PRELIMINARY

Integrated Circuit Systems, Inc.

ICS83940I-01

LOW SKEW, 1-TO-18 LVPECL-TO-LVCMOS / LVTTL FANOUT BUFFER

GENERAL DESCRIPTION

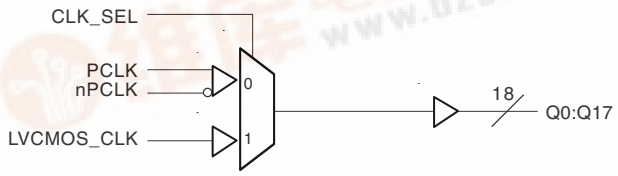
The ICS83940I-01 is a low skew, 1-to-18 LVPECL-to-LVCMOS/LVTTL Fanout Buffer and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS83940I-01 has two selectable clock inputs. The PCLK, nPCLK pair can accept LVPECL, CML or SSTL input levels. The single ended clock input accepts LVCMOS or LVTTL input levels. The low impedance LVCMOS/LVTTL outputs are designed to drive 50Ω series or parallel terminated transmission lines. The effective fanout can be increased from 18 to 36 by utilizing the ability of the outputs to drive two series terminated lines.

The ICS83940I-01 is characterized at full 3.3V, full 2.5V and mixed 3.3V input and 2.5V output operating supply modes. Guaranteed output and part-to-part skew characteristics make the ICS83940I-01 ideal for those clock distribution applications demanding well defined performance and repeatability.

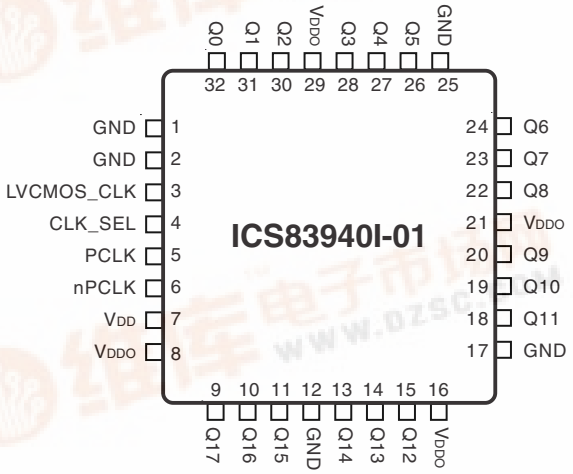
FEATURES

- 18 LVCMOS/LVTTL outputs, 23Ω typical output impedance
- Selectable LVCMOS_CLK or LVPECL clock inputs
- LVCMOS_CLK supports the following input types: LVCMOS or LVTTL
- PCLK, nPCLK supports the following input types: LVPECL, CML, SSTL
- Maximum output frequency: 250MHz
- Output skew: 150ps (maximum)
- Part-to-part skew: 750ps (maximum)
- Full 3.3V, 2.5V or mixed 3.3V, 2.5V supply modes
- -40°C to 85°C ambient operating temperature
- Pin compatible with the MPC940L in single supply applications

BLOCK DIAGRAM



PIN ASSIGNMENT



32-Lead LQFP
Y Pacakge
7mm x 7mm x 1.4mm package body
Top View

TABLE 1. PIN DESCRIPTIONS

Number	Name	Type		Description
1, 2, 12, 17, 25	GND	Power		Power supply ground.
3	LVCMOS_CLK	Input	Pulldown	Clock input. LVCMOS / LVTTL interface levels.
4	CLK_SEL	Input	Pulldown	Clock select input. Selects LVCMOS / LVTTL clock input when HIGH. Selects PCLK, nPCLK inputs when LOW. LVCMOS / LVTTL interface levels.
5	PCLK	Input	Pulldown	Non-inverting differential LVPECL clock input.
6	nPCLK	Input		Inverting differential LVPECL clock input. $V_{DD}/2$ default when left floating.
7	V_{DD}	Power		Core supply pins.
8, 16, 21, 29	V_{DDO}	Power		Output supply pins.
9, 10, 11, 13, 14, 15, 18, 19, 20, 22, 23, 24, 26, 27, 28, 30, 31, 32	Q17, Q16, Q15, Q14, Q13, Q12, Q11, Q10, Q9, Q8, Q7, Q6, Q5, Q4, Q3, Q2, Q1, Q0	Output		Clock outputs. LVCMOS / LVTTL interface levels.

NOTE: *Pulldow*n 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
C_{IN}	Input Capacitance			4		pF
C_{PD}	Power Dissipation Capacitance (per output)			6		pF
$R_{PULLDOWN}$	Input Pulldown Resistor			51		KΩ
R_{OUT}	Output Impedance		18		28	Ω

TABLE 3A. CLOCK SELECT FUNCTION TABLE

Control Input	Clock	
CLK_SEL	PCLK, nPCLK	LVCMOS_CLK
0	Selected	De-selected
1	De-selected	Selected

TABLE 3B. CLOCK INPUT FUNCTION TABLE

Inputs				Outputs	Input to Output Mode	Polarity
CLK_SEL	LVCMOS_CLK	PCLK	nPCLK	Q0:Q17		
0	—	0	1	LOW	Differential to Single Ended	Non Inverting
0	—	1	0	HIGH	Differential to Single Ended	Non Inverting
0	—	0	Biased; NOTE 1	LOW	Single Ended to Single Ended	Non Inverting
0	—	1	Biased; NOTE 1	HIGH	Single Ended to Single Ended	Non Inverting
0	—	Biased; NOTE 1	0	HIGH	Single Ended to Single Ended	Inverting
0	—	Biased; NOTE 1	1	LOW	Single Ended to Single Ended	Inverting
1	0	—	—	LOW	Single Ended to Single Ended	Non Inverting
1	1	—	—	HIGH	Single Ended to Single Ended	Non Inverting

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

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{DD}	3.6V
Inputs, V_I	-0.3V to V_{DD} + 0.3V
Outputs, V_O	-0.3V to V_{DDO} + 0.3V
Input Current, I_{IN}	±20mA
Storage Temperature, T_{STG}	-40°C to 125°C

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. DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40°$ TO $85°$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	LVCMOS_CLK		2.4		V_{DD}	V
V_{IL}	Input Low Voltage	LVCMOS_CLK				0.8	V
V_{PP}	Peak-to-Peak Input Voltage	PCLK, nPCLK		500		1000	mV
V_{CMR}	Input Common Mode Voltage; NOTE 1, 2	PCLK, nPCLK		V_{DD} - 1.4		V_{DD} - 0.6	V
I_{IN}	Input Current					±200	µA
V_{OH}	Output High Voltage		I_{OH} = -20mA	2.4			V
V_{OL}	Output Low Voltage		I_{OL} = 20mA			0.5	V
I_{DD}	Core Supply Current					25	mA

NOTE 1: For single ended applications, the maximum input voltage for PCLK, nPCLK is V_{DD} + 0.3V.
NOTE 2: Common mode voltage is defined as V_{IH}.

TABLE 5A. AC CHARACTERISTICS, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = -40°$ TO $85°$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency					250	MHz
tp_{LH}	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	f ≤ 150MHz				ns
		LVCMOS_CLK; NOTE 2, 5	f ≤ 150MHz				ns
tp_{LH}	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	f > 150MHz				ns
		LVCMOS_CLK; NOTE 2, 5	f > 150MHz				ns
*t*sk(o)	Output Skew; NOTE 3, 5	PCLK, nPCLK	Measured on rising edge @V_{DDO}/2				ps
		LVCMOS_CLK					ps
*t*sk(pp)	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	f ≤ 150MHz				ns
		LVCMOS_CLK	f ≤ 150MHz				ns
*t*sk(pp)	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	f > 150MHz				ns
		LVCMOS_CLK	f > 150MHz				ns
*t*sk(pp)	Part-to-Part Skew; NOTE 4, 5	PCLK, nPCLK	Measured on rising edge @V_{DDO}/2				ps
		LVCMOS_CLK					ps
t_R, t_F	Output Rise/Fall Time		0.5 to 2.4V	0.3		1.1	ns
odc	Output Duty Cycle		f < 134MHz	45	50	55	%
			134MHz ≤ f ≤ 250MHz	40	50	60	%

All parameters measured at 200MHz unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output V_{DDO}/2.
NOTE 2: Measured from V_{DD}/2 to V_{DDO}/2.
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at V_{DDO}/2.
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltages, same temperature, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at V_{DDO}/2.
NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 6: Defined as skew between outputs on different devices, across temperature and voltage ranges, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at V_{DDO}/2.

TABLE 4B. DC CHARACTERISTICS, V_{DD} = 3.3V ± 5%, V_{DDO} = 2.5V ± 5%, TA = -40° TO 85°

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	LVCMOS_CLK		2.4		V_{DD}	V
V_{IL}	Input Low Voltage	LVCMOS_CLK				0.8	V
V_{PP}	Peak-to-Peak Input Voltage	PCLK, nPCLK		300		1000	mV
V_{CMR}	Input Common Mode Voltage; NOTE 1, 2	PCLK, nPCLK		V_{DD} - 1.4		V_{DD} - 0.6	V
I_{IN}	Input Current					±200	µA
V_{OH}	Output High Voltage		I_{OH} = -20mA	1.8			V
V_{OL}	Output Low Voltage		I_{OL} = 20mA			0.5	V
I_{DD}	Core Supply Current					25	mA

NOTE 1: For single ended applications, the maximum input voltage for PCLK, nPCLK is V_{DD} + 0.3V.
NOTE 2: Common mode voltage is defined as V_{IH}.

TABLE 5B. AC CHARACTERISTICS, V_{DD} = 3.3V ± 5%, V_{DDO} = 2.5V ± 5%, TA = -40° TO 85°

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency					250	MHz
t_{pLH}	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	f ≤ 150MHz				ns
		LVCMOS_CLK; NOTE 2, 5	f ≤ 150MHz				ns
t_{pLH}	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	f > 150MHz				ns
		LVCMOS_CLK; NOTE 2, 5	f > 150MHz				ns
*t*sk(o)	Output Skew; NOTE 3, 5	PCLK, nPCLK	Measured on rising edge @V_{DDO}/2				ps
		LVCMOS_CLK					ps
*t*sk(pp)	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	f ≤ 150MHz				ns
		LVCMOS_CLK	f ≤ 150MHz				ns
*t*sk(pp)	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	f > 150MHz				ns
		LVCMOS_CLK	f > 150MHz				ns
*t*sk(pp)	Part-to-Part Skew; NOTE 4, 5	PCLK, nPCLK	Measured on rising edge @V_{DDO}/2				ps
		LVCMOS_CLK					ps
t_R, t_F	Output Rise/Fall Time		0.5 to 1.8V	0.3		1.2	ns
odc	Output Duty Cycle		f < 134MHz	45	50	55	%

All parameters measured at 200MHz unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output V_{DDO}/2.
NOTE 2: Measured from V_{DD}/2 to V_{DDO}/2.
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at V_{DDO}/2.
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltages, same temperature, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at V_{DDO}/2.
NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 6: Defined as skew between outputs on different devices, across temperature and voltage ranges, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at V_{DDO}/2.

TABLE 4C. DC CHARACTERISTICS, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40°$ TO $85°$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	LVCMOS_CLK		2		V_{DD}	V
V_{IL}	Input Low Voltage	LVCMOS_CLK				0.8	V
V_{PP}	Peak-to-Peak Input Voltage	PCLK, nPCLK		300		1000	mV
V_{CMR}	Input Common Mode Voltage; NOTE 1, 2	PCLK, nPCLK		V_{DD} - 1.4		V_{DD} - 0.6	V
I_{IN}	Input Current					±200	µA
V_{OH}	Output High Voltage		I_{OH} = -12mA	1.8			V
V_{OL}	Output Low Voltage		I_{OL} = 12mA			0.5	V
I_{DD}	Core Supply Current					25	mA

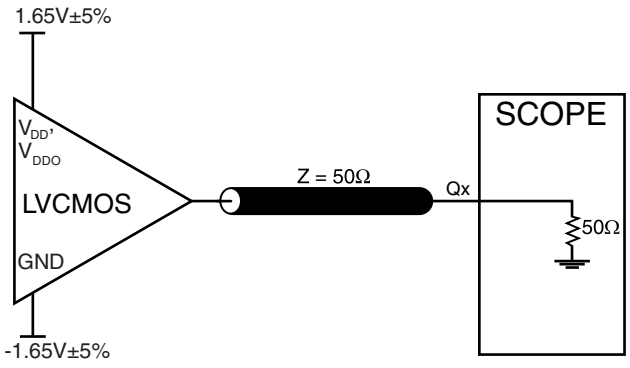
NOTE 1: For single ended applications, the maximum input voltage for PCLK, nPCLK is V_{DD} + 0.3V.
NOTE 2: Common mode voltage is defined as V_{IH}.

TABLE 5C. AC CHARACTERISTICS, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = -40°$ TO $85°$

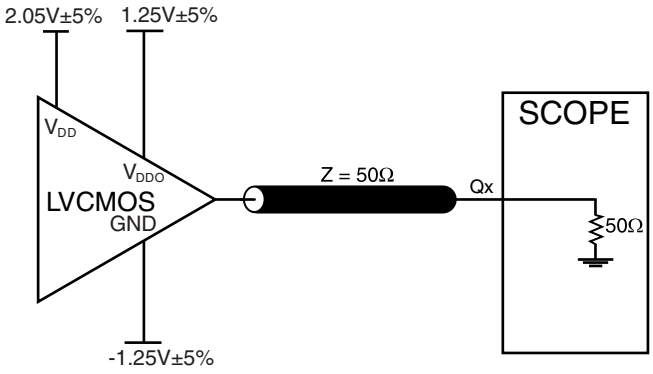
Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency					200	MHz
t_{pLH}	Propagation Delay;	PCLK, nPCLK; NOTE 1, 5	f ≤ 150MHz				ns
		LVCMOS_CLK; NOTE 2, 5	f ≤ 150MHz				ns
t_{pLH}	Propagation Delay;	PCLK, nPCLK; NOTE 1, 5	f > 150MHz				ns
		LVCMOS_CLK; NOTE 2, 5	f > 150MHz				ns
*t*sk(o)	Output Skew; NOTE 3, 5	PCLK, nPCLK	Measured on rising edge @V_{DDO}/2				ps
		LVCMOS_CLK					ps
*t*sk(pp)	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	f ≤ 150MHz				ns
		LVCMOS_CLK	f ≤ 150MHz				ns
*t*sk(pp)	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	f > 150MHz				ns
		LVCMOS_CLK	f > 150MHz				ns
*t*sk(pp)	Part-to-Part Skew; NOTE 4, 5	PCLK, nPCLK	Measured on rising edge @V_{DDO}/2				ns
		LVCMOS_CLK					ns
t_R, t_F	Output Rise/Fall Time		0.5 to 1.8V	0.3		1.2	ns
odc	Output Duty Cycle		f < 134MHz	45		55	%

All parameters measured at 200MHz unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output V_{DDO}/2.
NOTE 2: Measured from V_{DD}/2 to V_{DDO}/2.
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at V_{DDO}/2.
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltages, same temperature, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at V_{DDO}/2.
NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 6: Defined as skew between outputs on different devices, across temperature and voltage ranges, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at V_{DDO}/2.

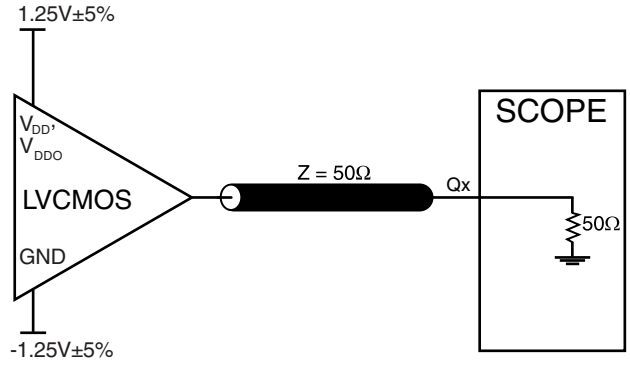
PARAMETER MEASUREMENT INFORMATION



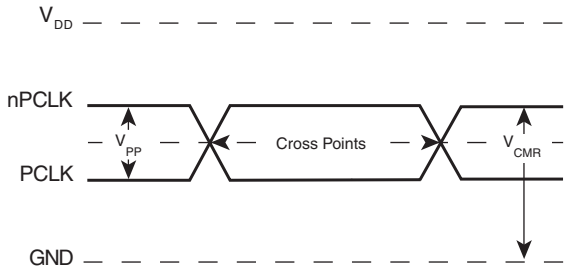
3.3V OUTPUT LOAD AC TEST CIRCUIT



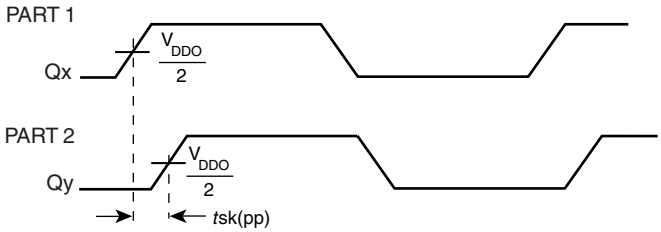
3.3V/2.5V OUTPUT LOAD AC TEST CIRCUIT



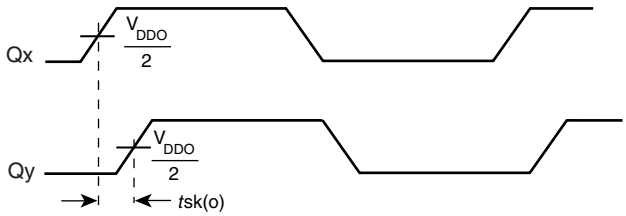
2.5V OUTPUT LOAD AC TEST CIRCUIT



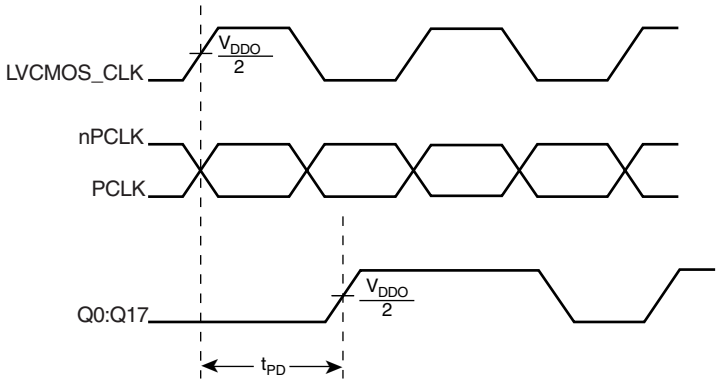
DIFFERENTIAL INPUT LEVEL



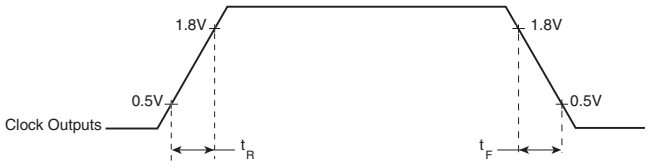
PART-TO-PART SKEW



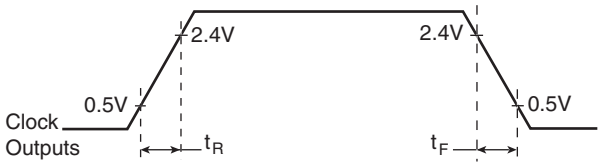
OUTPUT SKEW



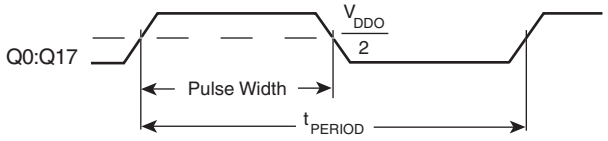
PROPAGATION DELAY



2.5V OUTPUT RISE/FALL TIME



3.3V OUTPUT RISE/FALL TIME



$$odc = \frac{t_{PW}}{t_{PERIOD}}$$

odc & t_{PERIOD}

APPLICATION INFORMATION

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 1 shows how the differential input can be wired to accept single ended levels. The reference voltage V_REF = V_{DD}/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_{DD} = 3.3V, V_REF should be 1.25V and R2/R1 = 0.609.

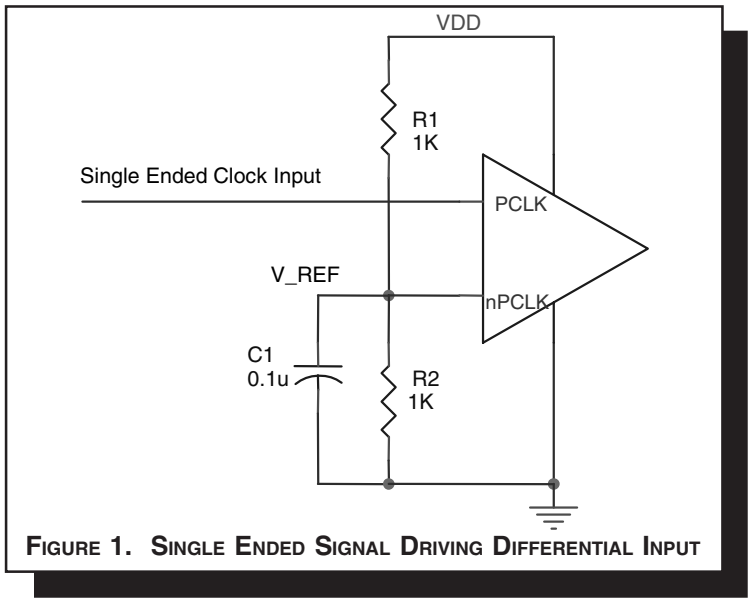


FIGURE 1. SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT

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 2A to 2E* 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.

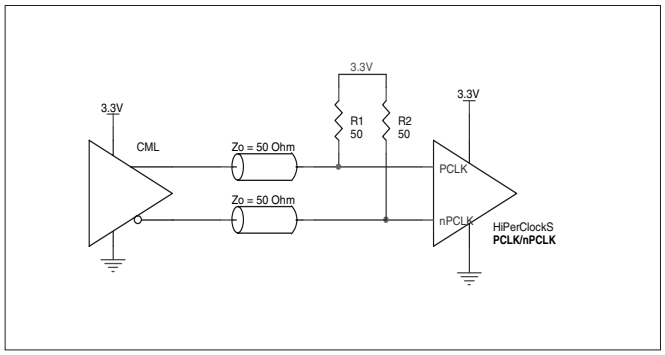


FIGURE 2A. HIPERCLOCKS PCLK/NPCLK INPUT DRIVEN BY A CML DRIVER

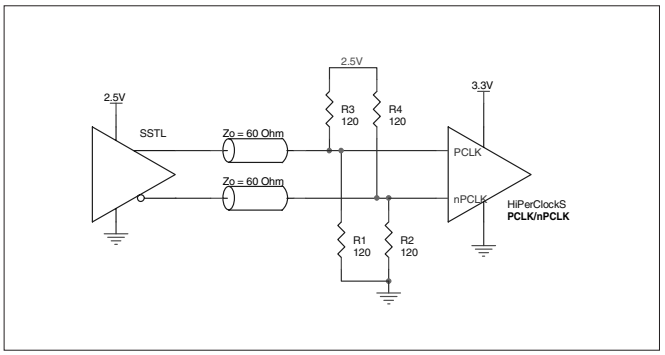


FIGURE 2B. HIPERCLOCKS PCLK/NPCLK INPUT DRIVEN BY AN SSTL DRIVER

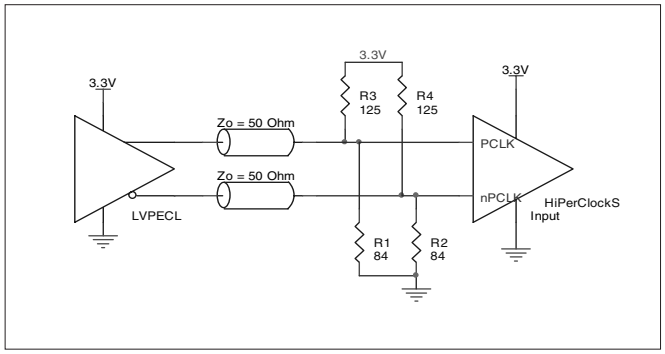


FIGURE 2C. HIPERCLOCKS PCLK/NPCLK INPUT DRIVEN BY A 3.3V LVPECL DRIVER

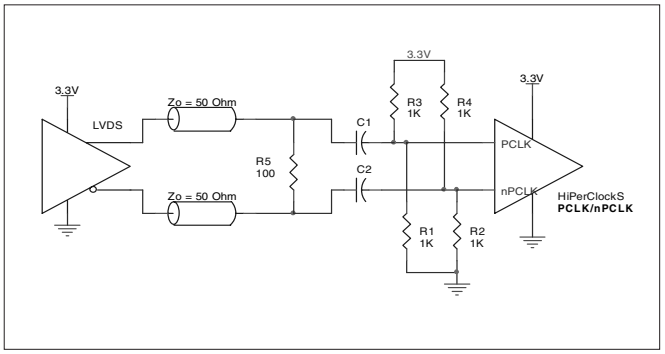


FIGURE 2D. HIPERCLOCKS PCLK/NPCLK INPUT DRIVEN BY A 3.3V LVDS DRIVER

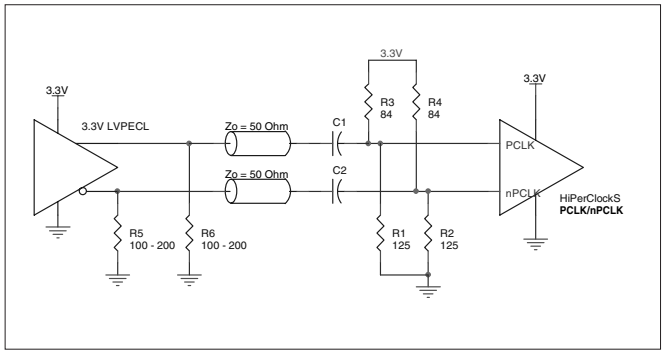


FIGURE 2E. HIPERCLOCKS PCLK/NPCLK INPUT DRIVEN BY A 3.3V LVPECL DRIVER WITH AC COUPLE

RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE

θ_{JA} by Velocity (Linear Feet per Minute)	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	67.8°C/W	55.9°C/W	50.1°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	47.9°C/W	42.1°C/W	39.4°C/W

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

TRANSISTOR COUNT

The transistor count for ICS83940I-01 is: 819

PACKAGE OUTLINE - Y SUFFIX

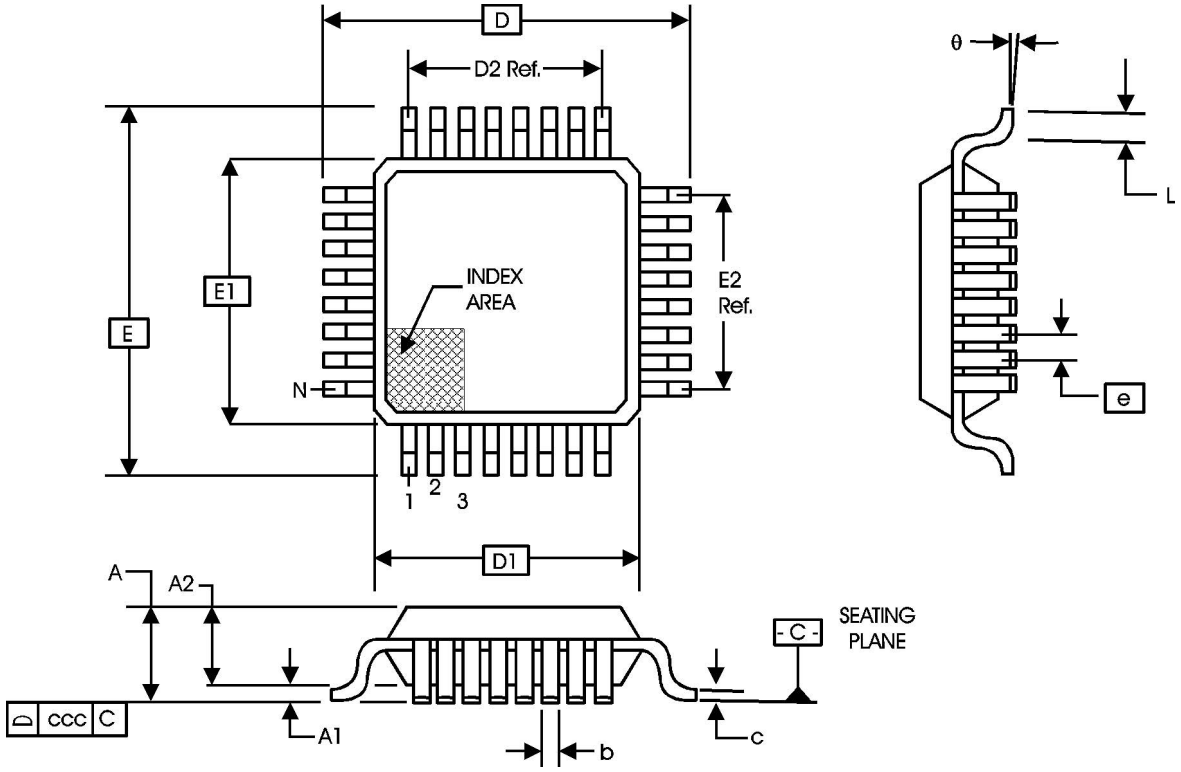


TABLE 7. PACKAGE DIMENSIONS

JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS			
SYMBOL	BBA		
	MINIMUM	NOMINAL	MAXIMUM
N		32	
A	--	--	1.60
A1	0.05	--	0.15
A2	1.35	1.40	1.45
b	0.30	0.37	0.45
c	0.09	--	0.20
D		9.00 BASIC	
D1		7.00 BASIC	
D2		5.60 Ref.	
E		9.00 BASIC	
E1		7.00 BASIC	
E2		5.60 Ref.	
e		0.80 BASIC	
L	0.45	0.60	0.75
θ	0°	--	7°
ccc	--	--	0.10

Reference Document: JEDEC Publication 95, MS-026

TABLE 8. ORDERING INFORMATION

Part/Order Number	Marking	Package	Count	Temperature
ICS83940DYI-01	ICS83940DI01	32 Lead LQFP	250 per tray	-40°C to 85°C
ICS83940DYI-01T	ICS83940DI01	32 Lead LQFP on Tape and Reel	1000	-40°C to 85°C
ICS83940DYI-01LF	ICS83940DI01L	32 Lead "Lead Free" LQFP	250 per tray	-40°C to 85°C
ICS83940DYI-01LFT	ICS83940DI01L	32 Lead "Lead Free" LQFP on Tape and Reel	1000	-40°C to 85°C