



## STG3699B

### Low Voltage 0.5Ω Max, Quad SPDT Switch with break-before-make feature

#### Features

- 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  $V_{IN}=0\text{V}$ :
  - $R_{ON} = 0.50\Omega$ (MAX.  $T_A = 25^\circ\text{C}$ )at  $V_{CC}=4.3\text{V}$
  - $R_{ON} = 0.55\Omega$ (MAX.  $T_A = 25^\circ\text{C}$ )at  $V_{CC}=3.0\text{V}$
  - $R_{ON} = 0.55\Omega$ (MAX.  $T_A = 25^\circ\text{C}$ )at  $V_{CC}=2.7\text{V}$
- Wide operanding voltage range:
  - $V_{CC}$  (OPR) = 1.65V to 4.3V Single supply
- 4.3V Tolerant and 1.8V compatible thresholds on digital control input at  $V_{CC} = 2.3$  to 3.0V
- Latch-up performance exceed 300mA (JESD 17)
- ESD performance (analog chan. Vs. GND):  
HBM > 2kV (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 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 ( $R_{ON}$ ) (<0.5Ω) at  $V_{CC}=3.0\text{V}$ . The nIN inputs are provided to control the switches. The switches nS1 are ON (they are connected to common Ports Dn) when the nIN input is held high and OFF (high impedance state exists between the two ports) when nIN is held low; the switches nS2 are ON (they are connected to common Ports Dn) when the nIN 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 is available in the commercial temperature range  $-40$  to  $125^\circ\text{C}$  in QFN16 2.6x1.8mm package.

#### Order Codes

Part Number	Temperature Range	Package	Tape and Reel
STG3699B	$-40$ to $125^\circ\text{C}$	QFN16L (2.6x1.8)	STG3699BVTR

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# 1 Summary Description

## 1.1 Pin Connection

Figure 1. Connections Diagram (top through view)

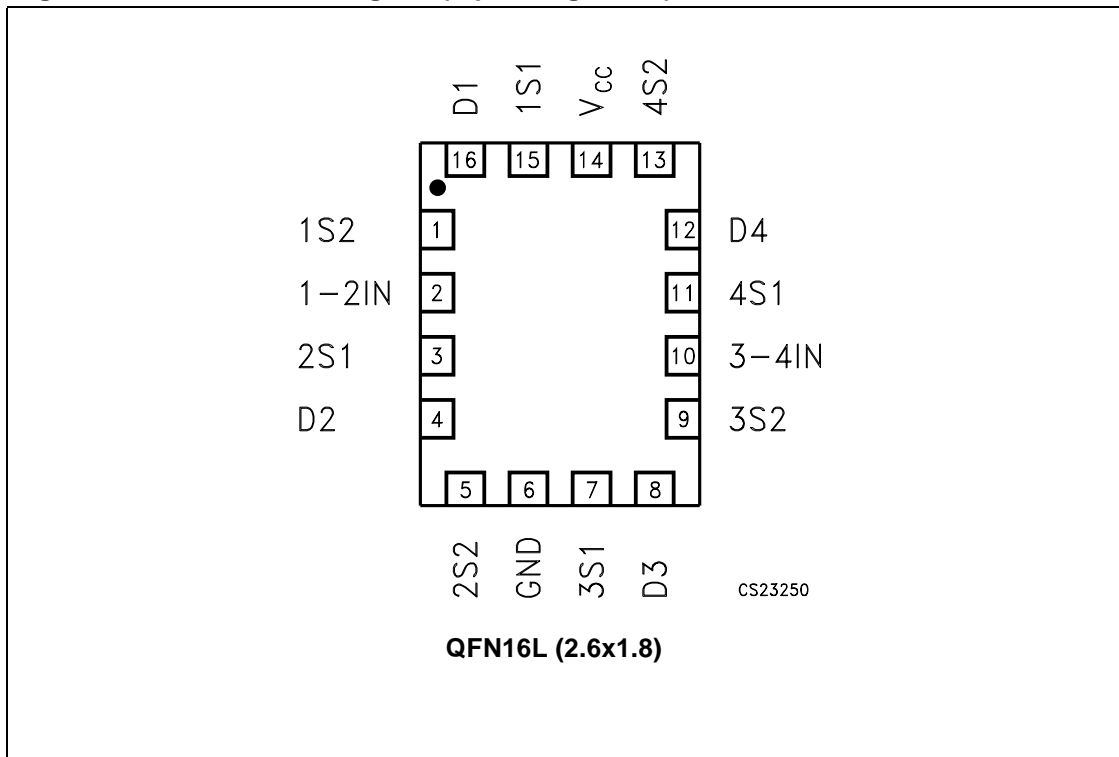
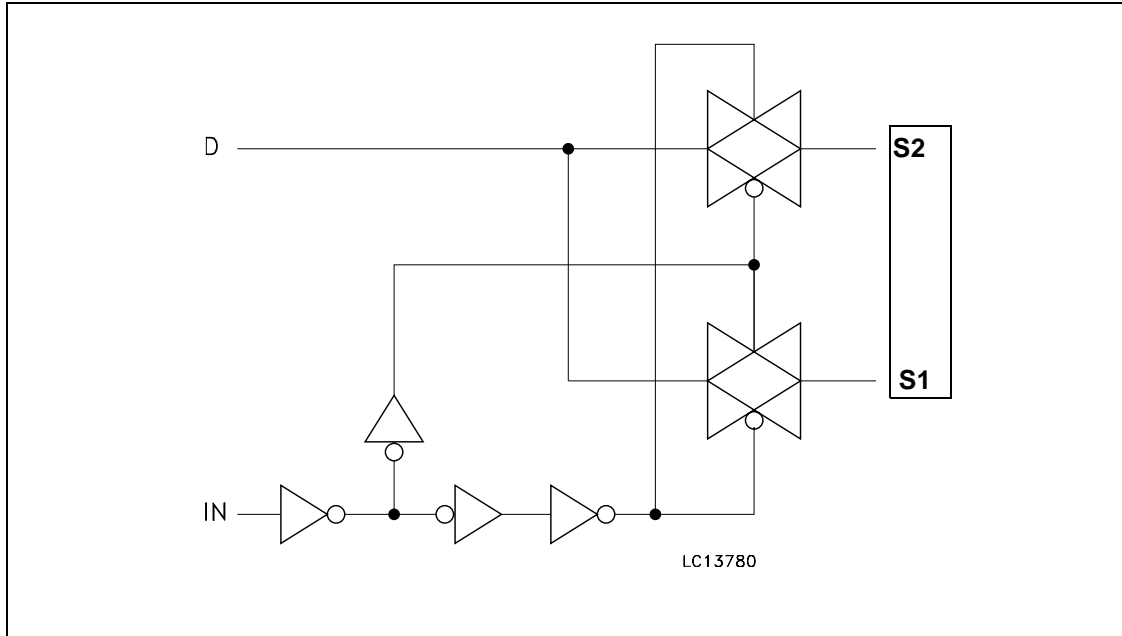


Table 1. Pin Description

Pin N° <sup>(1)</sup>	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)

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

**Figure 2. Input Equivalent Circuit**



**Table 2. 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 3. 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 ( $V_{IN} < 0V$ )	- 50	mA
$I_{IK}$	DC Input Diode Current ( $V_{IN} < 0V$ )	$\pm 50$	mA
$I_{OK}$	DC Output Diode Current	$\pm 20$	mA
$I_O$	DC Output Current	$\pm 300$	mA
$I_{OP}$	DC Output Current Peak (pulse at 1ms, 10% duty cycle)	$\pm 500$	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°C: by 18.5mW/°C.

*Note:* Absolute maximum ratings are those values above which damage to the device may occur. Functional operation under these conditions is not implied. All voltages are referenced to GND.

**Table 4. Recommended Operating Conditions**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage (Truth Table guaranteed: 1.2 to 4.3V)	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

### 3 DC and AC Parameters

**Table 5. DC Specification**

Symbol	Parameter	Test Conditions		Value						Unit	
		V <sub>CC</sub> (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		0.65			0.65		0.65		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> I <sub>S</sub> =100mA		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			
ΔR <sub>ON</sub>	ON Resistance Match between channels (1)	2.7	V <sub>S</sub> @ R <sub>ON</sub> Max I <sub>S</sub> =100mA		0.15					Ω	
R <sub>FLAT</sub>	ON Resistance FLATNESS (2)	4.3	V <sub>S</sub> =0V to V <sub>CC</sub> I <sub>S</sub> =100mA		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			

Table 5. DC Specification

Symbol	Parameter	Test Conditions		Value						Unit	
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
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  $\Delta R_{ON} = R_{ON(Max)} - R_{ON(Min)}$

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 6. 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> (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 R <sub>L</sub> = 50Ω V <sub>S</sub> =1.5V		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 <sub>L</sub> =100pF R <sub>L</sub> = 1MΩ V <sub>GEN</sub> = 0V R <sub>GEN</sub> = 0Ω		42						pC
		2.3-2.7			48						
		3.0-3.3			48						
		3.6-4.3			57						



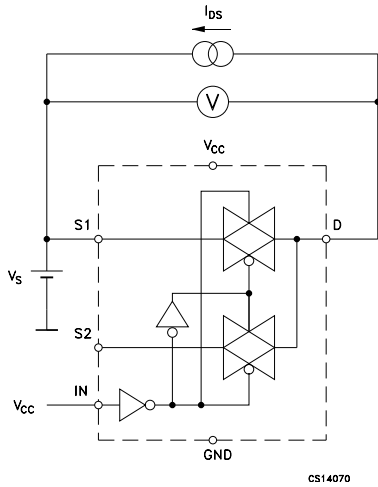
Table 7. Analog Switch Characteristics  $C_L = 5pF$ ,  $R_L = 50\Omega$ ,  $T_A = 25^\circ C$ 

Symbol	Parameter	Test Condition		Value						Unit		
		V <sub>CC</sub> (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 <i>Note: 1</i>	1.65-4.3	V <sub>S</sub> = 1V <sub>RMS</sub> f = 100KHz		-64							dB
Xtalk	Crosstalk	1.65-4.3	V <sub>S</sub> = 1V <sub>RMS</sub> f = 100KHz		-50							dB
THD	Total Harmonic Distortion	2.3-4.3	R <sub>L</sub> = 600Ω V <sub>IN</sub> = 2V <sub>PP</sub> f = 20Hz to 20kHz		0.03							%
BW	-3dB Bandwidth	1.65-4.3	R <sub>L</sub> = 50Ω		40							MHz
C <sub>IN</sub>	Control Pin Input Capacitance				5							pF
C <sub>Sn</sub>	Sn Port Capacitance	3.3	f = 1MHz		80							
C <sub>D</sub>	D Port Capacitance when Switch is Enabled	3.3	f = 1MHz		170							

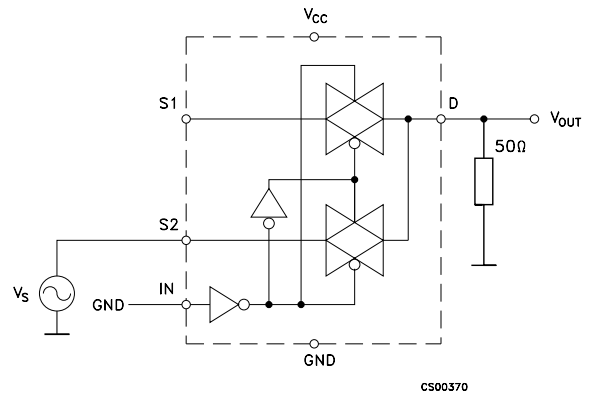
Note: 1 Off-isolation =  $20 \log_{10} (V_D/V_S)$ , V<sub>D</sub> = output, V<sub>S</sub> = input to off switch

# 4 Typical Application

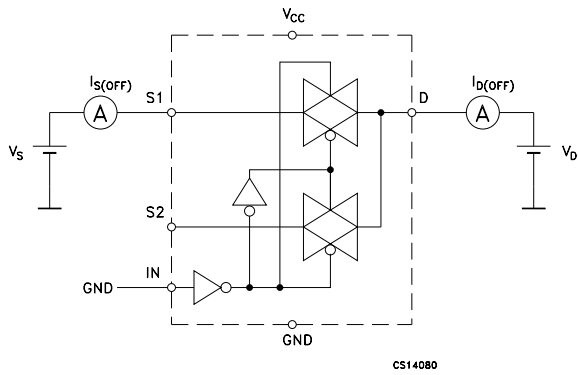
**Figure 3. On Resistance**



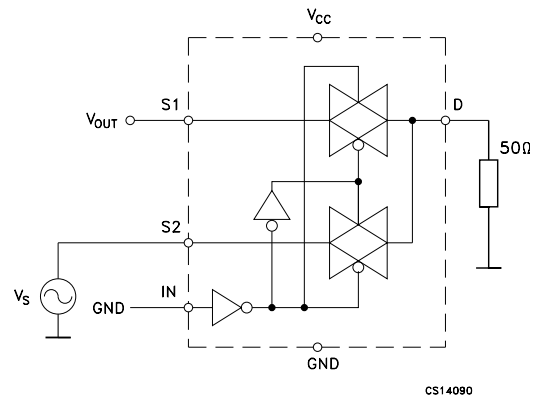
**Figure 4. Bandwidth**



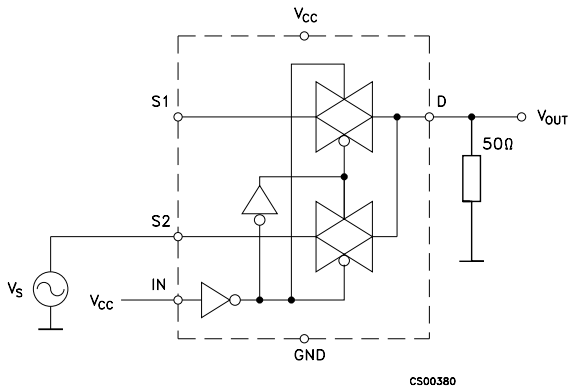
**Figure 5. Off Leakage**



**Figure 6. Channel To Channel Crosstalk**

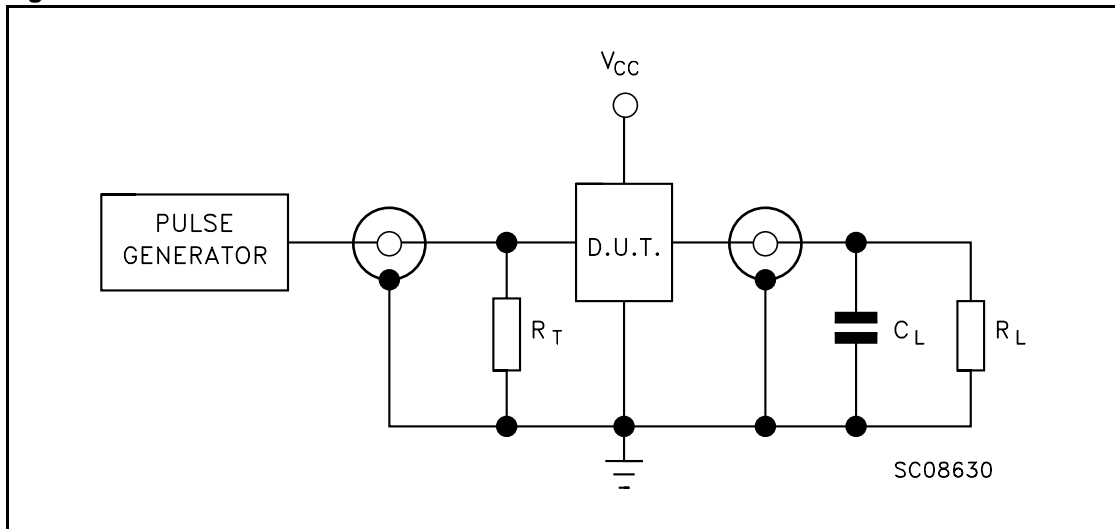


**Figure 7. Off Isolation**



## 5 Test Circuit

Figure 8. Test Circuit



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

$R_L = 50\Omega$  or equivalent

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

# 6 Waveforms

Figure 9. Break-Before-Make time delay

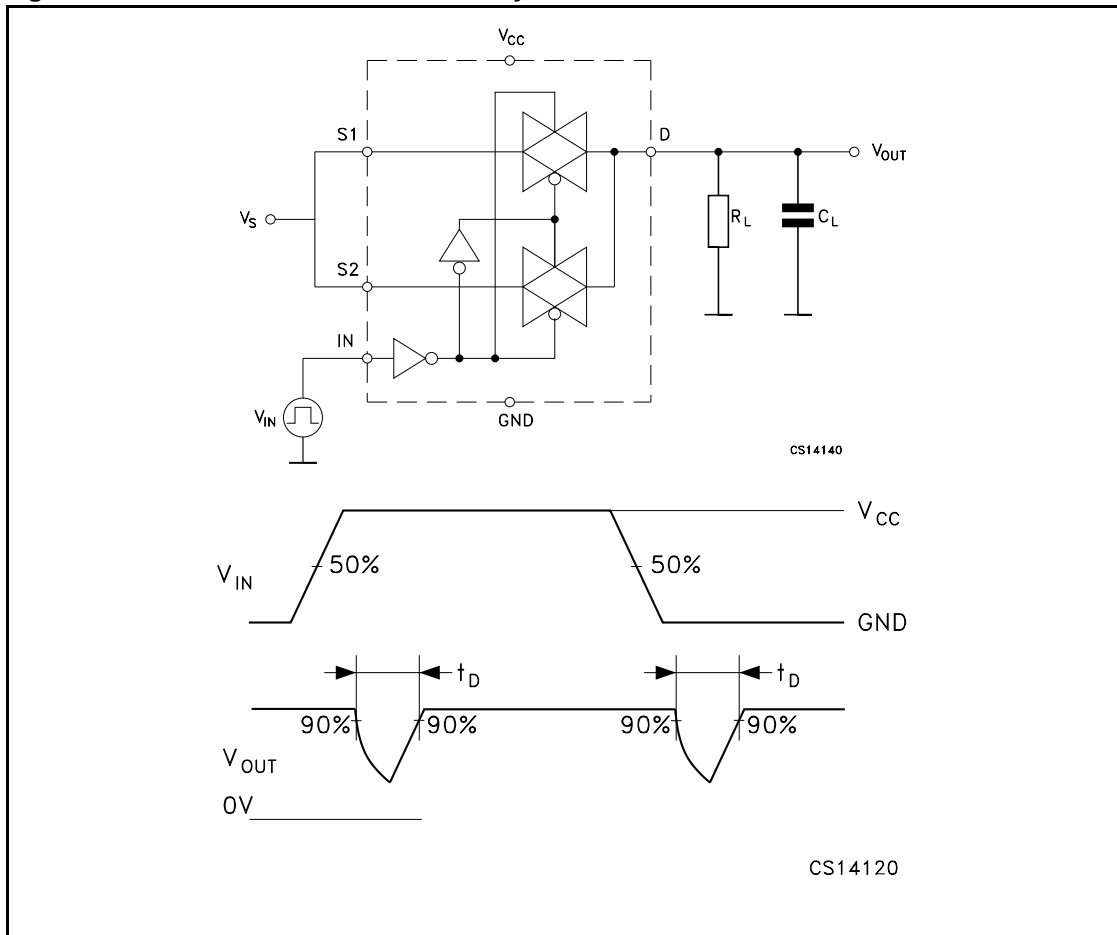


Figure 10. Switching time and charge injection ( $V_{GEN}=0V$ ,  $R_{GEN}=0\Omega$ ,  $R_L=1M\Omega$ ,  $C_L=100pF$ )

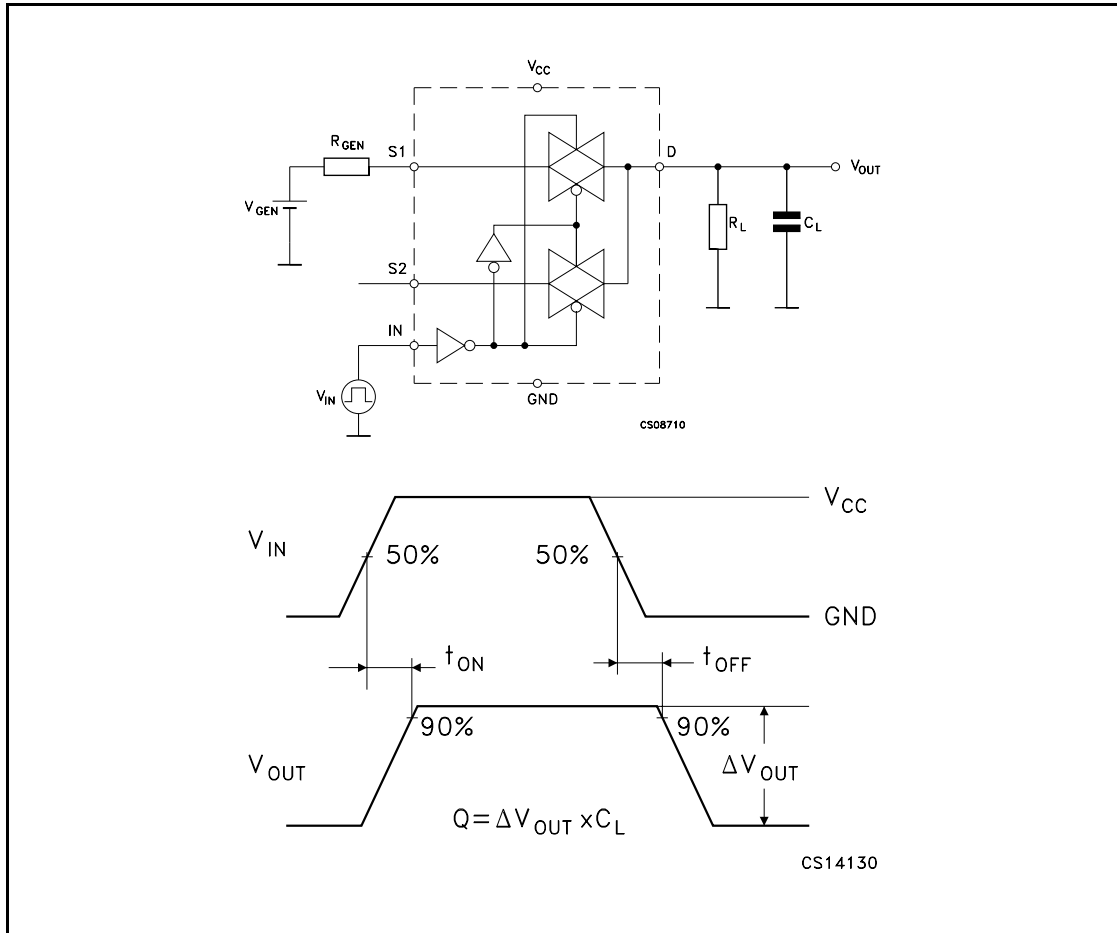
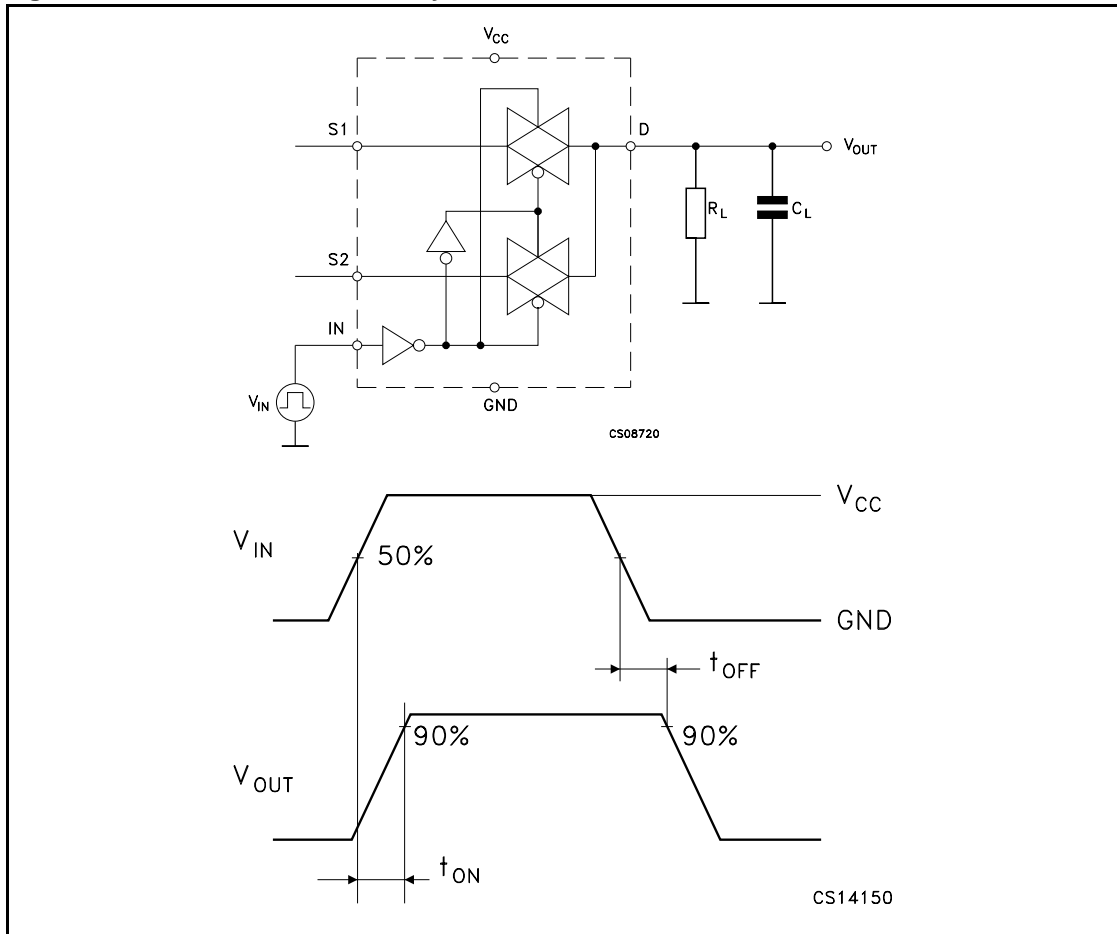


Figure 11. Turn On, Turn Off Delay Time



## 7 Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> 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).

**QFN16L (2.6x1.8) Mechanical Data**

Dimensions			
Ref.	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 12. Package Dimensions**

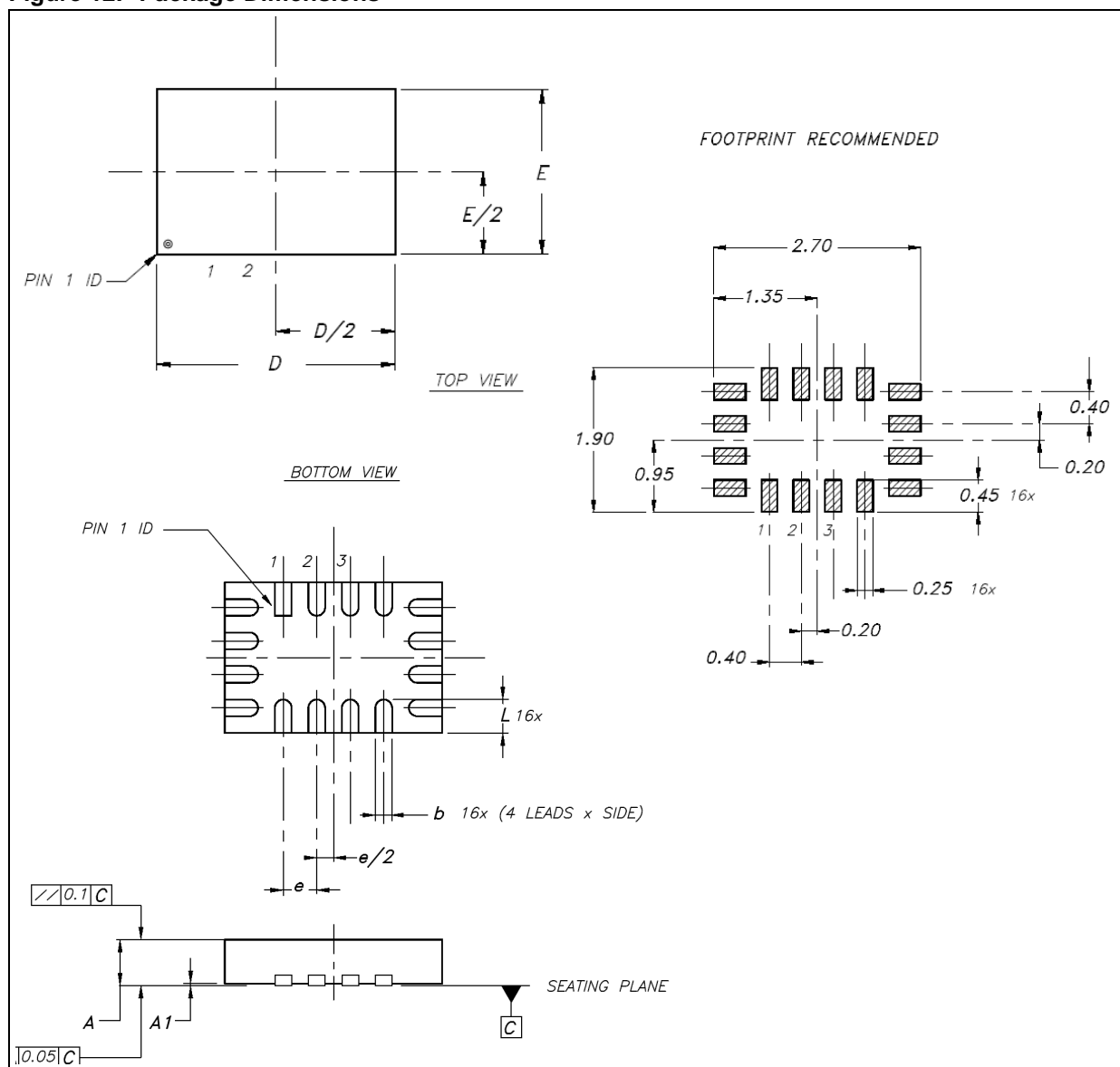
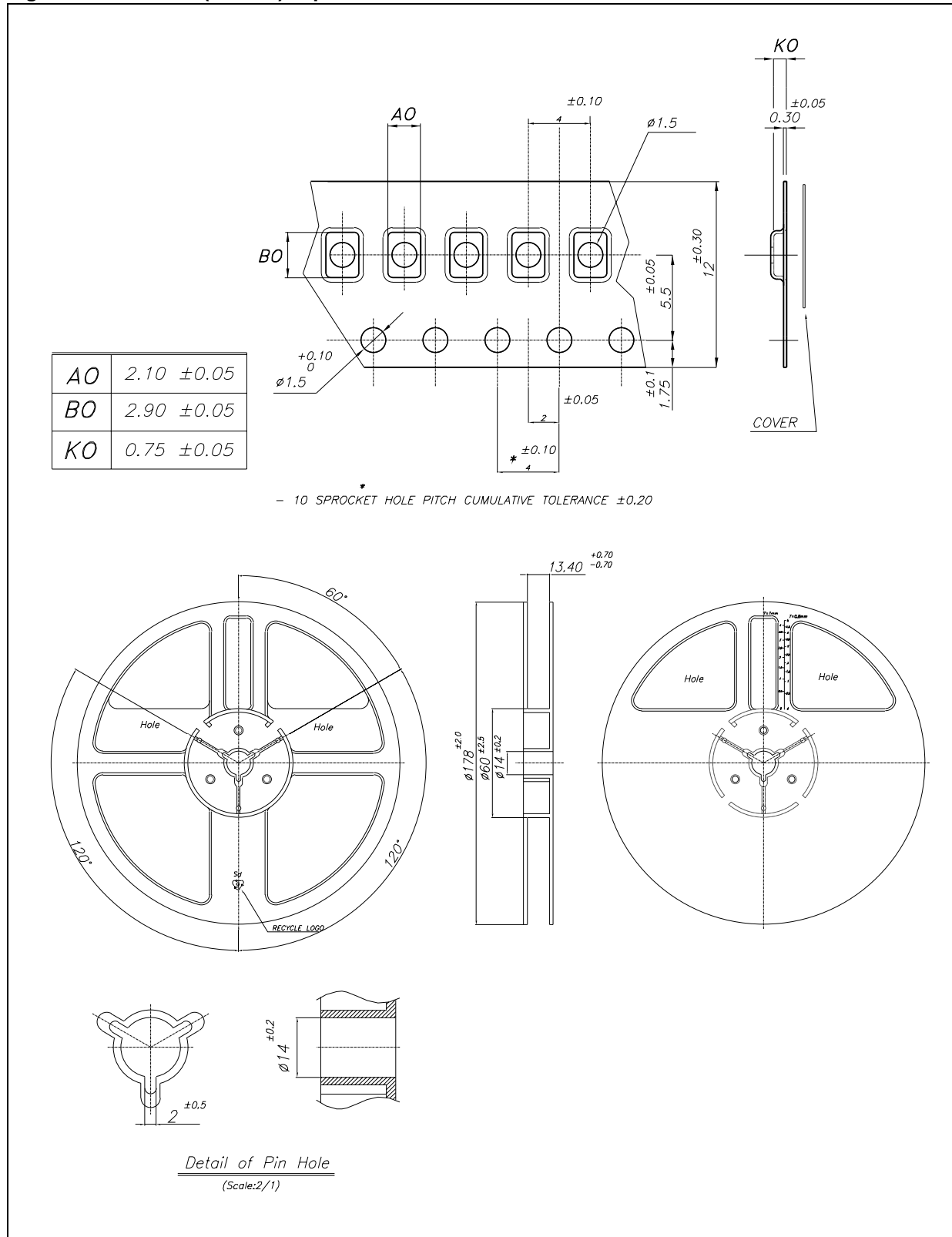




Figure 13. QFN16L (2.6x1.8) Tape & Reel



## 8 Revision History

Date	Revision	Description of Change
13-Oct-2005	1	First Release
21-Dec-2005	2	Added tape & reel information
17-Feb-2006	3	R <sub>FLAT</sub> updated it <a href="#">Table 5: DC Specification on page 6</a>

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