



## STP04CM596

### 4-Bit constant current for power-LED LED sink driver

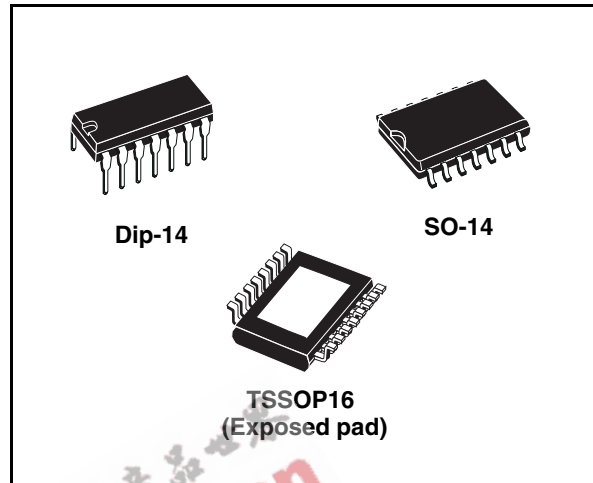
#### General features

- 4 constant current output channels
- Adjustable output current through one external resistor
- Serial data IN/parallel data OUT
- Serial OUT change state on the falling edges of clock
- Four outputs current: 80-500mA
- 25MHz clock frequency
- Available in high thermal TSSOP exposed pad.

#### Description

The STP04CM596 is a high-power LED Driver and 4-bit shift register designed for PowerLED applications.

The STP04CM596 contains a 4-bit serial IN, parallel OUT shift register that feeds a 4-bit D-type storage register. In the output stage, four regulated current sources were designed to provide 80-500mA constant current to drive the high powered LEDs.



The STP04CM596 guarantees 16V output driving capability, allowing users to connect more LEDs in series. The high clock frequency, 25 MHz, also satisfies the system requirements which include high volume data transmission.

The STP04CM596 is well suited for very high brightness displays and special lighting applications.

The STP04CM596 is offered in DIP-14, SO-14 and TSSOP16 Exposed Pad packages.

#### Order codes

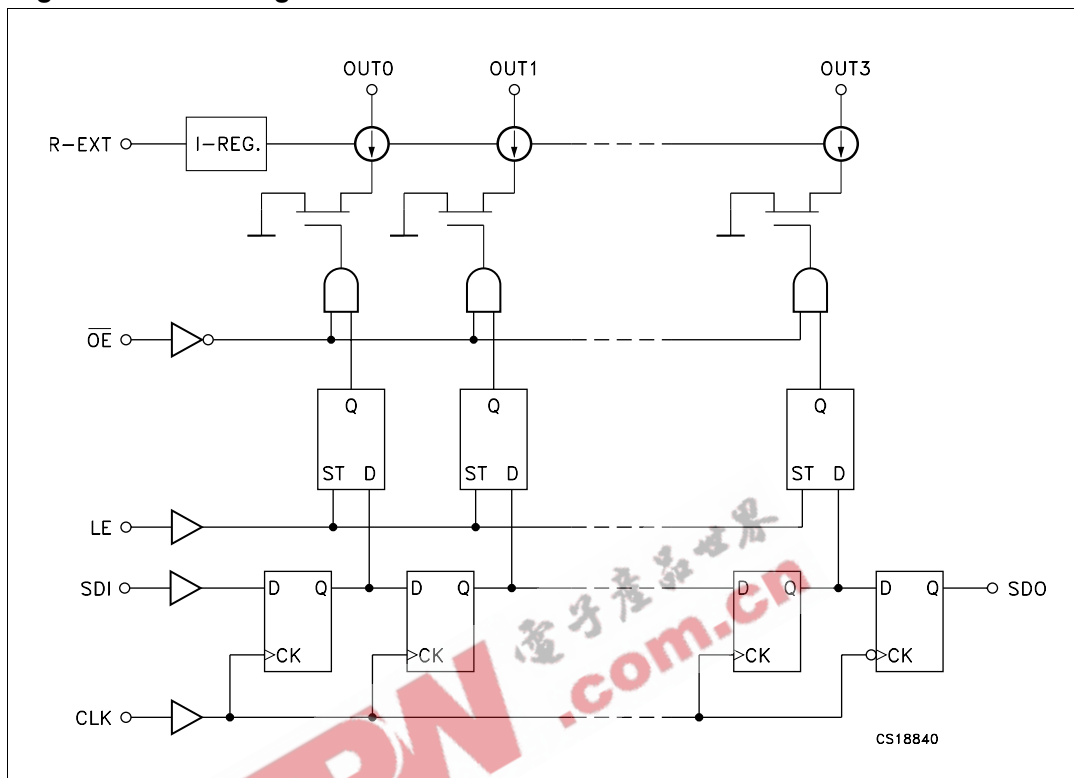
| Part Number    | Package                           | Packaging           |
|----------------|-----------------------------------|---------------------|
| STP04CM596B1R  | DIP-14                            | 25 parts per tube   |
| STP04CM596M    | SO-14 (Tube)                      | 50 parts per tube   |
| STP04CM596MTR  | SO-14 (Tape & Reel)               | 2500 parts per reel |
| STP04CM596XTTR | TSSOP16 Exposed-pad (Tape & Reel) | 2500 parts per reel |

# Contents

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# 1 Internal schematic

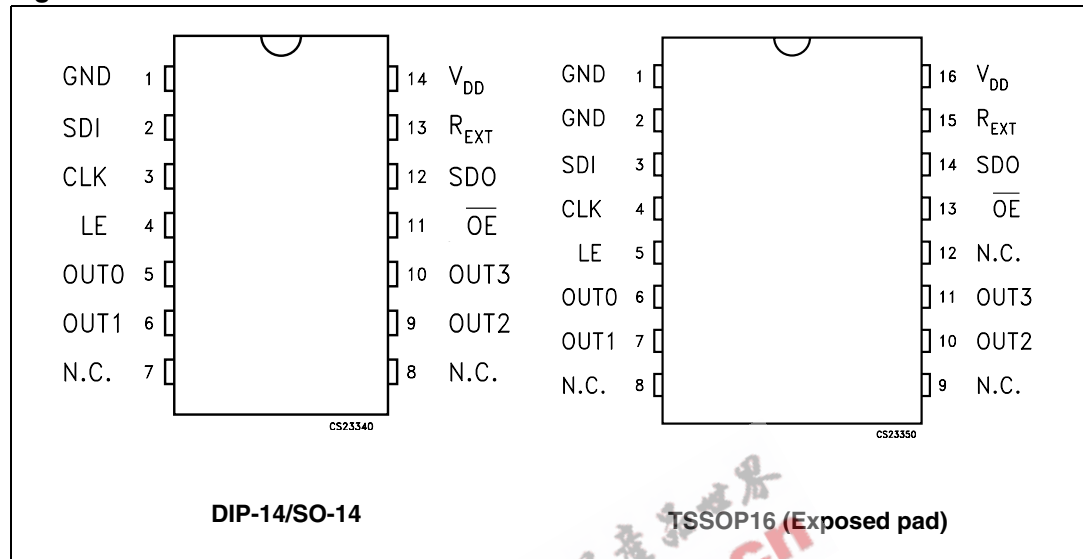
Figure 1. Block diagram



## 2 Pin settings

### 2.1 Pin connection

Figure 2. Pin connection



### 2.2 Pin description

Table 1. Pin description

| DIP-14 and SO-14 Pin N° | TSSOP16 Pin N° | Symbol          | Name and function                         |
|-------------------------|----------------|-----------------|-------------------------------------------|
| 1                       | 1, 2           | GND             | Ground terminal                           |
| 2                       | 3              | SDI             | Serial data input terminal                |
| 3                       | 4              | CLK             | Clock input terminal                      |
| 4                       | 5              | LE              | Latch input terminal                      |
| 5                       | 6              | OUT 0           | Output terminal                           |
| 6                       | 7              | OUT 1           | Output terminal                           |
| 7, 8                    | 8, 9, 12       | N.C.            | Not connected                             |
| 9                       | 10             | OUT 2           | Output terminal                           |
| 10                      | 11             | OUT 3           | Output terminal                           |
| 11                      | 13             | $\overline{OE}$ | Output enable input terminal (active low) |
| 12                      | 14             | SDO             | Serial data out terminal                  |
| 13                      | 15             | R-EXT           | Constant current programming              |
| 14                      | 16             | $V_{DD}$        | 5V supply voltage terminal                |

### 3 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 2. 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              | 500                  | mA   |
| $V_I$     | Input voltage               | -0.4 to $V_{DD}+0.4$ | V    |
| $I_{GND}$ | GND terminal current        | 2000                 | mA   |
| $f_{CLK}$ | Clock frequency             | 25                   | MHz  |
| $T_{OPR}$ | Operating temperature range | -40 to +125          | °C   |
| $T_{STG}$ | Storage temperature range   | -55 to +150          | °C   |

#### 3.1 Thermal data

**Table 3. Thermal data**

| Symbol     | Parameter                           | DIP-14            | SO-14              | TSSOP16             | Unit |
|------------|-------------------------------------|-------------------|--------------------|---------------------|------|
| $R_{thJA}$ | Thermal resistance junction-ambient | 70 <sup>(1)</sup> | 105 <sup>(2)</sup> | 37.5 <sup>(3)</sup> | °C/W |

- 1W of dissipated power, mounted on the board
- 1W of dissipated power, mounted on SM PCB1 SGS board
- Using the PCB Multi-Layer JEDEC Standard Test Boards

## 3.2 Recommended operating conditions

Table 4. Recommended operating conditions

| Symbol         | Parameter                   | Test conditions                  | Min         | Typ | Max          | Unit |
|----------------|-----------------------------|----------------------------------|-------------|-----|--------------|------|
| $V_{DD}$       | Supply voltage              |                                  | 3.3         | 5.0 | 5.5          | V    |
| $V_O$          | Output voltage              |                                  |             |     | 16.0         | V    |
| $I_O$          | Output current              | OUTn $V_{DD} = 5V$               | 80          |     | 500          | 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              | $V_{DD} = 3.0$ to $3.6V$         | 20          | 6.5 |              | ns   |
| $t_{wCLK}$     | CLK pulse width             |                                  | 20          | 7.0 |              | ns   |
| $t_{wEN}$      | $\overline{OE}$ pulse width |                                  | 400         | 100 |              | ns   |
| $t_{SETUP(D)}$ | Setup time for DATA         |                                  | 20          | 3.3 |              | ns   |
| $t_{HOLD(D)}$  | Hold time for DATA          |                                  | 15          | 1.5 |              | ns   |
| $t_{SETUP(L)}$ | Setup time for LATCH        |                                  | 15          | 5   |              | ns   |
| $t_{HOLD(E)}$  | Hold time for ENABLE        |                                  | 60          | 38  |              | ns   |
| $f_{CLK}$      | Clock frequency             | Cascade operation <sup>(1)</sup> |             |     | 25           | MHz  |
| $T_{OPR}$      | Operating temperature range |                                  | -40         |     | +125         | °C   |

1. If multiple devices are cascaded, it may not be possible achieve the maximum data transfer. Please consider the timing conditions carefully.

## 4 Electrical characteristics

**Table 5. Current accuracy**

| Output voltage | Current accuracy |             | Output current |
|----------------|------------------|-------------|----------------|
|                | Between bits     | Between ICs |                |
| $\geq 0.7V$    | Typ. $\pm 1\%$   | $\pm 6\%$   | 80 to 500 mA   |

**Table 6. Electrical characteristics** ( $V_{DD} = 5V$ ,  $T_A = 25^\circ C$ , 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          | $\mu A$   |
| $V_{OL}$         | 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                                   | $V_O = 0.7V R_{EXT} = 910\Omega$          | 77              | 82  | 87          | mA        |
| $I_{OL2}$        |                                                  | $V_O = 0.7V R_{EXT} = 160\Omega$          | 470             | 500 | 530         | mA        |
| $\Delta I_{OL1}$ | Output current error between bit (All Output ON) | $V_O = 0.7V R_{EXT} = 910\Omega$          |                 | 1   | $\pm 3$     | %         |
| $\Delta I_{OL2}$ |                                                  | $V_O = 0.7V R_{EXT} = 160\Omega$          |                 | 0.5 | $\pm 3$     | %         |
| $R_{SIN(up)}$    | 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)                             | $R_{EXT} = OPEN$<br>OUT 0 to 3 = OFF      |                 | 0.3 | 0.6         | mA        |
| $I_{DD(OFF2)}$   |                                                  | $R_{EXT} = 470\Omega$<br>OUT 0 to 3 = OFF |                 | 5.2 | 8.0         |           |
| $I_{DD(OFF3)}$   |                                                  | $R_{EXT} = 250\Omega$<br>OUT 0 to 3 = OFF |                 | 8.0 | 12          |           |
| $I_{DD(ON1)}$    | Supply current (ON)                              | $R_{EXT} = 470\Omega$<br>OUT 0 to 3 = ON  |                 | 5.6 | 8.0         |           |
| $I_{DD(ON2)}$    |                                                  | $R_{EXT} = 250\Omega$<br>OUT 0 to 3 = ON  |                 | 8.3 | 12          |           |

**Table 7. 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,<br>CLK- $\overline{OUTn}$ , LE = H, $\overline{OE} = L$ | $V_{DD} = 5V$ $V_{IH} = V_{DD}$<br>$V_{IL} = GND$ $C_L = 13pF$<br>$I_O = 40mA$ $V_L = 3V$<br>$R_{EXT} = 470\Omega$ $R_L = 65\Omega$ |     | 100 | 160 | ns   |
| $t_{PLH2}$ | Propagation delay time,<br>LE- $\overline{OUTn}$ , $\overline{OE} = L$          |                                                                                                                                     |     | 100 | 150 | ns   |
| $t_{PLH3}$ | Propagation delay time,<br>$\overline{OE}$ - $\overline{OUTn}$ , LE = H         |                                                                                                                                     |     | 90  | 140 | ns   |
| $t_{PLH}$  | Propagation delay time,<br>CLK-SDO                                              |                                                                                                                                     |     | 30  | 40  | ns   |
| $t_{PHL1}$ | Propagation delay time,<br>CLK- $\overline{OUTn}$ , LE = H, $\overline{OE} = L$ |                                                                                                                                     |     | 40  | 60  | ns   |
| $t_{PHL2}$ | Propagation delay time,<br>LE- $\overline{OUTn}$ , $\overline{OE} = L$          |                                                                                                                                     |     | 35  | 50  | ns   |
| $t_{PHL3}$ | Propagation delay time,<br>$\overline{OE}$ - $\overline{OUTn}$ , LE = H         |                                                                                                                                     |     | 40  | 70  | ns   |
| $t_{PHL}$  | Propagation delay time,<br>CLK-SDO                                              |                                                                                                                                     |     | 30  | 40  | ns   |
| $t_r$      | Output rise time <sup>(1)</sup>                                                 | $V_O = 1.6V$ , $R_L = 1\Omega$                                                                                                      |     | 300 | 400 | ns   |
| $t_f$      | Output fall time <sup>(1)</sup>                                                 | $R_{EXT} = 470\Omega$                                                                                                               |     | 55  | 80  | ns   |

1. If multiple devices are cascaded, it may not be possible to achieve the maximum data transfer. Please consider the timing conditions carefully.

## 5 Equivalent circuit of inputs and outputs

Figure 3.  $\overline{OE}$  terminal

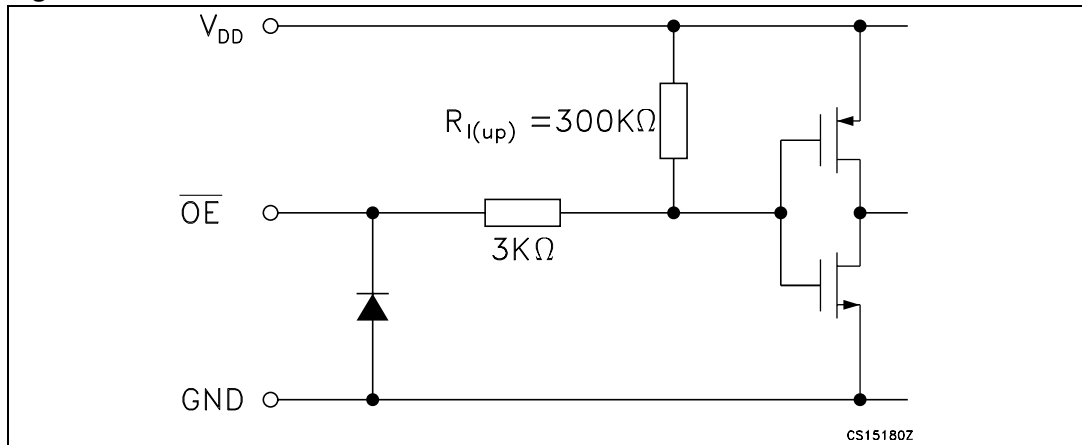


Figure 4. LE terminal

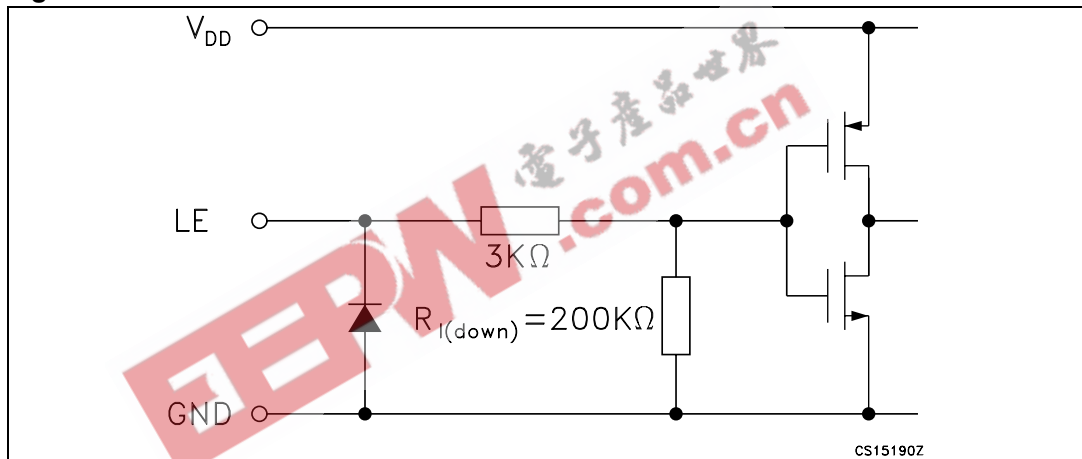


Figure 5. CLK, SDI terminal

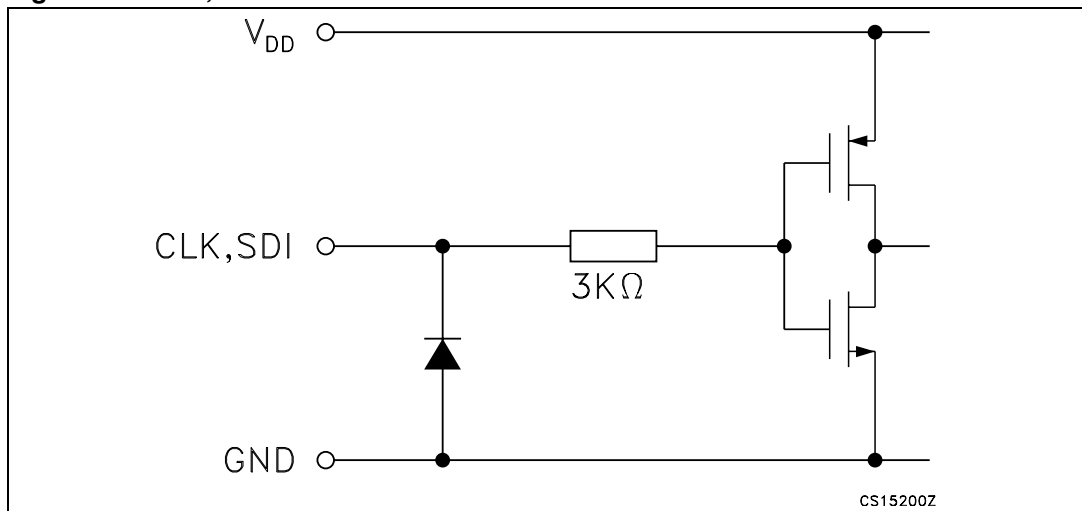
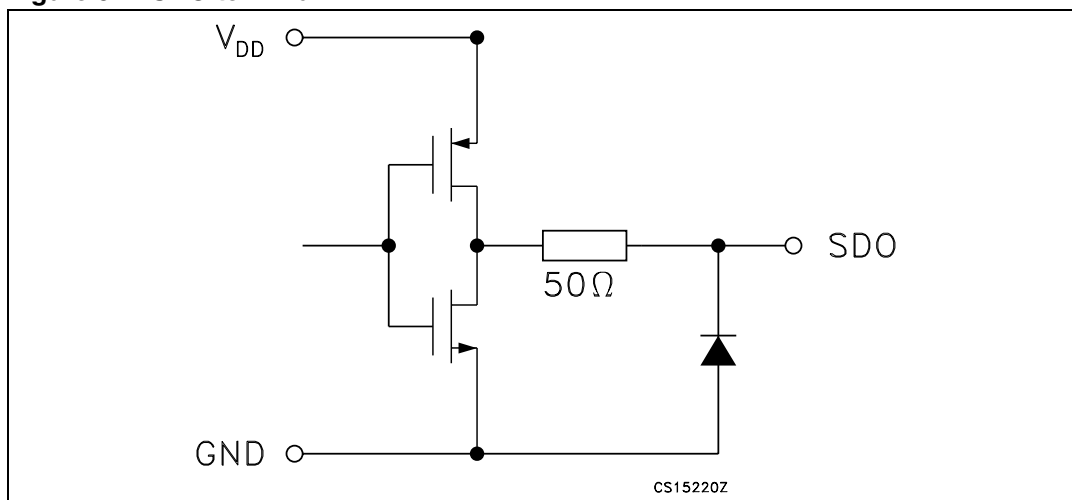


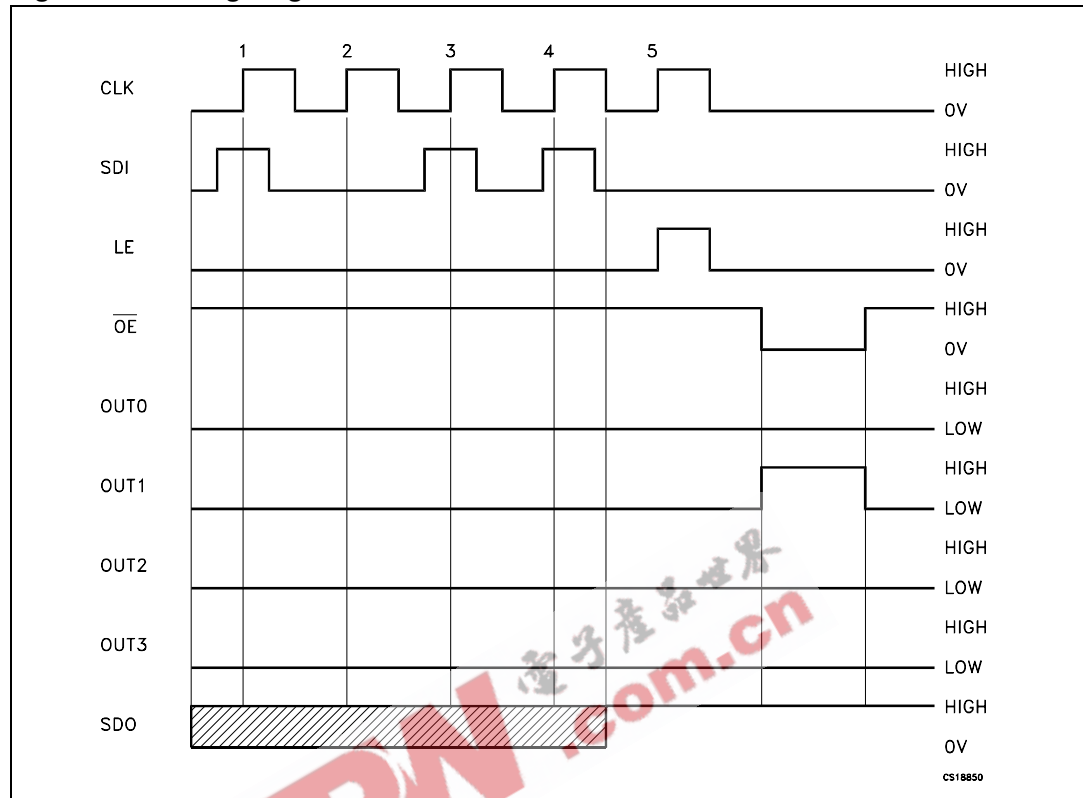
Figure 6. SDO terminal



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## 6 Timing diagrams

Figure 7. Timing diagram



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

- 1 When the LE terminal is at a High level, the latch circuit holds the data it passes from the input to the output.
- 2 When the  $\overline{OE}$  terminal is at a Low level, the output terminals OUT0 to OUT3 respond to the data, either ON or OFF.
- 3 When the  $\overline{OE}$  terminal is at a High level, it switches off all the data on the output terminal.

Figure 8. Clock, serial-IN, serial-OUT

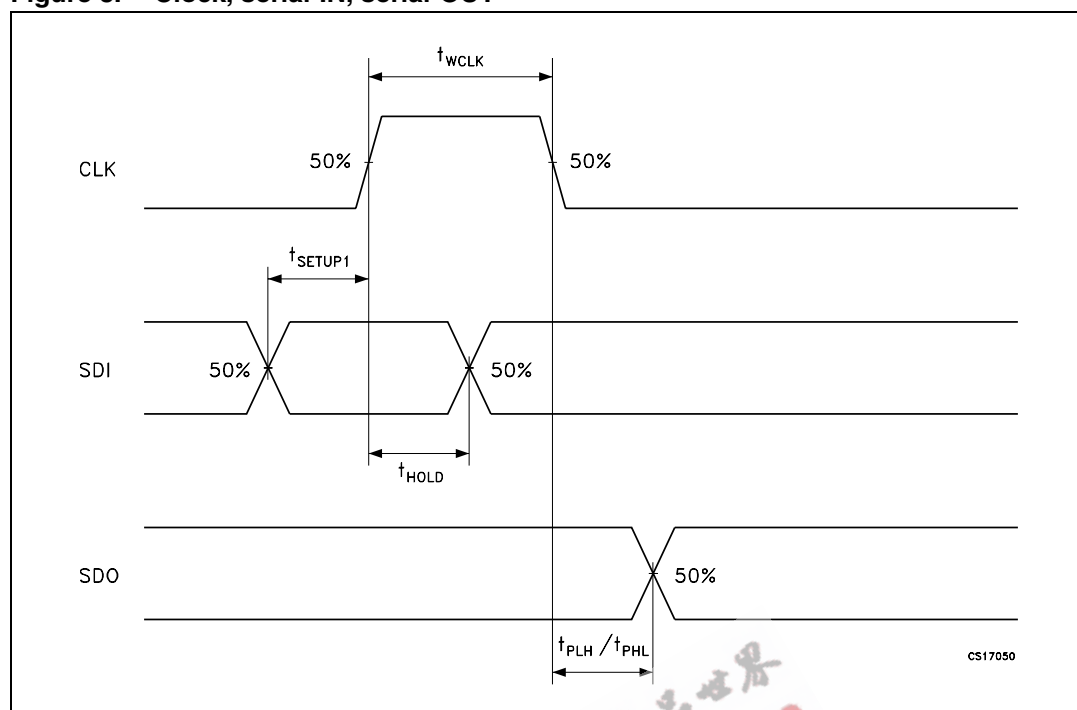


Figure 9. Clock, serial-IN, latch, enable, outputs

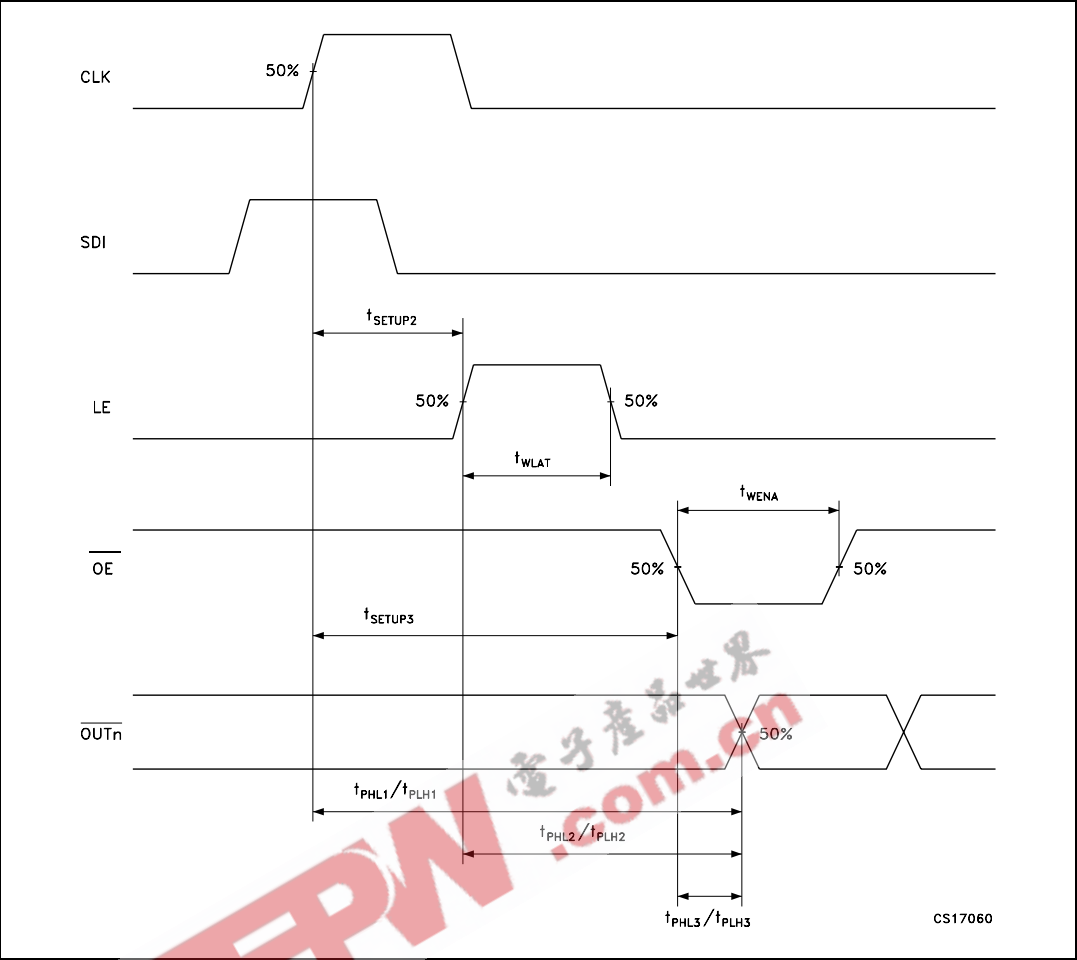
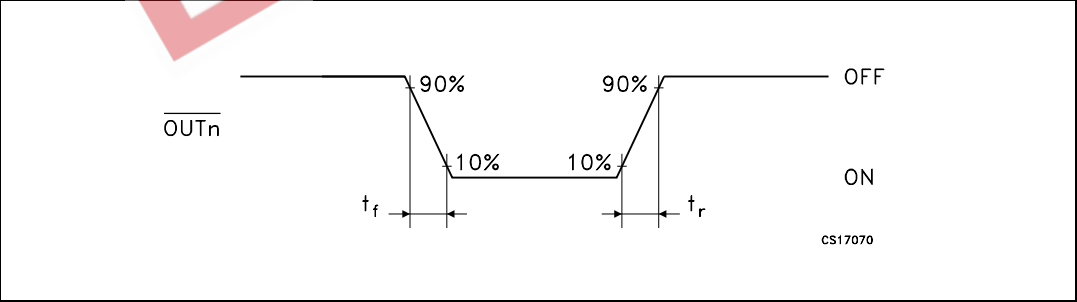


Figure 10. Outputs



## 7 Test circuit

Figure 11. DC characteristic

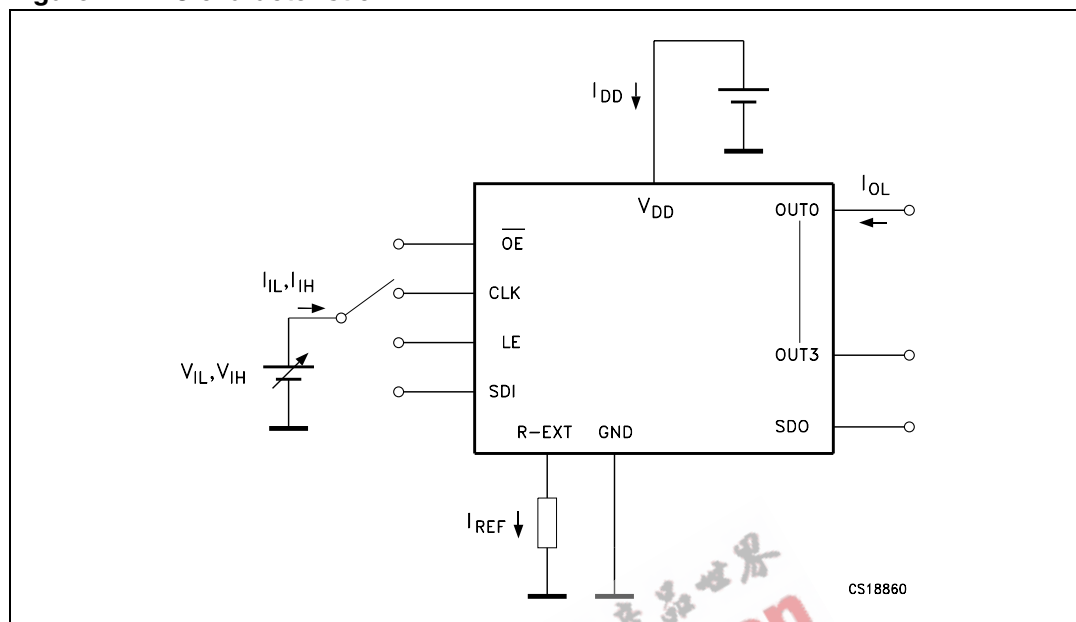
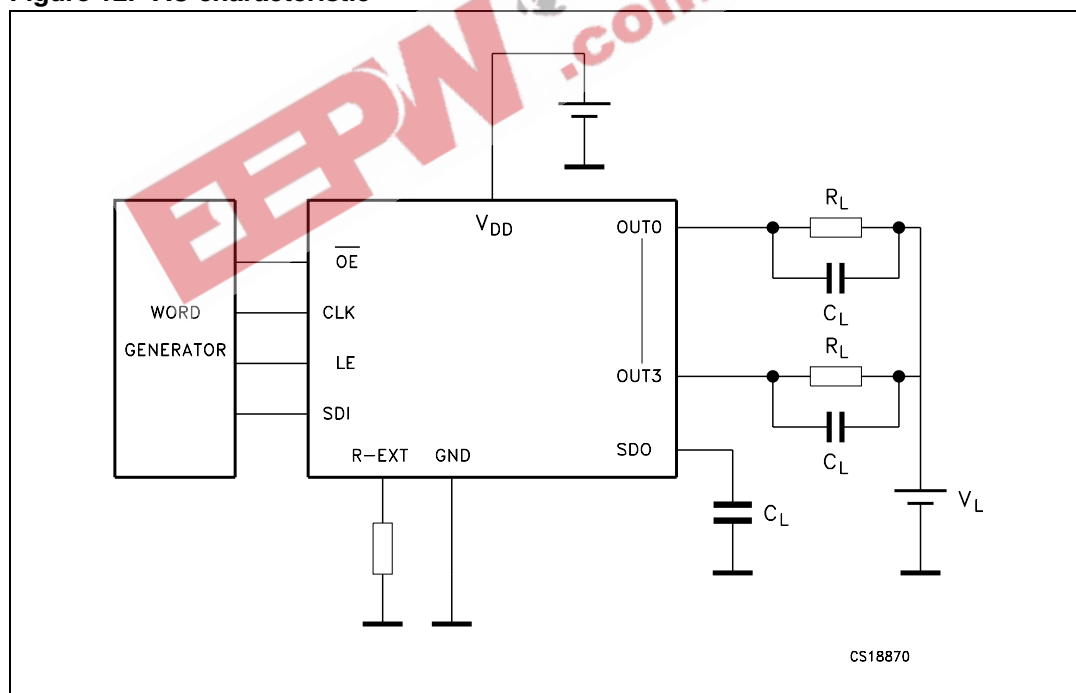


Figure 12. AC characteristic



8 Typical characteristics

Figure 13. Output current- $R_{EXT}$  resistor

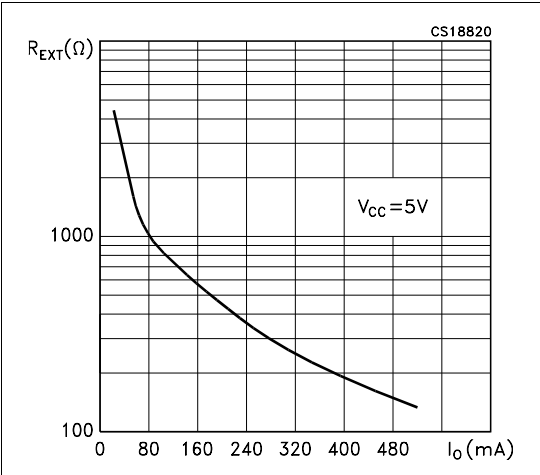


Figure 14. Output current vs dropout voltage

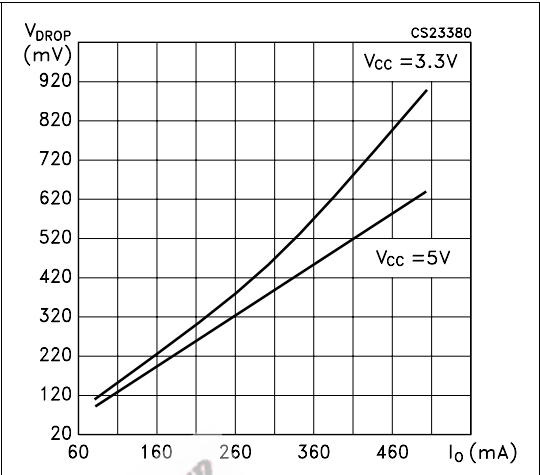


Figure 15. Output current vs  $\pm\Delta I_{OL}$ (%)

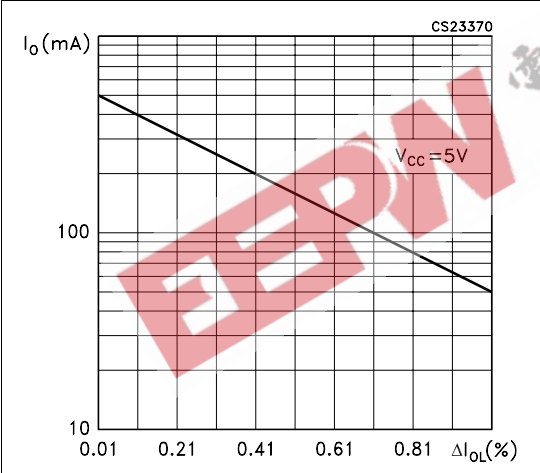
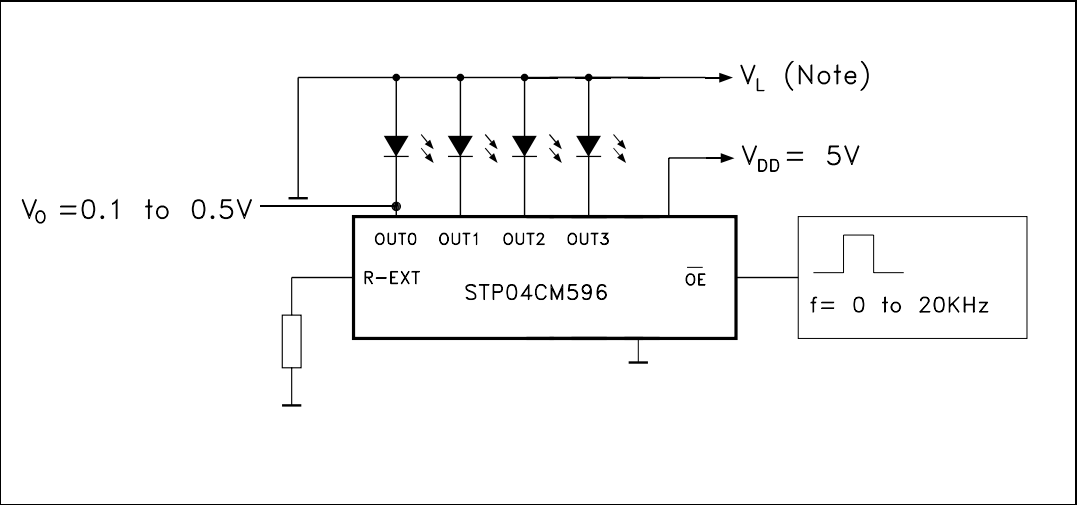
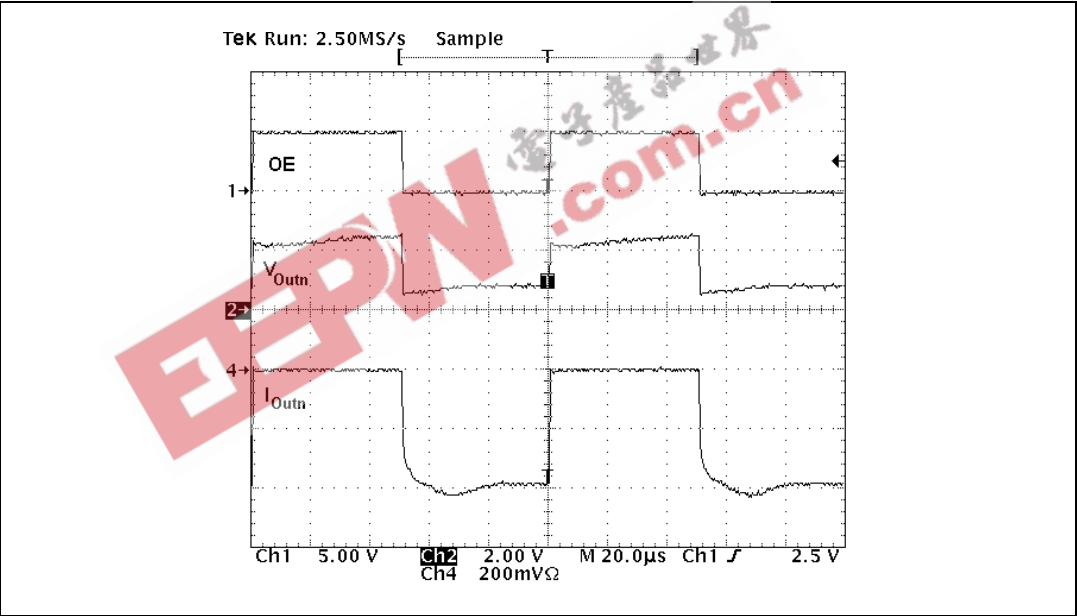


Figure 16. Blue powerLED typ. application circuit



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

Table 8. Typ. output waveform with blue powerLEDs



## 9 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](http://www.st.com)

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Table 9. DIP-14 mechanical data

| Dim. | mm.  |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | Min  | Typ   | Max  | Min   | Typ   | Max   |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 1.39 |       | 1.65 | 0.055 |       | 0.065 |
| b    |      | 0.5   |      |       | 0.020 |       |
| b1   |      | 0.25  |      |       | 0.010 |       |
| D    |      |       | 20   |       |       | 0.787 |
| E    |      | 8.5   |      |       | 0.335 |       |
| e    |      | 2.54  |      |       | 0.100 |       |
| e3   |      | 15.24 |      |       | 0.600 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    | 1.27 |       | 2.54 | 0.050 |       | 0.100 |

Figure 17. Package dimensions

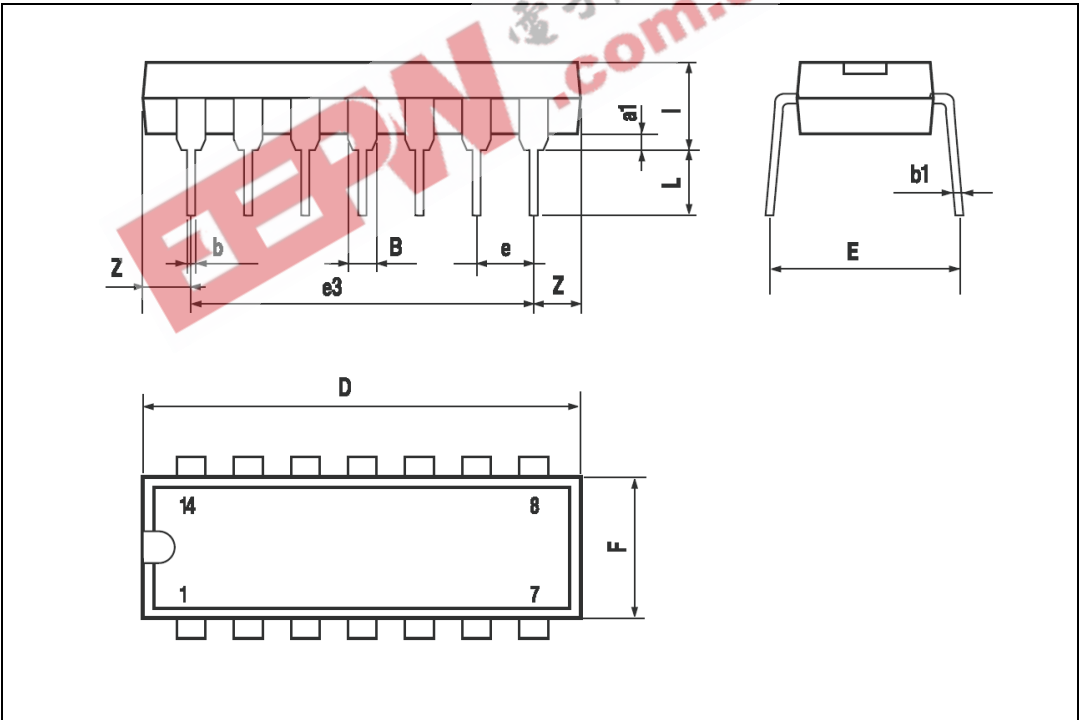


Table 10. SO-14 mechanical data

| Dim. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | Min        | Typ  | Max  | Min   | Typ   | Max   |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
| a2   |            |      | 1.65 |       |       | 0.064 |
| b    | 0.35       |      | 0.46 | 0.013 |       | 0.018 |
| b1   | 0.19       |      | 0.25 | 0.007 |       | 0.010 |
| C    |            | 0.5  |      |       | 0.019 |       |
| c1   | 45° (typ.) |      |      |       |       |       |
| D    | 8.55       |      | 8.75 | 0.336 |       | 0.344 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 7.62 |      |       | 0.300 |       |
| F    | 3.8        |      | 4.0  | 0.149 |       | 0.157 |
| G    | 4.6        |      | 5.3  | 0.181 |       | 0.208 |
| L    | 0.5        |      | 1.27 | 0.019 |       | 0.050 |
| M    |            |      | 0.68 |       |       | 0.026 |
| S    | 8° (max.)  |      |      |       |       |       |

Figure 18. Package dimensions

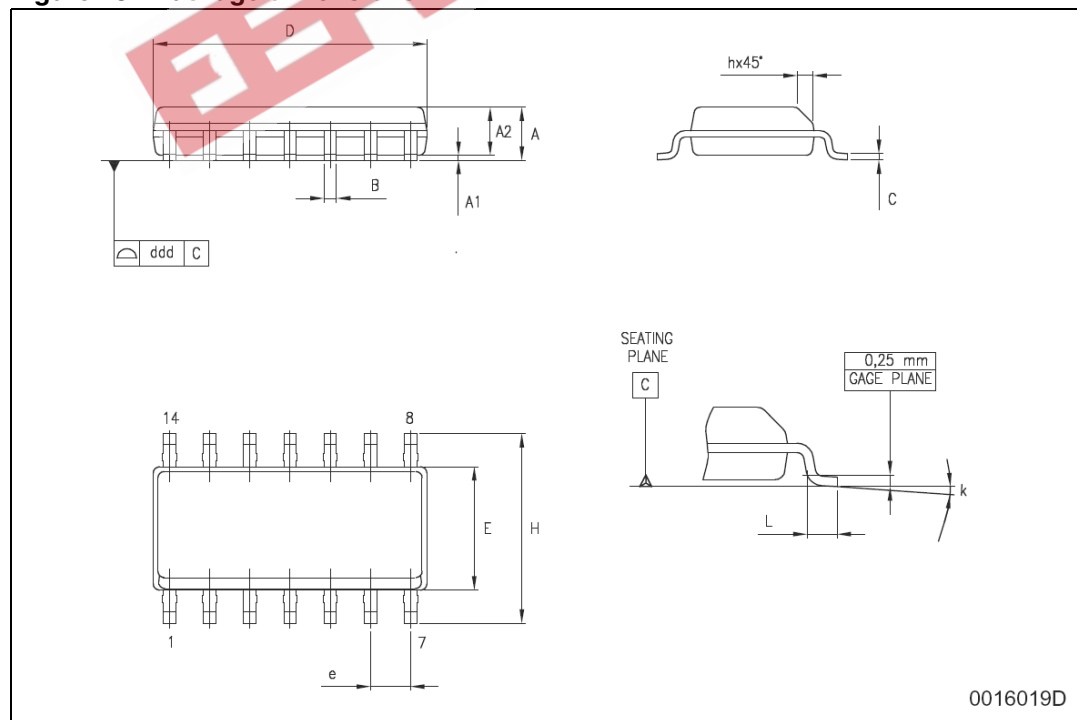


Table 11. TSSOP16 (Exposed pad) mechanical data

| Dim. | mm.  |          |      | inch  |            |        |
|------|------|----------|------|-------|------------|--------|
|      | Min  | Typ      | Max  | Min   | Typ        | Max    |
| A1   | 0.05 |          | 0.15 | 0.002 | 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 |            | 0.0079 |
| D    | 4.9  | 5        | 5.1  | 0.193 | 0.197      | 0.201  |
| E    | 6.2  | 6.4      | 6.6  | 0.244 | 0.252      | 0.260  |
| E1   | 4.3  | 4.4      | 4.48 | 0.169 | 0.173      | 0.176  |
| e    |      | 0.65 BSC |      |       | 0.0256 BSC |        |
| K    | 0°   |          | 8°   | 0°    |            | 8°     |
| L    | 0.45 | 0.60     | 0.75 | 0.018 | 0.024      | 0.030  |

Figure 19. Package dimensions

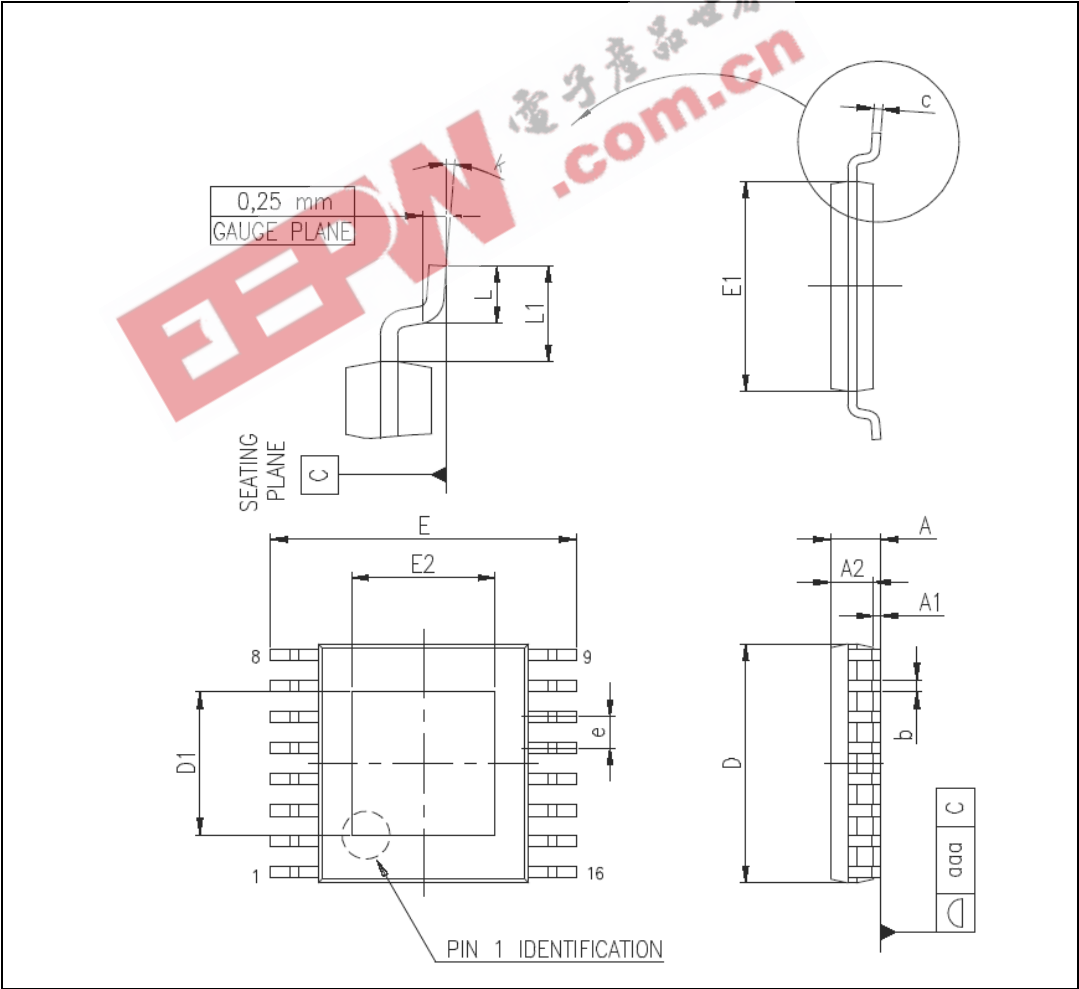


Table 12. Tape and reel SO-14

| 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   | 6.4  |     | 6.6  | 0.252 |     | 0.260  |
| Bo   | 9    |     | 9.2  | 0.354 |     | 0.362  |
| Ko   | 2.1  |     | 2.3  | 0.082 |     | 0.090  |
| Po   | 3.9  |     | 4.1  | 0.153 |     | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |     | 0.319  |

Figure 20. Tape and reel dimensions

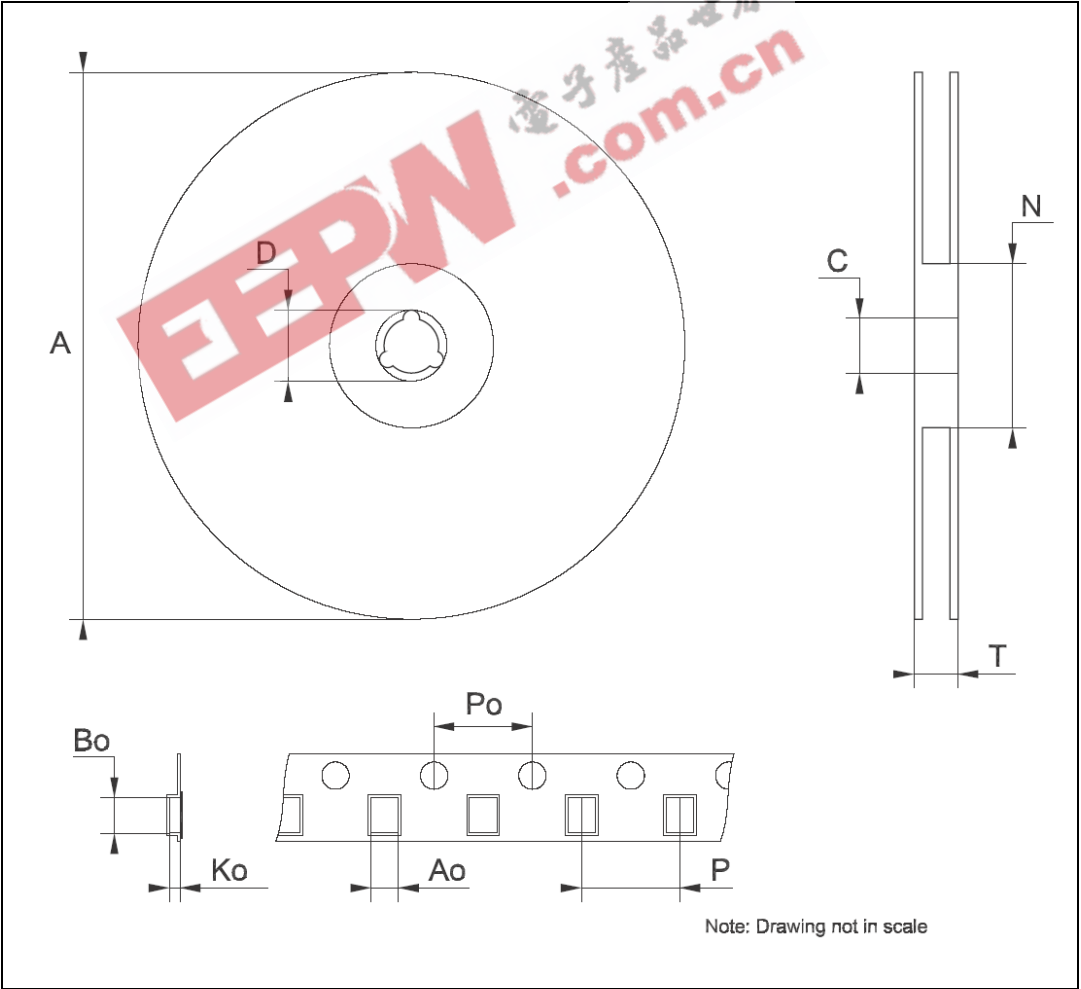
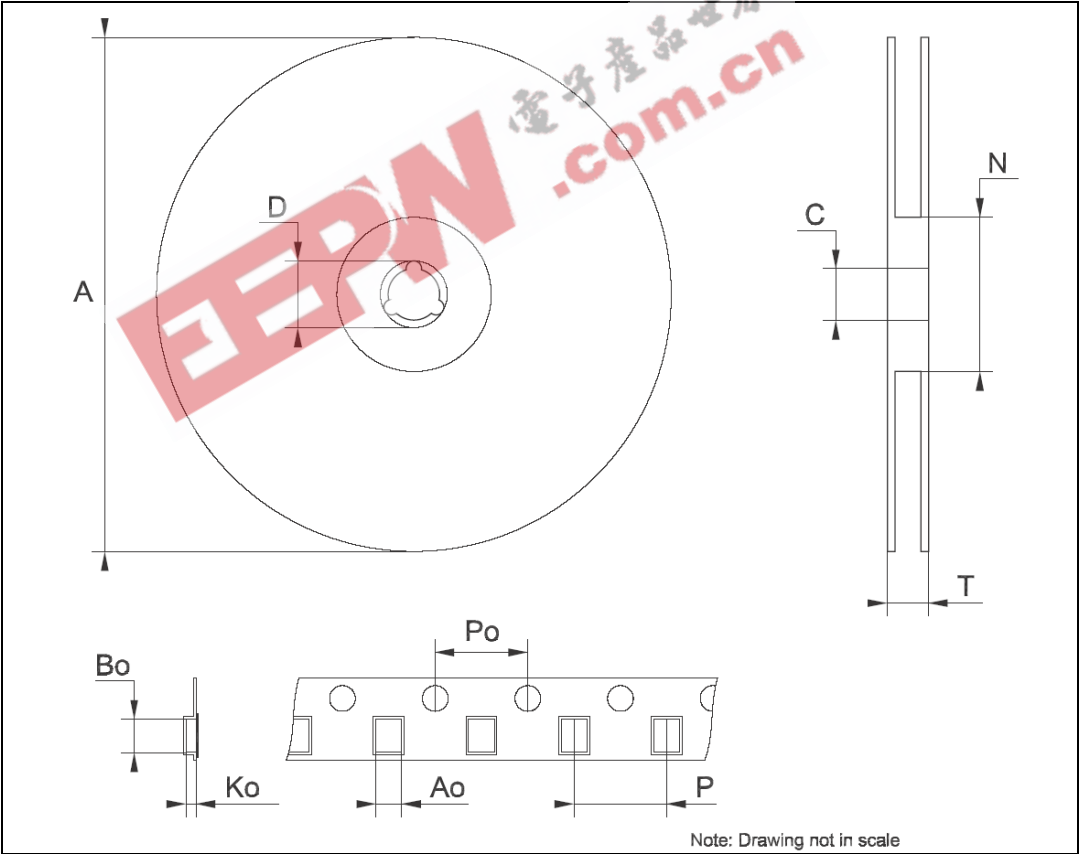


Table 13. TSSOP16 tape and reel

| 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   | 6.7  |     | 6.9  | 0.264 |     | 0.272  |
| Bo   | 5.3  |     | 5.5  | 0.209 |     | 0.217  |
| Ko   | 1.6  |     | 1.8  | 0.063 |     | 0.071  |
| Po   | 3.9  |     | 4.1  | 0.153 |     | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |     | 0.319  |

Figure 21. Tape and reel dimensions



## 10 Revision history

**Table 14. Revision history**

| Date        | Revision | Changes                                                                                                                  |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------|
| 26-Oct-2006 | 1        | Initial release                                                                                                          |
| 05-Apr-2006 | 2        | New template                                                                                                             |
| 23-May-2006 | 3        | Updated packaging information                                                                                            |
| 08-Jun-2006 | 4        | Typos in cover page                                                                                                      |
| 20-Jun-2006 | 5        | Block diagram updated <i>Figure 1 on page 3</i> , equivalent circuits updated <i>Figure 3, 4, 5, 6, on page 9 and 10</i> |

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