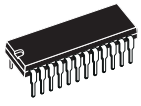
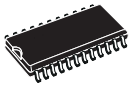
# STP16CL596

## LOW VOLTAGE 16-BIT CONSTANT CURRENT LED SINK DRIVER

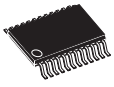
- LOW VOLTAGE POWER SUPPLY DOWN TO 3V
- 16 CONSTANT CURRENT OUTPUT CHANNELS
- ADJUSTABLE OUTPUT CURRENT THROUGH EXTERNAL RESISTOR
- SERIAL DATA IN/PARALLEL DATA OUT
- SERIAL OUT CHANGES STATE ON THE FALLING EDGES OF CLOCK
- 3.3V MICRO DRIVER-ABLE
- OUTPUT CURRENT: 15-90 mA
- 25 MHz CLOCK FREQ.
- AVAILABLE IN HIGH THERMAL EFFICIENCY TSSOP EXPOSED PAD



**DIP-24**



**SO-24**



**TSSOP24**

**TSSOP24 (exposed pad)**

### DESCRIPTION

The STP16CL596 is a monolithic, low voltage, low current power 16-bit shift register designed for LED panel displays. The STP16CL596 contains a 16-bit serial-in, parallel-out shift register that feeds a 16-bitD-type storage register. In the output stage, sixteen regulated current sources were designed to provide 15-90mA constant current to drive the LEDs.

Compared with the STPIC6C595, the device provides great flexibility and improved performance in LED panel system design.

Trough an external resistor, users can adjust the STP16CL596 output current, controlling in this way the light intensity of LEDs.

The STP16CL596 guarantees a 16V output driving capability, allowing users to connect more LEDs in series. The high clock frequency, 25 MHz, also satisfies the system requirement of high volume data transmission. The 3.3V of voltage supply is well useful for applications that interface any micro from 3.3V. Compared with a standard TSSOP package, the TSSOP exposed pad increases heat dissipation capability by a 2.5 factor.

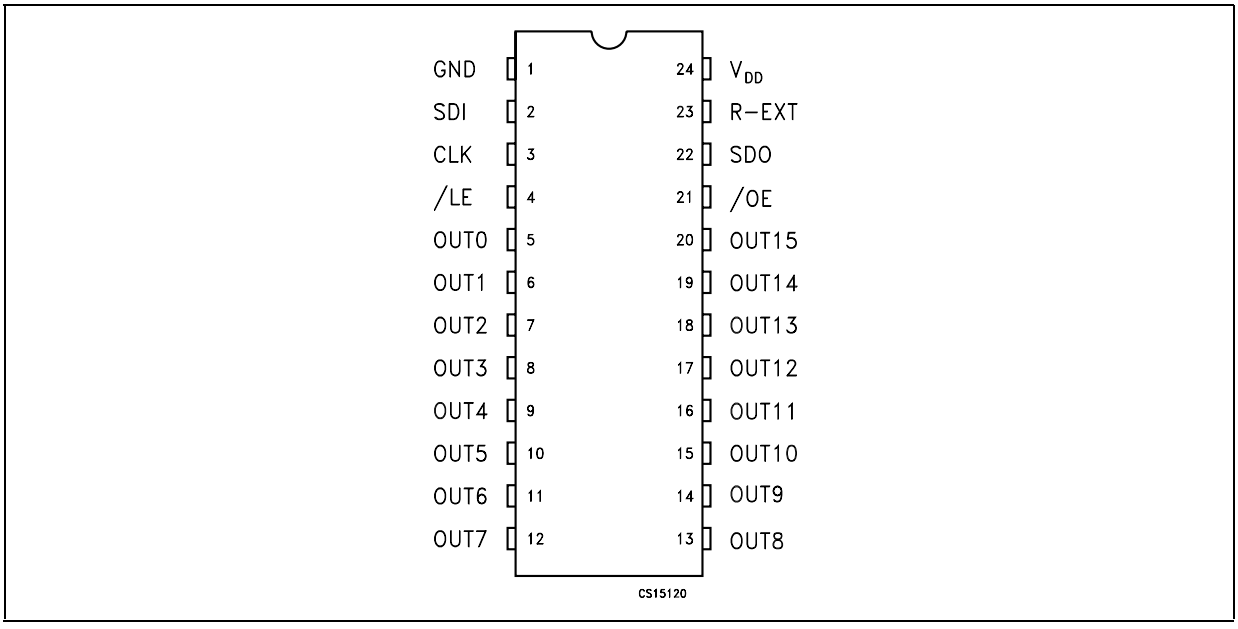
**Table 1: Order Codes**

| Part Number | Package | Comments |
|---|---|---|
| STP16CL596B1R | DIP-24 | 15 parts per tube |
| STP16CL596M | SO-24 (Tube) | 40 parts per tube |
| STP16CL596MTR | SO-24 (Tape & Reel) | 1000 parts per reel |
| STP16CL596TTR | TSSOP24 (Tape & Reel) | 2500 parts per reel |
| STP16CL596XTTR | TSSOP24 Exposed-Pad (Tape & Reel) | 2500 parts per reel |

### Table 2: Current Accuracy

| Output Voltage | Current accuracy | | Output Current |
|---|---|---|---|
| | Between bits | Between ICs | |
| ≥ 0.7V | ± 3% | ± 10% | 15 to 90 mA |

### Figure 1: Pin Connection (Note 1)




Note 1: The exposed Pad is electrically not connected.

### 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 | Latch input terminal |
| 5-20 | OUT 0-15 | Output terminal |
| 21 | /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 |

### 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 | 90 | mA |
| $V_I$ | Input Voltage | -0.4 to $V_{DD}$+0.4 | V |
| $I_{GND}$ | GND Terminal Current | 1440 | 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 |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Under these conditions, functional operation is not implied.

### Table 5: Thermal Data

| Symbol | Parameter | DIP-24 | SO-24 | TSSOP24 | TSSOP24 (*) (exposed pad) | Unit |
|---|---|---|---|---|---|---|
| $R_{thj\text{-}amb}$ | Thermal Resistance Junction-ambient | 60 | 75 | 85 | 37.5 | °C/W |

(*) The exposed pad should be soldered directly to the PCB to realize the thermal benefits.

### Table 6: Recommended Operating Conditions

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply Voltage | | 3.0 | 3.3 | 3.6 | V |
| $V_O$ | Output Voltage | | | | 16.0 | V |
| $I_O$ | Output Current | OUTn | 5 | | 90 | 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 | | | ns |
| $t_{wCLK}$ | CLK Pulse Width | | 20 | | | ns |
| $t_{wEN}$ | /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 | | | 25 | MHz |

**Table 7: Electrical Characteristics** ($V_{DD}$=3V, 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 | $V_{OH}$ = 16 V | | | 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 Ω | 19.2 | 20.6 | 22.0 | mA |
| $I_{OL2}$ | | $V_O$ = 0.7V $R_{EXT}$ = 360 Ω | 46.2 | 50.5 | 54.0 | mA |
| $\Delta I_{OL1}$ | Output Current Error between bit (All Output ON) | $V_O$ = 0.7V $R_{EXT}$ = 910 Ω | | ± 4 | ± 5 | % |
| $\Delta I_{OL2}$ | | $V_O$ = 0.7V $R_{EXT}$ = 360 Ω | | ± 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 |
| $I_{DD(OFF2)}$ | | $R_{EXT}$ = 470 Ω OUT 0 to 15 = OFF | | 5.5 | 7.7 | |
| $I_{DD(OFF3)}$ | | $R_{EXT}$ = 250 Ω OUT 0 to 15 = OFF | | 10.1 | 14.1 | |
| $I_{DD(ON1)}$ | Supply Current (ON) | $R_{EXT}$ = 470 Ω OUT 0 to 15 = ON | | 5.5 | 7.7 | |
| $I_{DD(ON2)}$ | | $R_{EXT}$ = 250 Ω OUT 0 to 15 = ON | | 10.1 | 14.1 | |

**Table 8: Switching Characteristics** ($V_{DD}$=3V, T = 25°C, unless otherwise specified.)

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $t_{PLH1}$ | Propagation Delay Time, CLK-OUTn, /LE = H, /OE = L | $V_{DD}$ = 3 V | $V_{IH}$ = $V_{DD}$ | | 250 | 280 | ns |
| $t_{PLH2}$ | Propagation Delay Time, /LE-OUTn, /OE = L | $V_{IL}$ = GND | $C_L$ = 13pF | | 220 | 250 | ns |
| $t_{PLH3}$ | Propagation Delay Time, /OE-OUTn, /LE = H | $I_O$ = 40mA | $V_L$ = 3 V | | 200 | 250 | ns |
| $t_{PLH}$ | Propagation Delay Time, CLK-SDO | $R_{EXT}$ = 470 Ω | $R_L$ = 65 Ω | | 25 | 50 | ns |
| $t_{PHL1}$ | Propagation Delay Time, CLK-OUTn, /LE = H, /OE = L | | | | 25 | 50 | ns |
| $t_{PHL2}$ | Propagation Delay Time, /LE-OUTn, /OE = L | | | | 25 | 50 | ns |
| $t_{PHL3}$ | Propagation Delay Time, /OE-OUTn, /LE = H | | | | 50 | 70 | ns |
| $t_{PHL}$ | Propagation Delay Time, CLK-SDO | | | | 25 | 50 | ns |
| $t_r$ | Output Rise Time | | | | 200 | 250 | ns |
| $t_f$ | Output Fall Time | | | | 17 | 25 | ns |

## EQUIVALENT CIRCUIT OF INPUTS AND OUTPUTS

**Figure 2: /OE Terminal**

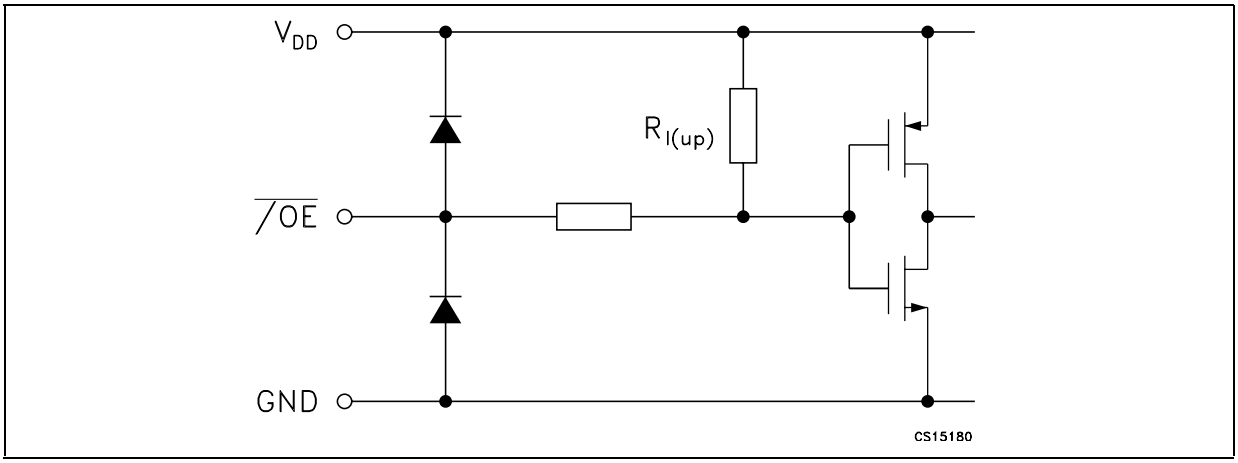



**Figure 3: /LE Terminal**

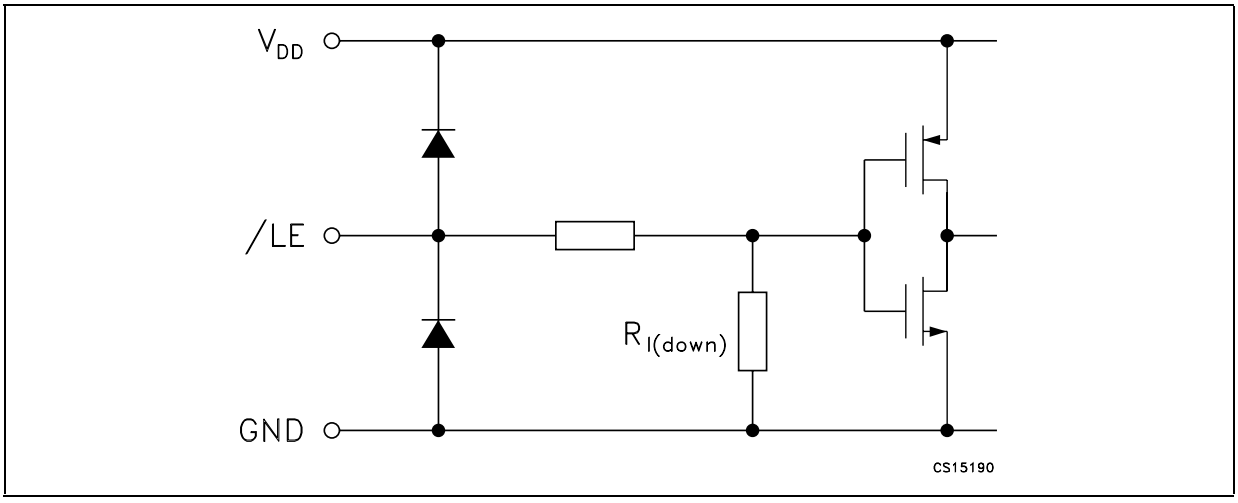



**Figure 4: CLK, SDI Terminal**

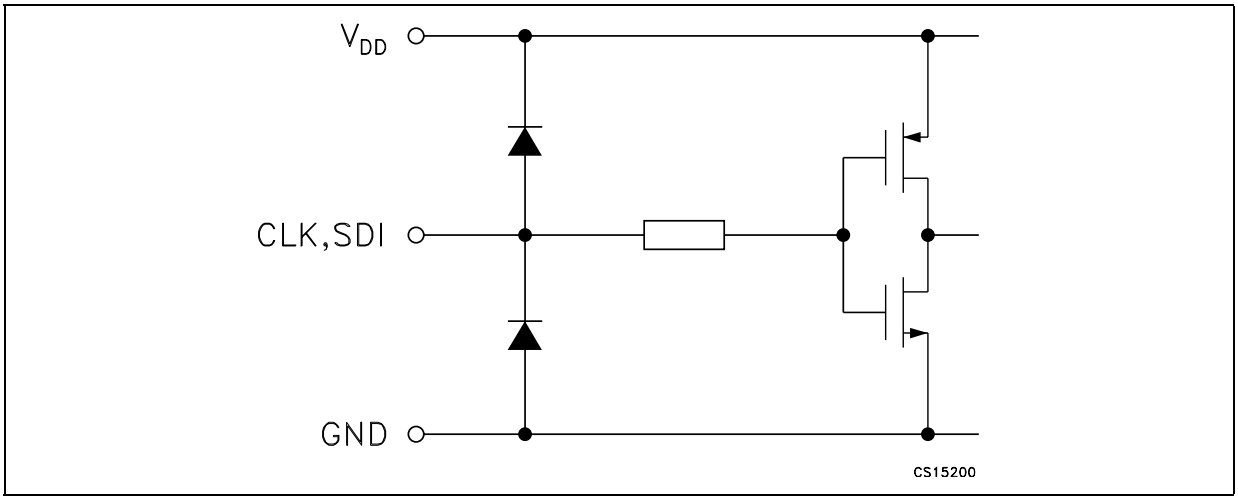


**Figure 5: SDO Terminal**

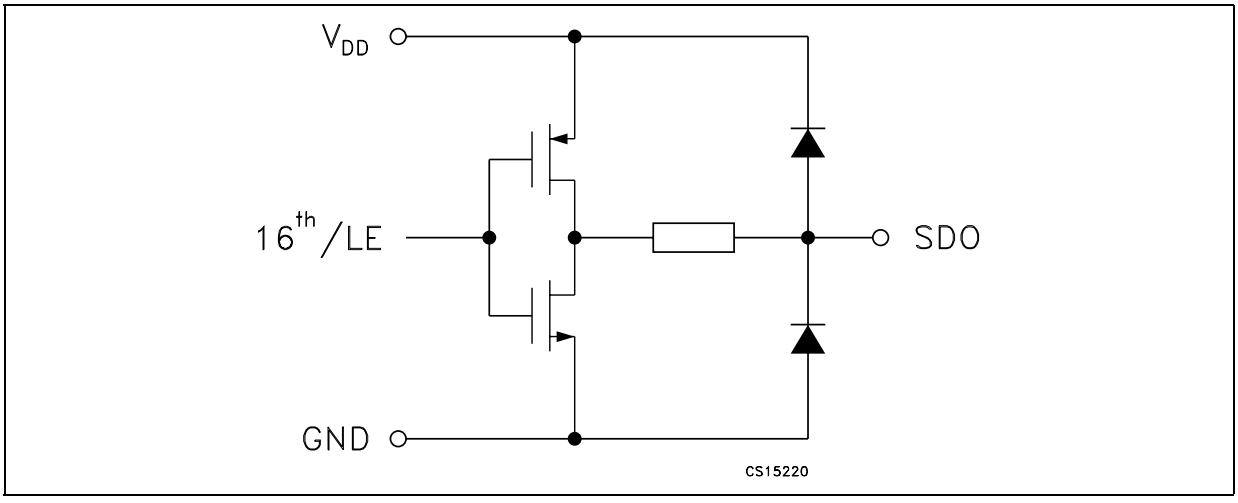
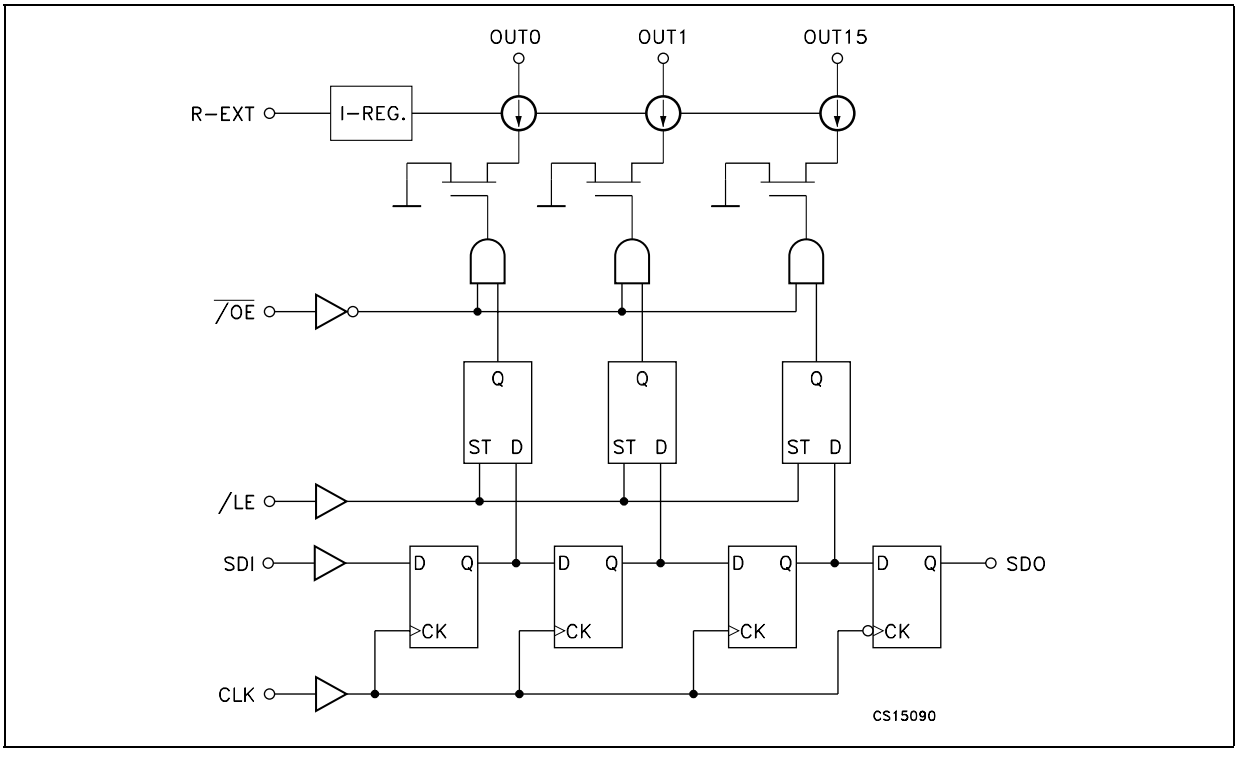



**Figure 6: Block Diagram**

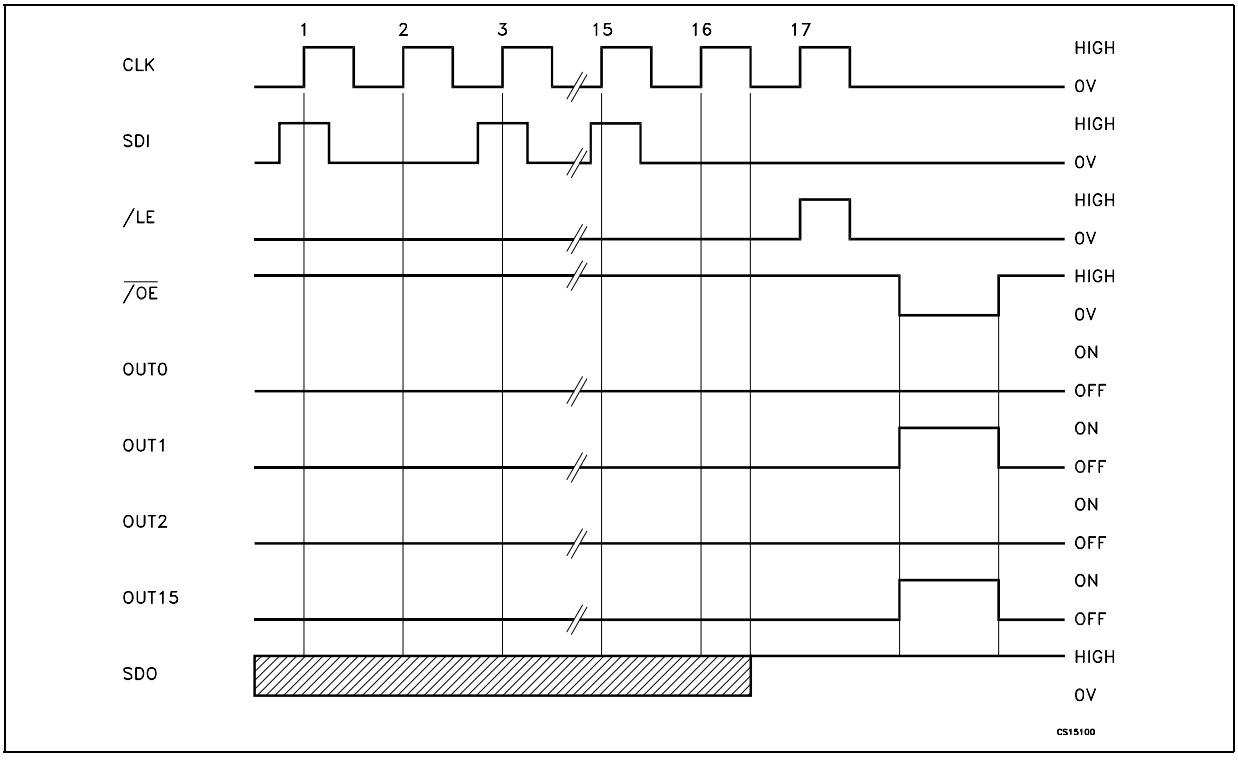


### Table 9: Truth Table

| CLOCK | /LE | /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 | OFF | Dn - 13 |

Note 1: OUT0 to OUT15 = ON when Dn = H; OUT0 to OUT15 = OFF when Dn = L.

### Figure 7: Timing Diagram




Note: The latches circuit holds data when the LE terminal is Low.
When LE terminal is at High level, latch circuit doesn't hold the data it passes from the input to the output.
When OE terminal is at Low level, output terminals OUT0 to OUT15 respond to the data, either ON or OFF.
When OE terminal is at High level, it switches off all the data on the output terminal.

**Figure 8: Clock, Serial-in, Serial-out**

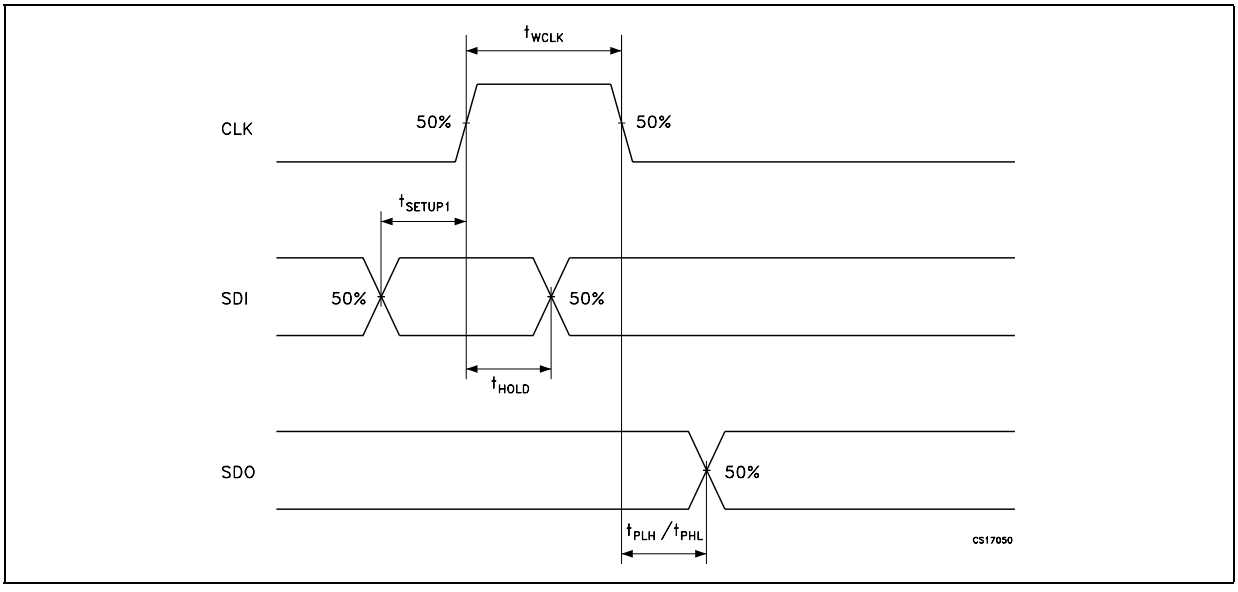



**Figure 9: Clock, Serial-in, Latch, Enable, Outputs**

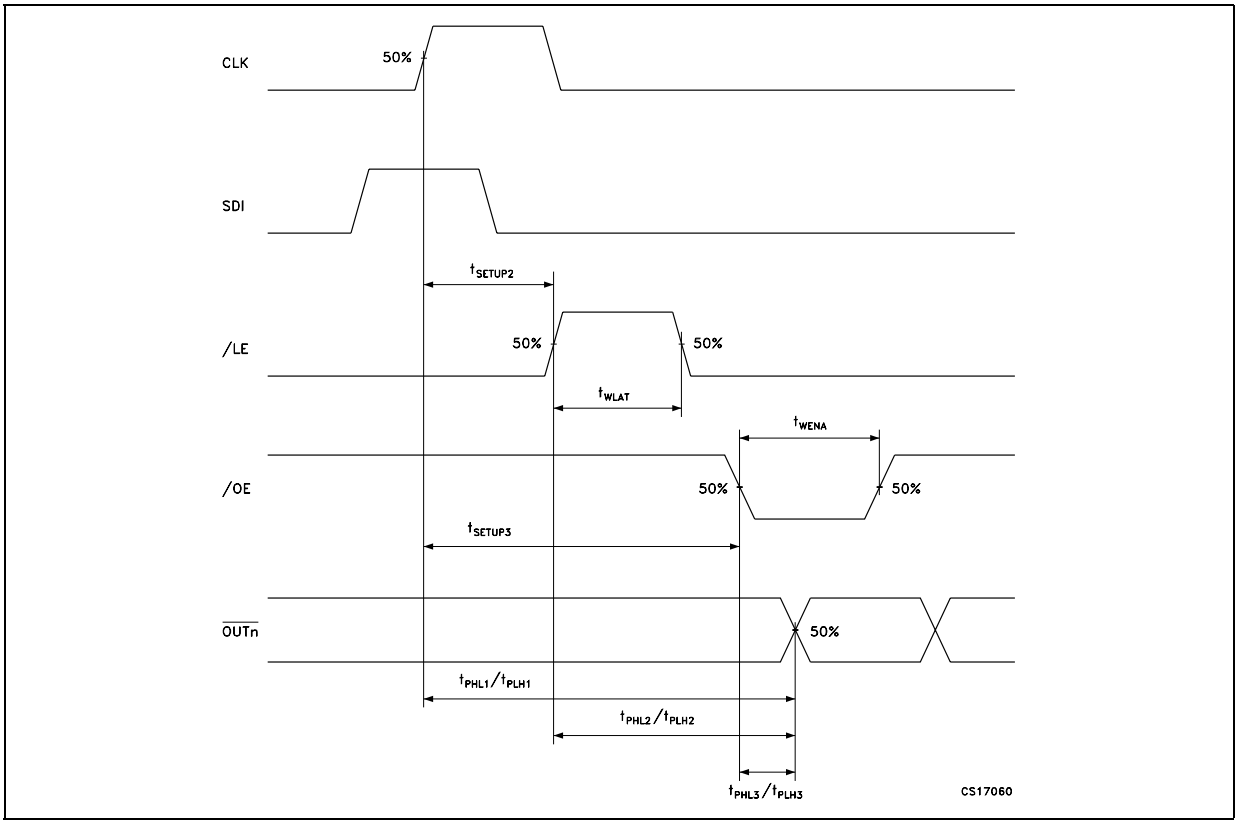
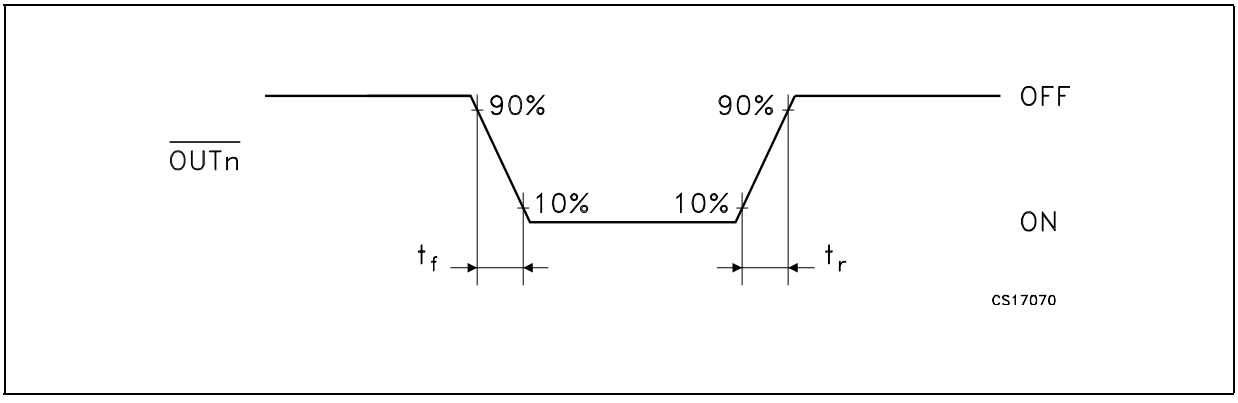


**Figure 10: Outputs**




## TEST CIRCUIT

**Figure 11: DC Characteristic**

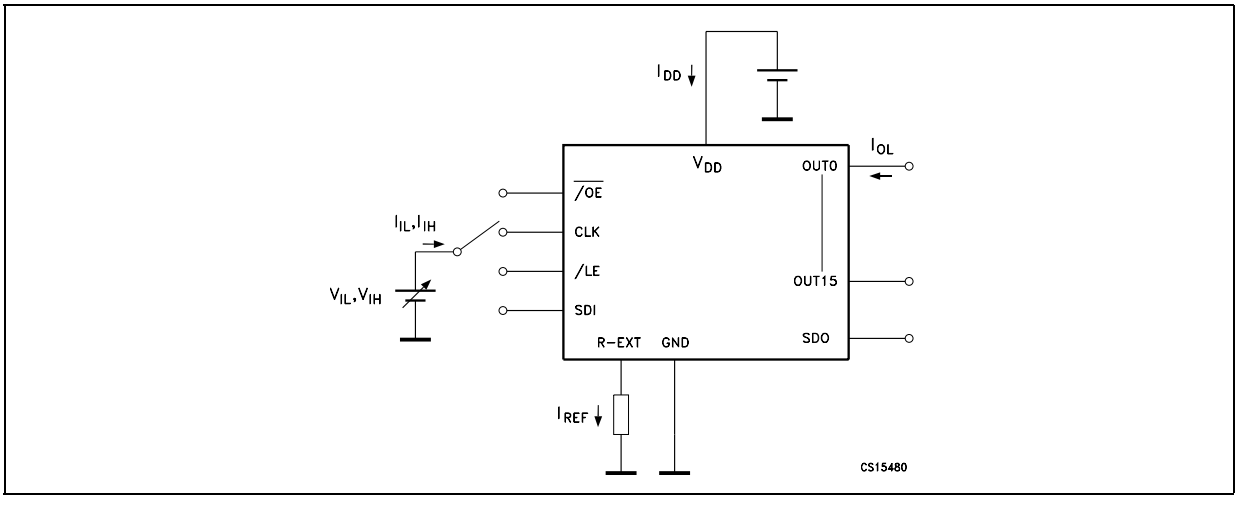



**Figure 12: AC Characteristic**

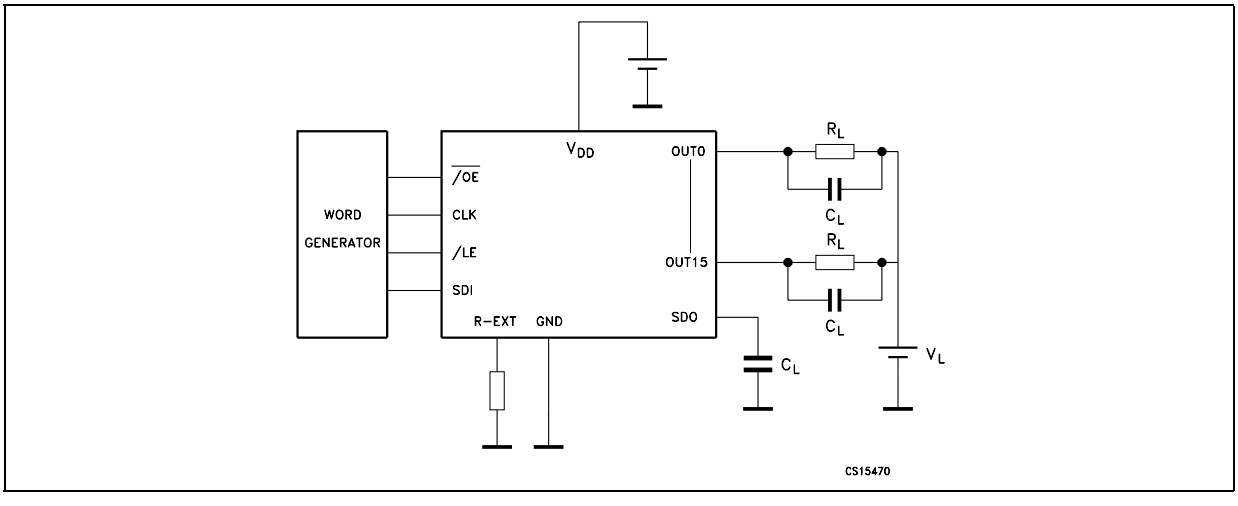


**Figure 13:** Output Current-$R_{EXT}$ Resistor

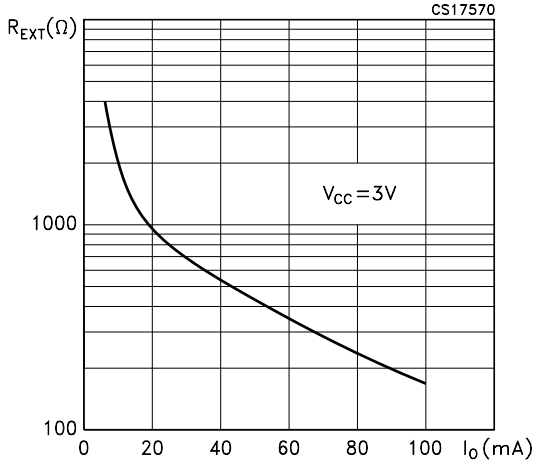
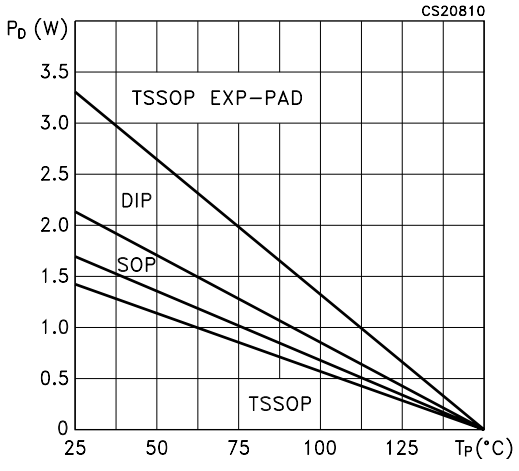
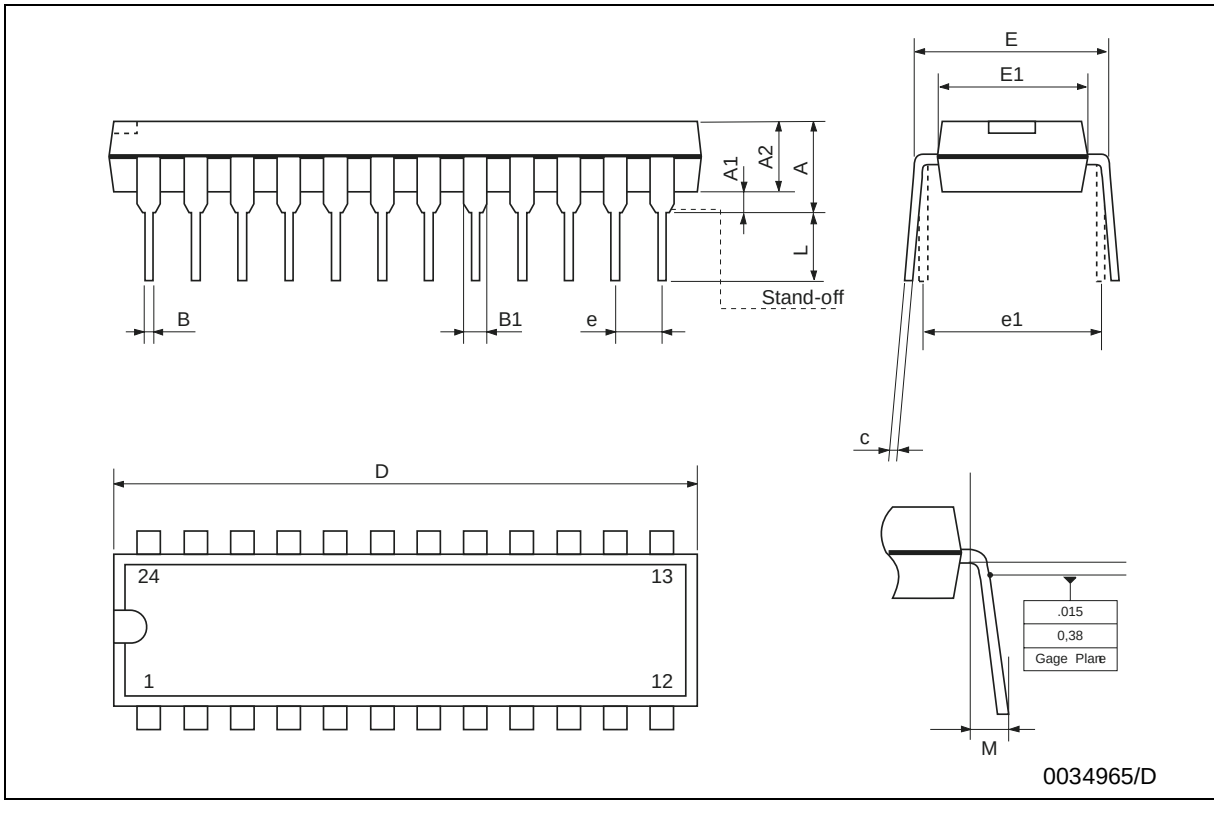



**Figure 14:** Power Dissipation vs Temperature Package



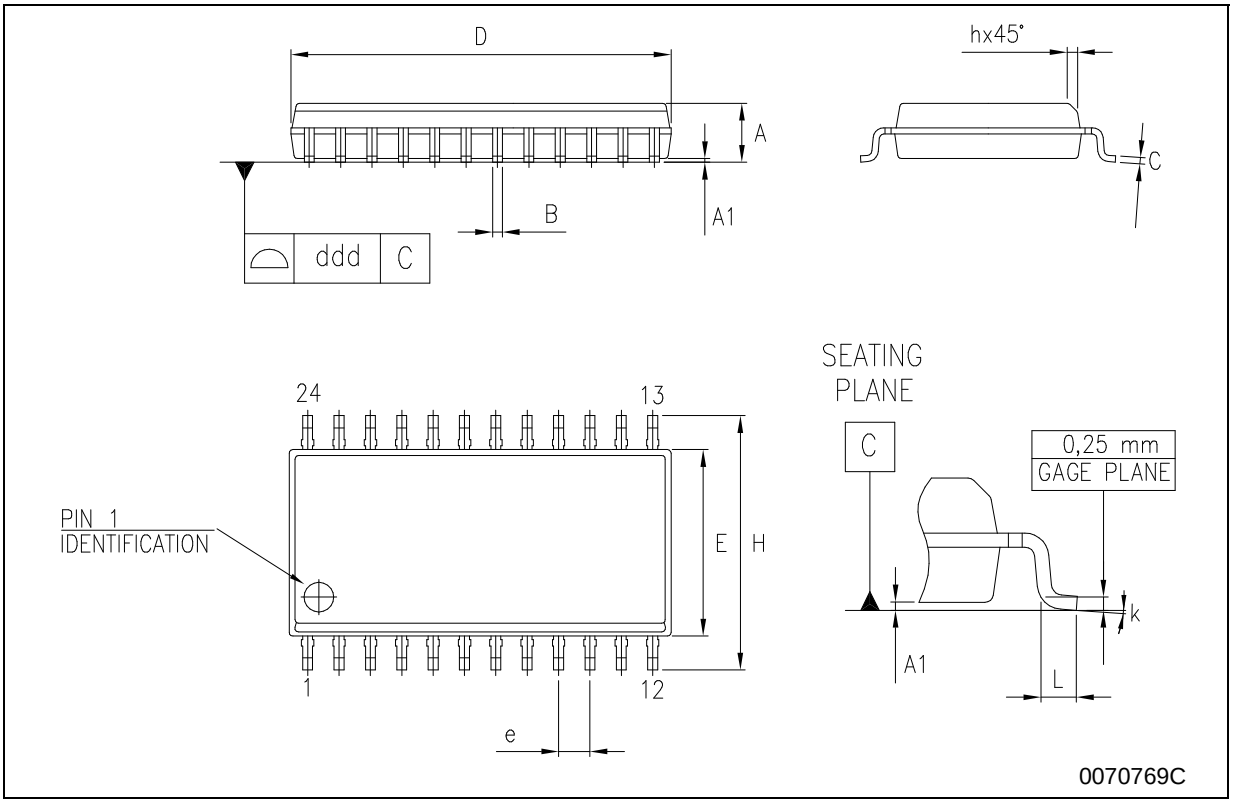
## Plastic DIP-24 (0.25) MECHANICAL DATA

| DIM. | 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° |



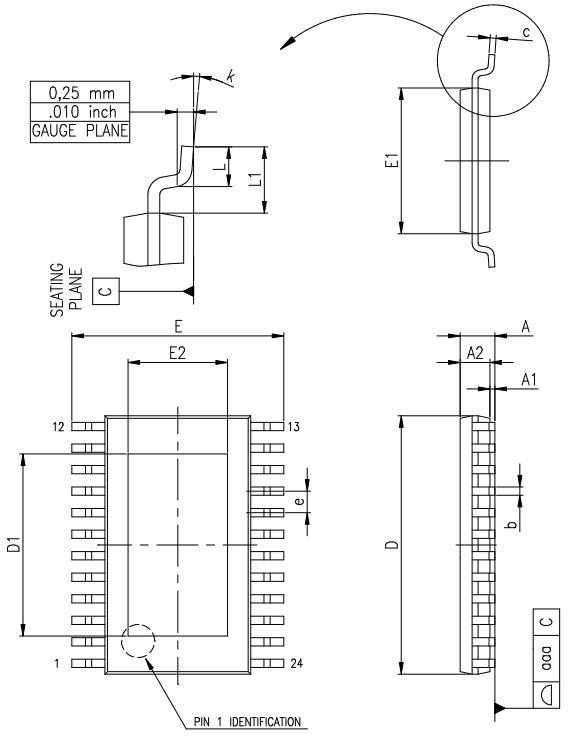
## SO-24 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 2.35 | | 2.65 | 0.093 | | 0.104 |
| A1 | 0.1 | | 0.30 | 0.004 | | 0.012 |
| B | 0.33 | | 0.51 | 0.013 | | 0.020 |
| C | 0.23 | | 0.32 | 0.009 | | 0.013 |
| D | 15.20 | | 15.60 | 0.598 | | 0.614 |
| E | 7.4 | | 7.6 | 0.291 | | 0.299 |
| e | | 1.27 | | | 0.050 | |
| H | 10.00 | | 10.65 | 0.394 | | 0.419 |
| h | 0.25 | | 0.75 | 0.010 | | 0.030 |
| L | 0.4 | | 1.27 | 0.016 | | 0.050 |
| k | 0° | | 8° | 0° | | 8° |
| ddd | | | 0.100 | | | 0.004 |



# TSSOP24 EXPOSED PAD MECHANICAL DATA

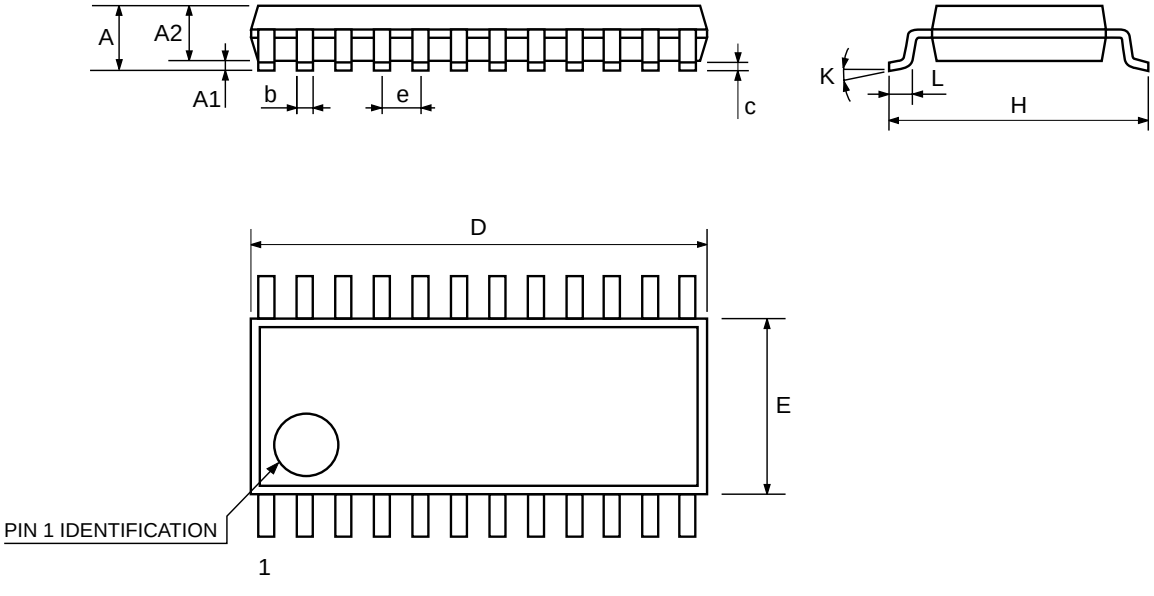
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | | | 0.15 | | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 7.7 | 7.8 | 7.9 | 0.303 | 0.307 | 0.311 |
| D1 | 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 |




7100778C

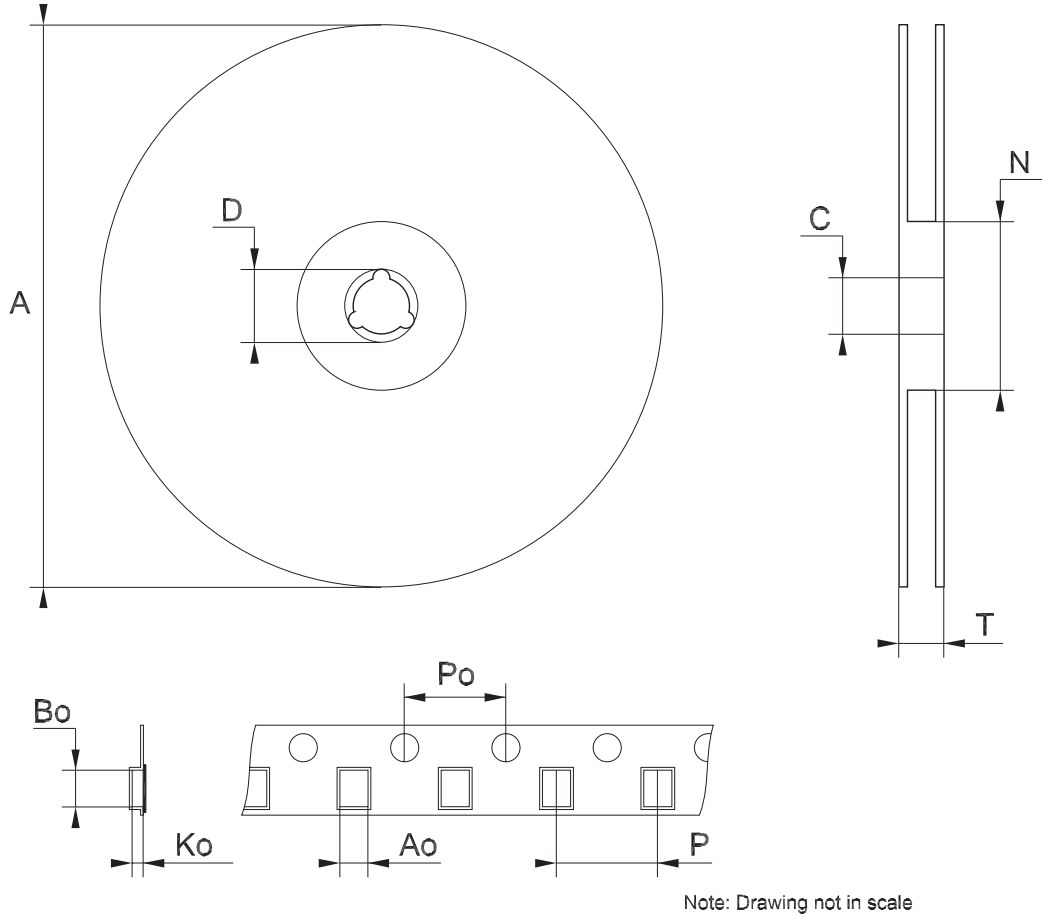
# TSSOP24 MECHANICAL DATA

| 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 |



## Tape & Reel SO-24 MECHANICAL DATA

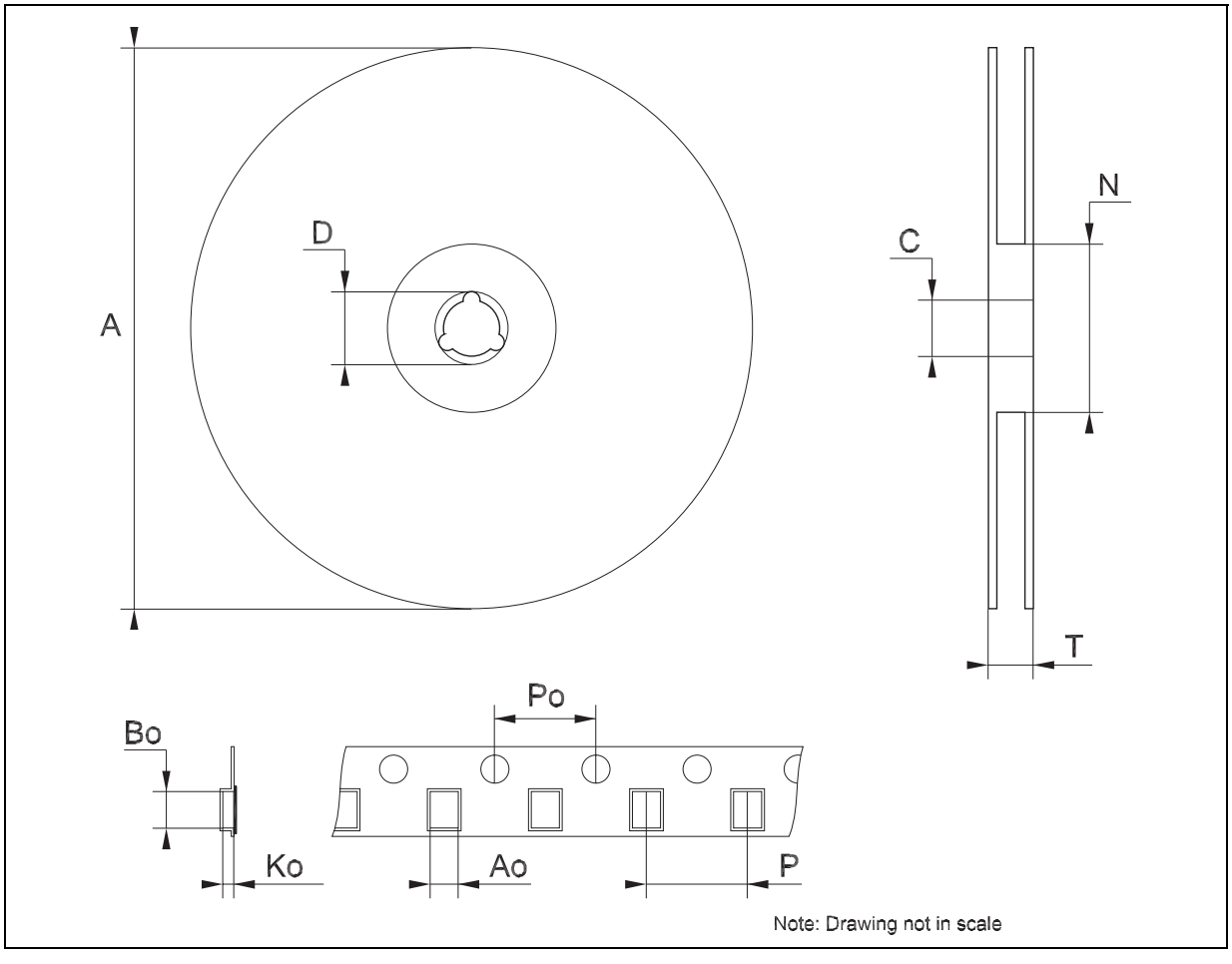
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 30.4 | | | 1.197 |
| Ao | 10.8 | | 11.0 | 0.425 | | 0.433 |
| 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 |




Note: Drawing not in scale

## Tape & Reel TSSOP24 MECHANICAL DATA

| 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 |




Note: Drawing not in scale

**Table 10: Revision History**

| Date | Revision | Description of Changes |
|---|---|---|
| 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. |