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# 1:10 Differential LVDS Fanout Buffer

## Features

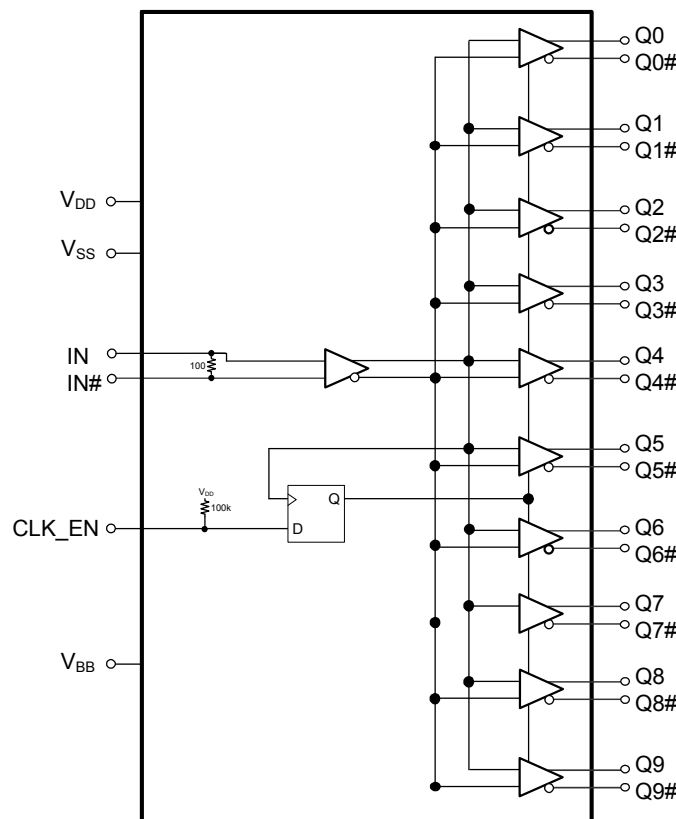
- Low-voltage differential signal (LVDS) input with on-chip 100 Ω input termination resistor
- Ten differential LVDS outputs
- 40 ps maximum output-to-output skew
- 600 ps maximum propagation delay
- 0.11 ps maximum additive RMS phase jitter at 156.25 MHz (12 kHz to 20 MHz offset)
- Up to 1.5 GHz operation
- Synchronous clock enable function
- 32-pin thin quad flat pack (TQFP) package
- 2.5 V or 3.3 V operating voltage [1]
- Commercial and industrial operating temperature range

## Functional Description

The CY2DL1510 is an ultra-low noise, low-skew, low-propagation delay 1:10 differential LVDS fanout buffer targeted to meet the requirements of high-speed clock distribution applications. The on-chip 100 Ω input termination resistor reduces board component count, while the synchronous clock enable function ensures glitch-free output transitions during enable and disable periods. The device has a fully differential internal architecture that is optimized to achieve low-additive jitter and low-skew at operating frequencies of up to 1.5 GHz.

For a complete list of related documentation, [click here](#).

## Logic Block Diagram



**Note**

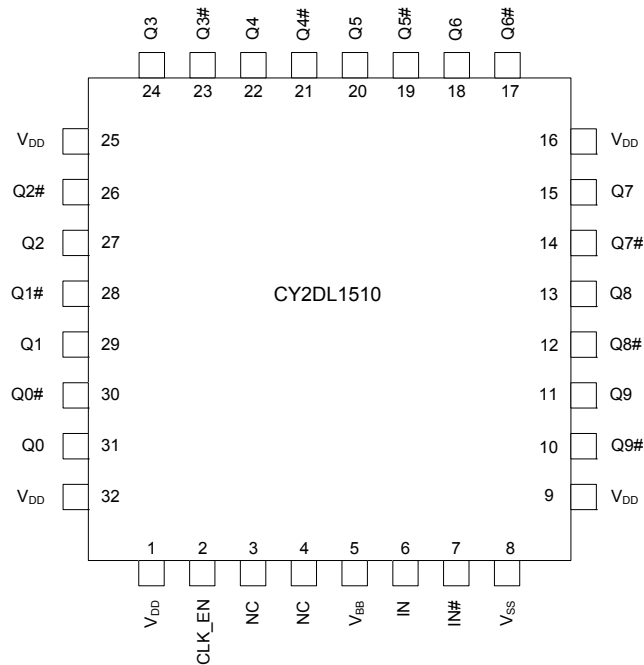
1. Input AC-coupling capacitors are required for voltage-translation applications.

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Pinouts

Figure 1. 32-pin TQFP pinout



Pin Definitions

Pin No.	Pin Name	Pin Type	Description
1, 9, 16, 25, 32	V <sub>DD</sub>	Power	Power supply
2	CLK_EN	Input	Synchronous clock enable. Low-voltage complementary metal oxide semiconductor (LVCMOS)/low-voltage transistor-transistor-logic (LVTTL). When CLK_EN = Low, Q(0:9) outputs are held low and Q(0:9)# outputs are held high
3, 4	NC		No connection
5	V <sub>BB</sub>	Output	LVDS reference voltage output
6	IN	Input	LVDS input clock
7	IN#	Input	LVDS complementary input clock
8	V <sub>SS</sub>	Power	Ground
10, 12, 14, 17, 19, 21, 23, 26, 28, 30	Q(0:9)#	Output	LVDS complementary output clocks
11, 13, 15, 18, 20, 22, 24, 27, 29, 31	Q(0:9)	Output	LVDS output clocks

## Absolute Maximum Ratings

Parameter	Description	Condition	Min	Max	Unit
$V_{DD}$	Supply voltage	Non-functional	-0.5	4.6	V
$V_{IN}^{[2]}$	Input voltage, relative to $V_{SS}$	Non-functional	-0.5	lesser of 4.0 or $V_{DD} + 0.4$	V
$V_{OUT}^{[2]}$	DC output or I/O Voltage, relative to $V_{SS}$	Non-functional	-0.5	lesser of 4.0 or $V_{DD} + 0.4$	V
$T_S$	Storage temperature	Non-functional	-55	150	°C
$ESD_{HBM}$	Electrostatic discharge (ESD) protection (Human body model)	JEDEC STD 22-A114-B	2000	-	V
$L_U$	Latch up		Meets or exceeds JEDEC Spec JESD78B IC latch up test		
UL-94	Flammability rating	At 1/8 in.	V-0		
MSL	Moisture sensitivity level		3		

## Operating Conditions

Parameter	Description	Condition	Min	Max	Unit
$V_{DD}$	Supply voltage	2.5 V supply	2.375	2.625	V
		3.3 V supply	3.135	3.465	V
$T_A$	Ambient operating temperature	Commercial	0	70	°C
		Industrial	-40	85	°C
$t_{PU}$	Power ramp time	Power-up time for $V_{DD}$ to reach minimum specified voltage (power ramp must be monotonic.)	0.05	500	ms

**Note**

2. The voltage on any I/O pin cannot exceed the power pin during power-up. Power supply sequencing is not required.

## DC Electrical Specifications

( $V_{DD} = 3.3\text{ V} \pm 5\%$  or  $2.5\text{ V} \pm 5\%$ ;  $T_A = 0\text{ }^\circ\text{C}$  to  $70\text{ }^\circ\text{C}$  (Commercial) or  $-40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$  (Industrial))

Parameter	Description	Condition	Min	Max	Unit
$I_{DD}$	Operating supply current	All LVDS outputs terminated with $100\ \Omega$ load [3, 4]	–	125	mA
$V_{IH1}$	Input high Voltage, LVDS input clocks, IN and IN#		–	$V_{DD} + 0.3$	V
$V_{IL1}$	Input low voltage, LVDS input clocks, IN and IN#		–0.3	–	V
$V_{IH2}$	Input high voltage, CLK_EN	$V_{DD} = 3.3\text{ V}$	2.0	$V_{DD} + 0.3$	V
$V_{IL2}$	Input low voltage, CLK_EN	$V_{DD} = 3.3\text{ V}$	–0.3	0.8	V
$V_{IH3}$	Input high voltage, CLK_EN	$V_{DD} = 2.5\text{ V}$	1.7	$V_{DD} + 0.3$	V
$V_{IL3}$	Input low voltage, CLK_EN	$V_{DD} = 2.5\text{ V}$	–0.3	0.7	V
$V_{ID}$ <sup>[5]</sup>	Input differential amplitude	See <a href="#">Figure 3 on page 7</a>	0.4	0.8	V
$V_{ICM}$	Input common mode voltage	See <a href="#">Figure 3 on page 7</a>	0.5	$V_{DD} - 0.2$	V
$I_{IH}$	Input high current, All inputs	Input = $V_{DD}$ <sup>[6]</sup>	–	150	$\mu\text{A}$
$I_{IL}$	Input low current, All inputs	Input = $V_{SS}$ <sup>[6]</sup>	–150	–	$\mu\text{A}$
$V_{PP}$	LVDS differential output voltage peak to peak, single-ended	$V_{DD} = 3.3\text{ V}$ or $2.5\text{ V}$ , $R_{TERM} = 100\ \Omega$ between Q and Q# pairs [3, 7]	250	470	mV
$\Delta V_{OCM}$	Change in $V_{OCM}$ between complementary output states	$V_{DD} = 3.3\text{ V}$ or $2.5\text{ V}$ , $R_{TERM} = 100\ \Omega$ between Q and Q# pairs [3, 7]	–	50	mV
$V_{BB}$	Output reference voltage	0 to $150\ \mu\text{A}$ output current	1.125	1.375	V
$R_{TERM}$	On-chip differential input termination resistor		80	120	$\Omega$
$R_P$	Internal pull-up resistance, LVCMOS logic input	CLK_EN pin	60	140	k $\Omega$
$C_{IN}$	Input capacitance	Measured at 10 MHz per pin	–	3	pF

## Thermal Resistance

Parameter <sup>[8]</sup>	Description	Test Conditions	32-pin TQFP	Unit
$\theta_{JA}$	Thermal resistance (junction to ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, in accordance with EIA/JESD51.	69	$^\circ\text{C}/\text{W}$
$\theta_{JC}$	Thermal resistance (junction to case)		14	$^\circ\text{C}/\text{W}$

### Notes

- Refer to [Figure 2 on page 7](#).
- $I_{DD}$  includes current that is dissipated externally in the output termination resistors.
- $V_{ID}$  minimum of 400 mV is required to meet all output AC Electrical Specifications. The device is functional with  $V_{ID}$  minimum of greater than 200 mV.
- Positive current flows into the input pin, negative current flows out of the input pin.
- Refer to [Figure 4 on page 7](#).
- These parameters are guaranteed by design and are not tested.

## AC Electrical Specifications

( $V_{DD} = 3.3\text{ V} \pm 5\%$  or  $2.5\text{ V} \pm 5\%$ ;  $T_A = 0\text{ }^\circ\text{C}$  to  $70\text{ }^\circ\text{C}$  (Commercial) or  $-40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$  (Industrial))

Parameter	Description	Condition	Min	Typ	Max	Unit
$F_{IN}$	Input frequency		DC	–	1.5	GHz
$F_{OUT}$	Output frequency	$F_{OUT} = F_{IN}$	DC	–	1.5	GHz
$t_{PD}^{[11]}$	Propagation delay input pair to output pair	Input rise/fall time < 1.5 ns (20% to 80%)	–	–	600	ps
$t_{ODC}^{[12]}$	Output duty cycle	50% duty cycle at input Frequency range up to 1 GHz	48	–	52	%
$t_{SK1}^{[13]}$	Output-to-output skew	Any output to any output, with same load conditions at DUT	–	–	40	ps
$t_{SK1D}^{[13]}$	Device-to-device output skew	Any output to any output between two or more devices. Devices must have the same input and have the same output load.	–	–	150	ps
$PN_{ADD}$	Additive RMS phase noise 156.25 MHz input Rise/fall time < 150 ps (20% to 80%) $V_{ID} > 400\text{ mV}$	Offset = 1 kHz	–	–	–120	dBc/Hz
		Offset = 10 kHz	–	–	–135	dBc/Hz
		Offset = 100 kHz	–	–	–135	dBc/Hz
		Offset = 1 MHz	–	–	–150	dBc/Hz
		Offset = 10 MHz	–	–	–154	dBc/Hz
		Offset = 20 MHz	–	–	–155	dBc/Hz
$t_{JIT}^{[14]}$	Additive RMS phase jitter (Random)	156.25 MHz, 12 kHz to 20 MHz offset; input rise/fall time < 150 ps (20% to 80%), $V_{ID} > 400\text{ mV}$	–	–	0.11	ps
$t_R, t_F^{[15]}$	Output rise/fall time, single-ended	50% duty cycle at input, 20% to 80% of full swing ( $V_{OL}$ to $V_{OH}$ ) Input rise/fall time < 1.5 ns (20% to 80%) Measured at 1 GHz	–	–	300	ps
$t_{SOD}$	Time from clock edge to outputs disabled	Synchronous clock enable (CLK_EN) switched low	–	–	700	ps
$t_{SOE}$	Time from clock edge to outputs enabled	Synchronous clock enable (CLK_EN) switched high	–	–	700	ps

### Notes

9. Refer to Figure 2 on page 7.
10. Refer to Figure 4 on page 7.
11. Refer to Figure 5 on page 7.
12. Refer to Figure 6 on page 7.
13. Refer to Figure 7 on page 8.
14. Refer to Figure 8 on page 8.
15. Refer to Figure 9 on page 8.

## Switching Waveforms

Figure 2. LVDS Output Termination

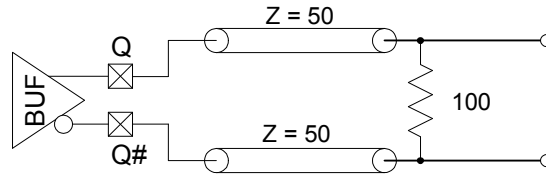


Figure 3. Input Differential and Common Mode Voltages

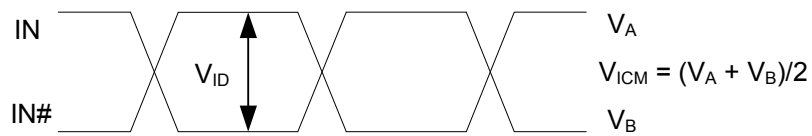


Figure 4. Output Differential and Common Mode Voltages

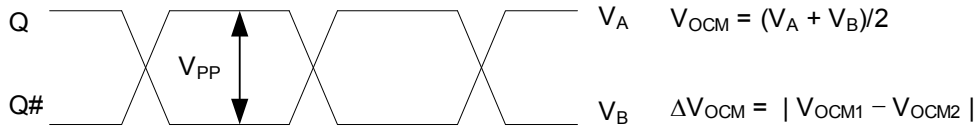


Figure 5. Input to Any Output Pair Propagation Delay

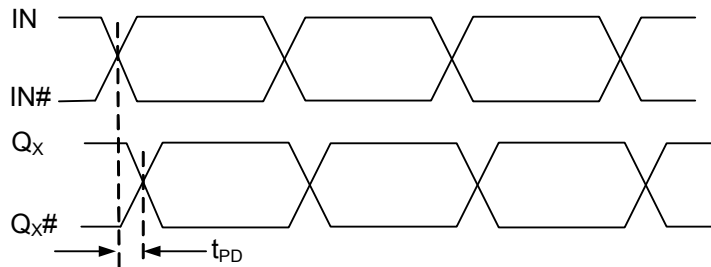
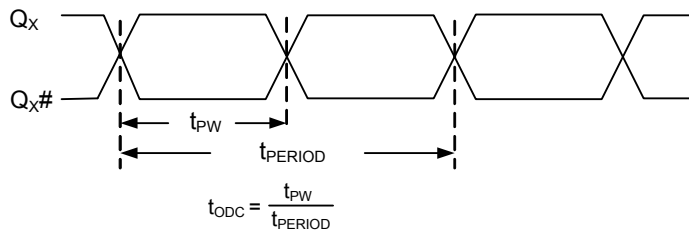


Figure 6. Output Duty Cycle





Switching Waveforms (continued)

Figure 7. Output-to-output and Device-to-device Skew

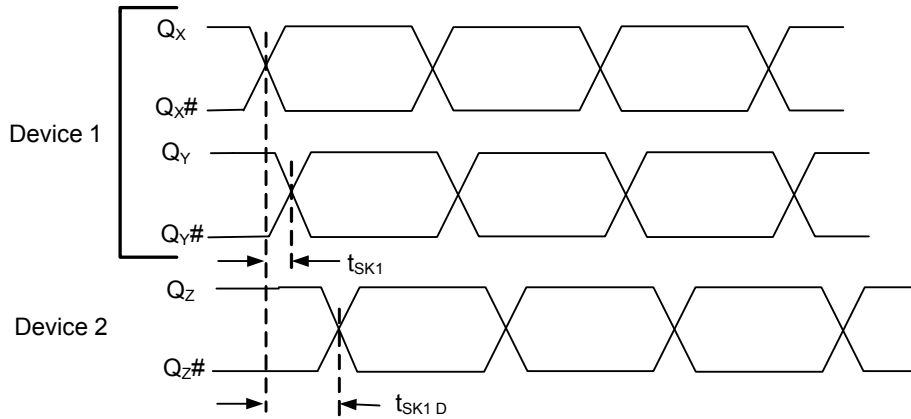


Figure 8. RMS Phase Jitter

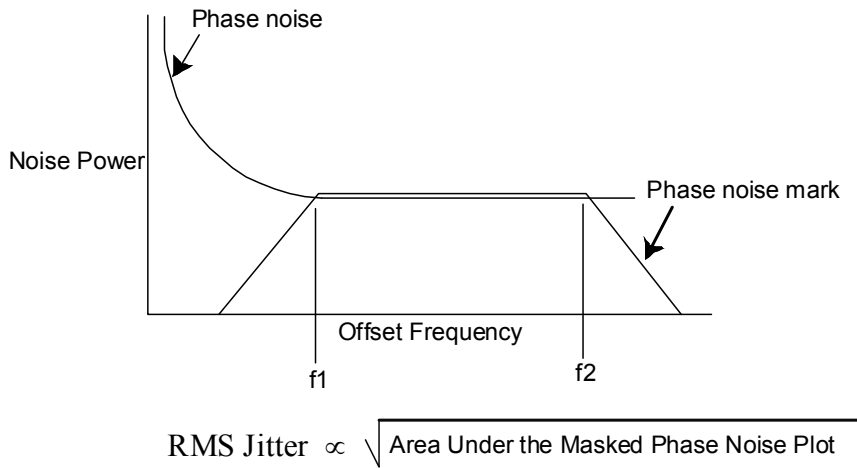
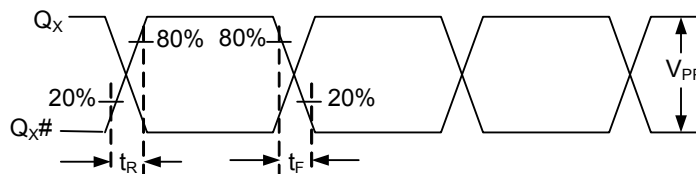
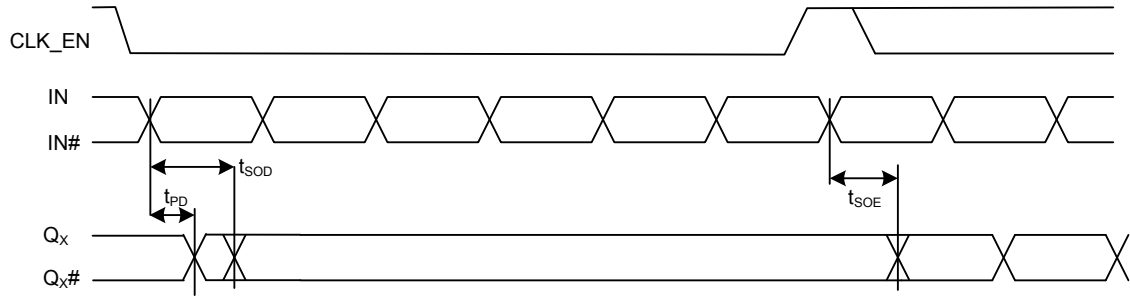


Figure 9. Output Rise/Fall Time



Switching Waveforms (continued)

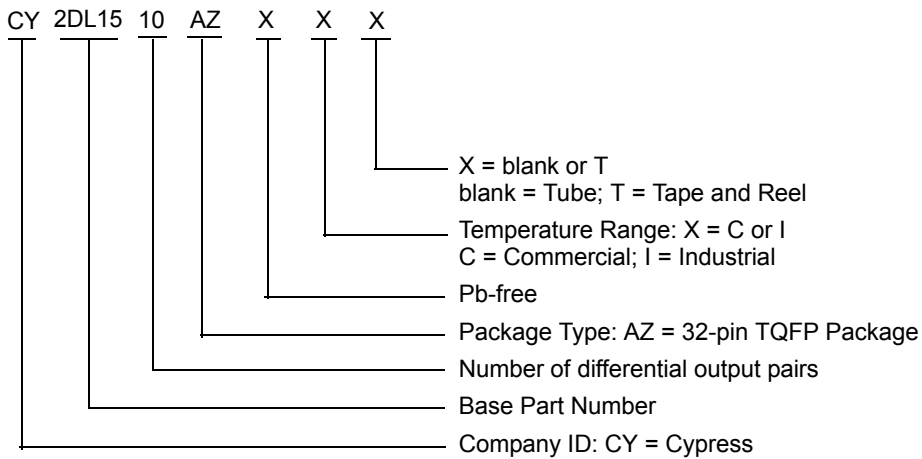
Figure 10. Synchronous Clock Enable Timing



**Ordering Information**

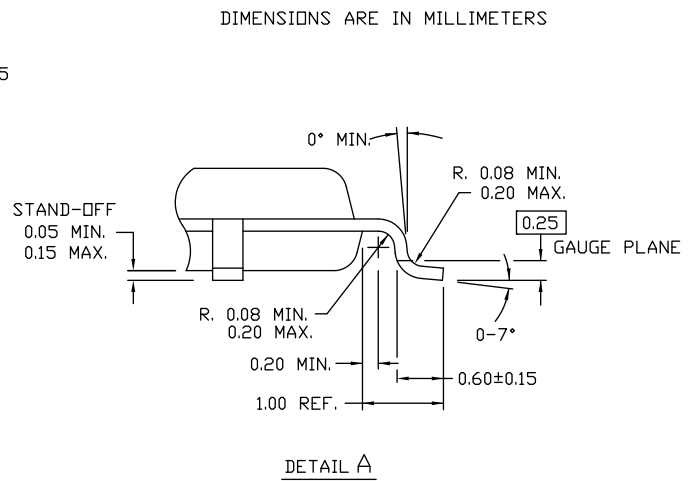
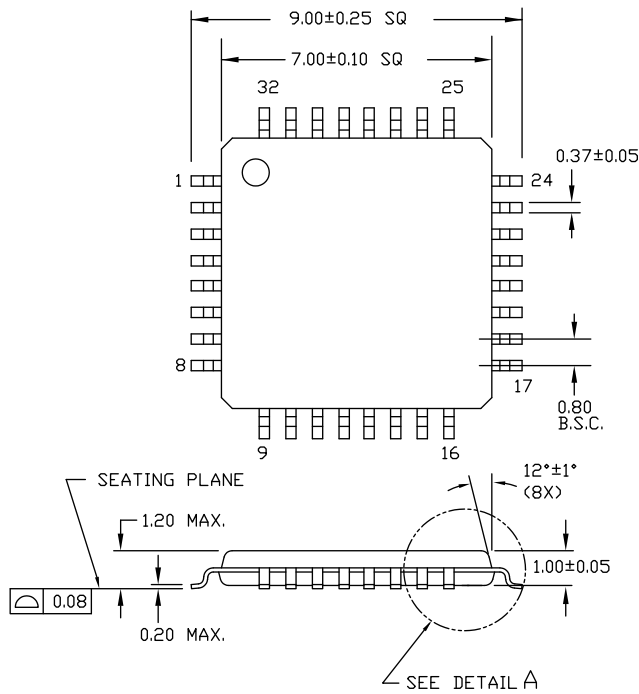
Part Number	Type	Production Flow
<b>Pb-free</b>		
CY2DL1510AZC	32-pin TQFP	Commercial, 0 °C to 70 °C
CY2DL1510AZCT	32-pin TQFP – Tape and Reel	Commercial, 0 °C to 70 °C
CY2DL1510AZI	32-pin TQFP	Industrial, –40 °C to 85 °C
CY2DL1510AZIT	32-pin TQFP – Tape and Reel	Industrial, –40 °C to 85 °C

**Ordering Code Definitions**



Package Diagram

Figure 11. 32-pin TQFP (7 × 7 × 1.0 mm) A 3210 Package Outline, 51-85063



51-85063 \*E

## Acronyms

Acronym	Description
ESD	Electrostatic Discharge
HBM	Human Body Model
JEDEC	Joint Electron Devices Engineering Council
LVDS	Low-Voltage Differential Signal
LVC MOS	Low-Voltage Complementary Metal Oxide Semiconductor
LV TTL	Low-Voltage Transistor-Transistor Logic
OE	Output Enable
RMS	Root Mean Square
TQFP	Thin Quad Flat Pack

## Document Conventions

### Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
dBc	decibels relative to the carrier
GHz	gigahertz
Hz	hertz
kΩ	kilohm
MHz	megahertz
μA	microampere
μF	microfarad
μs	microsecond
mA	milliampere
ms	millisecond
mV	millivolt
ns	nanosecond
Ω	ohm
pF	picofarad
ps	picosecond
V	volt
W	watt

**Document History Page**

Document Title: CY2DL1510, 1:10 Differential LVDS Fanout Buffer				
Document Number: 001-54863				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	2744225	CXQ / PYRS	08/19/09	New data sheet.
*A	2782891	CXQ	10/09/09	Updated format of Logic Block Diagram on page 1. Added $T_{SOD}$ and $T_{SOE}$ specs (700 ps max) to AC Specs table. Added $T_{SETUP}$ and $T_{HOLD}$ specs (300 ps min) to AC Specs table. Changed equation for RMS jitter in Figure 8 to proportionality. Changed package drawing from 1.4 mm thickness 51-85088 spec to 1.0 mm thickness 51-850063 spec. Added "Synchronous Clock Enable Function" to Features on page 1.
*B	2838916	CXQ	01/05/2010	Changed status from Advance to Preliminary. Changed from 0.34 ps to 0.25 ps maximum additive jitter in "Features" on page 1 and in $t_{JIT}$ in the AC Electrical Specs table on page 5. Added $t_{PU}$ spec to the Operating Conditions table on page 3. Removed $V_{OD}$ and $\Delta V_{OD}$ specs from the DC Electrical Specs table on page 4. Added $V_{PP}$ and $\Delta V_{PP}$ specs to the AC Electrical Specs table on page 5. $V_{PP}$ min = 250 mV and max = 470 mV; $\Delta V_{PP}$ max = 50 mV. Added internal pullup resistance spec for CLK_EN in the DC Electrical Specs table on page 4. Min = 60 k $\Omega$ , Max = 140 k $\Omega$ . Added a measurement definition for $C_{IN}$ in the DC Electrical Specs table on page 4. Changed letter case and some names of all the timing parameters in the AC Electrical Specs table on page 5 to be consistent with EROS. Lowered all additive phase noise mask specs by 3 dB in the AC Electrical Specs table on page 5. Added condition to $t_R$ and $t_F$ specs in the AC Electrical specs table on page 5 that input rise/fall time must be less than 1.5 ns (20% to 80%). Changed letter case and some names of all the timing parameters in Figures 5, 6, 7, and 9, to be consistent with EROS. Updated Figure 4 with definitions for $V_{PP}$ and $\Delta V_{PP}$ .
*C	2885033	CXQ	02/26/2010	Updated 32-Pin TQFP package diagram.
*D	3011766	CXQ	08/20/2010	Changed maximum additive jitter from 0.25 ps to 0.11 ps in "Features" on page 1 and in $t_{JIT}$ in the AC Electrical Specs table on page 5. Changed max $t_{PD}$ spec from 480 ps to 600 ps. Added note 5 to describe $I_{IH}$ and $I_{IL}$ specs. Removed reference to data distribution from "Functional Description". Changed $R_P$ for differential inputs from 100 k $\Omega$ to 150 k $\Omega$ in the Logic Block Diagram and from 60 k $\Omega$ min / 140 k $\Omega$ max to 90 k $\Omega$ min / 210 k $\Omega$ max in the DC Electrical Specs table. Added $V_{ID}$ max spec of 0.8V in the DC Electrical Specs table. Updated phase noise specs for 1 k/10 k/100 k/1 M/10 M/20 MHz offset to -120/-130/-135/-150/-150/-150dBc/Hz, respectively, in the AC Electrical Specs table. Added "Frequency range up to 1 GHz" condition to $t_{ODC}$ spec. Added Acronyms and Ordering Code Definition.
*E	3017258	CXQ	08/27/2010	Corrected Output Rise/Fall time diagram.

Document History Page (continued)

Document Title: CY2DL1510, 1:10 Differential LVDS Fanout Buffer Document Number: 001-54863				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
*F	3100234	CXQ	11/18/2010	<p>Changed <math>V_{IN}</math> and <math>V_{OUT}</math> specs from 4.0V to “lesser of 4.0 or <math>V_{DD} + 0.4</math>”</p> <p>Removed 200mA min LU spec, replaced with “Meets or exceeds JEDEC Spec JESD78B IC Latchup Test”</p> <p>Moved <math>V_{PP}</math> from AC spec table to DC spec table, removed <math>\Delta V_{PP}</math>.</p> <p>Removed <math>R_P</math> spec for differential input clock pins <math>IN_X</math> and <math>IN_X\#</math>.</p> <p>Changed <math>C_{IN}</math> condition to “Measured at 10 MHz”.</p> <p>Changed <math>PN_{ADD}</math> specs for 10kHz, 10MHz, and 20MHz offsets.</p> <p>Added “Measured at 1 GHz” to <math>t_R</math>, <math>t_F</math> spec condition.</p> <p>Removed <math>t_S</math> and <math>t_H</math> specs from AC specs table.</p> <p>Changed to CY2DL1510AZ package code in Ordering Information.</p> <p>Added to Z package code in Ordering Code Definition.</p>
*G	3135201	CXQ	01/12/2011	<p>Changed status from Preliminary to Final.</p> <p>Updated <a href="#">Logic Block Diagram</a> (Fixed typo and removed resistors from IN/IN#).</p> <p>Updated <a href="#">Switching Waveforms</a>:</p> <p>Added <a href="#">Figure 10</a> (to describe <math>T_{SOE}</math> and <math>T_{SOD}</math>).</p>
*H	3090938	CXQ	02/25/2011	Post to external web.
*I	3952187	CINM	04/02/2013	<p>Updated <a href="#">Package Diagram</a>:</p> <p>spec 51-85063 – Changed revision from *C to *D.</p> <p>Updated to new template.</p> <p>Completing Sunset Review.</p>
*J	4586288	CINM	12/04/2014	<p>Updated <a href="#">Functional Description</a>:</p> <p>Added “For a complete list of related documentation, <a href="#">click here</a>.” at the end.</p>
*K	5260362	TAVA	05/05/2016	<p>Added <a href="#">Thermal Resistance</a>.</p> <p>Updated <a href="#">Package Diagram</a>:</p> <p>spec 51-85063 – Changed revision from *D to *E.</p> <p>Updated to new template.</p> <p>Completing Sunset Review.</p>

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