ZL40216

Precision 1:6 LVDS Fanout Buffer

Data Sheet

April 2014

Features

Inputs/Outputs

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

Power

- Option for 2.5 V or 3.3 V power supply
- Current consumption of 93 mA
- On-chip Low Drop Out (LDO) Regulator for superior power supply noise rejection

Performance

- Ultra low additive jitter of 104 fs RMS

Ordering Information

ZL40216LDG1	32 Pin QFN	Trays
ZL40216LDF1	32 Pin QFN	Tape and Reel

Matte Tin

Package Size: 5 x 5 mm

-40^{o}C to +85^{o}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
- PCI Express generation 1/2/3 clock distribution
- Wireless communications
- High performance microprocessor clock distribution

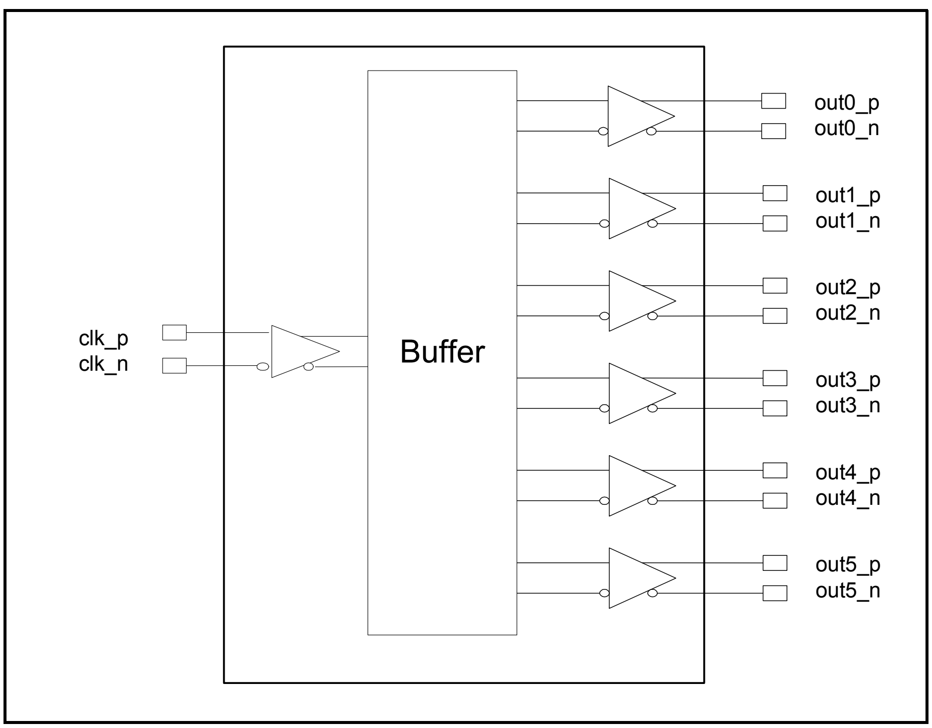

Figure 1 - Functional Block Diagram

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Change Summary

Below are the changes from the February 2013 issue to the April 2014 issue:

Page	Item	Change
1	Applications	Added PCI Express clock distribution.
6	Pin Description	Added exposed pad to Pin Description.
7, 8	Figure 3 and Figure 4	Removed 22 Ohm series resistors from Figure 3 and 4. These resistors are not required; however there is no impact to performance if the resistors are included.
18	Figure 19	Clarification of V_{ID} and V_{OD}.

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

Page	Item	Change
8	Figure 4	Changed text to indicate the circuit is not recommended for VDD_driver=2.5V.
8	Figure 5	Changed pull-up and pull-down resistors from 2kOhm to 100 Ohm.
12	Figure 12	Changed gate values to +/+ on the left and -/- on the right.

1.0 Package Description

The device is packaged in a 32 pin QFN

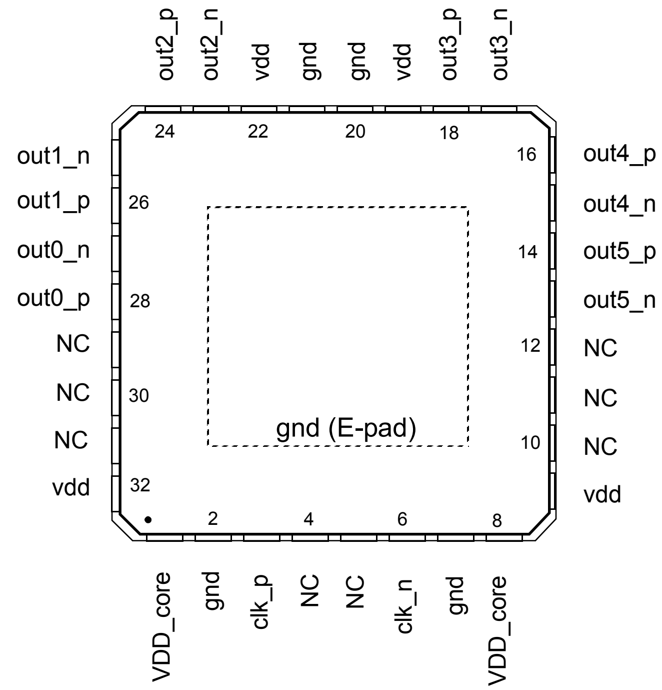


Figure 2 - Pin Connections

2.0 Pin Description

Pin #	Name	Description
3, 6	clk_p, clk_n,	**Differential Input (Analog Input).** Differential input signals.
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.
Exposed Pad		**Device GND**.

3.0 Functional Description

The ZL40216 is an LVDS clock fanout buffer with six identical output clock drivers capable of operating at frequencies up to 750MHz.

Inputs to the ZL40216 are externally terminated to allow use of precision termination components and to allow full flexibility of input termination. The ZL40216 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 ZL40216 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 ZL40216 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 ZL40216 to accept LVPECL, LVDS, CML, HCSL and single-ended inputs.

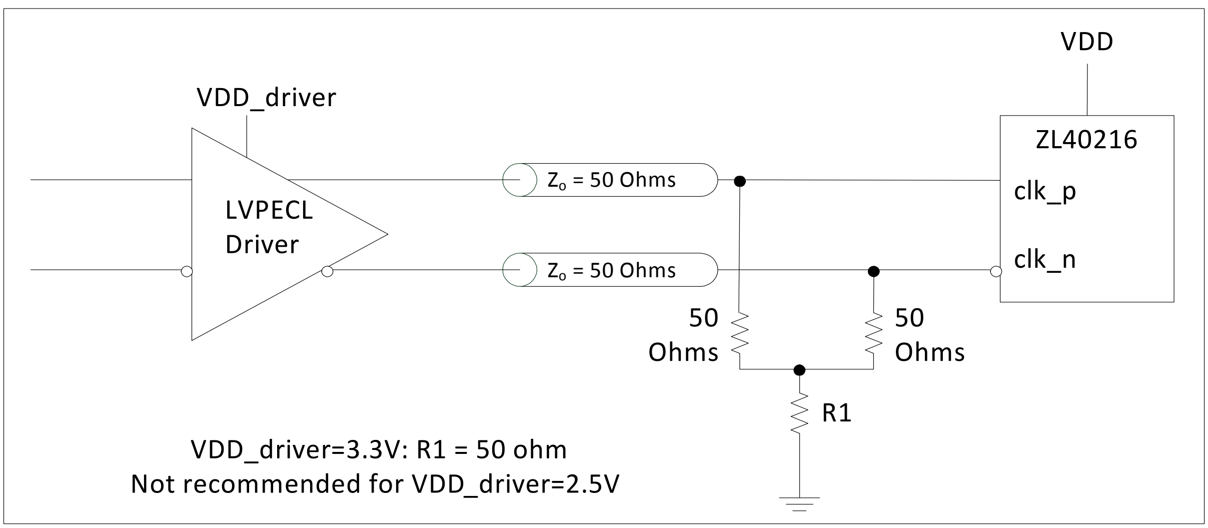


Figure 3 - LVPECL Input DC Coupled Thevenin Equivalent

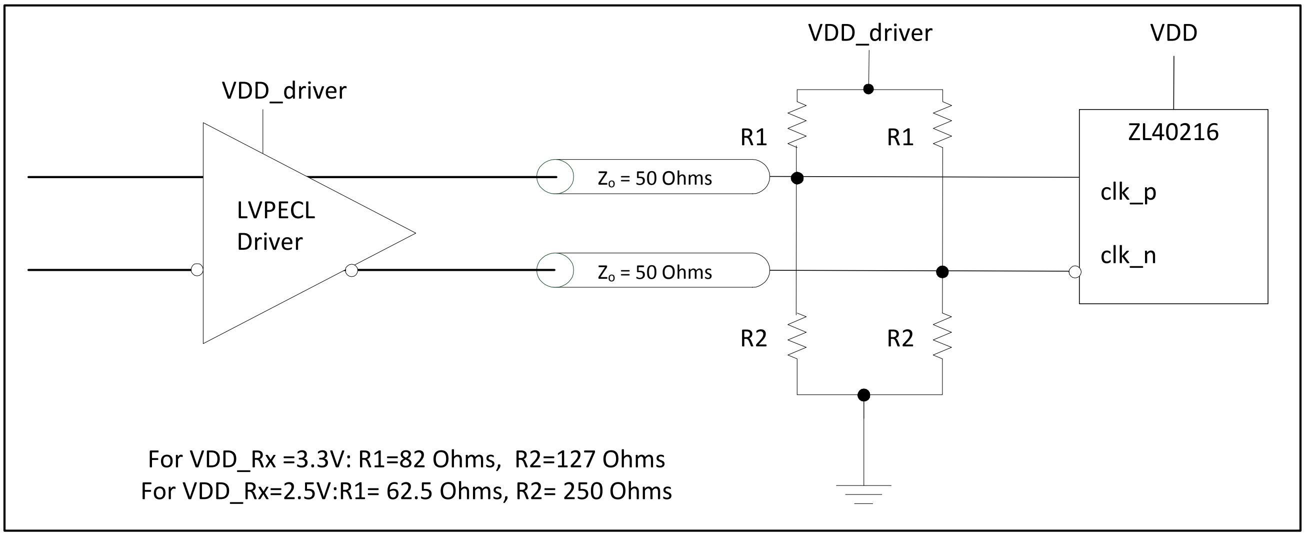


Figure 4 - LVPECL Input DC Coupled Parallel Termination

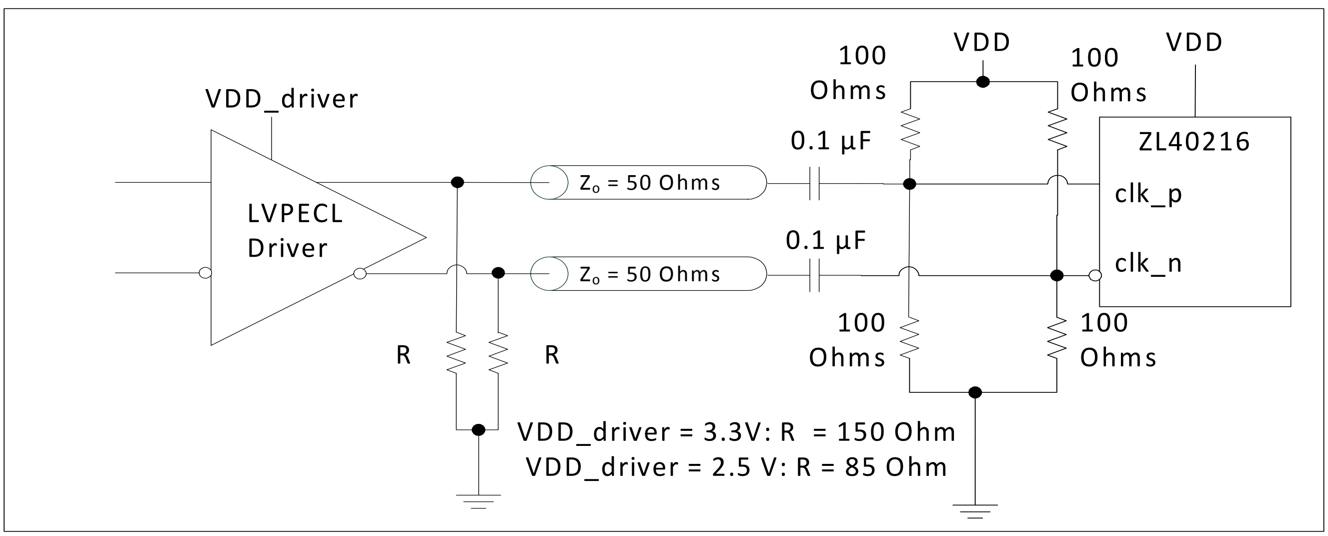


Figure 5 - LVPECL Input AC Coupled

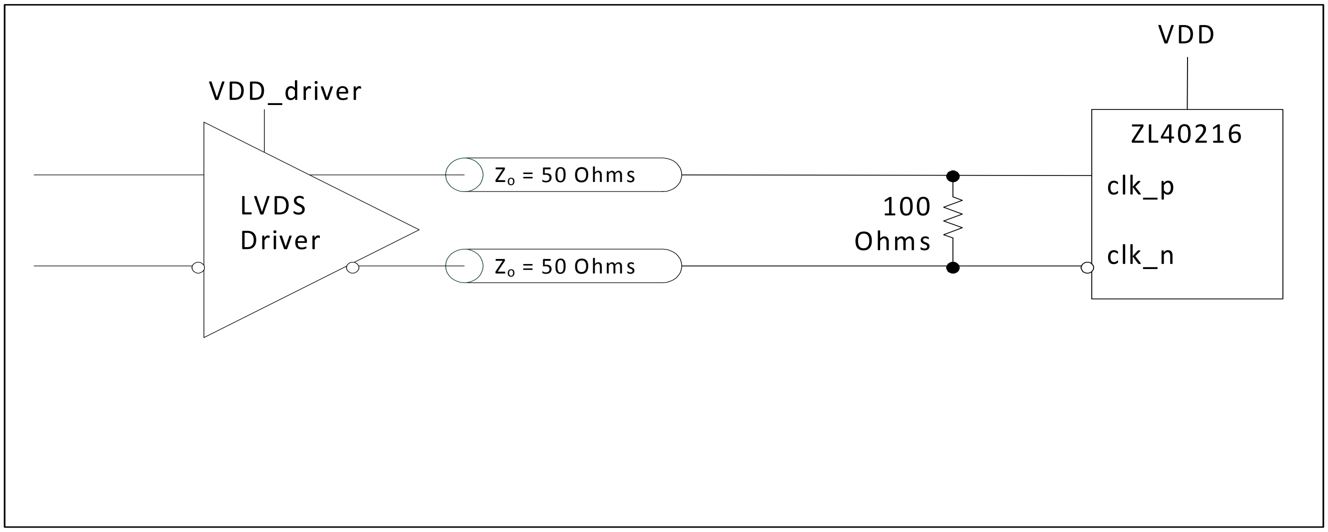


Figure 6 - LVDS Input DC Coupled

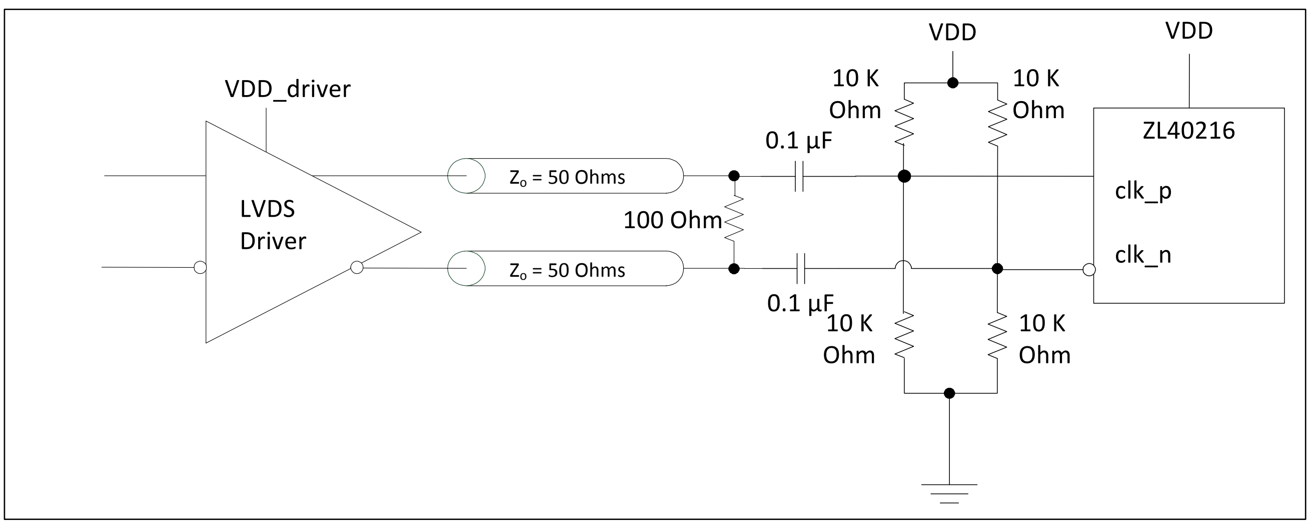


Figure 7 - LVDS Input AC Coupled

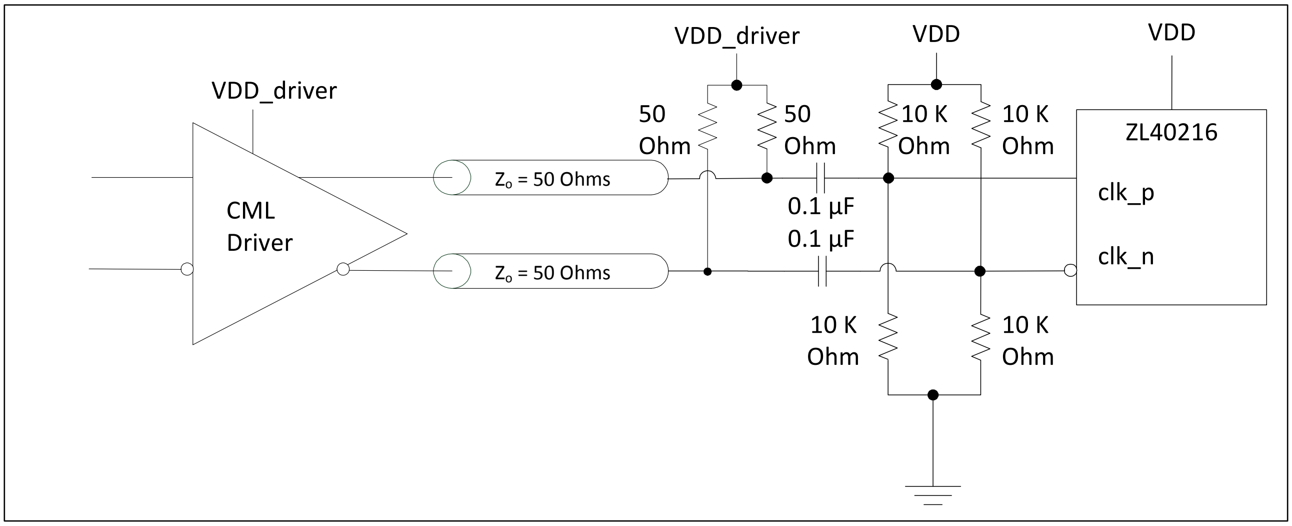


Figure 8 - CML Input AC Coupled

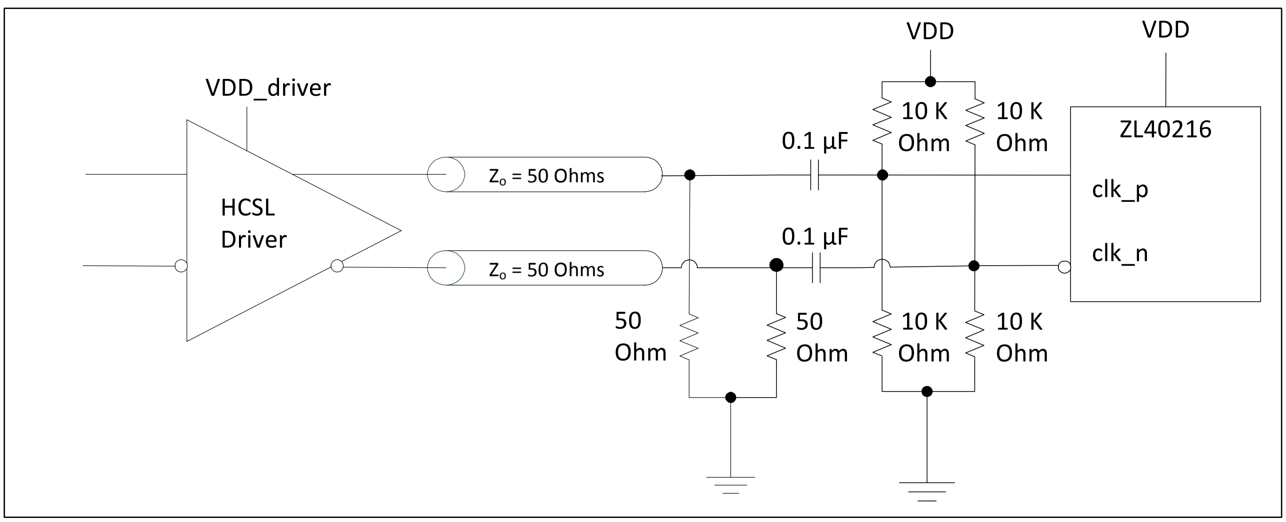


Figure 9 - HCSL Input AC Coupled

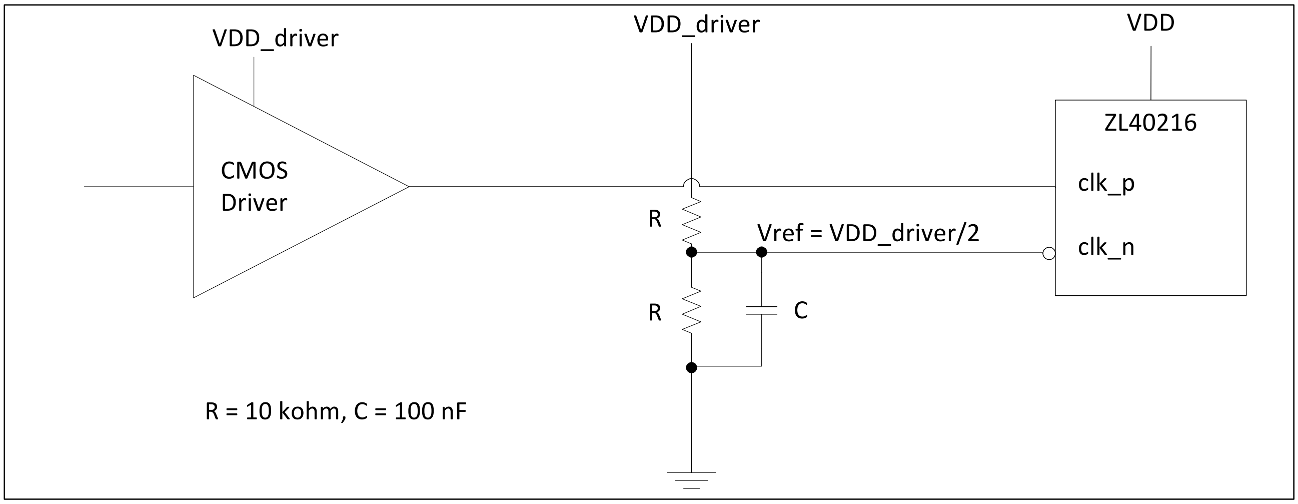


Figure 10 - CMOS Input DC Coupled Referenced to VDD/2

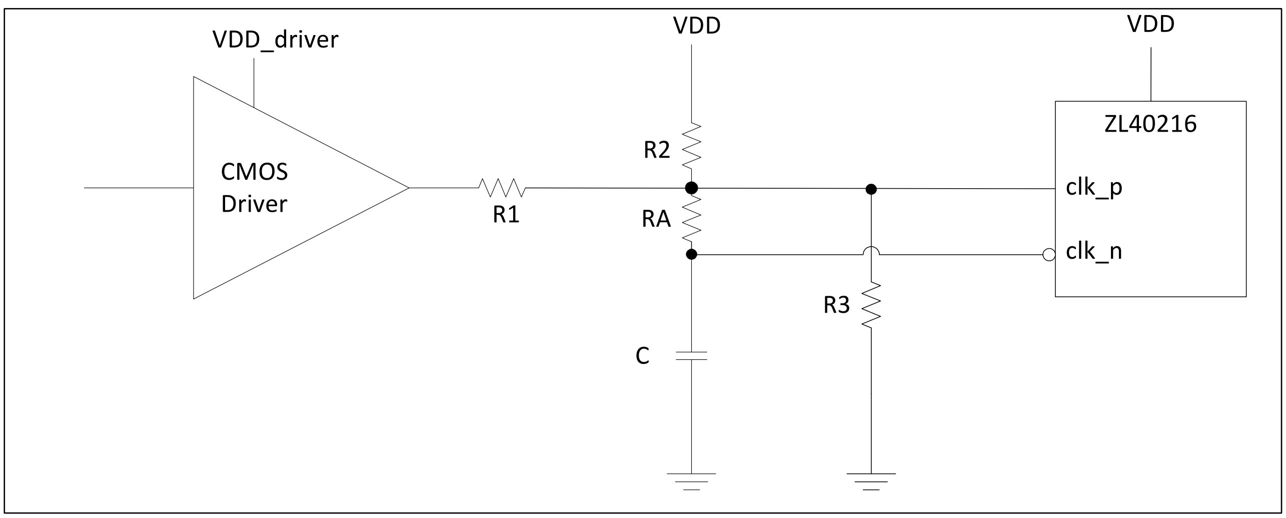


Figure 11 - CMOS Input DC Coupled Referenced to Ground

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

LVDS has lower signal swing than LVPECL which results in a low power consumption. A simplified diagram for the LVDS output stage is shown in Figure 12.

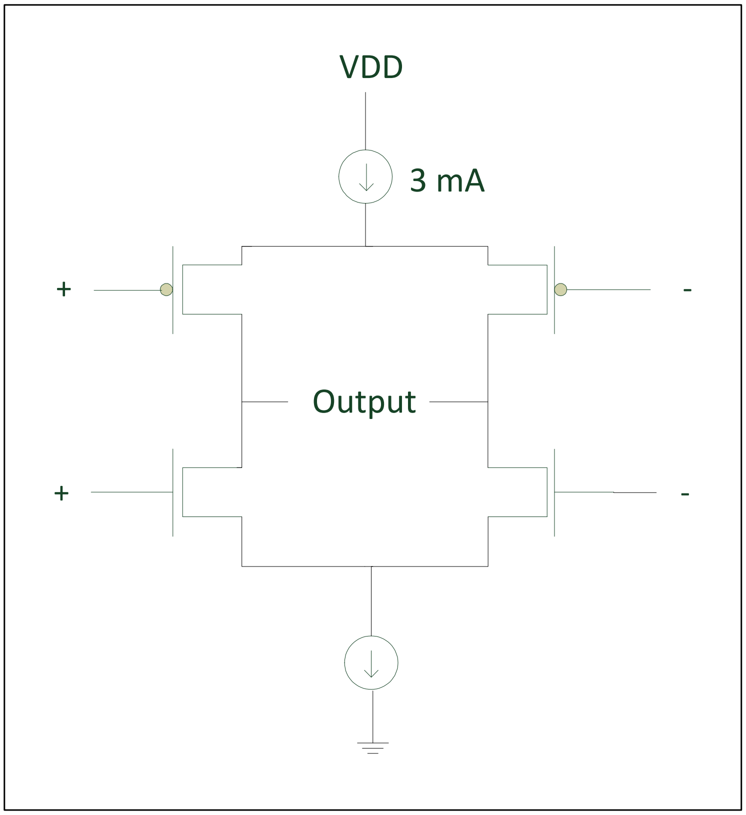


Figure 12 - Simplified LVDS Output Driver

The methods to terminate the ZL40216 drivers are shown in the following figures.

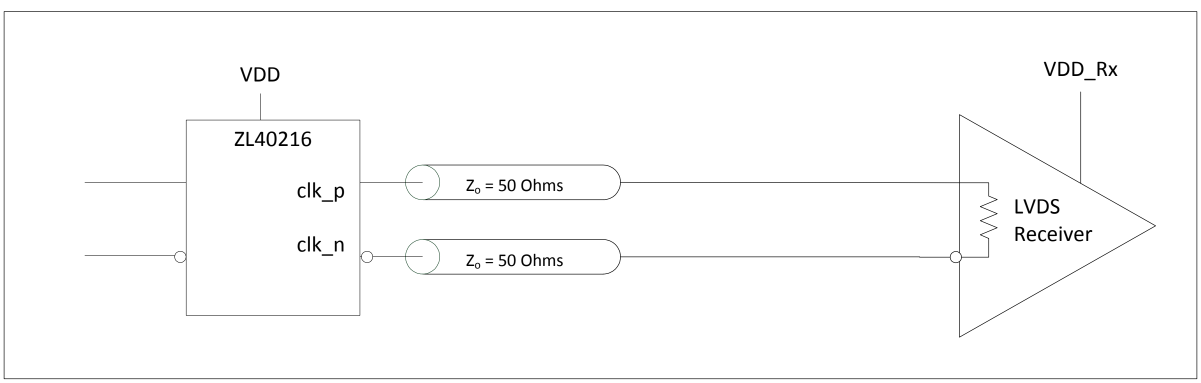


Figure 13 - LVDS DC Coupled Termination (Internal Receiver Termination)

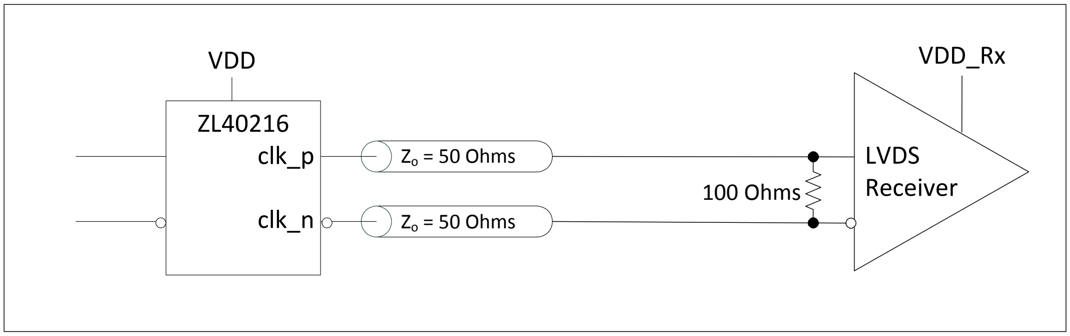


Figure 14 - LVDS DC Coupled Termination (External Receiver Termination)

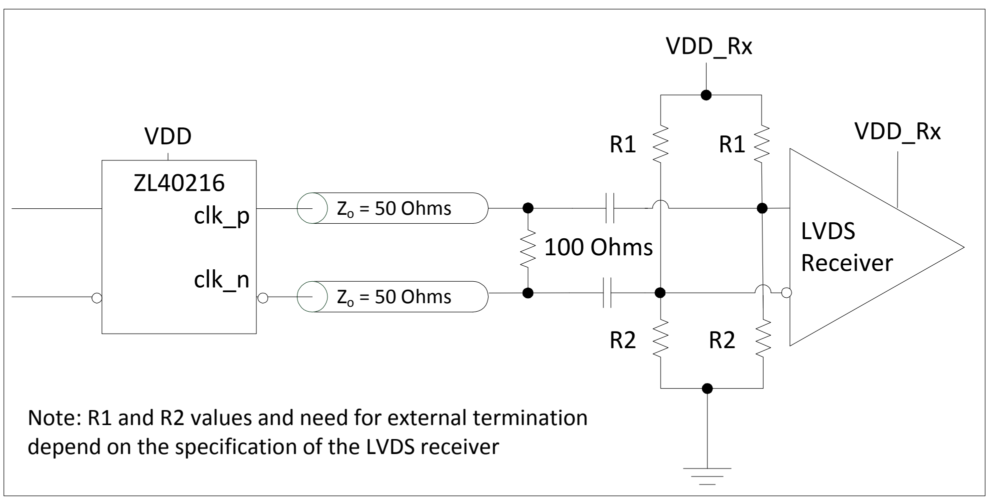


Figure 15 - LVDS AC Coupled Termination

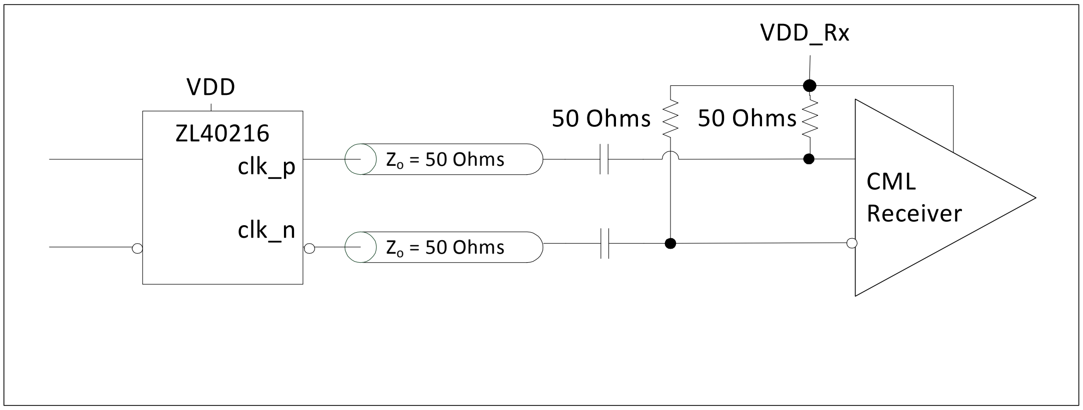


Figure 16 - LVDS AC Output Termination for CML Inputs

3.3 Device Additive Jitter

The ZL40216 clock fanout 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 ZL40216 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 ZL40216 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, but they are not shown in Figure 17.

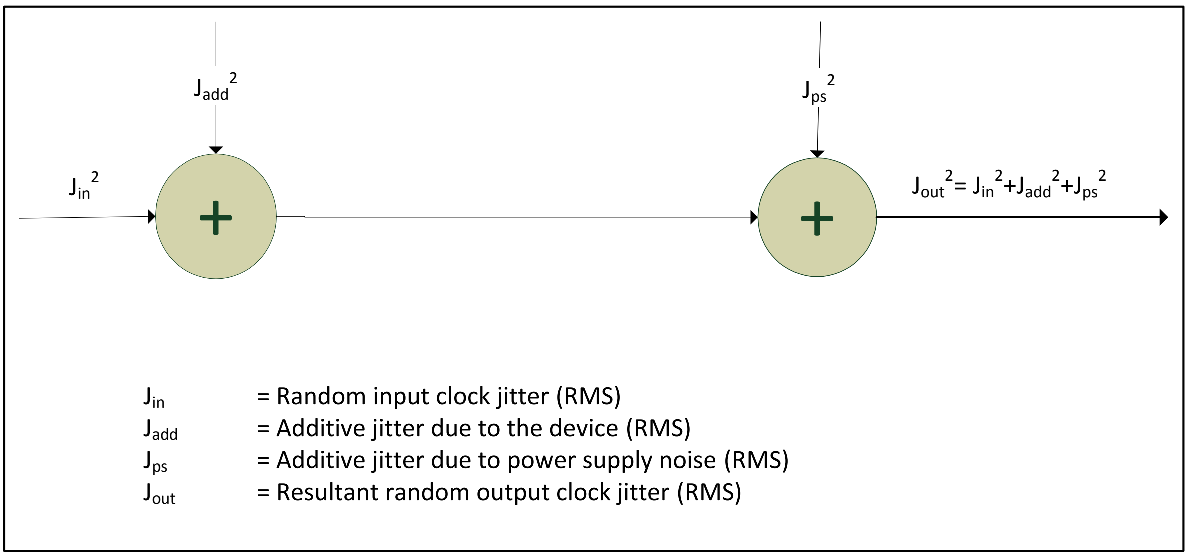


Figure 17 - Additive Jitter

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 ZL40216 is equipped with an on-chip 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 18.

- 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

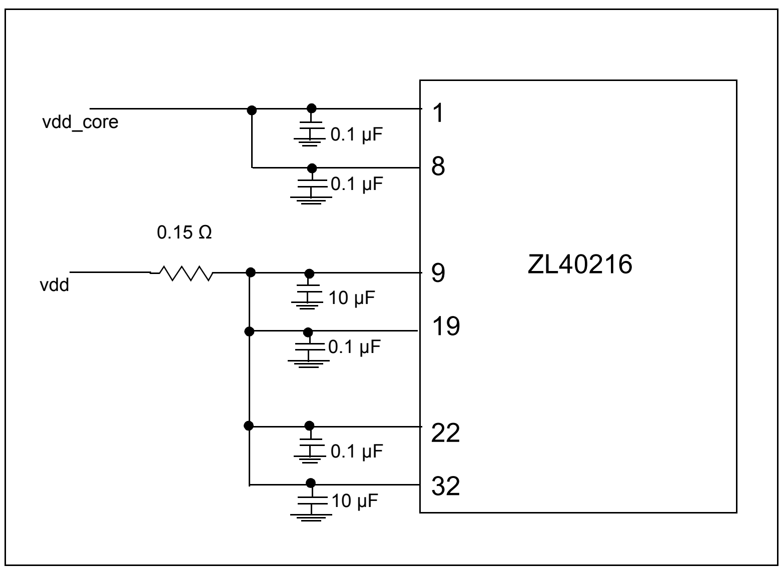


Figure 18 - Decoupling Connections for Power Pins

3.4.3 PCB layout considerations

The power nets in Figure 18 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	Soldering temperature	T		260	°C
4	Storage temperature	T_{ST}	-55	125	°C
5	Junction temperature	T_j		125	°C
6	Voltage on input pin	V_{input}		V_{DD}	V
7	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 LVDS drivers - loaded (all outputs are active)	I_{dd_load}		93		mA	

DC Electrical Characteristics - Inputs and Outputs - for 2.5/3.3 V Supply

	Characteristics	Sym.	Min.	Typ.	Max.	Units	Notes
1	Differential input common mode voltage	V_{ICM}	1.1		1.6	V	for 2.5 V
2	Differential input common mode voltage	V_{ICM}	1.1		2.0	V	for 3.3 V
3	Differential input voltage	V_{ID}	0.25		1	V	
4	LVDS output differential voltage*	V_{OD}	0.25	0.30	0.40	V	
5	LVDS Common Mode voltage	V_{CM}	1.1	1.25	1.375	V	

* The VOD parameter was measured between 125 and 750 MHz

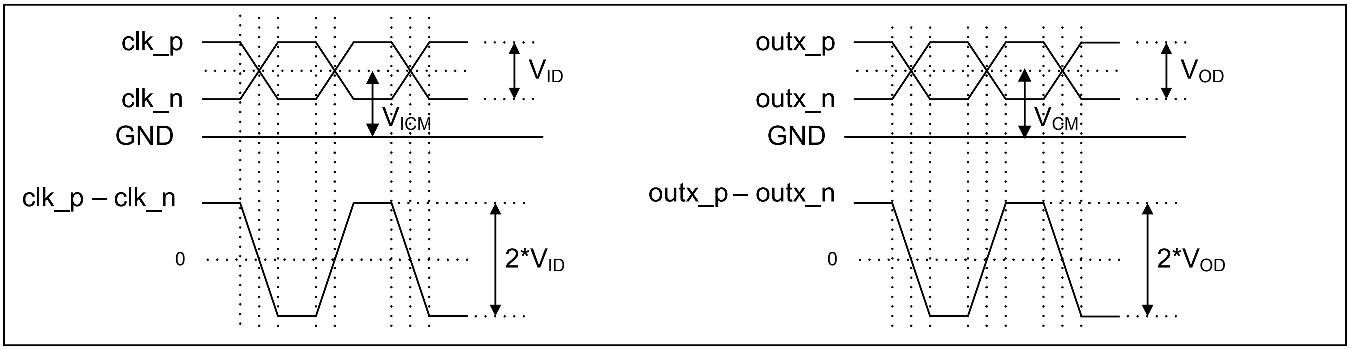


Figure 19 - Differential Voltage Parameter

AC Electrical Characteristics* - Inputs and Outputs (see Figure 20) - for 2.5/3.3 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	$t_{out2out}$		80	150	ps	
4	Part to part output skew	$t_{part2part}$		120	300	ps	
5	Output clock Duty Cycle degradation	t_{PWH}/ t_{PWL}	-5	0	5	Percent	
6	LVDS Output slew rate	r_{SL}	0.55			V/ns	

* Supply voltage and operating temperature are as per Recommended Operating Conditions

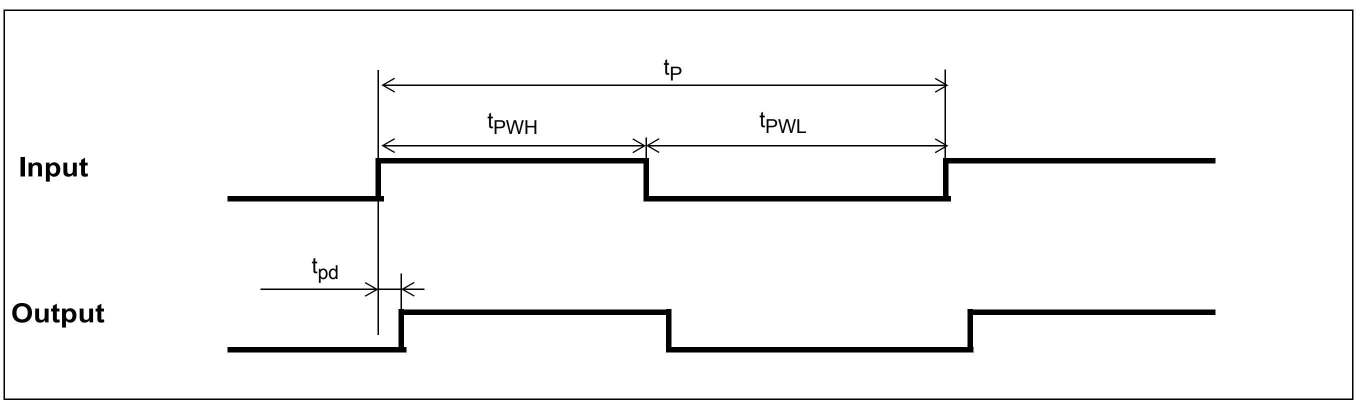


Figure 20 - Input To Output Timing

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	148	
2	212.5	12 kHz - 20 MHz	152	
3	311.04	12 kHz - 20 MHz	121	
4	425	12 kHz - 20 MHz	115	
5	500	12 kHz - 20 MHz	107	
6	622.08	12 kHz - 20 MHz	107	
7	750	12 kHz - 20 MHz	105	

*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	150	
2	212.5	12 kHz - 20 MHz	138	
3	311.04	12 kHz - 20 MHz	120	
4	425	12 kHz - 20 MHz	115	
5	500	12 kHz - 20 MHz	107	
6	622.08	12 kHz - 20 MHz	106	
7	750	12 kHz - 20 MHz	104	

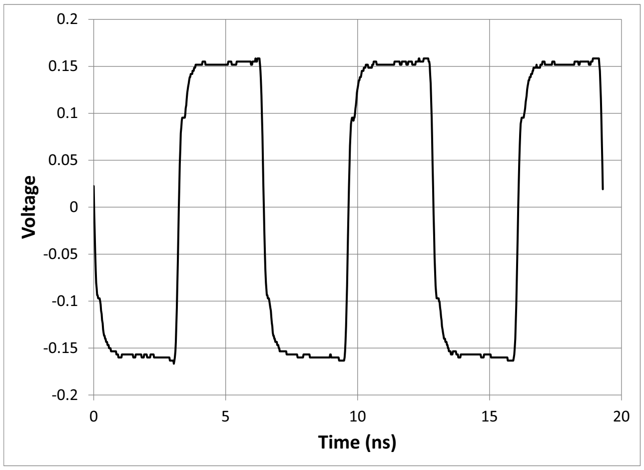
*The values in this table were taken with an approximate slew rate of 0.8 V/ns.

Additive Jitter from a Power Supply Tone*

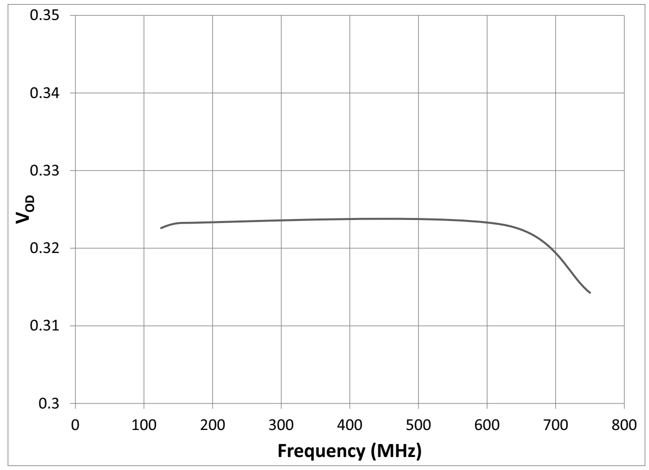
Carrier frequency	Parameter	Typical	Units	Notes
125MHz	25 mV at 100 kHz	24	fs RMS	
750MHz	25 mV at 100 kHz	23	fs RMS	

* 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} = 3.3 V. The magnitude of the interfering tone is measured at the DUT.

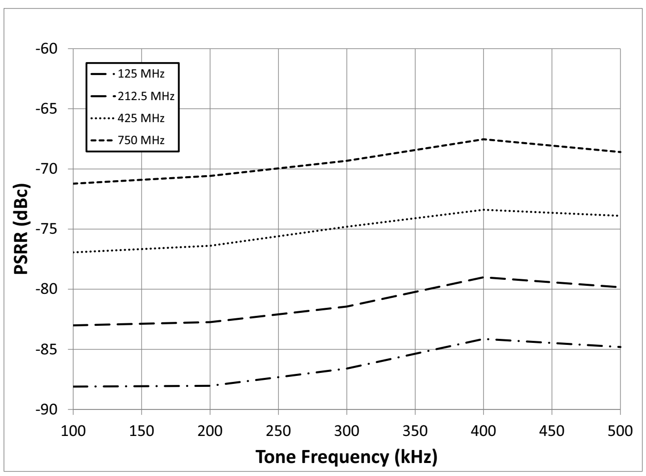
6.0 Typical Behavior



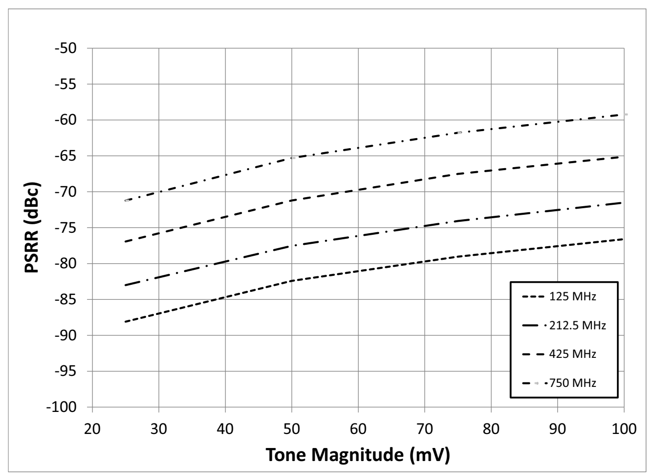
Typical Waveform at 155.52 MHz



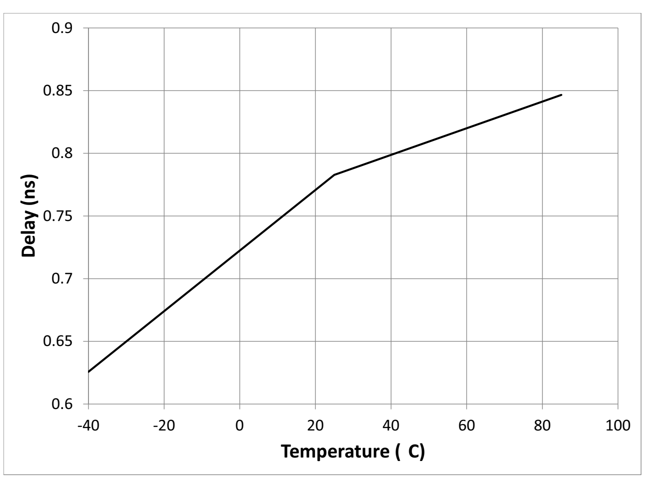
V_{OD} vs Frequency



Power Supply Tone Frequency versus PSRR



Power Supply Tone Magnitude versus PSRR



Propagation Delay versus Temperature

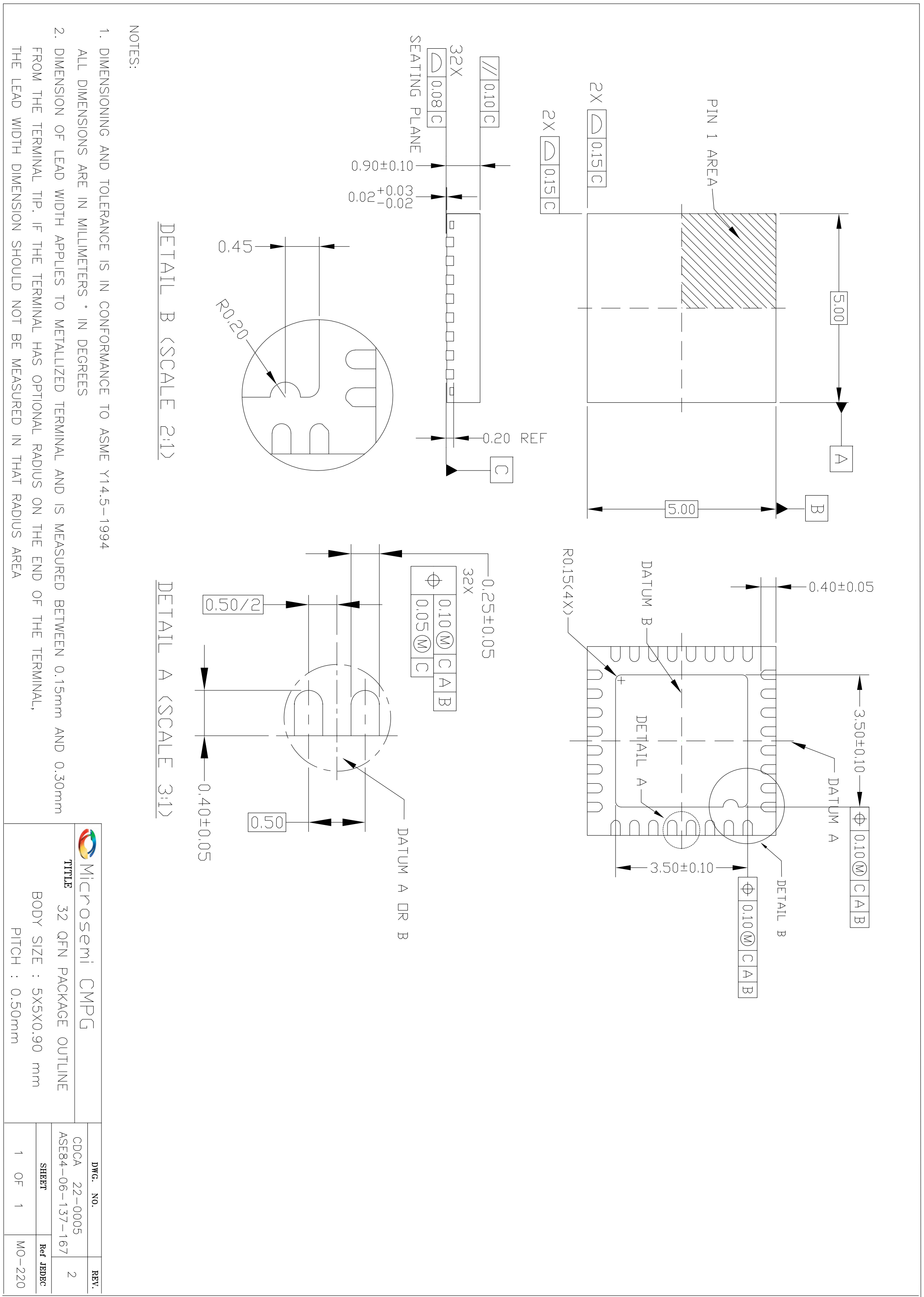
Note: This is for a single device. For more details, see the characterization section.

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	$^oC/W$
Junction to Case Thermal Resistance	Θ_{JC}		24.4	$^oC/W$
Junction to Board Thermal Resistance	Θ_{JB}		19.5	$^oC/W$
Maximum Junction Temperature*	T_{jmax}		125	^oC
Maximum Ambient Temperature	T_A		85	^oC

8.0 Mechanical Drawing



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