Integrated Circuit Systems, Inc.

# ICS8501

## LOW SKEW 1-TO-16 DIFFERENTIAL CURRENT MODE FANOUT BUFFER

## GENERAL DESCRIPTION

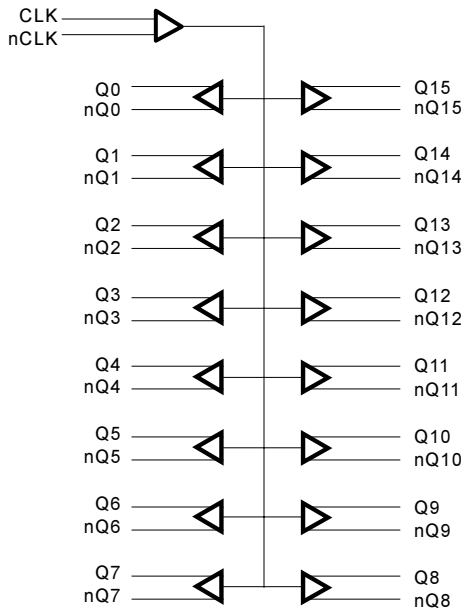
The ICS8501 is a low skew, 1-to-16 Differential Current Mode Fanout Buffer and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS8501 is designed to translate any differential signal levels to small swing differential current mode(DCM) output levels. An external reference resistor is used to set the value of the current supplied to an external load load/termination resistor. The load resistor value is chosen to equal the value of the characteristic line impedance of 50Ω. The ICS8501 is characterized at an operating supply voltage of 3.3V.

The small swing outputs, accurate crossover voltage and duty cycle makes the ICS8501 ideal for interfacing to today's most advanced microprocessors.

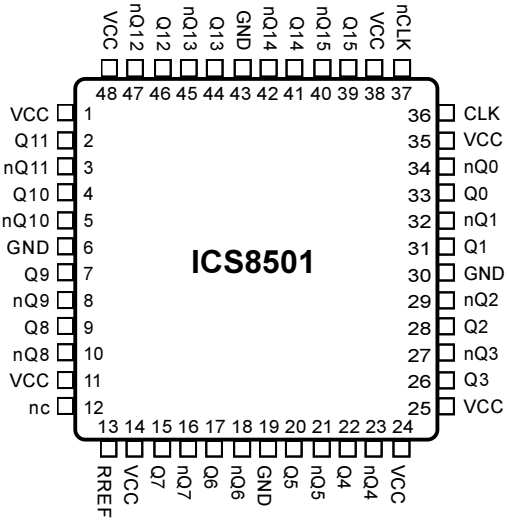
## FEATURES

- 16 small swing DCM outputs
- Translates any differential input signal(PECL, HSTL, LVDS, DCM) to DCM levels without external bias networks
- Translates single ended input levels to DCM levels with a resistor bias network on the nCLK input
- Translates single ended input levels to inverted DCM levels with a resistor bias network on the CLK input
- Voh(max) = 1.2V
- 40% of Voh ≤ Vcrossover ≤ 60% of Voh
- 45% ≤ Duty Cycle ≤ 55%
- Output frequency up to 500MHz
- 100ps output skew
- 3.3V operating supply
- 48 lead low-profile QFP(LQFP), 7mm x 7mm x 1.4mm package body, 0.5mm package lead pitch
- 0°C to 70°C ambient operating temperature

## BLOCK DIAGRAM




## PIN ASSIGNMENT




**48-Lead LQFP**
**Y Package**
Top View

**TABLE 1. PIN DESCRIPTIONS**

| Number | Name | Type | Description |
|---|---|---|---|
| 1, 11, 14, 24, 25, 35, 38, 48 | VCC | Power | Power supply pin. Connect to 3.3V. |
| 2, 3 | Q11, nQ11 | Output | Differential output. Differential current mode interface levels. |
| 4, 5 | Q10, nQ10 | Output | Differential output. Differential current mode interface levels. |
| 6, 19, 30, 43 | GND | Power | Power supply pin. Connect to ground. |
| 7, 8 | Q9, nQ9 | Output | Differential output. Differential current mode interface levels. |
| 9, 10 | Q8, nQ8 | Output | Differential output. Differential current mode interface levels. |
| 12 | nc | Unused | No connection. |
| 13 | RREF | Input | Reference current input. Used to set the output current. Connect to 475Ω resistor to ground. |
| 15, 16 | Q7, nQ7 | Output | Differential output. Differential current mode interface levels. |
| 17, 18 | Q6, nQ6 | Output | Differential output. Differential current mode interface levels. |
| 20, 21 | Q5, nQ5 | Output | Differential output. Differential current mode interface levels. |
| 22, 23 | Q4, nQ4 | Output | Differential output. Differential current mode interface levels. |
| 26, 27 | Q3, nQ3 | Output | Differential output. Differential current mode interface levels. |
| 28, 29 | Q2, nQ2 | Output | Differential output. Differential current mode interface levels. |
| 36 | CLK | Input | Non inverting differential clock input. Any differential input interface levels. |
| 37 | nCLK | Input | Inverting differential clock input. Any differential input interface levels. |
| 39, 40 | Q15, nQ15 | Output | Differential output. Differential current mode interface levels. |
| 41, 42 | Q14, nQ14 | Output | Differential output. Differential current mode interface levels. |
| 44, 45 | Q13, nQ13 | Output | Differential output. Differential current mode interface levels. |
| 46, 47 | Q12, nQ12 | Output | Differential output. Differential current mode interface levels. |

**TABLE 2. PIN CHARACTERISTICS**

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| CIN | Input Capacitance | | | 2 | | pF |
| CPD | Power Dissipation Capacitance (per output) | VCC = 3.465V, f=250MHz | | 4.6 | | pF |
| ROUT | Output Impedance | | | 14 | | KΩ |

**TABLE 3. FUNCTION TABLE**

| Inputs | | Outputs | | Input to Output Mode | Polarity |
|---|---|---|---|---|---|
| CLK | nCLK | Q0 thru Q15 | nQ0 thru nQ15 | | |
| 0 | 1 | 0 | 1 | Differential to Differential | Non Inverting |
| 1 | 0 | 1 | 0 | Differential to Differential | Non Inverting |
| 0 | Biased; NOTE 1 | 0 | 1 | Single Ended to Differential | Non Inverting |
| 1 | Biased; NOTE 1 | 1 | 0 | Single Ended to Differential | Non Inverting |
| Biased; NOTE 1 | 0 | 1 | 0 | Single Ended to Differential | Inverting |
| Biased; NOTE 1 | 1 | 0 | 1 | Single Ended to Differential | Inverting |

NOTE 1: Single ended use requires that one of the differential inputs be biased. The voltage at the biased input sets the switch point for the single ended input. For LVCMOS and LVTTL levels the recommended input bias network is a resistor to VCC, a resistor of equal value to ground and a 0.1μF capacitor from the input to ground. The resulting switch point is approximately VCC/2 ± 300mV.

### ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Supply Voltage | 4.6V |
| Inputs | -0.5V to VCC+0.5 V |
| Outputs | -0.5V to VCC+0.5V |
| Ambient Operating Temperature | 0°C to 70°C |
| Storage Temperature | -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 and functional operation of the device at these or any conditions beyond those listed in the *DC Electrical Characteristics* or *AC Electrical Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

**TABLE 4. DC ELECTRICAL CHARACTERISTICS,** VCC = 3.3V±5%, $T_A$ = 0°C TO 70°C

| Symbol | Parameter | | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|---|
| VCC | Operating Supply Voltage | | | 3.135 | 3.3 | 3.465 | V |
| VPP | Peak-to-Peak Input Voltage | | | 0.31 | | 1.3 | V |
| VCMR | Common Mode Input Voltage; NOTE 1 | | LVPECL Levels | 1.8 | | 2.4 | V |
| | | | DCM, HSTL, LVDS, SSTL Levels | 0.31 | | 1.3 | V |
| IIH | Input High Current | CLK, nCLK | VIN = VCC | | | 5 | µA |
| IIL | Input Low Current | CLK, nCLK | VIN = 0V | -5 | | | µA |
| ICC | Operating Supply Current | | | | | 70 | mA |
| IOH | Output Current; NOTE 2 | | 3.135V ≤ VCC ≤ 3.465V | 11 | 14 | 17 | mA |
| VOH | Output High Voltage | | RREF = 475Ω, RLOAD = 50Ω | 0.6 | 0.71 | 1.2 | V |
| VOL | Output Low Voltage | | RREF = 475Ω, RLOAD = 50Ω | | 0 | 0.05 | V |

NOTE 1: Common mode input voltage for LVPECL is defined as the minimum VIH. The LVPECL values noted in Table 4A are for VCC = 3.3V. VCMR for LVPECL will vary 1:1 with VCC. Common mode input voltage for DCM, HSTL, LVDS and SSTL is defined as the crossover voltage. See Figure 1A and 1B.
NOTE 2: IOH is the current per output being supplied to the load and should be included in the total supply current calculation. Therefore ICC(total) is equal to IOH times 16 plus ICC.

**TABLE 5. AC ELECTRICAL CHARACTERISTICS,** VCC = 3.3V±5%, $T_A$ = 0°C TO 70°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| fMAX | Maximum Input Frequency | Measured at the -3dB rolloff of the peak-to-peak output voltage | | | 500 | MHz |
| tpLH | Propagation Delay, Low-to-High | 0 < f ≤ 250MHz | 2 | | 3 | ns |
| tpHL | Propagation Delay, High-to-Low | 0 < f ≤ 250MHz | 2 | | 3 | ns |
| tsk(o) | Output Skew; NOTE 3 | Measured on at VOX | | | 100 | ps |
| tsk(pp) | Part-to-Part Skew; NOTE 4 | Measured on at VOX | | | 650 | ps |
| tR | Output Rise Time | 20% to 80% | 175 | | 700 | ps |
| tF | Output Fall Time | 20% to 80% | 175 | | 700 | ps |
| tPW | Output Pulse Width | | tCYCLE/2 - 0.3 | tCYCLE/2 | tCYCLE/2 + 0.3 | ns |
| VOX | Output Crossover Voltage | | 40% VOH | | 60% VOH | V |

NOTE 1: All parameters measured at 250MHz unless noted otherwise.
NOTE 2: RREF equals 475Ω. Outputs terminated with 50Ω resistor connected to ground.
NOTE 3: Defined as skew across outputs at the same supply voltages and with equal load conditions.
NOTE 4: Defined as skew at different outputs on different devices operating at the same supply voltages and with equal load conditions.

**FIGURE 1A, 1B, 1C - INPUT CLOCK WAVEFORMS**

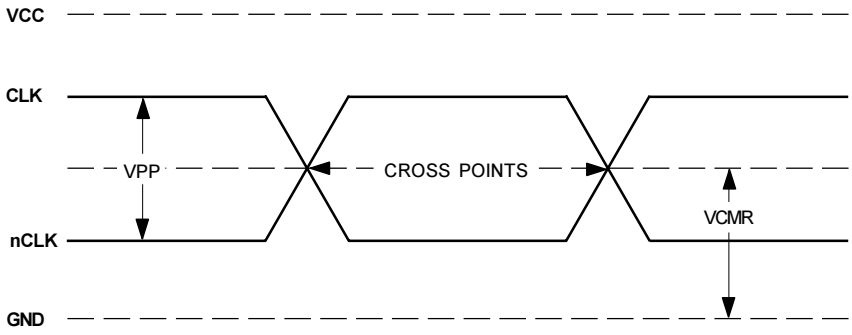



**FIGURE 1A - DCM, LVDS, HSTL, SSTL DIFFERENTIAL INPUT LEVELS**

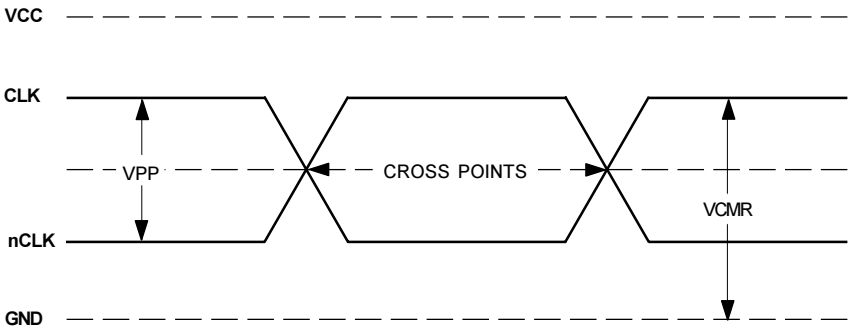



**FIGURE 1B - LVPECL DIFFERENTIAL INPUT LEVEL**

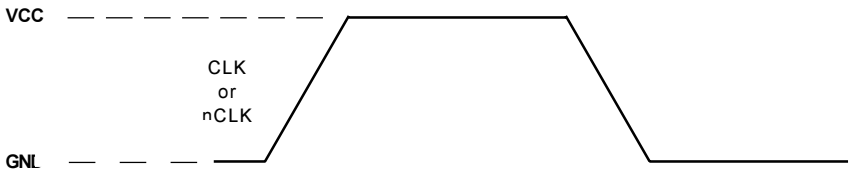



**FIGURE 1C- LVCMOS AND LVTTL SINGLE ENDED INPUT LEVEL**

**FIGURE 2A - TIMING WAVEFORMS**

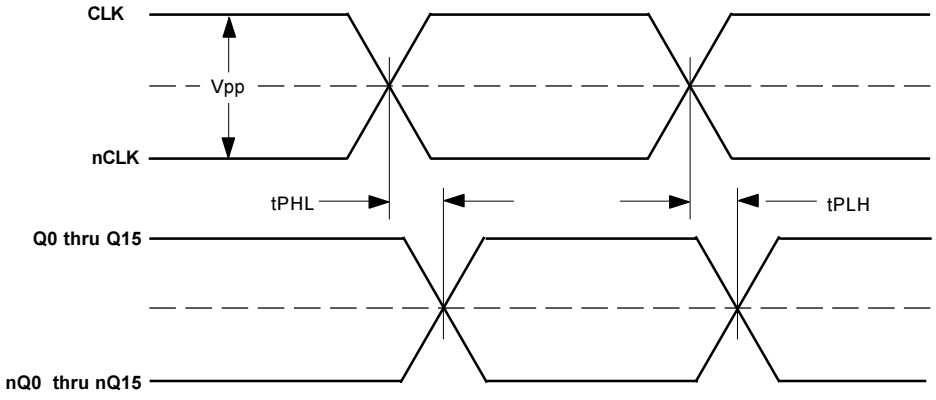



**FIGURE 3A - PROPAGATION DELAYS**

fin = 250MHz, Vpp = 300mV, tr = tf = 200ps

**FIGURE 3A - OUTPUT SKEW DEFINITION & WAVEFORMS**

**Output Skew -** Skew between any outputs. Outputs operating at the same temperature, supply voltages and with equal load conditions.

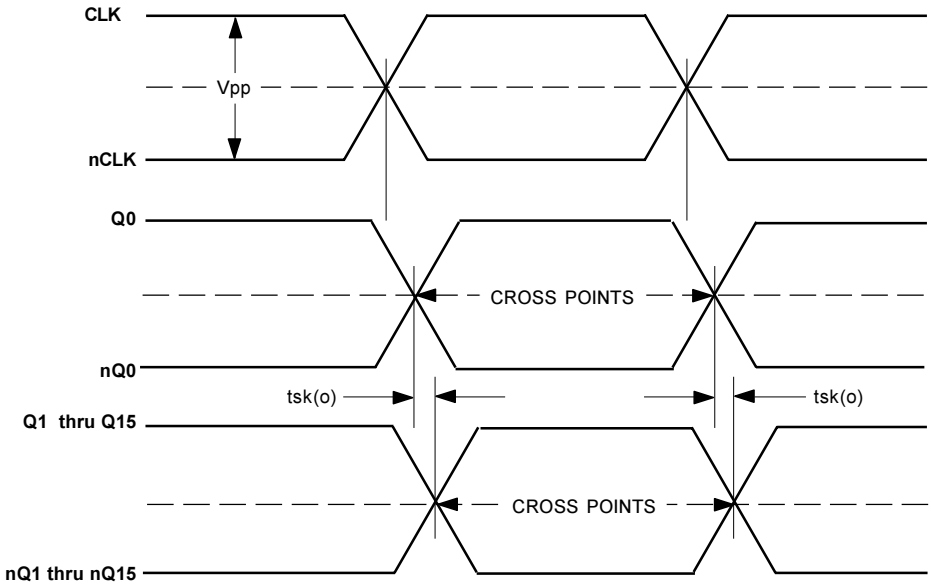



**FIGURE 3A - OUTPUT SKEW**

fin = 250MHz, Vpp = 300mV, tr = tf = 200ps

**FIGURE 3B - PART-TO-PART SKEW DEFINITION & WAVEFORMS**

**Part-to-Part Skew -** Skew between any outputs on different parts. Outputs operating at the same temperature, supply voltages and with equal load conditions.

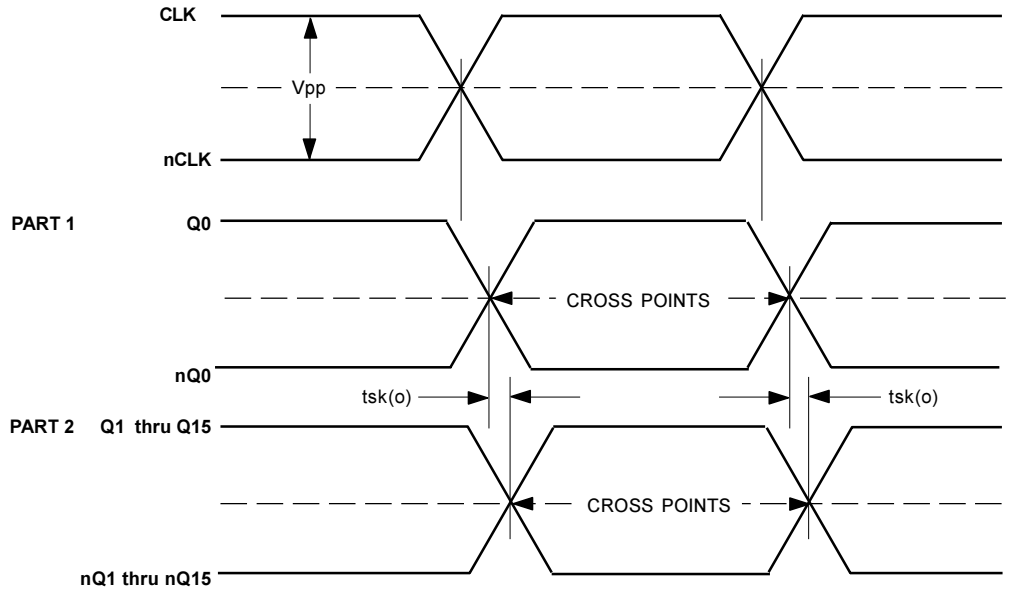
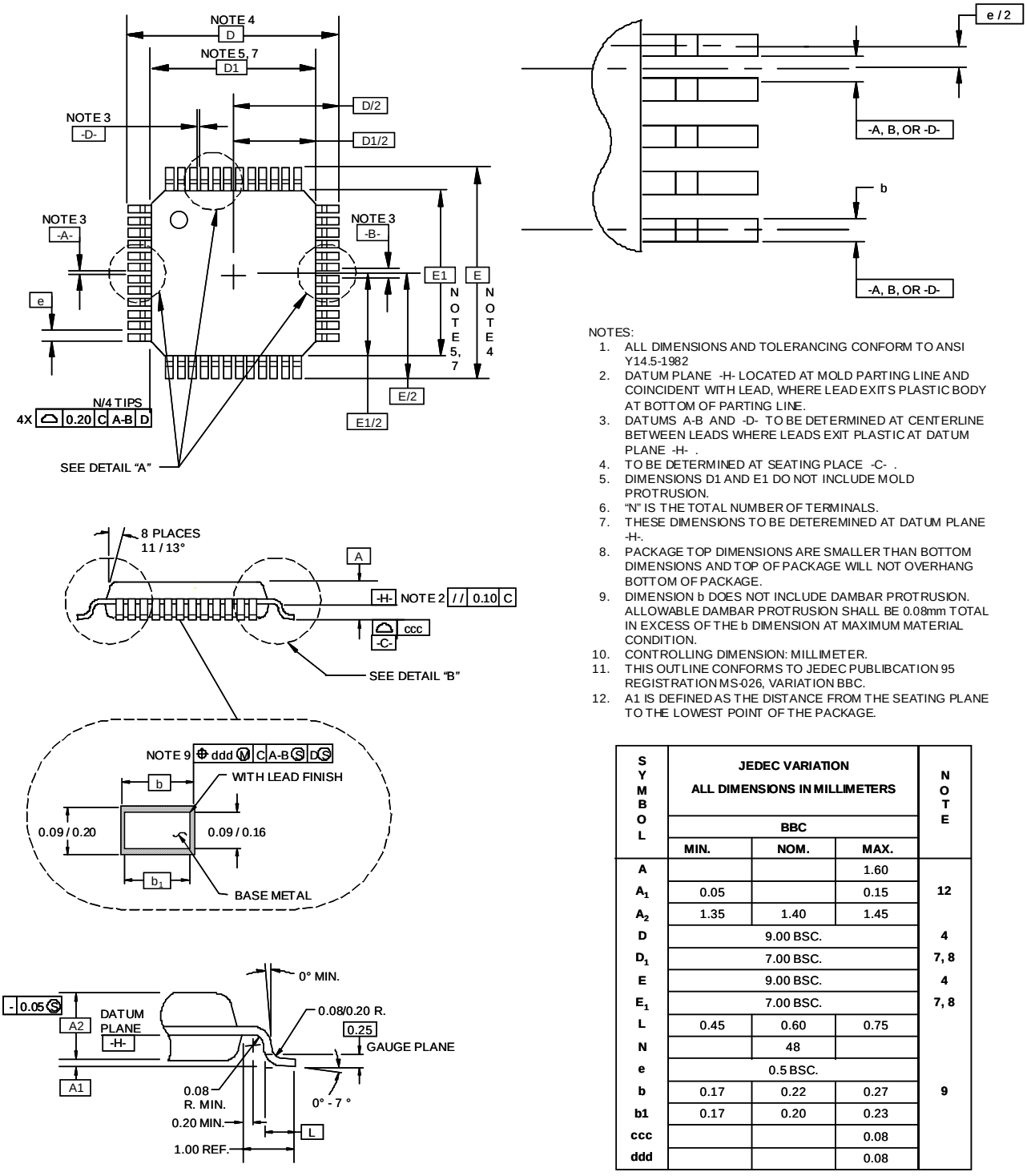



**FIGURE 3B - PART-TO-PART SKEW**

fin = 250MHz, Vpp = 300mV, tr = tf = 200ps

## PACKAGE OUTLINE AND DIMENSIONS - Y SUFFIX




NOTES:

1. ALL DIMENSIONS AND TOLERANCING CONFORM TO ANSI Y14.5-1982
2. DATUM PLANE -H- LOCATED AT MOLD PARTING LINE AND COINCIDENT WITH LEAD, WHERE LEAD EXITS PLASTIC BODY AT BOTTOM OF PARTING LINE.
3. DATUMS A-B AND -D- TO BE DETERMINED AT CENTERLINE BETWEEN LEADS WHERE LEADS EXIT PLASTIC AT DATUM PLANE -H- .
4. TO BE DETERMINED AT SEATING PLACE -C- .
5. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION.
6. "N" IS THE TOTAL NUMBER OF TERMINALS.
7. THESE DIMENSIONS TO BE DETEREMINED AT DATUM PLANE -H-.
8. PACKAGE TOP DIMENSIONS ARE SMALLER THAN BOTTOM DIMENSIONS AND TOP OF PACKAGE WILL NOT OVERHANG BOTTOM OF PACKAGE.
9. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08mm TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
10. CONTROLLING DIMENSION: MILLIMETER.
11. THIS OUTLINE CONFORMS TO JEDEC PUBLIBCATION 95 REGISTRATION MS-026, VARIATION BBC.
12. A1 IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE.

| SYMBOL | JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS | | | NOTE |
|---|---|---|---|---|
| | BBC | | | |
| | MIN. | NOM. | MAX. | |
| A | | | 1.60 | |
| $A_1$ | 0.05 | | 0.15 | 12 |
| $A_2$ | 1.35 | 1.40 | 1.45 | |
| D | | 9.00 BSC. | | 4 |
| $D_1$ | | 7.00 BSC. | | 7, 8 |
| E | | 9.00 BSC. | | 4 |
| $E_1$ | | 7.00 BSC. | | 7, 8 |
| L | 0.45 | 0.60 | 0.75 | |
| N | | 48 | | |
| e | | 0.5 BSC. | | |
| b | 0.17 | 0.22 | 0.27 | 9 |
| b1 | 0.17 | 0.20 | 0.23 | |
| ccc | | | 0.08 | |
| ddd | | | 0.08 | |

## ORDERING INFORMATION

| Part/Order Number | Marking | Package | Count | Temperature |
|---|---|---|---|---|
| ICS8501BY | ICS8501BY | 48 Lead LQFP | 250 per tray | 0°C to 70°C |
| ICS8501BYT | ICS8501BY | 48 Lead LQFP on Tape and Reel | 2000 | 0°C to 70°C |