

# CBTV24DD12

## 12-bit bus switch/multiplexer for DDR4-DDR3-DDR2 applications

Rev. 3.2 — 19 April 2016

Product data sheet

## 1. General description

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CBTV24DD12 is designed for 1.8 V/2.5 V/3.3 V supply voltage operation and it supports Pseudo Open Drain (POD), SSTL\_12, SSTL\_15 or SSTL\_18 signaling and CMOS select input levels. This device is designed for operation in DDR4, DDR3 or DDR2 memory bus systems, with speeds up to 3200 MT/s.

The CBTV24DD12 has a 1 : 2 switch or 2 : 1 multiplex topology and offers a 12-bit wide bus. Each 12-bit wide A-port can be switched to one of two ports B and C, for all bits simultaneously. Each port is non-directional due to the use of FET switches, allowing a multitude of applications requiring high-bandwidth switching or multiplexing.

The selection of the port is by a simple CMOS input (SELect). Another CMOS input ( $\overline{\text{EN}}\text{able}$ ) is available to allow all ports to be disconnected. The SEL0, SEL1 and  $\overline{\text{EN}}$  input signals are designed to operate transparently as CMOS input level signals up to 3.3 V.

CBTV24DD12 uses NXP's proprietary high-speed switch architecture providing high bandwidth, very little insertion loss, return loss, and very low propagation delay, allowing use in many applications requiring switching or multiplexing of high-speed signals. It is available in a 3.0 mm × 8.0 mm TFBGA48 package with 0.65 mm ball pitch, for optimal size versus board layout density considerations. It is characterized for operation from -10 °C to +85 °C.

## 2. Features and benefits

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### 2.1 Topology

- 12-bit bus width
- 1 : 2 switch/MUX topology
- Bidirectional operation
- Simple CMOS select pins (SEL0, SEL1)
- Simple CMOS enable pin ( $\overline{\text{EN}}$ )

### 2.2 Performance

- 3200 MT/s throughput
- 7.4 GHz bandwidth (for both single-ended and differential signals)
- Low ON insertion loss
- Low return loss
- Low crosstalk
- High OFF isolation



- POD\_12, SSTL\_12, SSTL\_15 or SSTL\_18 signaling
- Low  $R_{ON}$  (8  $\Omega$  typical)
- Low  $\Delta R_{ON}$  (<1  $\Omega$ )

### 2.3 General attributes

- 1.8 V/2.5 V/3.3 V supply voltage operation
- Very low supply current (600  $\mu$ A typical)
- Back current protection on all the I/O pins of these switches
- ESD robustness exceeds 2.5 kV HBM, 1 kV CDM
- Available in TFBGA48 package, 3.0 mm  $\times$  8.0 mm  $\times$  1 mm size, 0.65 mm pitch, Pb-free/Dark Green

## 3. Applications

- DDR4/DDR3/DDR2 memory bus systems
- NVDIMM module
- Systems requiring high-speed multiplexing
- Flash memory array subsystem

## 4. Ordering information

Table 1. Ordering information

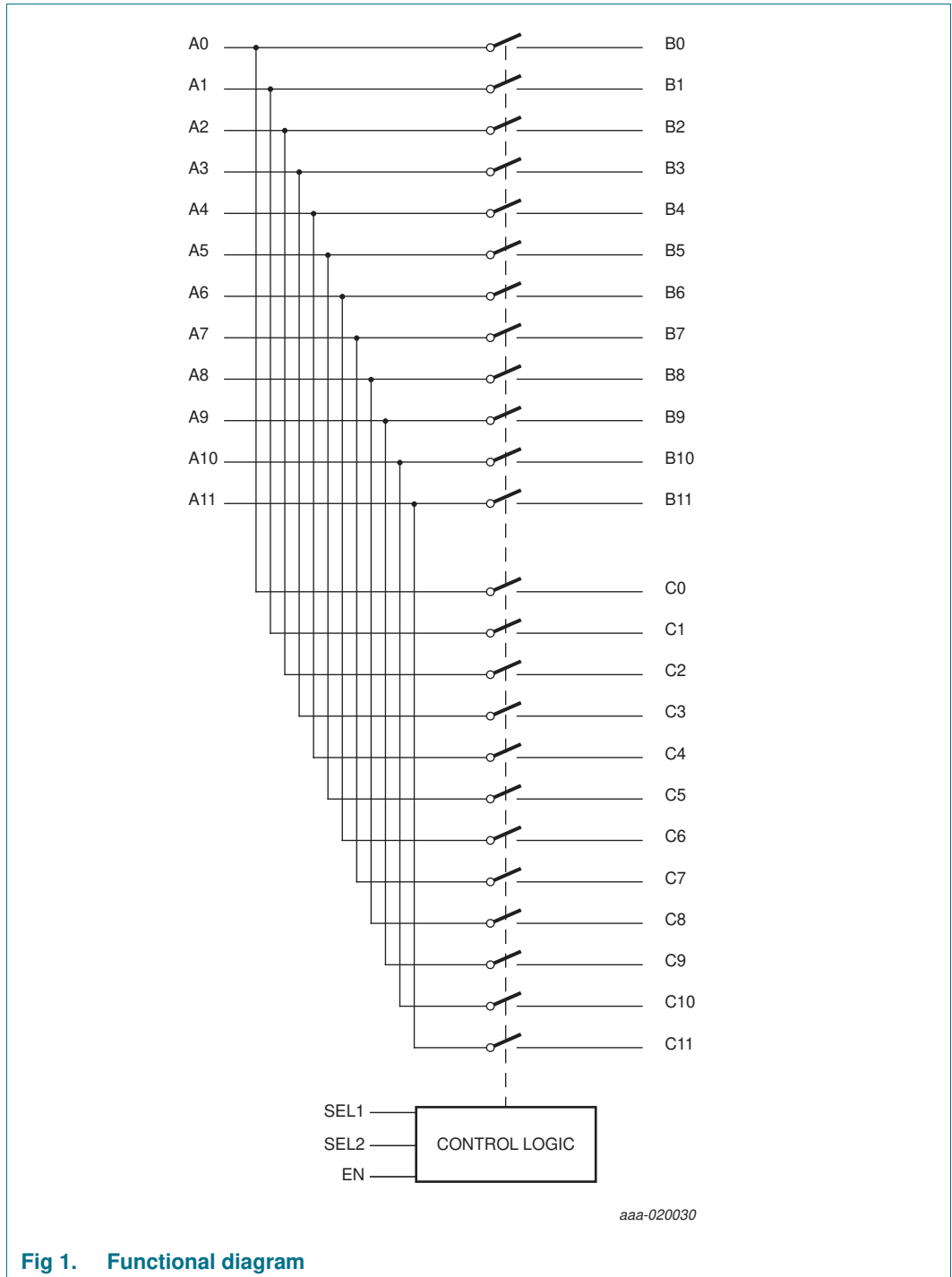
| Type number  | Topside mark | Package |  |           |
|--------------|--------------|---------|--|-----------|
|              |              | Name    | Description  | Version   |
| CBTV24DD12ET | V2412        | TFBGA48 | plastic low profile fine-pitch ball grid array package; 48 balls; body 3 $\times$ 8 $\times$ 1 mm; 0.65 mm pitch | SOT1365-1 |

### 4.1 Ordering options

Table 2. Ordering options

| Type number  | Orderable part number | Package | Packing method                                | Minimum order quantity | Temperature   |
|--------------|-----------------------|---------|---|------------------------|---|
| CBTV24DD12ET | CBTV24DD12ETY         | TFBGA48 | Reel 13" Q1/T1<br>*Standard mark SMD dry pack | 4500                   | T <sub>amb</sub> = -10 $^{\circ}$ C to +85 $^{\circ}$ C |

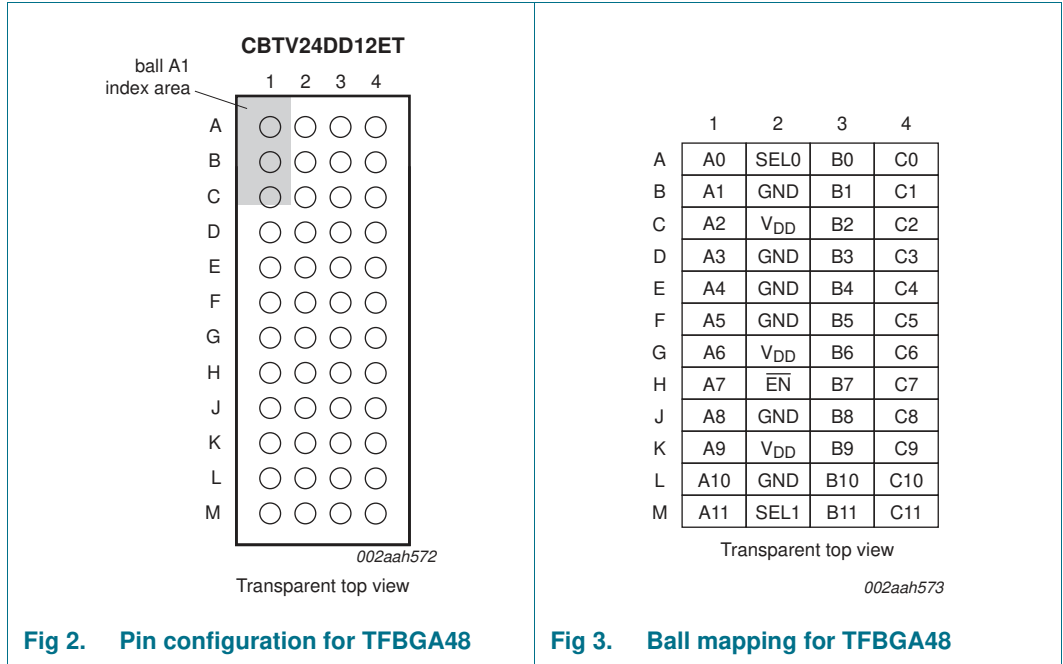
### 5. Functional diagram



**Fig 1. Functional diagram**

## 6. Pinning information

### 6.1 Pinning



**Fig 2. Pin configuration for TFBGA48**

**Fig 3. Ball mapping for TFBGA48**

### 6.2 Pin description

**Table 3. Pin description**

| Symbol     | Pin  | Type           | Description  |
|------------|--|----------------|--|
| A[0:11]    | A1, B1, C1, D1, E1, F1, G1, H1, J1, K1, L1, M1 | high-speed I/O | 12-bit wide input/output, port A   |
| B[0:11]    | A3, B3, C3, D3, E3, F3, G3, H3, J3, K3, L3, M3 | high-speed I/O | 12-bit wide input/output, port B   |
| C[0:11]    | A4, B4, C4, D4, E4, F4, G4, H4, J4, K4, L4, M4 | high-speed I/O | 12-bit wide input/output, port C   |
| SEL0, SEL1 | A2, M2   | CMOS input     | CMOS input signal.<br>When SEL0 = LOW, port A[0,1,4,5,8,9] and port B[0,1,4,5,8,9] are mutually connected.<br>When SEL0 = HIGH, port A[0,1,4,5,8,9] and port C[0,1,4,5,8,9] are mutually connected.<br>When SEL1 = LOW, port A[2,3,6,7,10,11] and port B[2,3,6,7,10,11] are mutually connected.<br>When SEL1 = HIGH, port A[2,3,6,7,10,11] and port C[2,3,6,7,10,11] are mutually connected. |

Table 3. Pin description ...continued

| Symbol                 | Pin                       | Type       | Description  |
|------------------------|---------------------------|------------|--|
| $\overline{\text{EN}}$ | H2                        | CMOS input | CMOS input signal.<br>When HIGH, all ports are mutually isolated.<br>When LOW, connection is set using the SEL[0:1] input signals. |
| V <sub>DD</sub>        | C2, G2, K2                | supply     | Must be connected to supply voltage power plane.   |
| GND                    | B2, D2, E2,<br>F2, J2, L2 | ground     | Must be connected to GND plane for both electrical grounding and thermal relief.   |

## 7. Functional description

Refer to [Figure 1 “Functional diagram”](#).

CBTV24DD12 supports 1.8 V, 2.5 V or 3.3 V power supply voltages. All signal paths are implemented using high-bandwidth pass-gate technology and are non-directional. No clock or reset signal is needed for the multiplexer to function. The switch position for the channels is selected using the select signals (SEL0, SEL1). The detailed operation is described in [Section 7.1](#).

### 7.1 Function selection

The internal multiplexer switch position is controlled by three logic inputs, SEL0, SEL1 and EN, as described in [Table 4](#).

When a channel is not being used, Port B and Port C of this channel should be tied to ground. For example, if Channel 2 is not used, B2 and C2 should be tied to ground and A2 should be left open.

**Table 4. Function selection**

*X = don't care.*

| Inputs |             | Switch position                     |                                     |
|--------|-------------|-------------------------------------|-------------------------------------|
| EN     | SELx        | A ↔ B                               | A ↔ C                               |
| HIGH   | X           | OFF (isolated)                      | OFF (isolated)                      |
| LOW    | SEL0 = LOW  | A[0,1,4,5,8,9] ↔ B[0,1,4,5,8,9]     | OFF (isolated)                      |
| LOW    | SEL0 = HIGH | OFF (isolated)                      | A[0,1,4,5,8,9] ↔ C[0,1,4,5,8,9]     |
| LOW    | SEL1 = LOW  | A[2,3,6,7,10,11] ↔ B[2,3,6,7,10,11] | OFF (isolated)                      |
| LOW    | SEL1 = HIGH | OFF (isolated)                      | A[2,3,6,7,10,11] ↔ C[2,3,6,7,10,11] |

## 8. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol           | Parameter                       | Conditions | Min  | Max  | Unit |
|------------------|---------------------------------|------------|------|------|------|
| V <sub>DD</sub>  | supply voltage                  |            | -0.3 | +4.4 | V    |
| T <sub>stg</sub> | storage temperature             |            | -65  | +150 | °C   |
| V <sub>ESD</sub> | electrostatic discharge voltage | HBM [1]    | -    | 2500 | V    |
|                  |                                 | CDM [2]    | -    | 1000 | V    |

- [1] Human Body Model: ANSI/ESDA/JEDEC JDS-001-2012 (Revision of ANSI/ESDA/JEDEC JS-001-2011), ESDA/JEDEC Joint standard for ESD sensitivity testing. Human Body Model - Component level; Electrostatic Discharge Association, Rome, NY, USA.; JEDEC Solid State Technology Association, Arlington, VA, USA.
- [2] Charged-Device Model: JESD22-C101E December 2009 (Revision of JESD22-C101D, October 2008), standard for ESD sensitivity testing, Charged-Device Model - Component level; JEDEC Solid State Technology Association, Arlington, VA, USA.

## 9. Recommended operating conditions

**Table 6. Operating conditions**

| Symbol           | Parameter           | Conditions             | Min  | Typ | Max  | Unit |
|------------------|---------------------|------------------------|------|-----|------|------|
| V <sub>DD</sub>  | supply voltage      |                        | 1.62 | -   | 3.63 | V    |
| V <sub>I</sub>   | input voltage       | channel inputs/outputs | -0.3 | -   | +1.8 | V    |
|                  |                     | control inputs         | -0.3 | -   | +3.6 | V    |
| T <sub>amb</sub> | ambient temperature | operating in free air  | -10  | -   | +85  | °C   |

## 10. Static characteristics

**Table 7. Static characteristics**

Typical V<sub>DD</sub>; T<sub>amb</sub> = -10 °C to +85 °C; unless otherwise specified.

| Symbol          | Parameter                | Conditions   | Min  | Typ [1] | Max  | Unit |
|-----------------|--------------------------|--|------|---------|------|------|
| I <sub>DD</sub> | supply current           | $\overline{EN}$ = LOW  | -    | 0.6     | 1.3  | mA   |
|                 |                          | $\overline{EN}$ = HIGH   | -    | -       | 45   | μA   |
| I <sub>IH</sub> | HIGH-level input current | High-speed I/O; A, B and C ports;<br>V <sub>I</sub> = 1.8 V    | -    | -       | ±5   | μA   |
|                 |                          | Control pins; SEL0, SEL1 and EN;<br>V <sub>I</sub> = 3.6 V     | -    | -       | ±10  | μA   |
| I <sub>IL</sub> | LOW-level input current  | V <sub>I</sub> = GND   | -    | -       | ±5   | μA   |
| V <sub>IH</sub> | HIGH-level input voltage | SEL0, SEL1, $\overline{EN}$ pins                               | 1.4  | -       | -    | V    |
| V <sub>IL</sub> | LOW-level input voltage  | SEL0, SEL1, $\overline{EN}$ pins                               | -0.5 | -       | +0.4 | V    |
| V <sub>IK</sub> | input clamping voltage   | voltage on high-speed channel pins;<br>I <sub>I</sub> = -18 mA | -    | -       | -1.2 | V    |

- [1] Typical values are at V<sub>DD</sub> = 2.5 V; T<sub>amb</sub> = 25 °C, and maximum loading.

## 11. Dynamic characteristics

Table 8. Dynamic characteristics for CBTV24DD12

| Symbol                       | Parameter                               | Conditions  | Min      | Typ  | Max | Unit          |
|------------------------------|---|---|----------|------|-----|---------------|
| $t_{\text{startup}}$         | start-up time                           | supply voltage valid or $\overline{\text{EN}}$ going HIGH to channel specified operating characteristics                    | -        | 90   | 300 | $\mu\text{s}$ |
| $t_{\text{rcfg}}$            | reconfiguration time                    | SEL[0:1] state change to channel specified operating characteristics; measuring from 50 % of SELx to 90 % of channel output | [1] -    | -    | 30  | ns            |
| $\alpha_{\text{il}}$         | insertion loss                          | channel is on; $0 \text{ Hz} \leq f \leq 4 \text{ GHz}$   | -        | -1.5 | -   | dB            |
|                              |   | channel is on; $f = 7 \text{ GHz}$  | -        | -3.0 | -   | dB            |
|                              |   | channel is off; $0 \text{ Hz} \leq f \leq 4 \text{ GHz}$  | -        | -20  | -   | dB            |
| $\text{RL}_{\text{in}}$      | input return loss                       | channel is on; $0 \text{ Hz} \leq f \leq 4 \text{ GHz}$   | -        | -16  | -   | dB            |
| $\alpha_{\text{ct}}$         | crosstalk attenuation                   | adjacent channels are on; $0 \text{ Hz} \leq f \leq 4 \text{ GHz}$  | -        | -24  | -   | dB            |
| B                            | bandwidth                               | -3.0 dB intercept (for both single-ended and differential signals)  | -        | 7.4  | -   | GHz           |
| $t_{\text{PD}}$              | propagation delay                       | from A port to B port or C port or vice versa   | -        | 65   | -   | ps            |
| $t_{\text{sk}}$              | skew time                               | from any output to any output   | -        | 3    | 6   | ps            |
| $R_{\text{ON}}$              | ON resistance                           | from any input to any output  | 5        | 6.5  | 9   | $\Omega$      |
| $R_{\text{ON}(\text{flat})}$ | ON resistance (flatness)                |   | [2] -    | 1.5  | -   | $\Omega$      |
| $\Delta R_{\text{ON}}$       | ON resistance mismatch between channels |   | [3][4] - | 0.4  | 1   | $\Omega$      |

[1] Smooth transition without glitch under DDR termination schemes.

[2]  $R_{\text{ON}(\text{flat})}$  is the difference of the  $R_{\text{ON}}$  in a given channel across all  $V_1$  voltage ranges.

[3]  $\Delta R_{\text{ON}}$  is the difference of  $R_{\text{ON}}$  from one port to any other ports when the same  $V_1$  voltage is applied to all channels.

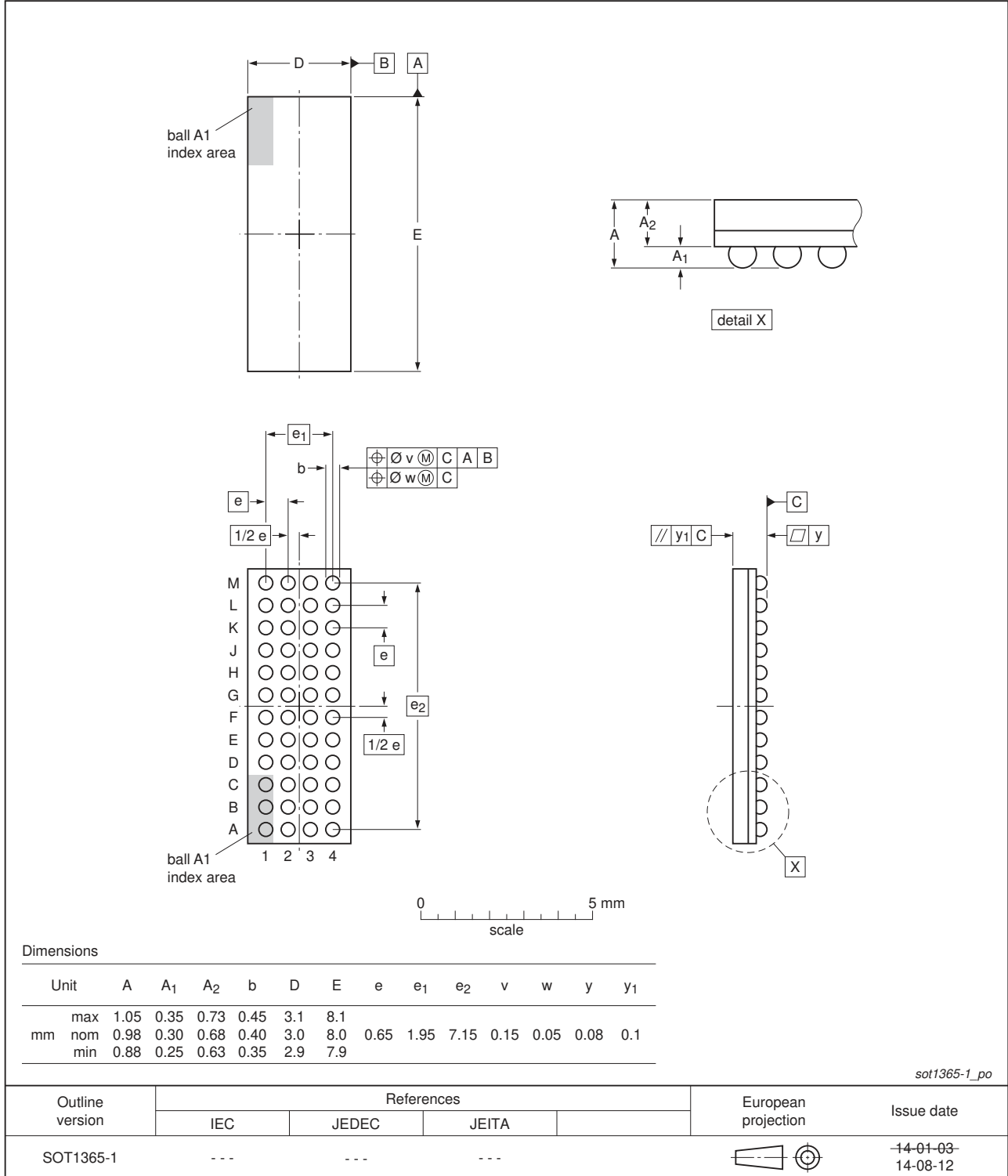
[4] Guaranteed by design.



**12. Package outline**

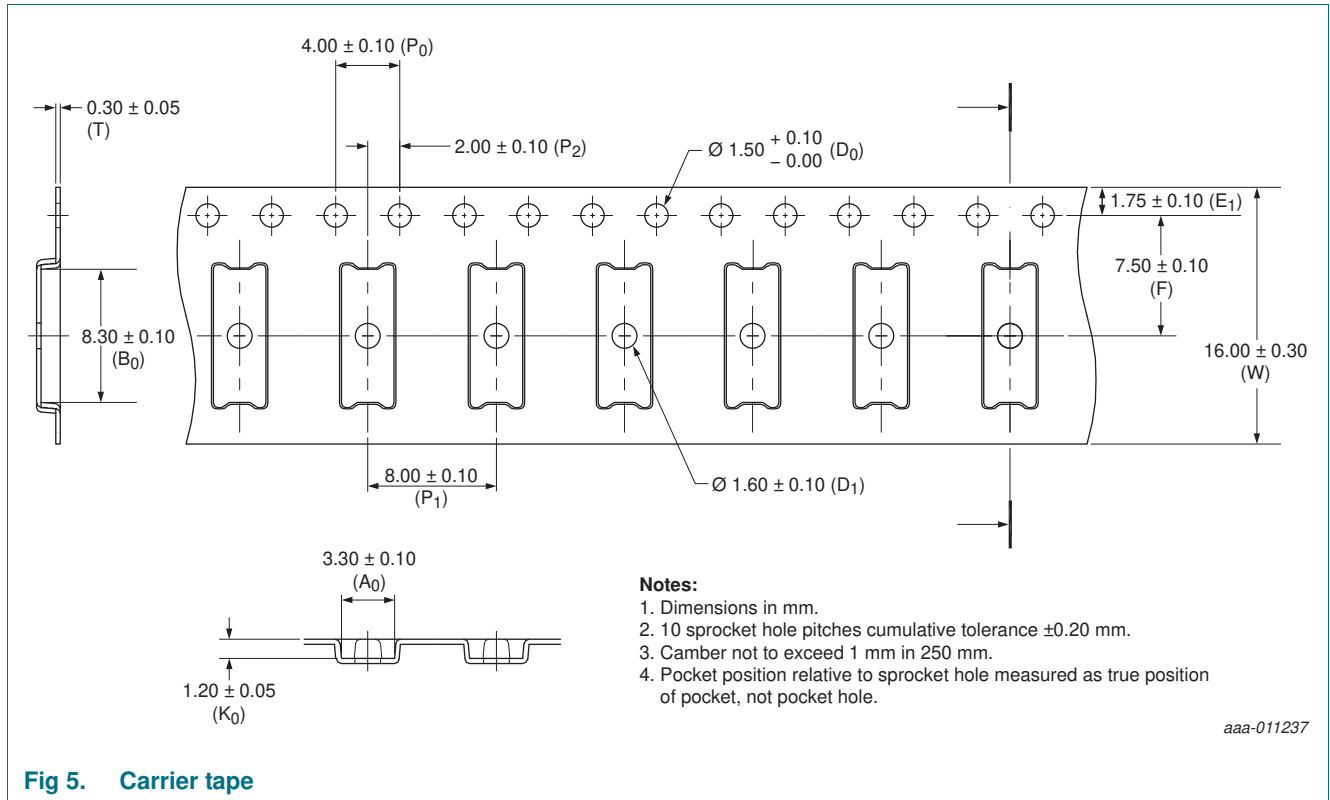
TFBGA48: plastic low profile fine-pitch ball grid array package; 48 balls

SOT1365-1

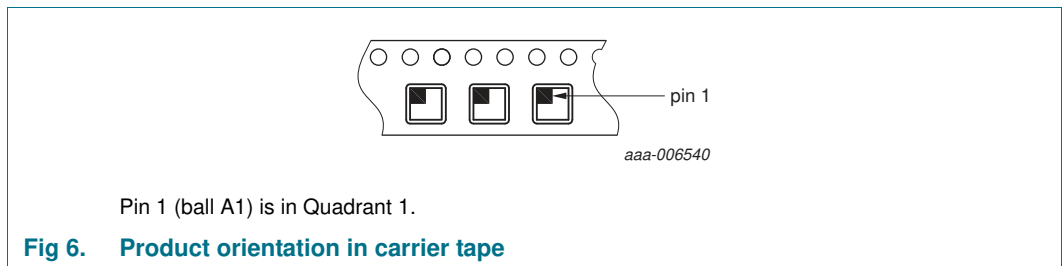


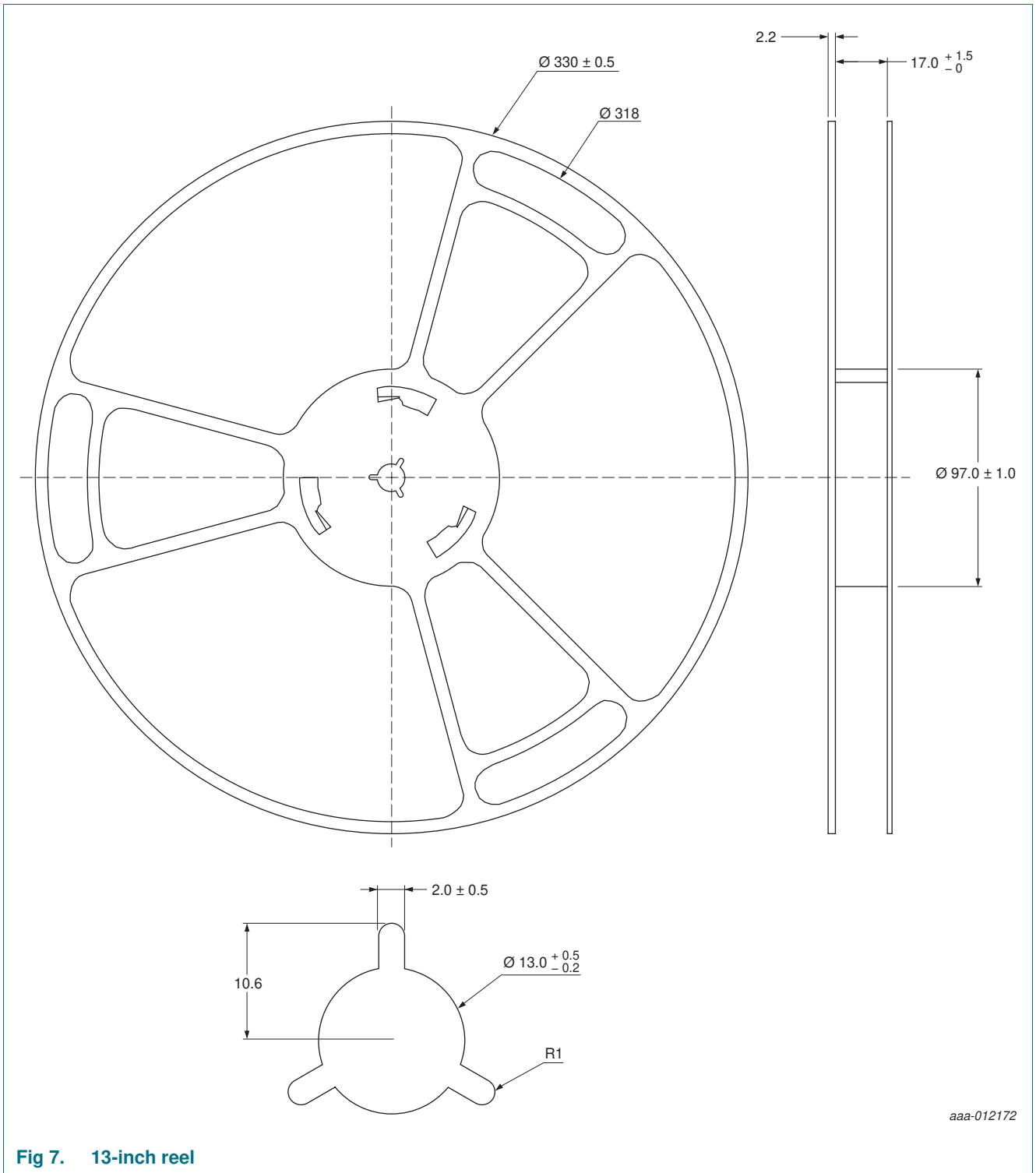
**Fig 4. Package outline TFBGA48 (SOT1365-1)**

**13. Packing information**



**Fig 5. Carrier tape**





**Fig 7. 13-inch reel**

## 14. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 14.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 14.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 14.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

**14.4 Reflow soldering**

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 8](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 9](#) and [10](#)

**Table 9. SnPb eutectic process (from J-STD-020D)**

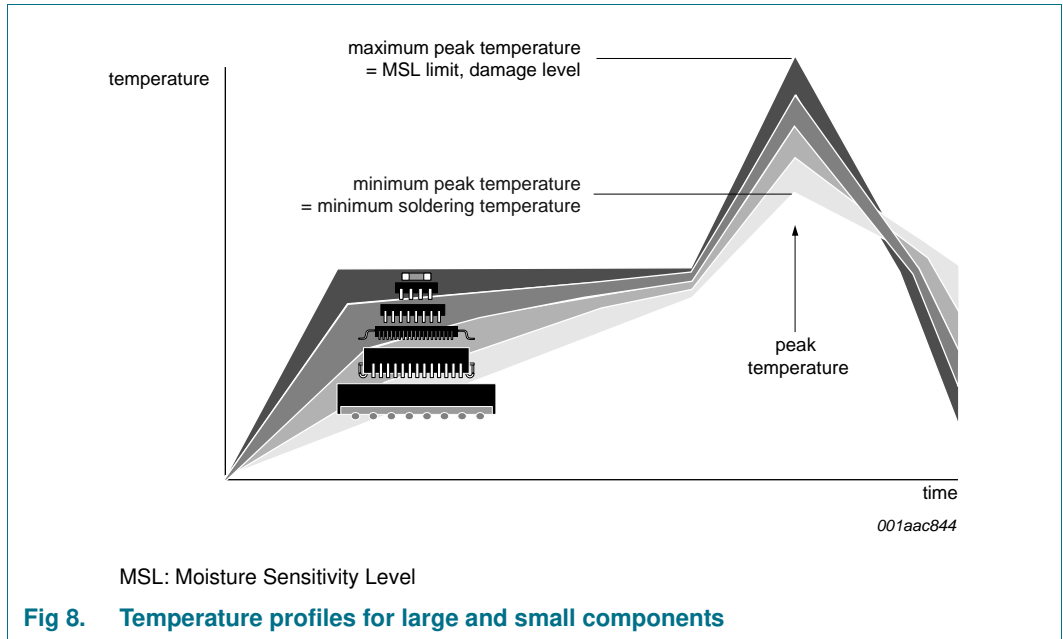
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 235                             | 220   |
| ≥ 2.5                  | 220                             | 220   |

**Table 10. Lead-free process (from J-STD-020D)**

| Package thickness (mm) | Package reflow temperature (°C) |             |        |
|------------------------|---------------------------------|-------------|--------|
|                        | Volume (mm <sup>3</sup> )       |             |        |
|                        | < 350                           | 350 to 2000 | > 2000 |
| < 1.6                  | 260                             | 260         | 260    |
| 1.6 to 2.5             | 260                             | 250         | 245    |
| > 2.5                  | 250                             | 245         | 245    |

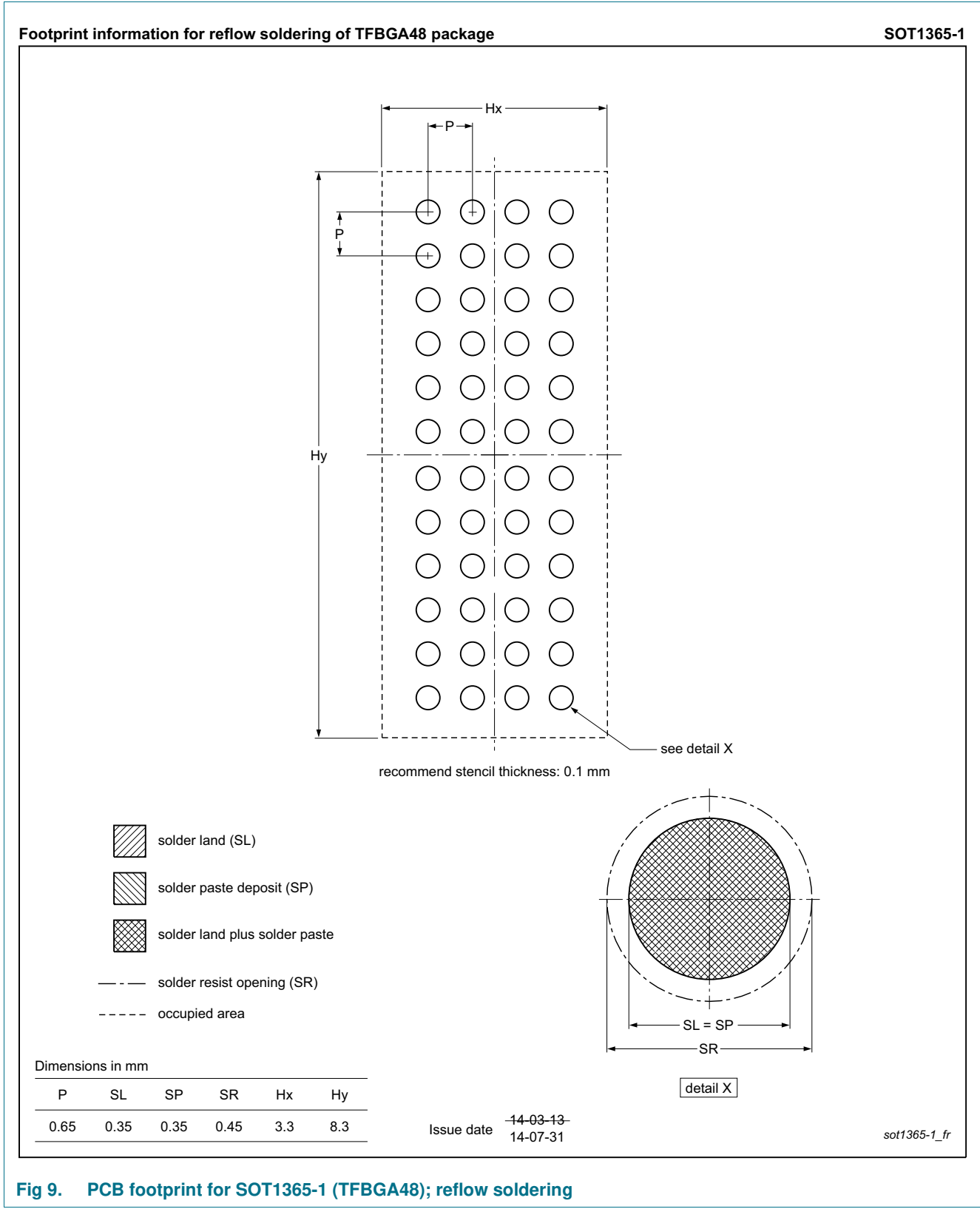
Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 8](#).



For further information on temperature profiles, refer to Application Note AN10365 “Surface mount reflow soldering description”.

**15. Soldering: PCB footprints**



**Fig 9. PCB footprint for SOT1365-1 (TFBGA48); reflow soldering**

Issue date ~~14-03-13~~  
14-07-31

sot1365-1\_fr

## 16. Abbreviations

Table 11. Abbreviations

| Acronym | Description                             |
|---------|---|
| CDM     | Charged-Device Model                    |
| CMOS    | Complementary Metal-Oxide Semiconductor |
| DDR2    | Double Data Rate 2                      |
| DDR3    | Double Data Rate 3                      |
| DDR4    | Double Data Rate 4                      |
| DRAM    | Dynamic Random Access Memory            |
| ESD     | ElectroStatic Discharge                 |
| FET     | Field-Effect Transistor                 |
| HBM     | Human Body Model                        |
| I/O     | Input/Output                            |
| MT/s    | Mega Transfers per second               |
| NVDIMM  | Non-Volatile Dual In-line Memory Module |
| POD     | Pseudo Open Drain                       |
| SSTL_12 | Stub Series Terminated Logic for 1.2 V  |
| SSTL_15 | Stub Series Terminated Logic for 1.5 V  |
| SSTL_18 | Stub Series Terminated Logic for 1.8 V  |

## 17. Revision history

Table 12. Revision history

| Document ID      | Release date  | Data sheet status  | Change notice | Supersedes       |
|------------------|---|--------------------|---------------|------------------|
| CBTV24DD12 v.3.2 | 20160419  | Product data sheet | -             | CBTV24DD12 v.3.1 |
| Modifications:   | <ul style="list-style-type: none"> <li>• <a href="#">Section 2.3 “General attributes”</a>: Added “Back current protection...”</li> </ul>  |                    |               |                  |
| CBTV24DD12 v.3.1 | 20151020  | Product data sheet | -             | CBTV24DD12 v.3   |
| Modifications:   | <ul style="list-style-type: none"> <li>• Updated <a href="#">Figure 1 “Functional diagram”</a></li> </ul>   |                    |               |                  |
| CBTV24DD12 v.3   | 20150820  | Product data sheet | -             | CBTV24DD12 v.2   |
| Modifications:   | <ul style="list-style-type: none"> <li>• <a href="#">Table 7 “Static characteristics”</a>: Changed max value for I<sub>IH</sub> control pins from “±5” to “±10”</li> <li>• <a href="#">Table 8 “Dynamic characteristics for CBTV24DD12”</a>: Updated conditions for t<sub>rcfg</sub>; changed min/typ/max values for R<sub>ON</sub></li> <li>• Changed document status from “Company Confidential” to “Company Public”</li> </ul> |                    |               |                  |
| CBTV24DD12 v.2   | 20140828  | Product data sheet | -             | CBTV24DD12 v.1   |
| CBTV24DD12 v.1   | 20140814  | Product data sheet | -             | -                |



## 18. Legal information

### 18.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition  |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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