PRELIMINARY

Integrated
Circuit
Systems, Inc.

ICS85214
Low Skew, 1-to-5
Differential-to-LVHSTL Fanout Buffer

General Description

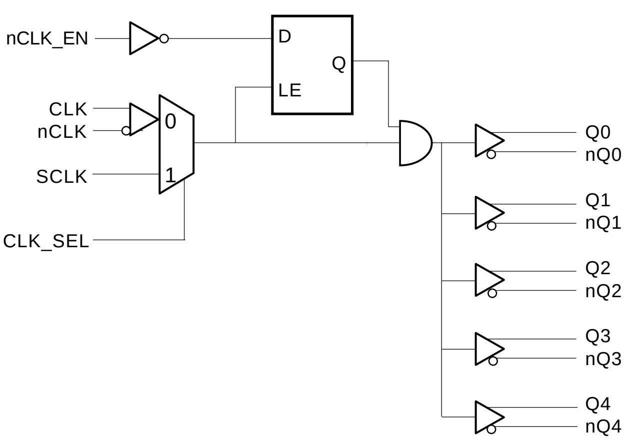
ICS HiPerClockS™

The ICS85214 is a low skew, high performance 1-to-5 Differential-to-LVHSTL Fanout Buffer and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The CLK, nCLK pair can accept most standard differential input levels. The single ended SCLK input accepts LVCMOS or LVTTL input levels. Guaranteed output and part-to-part skew characteristics make the ICS85214 ideal for those clock distribution applications demanding well defined performance and repeatability.

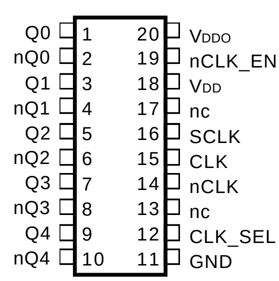
Features

- 5 differential LVHSTL outputs
- Selectable differential CLK, nCLK or LVCMOS clock inputs
- CLK, nCLK pair can accept the following differential input levels: LVDS, LVPECL, LVHSTL, SSTL, HCSL
- SCLK can accept the following input levels: LVCMOS or LVTTL
- Output frequency up to 650MHz
- Translates any single ended input signal to 3.3V LVHSTL levels with resistor bias on nCLK input
- Output skew: TBD
- Part-to-part skew: TBD
- Propagation delay: CLK, nCLK - 1.4ns (typical)
  SCLK - 1.6ns (typical)
- 3.3V core, 1.8V output operating supply
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request

Block Diagram



Pin Assignment



ICS85214
20-Lead TSSOP
6.5mm x 4.4mm x 0.92mm 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, 2	Q0, nQ0	Output		Differential output pair. LVHSTL interface levels.
3, 4	Q1, nQ1	Output		Differential output pair. LVHSTL interface levels.
5, 6	Q2, nQ2	Output		Differential output pair. LVHSTL interface levels.
7, 8	Q3, nQ3	Output		Differential output pair. LVHSTL interface levels.
9, 10	Q4, nQ4	Output		Differential output pair. LVHSTL interface levels.
11	GND	Power		Power supply ground. Connect to ground.
12	CLK_SEL	Input	Pulldown	Clock select input. When HIGH, selects SCLK input. When LOW, selects CLK, nCLK input. LVTTL / LVCMOS interface levels.
13, 17	nc	Unused		No connect.
14	nCLK	Input	Pullup	Inverting differential clock input.
15	CLK	Input	Pulldown	Non-inverting differential clock input.
16	SCLK	Input	Pulldown	Clock input. LVTTL / LVCMOS interface levels
18	V_{DD}	Power		Positive supply pin. Connect to 3.3V.
19	nCLK_EN	Input	Pullup	Synchronizing clock enable. When LOW, clock outputs follow clock input. When HIGH, Q outputs are forced low, nQ outputs are forced high. LVTTL / LVCMOS interface levels.
20	V_{DDO}	Power		Output supply pin. Connect to 1.8V.

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
C_{IN}	Input Capacitance				4	pF
R_{PULLUP}	Input Pullup Resistor			51		KΩ
$R_{PULLDOWN}$	Input Pulldown Resistor			51		KΩ

TABLE 3A. CONTROL INPUT FUNCTION TABLE

Inputs	Outputs	
nCLK_EN	**Q0 thru Q4**	**nQ0 thru nQ4**
0	Enabled	Enabled
1	Disabled; LOW	Disabled; HIGH

After nCLK_EN switches, the clock outputs are disabled or enabled following a rising and falling input clock edge as shown in Figure 1.

In the active mode, the state of the outputs are a function of the CLK, nCLK inputs as described in Table 3B.

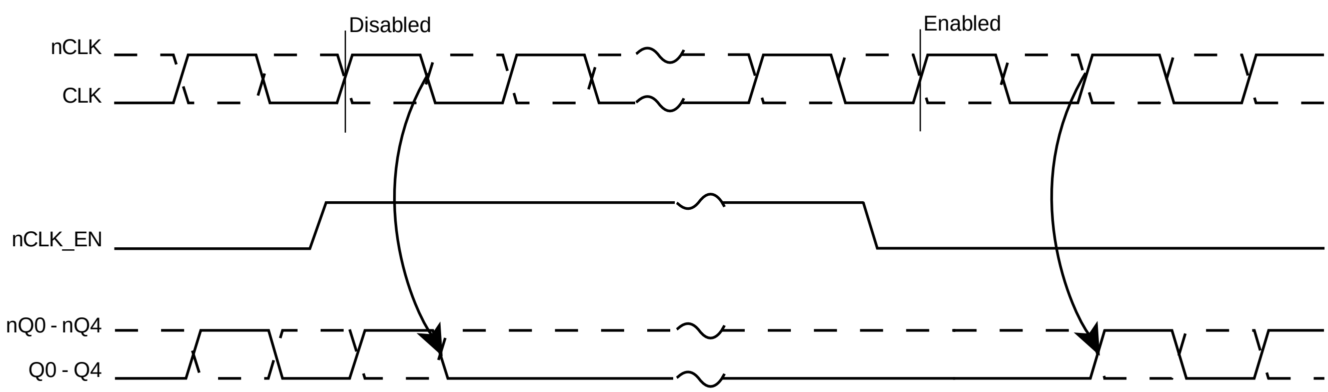


FIGURE 1 - nCLK_EN TIMING DIAGRAM

TABLE 3B. CLOCK INPUT FUNCTION TABLE

Inputs		Outputs		Input to Output Mode	Polarity
CLK, SCLK	**nCLK**	**Q0 thru Q4**	**nQ0 thru nQ4**		
0	1	LOW	HIGH	Differential to Differential	Non Inverting
1	0	HIGH	LOW	Differential to Differential	Non Inverting
0	Biased; NOTE 1	LOW	HIGH	Single Ended to Differential	Non Inverting
1	Biased; NOTE 1	HIGH	LOW	Single Ended to Differential	Non Inverting
Biased; NOTE 1	0	HIGH	LOW	Single Ended to Differential	Inverting
Biased; NOTE 1	1	LOW	HIGH	Single Ended to Differential	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_{DDx}	4.6V
Inputs, V_I	-0.5V to V_{DD} + 0.5V
Outputs, V_O	-0.5V to V_{DDO} + 0.5V
Package Thermal Impedance, θ_{JA}	73.2°C/W (0 lfpm)
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_{DD} = 3.3V±5%, V_{DDO} = 1.8V±0.2V, TA = 0°C TO 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Input Power Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Power Supply Voltage		1.6	1.8	2.0	V
I_{DD}	Power Supply Current			TBD		mA
I_{DDO}	Output Supply Current			TBD		mA

TABLE 4B. LVCMOS / LVTTL DC CHARACTERISTICS, V_{DD} = 3.3V±5%, V_{DDO} = 1.8V±0.2V, TA = 0°C TO 70°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	nCLK_EN, CLK_SEL		2		V_{DD} + 0.3	V
		SCLK		2		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage	nCLK_EN, CLK_SEL		-0.3		0.8	V
		SCLK		-0.3		1.3	V
I_{IH}	Input High Current	nCLK_EN	$V_{DD} = V_{IN}$ = 3.465V			5	µA
		SCLK, CLK_SEL	$V_{DD} = V_{IN}$ = 3.465V			150	µA
I_{IL}	Input Low Current	nCLK_EN	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
		SCLK, CLK_SEL	V_{DD} = 3.465V, V_{IN} = 0V	-5			µA

TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS, V_{DD} = 3.3V±5%, V_{DDO} = 1.8V±0.2V, TA = 0°C TO 70°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	nCLK	$V_{DD} = V_{IN}$ = 3.465V			5	µA
		CLK	$V_{DD} = V_{IN}$ = 3.465V			150	µA
I_{IL}	Input Low Current	nCLK	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
		CLK	V_{DD} = 3.465V, V_{IN} = 0V	-5			µA
V_{PP}	Peak-to-Peak Input Voltage			0.15		1.3	V
V_{CMR}	Common Mode Input Voltage; NOTE 1, 2			0.5		V_{DD} - 0.85	V

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

TABLE 4D. LVHSTL DC CHARACTERISTICS, V_{DD} = 3.3V±5%, V_{DDO} = 1.8V±0.2V, TA = 0°C TO 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OH}	Output High Voltage; NOTE 1		1		1.4	V
V_{OL}	Output Low Voltage; NOTE 1		0		0.4	V
V_{OX}	Output Crossover Voltage		40% x (V_{OH} - V_{OL}) + V_{OL}		60% x (V_{OH} - V_{OL}) + V_{OL}	V
V_{SWING}	Peak-to-Peak Output Voltage Swing		0.6		1.1	V

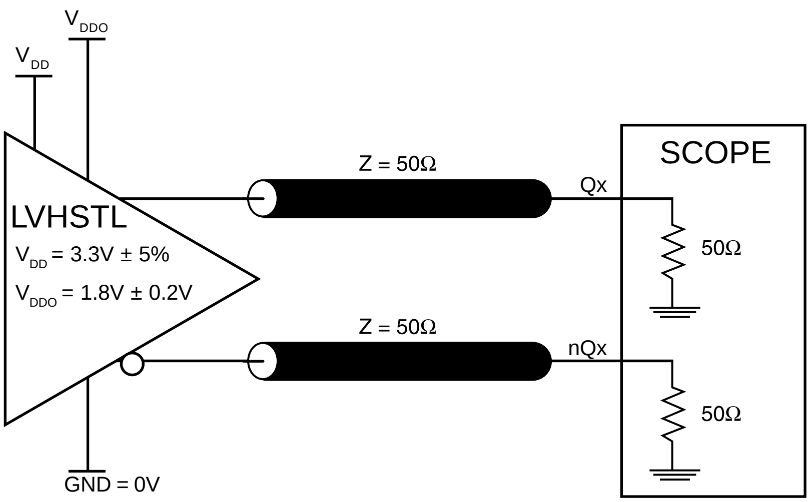
NOTE 1: Outputs terminated with 50Ω to ground.

TABLE 5. AC CHARACTERISTICS, V_{DD} = 3.3V±5%, V_{DDO} = 1.8V±0.2V, TA = 0°C TO 70°C

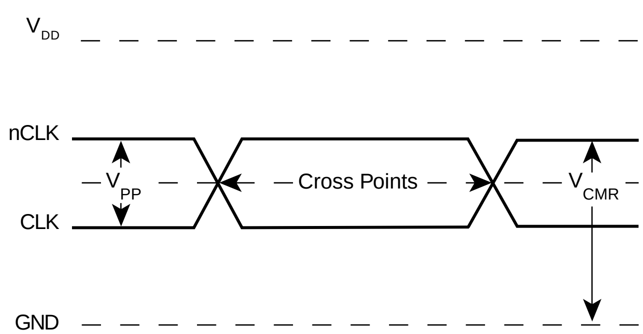
Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency					650	MHz
t_{PD}	Propagation Delay; NOTE 1	CLK, nCLK	$f \leq$ 650MHz		1.4		ns
		SCLK	$f \leq$ 650MHz		1.6		ns
*t*sk(o)	Output Skew; NOTE 2, 4				TBD		ps
*t*sk(pp)	Part-to-Part Skew; NOTE 3, 4				TBD		ps
t_R	Output Rise Time		20% to 80% @ 50MHz	300		700	ps
t_F	Output Fall Time		20% to 80% @ 50MHz	300		700	ps
odc	Output Duty Cycle			45		55	%

All parameters measured at 150MHz unless noted otherwise.
The cycle to cycle jitter on the input will equal the jitter on the output. The part does not add jitter.
NOTE 1: Measured from the differential input crossing point to the differential output crossing point.
NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at output differential cross points.
NOTE 3: 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 4: This parameter is defined in accordance with JEDEC Standard 65.

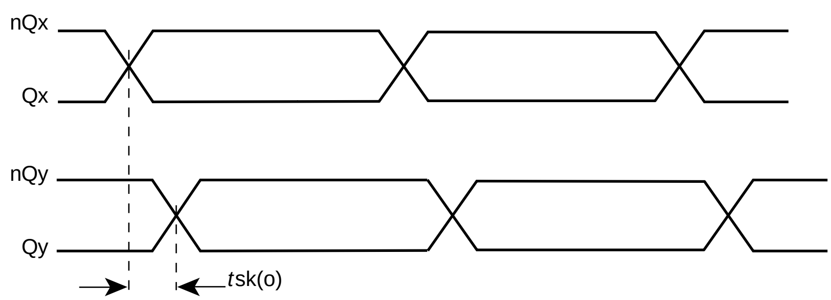
PARAMETER MEASUREMENT INFORMATION



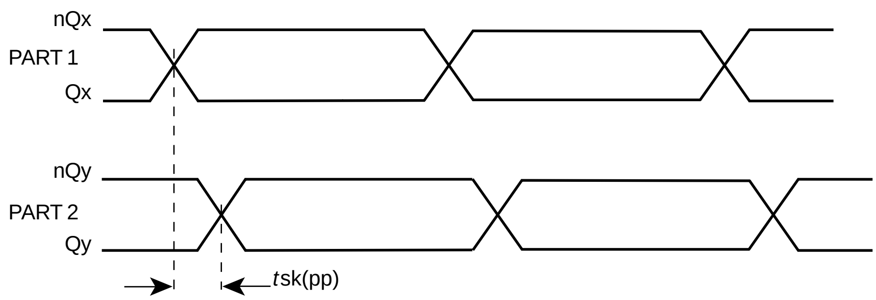
OUTPUT LOAD TEST CIRCUIT



DIFFERENTIAL INPUT LEVEL

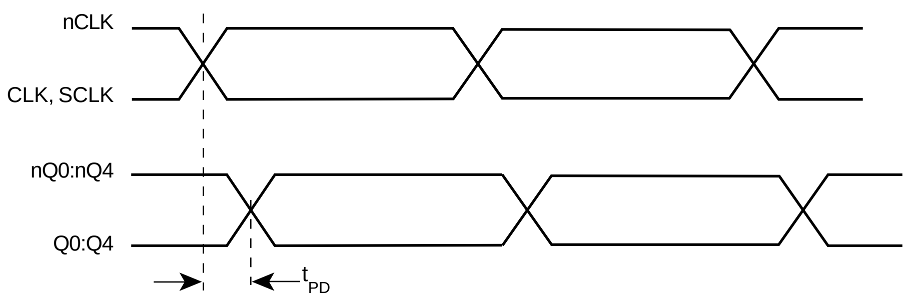


OUTPUT SKEW

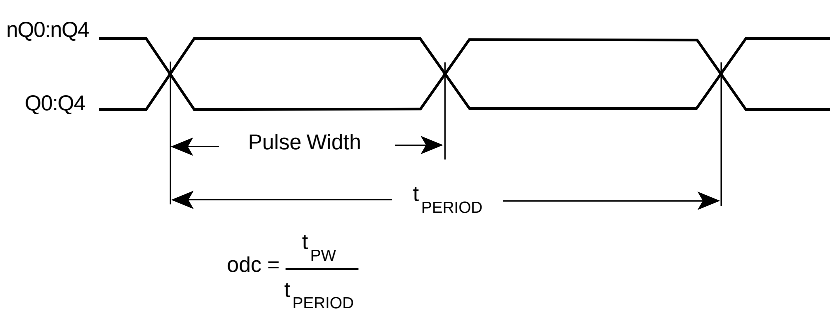


PART-TO-PART SKEW

INPUT AND OUTPUT RISE AND FALL TIME



PROPAGATION DELAY



odc & t_{PERIOD}

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. 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.

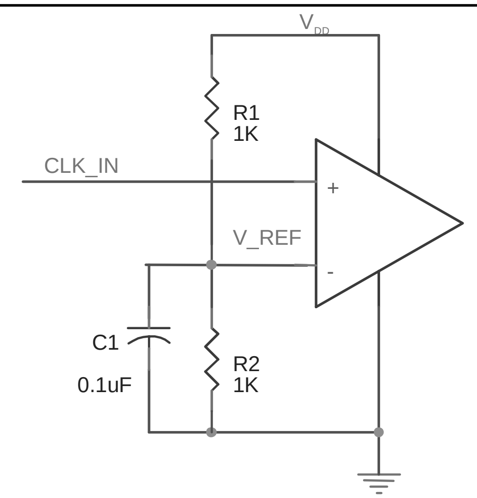


FIGURE 2 - SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT

POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the ICS85214.
Equations and example calculations are also provided.

1. Power Dissipation.
The total power dissipation for the ICS85214 is the sum of the core power plus the power dissipated in the load(s).
The following is the power dissipation for V_{DD} = 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 $(core)_{MAX} = V_{DD\_MAX} * I_{DD\_MAX}$ = 3.465V * 50mA = **173.3mW**
- Power $(outputs)_{MAX}$ = **32.8mW/Loaded Output pair**
  If all outputs are loaded, the total power is 5 * 32.8mW = **164mW**

Total Power $_{\_MAX}$ (3.465V, with all outputs switching) = 173.3mW + 164mW = **337.3mW**

2. Junction Temperature.
Junction temperature, Tj, 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 Tj is as follows: $Tj = \theta_{JA} * Pd\_total + T_A$

Tj = 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 66.6°C/W per Table 6 below.
Therefore, Tj for an ambient temperature of 70°C with all outputs switching is:

70°C + 0.337W * 66.6°C/W = 92.4°C. This is well below the limit of 125°C

This calculation is only an example. Tj 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 θ_{JA} FOR 20-PIN TSSOP, FORCED CONVECTION

θ_{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.

3. Calculations and Equations.

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

LVHSTL output driver circuit and termination are shown in *Figure 3.*

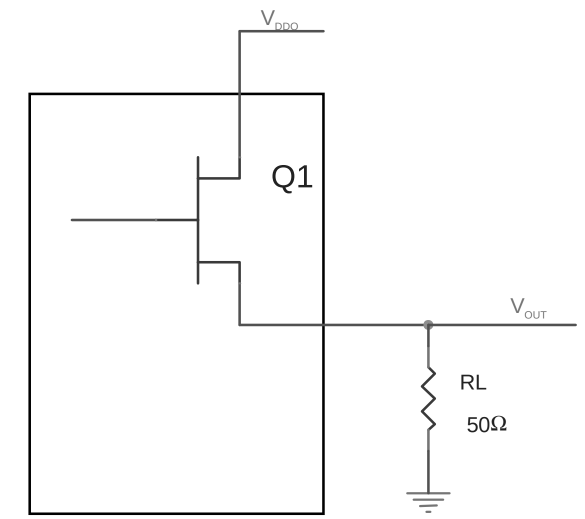


FIGURE 3 - LVHSTL DRIVER CIRCUIT AND TERMINATION

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load.

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

$$Pd\_H = (V_{OH\_MAX}/R_L) * (V_{DDO\_MAX} - V_{OH\_MAX})$$

$$Pd\_L = (V_{OL\_MAX}/R_L) * (V_{DDO\_MAX} - V_{OL\_MAX})$$

Pd_H = (1.0V/50Ω) * (2V - 1.0V) = **20mW**
Pd_L = (0.4V/50Ω) * (2V - 0.4V) = **12.8mW**

Total Power Dissipation per output pair = Pd_H + Pd_L = **32.8mW**

RELIABILITY INFORMATION

TABLE 7. θ_{JA} VS. AIR FLOW TABLE

θ_{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 ICS85214 is: 674

PACKAGE OUTLINE - G SUFFIX

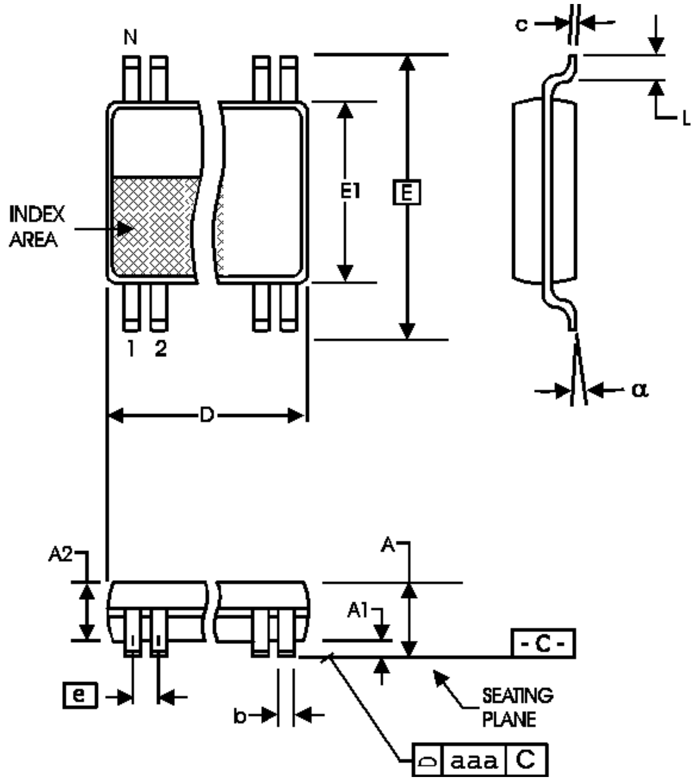


TABLE 8. PACKAGE DIMENSIONS

SYMBOL	Millimeters	
	Minimum	Maximum
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
α	0°	8°
aaa	--	0.10

Reference Document: JEDEC Publication 95, MO-153

TABLE 9. ORDERING INFORMATION

Part/Order Number	Marking	Package	Count	Temperature
ICS85214AG	ICS85214AG	20 lead TSSOP	72 per tube	0°C to 70°C
ICS85214AG	ICS85214AG	20 Lead TSSOP on Tape and Reel	2500	0°C to 70°C