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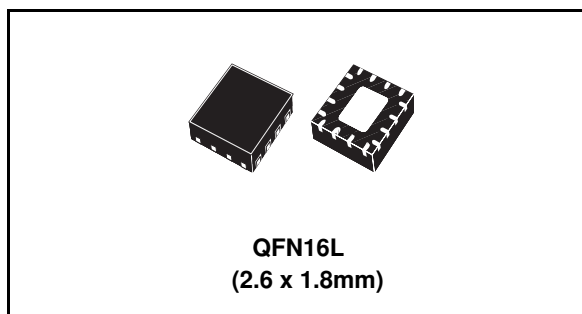
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



## Low voltage high bandwidth Quad SPDT switch

### Features

- Ultra low power dissipation:
  - $I_{CC} = 0.2\mu\text{A}$  (Max.) at  $T_A = 85^\circ\text{C}$
- Low “ON” resistance:
  - $R_{ON} = 4\Omega$  ( $T_A = 25^\circ\text{C}$ ) at  $V_{CC} = 3.0\text{V}$
- Wide operating voltage range:
  - $V_{CC}$  (Opr) = 1.65V to 4.3V single supply
- 4.3V tolerant and 1.8V compatible threshold on digital control input at  $V_{CC} = 2.3\text{V}$  to 3.0V
- Typical bandwidth (-3dB) at 800MHz on all channels
- Latch-up performance exceeds 100mA per JESD 78, Class II
- ESD performance exceeds JESD22
  - 2000-V Human body model (A114-A)
- USB (2.0) high speed (480Mbps) signal switching compliant



### Description

The STG3693 is a high-speed CMOS low voltage quad analog SPDT (Single Pole Dual Throw) switch or 2:1 Multiplexer /Demultiplexer Switch fabricated in silicon gate C2MOS technology. It is designed to operate from 1.65V to 4.3V, making this device ideal for portable applications.

The nSEL inputs are provided to control the switch. The switch S1 is ON (they are connected to common Ports Dn) when the nSEL input is held high and OFF (high impedance state exists between the two ports) when SEL is held low; the switch S2 is ON (it is connected to common Port D) when the nSEL input is held low and OFF (high impedance state exists between the two ports) when nSEL 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 immunity and transient excess voltage.

**Table 1. Device summary**

| Order code | Package                | Packaging     |
|------------|------------------------|---------------|
| STG3693QTR | QFN16L (2.6mm x 1.8mm) | Tape and reel |

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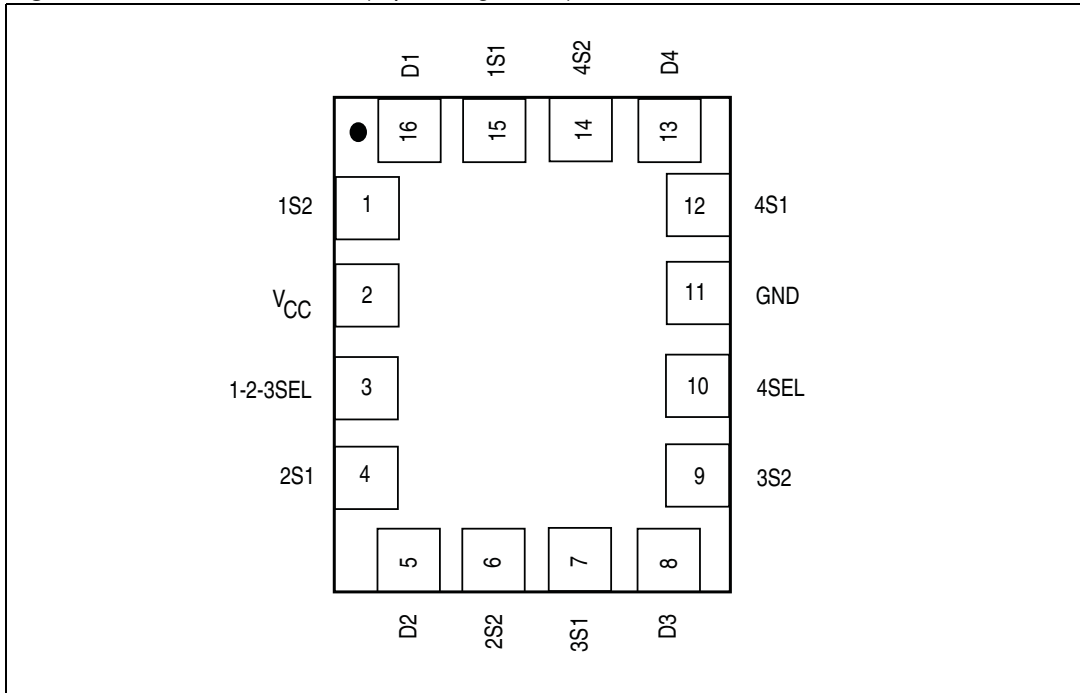
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# 1 Pin settings

## 1.1 Pin connection

Figure 1. Pin connection (top through view)



## 1.2 Pin description

Table 2. Pin description

| Pin N°                         | Symbol  | Name and function       |
|--------------------------------|---|-------------------------|
| 15,1,<br>4,6,<br>7,9,<br>12,14 | 1S1, 1S2,<br>2S1, 2S2,<br>3S1, 3S2,<br>4S1, 4S2 | Independent channels    |
| 16,5,8,13                      | D1, D2, D3, D4                                  | Common channels         |
| 3, 10                          | 1-2-3SEL,<br>4SEL                               | Control                 |
| 2                              | V <sub>CC</sub>                                 | Positive supply voltage |
| 11                             | GND   | Ground (0V)             |

Note: Exposed pad must be soldered to a floating plane. Do NOT connect to power or ground.

## 2 Device summary

Figure 2. Input equivalent circuit

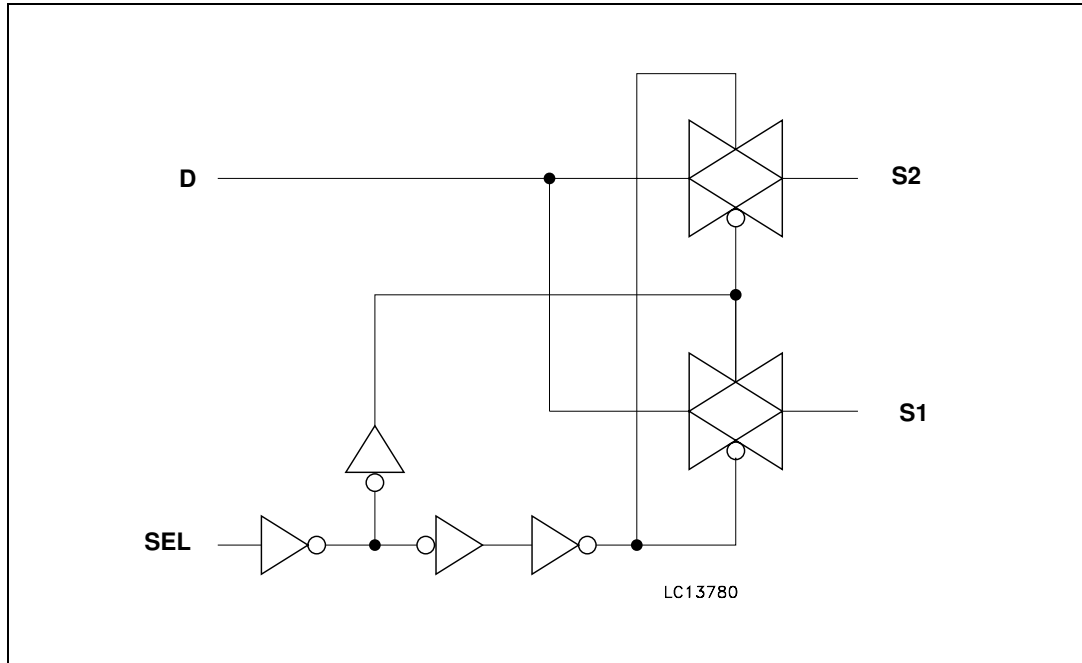


Table 3. Truth table

| 1-2-3SEL | 4SEL | SWITCH 1 | SWITCH 2 | SWITCH 3 | SWITCH 4 |
|----------|------|----------|----------|----------|----------|
| H        | X    | D1-1S1   | D2-2S1   | D3-3S1   | X        |
| L        | X    | D1-1S2   | D2-2S2   | D3-3S2   | X        |
| X        | H    | X        | X        | X        | 4D-4S1   |
| X        | L    | X        | X        | X        | 4D-4S2   |

### 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 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 ( $V_{SEL} < 0V$ ) | -50                    | mA         |
| $I_{IK}$              | DC input diode current ( $V_{SEL} < 0V$ )                | $\pm 50$               | mA         |
| $I_{OK}$              | DC output diode current                                  | $\pm 20$               | mA         |
| $I_O$                 | DC output current  | $\pm 128$              | mA         |
| $I_{OP}$              | DC output current peak (pulse at 1ms, 10% duty cycle)    | $\pm 300$              | mA         |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or ground current                            | $\pm 100$              | mA         |
| $P_D$                 | Power dissipation at $T_A = 70^\circ C$ <sup>(1)</sup>   | 1120                   | mW         |
| $T_{stg}$             | Storage temperature                                      | -65 to 150             | $^\circ C$ |
| $T_L$                 | Lead temperature (10 sec)                                | 300                    | $^\circ C$ |

1. Derate above 70 $^\circ C$  by 18.5mW/ $^\circ C$

### 3.1 Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol   | Parameter                              | Value                      | Unit       |
|----------|--|----------------------------|------------|
| $V_{CC}$ | Supply voltage                         | 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                 | $^\circ C$ |
| dt/dv    | Input rise and fall time control input | $V_{CC} = 1.65V$ to $2.7V$ | 0 to 20    |
|          |  | $V_{CC} = 3.0$ to $4.3V$   | 0 to 10    |

# 4 Electrical characteristics

**Table 6. DC Specifications**

| Symbol            | Parameter                            | Test conditions     |  | Value                 |      |      |                     |     | Unit |
|-------------------|--------------------------------------|---------------------|--|-----------------------|------|------|---------------------|-----|------|
|                   |                                      | V <sub>CC</sub> (V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C         |     |      |
|                   |                                      |                     |  | Min                   | Typ  | Max  | Min                 | Max |      |
| V <sub>IH</sub>   | High level input voltage             | 1.65-1.95           |  | 0.65V <sub>CC</sub>   |      |      | 0.65V <sub>CC</sub> |     | V    |
|                   |                                      | 2.3-2.5             |  | 1.2                   |      |      | 1.2                 |     |      |
|                   |                                      | 2.7-3.0             |  | 1.3                   |      |      | 1.3                 |     |      |
|                   |                                      | 3.3-3.6             |  | 1.4                   |      |      | 1.4                 |     |      |
|                   |                                      | 4.3                 |  | 1.6                   |      |      | 1.6                 |     |      |
| V <sub>IL</sub>   | Low level input voltage              | 1.65-1.95           |  |                       |      | 0.25 |                     |     | V    |
|                   |                                      | 2.3-2.5             |  |                       |      | 0.25 |                     |     |      |
|                   |                                      | 2.7-3.0             |  |                       |      | 0.25 |                     |     |      |
|                   |                                      | 3.3-3.6             |  |                       |      | 0.30 |                     |     |      |
|                   |                                      | 4.3                 |  |                       |      | 0.40 |                     |     |      |
| R <sub>PEAK</sub> | Switch ON peak resistance            | 1.8                 | V <sub>S</sub> = 0V to V <sub>CC</sub><br>I <sub>S</sub> = 8mA |                       | 12.0 | 16.0 |                     |     | Ω    |
|                   |                                      | 2.7                 |  |                       | 6.3  | 8.0  |                     |     |      |
|                   |                                      | 3.0                 |  |                       | 5.8  | 7.5  |                     |     |      |
|                   |                                      | 3.7                 |  |                       | 5.0  | 6.5  |                     |     |      |
|                   |                                      | 4.3                 |  |                       | 4.6  | 6.0  |                     |     |      |
| R <sub>ON</sub>   | Switch On resistance                 | 3.0                 | V <sub>S</sub> = 3V I <sub>S</sub> = 8mA                       |                       | 4.0  | 5.2  |                     |     | Ω    |
|                   |                                      | 3.0                 | V <sub>S</sub> = 0.8V I <sub>S</sub> = 8mA                     |                       | 5.0  | 6.5  |                     |     |      |
| ΔR <sub>ON</sub>  | ON resistance match between channels | 1.8                 | V <sub>S</sub> @ R <sub>ON</sub> Max<br>I <sub>S</sub> = 8mA   |                       |      |      |                     |     | Ω    |
|                   |                                      | 2.7                 |  |                       |      |      |                     |     |      |
|                   |                                      | 3.0                 |  |                       | 0.3  |      |                     |     |      |
|                   |                                      | 3.7                 |  |                       |      |      |                     |     |      |
|                   |                                      | 4.3                 |  |                       |      |      |                     |     |      |
| R <sub>FLAT</sub> | ON resistance flatness               | 1.8                 | V <sub>S</sub> = 0V to V <sub>CC</sub><br>I <sub>S</sub> = 8mA |                       | 6.6  |      |                     |     | Ω    |
|                   |                                      | 2.7                 |  |                       | 2.0  |      |                     |     |      |
|                   |                                      | 3.0                 |  |                       | 1.7  |      |                     |     |      |
|                   |                                      | 3.7                 |  |                       | 1.5  |      |                     |     |      |
|                   |                                      | 4.3                 |  |                       | 1.6  |      |                     |     |      |

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

| Symbol            | Parameter                                    | Test conditions |  | Value                 |     |      |             |      | Unit |
|-------------------|--|-----------------|--|-----------------------|-----|------|-------------|------|------|
|                   |  | Vcc (V)         |  | T <sub>A</sub> = 25°C |     |      | -40 to 85°C |      |      |
|                   |  |                 |  | Min                   | Typ | Max  | Min         | Max  |      |
| I <sub>OFF</sub>  | OFF state leakage current (SN), (D)          | 4.3             | V <sub>S</sub> = 0.3 or 4V                         |                       |     | ±20  |             | ±100 | nA   |
| I <sub>IN</sub>   | Input leakage current                        | 0 to 4.3        | V <sub>SEL</sub> = 0 to 4.3V                       |                       |     | ±0.1 |             | ±1   | µA   |
| I <sub>CC</sub>   | Quiescent supply current                     | 1.65 to 4.3     | V <sub>SEL</sub> = V <sub>CC</sub> or GND          |                       |     | ±0.1 |             | ±1.0 | µA   |
| I <sub>CCLV</sub> | Quiescent supply current low voltage driving | 4.3             | V <sub>1-2-3SEL</sub> , V <sub>4-SEL</sub> = 1.65V |                       | ±37 | ±50  |             | ±100 | µA   |
|                   |  |                 | V <sub>1-2-3SEL</sub> , V <sub>4-SEL</sub> = 1.80V |                       | ±33 | ±40  |             | ±50  |      |
|                   |  |                 | V <sub>1-2-3SEL</sub> , V <sub>4-SEL</sub> = 2.60V |                       | ±11 | ±20  |             | ±30  |      |

**Table 7. AC electrical characteristics (C<sub>L</sub> = 35pF, R<sub>L</sub> = 50Ω, t<sub>r</sub> = t<sub>f</sub> ≤ ns)**

| Symbol                              | Parameter         | Test conditions |                       | Value                 |      |     |             |     | Unit |
|-------------------------------------|-------------------|-----------------|-----------------------|-----------------------|------|-----|-------------|-----|------|
|                                     |                   | Vcc (V)         |                       | T <sub>A</sub> = 25°C |      |     | -40 to 85°C |     |      |
|                                     |                   |                 |                       | Min                   | Typ  | Max | Min         | Max |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation delay | 1.65-1.95       |                       |                       | 0.30 |     |             |     | ns   |
|                                     |                   | 2.3-2.7         |                       |                       | 0.30 |     |             |     |      |
|                                     |                   | 3.0-3.3         |                       |                       | 0.25 |     |             |     |      |
|                                     |                   | 3.6-4.3         |                       |                       | 0.25 |     |             |     |      |
| t <sub>ON</sub>                     | TURN-ON time      | 1.65-1.95       | V <sub>S</sub> = 0.8V |                       | 31   |     |             |     | ns   |
|                                     |                   | 2.3-2.7         |                       |                       | 20   | 26  |             | 34  |      |
|                                     |                   | 3.0-3.3         | V <sub>S</sub> = 1.5V |                       | 20   | 20  |             | 26  |      |
|                                     |                   | 3.6-4.3         |                       |                       | 20   | 15  |             | 20  |      |
| t <sub>OFF</sub>                    | TURN-OFF time     | 1.65-1.95       | V <sub>S</sub> = 0.8  |                       | 5    |     |             |     | ns   |
|                                     |                   | 2.3-2.7         |                       |                       | 4    | 6   |             | 8   |      |
|                                     |                   | 3.0-3.3         | V <sub>S</sub> = 1.5V |                       | 4    | 6   |             | 8   |      |
|                                     |                   | 3.6-4.3         |                       |                       | 3    | 5   |             | 6   |      |



**Table 7. AC electrical characteristics** ( $C_L = 35\text{pF}$ ,  $R_L = 50\Omega$ ,  $t_r = t_f \leq 5\text{ns}$ )

| Symbol         | Parameter                    | Test conditions |  | Value                 |     |     |             |     | Unit |
|----------------|------------------------------|-----------------|--|-----------------------|-----|-----|-------------|-----|------|
|                |                              | Vcc (V)         |  | T <sub>A</sub> = 25°C |     |     | -40 to 85°C |     |      |
|                |                              |                 |  | Min                   | Typ | Max | Min         | Max |      |
| t <sub>D</sub> | Break-before-make time delay | 1.65-1.95       | C <sub>L</sub> = 35pF<br>R <sub>L</sub> = 50Ω<br>V <sub>S</sub> = 1.5V   | 1                     | 7   |     |             |     | ns   |
|                |                              | 2.3-2.7         |  | 1                     | 5   |     |             |     |      |
|                |                              | 3.0-3.3         |  | 1                     | 4   |     |             |     |      |
|                |                              | 3.6-4.3         |  | 1                     | 3   |     |             |     |      |
| Q              | Charge injection             | 1.65            | C <sub>L</sub> = 100pF<br>V <sub>GEN</sub> = 0V<br>R <sub>GEN</sub> = 0Ω |                       | 2.8 |     |             |     | pC   |
|                |                              | 2.3             |  |                       | 3.5 |     |             |     |      |
|                |                              | 3.0             |  |                       | 3.8 |     |             |     |      |
|                |                              | 4.3             |  |                       | 5.0 |     |             |     |      |

**Table 8. Analog switch characteristics** ( $C_L = 5\text{pF}$ ,  $R_L = 50\Omega$ , T<sub>A</sub> = 25°C)

| Symbol         | Parameter                    | Test Conditions |  | Value                 |      |      |             |     | Unit |
|----------------|------------------------------|-----------------|--|-----------------------|------|------|-------------|-----|------|
|                |                              | Vcc (V)         |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |     |      |
|                |                              |                 |  | Min                   | Typ  | Max  | Min         | Max |      |
| OIRR           | Off Isolation (1)            | 1.65 - 4.3      | V <sub>S</sub> = 1V <sub>RMS</sub> , f = 1MHz<br>Signal = 0 dBm  |                       | -79  |      |             |     | dB   |
|                |                              |                 | V <sub>S</sub> = 1V <sub>RMS</sub> , f = 10MHz<br>Signal = 0 dBm   |                       | -60  |      |             |     |      |
| Xtalk          | Crosstalk                    | 1.65 - 4.3      | V <sub>S</sub> = 1V <sub>RMS</sub> , f = 1MHz<br>Signal = 0 dBm  |                       | -78  |      |             |     | dB   |
|                |                              |                 | V <sub>S</sub> = 1V <sub>RMS</sub> , f = 10MHz<br>Signal = 0 dBm   |                       | -61  |      |             |     |      |
| THD            | Total harmonic distortion    | 3.7             | f = 20Hz to 20kHz<br>R <sub>L</sub> = 32Ω, C <sub>L</sub> = 50Ω<br>V <sub>IN</sub> = 2.8V <sub>P-P</sub><br>V <sub>DC</sub> = V <sub>CC</sub> /2 |                       | 0.01 | 0.02 |             |     | %    |
| PSRR           | Power supply rejection ratio | 3.7             | f = 217Hz,<br>R <sub>L</sub> = 32Ω, C <sub>L</sub> = 50Ω<br>V <sub>ripple</sub> = 150mV<br>V <sub>DC</sub> = V <sub>CC</sub> /2                  |                       | -60  |      |             |     | dB   |
| BW             | -3dB Bandwidth               | 3.0 - 4.3       | R <sub>L</sub> = 50Ω<br>Signal = 0dBm  |                       | 800  |      |             |     | MHz  |
| D <sub>G</sub> | Differential gain            | 3.0 - 4.3       | R <sub>L</sub> = 150Ω  |                       | 0.64 |      |             |     | %    |

**Table 8. Analog switch characteristics** ( $C_L = 5\text{pF}$ ,  $R_L = 50\Omega$ ,  $T_A = 25^\circ\text{C}$ )

| Symbol           | Parameter                                   | Test Conditions     |                       | Value                 |     |     |             |     | Unit |     |
|------------------|---|---------------------|-----------------------|-----------------------|-----|-----|-------------|-----|------|-----|
|                  |   | V <sub>CC</sub> (V) |                       | T <sub>A</sub> = 25°C |     |     | -40 to 85°C |     |      |     |
|                  |   |                     |                       | Min                   | Typ | Max | Min         | Max |      |     |
| D <sub>P</sub>   | Differential phase                          | 3.0 - 4.3           | R <sub>L</sub> = 150Ω |                       | 0.1 |     |             |     |      | deg |
| C <sub>IN</sub>  | Control pin input capacitance               |                     | V <sub>CC</sub> = 0V  |                       | 6.2 |     |             |     |      | pF  |
| C <sub>ON</sub>  | Sn Port capacitance when switch is enabled  | 3.3                 | f = 1MHz              |                       | 10  |     |             |     |      |     |
| C <sub>OFF</sub> | Sn port capacitance when switch is disabled | 3.3                 | f = 1MHz              |                       | 5   |     |             |     |      |     |

1. Off Isolation =  $20\text{Log}_{10}(V_D/V_S)$ , V<sub>D</sub> = output. V<sub>S</sub> = input to off switch.

**Table 9. USB related AC electrical characteristics**

| Symbol             | Parameter                                      | Test conditions     |   | Value                 |     |     |             |     | Unit |    |
|--------------------|--|---------------------|---|-----------------------|-----|-----|-------------|-----|------|----|
|                    |  | V <sub>CC</sub> (V) |   | T <sub>A</sub> = 25°C |     |     | -40 to 85°C |     |      |    |
|                    |  |                     |   | Min                   | Typ | Max | Min         | Max |      |    |
| t <sub>SK(0)</sub> | Channel-to-channel skew                        | 3.0 to 3.6          | C <sub>L</sub> =10pF  |                       | 26  |     |             |     |      | ps |
| t <sub>SK(P)</sub> | Skew of opposite transition of the same output | 3.0 to 3.6          | C <sub>L</sub> =10pF  |                       | 60  |     |             |     |      | ps |
| T <sub>J</sub>     | Total jitter                                   | 3.0 to 3.6          | R <sub>L</sub> = 50Ω,<br>C <sub>L</sub> = 10pF,<br>t <sub>R</sub> = t <sub>F</sub> =<br>750ps at<br>480Mbps |                       | 130 |     |             |     |      | ps |

# 5 Test circuits

Figure 3. ON-Resistance

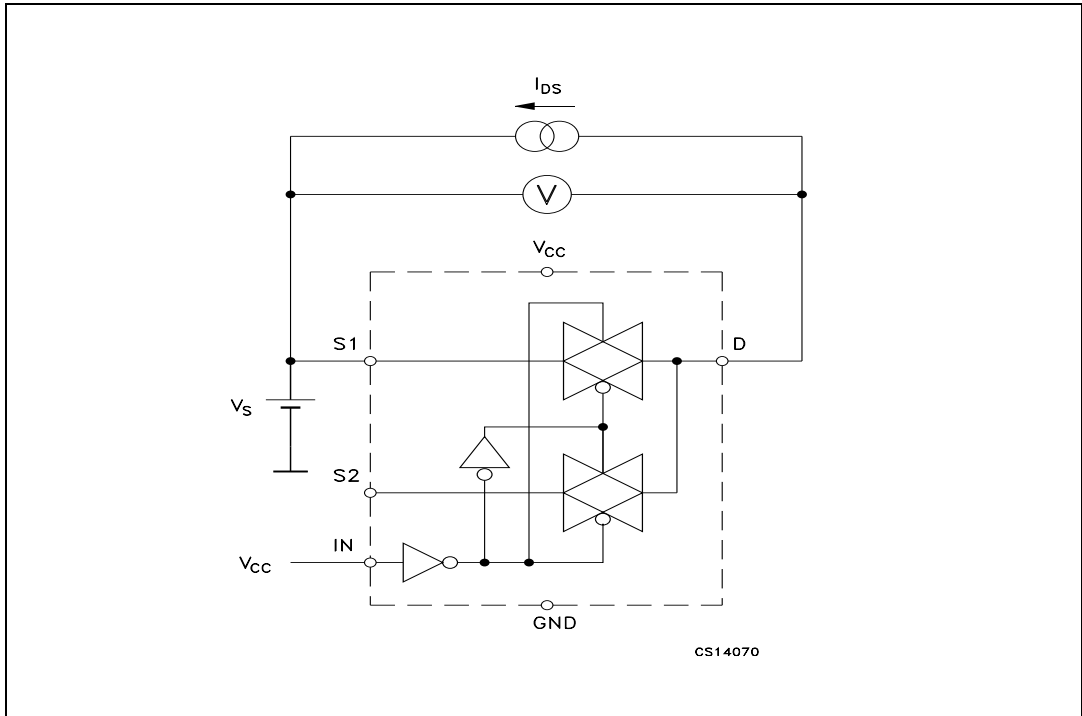


Figure 4. Bandwidth

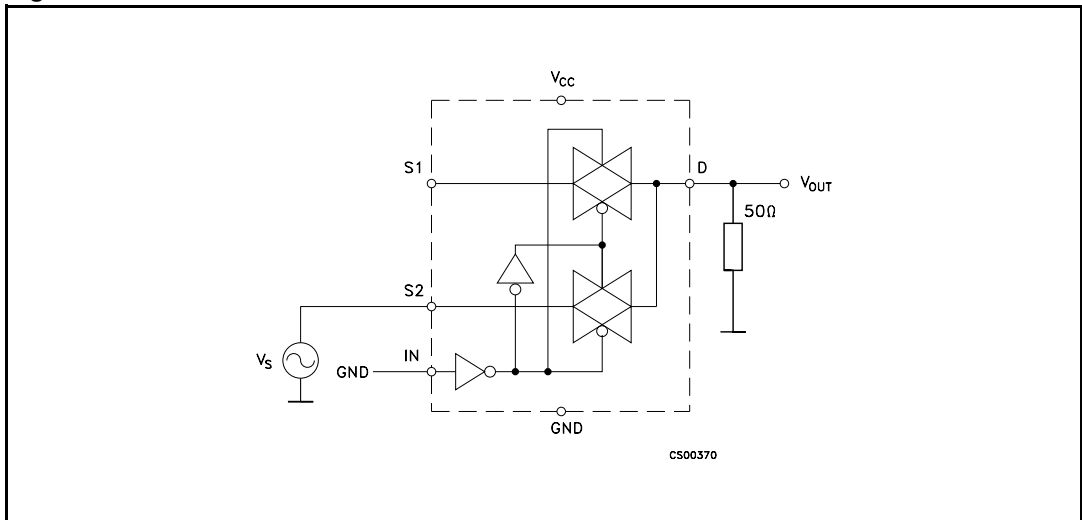


Figure 5. OFF Leakage

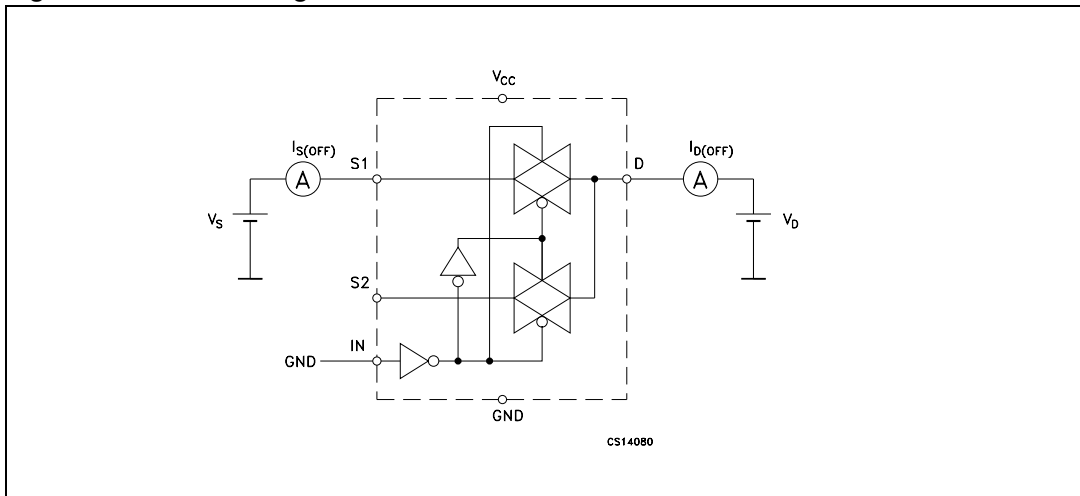


Figure 6. Channel to channel crosstalk

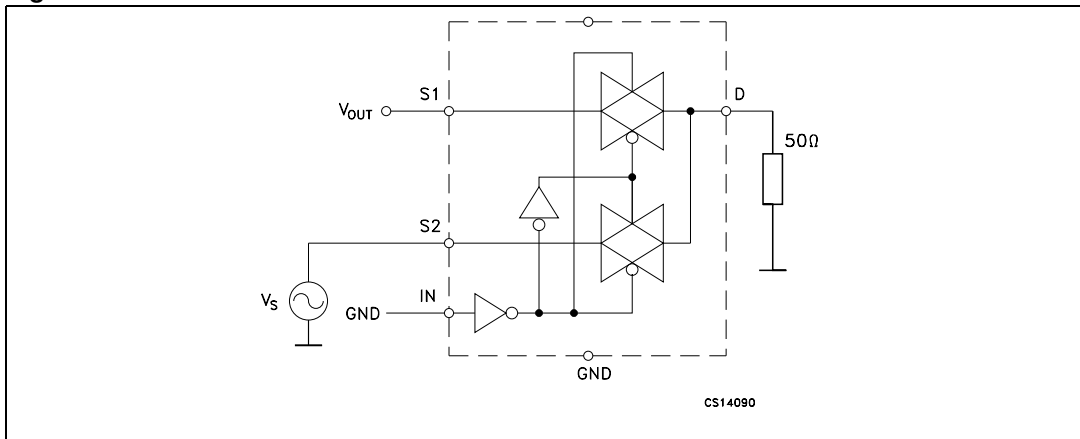
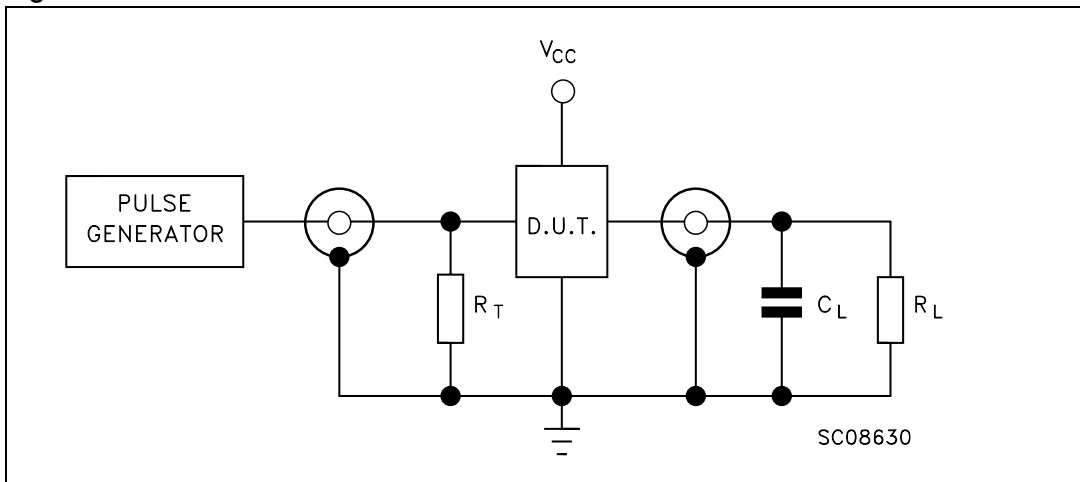
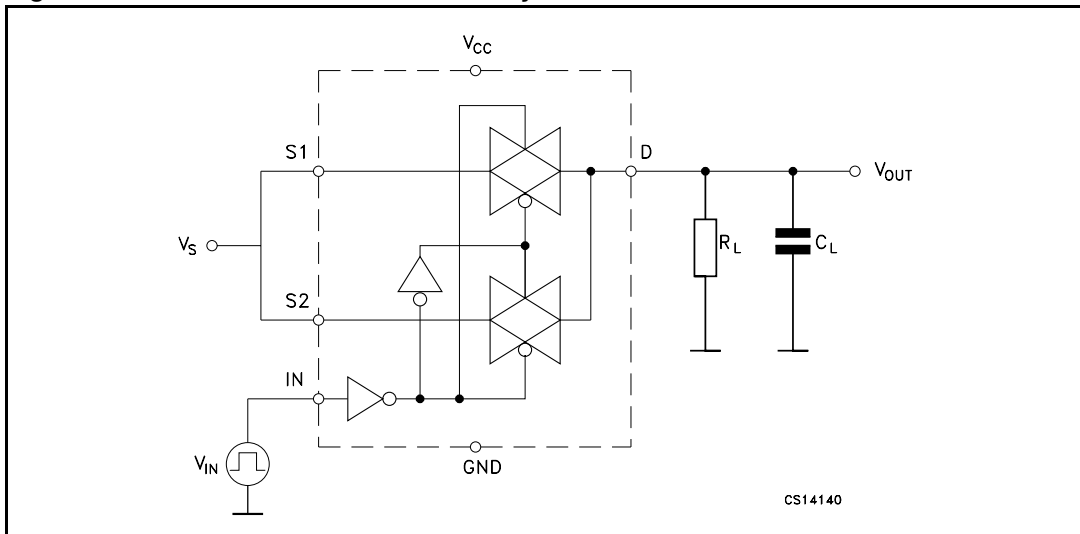


Figure 7. Test circuit

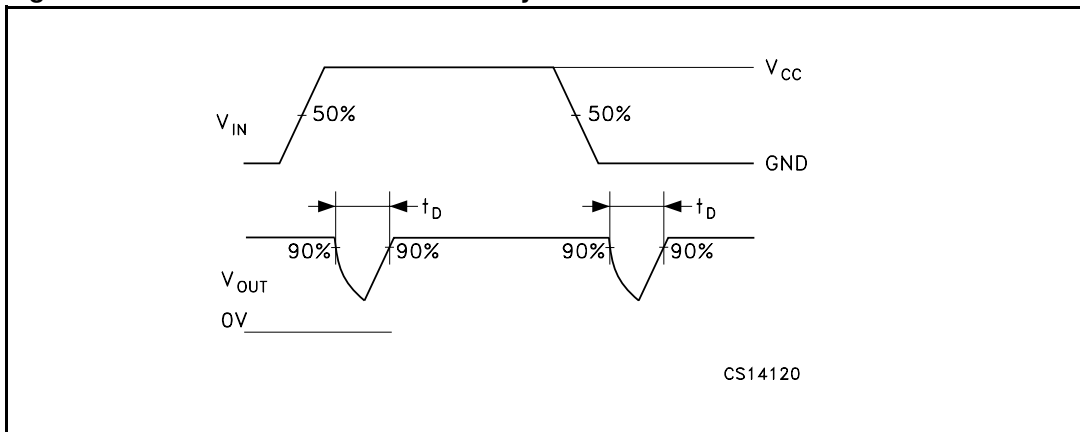


- 1.  $C_L = 5/35\text{pF}$  or equivalent: (includes jig capacitance)
- 1.  $R_L = 50\Omega$  or equivalent
- 1.  $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

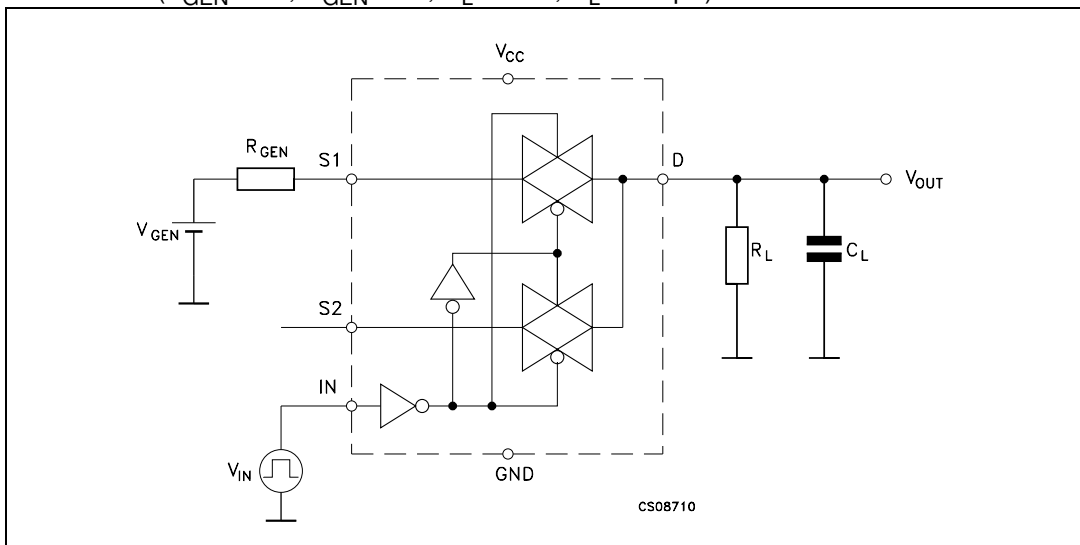
**Figure 8. Break-before-make time delay**



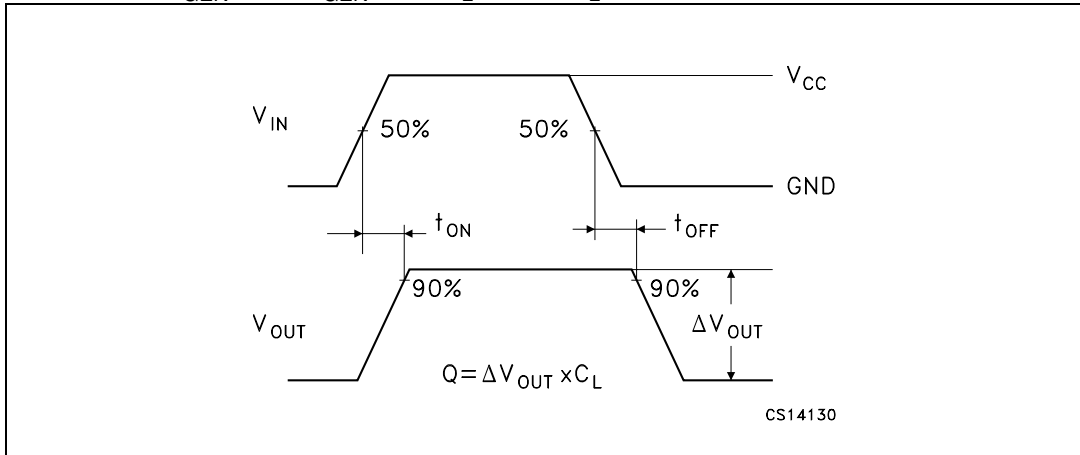
**Figure 9. Break-before-make time delay**



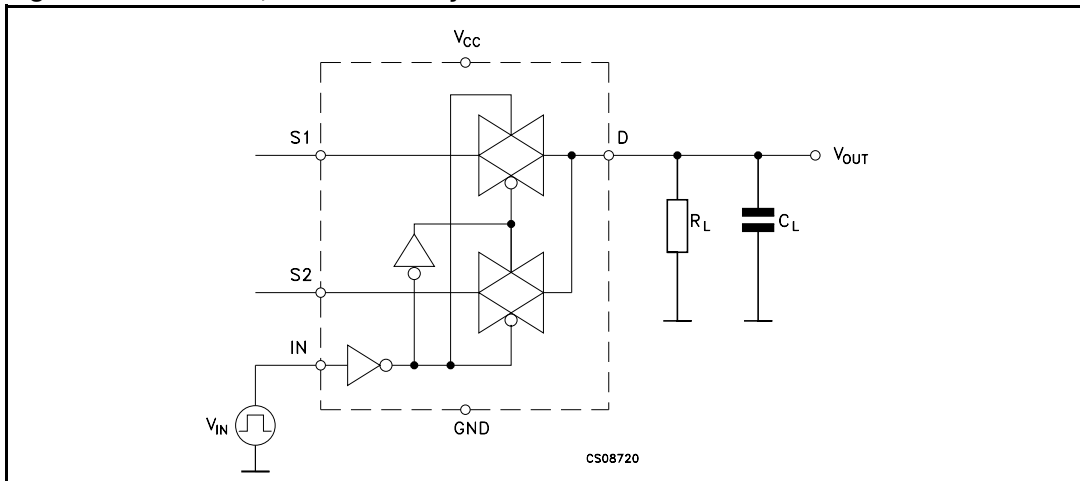
**Figure 10. Switching time and charge injection**  
 ( $V_{GEN} = 0V$ ,  $R_{GEN} = 0\Omega$ ,  $R_L = 1M\Omega$ ,  $C_L = 100pF$ )



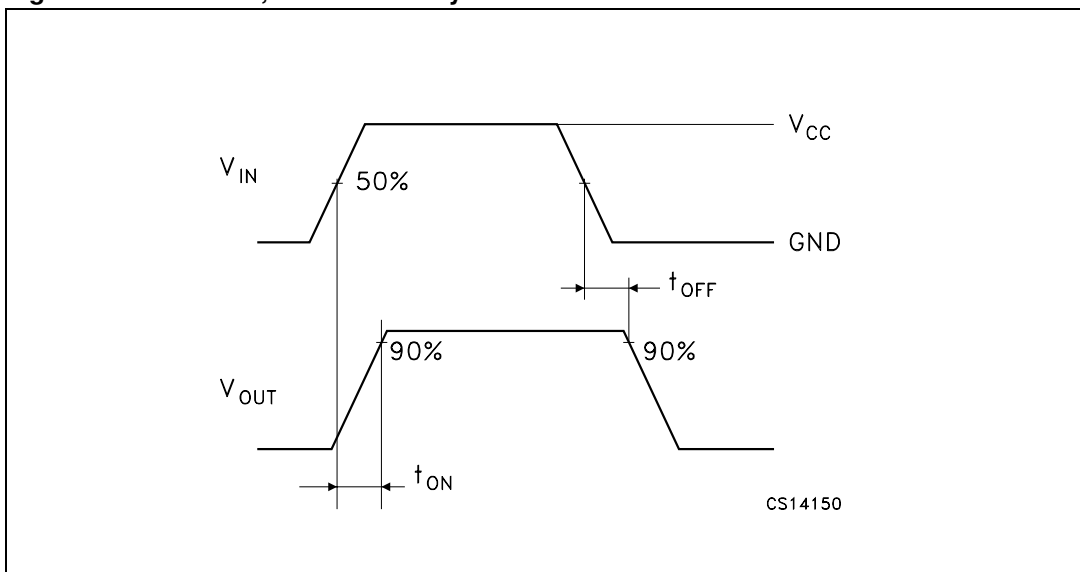
**Figure 11. Switching time and charge injection**  
 ( $V_{GEN} = 0V$ ,  $R_{GEN} = 0\Omega$ ,  $R_L = 1M\Omega$ ,  $C_L = 100pF$ )



**Figure 12. Turn ON, turn OFF delay time**



**Figure 13. Turn ON, turn OFF delay time**



## 6 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).

**Figure 14. QFN16L (2.6x1.8mm) package outline**

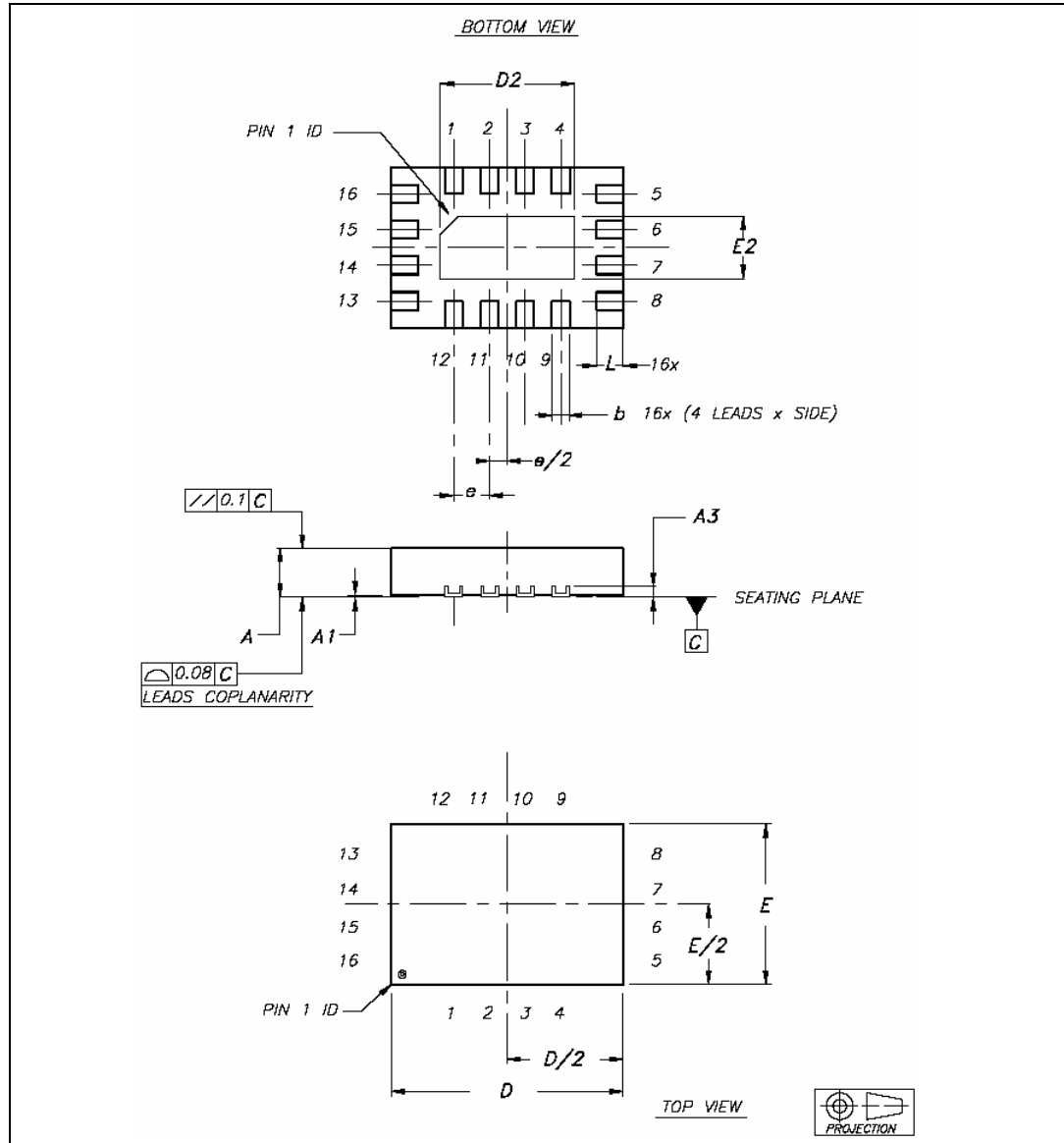
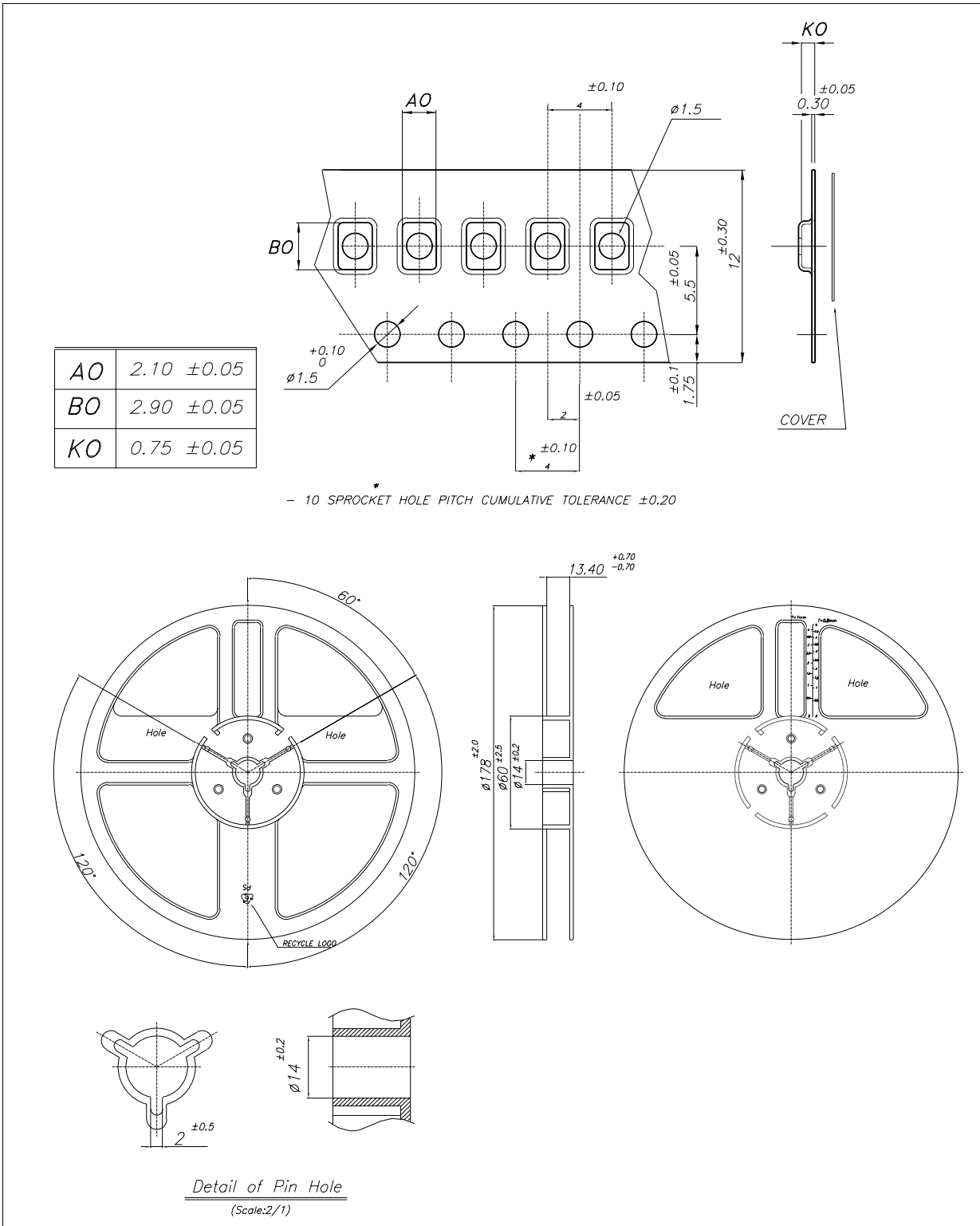






Figure 16. QFN16L (2.6mmx1.8mm) tape & reel information



## 7 Revision history

Table 11. Revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 3-Jan-2006  | 1        | First release   |
| 23-Jul-2007 | 2        | Updated C <sub>OFF</sub> value in <a href="#">Table 8 on page 8</a> |

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