



### GENERAL DESCRIPTION



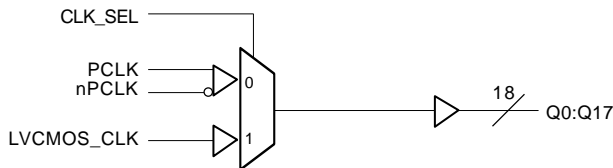
The ICS83940DI is a low skew, 1-to-18 LVPECL-to-LVCMOS/LVTTTL Fanout Buffer and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS83940DI has two selectable clock inputs. The PCLK, nPCLK pair can accept LVPECL, CML, or SSTL input levels. The LVCMOS\_CLK can accept LVCMOS or LVTTTL input levels. The low impedance LVCMOS/LVTTTL outputs are designed to drive 50Ω series or parallel terminated transmission lines.

The ICS83940DI is characterized at 3.3V, 2.5V or mixed 3.3V core, 2.5V output operating supply modes. Guaranteed output and part-to-part skew characteristics make the ICS83940DI ideal for those clock distribution applications demanding well defined performance and repeatability.

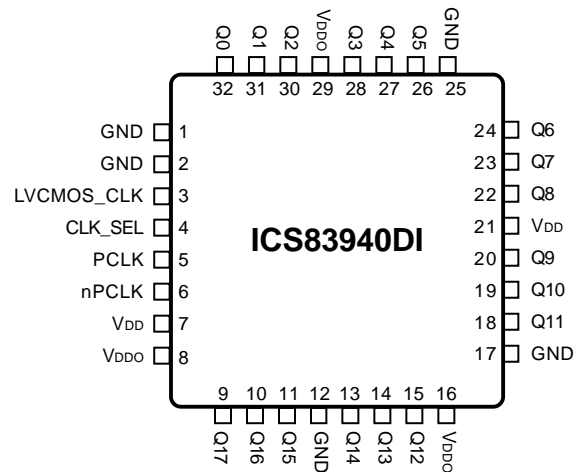
### FEATURES

- 18 LVCMOS/LVTTTL outputs
- Selectable LVCMOS\_CLK or LVPECL clock inputs
- PCLK, nPCLK supports the following input types: LVPECL, CML, SSTL
- LVCMOS\_CLK accepts the following input levels: LVCMOS or LVTTTL
- Maximum output frequency: 250MHz
- Output skew: 150ps (maximum)
- Part to part skew: 750ps (maximum)
- 3.3V, 2.5V or mixed 3.3V core, 2.5V output supply modes
- -40°C to 85°C ambient operating temperature
- Pin compatible with the MPC940L

### BLOCK DIAGRAM



### PIN ASSIGNMENT



**32-Lead LQFP**  
7mm x 7mm x 1.4mm package body  
**Y Package**  
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 / LVTTTL interface levels.
4	CLK_SEL	Input	Pulldown	Clock select input. Selects LVCMOS / LVTTTL clock input when HIGH. Selects PCLK, nPCLK inputs when LOW. LVCMOS / LVTTTL 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, 21	$V_{DD}$	Power		Core supply pins.
8, 16, 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 / LVTTTL interface levels.

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
$C_{IN}$	Input Capacitance			4		pF
$C_{PD}$	Power Dissipation Capacitance (per output)			6		pF
$R_{PULLDOWN}$	Input Pulldown Resistor			51		K $\Omega$
$R_{OUT}$	Output Impedance		18		28	$\Omega$

**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, $I_{IN}$	$\pm 20mA$
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,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ$  TO  $85^\circ$**

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				$\pm 200$	$\mu A$
$V_{OH}$	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,  $V_{DD} = V_{DDO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ$  TO  $85^\circ$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency				250	MHz
$t_{pLH}$	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	$f \leq 150MHz$	1.6	3.0	ns
		LVCMOS_CLK; NOTE 2, 5	$f \leq 150MHz$	1.8	3.0	ns
$t_{pLH}$	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	$f > 150MHz$	1.6	3.3	ns
		LVCMOS_CLK; NOTE 2, 5	$f > 150MHz$	1.8	3.2	ns
$t_{sk(o)}$	Output Skew; NOTE 3, 5	PCLK, nPCLK	Measured on rising edge @ $V_{DDO}/2$		150	ps
		LVCMOS_CLK			150	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	$f \leq 150MHz$		1.4	ns
		LVCMOS_CLK	$f \leq 150MHz$		1.2	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	$f > 150MHz$		1.7	ns
		LVCMOS_CLK	$f > 150MHz$		1.4	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 4, 5	PCLK, nPCLK	Measured on rising edge @ $V_{DDO}/2$		850	ps
		LVCMOS_CLK			750	ps
$t_R$	Output Rise Time	0.5 to 2.4V	0.3		1.1	ns
$t_F$	Output Fall Time	0.5 to 2.4V	0.3		1.1	ns
odc	Output Duty Cycle	$f < 134MHz$	45	50	55	%
		$134MHz \leq f \leq 250MHz$	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**,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ$  TO  $85^\circ$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage	LVC MOS_CLK	2.4		$V_{DD}$	V
$V_{IL}$	Input Low Voltage	LVC MOS_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				$\pm 200$	$\mu A$
$V_{OH}$	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**,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ$  TO  $85^\circ$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency				250	MHz
$t_{pLH}$	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	$f \leq 150MHz$	1.7	3.2	ns
		LVC MOS_CLK; NOTE 2, 5	$f \leq 150MHz$	1.7	3.0	ns
$t_{pLH}$	Propagation Delay	PCLK, nPCLK; NOTE 1, 5	$f > 150MHz$	1.6	3.4	ns
		LVC MOS_CLK; NOTE 2, 5	$f > 150MHz$	1.8	3.3	ns
$t_{sk(o)}$	Output Skew; NOTE 3, 5	PCLK, nPCLK	Measured on rising edge @ $V_{DDO}/2$		150	ps
		LVC MOS_CLK			150	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	$f \leq 150MHz$		1.5	ns
		LVC MOS_CLK	$f \leq 150MHz$		1.3	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	$f > 150MHz$		1.8	ns
		LVC MOS_CLK	$f > 150MHz$		1.5	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 4, 5	PCLK, nPCLK	Measured on rising edge @ $V_{DDO}/2$		850	ps
		LVC MOS_CLK			750	ps
$t_R$	Output Rise Time	0.5 to 1.8V	0.3		1.2	ns
$t_F$	Output 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,  $V_{DD} = V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ$  TO  $85^\circ$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage	LVC MOS_CLK	2		$V_{DD}$	V
$V_{IL}$	Input Low Voltage	LVC MOS_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				$\pm 200$	$\mu A$
$V_{OH}$	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,  $V_{DD} = V_{DDO} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ$  TO  $85^\circ$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Output Frequency				200	MHz
$t_{PLH}$	Propagation Delay;	PCLK, nPCLK; NOTE 1, 5	$f \leq 150MHz$	1.2	3.8	ns
		LVC MOS_CLK; NOTE 2, 5	$f \leq 150MHz$	1.5	3.2	ns
$t_{PLH}$	Propagation Delay;	PCLK, nPCLK; NOTE 1, 5	$f > 150MHz$	1.5	3.7	ns
		LVC MOS_CLK; NOTE 2, 5	$f > 150MHz$	2	3.6	ns
$t_{sk(o)}$	Output Skew; NOTE 3, 5	PCLK, nPCLK	Measured on rising edge @ $V_{DDO}/2$		200	ps
		LVC MOS_CLK			200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	$f \leq 150MHz$		2.6	ns
		LVC MOS_CLK	$f \leq 150MHz$		1.7	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 6	PCLK, nPCLK	$f > 150MHz$		2.2	ns
		LVC MOS_CLK	$f > 150MHz$		1.7	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 4, 5	PCLK, nPCLK	Measured on rising edge @ $V_{DDO}/2$		1.2	ns
		LVC MOS_CLK			1.0	ns
$t_R$	Output Rise Time	0.5 to 1.8V	0.3		1.2	ns
$t_F$	Output 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  $V_{DDO}/2$ .

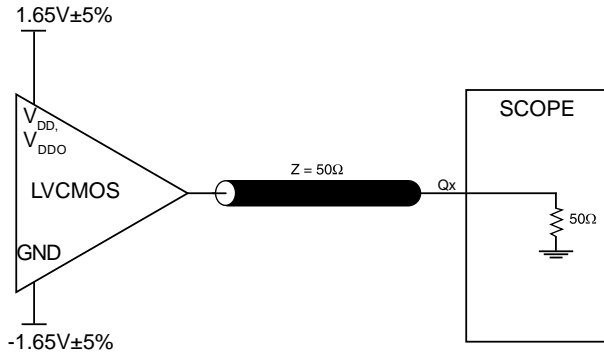
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltages, same temperature, and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at  $V_{DDO}/2$ .

NOTE 5: This parameter is defined in accordance with JEDEC Standard 65.

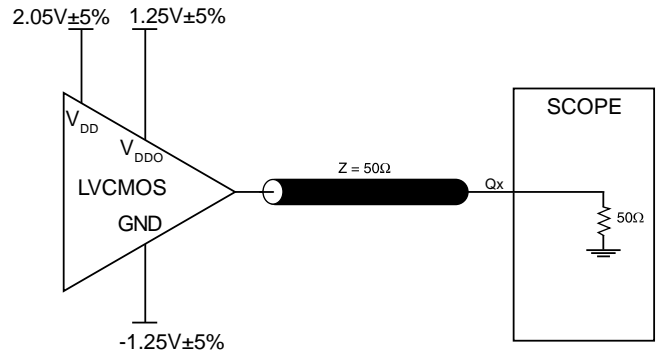
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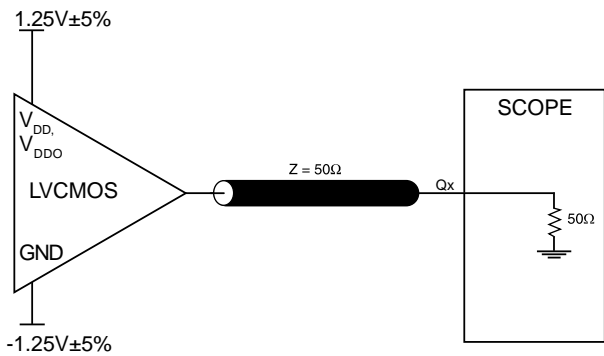
## PARAMETER MEASUREMENT INFORMATION



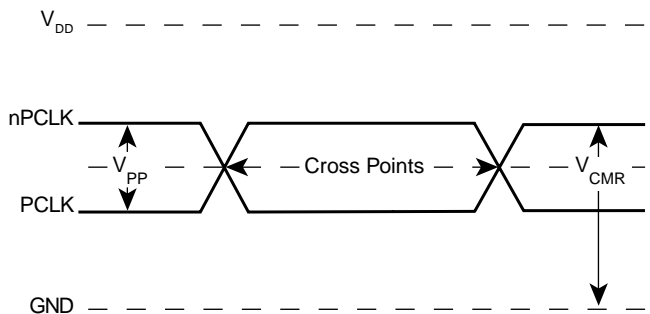
**3.3V OUTPUT LOAD AC TEST CIRCUIT**



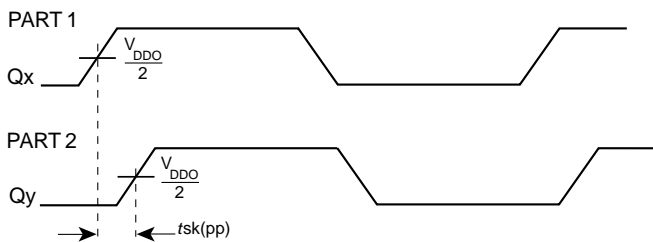
**3.3V/2.5V OUTPUT LOAD AC TEST CIRCUIT**



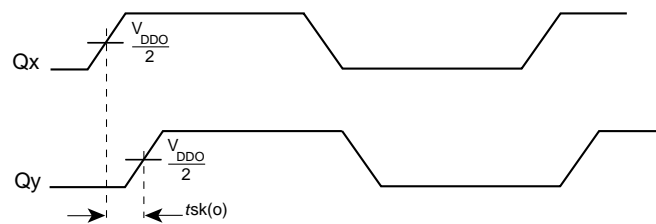
**2.5V OUTPUT LOAD AC TEST CIRCUIT**



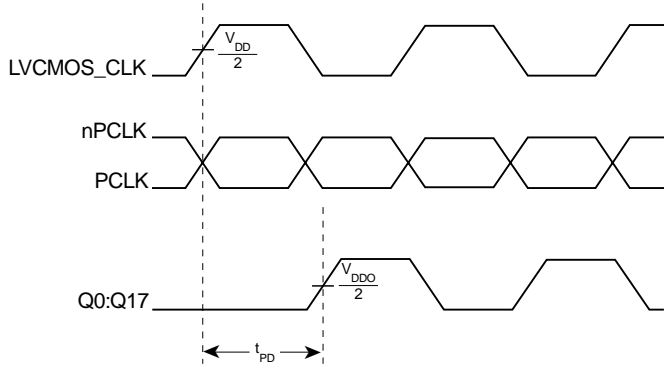
**DIFFERENTIAL INPUT LEVEL**



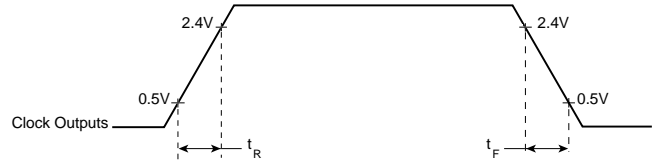
**PART-TO-PART SKEW**



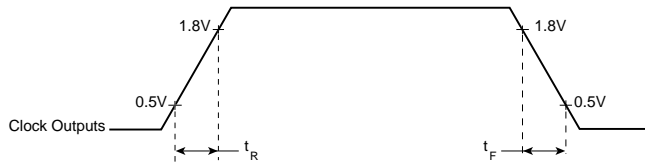
**OUTPUT SKEW**



**PROPAGATION DELAY**



**3.3V OUTPUT RISE/FALL TIME**



**2.5V OUTPUT RISE/FALL TIME**



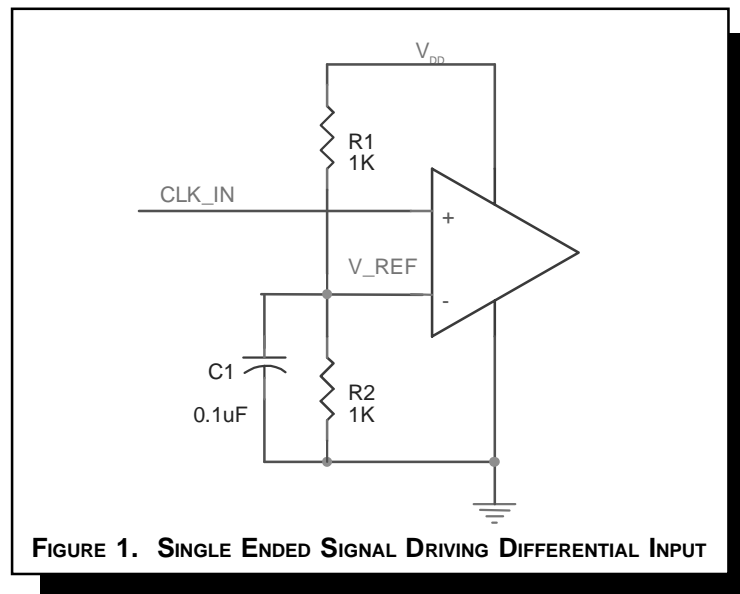


## APPLICATION INFORMATION

### 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  $R2/R1 = 0.609$ .





## RELIABILITY INFORMATION

TABLE 6.  $\theta_{JA}$  VS. AIR FLOW TABLE

$\theta_{JA}$ 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 ICS83940DI is: 820



PACKAGE OUTLINE - Y SUFFIX

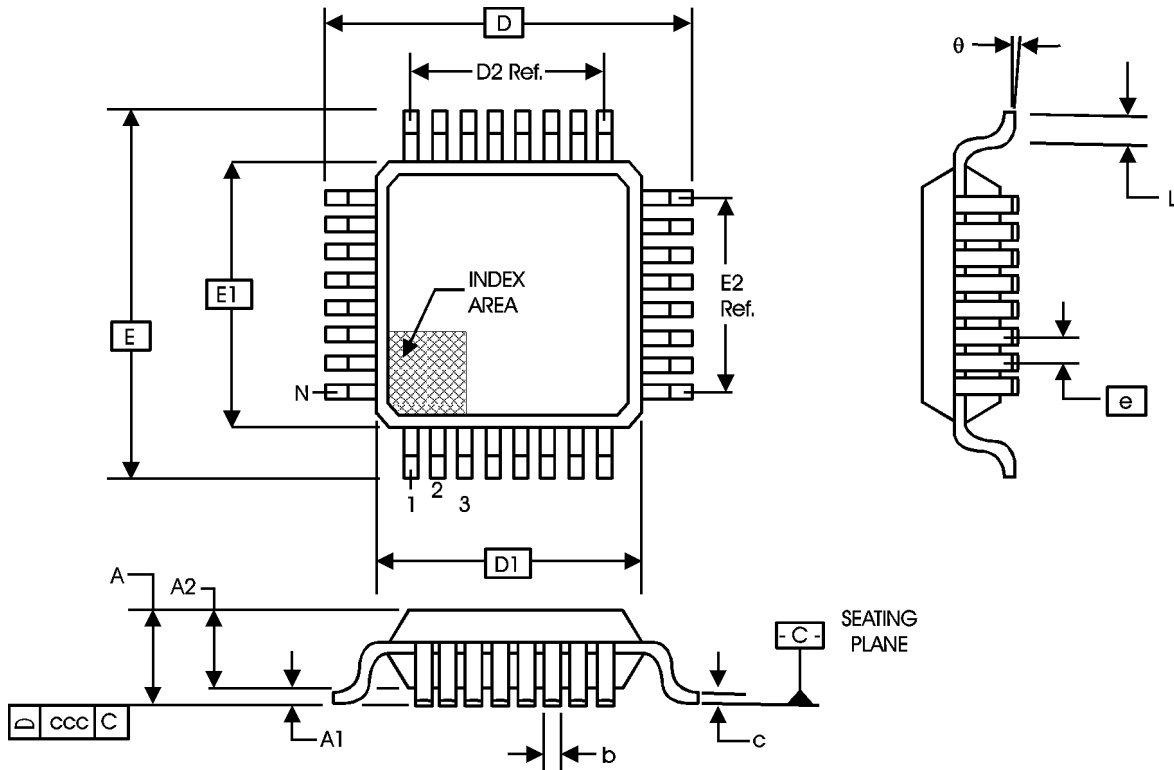


TABLE 7. PACKAGE DIMENSIONS

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



Integrated  
Circuit  
Systems, Inc.

**ICS83940DI**  
LOW SKEW, 1-TO-18  
LVPECL-TO-LVCMOS / LVTTTL FANOUT BUFFER

**TABLE 8. ORDERING INFORMATION**

<b>Part/Order Number</b>	<b>Marking</b>	<b>Package</b>	<b>Count</b>	<b>Temperature</b>
ICS83940DYI	ICS83940DYI	32 Lead LQFP	250 per tray	-40°C to 85°C
ICS83940DYI-T	ICS83940DYI	32 Lead LQFP on Tape and Reel	1000	-40°C to 85°C

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REVISION HISTORY SHEET				
Rev	Table	Page	Description of Change	Date
A	T2	2	Pin Characteristics table - changed R <sub>OUT</sub> 25Ω maximum to 28Ω maximum. Delete R <sub>PULLUP</sub> row.	12/12/02
		7	3.3V Output Load AC Test Circuit diagram - corrected GND equation to read -1.65V... from -1.165V... Added LVTTTL to title. Updated format.	