



# 74VCX163245

## 16-BIT DUAL SUPPLY BUS TRANSCEIVER LEVEL TRANSLATOR

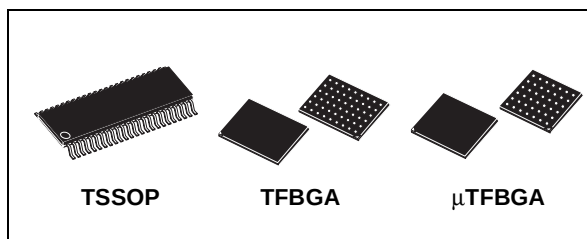
### TARGET DATA

- HIGH SPEED:  $t_{PD} = 4.4ns$  (MAX.) at  $T_A=85^\circ C$   
 $V_{CCA} = 3.0V$   $V_{CCB} = 2.3V$
- LOW POWER DISSIPATION:  
 $I_{CCA} = I_{CCB} = 20\mu A$  (MAX.) at  $T_A=85^\circ C$
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OHA}| = I_{OLA} = 12mA$  MIN at  
 $V_{CCA} = 3.0V$   $V_{CCB} = 1.65V$  or  $2.3V$   
 $|I_{OHA}| = I_{OLA} = 8mA$  MIN at  
 $V_{CCA} = 2.3V$   $V_{CCB} = 1.65V$
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \approx t_{PHL}$
- POWER DOWN PROTECTION ON INPUTS  
AND OUTPUTS
- OPERATING VOLTAGE RANGE:  
 $V_{CCA}(OPR) = 2.3V$  to  $3.6V$  (1.2V Data Retention)  
 $V_{CCB}(OPR) = 1.65V$  to  $2.7V$  (1.2V Data Retention)
- PIN AND FUNCTION COMPATIBLE WITH  
74 SERIES 16245
- LATCH-UP PERFORMANCE EXCEEDS  
500mA (JESD 17)
- ESD PERFORMANCE:  
HBM > 2000V (MIL STD 883 method 3015);  
MM > 200V

### DESCRIPTION

The 74VCX163245 is a dual supply low voltage CMOS 16-BIT BUS TRANSCEIVER fabricated with sub-micron silicon gate and five-layer metal wiring C<sup>2</sup>MOS technology. Designed for use as an interface between a 3.3V bus and a 2.5V or 1.8V bus in a mixed 3.3V/1.8V, 3.3V/2.5V and 2.5V/1.8V supply systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

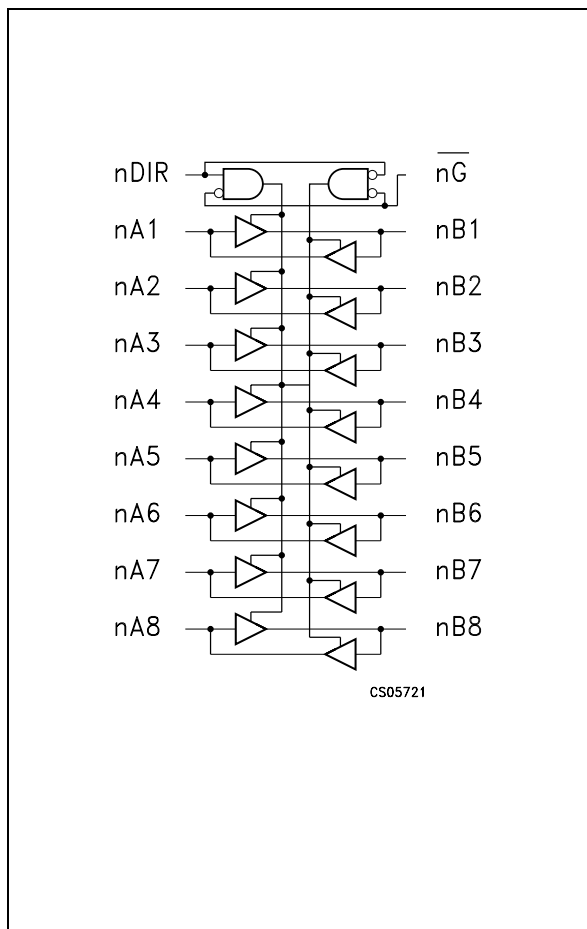
This IC is intended for two-way asynchronous communication between data buses and the direction of data transmission is determined by nDIR inputs. The enable inputs  $\overline{nOE}$  can be used to disable the device so that the buses are effectively isolated. The A-port interfaces with the 3V bus, the B-port with the 2.5V and 1.8V bus. All inputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage. All floating bus terminals during High Z State must be held HIGH or LOW.



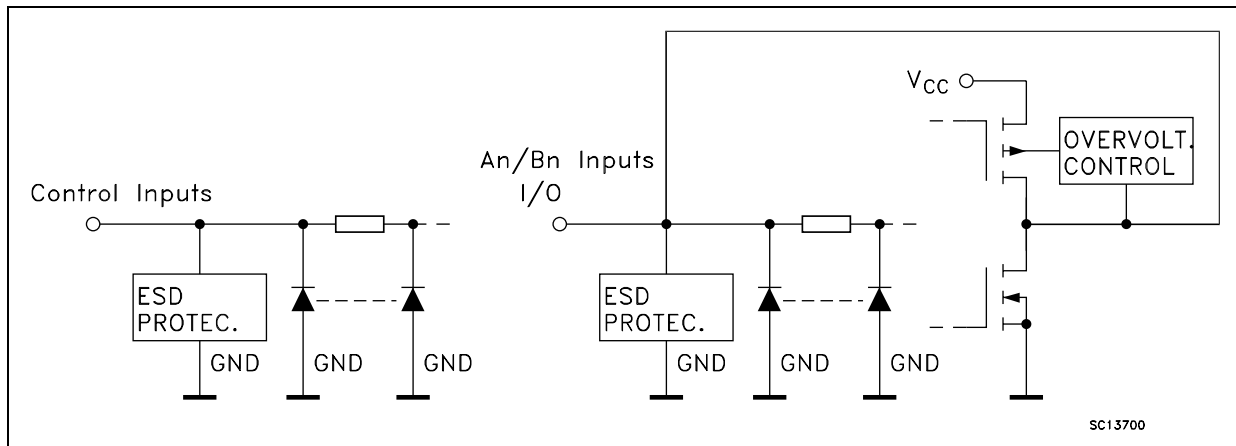
### ORDER CODES

| PACKAGE  | TRAY          | T & R          |
|----------|---------------|----------------|
| TSSOP48  |               | 74VCX163245TTR |
| TFBGA54  | 74VCX163245LB | 74VCX163245LBR |
| μTFBGA42 | 74VCX163245TB | 74VCX163245TBR |

### LOGIC DIAGRAM

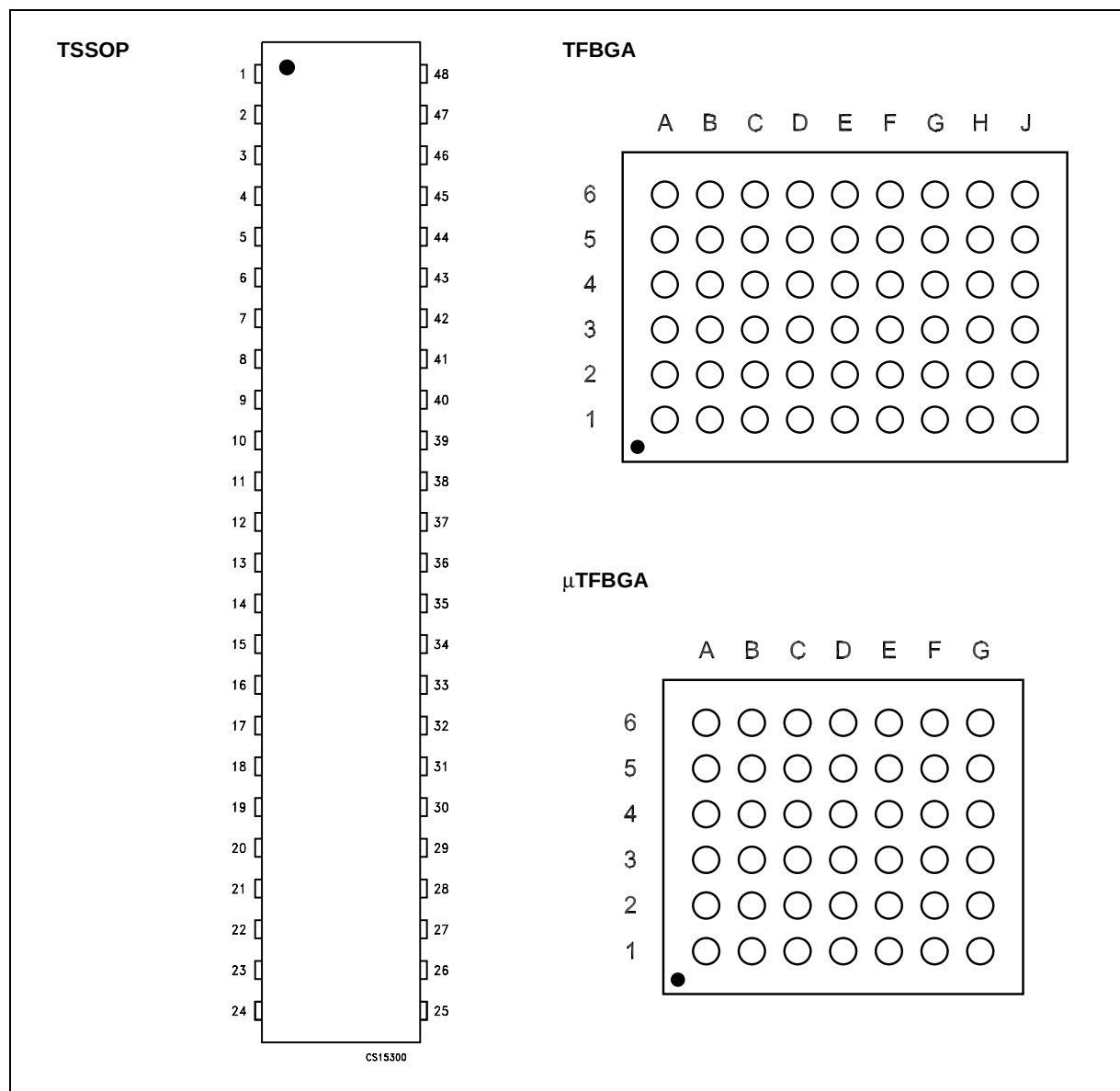


## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

| TFBGA54 PIN N°                 | μTFBGA42 PIN N°                | TSSOP PIN N°                   | SYMBOL           | NAME AND FUNCTION       |
|--------------------------------|--------------------------------|--------------------------------|------------------|-------------------------|
| A3                             | B3                             | 1                              | 1DIR             | Directional Controls    |
| J3                             | F3                             | 24                             | 2DIR             | Directional Controls    |
| A6, B5, B6, C5, C6, D5, D6, E5 | A4, A5, A6, B5, B6, C5, C6, D5 | 47, 46, 44, 43, 41, 40, 38, 37 | 1A1 to 1A8       | Data Inputs/Outputs     |
| E6, F5, F6, G5, G6, H5, H6, J6 | D6, E5, E6, F5, F6, G4, G5, G6 | 36, 35, 33, 32, 30, 29, 27, 26 | 2A1 to 2A8       | Data Inputs/Outputs     |
| A1, B2, B1, C2, C1, D2, D1, E2 | A3, A2, A1, B2, B1, C2, C1, D2 | 2, 3, 5, 6, 8, 9, 11, 12       | 1B1 to 1B8       | Data Inputs/Outputs     |
| E1, F2, F1, G2, G1, H2, H1, J1 | D1, E2, E1, F2, F1, G3, G2, G1 | 13, 14, 16, 17, 19, 20, 22, 23 | 2B1 to 2B8       | Data Inputs/Outputs     |
| J4                             | F4                             | 25                             | G2               | Output Enable Inputs    |
| A4                             | B4                             | 48                             | G1               | Output Enable Inputs    |
| D3, D4, E3, E4, F3, F4         | C3, C4, E3, E4                 | 4, 10, 15, 21, 28, 34, 39, 45  | GND              | Ground (0V)             |
| A2, A5, B3, B4, H3, H4, J2, J5 | -                              | -                              | NC               | No Connected            |
| C4, G4                         | D4                             | 42, 31                         | V <sub>CCA</sub> | Positive Supply Voltage |
| C3, G3                         | D3                             | 7, 18                          | V <sub>CCB</sub> | Positive Supply Voltage |

**PIN CONNECTION** (top view for TSSOP, bottom view for BGA)**TRUTH TABLE**

| INPUTS         |     | FUNCTION |        | OUTPUT |
|----------------|-----|----------|--------|--------|
| $\overline{G}$ | DIR | A BUS    | B BUS  |        |
| L              | L   | OUTPUT   | INPUT  | A = B  |
| L              | H   | INPUT    | OUTPUT | B = A  |
| H              | X   | Z        | Z      | Z      |

X=Don't care; Z=High Impedance

## ABSOLUTE MAXIMUM RATINGS

| Symbol     | Parameter                        | Value                   | Unit |
|------------|----------------------------------|-------------------------|------|
| $V_{CCA}$  | Supply Voltage                   | -0.5 to +4.6            | V    |
| $V_{CCB}$  | Supply Voltage                   | -0.5 to +4.6            | V    |
| $V_I$      | DC Input Voltage                 | -0.5 to +4.6            | V    |
| $V_{I/OA}$ | DC I/O Voltage (Output disabled) | -0.5 to +4.6            | V    |
| $V_{I/OB}$ | DC I/O Voltage (Output disabled) | -0.5 to +4.6            | V    |
| $V_{I/OA}$ | DC I/O Voltage                   | -0.5 to $V_{CCA} + 0.5$ | V    |
| $V_{I/OB}$ | DC I/O Voltage                   | -0.5 to $V_{CCB} + 0.5$ | V    |
| $I_{IK}$   | DC Input Diode Current           | - 20                    | mA   |
| $I_{OK}$   | DC Output Diode Current          | - 50                    | mA   |
| $I_{OA}$   | DC Output Current                | $\pm 50$                | mA   |
| $I_{OB}$   | DC Output Current                | $\pm 50$                | mA   |
| $I_{CCA}$  | DC $V_{CC}$ or Ground Current    | $\pm 100$               | mA   |
| $I_{CCB}$  | DC $V_{CC}$ or Ground Current    | $\pm 100$               | mA   |
| $P_d$      | Power Dissipation                | 400                     | mW   |
| $T_{stg}$  | Storage Temperature              | -65 to +150             | °C   |
| $T_L$      | Lead Temperature (10 sec)        | 300                     | °C   |

Absolute Maximum Rating are those value beyond which damage to the device may occur. Functional operation under these condition is not implied

(\*) 500mW:  $\approx 65^\circ\text{C}$  derated to 300mW by 10mW/°C:  $65^\circ\text{C}$  to  $85^\circ\text{C}$

## RECOMMENDED OPERATING CONDITIONS

| Symbol     | Parameter                         | Value          | Unit |
|------------|-----------------------------------|----------------|------|
| $V_{CCA}$  | Supply Voltage                    | 2.3 to 3.6     | V    |
| $V_{CCB}$  | Supply Voltage                    | 1.65 to 2.7    | V    |
| $V_I$      | Input Voltage (Dir, OE)           | 0 to $V_{CCB}$ | V    |
| $V_{I/OA}$ | I/O Voltage                       | 0 to $V_{CCA}$ | V    |
| $V_{I/OB}$ | I/O Voltage                       | 0 to $V_{CCB}$ | V    |
| $T_{op}$   | Operating Temperature             | -40 to 85      | °C   |
| dt/dv      | Input Rise and Fall Time (note 1) | 0 to 10        | ns/V |

1)  $V_{IN}$  from 0.8V to 2.0V at  $V_{CC} = 3.0V$

DC SPECIFICATION FOR  $V_{CCA}$ 

| Symbol                | Parameter                                     | Test Condition                 |                                |                                                                                                                  | Value                  |      |       |              |       | Unit |
|-----------------------|-----------------------------------------------|--------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------|------------------------|------|-------|--------------|-------|------|
|                       |                                               | V <sub>CCB</sub><br>(*)<br>(V) | V <sub>CCA</sub><br>(*)<br>(V) |                                                                                                                  | T <sub>A</sub> = 25 °C |      |       | -40 to 85 °C |       |      |
|                       |                                               |                                |                                |                                                                                                                  | Min.                   | Typ. | Max.  | Min.         | Max.  |      |
| V <sub>IHA</sub>      | High Level Input Voltage (An)                 | 1.8                            | 2.5                            |                                                                                                                  | 1.6                    |      |       | 1.6          |       | V    |
|                       |                                               | 1.8                            | 3.3                            |                                                                                                                  | 2.0                    |      |       | 2.0          |       |      |
|                       |                                               | 2.5                            | 3.3                            |                                                                                                                  | 2.0                    |      |       | 2.0          |       |      |
| V <sub>ILA</sub>      | Low Level Input Voltage (An)                  | 1.8                            | 2.5                            |                                                                                                                  |                        |      | 0.7   |              | 0.7   | V    |
|                       |                                               | 1.8                            | 3.3                            |                                                                                                                  |                        |      | 0.8   |              | 0.8   |      |
|                       |                                               | 2.5                            | 3.3                            |                                                                                                                  |                        |      | 0.8   |              | 0.8   |      |
| V <sub>OHA</sub>      | High Level Output Voltage                     | 2.3                            | 3.0                            | I <sub>O</sub> =-100 μA                                                                                          | 2.8                    |      |       | 2.8          |       | V    |
|                       |                                               | 2.3                            | 3.0                            | I <sub>O</sub> =-24 mA                                                                                           | 2.2                    |      |       | 2.2          |       |      |
|                       |                                               | 1.65                           | 3.0                            | I <sub>O</sub> =-24 mA                                                                                           | 2.2                    |      |       | 2.2          |       |      |
|                       |                                               | 1.65                           | 2.3                            | I <sub>O</sub> =-18 mA                                                                                           | 1.7                    |      |       | 1.7          |       |      |
| V <sub>OLA</sub>      | Low Level Output Voltage                      | 2.3                            | 3.0                            | I <sub>O</sub> =100 μA                                                                                           |                        |      | 0.2   |              | 0.2   | V    |
|                       |                                               | 2.3                            | 3.0                            | I <sub>O</sub> =24 mA                                                                                            |                        |      | 0.55  |              | 0.55  |      |
|                       |                                               | 1.65                           | 3.0                            | I <sub>O</sub> =24 mA                                                                                            |                        |      | 0.55  |              | 0.55  |      |
|                       |                                               | 1.65                           | 2.3                            | I <sub>O</sub> =18 mA                                                                                            |                        |      | 0.60  |              | 0.60  |      |
| I <sub>IA</sub>       | Input Leakage Current                         | 2.7                            | 3.6                            | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                          |                        |      | ± 0.5 |              | ± 5   | μA   |
| I <sub>OZA</sub>      | High Impedance Output Leakage Current         | 2.7                            | 3.6                            | V <sub>IA</sub> = Gnd or 3.6V<br>V <sub>IB</sub> = V <sub>IHB</sub> or V <sub>ILB</sub><br>OE = V <sub>CCB</sub> |                        |      | ± 1.0 |              | ± 10  | μA   |
| I <sub>IA(HOLD)</sub> | Input Hold Current                            | 1.65                           | 2.3                            | V <sub>I</sub> = 0.57V                                                                                           | 25                     |      |       | 25           |       | μA   |
|                       |                                               | 1.65                           | 2.3                            | V <sub>I</sub> = 1.07V                                                                                           | -25                    |      |       | -25          |       |      |
|                       |                                               | 1.65                           | 3.0                            | V <sub>I</sub> = 0.57V                                                                                           | 25                     |      |       | 25           |       | μA   |
|                       |                                               | 1.65                           | 3.0                            | V <sub>I</sub> = 1.07V                                                                                           | -25                    |      |       | -25          |       |      |
|                       |                                               | 2.3                            | 3.0                            | V <sub>I</sub> = 0.7V                                                                                            | 45                     |      |       | 45           |       | μA   |
|                       |                                               | 2.3                            | 3.0                            | V <sub>I</sub> = 1.6V                                                                                            | -45                    |      |       | -45          |       |      |
|                       |                                               | 2.7                            | 3.6                            | V <sub>IB</sub> = 0 to 2.7V                                                                                      |                        |      |       |              | ± 300 |      |
| I <sub>OFF</sub>      | Power Off Leakage Current                     | 0                              | 0                              | V <sub>IA</sub> = Gnd to 3.6V<br>V <sub>IB</sub> = Gnd to 3.6V<br>G, Dir = GND to 3.6V                           |                        |      | ± 1.0 |              | ± 10  | μA   |
| I <sub>CCIA</sub>     | Quiescent Supply Current                      | 1.95                           | 3.6                            | V <sub>IA</sub> =V <sub>CCA</sub> or GND<br>V <sub>IB</sub> =V <sub>CCB</sub> or GND                             |                        |      | 2     |              | 20    | μA   |
|                       |                                               | 1.95                           | 2.7                            |                                                                                                                  |                        |      |       |              |       |      |
|                       |                                               | 2.7                            | 3.6                            |                                                                                                                  |                        |      |       |              |       |      |
| ΔI <sub>CCIA</sub>    | Maximum Quiescent Supply Current / Input (An) | 2.7                            | 3.6                            | V <sub>IA</sub> =V <sub>CCA</sub> - 0.6V<br>V <sub>IB</sub> =V <sub>CCB</sub> or GND                             |                        |      |       |              | 0.75  | mA   |
|                       |                                               | 1.95                           | 3.6                            |                                                                                                                  |                        |      |       |              |       |      |
|                       |                                               | 1.95                           | 2.7                            |                                                                                                                  |                        |      |       |              |       |      |

DC SPECIFICATION FOR  $V_{CCB}$ 

| Symbol                | Parameter                                              | Test Condition                 |                                |                                                                                                                 | Value                  |      |                      |                      |                      | Unit |
|-----------------------|--------------------------------------------------------|--------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------|------|----------------------|----------------------|----------------------|------|
|                       |                                                        | V <sub>CCB</sub><br>(V)<br>(*) | V <sub>CCA</sub><br>(V)<br>(*) |                                                                                                                 | T <sub>A</sub> = 25 °C |      |                      | -40 to 85 °C         |                      |      |
|                       |                                                        |                                |                                |                                                                                                                 | Min.                   | Typ. | Max.                 | Min.                 | Max.                 |      |
| V <sub>IHB</sub>      | High Level Input Voltage (Bn, Dir, OE)                 | 1.8                            | 2.5                            |                                                                                                                 | 0.65V <sub>CCB</sub>   |      |                      | 0.65V <sub>CCB</sub> |                      | V    |
|                       |                                                        | 1.8                            | 3.3                            |                                                                                                                 | 0.65V <sub>CCB</sub>   |      |                      | 0.65V <sub>CCB</sub> |                      |      |
|                       |                                                        | 2.5                            | 3.3                            |                                                                                                                 | 1.6                    |      |                      | 1.6                  |                      |      |
| V <sub>ILB</sub>      | Low Level Input Voltage (Bn, Dir, OE)                  | 1.8                            | 2.5                            |                                                                                                                 |                        |      | 0.35V <sub>CCB</sub> |                      | 0.35V <sub>CCB</sub> | V    |
|                       |                                                        | 1.8                            | 3.3                            |                                                                                                                 |                        |      | 0.35V <sub>CCB</sub> |                      | 0.35V <sub>CCB</sub> |      |
|                       |                                                        | 2.5                            | 3.3                            |                                                                                                                 |                        |      | 0.7                  |                      | 0.7                  |      |
| V <sub>OHB</sub>      | High Level Output Voltage                              | 2.3                            | 3.0                            | I <sub>O</sub> =-100 μA                                                                                         | 2.8                    |      |                      | 2.8                  |                      | V    |
|                       |                                                        | 2.3                            | 3.0                            | I <sub>O</sub> =-18 mA                                                                                          | 1.7                    |      |                      | 1.7                  |                      |      |
|                       |                                                        | 1.65                           | 3.0                            | I <sub>O</sub> =-6 mA                                                                                           | 1.25                   |      |                      | 1.25                 |                      |      |
|                       |                                                        | 1.65                           | 2.3                            | I <sub>O</sub> =-6 mA                                                                                           | 1.25                   |      |                      | 1.25                 |                      |      |
| V <sub>OLB</sub>      | Low Level Output Voltage                               | 2.3                            | 3.0                            | I <sub>O</sub> =100 μA                                                                                          |                        |      | 0.2                  |                      | 0.2                  | V    |
|                       |                                                        | 2.3                            | 3.0                            | I <sub>O</sub> =18 mA                                                                                           |                        |      | 0.60                 |                      | 0.60                 |      |
|                       |                                                        | 1.65                           | 3.0                            | I <sub>O</sub> =6 mA                                                                                            |                        |      | 0.30                 |                      | 0.30                 |      |
|                       |                                                        | 1.65                           | 2.3                            | I <sub>O</sub> =6 mA                                                                                            |                        |      | 0.30                 |                      | 0.30                 |      |
| I <sub>IB</sub>       | Input Leakage Current                                  | 2.7                            | 3.6                            | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                         |                        |      | ± 0.5                |                      | ± 5                  | μA   |
| I <sub>OZB</sub>      | High Impedance Output Leakage Current                  | 2.7                            | 3.6                            | V <sub>IA</sub> = V <sub>IHA</sub> or V <sub>ILA</sub><br>V <sub>IB</sub> = GND or 2.7V<br>G = V <sub>CCB</sub> |                        |      | ± 1.0                |                      | ± 10                 | μA   |
| I <sub>IB(HOLD)</sub> | Input Hold Current                                     | 1.65                           | 2.3                            | V <sub>I</sub> = 0.57V                                                                                          | 25                     |      |                      | 25                   |                      | μA   |
|                       |                                                        | 1.65                           | 2.3                            | V <sub>I</sub> = 1.07V                                                                                          | -25                    |      |                      | -25                  |                      |      |
|                       |                                                        | 1.65                           | 3.0                            | V <sub>I</sub> = 0.57V                                                                                          | 25                     |      |                      | 25                   |                      | μA   |
|                       |                                                        | 1.65                           | 3.0                            | V <sub>I</sub> = 1.07V                                                                                          | -25                    |      |                      | -25                  |                      |      |
|                       |                                                        | 2.3                            | 3.0                            | V <sub>I</sub> = 0.7V                                                                                           | 45                     |      |                      | 45                   |                      | μA   |
|                       |                                                        | 2.3                            | 3.0                            | V <sub>I</sub> = 1.6V                                                                                           | -45                    |      |                      | -45                  |                      |      |
|                       |                                                        | 2.7                            | 3.6                            | V <sub>IB</sub> = 0 to 2.7V                                                                                     |                        |      |                      |                      | ± 300                |      |
| I <sub>CCtB</sub>     | Quiescent Supply Current                               | 1.95                           | 3.6                            | V <sub>IA</sub> =V <sub>CCA</sub> or GND                                                                        |                        |      | 2                    |                      | 20                   | μA   |
|                       |                                                        | 1.95                           | 2.7                            | V <sub>IB</sub> =V <sub>CCB</sub> or GND                                                                        |                        |      |                      |                      |                      |      |
|                       |                                                        | 2.7                            | 3.6                            | Dir or G=V <sub>CCB</sub> or GND                                                                                |                        |      |                      |                      |                      |      |
| ΔI <sub>CCtB</sub>    | Maximum Quiescent Supply Current / Input (Bn, DIR, OE) | 2.7                            | 3.6                            | V <sub>IB</sub> =V <sub>CCB</sub> - 0.6V<br>V <sub>IA</sub> =V <sub>CCA</sub> or GND                            |                        |      |                      |                      | 0.75                 | mA   |
|                       |                                                        | 1.95                           | 3.6                            |                                                                                                                 |                        |      |                      |                      |                      |      |
|                       |                                                        | 1.95                           | 2.7                            |                                                                                                                 |                        |      |                      |                      |                      |      |

## DYNAMIC SWITCHING CHARACTERISTICS

| Symbol            | Parameter                            | Test Condition          |                         |                                                                              | Value                  |       |      |              |      | Unit |
|-------------------|--------------------------------------|-------------------------|-------------------------|------------------------------------------------------------------------------|------------------------|-------|------|--------------|------|------|
|                   |                                      | V <sub>CCB</sub><br>(V) | V <sub>CCA</sub><br>(V) |                                                                              | T <sub>A</sub> = 25 °C |       |      | -40 to 85 °C |      |      |
|                   |                                      |                         |                         |                                                                              | Min.                   | Typ.  | Max. | Min.         | Max. |      |
| V <sub>OLPA</sub> | Dynamic Low Level<br>Quiet An Output | 1.8                     | 2.5                     | C <sub>L</sub> =30pF<br>V <sub>IL</sub> =0V V <sub>IH</sub> =V <sub>cc</sub> |                        | 0.25  |      |              |      | V    |
|                   |                                      | 1.8                     | 3.3                     |                                                                              |                        | 0.25  |      |              |      |      |
|                   |                                      | 2.5                     | 3.3                     |                                                                              |                        | 0.6   |      |              |      |      |
| V <sub>OLPB</sub> | Dynamic Low Level<br>Quiet Bn Output | 1.8                     | 2.5                     | C <sub>L</sub> =30pF<br>V <sub>IL</sub> =0V V <sub>IH</sub> =V <sub>cc</sub> |                        | 0.6   |      |              |      | V    |
|                   |                                      | 1.8                     | 3.3                     |                                                                              |                        | 0.8   |      |              |      |      |
|                   |                                      | 2.5                     | 3.3                     |                                                                              |                        | 0.8   |      |              |      |      |
| V <sub>OLVA</sub> | Dynamic Low Level<br>Quiet An Output | 1.8                     | 2.5                     | C <sub>L</sub> =30pF<br>V <sub>IL</sub> =0V V <sub>IH</sub> =V <sub>cc</sub> |                        | -0.6  |      |              |      | V    |
|                   |                                      | 1.8                     | 3.3                     |                                                                              |                        | -0.8  |      |              |      |      |
|                   |                                      | 2.5                     | 3.3                     |                                                                              |                        | -0.8  |      |              |      |      |
| V <sub>OLVB</sub> | Dynamic Low Level<br>Quiet Bn Output | 1.8                     | 2.5                     | C <sub>L</sub> =30pF<br>V <sub>IL</sub> =0V V <sub>IH</sub> =V <sub>cc</sub> |                        | -0.25 |      |              |      | V    |
|                   |                                      | 1.8                     | 3.3                     |                                                                              |                        | -0.25 |      |              |      |      |
|                   |                                      | 2.5                     | 3.3                     |                                                                              |                        | -0.6  |      |              |      |      |
| V <sub>OHVA</sub> | Dynamic Low Level<br>Quiet An Output | 1.8                     | 2.5                     | C <sub>L</sub> =30pF<br>V <sub>IL</sub> =0V V <sub>IH</sub> =V <sub>cc</sub> |                        | 1.7   |      |              |      | V    |
|                   |                                      | 1.8                     | 3.3                     |                                                                              |                        | 2.0   |      |              |      |      |
|                   |                                      | 2.5                     | 3.3                     |                                                                              |                        | 2.0   |      |              |      |      |
| V <sub>OHVB</sub> | Dynamic Low Level<br>Quiet Bn Output | 1.8                     | 2.5                     | C <sub>L</sub> =30pF<br>V <sub>IL</sub> =0V V <sub>IH</sub> =V <sub>cc</sub> |                        | 1.3   |      |              |      | V    |
|                   |                                      | 1.8                     | 3.3                     |                                                                              |                        | 1.3   |      |              |      |      |
|                   |                                      | 2.5                     | 3.3                     |                                                                              |                        | 1.7   |      |              |      |      |

## AC ELECTRICAL CHARACTERISTICS

| Symbol                                 | Parameter                                | Test Condition          |                         |                                                  | Value        |      | Unit |
|----------------------------------------|------------------------------------------|-------------------------|-------------------------|--------------------------------------------------|--------------|------|------|
|                                        |                                          | V <sub>CCB</sub><br>(V) | V <sub>CCA</sub><br>(V) |                                                  | -40 to 85 °C |      |      |
|                                        |                                          |                         |                         |                                                  | Min.         | Max. |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time<br>An to Bn       | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω | 1.0          | 5.8  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  | 1.0          | 6.2  |      |
|                                        |                                          | 2.5 ± 0.2               | 3.3 ± 0.3               |                                                  | 1.0          | 4.4  |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time<br>Bn to An       | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω | 1.0          | 5.5  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  | 1.0          | 5.1  |      |
|                                        |                                          | 2.5 ± 0.2               | 3.3 ± 0.3               |                                                  | 1.0          | 4.0  |      |
| t <sub>PZL</sub> t <sub>PZH</sub>      | Output Enable Time<br>OE to An           | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω | 1.0          | 5.3  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  | 1.0          | 5.1  |      |
|                                        |                                          | 2.5 ± 0.2               | 3.3 ± 0.3               |                                                  | 1.0          | 4.0  |      |
| t <sub>PZL</sub> t <sub>PZH</sub>      | Output Enable Time<br>OE to Bn           | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω | 1.0          | 8.3  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  | 1.0          | 8.2  |      |
|                                        |                                          | 2.5 ± 0.2               | 3.3 ± 0.3               |                                                  | 1.0          | 4.6  |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | Output Disable Time<br>OE to An          | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω | 1.0          | 5.2  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  | 1.0          | 5.6  |      |
|                                        |                                          | 2.5 ± 0.2               | 3.3 ± 0.3               |                                                  | 1.0          | 4.5  |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | Output Disable Time<br>OE to Bn          | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω | 1.0          | 4.6  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  | 1.0          | 4.5  |      |
|                                        |                                          | 2.5 ± 0.2               | 3.3 ± 0.3               |                                                  | 1.0          | 4.4  |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output To Output Skew<br>Time (note1, 2) | 1.8 ± 0.15              | 2.5 ± 0.2               | C <sub>L</sub> = 30 pF<br>R <sub>L</sub> = 500 Ω |              | 0.5  | ns   |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  |              | 0.5  |      |
|                                        |                                          | 1.8 ± 0.15              | 3.3 ± 0.3               |                                                  |              | 0.75 |      |

## AC ELECTRICAL CHARACTERISTICS

| Symbol                                 | Parameter                             | Test Condition T <sub>A</sub> = -40 to 85 °C |      |                                |      |                               |      | Unit |
|----------------------------------------|---------------------------------------|----------------------------------------------|------|--------------------------------|------|-------------------------------|------|------|
|                                        |                                       | V <sub>CCB</sub> = 1.8 ± 0.15V               |      | V <sub>CCB</sub> = 1.8 ± 0.15V |      | V <sub>CCB</sub> = 2.5 ± 0.2V |      |      |
|                                        |                                       | V <sub>CCA</sub> = 2.5 ± 0.2V                |      | V <sub>CCA</sub> = 3.3 ± 0.3V  |      | V <sub>CCA</sub> = 3.3 ± 0.3V |      |      |
|                                        |                                       | Min.                                         | Max. | Min.                           | Max. | Min.                          | Max. |      |
| t <sub>PLH</sub> , t <sub>PHL</sub>    | Propagation Delay Time An to Bn       | 1.0                                          | 5.8  | 1.0                            | 6.2  | 1.0                           | 4.4  | ns   |
| t <sub>PLH</sub> , t <sub>PHL</sub>    | Propagation Delay Time Bn to An       | 1.0                                          | 5.5  | 1.0                            | 5.1  | 1.0                           | 4.0  |      |
| t <sub>PZL</sub> , t <sub>PZH</sub>    | Output Enable Time <u>OE</u> to An    | 1.0                                          | 5.3  | 1.0                            | 5.1  | 1.0                           | 4.0  | ns   |
| t <sub>PZL</sub> , t <sub>PZH</sub>    | Output Enable Time <u>OE</u> to Bn    | 1.0                                          | 8.3  | 1.0                            | 8.2  | 1.0                           | 4.6  |      |
| t <sub>PLZ</sub> , t <sub>PHZ</sub>    | Output Disable Time <u>OE</u> to An   | 1.0                                          | 5.2  | 1.0                            | 5.6  | 1.0                           | 4.8  | ns   |
| t <sub>PLZ</sub> , t <sub>PHZ</sub>    | Output Disable Time <u>OE</u> to Bn   | 1.0                                          | 4.6  | 1.0                            | 4.5  | 1.0                           | 4.4  |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output To Output Skew Time (note1, 2) |                                              | 5.0  |                                | 0.5  |                               | 0.75 | ns   |

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW ( $t_{OSLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{OSHL} = |t_{PHLm} - t_{PHLn}|$ )  
 2) Parameter guaranteed by design

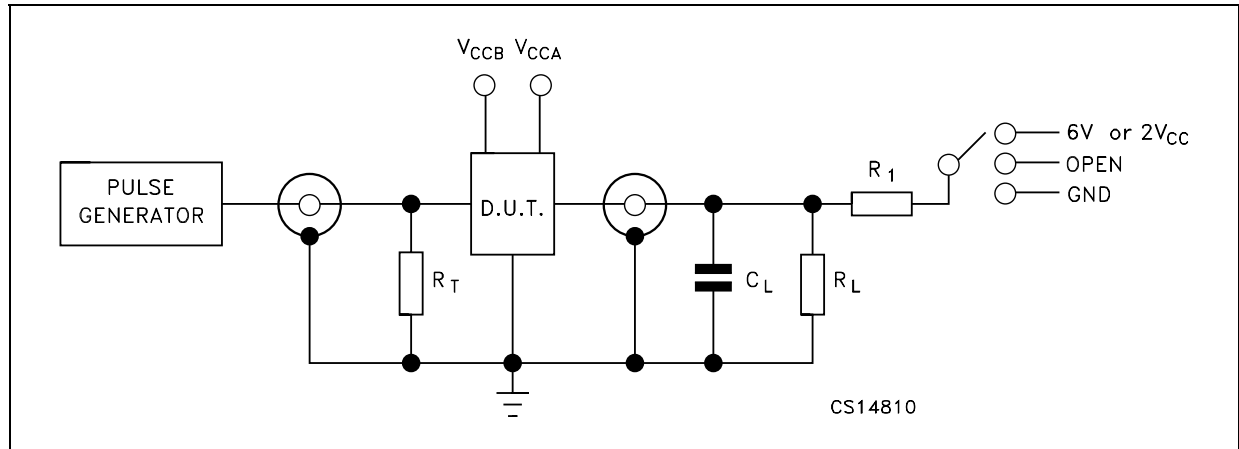
## CAPACITANCE CHARACTERISTICS

| Symbol           | Parameter                     | Test Condition          |                         |         | Value                  |      |      |              |      | Unit |
|------------------|-------------------------------|-------------------------|-------------------------|---------|------------------------|------|------|--------------|------|------|
|                  |                               | V <sub>CCB</sub><br>(V) | V <sub>CCA</sub><br>(V) |         | T <sub>A</sub> = 25 °C |      |      | -40 to 85 °C |      |      |
|                  |                               |                         |                         |         | Min.                   | Typ. | Max. | Min.         | Max. |      |
| C <sub>INA</sub> | Input Capacitance             | open                    | open                    |         |                        | 5    |      |              |      | V    |
| C <sub>I/O</sub> | Input/Output Capacitance      | 2.5                     | 3.3                     |         |                        | 6    |      |              |      | V    |
| C <sub>PD</sub>  | Power Dissipation Capacitance | 2.5                     | 3.3                     | f=10MHz |                        | 20   |      |              |      | V    |

1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/16$  (per circuit)



## TEST CIRCUIT

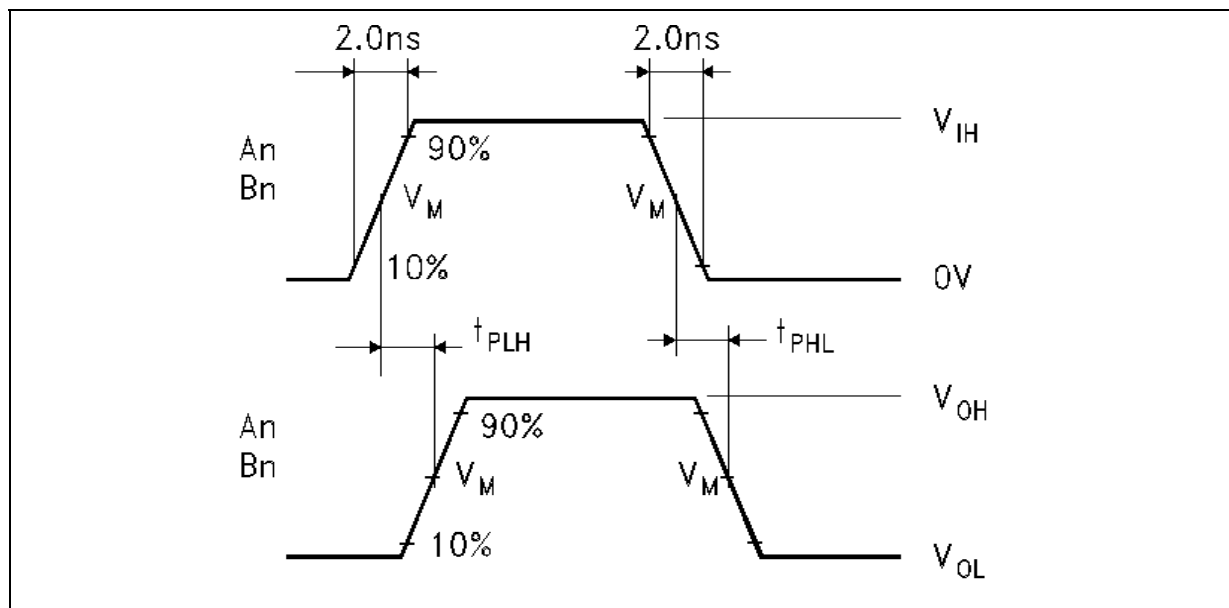
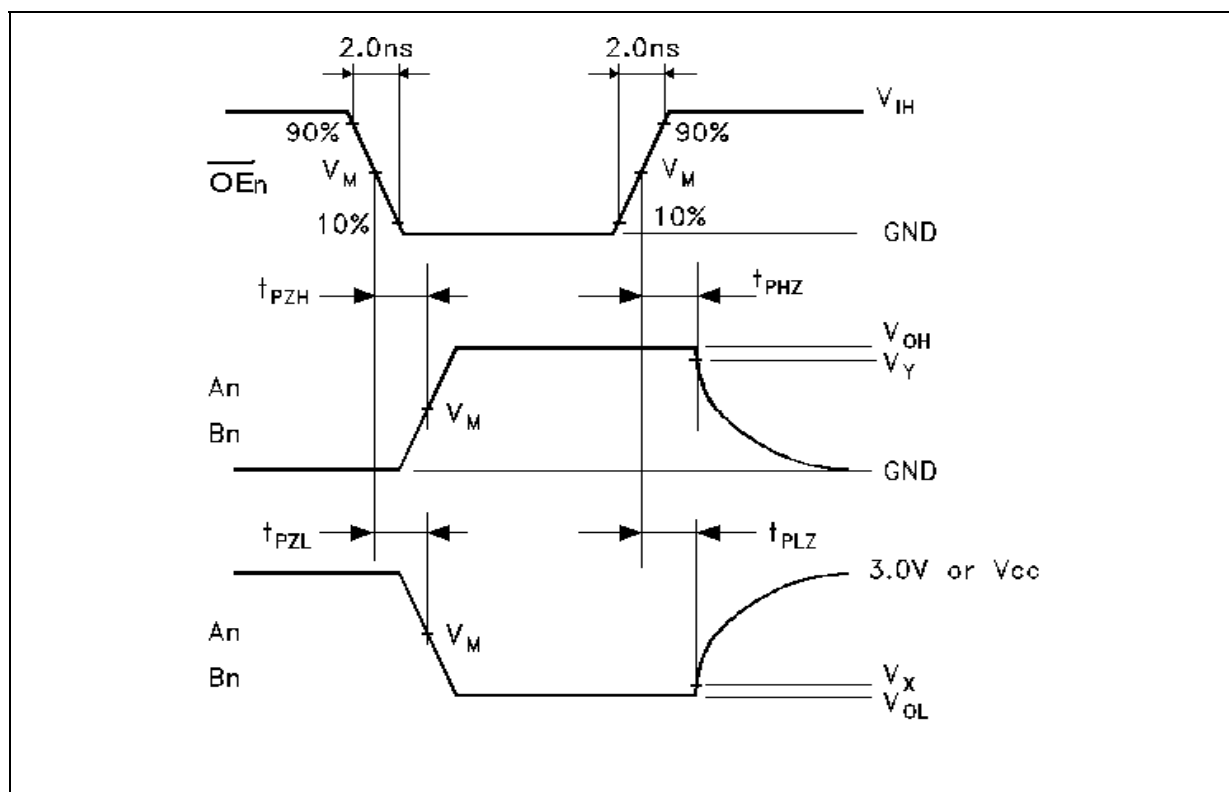


| TEST                                                                             | SWITCH    |
|----------------------------------------------------------------------------------|-----------|
| $t_{PLH}$ , $t_{PHL}$                                                            | Open      |
| $t_{PZL}$ , $t_{PLZ}$ ( $V_{CC} = 3.0$ to $3.6V$ )                               | 6V        |
| $t_{PZL}$ , $t_{PLZ}$ ( $V_{CC} = 2.3$ to $2.7V$ or $V_{CC} = 1.65$ to $1.95V$ ) | $2V_{CC}$ |
| $t_{PZH}$ , $t_{PHZ}$                                                            | GND       |

$C_L = 30pF$  or equivalent (includes jig and probe capacitance)  
 $R_L = R_1 = 500\Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

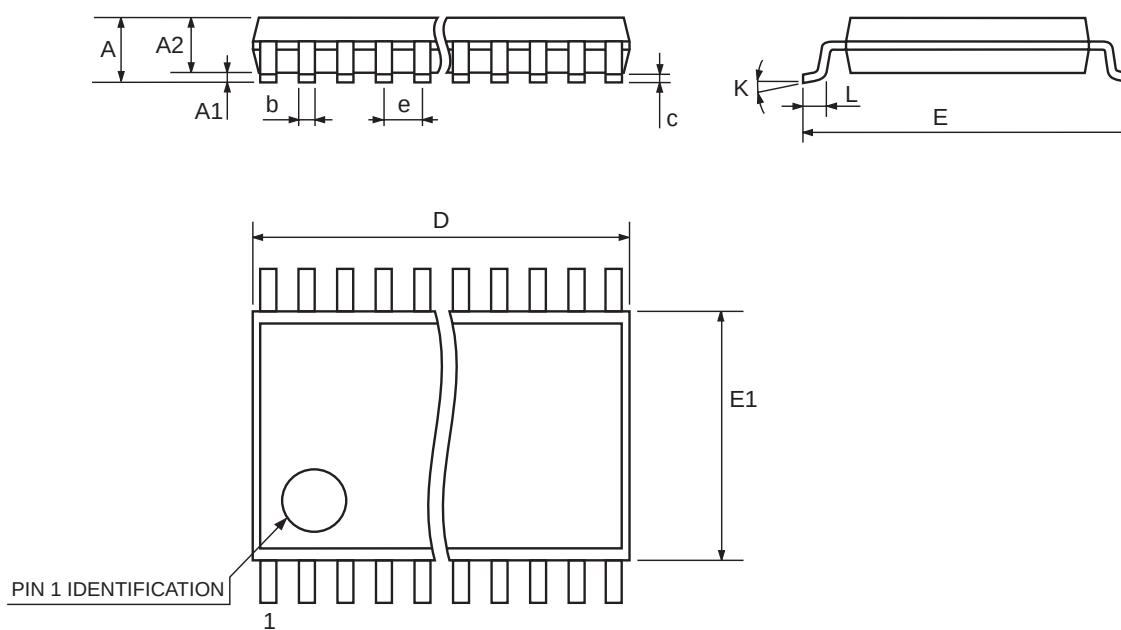
## WAVEFORM SYMBOL VALUE

| Symbol   | $V_{CC}$        |                  |                  |
|----------|-----------------|------------------|------------------|
|          | 3.0 to 3.6V     | 2.3 to 2.7V      | 1.65 to 1.95V    |
| $V_{IH}$ | $V_{CC}$        | $V_{CC}$         | $V_{CC}$         |
| $V_M$    | 1.5V            | $V_{CC}/2$       | $V_{CC}/2$       |
| $V_X$    | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ | $V_{OL} + 0.15V$ |
| $V_Y$    | $V_{OL} - 0.3V$ | $V_{OL} - 0.15V$ | $V_{OL} - 0.15V$ |

**WAVEFORM 1: PROPAGATION DELAY** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIME** ( $f=1\text{MHz}$ ; 50% duty cycle)

## TSSOP48 MECHANICAL DATA

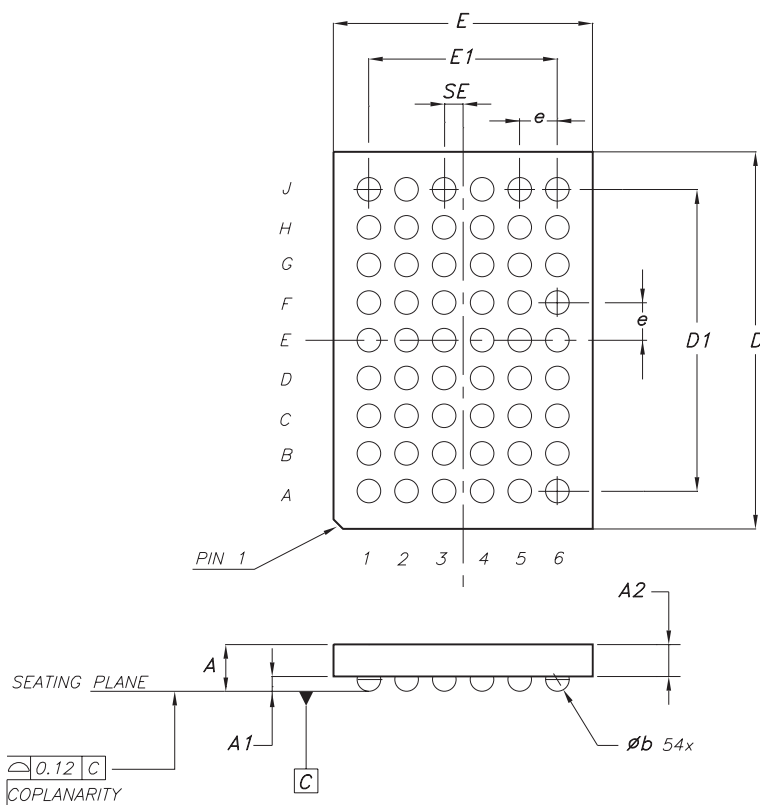
| DIM. | mm.  |         |      | inch   |            |        |
|------|------|---------|------|--------|------------|--------|
|      | MIN. | TYP     | MAX. | MIN.   | TYP.       | MAX.   |
| A    |      |         | 1.2  |        |            | 0.047  |
| A1   | 0.05 |         | 0.15 | 0.002  |            | 0.006  |
| A2   |      | 0.9     |      |        | 0.035      |        |
| b    | 0.17 |         | 0.27 | 0.0067 |            | 0.011  |
| c    | 0.09 |         | 0.20 | 0.0035 |            | 0.0079 |
| D    | 12.4 |         | 12.6 | 0.488  |            | 0.496  |
| E    |      | 8.1 BSC |      |        | 0.318 BSC  |        |
| E1   | 6.0  |         | 6.2  | 0.236  |            | 0.244  |
| e    |      | 0.5 BSC |      |        | 0.0197 BSC |        |
| K    | 0°   |         | 8°   | 0°     |            | 8°     |
| L    | 0.50 |         | 0.75 | 0.020  |            | 0.030  |



7065588C

## TFBGA54 MECHANICAL DATA

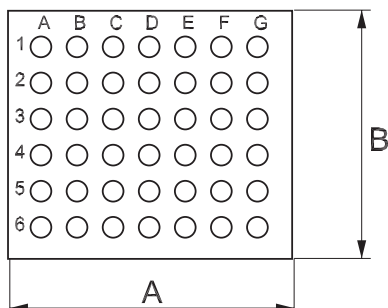
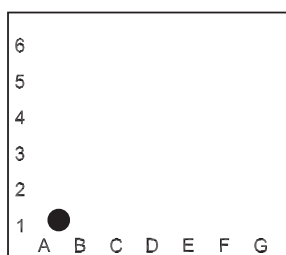
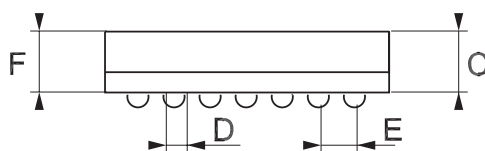
| DIM. | mm.  |     |      | mils  |       |       |
|------|------|-----|------|-------|-------|-------|
|      | MIN. | TYP | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      |     | 1.2  |       |       | 47.2  |
| A1   | 0.25 |     |      | 9.8   |       |       |
| A2   | 0.85 |     |      | 33.5  |       |       |
| B    | 0.45 |     | 0.55 | 17.7  |       | 21.7  |
| D    | 7.9  |     | 8.1  | 311.0 |       | 318.9 |
| D1   |      | 6.4 |      |       | 252.0 |       |
| E    | 5.4  | 5.5 | 5.6  | 212.6 | 216.5 | 220.5 |
| E1   |      | 4   |      |       | 157.5 |       |
| e    |      | 0.8 |      |       | 31.5  |       |
| SE   |      | 0.4 |      |       | 15.7  |       |



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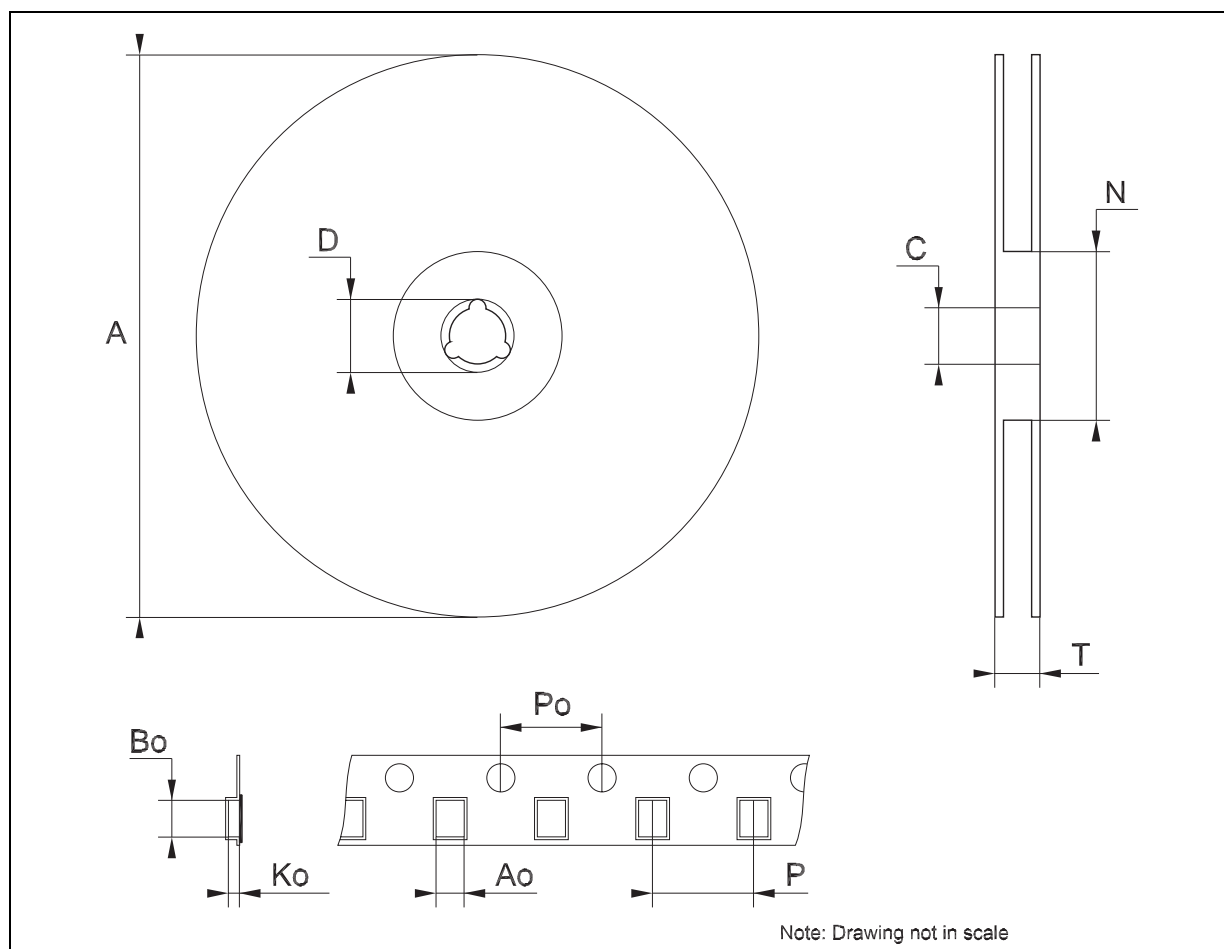
# μFBGA42 MECHANICAL DATA

| DIM. | mm.  |      |      | mils  |      |       |
|------|------|------|------|-------|------|-------|
|      | MIN. | TYP  | MAX. | MIN.  | TYP. | MAX.  |
| A    | 3.90 |      | 4.10 | 153.5 |      | 161.4 |
| B    | 3.40 |      | 3.60 | 133.9 |      | 141.7 |
| C    |      | 1.07 | 1.16 |       | 42.1 | 45.6  |
| D    |      | 0.3  |      |       | 11.8 |       |
| E    |      | 0.5  |      |       | 19.7 |       |
| F    | 0.78 |      | 0.86 | 30.7  |      | 33.9  |



### Tape & Reel TSSOP48 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 30.4 |       |      | 1.197  |
| Ao   | 8.7  |     | 8.9  | 0.343 |      | 0.350  |
| Bo   | 13.1 |     | 13.3 | 0.516 |      | 0.524  |
| Ko   | 1.5  |     | 1.7  | 0.059 |      | 0.067  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 11.9 |     | 12.1 | 0.468 |      | 0.476  |



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