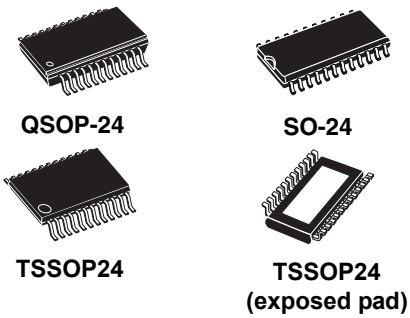
# STP16CP05

## Low voltage 16-bit constant current LED sink driver

## Features

- Low voltage power supply down to 3 V
- 16 constant current output channels
- Adjustable output current through external resistor
- Serial data IN/parallel data OUT
- Can be driven by a 3.3 V microcontroller
- Output current: 5-100 mA
- Max clock frequency 30 MHz
- ESD protection 2 kV HBM, 200 V MM




## Description

The STP16CP05 is a monolithic, low voltage, low current power 16-bit shift register designed for LED panel displays. The STP16CP05 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 provide from 5 mA to 100 mA constant current to drive the LEDs.

The output current setup time is 40 ns (typ), thus improving the system performance.

The LEDs' brightness can be controlled by using an external resistor to adjust the STP16CP05 output current.

The STP16CP05 guarantees a 20 V output driving capability, allowing users to connect more LEDs in series.The high clock frequency, 30 MHz, makes the device suitable for high data rate transmission. The 3.3 V voltage supply is useful in applications that interface with a 3.3 V micro controller.

**Table 1. Device summary**

| Order codes | Package | Packaging |
|---|---|---|
| STP16CP05MTR | SO-24 | 1000 parts per reel |
| STP16CP05TTR | TSSOP24 | 2500 parts per reel |
| STP16CP05XTTR | TSSOP24 exposed pad | 2500 parts per reel |
| STP16CP05PTR | QSOP-24 | 2500 parts per reel |

# Contents

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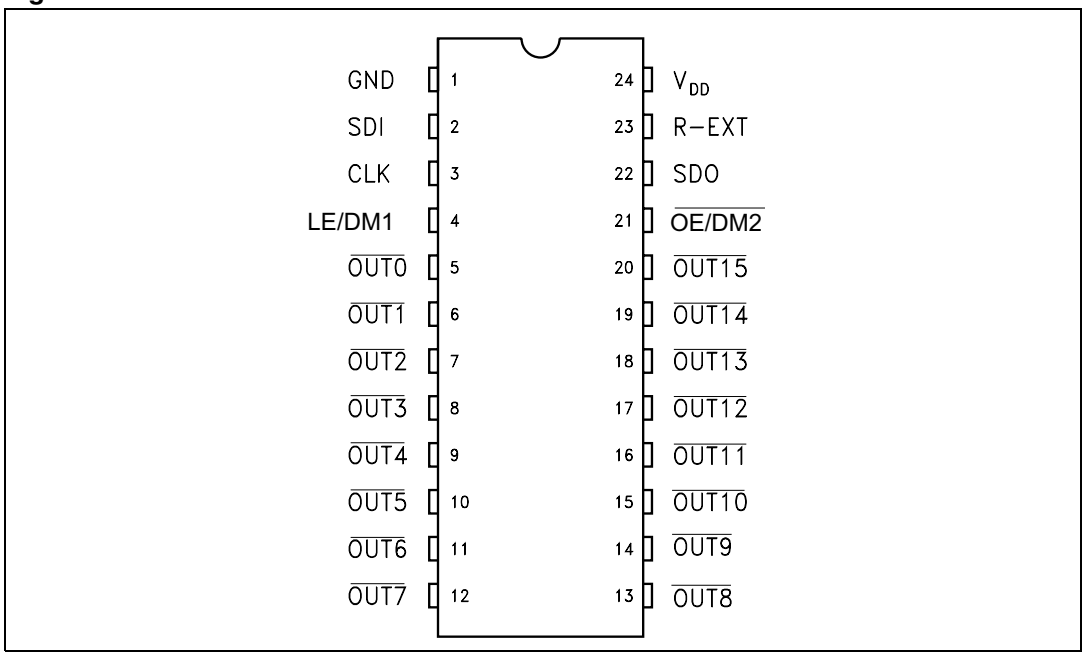
# 1 Summary description

**Table 2. Typical current accuracy**

| Output voltage | Current accuracy | | Output current | $V_{DD}$ | Temperature |
|---|---|---|---|---|---|
| | Between bits | Between ICs | | | |
| ≥ 1.3 V | ±1.5% | ±5% | ≥ 20 to 100 mA | 3.3 V to 5 V | 25 °C |

## 1.1 Pin connection and description

**Figure 2. Pin connection**




*Note: The exposed pad should be electrically connected to a metal land electrically isolated or connected to ground.*

**Table 3. 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/DM1 | Latch input terminal |
| 5-20 | OUT 0-15 | Output terminal |
| 21 | $\overline{OE/DM2}$ | 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 |

# 2 Electrical ratings

## 2.1 Absolute maximum ratings

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.

**Table 4. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DD}$ | Supply voltage | 0 to 7 | V |
| $V_O$ | Output voltage | -0.5 to 20 | V |
| $I_O$ | Output current | 100 | mA |
| $V_I$ | Input voltage | -0.4 to $V_{DD}$ | V |
| $I_{GND}$ | GND terminal current | 1600 | mA |
| $f_{CLK}$ | Clock frequency | 50 | MHz |
| $T_J$ | Junction temperature range | -40 to +170 | °C |

## 2.2 Thermal data

**Table 5. Thermal data**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $T_{OPR}$ | Operating temperature range | | -40 to +125 | °C |
| $T_{STG}$ | Storage temperature range | | -55 to +150 | °C |
| $R_{thJA}$ | Thermal resistance junction-ambient (1) | SO-24 | 42.7 | °C/W |
| | | TSSOP24 | 55 | °C/W |
| | | TSSOP24(2) exposed pad | 37.5 | °C/W |
| | | QSOP-24 | 55 | °C/W |

1. According with Jedec 51-7
2. The exposed pad should be soldered directly to the PCB to realize the thermal benefits.

## 2.3 Recommended operating conditions

$T_A$ = 25 °C

**Table 6. Recommended operating conditions**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply voltage | | 3.0 | - | 5.5 | V |
| $V_O$ | Output voltage | | | - | 20 | V |
| $I_O$ | Output current | OUTn | 3 | - | 100 | mA |
| $I_{OH}$ | Output current | SERIAL-OUT | | - | +1 | mA |
| $I_{OL}$ | Output current | SERIAL-OUT | | - | -1 | mA |
| $V_{IH}$ | Input voltage | | $0.7V_{DD}$ | - | $V_{DD}$ | V |
| $V_{IL}$ | Input voltage | | -0.3 | - | $0.3V_{DD}$ | V |
| $t_{wLAT}$ | LE/DM1 pulse width | $V_{DD}$ = 3.3 V to 5.0 V | 6 | - | | ns |
| $t_{wCLK}$ | CLK pulse width | | 8 | - | | ns |
| $t_{wEN}$ | $\overline{OE}$/DM2 pulse width | | 100 | - | | ns |
| $t_{SETUP(D)}$ | Setup time for DATA | | 5 | - | | ns |
| $t_{HOLD(D)}$ | Hold time for DATA | | 3 | - | | ns |
| $t_{SETUP(L)}$ | Setup time for LATCH | | 18 | - | | ns |
| $f_{CLK}$ | Clock frequency | Cascade operation (1) $V_{DD}$ = 5 V | | - | 30 | 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

$V_{DD}$ = 3.3 V to 5 V, $T_A$ = 25 °C, unless otherwise specified

**Table 7. Electrical characteristics**

| 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 | $V_{OH}$ = 20 V | | | 1 | µA |
| $V_{OL}$ | Output voltage (Serial-OUT) | $I_{OL}$ = 1 mA | | | 0.4 | V |
| $V_{OH}$ | Output voltage (Serial-OUT) | $I_{OH}$ = -1 mA | $V_{DD}$-0.4V | | | V |
| $I_{OL1}$ | Output current | $V_O$ = 0.3 V, $R_{ext}$ = 4.2 kΩ | 4.25 | 5 | 5.75 | mA |
| $I_{OL2}$ | | $V_O$ = 0.3 V, $R_{ext}$ = 1 kΩ | 19 | 20 | 21 | |
| $I_{OL3}$ | | $V_O$ = 1.3 V, $R_{ext}$ = 200 Ω | 96 | 100 | 104 | |
| $\Delta I_{OL1}$ | Output current error between bit (All Output ON) | $V_O$ = 0.3 V, $R_{ext}$ = 4.2 kΩ | | ± 5 | ± 8 | % |
| $\Delta I_{OL2}$ | | $V_O$ = 0.3 V, $R_{ext}$ = 1 kΩ | | ± 1.5 | ± 3 | |
| $\Delta I_{OL3}$ | | $V_O$ = 1.3 V, $R_{ext}$ = 200 Ω | | ± 1.2 | ± 3 | |
| $R_{SIN(up)}$ | Pull-up resistor | | 150 | 300 | 600 | kΩ |
| $R_{SIN(down)}$ | Pull-down resistor | | 100 | 200 | 400 | kΩ |
| $I_{DD(OFF1)}$ | Supply current (OFF) | $R_{EXT}$ = 1 kΩ OUT 0 to 15 = OFF | | 4 | | mA |
| $I_{DD(OFF2)}$ | | $R_{EXT}$ = 250Ω OUT 0 to 15 = OFF | | 11.2 | | |
| $I_{DD(ON1)}$ | Supply current (ON) | $R_{EXT}$ = 1 kΩ OUT 0 to 15 = ON | | 4.5 | | |
| $I_{DD(ON2)}$ | | $R_{EXT}$ = 250Ω OUT 0 to 15 = ON | | 11.7 | | |
| Thermal | Thermal protection | | | 170 | | °C |

$V_{DD}$ = 5 V, T = 25 °C, unless otherwise specified

**Table 8. Switching characteristics**

| Symbol | Parameter | Test conditions | | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| $t_{PLH1}$ | Propagation delay time, CLK-$\overline{OUTn}$, LE/DM1 = H, $\overline{OE/DM2}$ = L | $V_{IH}$ = $V_{DD}$<br>$V_{IL}$ = GND<br>$I_O$ = 20 mA<br>$R_{EXT}$ = 1 KΩ | $C_L$ = 10 pF<br>$V_L$ = 3.0 V<br>$R_L$ = 60 Ω | $V_{DD}$ = 3.3 V | - | 45 | 74 | ns |
| | | | | $V_{DD}$ = 5 V | - | 24 | 38 | |
| $t_{PLH2}$ | Propagation delay time, LE/DM1-$\overline{OUTn}$, $\overline{OE/DM2}$ = L | | | $V_{DD}$ = 3.3 V | - | 48 | 77 | ns |
| | | | | $V_{DD}$ = 5 V | - | 27 | 46 | |
| $t_{PLH3}$ | Propagation delay time, $\overline{OE/DM2}$-$\overline{OUTn}$, LE/DM1 = H | | | $V_{DD}$ = 3.3 V | - | 75 | 128 | ns |
| | | | | $V_{DD}$ = 5 V | - | 43 | 64 | |
| $t_{PLH}$ | Propagation delay time, CLK-SDO | | | $V_{DD}$ = 3.3 V | - | 19 | 28 | ns |
| | | | | $V_{DD}$ = 5 V | - | 11 | 16.5 | |
| $t_{PHL1}$ | Propagation delay time, CLK-$\overline{OUTn}$, LE/DM1 = H, $\overline{OE/DM2}$ = L | | | $V_{DD}$ = 3.3 V | - | 15 | 23 | ns |
| | | | | $V_{DD}$ = 5 V | - | 10 | 14 | |
| $t_{PHL2}$ | Propagation delay time, LE/DM1-$\overline{OUTn}$, $\overline{OE/DM2}$ = L | | | $V_{DD}$ = 3.3 V | - | 13 | 18.5 | ns |
| | | | | $V_{DD}$ = 5 V | - | 9 | 12 | |
| $t_{PHL3}$ | Propagation delay time, $\overline{OE/DM2}$-$\overline{OUTn}$, LE/DM1 = H | | | $V_{DD}$ = 3.3 V | - | 17 | 24.5 | ns |
| | | | | $V_{DD}$ = 5 V | - | 14 | 19.5 | |
| $t_{PHL}$ | Propagation delay time, CLK-SDO | | | $V_{DD}$ = 3.3 V | - | 23 | 35 | ns |
| | | | | $V_{DD}$ = 5 V | - | 14 | 21 | |
| $t_{ON}$ | Output rise time 10~90% of voltage waveform | | | $V_{DD}$ = 3.3 V | - | 35 | 68 | ns |
| | | | | $V_{DD}$ = 5 V | - | 21 | 31.5 | |
| $t_{OFF}$ | Output fall time 90~10% of voltage waveform | | | $V_{DD}$ = 3.3 V | - | 10.5 | 15 | ns |
| | | | | $V_{DD}$ = 5 V | - | 11 | 15.5 | |
| $t_r$ | CLK rise time (1) | | | | - | | 5000 | ns |
| $t_f$ | CLK fall time (1) | | | | - | | 5000 | ns |

1. In order to achieve high cascade data transfer, please consider tr/tf timings carefully.

# 4 Equivalent circuit and outputs

**Figure 3. $\overline{\text{OE/DM2}}$ terminal**

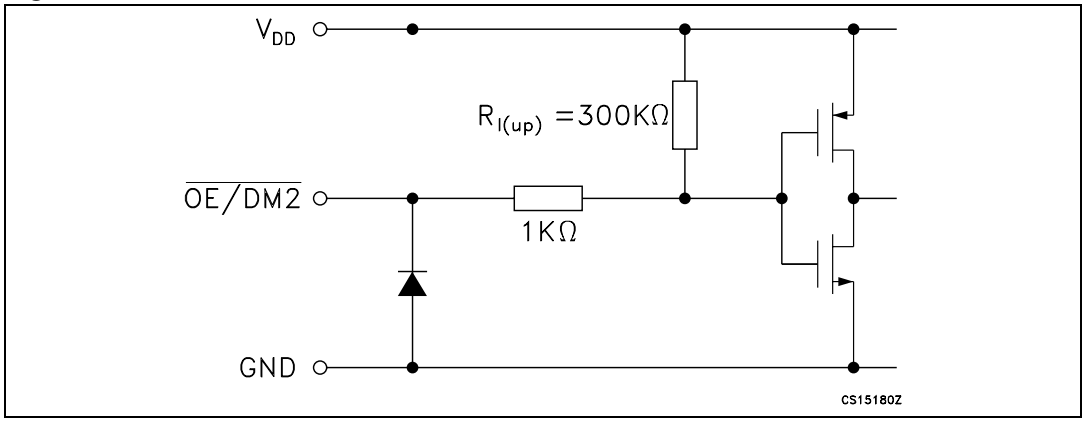



**Figure 4. LE/DM1 terminal**

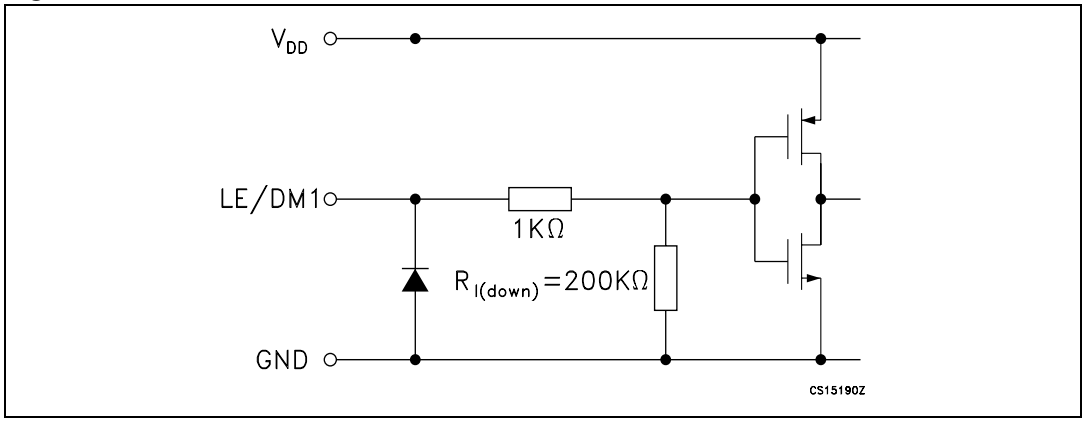



**Figure 5. CLK, SDI terminal**

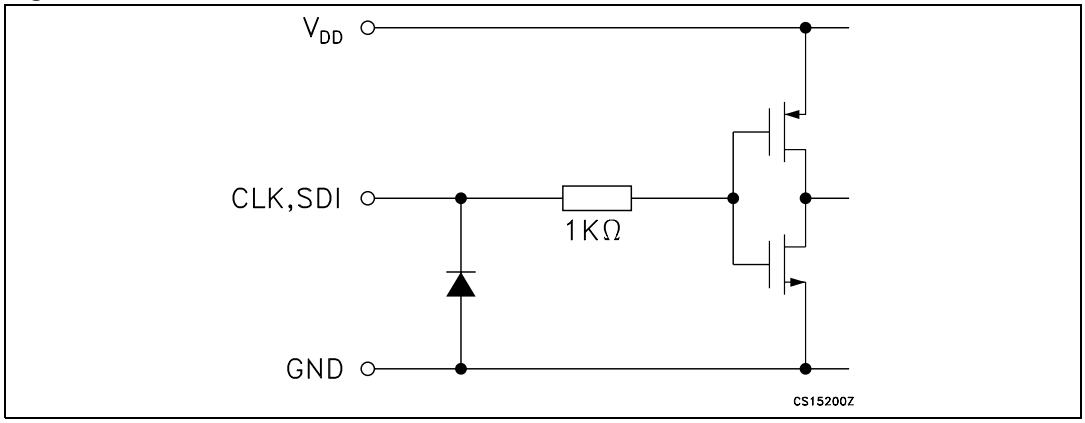


**Figure 6. SDO terminal**

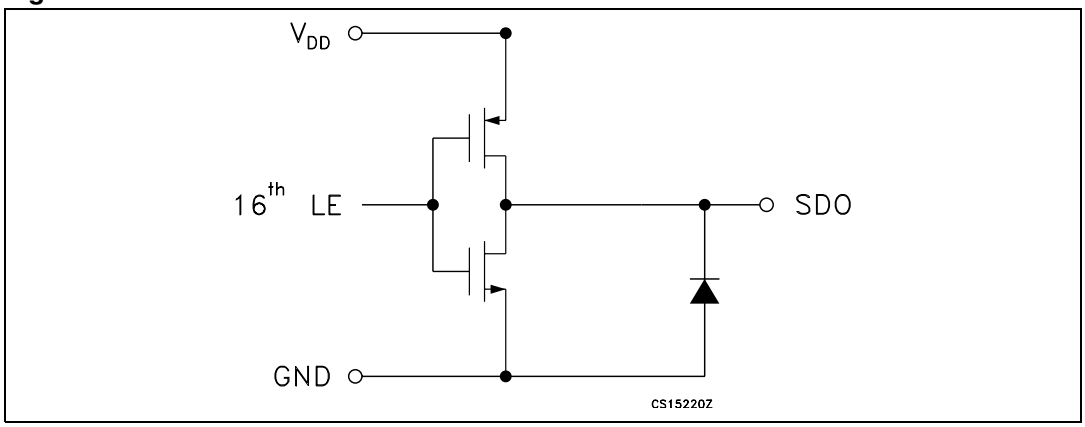
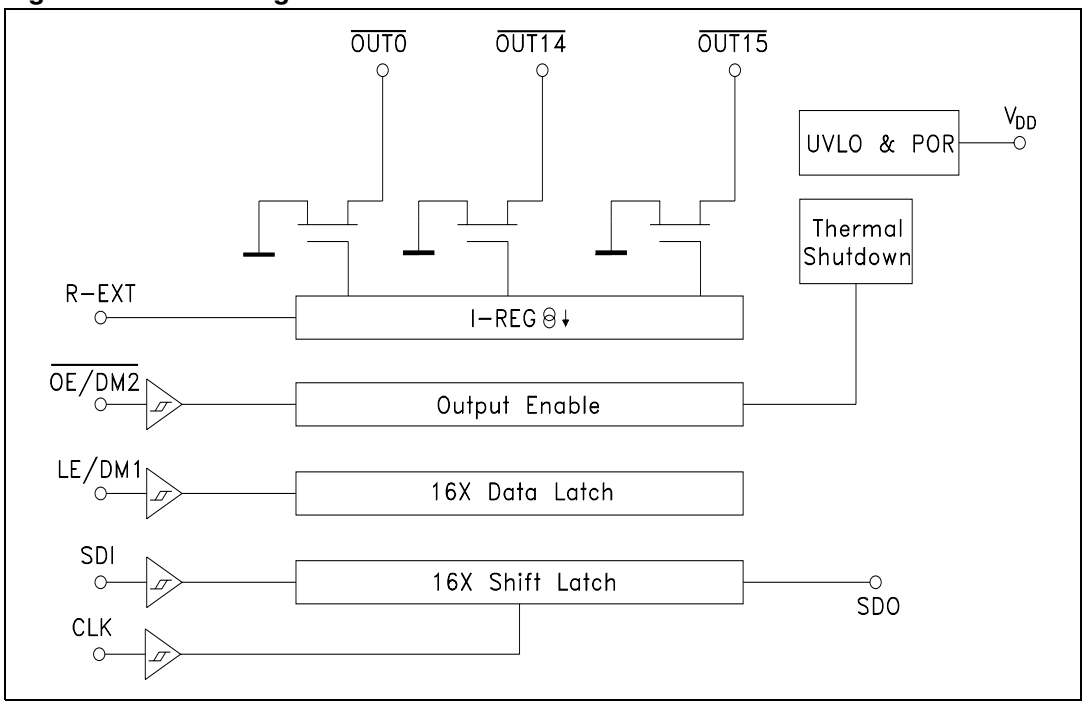



**Figure 7. Block diagram**



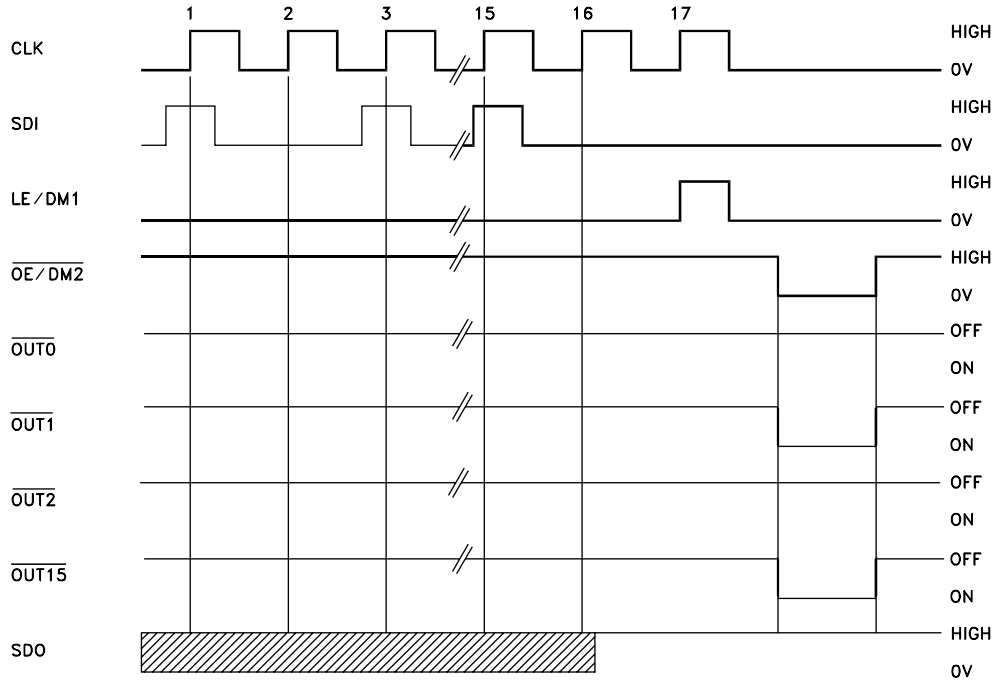
# 5 Timing diagrams

**Table 9. Truth table**

| CLOCK | LE/DM1 | $\overline{OE}$/DM2 | Serial-IN | $\overline{OUT0}$ ..... $\overline{OUT7}$ ..... $\overline{OUT15}$ | 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 | H | Dn + 3 | OFF | Dn - 13 |

*Note: OUTn = ON when Dn = H OUTn = OFF when Dn = L*

**Figure 8. Timing diagram**




*Note: 1 Latch and Output Enable are level sensitive and ARE NOT synchronized with rising-or-falling edge of CLK signal.*

*2 When LE/DM1 terminal is low level, the latch circuits hold previous set of data*

*3 When LE/DM1 terminal is high level, the latch circuits refresh new set of data from SDI chain.*

*4 When $\overline{OE}$/DM2 terminal is low level, the output terminals - Out0 to Out15 respond to data in the latch circuits, either '1' for ON or '0' for OFF*

*5 When $\overline{OE}$/DM2 terminal is at high level, all output terminals will be switched OFF.*

**Figure 9. Clock, serial-in, serial-out**

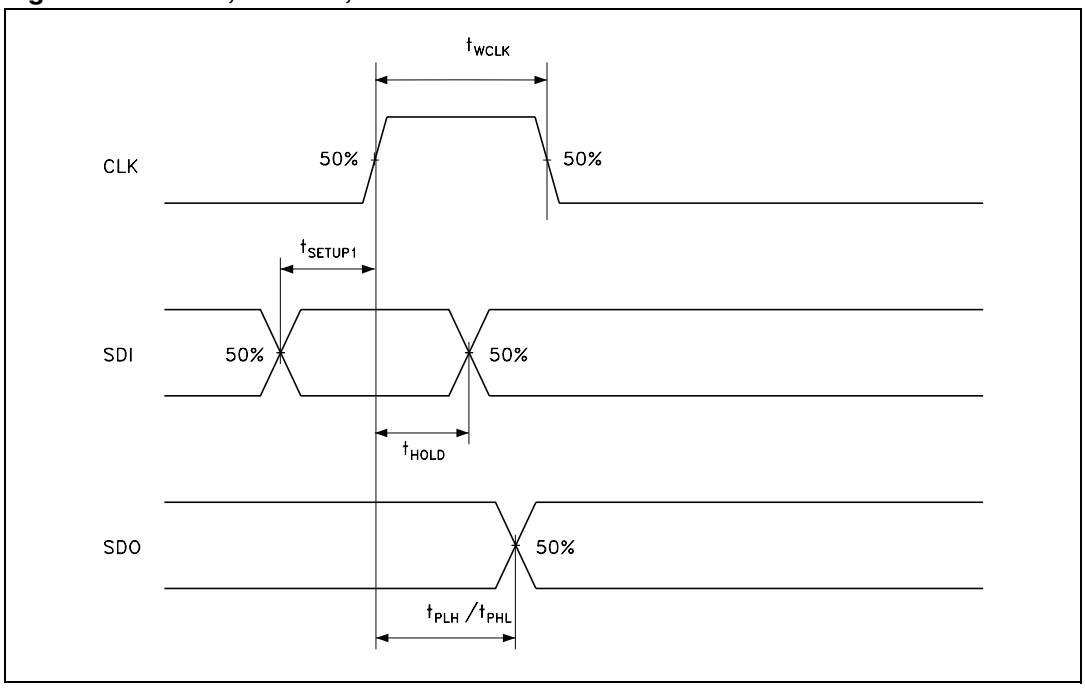


**Figure 10. Clock, serial-in, latch, enable, outputs**

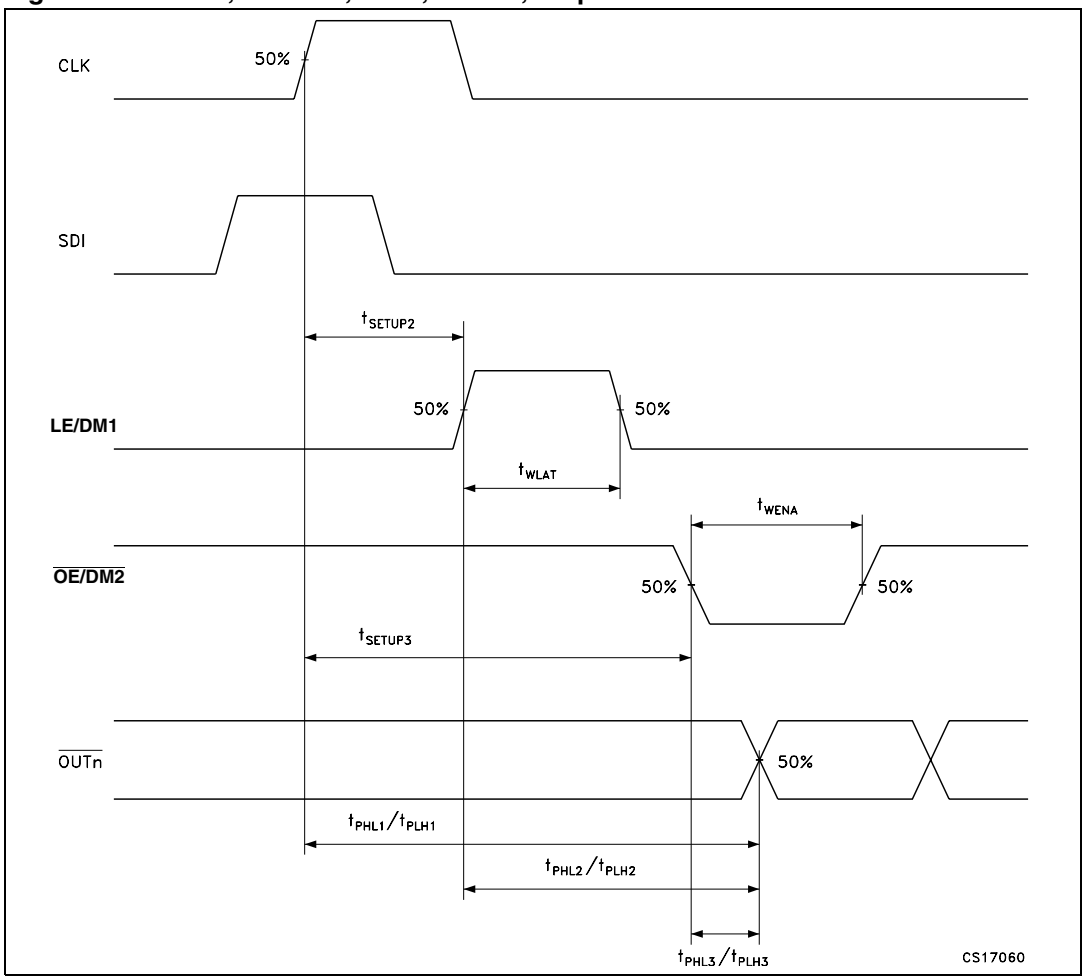
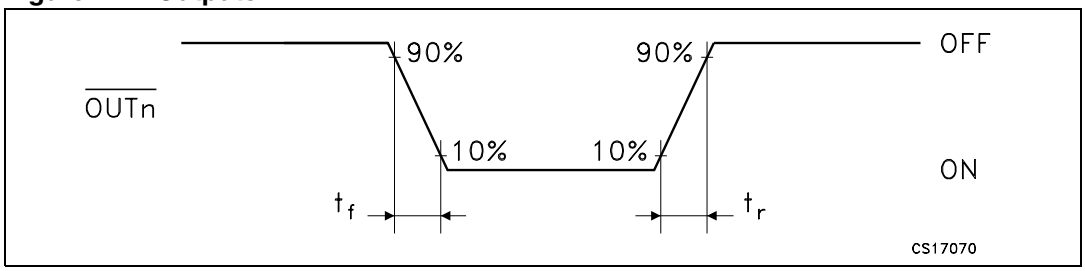



**Figure 11. Outputs**



# 6 Typical characteristics

**Figure 12. Output current-$R_{EXT}$ resistor**

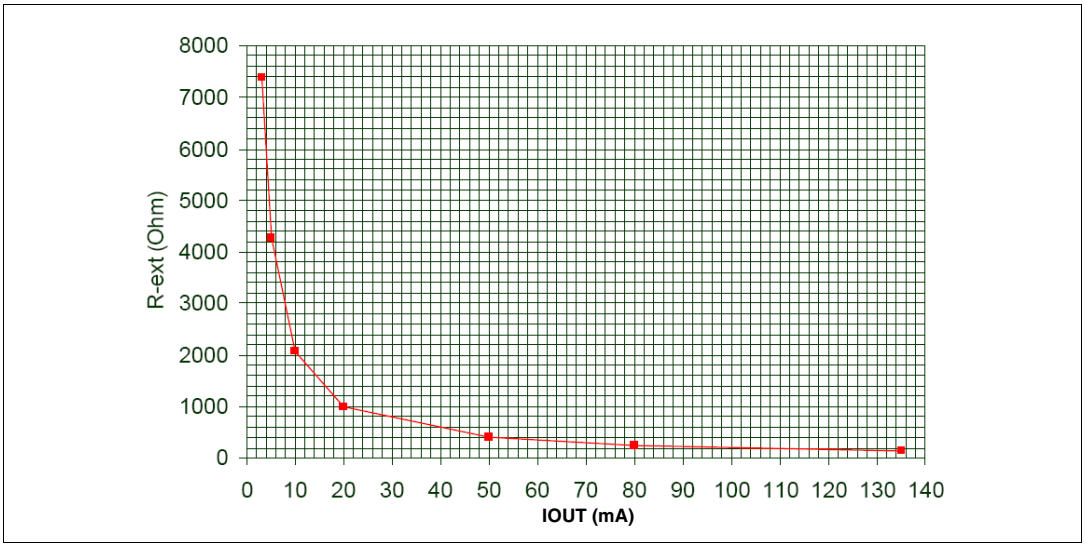



**Table 10. Output current-R-EXT resistor**

| R-EXT (Ω) | Output current (mA) |
|---|---|
| 7370 | 3 |
| 4270 | 5 |
| 2056 | 10 |
| 1006 | 20 |
| 382 | 50 |
| 251 | 80 |
| 200 | 100 |

Figure 13. Output current vs $\pm \Delta I_{OL}$(%) $T_A$ = 25 °C

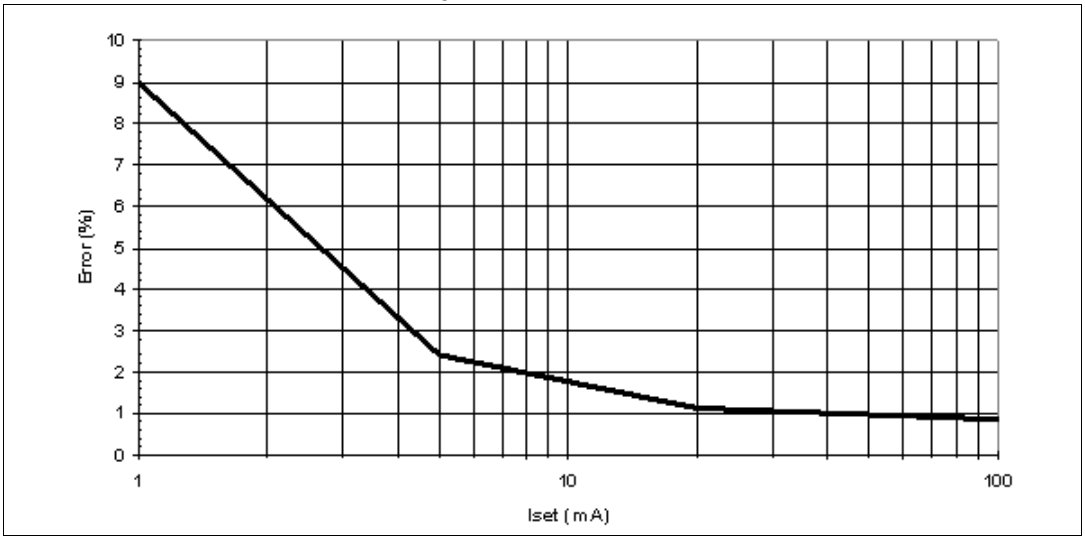



Figure 14. $I_{SET}$ vs drop out voltage ($V_{drop}$) $T_A$ = 25 °C

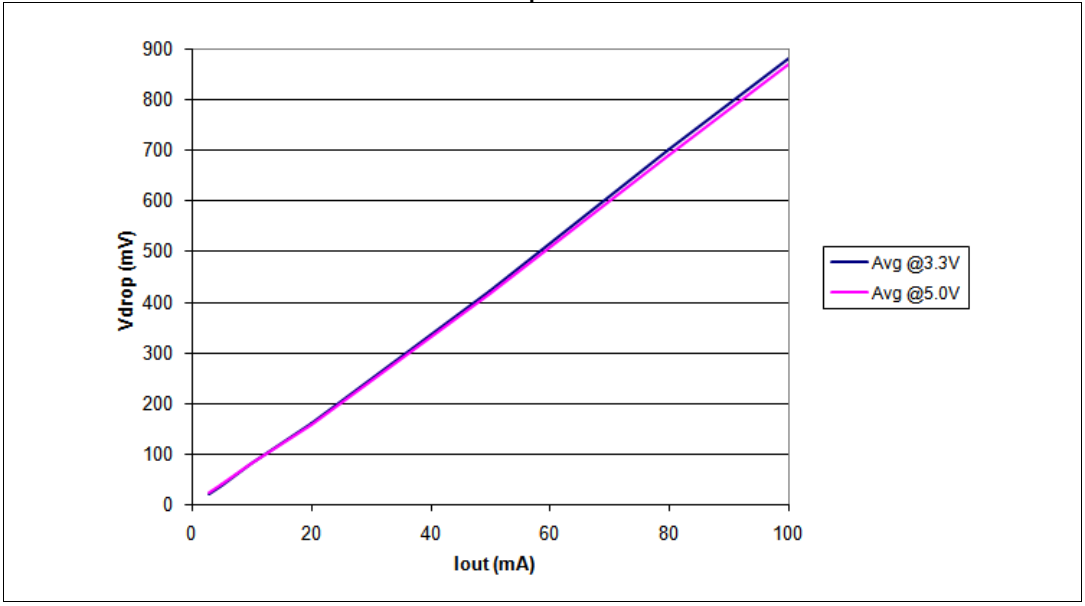
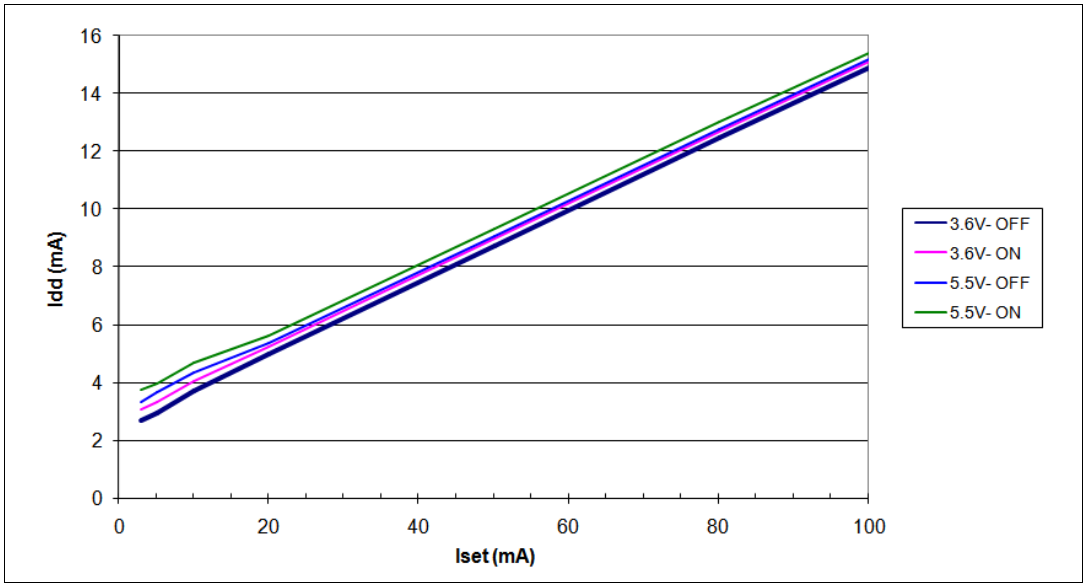



Table 11. $I_{SET}$ vs drop out voltage ($V_{drop}$)

| Iout (mA) | Avg @3.3 V | Avg @5.0 V |
|---|---|---|
| 3 | 20 | 22 |
| 5 | 37 | 40 |
| 10 | 79 | 79 |
| 20 | 160 | 158 |
| 50 | 422 | 415 |
| 80 | 700 | 690 |
| 100 | 880 | 870 |

**Figure 15. $I_{DD}$ ON/OFF, $T_A$ = 25 °C**



# 7 Test circuit

**Figure 16. DC characteristic**

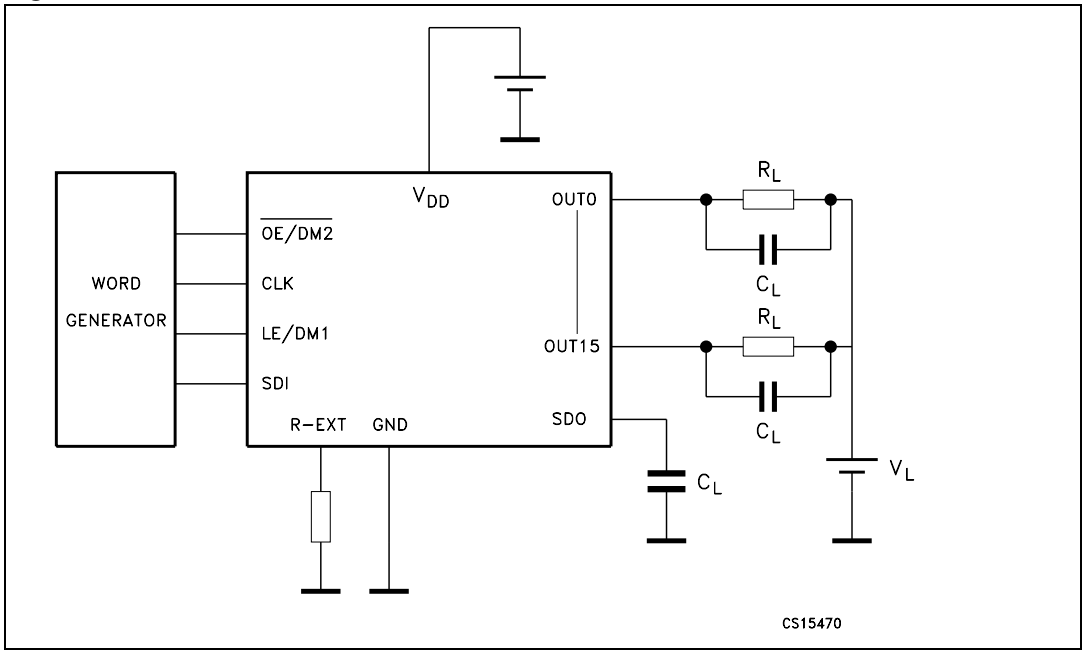



**Figure 17. AC characteristic**

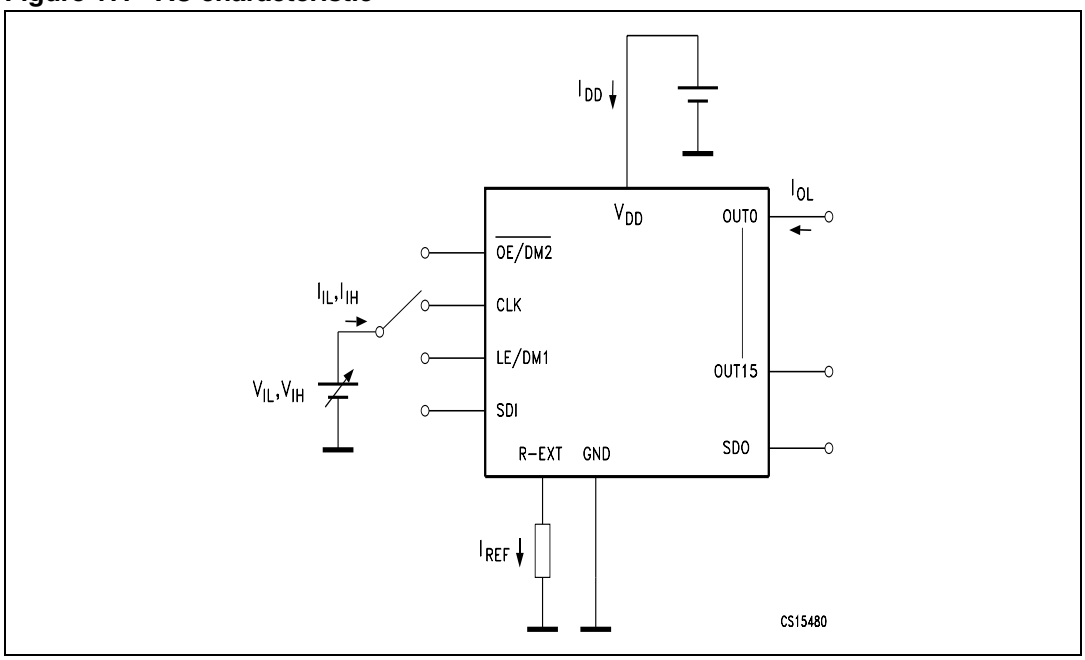
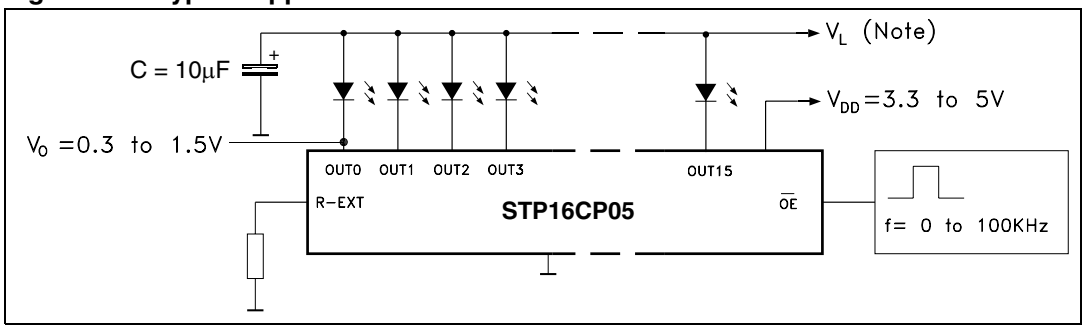


**Figure 18. Typical application schematic**




*Note: $V_L$ will be determined by the $V_F$ of the LEDs*

Test condition: Temp. = 25 °C, $V_{DD}$ = 3.0 V, $V_{IN}$ = $V_{DD}$, $C_L$ = 10 pF, Freq. = 1 MHz, Ch1 = $\overline{OE}$/DM2, Ch2 = SDI, Ch3 = $V_{OUT}$, Ch4 = $I_{OUT}$

**Figure 19. Turn ON output current setup**

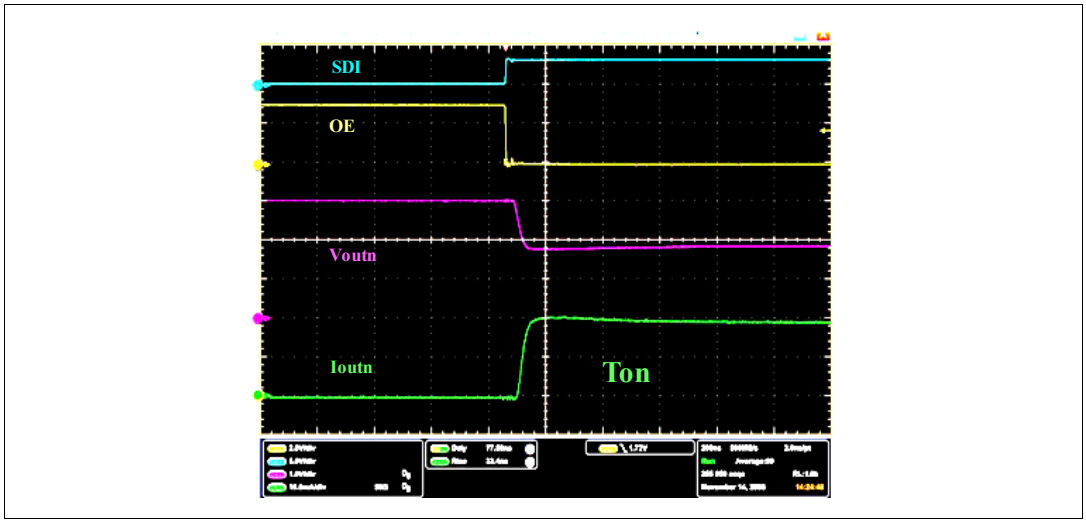
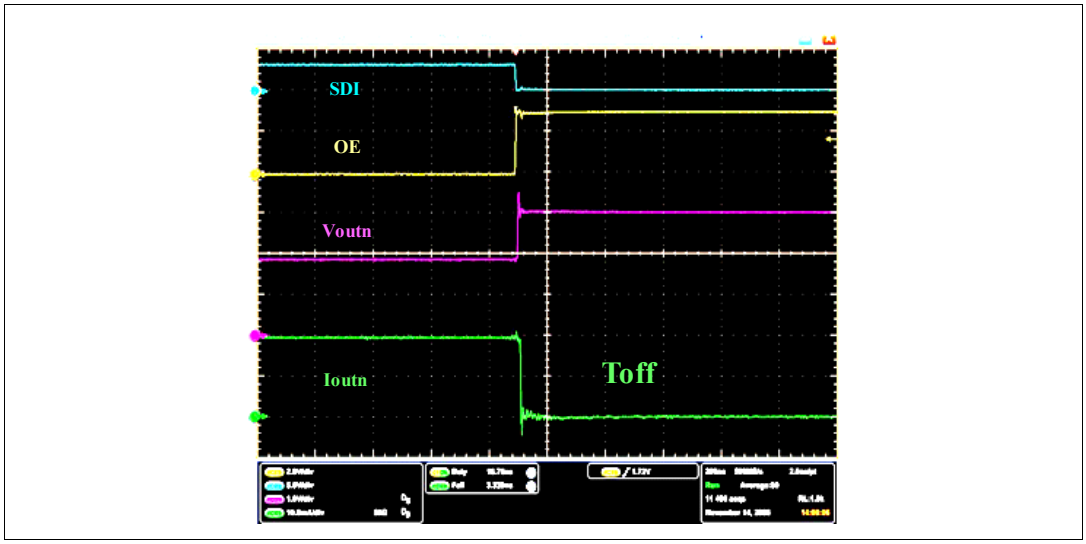



**Figure 20. Turn OFF output current setup**



# 8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

**Table 12. QSOP-24 mechanical data**

| Dim. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 1.54 | 1.62 | 1.73 | 0.061 | 0.064 | 0.068 |
| A1 | 0.1 | 0.15 | 0.25 | 0.004 | 0.006 | 0.010 |
| A2 | | 1.47 | | | 0.058 | |
| b | 0.31 | 0.2 | | 0.012 | 0.008 | |
| c | 0.254 | 0.17 | | 0.010 | 0.007 | |
| D | 8.56 | 8.66 | 8.76 | 0.337 | 0.341 | 0.345 |
| E | 5.8 | 6 | 6.2 | 0.228 | 0.236 | 0.244 |
| E1 | 3.8 | 3.91 | 4.01 | 0.150 | 0.154 | 0.158 |
| e | | 0.635 | | | 0.025 | |
| L | 0.4 | 0.635 | 0.89 | 0.016 | 0.025 | 0.035 |
| h | 0.25 | 0.33 | 0.41 | 0.010 | 0.013 | 0.016 |
| < | 8° | 0° | | | | |

**Figure 21. QSOP-24 package dimensions**

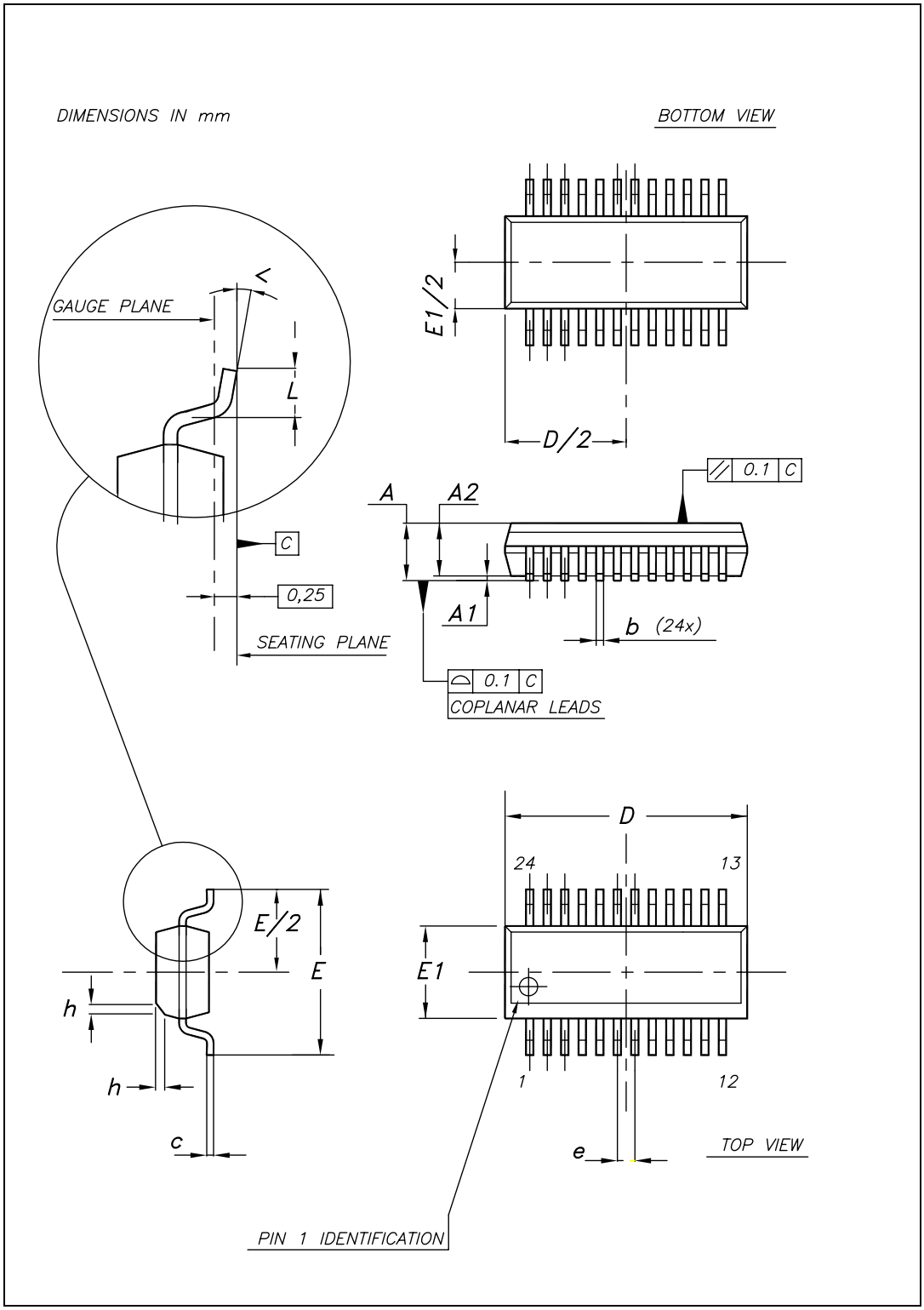


**Table 13. QSOP-24 tape and reel**

| Dim. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| R1 | 12.8 | 13 | 13.5 | 5.039 | 5.118 | 5.315 |
| R2 | | 330 | | | 129.921 | |
| R3 | | 100 | | | 39.37 | |
| eint | | 16.4 | | | 6.457 | |
| e1 | 1.5 | 2 | 2.5 | 0.591 | 0.787 | 0.984 |

**Table 14. QSOP-24 tape and reel dimensions**

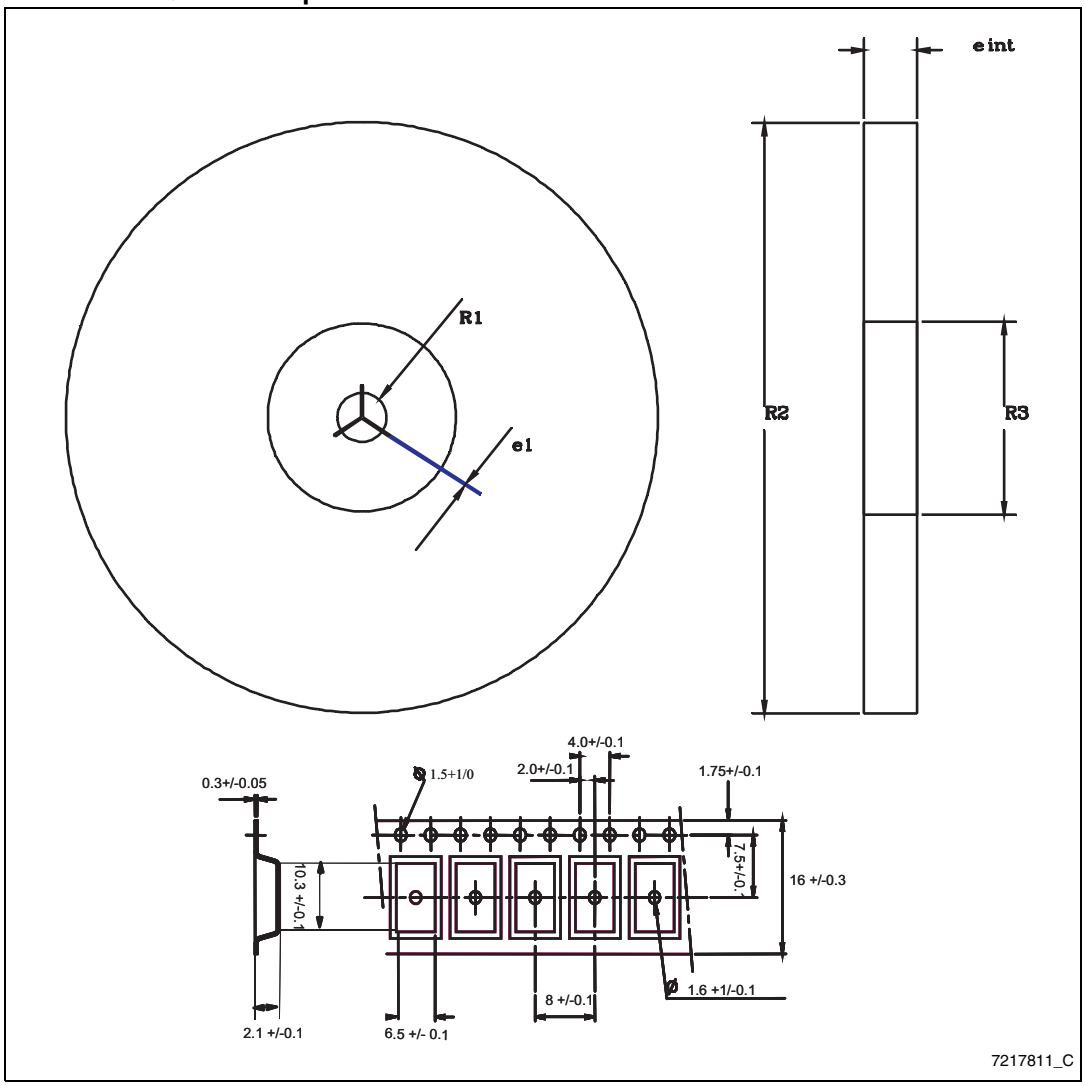


**Table 15. TSSOP24 mechanical data**

| Dim. | 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 22. TSSOP24 package dimensions**

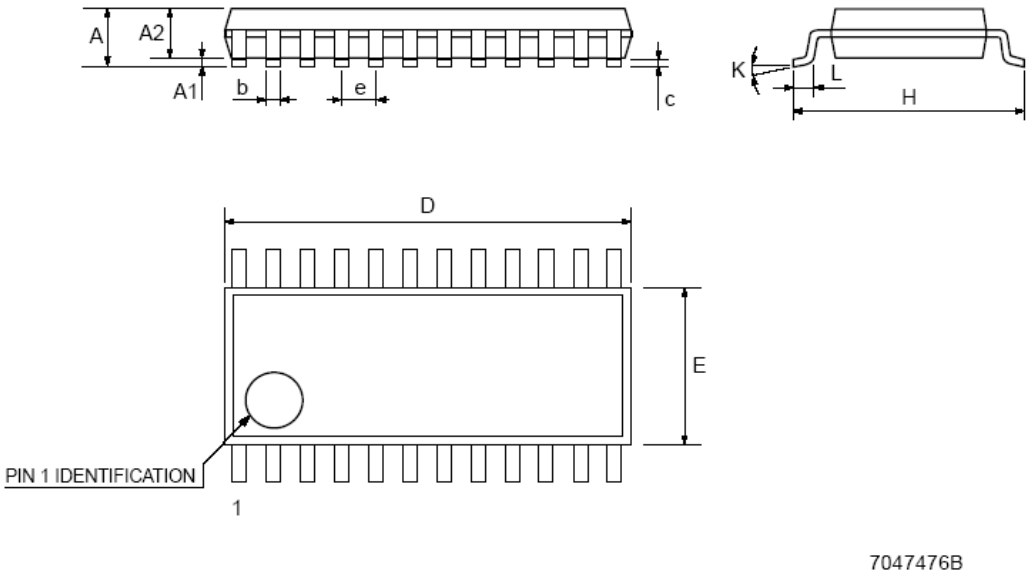


**Table 16. Tape and reel TSSOP24**

| Dim. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | - | 330 | | - | 12.992 |
| C | 12.8 | - | 13.2 | 0.504 | - | 0.519 |
| D | 20.2 | - | | 0.795 | - | |
| N | 60 | - | | 2.362 | - | |
| T | | - | 22.4 | | - | 0.882 |
| Ao | 6.8 | - | 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 23. TSSOP24 reel dimensions**

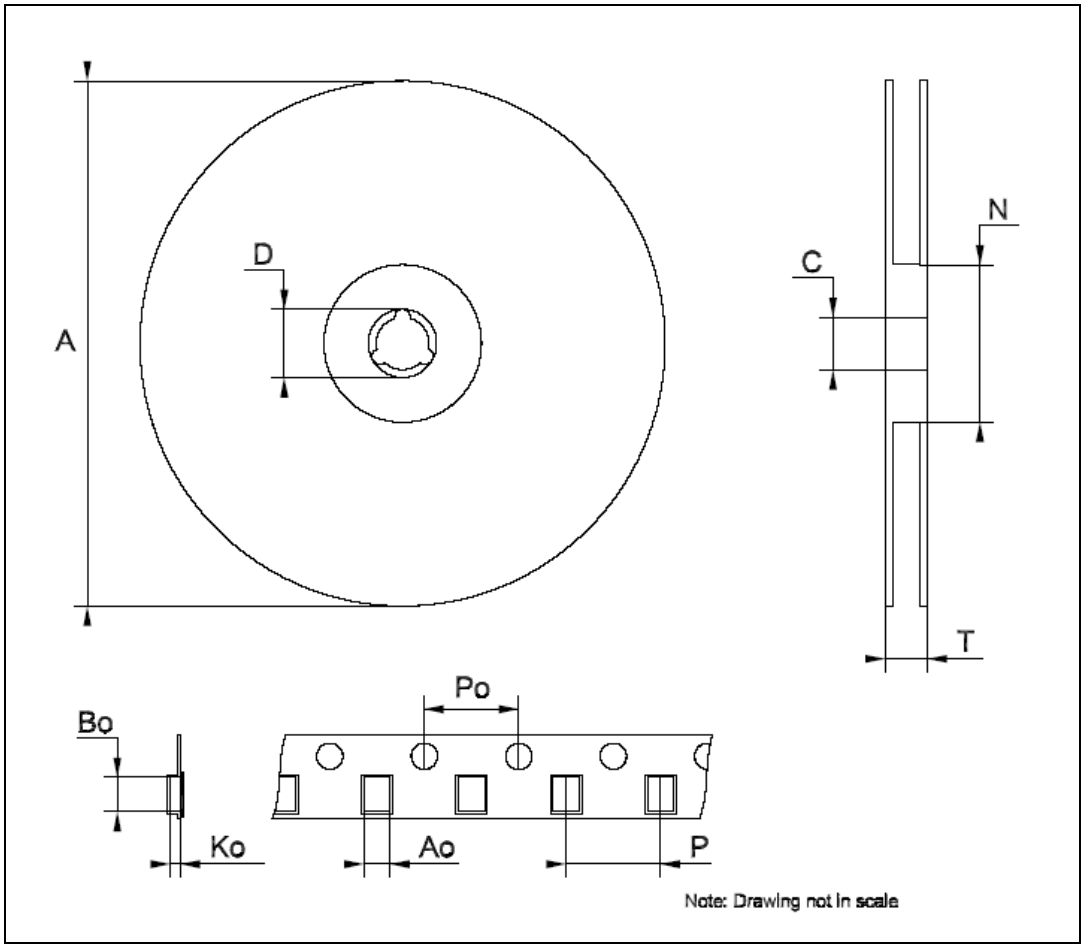


**Table 17. SO-24 mechanical data**

| Dim. | 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 24. SO-24 package dimensions**

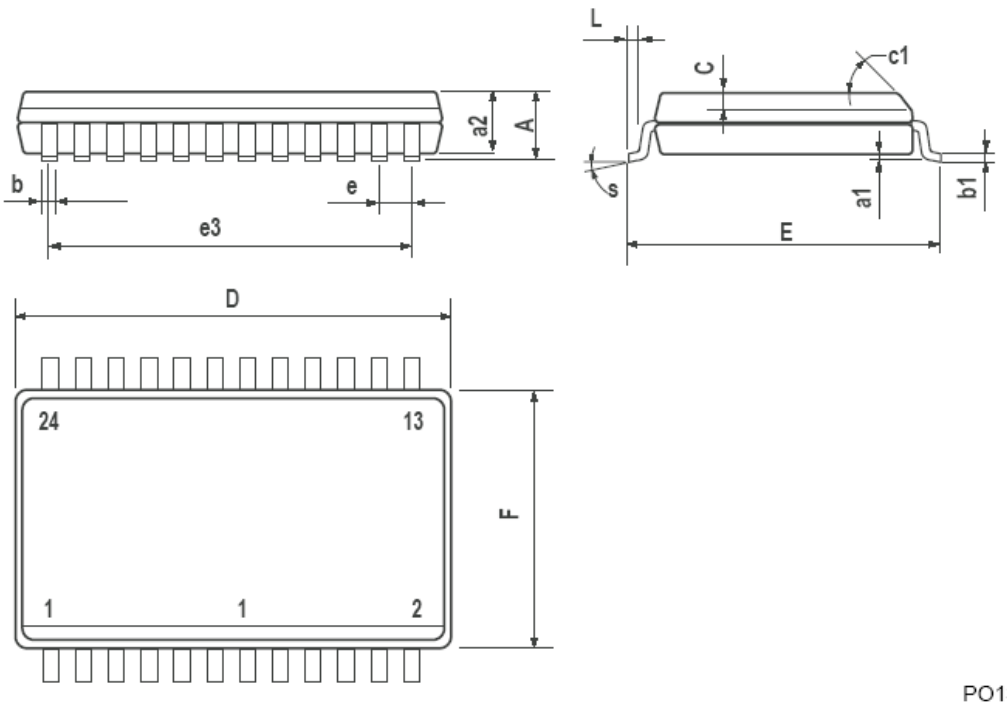


**Table 18. Tape and reel SO-24**

| Dim. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | - | 330 | | - | 12.992 |
| C | 12.8 | - | 13.2 | 0.504 | - | 0.519 |
| D | 20.2 | - | | 0.795 | - | |
| N | 60 | - | | 2.362 | - | |
| T | | - | 30.4 | | - | 1.197 |
| Ao | 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 25. Reel dimensions SO-24**

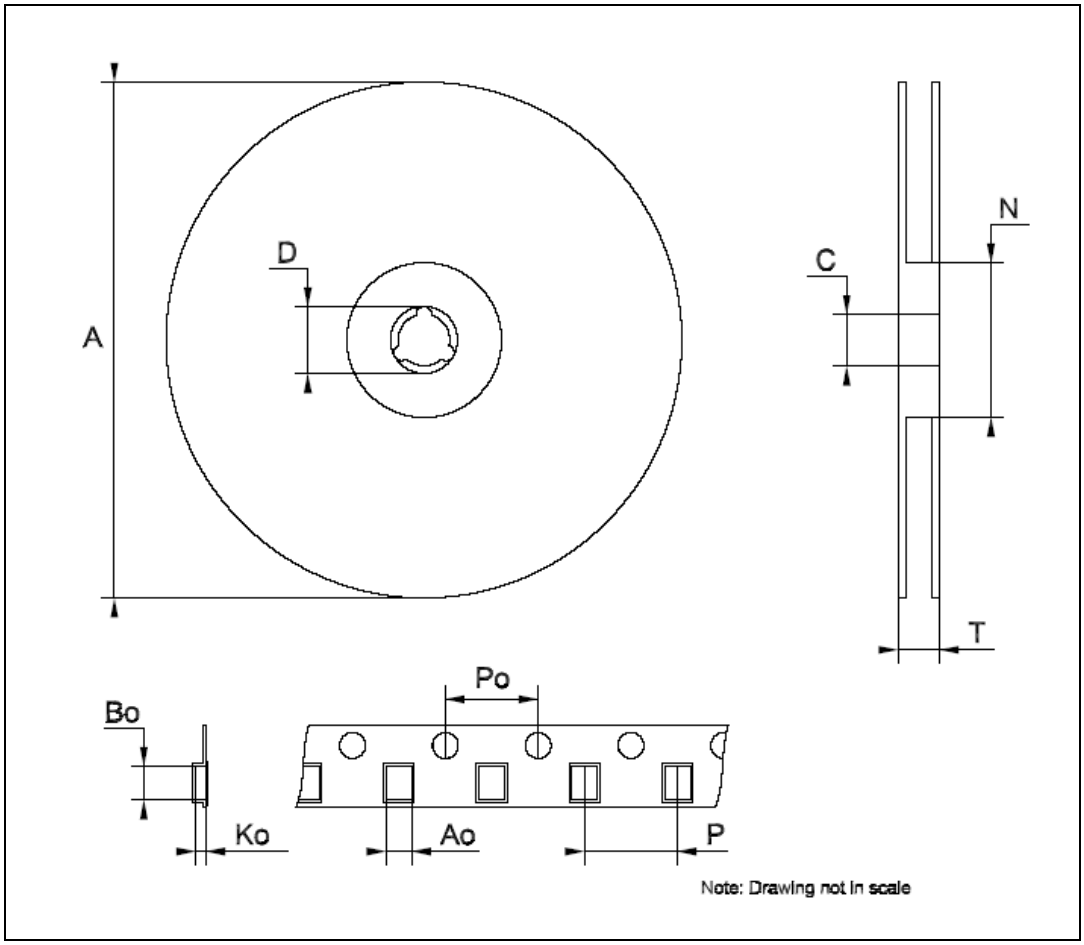
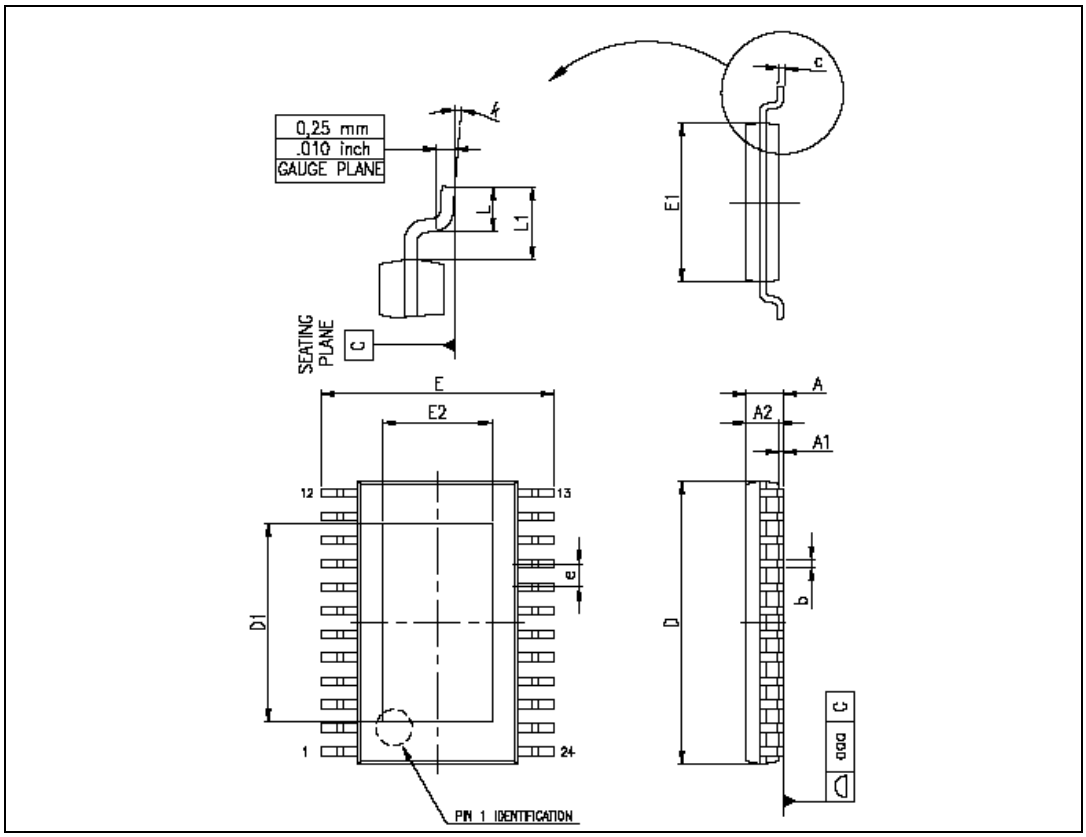


**Table 19. TSSOP24 exposed-pad**

| Dim. | 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 | 4.7 | 5.0 | 5.3 | 0.185 | 0.197 | 0.209 |
| 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 | 2.9 | 3.2 | 3.5 | 0.114 | 0.126 | 0.138 |
| e | | 0.65 | | | 0.0256 | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |

**Figure 26. TSSOP24 dimensions**



# 9 Revision history

**Table 20. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 28-Jul-2006 | 1 | First release |
| 21-Dec-2006 | 2 | Final datasheet |
| 17-May-2007 | 3 | Updated *Table 7 on page 6* |
| 10-Jul-2007 | 4 | Updated *Table 9: Truth table on page 10* |
| 12-Mar-2008 | 5 | Updated *Table 15: TSSOP24 exposed-pad on page 23*, added QSOP-24*Table 12* and *Figure 21 on page 19* |
| 07-May-2008 | 6 | Updated *Section 5 on page 10* |
| 03-Dec-2008 | 7 | Updated cover page, *Table 6 on page 5*, *Table 7 on page 6*, *Table 8 on page 7*, *Figure 12 on page 13*, *Table 10 on page 13*, *Figure 13*, *14*, and *Figure 15 on page 15* |
| 12-May-2009 | 8 | Updated cover page, *Table 6 on page 5*, *Table 7 on page 6*, *Table 8 on page 7* |
| 22-Oct-2009 | 9 | Updated *Note: on page 3* |
| 20-Jan-2010 | 10 | Updated *Table 5 on page 4* |

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