# STG3699B

## Low voltage 0.5 Ω max, quad SPDT switch with break-before-make feature

### Features

- High speed:
  - $t_{PD}$ = 1.5 ns (typ.) at $V_{CC}$ = 3.0 V
  - $t_{PD}$ = 1.5 ns (typ.) at $V_{CC}$ = 2.3 V
- Ultra low power dissipation:
  - $I_{CC}$ = 0.2 μA (max.) at $T_A$ = 85°C
- Low ON resistance $V_{IN}$ = 0 V:
  - $R_{ON}$ = 0.50 Ω (max. $T_A$ = 25°C) at $V_{CC}$ = 4.3 V
  - $R_{ON}$ = 0.55 Ω (max. $T_A$ = 25°C) at $V_{CC}$ = 3.0 V
  - $R_{ON}$ = 0.55 Ω (max. $T_A$ = 25°C) at $V_{CC}$ = 2.7 V
- Wide operating voltage range:
  - $V_{CC}$ (OPR) = 1.65 to 4.3 V single supply
- 4.3 V tolerant and 1.8 V compatible thresholds on digital control input at $V_{CC}$ = 2.3 to 3.0 V
- Latch-up performance exceed 300 mA (JESD 17)
- ESD performance (analog chan. vs. GND): HBM > 2 kV (MIL STD 883 method 3015)

### Description

The STG3699B is a high-speed CMOS low voltage quad analog SPDT (single-pole double-throw) switch or 2:1 multiplexer/demultiplexer switch fabricated using silicon gate $C^2$MOS technology. Designed to operate from 1.65 to 4.3 V, this device is ideal for portable applications.



**QFN16L (2.6 x 1.8 mm)**
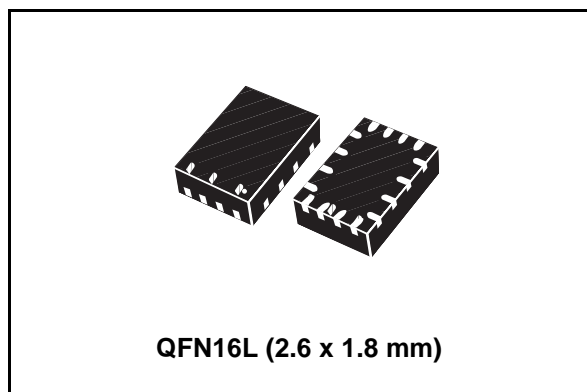
It offers very low ON resistance ($R_{ON}$ < 0.5 Ω) at $V_{CC}$ = 3.0 V. The nIN inputs are provided to control the independent channel switches nS1 and nS2. The switches nS1 are ON (connected to common ports Dn) when the nIN input is held high and OFF (state of high impedance exists between the two ports) when nIN is held low. The switches nS2 are ON (connected to common ports Dn) when the nIN input is held low and OFF (state of high impedance exists between the two ports) when IN is held high. Additional key features are fast switching speed, break-before-make delay time and ultra low power consumption. All inputs and outputs are equipped with protection circuits against static discharge, giving them ESD and excess transient voltage immunity.

The STG3699B is available in the commercial temperature range of -40 to 125°C in a QFN16L, 2.6 x 1.8 mm package.

**Table 1.     Device summary**

| Order code | Temperature range | Package | Packaging |
|---|---|---|---|
| STG3699BVTR | −40 to 125°C | QFN16L (2.6 x 1.8 mm) | Tape and reel |

# Contents

# 1 Summary description

## 1.1 Pin connection

**Figure 1. Connections diagram** (top through view)
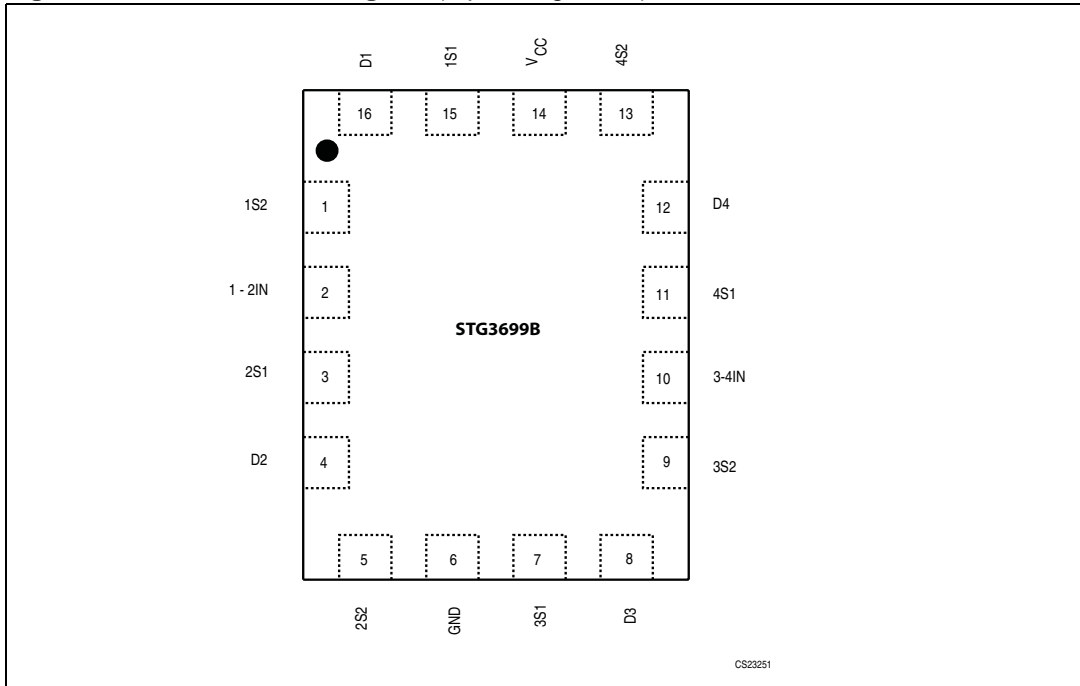


**Table 2. Pin description**

| Pin N° | Symbol | Name and function |
|---|---|---|
| 15, 3, 7, 11, 1, 5, 9, 13 | 1S1 to 4S1, 1S2 to 4S2 | Independent channels switches |
| 16, 4, 8, 12 | D1 to D4 | Common channels |
| 2, 10 | 1-2IN, 3-4IN | Input controls |
| 14 | $V_{CC}$ | Positive supply voltage |
| 6 | GND | Ground (0V) |

**Figure 2.    Input equivalent circuit**
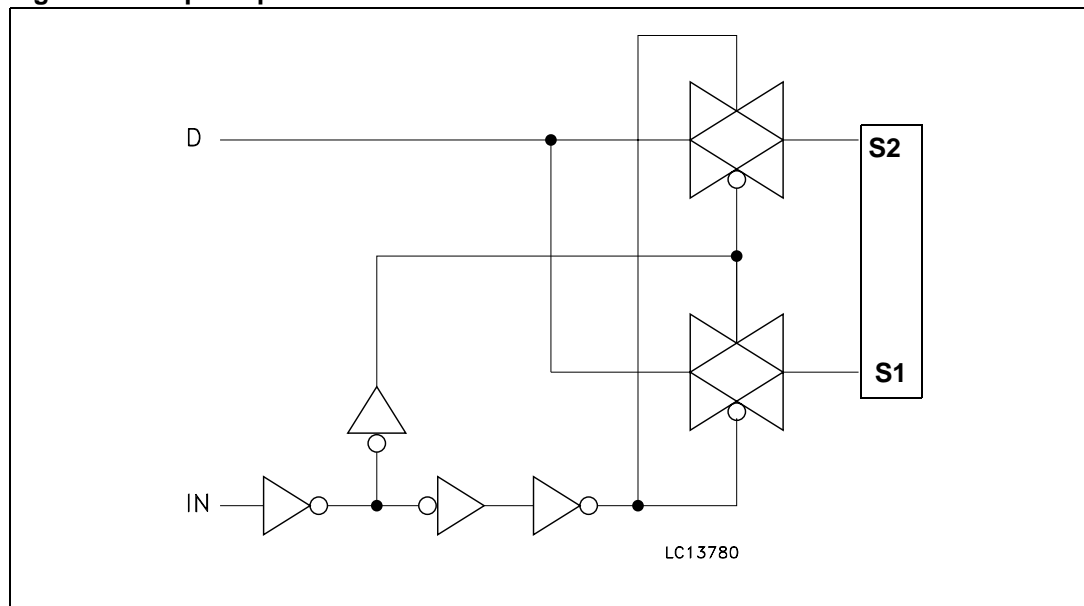


**Table 3.    Truth table**

| 1-2IN | 3-4IN | ON switches |
|-------|-------|-------------|
| L | - | 1S2-D1, 2S2-D2 |
| H | - | 1S1-D1, 2S1-D2 |
| - | L | 3S2-D3, 4S2-D4 |
| - | H | 3S1-D3, 4S1-D4 |

# 2 Maximum rating

Stressing the device above the rating listed in the "Absolute maximum ratings" table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

**Table 4.    Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage | −0.5 to 5.5 | V |
| $V_I$ | DC input voltage | −0.5 to $V_{CC}$ + 0.5 | V |
| $V_{IC}$ | DC control input voltage | −0.5 to 5.5 | V |
| $V_O$ | DC output voltage | −0.5 to $V_{CC}$ +0.5 | V |
| $I_{IKC}$ | DC input diode current on control pin ($V_{IN}$ < 0 V) | −50 | mA |
| $I_{IK}$ | DC input diode current ($V_{IN}$ < 0 V) | ±50 | mA |
| $I_{OK}$ | DC output diode current | ±50 | mA |
| $I_O$ | DC output current | ±300 | mA |
| $I_{OP}$ | DC output current peak (pulse at 1 ms, 10% duty cycle) | ±500 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or ground current | ±100 | mA |
| $P_D$ | Power dissipation at $T_A$ = 70°C [1] | 1120 | mW |
| $T_{STG}$ | Storage temperature | −65 to 150 | °C |
| $T_L$ | Lead temperature (10 sec) | 300 | °C |

1.  Derate above 70°C: by 18.5mW/°C.

**Table 5.    Recommended operating conditions**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply voltage (truth table guaranteed: 1.2 to 4.3 V) | | 1.65 to 4.3 | V |
| $V_I$ | Input voltage | | 0 to $V_{CC}$ | V |
| $V_{IC}$ | Control input voltage | | 0 to 4.3 | V |
| $V_O$ | Output voltage | | 0 to $V_{CC}$ | V |
| $T_{OP}$ | Operating temperature | | −55 to 125 | °C |
| dt/dv | Input rise and fall time control input | $V_{CC}$ = 1.65 to 2.7 V | 0 to 20 | ns/V |
| | | $V_{CC}$ = 3.0 to 4.3 V | 0 to 10 | |

# 3 DC and AC parameters

**Table 6. DC specification**

| Symbol | Parameter | $V_{CC}$ (V) | Test condition | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| $V_{IH}$ | High level input voltage | 1.65 – 1.95 | | 0.65 $V_{CC}$ | | | 0.65 $V_{CC}$ | | 0.65 $V_{CC}$ | | V |
| | | 2.3 – 2.5 | | 1.2 | | | 1.2 | | 1.2 | | |
| | | 2.7 – 3.0 | | 1.3 | | | 1.3 | | 1.3 | | |
| | | 3.3 | | 1.4 | | | 1.4 | | 1.4 | | |
| | | 3.6 | | 1.5 | | | 1.5 | | 1.5 | | |
| | | 4.3 | | 1.6 | | | 1.6 | | 1.6 | | |
| $V_{IL}$ | Low level input voltage | 1.65 – 1.95 | | | | 0.25 | | 0.25 | | 0.25 | V |
| | | 2.3 – 2.5 | | | | 0.25 | | 0.25 | | 0.25 | |
| | | 2.7 – 3.0 | | | | 0.25 | | 0.25 | | 0.25 | |
| | | 3.3 | | | | 0.30 | | 0.30 | | 0.30 | |
| | | 3.6 | | | | 0.30 | | 0.30 | | 0.30 | |
| | | 4.3 | | | | 0.40 | | 0.40 | | 0.40 | |
| $R_{ON}$ | Switch ON resistance | 4.3 | $V_S$ = 0 V to $V_{CC}$ $I_S$ = 100 mA | | 0.35 | 0.50 | | 0.60 | | | Ω |
| | | 3.0 | | | 0.45 | 0.55 | | 0.65 | | | |
| | | 2.7 | | | 0.45 | 0.55 | | 0.65 | | | |
| | | 2.3 | | | 0.45 | 0.70 | | 0.80 | | | |
| | | 1.8 | | | 0.55 | 1.5 | | 2.0 | | | |
| | | 1.65 | | | 0.65 | 1.5 | | 2.0 | | | |
| $\Delta R_{ON}$ | ON resistance match between channels [1] | 2.7 | $V_S$ at $R_{ON}$ max $I_S$ = 100 mA | | 0.15 | | | | | | Ω |
| $R_{FLAT}$ | ON resistance flatness [2] | 4.3 | $V_S$ = 0 V to $V_{CC}$ $I_S$ = 100 mA | | 0.15 | 0.20 | | 0.20 | | | Ω |
| | | 3.0 | | | 0.20 | 0.25 | | 0.25 | | | |
| | | 2.7 | | | 0.20 | 0.25 | | 0.25 | | | |
| | | 2.3 | | | 0.20 | 0.25 | | 0.25 | | | |
| | | 1.65 | | | 0.32 | 0.42 | | 0.42 | | | |
| $I_{OFF}$ | OFF state leakage current (nSn), (Dn) | 4.3 | $V_S$ = 0.3 or 4 V | | | ±20 | | ±100 | | | nA |

**Table 6.** DC specification (continued)

| Symbol | Parameter | V$_{CC}$ (V) | Test condition | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | T$_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| I$_{IN}$ | Input leakage current | 0 – 4.3 | V$_{IN}$ = 0 to 4.3V | | | ±0.1 | | ±1 | | | µA |
| I$_{CC}$ | Quiescent supply current | 1.65 – 4.3 | V$_{IN}$ = V$_{CC}$ or GND | | | ±0.05 | | ±0.2 | | ±1 | µA |
| I$_{CCLV}$ | Quiescent supply current low voltage driving | 4.3 | V$_{1-2IN}$, V$_{3-4IN}$ = 1.65 V | | ±37 | ±50 | | ±100 | | | µA |
| | | | V$_{1-2IN}$, V$_{3-4IN}$ = 1.80 V | | ±33 | ±40 | | ±50 | | | |
| | | | V$_{1-2IN}$, V$_{3-4IN}$ = 2.60 V | | ±12 | ±20 | | ±30 | | | |

1. $\Delta R_{ON} = R_{ON(Max)} - R_{ON(Min)}$

2. Flatness is defined as the difference between the maximum and minimum value of ON resistance as measured over the specified analog signal ranges.

**Table 7.** AC electrical characteristics (C$_L$ = 35 pF, R$_L$ = 50 Ω, t$_r$ = t$_f$ ≤5 ns)

| Symbol | Parameter | V$_{CC}$ (V) | Test condition | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | T$_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| t$_{PLH}$,t$_{PHL}$ | Propagation delay | 1.65 – 1.95 | V$_I$ = OPEN | | 0.45 | | | | | | ns |
| | | 2.3 – 2.7 | | | 0.40 | | | | | | |
| | | 3.0 – 3.3 | | | 0.30 | | | | | | |
| | | 3.6 – 4.3 | | | 0.30 | | | | | | |
| t$_{ON}$ | Turn-ON time | 1.65 – 1.95 | V$_S$ = 0.8 V | | 120 | | | | | | ns |
| | | 2.3 – 2.7 | | | 45 | 55 | | 65 | | | |
| | | 3.0 – 3.3 | V$_S$ = 1.5 V | | 42 | 55 | | 65 | | | |
| | | 3.6 – 4.3 | | | 40 | 55 | | 65 | | | |
| t$_{OFF}$ | Turn-OFF time | 1.65 – 1.95 | V$_S$ = 0.8 V | | 22 | | | | | | ns |
| | | 2.3 – 2.7 | | | 18 | 30 | | 40 | | | |
| | | 3.0 – 3.3 | V$_S$ = 1.5 V | | 16 | 30 | | 40 | | | |
| | | 3.6 – 4.3 | | | 15 | 30 | | 40 | | | |

**Table 7. AC electrical characteristics** ($C_L$ = 35 pF, $R_L$ = 50 Ω, $t_r$ = $t_f$ ≤5 ns) (continued)

| Symbol | Parameter | $V_{CC}$ (V) | Test condition | Value | | | | | | | Unit |
|--------|-----------|-----------|----------------|-------|-----|-----|-----|-----|-----|-----|------|
| | | | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| $t_D$ | Break-before- make time delay | 1.65 – 1.95 | $C_L$ = 35 pF $R_L$ = 50 Ω $V_S$ = 1.5 V | | 53 | | | | | | ns |
| | | 2.3 – 2.7 | | | 28 | | | | | | |
| | | 3.0 – 3.3 | | | 12 | | | | | | |
| | | 3.6 – 4.3 | | | 8 | | | | | | |
| Q | Charge injection | 1.65 – 1.95 | $C_L$=100 pF $R_L$= 1 MΩ $V_{GEN}$ = 0 V $R_{GEN}$ = 0 Ω | | 42 | | | | | | pC |
| | | 2.3 – 2.7 | | | 48 | | | | | | |
| | | 3.0 – 3.3 | | | 48 | | | | | | |
| | | 3.6 – 4.3 | | | 57 | | | | | | |

**Table 8. Analog switch characteristics** ($C_L$ = 5 pF, $R_L$ = 50 Ω, $T_A$ = 25° C)

| Symbol | Parameter | $V_{CC}$ (V) | Test condition | Value | | | | | | | Unit |
|--------|-----------|-----------|----------------|-------|-----|-----|-----|-----|-----|-----|------|
| | | | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| OIRR [1] | Off Isolation | 1.65 – 4.3 | $V_S$ = 1$V_{RMS}$ f = 100 kHz | | −71 | | | | | | dB |
| Xtalk | Crosstalk | 1.65 – 4.3 | $V_S$ =1 $V_{RMS}$ f = 100 kHz | | −72 | | | | | | dB |
| THD | Total harmonic distortion | 2.3 – 4.3 | $R_L$ = 600 Ω $V_{IN}$ = 2$V_{PP}$ f = 20 Hz to 20 kHz | | 0.03 | | | | | | % |
| BW | -3dB Bandwidth | 1.65 – 4.3 | $R_L$= 50 Ω | | 40 | | | | | | MHz |
| $C_{IN}$ | Control pin input capacitance | | | | 5 | | | | | | pF |
| $C_{Sn}$ | Sn port capacitance | 3.3 | f = 1 MHz | | 80 | | | | | | |
| $C_D$ | D port capacitance when switch is enabled | 3.3 | f = 1 MHz | | 170 | | | | | | |

1. Off-isolation = 20 $\log_{10}$ ($V_D$/$V_S$), $V_D$ = output, $V_S$ = input to off switch

# 4        Typical application

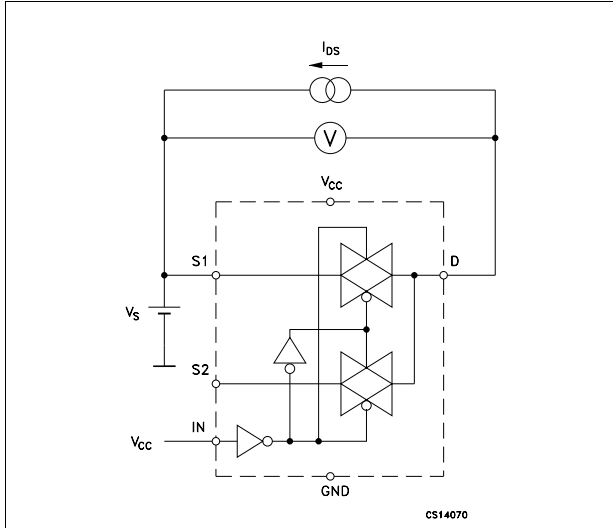Figure 3.        ON resistance



Figure 4.        Bandwidth


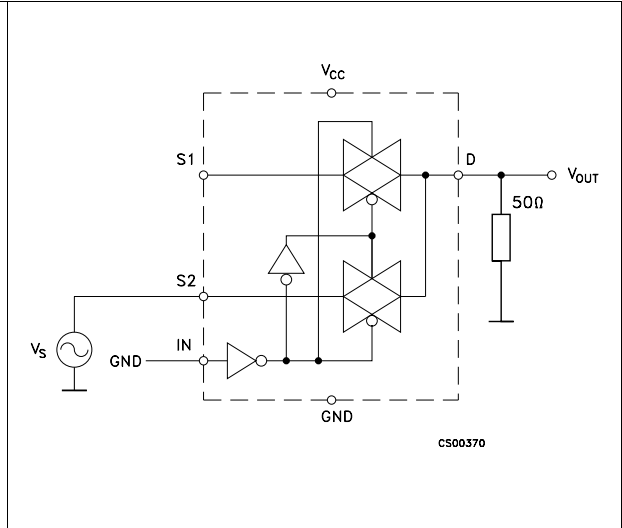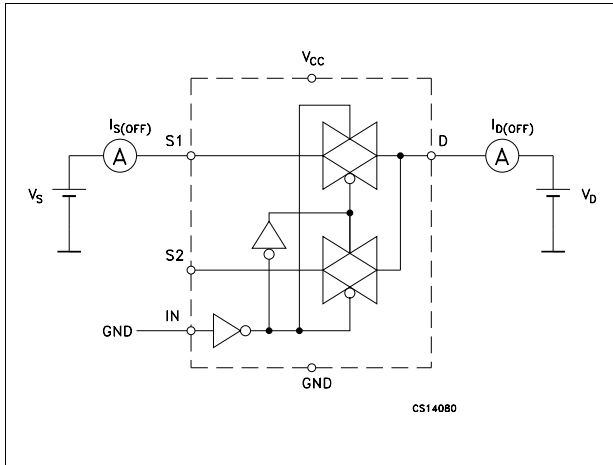
Figure 5.        OFF leakage



Figure 6.        Channel-to-channel crosstalk
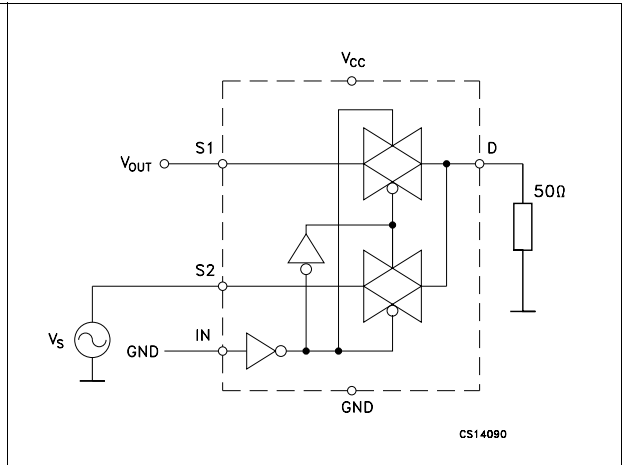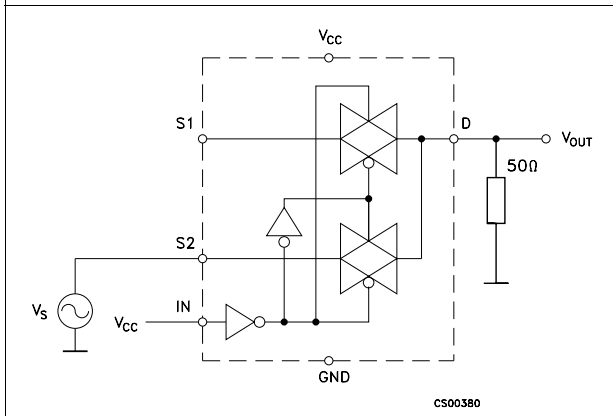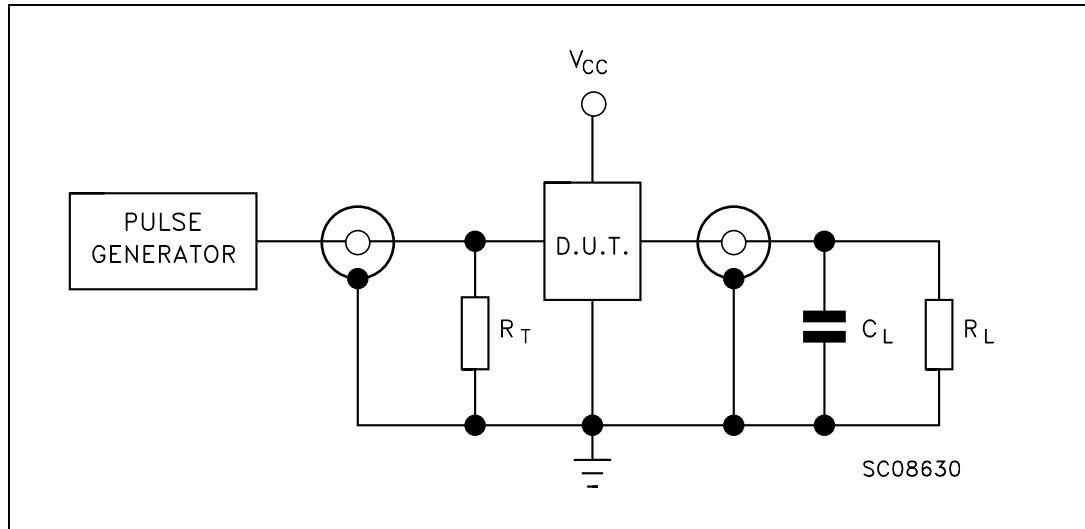


Figure 7.        OFF isolation

# 5    Test circuit

**Figure 8.    Test circuit**



$C_L$ = 5/35 pF or equivalent (includes jig and probe capacitance)

$R_L$ = 50 $\Omega$ or equivalent

$R_T$ = $Z_{OUT}$ of pulse generator (typically 50 $\Omega$)
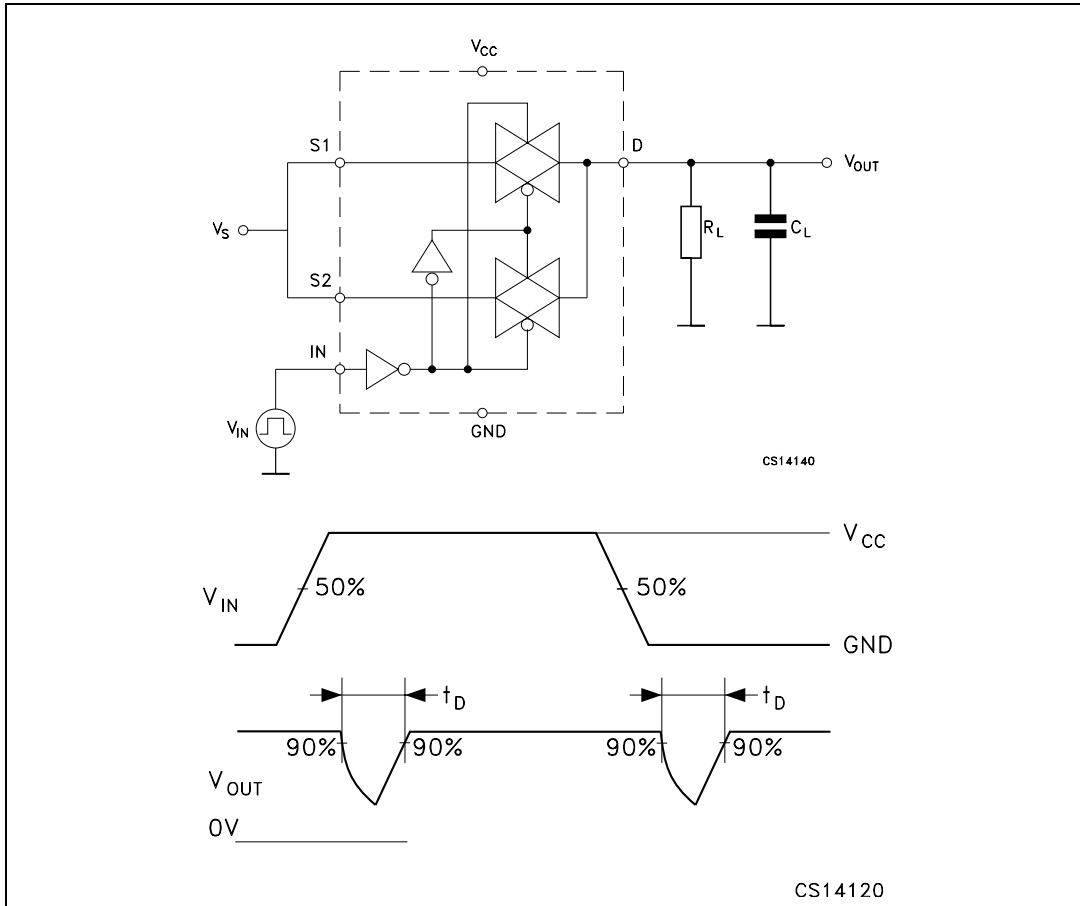
# 6        Waveforms

**Figure 9.        Break-before-make time delay**

**Figure 10. Switching time and charge injection** ($V_{GEN}$ = 0 V, $R_{GEN}$ = 0 $\Omega$, $R_L$ = 1 M$\Omega$, $C_L$ = 100 pF)
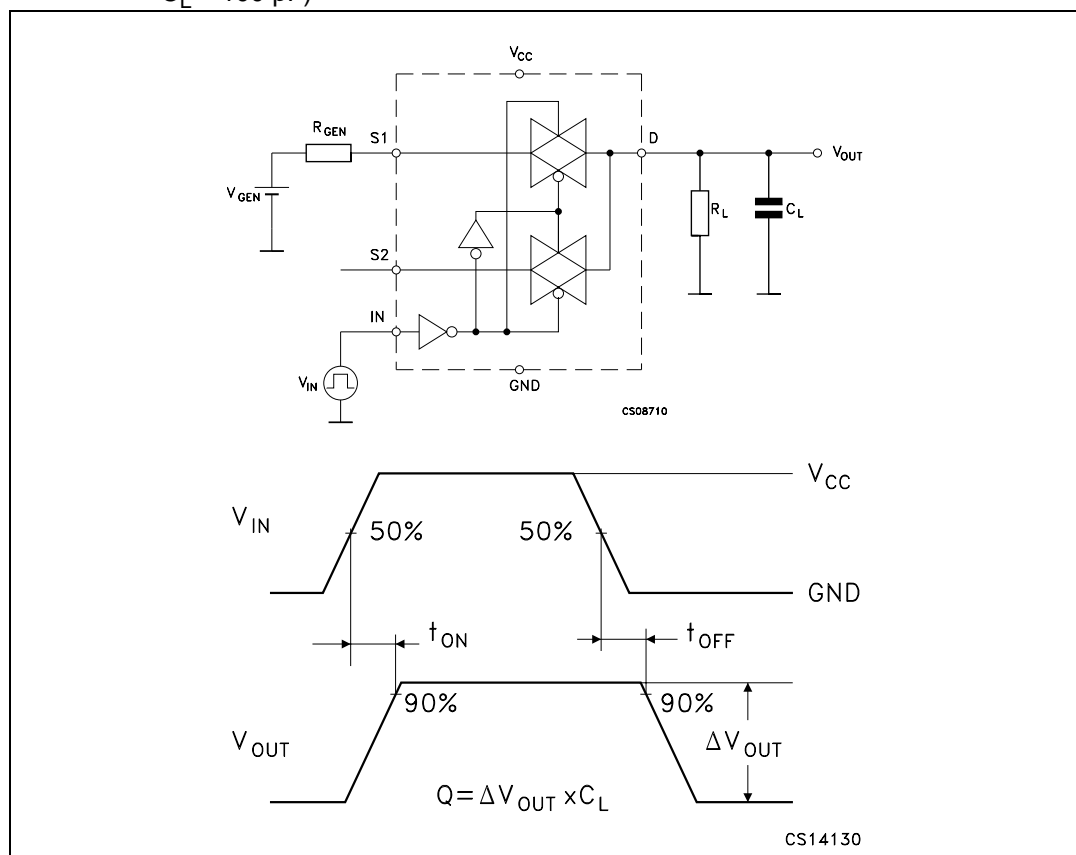
**Figure 11.   Turn ON, Turn OFF delay time**
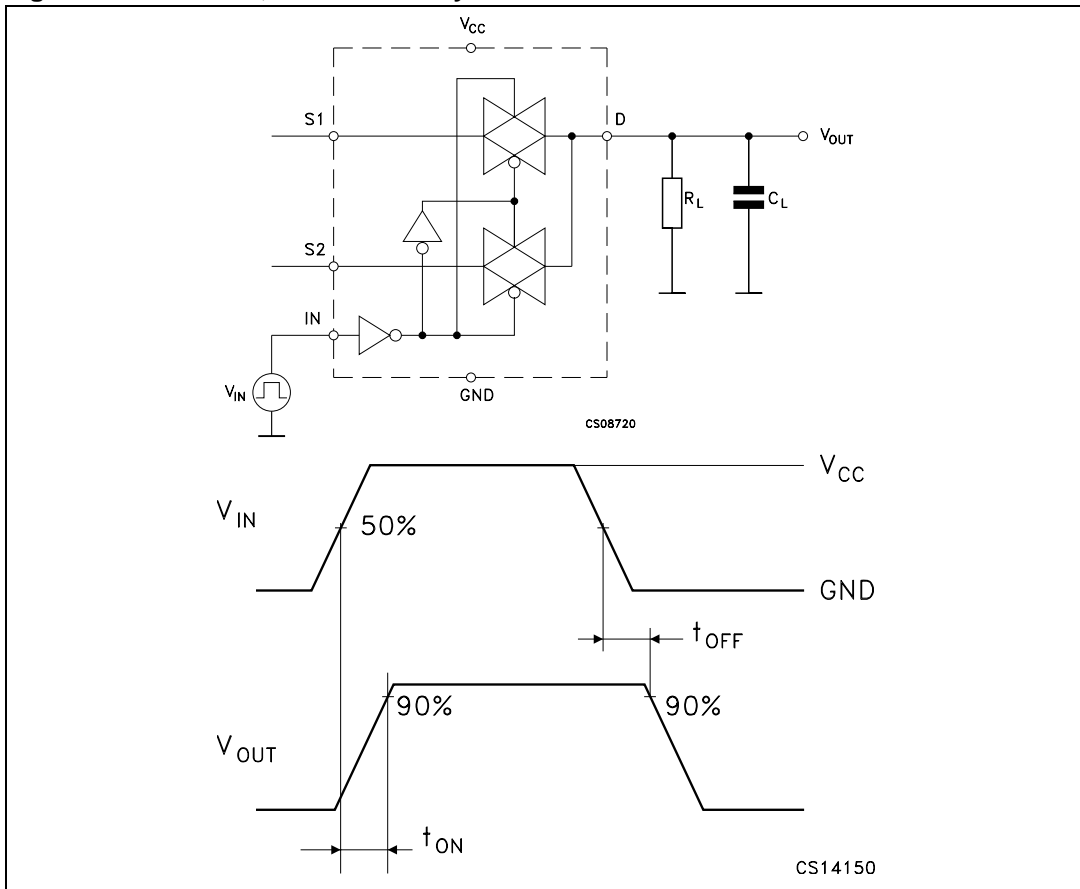
# 7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK®
packages. These packages have a Lead-free second level interconnect. The category of
second Level Interconnect is marked on the package and on the inner box label, in
compliance with JEDEC Standard JESD97. The maximum ratings related to soldering
conditions are also marked on the inner box label. ECOPACK is an ST trademark.
ECOPACK specifications are available at: www.st.com.

**Figure 12.  QFN16L (2.6 x 1.8 mm) package outline**
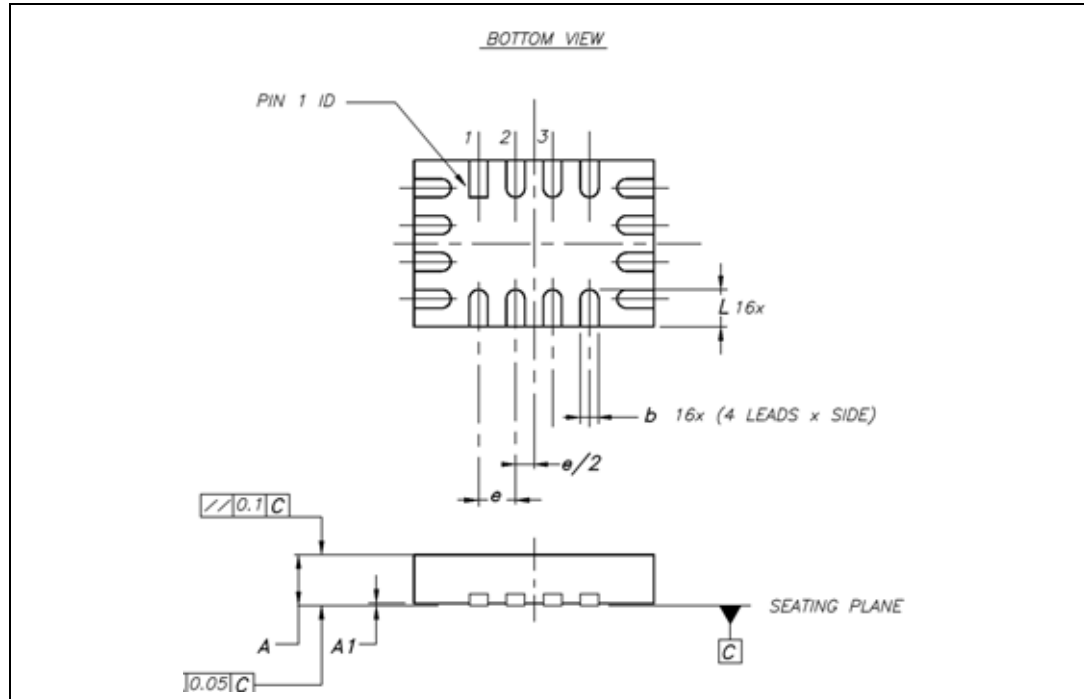


1.  Drawing not to scale.

**Table 9.  QFN16L (2.6 x 1.8 mm) mechanical data**

| Dimensions | | | |
|---|---|---|---|
| **Symbol** | **Databook (mm)** | | |
| | **Nom** | **Min** | **Max** |
| A | 0.55 | 0.45 | 0.60 |
| A1 | 0.02 | 0 | 0.05 |
| b | 0.20 | 0.15 | 0.25 |
| D | 2.60 | 2.50 | 2.70 |
| E | 1.80 | 1.70 | 1.90 |
| e | 0.40 | | |
| L | 0.40 | 0.35 | 0.45 |

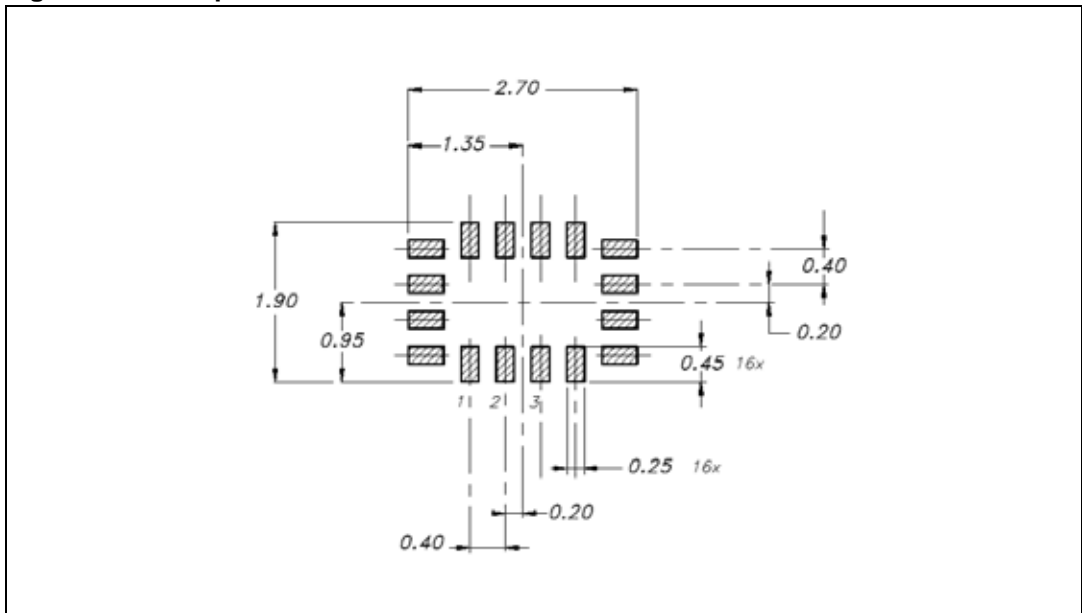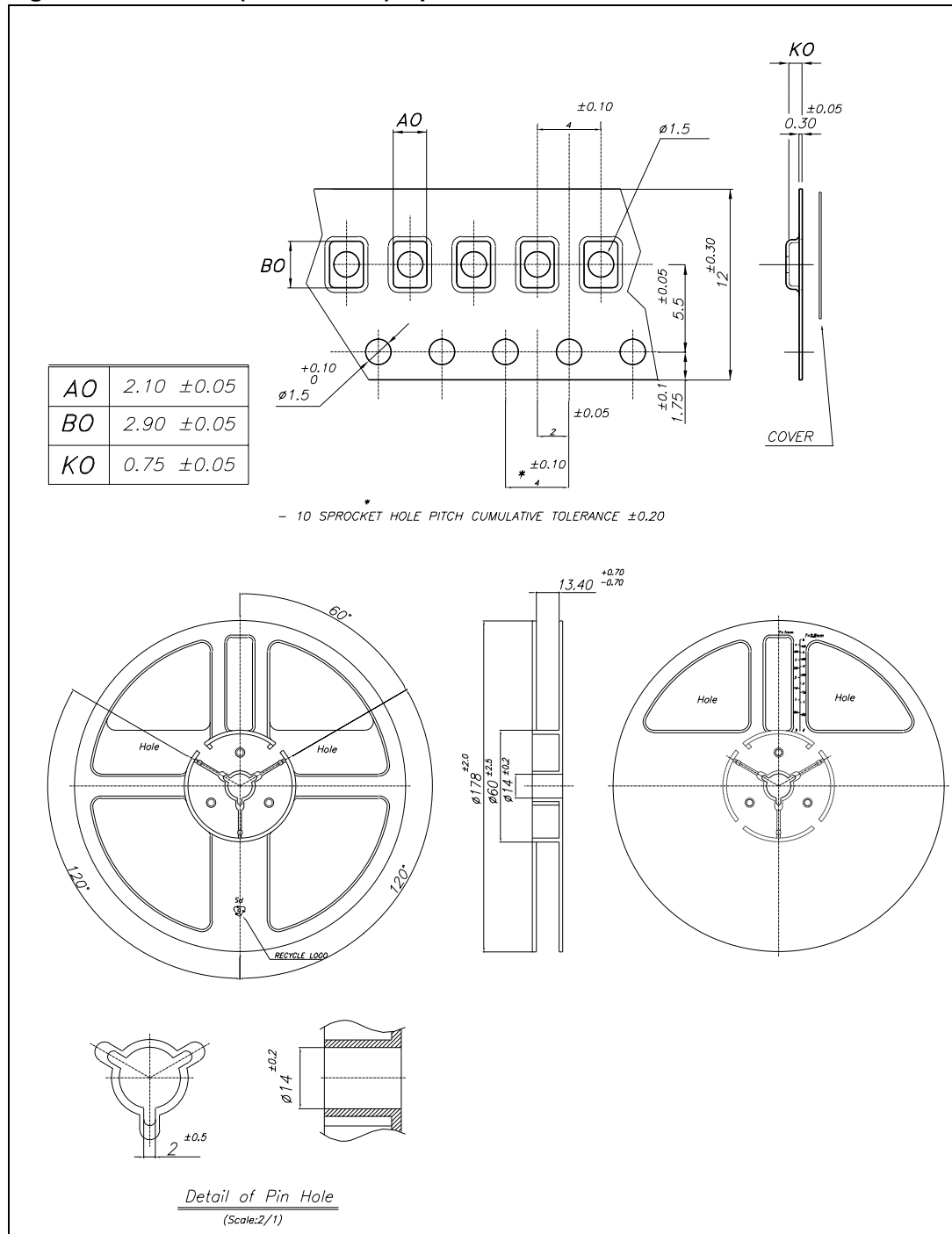**Figure 13.    Footprint recommendations**

**Figure 14. QFN16L (2.6 x 1.8 mm) tape & reel information**

# 8 Revision history

**Table 10. Document revision history**

| Date | Revision | Changes |
|------|----------|---------|
| 13-Oct-2005 | 1 | First Release. |
| 21-Dec-2005 | 2 | Added tape & reel information. |
| 17-Feb-2006 | 3 | $R_{FLAT}$ updated it *Table 6: DC specification on page 6*. |
| 10-Aug-2006 | 4 | New template, *Table 1* updated. |
| 19-Feb-2007 | 5 | Updated OIRR, Xtalk valuers in *Table 8 on page 8*. |
| 4-Sept-2007 | 6 | Updated $I_{OK}$ value in *Table 4 on page 5*, small text changes, restructured layout. |

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