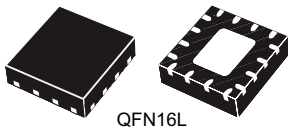
STG3693

Low voltage high bandwidth quad SPDT switch

Datasheet - production data



QFN16L
(2.6x1.8 mm)

Features

- Ultra low power dissipation:
  - I_{CC} = 0.3 µA at T_A = 125 °C
- Low on-resistance:
  - $R_{DS(on)}$ = 4 Ω (T_A = 25 °C) at V_{CC} = 3.0 V
- Wide operating voltage range:
  - V_{CC} (opr) = 1.65 V to 4.3 V single supply
- 4.3 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 dB) at 800 MHz on all channels
- Latch-up performance exceeds 100 mA per JESD 78, Class II
- ESD performance exceeds JESD22
  - 2000-V human body model (A114-A)
- USB (2.0) high speed (480 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 4.3 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.

Table 1. Device summary

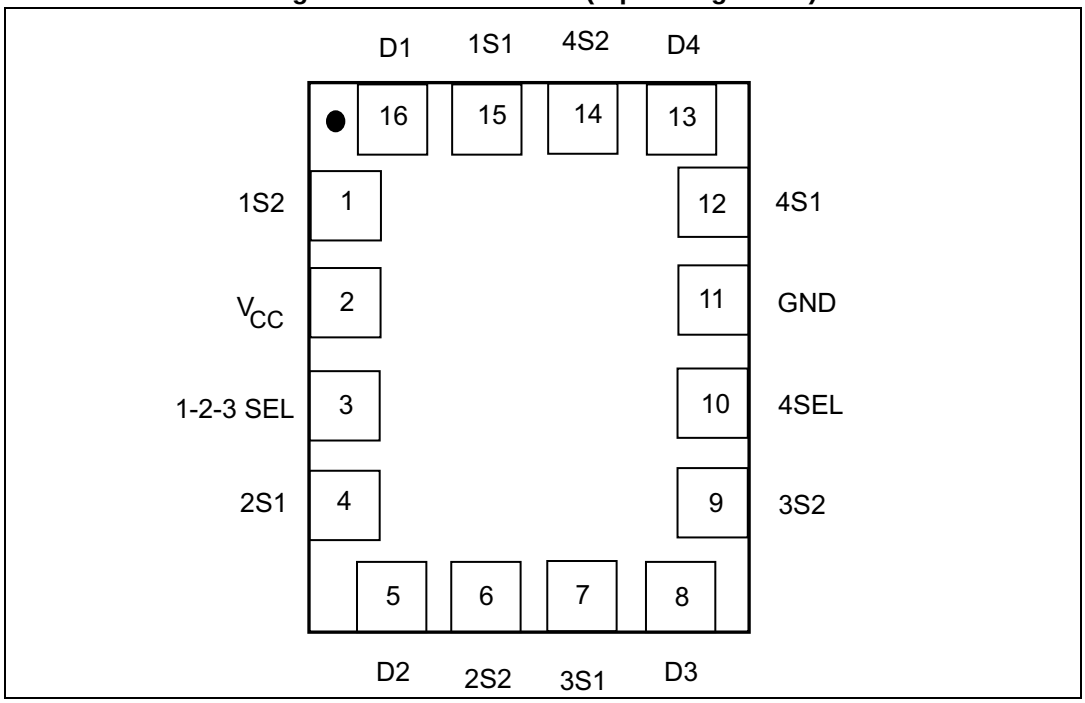
Order code	Package	Packing
STG3693QTR	QFN16L (2.6x1.8 mm)	Tape and reel

Contents

1 Pin settings

1.1 Pin connection

Figure 1. Pin connection (top through view)



1.2 Pin description

Table 2. Pin description

Pin	Symbol	Name and function
15,1, 4,6, 7,9, 12,14	1S1, 1S2, 2S1, 2S2, 3S1, 3S2, 4S1, 4S2	Independent channels
16,5,8,13	D1, D2, D3, D4	Common channels
3, 10	1-2-3SEL, 4SEL	Control
2	V_{CC}	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

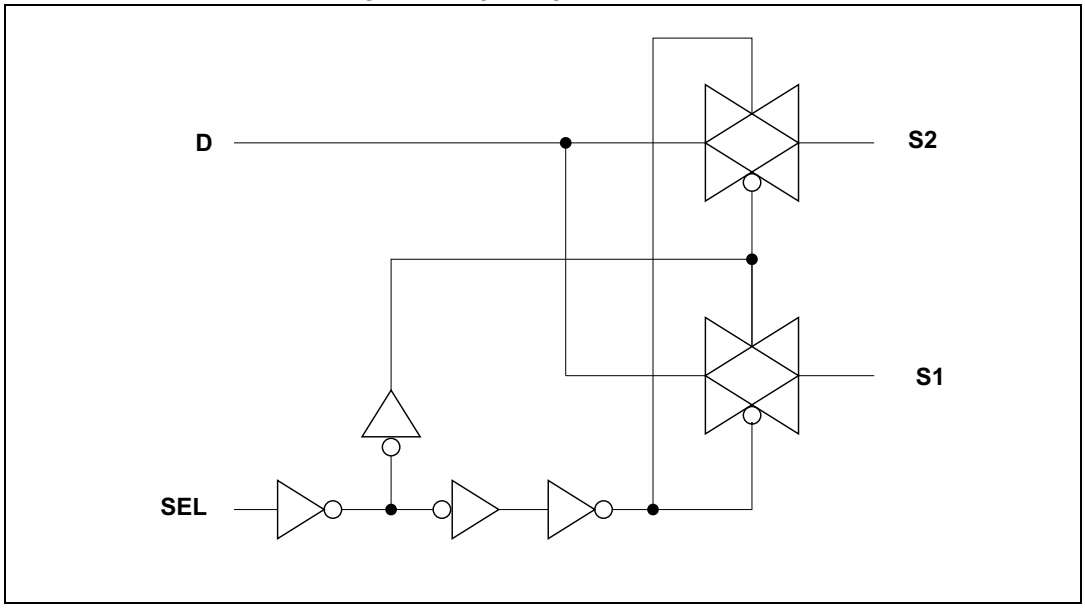


Table 3. Truth table

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 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)	±50	mA
I_{OK}	DC output diode current	±20	mA
I_O	DC output current	±128	mA
I_{OP}	DC output current peak (pulse at 1ms, 10% duty cycle)	±300	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 s)	300	°C

1. Derate above 70 ºC by18.5 mW/C

3.1 Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameters		Value	Unit
V_{CC}	Supply voltage		1.65 to 4.3	V
V_I	Input voltage		0 to V_{CC}	
V_{IC}	Control input voltage		0 to 4.3	
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 6. DC specifications

Symbol	Parameter	Test conditions		Value					Unit
		V_{CC} (V)		T_A = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
V_{IH}	High level input voltage	1.65 -1.95		0.65 V_{CC}			0.65 V_{CC}		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_{IL}	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	
R_{PEAK}	Switch-on peak resistance	1.8	V_S = 0 V to V_{CC} I_S = 8 mA		12.0	16.0	8.2	16.1	Ω
		2.7			6.3	8.0	3.3	9.3	
		3.0			5.8	7.5	3.0	8.5	
		3.7			5.0	6.5	2.6	7.3	
		4.3			4.6	6.0	2.4	6.8	
R_{ON}	Switch-on resistance	3.0	V_S = 3 V I_S = 8 mA		4.0	5.2	2.2	5.7	Ω
		3.0	V_S = 0.8 V I_S = 8 mA		5.0	6.5	2.7	7.4	
ΔR_{ON}	ON-resistance match between channels	1.8	V_S @ R_{ON} max. I_S = 8 mA						Ω
		2.7							
		3.0			0.3		0.3		
		3.7							
		4.3							
R_{FLAT}	ON-resistance flatness	1.8	V_S = 0 V to V_{CC} I_S = 8 mA		6.6		5.2	7.9	Ω
		2.7			2.0		0.8	3.2	
		3.0			1.7		0.8	2.9	
		3.7			1.5		0.8	2.4	
		4.3			1.6		0.8	2.2	

Table 6. DC specifications

Symbol	Parameter	Test conditions		Value					Unit
		V_{CC} (V)		T_A = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
I_{OFF}	OFF-state leakage current (SN), (D)	4.3	V_S = 0.3 or 4 V			±20		±100	nA
I_{IN}	Input leakage current	0 to 4.3	V_{SEL} = 0 to 4.3 V			±0.1		±1	µA
I_{CC}	Quiescent supply current	1.65 to 4.3	V_{SEL} = V_{CC} or GND			0.1		1.0	µA
I_{CCLV}	Quiescent supply current low voltage driving	4.3	$V_{1\text{-}2\text{-}3SEL}$, $V_{4\text{-}SEL}$ = 1.65 V		37	50		100	µA
			$V_{1\text{-}2\text{-}3SEL}$, $V_{4\text{-}SEL}$ = 1.80 V		33	40		50	
			$V_{1\text{-}2\text{-}3SEL}$, $V_{4\text{-}SEL}$ = 2.60 V		11	20		30	

Table 7. Analog switch characteristics (C_L = 35 pF, R_L = 50 Ω, $t_r = t_f \leq$ 5 ns)

Symbol	Parameter	Test conditions		Value					Unit
		V_{CC} (V)		T_A = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
t_{PLH}, t_{PHL}	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_{ON}	Turn-on time	1.65 -1.95	V_S=0.8 V		31				ns
		2.3-2.7	V_S=1.5 V		20	26		34	
		3.0-3.3			20	20		26	
		3.6-4.3			20	15		20	
t_{ON} channel skew	Turn-on time skew between channels	3.0-3.3	V_S=1.5 V		600				ps
t_{OFF}	Turn-off time	1.65 -1.95	V_S=0.8 V		5			8	ns
		2.3-2.7	V_S=1.5 V		4	6		8	
		3.0-3.3			4	6		6	
		3.6-4.3			3	5			
t_{OFF} channel skew	Turn-off time skew between channels	3.0-3.3	V_S=1.5 V		900				ps
t_D	Break-before-make time delay	1.65-1.95	C_L = 35 pF R_L = 50 Ω V_S = 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_L = 100 pF V_{GEN} = 0 V R_{GEN} = 0 Ω		2.8				pC
		2.3			3.5				
		3.0			3.8				
		4.3			5.0				

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

Symbol	Parameter	Test conditions		Value					Unit
		V_{CC} (V)		T_A = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
OIRR	Off isolation(1)	1.65 -4.3	V_S = 1V_{RMS}, f = 1 MHz signal = 0 dBm		-79				dB
			V_S = 1V_{RMS}, f = 1 MHz signal = 0 dBm		-60				
Xtalk	Crosstalk	1.65 -4.3	V_S = 1V_{RMS}, f = 1 MHz signal = 0 dBm		-78				dB
			V_S = 1V_{RMS}, f = 1 MHz signal = 0 dBm		-61				
THD	Total harmonic distortion	3.7	f = 20 Hz to 20 kHz R_L = 32 Ω, C_L=50 Ω 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 Hz R_L = 32 Ω, C_L=50 Ω V_{ripple} = 150 mV, V_{DC} = V_{CC}/2		-60				dB
BW	-3 dB bandwidth	3.0-4.3	R_L = 50 Ω signal= 0 dBm		800				MHz
D_G	Differential gain	3.0-4.3	R_L = 150 Ω		0.64				%

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

Symbol	Parameter	Test conditions		Value					Unit
		V_{CC} (V)		T_A = 25 °C			-40 to 125 °C		
				Min.	Typ.	Max.	Min.	Max.	
D_P	Differential phase	3.0-4.3	R_L = 150 Ω		0.1				deg
C_{IN}	Control pin input capacitance		V_{CC} = 0 V		6.2				pF
C_{ON}	Sn Port capacitance when switch is enabled	3.3	f = 1 MHz		10				
C_{OFF}	Sn port capacitance when switch is disabled	3.3	f = 1 MHz		5				

1. Off Isolation = 20Log10 (V_D/V_S), V_D = output. V_S = input to off switch.

Table 9. USB related AC electrical characteristics

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

5 Test circuits

Figure 3. On-resistance

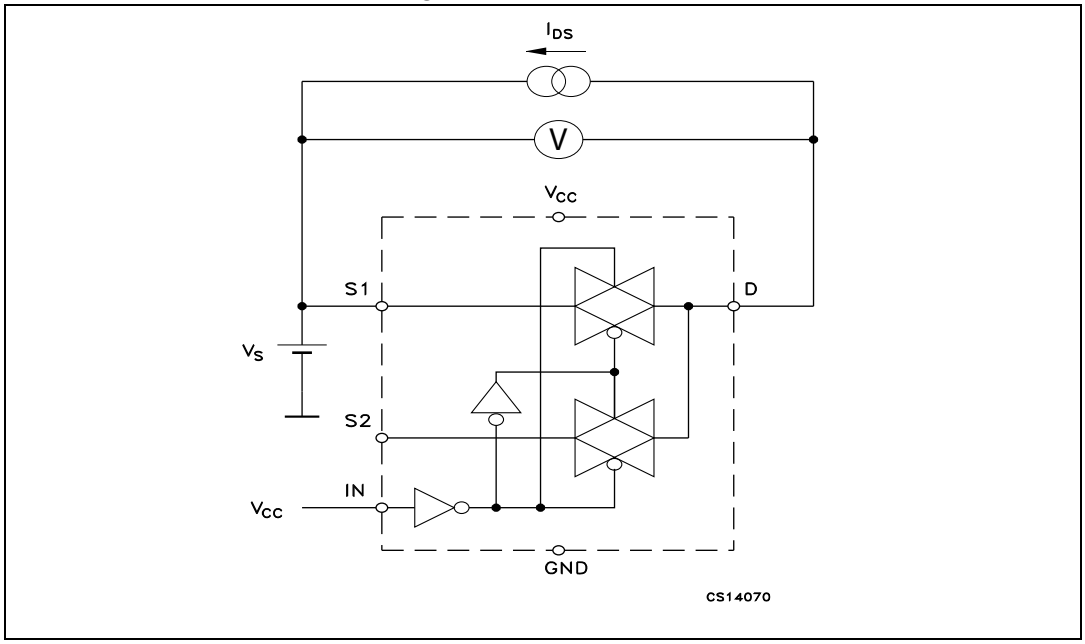


Figure 4. Bandwidth

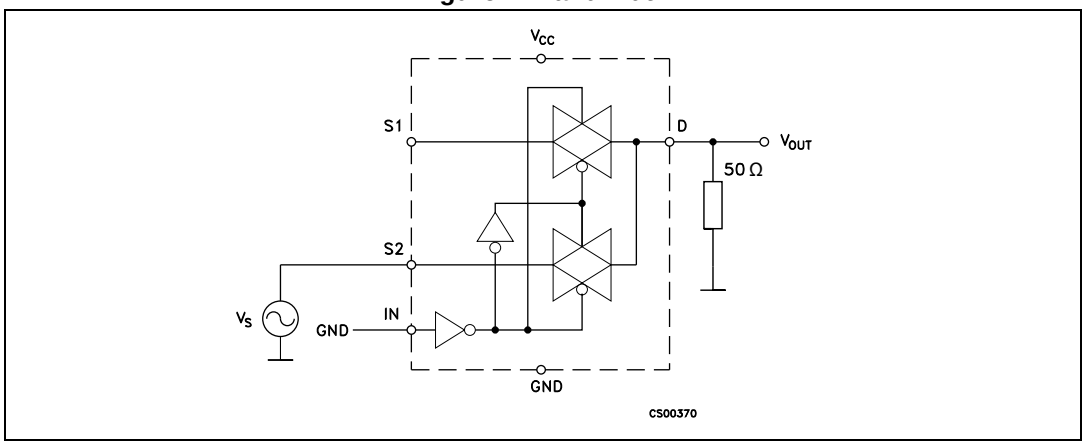


Figure 5. Off leakage

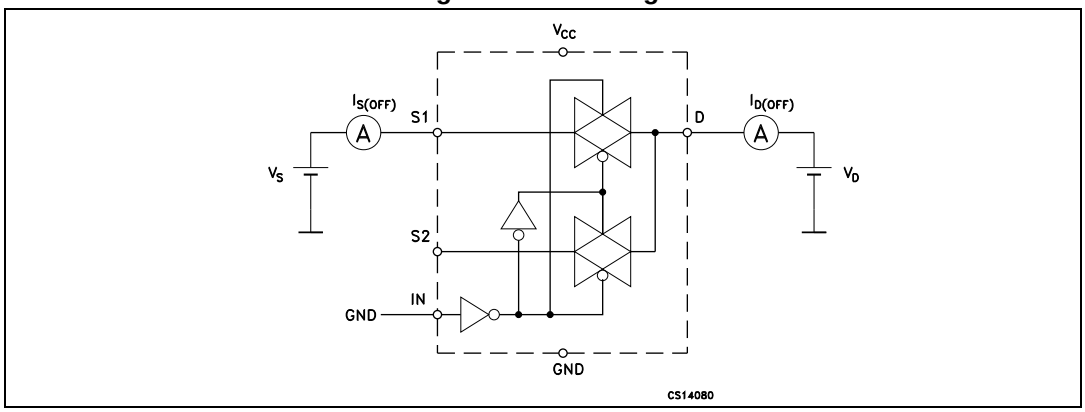


Figure 6. Channel-to-channel crosstalk

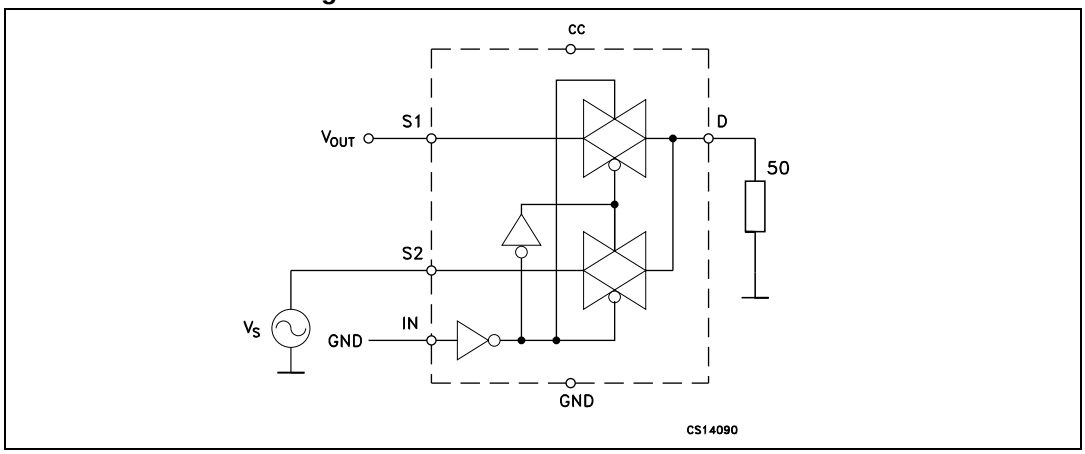
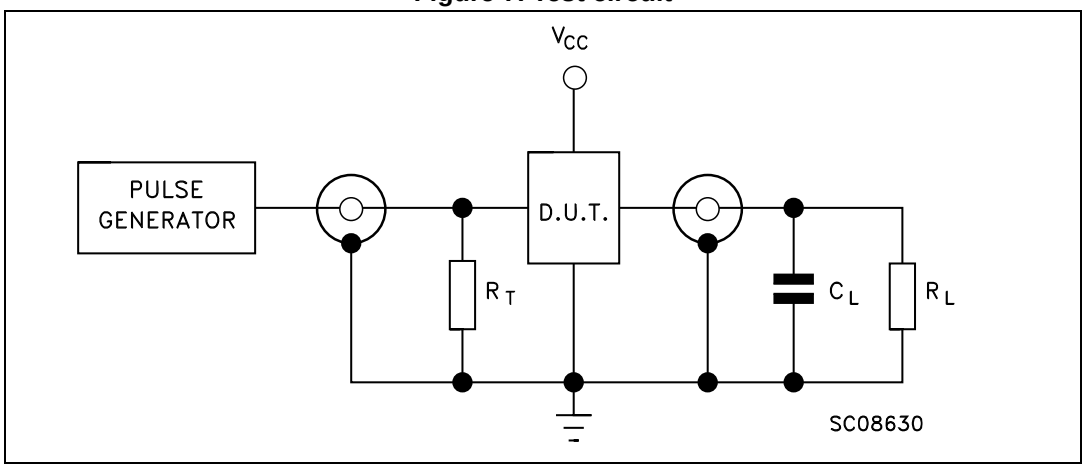


Figure 7. Test circuit



Note: *CL = 5/35 pF or equivalent: (includes jig capacitance)*

RL = 50 Ω or equivalent

RT = ZOUT of pulse generator (typically 50 Ω

Figure 8. Break-before-make time delay

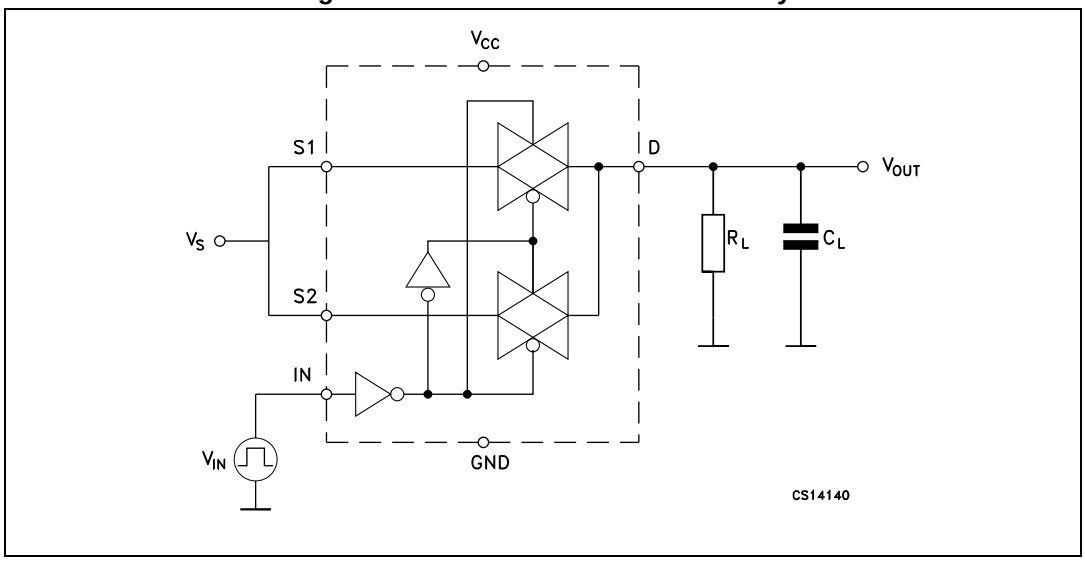


Figure 9. Break-before-make time delay 2

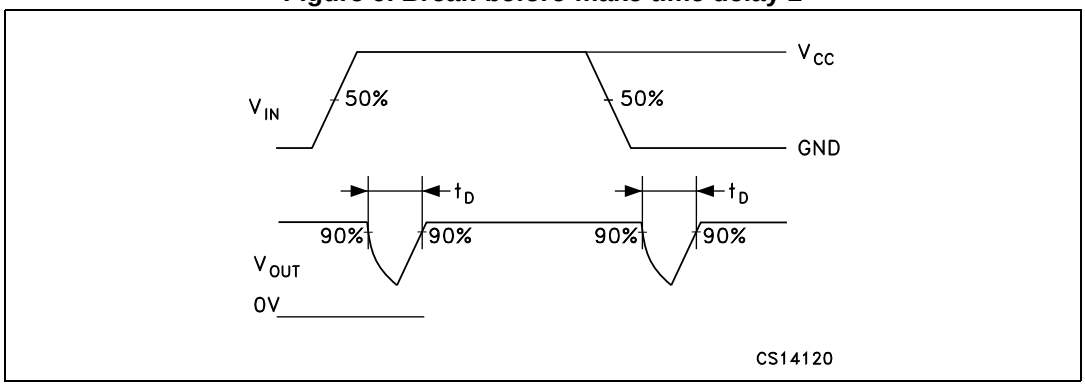


Figure 10. Switching time and charge injection (V_{GEN} = 0 V, R_{GEN} = 0 Ω, R_L = 1 MΩ, C_L= 100 pF)

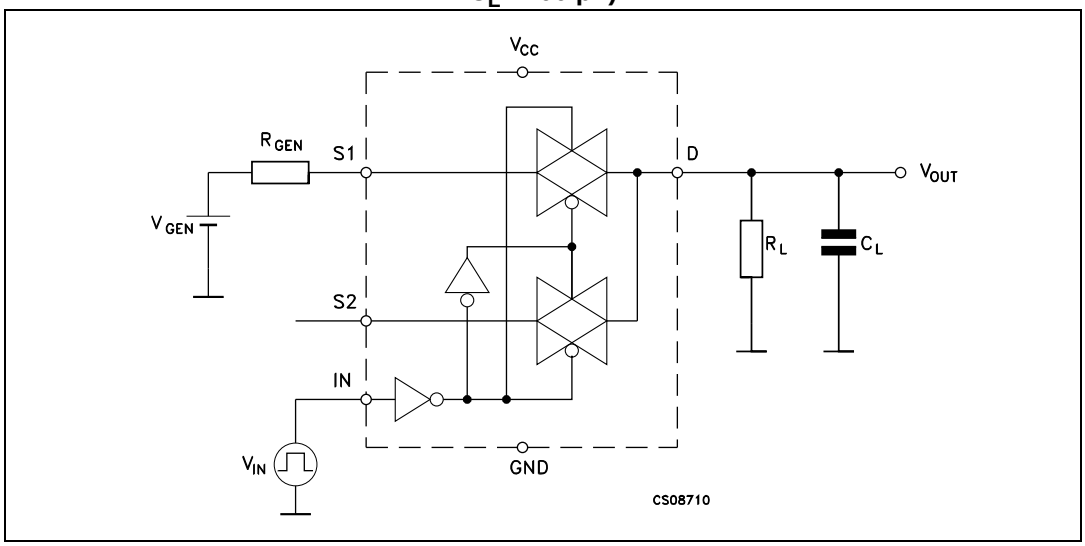


Figure 11. Switching time and charge injection (V_{GEN} = 0 V, R_{GEN} = 0 Ω, R_L = 1 MΩ, C_L= 100 pF) 2

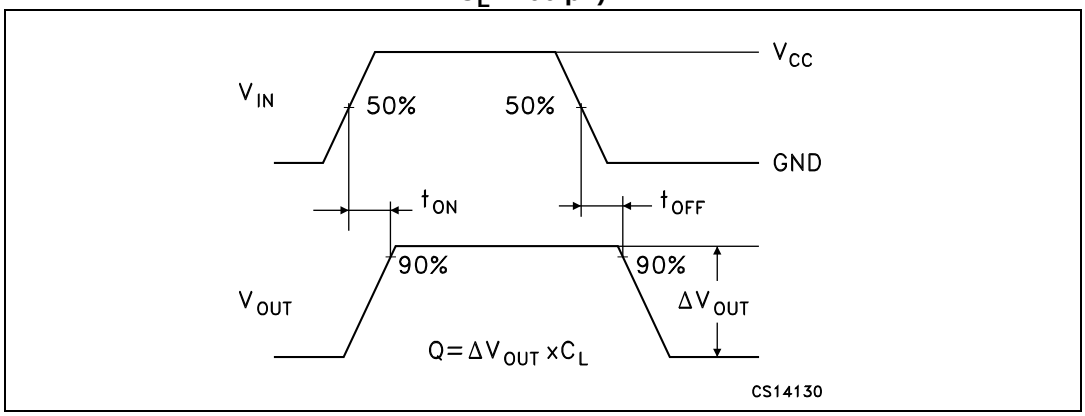


Figure 12. Turn-on, turn-off delay time

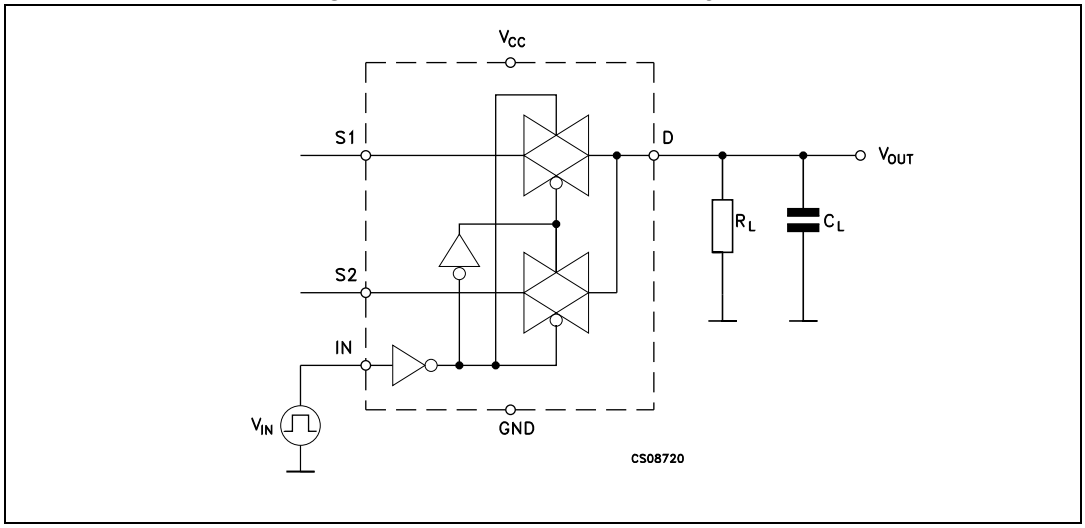
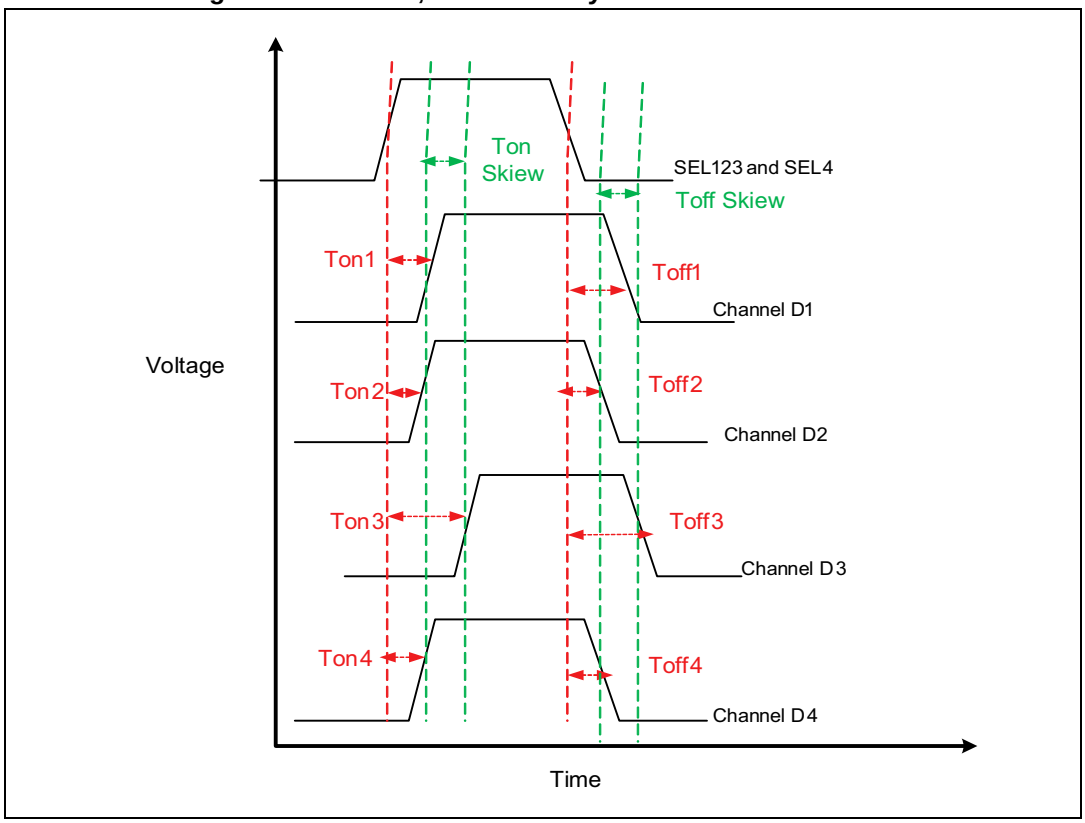


Figure 13. Turn-on, turn-off delay time and channel skew



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*. ECOPACK® is an ST trademark.

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

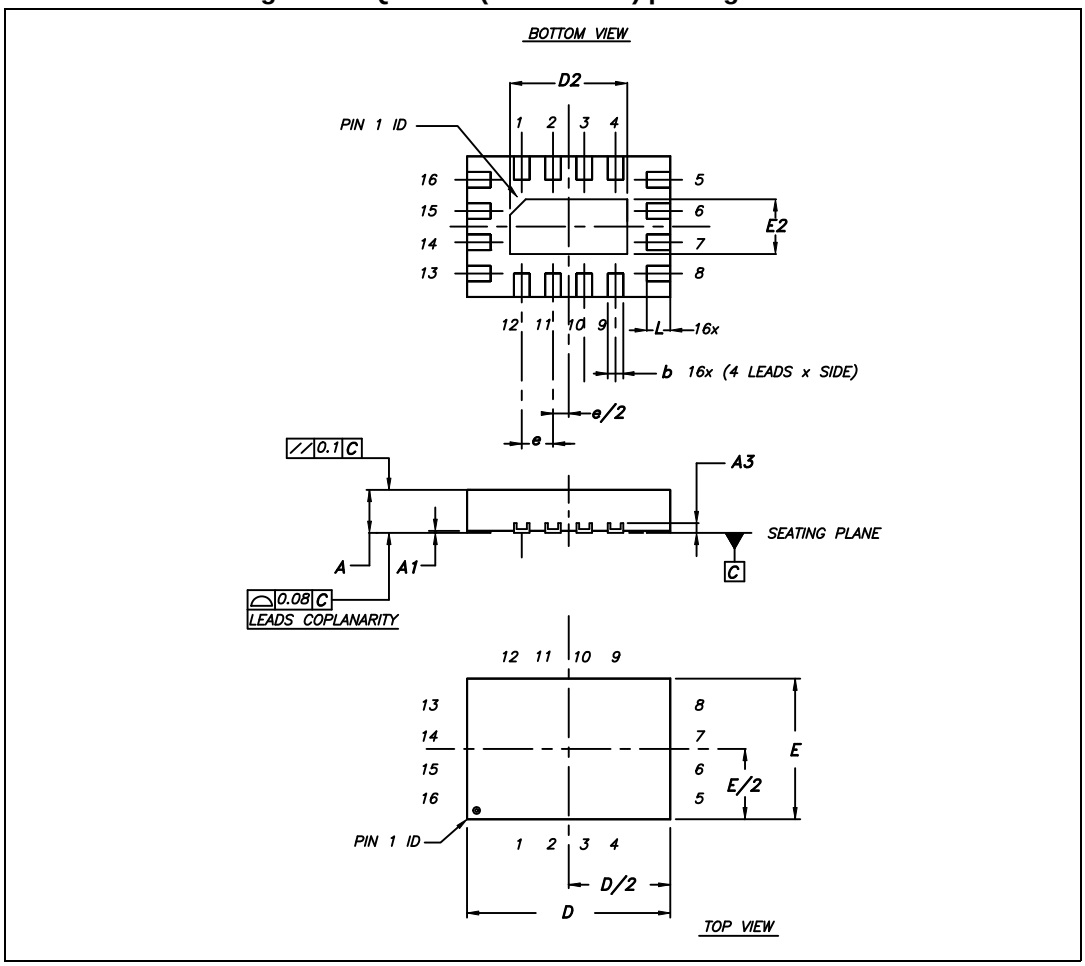


Table 10. QFN16L (2.6x1.8 mm) package mechanical data(1)

Symbol	mm		
	Min.	Typ.	Max.
A	0.45	0.50	0.55
A1	0	0.02	0.05
A3		0.127	
b	0.15	0.20	0.25
D	2.50	2.60	2.70
D2	1.40	1.50	1.60
E	1.70	1.80	1.90
E2	0.60	0.70	0.80
e		0.40	
L	0.25	0.30	0.35

1. VFQFPN - Standard for thermally enhanced vey fine pitch quad flat package no leads.

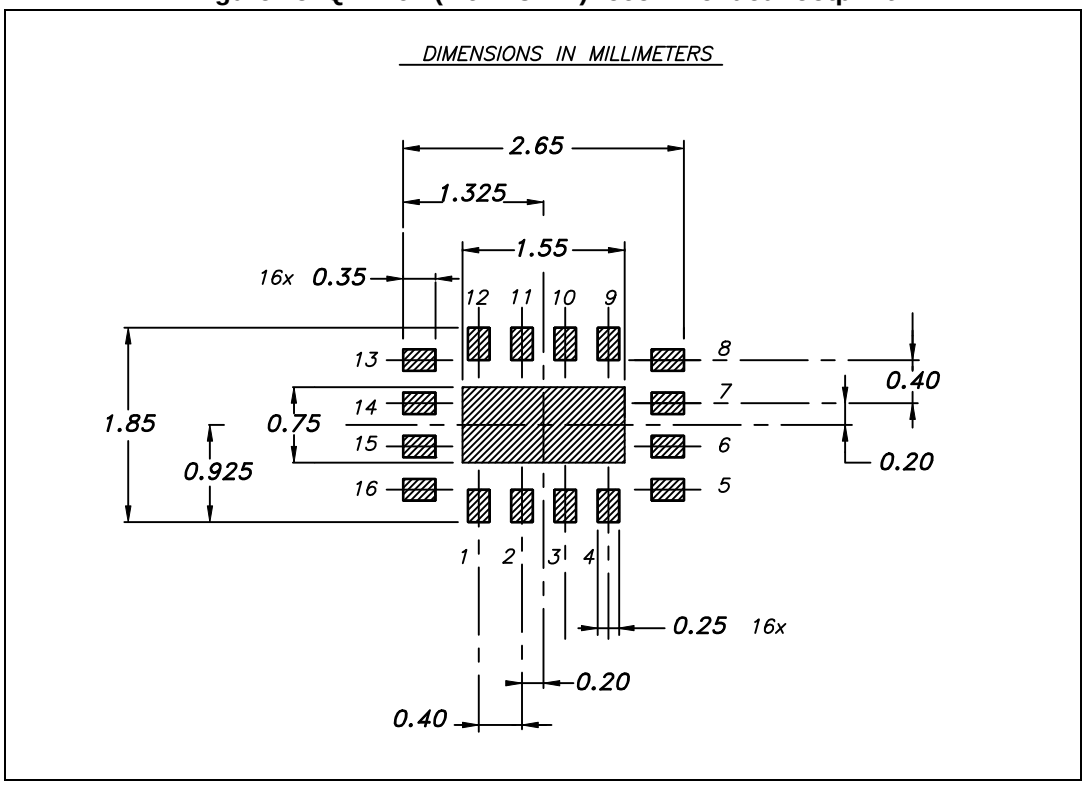
The leads size is comprehensive of the thickness of the leads finishing material.

Dimensions do not include mold protusion.

Package outline exclusive of metal burrs dimensions.

Shipping media tape and reel units: 3000

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



6.1 Packing information

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

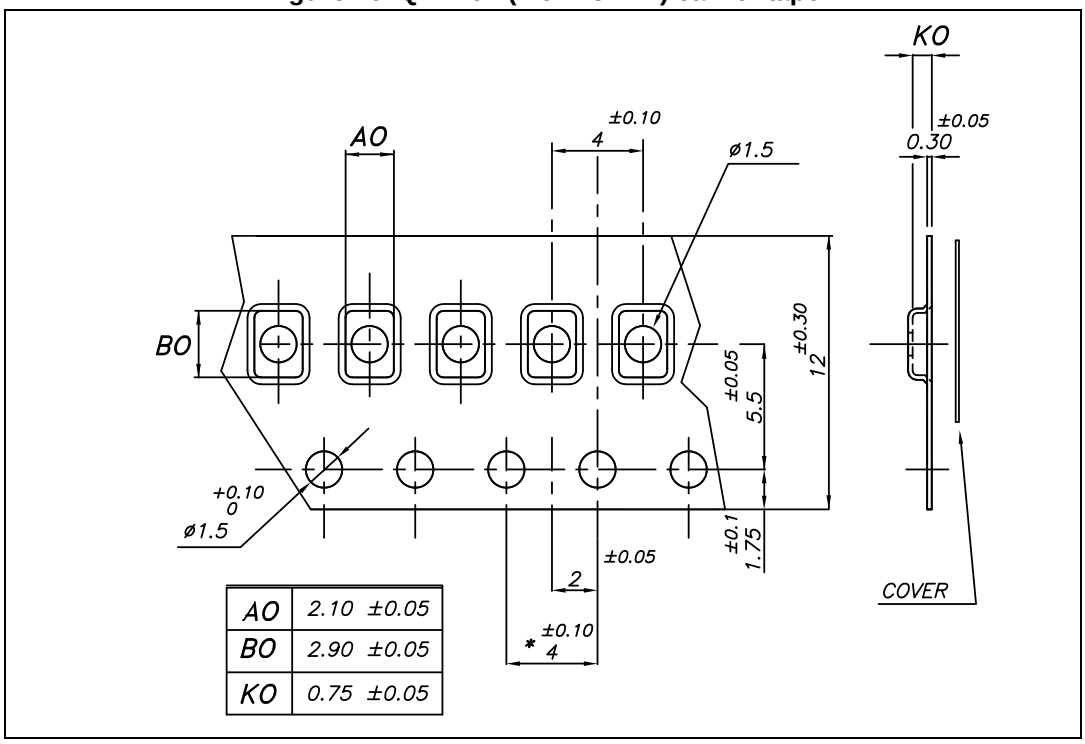
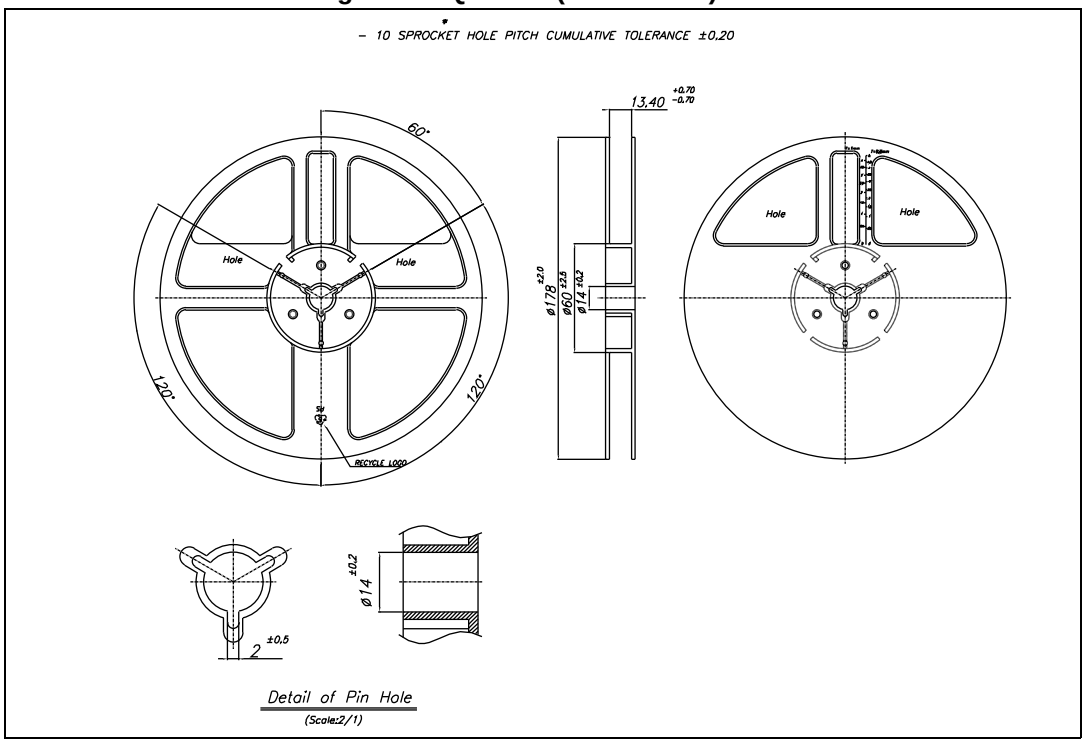


Figure 17. QFN16L (2.6x1.8 mm) reel



7 Revision history

Table 11. Document revision history

Date	Revision	Changes
03-Jan-2006	1	Initial release.
23-Jul-2007	2	Updated C_{OFF} 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*