

## Power logic 8-bit shift register

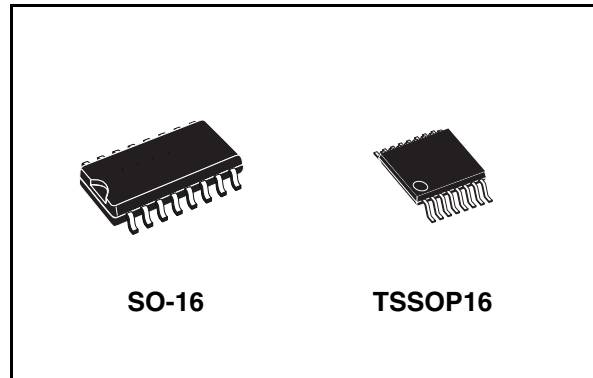
### Features

- Low  $R_{DS(on)}$ : 4  $\Omega$  typ
- 30 mJ avalanche energy
- Eight 100 mA DMOS outputs
- 250 mA current limit capability
- 33 V output clamp voltage
- Device are cascadable
- Low power consumption

### Description

This STPIC6C595 is a monolithic, medium-voltage, low current power 8-bit shift register designed for use in systems that require relatively moderate load power such as LEDs. The device contains a built-in voltage clamp on the outputs for inductive transient protection. Power driver applications include relays, solenoids, and other low-current or medium-voltage loads.

The device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. Data transfers through both the shift and storage register clock (SRCK) and the register clock ( $\overline{RCK}$ ), respectively. The device transfers data out the serial output (SER OUT) port on the rising edge of SRCK. The storage register transfers data to the output buffer when shift register clear (CLR) is high. When  $\overline{CLR}$  is low, the input shift register is cleared. When output enable ( $\overline{G}$ ) is held high, all data in the output buffer is held low and all drain output are off. When G is held low, data from the storage register is transparent to the output buffer.



When data in the output buffers is low, the DMOS transistor outputs are off. When data is high, the DMOS transistor outputs have sink-current capability. The SER OUT allows for cascading of the data from the shift register to additional devices.

Output are low-side, open-drain DMOS transistors with output ratings of 33 V and 100 mA continuous sink-current capability. Each output provides a 250 mA maximum current limit at  $T_C = 25^\circ\text{C}$ . The current limit decreases as the junction temperature increases for additional device protection. The device also provides up to 1.5 kV of ESD protection when tested using the human-body model and 150 V machine model.

The STPIC6C595 is characterized for operation over the operating case temperature range of  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

**Table 1. Device summary**

| Order codes   | Package                 | Packaging           |
|---------------|-------------------------|---------------------|
| STPIC6C595MTR | SO-16 (Tape and reel)   | 2500 parts per reel |
| STPIC6C595TTR | TSSOP16 (Tape and reel) | 2500 parts per reel |

# Contents

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# 1 Logic symbol and pin configuration

Figure 1. Logic symbol and pin configuration

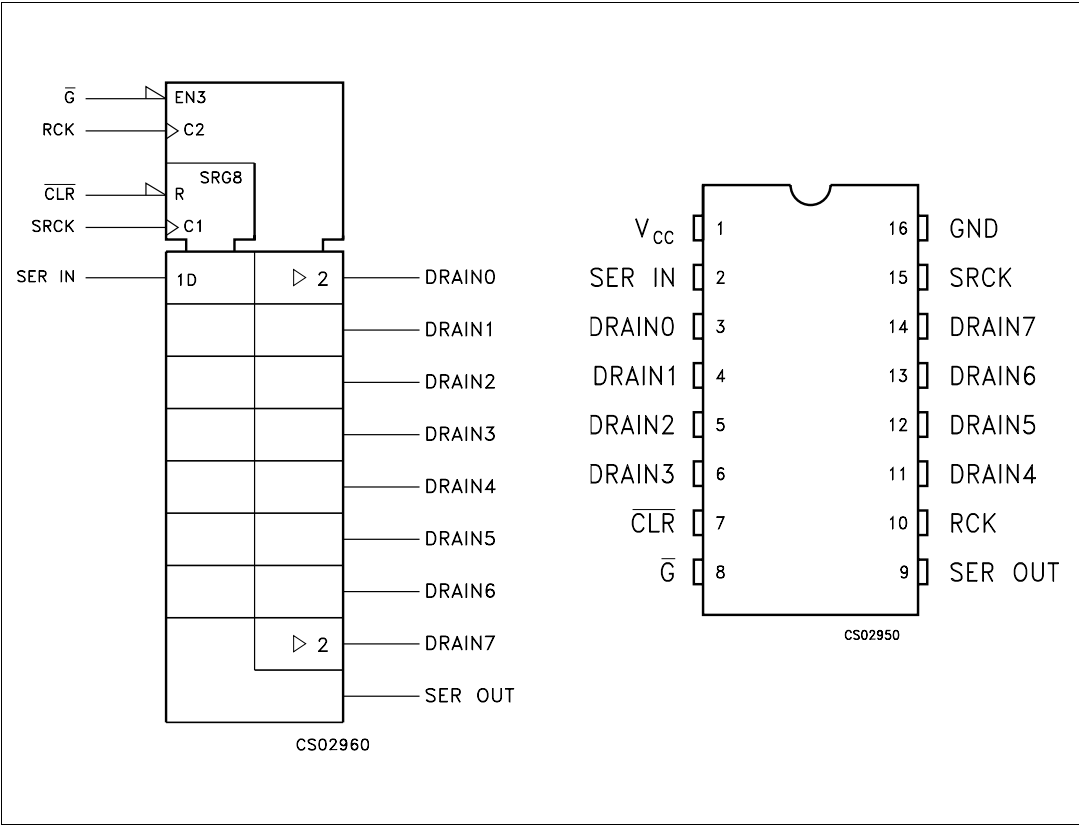
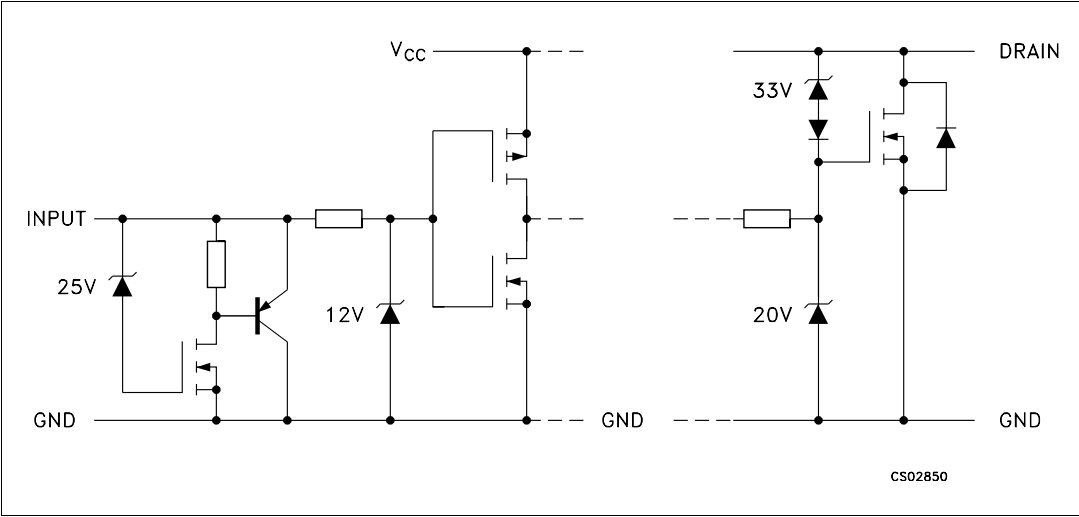


Figure 2. Input and output equivalent circuits



## 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.

### 2.1 Absolute maximum ratings

**Table 2. Absolute maximum ratings**

| Symbol    | Parameter                                                                                    | Value       | Unit |
|-----------|----------------------------------------------------------------------------------------------|-------------|------|
| $V_{CC}$  | Logic supply voltage (See <a href="#">Note 1</a> )                                           | 7           | V    |
| $V_I$     | Logic input voltage range                                                                    | -0.3 to 7   | V    |
| $V_{DS}$  | Power DMOS drain to source voltage (See <a href="#">Note 2</a> )                             | 33          | V    |
| $I_{DS}$  | Continuous source to drain diode anode current                                               | 250         | mA   |
| $I_{DS}$  | Pulsed source to drain diode anode current (See <a href="#">Note 3</a> )                     | 500         | mA   |
| $I_D$     | Pulsed drain current, each output, all output ON ( $T_C = 25\text{ °C}$ )                    | 250         | mA   |
| $I_D$     | Continuous current, each output, all output ON ( $T_C = 25\text{ °C}$ )                      | 100         | mA   |
| $I_D$     | Peak drain current single output ( $T_C = 25\text{ °C}$ ) (See <a href="#">Note 3</a> )      | 250         | mA   |
| $E_{AS}$  | Single pulse avalanche energy (See <a href="#">Figure 11</a> and <a href="#">Figure 12</a> ) | 30          | mJ   |
| $I_{AS}$  | Avalanche current (See <a href="#">Note 4</a> and <a href="#">Figure 17</a> )                | 200         | mA   |
| $P_d$     | Continuous total dissipation ( $T_C \leq 25\text{ °C}$ )                                     | 1087        | mW   |
| $P_d$     | Continuous total dissipation ( $T_C = 125\text{ °C}$ )                                       | 217         | mW   |
| $T_J$     | Operating virtual junction temperature range                                                 | -40 to +150 | °C   |
| $T_C$     | Operating case temperature range                                                             | -40 to +125 | °C   |
| $T_{stg}$ | Storage temperature range                                                                    | -65 to +150 | °C   |
| $T_L$     | Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds                                 | 260         | °C   |

## 2.2 Thermal data

Table 3. Thermal data

| Symbol       | Parameter                           | Value | Unit |
|--------------|-------------------------------------|-------|------|
| $R_{th(JA)}$ | Thermal resistance junction-ambient | 115   | °C/W |

## 2.3 Recommended operating conditions

Table 4. Recommended operating conditions

| Symbol   | Parameter                                                                                                                                                                              | Min          | Typ | Max          | Unit |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----|--------------|------|
| $V_{CC}$ | Logic supply voltage                                                                                                                                                                   | 4.5          |     | 5.5          | V    |
| $V_{IH}$ | High level input voltage                                                                                                                                                               | $0.85V_{CC}$ |     | $V_{CC}$     | V    |
| $V_{IL}$ | Low level input voltage                                                                                                                                                                | 0            |     | $0.15V_{CC}$ | V    |
| $I_{DP}$ | Pulse drain output current<br>( $T_C = 25\text{ °C}$ , $V_{CC} = 5\text{ V}$ , all outputs ON)<br>(see <a href="#">Note 3</a> , <a href="#">Note 5</a> and <a href="#">Figure 15</a> ) |              |     | 250          | mA   |
| $t_{su}$ | Set-up time, SER IN high before SRCK ↑<br>(see <a href="#">Figure 4</a> and <a href="#">Figure 8</a> )                                                                                 | 1.6          | 3.0 | 5.7          | ns   |
| $t_{hL}$ | Hold time, SER IN high before $\overline{G}$ ↑<br>(see <a href="#">Figure 4</a> , <a href="#">Figure 7</a> , <a href="#">Figure 8</a> )                                                | 2.8          | 4.0 | 9.6          | ns   |
| $t_W$    | Pulse duration (see <a href="#">Figure 8</a> )                                                                                                                                         | 40           |     |              | ns   |
| $T_C$    | Operating case temperature                                                                                                                                                             | -40          |     | 125          | °C   |

## 3 Electrical characteristics

### 3.1 DC characteristics

**Table 5. DC characteristics** ( $V_{CC} = 5\text{ V}$ ,  $T_C = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified.)

| Symbol        | Parameter                                                                                                                                                   | Test conditions                                                                                                                                                    | Min | Typ   | Max | Unit          |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------|-----|---------------|
| $V_{(BR)DSX}$ | Drain-to-source breakdown voltage                                                                                                                           | $I_D = 1\text{ mA}$                                                                                                                                                | 33  | 37    |     | V             |
| $V_{SD}$      | Source-to-drain diode forward voltage                                                                                                                       | $I_F = 100\text{ mA}$                                                                                                                                              |     | 0.85  | 1.2 | V             |
| $V_{OH}$      | High level output voltage SER OUT                                                                                                                           | $I_{OH} = -20\text{ }\mu\text{A}$ , $V_{CC} = 4.5\text{ V}$                                                                                                        | 4.4 | 4.49  |     | V             |
|               |                                                                                                                                                             | $I_{OH} = -4\text{ mA}$ , $V_{CC} = 4.5\text{ V}$                                                                                                                  | 4   | 4.2   |     | V             |
| $V_{OL}$      | Low level output voltage SER OUT                                                                                                                            | $I_{OH} = 20\text{ }\mu\text{A}$ , $V_{CC} = 4.5\text{ V}$                                                                                                         |     | 0.005 | 0.1 | V             |
|               |                                                                                                                                                             | $I_{OH} = 4\text{ mA}$ , $V_{CC} = 4.5\text{ V}$                                                                                                                   |     | 0.3   | 0.5 | V             |
| $I_{IH}$      | High level input current                                                                                                                                    | $V_{CC} = 5.5\text{ V}$ , $V_I = V_{CC}$                                                                                                                           |     |       | 1   | $\mu\text{A}$ |
| $I_{IL}$      | Low level input current                                                                                                                                     | $V_{CC} = 5.5\text{ V}$ , $V_I = 0$                                                                                                                                |     |       | -1  | $\mu\text{A}$ |
| $I_{CC}$      | Logic supply current                                                                                                                                        | $V_{CC} = 5.5\text{ V}$ , all outputs OFF or ON                                                                                                                    |     | 20    | 200 | $\mu\text{A}$ |
| $I_{CC(FRQ)}$ | Logic supply current at frequency                                                                                                                           | $f_{SRCK} = 5\text{ MHz}$ , $C_L = 30\text{ pF}$<br>All outputs OFF<br>(See <a href="#">Figure 6</a> , <a href="#">Figure 18</a> and <a href="#">Figure 19</a> )   |     | 0.2   | 2   | mA            |
| $I_N$         | Nominal current                                                                                                                                             | $V_{DS(on)} = 0.5\text{ V}$ , $I_N = I_D$<br>$T_C = 85\text{ }^{\circ}\text{C}$<br>(See <a href="#">Note 5</a> , <a href="#">Note 6</a> , <a href="#">Note 7</a> ) |     | 90    |     | mA            |
| $I_{DSX}$     | Off-state drain current                                                                                                                                     | $V_{DS} = 30\text{ V}$ , $V_{CC} = 5.5\text{ V}$                                                                                                                   |     | 0.3   | 5   | $\mu\text{A}$ |
|               |                                                                                                                                                             | $V_{DS} = 30\text{ V}$ , $V_{CC} = 5.5\text{ V}$ or $0\text{ V}$<br>$T_C = 125\text{ }^{\circ}\text{C}$                                                            |     | 0.6   | 8   | $\mu\text{A}$ |
| $R_{DS(on)}$  | Static drain source on state resistance<br>(See <a href="#">Note 5</a> , <a href="#">Note 6</a> and <a href="#">Figure 14</a> , <a href="#">Figure 16</a> ) | $I_D = 50\text{ mA}$ , $V_{CC} = 4.5\text{ V}$                                                                                                                     |     | 4.5   | 6   | $\Omega$      |
|               |                                                                                                                                                             | $I_D = 50\text{ mA}$ , $V_{CC} = 4.5\text{ V}$<br>$T_C = 125\text{ }^{\circ}\text{C}$                                                                              |     | 6.5   | 9   | $\Omega$      |
|               |                                                                                                                                                             | $I_D = 100\text{ mA}$ , $V_{CC} = 4.5\text{ V}$                                                                                                                    |     | 4.5   | 6   | $\Omega$      |

## 3.2 Switching characteristics

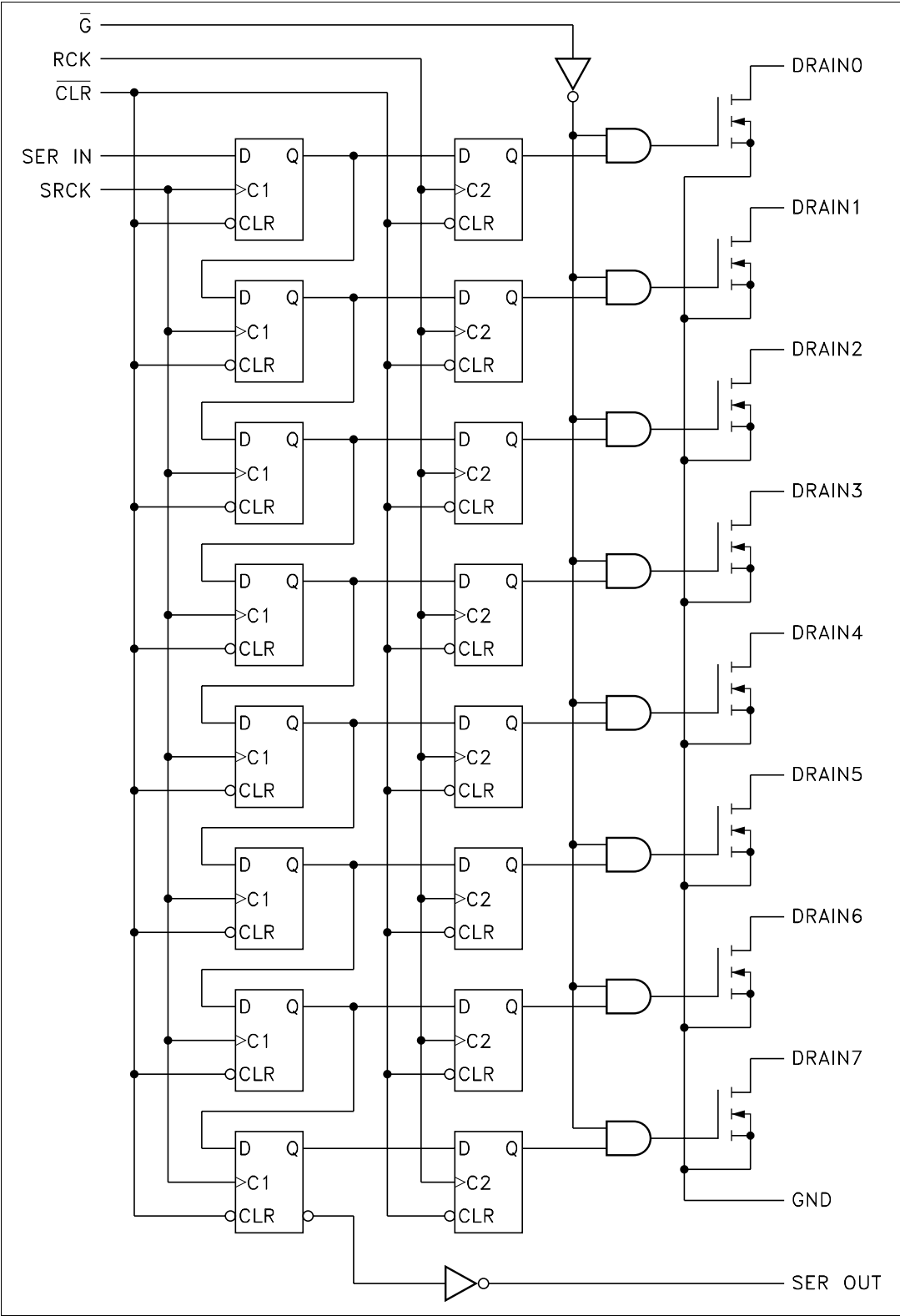
**Table 6. Switching characteristics** ( $V_{CC} = 5\text{ V}$ ,  $T_C = 25\text{ °C}$ , unless otherwise specified.)

| Symbol    | Parameter                                                            | Test conditions                                                                                                                                                                             | Min | Typ | Max | Unit |
|-----------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $t_{PHL}$ | Propagation delay time, high to low level output from $\overline{G}$ | $C_L = 30\text{ pF}$ , $I_D = 75\text{ mA}$<br>(See <a href="#">Figure 4</a> , <a href="#">Figure 5</a> , <a href="#">Figure 6</a> , <a href="#">Figure 7</a> , <a href="#">Figure 20</a> ) |     | 80  |     | ns   |
| $t_{PLH}$ | Propagation delay time, low to high level output from $\overline{G}$ |                                                                                                                                                                                             |     | 130 |     | ns   |
| $t_r$     | Rise time, drain output                                              |                                                                                                                                                                                             |     | 60  |     | ns   |
| $t_f$     | Fall time, drain output                                              |                                                                                                                                                                                             |     | 50  |     | ns   |
| $t_{pd}$  | propagation delay time                                               |                                                                                                                                                                                             |     | 20  |     | ns   |
| $t_a$     | Reverse recovery current rise time                                   | $I_F = 100\text{ mA}$ , $di/dt = 10\text{ A}/\mu\text{s}$<br>(See <a href="#">Figure 5</a> , <a href="#">Figure 6</a> , and <a href="#">Figure 9</a> , <a href="#">Figure 10</a> )          |     | 39  |     | ns   |
| $t_{rr}$  | Reverse recovery time                                                |                                                                                                                                                                                             |     | 115 |     | ns   |

- Note:
- 1 All voltage value are with respect to GND
  - 2 Each power DMOS source is internally connected to GND
  - 3 Pulse duration  $\leq 100\text{ }\mu\text{s}$  and duty cycle  $\leq 2\%$
  - 4 Drain supply voltage = 15 V, starting junction temperature ( $T_{JS}$ ) = 25 °C.  $L = 1.5\text{ H}$  and  $I_{AS} = 200\text{ mA}$  (see Fig. 11 and 12)
  - 5 Technique should limit  $T_J - T_C$  to 10 °C maximum
  - 6 These parameters are measured with voltage sensing contacts separate from the current-carrying contacts.
  - 7 Nominal current is defined for a consistent comparison between devices from different sources. It is the current that produces a voltage drop of 0.5 V at  $T_C = 85\text{ °C}$ .

4      **Logic diagram**

**Figure 3.    Logic diagram**



## 5 Typical operating circuit

Figure 4. Typical operation mode test circuits

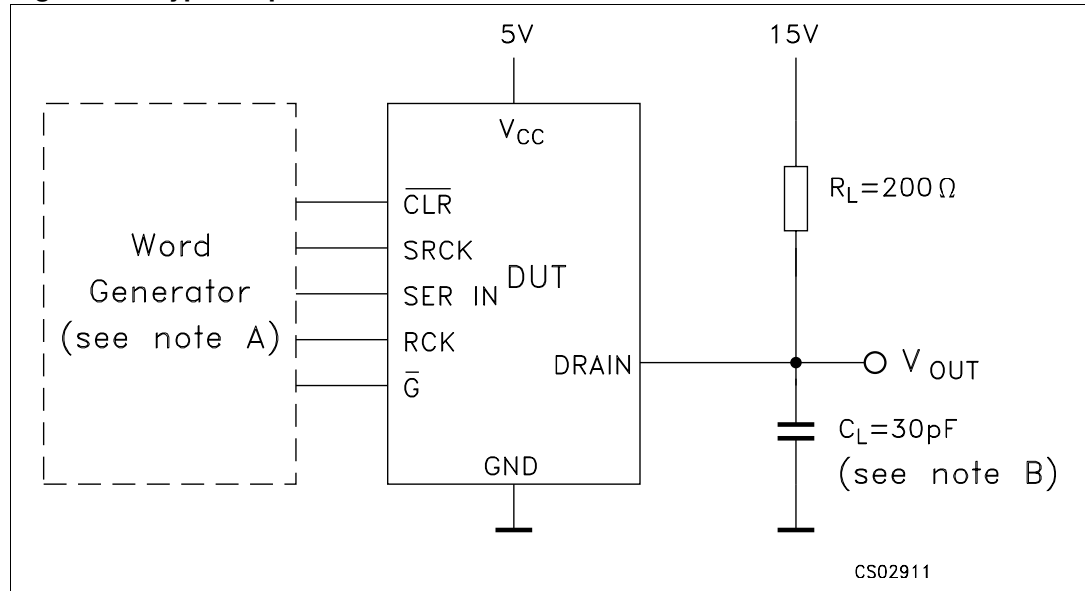
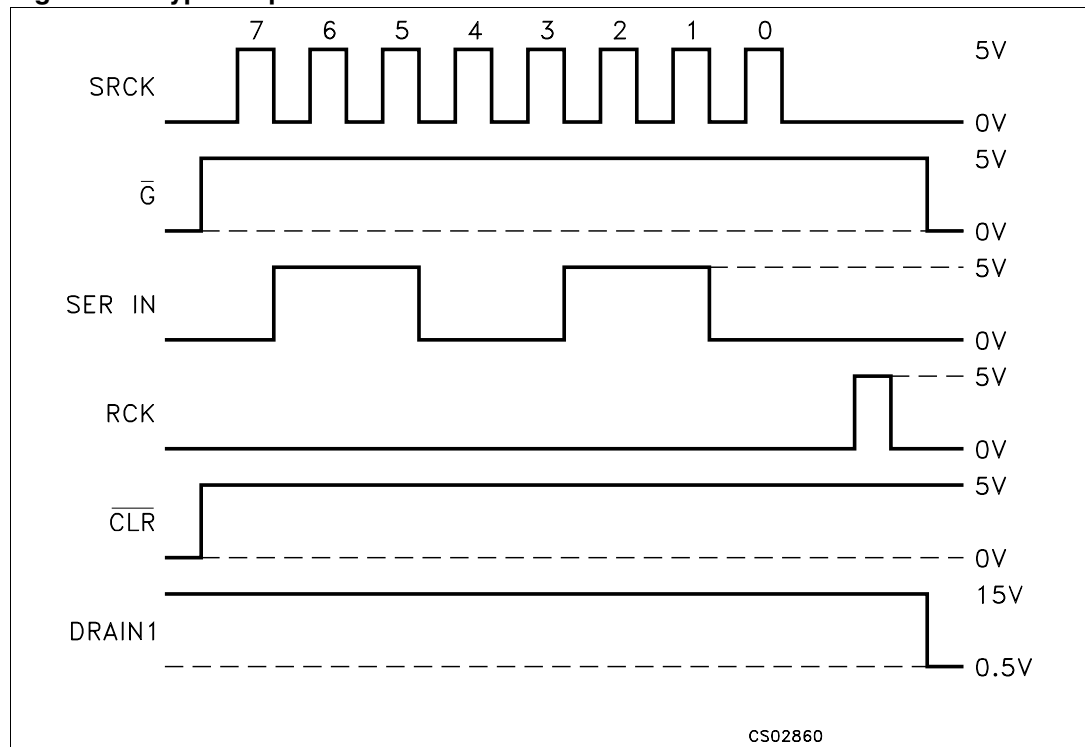


Figure 5. Typical operation mode waveforms



- Note:
- 1 A) The word generator has the following characteristics:  $t_r \leq 10\text{ ns}$ ,  $t_f \leq 10\text{ ns}$ ,  $t_W = 300\text{ ns}$ , pulse repetition rate (PRR) = 5 kHz,  $Z_O = 50\ \Omega$
  - 2 B)  $C_L$  includes probe and jig capacitance.

Figure 6. Typical operation mode test circuits

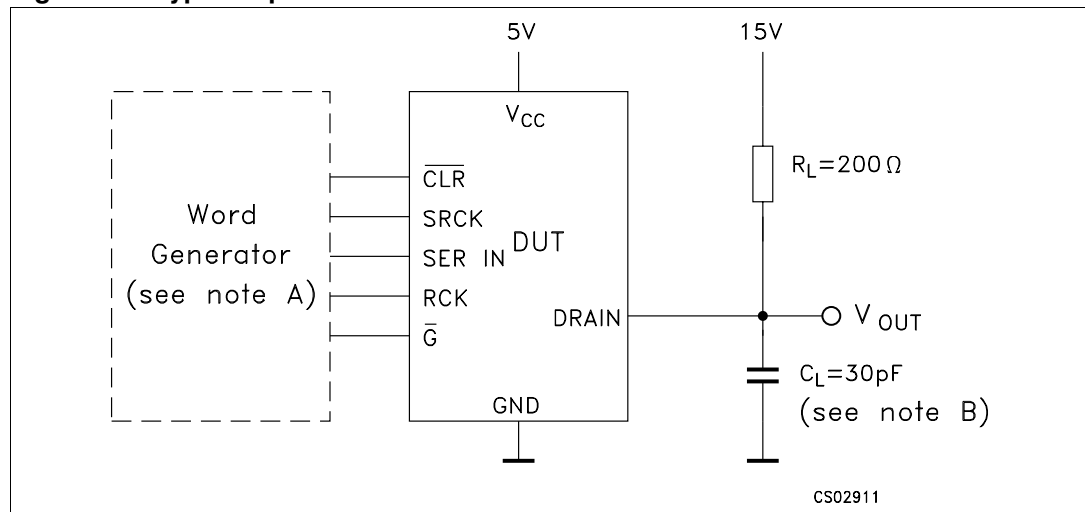


Figure 7. Switching time waveform

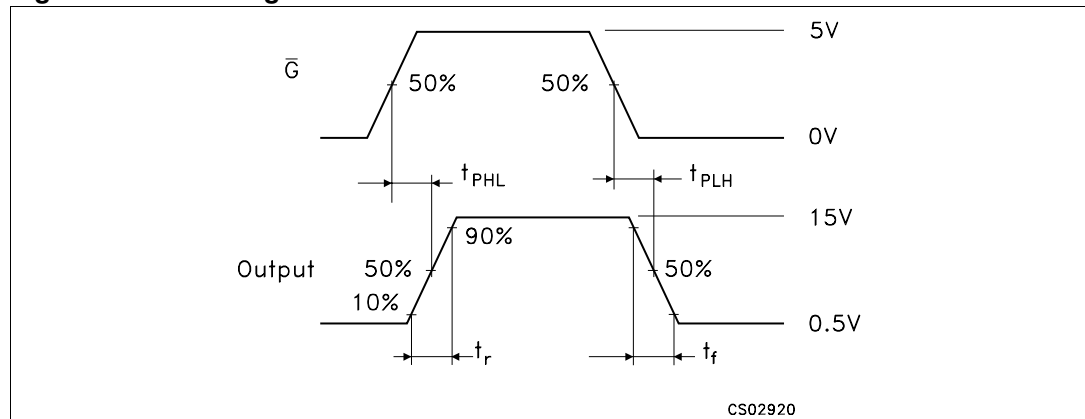
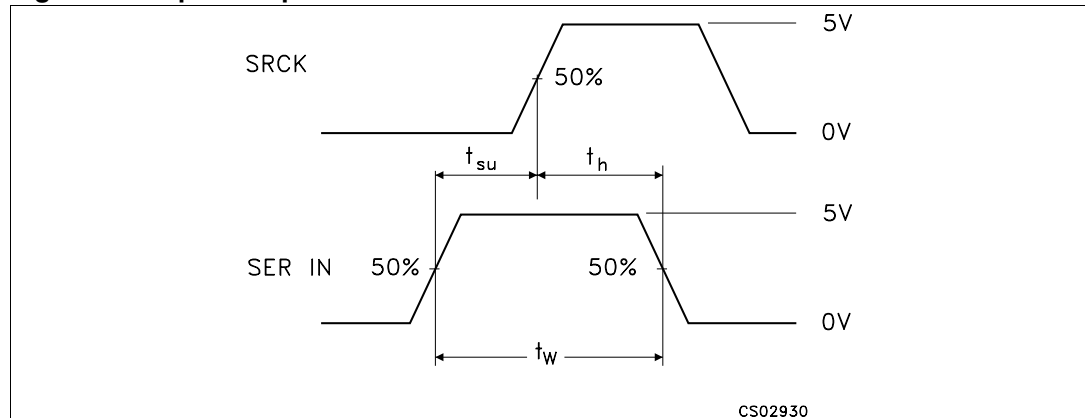


Figure 8. Input setup and hold waveform



- Note:
- 1 A) The word generator has the following characteristics:  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ ,  $t_W = 300 \text{ ns}$ , pulse repetition rate (PRR) = 5 kHz,  $Z_O = 50 \Omega$
  - 2 B)  $C_L$  includes probe and jig capacitance.

Figure 9. Reverse recovery current test circuits

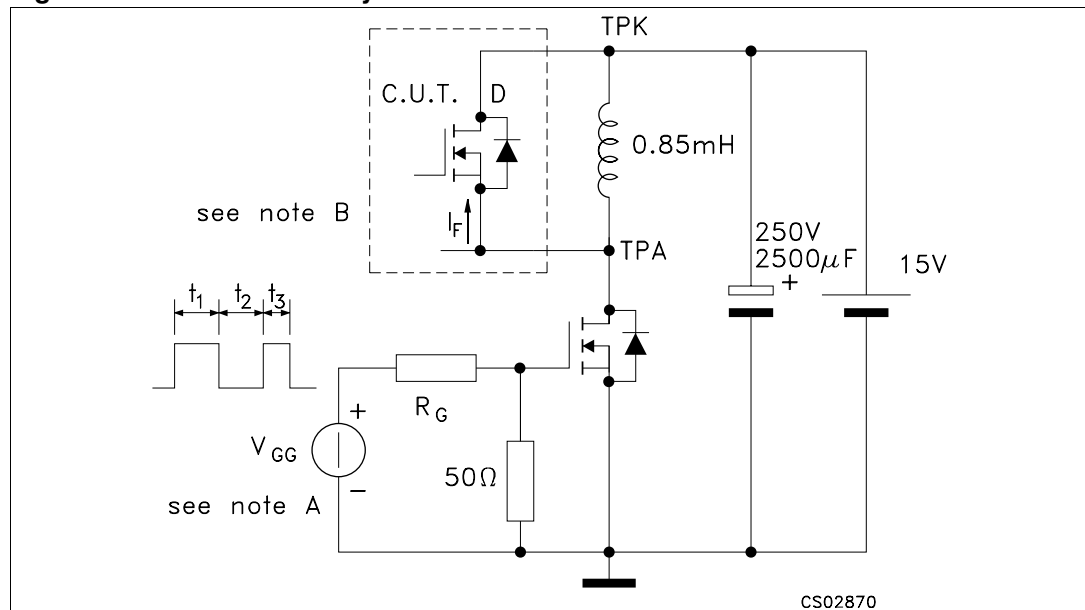
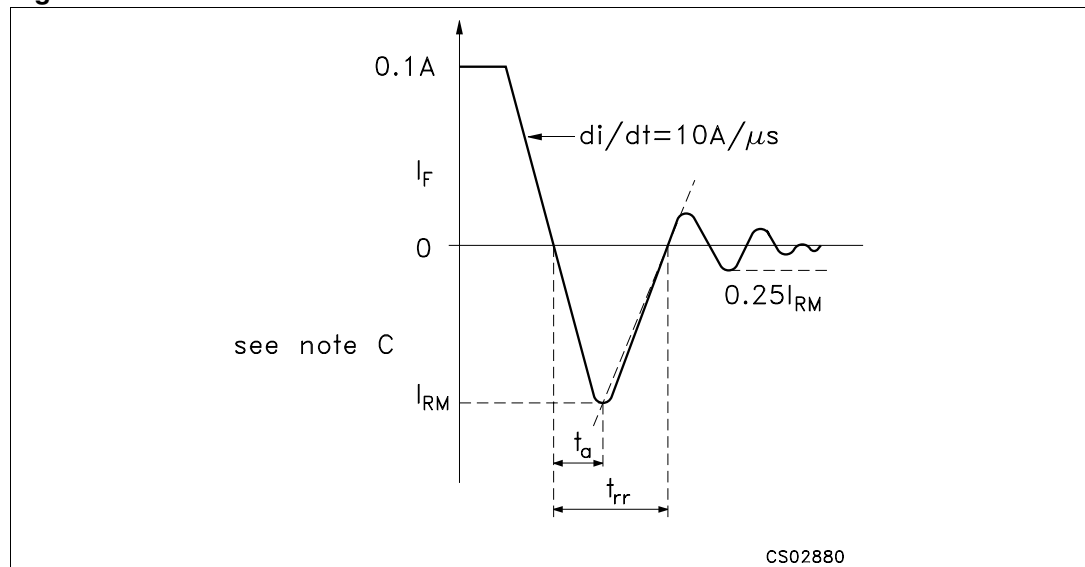


Figure 10. Source drain diode waveform



- Note:
- 1 A) The  $V_{GG}$  amplitude and  $R_G$  are adjusted for  $di/dt = 10 \text{ A}/\mu\text{s}$ . A  $V_{GG}$  double-pulse train is used to set  $I_F = 0.1 \text{ A}$ , where  $t_1 = 10 \mu\text{s}$ ,  $t_2 = 7 \mu\text{s}$  and  $t_3 = 3 \mu\text{s}$
  - 2 B) The drain terminal under test is connected to the TPK test point. All other terminals are connected together and connected to the TPA test point.
  - 3 C)  $I_{RM}$  = maximum recovery current.

Figure 11. Single pulse avalanche energy test circuits

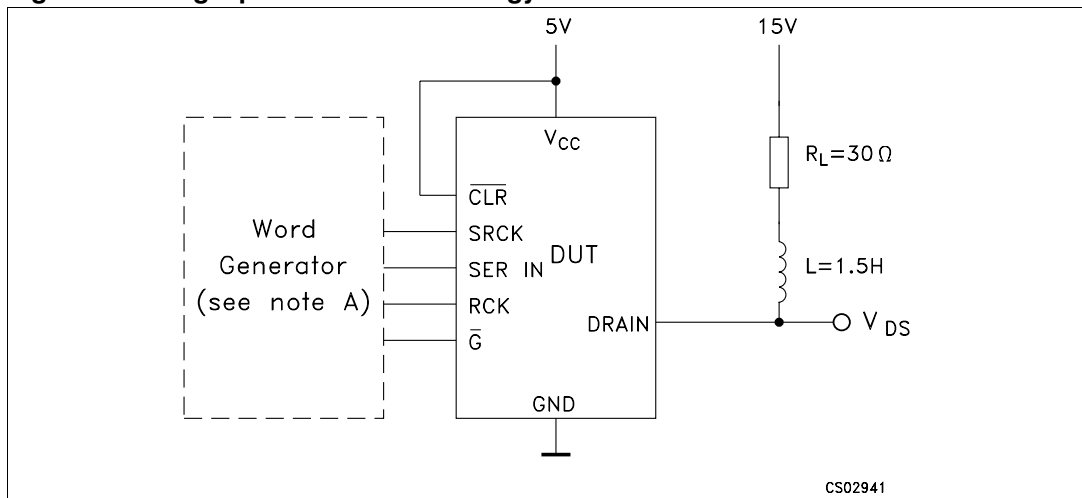
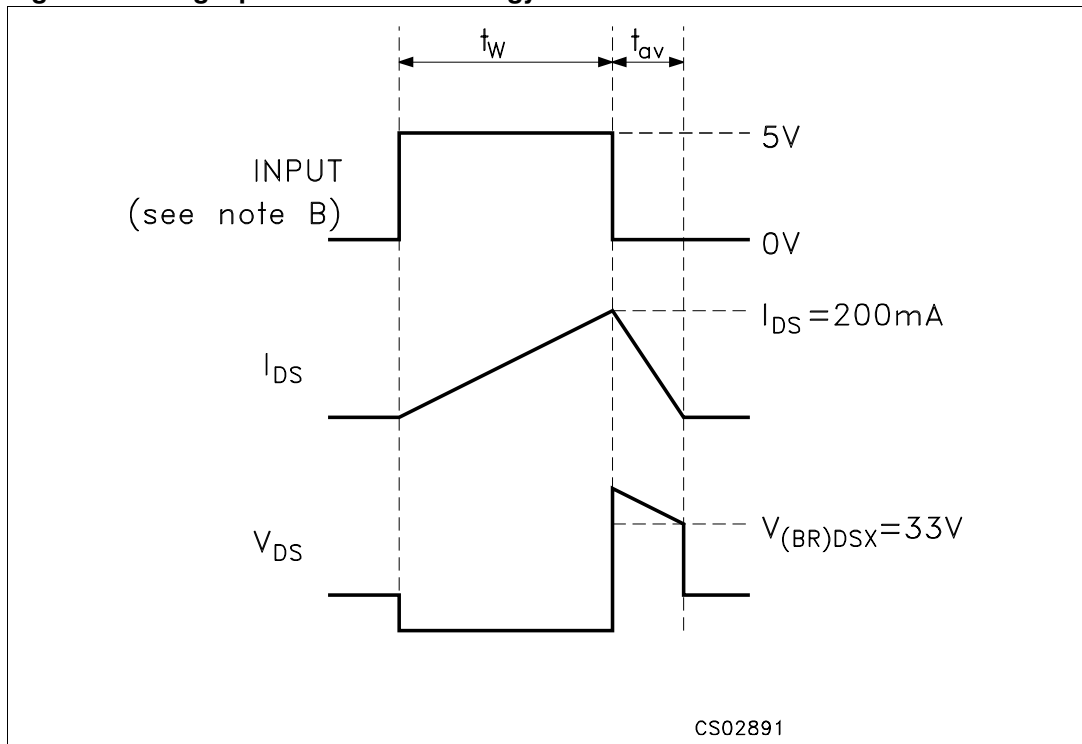


Figure 12. Single pulse avalanche energy waveform

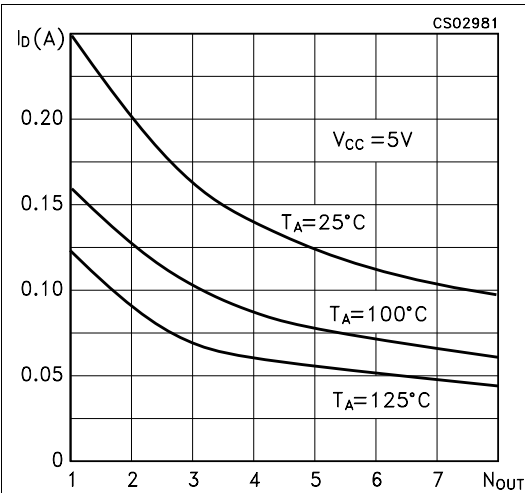


- Note:
- 1 A) The word generator has the following characteristics:  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ ,  $Z_O = 50 \Omega$
  - 2 B) Input pulse duration,  $t_W$  is increased until peak current  $I_{AS} = 200 \text{ mA}$ . Energy test level is defined as  $E_{AS} = (I_{AS} \times V_{(BR)DSX} \times t_{AV})/2 = 30 \text{ mJ}$ .

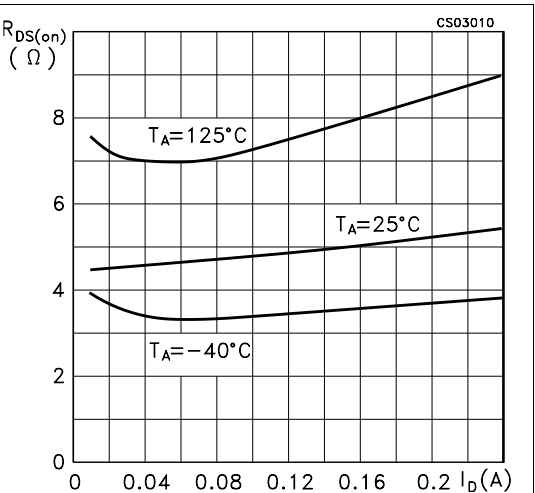
# 6 Typical performance and characteristics

(unless otherwise specified  $T_J = 25\text{ }^{\circ}\text{C}$ )

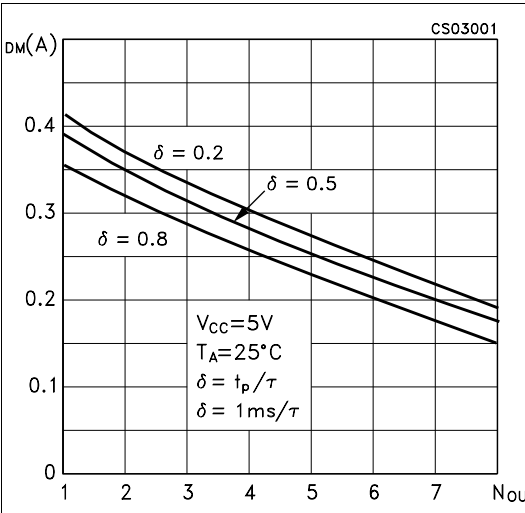
**Figure 13. Max continuous drain current vs number of outputs conducting simultaneously**



**Figure 14. Static drain-source on-state resistance vs drain current**



**Figure 15. Maximum peak drain current vs number of outputs conducting simultaneously**



**Figure 16. Static drain-source on-state resistance vs logic supply voltage**

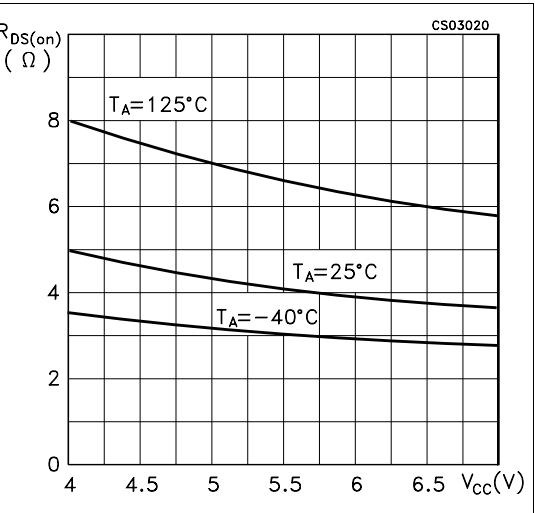


Figure 17. Peak avalanche current vs time duration of avalanche

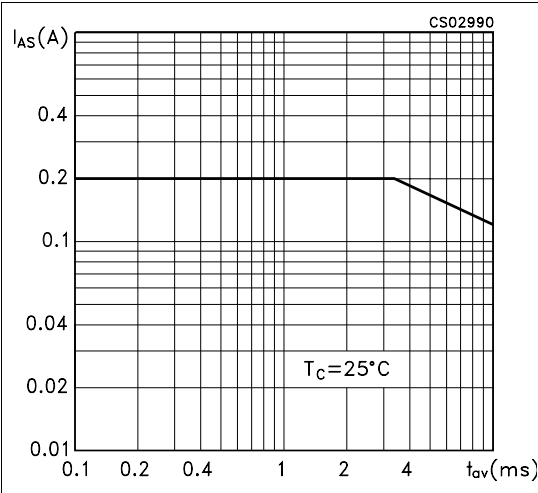


Figure 18. Supply current vs frequency

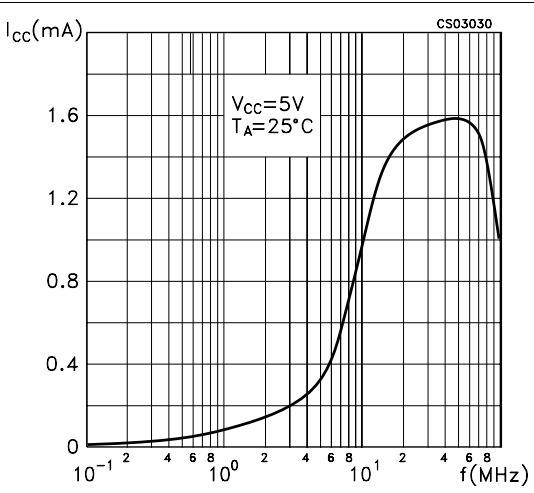


Figure 19. Supply current vs supply voltage

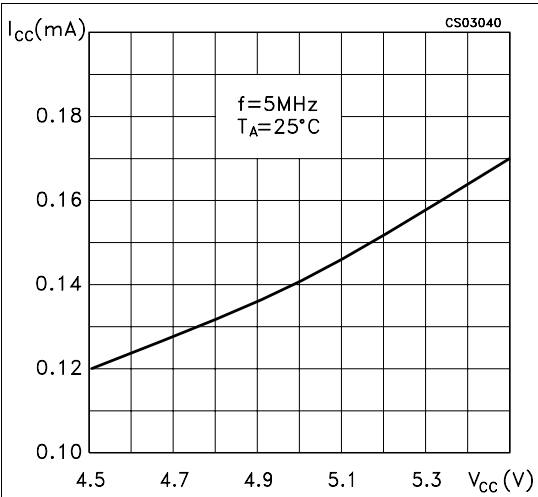


Figure 20. Switching time vs case temperature

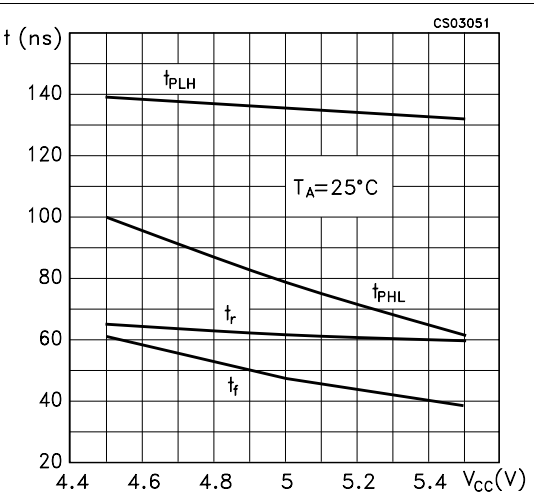
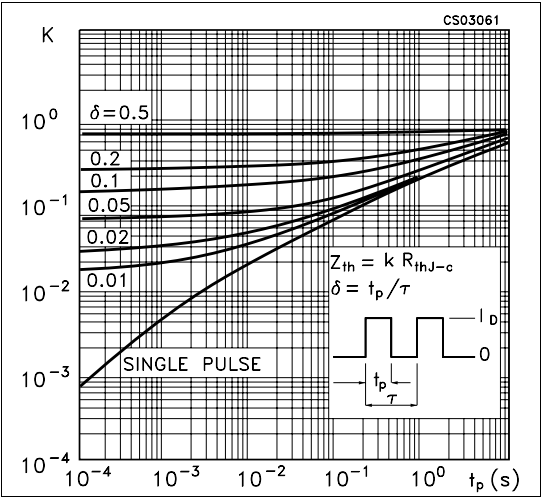


Figure 21. Normalized junction to ambient thermal resistance



## 7 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](http://www.st.com). ECOPACK® is an ST trademark.

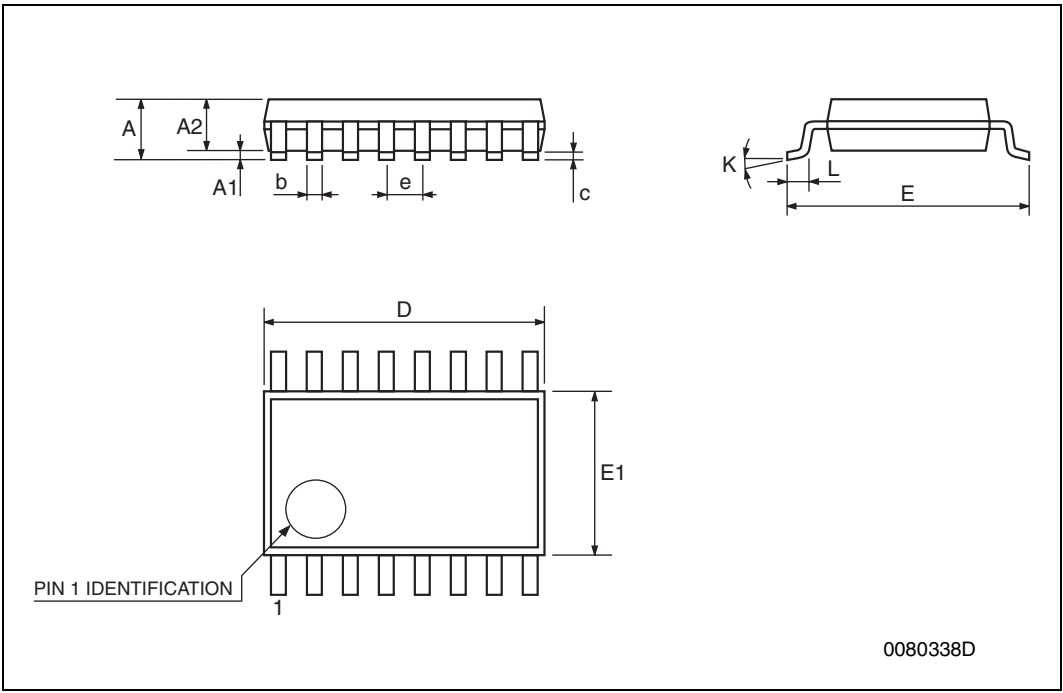
| SO-16 MECHANICAL DATA |            |      |      |       |       |       |
|-----------------------|------------|------|------|-------|-------|-------|
| DIM.                  | mm.        |      |      | inch  |       |       |
|                       | MIN.       | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A                     |            |      | 1.75 |       |       | 0.068 |
| a1                    | 0.1        |      | 0.25 | 0.004 |       | 0.010 |
| a2                    |            |      | 1.64 |       |       | 0.063 |
| 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                     | 9.8        |      | 10   | 0.385 |       | 0.393 |
| E                     | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e                     |            | 1.27 |      |       | 0.050 |       |
| e3                    |            | 8.89 |      |       | 0.350 |       |
| 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                     |            |      | 0.62 |       |       | 0.024 |
| S                     | 8° (max.)  |      |      |       |       |       |

0016020D

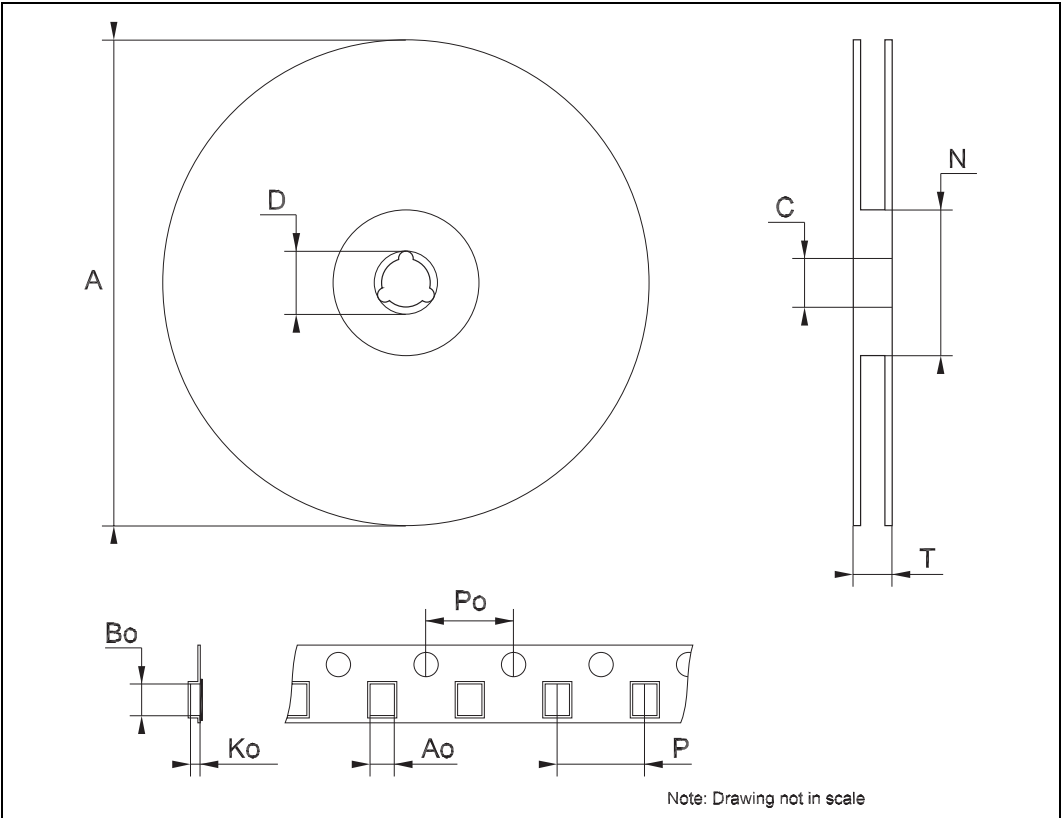
TSSOP16 MECHANICAL DATA

| DIM. | mm.  |          |      | inch  |            |        |
|------|------|----------|------|-------|------------|--------|
|      | MIN. | TYP      | MAX. | MIN.  | TYP.       | MAX.   |
| A    |      |          | 1.2  |       |            | 0.047  |
| 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  |



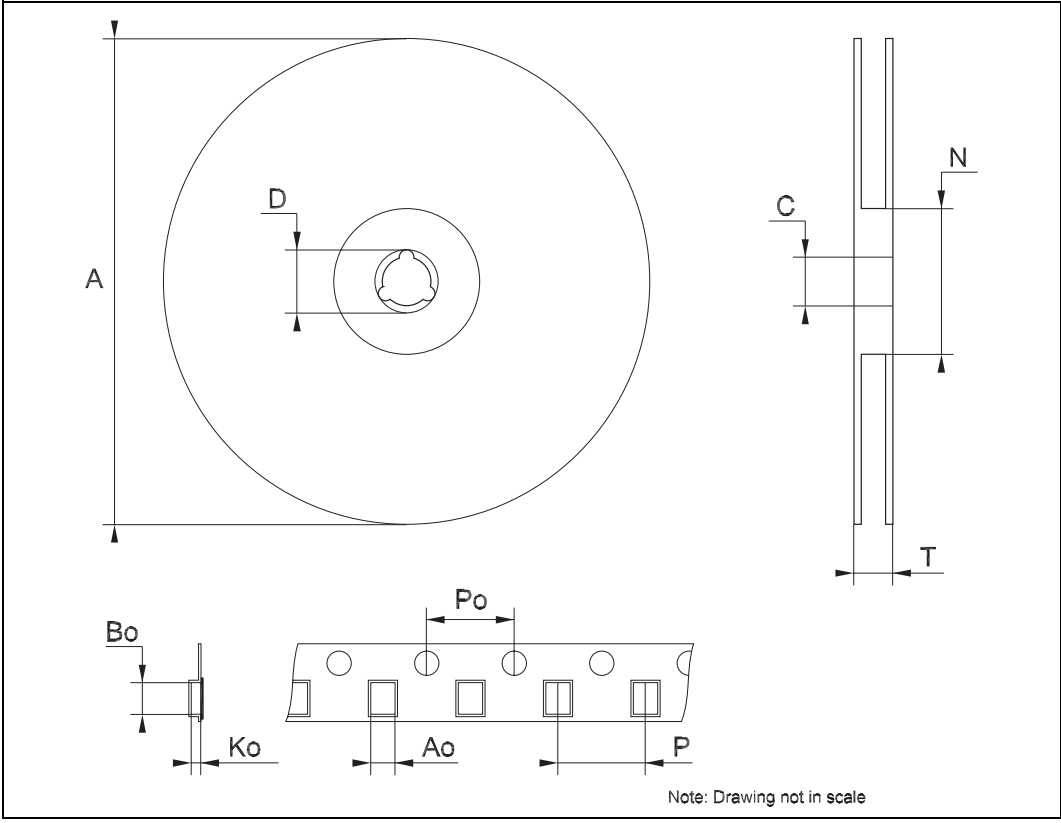
Tape & Reel SO-16 MECHANICAL DATA

| 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   | 6.45 |     | 6.65 | 0.254 |      | 0.262  |
| Bo   | 10.3 |     | 10.5 | 0.406 |      | 0.414  |
| 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  |



Tape & Reel TSSOP16 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   | 6.7  |     | 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  |



## 8 Revision history

**Table 7. Document revision history**

| Date        | Revision | Changes                                                                         |
|-------------|----------|---------------------------------------------------------------------------------|
| 07-Jul-2004 | 2        | Update <a href="#">Figure 3</a>                                                 |
| 07-May-2007 | 3        | Document reformatted, tube package deleted                                      |
| 21-May-2008 | 4        | Update: tsu and ThL values in <a href="#">Table 4</a> , ESD value on cover page |
| 16-Mar-2009 | 5        | Updated <a href="#">Table 5 on page 6</a>                                       |

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**Наши контакты:**

**Телефон:** +7 812 627 14 35

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Промышленная ул, дом № 19, литера Н,  
помещение 100-Н Офис 331