

# GTL2005

## Quad GTL/GTL+ to LVTTTL/TTL bidirectional non-latched translator

Rev. 07 — 3 February 2009

Product data sheet

## 1. General description

The GTL2005 is a quad translating transceiver designed for 3.3 V system interface with a GTL/GTL+ bus.

The direction pin (DIR) allows the part to function as either a GTL-to-TTL sampling receiver or as a TTL-to-GTL interface.

The GTL2005 LVTTTL interface is tolerant up to 5.5 V allowing direct access to TTL or 5 V CMOS outputs.

The GTL2005  $V_{ref}$  linearity degrades below 0.8 V (see [Section 10.1](#)). If the application allows, use the GTL2014, otherwise more closely review noise margins.

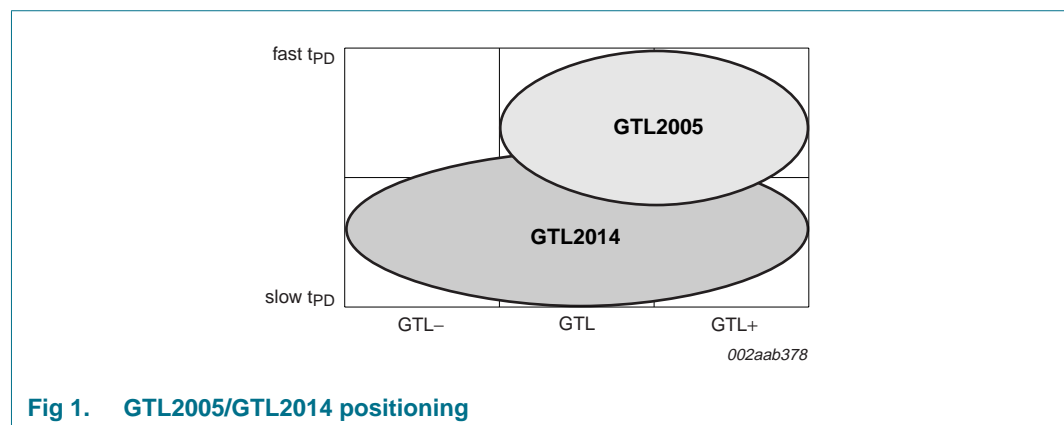


Fig 1. GTL2005/GTL2014 positioning

## 2. Features

- Operates as a quad GTL/GTL+ sampling receiver or as a LVTTTL/TTL to GTL/GTL+ driver
- Quad bidirectional bus interface
- 3.0 V to 3.6 V operation with 5 V tolerant LVTTTL I/O
- Live insertion/extraction permitted
- Latch-up protection exceeds 500 mA per JESD78
- ESD protection exceeds 2000 V HBM per JESD22-A114, 150 V MM per JESD22-A115, and 1000 V CDM per JESD22-CC101
- Package offered: TSSOP14

### 3. Quick reference data

**Table 1. Quick reference data**

$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$

| Symbol  | Parameter                   | Conditions  | Min | Typ <sup>[1]</sup> | Max | Unit |
|---|-----------------------------|---|-----|--------------------|-----|------|
| $C_i$   | input capacitance           | control inputs;<br>$V_I = 3.0\text{ V}$ or $0\text{ V}$ | -   | 2.3                | 3.5 | pF   |
| $C_{io}$  | input/output capacitance    | A port;<br>$V_O = V_{TT}$ or $0\text{ V}$               | -   | 3.4                | 5.0 | pF   |
|   |                             | B port;<br>$V_O = 3.0\text{ V}$ or $0\text{ V}$         | -   | 6.0                | 7.0 | pF   |
| <b>GTL; <math>V_{ref} = 0.8\text{ V}</math></b> |                             |   |     |                    |     |      |
| $t_{PLH}$                                       | propagation delay, Bn to An | see <a href="#">Figure 7</a>                            | -   | 2.1                | 2.3 | ns   |
| $t_{PHL}$                                       |                             |   | -   | 1.9                | 2.6 | ns   |
| $t_{PLH}$                                       | propagation delay, An to Bn | see <a href="#">Figure 8</a>                            | -   | 4.1                | 5.9 | ns   |
| $t_{PHL}$                                       |                             |   | -   | 4.4                | 5.9 | ns   |

[1] All typical values are measured at  $V_{CC} = 3.3\text{ V}$  and  $T_{amb} = 25\text{ }^\circ\text{C}$ .

### 4. Ordering information

**Table 2. Ordering information**

$T_{amb} = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$

| Type number | Topside mark | Package |  |          |
|-------------|--------------|---------|--|----------|
|             |              | Name    | Description  | Version  |
| GTL2005PW   | GTL2005      | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |

## 5. Functional diagram

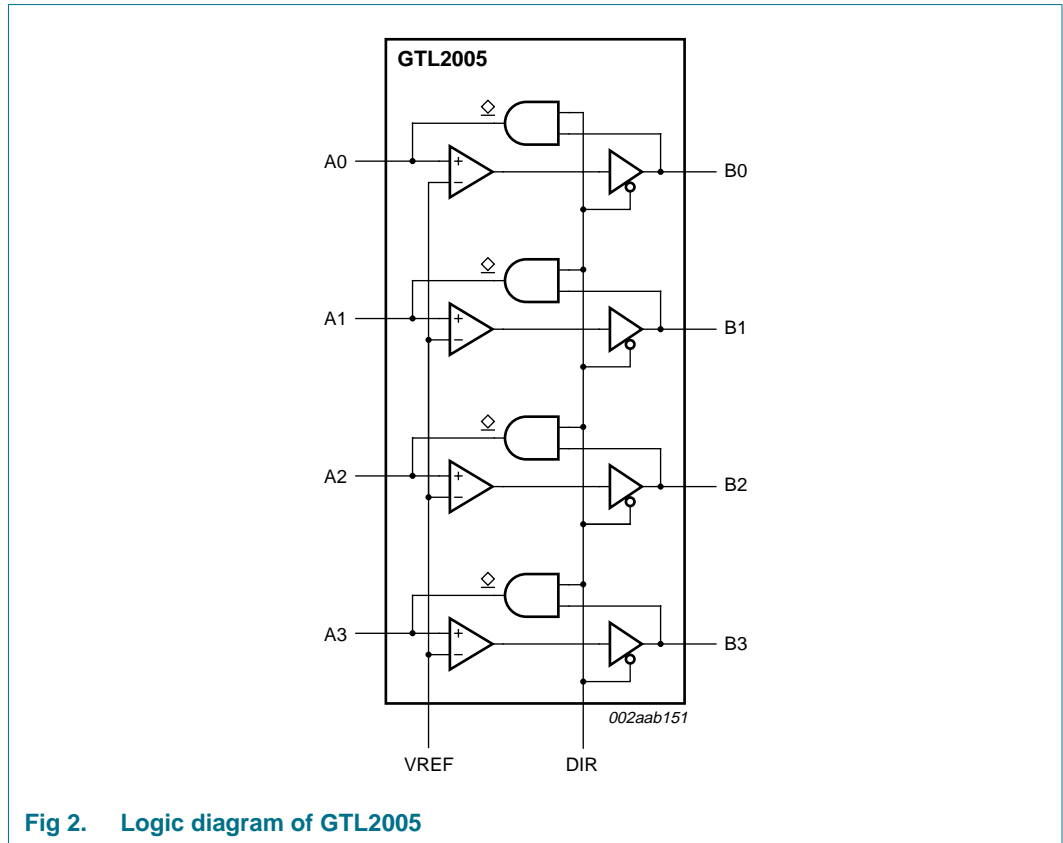


Fig 2. Logic diagram of GTL2005

## 6. Pinning information

### 6.1 Pinning

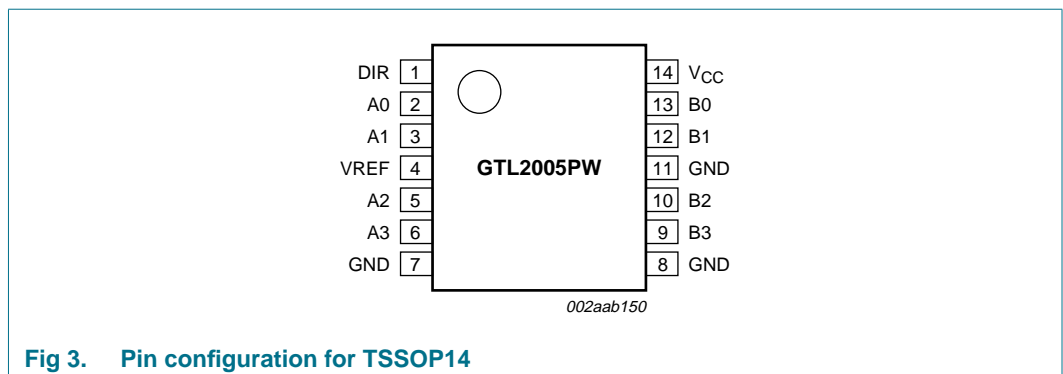


Fig 3. Pin configuration for TSSOP14

## 6.2 Pin description

**Table 3. Pin description**

| Symbol          | Pin      | Description                       |
|-----------------|----------|-----------------------------------|
| DIR             | 1        | direction control input           |
| A0              | 2        | data inputs/outputs (A side, GTL) |
| A1              | 3        |                                   |
| A2              | 5        |                                   |
| A3              | 6        |                                   |
| B0              | 13       | data inputs/outputs (B side, TTL) |
| B1              | 12       |                                   |
| B2              | 10       |                                   |
| B3              | 9        |                                   |
| VREF            | 4        | GTL reference voltage             |
| GND             | 7, 8, 11 | ground (0 V)                      |
| V <sub>CC</sub> | 14       | positive supply voltage           |

## 7. Functional description

Refer to [Figure 2 “Logic diagram of GTL2005”](#).

### 7.1 Function table

**Table 4. Function table**

*H = HIGH voltage level; L = LOW voltage level.*

| Input | Input/output                    |                                 |
|-------|---------------------------------|---------------------------------|
|       | B (TTL)                         | A (GTL)                         |
| H     | inputs                          | B <sub>n</sub> = A <sub>n</sub> |
| L     | A <sub>n</sub> = B <sub>n</sub> | inputs                          |

## 8. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).<sup>[1]</sup>  
 Voltages are referenced to GND (ground = 0 V).

| Symbol    | Parameter                                 | Conditions                          | Min                 | Max  | Unit |
|-----------|---|-------------------------------------|---------------------|------|------|
| $V_{CC}$  | DC supply voltage                         |                                     | -0.5                | +4.6 | V    |
| $I_{IK}$  | DC input diode current                    | $V_I < 0$ V                         | -                   | -50  | mA   |
| $V_I$     | DC input voltage                          | A port                              | -0.5 <sup>[2]</sup> | +7.0 | V    |
|           |   | B port                              | -0.5 <sup>[2]</sup> | +4.6 | V    |
| $I_{OK}$  | DC output diode current                   | $V_O < 0$ V                         | -                   | -50  | mA   |
| $V_O$     | DC output voltage                         | output in OFF or HIGH state; A port | -0.5 <sup>[2]</sup> | +7.0 | V    |
|           |   | output in OFF or HIGH state; B port | -0.5 <sup>[2]</sup> | +4.6 | V    |
| $I_{OL}$  | current into any output in the LOW state  | B port                              | -                   | 128  | mA   |
|           |   | A port                              | -                   | 80   | mA   |
| $I_{OH}$  | current into any output in the HIGH state | B port                              | -                   | -64  | mA   |
| $T_{stg}$ | storage temperature range                 |                                     | <sup>[3]</sup> -60  | +150 | °C   |

- [1] Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under [Section 9 "Recommended operating conditions"](#) is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- [2] The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.
- [3] The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150 °C.

## 9. Recommended operating conditions

Table 6. Operating conditions [1]

| Symbol    | Parameter                 | Conditions            | Min     | Typ                 | Max  | Unit |
|-----------|---------------------------|-----------------------|---------|---------------------|------|------|
| $V_{CC}$  | supply voltage            |                       | 3.0     | 3.3                 | 3.6  | V    |
| $V_{TT}$  | termination voltage       | GTL–                  | 0.85    | 0.9                 | 0.95 | V    |
|           |                           | GTL                   | 1.14    | 1.2                 | 1.26 | V    |
|           |                           | GTL+                  | 1.35    | 1.5                 | 1.65 | V    |
| $V_{ref}$ | reference voltage         | overall               | [2] 0.5 | $\frac{2}{3}V_{TT}$ | 1.8  | V    |
|           |                           | GTL–                  | 0.5     | 0.6                 | 0.63 | V    |
|           |                           | GTL                   | 0.76    | 0.8                 | 0.84 | V    |
|           |                           | GTL+                  | 0.87    | 1.0                 | 1.10 | V    |
| $V_I$     | input voltage             | A port                | 0       | $V_{TT}$            | 3.6  | V    |
|           |                           | except A port         | 0       | 3.3                 | 5.5  | V    |
| $V_{IH}$  | HIGH-level input voltage  | A port                | [3]     | -                   | -    | V    |
|           |                           | except A port         | 2       | -                   | -    | V    |
| $V_{IL}$  | LOW-level input voltage   | A port                | -       | -                   | [3]  | V    |
|           |                           | except A port         | -       | -                   | 0.8  | V    |
| $I_{OH}$  | HIGH-level output current | B port                | -       | -                   | -12  | mA   |
| $I_{OL}$  | LOW-level output current  | A port                | -       | -                   | 40   | mA   |
|           |                           | B port                | -       | -                   | 12   | mA   |
| $T_{amb}$ | ambient temperature       | operating in free-air | -40     | -                   | +85  | °C   |

[1] Unused inputs must be held HIGH or LOW to prevent them from floating.

[2]  $V_{ref}$  is normally  $\frac{2}{3}V_{TT}$ , but based upon application and noise margin requirements can be set anywhere within this range and does not need to follow GTL-/GTL/GTL+ specification.

[3] Nominally  $\pm 50$  mV around  $V_{ref}$ . See [Figure 4](#), [Figure 5](#), and [Figure 6](#) for actual performance versus  $V_{ref}$ ,  $V_{CC}$ , and temperature.

## 10. Static characteristics

**Table 7. Static characteristics**

Recommended operating conditions; voltages are referenced to GND (ground = 0 V);  $T_{amb} = -40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ .

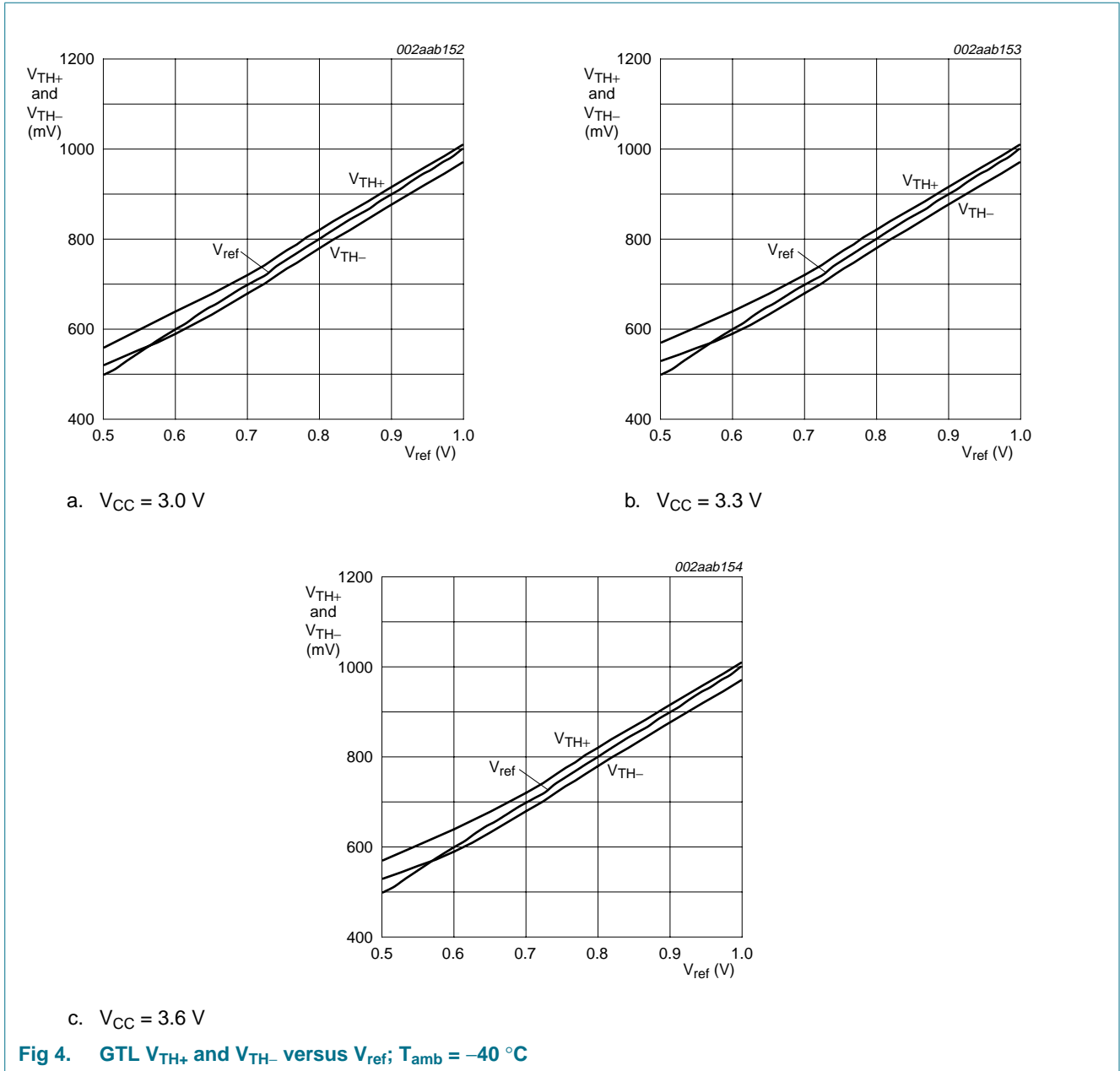
| Symbol                          | Parameter                                    | Conditions   | Min                       | Typ <sup>[1]</sup> | Max  | Unit |
|---------------------------------|--|--|---------------------------|--------------------|------|------|
| V <sub>OH</sub>                 | HIGH-level output voltage                    | B port; V <sub>CC</sub> = 3.0 V to 3.6 V; I <sub>OH</sub> = -100 μA                                  | [2] V <sub>CC</sub> - 0.2 | -                  | -    | V    |
|                                 |  | B port; V <sub>CC</sub> = 3.0 V; I <sub>OH</sub> = -12 mA  | [2] 2.0                   | -                  | -    | V    |
| V <sub>OL</sub>                 | LOW-level output voltage                     | A port; V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 40 mA   | [2] -                     | -                  | 0.4  | V    |
|                                 |  | B port; V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 4 mA  | [2] -                     | -                  | 0.4  | V    |
|                                 |  | B port; V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 8 mA  | [2] -                     | -                  | 0.55 | V    |
|                                 |  | B port; V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 12 mA   | [2] -                     | -                  | 0.8  | V    |
| I <sub>I</sub>                  | input current                                | control inputs; V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub> or GND                     | -                         | -                  | ±1   | μA   |
|                                 |  | A port; V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>TT</sub> or GND                             | -                         | -                  | ±1   | μA   |
|                                 |  | B port; V <sub>CC</sub> = 0 V or 3.6 V; V <sub>I</sub> = 5.5 V                                       | -                         | -                  | 10   | μA   |
|                                 |  | B port; V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub>                                    | -                         | -                  | ±1   | μA   |
|                                 |  | B port; V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = 0 V  | -                         | -                  | -5   | μA   |
| I <sub>OFF</sub>                | output OFF current                           | A port; V <sub>CC</sub> = 0 V; V <sub>I</sub> or V <sub>O</sub> = 0 V to 4.5 V                       | -                         | -                  | ±100 | μA   |
| I <sub>EX</sub>                 | high contention over voltage leakage current | B port; V <sub>CC</sub> = 3.0 V; V <sub>O</sub> = 5.5 V  | -                         | 50                 | 125  | μA   |
| I <sub>CC</sub>                 | supply current                               | A or B port; V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 mA | -                         | -                  | 3    | mA   |
| ΔI <sub>CC</sub> <sup>[3]</sup> | additional supply current per input          | B port or control inputs; V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub> - 0.6 V          | -                         | -                  | 500  | μA   |
| C <sub>i</sub>                  | input capacitance                            | control inputs; V <sub>I</sub> = 3.0 V or 0 V  | -                         | 2.3                | 3.5  | pF   |
| C <sub>io</sub>                 | input/output capacitance                     | A port; V <sub>O</sub> = V <sub>TT</sub> or 0 V  | -                         | 3.4                | 5.0  | pF   |
|                                 |  | B port; V <sub>O</sub> = 3.0 V or 0 V  | -                         | 6.0                | 7.0  | pF   |

[1] All typical values are measured at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.

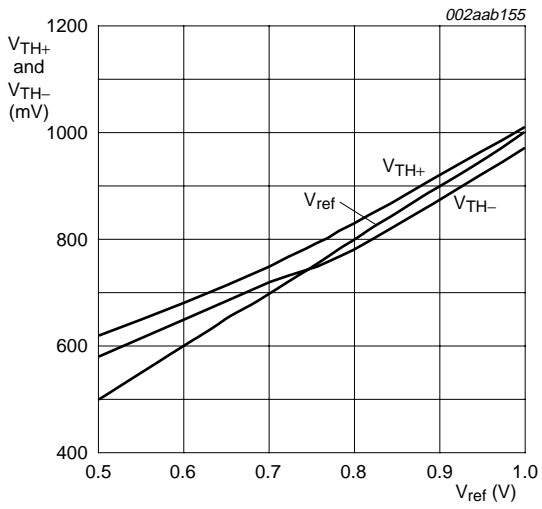
[2] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[3] This is the increase in supply current for each input that is at the specified TTL voltage level rather than V<sub>CC</sub> or GND.

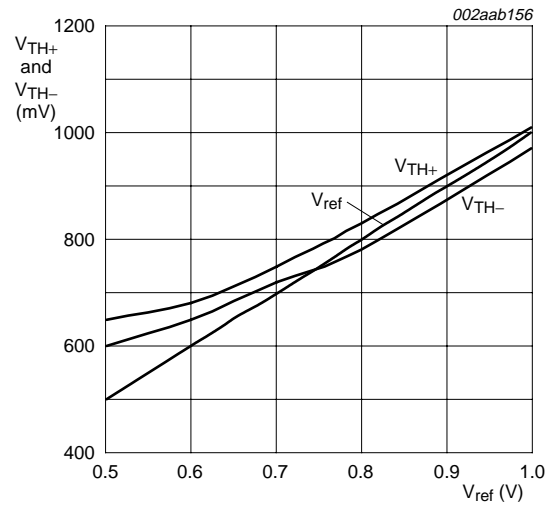
10.1 Performance curves



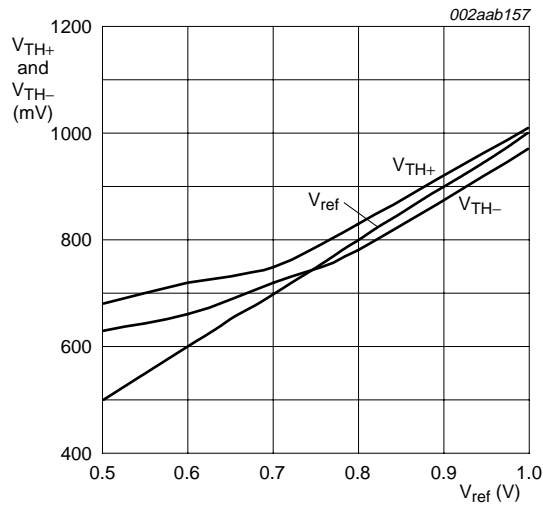




a.  $V_{CC} = 3.0 \text{ V}$

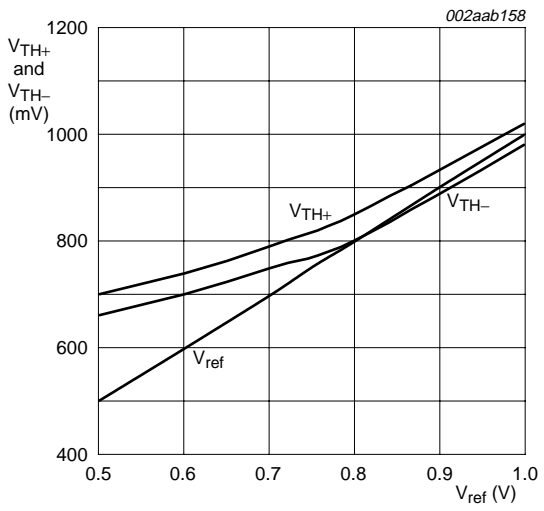


b.  $V_{CC} = 3.3 \text{ V}$

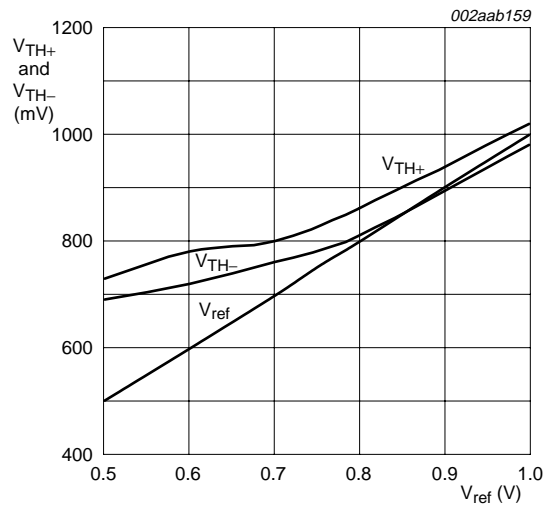


c.  $V_{CC} = 3.6 \text{ V}$

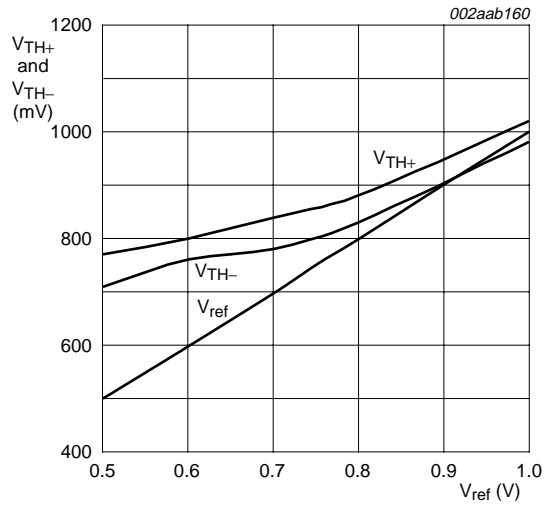
Fig 5. GTL  $V_{TH+}$  and  $V_{TH-}$  versus  $V_{ref}$ ;  $T_{amb} = +25 \text{ }^\circ\text{C}$



a.  $V_{CC} = 3.0\text{ V}$



b.  $V_{CC} = 3.3\text{ V}$



c.  $V_{CC} = 3.6\text{ V}$

Fig 6. GTL  $V_{TH+}$  and  $V_{TH-}$  versus  $V_{ref}$ ;  $T_{amb} = +85\text{ }^{\circ}\text{C}$

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

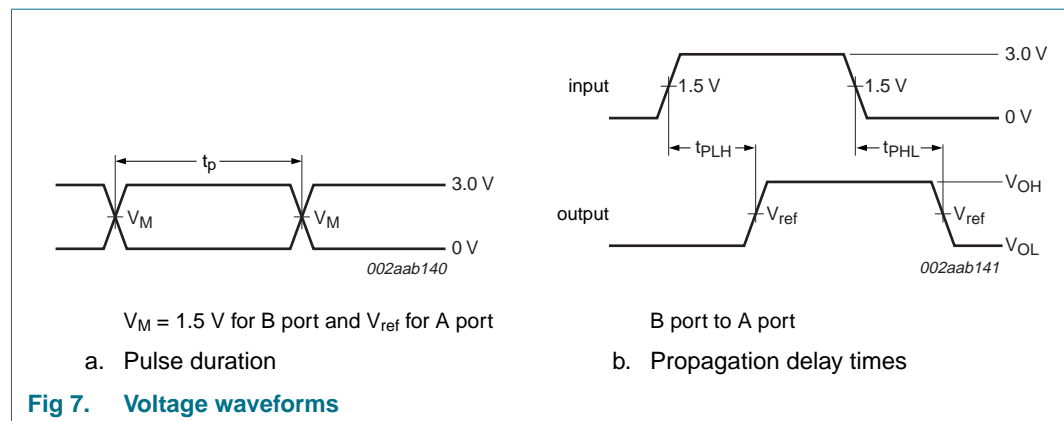
$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$

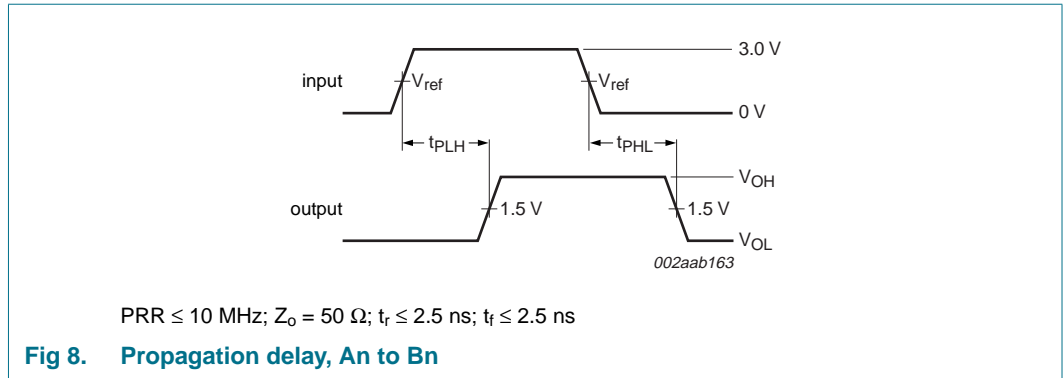
| Symbol   | Parameter                   | Conditions                   | Min | Typ <sup>[1]</sup> | Max | Unit |
|--|-----------------------------|------------------------------|-----|--------------------|-----|------|
| <b>GTL-; <math>V_{ref} = 0.6\text{ V}</math></b> |                             |                              |     |                    |     |      |
| $t_{PLH}$  | propagation delay, Bn to An | see <a href="#">Figure 7</a> | -   | 2.1                | 2.3 | ns   |
| $t_{PHL}$  |                             |                              | -   | 1.9                | 2.6 | ns   |
| $t_{PLH}$  | propagation delay, An to Bn | see <a href="#">Figure 8</a> | -   | 4.1                | 5.9 | ns   |
| $t_{PHL}$  |                             |                              | -   | 4.4                | 5.9 | ns   |
| <b>GTL; <math>V_{ref} = 0.8\text{ V}</math></b>  |                             |                              |     |                    |     |      |
| $t_{PLH}$  | propagation delay, Bn to An | see <a href="#">Figure 7</a> | -   | 2.1                | 2.3 | ns   |
| $t_{PHL}$  |                             |                              | -   | 1.9                | 2.6 | ns   |
| $t_{PLH}$  | propagation delay, An to Bn | see <a href="#">Figure 8</a> | -   | 4.1                | 5.9 | ns   |
| $t_{PHL}$  |                             |                              | -   | 4.4                | 5.9 | ns   |
| <b>GTL+; <math>V_{ref} = 1.0\text{ V}</math></b> |                             |                              |     |                    |     |      |
| $t_{PLH}$  | propagation delay, Bn to An | see <a href="#">Figure 7</a> | -   | 2.1                | 2.3 | ns   |
| $t_{PHL}$  |                             |                              | -   | 1.9                | 2.6 | ns   |
| $t_{PLH}$  | propagation delay, An to Bn | see <a href="#">Figure 8</a> | -   | 4.2                | 5.7 | ns   |
| $t_{PHL}$  |                             |                              | -   | 3.8                | 5.4 | ns   |

[1] All typical values are at  $V_{CC} = 3.3\text{ V}$  and  $T_{amb} = 25\text{ }^\circ\text{C}$ .

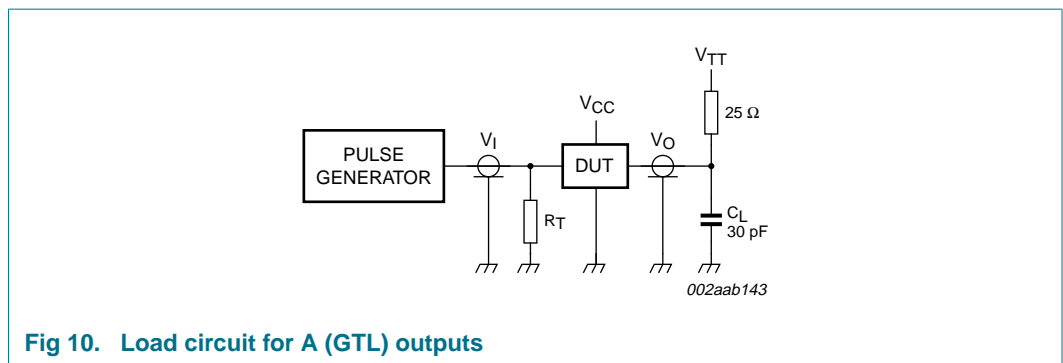
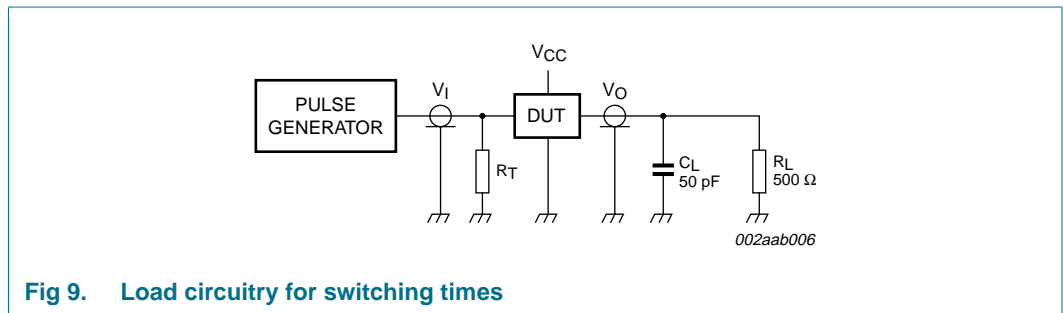
### 11.1 Waveforms

$V_M = 1.5\text{ V}$  at  $V_{CC} \geq 3.0\text{ V}$ ;  $V_M = V_{CC}/2$  at  $V_{CC} \leq 2.7\text{ V}$  for B ports and control pins;  
 $V_M = V_{ref}$  for A ports.





## 12. Test information



$R_L$  — Load resistor

$C_L$  — Load capacitance; includes jig and probe capacitance

$R_T$  — Termination resistance; should be equal to  $Z_o$  of pulse generators.

13. Package outline

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

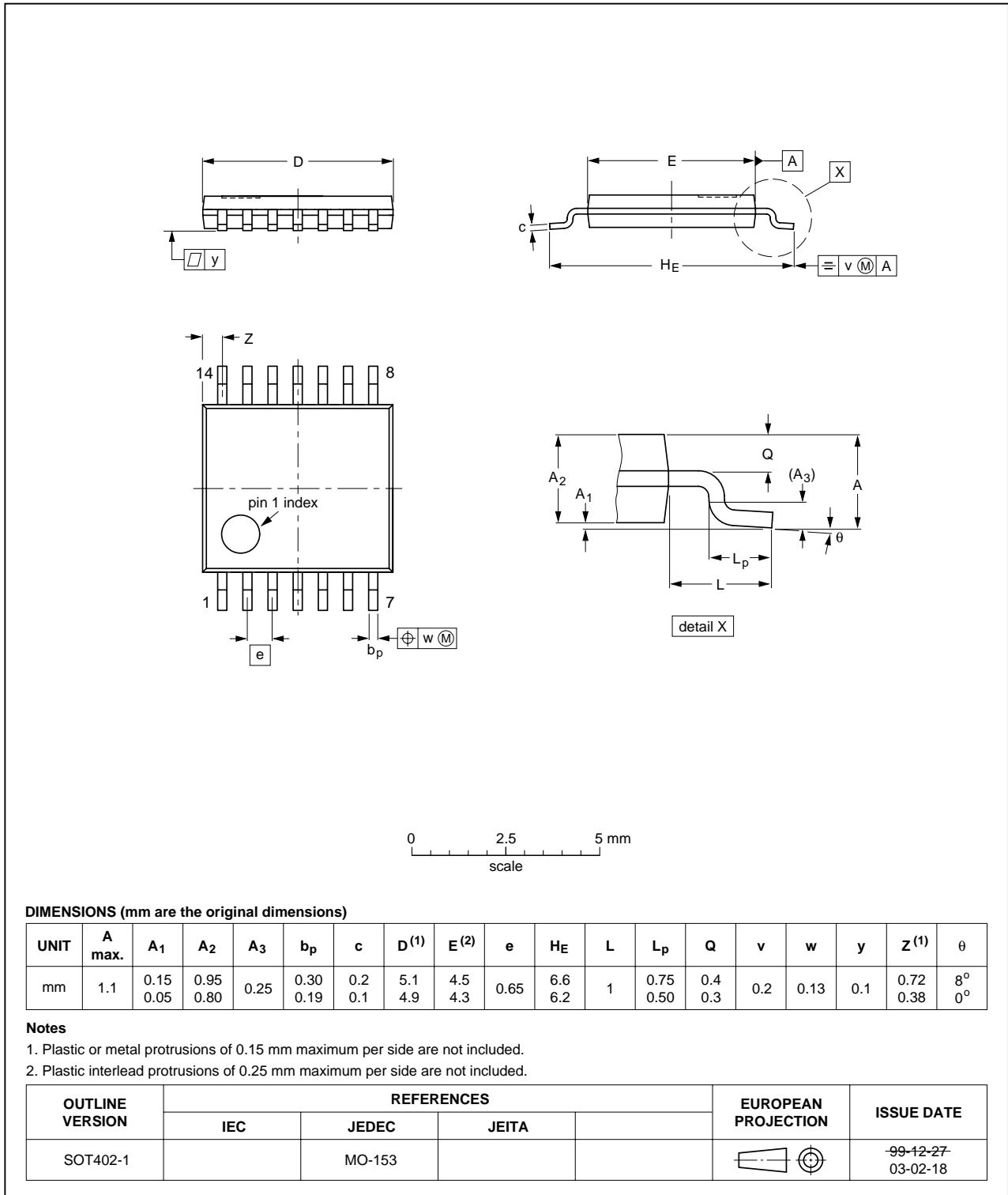


Fig 11. Package outline SOT402-1 (TSSOP14)

## 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 12](#)) 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-020C)**

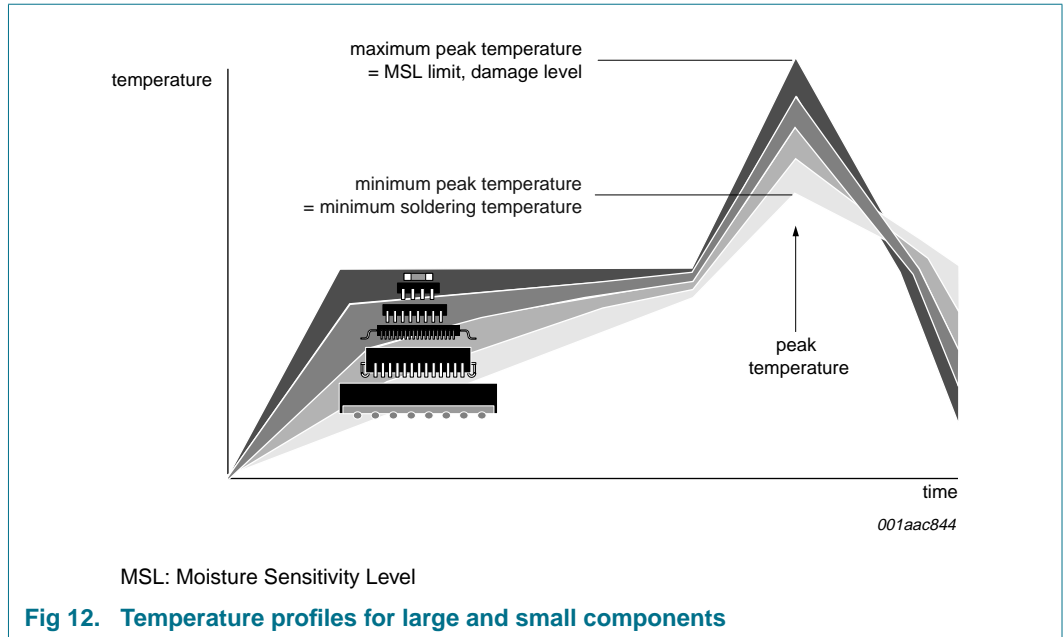
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                 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

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

| 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 12](#).



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

## 15. Abbreviations

**Table 11. Abbreviations**

| Acronym | Description                             |
|---------|---|
| CDM     | Charged-Device Model                    |
| CMOS    | Complementary Metal-Oxide Semiconductor |
| DUT     | Device Under Test                       |
| ESD     | ElectroStatic Discharge                 |
| GTL     | Gunning Transceiver Logic               |
| HBM     | Human Body Model                        |
| I/O     | Input/Output                            |
| LVTTTL  | Low Voltage Transistor-Transistor Logic |
| MM      | Machine Model                           |
| TTL     | Transistor-Transistor Logic             |



## 16. Revision history

**Table 12. Revision history**

| Document ID                   | Release date   | Data sheet status  | Change notice  | Supersedes |
|-------------------------------|--|--------------------|----------------|------------|
| GTL2005_7                     | 20090203   | Product data sheet | -              | GTL2005_6  |
| Modifications:                | <ul style="list-style-type: none"> <li>• <a href="#">Figure 2 "Logic diagram of GTL2005"</a> modified: symbol for AND gate replaced and its direction reversed</li> <li>• updated soldering information</li> </ul> |                    |                |            |
| GTL2005_6                     | 20070906   | Product data sheet | -              | GTL2005_5  |
| GTL2005_5<br>(9397 750 14285) | 20050406   | Product data sheet | -              | GTL2005_4  |
| GTL2005_4<br>(9397 750 13104) | 20040510   | Product data       | -              | GTL2005_3  |
| GTL2005_3<br>(9397 750 07222) | 20000619   | Product data       | 853-2171 23901 | GTL2005_2  |
| GTL2005_2<br>(9397 750 06695) | 19990917   | Product data       | 853-2171 22353 | GTL2005_1  |
| GTL2005_1<br>(9397 750 06497) | 19990917   | Product data       | -              | -          |

## 17. Legal information

### 17.1 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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