



### GENERAL DESCRIPTION

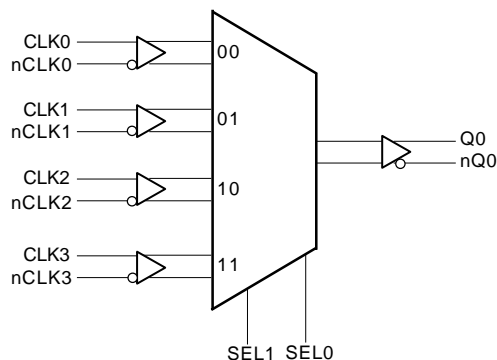


The ICS85357-01 is a 4:1 or 2:1 Differential-to-3.3V LVPECL / ECL clock multiplexer which can operate up to 750MHz and is a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS85357-01 has 4 selectable clock inputs. The CLK, nCLK pair can accept most standard differential input levels. The device can operate using a 3.3V LVPECL ( $V_{EE} = 0V$ ,  $V_{CC} = 3.135V$  to  $3.465V$ ) or 3.3V ECL ( $V_{CC} = 0V$ ,  $V_{EE} = -3.135V$  to  $-3.465V$ ). The fully differential architecture and low propagation delay make it ideal for use in clock distribution circuits. The select pins have internal pulldown resistors. Leaving one input unconnected (pulled to logic low by the internal resistor) will transform the device into a 2:1 multiplexer. The SEL1 pin is the most significant bit and the binary number applied to the select pins will select the same numbered data input (i.e., 00 selects CLK0, nCLK0).

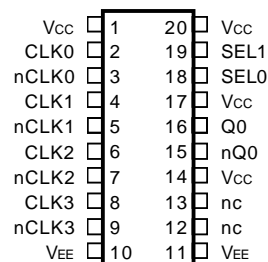
### FEATURES

- High speed differential multiplexer. The device can be configured as either a 4:1 or 2:1 multiplexer
- 1 differential 3.3V LVPECL output
- 4 selectable CLK, nCLK inputs
- CLK, nCLK pair can accept the following differential input levels: LVDS, LVPECL, LVHSTL, SSTL, HCSL
- Maximum output frequency up to 750MHz
- Translates any single ended input signal to 3.3V LVPECL levels with resistor bias on nCLKx input
- Part-to-part skew: 150ps (maximum)
- Propagation delay: 1.5ns (maximum)
- LVPECL mode operating voltage supply range:  
 $V_{CC} = 3.135V$  to  $3.465V$ ,  $V_{EE} = 0V$
- ECL mode operating voltage supply range:  
 $V_{CC} = 0V$ ,  $V_{EE} = -3.135V$  to  $-3.465V$
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request

### BLOCK DIAGRAM



### PIN ASSIGNMENT



### ICS85357-01

20-Lead TSSOP

4.40mm x 6.50mm x 0.90mm body package

G Package

Top View



**TABLE 1. PIN DESCRIPTIONS**

Number	Name	Type		Description
1, 14, 17, 20	V <sub>CC</sub>	Power		Positive supply pins. Connect to 3.3V.
2	CLK0	Input	Pulldown	Non-inverting differential clock input.
3	nCLK0	Input	Pullup	Inverting differential clock input.
4	CLK1	Input	Pulldown	Non-inverting differential clock input.
5	nCLK1	Input	Pullup	Inverting differential clock input.
6	CLK2	Input	Pulldown	Non-inverting differential clock input.
7	nCLK2	Input	Pullup	Inverting differential clock input.
8	CLK3	Input	Pulldown	Non-inverting differential clock input.
9	nCLK3	Input	Pullup	Inverting differential clock input.
10, 11	V <sub>EE</sub>	Power		Negative supply pins. Connect to ground.
12, 13	nc	Unused		No connect.
15, 16	nQ0, Q0	Output		Differential output pairs. LVPECL interface levels.
18	SEL0	Input	Pulldown	Clock select input. LVCMOS / LVTTTL interface levels.
19	SEL1	Input	Pulldown	Clock select input. LVCMOS / LVTTTL interface levels.

NOTE: *Pullup* and *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 <sub>IN</sub>	Input Capacitance	CLK, nCLK, CLK1, nCLK1, CLK2, nCLK2, CLK3, nCLK3				4	pF
		SEL0, SEL1				4	pF
R <sub>PULLUP</sub>	Input Pullup Resistor				51		KΩ
R <sub>PULLDOWN</sub>	Input Pulldown Resistor				51		KΩ

**TABLE 3. CONTROL INPUT FUNCTION TABLE**

Inputs		Clock Out
SEL1	SEL0	CLK
0	0	CLK0, nCLK0
0	1	CLK1, nCLK1
1	0	CLK2, nCLK2
1	1	CLK3, nCLK3



#### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{CC}$	4.6V
Inputs, $V_I$	-0.5V to $V_{CC} + 0.5V$
Outputs, $V_O$	-0.5V to $V_{CC} + 0.5V$
Package Thermal Impedance, $\theta_{JA}$	73.2°C/W (0lfpm)
Storage Temperature, $T_{STG}$	-65°C to 150°C

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,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{CC}$	Positive Supply Voltage		3.135	3.3	3.465	V
$I_{EE}$	Power Supply Current				35	mA

**TABLE 4B. LVCMOS / LVTTTL DC CHARACTERISTICS,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage	SEL0, SEL1	2		3.765	V
$V_{IL}$	Input Low Voltage	SEL0, SEL1	-0.3		0.8	V
$I_{IH}$	Input High Current	SEL0, SEL1 $V_{CC} = V_{IN} = 3.465V$			150	$\mu A$
$I_{IL}$	Input Low Current	SEL0, SEL1 $V_{CC} = 3.465V, V_{IN} = 0V$	-5			$\mu A$

**TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$I_{IH}$	Input High Current	CLK0, CLK1, CLK2, CLK3 $V_{CC} = V_{IN} = 3.465V$			150	$\mu A$
		nCLK0, nCLK1, nCLK2, nCLK3 $V_{CC} = V_{IN} = 3.465V$			5	$\mu A$
$I_{IL}$	Input Low Current	CLK0, CLK1, CLK2, CLK3 $V_{CC} = 3.465V, V_{IN} = 0V$	-5			$\mu A$
		nCLK0, nCLK1, nCLK2, nCLK3 $V_{CC} = 3.465V, V_{IN} = 0V$	-150			$\mu A$
$V_{PP}$	Peak-to-Peak Voltage		0.15		1.3	V
$V_{CMR}$	Common Mode Input Voltage; NOTE 1, 2		$V_{EE} + 0.5$		$V_{CC} - 0.85$	V

NOTE 1: Common mode input voltage is defined as  $V_{IH}$ .

NOTE 2: For single ended applications, the maximum input voltage for CLKx, nCLKx is  $V_{CC} + 0.3V$ .



**TABLE 4D. LVPECL DC CHARACTERISTICS**,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OH}$	Output High Voltage; NOTE 1		$V_{CC} - 1.4$		$V_{CC} - 1.0$	V
$V_{OL}$	Output Low Voltage; NOTE 1		$V_{CC} - 2.0$		$V_{CC} - 1.7$	V
$V_{SWING}$	Peak-to-Peak Output Voltage Swing		0.6		0.85	V

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

**TABLE 5. AC CHARACTERISTICS**,  $V_{CC} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{MAX}$	Maximum Output Frequency				750	MHz
$t_{PD}$	Propagation Delay; NOTE 1	$f \leq 750MHz$	1	1.2	1.5	ns
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 2, 3				150	ps
$t_R$	Output Rise Time	20% to 80% @50MHz	300	400	700	ps
$t_F$	Output Fall Time	20% to 80% @50MHz	300	400	700	ps
odc	Output Duty Cycle		47		53	%

All parameters measured at 500MHz unless noted otherwise.

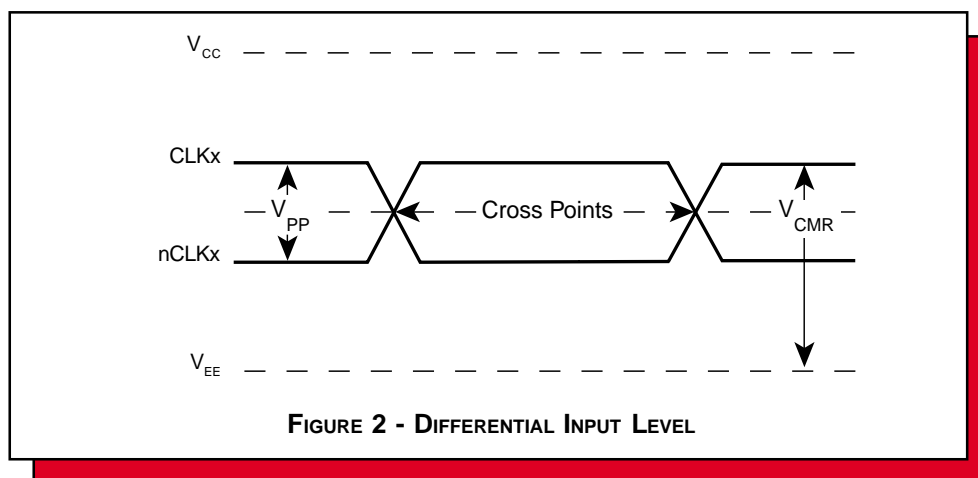
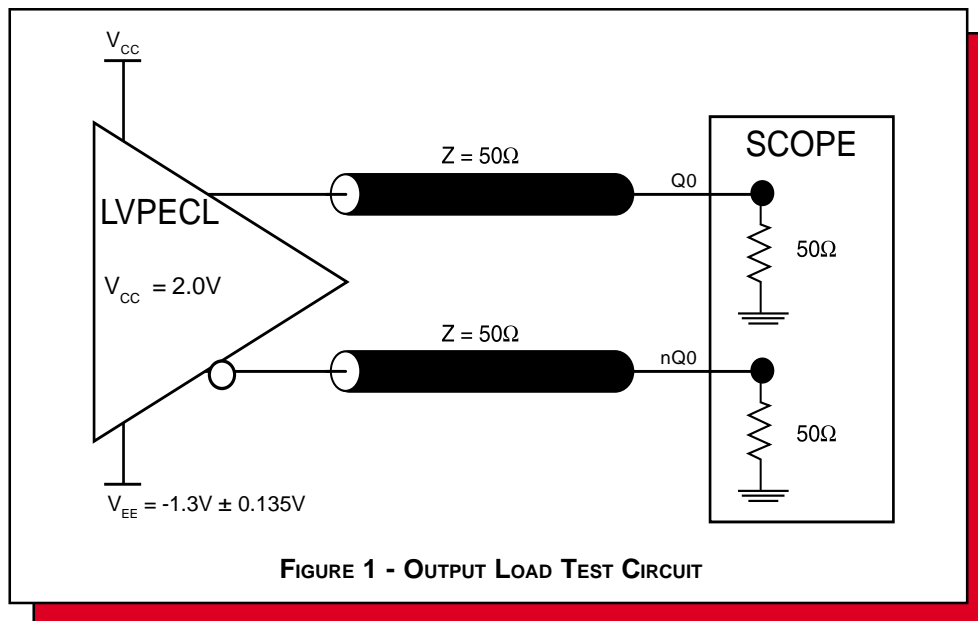
NOTE 1: Measured from the differential input crossing point to the differential output crossing point.

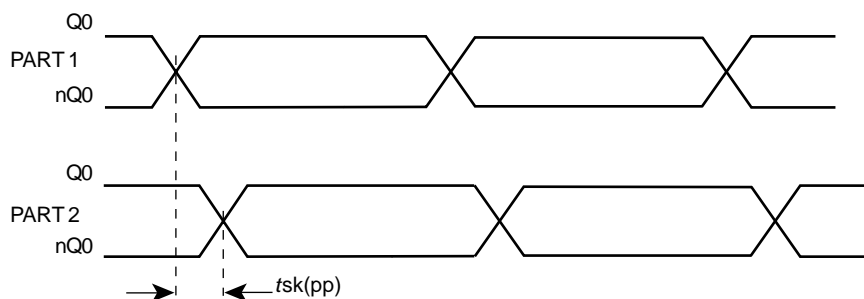
NOTE 2: Defined as skew between outputs on different devices operating at the same supply voltages and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential cross points.

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.



## PARAMETER MEASUREMENT INFORMATION

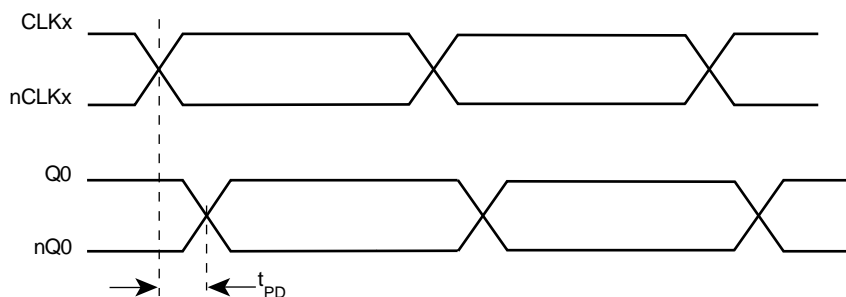




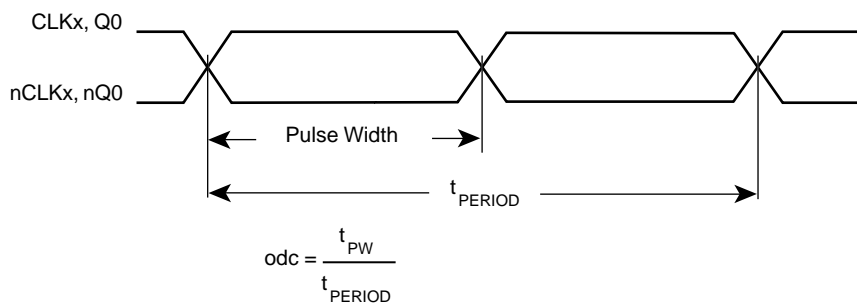
**FIGURE 3- PART-TO-PART SKEW**



**FIGURE 4 - INPUT AND OUTPUT RISE AND FALL TIME**



**FIGURE 5 - PROPAGATION DELAY**



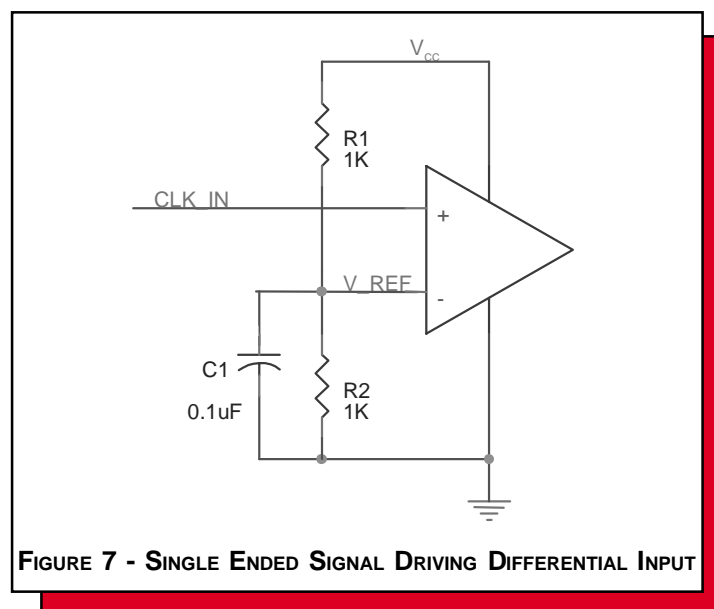
**FIGURE 6 - odc &  $t_{PERIOD}$**



## APPLICATION INFORMATION

### WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 7 shows how the differential input can be wired to accept single ended levels. The reference voltage  $V_{REF} \approx V_{CC}/2$  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 7 - SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT**



## POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the ICS85357-01. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS85357-01 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{CC} = 3.3V + 5\% = 3.465V$ , 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> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 35mA = 121.3mW$
- Power (outputs)<sub>MAX</sub> = **30.2mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $1 * 30.2mW = 30.2mW$

$$\text{Total Power}_{\_MAX} (3.465V, \text{ with all outputs switching}) = 173.25mW + 120.8mW = 151.5mW$$

### 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 a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 66.6°C/W per Table 6 below.

Therefore,  $T_j$  for an ambient temperature of 70°C with all outputs switching is:

$$70^\circ C + 0.151W * 66.6^\circ C/W = 80.06^\circ C. \text{ This is well below the limit of } 125^\circ C$$

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 (single layer or multi-layer).

**Table 6. Thermal Resistance  $\theta_{JA}$  for 20-pin TSSOP, Forced Convection**

$\theta_{JA}$ by Velocity (Linear Feet per Minute)			
	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	114.5°C/W	98.0°C/W	88.0°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	73.2°C/W	66.6°C/W	63.5°C/W
<b>NOTE:</b> Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.			

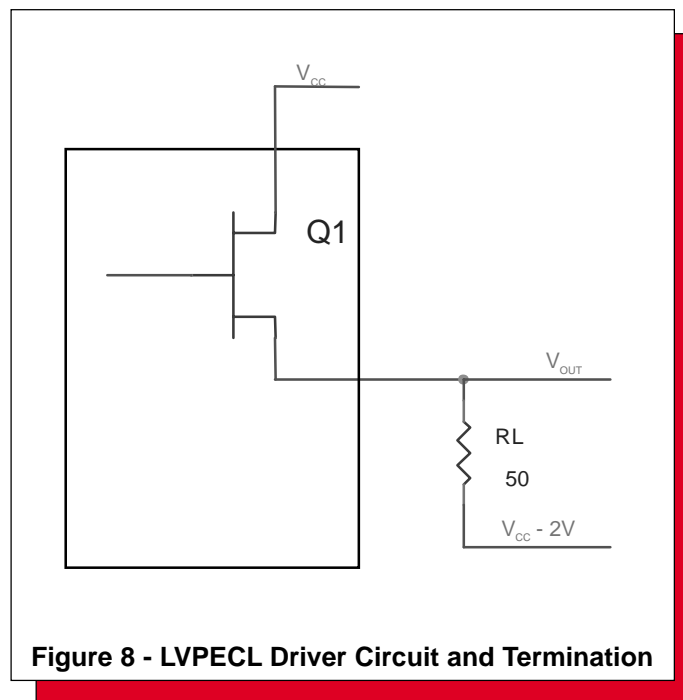




### 3. Calculations and Equations.

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

LVPECL output driver circuit and termination are shown in *Figure 8*.



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

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

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

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

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

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CC\_MAX} - 1.0V$

Using  $V_{CC\_MAX} = 3.465V$ , this results in  $V_{OH\_MAX} = 2.465V$

- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CC\_MAX} - 1.7V$

Using  $V_{CC\_MAX} = 3.465V$ , this results in  $V_{OL\_MAX} = 1.765V$

$$Pd\_H = [(2.465V - (3.465V - 2V)) / 50\Omega] * (3.465V - 2.465V) = 20mW$$

$$Pd\_L = [(1.765V - (3.465V - 2V)) / 50\Omega] * (3.465V - 1.765V) = 10.2mW$$

$$\text{Total Power Dissipation per output pair} = Pd\_H + Pd\_L = 30.2mW$$



## RELIABILITY INFORMATION

**TABLE 7.  $\theta_{JA}$  VS. AIR FLOW TABLE**

$\theta_{JA}$ by Velocity (Linear Feet per Minute)			
	0	200	500
Single-Layer PCB, JEDEC Standard Test Boards	114.5°C/W	98.0°C/W	88.0°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	73.2°C/W	66.6°C/W	63.5°C/W

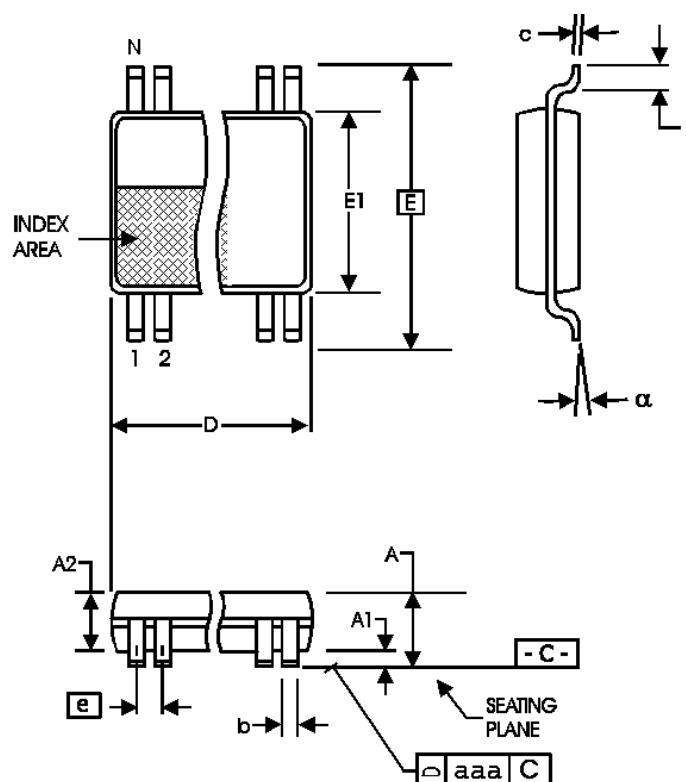
**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

### TRANSISTOR COUNT

The transistor count for ICS85357-01 is: 400



**PACKAGE OUTLINE - G SUFFIX**



**TABLE 8. PACKAGE DIMENSIONS**

SYMBOL	Millimeters	
	MIN	MAX
N	20	
A	--	1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	6.40	6.60
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



Integrated  
Circuit  
Systems, Inc.

**ICS85357-01**

4:1 OR 2:1

**DIFFERENTIAL-TO-3.3V LVPECL / ECL CLOCK MULTIPLEXER**

**TABLE 9. ORDERING INFORMATION**

Part/Order Number	Marking	Package	Count	Temperature
ICS85357AG-01	ICS85357AG-01	20 lead TSSOP	74 per tube	0°C to 70°C
ICS85357AG-01T	ICS85357AG-01	20 lead TSSOP on Tape and Reel	2500	0°C to 70°C

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