

## 16-BIT DUAL SUPPLY BUS TRANSCEIVER LEVEL TRANSLATOR WITH A SIDE SERIES RESISTOR

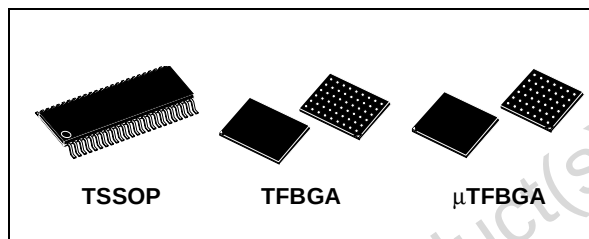
- **HIGH SPEED:**  $t_{PD} = 4.4ns$  (MAX.) at  $T_A=85^\circ C$   
 $V_{CCA} = 3.0V$   $V_{CCB} = 2.3V$
- **LOW POWER DISSIPATION:**  
 $I_{CCA} = I_{CCB} = 20\mu A$  (MAX.) at  $T_A=85^\circ C$
- **SYMMETRICAL OUTPUT IMPEDANCE:**  
 $|I_{OHA}| = I_{OLA} = 8mA$  MIN at  
 $V_{CCA} = 3.0V$ ;  $V_{CCB} = 1.65V$  or  $2.3V$   
 $|I_{OHB}| = I_{OLB} = 6mA$  (MIN at  
 $V_{CCA} = 2.3V$  or  $3.0V$ ;  $V_{CCB} = 1.65V$ )
- **BALANCED PROPAGATION DELAYS:**  
 $t_{PLH} \approx t_{PHL}$
- **POWER DOWN PROTECTION ON INPUTS AND OUTPUTS**
- **SERIES RESISTOR ON A SIDE**
- **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**
- **BUS HOLD PROVIDED ON DATA INPUT BOTH SIDE**
- **LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)**
- **ESD PERFORMANCE:**  
HBM > 2000V (MIL STD 883 method 3015);  
MM > 200V

### DESCRIPTION

The 74VCXH1632245 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  $\overline{nG}$  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



### ORDER CODES

| PACKAGE  | T & R            |
|----------|------------------|
| TSSOP48  | 74VCXH1632245TIR |
| TFBGA54  | 74VCXH1632245LBR |
| μTFBGA42 | 74VCXH1632245TBR |

bus terminals during High Z State don't need external pull-up or pull-down resistor.

### LOGIC DIAGRAM

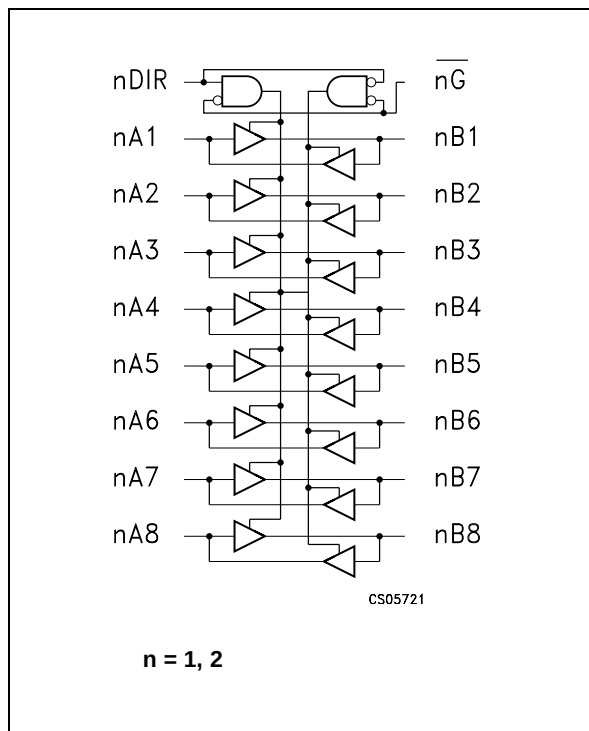


Figure 1: Input And Output Equivalent Circuit

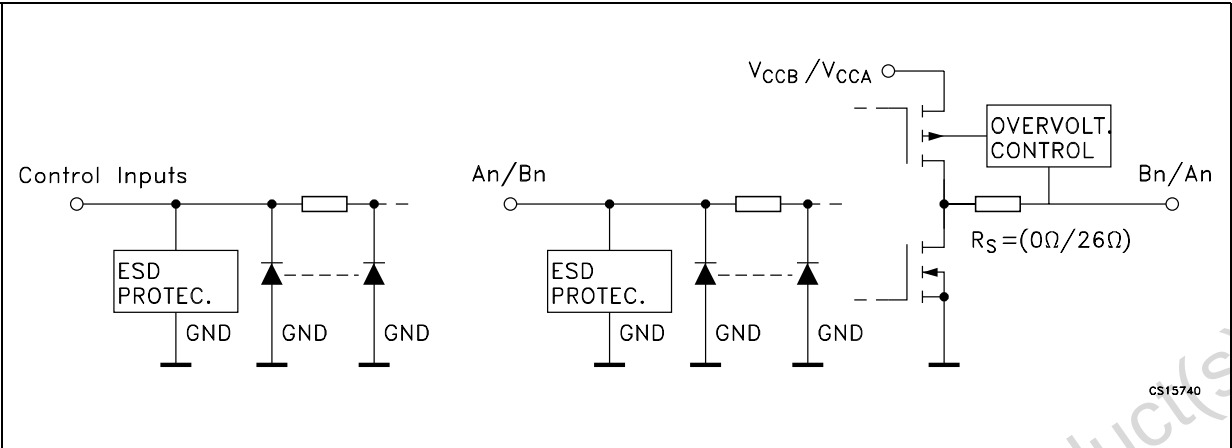
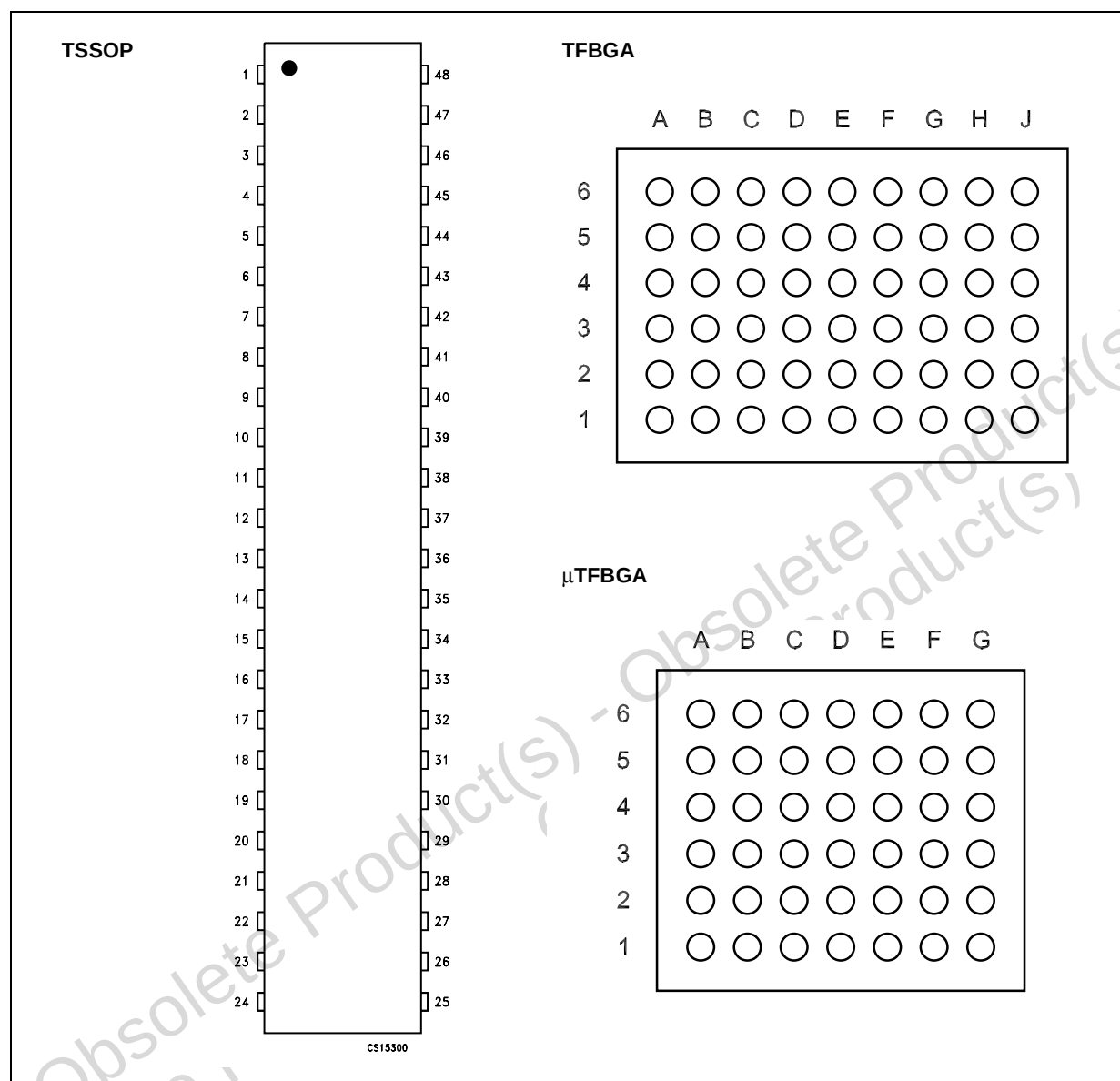


Table 1: Pin Description

| 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                             | 2G         | Output Enable Inputs    |
| A4                             | B4                             | 48                             | 1G         | 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                         | VCCA       | Positive Supply Voltage |
| C3, G3                         | D3                             | 7, 18                          | VCCB       | Positive Supply Voltage |

**Figure 2: Pin Connection** (top view for TSSOP, top through view for BGA)**Table 2: 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

**Table 3: 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)        | 260                     | °C   |

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

**Table 4: Recommended Operating Conditions**

| Symbol     | Parameter                         | Value             | Unit |
|------------|-----------------------------------|-------------------|------|
| $V_{CCA}$  | Supply Voltage                    | 2.3 to 3.6        | V    |
| $V_{CCB}$  | Supply Voltage                    | 1.65 to $V_{CCA}$ | V    |
| $V_I$      | Input Voltage (Dir, G)            | 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  $V_{CC}=3.0V$

Table 5: 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> =-100μA                                                                                          | 2.8                    |      |       | 2.8          |       | V    |
|                       |                                               | 2.3                            | 3.0                            | I <sub>O</sub> =-8mA                                                                                            | 2.4                    |      |       | 2.4          |       |      |
|                       |                                               | 1.65                           | 3.0                            | I <sub>O</sub> =-8mA                                                                                            | 2.4                    |      |       | 2.4          |       |      |
|                       |                                               | 1.65                           | 2.3                            | I <sub>O</sub> =-6mA                                                                                            | 1.8                    |      |       | 1.8          |       |      |
| V <sub>OLA</sub>      | Low Level Output Voltage                      | 2.3                            | 3.0                            | I <sub>O</sub> =100μA                                                                                           |                        |      | 0.2   |              | 0.2   | V    |
|                       |                                               | 2.3                            | 3.0                            | I <sub>O</sub> =8mA                                                                                             |                        |      | 0.55  |              | 0.55  |      |
|                       |                                               | 1.65                           | 3.0                            | I <sub>O</sub> =8mA                                                                                             |                        |      | 0.55  |              | 0.55  |      |
|                       |                                               | 1.65                           | 2.3                            | I <sub>O</sub> =6mA                                                                                             |                        |      | 0.40  |              | 0.40  |      |
| 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>IA(HOLD)</sub> | Input Hold Current                            | 1.65                           | 2.3                            | V <sub>I</sub> = 0.7 V                                                                                          | 45                     |      |       | 45           |       | μA   |
|                       |                                               | 1.65                           | 2.3                            | V <sub>I</sub> = 1.6 V                                                                                          | -45                    |      |       | -45          |       |      |
|                       |                                               | 1.65                           | 3.0                            | V <sub>I</sub> = 0.8 V                                                                                          | 75                     |      |       | 75           |       |      |
|                       |                                               | 1.65                           | 3.0                            | V <sub>I</sub> = 2.0 V                                                                                          | -75                    |      |       | -75          |       |      |
|                       |                                               | 2.3                            | 3.0                            | V <sub>I</sub> = 0.8 V                                                                                          | 75                     |      |       | 75           |       |      |
|                       |                                               | 2.3                            | 3.0                            | V <sub>I</sub> = 2.0 V                                                                                          | -75                    |      |       | -75          |       |      |
|                       |                                               | 2.7                            | 3.6                            | V <sub>I</sub> = 0 to 3.6 V                                                                                     |                        |      |       |              | ± 500 |      |
| 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>G = V <sub>CCB</sub> |                        |      | ± 1.0 |              | ± 10  | μA   |
| 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                                                                        |                        |      | 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>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                            |                                                                                                                 |                        |      |       |              |       |      |

(\*)  $V_{CC}$  range =  $3.3 \pm 0.3$ ;  $2.5 \pm 0.2\text{V}$ ;  $1.8 \pm 0.15\text{V}$

Table 6: 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, G)                 | 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, G)                  | 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> =-100μA                                                                                          | 2.1                    |      |                      | 2.1                  |                      | V    |
|                        |                                                       | 2.3                            | 3.0                            | I <sub>O</sub> =-18mA                                                                                           | 1.7                    |      |                      | 1.7                  |                      |      |
|                        |                                                       | 1.65                           | 3.0                            | I <sub>O</sub> =-6mA                                                                                            | 1.25                   |      |                      | 1.25                 |                      |      |
|                        |                                                       | 1.65                           | 2.3                            | I <sub>O</sub> =-6mA                                                                                            | 1.25                   |      |                      | 1.25                 |                      |      |
| V <sub>OLB</sub>       | Low Level Output Voltage                              | 2.3                            | 3.0                            | I <sub>O</sub> =100μA                                                                                           |                        |      | 0.2                  |                      | 0.2                  | V    |
|                        |                                                       | 2.3                            | 3.0                            | I <sub>O</sub> =18mA                                                                                            |                        |      | 0.60                 |                      | 0.60                 |      |
|                        |                                                       | 1.65                           | 3.0                            | I <sub>O</sub> =6mA                                                                                             |                        |      | 0.30                 |                      | 0.30                 |      |
|                        |                                                       | 1.65                           | 2.3                            | I <sub>O</sub> =6mA                                                                                             |                        |      | 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>IB</sub> (HOLD) | Input Hold Current                                    | 1.65                           | 2.3                            | V <sub>I</sub> = 0.57 V                                                                                         | 25                     |      |                      | 25                   |                      | μA   |
|                        |                                                       | 1.65                           | 2.3                            | V <sub>I</sub> = 1.07 V                                                                                         | -25                    |      |                      | -25                  |                      |      |
|                        |                                                       | 1.65                           | 3.0                            | V <sub>I</sub> = 0.57 V                                                                                         | 25                     |      |                      | 25                   |                      |      |
|                        |                                                       | 1.65                           | 3.0                            | V <sub>I</sub> = 1.07 V                                                                                         | -25                    |      |                      | -25                  |                      |      |
|                        |                                                       | 2.3                            | 3.0                            | V <sub>I</sub> = 0.7 V                                                                                          | 45                     |      |                      | 45                   |                      |      |
|                        |                                                       | 2.3                            | 3.0                            | V <sub>I</sub> = 1.6 V                                                                                          | -45                    |      |                      | -45                  |                      |      |
|                        |                                                       | 2.7                            | 3.6                            | V <sub>I</sub> = 0 to 2.7 V                                                                                     |                        |      |                      |                      | ± 500                |      |
| 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 3.6V<br>G = V <sub>CCB</sub> |                        |      | ± 1.0                |                      | ± 10                 | μA   |
| I <sub>CCIB</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>CCIB</sub>     | Maximum Quiescent Supply Current / Input (Bn, DIR, G) | 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                            |                                                                                                                 |                        |      |                      |                      |                      |      |

(\*)  $V_{CC}$  range =  $3.3 \pm 0.3$ ;  $2.5 \pm 0.2\text{V}$ ;  $1.8 \pm 0.15\text{V}$

Table 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>CCB</sub> |                        | 0.25  |      |              |      | V    |
|                   |                                       | 1.8                     | 3.3                     |                                                                               |                        | 0.35  |      |              |      |      |
|                   |                                       | 2.5                     | 3.3                     |                                                                               |                        | 0.35  |      |              |      |      |
| 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>CCA</sub> |                        | 0.25  |      |              |      | V    |
|                   |                                       | 1.8                     | 3.3                     |                                                                               |                        | 0.25  |      |              |      |      |
|                   |                                       | 2.5                     | 3.3                     |                                                                               |                        | 0.6   |      |              |      |      |
| 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>CCB</sub> |                        | -0.25 |      |              |      | V    |
|                   |                                       | 1.8                     | 3.3                     |                                                                               |                        | -0.25 |      |              |      |      |
|                   |                                       | 2.5                     | 3.3                     |                                                                               |                        | -0.35 |      |              |      |      |
| 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>CCA</sub> |                        | -0.25 |      |              |      | V    |
|                   |                                       | 1.8                     | 3.3                     |                                                                               |                        | -0.25 |      |              |      |      |
|                   |                                       | 2.5                     | 3.3                     |                                                                               |                        | -0.6  |      |              |      |      |
| V <sub>OHVA</sub> | Dynamic High 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>CCB</sub> |                        | 2.1   |      |              |      | V    |
|                   |                                       | 1.8                     | 3.3                     |                                                                               |                        | 2.6   |      |              |      |      |
|                   |                                       | 2.5                     | 3.3                     |                                                                               |                        | 2.6   |      |              |      |      |
| V <sub>OHVB</sub> | Dynamic High 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>CCA</sub> |                        | 1.7   |      |              |      | V    |
|                   |                                       | 1.8                     | 3.3                     |                                                                               |                        | 1.7   |      |              |      |      |
|                   |                                       | 2.5                     | 3.3                     |                                                                               |                        | 2.0   |      |              |      |      |

Table 8: 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<br>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<br>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<br>G 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<br>G 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<br>G to An           | 1.0                                          | 5.3  | 1.0                            | 5.1  | 1.0                           | 4.0  | ns   |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | Output Disable Time<br>G to Bn           | 1.0                                          | 8.3  | 1.0                            | 8.2  | 1.0                           | 4.6  |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output To Output Skew<br>Time (note1, 2) |                                              | 0.5  |                                | 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 ( $t_{OSLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{OSHL} = |t_{PHLm} - t_{PHLn}|$ )

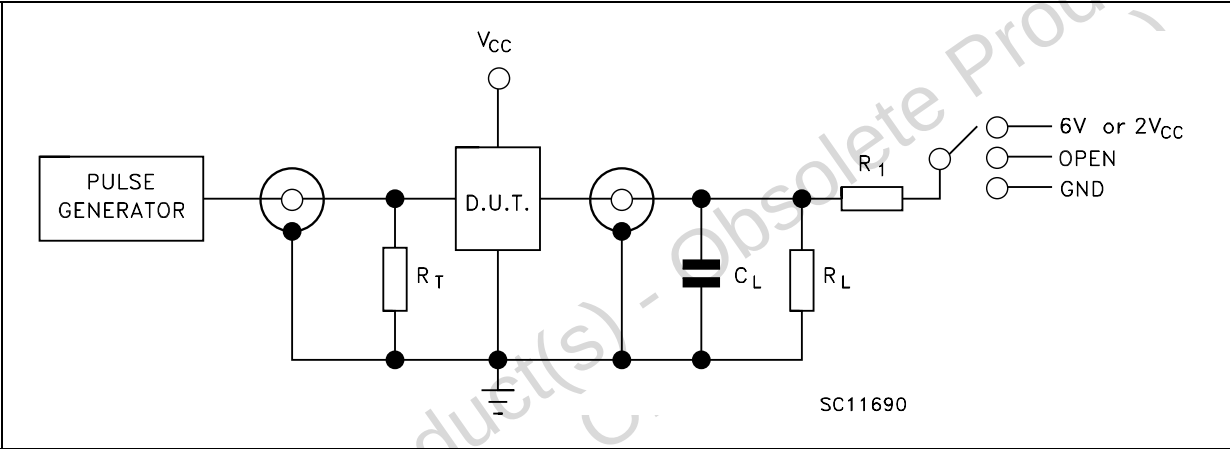
2) Parameter guaranteed by design

Table 9: Capacitance Characteristics

| Symbol           | Parameter                     | Test Condition          |                         |         | Value                  |      |      |              |      | Unit |
|------------------|-------------------------------|-------------------------|-------------------------|---------|------------------------|------|------|--------------|------|------|
|                  |                               | V <sub>CCA</sub><br>(V) | V <sub>CCB</sub><br>(V) |         | T <sub>A</sub> = 25 °C |      |      | -40 to 85 °C |      |      |
|                  |                               |                         |                         |         | Min.                   | Typ. | Max. | Min.         | Max. |      |
| C <sub>INB</sub> | Input Capacitance             | open                    | open                    |         |                        | 5    |      |              |      | pF   |
| C <sub>I/O</sub> | Input/Output Capacitance      | 3.3                     | 2.5                     |         |                        | 6    |      |              |      | pF   |
| C <sub>PD</sub>  | Power Dissipation Capacitance | 3.3                     | 2.5                     | f=10MHz |                        | 29   |      |              |      | pF   |
|                  |                               | 3.3                     | 1.8                     |         |                        | 29   |      |              |      |      |

1) C<sub>PD</sub> 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)

Figure 3: Test Circuit



| TEST                                                                                                   | SWITCH           |
|--------------------------------------------------------------------------------------------------------|------------------|
| t <sub>PLH</sub> , t <sub>PHL</sub>                                                                    | Open             |
| t <sub>PZL</sub> , t <sub>PLZ</sub> (V <sub>CC</sub> = 3.0 to 3.6V)                                    | 6V               |
| t <sub>PZL</sub> , t <sub>PLZ</sub> (V <sub>CC</sub> = 2.3 to 2.7V or V <sub>CC</sub> = 1.65 to 1.95V) | 2V <sub>CC</sub> |
| t <sub>PZH</sub> , t <sub>PHZ</sub>                                                                    | GND              |

C<sub>L</sub> = 30pF or equivalent (includes jig and probe capacitance)  
R<sub>L</sub> = R<sub>1</sub> = 500Ω or equivalent  
R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

Table 10: Waveform Symbol Value

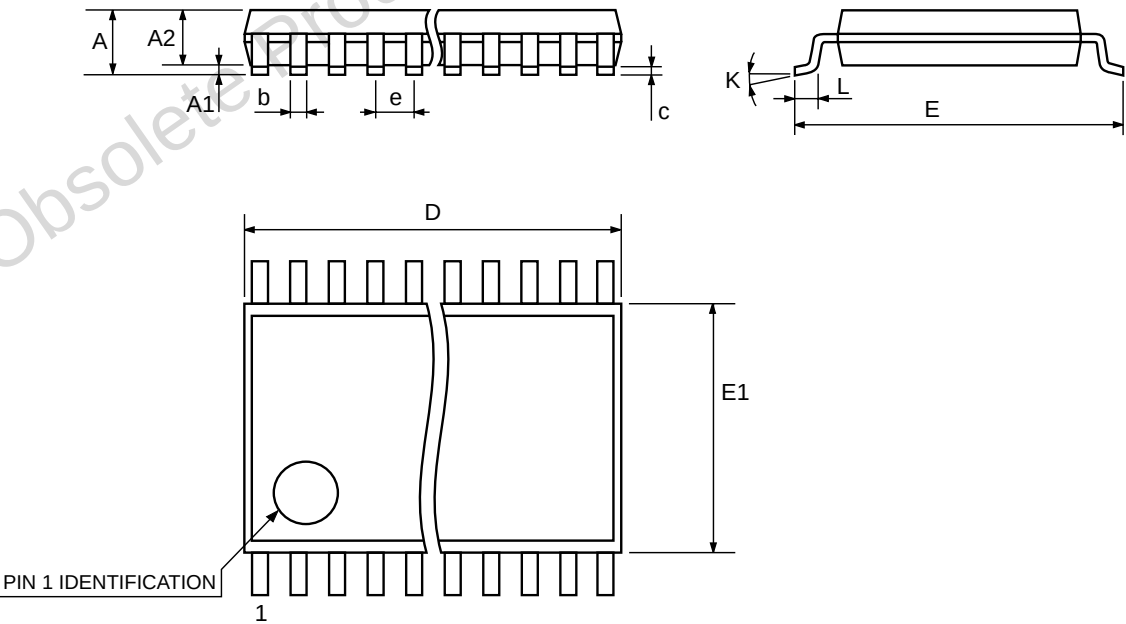
| Symbol          | V <sub>CC</sub>       |                        |                        |
|-----------------|-----------------------|------------------------|------------------------|
|                 | 3.0 to 3.6V           | 2.3 to 2.7V            | 1.65 to 1.95V          |
| V <sub>IH</sub> | V <sub>CC</sub>       | V <sub>CC</sub>        | V <sub>CC</sub>        |
| V <sub>M</sub>  | 1.5V                  | V <sub>CC</sub> /2     | V <sub>CC</sub> /2     |
| V <sub>X</sub>  | V <sub>OL</sub> +0.3V | V <sub>OL</sub> +0.15V | V <sub>OL</sub> +0.15V |
| V <sub>Y</sub>  | V <sub>OL</sub> -0.3V | V <sub>OL</sub> -0.15V | V <sub>OL</sub> -0.15V |





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    | 0.45 |         | 0.75 | 0.018  |            | 0.030  |

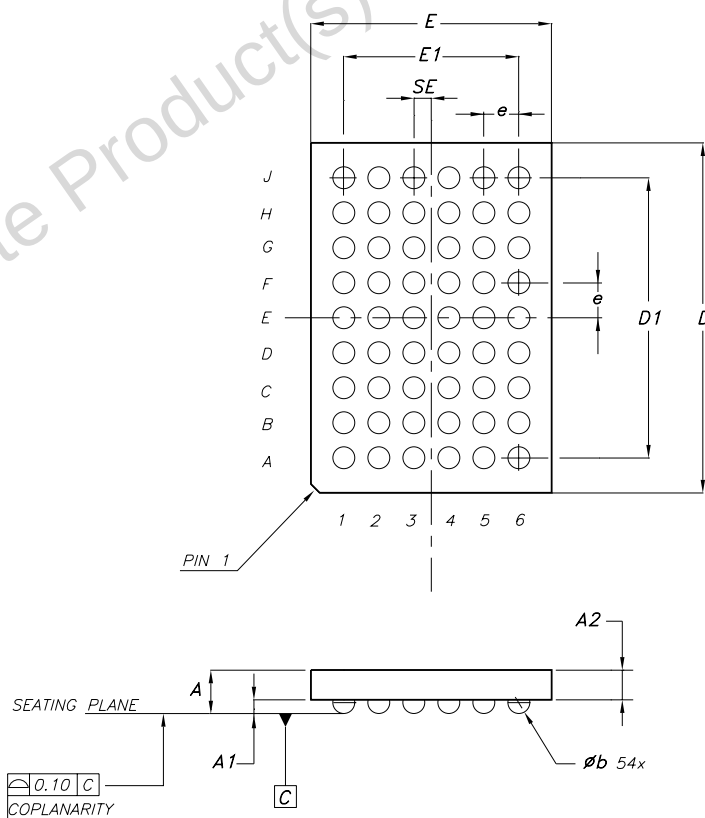


7065588D



## TFBGA54 MECHANICAL DATA

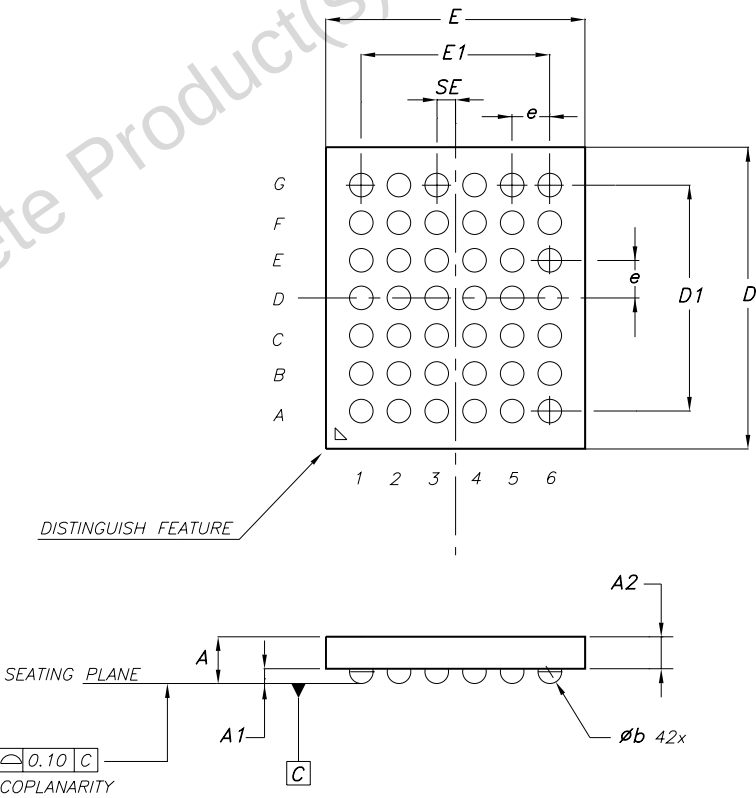
| DIM. | mm.  |     |      | mils  |       |       |
|------|------|-----|------|-------|-------|-------|
|      | MIN. | TYP | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      |     | 1.2  |       |       | 47.2  |
| A1   | 0.25 |     |      | 9.8   |       |       |
| A2   | 0.78 |     | 0.86 | 30.7  |       | 33.8  |
| B    | 0.35 | 0.4 | 0.45 | 13.7  | 15.7  | 17.7  |
| 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  |       |



7390143/C

μTFBGA42 MECHANICAL DATA

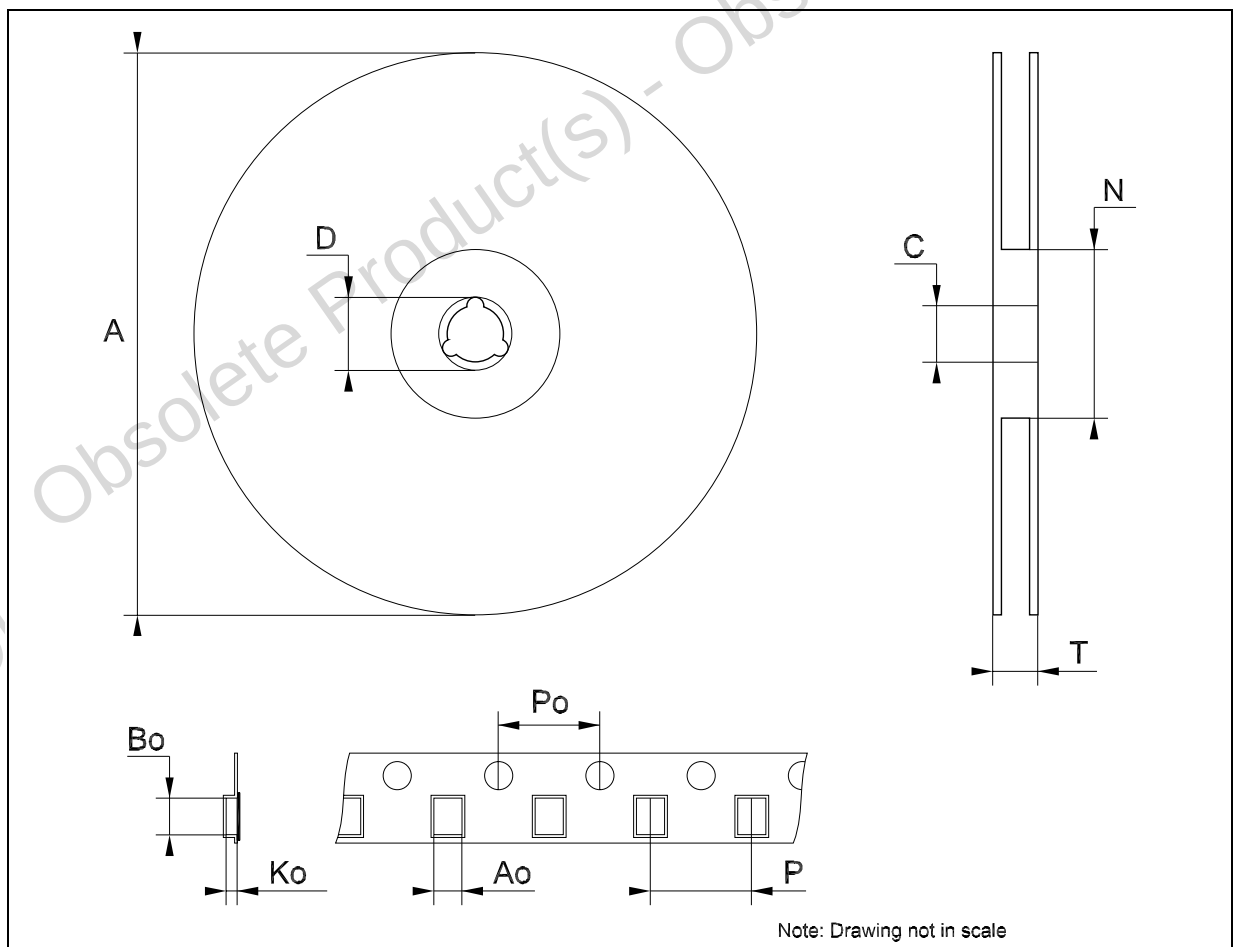
| DIM. | mm.  |      |      | mils  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 1.0  | 1.1  | 1.16 | 39.4  | 43.3  | 45.7  |
| A1   |      |      | 0.25 |       |       | 9.8   |
| A2   | 0.78 |      | 0.86 | 30.7  |       | 33.9  |
| b    | 0.25 | 0.30 | 0.35 | 9.8   | 11.8  | 13.8  |
| D    | 3.9  | 4.0  | 4.1  | 153.5 | 157.5 | 161.4 |
| D1   |      | 3    |      |       | 118.1 |       |
| E    | 3.4  | 3.5  | 3.6  | 133.9 | 137.8 | 141.7 |
| E1   |      | 2.5  |      |       | 98.4  |       |
| e    |      | 0.5  |      |       | 19.7  |       |
| SE   |      | 0.25 |      |       | 9.8   |       |



7513237/A

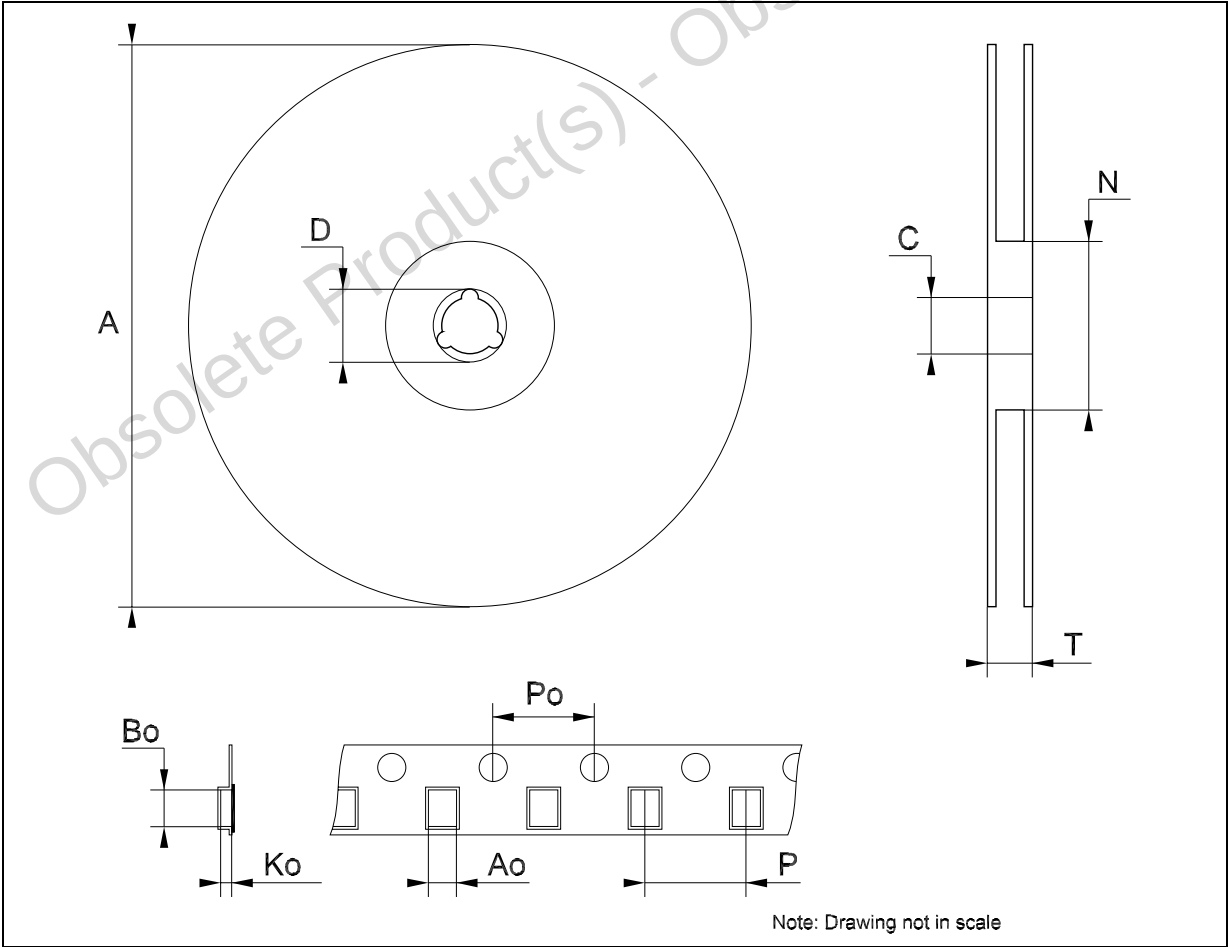
# Tape & Reel TSSOP48 MECHANICAL DATA

| 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  |



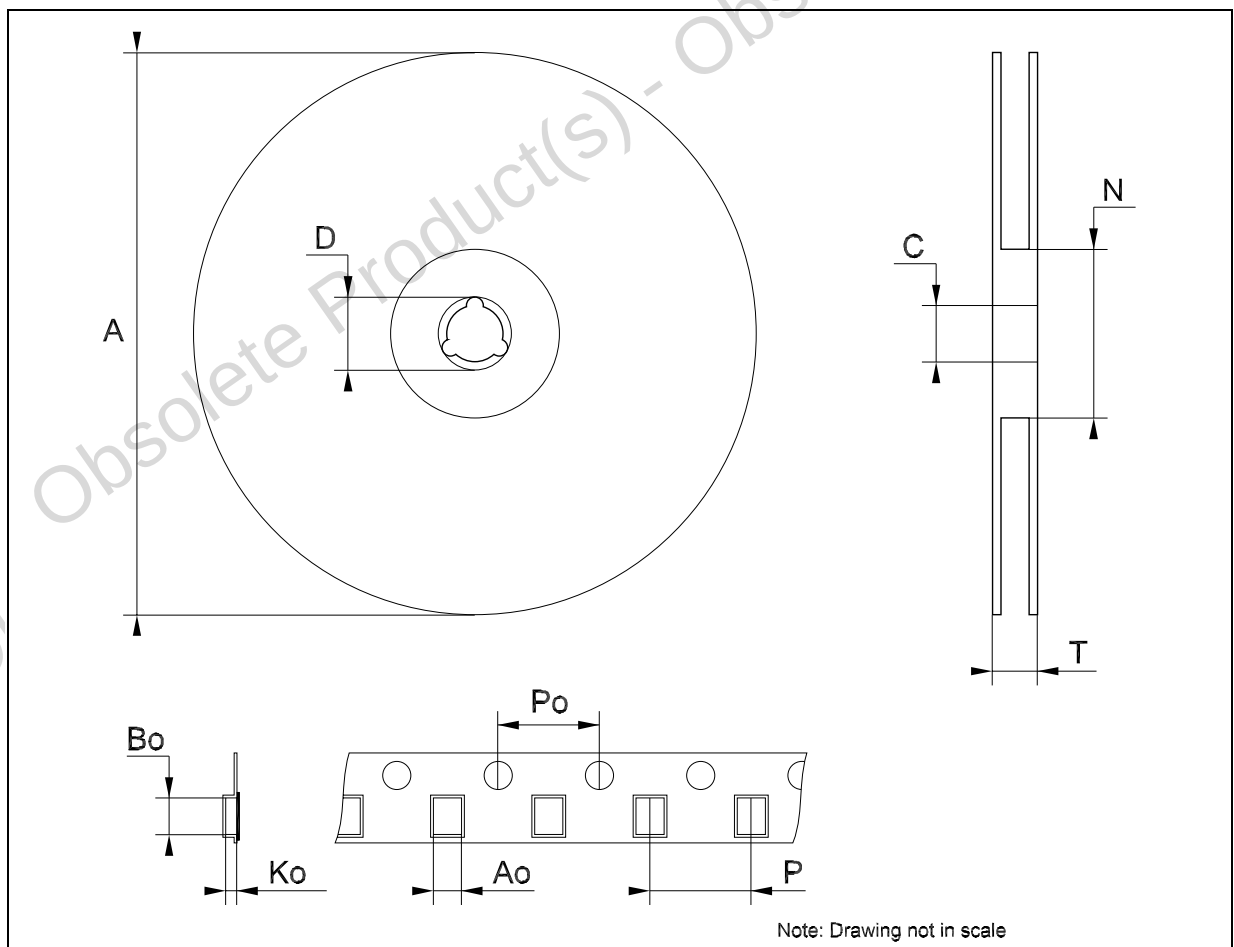
Tape & Reel TFBGA42 MECHANICAL DATA

| 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    |      |      | 14.4 |       |       | 0.567  |
| Ao   |      | 3.8  |      |       | 0.149 |        |
| Bo   |      | 4.3  |      |       | 0.169 |        |
| Ko   |      | 1.05 |      |       | 0.041 |        |
| Po   | 3.9  |      | 4.1  | 0.153 |       | 0.161  |
| P    | 7.9  |      | 8.1  | 0.311 |       | 0.319  |



# Tape & Reel TFBGA54 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    |      |     | 22.4 |       |       | 0.882  |
| Ao   |      | 6.1 |      |       | 0.240 |        |
| Bo   |      | 8.6 |      |       | 0.339 |        |
| Ko   |      | 1.8 |      |       | 0.071 |        |
| Po   | 3.9  |     | 4.1  | 0.153 |       | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |       | 0.319  |



**Table 11: Revision History**

| Date        | Revision | Description of Changes |
|-------------|----------|------------------------|
| 01-Jun-2004 | 1        | First Release.         |

Obsolete Product(s) - Obsolete Product(s)  
Obsolete Product(s) - Obsolete Product(s)



Obsolete Product(s) - Obsolete Product(s)

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