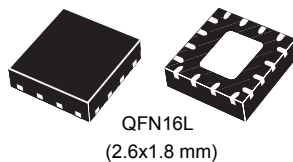


## Low voltage high bandwidth quad SPDT switch



### Features

- Ultra low power dissipation:
  - $I_{CC} = 0.3 \mu A$  at  $T_A = 125 \text{ }^\circ C$
- Low on-resistance:
  - $R_{DS(on)} = 4 \Omega$  ( $T_A = 25 \text{ }^\circ C$ ) at  $V_{CC} = 3.0 V$
- Wide operating voltage range:
  - $V_{CC} (opr) = 1.65 V$  to  $5 V$  single supply
- $5 V$  tolerant and  $1.8 V$  compatible threshold on digital control input at  $V_{CC} = 2.3 V$  to  $3.0 V$
- Typical bandwidth ( $-3 \text{ dB}$ ) at  $800 \text{ MHz}$  on all channels
- Latch-up performance exceeds  $100 \text{ mA}$  per JESD 78, Class II
- ESD performance exceeds JESD22
  - $2000\text{-V}$  human body model (A114-A)
- USB (2.0) high speed ( $480 \text{ Mbps}$ ) 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  $1.65 V$  to  $5 V$ , making this device ideal for portable applications.

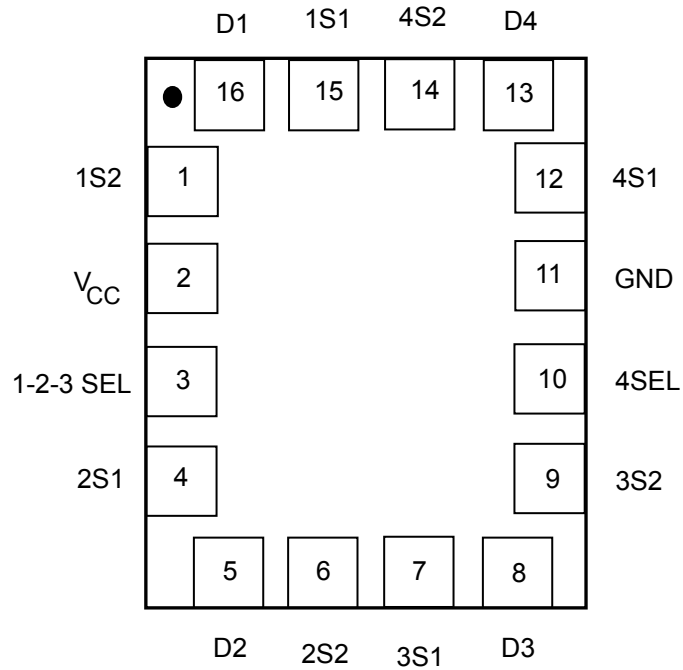
The nSEL inputs are provided to control the switch. The switch S1 is ON (it is connected to common ports Dn) when the nSEL input is held high and OFF (high impedance state exists between the two ports) when SEL is held low; the switch S2 is ON (it is connected to common port D) when the nSEL input is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

Product status link	
<a href="#">STG3693</a>	
Product summary	
Order code	STG3693QTR
Package	QFN16L (2.6x1.8 mm)
Packing	Tape and reel

# 1 Pin settings

## 1.1 Pin connections

Figure 1. Pin connection (top through view)



## 1.2 Pin description

Table 1. Pin description

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

*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

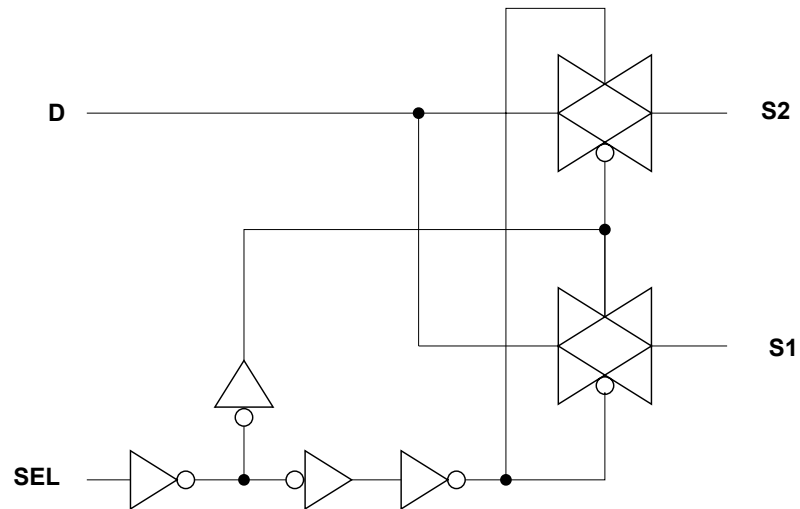


Table 2. Truth table

1-2-3-SEL	4 SEL	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 ratings

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 ( $V_{SEL} < 0$ V)	-50	mA
$I_{IK}$	DC input diode current ( $V_{SEL} < 0$ V)	$\pm 50$	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 1 ms, 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 $T_A = 70$ °C <sup>(1)</sup>	1120	mW
$T_{stg}$	Storage temperature	-65 to 150	°C
$T_L$	Lead temperature (10 s)	300	°C

1. Derate above 70 °C by 18.5 mW/C.

#### 3.1 Recommended operating conditions

**Table 4. Recommended operating conditions**

Symbol	Parameters	Value	Unit	
$V_{CC}$	Supply voltage	1.65 to 5	V	
$V_I$	Input voltage	0 to $V_{CC}$		
$V_{IC}$	Control input voltage	0 to 5		
$V_O$	Output voltage	0 to $V_{CC}$		
$T_{op}$	Operating temperature	-55 to 125	°C	
$dt/dv$	Input rise and fall time control input	$V_{CC} = 1.65$ V to 2.7 V	0 to 20	ns/V
		$V_{CC} = 3.0$ to 4.3 V	0 to 10	

## 4 Electrical characteristics

**Table 5. DC specifications**

Symbol	Parameter	Test conditions		Value					Unit
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
V <sub>IH</sub>	High level input voltage	1.65 -1.95		0.65			0.65		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		
		5		2			2		
V <sub>IL</sub>	Low level input voltage	1.65-1.95				0.25		0.25	V
		2.3-2.5				0.25		0.25	
		2.7-3.0				0.25		0.25	
		3.3-3.6				0.30		0.30	
		4.3				0.40		0.40	
		5				0.40		0.40	
R <sub>PEAK</sub>	Switch-on peak resistance	1.8	V <sub>S</sub> = 0 V to V <sub>CC</sub> , I <sub>S</sub> = 8 mA		12	16	8.2	16.1	Ω
		2.7			6.3	8	3.3	9.3	
		3			5.8	7.5	3	8.5	
		3.7			5	6.5	2.6	7.3	
		4.3			4.6	6.0	2.4	6.8	
		5			4.6	6.0	2.4	6.8	
R <sub>ON</sub>	Switch-on resistance	3	V <sub>S</sub> = 3 V, I <sub>S</sub> = 8 mA		4	5.2	2.2	5.7	Ω
		3	V <sub>S</sub> = 0.8 V, I <sub>S</sub> = 8 mA		5	6.5	2.7	7.4	
ΔR <sub>ON</sub>	ON-resistance match between channels	1.8	V <sub>S</sub> @ R <sub>ON</sub> max., I <sub>S</sub> = 8 mA						Ω
		2.7							
		3			0.3		0.3		
		3.7							
		4.3							
		5							
R <sub>FLAT</sub>	ON-resistance flatness	1.8	V <sub>S</sub> = 0 V to V <sub>CC</sub> , I <sub>S</sub> = 8 mA		6.6		5.2	7.9	Ω
		2.7			2		0.8	3.2	
		3			1.7		0.8	2.9	
		3.7			1.5		0.8	2.4	
		4.3			1.6		0.8	2.2	
		5			4.6		0.8	2.2	
I <sub>OFF</sub>	OFF-state leakage current (SN), (D)	4.3	V <sub>S</sub> = 0.3 or 4 V			±20		±100	nA

Symbol	Parameter	Test conditions		Value					Unit
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
I <sub>IN</sub>	Input leakage current	0 to 4.3	V <sub>SEL</sub> = 0 to 4.3 V			±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	µA
I <sub>CCLV</sub>	Quiescent supply current low voltage driving	4.3	V1-2-3SEL, V4-SEL = 1.65 V		37	50		100	µA
			V1-2-3SEL, V4-SEL = 1.80 V		33	40		50	
			V1-2-3SEL, V4-SEL = 2.60 V		11	20		30	

**Table 6. Analog switch characteristics (C<sub>L</sub> = 35 pF, R<sub>L</sub> = 50 Ω, t<sub>r</sub> = t<sub>f</sub> ≤ 5 ns)**

Symbol	Parameter	Test conditions		Value					Unit
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation delay	1.65 -1.95			0.3				ns
		2.3-2.7			0.3				
		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> =0.8 V		31				ns
		2.3-2.7	V <sub>S</sub> =1.5 V		20	26		34	
		3.0-3.3			20	20		26	
		3.6-4.3			20	15		20	
t <sub>ON</sub> channel skew	Turn-on time skew between channels	3.0-3.3	V <sub>S</sub> =1.5 V		600				ps
t <sub>OFF</sub>	Turn-off time	1.65 -1.95	V <sub>S</sub> =0.8 V		5			8	ns
		2.3-2.7	V <sub>S</sub> =1.5 V		4	6		8	
		3.0-3.3			4	6		6	
		3.6-4.3			3	5			
t <sub>OFF</sub> channel skew	Turn-off time skew between channels	3.0-3.3	V <sub>S</sub> =1.5 V		900				ps
t <sub>D</sub>	Break- before-make time delay	1.65-1.95	C <sub>L</sub> = 35 pF, R <sub>L</sub> = 50 Ω, V <sub>S</sub> = 1.5 V		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> = 100 pF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω		2.8				pC
		2.3			3.5				
		3			3.8				
		4.3			5				

**Table 7. Analog switch characteristics ( $C_L = 5 \text{ pF}$ ,  $R_L = 50 \text{ } \Omega$ ,  $T_A = 25 \text{ } ^\circ\text{C}$ )**

Symbol	Parameter	Test conditions		Value					Unit	
		$V_{CC}$ (V)		$T_A = 25 \text{ } ^\circ\text{C}$	$-40 \text{ to } 125 \text{ } ^\circ\text{C}$					
				Min.	Typ.	Max.	Min.	Max.		
OIRR	Off isolation <sup>(1)</sup>	1.65 -4.3	$V_S = 1 V_{RMS}$ , $f = 1 \text{ MHz}$ , signal = 0 dBm		-79					dB
			$V_S = 1 V_{RMS}$ , $f = 1 \text{ MHz}$ , signal = 0 dBm		-60					
Xtalk	Crosstalk	1.65 -4.3	$V_S = 1 V_{RMS}$ , $f = 1 \text{ MHz}$ , signal = 0 dBm		-78					dB
			$V_S = 1 V_{RMS}$ , $f = 1 \text{ MHz}$ , signal = 0 dBm		-61					
THD	Total harmonic distortion	3.7	$f = 20 \text{ Hz to } 20 \text{ kHz}$ , $R_L = 32 \text{ } \Omega$ , $C_L = 50 \text{ } \Omega$ , $V_{IN} = 2.8 V_{P-P}$ , $V_{DC} = V_{CC}/2$		0.01	0.02				%
PSRR	Power supply rejection ratio	3.7	$f = 217 \text{ Hz}$ , $R_L = 32 \text{ } \Omega$ , $C_L = 50 \text{ } \Omega$ , $V_{ripple} = 150 \text{ mV}$ , $V_{DC} = V_{CC}/2$		-60					dB
BW	-3 dB bandwidth	3.0-4.3	$R_L = 50 \text{ } \Omega$ , signal = 0 dBm		800					MHz
$D_G$	Differential gain	3.0-4.3	$R_L = 150 \text{ } \Omega$		0.64					%
$D_P$	Differential phase	3.0-4.3	$R_L = 150 \text{ } \Omega$		0.1					deg
$C_{IN}$	Control pin input capacitance		$V_{CC} = 0 \text{ V}$		6.2					pF
$C_{ON}$	Sn port capacitance when switch is enabled	3.3	$f = 1 \text{ MHz}$		10					pF
$C_{OFF}$	Sn port capacitance when switch is disabled	3.3	$f = 1 \text{ MHz}$		5					pF

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

**Table 8. USB related AC electrical characteristics**

Symbol	Parameter	Test conditions		Value					Unit	
		$V_{CC}$ (V)		$T_A = 25 \text{ } ^\circ\text{C}$	$-40 \text{ to } 125 \text{ } ^\circ\text{C}$					
				Min.	Typ.	Max.	Min.	Max.		
$t_{SK(0)}$	Channel-to-channel skew	3.0 to 3.6	$C_L = 10 \text{ pF}$		26					ps
$t_{SK(P)}$	Skew of opposite transition of the same output	3.0 to 3.6	$C_L = 10 \text{ pF}$		60					ps
$T_J$	Total jitter	3.0 to 3.6	$R_L = 50 \text{ } \Omega$ , $C_L = 10 \text{ pF}$ , $t_R = t_F = 750 \text{ ps}$ at 480 Mbps		130					dB

## 5 Test circuits

Figure 3. On-resistance

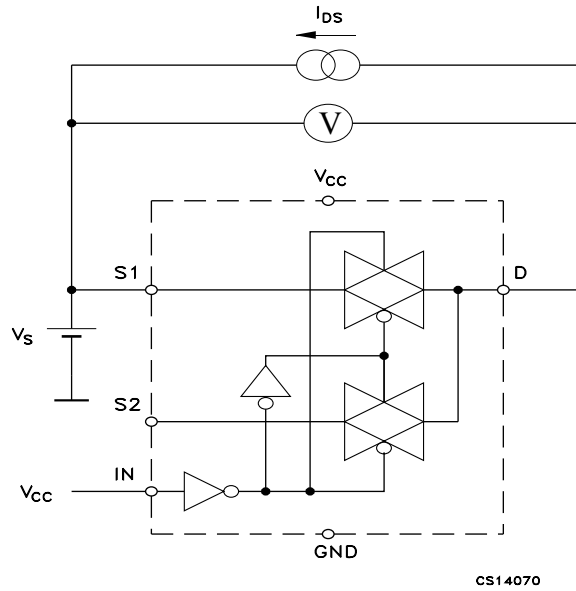


Figure 4. Bandwidth

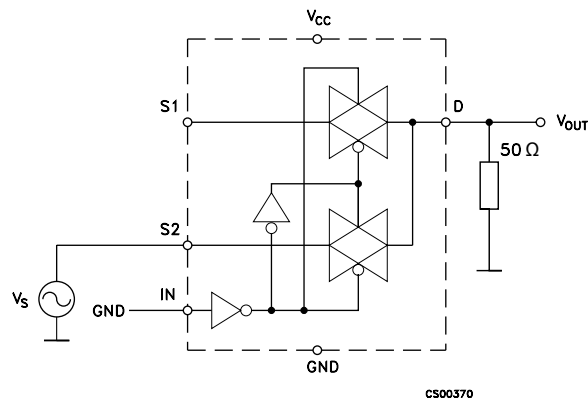


Figure 5. Off leakage

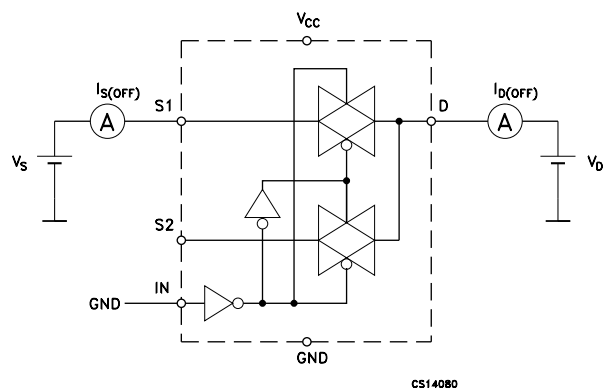




Figure 6. Channel-to-channel crosstalk

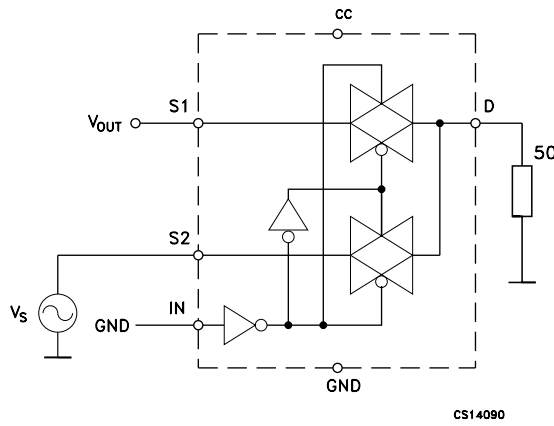
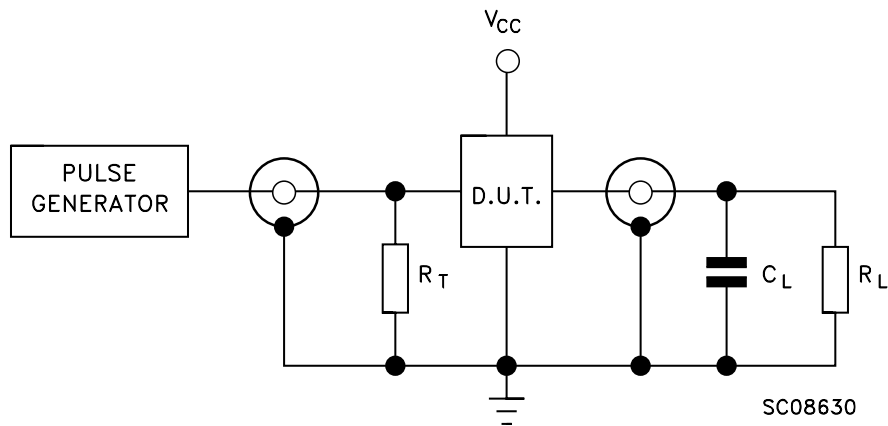


Figure 7. Test circuits



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

Figure 8. Break-before-make time delay

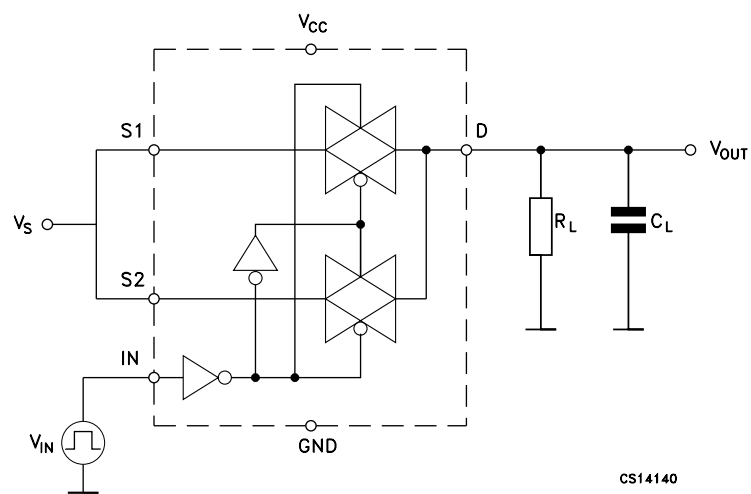


Figure 9. Break-before-make time delay2

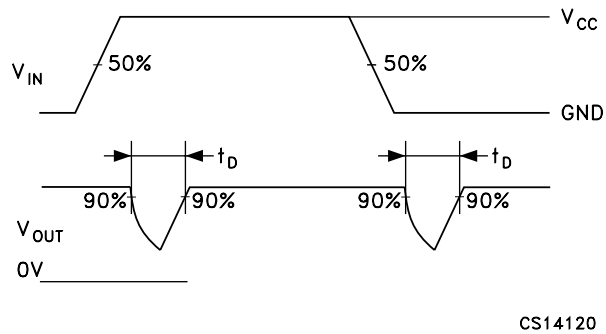


Figure 10. Switching time and charge injection ( $V_{GEN} = 0\text{ V}$ ,  $R_{GEN} = 0\ \Omega$ ,  $R_L = 1\text{ M}\Omega$ ,  $C_L = 100\text{ pF}$ )

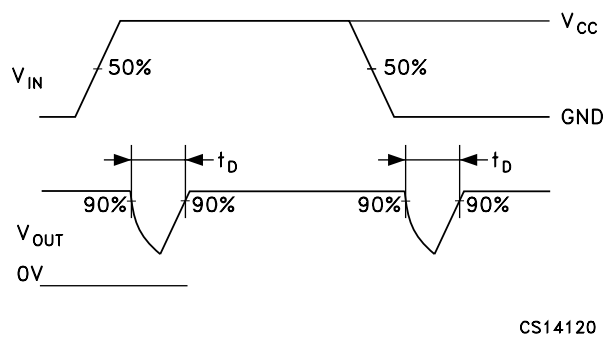


Figure 11. Switching time and charge injection ( $V_{GEN} = 0\text{ V}$ ,  $R_{GEN} = 0\ \Omega$ ,  $R_L = 1\text{ M}\Omega$ ,  $C_L = 100\text{ pF}$ ) 2

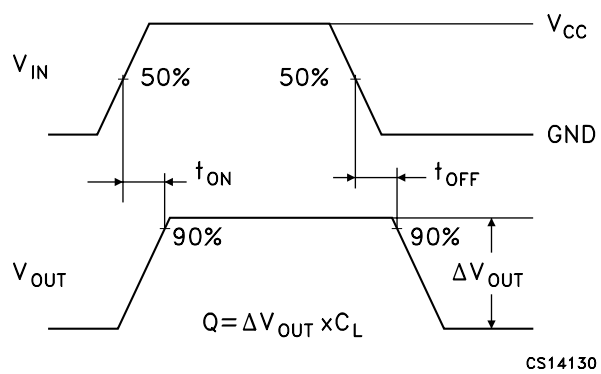


Figure 12. Turn-on, turn-off delay time

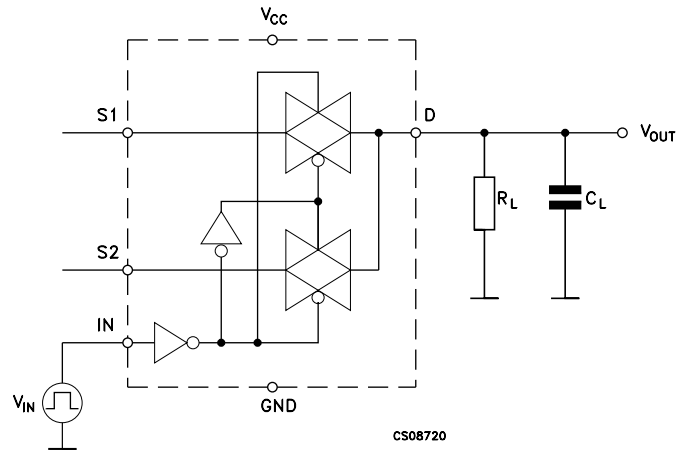
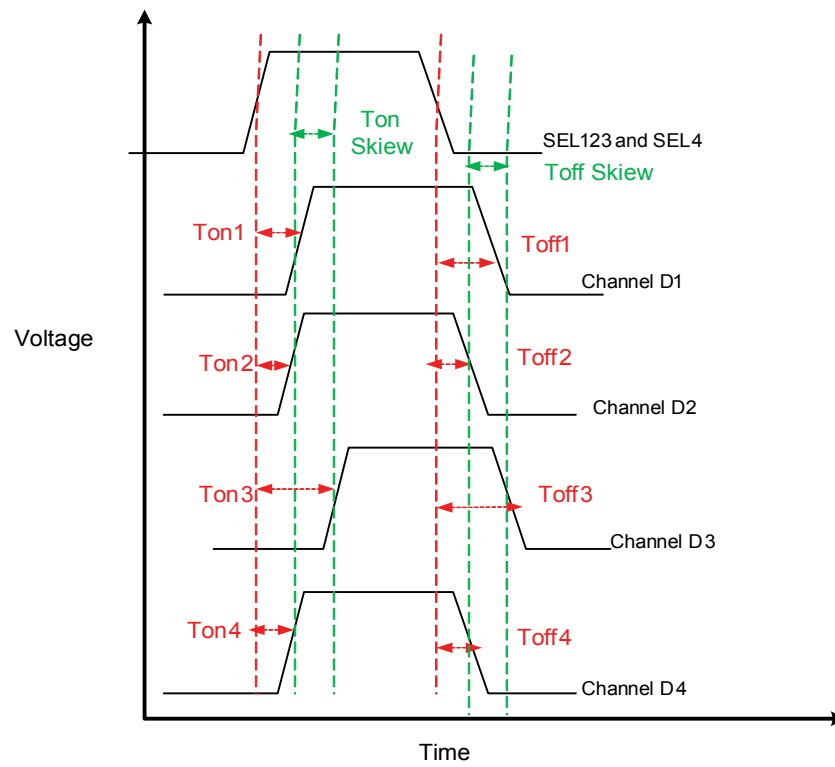


Figure 13. Turn-on, turn-off delay time and channel skew



## 6 Package information

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.

### 6.1 QFN16L (2.6x1.8 mm) package information

Figure 14. [package name] package outline

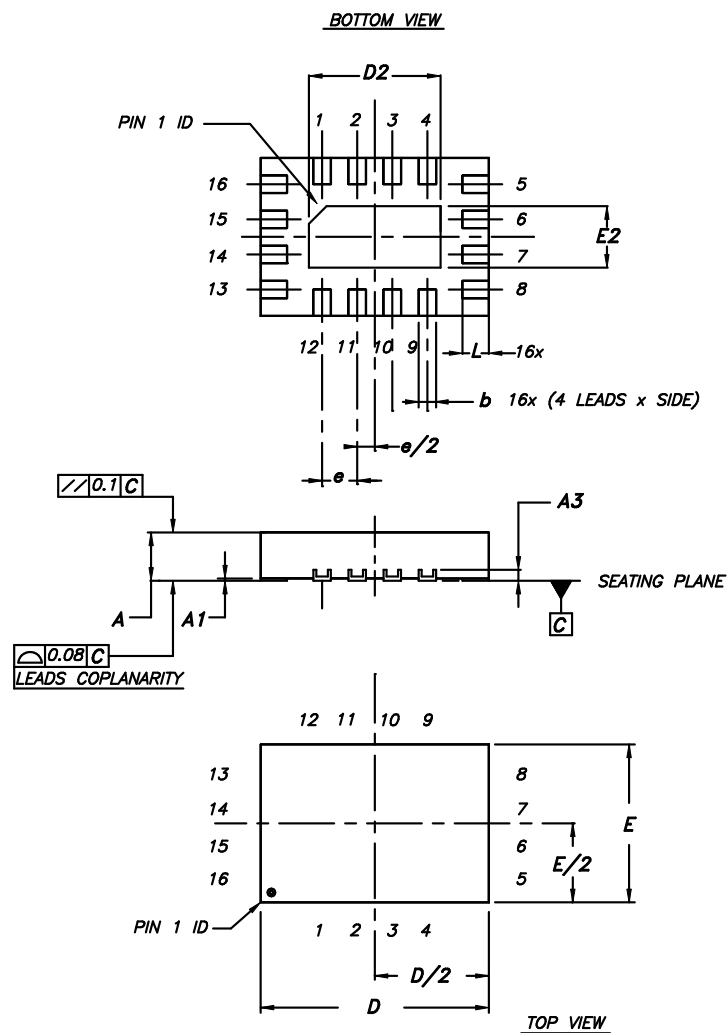


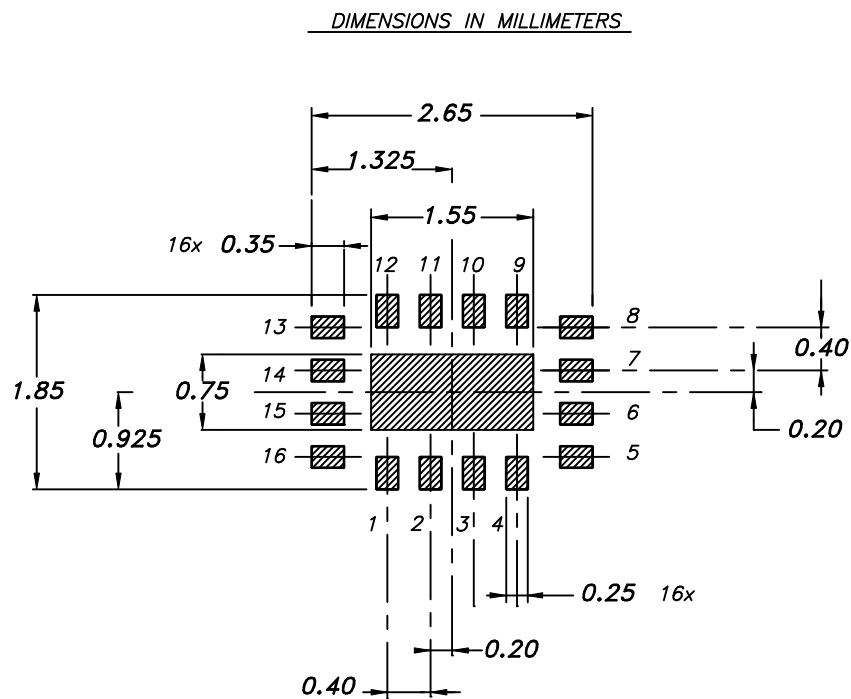
Table 9. QFN16L (2.6x1.8 mm) package mechanical data

Symbol	mm		
	Min.	Typ.	Max.
A	0.45	0.5	0.55
A1	0	0.02	0.05
A3		0.127	
b	0.15	0.2	0.25

Symbol	mm		
	Min.	Typ.	Max.
D	2.55	2.6	2.65
D2	1.45	1.5	1.55
E	1.75	1.8	1.85
E2	0.65	0.7	0.75
e		0.4	
L	0.25	0.3	0.35

**Note:** VFQFPN - Standard for thermally enhanced very fine pitch quad flat package no leads. The leads size is comprehensive of the thickness of the leads finishing material. Dimensions do not include mold protusion. Package outline exclusive of metal burrs dimensions. Shipping media tape and reel units: 3000.

**Figure 15. QFN16L (2.6x1.8 mm) recommended footprint**



## 6.2 QFN16L (2.6x1.8 mm) packing information

Figure 16. QFN16L (2.6x1.8 mm) carrier tape

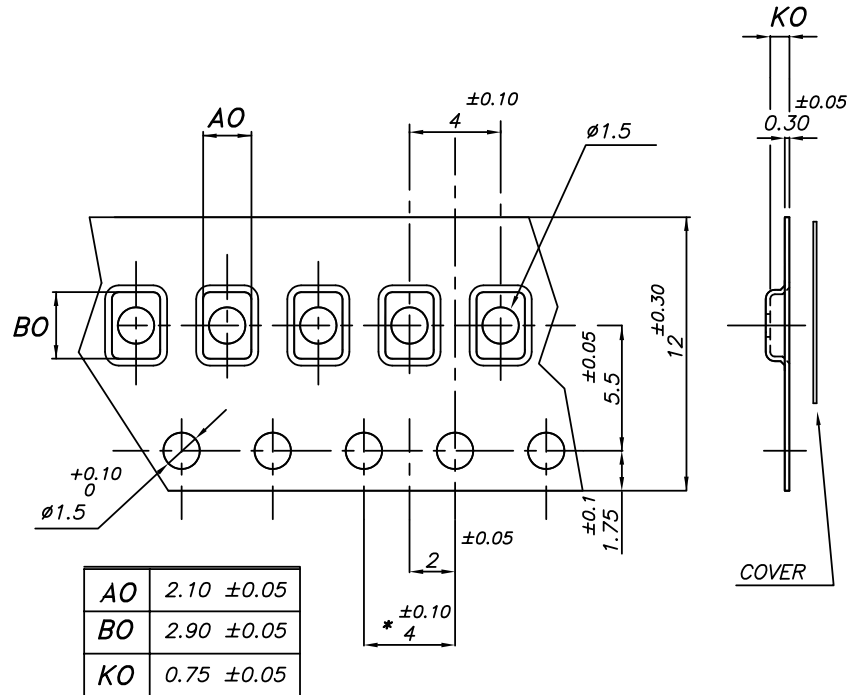
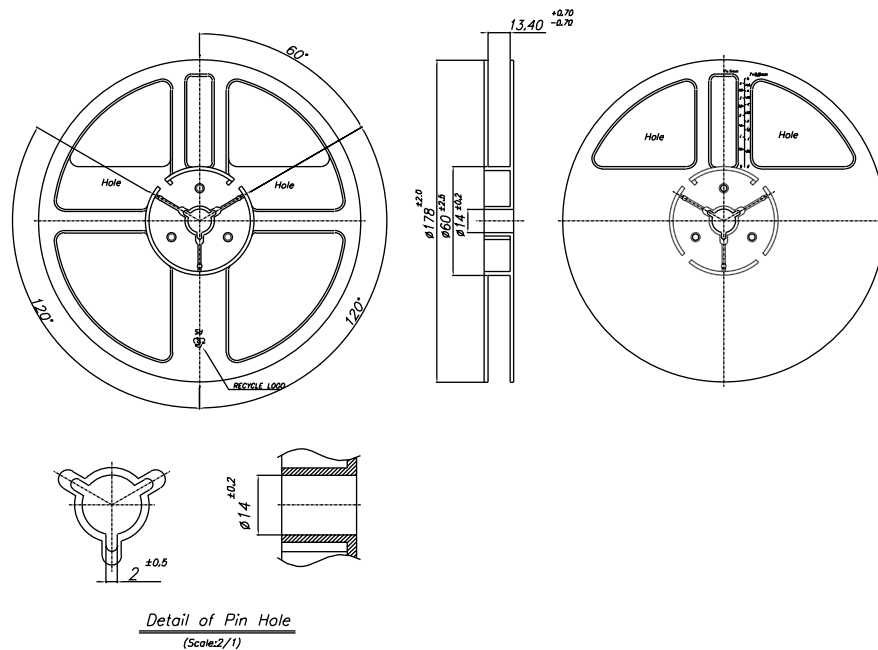


Figure 17. QFN16L (2.6x1.8 mm) reel

- 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.20



## Revision history

**Table 10. Document revision history**

Date	Version	Changes
03-Jan-2006	1	Initial release.
23-Jul-2007	2	Updated C <sub>OFF</sub> value in Table 8 on page 8
18-Sep-2018	3	Updated Features, Table 6, Table 7, Table 8, Table 9. Updated Figure 13
12-Oct-2018	4	Updated Section 4: Electrical characteristics
04-Jun-2019	5	Updated features, the description and <a href="#">Table 4. Recommended operating conditions</a> .

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