

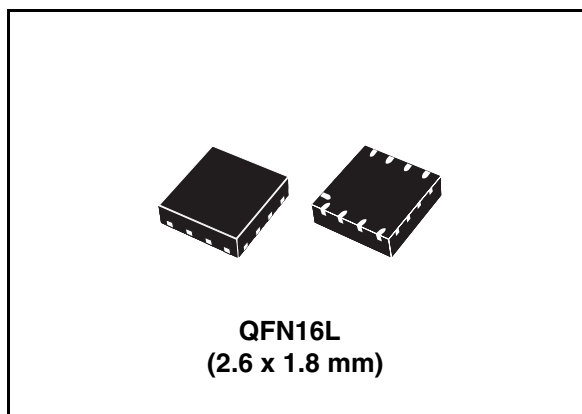
## 4-bit dual supply level translator without direction control pin

### Features

- 45 Mbps (max) data rate when driven by a totem pole driver
- 4 Mbps (max) data rate when driven by an open drain pole driver
- Bi-directional level translation without direction control pin
- Wide  $V_L$  voltage range of 1.65 to 3.6 V
- Wide  $V_{CC}$  voltage range of 1.80 to 5.5 V
- Power down mode feature – when either supply is off, all I/Os are in high impedance
- Low quiescent current (max 24  $\mu$ A)
- Able to be driven by totem pole and open drain drivers
- 5.5 V tolerant enable pin
- ESD performance on all pins:  $\pm 2$  kV HBM
- Small package and footprint  
QFN16 (2.6 x 1.8 mm) package

### Applications

- Low voltage system level translation
- Mobile phones and other mobile devices
- I<sup>2</sup>C level translation
- UART level translation



### Description

The ST2349 is a 4-bit dual supply level translator which provides the level shifting capability to allow data transfer in a multi-voltage system. Externally applied voltages,  $V_{CC}$  and  $V_L$ , set the logic levels on either side of the device. It utilizes transmission gate-based design that allows bi-directional level translation without a control pin.

The ST2349 accepts a  $V_L$  from 1.65 to 3.6 V and  $V_{CC}$  from 1.80 to 5.5 V, making it ideal for data transfer between low-voltage ASICs/PLD and higher voltage systems. This device has a tri-state output mode which can be used to disable all I/Os.

The ST2349 supports power down mode when  $V_{CC}$  is grounded/floating and the device is disabled via the OE pin.

**Table 1. Device summary**

Order code	Package	Packaging
ST2349QTR	QFN16 (2.6 x 1.8 mm)	Tape & reel (3000 parts per reel)

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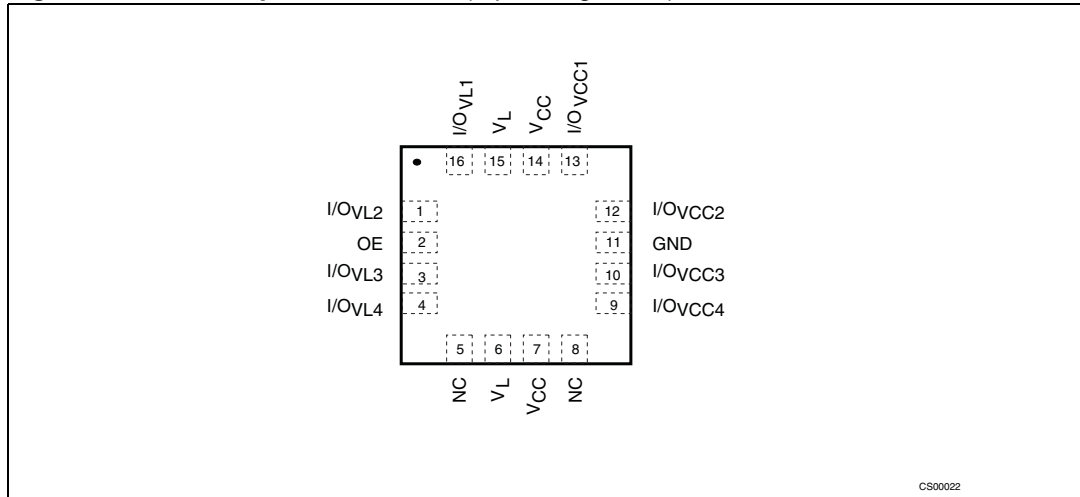
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# 1 Pin settings

## 1.1 Pin connection

Figure 1. ST2349 pin connection (top through view)



## 1.2 Pin description

Table 2. ST2349 pin description

Pin number	Symbol	Name and function
1	I/OVL2	Data input/output
2	OE	Output enable
3	I/OVL3	Data input/output
4	I/OVL4	Data input/output
5	NC	No connection
6	VL	Supply voltage
7	VCC	Supply voltage
8	NC	No connection
9	I/OVCC4	Data input/output
10	I/OVCC3	Data input/output
11	GND	Ground
12	I/OVCC2	Data input/output
13	I/OVCC1	Data input/output
14	VCC	Supply voltage
15	VL	Supply voltage
16	I/OVL1	Data input/output

## 2 Device block diagrams

Figure 2. ST2349 block diagram

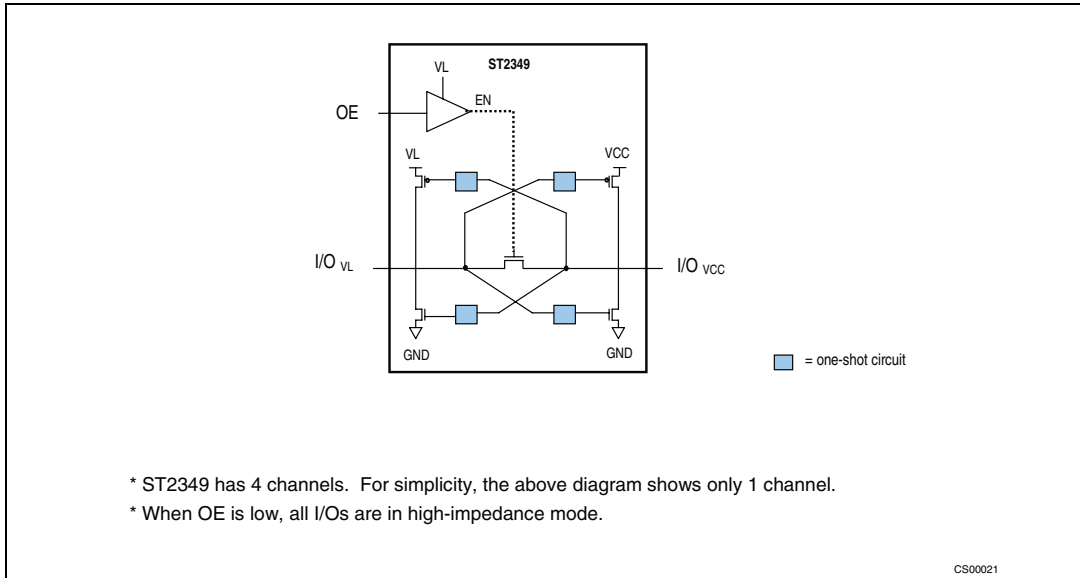
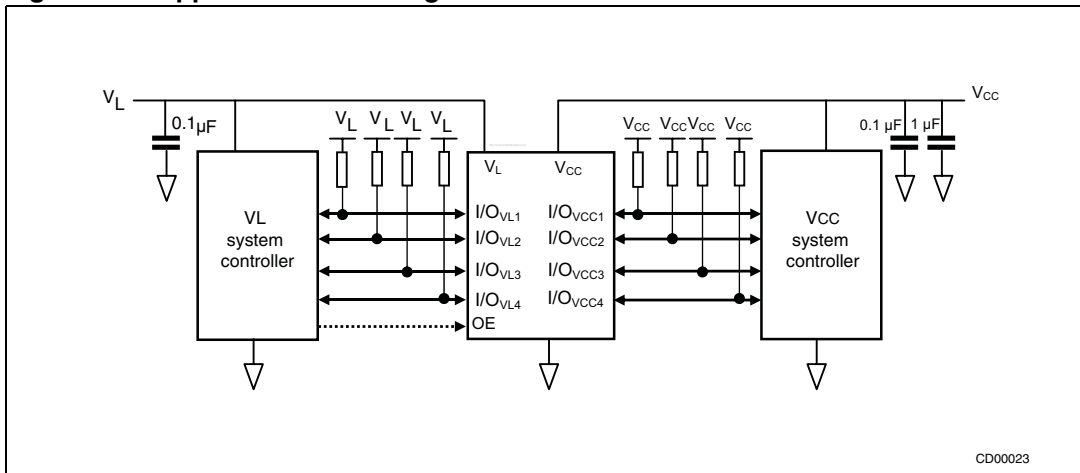


Figure 3. Application block diagram



## 3 Supplementary notes

### 3.1 Driver requirement

The ST2349 may be driven by an open drain or totem pole driver and the nature of the device's output is "open drain". It must not be used to drive a pull-down resistor since the impedance of the output at HIGH state depends on the pull-up resistor placed at the I/Os.

As the device has pull-up resistors on both the  $I/O_{VCC}$  and  $I/O_{VL}$  ports, the user needs to ensure that the driver is able to sink the required amount of current. For example, if the settings are  $V_{CC} = 5.5$  V,  $V_L = 4.3$  V and the pull-up resistor is 10 k $\Omega$ , then the driver must be able to sink at least  $(5.5 \text{ V}/10 \text{ k}\Omega) + (4.3 \text{ V}/10 \text{ k}\Omega) = 1$  mA and still meet the  $V_{IL}$  requirements of the ST2349.

### 3.2 Load driving capability

To support the open drain system, the one-shot transistor is turned on only during state transition at the output side. When it drives a high state, after the one-shot transistor is turned off, only the pull-up resistor is able to maintain the state. In this case, the resistive load is not recommended.

### 3.3 Power off feature

In some applications where it might be required to turn off one of the power supplies powering up the level translator, the user may turn off the  $V_{CC}$  only when the OE pin is low (device is disabled). There will be no current consumption in  $V_L$  due to floating gates or other causes, and the I/Os are in a high-impedance state in this mode.

### 3.4 Truth table

Table 3. Truth table

Enable	Bi-directional Input/Output	
OE	$I/O_{VCC}$	$I/O_{VL}$
H <sup>(1)</sup>	H <sup>(2)</sup>	H <sup>(1)</sup>
H <sup>(1)</sup>	L	L
L	Z <sup>(3)</sup>	Z <sup>(3)</sup>

1. High level  $V_L$  power supply referred
2. High level  $V_{CC}$  power supply referred
3. Z = high impedance

## 4 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
$V_L$	Supply voltage	-0.3 to 4.6	V
$V_{CC}$	Supply voltage	-0.3 to 6.5	V
$V_{OE}$	DC control input voltage	-0.3 to 6.5	V
$V_{I/OVL}$	DC I/O <sub>VL</sub> input voltage (OE = GND or $V_L$ )	-0.3 to $V_L + 0.3$	V
$V_{I/OVCC}$	DC I/O <sub>VCC</sub> input voltage (OE = GND or $V_L$ )	-0.3 to $V_{CC} + 0.3$	V
$I_{IK}$	DC input diode current	-20	mA
$I_{I/OVL}$	DC output current	±25	mA
$I_{I/OVCC}$	DC output current	±258	mA
$I_{SCTOUT}$	Short circuit duration, continuous	40	mA
$P_D$	Power dissipation <sup>(1)</sup>	500	mW
$T_{STG}$	Storage temperature	-65 to 150	°C
TL	Lead temperature (10 seconds)	300	°C
ESD	Electrostatic discharge protection (HBM)	±2	kV

1. 500mW: 65 °C derated to 300 mW by 10W/°C: 65 °C to 85 °C

### 4.1 Recommended operating conditions

**Table 5. Recommended operating conditions**

Symbol	Parameter	Min	Typ	Max	Unit
$V_L$	Supply voltage	1.65		3.6	V
$V_{CC}^{(1)}$	Supply voltage	1.8		5.5	V
$V_{OE}$	Input voltage (OE output enable pin, $V_L$ power supply referred)	0		3.6	V
$V_{I/OVL}$	I/O <sub>VL</sub> voltage	0		$V_L$	V
$V_{I/OVCC}$	I/O <sub>VCC</sub> voltage	0		$V_{CC}$	V
$T_{op}$	Operating temperature	-40		85	°C
dt/dV	Input rise and fall time (for 45 Mbps operation)	0		1	ns/V

1.  $V_{CC}$  must be greater than  $V_L$ .



## 5 Electrical characteristics

**Table 6. DC characteristics** (over recommended operating conditions unless otherwise noted. All typical values are at  $T_A = 25\text{ °C}$ )

Symbol	Parameter	Test conditions			Value					Unit
		$V_L$	$V_{CC}$		$T_A = 25\text{ °C}$			$-40\text{ to }85\text{ °C}$		
					Min	Typ	Max	Min	Max	
$V_{IHL}$	High level input voltage ( $I/O_{VL}$ )	1.65	$V_L$ to 5.5		1.4			1.4		V
		2.0			1.6			1.6		
		2.5			2.0			2.0		
		3.0			2.4			2.4		
		3.6			2.8			2.8		
$V_{ILL}$	Low level input voltage ( $I/O_{VL}$ )	1.65	$V_L$ to 5.5				0.3		0.3	V
		2.0					0.4		0.4	
		2.5					0.5		0.5	
		3.0					0.6		0.6	
		3.6					0.8		0.8	
$V_{IHC}$	High level input voltage ( $I/O_{VCC}$ )	1.65 to $V_{CC}$	1.8		1.6			1.6		V
			2.5		2.3			2.3		
			3.0		2.7			2.7		
			3.6		3.3			3.3		
			4.3		3.5			3.5		
			5.5		4.2			4.2		
$V_{ILC}$	Low level input voltage ( $I/O_{VCC}$ )	1.65 - 2.5	3 - 5.5					0.3		V
		2.7 - 3.6	3.6 - 5.5					0.5		
$V_{IH-OE}$	High level input voltage (OE)	1.65	$V_L$ to 5.5		1.0			1.0		V
		2.0			1.2			1.2		
		2.5			1.4			1.4		
		3.0			1.6			1.6		
		3.6			2.0			2.0		
$V_{IL-OE}$	Low level input voltage (OE)	1.65	$V_L$ to 5.5				0.33		0.33	V
		2.0					0.40		0.40	
		2.5					0.50		0.50	
		3.0					0.60		0.60	
		3.6					0.75		0.75	

**Table 6. DC characteristics** (over recommended operating conditions unless otherwise noted. All typical values are at  $T_A = 25\text{ °C}$ ) (continued)

Symbol	Parameter	Test conditions			Value					Unit
		$V_L$	$V_{CC}$		$T_A = 25\text{ °C}$			-40 to 85 °C		
					Min	Typ	Max	Min	Max	
$V_{OLL}$	Low level output voltage ( $I/O_{VL}$ )	1.65 to 3.6	$V_L$ to 5.5	$I_O = 1.0\text{ mA}$ $I/O_{VCC} \leq 0.15\text{ V}$			0.40		0.40	V
$V_{OLC}$	Low level output voltage ( $I/O_{VCC}$ )	1.65 to 3.6	$V_L$ to 5.5	$I_O = 1.0\text{ mA}$ $I/O_{VL} \leq 0.15\text{ V}$			0.40		0.40	V
$I_{OE}$	Control input leakage current (OE)	1.65 to 3.6	$V_L$ to 5.5	$V_{OE} = \text{GND}$ or $V_L$			$\pm 0.1$		$\pm 0.1$	$\mu\text{A}$
$I_{IO\_LKG}$	High impedance leakage current ( $I/O_{VL}$ , $I/O_{VCC}$ )	1.65 to 3.6	$V_L$ to 5.5	OE = GND			$\pm 0.1$		$\pm 0.1$	$\mu\text{A}$
$I_{QVCC}$	Quiescent supply current $V_{CC}$	1.65 to 3.6	$V_L$ to 5.5	only pull-up resistor connected to I/O		6	10		24	$\mu\text{A}$
$I_{QVL}$	Quiescent supply current $V_L$	1.65 to 3.6	$V_L$ to 5.5	only pull-up resistor connected to I/O		0.01	0.1		1	$\mu\text{A}$
$I_{Z-VCC}$	High impedance quiescent supply current $V_{CC}$	1.65 to 3.6	$V_L$ to 5.5	OE = GND; only pull-up resistor connected to I/O		6	10		24	$\mu\text{A}$
$I_{Z-VL}$	High impedance quiescent supply current $V_L$	1.65 to 3.6	$V_L$ to 5.5	OE = GND; only pull-up resistor connected to I/O		0.01	0.1		1	$\mu\text{A}$

## 5.1 AC characteristics (device driven by open drain driver)

**Table 7. AC characteristics** - test conditions:  $V_L = 1.65 - 1.8$  V (load  $C_L = 15$  pF;  $R_{up} = 4.7$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C

Symbol	Parameter	$V_{CC} = 1.8 - 2.5$ V		$V_{CC} = 2.7 - 3.6$ V		$V_{CC} = 4.3 - 5.5$ V		Unit
		Min	Max	Min	Max	Min	Max	
$t_{RVCC}$	Rise time $I/O_{VCC}$		80		50		30	ns
$t_{FVCC}$	Fall time $I/O_{VCC}$		3		3		3	ns
$t_{RVL}$	Rise time $I/O_{VL}$		7		6		6	ns
$t_{FVL}$	Fall time $I/O_{VL}$		4		5		5	ns
$t_{I/OVL-VCC}$	Propagation delay time $I/O_{VL-LH}$ to $I/O_{VCC-LH}$ $I/O_{VL-HL}$ to $I/O_{VCC-HL}$	$t_{PLH}$	5		5		5	ns
		$t_{PHL}$		5		5		5
$t_{I/OVCC-VL}$	Propagation delay time $I/O_{VCC-LH}$ to $I/O_{VL-LH}$ $I/O_{VCC-HL}$ to $I/O_{VL-LH}$	$t_{PLH}$		5		5		ns
		$t_{PHL}$		5		7		ns
$t_{PZL}$ $t_{PZH}$ $t_{PLZ}$ $t_{PHZ}$	Output enable and disable time	En		10		10		ns
		Dis		40		40		ns
$D_R$	Data rate <sup>(1)</sup>		1.6		2.5		4	MHz

1. The data rate is guaranteed based on the condition that the output I/O signal rise/fall time is less than 15% of the input I/O signal period; the input I/O signal is at 50% duty cycle and the output I/O signal duty cycle deviation not less than 30%.

**Table 8. AC characteristics** - test conditions:  $V_L = 2.5 - 2.7$  V (load  $C_L = 15$  pF;  $R_{up} = 4.7$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C

Symbol	Parameter	$V_{CC} = 2.7 - 3.6$ V		$V_{CC} = 4.3 - 5.5$ V		Unit	
		Min	Max	Min	Max		
$t_{RVCC}$	Rise time $I/O_{VCC}$		70		40	ns	
$t_{FVCC}$	Fall time $I/O_{VCC}$		3		3	ns	
$t_{RVL}$	Rise time $I/O_{VL}$		5		5	ns	
$t_{FVL}$	Fall time $I/O_{VL}$		3		3	ns	
$t_{I/OVL-VCC}$	Propagation delay time $I/O_{VL-LH}$ to $I/O_{VCC-LH}$ $I/O_{VL-HL}$ to $I/O_{VCC-HL}$	$t_{PLH}$		2		2	ns
		$t_{PHL}$		3		3	ns
$t_{I/OVCC-VL}$	Propagation delay time $I/O_{VCC-LH}$ to $I/O_{VL-LH}$ $I/O_{VCC-HL}$ to $I/O_{VL-LH}$	$t_{PLH}$		3		3	ns
		$t_{PHL}$		4		4	ns

**Table 8. AC characteristics** - test conditions:  $V_L = 2.5 - 2.7$  V (load  $C_L = 15$  pF;  $R_{up} = 4.7$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C

Symbol	Parameter	$V_{CC} = 2.7 - 3.6$ V		$V_{CC} = 4.3 - 5.5$ V		Unit
		Min	Max	Min	Max	
$t_{PZL}$ $t_{PZH}$ $t_{PLZ}$ $t_{PHZ}$	Output enable and disable time	En	6		6	ns
		Dis	40		40	ns
$D_R$	Data rate <sup>(1)</sup>		2.5		3.2	MHz

1. The data rate is guaranteed based on the condition that the output I/O signal rise/fall time is less than 15% of the input I/O signal period; the input I/O signal is at 50% duty cycle and the output I/O signal duty cycle deviation not less than 30%.

**Table 9. AC characteristics** - test conditions:  $V_L = 2.7 - 3.6$  V (load  $C_L = 15$  pF;  $R_{up} = 4.7$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C

Symbol	Parameter	$V_{CC} = 4.3 - 5.5$ V		Unit
		Min	Max	
$t_{RVCC}$	Rise time I/O $_{VCC}$		55	ns
$t_{FVCC}$	Fall time I/O $_{VCC}$		3	ns
$t_{RVL}$	Rise time I/O $_V$ L		4	ns
$t_{FVL}$	Fall time I/O $_V$ L		3	ns
$t_{I/OVL-VCC}$	Propagation delay time I/O $_V$ L-LH to I/O $_{VCC}$ -LH I/O $_V$ L-HL to I/O $_{VCC}$ -HL	$t_{PLH}$	2	ns
		$t_{PHL}$	4	ns
$t_{I/OVCC-VL}$	Propagation delay time I/O $_{VCC}$ -LH to I/O $_V$ L-LH I/O $_{VCC}$ -HL to I/O $_V$ L-HL	$t_{PLH}$	4	ns
		$t_{PHL}$	4	ns
$t_{PZL}$ $t_{PZH}$ $t_{PLZ}$ $t_{PHZ}$	Output enable and disable time	En	6	ns
		Dis	40	ns
$D_R$	Data rate <sup>(1)</sup>		2.8	MHz

1. The data rate is guaranteed based on the condition that the output I/O signal rise/fall time is less than 15% of the input I/O signal period; the input I/O signal is at 50% duty cycle and the output I/O signal duty cycle deviation not less than 30%.

## 5.2 AC characteristics (device driven by totem pole driver )

**Table 10. AC characteristics** (test conditions:  $V_L = 1.65 - 1.8$  V (load  $C_L = 15$  pF;  $R_{up} = 10$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C)

Symbol	Parameter	$V_{CC} = 1.8 - 2.5$ V		$V_{CC} = 2.7 - 3.6$ V		$V_{CC} = 4.3 - 5.5$ V		Unit
		Min	Max	Min	Max	Min	Max	
$t_{RVCC}$	Rise time $I/O_{VCC}$		7		3		4	ns
$t_{FVCC}$	Fall time $I/O_{VCC}$		7		3		3	ns
$t_{RVL}$	Rise time $I/O_{VL}$		6		4		5	ns
$t_{FVL}$	Fall time $I/O_{VL}$		4		4		4	ns
$t_{I/OVL-VCC}$	Propagation delay time $I/O_{VL-LH}$ to $I/O_{VCC-LH}$ $I/O_{VL-HL}$ to $I/O_{VCC-HL}$	$t_{PLH}$	6		5		4	ns
		$t_{PHL}$	5		5		5	ns
$t_{I/OVCC-VL}$	Propagation delay time $I/O_{VCC-LH}$ to $I/O_{VL-LH}$ $I/O_{VCC-HL}$ to $I/O_{VL-HL}$	$t_{PLH}$	6		5		4	ns
		$t_{PHL}$	4.5		5.2		7	ns
$t_{PZL}$ $t_{PZH}$ $t_{PLZ}$ $t_{PHZ}$	Output enable and disable time	En	10		10		10	ns
		Dis	40		40		40	ns
$D_R$	Data rate <sup>(1)</sup>		12		32		32	MHz

1. The data rate is guaranteed based on the condition that the output I/O signal rise/fall time is less than 15% of the input I/O signal period; the input I/O signal is at 50% duty cycle and the output I/O signal duty cycle deviation not less than 30%.

**Table 11. AC characteristics** (test conditions:  $V_L = 2.5 - 2.7$  V (load  $C_L = 15$  pF;  $R_{up} = 10$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C)

Symbol	Parameter	$V_{CC} = 2.7 - 3.6$ V		$V_{CC} = 4.3 - 5.5$ V		Unit
		Min	Max	Min	Max	
$t_{RVCC}$	Rise time $I/O_{VCC}$		6		4	ns
$t_{FVCC}$	Fall time $I/O_{VCC}$		3		3	ns
$t_{RVL}$	Rise time $I/O_{VL}$		5		5	ns
$t_{FVL}$	Fall time $I/O_{VL}$		3		3	ns
$t_{I/OVL-VCC}$	Propagation delay time $I/O_{VL-LH}$ to $I/O_{VCC-LH}$ $I/O_{VL-HL}$ to $I/O_{VCC-HL}$	$t_{PLH}$	3.5		3	ns
		$t_{PHL}$	4		4	ns
$t_{I/OVCC-VL}$	Propagation delay time $I/O_{VCC-LH}$ to $I/O_{VL-LH}$ $I/O_{VCC-HL}$ to $I/O_{VL-HL}$	$t_{PLH}$	2.5		2.1	ns
						ns
		$t_{PHL}$	4		4	ns
						ns

**Table 11. AC characteristics** (test conditions:  $V_L = 2.5 - 2.7$  V (load  $C_L = 15$  pF;  $R_{up} = 10$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C) (continued)

Symbol	Parameter		$V_{CC} = 2.7 - 3.6$ V		$V_{CC} = 4.3 - 5.5$ V		Unit
			Min	Max	Min	Max	
$t_{PZL}$ $t_{PZH}$	Output enable and disable time	En		6		6	ns
$t_{PLZ}$ $t_{PHZ}$		Dis		40		40	ns
$D_R$	Data rate <sup>(1)</sup>			45		45	MHz

1. The data rate is guaranteed based on the condition that the output I/O signal rise/fall time is less than 15% of the input I/O signal period; the input I/O signal is at 50% duty cycle and the output I/O signal duty cycle deviation not less than 30%.

**Table 12. AC characteristics** (test conditions:  $V_L = 2.7 - 3.6$  V (load  $C_L = 15$  pF;  $R_{up} = 10$  k $\Omega$ ; driver  $t_r = t_f \leq 2$  ns) over temperature range  $-40$  °C to  $85$  °C)

Symbol	Parameter		$V_{CC} = 4.3 - 5.5$ V		Unit
			Min	Max	
$t_{RVCC}$	Rise time I/O <sub>VCC</sub>			5	ns
$t_{FVCC}$	Fall time I/O <sub>VCC</sub>			3	ns
$t_{RVL}$	Rise time I/O <sub>VL</sub>			4	ns
$t_{FVL}$	Fall time I/O <sub>VL</sub>			3	ns
$t_{I/OVL-VCC}$	Propagation delay time I/O <sub>VL-LH</sub> to I/O <sub>VCC-LH</sub> I/O <sub>VL-HL</sub> to I/O <sub>VCC-HL</sub>	$t_{PLH}$		2.5	ns
		$t_{PHL}$		4	ns
$t_{I/OVCC-VL}$	Propagation delay time I/O <sub>VCC-LH</sub> to I/O <sub>VL-LH</sub> I/O <sub>VCC-HL</sub> to I/O <sub>VL-HL</sub>	$t_{PLH}$		2	ns
					ns
		$t_{PHL}$		4	ns
					ns
$t_{PZL}$ $t_{PZH}$ $t_{PLZ}$ $t_{PHZ}$	Output enable and disable time	En		6	ns
		Dis		40	ns
$D_R$	Data rate <sup>(1)</sup>			45	MHz

1. The data rate is guaranteed based on the condition that the output I/O signal rise/fall time is less than 15% of the input I/O signal period; the input I/O signal is at 50% duty cycle and the output I/O signal duty cycle deviation not less than 30%.

Figure 4. Test circuit

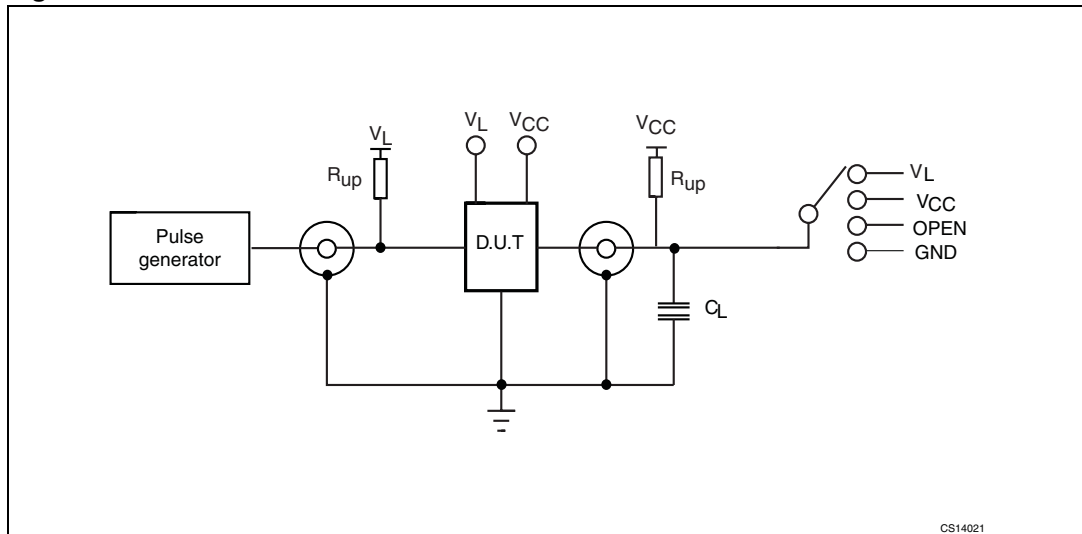


Table 13. Test circuit switches

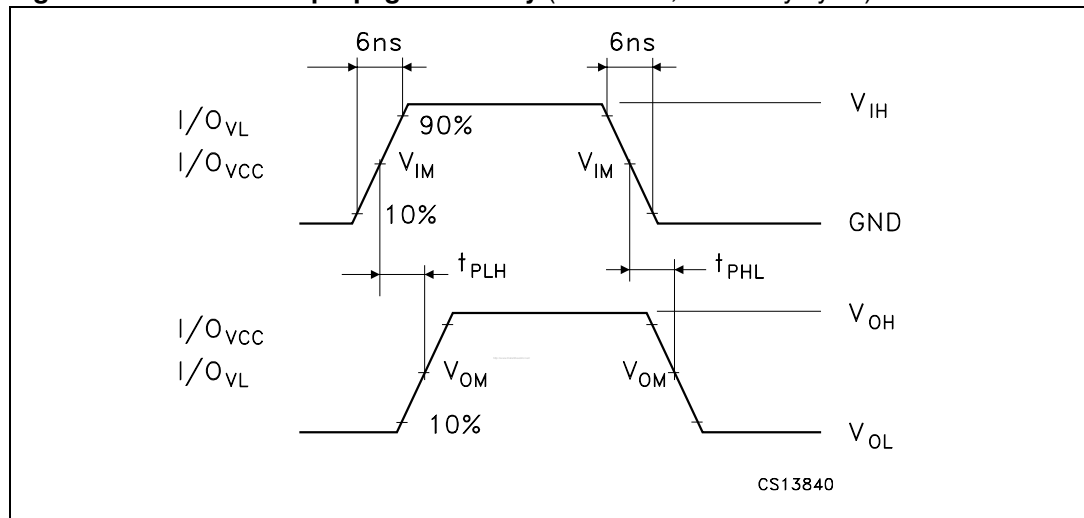
Test	Switch		
	Driving I/O $V_L$	Driving I/O $V_{CC}$	Open drain driving
$t_{PLH}$ , $t_{PHL}$	Open	Open	Open

## 6 Waveforms

**Table 14. Waveform symbol value**

Symbol	Driving I/O <sub>VL</sub>		Driving I/O <sub>VCC</sub>	
	$1.8\text{ V} \leq V_L \leq V_{CC} \leq 2.5\text{ V}$	$3.3\text{ V} \leq V_L \leq V_{CC} \leq 5.0\text{ V}$	$1.8\text{ V} \leq V_L \leq V_{CC} \leq 2.5\text{ V}$	$3.3\text{ V} \leq V_L \leq V_{CC} \leq 5.0\text{ V}$
V <sub>IH</sub>	V <sub>L</sub>	V <sub>L</sub>	V <sub>CC</sub>	V <sub>CC</sub>
V <sub>IM</sub>	50% V <sub>L</sub>	50% V <sub>L</sub>	50% V <sub>CC</sub>	50% V <sub>CC</sub>
V <sub>OM</sub>	50% V <sub>CC</sub>	50% V <sub>CC</sub>	50% V <sub>L</sub>	50% V <sub>L</sub>
V <sub>X</sub>	V <sub>OL</sub> + 0.15V	V <sub>OL</sub> + 0.3V	V <sub>OL</sub> + 0.15V	V <sub>OL</sub> + 0.3V
V <sub>Y</sub>	V <sub>OH</sub> - 0.15V	V <sub>OH</sub> - 0.3V	V <sub>OH</sub> - 0.15V	V <sub>OH</sub> - 0.3V

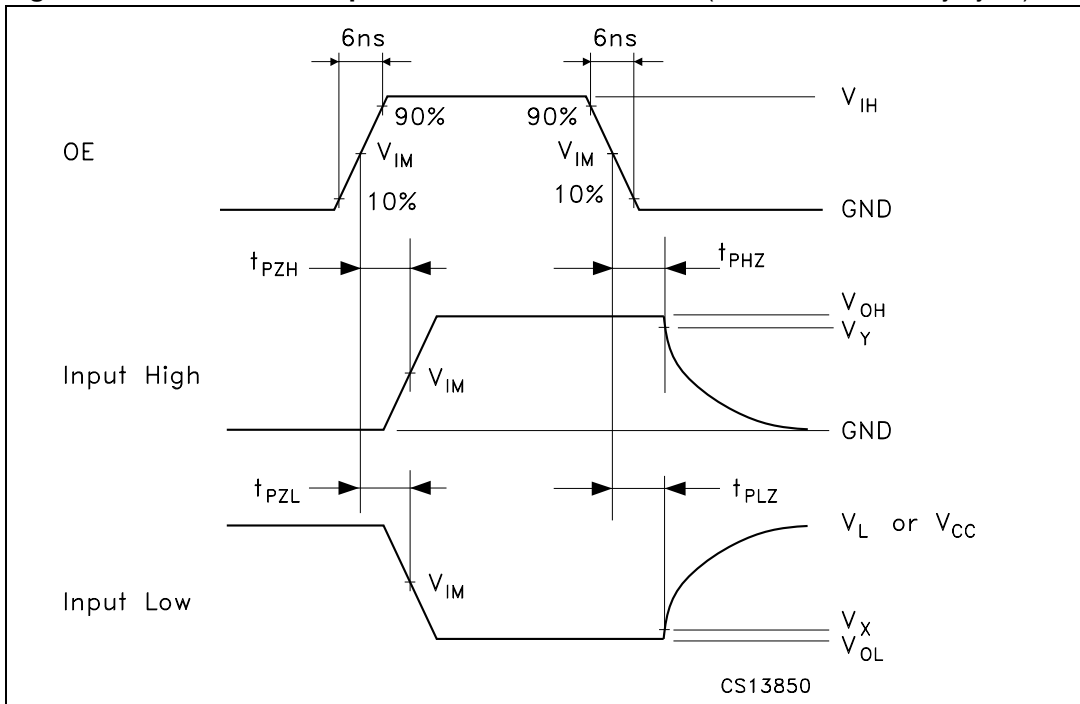
**Figure 5. Waveform - propagation delay (f = 1 MHz; 50% duty cycle)**



CS13840



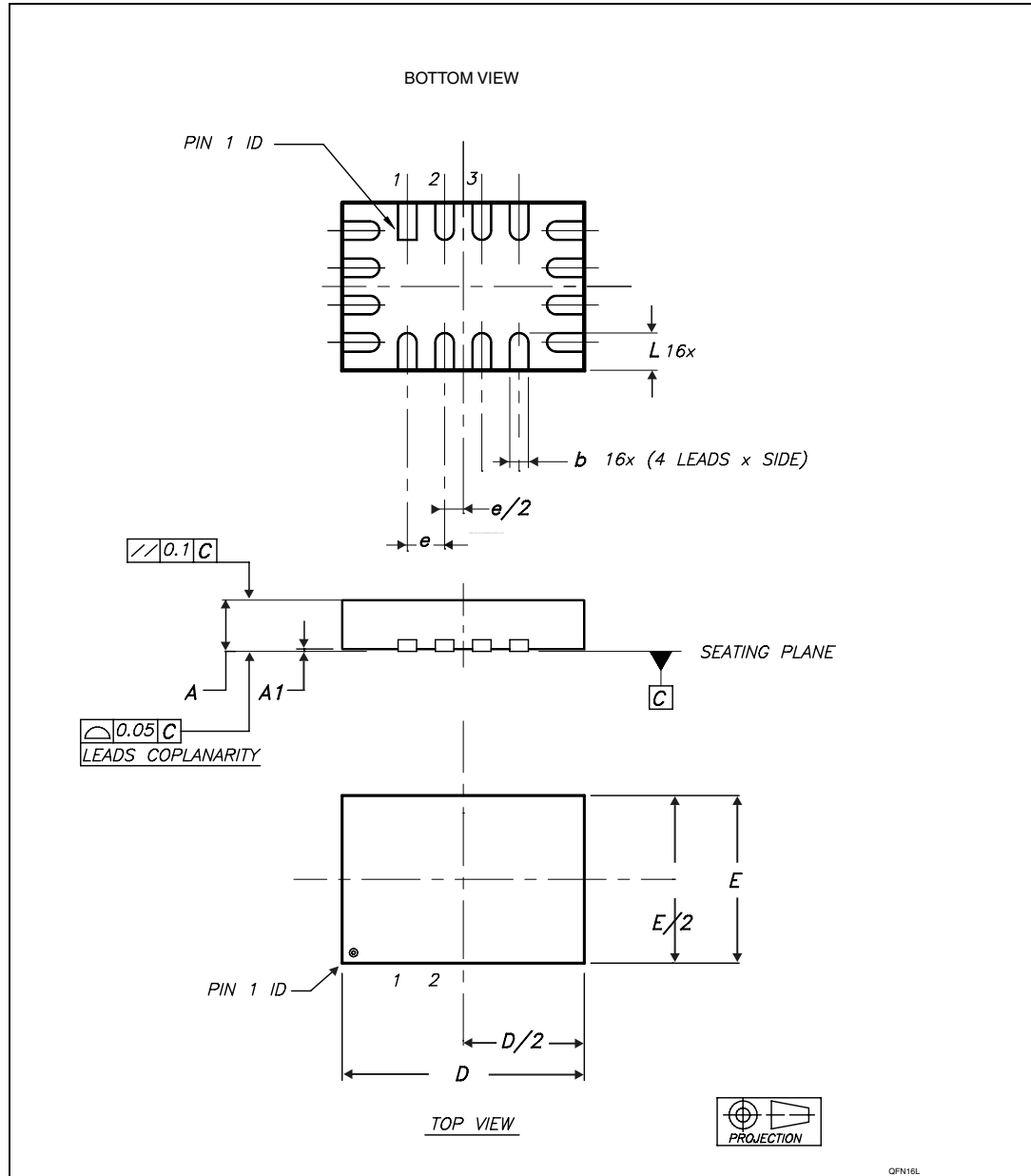
Figure 6. Waveform - output enable and disable time (f = 1 MHz; 50% duty cycle)



# 7 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 7. QFN16L (2.6 x 1.8 mm) package outline**

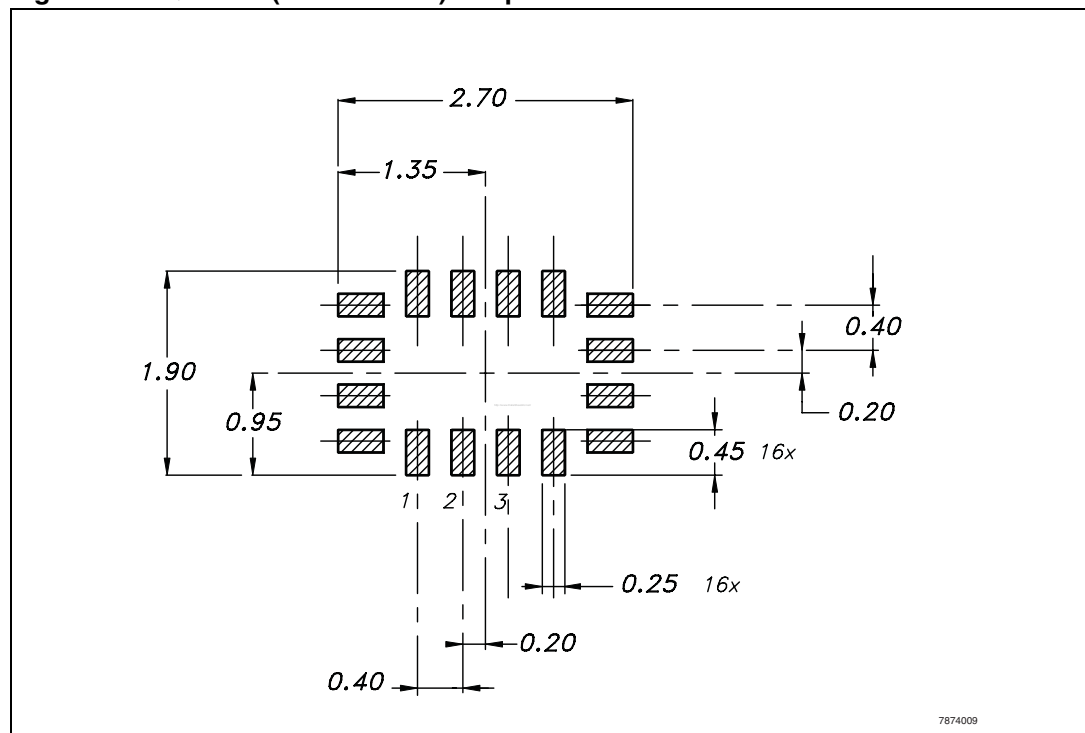


1. Drawing not to scale.
2. Dimensions are in millimeters.

Table 15. QFN16L (2.6 x 1.8 mm) mechanical data

Symbol	millimeters		
	Typ	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 8. QFN16L (2.6 x 1.8 mm) footprint recommendations



1. Drawing not to scale.
2. Dimensions are in millimeters.

Figure 9. QFN16L (2.6 x 1.8 mm) carrier tape

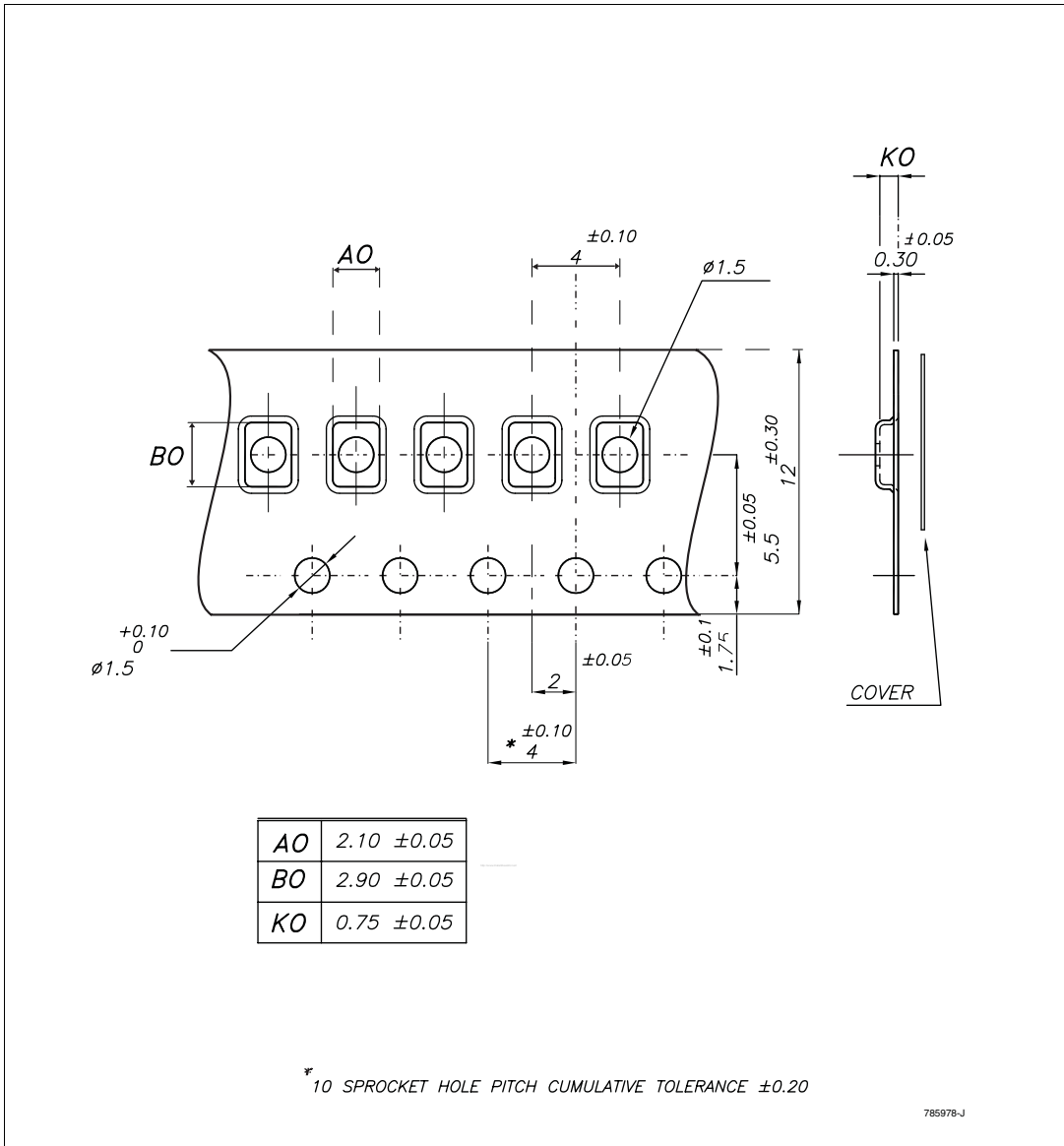
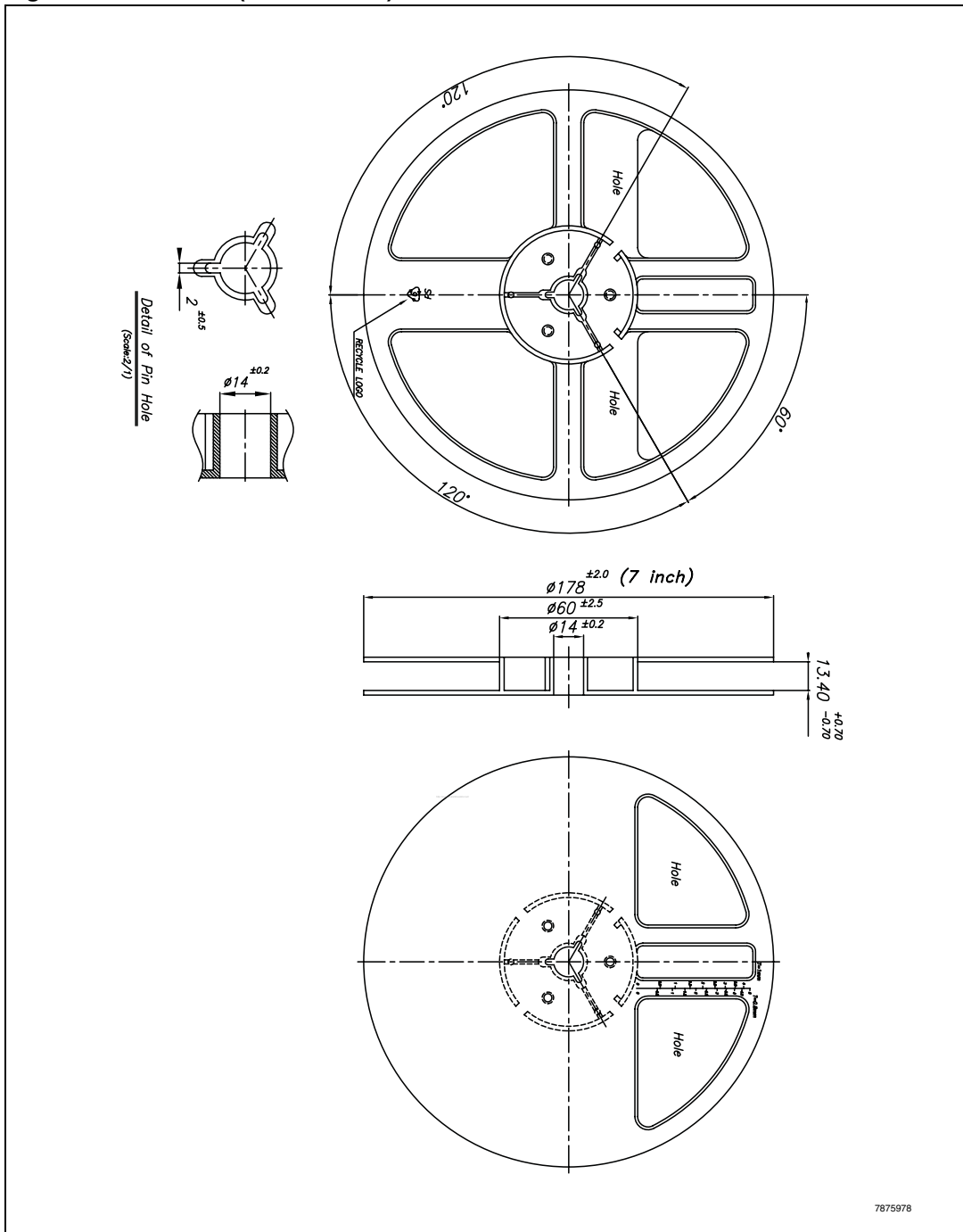


Figure 10. QFN16L (2.6 x 1.8 mm) reel information



1. Drawing not to scale.
2. Dimensions are in millimeters

## 8 Revision history

**Table 16. Document revision history**

Date	Revision	Changes
07-May-2007	1	Initial release.
29-May-2007	2	Typo in cover page title.
26-Nov-2007	3	Removed Data Brief classification from the cover page. Modified title and features section, added the following sections: <i>Section 1: Pin settings</i> , <i>Section 2: Device block diagrams</i> , <i>Section 3: Supplementary notes</i> , <i>Section 4: Maximum rating</i> , <i>Section 5: Electrical characteristics</i> <i>Section 6: Waveforms</i> and updated <i>Section 7: Package mechanical data</i> .

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