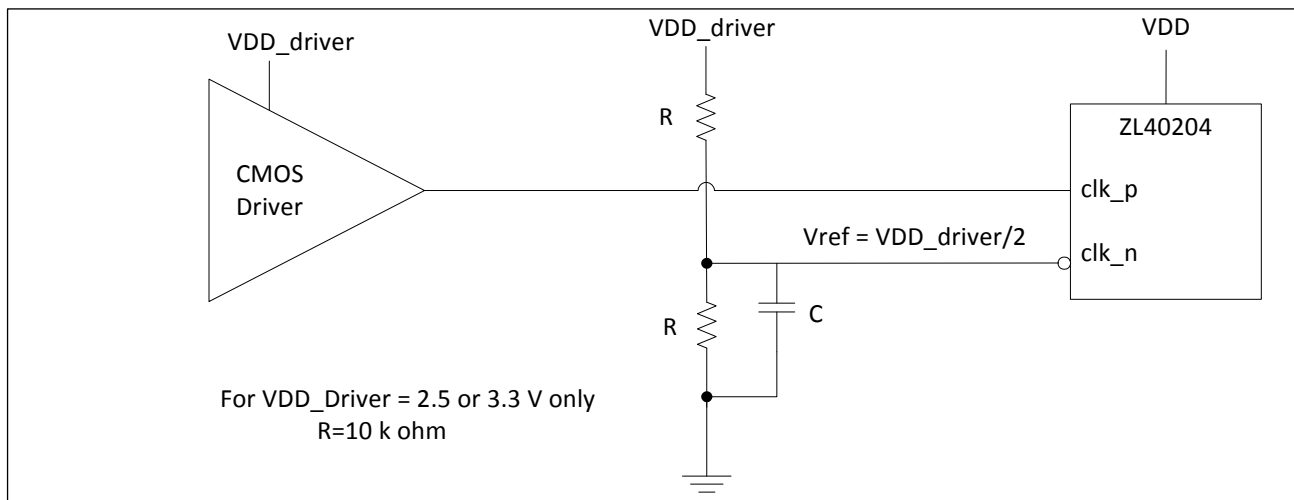
Figure 10 - CMOS Input DC Coupled Referenced to VDD/2
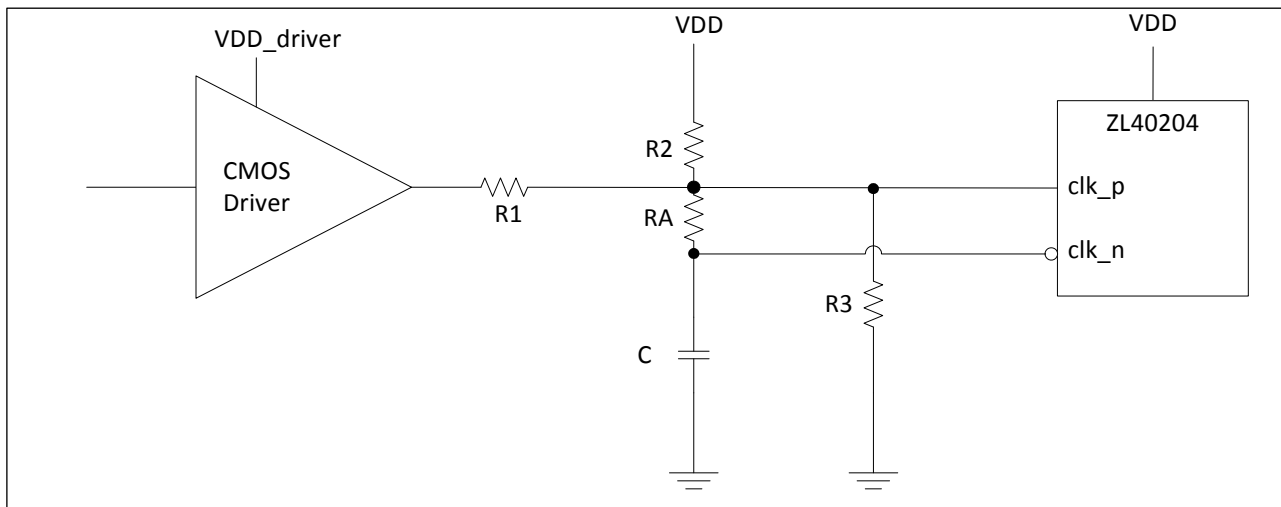
Figure 11 - CMOS Input DC Coupled Referenced to Ground

VDD_driver	R1 (kΩ)	R2 (kΩ)	R3 (kΩ)	RA (kΩ)	C (pF)
1.5	1.25	3.075	open	10	10
1.8	1	3.8	open	10	10
2.5	0.33	4.2	open	10	10
3.3	0.75	open	4.2	10	10

Table 1 - Component Values for Single Ended Input Reference to Ground

* For frequencies below 100 MHz, increase C to avoid signal integrity issues.

3.2   Clock Outputs

LVPECL has a very low output impedance and a differential signal swing between 1V and 1.6 V. A simplified diagram for the output stage is shown in Figure 12.The LVPECL to LVDS output termination is not shown since there is a separate device that has the same input and LVDS outputs.
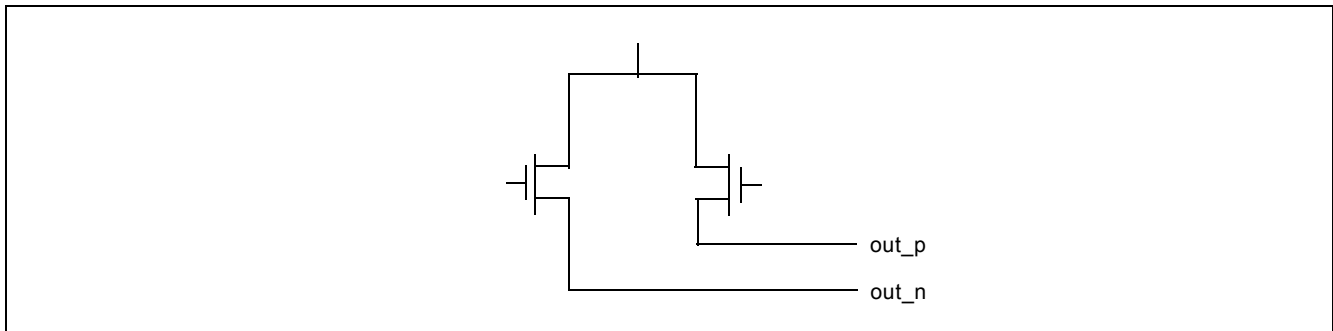
Figure 12 - Simplified Output Driver

The methods to terminate the ZL40204 LVPECL drivers are shown in the following figures.
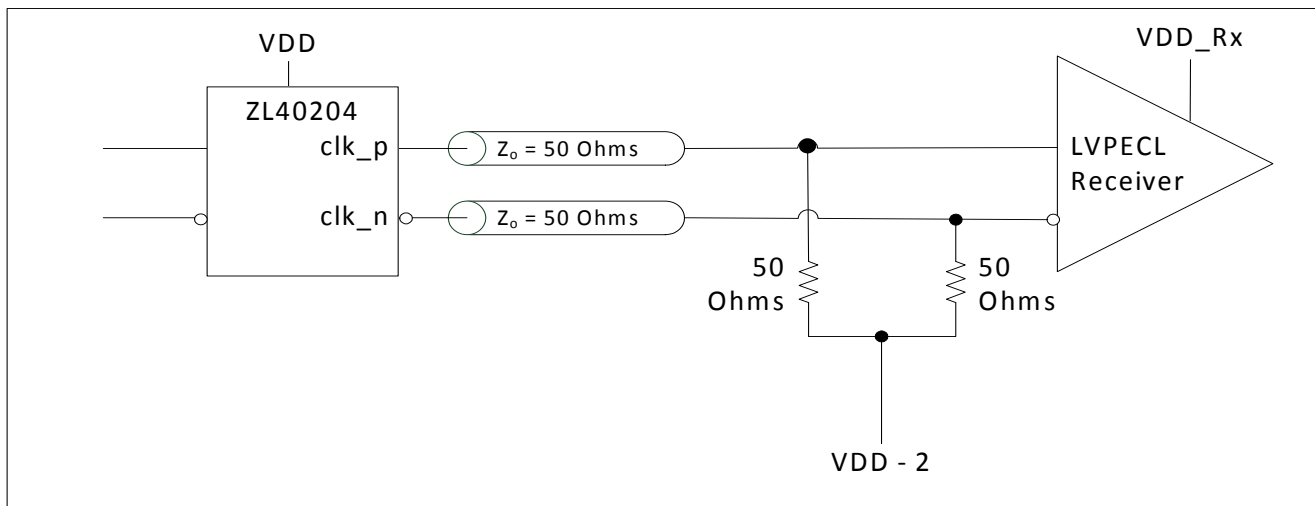
Figure 13 - LVPECL Basic Output Termination
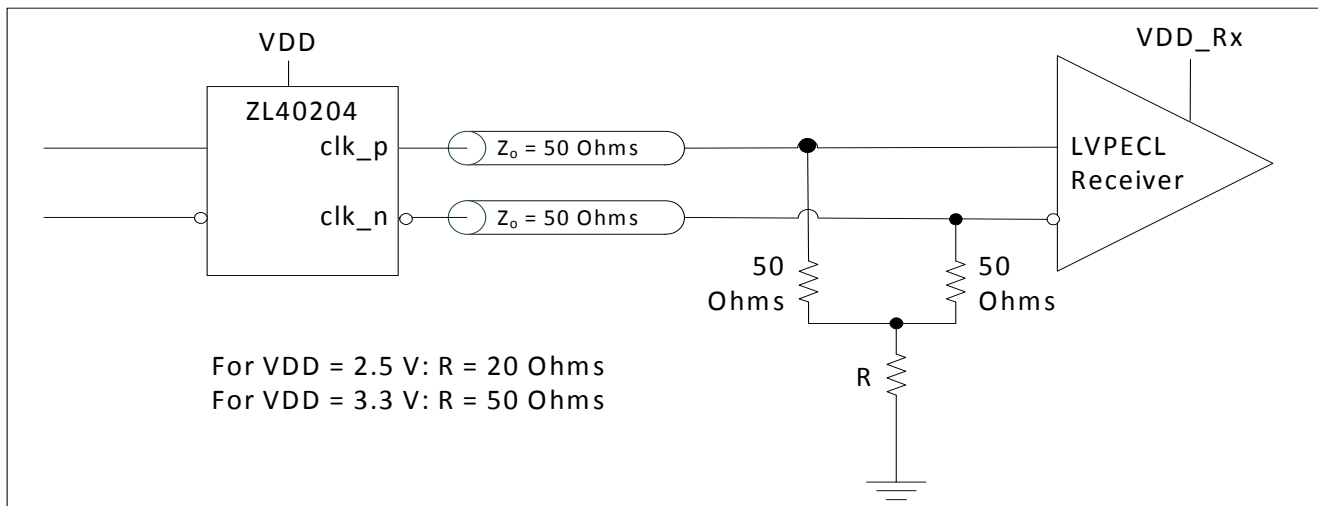
Figure 14 - LVPECL Parallel Output Termination

Within Figure 14:
VDD
VDD_Rx
ZL40204
clk_p
clk_n
Z_o = 50 Ohms
Z_o = 50 Ohms
LVPECL
Receiver
50 Ohms
50 Ohms
For VDD = 2.5 V: R = 20 Ohms
For VDD = 3.3 V: R = 50 Ohms
R
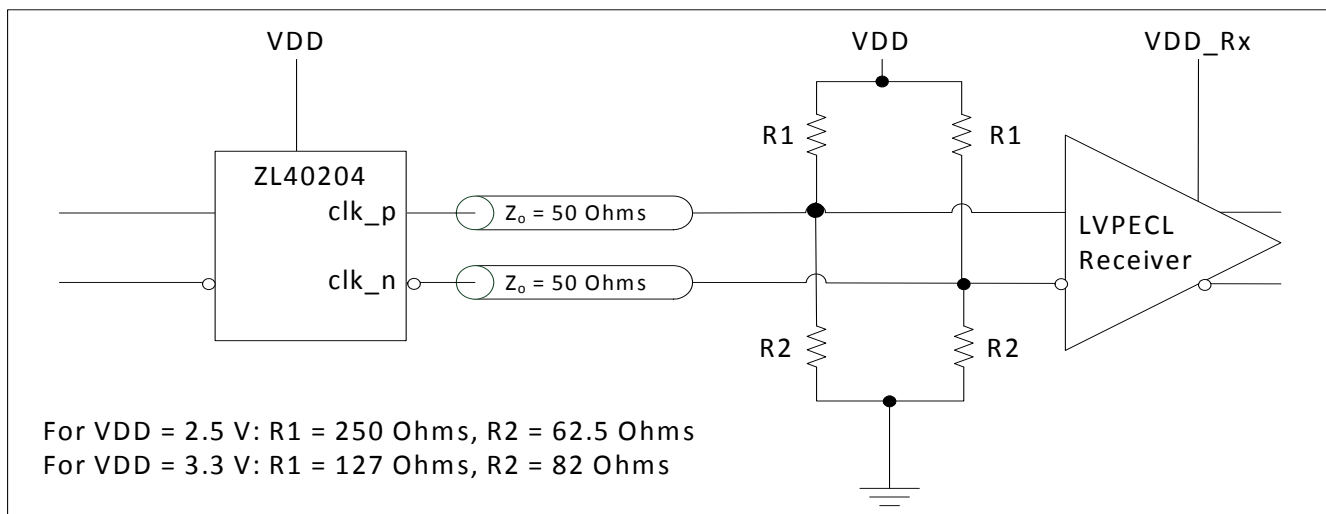
Figure 15 - LVPECL Parallel Thevenin-Equivalent Output Termination

Within Figure 15:
VDD
VDD
VDD_Rx
ZL40204
clk_p
clk_n
Z_o = 50 Ohms
Z_o = 50 Ohms
R1
R1
R2
R2
LVPECL
Receiver
For VDD = 2.5 V: R1 = 250 Ohms, R2 = 62.5 Ohms
For VDD = 3.3 V: R1 = 127 Ohms, R2 = 82 Ohms

Figure 16 - LVPECL AC Output Termination for Externally Terminated LVPECL Inputs
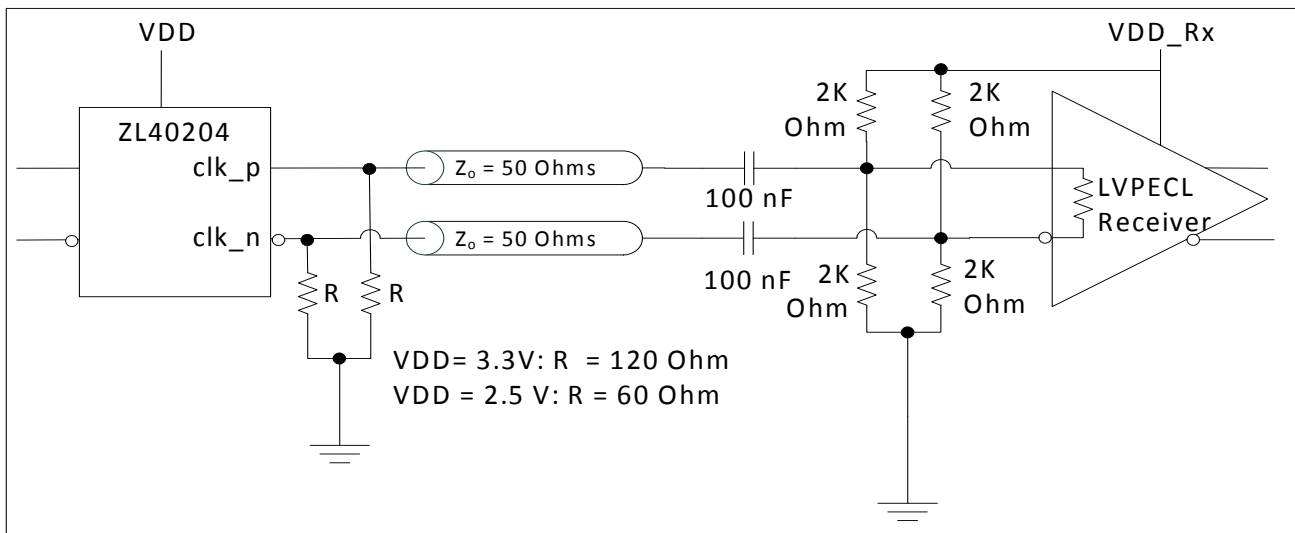
Figure 17 - LVPECL AC Output Termination for Internally Terminated LVPECL Inputs
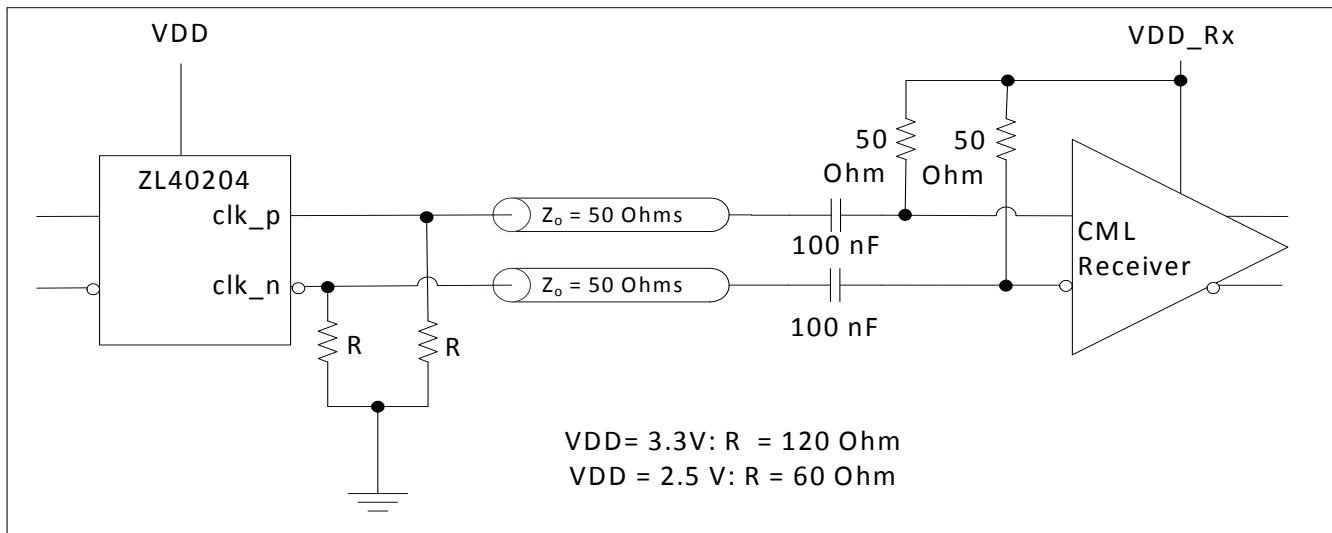
Figure 18 - LVPECL AC Output Termination for CML Inputs

3.3   Device Additive Jitter

The ZL40204 clock fan out buffer is not intended to filter clock jitter. The jitter performance of this type of device is characterized by its additive jitter. Additive jitter is the jitter the device would add to a hypothetical jitter-free clock as it passes through the device. The additive jitter of the ZL40204 is random and as such it is not correlated to the jitter of the input clock signal.

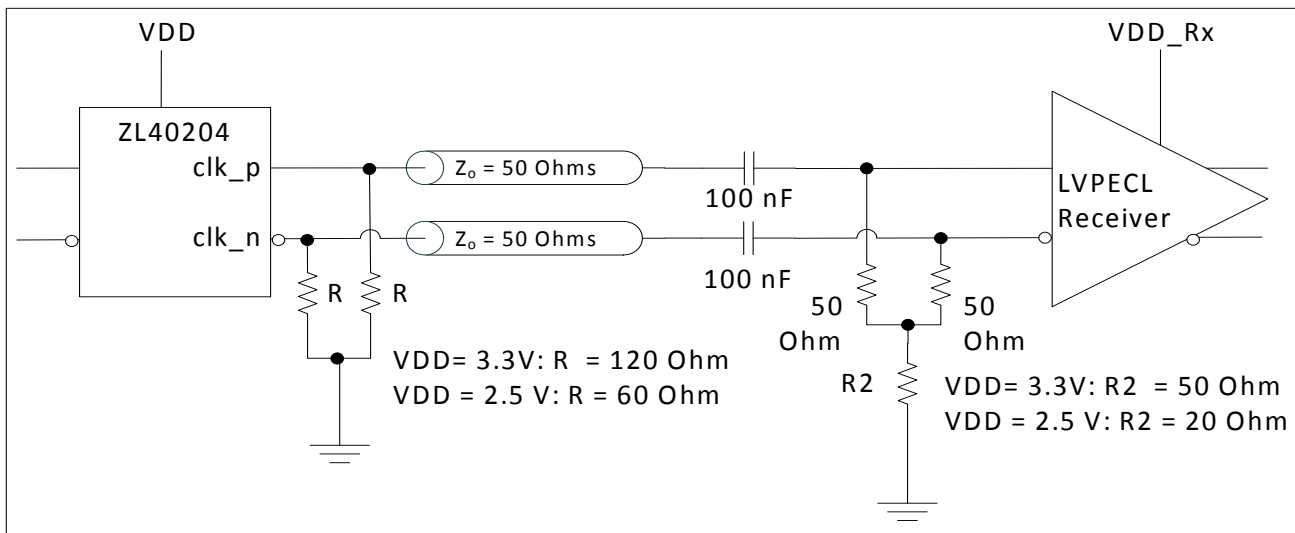The square of the resultant random RMS jitter at the output of the ZL40204 is equal to the sum of the squares of the various random RMS jitter sources including: input clock jitter; additive jitter of the buffer; and additive jitter due to power supply noise. There may be additional deterministic jitter sources that are not shown in Figure 19.

J_{add}^2

J_{ps}^2

J_{in}^2

$J_{out}^2 = J_{in}^2 + J_{add}^2 + J_{ps}^2$

J_{in} = Random input clock jitter (RMS)

J_{add} = Additive jitter due to the device (RMS)

J_{ps} = Additive jitter due to power supply noise (RMS)

J_{out} = Resultant random output clock jitter (RMS)

Figure 19 - Additive Jitter

3.4   Power Supply

This device operates employing either a 2.5V supply or 3.3V supply.

3.4.1   Sensitivity to power supply noise

Power supply noise from sources such as switching power supplies and high-power digital components such as FPGAs can induce additive jitter on clock buffer outputs. The ZL40204 is equipped with a low drop out (LDO) on-ch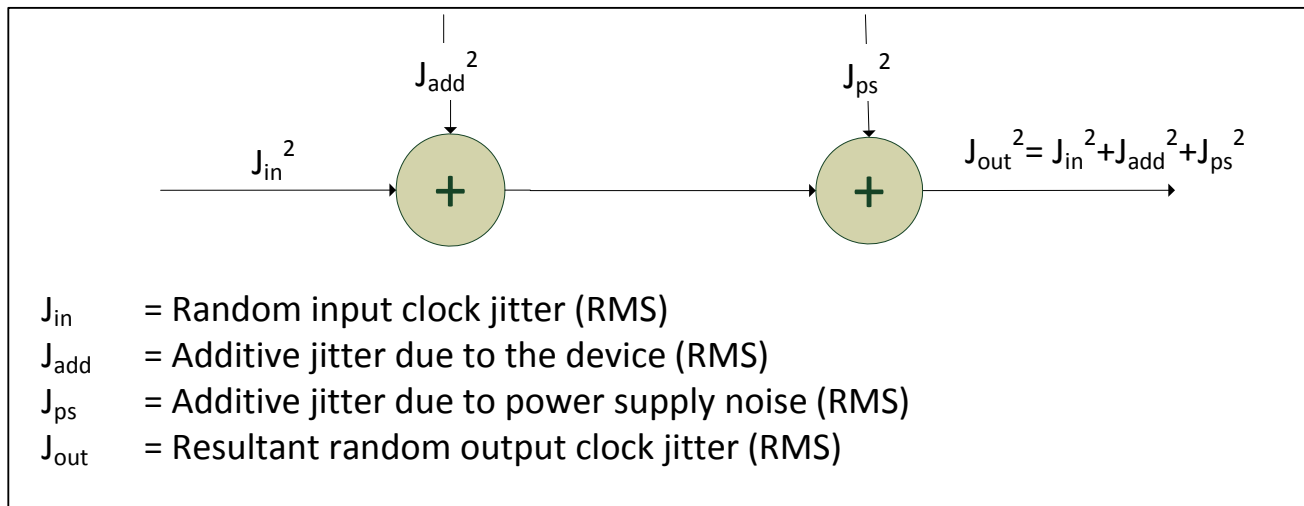ip linear power regulator and on-chip bulk capacitors to minimize additive jitter due to power supply noise. The on-chip regulation, recommended power supply filtering, and good PCB layout all work together to minimize the additive jitter from power supply noise.

3.4.2   Power supply filtering

Jitter levels may increase when noise is present on the power pins. For optimal jitter performance, the device should be isolated from the power planes connected to its power supply pins as shown in Figure 20.
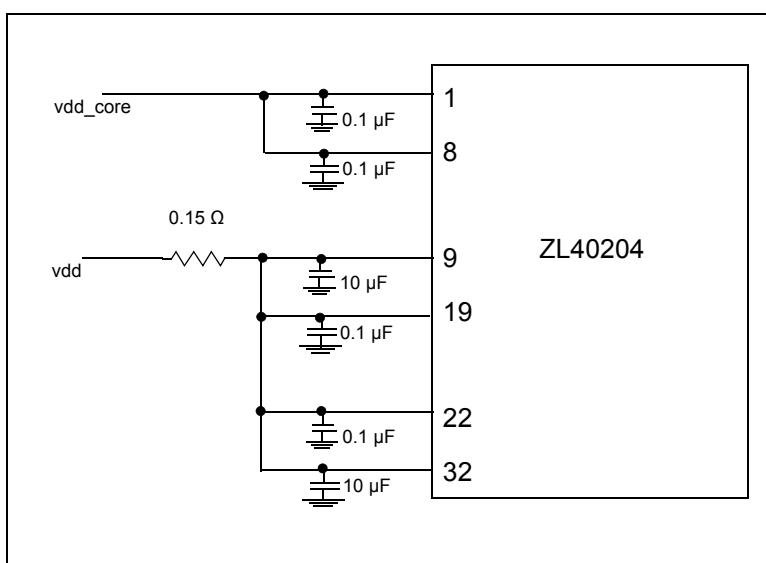
Figure 20 - Decoupling Connections for Power Pins

- 10 µF capacitors should be size 0603 or size 0805 X5R or X7R ceramic, 6.3 V minimum rating
- 0.1 µF capacitors should be size 0402 X5R ceramic, 6.3 V minimum rating
- Capacitors should be placed next to the connected device power pins
- A 0.15 ohm resistor is recommended

3.4.3   PCB layout considerations

The power nets in Figure 20 can be implemented either as a plane island or routed power topology without changing the overall jitter performance of the device.

4.0　AC and DC Electrical Characteristics

Absolute Maximum Ratings*

	Parameter	Sym.	Min.	Max.	Units
1	Supply voltage	V_{DD_R}	-0.5	4.6	V
2	Voltage on any digital pin	V_{PIN}	-0.5	V_{DD}	V
3	LVPECL output current	I_{out}		30	mA
4	Soldering temperature	T		260	°C
5	Storage temperature	T_{ST}	-55	125	°C
6	Junction temperature	T_j		125	°C
7	Voltage on input pin	V_{input}		V_{DD}	V
8	Input capacitance each pin	C_p		500	fF

* 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*

	Characteristics	Sym.	Min.	Typ.	Max.	Units
1	Supply voltage 2.5 V mode	V_{DD25}	2.375	2.5	2.625	V
2	Supply voltage 3.3 V mode	V_{DD33}	3.135	3.3	3.465	V
3	Operating temperature	T_A	-40	25	85	°C

* Voltages are with respect to ground (GND) unless otherwise stated

DC Electrical Characteristics - Current Consumption

	Characteristics	Sym.	Min.	Typ.	Max.	Units	Notes
1	Supply current LVPECL drivers - unloaded	I_{dd_unload}		110		mA	
2	Supply current LVPECL drivers - loaded (all outputs are active)	I_{dd_load}		209		mA	Including power to $R_L = 50\Omega$

DC Electrical Characteristics - Inputs and Outputs - for 3.3 V Supply

	Characteristics	Sym.	Min.	Typ.	Max.	Units	Notes
1	Differential input common mode voltage	V_{CM}	1.1		2.0	V	
2	Differential input voltage difference	V_{ID}	0.25		1	V	
3	LVPECL output high voltage	V_{OH}	$V_{DD} - 1.4$			V	
4	LVPECL output low voltage	V_{OL}			$V_{DD} - 1.62$	V	
5	LVPECL output differential voltage*	V_{OD}	0.5		0.9	V	

*The VOD parameter was measured from 125 Mhz to 750 MHz.

DC Electrical Characteristics - Inputs and Outputs - for 2.5 V Supply

	Characteristics	Sym.	Min.	Typ.	Max.	Units	Notes
1	Differential input common mode voltage	V_{CM}	1.1		1.6	V	
2	Differential input voltage difference	V_{ID}	0.25		1	V	
3	Differential input resistance	V_{IR}	80	100	120	ohm	
4	LVPECL output high voltage	V_{OH}	V_{DD} - 1.4			V	
5	LVPECL output low voltage	V_{OL}			V_{DD} - 1.62	V	
6	LVPECL output differential voltage*	V_{OD}	0.4		0.9	V	

*The VOD parameter was measured from 125 Mhz to 750 MHz.

Figure 21 - Differential Voltage Parameter

AC Electrical Characteristics* - Inputs and Outputs (see Figure 22) - for 2.5 and 3.3 V supply.

	Characteristics	Sym.	Min.	Typ.	Max.	Units	Notes
1	Maximum Operating Frequency	$1/t_p$			750	MHz	
2	Input to output clock propagation delay	t_{pd}	0	1	2	ns	
3	Output to output skew	$t_{out2out}$		50	100	ps	
4	Part to part output skew	$t_{part2part}$		80	300	ps	
5	Output clock Duty Cycle degradatio	t_{PWH}/ t_{PWL}	-2	0	2	Percent	
6	LVPECL Output clock slew rate	r_{SL}	0.75	1.2		V/ns	

* Supply voltage and operating temperature are as per Recommended Operating Conditions
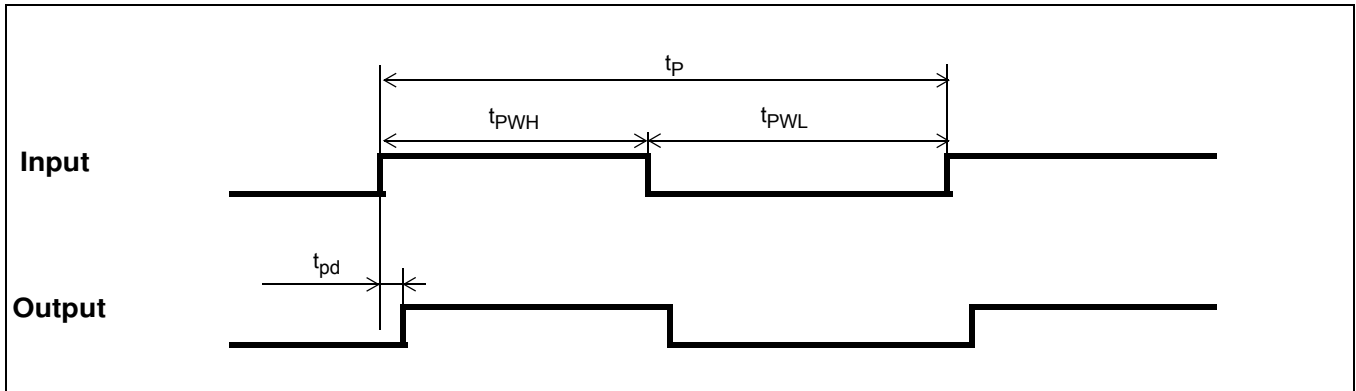
Figure 22 - Input To Output Timing

5.0   Performance Characterization

Additive Jitter at 2.5 V*

	Output Frequency (MHz)	Jitter Measurement Filter	Typical RMS (fs)	Notes
1	125	12 kHz - 20 MHz	139	
2	212.5	12 kHz - 20 MHz	112	
3	311.04	12 kHz - 20 MHz	96	
4	425	12 kHz - 20 MHz	74	
5	500	12 kHz - 20 MHz	64	
6	622.08	12 kHz - 20 MHz	52	
7	750	12 kHz - 20 MHz	47	

*The values in this table were taken with an approximate slew rate of 0.8 V/ns

Additive Jitter at 3.3 V*

|	Output Frequency (MHz)	Jitter Measurement Filter	Typical RMS (fs)	Notes
1	125	12 kHz - 20 MHz	110	
2	212.5	12 kHz - 20 MHz	83	
3	311.04	12 kHz - 20 MHz	70	
4	425	12 kHz - 20 MHz	56	
5	500	12 kHz - 20 MHz	47	
6	622.08	12 kHz - 20 MHz	40	
7	750	12 kHz - 20 MHz	38	

*The values in this table were taken with an approximate slew rate of 0.8 V/ns

Additive Jitter from a Power Supply Tone*

Carrier frequency	Parameter	Typical	Units	Notes
125MHz	25 mV at 100 kHz	97	fs RMS	
750MHz	25 mV at 100 kHz	55	fs RMS	

* The values in this table are the additive periodic jitter caused by an interfering tone typically caused by a switching power supply. For this test, measurements were taken over the full temperature and voltage range for V_{DD} = 2.5V. The magnitude of the interfering tone is measured at the DUT.
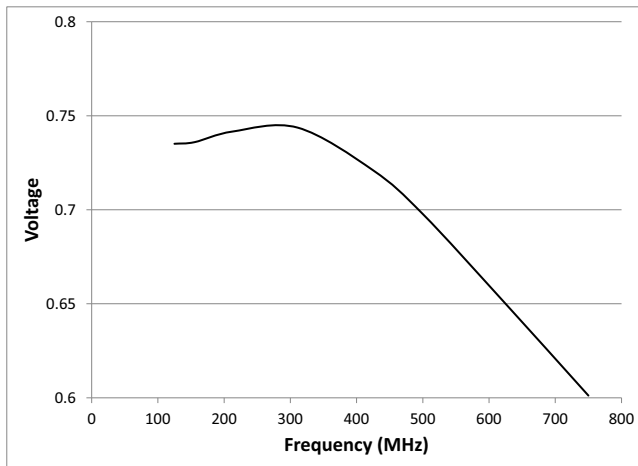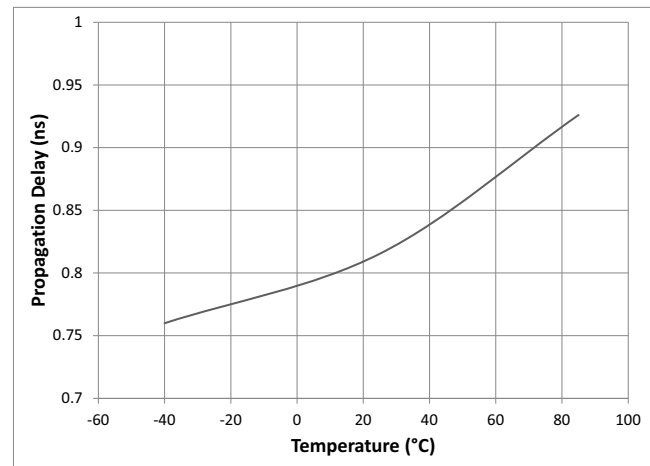
6.0   Typical Behavior
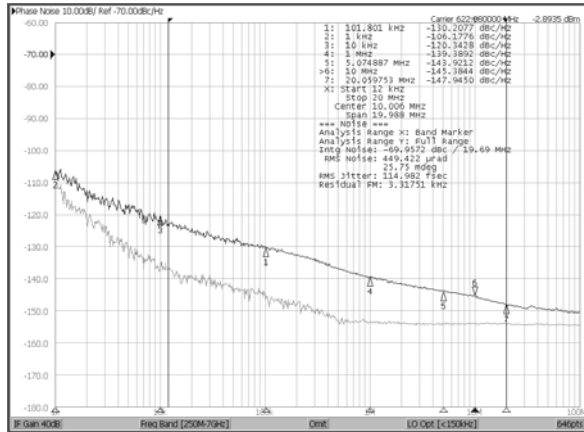
Typical Phase Noise at 622.08 MHz
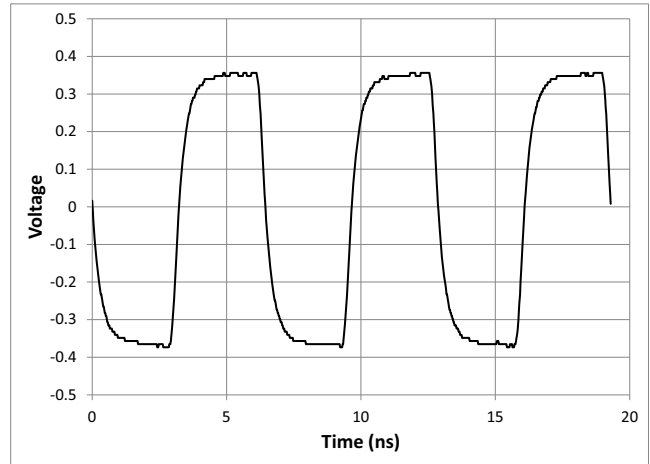
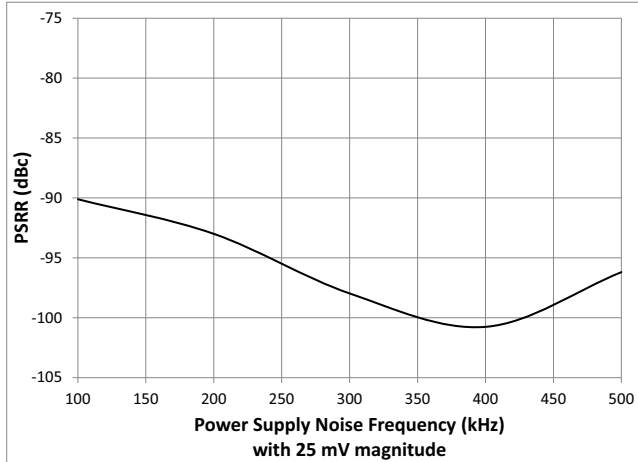Typical Waveformat 155.52 MHz

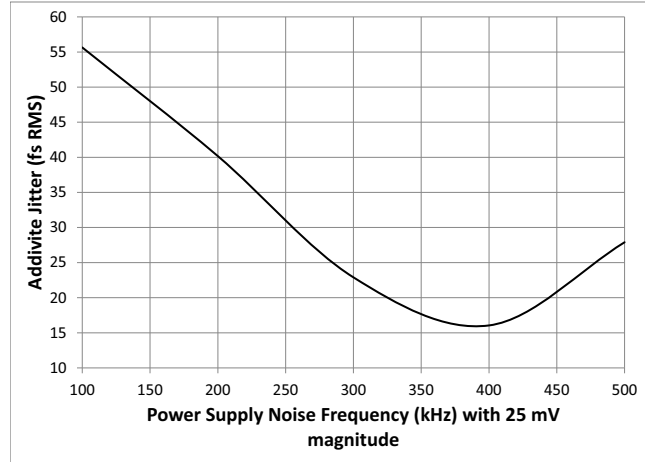V_{OD} versus Frequency

Propagation Delay versus Temperature
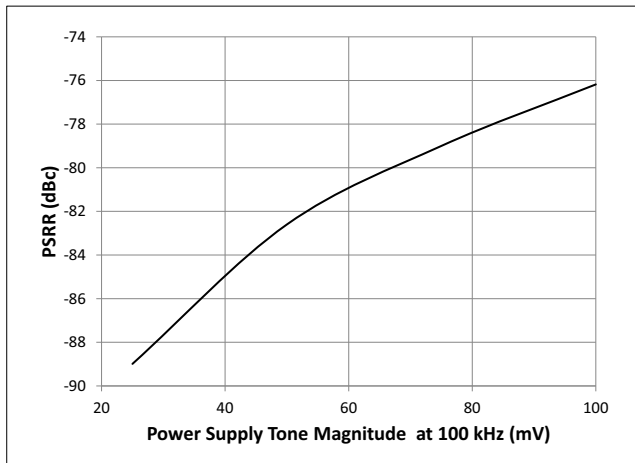Note: This is for a single device. For more details see the
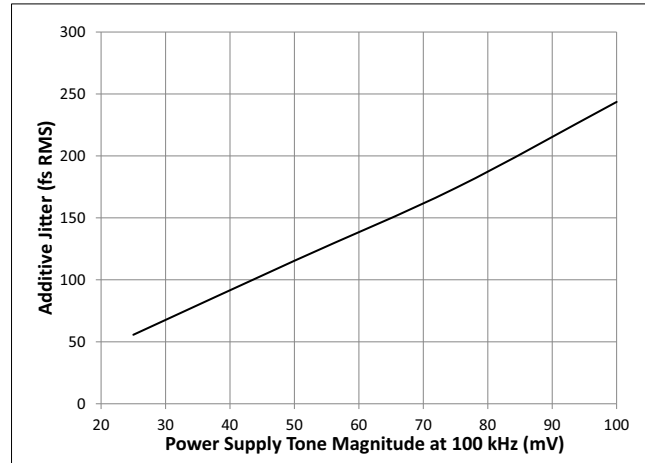
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Power Supply Tone Frequency (at 25 mV) versus PSRR at 125 MHz

Power Supply Tone Frequency (at 25 mV) versus Additive Jitter at 125 MHz

Power Supply Tone Magnitude (at 100 kHz) versus PSRR at 125 MHz

Power Supply Tone Magnitude (at 100 kHz) versus Additive Jitter at 125 MHz

7.0   Package Characteristics

Thermal Data

Parameter	Symbol	Test Condition	Value	Unit
Junction to Ambient Thermal Resistance	Θ_{JA}	Still Air 1 m/s 2 m/s	37.4 33.1 31.5	^{o}C/W
Junction to Case Thermal Resistance	Θ_{JC}		24.4	^{o}C/W
Junction to Board Thermal Resistance	Θ_{JB}		19.5	^{o}C/W
Maximum Junction Temperature*	T_{jmax}		125	^{o}C
Maximum Ambient Temperature	T_{A}		85	^{o}C

8.0 Mechanical Drawing