

MO3372

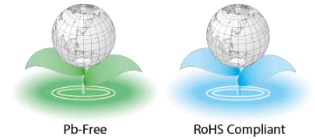
1 to 220 MHz Ultra-low Jitter Differential VCML

Features

- Any frequency between 1 MHz and 220 MHz accurate to 6 decimal places
- Widest pull range options: ± 25 , ± 50 , ± 80 , ± 100 , ± 150 , ± 200 , ± 400 , ± 800 , ± 1600 , ± 3200 ppm
- 0.23ps RMS phase jitter (Typ) over 12 kHz to 20 MHz bandwidth
- Wide temperature range from -40°C to $+105^{\circ}\text{C}$
- Industry-standard packages: 3.2x2.5 , 5.0x3.2 , 7.0x5.0 mm
- For frequencies 220.000001 MHz to 720 MHz, refer to MO3373 datasheet

Applications

- Cable Modem Termination System (CMTS), Video, Broadcasting System, Audio, Industrial Sensors, Remote Radio Head (RRH)
- SATA, SAS, 10GB Ethernet, Fibre Channel, PCI-Express



Electrical Characteristics

Table 1. Electrical Characteristics - Common to LVPECL, LVDS and HCSL

All Min and Max limits in the Electrical Characteristics tables are specified over temperature and rated operating voltage with standard output termination show in the termination diagrams. Typical values are at $+25^{\circ}\text{C}$ and nominal supply voltage.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency Range						
Output Frequency Range	f	1	–	220	MHz	Accurate to 6 decimal places
Frequency Stability						
Frequency Stability	F_stab	-15	–	+15	ppm	Inclusive of initial tolerance, operating temperature, rated power supply voltage, load variations, and first year aging at $+25^{\circ}\text{C}$. Contact KDS for ± 15 ppm.
		-20	–	+20	ppm	
		-30	–	+30	ppm	
		-50	–	+50	ppm	
Temperature Range						
Operating Temperature Range	T_use	-20	–	+70	$^{\circ}\text{C}$	Extended Commercial
		-40	–	+85	$^{\circ}\text{C}$	Industrial.
		-40	–	+95	$^{\circ}\text{C}$	
		-40	–	+105	$^{\circ}\text{C}$	Extended Industrial
Supply Voltage						
Supply Voltage	Vdd	+2.97	+3.3	+3.63	V	
		+2.7	+3.0	+3.3	V	
		+2.52	+2.8	+3.08	V	
		+2.25	+2.5	+2.75	V	
Voltage Control Characteristics						
Pull Range	PR	± 25 , ± 50 , ± 80 , ± 100 , ± 150 , ± 200 , ± 400 , ± 800 , ± 1600 , ± 3200			ppm	See the APR (Absolute Pull Range) Table 11. Contact KDS for custom pull range options.
Upper Control Voltage	VC_U	90%	–	–	Vdd	Voltage at which maximum frequency deviation is guaranteed
Lower Control Voltage	VC_L	–	–	10%	Vdd	Voltage at which minimum frequency deviation is guaranteed
Control Voltage Input Impedance	VC_z	–	10	–	M Ω	
Control Voltage Input Bandwidth	V_c	–	10	–	kHz	Contact KDS for other input bandwidth options
Pull Range Linearity	Lin	–	–	1.0	%	
Frequency Change Polarity	–	Positive Slope			–	
Input Characteristics						
Input Voltage High	VIH	70%	–	–	Vdd	Pin 2, OE
Input Voltage Low	VIL	–	–	30%	Vdd	Pin 2, OE
Input Pull-up Impedance	Z_in	–	100	–	k Ω	Pin 2, OE logic high or logic low
Output Characteristics						
Duty Cycle	DC	45	–	55	%	
Startup and OE Timing						
Start-up Time	T_start	–	–	3.0	ms	Measured from the time Vdd reaches its rated minimum value.
OE Enable/Disable Time	T_oe	–	–	3.8	μs	f = 156.25 MHz. Measured from the time OE pin reaches rated VIH and VIL to the time clock pins reach 90% of swing and high-Z. See Figure 7 and Figure 8.

Table 2. Electrical Characteristics - LVPECL Specific

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current Consumption						
Current Consumption	I _{dd}	–	–	+92	mA	Excluding Load Termination Current, V _{dd} = +3.3V or +2.5V
OE Disable Supply Current	I _{OE}	–	–	+61	mA	OE = Low
Output Disable Leakage Current	I _{leak}	–	+0.15	–	μA	OE = Low
Maximum Output Current	I _{driver}	–	–	+33	mA	Maximum average current drawn from OUT+ or OUT-
Output Characteristics						
Output High Voltage	V _{OH}	V _{dd} -1.15	–	V _{dd} -0.7	V	See Figure 3
Output Low Voltage	V _{OL}	V _{dd} -2.0	–	V _{dd} -1.5	V	See Figure 3
Output Differential Voltage Swing	V _{Swing}	+1.2	+1.6	+2.0	V	See Figure 3
Rise/Fall Time	T _r , T _f	–	225	290	ps	20% to 80%, See Figure 4
Jitter – 7.0 x 5.0 mm package						
RMS Period Jitter ⁽¹⁾	T _{jitt}	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, V _{DD} = +3.3V or +2.5V
RMS Phase Jitter (random)	T _{phj}	–	0.225	0.270	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -20 to +70°C and -40 to +85°C.
		–	0.225	0.300	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -40 to +95°C and -40 to +105°C.
		–	0.1	–	ps	f = 156.25, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all V _{dd} levels.
Jitter – 5.0 x 3.2 mm and 3.2 x 2.5 mm package						
RMS Period Jitter ⁽¹⁾	T _{jitt}	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, V _{DD} = +3.3V or +2.5V
RMS Phase Jitter (random)	T _{phj}	–	0.225	0.275	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -20 to +70°C and -40 to +85°C.
		–	0.225	0.340	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -40 to +95°C and -40 to +105°C.
		–	0.1	–	ps	f = 156.25 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all V _{dd} levels.

Notes:

1. Measured according to JESD65B.

Table 3. Electrical Characteristics – LVDS Specific

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current Consumption						
Current Consumption	I _{dd}	–	–	+84	mA	Excluding Load Termination Current, V _{dd} = +3.3V or +2.5V
OE Disable Supply Current	I _{OE}	–	–	+62	mA	OE = Low
Output Disable Leakage Current	I _{leak}	–	+0.15	–	μA	OE = Low
Output Characteristics						
Differential Output Voltage	VOD	+250	–	+450	mV	See Figure 5
VOD Magnitude Change	ΔVOD	–	–	+50	mV	See Figure 5
Offset Voltage	VOS	+1.125	–	+1.375	V	See Figure 5
VOS Magnitude Change	ΔVOS	–	–	+50	mV	See Figure 5
Rise/Fall Time	T _r , T _f	–	400	470	ps	Measured with 2 pF capacitive loading to GND, 20% to 80%, see Figure 6
Jitter – 7.0 x 5.0 mm package						
RMS Period Jitter ^[2]	T _{jitt}	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, VDD = +3.3V or +2.5V
RMS Phase Jitter (random)	T _{phj}	–	0.215	0.265	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels. Includes spurs, pull range = 100 ppm. Temperature range -20 to +70°C and -40 to +85°C.
		–	0.215	0.300	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels. Includes spurs, pull range = 100 ppm. Temperature range -40 to +95°C and -40 to +105°C.
		–	0.1	–	ps	f = 156.25 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all Vdd levels.
Jitter – 5.0 x 3.2 mm and 3.2 x 2.5 mm package						
RMS Period Jitter ^[2]	T _{jitt}	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, VDD = +3.3V or +2.5V
RMS Phase Jitter (random)	T _{phj}	–	0.235	0.275	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels. Includes spurs, pull range = 100 ppm. Temperature range -20 to +70°C and -40 to +85°C.
		–	0.235	0.320	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels. Includes spurs, pull range = 100 ppm. Temperature range -40 to +95°C and -40 to +105°C.
		–	0.1	–	ps	f = 156.25 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all Vdd levels.

Notes:

2. Measured according to JESD65B.

Table 4. Electrical Characteristics – HCSL Specific

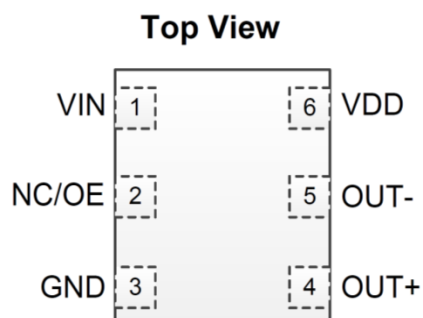
Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current Consumption						
Current Consumption	I _{dd}	–	–	+97	mA	Excluding Load Termination Current, V _{dd} = +3.3V or +2.5V
OE Disable Supply Current	I _{OE}	–	–	+62	mA	OE = Low
Output Disable Leakage Current	I _{leak}	–	+0.15	–	μA	OE = Low
Maximum Output Current	I _{driver}	–	–	+35	mA	Maximum average current drawn from OUT+ or OUT-
Output Characteristics						
Output High Voltage	V _{OH}	+0.60	–	+0.90	V	See Figure 3
Output Low Voltage	V _{OL}	-0.05	–	+0.08	V	See Figure 3
Output Differential Voltage Swing	V _{Swing}	+1.2	+1.4	+1.8	V	See Figure 4
Rise/Fall Time	T _r , T _f	–	360	495	ps	Measured with 2 pF capacitive loading to GND, 20% to 80%, see Figure 4
Jitter – 7.0 x 5.0 mm package						
RMS Period Jitter ^[3]	T _{jitt}	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, V _{DD} = +3.3V or +2.5V
RMS Phase Jitter (random)	T _{phj}	–	0.220	0.270	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -20 to +70°C and -40 to +85°C.
		–	0.220	0.300	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -40 to +95°C and -40 to +105°C.
		–	0.1	–	ps	f = 156.25 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all V _{dd} levels.
Jitter – 5.0 x 3.2 mm and 3.2 x 2.5 mm package						
RMS Period Jitter ^[3]	T _{jitt}	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, V _{DD} = +3.3V or +2.5V
RMS Phase Jitter (random)	T _{phj}	–	0.230	0.275	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -20 to +70°C and -40 to +85°C.
		–	0.230	0.340	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V _{dd} levels. Includes spurs, pull range = 100 ppm. Temperature range -40 to +95°C and -40 to +105°C.
		–	0.1	–	ps	f = 156.25 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all V _{dd} levels.

Notes:

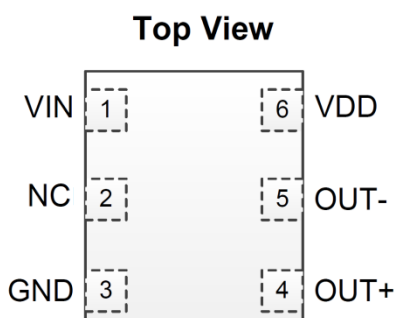
3. Measured according to JESD65B.

Table 5. Pin Description

Pin	Map	Functionality	
1	VIN	Input	Control Voltage
2	OE/NC	Non Connect (NC)	No Connect: Leave it floating or connect to GND for better heat dissipation. NC for all 3.2 x 2.5 mm package options.
		Output Enable (OE)	H ^[4,5] : specified frequency output L: output is high impedance. Only output driver is disabled. OE function only available on 7050 and 5032 package. Pin 2 on 3225 package is NC.
3	GND	Power	VDD Power Supply Ground
4	OUT+	Output	Oscillator output
5	OUT-	Output	Complementary oscillator output
6	VDD	Power	Power supply voltage ^[6]



**Figure 1. Pin Assignments
(7.0 x 5.0 mm and
5.0 x 3.2 mm packages)**



**Figure 2. Pin Assignments
(3.2 x 2.5 mm package)**

Notes:

4. A pull-up resistor of 10 kΩ or less is recommended if pin 1 is not externally driven.
5. OE mode is only available in the 7050 and 5032 package. 3225 package is NC.
6. A capacitor of value 0.1 μF or higher between Vdd and GND is required. An additional 10 μF capacitor between Vdd and GND is required for the best phase jitter performance.

Table 6. Absolute Maximum Ratings

Attempted operation outside the absolute maximum ratings may cause permanent damage to the part. Actual performance of the IC is only guaranteed within the operational specifications, not at absolute maximum ratings.

Parameter	Min.	Max.	Unit
VDD	-0.5	+4.0	V
VIH	–	Vdd + 0.3	V
VIL	-0.3	–	V
Storage Temperature	-65	+150	°C
Maximum Junction Temperature	–	+130	°C
Soldering Temperature (follow standard Pb free soldering guidelines)	–	+260	°C

Table 7. Thermal Consideration^[7]

Package	θ_{JA} , 4 Layer Board (°C/W)	θ_{JC} , Bottom (°C/W)
3225, 6-pin	80	30
5032, 6-pin	TBD	TBD
7050, 6-pin	52	19

Notes:

7. Refer to JESD51 for θ_{JA} and θ_{JC} definitions, and reference layout used to determine the θ_{JA} and θ_{JC} values in the above table.

Table 8. Maximum Operating Junction Temperature^[8]

Max Operating Temperature (ambient)	Maximum Operating Junction Temperature
+70°C	+95°C
+85°C	+110°C
+95°C	+120°C
+105°C	+130°C

Notes:

8. Datasheet specifications are not guaranteed if junction temperature exceeds the maximum operating junction temperature.

Table 9. Environmental Compliance

Parameter	Test Conditions	Value	Unit
Mechanical Shock Resistance	MIL-STD-883F, Method 2002	10,000	g
Mechanical Vibration Resistance	MIL-STD-883F, Method 2007	70	g
Soldering Temperature (follow standard Pb free soldering guidelines)	MIL-STD-883F, Method 2003	260	°C
Moisture Sensitivity Level	MSL1 @ +260°C		
Electrostatic Discharge (HBM)	HBM, JESD22-A114	20,000	V
Charge-Device Model ESD Protection	JESD220C101	750	V
Latch-up Tolerance	JESD78 Compliant		

Waveform Diagrams

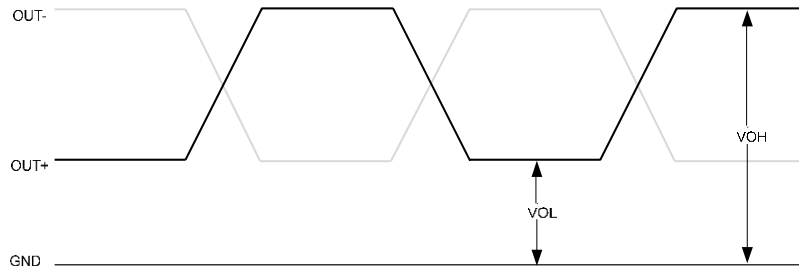


Figure 3. LVPECL/HCSL Voltage Levels per Differential Pin (OUT+/OUT-)

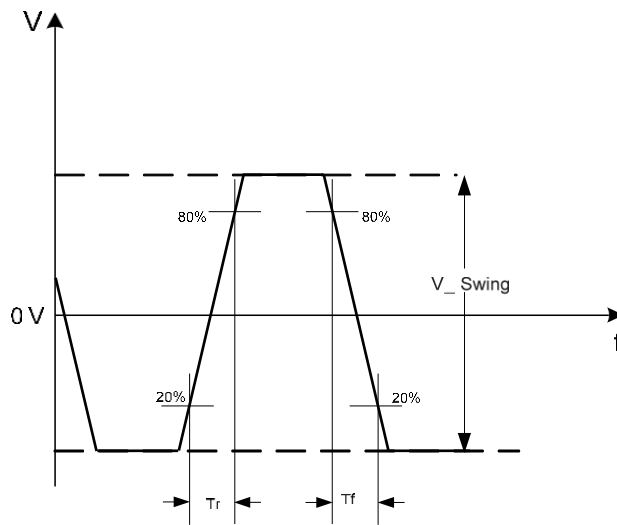


Figure 4. LVPECL/HCSL Voltage Levels across Differential Pair

Waveform Diagrams(continued)

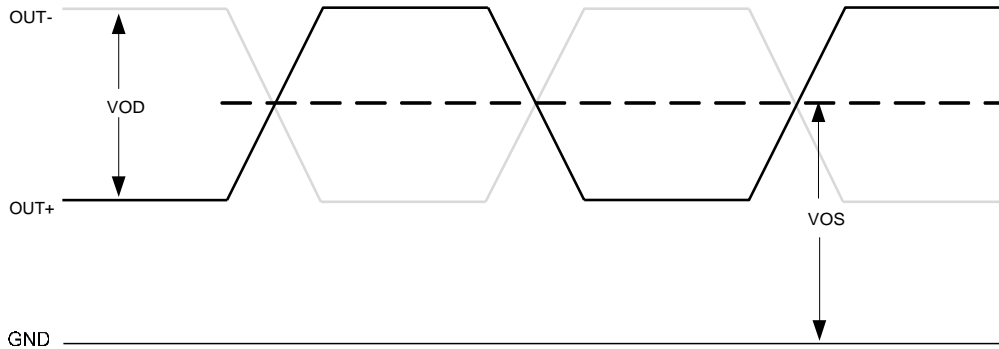


Figure 5. LVDS Voltage Levels per Differential Pin (OUT+/OUT-)

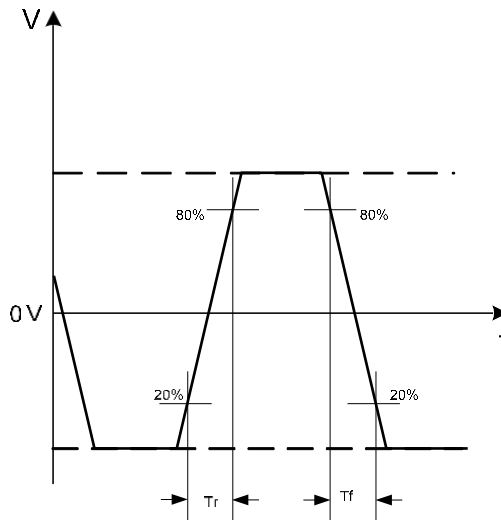


Figure 6. LVDS Differential Waveform

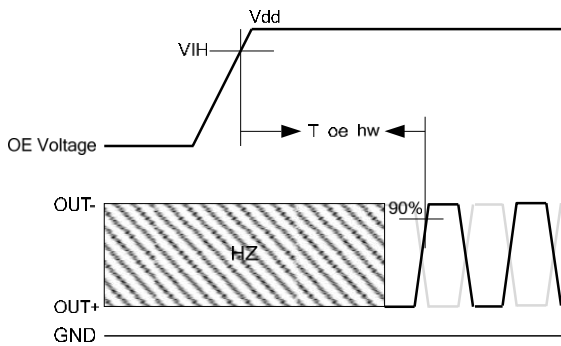


Figure 7. Hardware OE Enable Timing

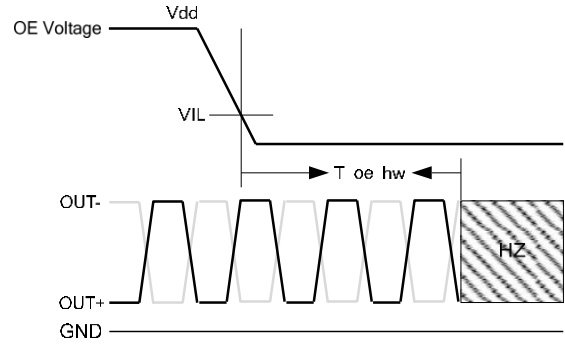


Figure 8. Hardware OE Disable Timing

Termination Diagrams

LVPECL:

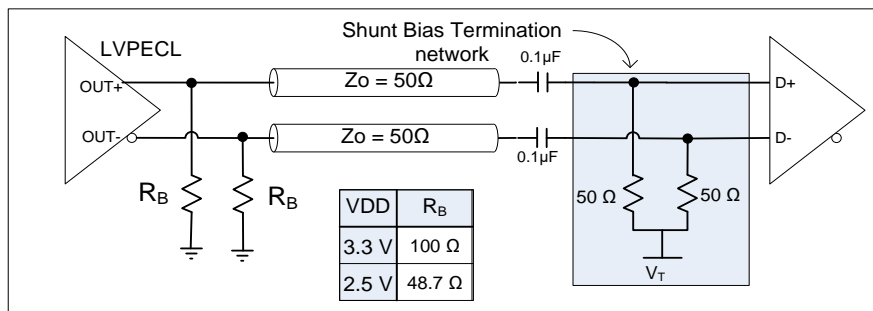


Figure 9. LVPECL with AC-coupled termination

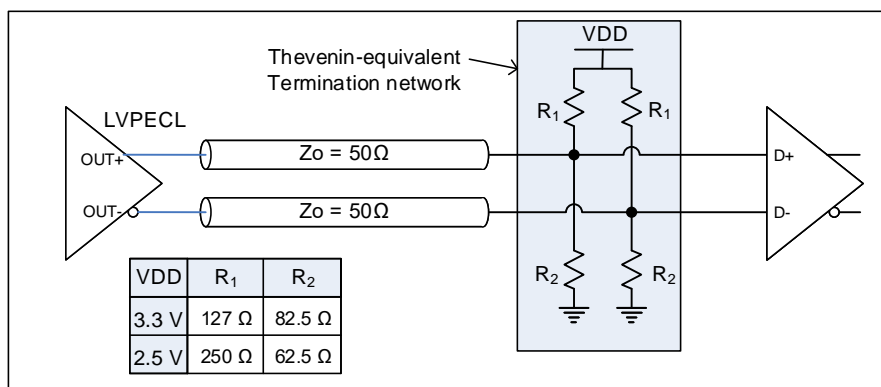


Figure 10. LVPECL DC-coupled load termination with Thevenin equivalent network

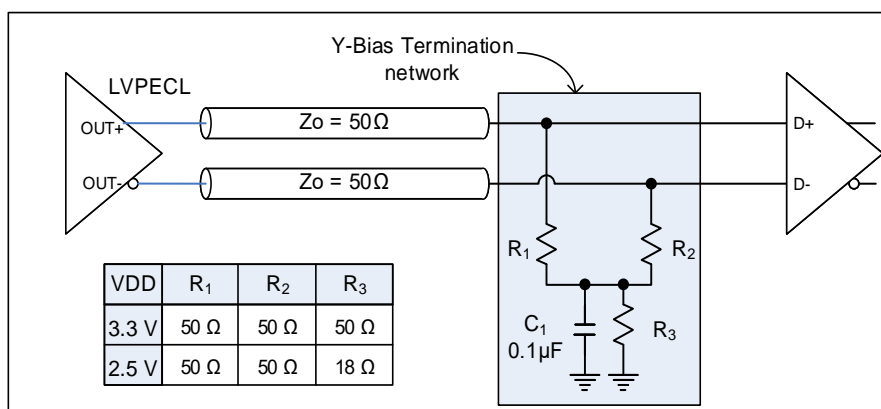


Figure 11. LVPECL with Y-Bias termination

Termination Diagrams (Continued)

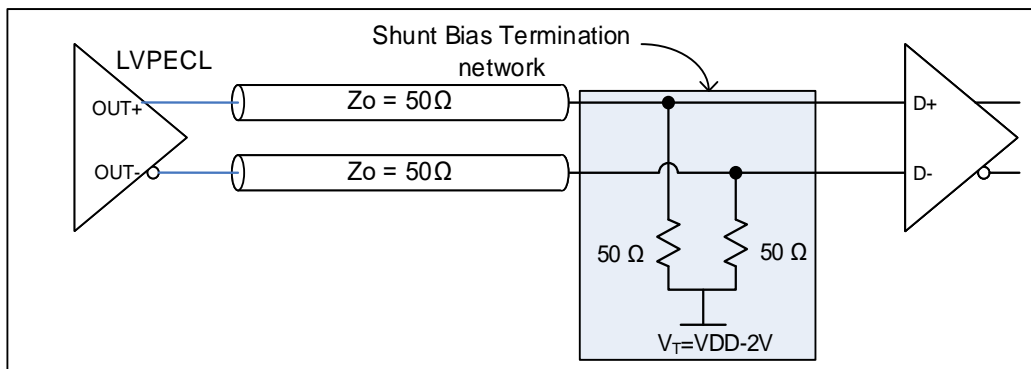


Figure 12. LVPECL with DC-coupled parallel shunt load termination

Termination Diagrams (Continued)

LVDS:

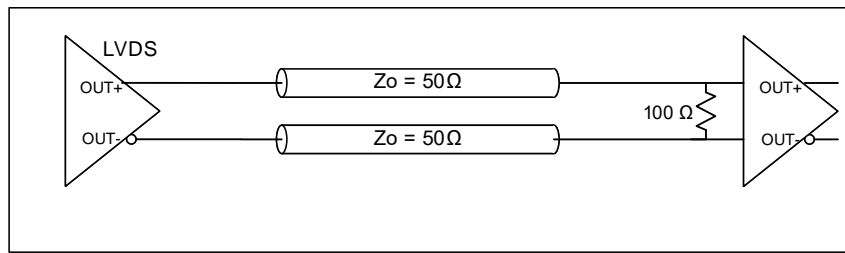


Figure 13. LVDS single DC termination at the load

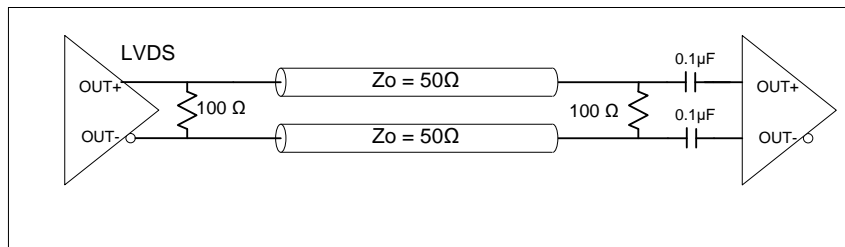


Figure 14. LVDS double AC termination with capacitor close to the load

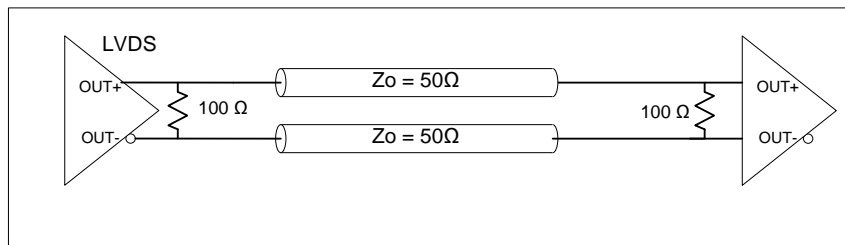


Figure 15. LVDS double DC termination

HCSL:

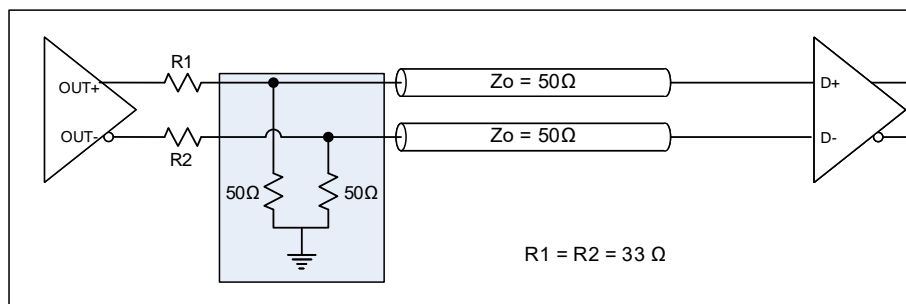


Figure 16. HCSL interface termination

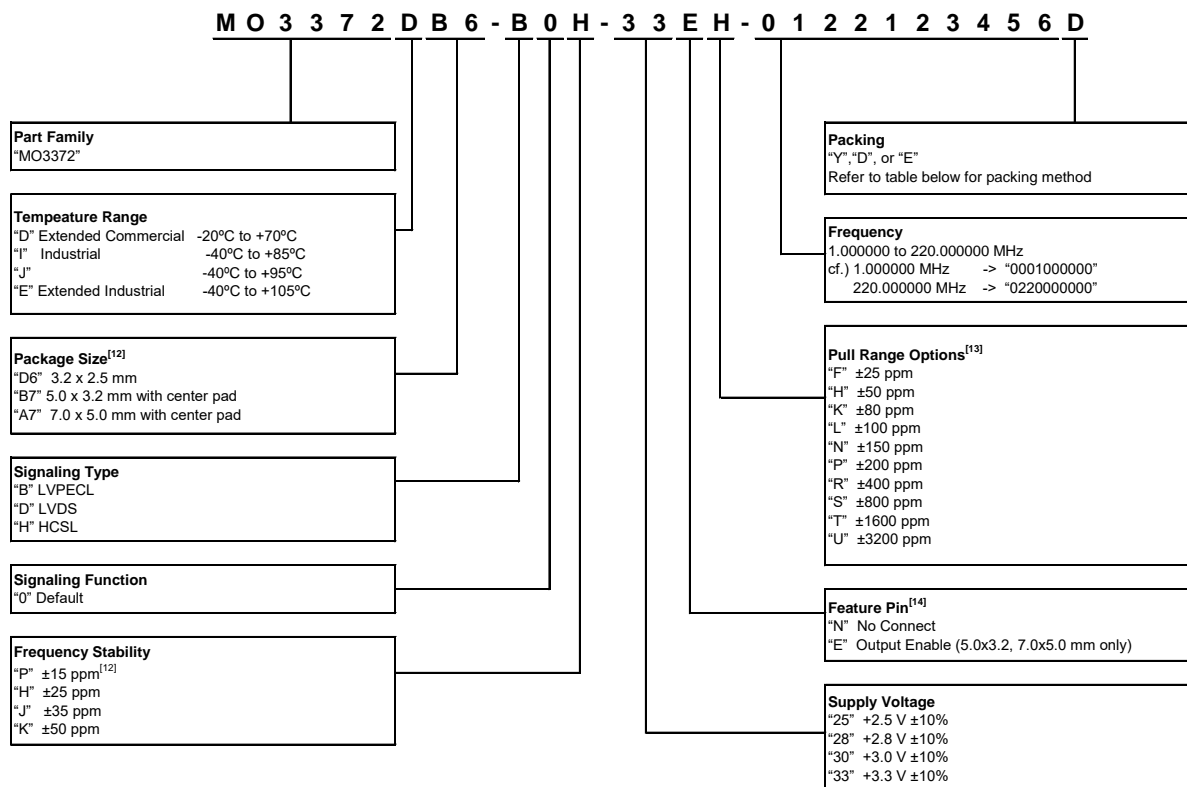
Dimensions and Patterns

Package Size – Dimensions (Unit: mm) ^[9]	Recommended Land Pattern (Unit: mm) ^[10]																																																									
<p>3.2 x 2.5x 0.85 mm</p> <div style="float: right; border: 1px solid black; padding: 5px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="5">Dimension Table</th> </tr> <tr> <th></th> <th>Symbol</th> <th>Min</th> <th>Nom</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>TOTAL THICKNESS</td> <td>A</td> <td>0.800</td> <td>0.850</td> <td>0.900</td> </tr> <tr> <td rowspan="2">BODY SIZE</td> <td>X</td> <td>D</td> <td>2.400</td> <td>2.500</td> <td>2.600</td> </tr> <tr> <td>Y</td> <td>E</td> <td>3.200</td> <td>3.200</td> <td>3.300</td> </tr> <tr> <td>LEAD PITCH</td> <td>e</td> <td colspan="3" style="text-align: center;">1.100 BSC</td> </tr> <tr> <td>LEAD LENGTH</td> <td>L</td> <td>0.650</td> <td>0.700</td> <td>0.750</td> </tr> <tr> <td>LEAD WIDTH</td> <td>W</td> <td>0.550</td> <td>0.600</td> <td>0.650</td> </tr> </tbody> </table> </div> <div style="clear: both;"></div> <div style="text-align: right; margin-top: 10px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">6L QFN</td> <td style="width: 50%;">Package Outline</td> </tr> <tr> <td>3.2 x 2.5 x 0.75 mm</td> <td rowspan="2" style="text-align: center;"> </td> </tr> <tr> <td>POD-38 Rev A</td> </tr> </table> </div>	Dimension Table						Symbol	Min	Nom	Max	TOTAL THICKNESS	A	0.800	0.850	0.900	BODY SIZE	X	D	2.400	2.500	2.600	Y	E	3.200	3.200	3.300	LEAD PITCH	e	1.100 BSC			LEAD LENGTH	L	0.650	0.700	0.750	LEAD WIDTH	W	0.550	0.600	0.650	6L QFN	Package Outline	3.2 x 2.5 x 0.75 mm		POD-38 Rev A	<p>3.2 x 2.5x 0.85 mm</p>											
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Notes:

9. Top Marking: Y denotes manufacturing origin and XXXX denotes manufacturing lot number. The value of "Y" will depend on the assembly location of the device.
10. A capacitor of value 0.1 μF or higher between Vdd and GND is required. An additional 10 μF capacitor between Vdd and GND is required for the best phase jitter performance
11. The center pad has no electrical function. Soldering down the center pad to the GND is recommended for best thermal dissipation, but is optional.

Ordering Information



Notes:

- 12. Contact KDS for ±15 ppm
- 13. Contact KDS for custom pull range options
- 14. "E": Output Enable function is only available in 7.0 x 5.0 mm and 5.0 x 3.2 mm packages

Table 10. Ordering Codes for Supported Tape & Reel Packing Method

Device Size (mm x mm)	8 mm T&R (3ku)	8 mm T&R (1ku)	12 mm T&R (3ku)	12 mm T&R (1ku)	16 mm T&R (3ku)	16 mm T&R (1ku)
7.0 x 5.0 mm	-	-	-	-	-	Y
5.0 x 3.2 mm	-	-	-	Y	-	-
3.2 x 2.5 mm	D	E	-	-	-	-

MO3372

1 to 220 MHz Ultra-low Jitter Differential VCMO

Table 11. APR Table

Absolute pull range (APR) = Nominal pull range (PR) - frequency stability (F_stab)-aging

Nominal Pull Range	Frequency Stability			
	± 15	± 25	± 35	± 50
	APR (ppm)			
± 25	± 5	-	-	-
± 50	± 30	± 20	± 10	-
± 80	± 60	± 50	± 40	± 25
± 100	± 80	± 70	± 60	± 45
± 150	± 130	± 120	± 110	± 95
± 200	± 180	± 170	± 160	± 145
± 400	± 380	± 370	± 360	± 345
± 800	± 780	± 770	± 760	± 745
± 1600	± 1580	± 1570	± 1560	± 1545
± 3200	± 3180	± 3170	± 3160	± 3145

Table 12. Revision History

Revision	Release Date	Change Summary
1.0	10/13/2017	Initial release
1.03	05/10/2018	Updated the Part Ordering info with added 5.0 x 3.2 mm package