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# LOW SKEW, ÷2, ÷4, ÷8 DIFFERENTIAL-TO-LVPECL CLOCK DIVIDER

# ICS873034

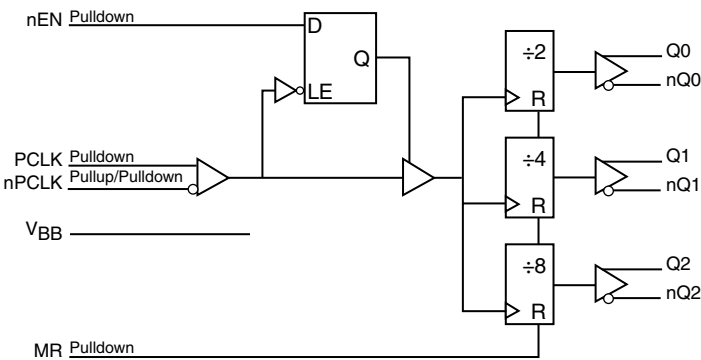
## General Description

 The ICS873034 is a high-speed, differential-to-LVPECL clock divider designed for high-performance telecommunication, computing and networking applications. High clock frequency capability and the differential design make the ICS873034 an ideal choice for performance clock distribution networks. The device frequency-divides the input clock by ÷2, ÷4 and ÷8. Each frequency-divided clock signal is output at a separate LVPECL output. The differential input pair can be driven by LVPECL, LVDS, CML and SSTL signals, single-ended input signals are supported by using the integrated bias voltage generator ( $V_{BB}$ ). The ICS873034 is optimized for 3.3V and 2.5V power supply voltages and the temperature range of -40 to +85°C. The device is available in space-saving 16-lead TSSOP and SOIC packages.

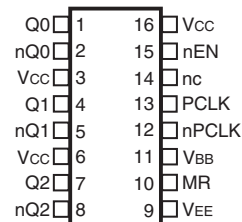
## Features

- ÷2, ÷4 and ÷8 clock frequency divider
- Three differential LVPECL output pairs
- One differential PCLK/nPCLK input pair
- PCLK/nPCLK pair can accept the following differential input levels: LVPECL, LVDS, CML, SSTL
- $V_{BB}$  bias voltage generator supports single-ended LVPECL clock input signals
- LVCMOS control inputs
- Maximum input frequency: 2.8GHz
- Translates any single-ended input signal to 3.3V LVPECL levels with bias resistor on nPCLK input
- LVPECL mode operating voltage supply range:  $V_{CC} = 2.375V$  to  $3.8V$ ,  $V_{EE} = 0V$
- -40°C to 85°C ambient operating temperature
- Available in both standard (RoHS 5) and lead-free (RoHS 6) packages

## Block Diagram



## Pin Assignment



### ICS873034

16-Lead SOIC, 300 Mil

7.5mm x 10.3mm x 2.3mm package body

M Package

Top View

16-Lead TSSOP

4.4mm x 5.0mm x 0.925mm package body

G Package

Top View

**Table 1. Pin Descriptions**

Number	Name	Type		Description
1, 2	nQ0, Q0	Output		Differential output pair. LVPECL interface levels.
3, 6, 16	V <sub>CC</sub>	Power		Power supply pins.
4, 5	Q1, nQ1	Output		Differential output pair. LVPECL interface levels.
7, 8	Q2, nQ2	Output		Differential output pair. LVPECL interface levels.
9	V <sub>EE</sub>	Power		Negative supply pin.
10	MR	Input	Pulldown	Active High Master Reset. When logic HIGH, the internal dividers are reset causing the true outputs Qx to go low and the inverted outputs nQx to go high. When logic LOW, the internal dividers and the outputs are enabled. LVCMOS/LVTTL interface levels.
11	V <sub>BB</sub>	Output		Bias voltage.
12	nPCLK	Input	Pullup/ Pulldown	Inverting differential clock input. Defaults to $0.66 * V_{CC}$ when left open. LVPECL interface levels.
13	PCLK	Input	Pulldown	Non-inverting differential clock input. LVPECL interface levels.
14	nc	Unused		No connect.
15	nEN	Input	Pulldown	Synchronizing clock enable. When LOW, clock outputs follow clock input. When HIGH, Qx outputs are forced LOW, nQx outputs are forced HIGH. LVTTTL / LVCMOS 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 <sub>PULLDOWN</sub>	Input Pulldown Resistor			75		k $\Omega$
R <sub>PULLUP</sub>	Input Pullup Resistor			37.5		k $\Omega$

**Function Table****Table 3. Truth Table**

Inputs			Function
PCLK	nEN	MR	
↓	L	L	Divide
↑	H	L	Hold Q[0:2]
X	X	H	Reset Q[0:2]

↑ = Rising edge transition  
 ↓ = Falling edge transition  
 X = Don't care

## 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, $V_{CC}$	6V (LVPECL mode, $V_{EE} = 0V$ )
Inputs, $V_I$ (LVPECL mode)	-0.5V to $V_{CC} + 0.5V$
Outputs, $I_O$ Continuous Current Surge Current	50mA 100mA
$V_{BB}$ Sink/Source, $I_{BB}$	±0.5mA
Operating Temperature Range, $T_A$	-40°C to +85°C
Package Thermal Impedance, $\theta_{JA}$ 16 Lead SOIC, Junction-to-Ambient 16 Lead TSSOP, Junction-to-Ambient	82°C/W (0 mps) 103°C/W (0 mps)
Storage Temperature, $T_{STG}$	-65°C to 150°C

## DC Electrical Characteristics

**Table 4A. Power Supply DC Characteristics,  $V_{CC} = 2.375V$  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
$I_{EE}$	Power Supply Current				52	mA

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

Symbol	Parameter	-40°C			25°C			80°C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$V_{OH}$	Output High Voltage; NOTE 1	$V_{CC}-1.145$	$V_{CC}-1.020$	$V_{CC}-0.895$	$V_{CC}-1.145$	$V_{CC}-1.020$	$V_{CC}-0.895$	$V_{CC}-1.145$	$V_{CC}-1.020$	$V_{CC}-0.895$	V
$V_{OL}$	Output Low Voltage; NOTE 1	$V_{CC}-1.945$	$V_{CC}-1.700$	$V_{CC}-1.600$	$V_{CC}-1.945$	$V_{CC}-1.700$	$V_{CC}-1.600$	$V_{CC}-1.945$	$V_{CC}-1.700$	$V_{CC}-1.600$	V
$V_{IH}$	Input High Voltage (Single-ended)	$0.7V_{CC}$		$V_{CC} + 0.3$	$0.7V_{CC}$		$V_{CC} + 0.3$	$0.7V_{CC}$		$V_{CC} + 0.3$	V
$V_{IL}$	Input Low Voltage (Single-ended)	-0.3		$0.3V_{CC}$	-0.3		$0.3V_{CC}$	-0.3		$0.3V_{CC}$	V
$V_{BB}$	Output Voltage Reference	$V_{CC} - 1.44$		$V_{CC} - 1.32$	$V_{CC} - 1.44$		$V_{CC} - 1.32$	$V_{CC} - 1.44$		$V_{CC} - 1.32$	V
$V_{PP}$	Peak-to-Peak Input Voltage; NOTE 2	0.15	800		0.15	800		0.15	800		V
$V_{CMR}$	Input High Voltage Common Mode Range; NOTE 2, 3	1.2		$V_{CC}$	1.2		$V_{CC}$	1.2		$V_{CC}$	V
$I_{IH}$	Input High Current			150			150			150	$\mu A$
$I_{IL}$	Input Low Current	PCLK, MR, nEN	-10		-10		-10			-10	$\mu A$
		nPCLK	-150		-150		-150			-150	$\mu A$

Input and output parameters vary 1:1 with  $V_{CC}$ .

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{CC} - 2V$ .

NOTE 2:  $V_{IL}$  cannot be less than -0.3V.

NOTE 3: Common mode voltage is defined as  $V_{IH}$ .

## AC Electrical Characteristics

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

Symbol	Parameter		-40°C			25°C			80°C			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{MAX}$	Output Frequency		2.8			2.8			2.8			GHz
$t_{PD}$	Propagation Delay; NOTE 1		410	510	610	440	540	640	480	580	680	ps
$t_{sk(o)}$	Output Skew; NOTE 2				50			50			50	ps
$t_{RR}$	Set/Reset Recovery			320	500		320	500		320	500	ps
$t_S$	Setup Time	nEN			400			400			400	ps
$t_H$	Hold Time	nEN			200			200			200	ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	105	170	240	110	180	245	120	200	255	ps
odc	Output Duty Cycle		48		52	48		52	48		52	%

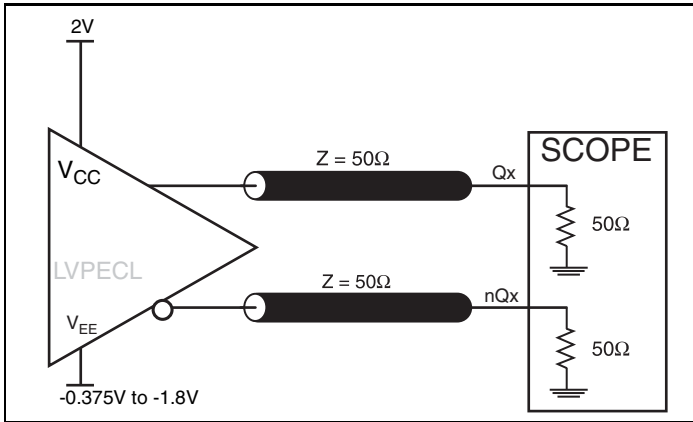
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when device is mounted in a test socket with maintained transverse airflow greater than 500 lpm. Device will meet specifications after thermal equilibrium has been reached under these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

All parameters are measured at  $f \leq 2.5GHz$ , unless otherwise noted.

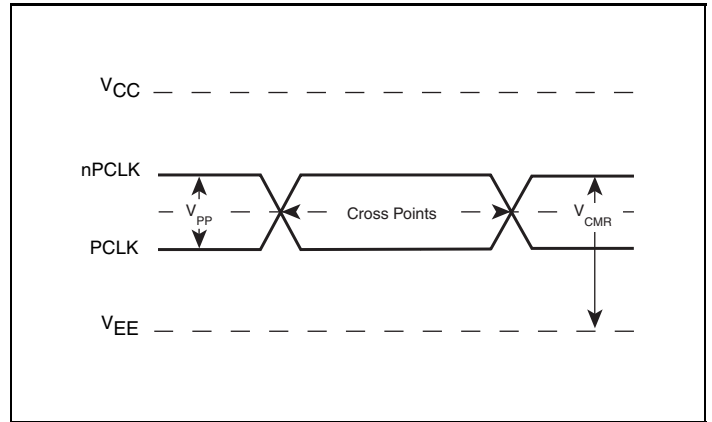
NOTE 1: Measured from the differential input crossing point to the differential output crossing point.

NOTE 2: Output skew at coincident rising edges.

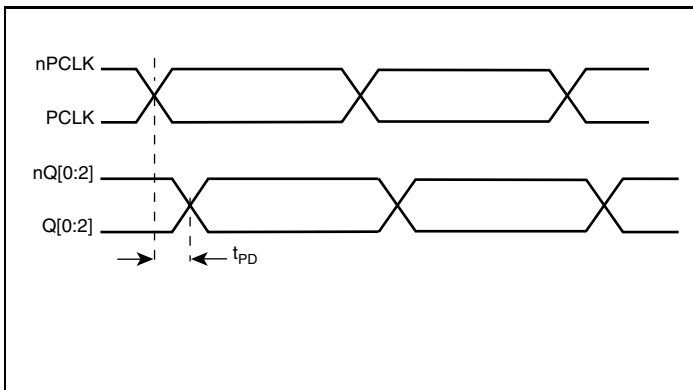
### Parameter Measurement Information



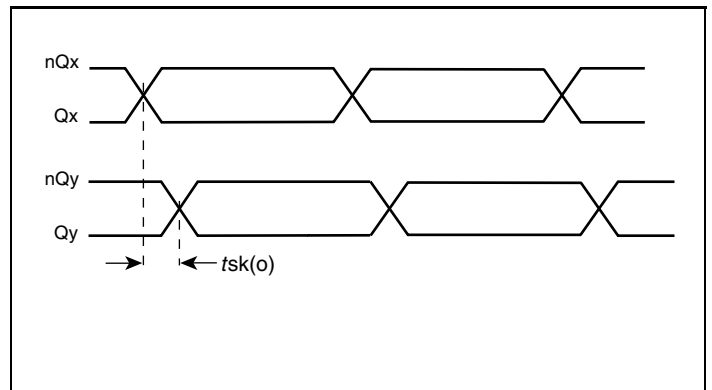
LVPECL Output Load AC Test Circuit



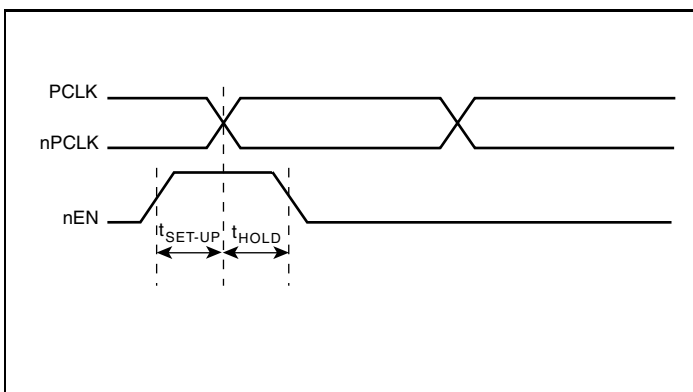
Differential Input Level



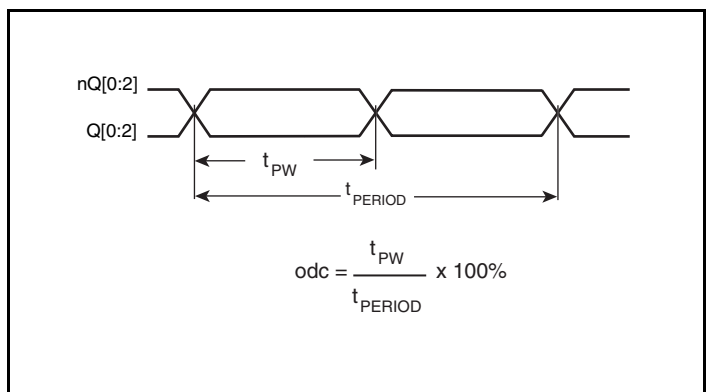
Propagation Delay



Output Skew

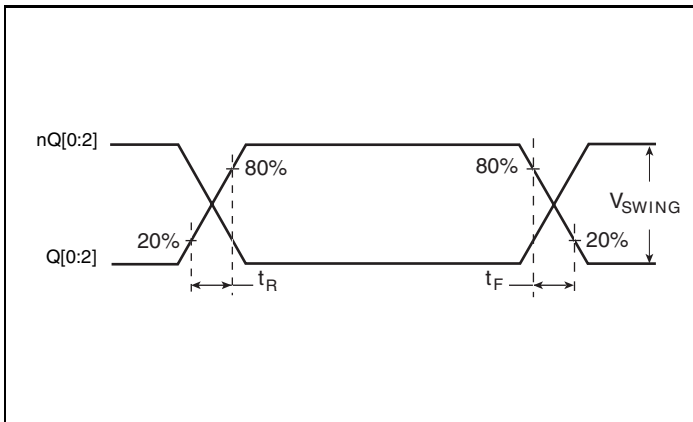


Setup and Hold Time



Output Duty Cycle

## Parameter Measurement Information, continued



Output Rise/Fall Time

## Application Information

### Recommendations for Unused Output Pins

#### Inputs:

##### LVC MOS Control Pins

All control pins have internal pulldowns; additional resistance is not required but can be added for additional protection. A  $1k\Omega$  resistor can be used.

#### 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.

## Wiring the Differential Input to Accept Single-ended LVCMOS Levels

Figure 1A shows an example of the differential input that can be wired to accept single-ended LVCMOS 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.

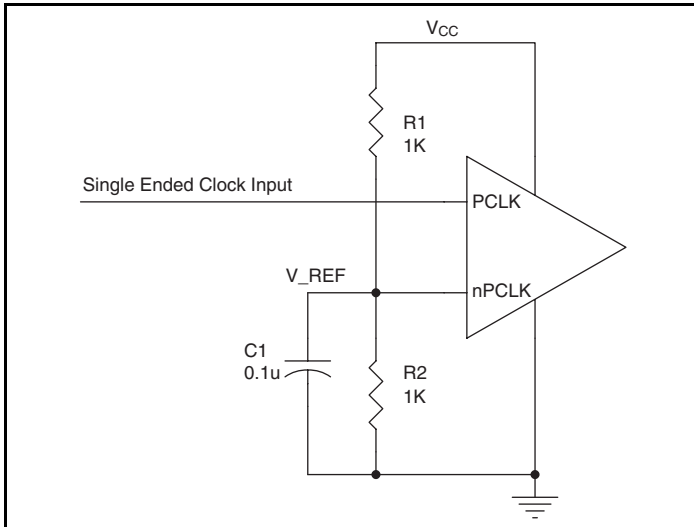


Figure 1A. Single-Ended LVCMOS Signal Driving Differential Input

## Wiring the Differential Input to Accept Single-ended LVPECL Levels

Figure 1B 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.

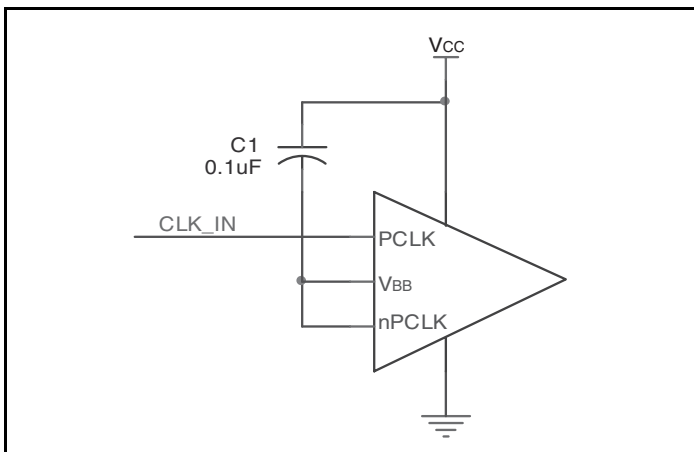
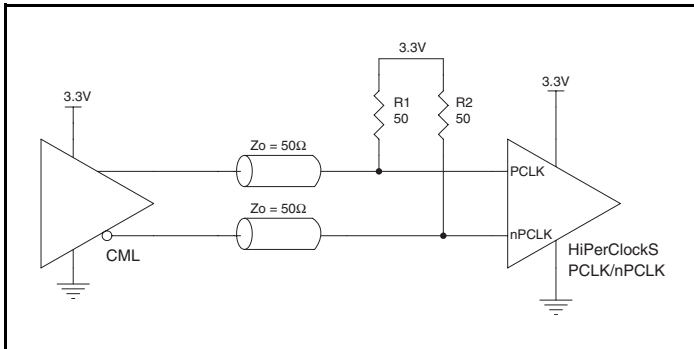


Figure 1B. Single-Ended LVPECL Signal Driving Differential Input

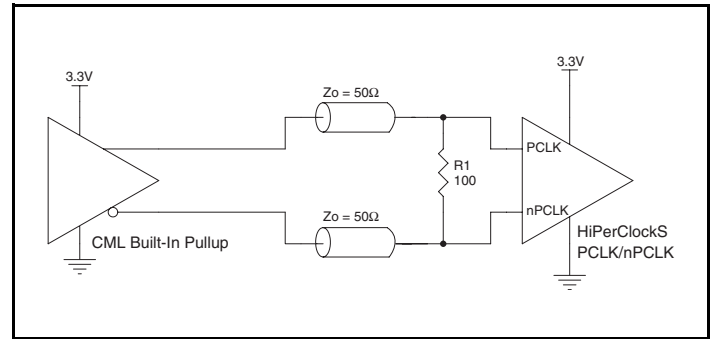
### LVPECL Clock Input Interface

The PCLK/nPCLK accepts LVPECL, LVDS, CML, SSTL and other differential signals. Both  $V_{SWING}$  and  $V_{OH}$  must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. Figures 2A to 2F show interface examples for the HiPerClockS PCLK/nPCLK input driven by the

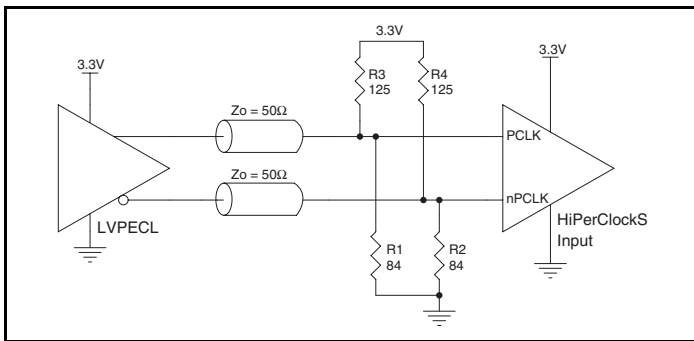
most common driver types. The input interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.



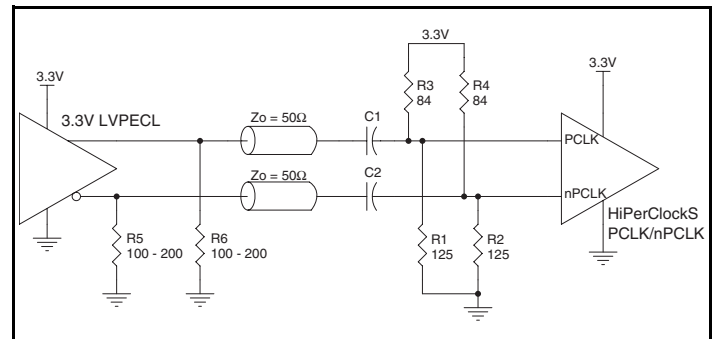
**Figure 2A. HiPerClockS PCLK/nPCLK Input Driven by an Open Collector CML Driver**



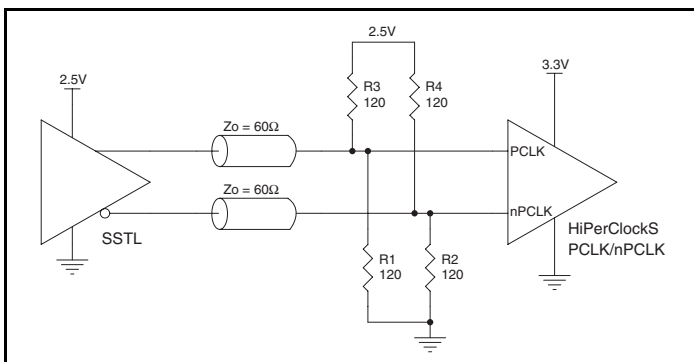
**Figure 2B. HiPerClockS PCLK/nPCLK Input Driven by a Built-In Pullup CML Driver**



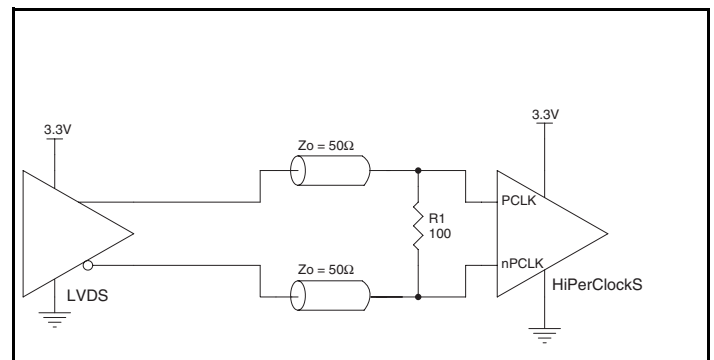
**Figure 2C. HiPerClockS PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver**



**Figure 2D. HiPerClockS PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver with AC Couple**



**Figure 2E. HiPerClockS PCLK/nPCLK Input Driven by an SSTL Driver**



**Figure 2F. HiPerClockS PCLK/nPCLK Input Driven by a 3.3V LVDS Driver**

## 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.

FOUT and nFOUT 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 50Ω

transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion. *Figures 3A and 3B* 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.

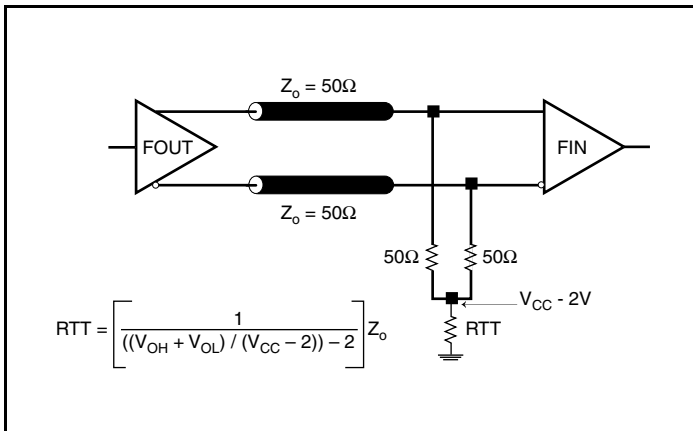


Figure 3A. 3.3V LVPECL Output Termination

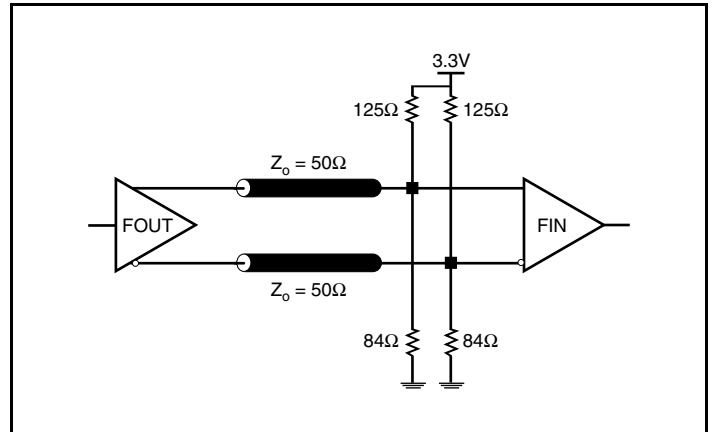


Figure 3B. 3.3V LVPECL Output Termination

## Termination for 2.5V LVPECL Outputs

Figure 4A and Figure 4B show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating  $50\Omega$  to  $V_{CC} - 2V$ . For  $V_{CC} = 2.5V$ , the  $V_{CC} - 2V$  is very close to

ground level. The R3 in Figure 4B can be eliminated and the termination is shown in Figure 4C.

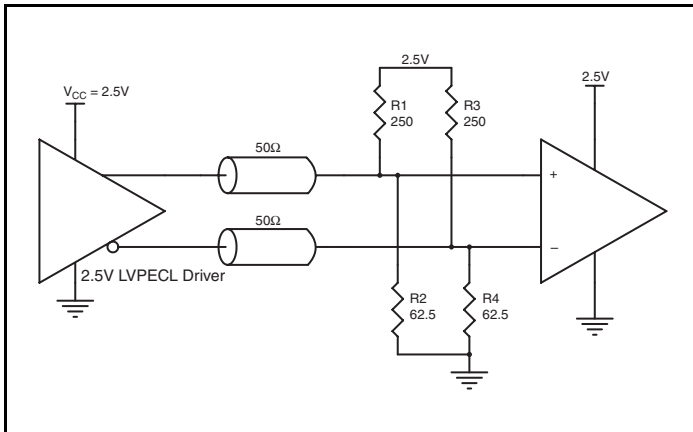


Figure 4A. 2.5V LVPECL Driver Termination Example

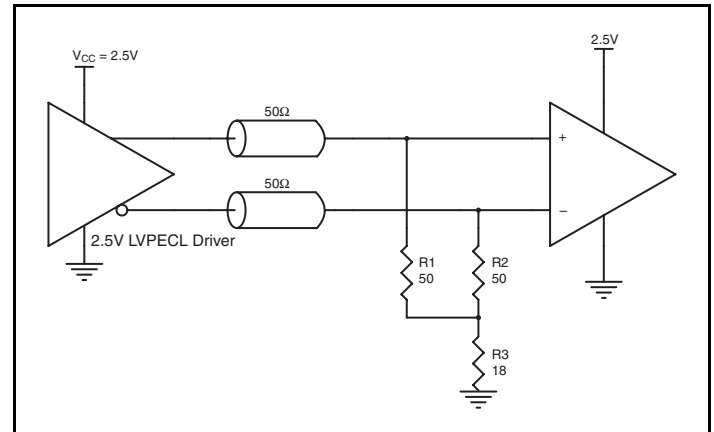


Figure 4B. 2.5V LVPECL Driver Termination Example

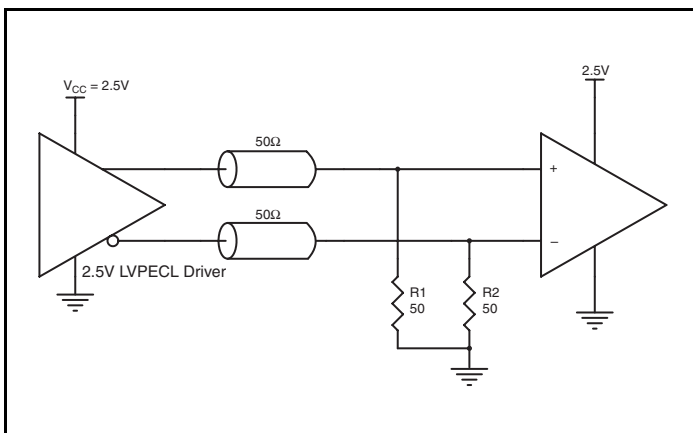


Figure 4C. 2.5V LVPECL Driver Termination Example

### Application Schematic Example

Figure 5 shows an example of ICS873034 application schematic. In this example, the device is operated at  $V_{CC} = 3.3V$ . The decoupling capacitor should be located as close as possible to the power pin. The input is driven by a 3.3V LVPECL driver. For the

LVPECL output drivers, only two terminations examples are shown in this schematic. More termination approaches are shown in the LVPECL Termination Application Note.

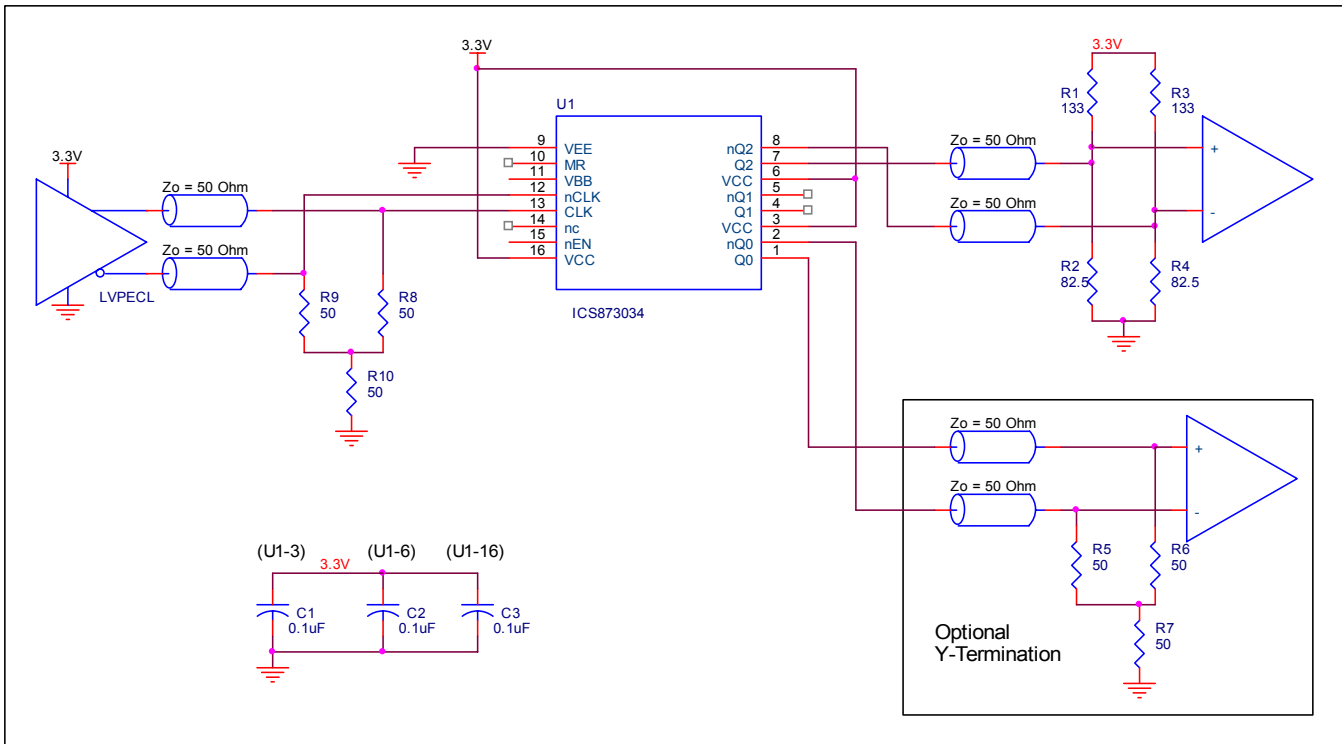


Figure 5. ICS873034 Application Schematic Example

## Power Considerations

This section provides information on power dissipation and junction temperature for the ICS873034. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS873034 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)<sub>MAX</sub> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.8V * 52mA = 197.6mW$
- Power (outputs)<sub>MAX</sub> = **32.58mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $3 * 32.58mW = 97.74mW$

**Total Power**<sub>MAX</sub> (3.8V, with all outputs switching) =  $197.6mW + 97.74mW = 295.34mW$

### 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 for HiPerClockS devices is 125°C.

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

$T_j$  = Junction Temperature

$\theta_{JA}$  = 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  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is 103°C/W per Table 6B below.

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

$$85^\circ\text{C} + 0.295\text{W} * 103^\circ\text{C/W} = 115.4^\circ\text{C}. \text{ This is below the limit of } 125^\circ\text{C}.$$

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  $\theta_{JA}$  for 16 Lead SOIC Forced Convection**

Meters per Second	$\theta_{JA}$ by Velocity		
	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	82.0°C/W	75.6°C/W	72.0°C/W

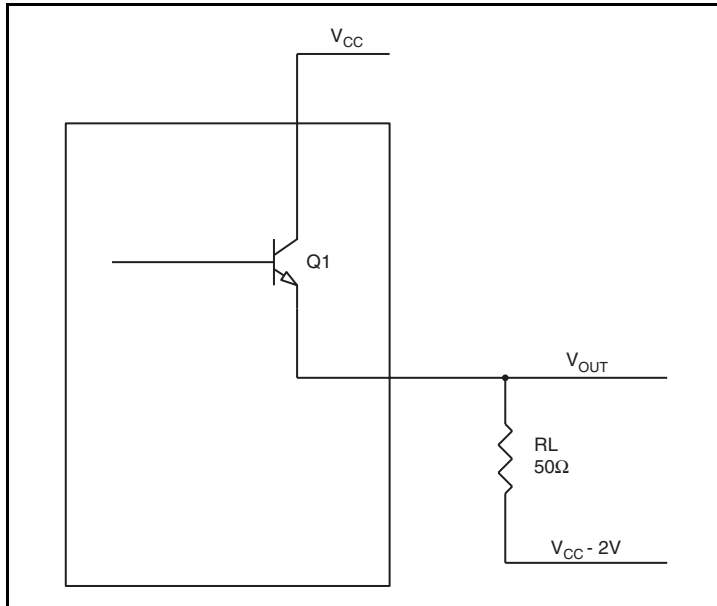
**Table 6B. Thermal Resistance  $\theta_{JA}$  for 16 Lead TSSOP Forced Convection**

Meters per Second	$\theta_{JA}$ by Velocity		
	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	103.0°C/W	97.6°C/W	93.8°C/W

### 3. Calculations and Equations.

The purpose of this section is to derive the power dissipated into the load.

LVPECL output driver circuit and termination are shown in *Figure 6*.



**Figure 6. 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  $V_{CC} - 2V$ .

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CC\_MAX} - 0.895V$   
 $(V_{CC\_MAX} - V_{OH\_MAX}) = 0.895V$
- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CC\_MAX} - 1.6V$   
 $(V_{CC\_MAX} - V_{OL\_MAX}) = 1.6V$

$Pd\_H$  is power dissipation when the output drives high.

$Pd\_L$  is the power dissipation when the output drives low.

$$Pd\_H = [(V_{OH\_MAX} - (V_{CC\_MAX} - 2V))/R_L] * (V_{CC\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CC\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CC\_MAX} - V_{OH\_MAX}) = [(2V - 0.895V)/50\Omega] * 0.895V = 19.78mW$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CC\_MAX} - 2V))/R_L] * (V_{CC\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CC\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CC\_MAX} - V_{OL\_MAX}) = [(2V - 1.6V)/50\Omega] * 1.6V = 12.8mW$$

$$\text{Total Power Dissipation per output pair} = Pd\_H + Pd\_L = 32.58mW$$

## Reliability Information

**Table 7A.  $\theta_{JA}$  vs. Air Flow Table for an 16 Lead SOIC**

$\theta_{JA}$ vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	82.0°C/W	75.6°C/W	72.0°C/W

**Table 7B.  $\theta_{JA}$  vs. Air Flow Table for an 16 Lead TSSOP Forced Convection**

$\theta_{JA}$ by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	103.0°C/W	97.6°C/W	93.8°C/W

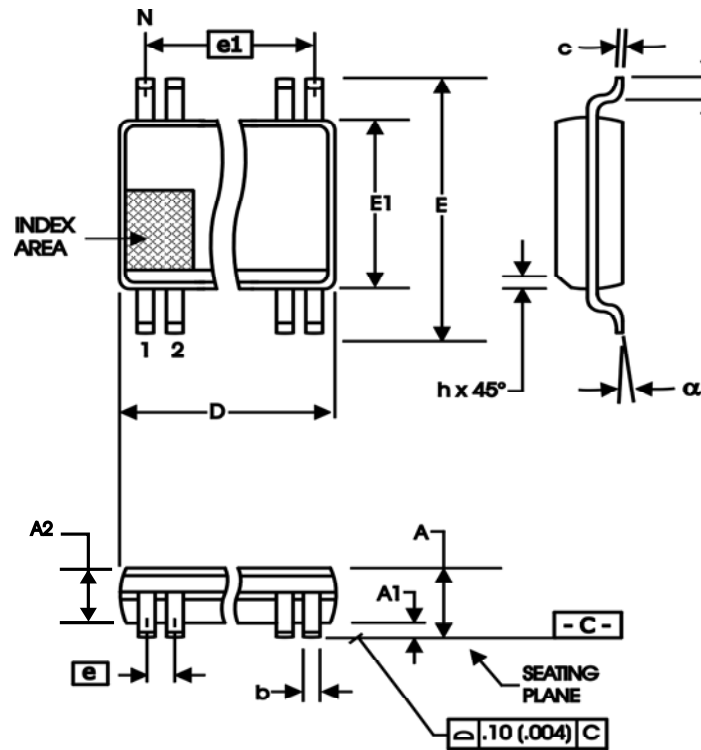
## Transistor Count

The transistor count for ICS873034 is: 280

Pin compatible with MC100LVEP34

## Package Outlines and Package Dimensions

Package Outline - G Suffix for 16 Lead TSSOP



Package Outline - M Suffix for 16 Lead SOIC

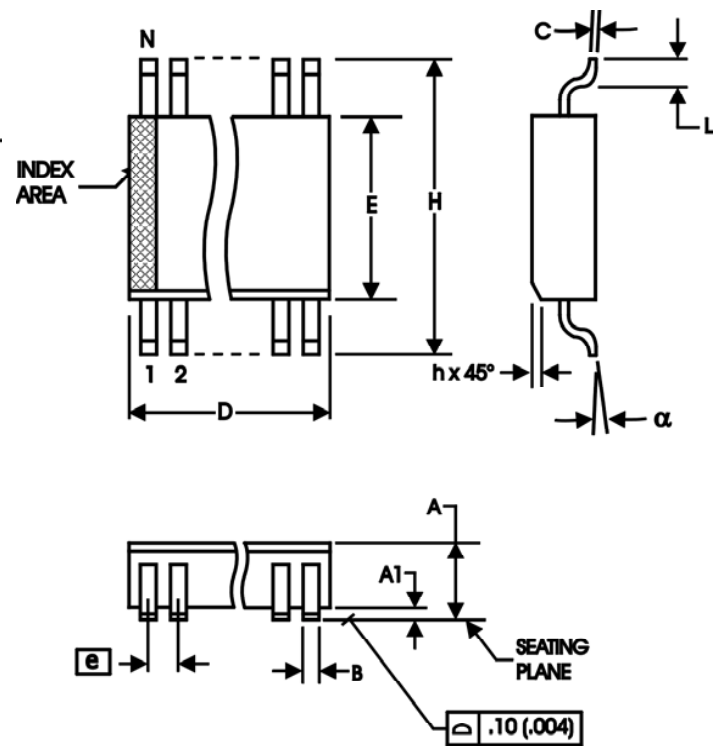


Table 8A. Package Dimensions

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	16	
A		1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	4.90	5.10
E	6.40 Basic	
E1	4.30	4.50
e	0.65 Basic	
L	0.45	0.75
$\alpha$	0°	8°
aaa		0.10

Reference Document: JEDEC Publication 95, MO-153

Table 8B. Package Dimensions

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	16	
A		2.65
A1	0.10	
A2	2.05	2.55
B	0.33	0.51
C	0.18	0.32
D	10.10	10.50
E	7.40	7.60
e	1.27 Basic	
H	10.0	10.65
h	0.25	0.75
L	0.40	1.27
$\alpha$	0°	8°

Reference Document: JEDEC Publication 95, MS-013, MS-119

## Ordering Information

Table 9. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
873034AM	873034AM	16 Lead SOIC	Tube	-40°C to 85°C
873034AMT	873034AM	16 Lead SOIC	1000 Tape & Reel	-40°C to 85°C
873034AMLF	873034AMLF	"Lead-Free" 16 Lead SOIC	Tube	-40°C to 85°C
873034AMLFT	873034AMLF	"Lead-Free" 16 Lead SOIC	1000 Tape & Reel	-40°C to 85°C
873034AG	873034AG	16 Lead TSSOP	Tube	-40°C to 85°C
873034AGT	873034AG	16 Lead TSSOP	2500 Tape & Reel	-40°C to 85°C
873034AGLF	873034AGL	"Lead-Free" 16 Lead TSSOP	Tube	-40°C to 85°C
873034AGFT	873034AGL	"Lead-Free" 16 Lead TSSOP	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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ICS873034

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