



Integrated
Circuit
Systems, Inc.

PRELIMINARY

ICS873032

**HIGH SPEED, ÷2 DIFFERENTIAL-TO-
3.3V, 5V LVPECL/ECL CLOCK GENERATOR**

GENERAL DESCRIPTION

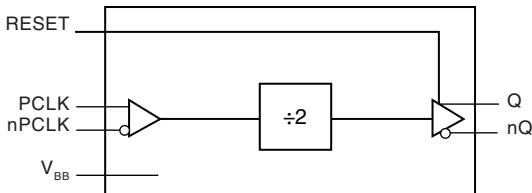


The ICS873032 is a high speed, high performance Differential-to-3.3V, 5V LVPECL/ECL Clock Generator and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS873032 is characterized to operate from either a 3.3V for a 5V power supply.

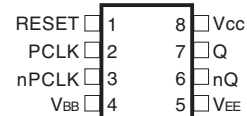
FEATURES

- 1 differential 3.3V, 5V LVPECL / ECL output
- 1 differential PCLK, nPCLK input pair
- PCLK, nPCLK pair can accept the following differential input levels: LVPECL, LVDS, CML, SSTL
- Input frequency: 4GHz
- Translates any single ended input signal to 3.3V LVPECL levels with resistor bias on nPCLK input
- LVPECL mode operating voltage supply range: $V_{CC} = 3.0V$ to $5.5V$, $V_{EE} = 0V$
- ECL mode operating voltage supply range: $V_{CC} = 0V$, $V_{EE} = -5.5V$ to $-3.0V$
- $-40^{\circ}C$ to $85^{\circ}C$ ambient operating temperature
- Pin compatible with MC100EP32

BLOCK DIAGRAM



PIN ASSIGNMENT



ICS873032
8-Lead SOIC

3.90mm x 4.90mm x 1.37mm package body

M Package
Top View

ICS873032

8-Lead TSSOP, 118 mil

3mm x 3mm x 0.95mm package body

G Package
Top View

The Preliminary Information presented herein represents a product in prototyping or pre-production. The noted characteristics are based on initial product characterization. Integrated Circuit Systems, Incorporated (ICS) reserves the right to change any circuitry or specifications without notice.



TABLE 1. PIN DESCRIPTIONS

Number	Name	Type	Description	
1	RESET	Input	Pulldown	Reset pin. Single-ended 100h LVPECL interface levels.
2	PCLK	Input	Pulldown	Clock input. Default LOW when left floating. LVPECL interface levels.
3	nPCLK	Input	Pulldown	Clock input. LVPECL interface levels.
4	V _{BB}	Output		Bias voltage.
5	V _{EE}	Power		Negative supply pin.
6, 7	nQ, Q	Output		Differential output pair. LVPECL interface levels.
8	V _{CC}	Power		Positive supply pin.

NOTE: *Pulldown* refers 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

TABLE 3. TRUTH TABLE

Inputs			Outputs	
PCLK	nPCLK	RESET	Q	nQ
X	X	Z	L	H
Z	nZ	L	F	F

Z = LOW to HIGH transition
nZ = HIGH to LOW transition
F = Divide by 2 Function

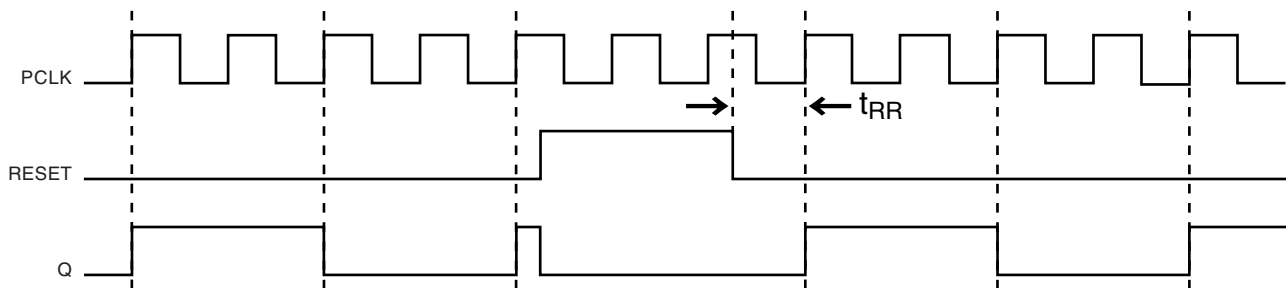


FIGURE 1. TIMING DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC}	6V (LVPECL mode, $V_{EE} = 0$)
Negative Supply Voltage, V_{EE}	-6V (ECL mode, $V_{CC} = 0$)
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	50mA
Surge Current	100mA
V_{BB} Sink/Source, I_{BB}	$\pm 0.5mA$
Operating Temperature Range, T_A	-40°C to +85°C
Storage Temperature, T_{STG}	-65°C to 150°C
Package Thermal Impedance, θ_{JA}	112.7°C/W (0 lfpm) (Junction-to-Ambient) for 8 Lead SOIC
Package Thermal Impedance, θ_{JA}	101.7°C/W (0 m/s) (Junction-to-Ambient) for 8 Lead TSSOP

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.

TABLE 4A. POWER SUPPLY DC CHARACTERISTICS, $V_{CC} = 3.0V$ TO $5.5V$; $V_{EE} = 0V$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{CC}	Positive Supply Voltage		3.0	3.3	5.5	V
I_{EE}	Power Supply Current			22		mA

TABLE 4B. LVPECL DC CHARACTERISTICS, $V_{CC} = 3.3V$; $V_{EE} = 0V$

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	2.38	2.225	2.295	2.37	2.295	2.33	2.365	V
V_{OL}	Output Low Voltage; NOTE 1	1.405	1.545	1.68	1.425	1.52	1.615	1.44	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	1.86		1.98	1.86		1.98	1.86		1.98	V
V_{PP}	Peak-to-Peak Input Voltage	150	800	1200	150	800	1200	150	800	1200	mV
V_{CMR}	Input High Voltage Common Mode Range; NOTE 2, 3	1.2		3.3	1.2		3.3	1.2		3.3	V
I_{IH}	Input High Current			150			150			150	µA
I_{IL}	Input Low Current										µA

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 $V_{CC} - 2V$.

NOTE 2: Common mode voltage is defined as V_{IH} .

NOTE 3: For single-ended applications, the maximum input voltage for PCLK, nPCLK is $V_{CC} + 0.3V$.



TABLE 4C. LVPECL DC CHARACTERISTICS, $V_{CC} = 5V$; $V_{EE} = 0V$

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	3.875	3.975	4.08	3.925	3.995	4.07	3.995	4.03	4.065	V
V_{OL}	Output Low Voltage; NOTE 1	3.105	3.245	3.38	3.125	3.22	3.315	3.14	3.235	3.33	V
V_{IH}	Input High Voltage(Single-Ended)	3.775		4.06	3.775		4.06	3.775		4.06	V
V_{IL}	Input Low Voltage(Single-Ended)	3.13		3.465	3.13		3.465	3.13		3.465	V
V_{BB}	Output Voltage Reference	3.56		3.68	3.56		3.68	3.56		3.68	V
V_{PP}	Peak-to-Peak Input Voltage	150	800	1200	150	800	1200	150	800	1200	mV
V_{CMR}	Input High Voltage Common Mode Range; NOTE 2, 3	1.2		5	1.2		5	1.2		5	V
I_{IH}	Input High Current	PCLK, nPCLK		150			150			150	μA
I_{IL}	Input Low Current	PCLK, nPCLK		-10			-10			-10	μA

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 $V_{CC} - 2V$.

NOTE 2: Common mode voltage is defined as V_{IH} .

NOTE 3: For single-ended applications, the maximum input voltage for PCLK, nPCLK is $V_{CC} + 0.3V$.

TABLE 4D. ECL DC CHARACTERISTICS, $V_{CC} = 0V$; $V_{EE} = -5.5V$ TO $-3.0V$

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	-0.92	-1.075	-1.005	-0.93	-1.005	-0.97	-0.935	V
V_{OL}	Output Low Voltage; NOTE 1	-1.895	-1.755	-1.62	-1.875	-1.78	-1.685	-1.86	-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	-1.44		-1.32	-1.44		-1.32	-1.44		-1.32	V
V_{PP}	Peak-to-Peak Input Voltage	150	800	1200	150	800	1200	150	800	1200	mV
V_{CMR}	Input High Voltage Common Mode Range; NOTE 2, 3	$V_{EE} + 1.2V$		0	$V_{EE} + 1.2V$		0	$V_{EE} + 1.2V$		0	V
I_{IH}	Input High Current	PCLK, nPCLK		150			150			150	μA
I_{IL}	Input Low Current	PCLK, nPCLK		-10			-10			-10	μA

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 $V_{CC} - 2V$.

NOTE 2: Common mode voltage is defined as V_{IH} .

NOTE 3: For single-ended applications, the maximum input voltage for PCLK, nPCLK is $V_{CC} + 0.3V$.



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TABLE 5. AC CHARACTERISTICS, $V_{CC} = 0V$; $V_{EE} = -5.5V$ TO $-3.0V$ OR $V_{CC} = 3.0$ TO $5.5V$; $V_{EE} = 0V$

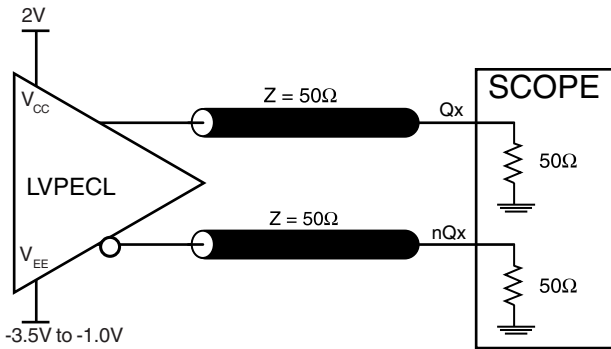
Symbol	Parameter		-40°C			25°C			85°C			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
f_{MAX}	Input Frequency			TBD			4			TBD		GHz
t_{PD}	Propagation Delay; NOTE 1			TBD			400			TBD		ps
t_{RR}	Set/Reset Recovery			TBD			175			TBD		ps
t_R/t_F	Output Rise/Fall Time	20% to 80%		TBD			160			TBD		ps
t_{PW}	Pulse Width	RESET		TBD			500			TBD		ps

All parameters are measured at $f \leq 1.7GHz$, unless otherwise noted.

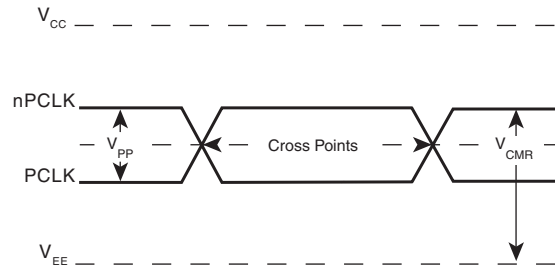
NOTE 1: Measured from the differential input crossing point to the differential output crossing point.



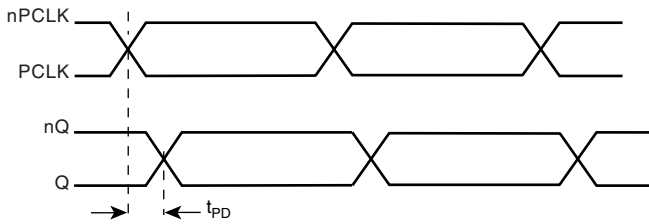
PARAMETER MEASUREMENT INFORMATION



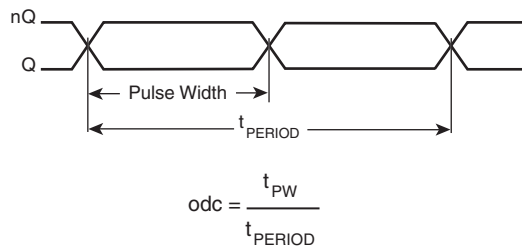
OUTPUT LOAD AC TEST CIRCUIT



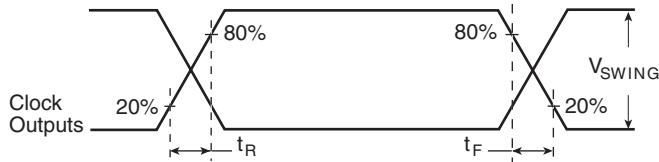
DIFFERENTIAL INPUT LEVEL



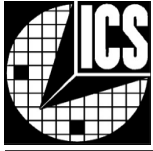
PROPAGATION DELAY



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



OUTPUT RISE/FALL TIME

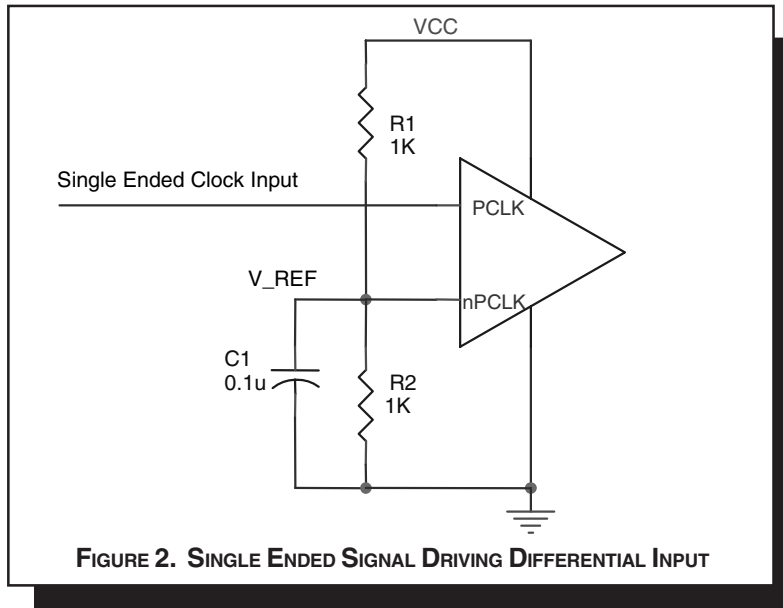


APPLICATION INFORMATION

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 2 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.

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 $R2/R1 = 0.609$.



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.

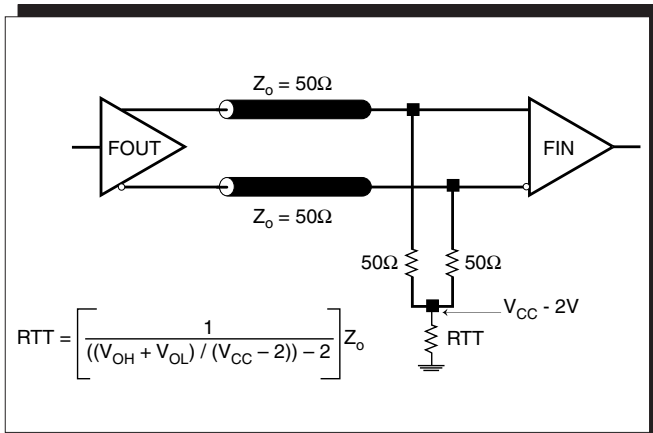


FIGURE 3A. LVPECL OUTPUT TERMINATION

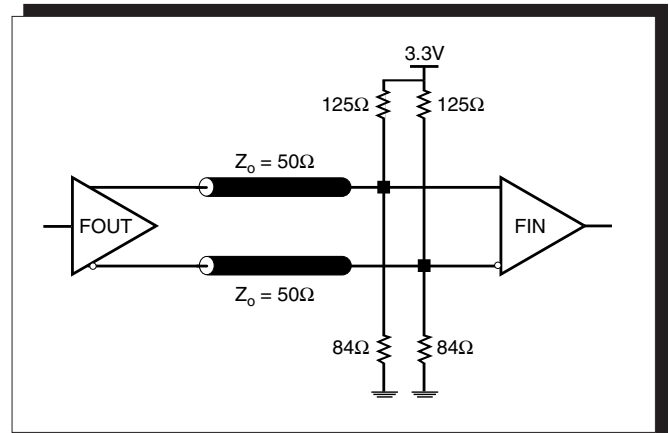


FIGURE 3B. LVPECL OUTPUT TERMINATION



LVPECL CLOCK INPUT INTERFACE

The PCLK /nPCLK accepts LVPECL, CML, SSTL and other differential signals. Both V_{SWING} and V_{OH} must meet the V_{PP} and V_{CMR} input requirements. Figures 5A to 5F 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.

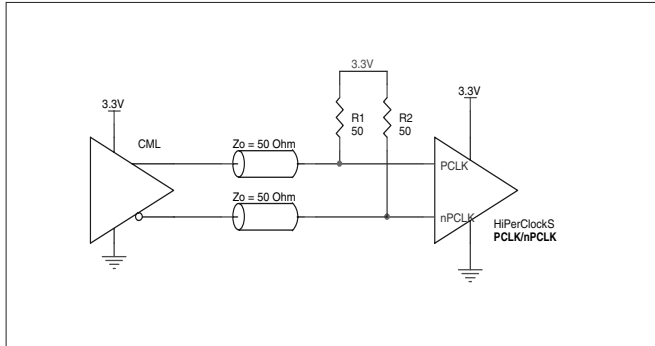


FIGURE 4A. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY AN OPEN COLLECTOR CML DRIVER

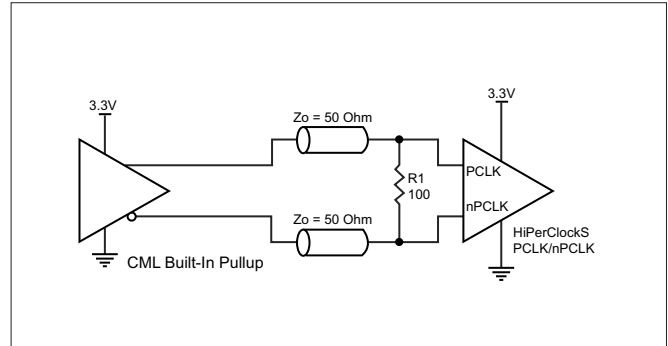


FIGURE 4B. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A BUILT-IN PULLUP CML DRIVER

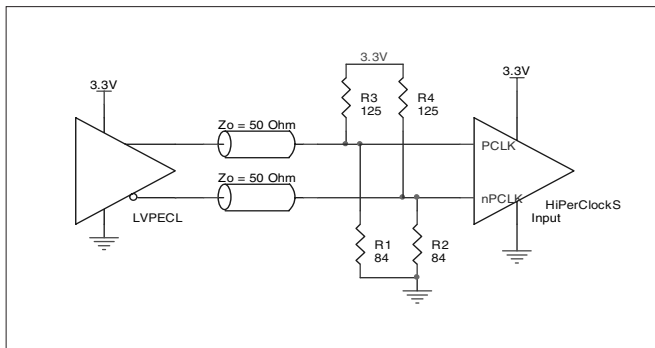


FIGURE 4C. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A 3.3V LVPECL DRIVER

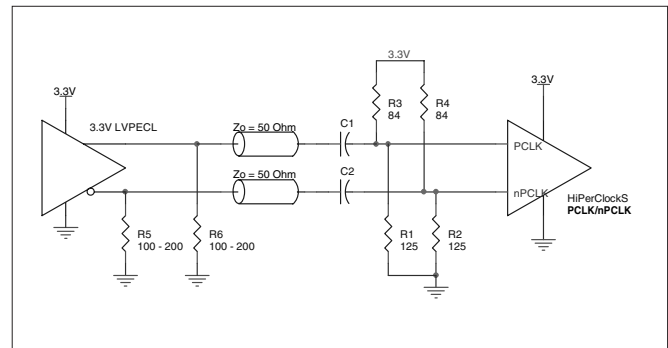


FIGURE 4D. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A 3.3V LVPECL DRIVER WITH AC COUPLE

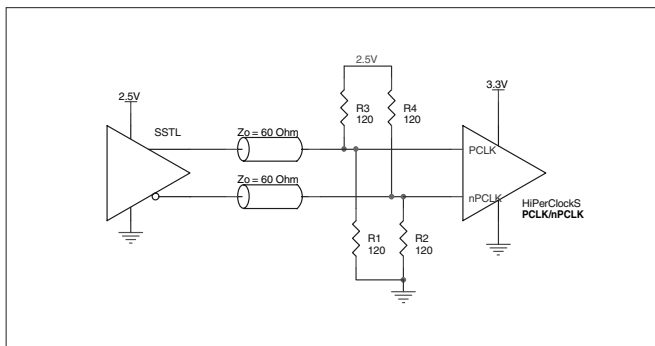


FIGURE 4E. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY AN SSTL DRIVER

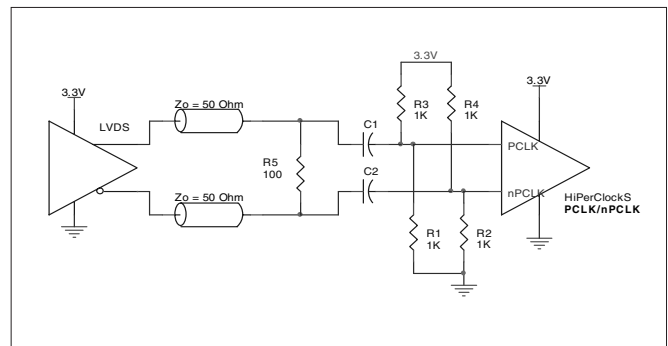


FIGURE 4F. HiPerClockS PCLK/nPCLK INPUT DRIVEN BY A 3.3V LVDS DRIVER



POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the ICS873032. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the ICS873032 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{CC} = 5.5V$, which gives worst case results.

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

- Power (core)_{MAX} = $V_{CC_MAX} * I_{EE_MAX} = 5.5V * 22mA = 121mW$
- Power (outputs)_{MAX} = **30.94mW/Loaded Output pair**
If all outputs are loaded, the total power is $1 * 30.94mW = 30.94mW$

Total Power_{MAX} (5.5V, with all outputs switching) = $121mW + 30.94mW = 151.9mW$

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

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 a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 103.3°C/W per Table 6A below.

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

$85^\circ C + 0.152W * 103.3^\circ C/W = 100.7^\circ C$. This is well below the limit of 125°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 (single layer or multi-layer).

TABLE 6A. THERMAL RESISTANCE θ_{JA} FOR 8-PIN SOIC, FORCED CONVECTION

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	153.3°C/W	128.5°C/W	115.5°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	112.7°C/W	103.3°C/W	97.1°C/W

NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

TABLE 6B. THERMAL RESISTANCE θ_{JA} FOR 8-PIN TSSOP, FORCED CONVECTION

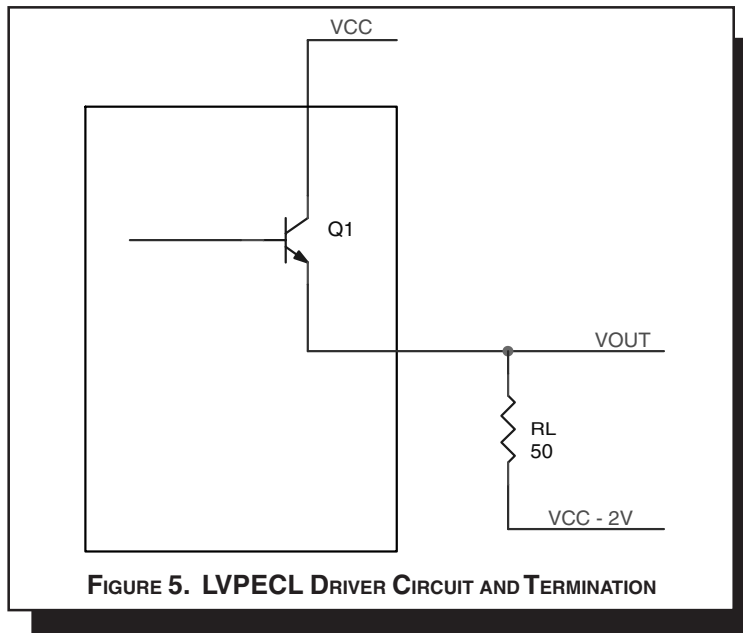
θ_{JA} by Velocity (Meters per Second)			
	0	1	2
Multi-Layer PCB, JEDEC Standard Test Boards	101.7°C/W	90.5°C/W	89.8°C/W



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 5.



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, $V_{OUT} = V_{OH_MAX} = V_{CC_MAX} - 0.935V$
 $(V_{CC_MAX} - V_{OH_MAX}) = 0.935V$
- For logic low, $V_{OUT} = V_{OL_MAX} = V_{CC_MAX} - 1.67V$
 $(V_{CC_MAX} - V_{OL_MAX}) = 1.67V$

Pd_H is power dissipation when the output drives high.
 Pd_L is the power dissipation when the output drives low.

$$Pd_H = [(V_{OH_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - (V_{CC_MAX} - V_{OH_MAX}))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - 0.935V)/50\Omega] * 0.935V = 19.92mW$$

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

Total Power Dissipation per output pair = $Pd_H + Pd_L = 30.94mW$



RELIABILITY INFORMATION

TABLE 7A. θ_{JA} VS. AIR FLOW TABLE FOR 8 LEAD SOIC

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	153.3°C/W	128.5°C/W	115.5°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	112.7°C/W	103.3°C/W	97.1°C/W

NOTE: Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

TABLE 7B. θ_{JA} VS. AIR FLOW TABLE FOR 8 LEAD TSSOP

θ_{JA} by Velocity (Meters per Second)			
	0	1	2
Multi-Layer PCB, JEDEC Standard Test Boards	101.7°C/W	90.5°C/W	89.8°C/W

TRANSISTOR COUNT

The transistor count for ICS873032 is: 165



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PACKAGE OUTLINE - M SUFFIX FOR 8 LEAD SOIC

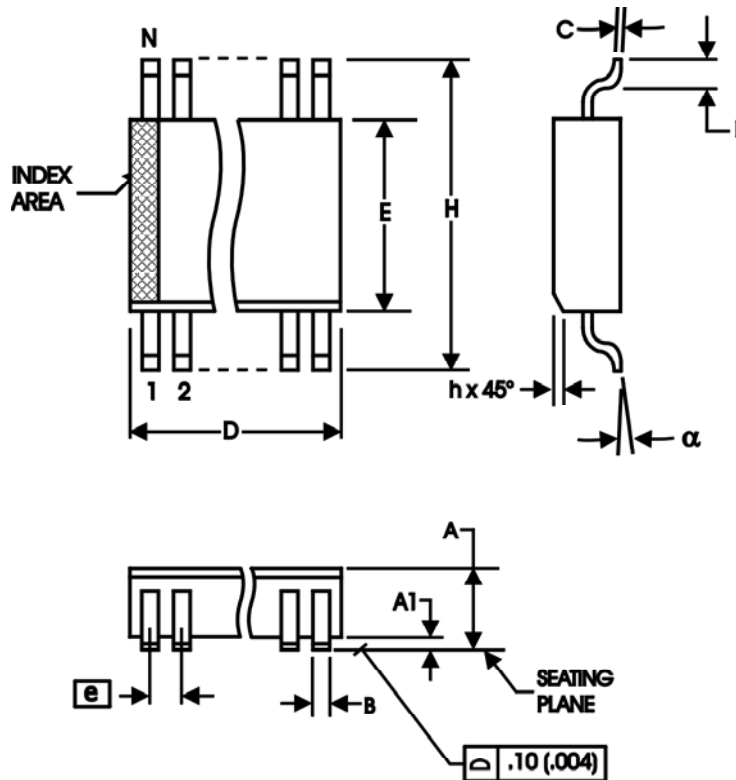


TABLE 8A. PACKAGE DIMENSIONS

SYMBOL	Millimeters	
	MINIMUM	MAXIMUM
N	8	
A	1.35	1.75
A1	0.10	0.25
B	0.33	0.51
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BASIC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.27
α	0°	8°

Reference Document: JEDEC Publication 95, MS-012



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PACKAGE OUTLINE - G SUFFIX FOR 8 LEAD TSSOP

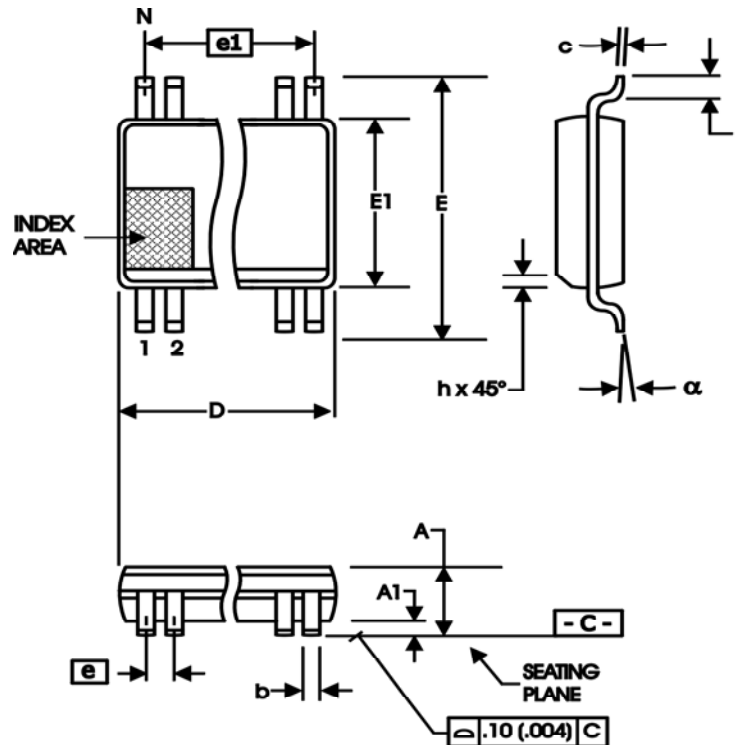


TABLE 8B. PACKAGE DIMENSIONS

SYMBOL	Millimeters	
	Minimum	Maximum
N	8	
A	--	1.10
A1	0	0.15
A2	0.79	0.97
b	0.22	0.38
c	0.08	0.23
D	3.00 BASIC	
E	4.90 BASIC	
E1	3.00 BASIC	
e	0.65 BASIC	
e1	1.95 BASIC	
L	0.40	0.80
α	0°	8°
aaa	--	0.10

Reference Document: JEDEC Publication 95, MO-187



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TABLE 9. ORDERING INFORMATION

Part/Order Number	Marking	Package	Count	Temperature
ICS873032AM	873032AM	8 lead SOIC	96 per tube	-40°C to 85°C
ICS873032AMT	873032AM	8 lead SOIC on Tape and Reel	2500	-40°C to 85°C
ICS873032AG	032	8 lead TSSOP	96 per tube	-40°C to 85°C
ICS873032AGT	032	8 lead TSSOP on Tape and Reel	2500	-40°C to 85°C

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