

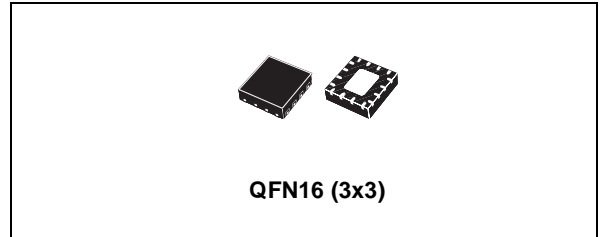
## LOW VOLTAGE 0.5Ω MAX QUAD SPDT SWITCH WITH BREAK BEFORE MAKE FEATURE

- HIGH SPEED:  
 $t_{PD} = 1.5\text{ns}$  (TYP.) at  $V_{CC} = 3.0\text{V}$   
 $t_{PD} = 1.5\text{ns}$  (TYP.) at  $V_{CC} = 2.3\text{V}$
- ULTRA LOW POWER DISSIPATION:  
 $I_{CC} = 0.2\mu\text{A}$  (MAX.) at  $T_A = 85^\circ\text{C}$
- LOW "ON" RESISTANCE  $V_{IN}=0\text{V}$ :  
 $R_{ON} = 0.5\Omega$  (MAX.  $T_A = 25^\circ\text{C}$ ) at  $V_{CC} = 2.7\text{V}$   
 $R_{ON} = 0.7\Omega$  (MAX.  $T_A = 25^\circ\text{C}$ ) at  $V_{CC} = 2.3\text{V}$   
 $R_{ON} = 1.5\Omega$  (MAX.  $T_A = 25^\circ\text{C}$ ) at  $V_{CC} = 1.8\text{V}$
- 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  $V_{CC} = 2.3$  to  $3.0\text{V}$
- LATCH-UP PERFORMANCE EXCEEDS 300mA (JESD 17)

### DESCRIPTION

The STG3699A is an high-speed CMOS LOW VOLTAGE QUAD ANALOG S.P.D.T. (Single Pole Dual Throw) SWITCH or 2:1 Multiplexer/Demultiplexer Switch fabricated in silicon gate C<sup>2</sup>MOS technology. It is designed to operate from 1.65V to 4.3V, making this device ideal for portable applications.

It offers very low ON-Resistance ( $<0.5\Omega$ ) at  $V_{CC}=3.0\text{V}$ . The  $n_{IN}$  inputs are provided to control the switches. The switches  $n_{S1}$  are ON (they are connected to common Ports  $D_n$ ) when the  $n_{IN}$



**Table 1: Order Codes**

| PACKAGE     | T & R       |
|-------------|-------------|
| QFN16 (3x3) | STG3699AQTR |

input is held high and OFF (high impedance state exists between the two ports) when  $n_{IN}$  is held low; the switches  $n_{S2}$  are ON (they are connected to common Ports  $D_n$ ) when the  $n_{IN}$  input is held low and OFF (high impedance state 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 immunity and transient excess voltage. It's available in the commercial temperature range in QFN16 3x3mm package.

**Figure 1: Pin Connection**

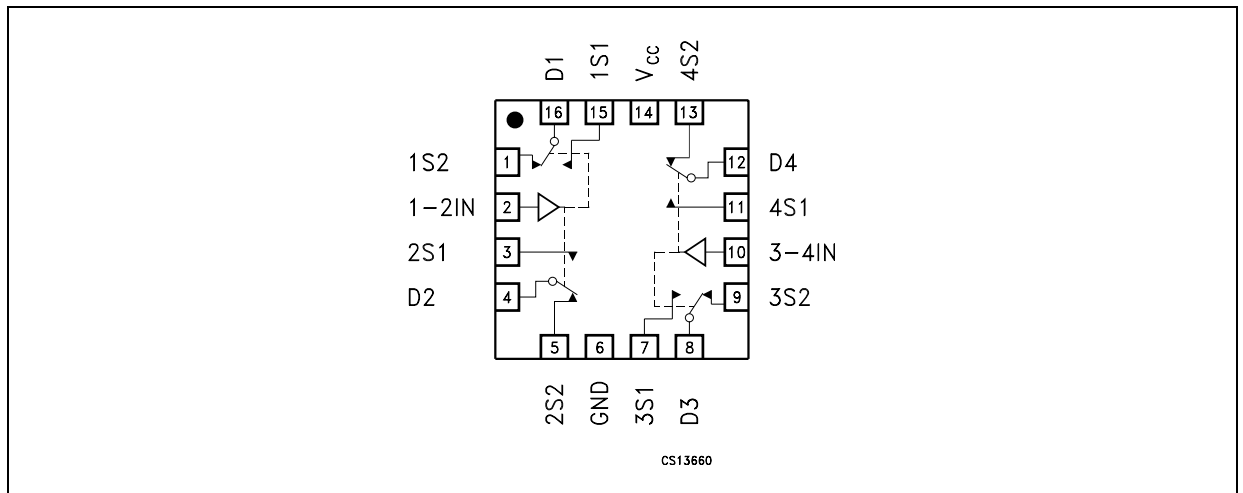


Figure 2: Input Equivalent Circuit

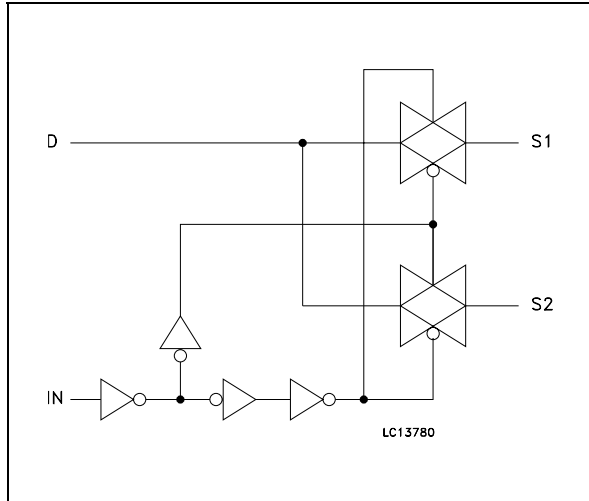


Table 2: Pin Description

| PIN N°                    | SYMBOL                 | NAME AND FUNCTION       |
|---------------------------|------------------------|-------------------------|
| 15, 3, 7, 11, 1, 5, 9, 13 | 1S1 to 4S1, 1S2 to 4S2 | Independent Channels    |
| 16, 4, 8, 12              | D1 to D4               | Common Channels         |
| 2, 10                     | 1-2IN, 3-4IN           | Controls                |
| 14                        | V <sub>CC</sub>        | Positive Supply Voltage |
| 6                         | GND                    | Ground (0V)             |

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 |

Table 4: Absolute Maximum Ratings

| Symbol                              | Parameter  | Value                         | Unit |
|-------------------------------------|--|-------------------------------|------|
| V <sub>CC</sub>                     | Supply Voltage   | -0.5 to 5                     | V    |
| V <sub>I</sub>                      | DC Input Voltage   | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| V <sub>IC</sub>                     | DC Control Input Voltage                                     | -0.5 to 4.6                   | V    |
| V <sub>O</sub>                      | DC Output Voltage  | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| I <sub>IKC</sub>                    | DC Input Diode Current on control pin (V <sub>IN</sub> < 0V) | - 50                          | mA   |
| I <sub>IK</sub>                     | DC Input Diode Current (V <sub>IN</sub> < 0V)                | ± 50                          | mA   |
| I <sub>OK</sub>                     | DC Output Diode Current                                      | ± 20                          | mA   |
| I <sub>O</sub>                      | DC Output Current  | ± 300                         | mA   |
| I <sub>OP</sub>                     | DC Output Current Peak (pulse at 1ms, 10% duty cycle)        | ± 500                         | mA   |
| I <sub>CC</sub> or I <sub>GND</sub> | DC V <sub>CC</sub> or Ground Current                         | ± 100                         | mA   |
| P <sub>D</sub>                      | Power Dissipation at T <sub>a</sub> = 70°C (1)               | 1120                          | mW   |
| T <sub>stg</sub>                    | Storage Temperature  | -65 to 150                    | °C   |
| T <sub>L</sub>                      | Lead Temperature (10 sec)                                    | 300                           | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions not implied.

(1) Derate above 70°C: by 18.5mW/°C.

Table 5: Recommended Operating Conditions

| Symbol          | Parameter                              | Value                           | Unit    |
|-----------------|--|---------------------------------|---------|
| V <sub>CC</sub> | Supply Voltage (note 1)                | 1.65 to 4.3                     | V       |
| V <sub>I</sub>  | Input Voltage                          | 0 to V <sub>CC</sub>            | V       |
| V <sub>IC</sub> | Control Input Voltage                  | 0 to 4.3                        | V       |
| V <sub>O</sub>  | Output Voltage                         | 0 to V <sub>CC</sub>            | V       |
| T <sub>op</sub> | Operating Temperature                  | -55 to 125                      | °C      |
| dt/dv           | Input Rise and Fall Time Control Input | V <sub>CC</sub> = 1.65V to 2.7V | 0 to 20 |
|                 |  | V <sub>CC</sub> = 3.0V to 4.3V  | 0 to 10 |

1) Truth Table guaranteed: 1.2V to 4.3V.

Table 6: DC Specifications

| Symbol            | Parameter                                    | Test Conditions        |  | Value                 |      |       |                     |      |                     | Unit |      |
|-------------------|--|------------------------|--|-----------------------|------|-------|---------------------|------|---------------------|------|------|
|                   |  | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |       | -40 to 85°C         |      | -55 to 125°C        |      |      |
|                   |  |                        |  | Min.                  | Typ. | Max.  | Min.                | 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> |      | 0.65V <sub>CC</sub> |      | 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 <sub>IL</sub>   | 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 <sub>ON</sub>   | Switch ON Resistance                         | 4.3                    | V <sub>S</sub> =0V to V <sub>CC</sub><br>I <sub>S</sub> =100mA |                       | 0.35 | 0.45  |                     | 0.50 |                     |      | Ω    |
|                   |  | 3.0                    |  |                       | 0.40 | 0.50  |                     | 0.60 |                     |      |      |
|                   |  | 2.7                    |  |                       | 0.40 | 0.50  |                     | 0.60 |                     |      |      |
|                   |  | 2.3                    |  |                       | 0.45 | 0.70  |                     | 0.80 |                     |      |      |
|                   |  | 1.8                    |  |                       | 0.55 | 1.5   |                     | 2.0  |                     |      |      |
|                   |  | 1.65                   |  |                       | 0.65 | 1.5   |                     | 2.0  |                     |      |      |
| ΔR <sub>ON</sub>  | ON Resistance Match between channels (1)     | 2.7                    | V <sub>S</sub> @ R <sub>ON</sub> Max<br>I <sub>S</sub> =100mA  |                       | 0.06 |       |                     |      |                     | Ω    |      |
| R <sub>FLAT</sub> | ON Resistance FLATNESS (2)                   | 4.3                    | V <sub>S</sub> =0V to V <sub>CC</sub><br>I <sub>S</sub> =100mA |                       | 0.15 | 0.20  |                     | 0.20 |                     |      | Ω    |
|                   |  | 3.0                    |  |                       | 0.15 | 0.20  |                     | 0.20 |                     |      |      |
|                   |  | 2.7                    |  |                       | 0.15 | 0.20  |                     | 0.20 |                     |      |      |
|                   |  | 2.3                    |  |                       | 0.20 | 0.25  |                     | 0.25 |                     |      |      |
|                   |  | 1.65                   |  |                       | 0.30 | 0.35  |                     | 0.35 |                     |      |      |
| I <sub>OFF</sub>  | OFF State Leakage Current (nSn), (Dn)        | 4.3                    | V <sub>S</sub> =0.3 or 4V                                      |                       |      | ±20   |                     | ±100 |                     | nA   |      |
| I <sub>IN</sub>   | Input Leakage Current                        | 0 - 4.3                | V <sub>IN</sub> = 0 to 4.3V                                    |                       |      | ±0.1  |                     | ±1   |                     | μA   |      |
| I <sub>CC</sub>   | Quiescent Supply Current                     | 1.65-4.3               | V <sub>IN</sub> =V <sub>CC</sub> or GND                        |                       |      | ±0.05 |                     | ±0.2 |                     | ±1   | μA   |
| I <sub>CCLV</sub> | Quiescent Supply Current Low Voltage Driving | 4.3                    | V <sub>1-2IN</sub> , V <sub>3-4IN</sub> = 1.65V                |                       | ±37  | ±50   |                     | ±100 |                     |      | μA   |
|                   |  |                        | V <sub>1-2IN</sub> , V <sub>3-4IN</sub> = 1.80V                |                       | ±33  | ±40   |                     | ±50  |                     |      |      |
|                   |  |                        | V <sub>1-2IN</sub> , V <sub>3-4IN</sub> = 2.60V                |                       | ±12  | ±20   |                     | ±30  |                     |      |      |

Note 1: ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub>

Note 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** ( $C_L = 35\text{pF}$ ,  $R_L = 50\Omega$ ,  $t_r = t_f \leq 5\text{ns}$ )

| Symbol                              | Parameter                    | Test Condition         |  | Value                 |      |      |             |      |              | Unit |      |
|-------------------------------------|------------------------------|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                                     |                              | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                     |                              |                        |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay            | 1.65-1.95              | V <sub>I</sub> =OPEN   |                       | 0.45 |      |             |      |              |      | ns   |
|                                     |                              | 2.3-2.7                |  |                       | 0.40 |      |             |      |              |      |      |
|                                     |                              | 3.0-3.3                |  |                       | 0.30 |      |             |      |              |      |      |
|                                     |                              | 3.6-4.3                |  |                       | 0.30 |      |             |      |              |      |      |
| t <sub>ON</sub>                     | TURN-ON time                 | 1.65-1.95              | V <sub>S</sub> =0.8V   |                       | 120  |      |             |      |              |      | ns   |
|                                     |                              | 2.3-2.7                | V <sub>S</sub> =1.5V   |                       | 45   | 55   |             | 65   |              |      |      |
|                                     |                              | 3.0-3.3                |  |                       | 42   | 55   |             | 65   |              |      |      |
|                                     |                              | 3.6-4.3                |  |                       | 40   | 55   |             | 65   |              |      |      |
| t <sub>OFF</sub>                    | TURN-OFF time                | 1.65-1.95              | V <sub>S</sub> =0.8V   |                       | 22   |      |             |      |              |      | ns   |
|                                     |                              | 2.3-2.7                | V <sub>S</sub> =1.5V   |                       | 18   | 30   |             | 40   |              |      |      |
|                                     |                              | 3.0-3.3                |  |                       | 16   | 30   |             | 40   |              |      |      |
|                                     |                              | 3.6-4.3                |  |                       | 15   | 30   |             | 40   |              |      |      |
| 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 |                       | 10   | 80   |             |      |              |      | ns   |
|                                     |                              | 2.3-2.7                |  |                       | 10   | 60   |             |      |              |      |      |
|                                     |                              | 3.0-3.3                |  |                       | 10   | 55   |             |      |              |      |      |
|                                     |                              | 3.6-4.3                |  |                       | 10   | 50   |             |      |              |      |      |
| Q                                   | Charge injection             | 1.65-1.95              | C <sub>L</sub> = 100pF   |                       |      |      |             |      |              |      | pC   |
|                                     |                              | 2.3-2.7                | R <sub>L</sub> = 1MΩ   |                       | 200  |      |             |      |              |      |      |
|                                     |                              | 3.0-3.3                | V <sub>GEN</sub> = 0V  |                       | 200  |      |             |      |              |      |      |
|                                     |                              | 3.6-4.3                | R <sub>GEN</sub> = 0Ω  |                       | 200  |      |             |      |              |      |      |

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

| Symbol          | Parameter                                 | Test Condition         |   | Value                 |      |      |             |      |              | Unit |      |
|-----------------|---|------------------------|---|-----------------------|------|------|-------------|------|--------------|------|------|
|                 |   | V <sub>CC</sub><br>(V) |   | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |   |                        |   | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| OIRR            | Off Isolation (1)                         | 1.65-4.3               | V <sub>S</sub> = 1V <sub>RMS</sub><br>f= 100KHz                                 |                       | -64  |      |             |      |              |      | dB   |
| Xtalk           | Crosstalk                                 | 1.65-4.3               | V <sub>S</sub> = 1V <sub>RMS</sub><br>f= 100KHz                                 |                       | -54  |      |             |      |              |      | dB   |
| THD             | Total Harmonic Distortion                 | 2.3-4.3                | R <sub>L</sub> = 600Ω<br>V <sub>IN</sub> = 2V <sub>PP</sub><br>f= 20Hz to 20kHz |                       | 0.03 |      |             |      |              |      | %    |
| BW              | -3dB Bandwidth                            | 1.65-4.3               | R <sub>L</sub> = 50Ω  |                       | 50   |      |             |      |              |      | MHz  |
| C <sub>IN</sub> | Control Pin Input Capacitance             |                        |   |                       | 5    |      |             |      |              |      | pF   |
| C <sub>Sn</sub> | Sn Port Capacitance                       | 3.3                    | f= 1MHz   |                       | 30   |      |             |      |              |      |      |
| C <sub>D</sub>  | D Port Capacitance when Switch is Enabled | 3.3                    | f= 1MHz   |                       | 84   |      |             |      |              |      |      |

Note 1: Off Isolation = 20Log<sub>10</sub> (V<sub>D</sub>/V<sub>S</sub>), V<sub>D</sub> = output. V<sub>S</sub> = input to off switch

Figure 3: On Resistance

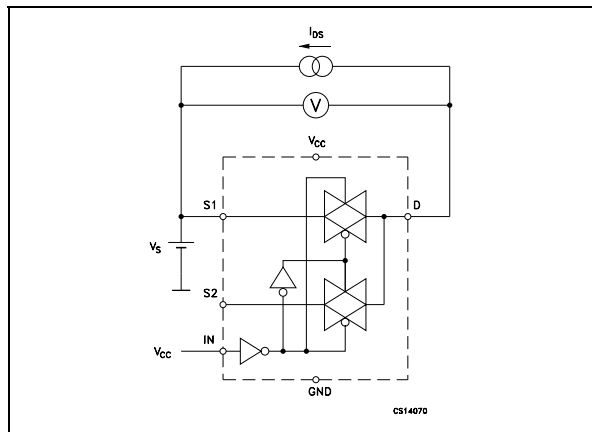


Figure 6: Bandwidth

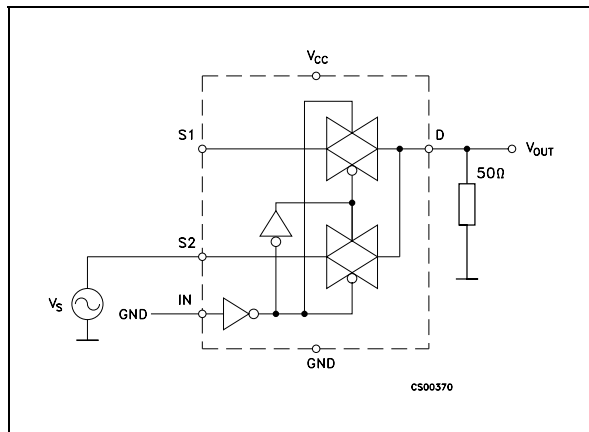


Figure 4: Off Leakage

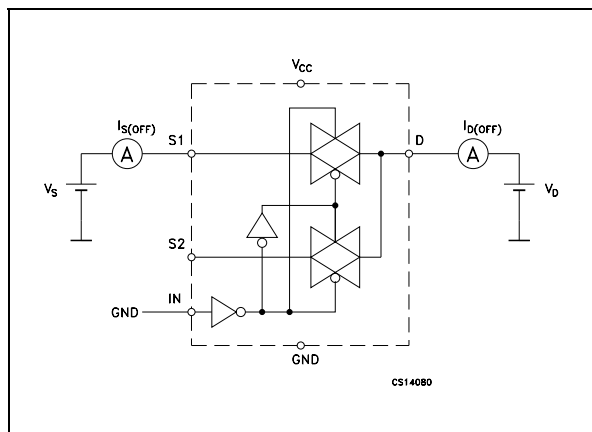


Figure 7: Channel To Channel Crosstalk

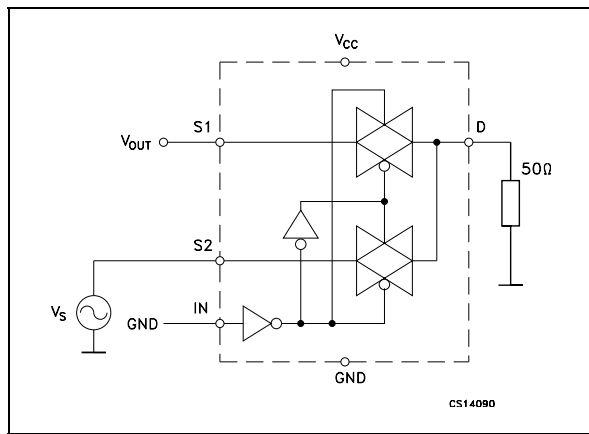


Figure 5: Off Isolation

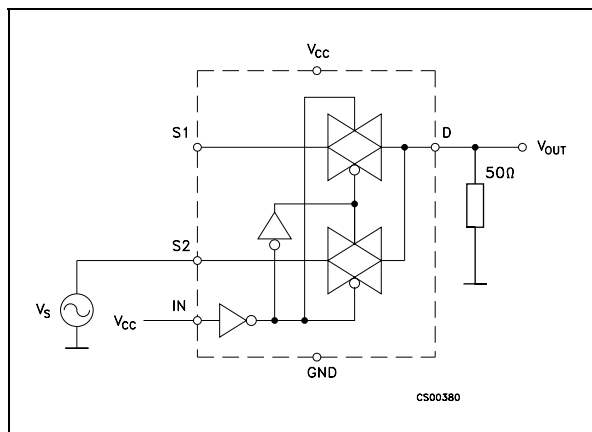
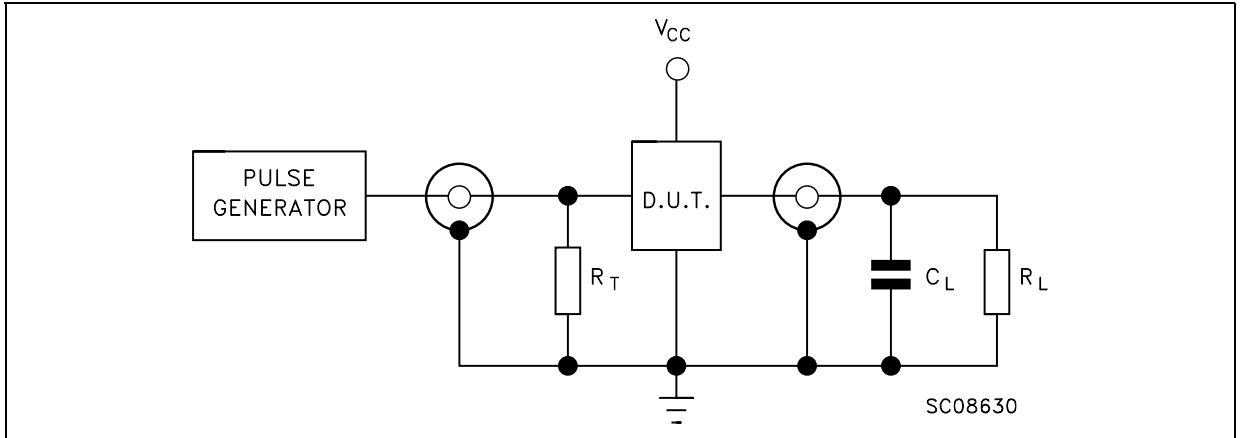


Figure 8: Test Circuit



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

Figure 9: Break Before Make Time Delay

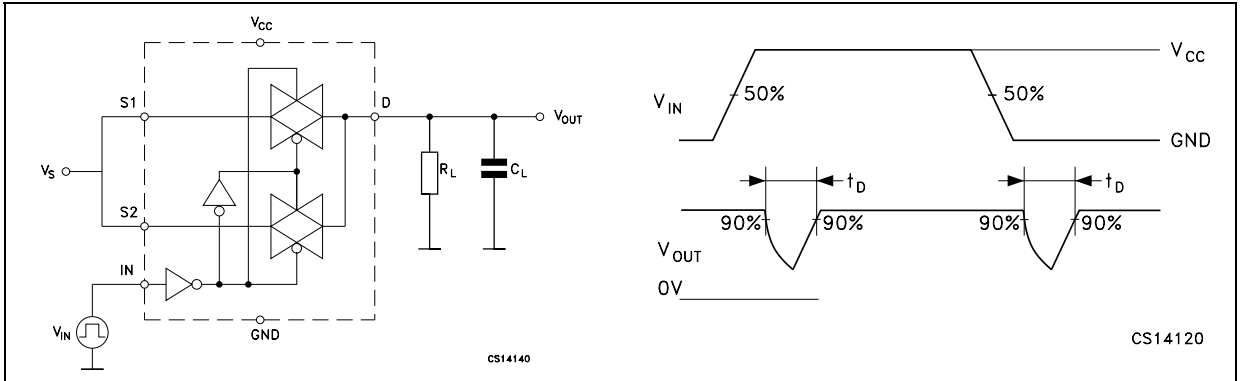


Figure 10: Switching Time And Charge Injection ( $V_{GEN}=0V$ ,  $R_{GEN}=0\Omega$ ,  $R_L=1M\Omega$ ,  $C_L=100\text{pF}$ )

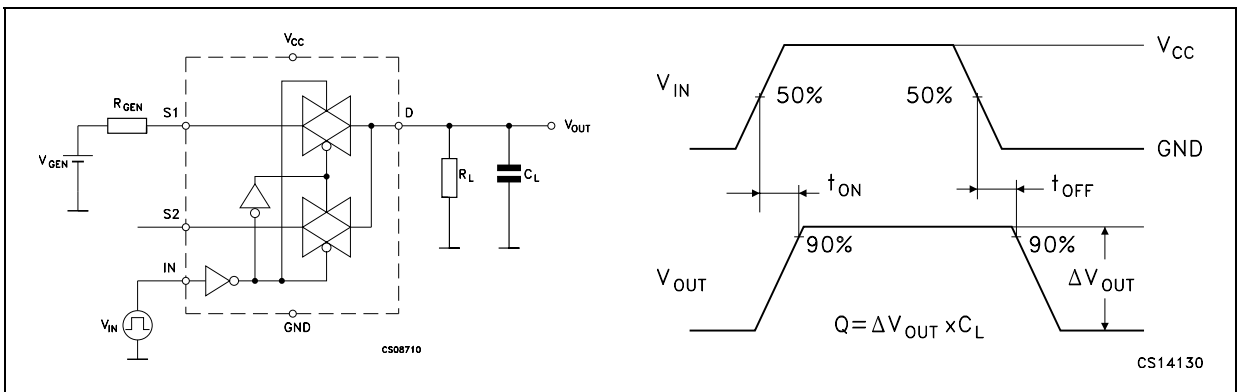
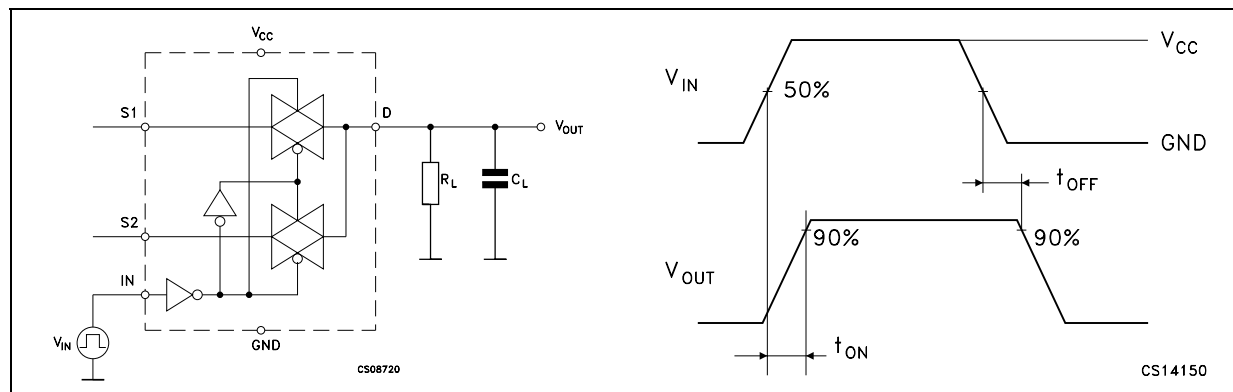
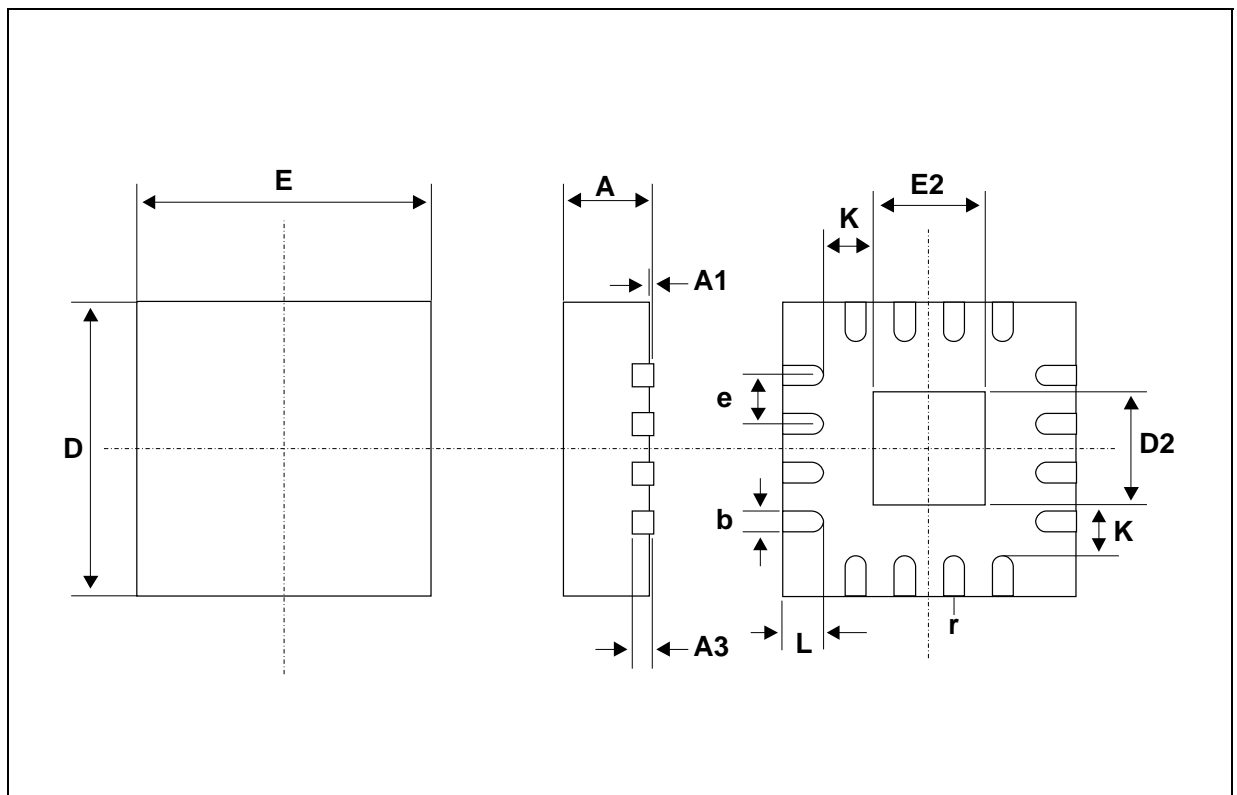


Table 9: Turn On, Turn Off Delay Time



## QFN16 (3x3) MECHANICAL DATA

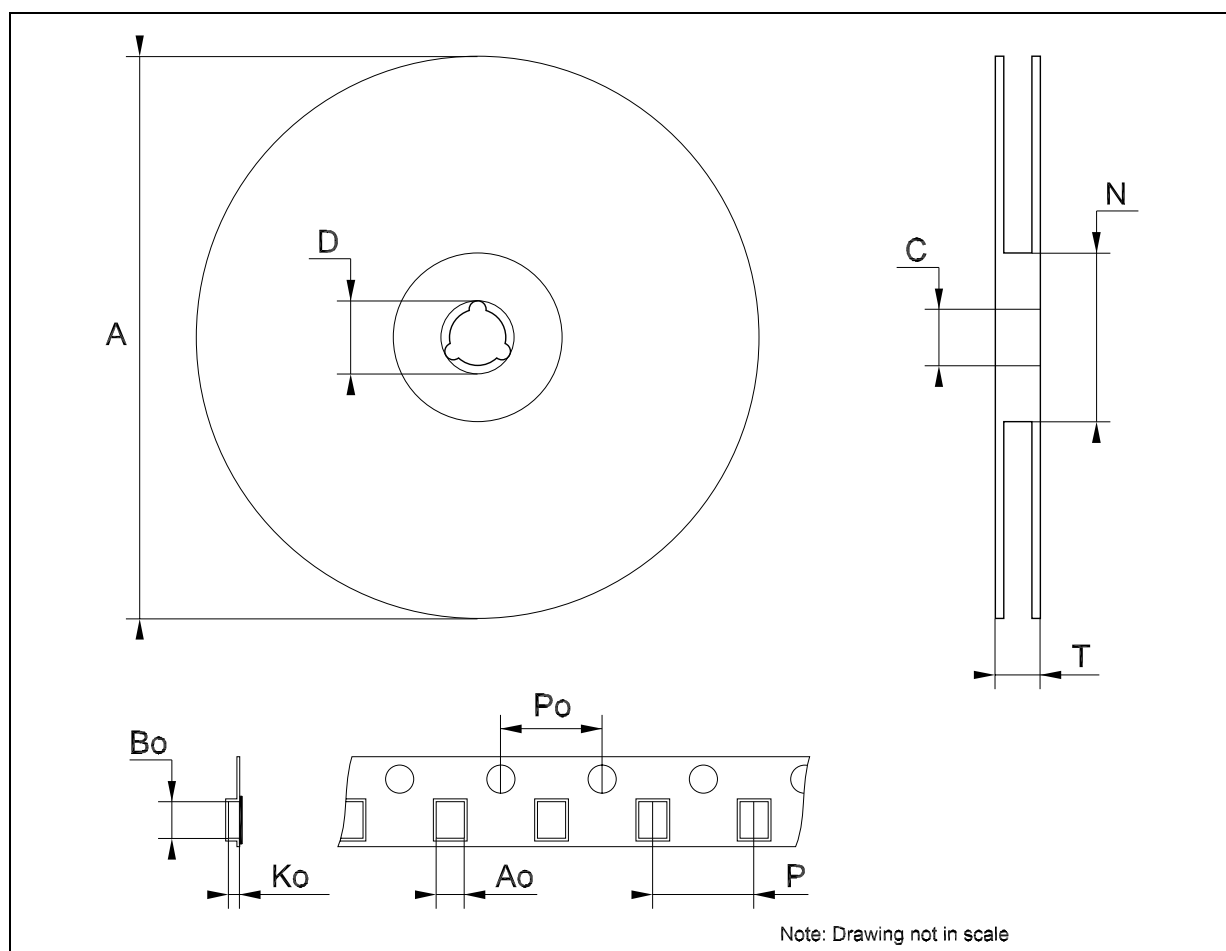
| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 0.80 | 0.90 | 1.00 | 0.032 | 0.035 | 0.039 |
| A1   |      | 0.02 | 0.05 |       | 0.001 | 0.002 |
| A3   |      | 0.20 |      |       | 0.008 |       |
| b    | 0.18 | 0.25 | 0.30 | 0.007 | 0.010 | 0.012 |
| D    |      | 3.00 |      |       | 0.118 |       |
| D2   | 1.55 | 1.70 | 1.80 | 0.061 | 0.067 | 0.071 |
| E    |      | 3.00 |      |       | 0.118 |       |
| E2   | 1.55 | 1.70 | 1.80 | 0.061 | 0.067 | 0.071 |
| e    |      | 0.50 |      |       | 0.020 |       |
| K    |      | 0.20 |      |       | 0.008 |       |
| L    | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| r    | 0.09 |      |      | 0.006 |       |       |





## Tape &amp; Reel QFNxx/DFNxx (3x3) 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    |      |     | 18.4 |       |       | 0.724  |
| Ao   |      | 3.3 |      |       | 0.130 |        |
| Bo   |      | 3.3 |      |       | 0.130 |        |
| Ko   |      | 1.1 |      |       | 0.043 |        |
| Po   |      | 4   |      |       | 0.157 |        |
| P    |      | 8   |      |       | 0.315 |        |



**Table 10: Revision History**

| <b>Date</b> | <b>Revision</b> | <b>Description of Changes</b>                                       |
|-------------|-----------------|---|
| 24-Nov-2004 | 1               | First Release.  |
| 13-Jan-2005 | 2               | I <sub>CCLV</sub> is changed on Table 6.                            |
| 23-Mar-2005 | 3               | Table 3 has been updated and V <sub>CC</sub> is changed on Table 4. |

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