# STP16C596

## 16-Bit, constant current LED sink driver

## Features

- 16 constant current output channels
- Adjustable output current through external resistor
- Serial data IN/parallel data OUT
- Serial out change state on the falling edges of clock
- Output current: 15-120 ma
- 25MHz clock frequency
- Available in high thermal TSSOP exposed pad
- Efficiency package



**DIP-24**   **SO-24**

**TSSOP24**   **TSSOP24 (exposed pad)**
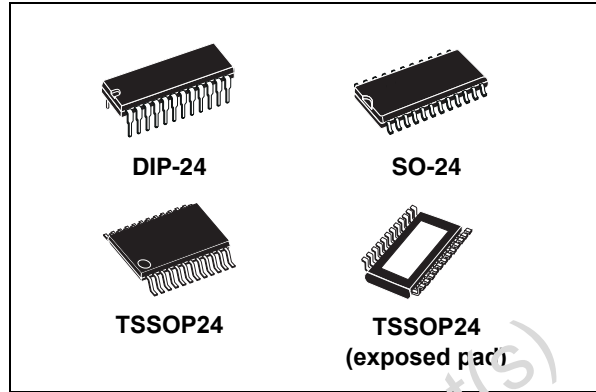
## Description

The STP16C596 is a monolithic, medium-voltage, low current power 16-bit shift register designed for LED panel displays. The STP16C596 contains a 16-bit serial-IN, parallel-OUT shift register that feeds a 16-bit, D-type storage register. In the output stage, sixteen regulated current sources are designed to provide 15-120mA constant current to drive the LEDs.

The serial output change state on the falling edges of clock, this special feature will provide an improved performance of the application when the clock signal is skewed because the daisy chain is too long.

Through an external resistor, users may adjust the STP16C596 output current, controlling in this way the light intensity of LEDs.

The STP16C596 guarantees a 16V output driving capability, allowing users to connect more LEDs in series. The high clock frequency, 25MHz, also satisfies the system demand for high volume data transmission. Compared with a standard TSSOP package, the TSSOP exposed pad increases heat dissipation capability by a 2.5 factor.

## Order codes

| Part Number | Package | Packaging |
|---|---|---|
| STP16C596B1R | DIP-24 | 15 parts per tube |
| STP16C596M | SO-24 (Tube) | 40 parts per tube |
| STP16C596MTR | SO-24 (Tape & Reel) | 1000 parts per reel |
| STP16C596TTR | TSSOP24 (Tape & Reel) | 2500 parts per reel |
| STP16C596XTTR | TSSOP24 Exposed-Pad (Tape & Reel) | 2500 parts per reel |

# Contents

# 1 Summary description

**Table 1.    Current accuracy**

| Output voltage | Current accuracy | | Output current |
|---|---|---|---|
| | **Between bits** | **Between ICs** | |
| ≥ 0.7V | Typ. ± 3% | ± 10% | 15 to 120mA |

## 1.1    Pin connection and description

**Figure 1.    Connections diagram**
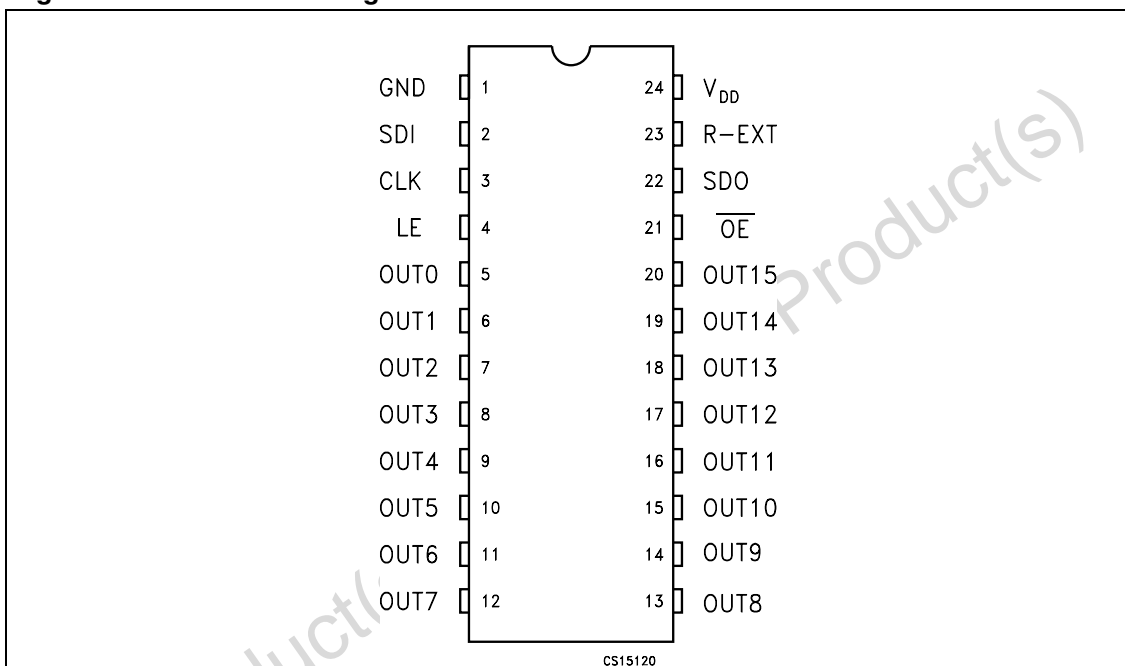


*Note:    The Exposed-Pad is electrically not connected*

**Table 2.    Pin description**

| PIN N° | Symbol | Name and function |
|---|---|---|
| 1 | GND | Ground terminal |
| 2 | SDI | Serial data input terminal |
| 3 | CLK | Clock input terminal |
| 4 | LE | Latch input terminal |
| 5-20 | OUT 0-15 | Output terminal |
| 21 | $\overline{OE}$ | Input terminal of output enable (active low) |
| 22 | SDO | Serial data out terminal |
| 23 | R-EXT | Input terminal of an external resistor for constant current programing |
| 24 | $V_{DD}$ | Supply voltage terminal |

## 1.2     Equivalent circuit of inputs and outputs

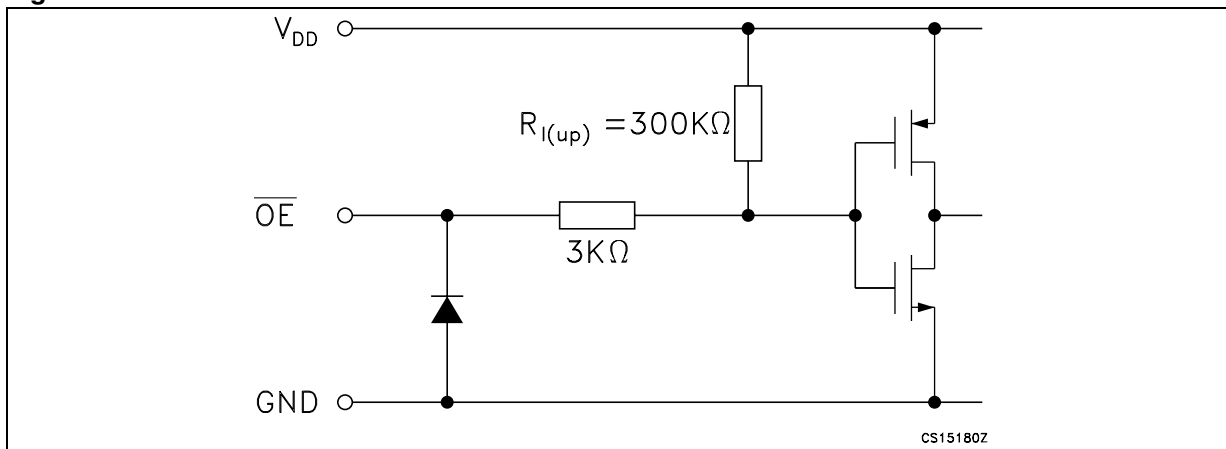**Figure 2.     $\overline{\text{OE}}$ terminal**



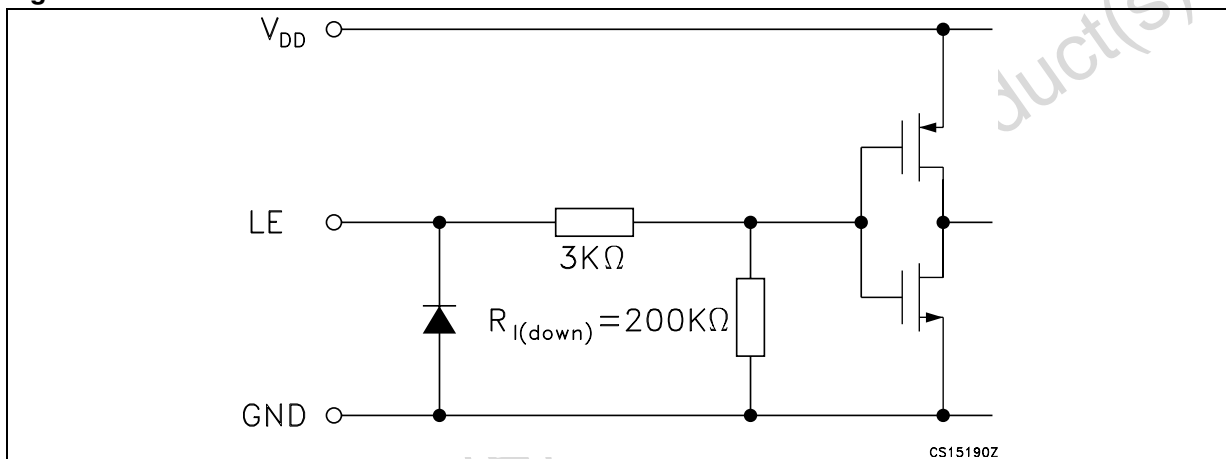**Figure 3.     LE  terminal**



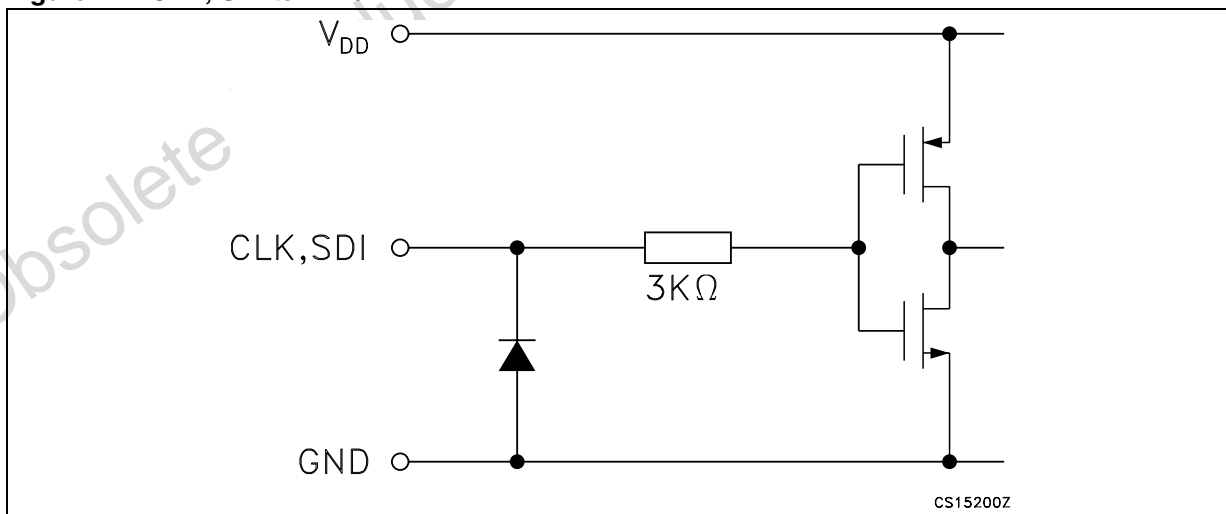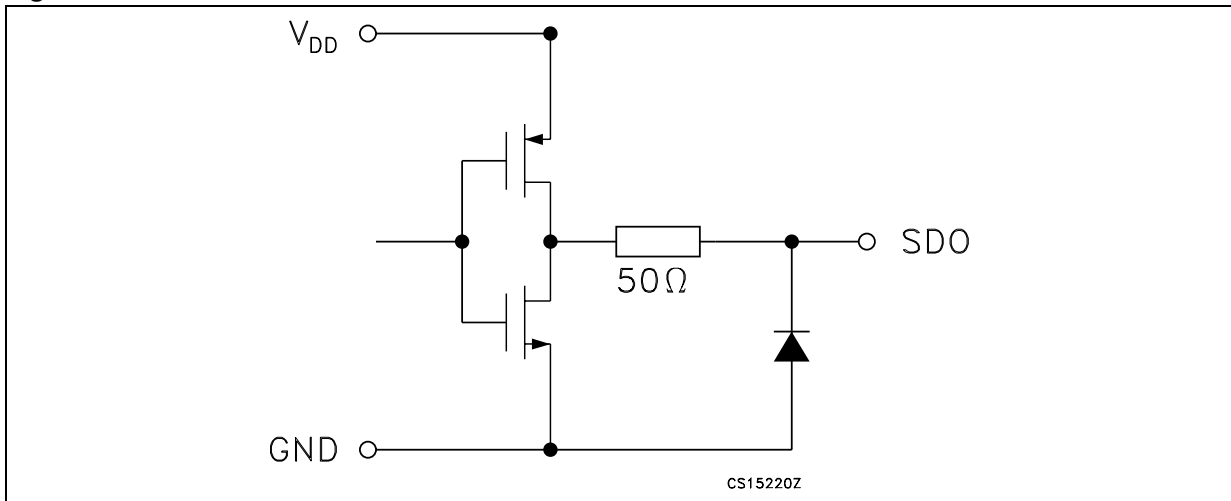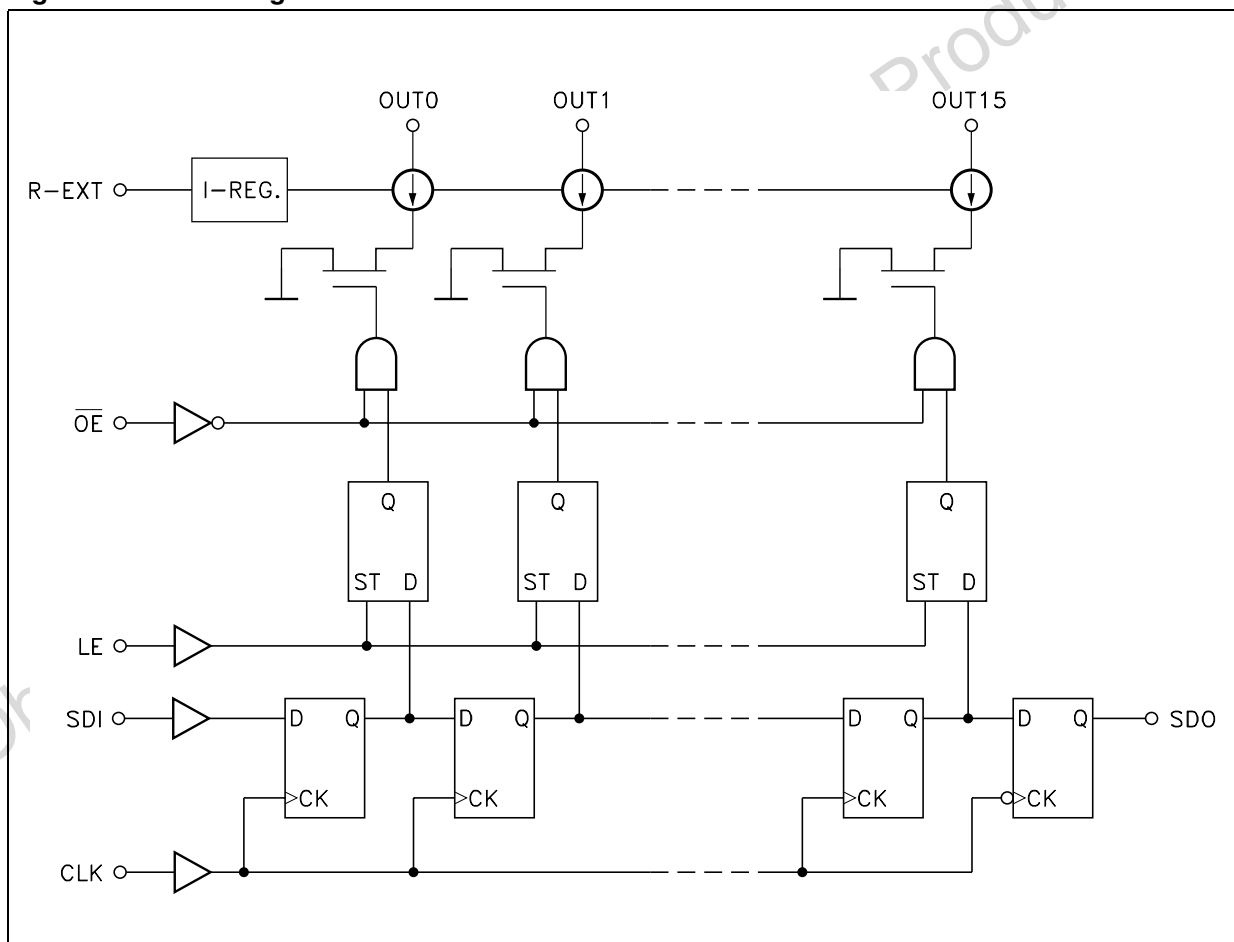**Figure 4.     CLK, SDI terminal**

**Figure 5. SDO terminal**



## 1.3 Block diagram

**Figure 6. Block diagram - normal mode**

## 1.4 Truth table

**Table 3.    Truth table**

| Clock | LE | $\overline{OE}$ | SERIAL-IN | OUT0 ................. OUT7 ................... OUT15 | SDO |
|---|---|---|---|---|---|
| ⌐ | H | L | Dn | Dn ..... Dn -7 ..... Dn -15 | Dn -15 |
| ⌐ | L | L | Dn + 1 | No Change | Dn -14 |
| ⌐ | H | L | Dn + 2 | Dn -2 ..... Dn -5 ..... Dn -13 | Dn -13 |
| ⌐ | X | L | Dn + 3 | Dn -2 ..... Dn -5 ..... Dn -13 | Dn -13 |
| ⌐ | X | L | Dn + 3 | ON | Dn -13 |

*Note:    OUT0 to OUT15 = ON when Dn = H; OUT0 to OUT15 = OFF when Dn = L.*

## 1.5 Timing diagrams

**Figure 7.    Timing diagram - normal mode**
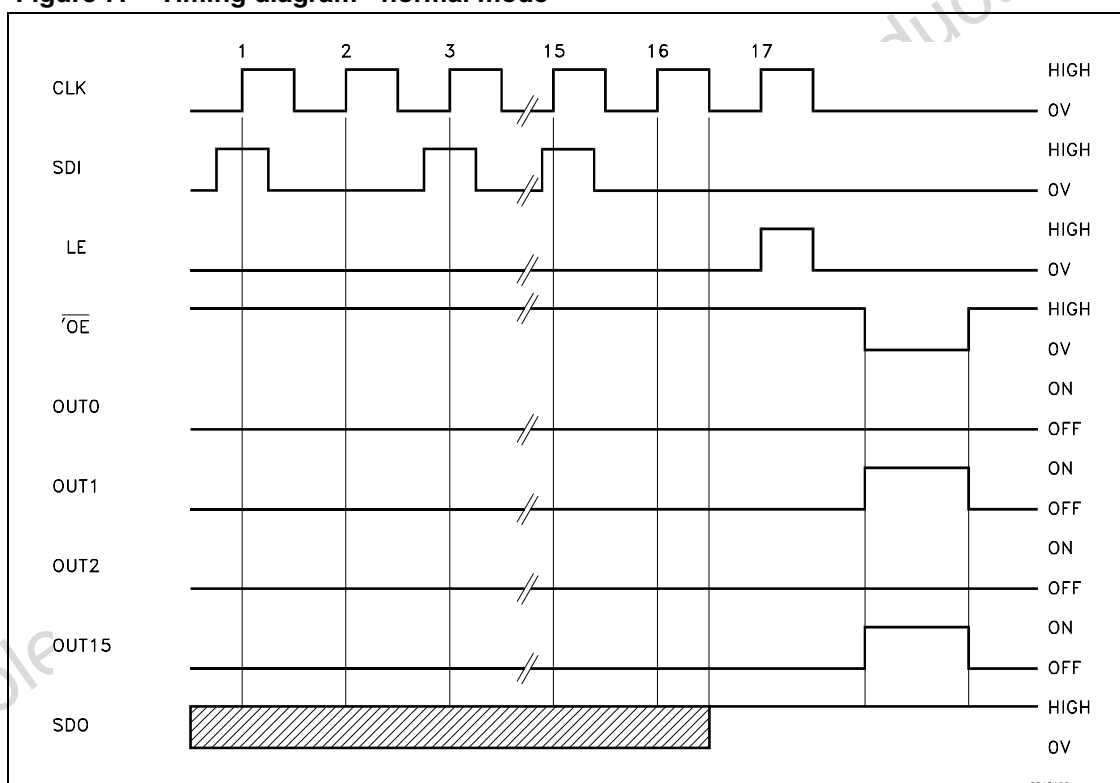


*Note:    Note: The latches circuit holds data when the LE terminal is Low.*

*When the LE terminal is at High level, latch circuit doesn't hold the data it passes from the input to the output.*

*When the $\overline{OE}$ terminal is at Low level, output terminals OUT0 to OUT15 respond to the data, either ON or OFF.*

*When the $\overline{OE}$ terminal is at High level, it switches off all the data on the output terminal.*

**Figure 8.    Clock, Serial-In, Serial-Out**



**Figure 9.    Clock, Serial-In, Latch, Enable, Outputs**
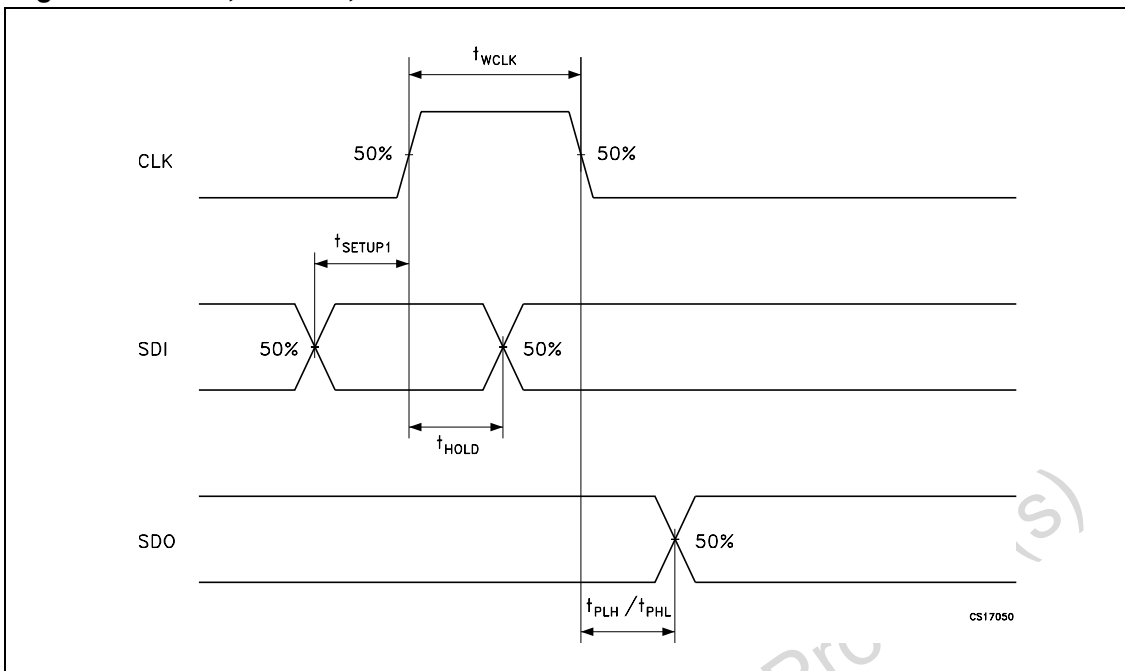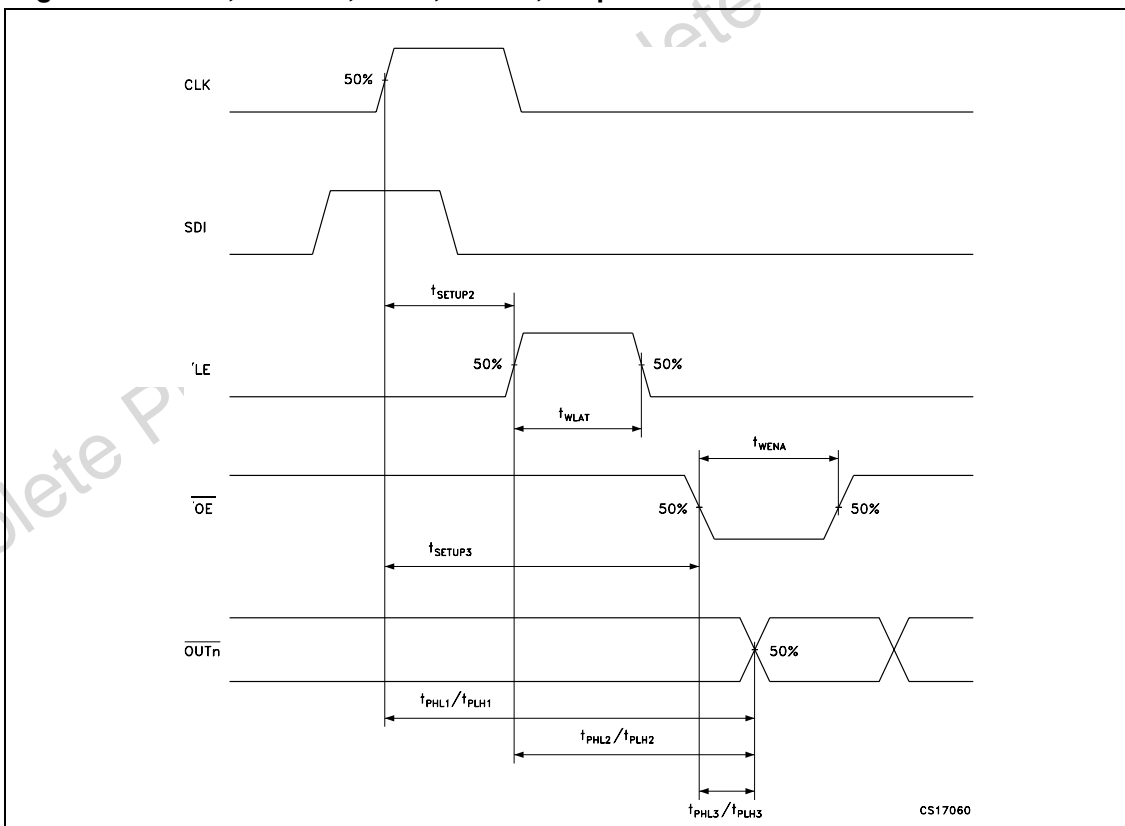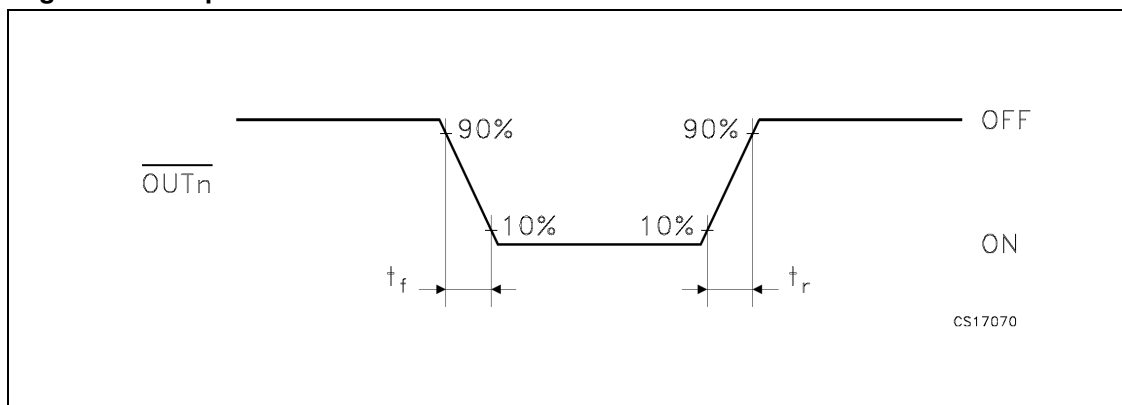
**Figure 10. Outputs**

# 2        Maximum rating

Stressing the device above the rating listed in the "Absolute Maximum Ratings" table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

**Table 4.        Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|--------|-----------|-------|------|
| $V_{DD}$ | Supply voltage | 0 to 7 | V |
| $V_O$ | Output voltage | -0.5 to 16 | V |
| $I_O$ | Output current | 120 | mA |
| $V_I$ | Input voltage | -0.4 to $V_{DD}$+0.4 | V |
| $I_{GND}$ | GND terminal current | 1920 | mA |
| $f_{CLK}$ | Clock frequency | 25 | MHz |
| $T_{OPR}$ | Operating temperature range | -40 to +125 | °C |
| $T_{STG}$ | Storage temperature range | -65 to +150 | °C |

## 2.1      Thermal data

**Table 5.        Thermal data**

| Symbol | Parameter | DIP-24 | SO-24 | TSSOP-24 | TSSOP-24[1] (exposed pad) | Unit |
|--------|-----------|--------|-------|----------|---------------------------|------|
| $R_{thJA}$ | Thermal resistance junction-ambient | 60 | 75 | 85 | 37.5 | °C/W |

1.   The Exposed-Pad should be soldered to the PBC to realize the thermal benefits

## 2.2 Recommended operating conditions

**Table 6.     Recommended operating conditions**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply voltage | | 4.5 | 5.0 | 5.5 | V |
| $V_O$ | Output voltage | | | | 16.0 | V |
| $I_O$ | Output current | OUTn | 5 | | 120 | mA |
| $I_{OH}$ | Output current | SERIAL-OUT | | | +1 | mA |
| $I_{OL}$ | Output current | SERIAL-OUT | | | -1 | mA |
| $V_{IH}$ | Input voltage | | $0.7V_{DD}$ | | $V_{DD}+0.3$ | V |
| $V_{IL}$ | Input voltage | | -0.3 | | $0.3V_{DD}$ | V |
| $t_{wLAT}$ | LE pulse width | $V_{DD}$ = 4.5 to 5.5V | 20 | | | ns |
| $t_{wCLK}$ | CLK pulse width | | 20 | | | ns |
| $t_{wEN}$ | $\overline{OE}$ pulse width | | 400 | | | ns |
| $t_{SETUP(D)}$ | Setup time for DATA | | 20 | | | ns |
| $t_{HOLD(D)}$ | Hold time for DATA | | 15 | | | ns |
| $t_{SETUP(L)}$ | Setup time for LATCH | | 15 | | | ns |
| $f_{CLK}$ | Clock frequency | Cascade operation[1] | | | 25 | MHz |

1.  If the device is connected in cascade, it may not be possible achieve the maximum data transfer. Please considered the timings carefully.

# 3 Electrical characteristics

**Table 7.    Electrical characteristics** ($V_{DD}$ = 5V, T = 25°C, unless otherwise specified.)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IH}$ | Input voltage high level | | $0.7V_{DD}$ | | $V_{DD}$ | V |
| $V_{IL}$ | Input voltage low level | | GND | | $0.3V_{DD}$ | V |
| $I_{OH}$ | Output leakage current | $V_{OH}$ = 16V | | | 10 | μA |
| $V_{OL}$ | Output voltage (Serial-OUT) | $I_{OL}$ = 1mA | | | 0.4 | V |
| $V_{OH}$ | Output voltage (Serial-OUT) | $I_{OH}$ = -1mA | $V_{DD}$-0.4V | | | V |
| $I_{OL1}$ | Output current | $V_O$ = 0.7V $R_{EXT}$ = 910Ω | 18.6 | 20.4 | 22.4 | mA |
| $I_{OL2}$ | | $V_O$ = 0.7V $R_{EXT}$ = 360Ω | 45.7 | 50.2 | 55.2 | mA |
| $\Delta I_{OL1}$ | Output current error between bit (All Output ON) | $V_O$ = 0.7V $R_{EXT}$ = 910Ω | | ± 3 | ± 4 | % |
| $\Delta I_{OL2}$ | | $V_O$ = 0.7V $R_{EXT}$ = 360Ω | | ± 3 | ± 4 | % |
| $R_{SIN(up)}$ | Pull-up resistor | | 150 | 300 | 600 | KΩ |
| $R_{SIN(down)}$ | Pull-down resistor | | 100 | 200 | 400 | KΩ |
| $I_{DD(OFF1)}$ | Supply current (OFF) | $R_{EXT}$ = OPEN OUT 0 to 15 = OFF | | 0.3 | 0.6 | mA |
| $I_{DD(OFF2)}$ | | $R_{EXT}$ = 470Ω OUT 0 to 15 = OFF | | 5.5 | 7.7 | |
| $I_{DD(OFF3)}$ | | $R_{EXT}$ = 250Ω OUT 0 to 15 = OFF | | 10.1 | 14.1 | |
| $I_{DD(ON1)}$ | Supply current (ON) | $R_{EXT}$ = 470Ω OUT 0 to 15 = ON | | 5.5 | 7.7 | |
| $I_{DD(ON2)}$ | | $R_{EXT}$ = 250Ω OUT 0 to 15 = ON | | 10.1 | 14.1 | |

# 4     Switching characteristics

**Table 8.     Switching characteristics** ($V_{DD}$ = 5V, T = 25°C, unless otherwise specified.)

| Symbol | Parameter | Test conditions | | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|---|------|------|------|------|
| $t_{PLH1}$ | Propagation delay time, CLK-$\overline{OUT}$n, LE = H, $\overline{OE}$ = L | | | | 200 | 280 | ns |
| $t_{PLH2}$ | Propagation delay time, LE-$\overline{OUT}$n, $\overline{OE}$ = L | | | | 160 | 250 | ns |
| $t_{PLH3}$ | Propagation delay time, $\overline{OE}$-$\overline{OUT}$n, LE = H | $V_{DD}$ = 5V | $V_{IH} = V_{DD}$ | | 145 | 200 | ns |
| $t_{PLH}$ | Propagation delay time, CLK-SDO | $V_{IL}$ = GND | $C_L$ = 13pF | | 15 | 30 | ns |
| $t_{PHL1}$ | Propagation delay time, CLK-$\overline{OUT}$n, LE = H, $\overline{OE}$ = L | $I_O$ = 40mA | $V_L$ = 3 V | | 15 | 30 | ns |
| $t_{PHL2}$ | Propagation delay time, LE-$\overline{OUT}$n, $\overline{OE}$ = L | $R_{EXT}$ = 470Ω | $R_L$ = 65Ω | | 15 | 30 | ns |
| $t_{PHL3}$ | Propagation delay time, $\overline{OE}$-$\overline{OUT}$n, LE = H | CLK = 1MHz | | | 45 | 60 | ns |
| $t_{PHL}$ | Propagation delay time, CLK-SDO | | | | 15 | 30 | ns |
| $t_r$ | Output rise time | | | | 160 | 200 | ns |
| $t_f$ | Output fall time | | | | 15 | 25 | ns |

Note:  1  *To prevent current overshoot, during the Outputs switching, the overhead output voltage must be less than 1V*

2  *The Maximum suggested swithing frequency is up to 10KHz*
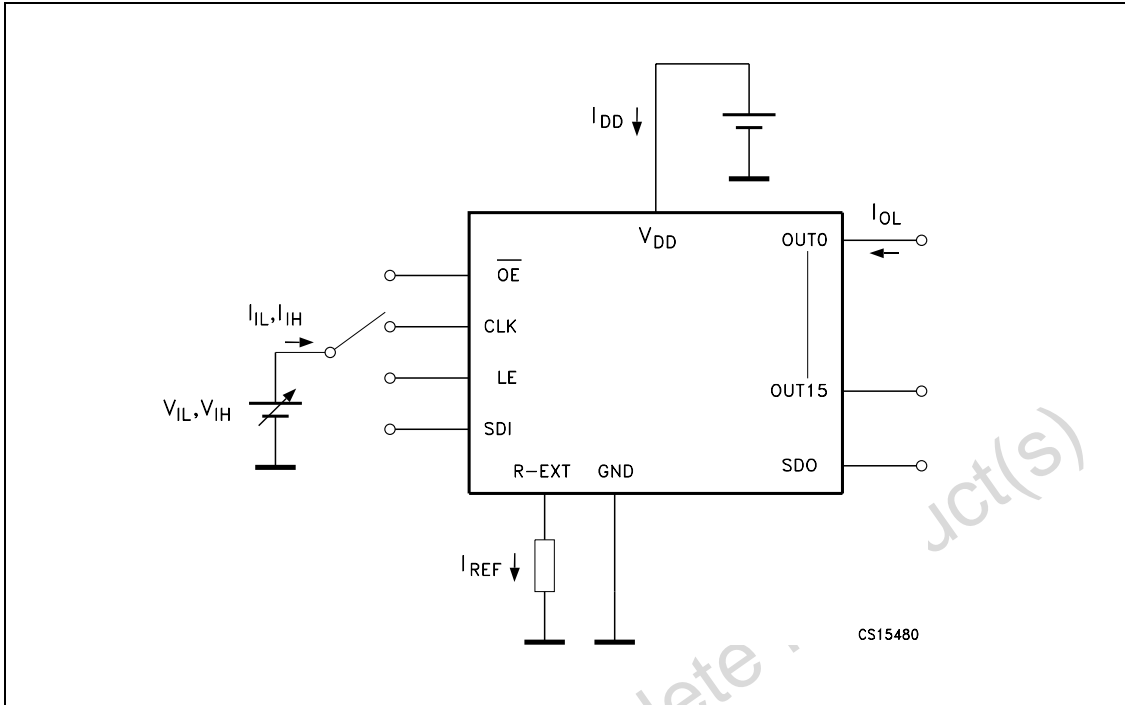
# 5    Test circuit

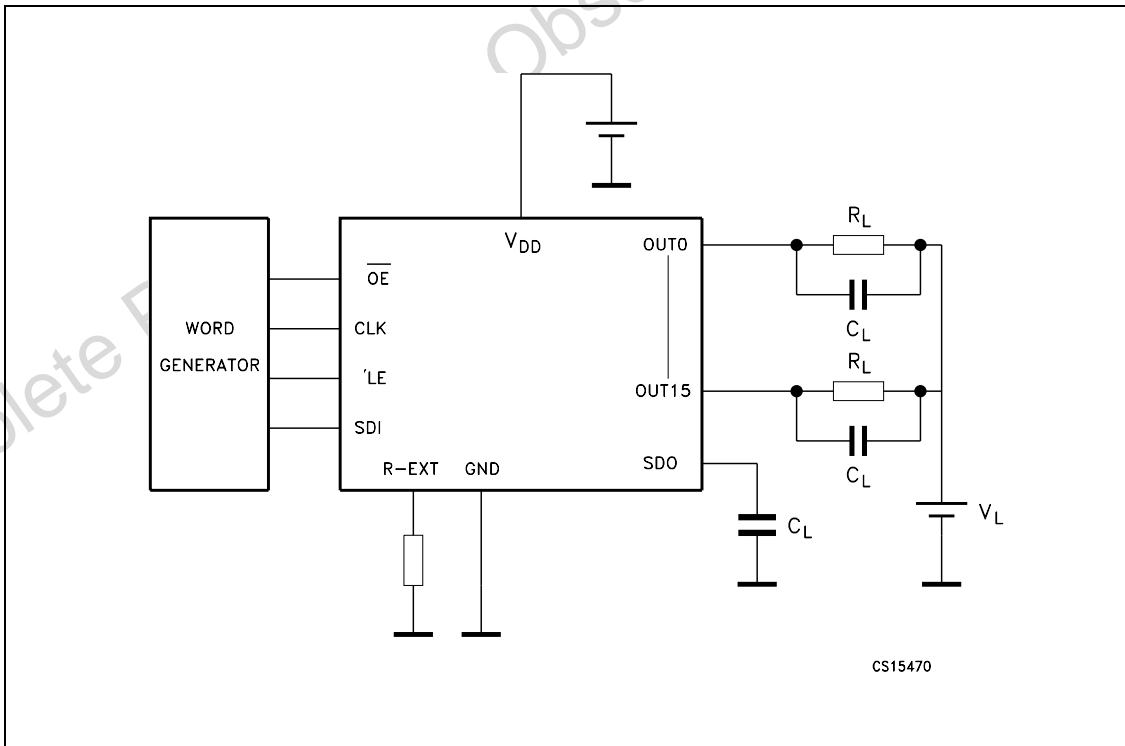**Figure 11.   DC characteristics**



**Figure 12.   AC characteristics**

# 6 Typical characteristics
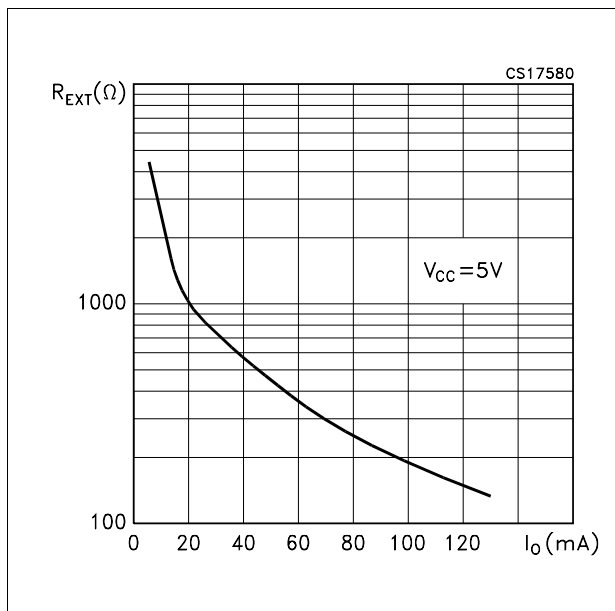
**Figure 13. Output current-R$_{EXT}$ resistor**



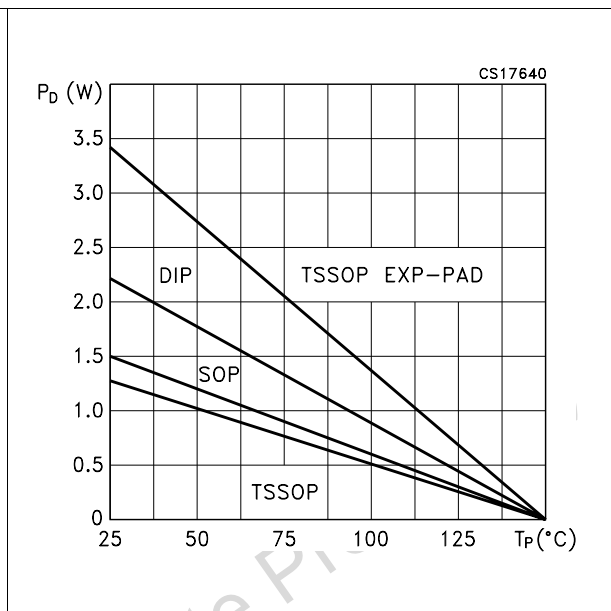**Figure 14. Power dissipation vs. temperature package**



**Figure 15. Output current vs. drop voltage**
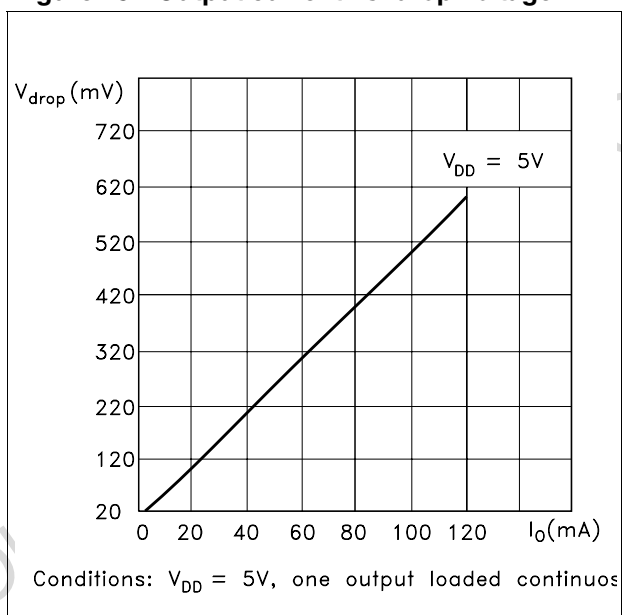
**Figure 16.   Blue powerLED application circuit**
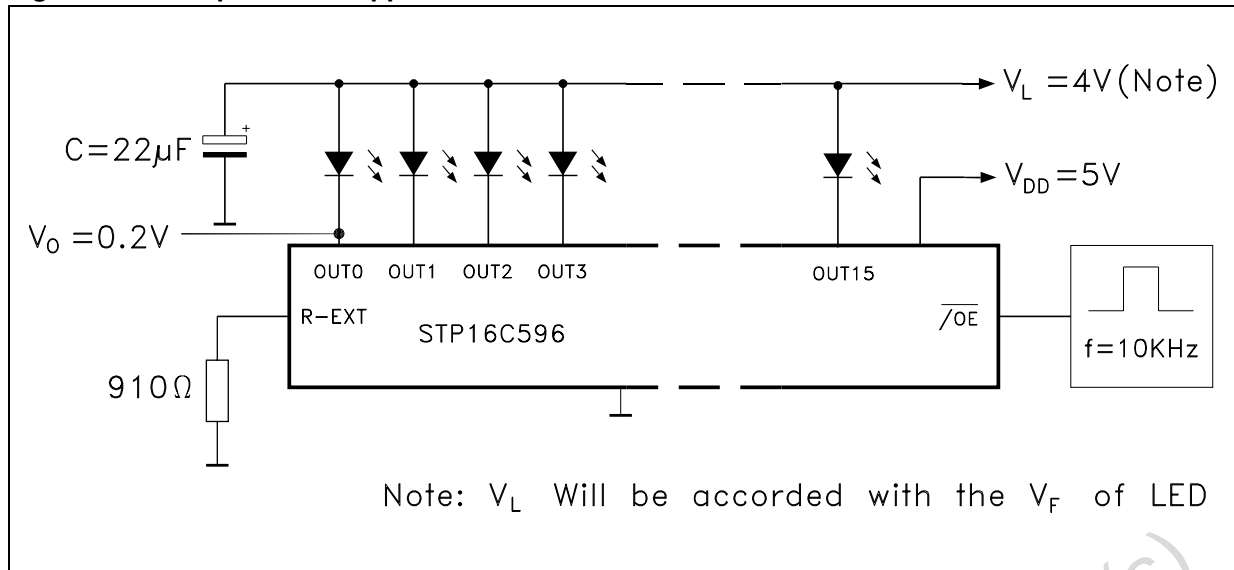
# 7       Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

**Table 9.        Plastic DIP-24 (0.25) Mechanical data**

| Ref | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | | | 4.32 | | | 0.170 |
| A1 | 0.38 | | | 0.015 | | |
| A2 | | 3.3 | | | 0.130 | |
| B | 0.41 | 0.46 | 0.51 | 0.016 | 0.018 | 0.020 |
| B1 | 1.40 | 1.52 | 1.65 | 0.055 | 0.060 | 0.065 |
| c | 0.20 | 0.25 | 0.30 | 0.008 | 0.010 | 0.012 |
| D | 31.62 | 31.75 | 31.88 | 1.245 | 1.250 | 1.255 |
| E | 7.62 | | 8.26 | 0.300 | | 0.325 |
| E1 | 6.35 | 6.60 | 6.86 | 0.250 | 0.260 | 0.270 |
| e | | 2.54 | | | 0.100 | |
| E1 | | 7.62 | | | 0.300 | |
| L | 3.18 | | 3.43 | 0.125 | | 0.135 |
| M | 0° | | 15° | 0° | | 15° |

**Figure 17.   Plastic DIP-24 (0.25) Package dimensions**



0034965/D
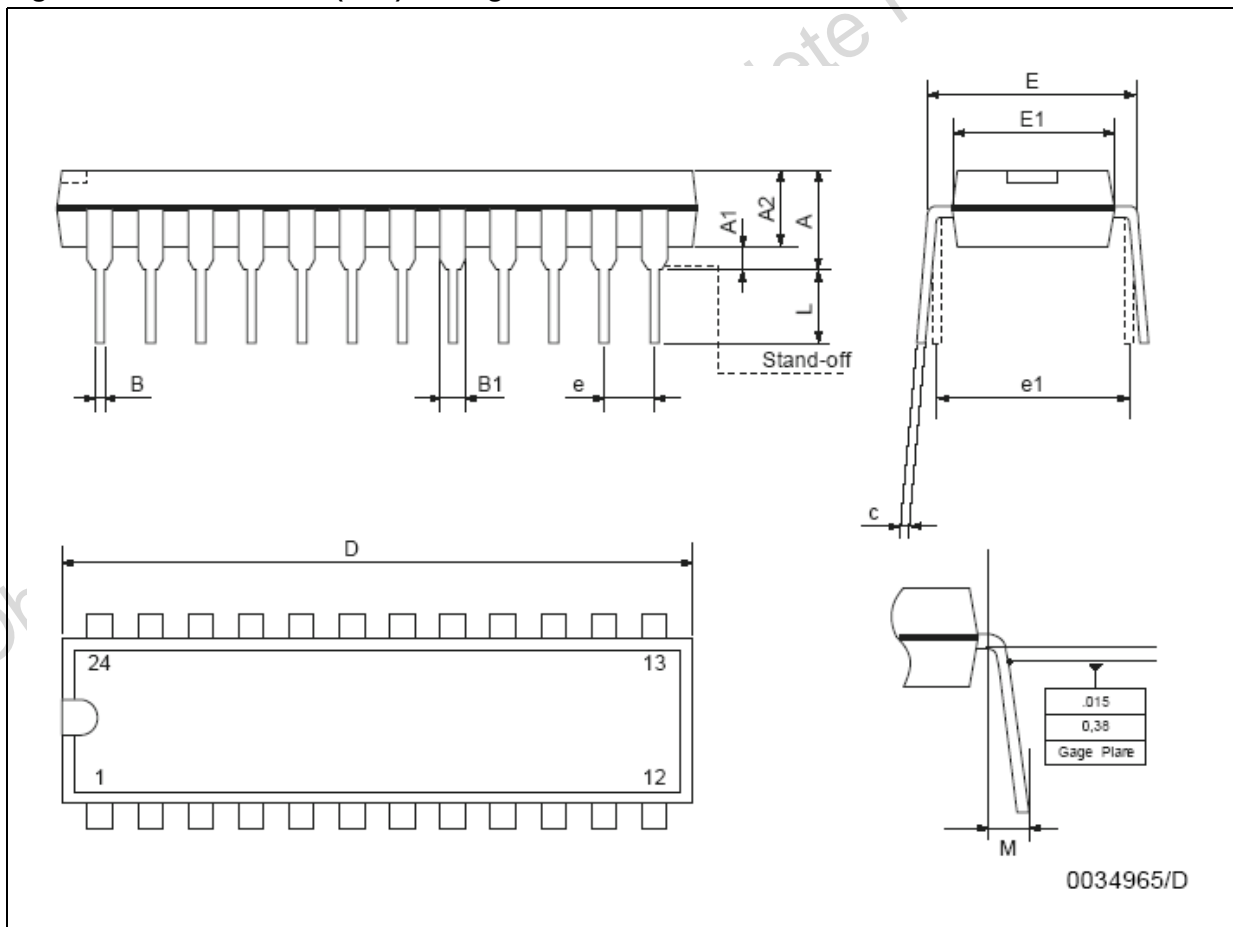
**Table 10.　TSSOP24 Mechanical data**

| Ref | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | | | 1.1 | | | 0.043 |
| A1 | 0.05 | | 0.15 | 0.002 | | 0.006 |
| A2 | | 0.9 | | | 0.035 | |
| b | 0.19 | | 0.30 | 0.0075 | | 0.0118 |
| c | 0.09 | | 0.20 | 0.0035 | | 0.0079 |
| D | 7.7 | | 7.9 | 0.303 | | 0.311 |
| E | 4.3 | | 4.5 | 0.169 | | 0.177 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| H | 6.25 | | 6.5 | 0.246 | | 0.256 |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.50 | | 0.70 | 0.020 | | 0.028 |

**Figure 18.　TSSOP24 Package dimensions**
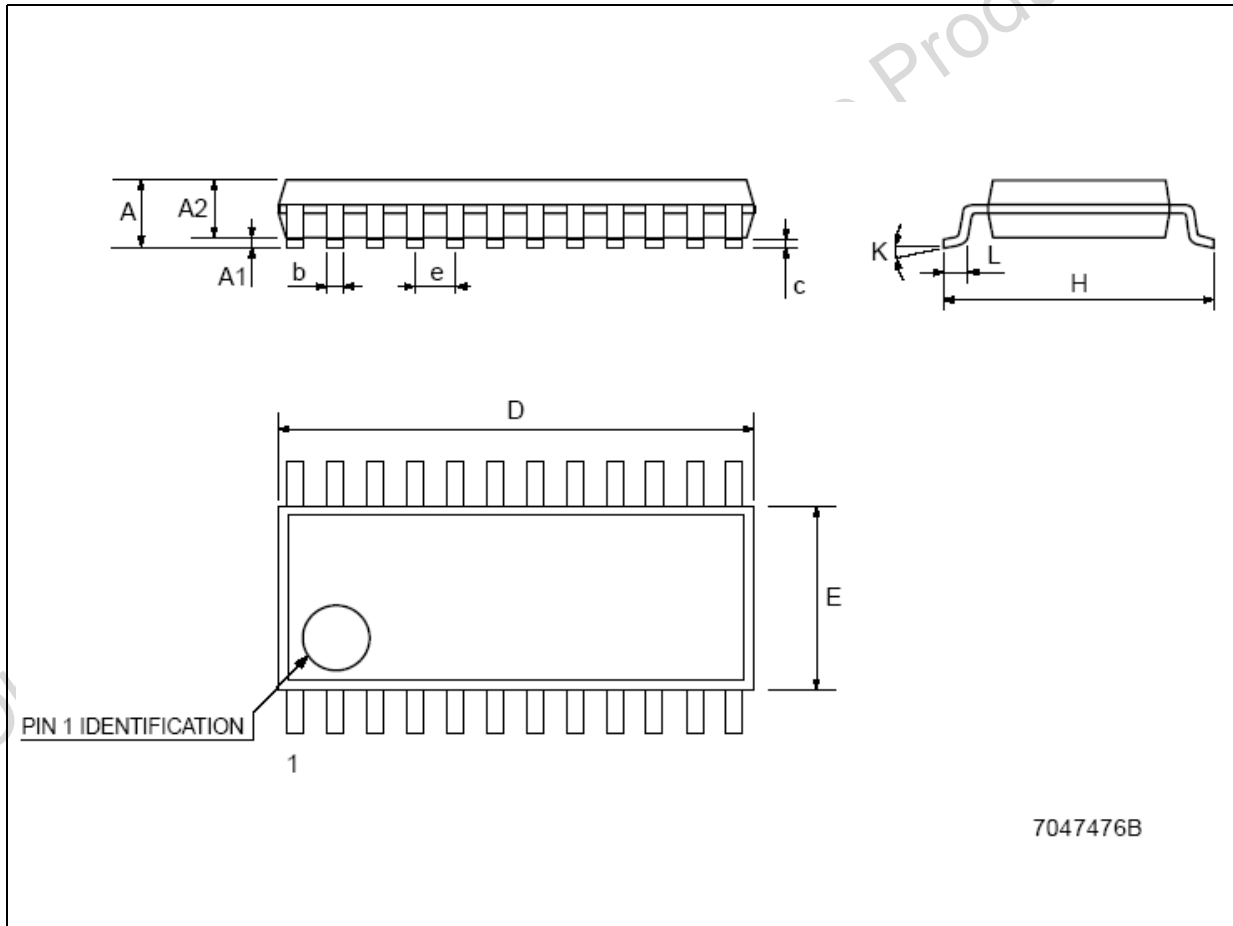
**Table 11.    Tape & Reel TSSOP24**

| Ref | 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 | 6.8 | | 7 | 0.268 | | 0.276 |
| Bo | 8.2 | | 8.4 | 0.323 | | 0.331 |
| Ko | 1.7 | | 1.9 | 0.067 | | 0.075 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 11.9 | | 12.1 | 0.468 | | 0.476 |

**Figure 19.   Reel dimensions**



Note: Drawing not in scale
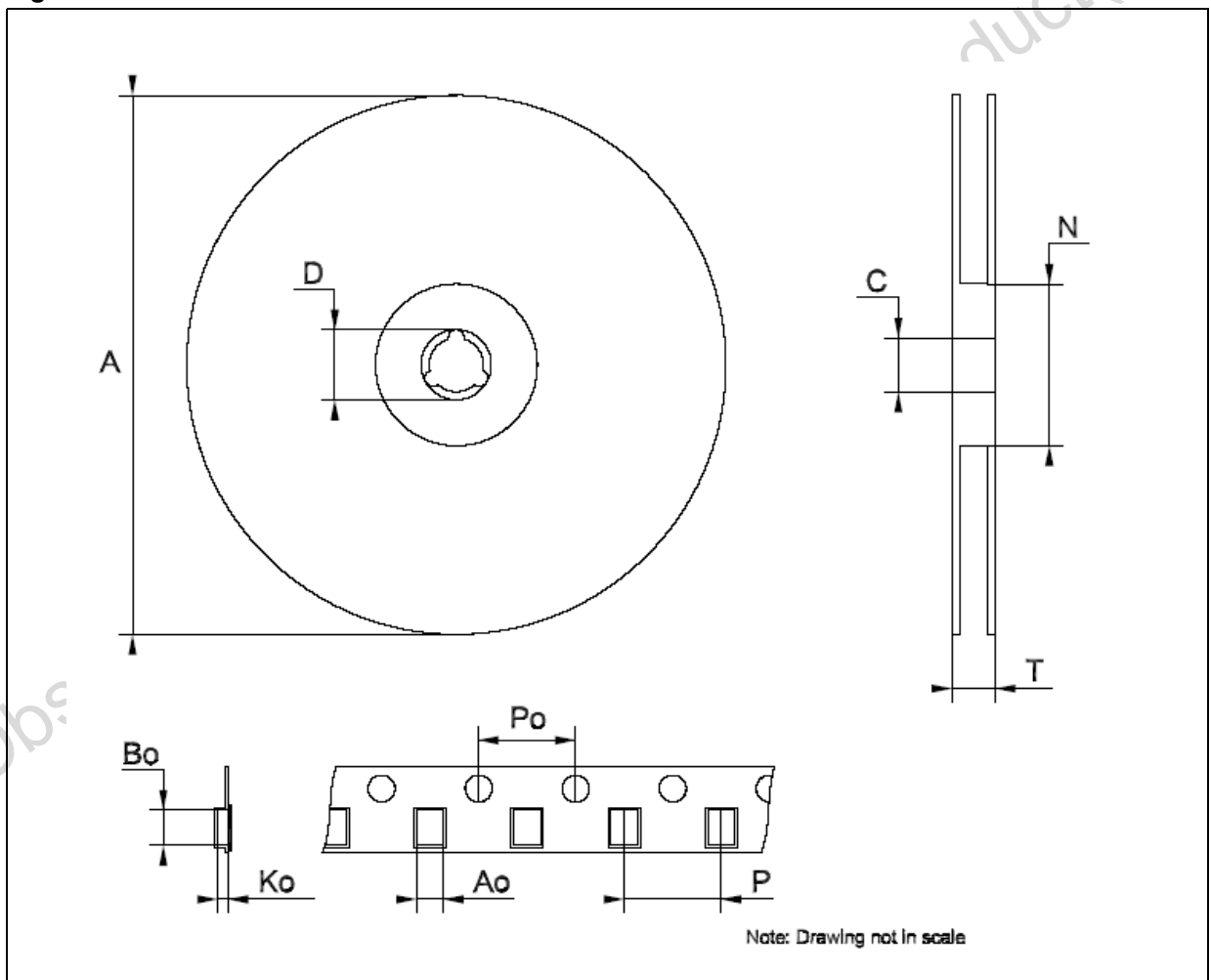
**Table 12.    SO-24 Mechanical data**

| Ref | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | | | 2.65 | | | 0.104 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.008 |
| a2 | | | 2.45 | | | 0.096 |
| b | 0.35 | | 0.49 | 0.014 | | 0.019 |
| b1 | 0.23 | | 0.32 | 0.009 | | 0.012 |
| C | | 0.5 | | | 0.020 | |
| c1 | 45°(typ.) | | | | | |
| D | 15.20 | | 15.60 | 0.598 | | 0.614 |
| E | 10.00 | | 10.65 | 0.393 | | 0.419 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 13.97 | | | 0.550 | |
| F | 7.40 | | 7.60 | 0.291 | | 0.300 |
| L | 0.50 | | 1.27 | 0.020 | | 0.050 |
| S | °(max.) 8 | | | | | |

**Figure 20.   SO-24 Package dimensions**
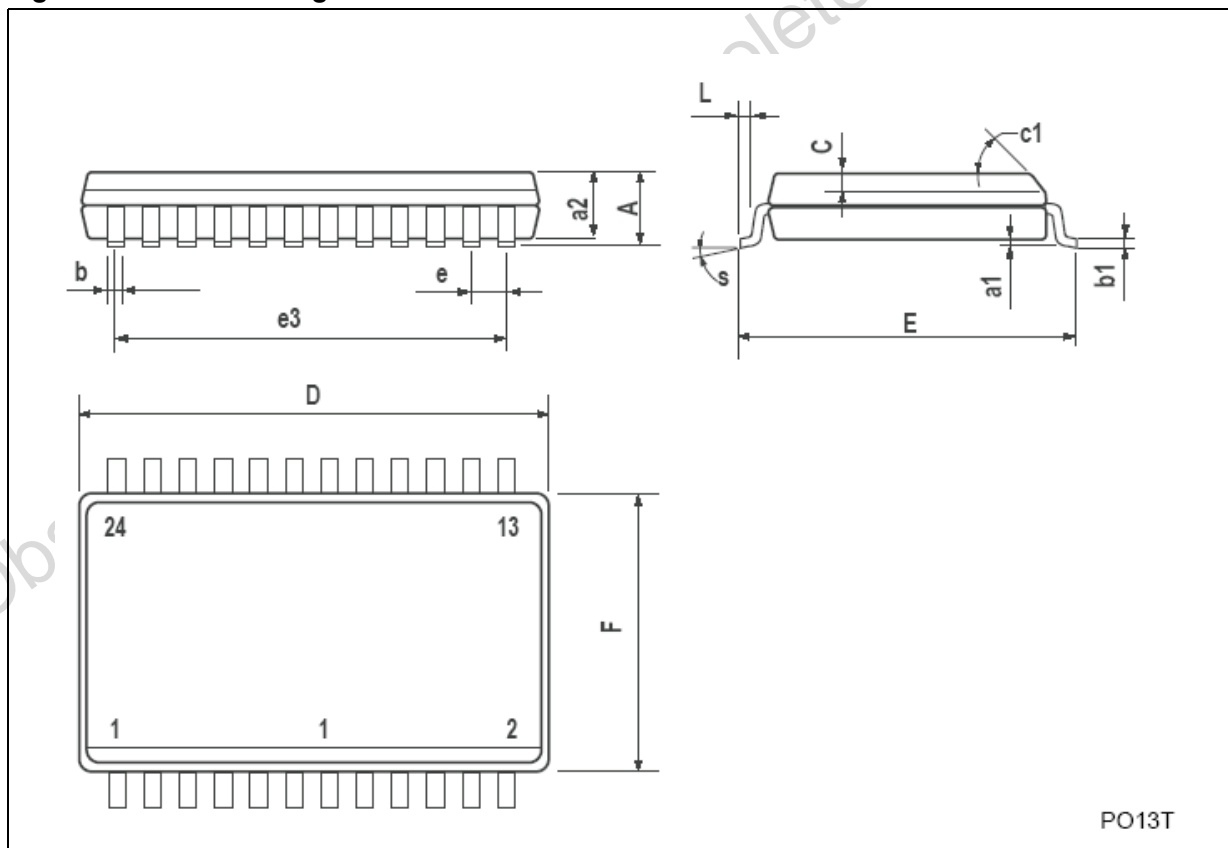


PO13T

**Table 13.    Tape & Reel SO-24**

| Ref | 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 | 10.8 | | 11.0 | 0.425 | | 0.433 |
| Bo | 15.7 | | 15.9 | 0.618 | | 0.626 |
| Ko | 2.9 | | 3.1 | 0.114 | | 0.122 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 11.9 | | 12.1 | 0.468 | | 0.476 |

**Figure 21.   Reel dimensions**



Note: Drawing not in scale
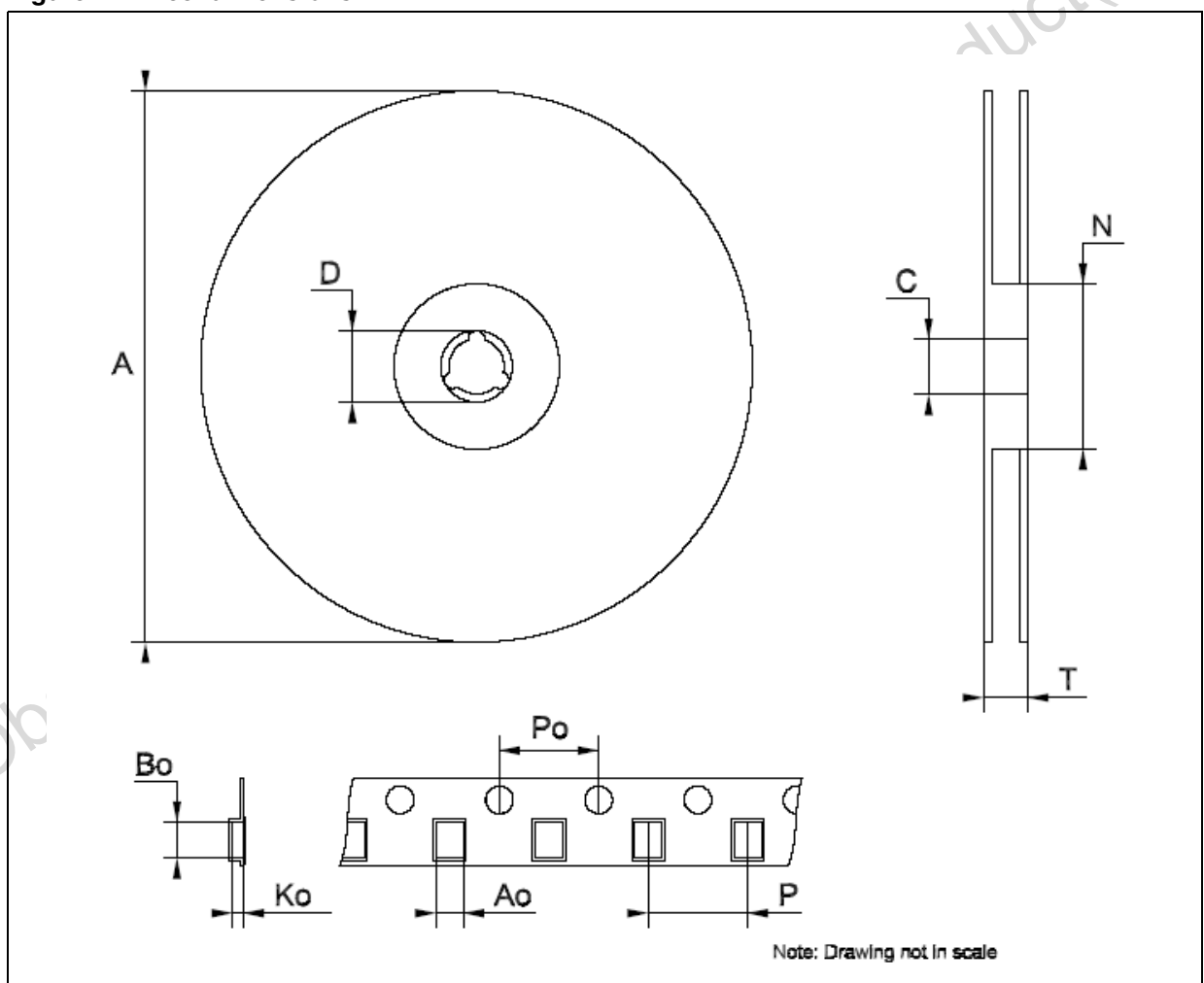
**Table 14.    TSSOP24 Exposed-pad**

| Ref | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | | | 1.2 | | | 0.047 |
| A1 | | | 0.15 | | 0.004 | 0.006 |
| | | | | | | |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 7.7 | 7.8 | 7.9 | 0.303 | 0.307 | 0.311 |
| D1 | | 2.7 | | | 0.106 | |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.5 | 0.169 | 0.173 | 0.177 |
| E2 | | 1.5 | | | 0.059 | |
| e | | 0.65 | | | 0.0256 | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |

**Figure 22.   TSSOP24 Dimensions**
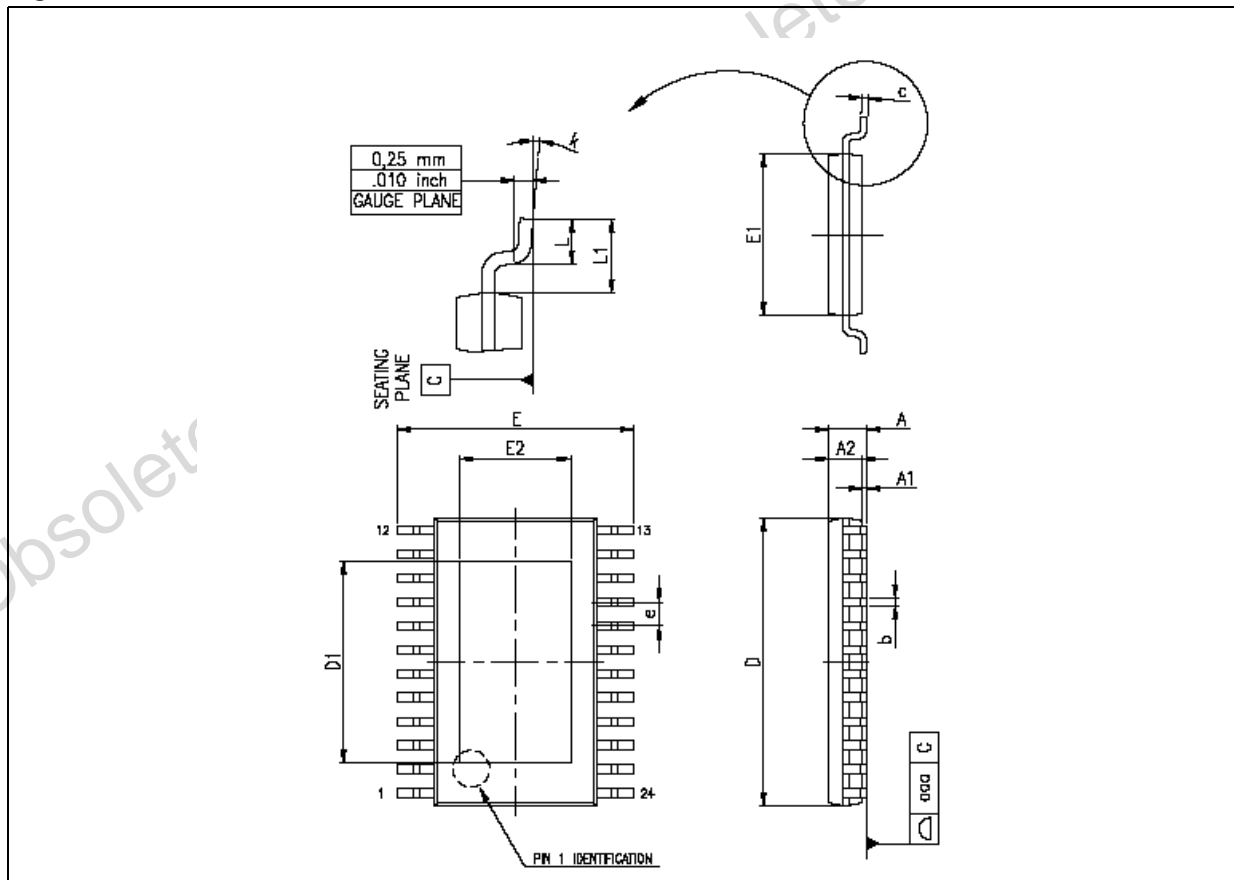
# 8 Revision history

**Table 15. Revision history**

| Date | Revision | Change |
|---|---|---|
| 06-May-2004 | 4 | Table 6 and Table 7 parameters changed. |
| 03-Aug-2004 | 5 | Figure 14 - pag. 10 is changed. |
| 31-Mar-2005 | 6 | Mistake on Fig. 7. |
| 02-May-2005 | 7 | Typing Error on the description features. |
| 22-Jul-2005 | 8 | Add note on Fig. 1 and Table 5. |
| 16-May-2006 | 9 | New template |
| 26-Jul-2006 | 10 | Block diagram *Figure 6 on page 5* and *Section 1.2: Equivalent circuit of inputs and outputs on page 4* |

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

**www.st.com**