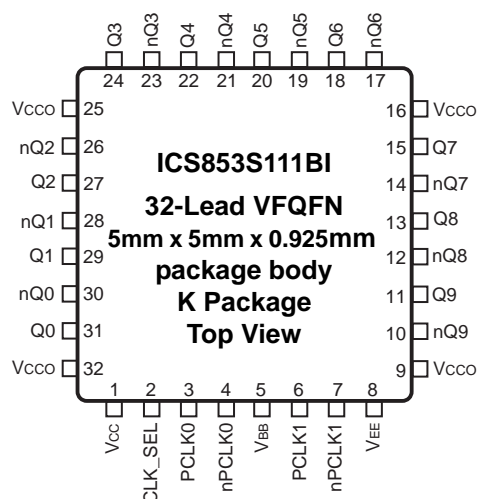
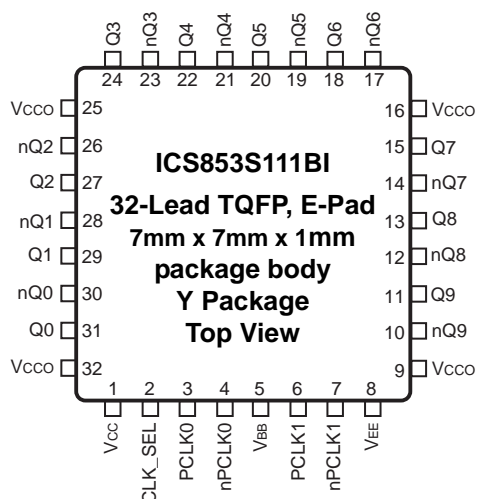




General Description

The ICS853S111BI is a low skew, high performance 1-to-10 Differential-to-2.5V/ 3.3V LVPECL/ECL Fanout Buffer. The ICS853S111BI is characterized to operate from either a 2.5V or a 3.3V power supply. Guaranteed output and part-to-part skew characteristics make the ICS853S111BI ideal for those clock distribution applications demanding well defined performance and repeatability.

Pin Assignments



Features

- Ten differential 2.5V, 3.3V LVPECL/ECL outputs
- Two selectable differential input pairs
- PCLKx, nPCLKx pairs can accept the following differential input levels: LVPECL, LVDS, SSTL
- Maximum output frequency: 2.5GHz
- Translates any single-ended input signal to 3.3V LVPECL levels with resistor bias on nPCLK input
- Output skew: 50ps (maximum)
- Part-to-part skew: 150ps (maximum)
- Propagation delay: 645ps (maximum)
- Additive Phase Jitter, RMS: 0.03ps (typical)
- LVPECL mode operating voltage supply range: $V_{CC} = 2.375V$ to $3.8V$, $V_{EE} = 0V$
- ECL mode operating voltage supply range: $V_{CC} = 0V$, $V_{EE} = -3.8V$ to $-2.375V$
- $-40^{\circ}C$ to $85^{\circ}C$ ambient operating temperature
- Available lead-free (RoHS 6) package

Block Diagram

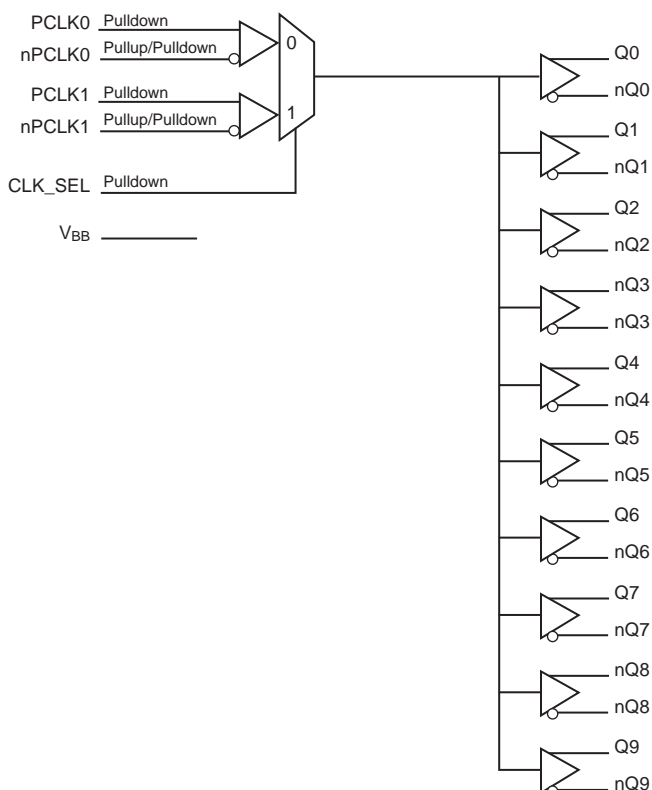


Table 1. Pin Descriptions

Number	Name	Type		Description
1	V _{CC}	Power		Positive supply pin.
2	CLK_SEL	Input	Pulldown	Clock select input. When HIGH, selects PCLK1/nPCLK1 inputs. When LOW, selects PCLK0/nPCLK0 inputs. LVPECL interface levels. Also accepts standard LVCMOS input levels.
3	PCLK0	Input	Pulldown	Non-inverting differential LVPECL clock input.
4	nPCLK0	Input	Pullup/ Pulldown	Inverting differential LVPECL clock input. V _{CC} /2 default when left floating.
5	V _{BB}	Output		Bias voltage to be connected for single-ended applications.
6	PCLK1	Input	Pulldown	Non-inverting differential LVPECL clock input.
7	nPCLK1	Input	Pullup/ Pulldown	Inverting differential LVPECL clock input. V _{CC} /2 default when left floating.
8	V _{EE}	Power		Negative supply pin.
9, 16, 25, 32	V _{CCO}	Power		Output supply pins.
10, 11	nQ9, Q9	Output		Differential output pair. LVPECL/ECL interface levels.
12, 13	nQ8, Q8	Output		Differential output pair. LVPECL/ECL interface levels.
14, 15	nQ7, Q7	Output		Differential output pair. LVPECL/ECL interface levels.
17, 18	nQ6, Q6	Output		Differential output pair. LVPECL/ECL interface levels.
19, 20	nQ5, Q5	Output		Differential output pair. LVPECL/ECL interface levels.
21, 22	nQ4, Q4	Output		Differential output pair. LVPECL/ECL interface levels.
23, 24	nQ3, Q3	Output		Differential output pair. LVPECL/ECL interface levels.
26, 27	nQ2, Q2	Output		Differential output pair. LVPECL/ECL interface levels.
28, 29	nQ1, Q1	Output		Differential output pair. LVPECL/ECL interface levels.
30, 31	nQ0, Q0	Output		Differential output pair. LVPECL/ECL interface levels.

NOTE: *Pullup* and *Pulldown* refer to internal input resistors. See Table 2, *Pin Characteristics*, for typical values.

Table 2. Pin Characteristics

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
R _{PULLDOWN}	Input Pulldown Resistor			75		kΩ
R _{VCC/2}	RPullup/Pulldown Resistors			50		kΩ

Function Tables

Table 3A. Clock Input Function Table

Inputs		Outputs		Input to Output Mode	Polarity
PCLK0 or PCLK1	nPCLK0 or nPCLK1	Q0:Q9	nQ0:nQ9		
0	1	LOW	HIGH	Differential to Differential	Non-Inverting
1	0	HIGH	LOW	Differential to Differential	Non-Inverting
0	Biased; NOTE 1	LOW	HIGH	Single-Ended to Differential	Non-Inverting
1	Biased; NOTE 1	HIGH	LOW	Single-Ended to Differential	Non-Inverting
Biased; NOTE 1	0	HIGH	LOW	Single-Ended to Differential	Inverting
Biased; NOTE 1	1	LOW	HIGH	Single-Ended to Differential	Inverting

NOTE 1: Please refer to the Applications Information, "Wiring the Differential Input to Accept Single Ended Levels".

Table 3B. Control Input Function Table

Inputs	
CLK_SEL	Selected Source
0	PCLK0, nPCLK0
1	PCLK1, nPCLK1

Absolute Maximum Ratings

NOTE: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

Item	Rating
Supply Voltage, V_{CC}	4.6V (LVPECL mode, $V_{EE} = 0V$)
Negative Supply Voltage, V_{EE}	-4.6V (ECL mode, $V_{CC} = 0V$)
Inputs, V_I (LVPECL mode)	-0.5V to $V_{CC} + 0.5V$
Inputs, V_I (ECL mode)	0.5V to $V_{EE} - 0.5V$
Outputs, I_O Continuous Current Surge Current	50mA 100mA
V_{BB} Sink/Source, I_{BB}	$\pm 0.5mA$
Operating Temperature Range, T_A	-40°C to +85°C
Package Thermal Impedance, θ_{JA} 32-Lead TQFP, Epad 32-Lead VFQFN	36.2°C/W (0 mps) 42.7°C/W (0 mps)
Storage Temperature, T_{STG}	-65°C to 150°C

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, $V_{CC} = V_{CCO} = 2.375V$ to $3.8V$; $V_{EE} = 0V$, $T_A = -40^\circ C$ to $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{CC}	Positive Supply Voltage		2.375	3.3	3.8	V
V_{CCO}	Output Supply Voltage		2.375	3.3	3.8	V
I_{EE}	Power Supply Current				124	mA

Table 4B. LVPECL DC Characteristics, $V_{CC} = V_{CCO} = 3.3V$; $V_{EE} = 0V$, $T_A = -40^{\circ}C$ to $85^{\circ}C$

Symbol	Parameter	-40°C			25°C			85°C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OH}	Output High Voltage; NOTE 1	2.175	2.275	2.445	2.225	2.295	2.445	2.215	2.33	2.410	V
V_{OL}	Output Low Voltage; NOTE 1	1.405	1.545	1.70	1.375	1.52	1.645	1.355	1.535	1.63	V
V_{IH}	Input High Voltage (Single-ended)	2.075		2.36	2.075		2.36	2.075		2.36	V
V_{IL}	Input Low Voltage (Single-ended)	1.43		1.765	1.43		1.765	1.43		1.765	V
V_{BB}	Output Voltage Reference; NOTE 2	1.86		1.98	1.86		1.98	1.86		1.98	V
V_{PP}	Peak-to-Peak Input Voltage; NOTE 3	150	800	1300	150	800	1200	150	800	1200	mV
V_{CMR}	Input High Voltage Common Mode Range; NOTE 3, 4	1.3		3.3	1.2		3.3	1.2		3.3	V
I_{IH}	Input High Current	PCLK0, PCLK1 nPCLK0, nPCLK1		200			200			200	μA
I_{IL}	Input Low Current	PCLK0, PCLK1		-10			-10			-10	μA
		nPCLK0, nPCLK1		-200			-200			-200	μA

NOTE: Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.925V to -0.5V.NOTE 1: Outputs terminated with 50Ω to $V_{CCO} - 2V$.NOTE 2: Single-ended input operation is limited. $V_{CC} \geq 3V$ in LVPECL mode.NOTE 3: V_{IL} should not be less than $V_{EE} - 0.3V$.NOTE 4: Common mode voltage is defined as V_{IH} .**Table 4C. LVPECL DC Characteristics, $V_{CC} = V_{CCO} = 2.5V$; $V_{EE} = 0V$, $T_A = -40^{\circ}C$ to $85^{\circ}C$**

Symbol	Parameter	-40°C			25°C			85°C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OH}	Output High Voltage; NOTE 1	1.375	1.475	1.645	1.425	1.495	1.645	1.415	1.53	1.61	V
V_{OL}	Output Low Voltage; NOTE 1	0.605	0.745	0.90	0.575	0.72	0.845	0.555	0.735	0.83	V
V_{IH}	Input High Voltage (Single-ended)	1.275		1.56	1.275		1.56	1.275		1.56	V
V_{IL}	Input Low Voltage (Single-ended)	0.63		0.965	0.63		0.965	0.63		0.965	V
V_{PP}	Peak-to-Peak Input Voltage; NOTE 2	150	800	1300	150	800	1200	150	800	1200	mV
V_{CMR}	Input High Voltage Common Mode Range; NOTE 2, 3	1.3		2.5	1.2		2.5	1.2		2.5	V
I_{IH}	Input High Current	PCLK0, PCLK1 nPCLK0, nPCLK1		200			200			200	μA
I_{IL}	Input Low Current	PCLK0, PCLK1		-10			-10			-10	μA
		nPCLK0, nPCLK1		-200			-200			-200	μA

NOTE: Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.925V to -0.5V.NOTE 1: Outputs terminated with 50Ω to $V_{CCO} - 2V$.NOTE 2: V_{IL} should not be less than $V_{EE} - 0.3V$.NOTE 3: Common mode voltage is defined as V_{IH} .

Table 4D. ECL DC Characteristics, $V_{CC} = 0V$; $V_{EE} = -3.8V$ to $-2.375V$, $T_A = -40^{\circ}C$ to $85^{\circ}C$

Symbol	Parameter	-40°C			25°C			85°C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OH}	Output High Voltage; NOTE 1	-1.125	-1.025	-0.855	-1.075	-1.005	-0.855	-1.085	-0.97	-0.890	V
V_{OL}	Output Low Voltage; NOTE 1	-1.895	-1.755	-1.60	-1.925	-1.78	-1.655	-1.945	-1.765	-1.67	V
V_{IH}	Input High Voltage (Single-ended)	-1.225		-0.94	-1.225		-0.94	-1.225		-0.94	V
V_{IL}	Input Low Voltage (Single-ended)	-1.87		-1.535	-1.87		-1.535	-1.87		-1.535	V
V_{BB}	Output Voltage Reference; NOTE 2	-1.44		-1.32	-1.44		-1.32	-1.44		-1.32	V
V_{PP}	Peak-to-Peak Input Voltage; NOTE 3	150	800	1300	150	800	1200	150	800	1200	mV
V_{CMR}	Input High Voltage Common Mode Range; NOTE 3, 4	$V_{EE}+1.3$		0	$V_{EE}+1.2$		0	$V_{EE}+1.2$		0	V
I_{IH}	Input High Current	PCLK0, PCLK1 nPCLK0, nPCLK1		200			200			200	μA
I_{IL}	Input Low Current	PCLK0, PCLK1		-10	-10			-10			μA
		nPCLK0, nPCLK1		-200	-200			-200			μA

NOTE: Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.925V to -0.5V.

NOTE 1: Outputs terminated with 50Ω to $V_{CCO} - 2V$.

NOTE 2: Single-ended input operation is limited. $V_{CC} \geq 3V$ in LVPECL mode.

NOTE 3: V_{IL} should not be less than $V_{EE} - 0.3V$.

NOTE 4: Common mode voltage is defined as V_{IH} .

AC Electrical Characteristics

Table 5. AC Characteristics, $V_{CC} = V_{CCO} = -3.8V$ to $-2.375V$ or , $V_{CC} = V_{CCO} = 2.375V$ to $3.8V$; $V_{EE} = 0V$, $T_A = -40^{\circ}C$ to $85^{\circ}C$

Symbol	Parameter		-40°C			25°C			85°C			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
f_{OUT}	Output Frequency				2.5			2.5			2.5	GHz
t_{PD}	Propagation Delay; NOTE 1		375	475	580	395	495	610	425	530	645	ps
$t_{sk(o)}$	Output Skew; NOTE 2, 4			30	50		30	50		30	50	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4			85	150		85	150		85	150	ps
σ_{jit}	Buffer Additive Phase Jitter, RMS; refer to Additive Phase Jitter Section			0.03	0.13		0.03	0.13		0.03	0.13	ps
t_R / t_F	Output Rise/Fall Time	20% to 80%	75	150	220	80	150	215	78	150	235	ps

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE: All parameters are measured at $f \leq 1GHz$, unless otherwise noted.

NOTE 1: Measured from the differential input crossing point to the differential output crossing point.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the output differential cross points.

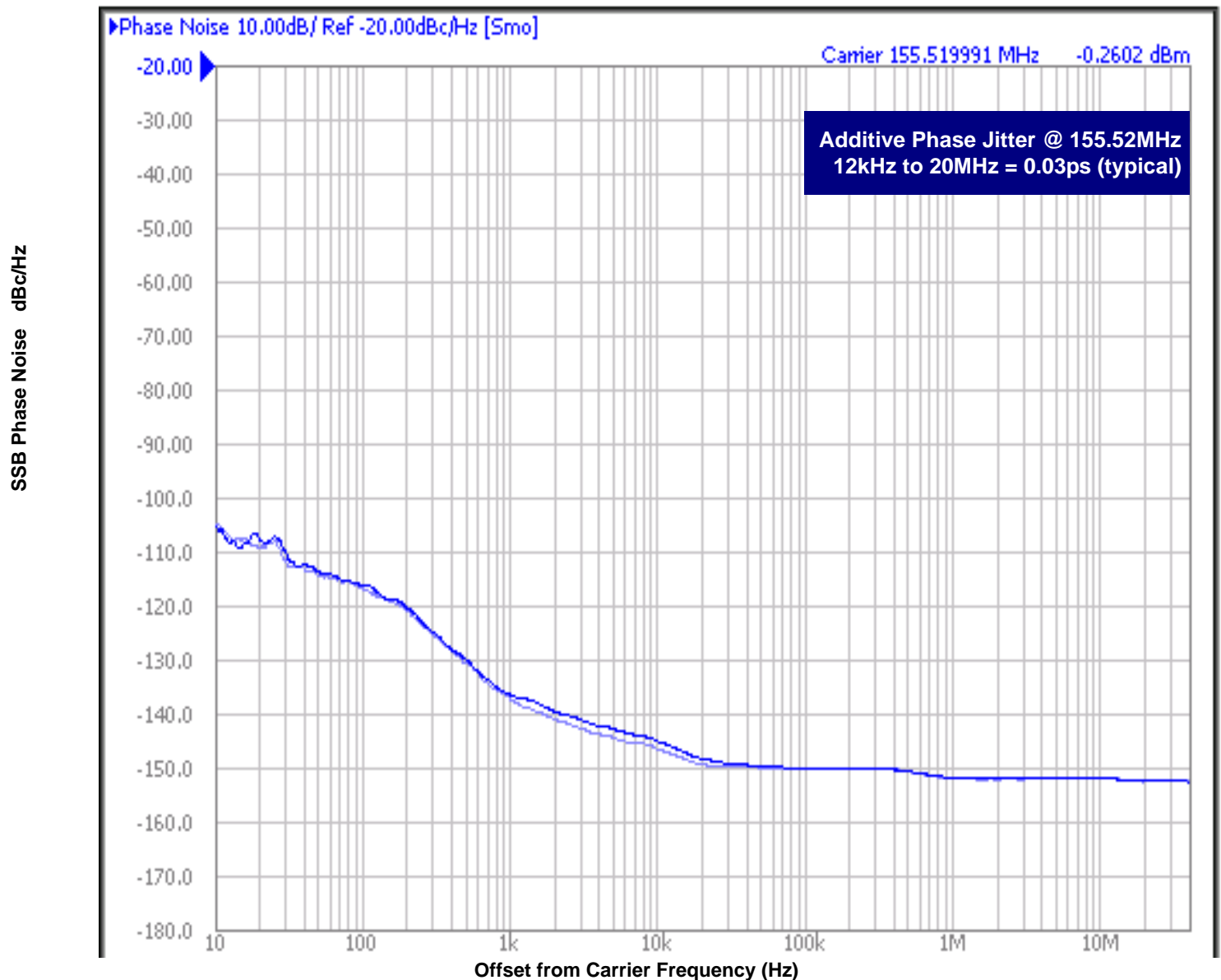
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same temperature, same frequency and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.

Additive Phase Jitter

The spectral purity in a band at a specific offset from the fundamental compared to the power of the fundamental is called the **dBc Phase Noise**. This value is normally expressed using a Phase noise plot and is most often the specified plot in many applications. Phase noise is defined as the ratio of the noise power present in a 1Hz band at a specified offset from the fundamental frequency to the power value of the fundamental. This ratio is expressed in decibels (dBm) or a ratio

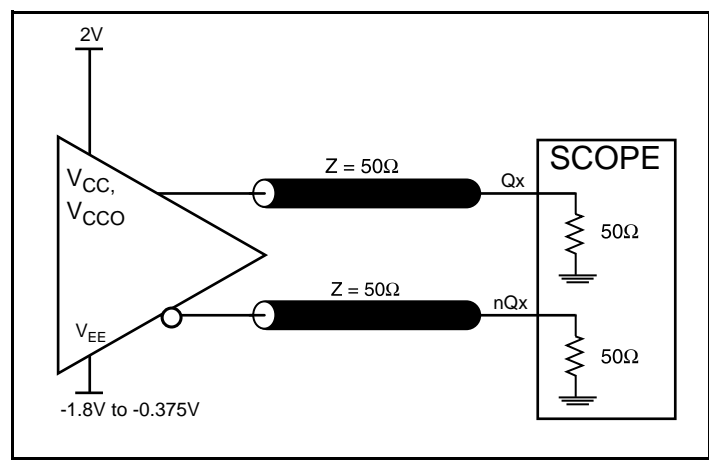
of the power in the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a **dBc** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects on the desired application over the entire time record of the signal. It is mathematically possible to calculate an expected bit error rate given a phase noise plot.



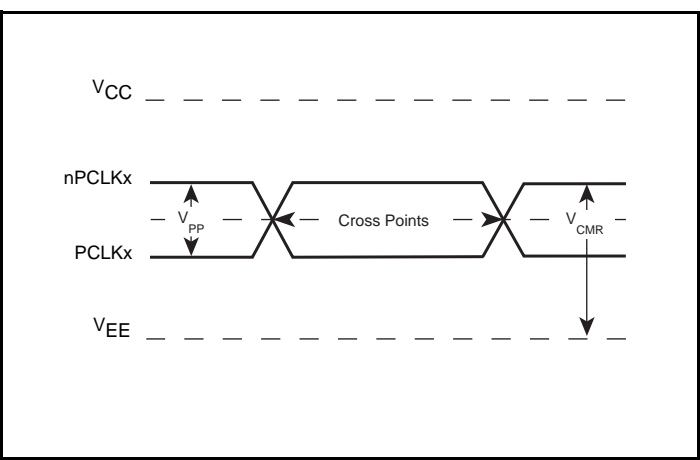
As with most timing specifications, phase noise measurements have issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The device meets the noise floor of what is shown, but can actually be lower. The phase noise is dependent on the input source and measurement equipment.

Rohde & Schwarz SMA100A Signal Generator 9kHz - 6GHz as external input to a Hewlett Packard 8133A 3GHz Pulse Generator.

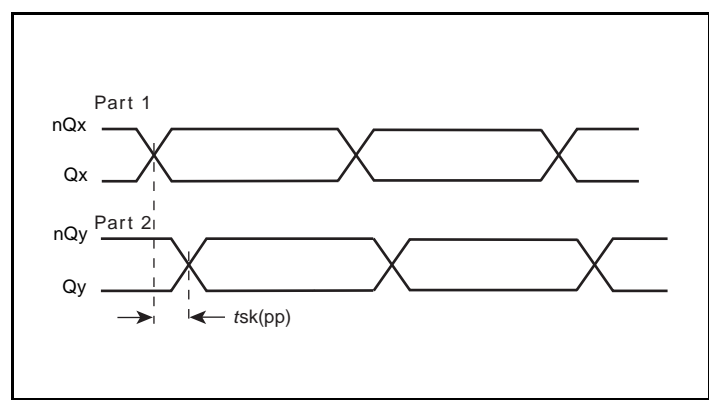
Parameter Measurement Information



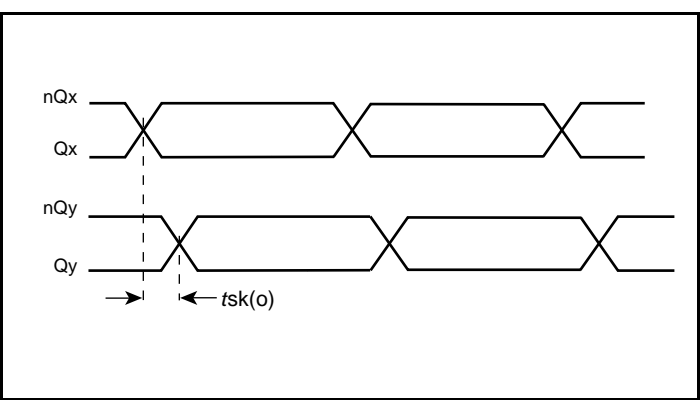
LVPECL Output Load AC Test Circuit



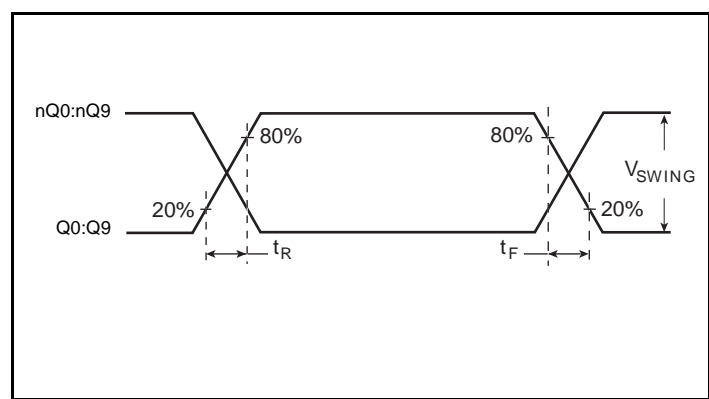
Differential Input Level



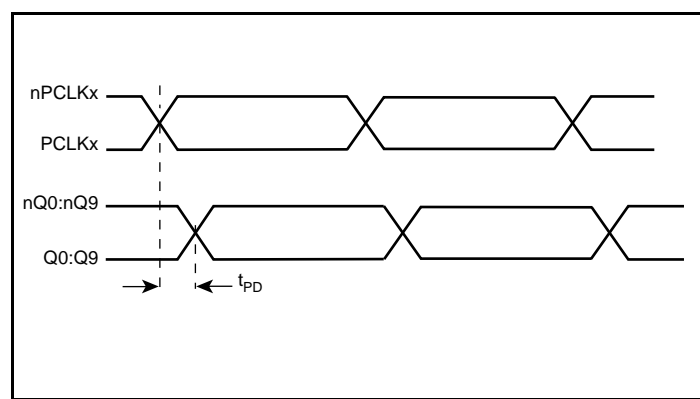
Part-to-Part Skew



Output Skew



Output Rise/Fall Time



Propagation Delay

Applications Information

Wiring the Differential Input to Accept Single-ended LVCMOS Levels

Figure 1 shows how the differential input can be wired to accept single-ended levels. The reference voltage $V_{REF} = V_{CC}/2$ is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin. The ratio of

R1 and R2 might need to be adjusted to position the V_{REF} in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and $V_{CC} = 3.3V$, V_{REF} should be 1.25V and $R2/R1 = 0.609$.

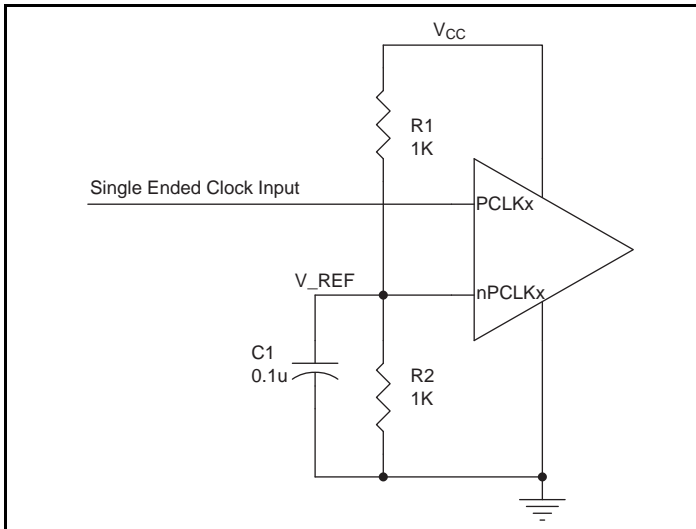


Figure 1. Single-Ended LVCMOS Signal Driving Differential Input

Wiring the Differential Input to Accept Single-ended LVPECL Levels

Figure 2 shows an example of the differential input that can be wired to accept single-ended LVPECL levels. The reference voltage level V_{BB} generated from the device is connected to the negative input.

The C1 capacitor should be located as close as possible to the input pin.

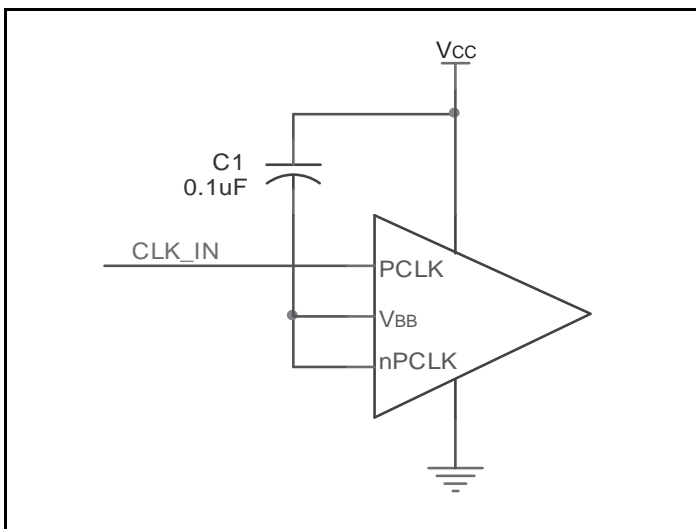


Figure 2. Single-Ended LVPECL Signal Driving Differential Input

LVPECL Clock Input Interface

The PCLK /nPCLK accepts LVPECL, LVDS, SSTL and other differential signals. Both V_{SWING} and V_{OH} must meet the V_{PP} and V_{CMR} input requirements. *Figures 3A to 3D* show interface examples for the PCLK/nPCLK input driven by the most common driver types.

The input interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.

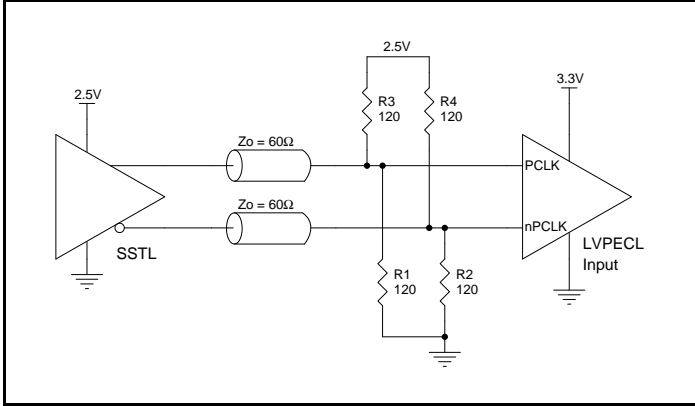


Figure 3A. PCLK/nPCLK Input Driven by an SSTL Driver

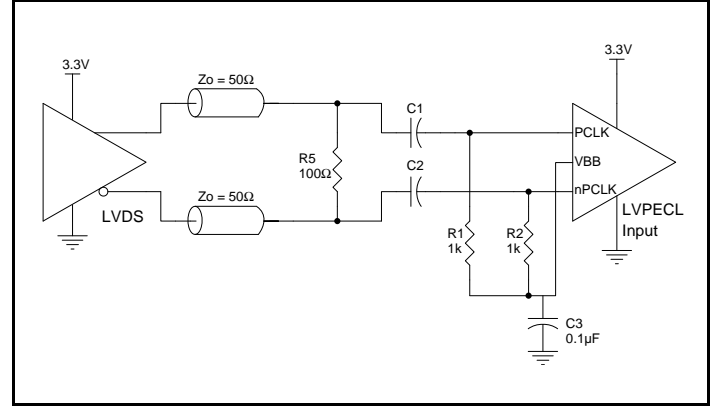


Figure 3B. PCLK/nPCLK Input Driven by a 3.3V LVDS Driver

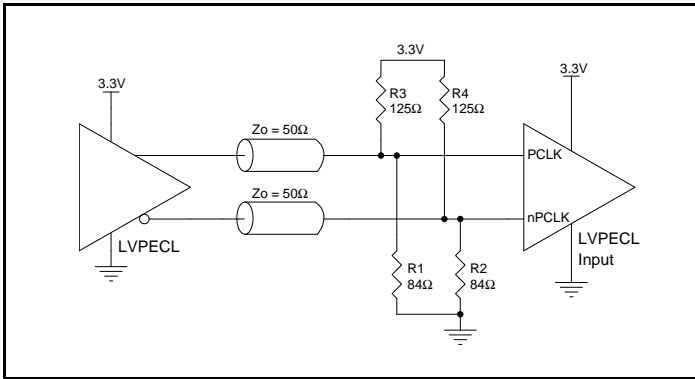


Figure 3C. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver

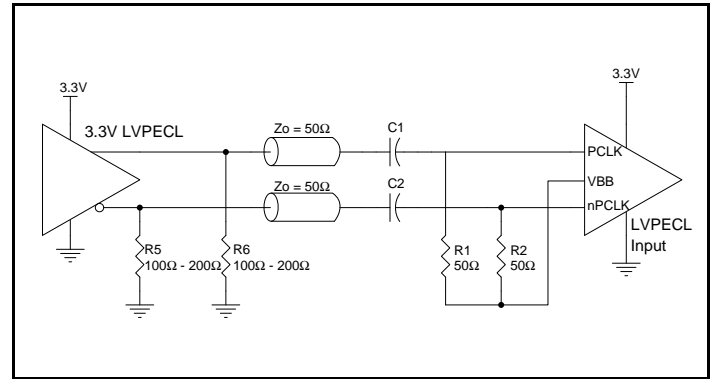


Figure 3D. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver with AC Couple

Recommendations for Unused Output Pins

Inputs:

PCLK/nPCLK Inputs

For applications not requiring the use of a differential input, both the PCLK and nPCLK pins can be left floating. Though not required, but for additional protection, a 1k Ω resistor can be tied from PCLK to ground.

Outputs:

LVPECL Outputs

All unused LVPECL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

Termination for 3.3V LVPECL Outputs

The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

The differential outputs are low impedance follower outputs that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to drive 50 Ω

transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion.

Figures 4A and 4B show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.

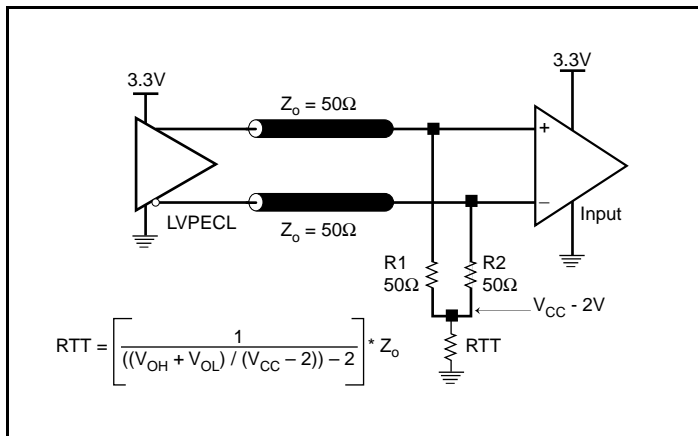


Figure 4A. 3.3V LVPECL Output Termination

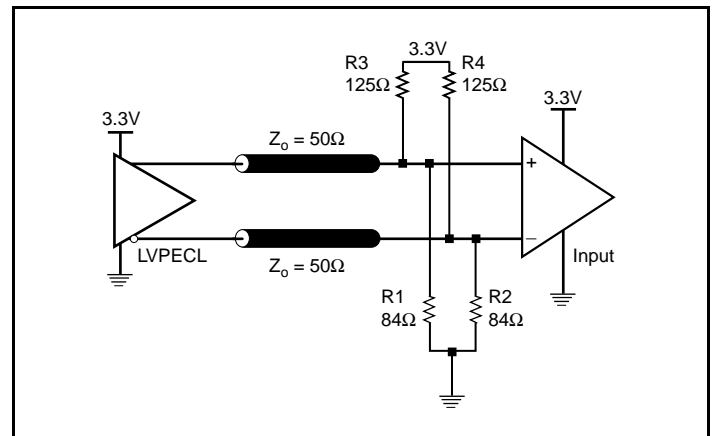


Figure 4B. 3.3V LVPECL Output Termination

Termination for 2.5V LVPECL Outputs

Figure 5A and Figure 5B show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating 50Ω to $V_{CC} - 2V$. For $V_{CC} = 2.5V$, the $V_{CC} - 2V$ is very close to ground

level. The $R3$ in Figure 5B can be eliminated and the termination is shown in Figure 5C.

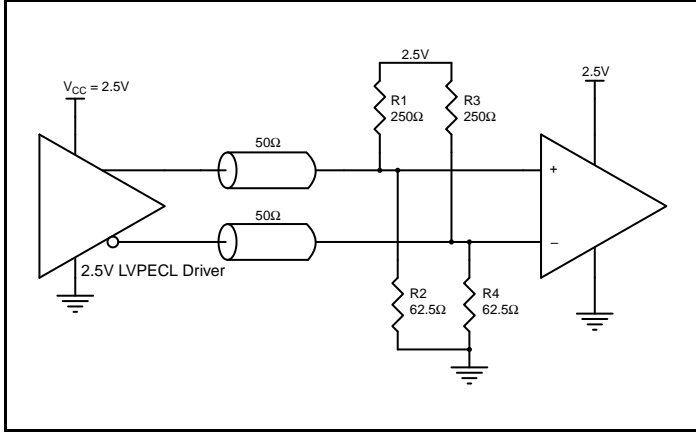


Figure 5A. 2.5V LVPECL Driver Termination Example

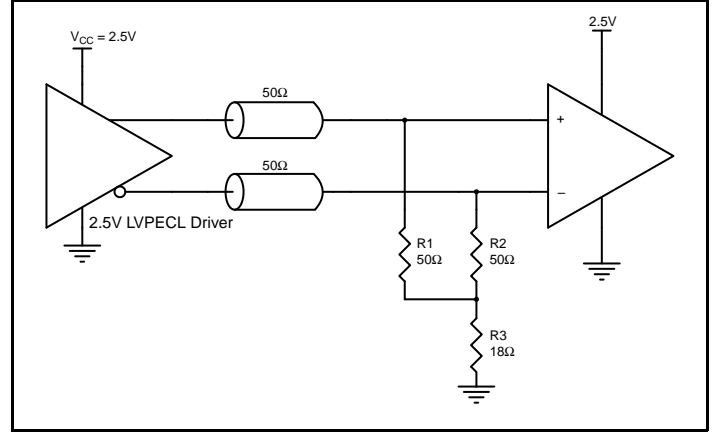


Figure 5B. 2.5V LVPECL Driver Termination Example

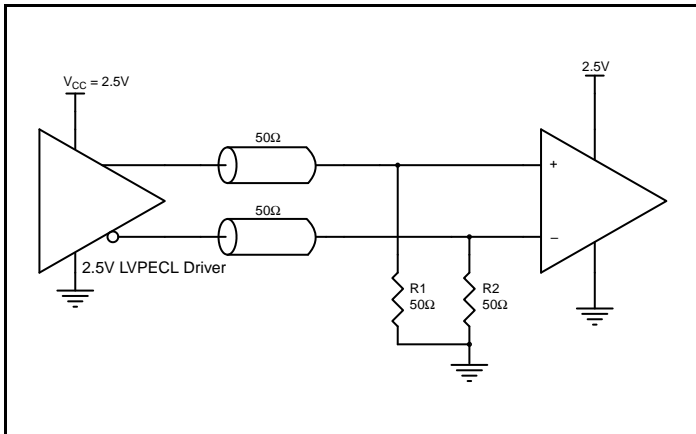


Figure 5C. 2.5V LVPECL Driver Termination Example

TQFP EPAD Thermal Release Path

In order to maximize both the removal of heat from the package and the electrical performance, a land pattern must be incorporated on the Printed Circuit Board (PCB) within the footprint of the package corresponding to the exposed metal pad or exposed heat slug on the package, as shown in *Figure 6*. The solderable area on the PCB, as defined by the solder mask, should be at least the same size/shape as the exposed pad/slug area on the package to maximize the thermal/electrical performance. Sufficient clearance should be designed on the PCB between the outer edges of the land pattern and the inner edges of pad pattern for the leads to avoid any shorts.

While the land pattern on the PCB provides a means of heat transfer and electrical grounding from the package to the board through a solder joint, thermal vias are necessary to effectively conduct from the surface of the PCB to the ground plane(s). The land pattern must be connected to ground through these vias. The vias act as “heat pipes”. The number of vias (i.e. “heat pipes”) are application specific

and dependent upon the package power dissipation as well as electrical conductivity requirements. Thus, thermal and electrical analysis and/or testing are recommended to determine the minimum number needed. Maximum thermal and electrical performance is achieved when an array of vias is incorporated in the land pattern. It is recommended to use as many vias connected to ground as possible. It is also recommended that the via diameter should be 12 to 13mils (0.30 to 0.33mm) with 1oz copper via barrel plating. This is desirable to avoid any solder wicking inside the via during the soldering process which may result in voids in solder between the exposed pad/slug and the thermal land. Precautions should be taken to eliminate any solder voids between the exposed heat slug and the land pattern. Note: These recommendations are to be used as a guideline only. For further information, refer to the Application Note on the *Surface Mount Assembly* of Amkor's Thermally/Electrically Enhance Leadframe Base Package, Amkor Technology.

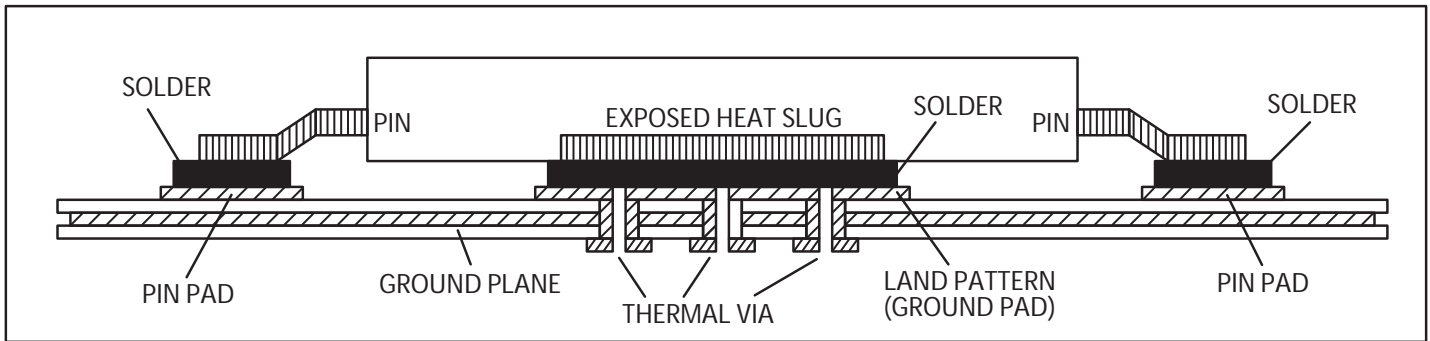


Figure 6. Assembly for Exposed Pad Thermal Release Path - Side View (drawing not to scale)

VFQFN EPAD Thermal Release Path

In order to maximize both the removal of heat from the package and the electrical performance, a land pattern must be incorporated on the Printed Circuit Board (PCB) within the footprint of the package corresponding to the exposed metal pad or exposed heat slug on the package, as shown in *Figure 7*. The solderable area on the PCB, as defined by the solder mask, should be at least the same size/shape as the exposed pad/slug area on the package to maximize the thermal/electrical performance. Sufficient clearance should be designed on the PCB between the outer edges of the land pattern and the inner edges of pad pattern for the leads to avoid any shorts.

While the land pattern on the PCB provides a means of heat transfer and electrical grounding from the package to the board through a solder joint, thermal vias are necessary to effectively conduct from the surface of the PCB to the ground plane(s). The land pattern must be connected to ground through these vias. The vias act as “heat pipes”. The number of vias (i.e. “heat pipes”) are application specific

and dependent upon the package power dissipation as well as electrical conductivity requirements. Thus, thermal and electrical analysis and/or testing are recommended to determine the minimum number needed. Maximum thermal and electrical performance is achieved when an array of vias is incorporated in the land pattern. It is recommended to use as many vias connected to ground as possible. It is also recommended that the via diameter should be 12 to 13mils (0.30 to 0.33mm) with 1oz copper via barrel plating. This is desirable to avoid any solder wicking inside the via during the soldering process which may result in voids in solder between the exposed pad/slug and the thermal land. Precautions should be taken to eliminate any solder voids between the exposed heat slug and the land pattern. Note: These recommendations are to be used as a guideline only. For further information, please refer to the Application Note on the Surface Mount Assembly of Amkor’s Thermally/Electrically Enhance Leadframe Base Package, Amkor Technology.

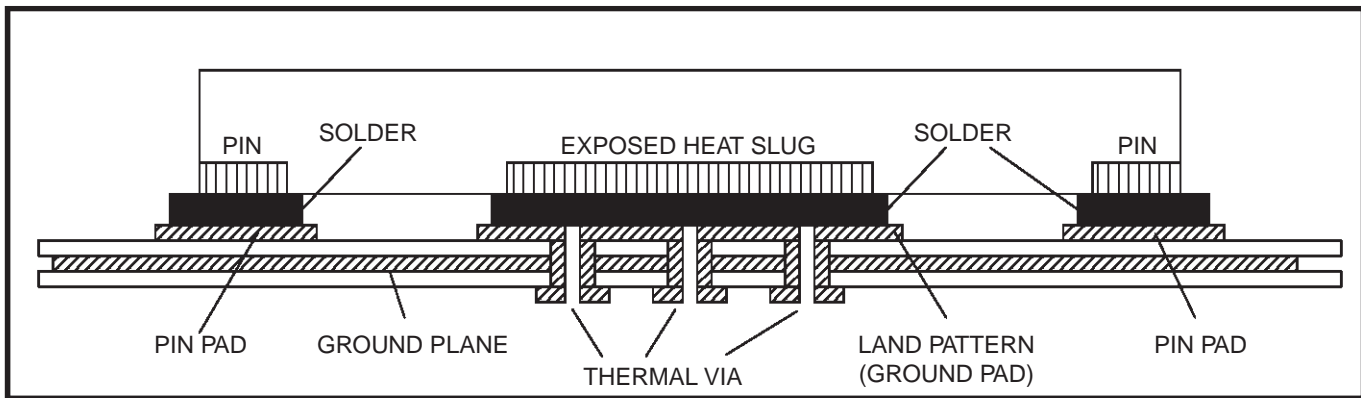


Figure 7. P.C. Assembly for Exposed Pad Thermal Release Path – Side View (drawing not to scale)

Schematic Example

This application note provides a general design guide using ICS853S111BI LVPECL buffer. *Figure 8* shows a schematic example of the ICS853S111BI LVPECL clock buffer. In this example, the input

is driven by an LVPECL driver. CLK_SEL is set at logic high to select PCLK0, nPCLK0 input.

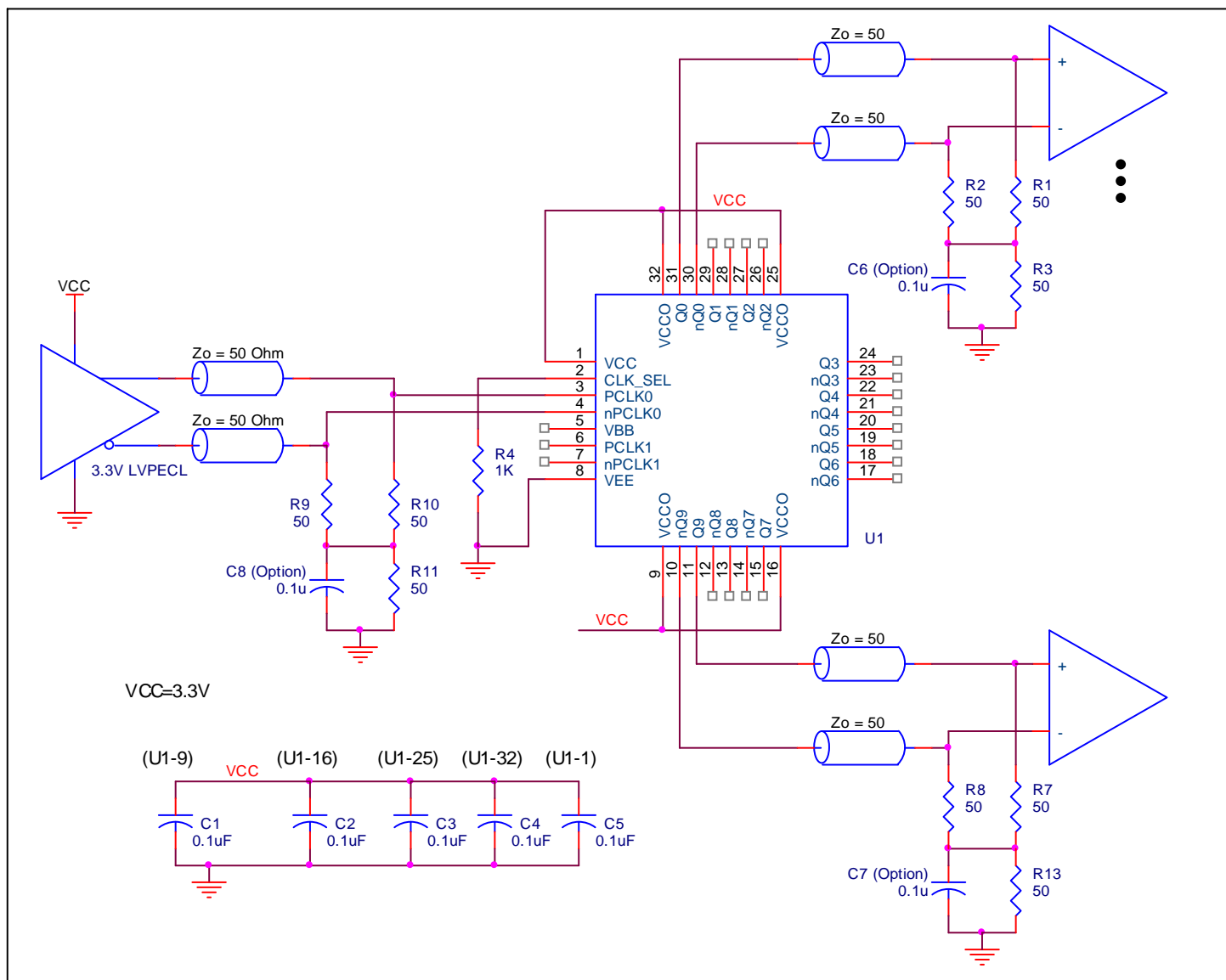


Figure 8. ICS853S111BI Example LVPECL Clock Output Buffer Schematic

Power Considerations

This section provides information on power dissipation and junction temperature for the ICS853S111BI. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the ICS853S111BI is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{CC} = 3.8V$, which gives worst case results.

NOTE: Please refer to Section 3 for details on calculating power dissipated in the load.

- Power (core)_{MAX} = $V_{CC_MAX} * I_{EE_MAX} = 3.8V * 124mA = 471.2mW$
- Power (outputs)_{MAX} = **30.78mW/Loaded Output pair**
If all outputs are loaded, the total power is $10 * 30.78mW = 307.8mW$

Total Power_{MAX} (3.8V, with all outputs switching) = $471.2mW + 307.8mW = 779mW$

2. Junction Temperature.

Junction temperature, T_j , is the temperature at the junction of the bond wire and bond pad, and directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature, T_j , to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for T_j is as follows: $T_j = \theta_{JA} * Pd_{total} + T_A$

T_j = Junction Temperature

θ_{JA} = Junction-to-Ambient Thermal Resistance

Pd_{total} = Total Device Power Dissipation (example calculation is in section 1 above)

T_A = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance θ_{JA} must be used. Assuming no air flow and a multi-layer board, the appropriate value is 42.7°C/W per Table 6B below.

Therefore, T_j for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ C + 0.779W * 42.7^\circ C/W = 118.3^\circ C. \text{ This is well below the limit of } 125^\circ C.$$

This calculation is only an example. T_j will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

Table 6A. Thermal Resistance θ_{JA} for 32 Lead TQFP, E-Pad Forced Convection

θ_{JA} by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	36.2°C/W	30.6°C/W	29.2°C/W

Table 6B. Thermal Resistance θ_{JA} for 32 Lead VFQFN, Forced Convection

θ_{JA} by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	42.7°C/W	37.3°C/W	33.5°C/W

3. Calculations and Equations.

The purpose of this section is to calculate the power dissipation for the LVPECL output pair.

LVPECL output driver circuit and termination are shown in *Figure 9*.

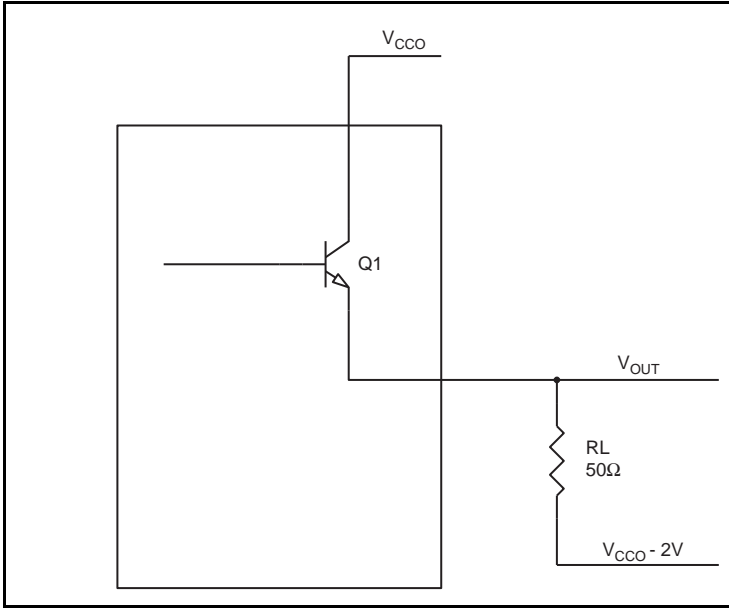


Figure 9. LVPECL Driver Circuit and Termination

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination voltage of $V_{CCO} - 2V$.

- For logic high, $V_{OUT} = V_{OH_MAX} = V_{CCO_MAX} - 0.89V$
 $(V_{CCO_MAX} - V_{OH_MAX}) = 0.89V$
- For logic low, $V_{OUT} = V_{OL_MAX} = V_{CCO_MAX} - 1.67V$
 $(V_{CCO_MAX} - V_{OL_MAX}) = 1.67V$

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$$Pd_H = [(V_{OH_MAX} - (V_{CCO_MAX} - 2V))/R_L] * (V_{CCO_MAX} - V_{OH_MAX}) = [(2V - (V_{CCO_MAX} - V_{OH_MAX}))/R_L] * (V_{CCO_MAX} - V_{OH_MAX}) = [(2V - 0.89V)/50\Omega] * 0.89V = 19.76mW$$

$$Pd_L = [(V_{OL_MAX} - (V_{CCO_MAX} - 2V))/R_L] * (V_{CCO_MAX} - V_{OL_MAX}) = [(2V - (V_{CCO_MAX} - V_{OL_MAX}))/R_L] * (V_{CCO_MAX} - V_{OL_MAX}) = [(2V - 1.67V)/50\Omega] * 1.67V = 11.02mW$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = 30.78mW$$

Reliability Information

Table 7A. θ_{JA} vs. Air Flow Table for a 32 Lead TQFP, E-Pad

θ_{JA} vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	36.2°C/W	30.6°C/W	29.2°C/W

Table 7B. θ_{JA} vs. Air Flow Table for a 32 Lead VFQFN

θ_{JA} vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	42.7°C/W	37.3°C/W	33.5°C/W

Transistor Count

The transistor count for ICS853S111BI is: 448

This device is pin and functional compatible with and is the suggested replacement for the ICS853111B.

Pin compatible with MC100EP111, MC100LVEP111 and ICS853111B.

Package Outline and Package Dimensions

Package Outline - G Suffix for 32 Lead TQFP, E-Pad

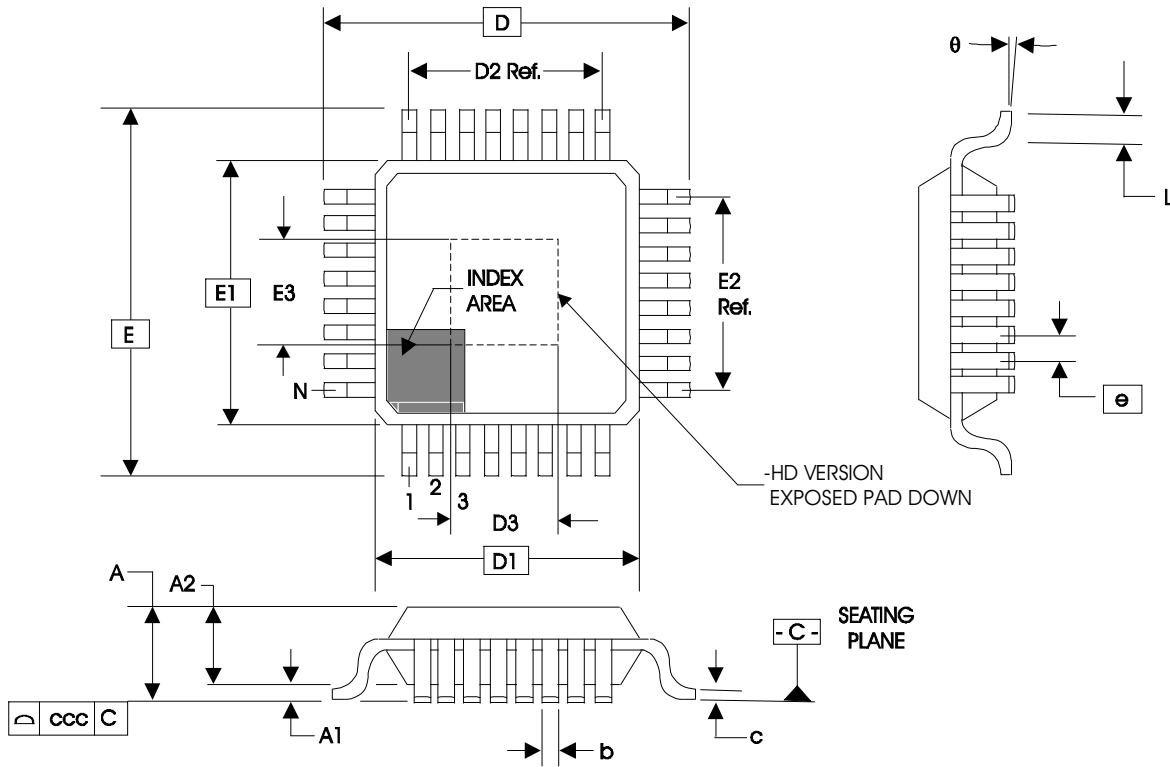


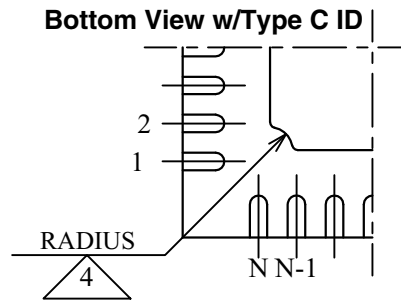
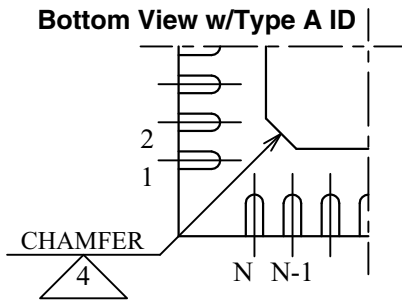
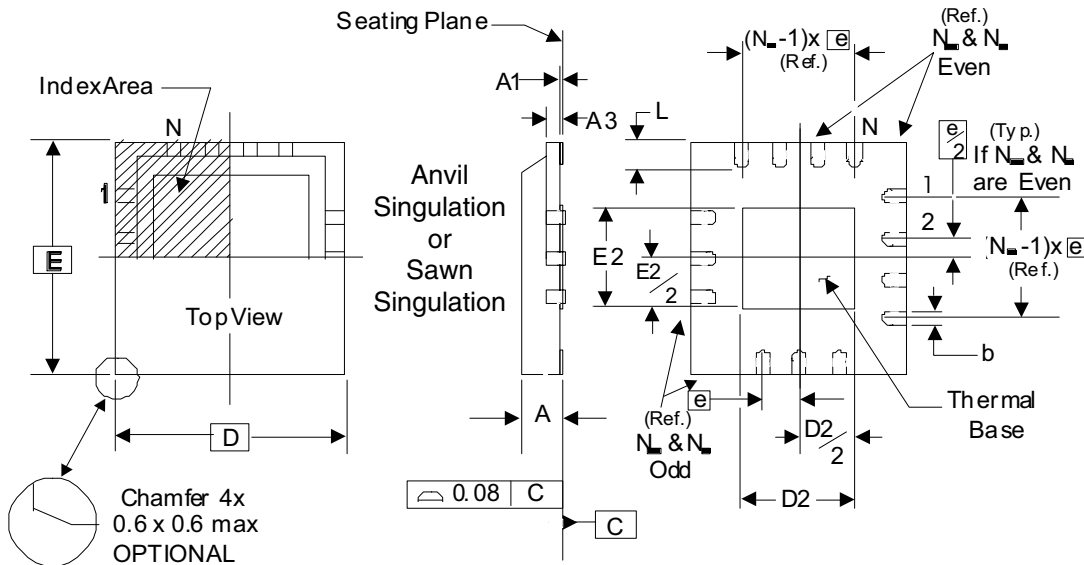
Table 8. Package Dimensions 32 Lead TQFP, E-Pad

JEDEC Variation: ABC - HD All Dimensions in Millimeters			
Symbol	Minimum	Nominal	Maximum
N	32		
A			1.20
A1	0.05	0.10	0.15
A2	0.95	1.00	1.05
b	0.30	0.35	0.40
c	0.09		0.20
D & E	9.00 Basic		
D1 & E1	7.00 Basic		
D2 & E2	5.60 Ref.		
D3 & E3	3.0		4.0
e	0.80 Basic		
L	0.45	0.60	0.75
θ	0°		7°
ccc			0.10

Reference Document: JEDEC Publication 95, MS-026

Package Outline and Package Dimensions

Package Outline - K Suffix for 32 Lead VFQFN



There are 2 methods of indicating pin 1 corner at the back of the VFQFN package are:

1. Type A: Chamfer on the paddle (near pin 1)
2. Type C: Mouse bite on the paddle (near pin 1)

Table 9. Package Dimensions

JEDEC Variation: VHHD-2/-4 All Dimensions in Millimeters			
Symbol	Minimum	Nominal	Maximum
N	32		
A	0.80		1.00
A1	0		0.05
A3	0.25 Ref.		
b	0.18	0.25	0.30
N_D & N_E			8
D & E	5.00 Basic		
D2 & E2	3.0		3.3
e	0.50 Basic		
L	0.30	0.40	0.50

Reference Document: JEDEC Publication 95, MO-220

NOTE: The following package mechanical drawing is a generic drawing that applies to any pin count VFQFN package. This drawing is not intended to convey the actual pin count or pin layout of this device. The pin count and pinout are shown on the front page. The package dimensions are in Table 9.

Ordering Information

Table 10. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
853S111BYILF	ICS53S111BIL	32 Lead TQFP, E-Pad	Tube	-40°C to 85°C
853S111BYILFT	ICS53S111BIL	32 Lead TQFP, E-Pad	1000 Tape & Reel	-40°C to 85°C
853S111BKILF	ICS3S111BIL	32 Lead VFQFN	Tray	-40°C to 85°C
853S111BKILFT	ICS3S111BIL	32 Lead VFQFN	2500 Tape & Reel	-40°C to 85°C

NOTE: Parts that are ordered with an “LF” suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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Revision History Sheet

Rev	Table	Page	Description of Change	Date
B		1	Added 32-Lead VFQFN Pin Assignment and all references throughout the datasheet.	11/18/2011
	T6A	17	Thermal Resistance Table, updated theta ja numbers.	
	T7A	19	Thermal Resistance, updated theta ja numbers.	
	T10	22	Ordering Information Table - added 32-Lead VFQFN ordering information.	
C	T5	7	Added 0.13 value to Max columns for tjit Buffer Additive Phase Jitter, RMS.	4/5/2012

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