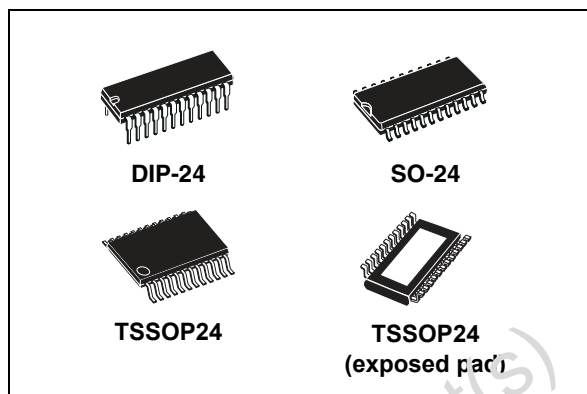


16-Bit, constant current LED sink driver

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



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

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Obsolete Product(s)

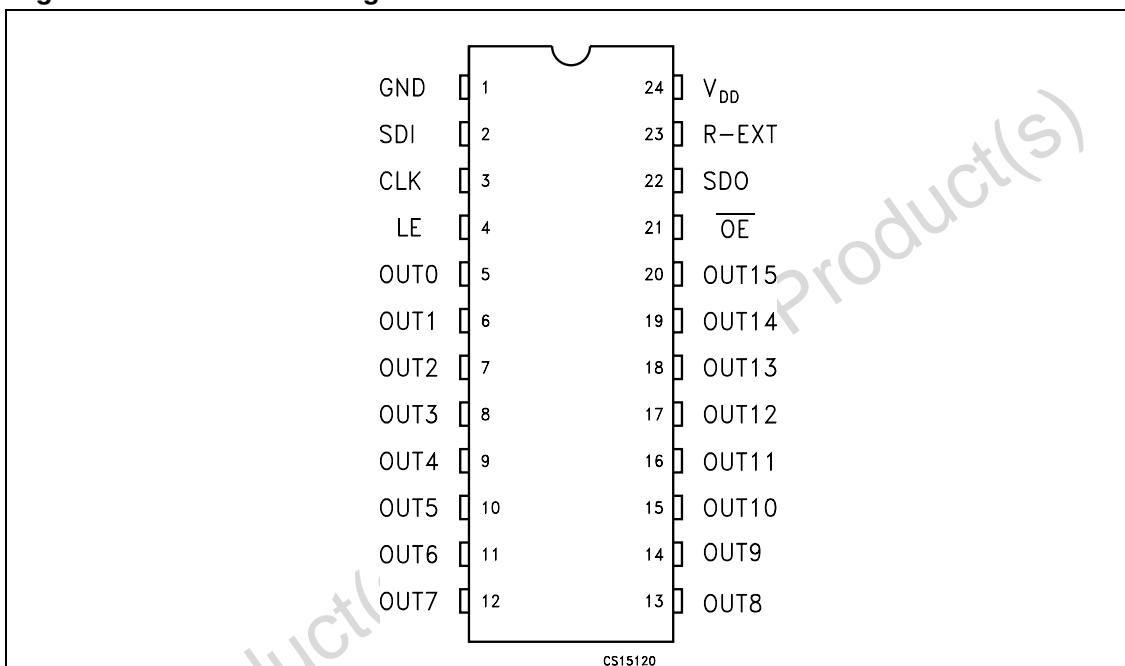
1 Summary description

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{OE} terminal

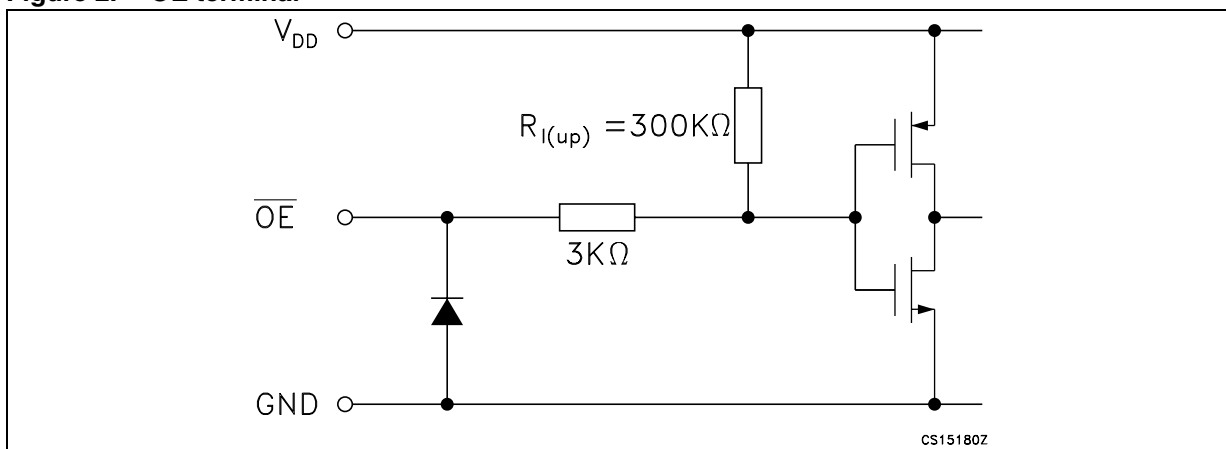


Figure 3. LE terminal

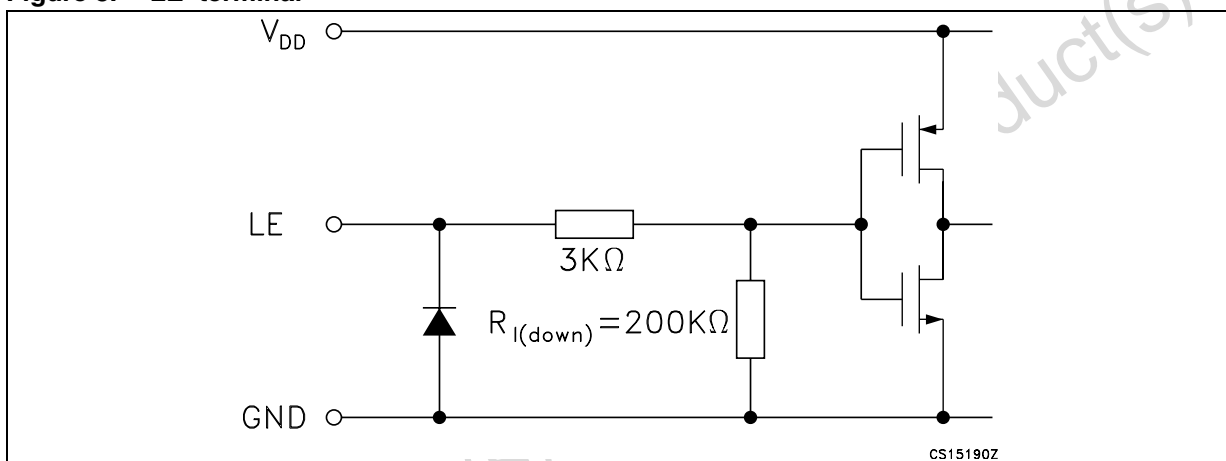


Figure 4. CLK, SDI terminal

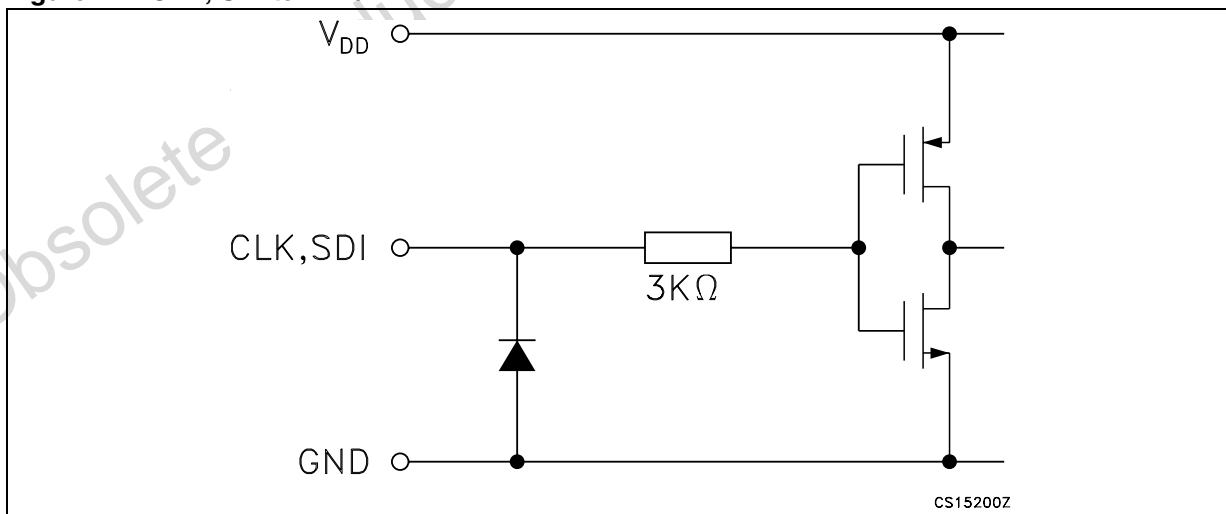
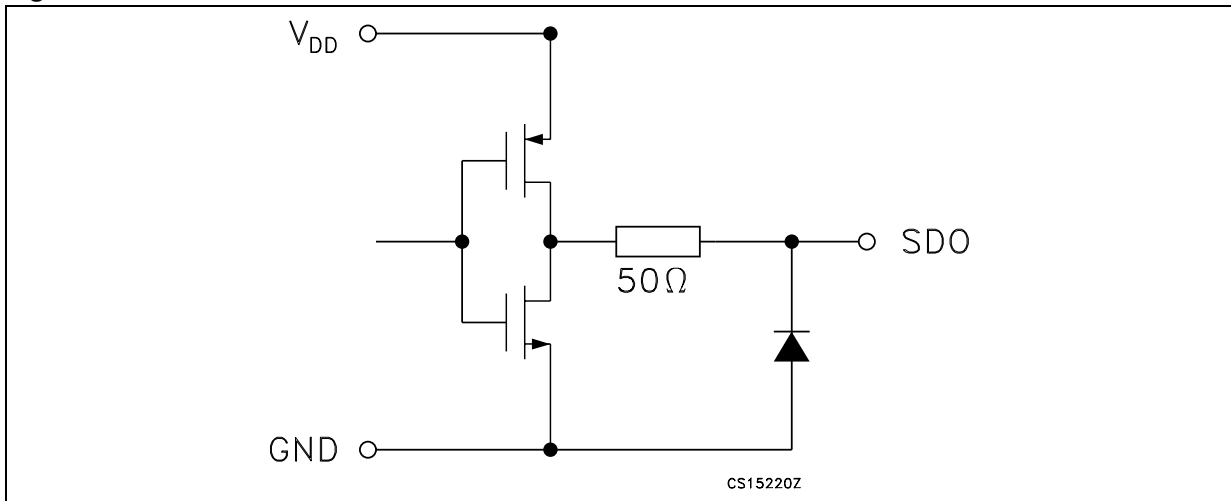
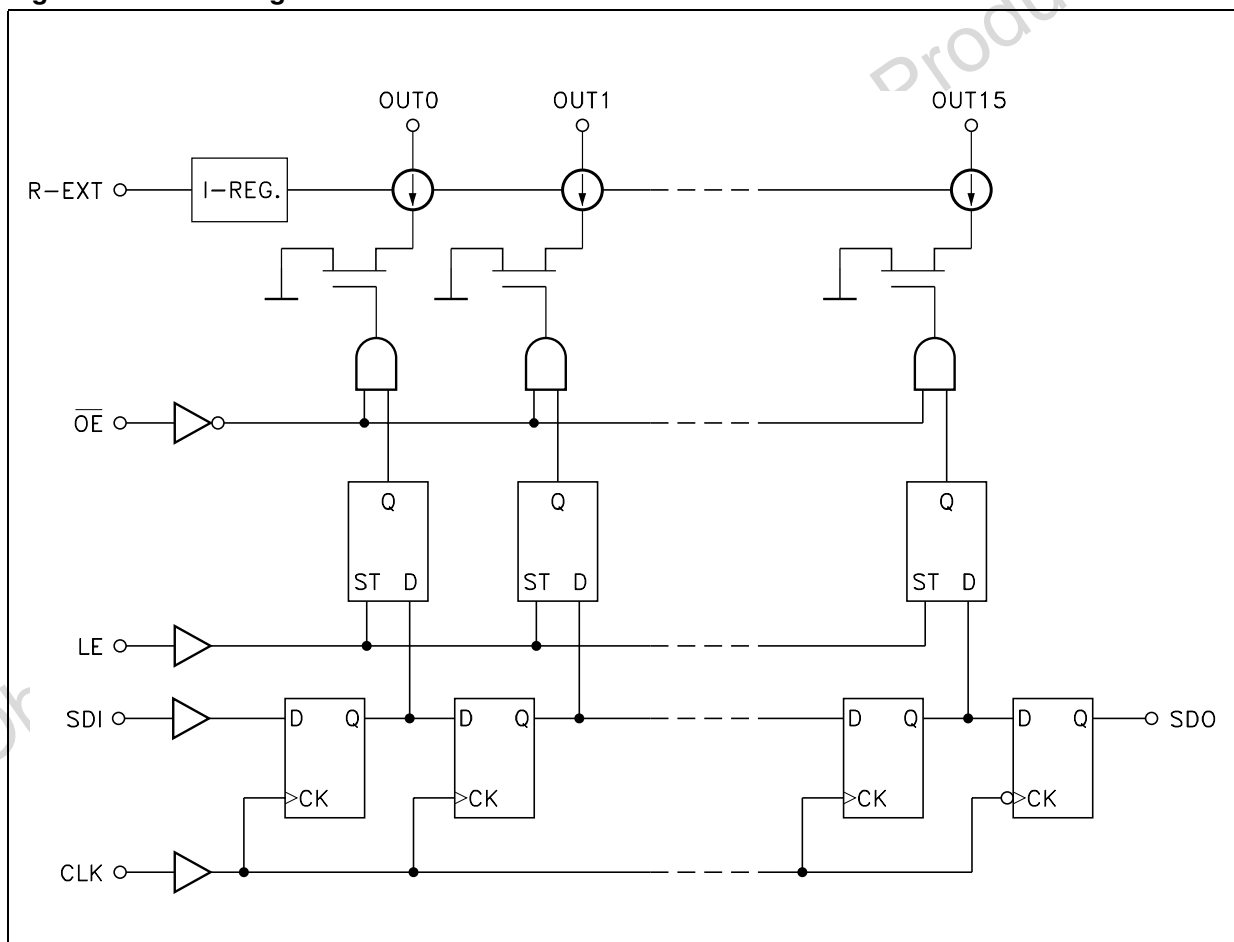


Figure 5. SDO terminal



1.3 Block diagram

Figure 6. Block diagram - normal mode



1.4 Truth table

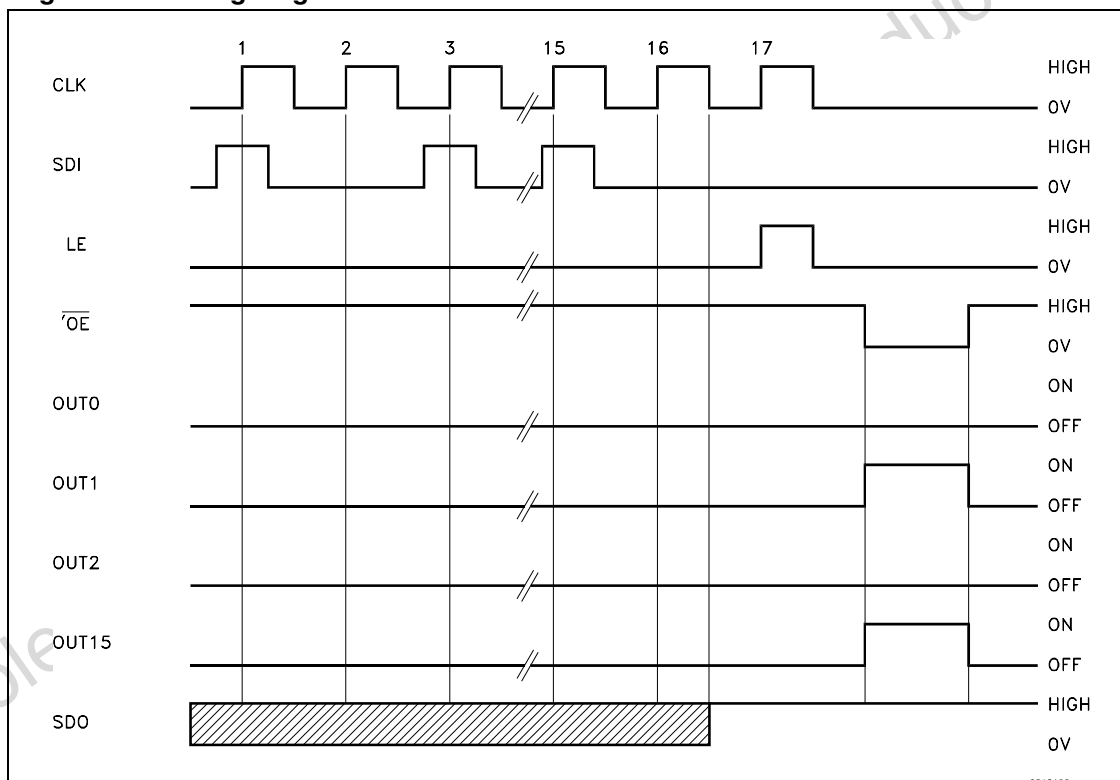
Table 3. Truth table

| 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

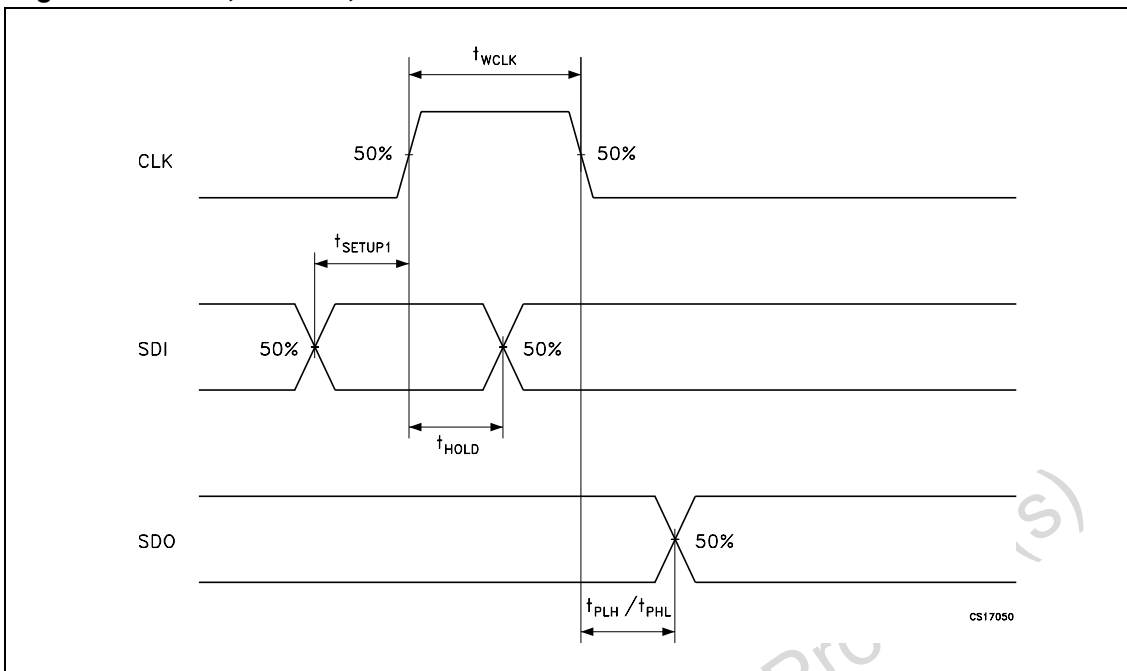


Figure 9. Clock, Serial-In, Latch, Enable, Outputs

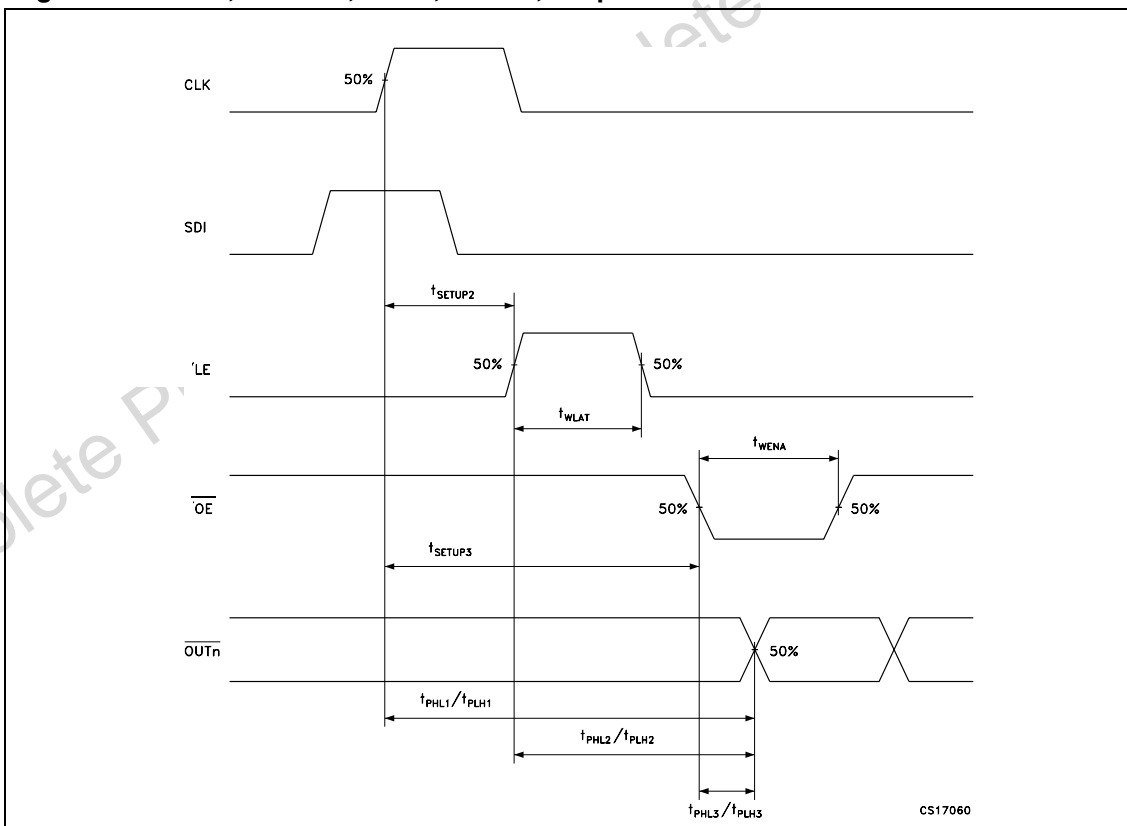
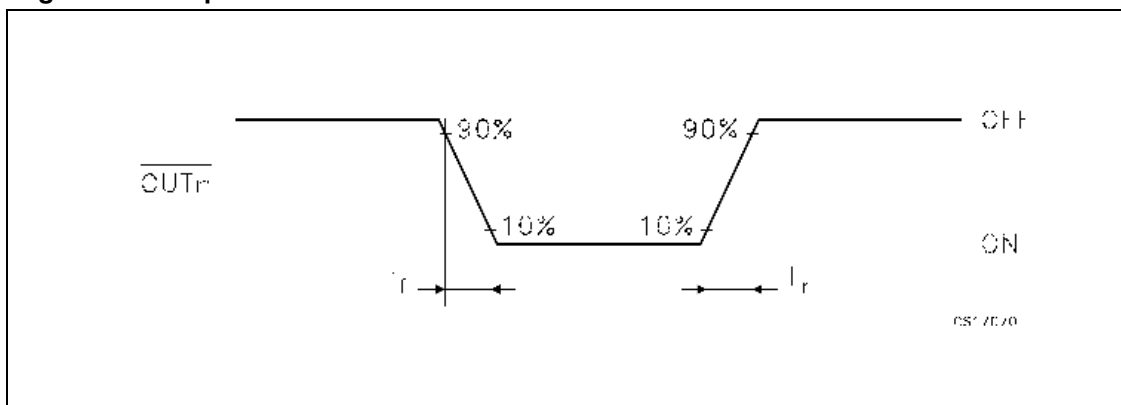


Figure 10. Outputs



Obsolete Product(s) - Obsolete Product(s)

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 |

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

3 Electrical characteristics

Table 7. Electrical characteristics ($V_{DD} = 5V$, $T = 25^{\circ}C$, 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 | $V_O = 0.7V$ $R_{EXT} = 910\Omega$ | 18.6 | 20.4 | 22.4 | mA |
| I_{OL2} | | $V_O = 0.7V$ $R_{EXT} = 360\Omega$ | 45.7 | 50.2 | 55.2 | |
| ΔI_{OL1} | Output current error between bit (All Output ON) | $V_O = 0.7V$ $R_{EXT} = 910\Omega$ | | ± 3 | ± 4 | % |
| ΔI_{OL2} | | $V_O = 0.7V$ $R_{EXT} = 360\Omega$ | | ± 3 | ± 4 | |
| $R_{SIN(up)}$ | Pull-up resistor | | 150 | 300 | 600 | $K\Omega$ |
| $R_{SIN(down)}$ | Pull-down resistor | | 100 | 200 | 400 | $K\Omega$ |
| $I_{DD(OFF1)}$ | Supply current (OFF) | $R_{EXT} = OPEN$ OUT 0 to 15 = OFF | | 0.3 | 0.6 | mA |
| $I_{DD(OFF2)}$ | | $R_{EXT} = 470\Omega$ OUT 0 to 15 = OFF | | 5.5 | 7.7 | |
| $I_{DD(OFF3)}$ | | $R_{EXT} = 250\Omega$ OUT 0 to 15 = OFF | | 10.1 | 14.1 | |
| $I_{DD(ON1)}$ | Supply current (ON) | $R_{EXT} = 470\Omega$ OUT 0 to 15 = ON | | 5.5 | 7.7 | |
| $I_{DD(ON2)}$ | | $R_{EXT} = 250\Omega$ OUT 0 to 15 = ON | | 10.1 | 14.1 | |

4 Switching characteristics

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

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

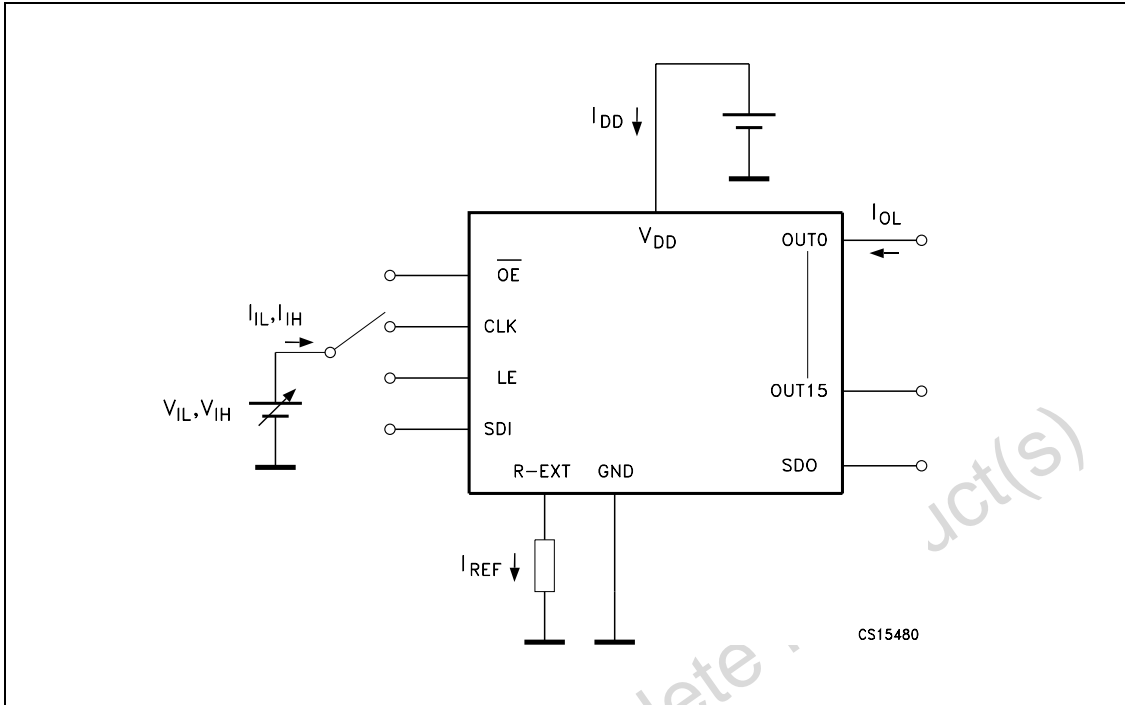
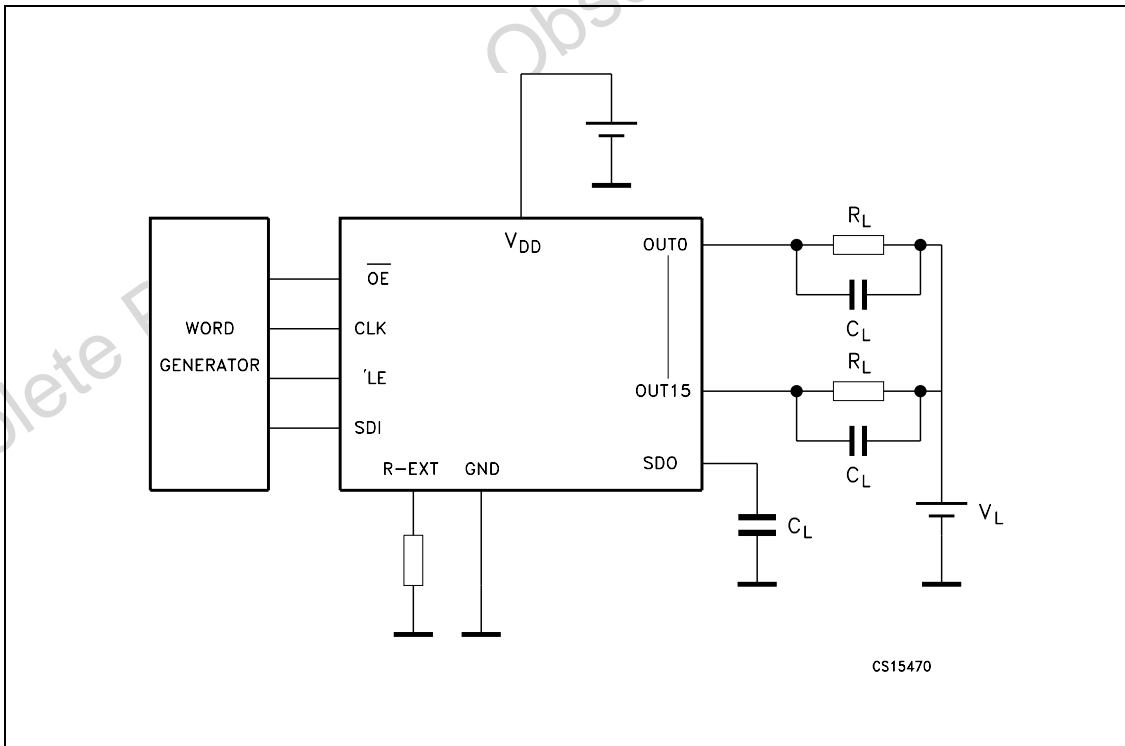


Figure 12. AC characteristics



6 Typical characteristics

Figure 13. Output current- R_{EXT} resistor

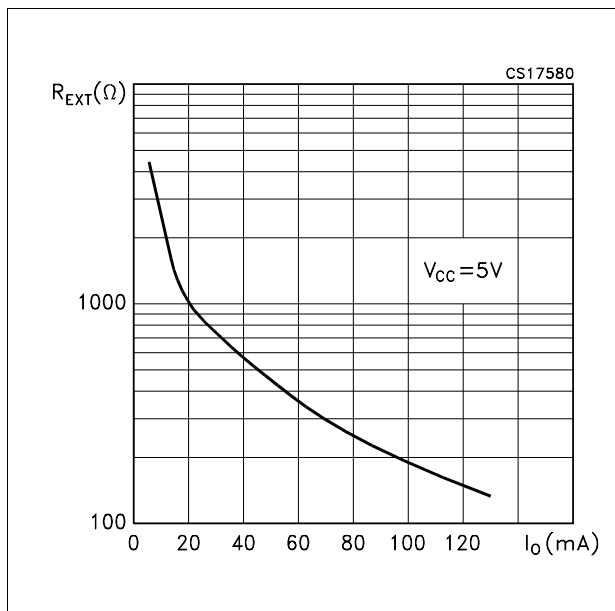


Figure 14. Power dissipation vs. temperature package

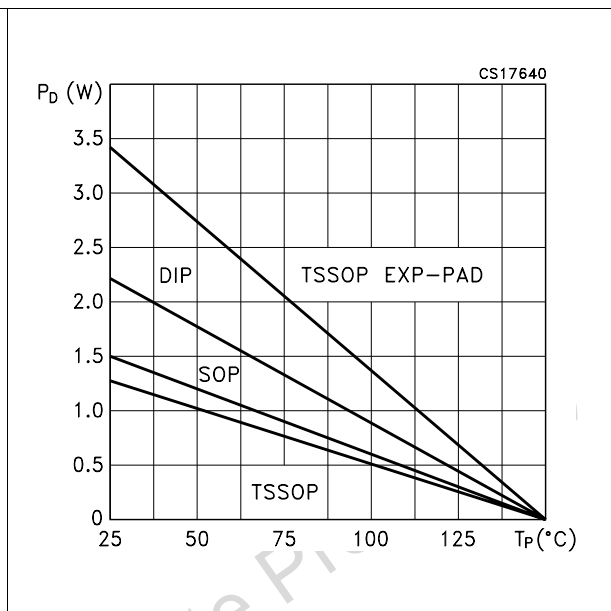


Figure 15. Output current vs. drop voltage

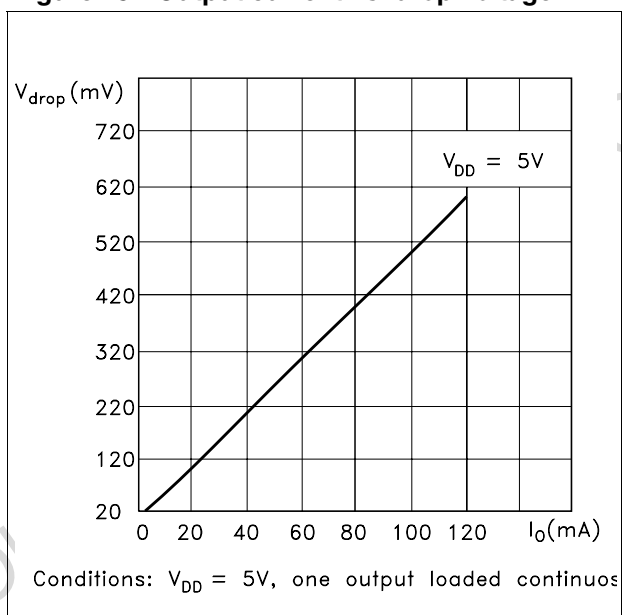
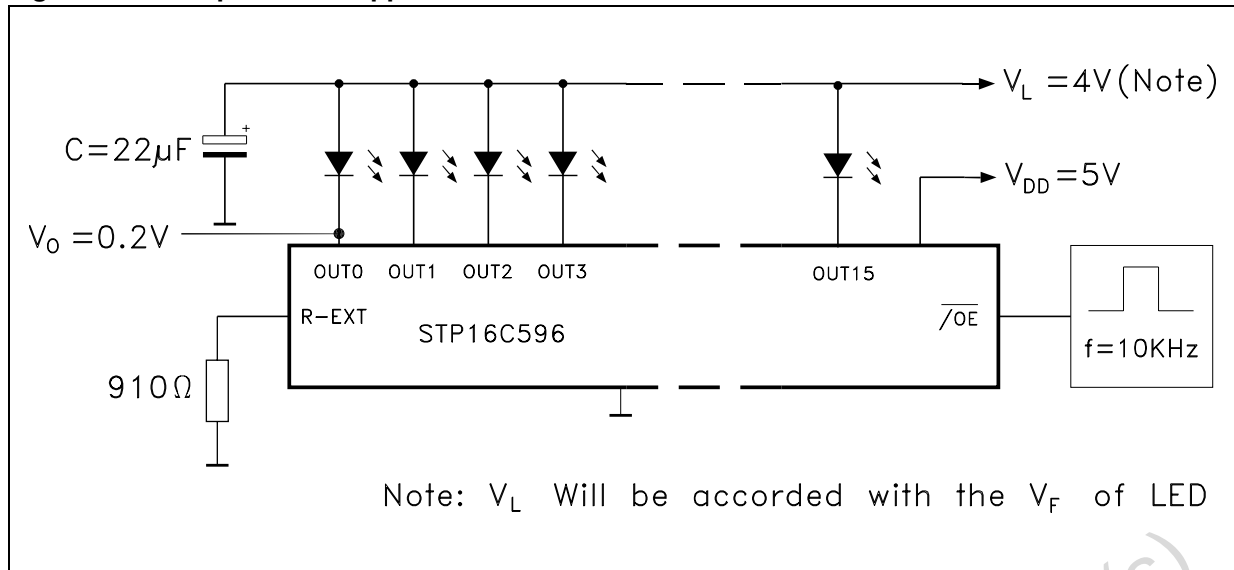


Figure 16. Blue powerLED application circuit



Obsolete Product(s) - Obsolete Product(s)

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.

Obsolete Product(s) - Obsolete Product(s)

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

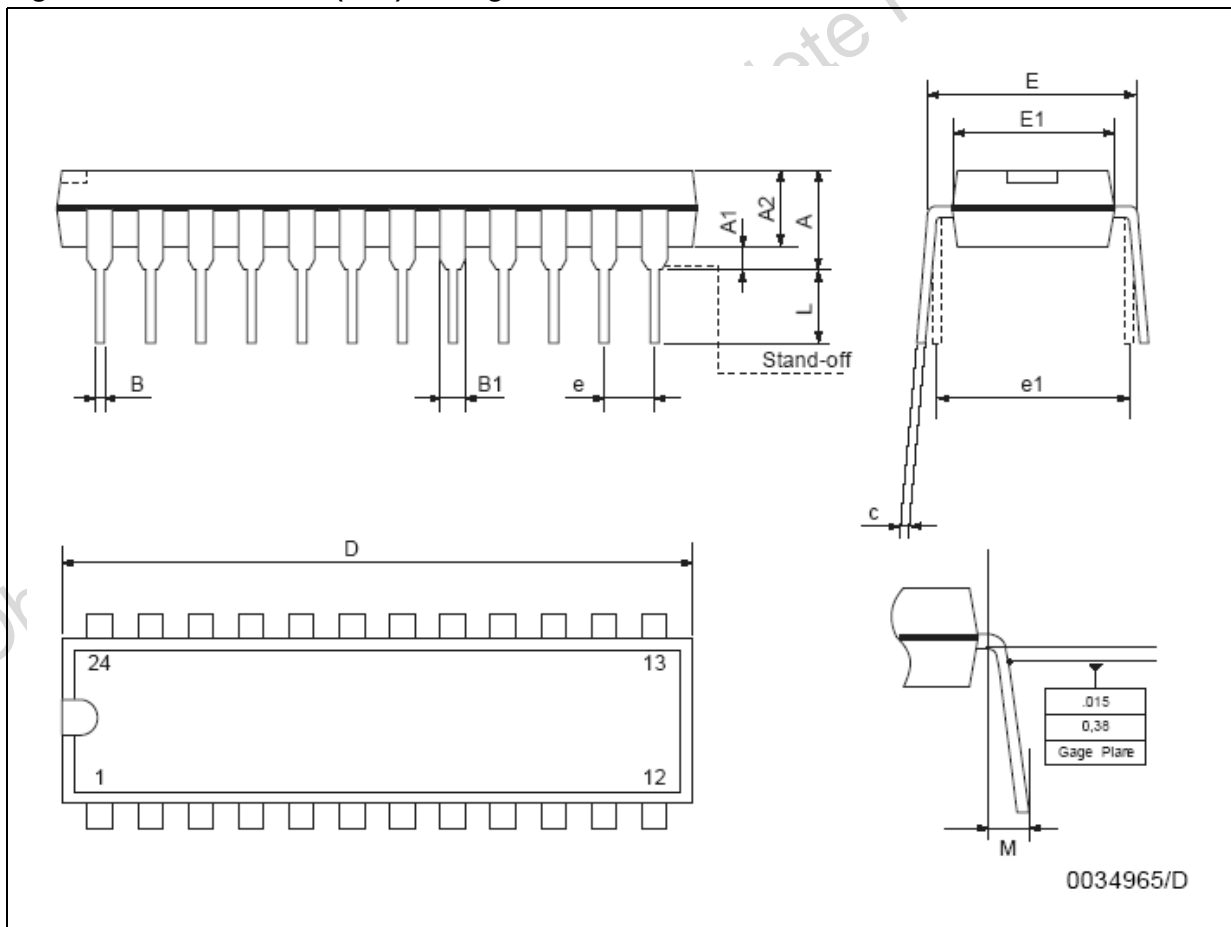


Table 10. TSSOP24 Mechanical data

| 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

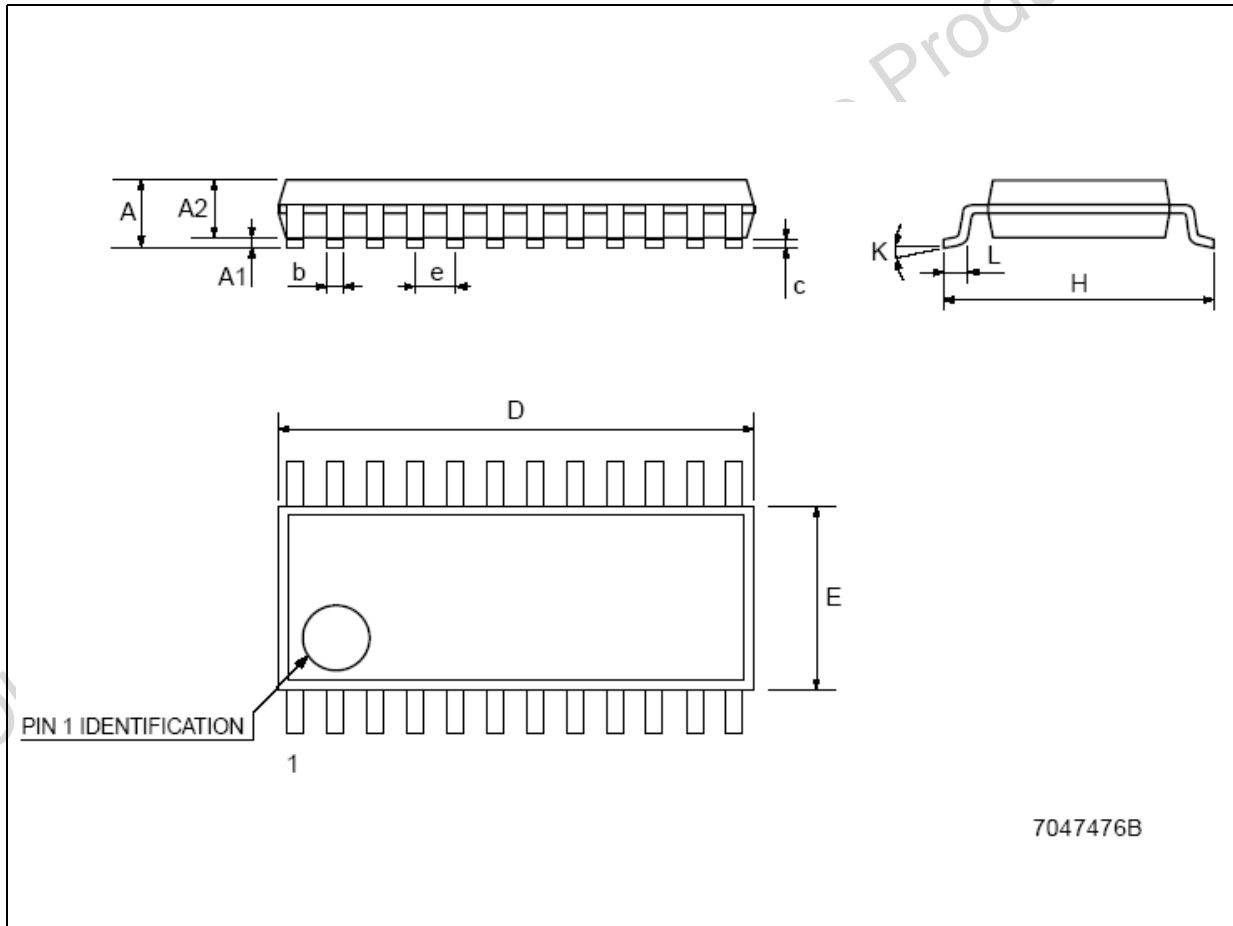


Table 11. Tape & Reel TSSOP24

| 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

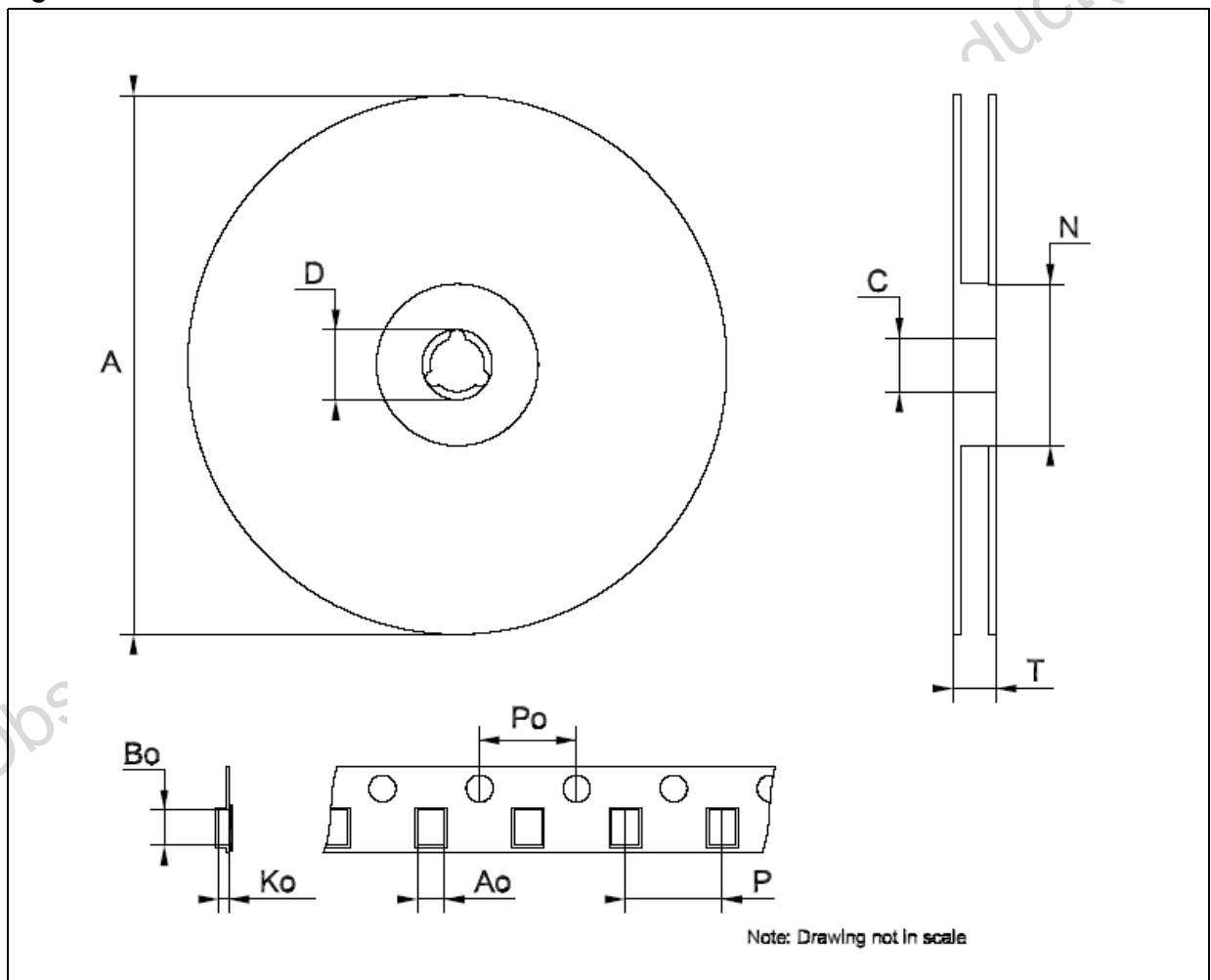
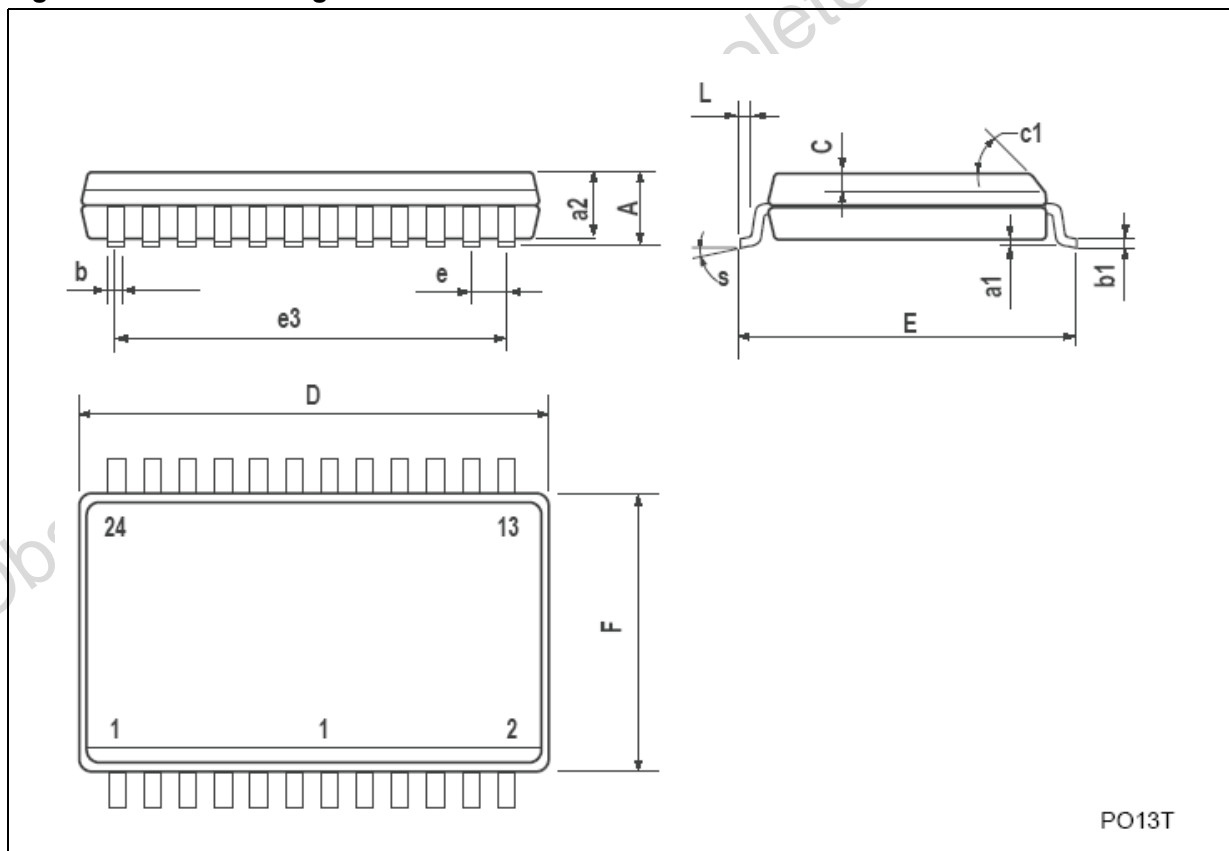


Table 12. SO-24 Mechanical data

| 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

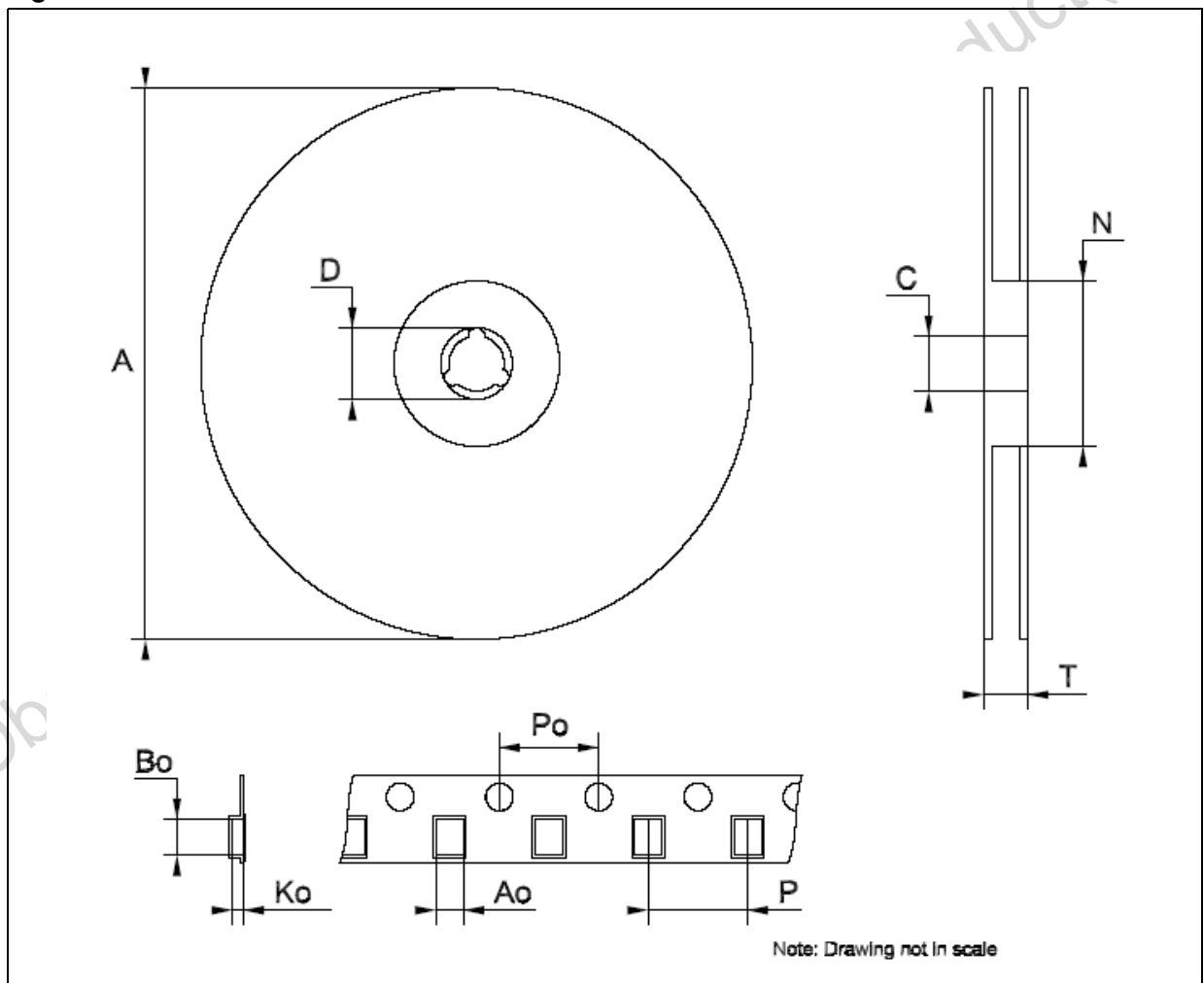
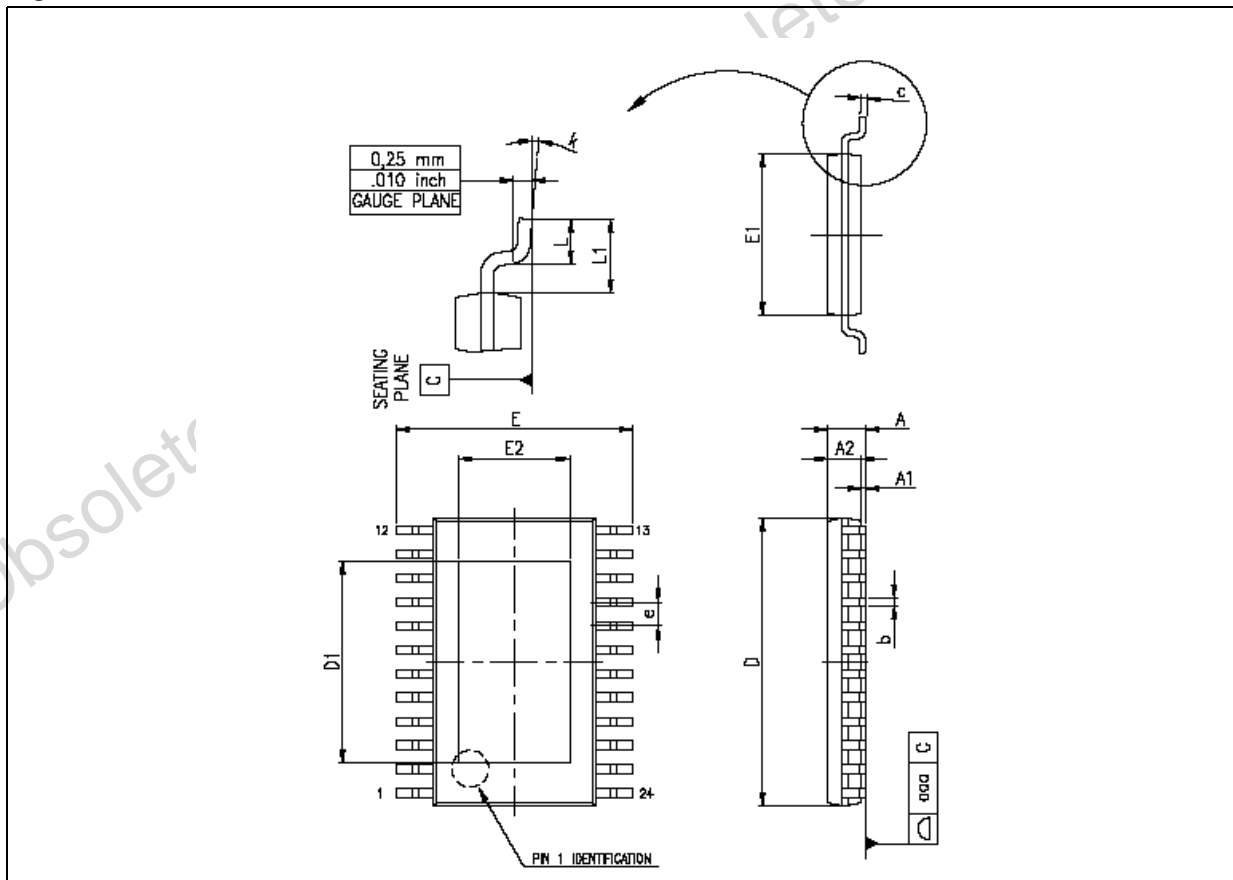


Table 14. TSSOP24 Exposed-pad

| 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 <i>Figure 6 on page 5</i> and <i>Section 1.2: Equivalent circuit of inputs and outputs on page 4</i> |

Obsolete Product(s) - Obsolete Product(s)

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