

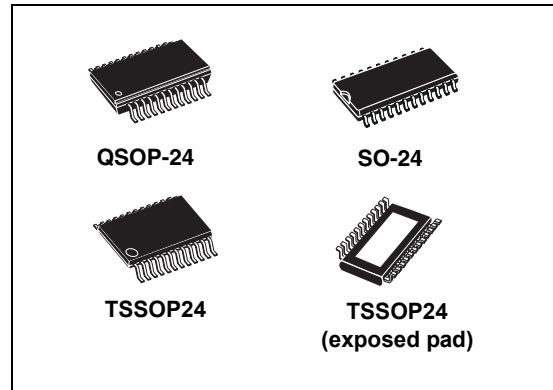


# STP16CPS05

## Low voltage 16-bit constant current LED sink driver with auto power saving

### Features

- Low voltage power supply down to 3 V
- 16 constant current output channels
- Adjustable output current through external resistor
- Serial data IN / parallel data OUT
- Auto power-saving feature minimizes the quiescent current if no active data is detected on the latches
- Can be driven by a 3.3 V microcontroller
- Output current: 5-100 mA
- Max clock frequency 30 MHz
- ESD protection 2.5 kV HBM, 200 V MM



### Description

The STP16CPS05 is a monolithic, low voltage, low current power 16-bit shift register designed for LED panel displays. The STP16CPS05 contains a 16-bit serial-in, parallel-out shift register that feeds a 16-bit, D-type storage register. In the output stage, sixteen regulated current sources provide from 5 mA to 100 mA constant current to drive the LEDs.

The auto power shut-down and auto power-ON feature allows the device to save power without any external intervention.

The output current setup time is 40 ns (typ), thus improving the system performance.

The LEDs' brightness can be controlled by using an external resistor to adjust the STP16CPS05 output current.

The STP16CPS05 guarantees a 20 V output driving capability, allowing users to connect more LEDs in series. The high clock frequency, 30 MHz, makes the device suitable for high data rate transmission. The 3.3 V voltage supply is useful in applications that interface with a 3.3 V microcontroller.

**Table 1. Device summary**

Order codes	Package	Packaging
STP16CPS05MTR	SO-24	1000 parts per reel
STP16CPS05TTR	TSSOP24	2500 parts per reel
STP16CPS05XTTR	TSSOP24 Exposed Pad	2500 parts per reel
STP16CPS05PTR	QSOP-24	2500 parts per reel

---

# Contents

<b>1</b>	<b>Summary description</b> .....	<b>3</b>
1.1	Pin connection and description .....	3
<b>2</b>	<b>Electrical ratings</b> .....	<b>4</b>
2.1	Absolute maximum ratings .....	4
2.2	Thermal data .....	4
2.3	Recommended operating conditions .....	5
<b>3</b>	<b>Electrical characteristics</b> .....	<b>6</b>
<b>4</b>	<b>Equivalent circuit and outputs</b> .....	<b>8</b>
<b>5</b>	<b>Timing diagrams</b> .....	<b>10</b>
<b>6</b>	<b>Typical characteristics</b> .....	<b>13</b>
<b>7</b>	<b>Test circuit</b> .....	<b>17</b>
<b>8</b>	<b>Package mechanical data</b> .....	<b>19</b>
<b>9</b>	<b>Revision history</b> .....	<b>26</b>

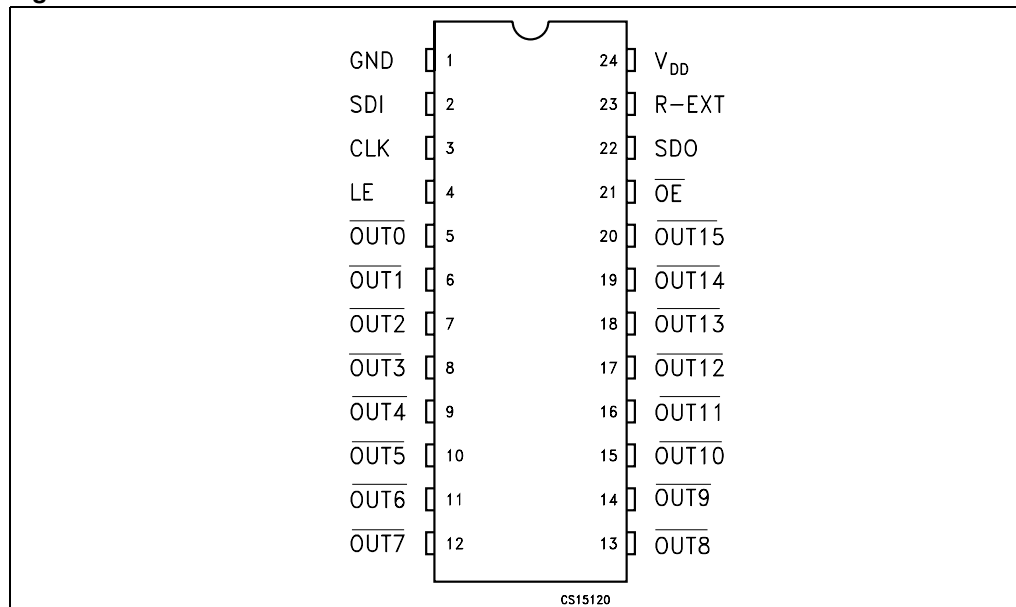
# 1 Summary description

Table 2. Typical current accuracy

Output voltage	Current accuracy		Output current	V <sub>DD</sub>	Temperature
	Between bits	Between ICs			
≥ 1.3 V	± 1.5 %	± 5 %	≥ 20 to 100 mA	3.3 V to 5 V	25 °C

## 1.1 Pin connection and description

Figure 1. Pin connection



*Note:* The exposed pad should be electrically connected to a metal land electrically isolated or connected to GND

Table 3. Pin description

Pin N°	Symbol	Name and function
1	GND	Ground terminal
2	SDI	Serial data input terminal
3	CLK	Clock input terminal
4	LE	Latch input terminal
5-20	OUT 0-15	Output terminal
21	$\overline{OE}$	Input terminal of output enable (active low)
22	SDO	Serial data out terminal
23	R-EXT	Input terminal of an external resistor for constant current programming
24	V <sub>DD</sub>	Supply voltage terminal

## 2 Electrical ratings

### 2.1 Absolute 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.

**Table 4. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DD}$	Supply voltage	0 to 7	V
$V_O$	Output voltage	-0.5 to 20	V
$I_O$	Output current	100	mA
$V_I$	Input voltage	-0.4 to $V_{DD}$	V
$I_{GND}$	GND terminal current	1600	mA
$f_{CLK}$	Clock frequency	50	MHz
$T_J$	Junction temperature range <sup>(1)</sup>	-40 to +170	°C

1. Such absolute value is achieved according the thermal shutdown

### 2.2 Thermal data

**Table 5. Thermal data**

Symbol	Parameter	Value	Unit	
$T_{OPR}$	Operating temperature range	-40 to +125	°C	
$T_{STG}$	Storage temperature range	-55 to +150	°C	
$R_{thJA}$	Thermal resistance junction <sup>(1)</sup>	SO-24	42.7	°C/W
		TSSOP24	55	°C/W
		TSSOP24 <sup>(2)</sup> Exposed Pad	37.5	°C/W
		QSOP-24	55	°C/W

1. According to jedec standard 51-7B

2. The exposed pad should be soldered directly to the PCB to realize the thermal benefits.

## 2.3 Recommended operating conditions

**Table 6. Recommended operating conditions at 25 °C**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$V_{DD}$	Supply voltage		3.0		5.5	V
$V_O$	Output voltage				20	V
$I_O$	Output current	OUTn	5		100	mA
$I_{OH}$	Output current	SERIAL-OUT			+1	mA
$I_{OL}$	Output current	SERIAL-OUT			-1	mA
$V_{IH}$	Input voltage		$0.7V_{DD}$		$V_{DD}$	V
$V_{IL}$	Input voltage		-0.3		$0.3V_{DD}$	V
$t_{wLAT}$	LE pulse width	$V_{DD} = 3.3\text{ V to }5.0\text{ V}$	10			ns
$t_{wCLK}$	CLK pulse width		8			ns
$t_{wEN}$	$\overline{OE}$ pulse width		100			ns
$t_{SETUP(D)}$	Setup time for DATA		14			ns
$t_{HOLD(D)}$	Hold time for DATA		5			ns
$t_{SETUP(L)}$	Setup time for LATCH		15			ns
$f_{CLK}$	Clock frequency		Cascade operation <sup>(1)</sup>			30

1. If the device is connected in cascade, it may not be possible to achieve the maximum data transfer. Please consider the timings carefully.

### 3 Electrical characteristics

**Table 7. Electrical characteristics ( $V_{DD} = 3.3\text{ V}$  to  $5\text{ V}$ ,  $T = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$V_{IH}$	Input voltage high level		$0.7V_{DD}$		$V_{DD}$	V
$V_{IL}$	Input voltage low level		GND		$0.3V_{DD}$	V
$I_{OH}$	Output leakage current	$V_{OH} = 20\text{ V}$			10	$\mu\text{A}$
$V_{OL}$	Output voltage (Serial-OUT)	$I_{OL} = 1\text{ mA}$			0.4	V
$V_{OH}$	Output voltage (Serial-OUT)	$I_{OH} = -1\text{ mA}$	$V_{DD}-0.4\text{V}$			V
$I_{OL1}$	Output current	$V_O = 0.3\text{ V}$ , $R_{ext} = 3.9\text{ k}\Omega$	4.25	5	5.75	mA
$I_{OL2}$		$V_O = 0.3\text{ V}$ , $R_{ext} = 970\ \Omega$	19	20	21	
$I_{OL3}$		$V_O = 1.3\text{ V}$ , $R_{ext} = 190\ \Omega$	96	100	104	
$\Delta I_{OL1}$	Output current error between bit (All Output ON)	$V_O = 0.3\text{ V}$ , $R_{EXT} = 3.9\text{ k}\Omega$		$\pm 5$	$\pm 8$	%
$\Delta I_{OL2}$		$V_O = 0.3\text{ V}$ , $R_{EXT} = 970\ \Omega$		$\pm 1.5$	$\pm 3$	
$\Delta I_{OL3}$		$V_O = 1.3\text{ V}$ , $R_{EXT} = 190\ \Omega$		$\pm 1.2$	$\pm 3$	
$R_{SIN(up)}$	Pull-up resistor		150	300	600	k $\Omega$
$R_{SIN(down)}$	Pull-down resistor		100	200	400	k $\Omega$
$I_{DD(SH)}$	Shut-down current All Latched Data = L	$V_{DD} = 3.3\text{ V}$		120	170	$\mu\text{A}$
		$V_{DD} = 5\text{ V}$		140	200	$\mu\text{A}$
$I_{DD(OFF1)}$	Supply current (OFF)	$R_{EXT} = 970$ OUT 0 to 15 = OFF		5		mA
$I_{DD(OFF2)}$		$R_{EXT} = 240$ OUT 0 to 15 = OFF		12.5		
$I_{DD(ON1)}$	Supply current (ON)	$R_{EXT} = 970$ OUT 0 to 15 = ON		5.5		
$I_{DD(ON2)}$		$R_{EXT} = 240$ OUT 0 to 15 = ON		13		
Thermal	Thermal protection			170		$^{\circ}\text{C}$

Table 8. Switching characteristics ( $V_{DD} = 3.3$  to  $5$  V,  $T = 25$  °C)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit	
$t_{PLH1}$	Propagation delay time, CLK-OUT $\bar{n}$ , LE = H, $\overline{OE} = L$	$V_{IH} = V_{DD}$ $V_{IL} = GND$ $I_O = 20$ mA $R_{EXT} = 1$ K $\Omega$ $C_L = 10$ pF $V_L = 3.0$ V $R_L = 60$ $\Omega$	$V_{DD} = 3.3$ V		35	55	ns
			$V_{DD} = 5$ V		17.5	26	
$t_{PLH2}$	Propagation delay time, LE-OUT $\bar{n}$ , $\overline{OE} = L$		$V_{DD} = 3.3$ V		33.5	52	ns
			$V_{DD} = 5$ V		17	20	
$t_{PLH3}$	Propagation delay time, $\overline{OE}$ -OUT $\bar{n}$ , LE = H		$V_{DD} = 3.3$ V		53.5	84.5	ns
			$V_{DD} = 5$ V		28.5	40.5	
$t_{PLH}$	Propagation delay time, CLK-SDO		$V_{DD} = 3.3$ V		19	27.5	ns
			$V_{DD} = 5$ V		13	18.5	
$t_{PHL1}$	Propagation delay time, CLK-OUT $\bar{n}$ , LE = H, $\overline{OE} = L$		$V_{DD} = 3.3$ V		13	19	ns
			$V_{DD} = 5$ V		8.5	12	
$t_{PHL2}$	Propagation delay time, LE-OUT $\bar{n}$ , $\overline{OE} = L$		$V_{DD} = 3.3$ V		10	14.5	ns
			$V_{DD} = 5$ V		6.5	9	
$t_{PHL3}$	Propagation delay time, $\overline{OE}$ -OUT $\bar{n}$ , LE = H	$V_{DD} = 3.3$ V		10.5	15	ns	
		$V_{DD} = 5$ V		7.5	10.5		
$t_{PHL}$	Propagation delay time, CLK-SDO	$V_{DD} = 3.3$ V		23	33	ns	
		$V_{DD} = 5$ V		15.5	21.5		
$t_{ON}$	Output rise time 10~90 % of voltage waveform	$V_{DD} = 3.3$ V		23.5	31.5	ns	
		$V_{DD} = 5$ V		9	10.5		
$t_{OFF}$	Output fall time 90~10 % of voltage waveform	$V_{DD} = 3.3$ V		4.6	5.5	ns	
		$V_{DD} = 5$ V		3.5	5		
$t_r$	CLK rise time <sup>(1)</sup>				5000	ns	
$t_f$	CLK fall time <sup>(1)</sup>				5000	ns	

1. In order to achieve high cascade data transfer, please consider  $t_r/t_f$  timings carefully.

## 4 Equivalent circuit and outputs

Figure 2.  $\overline{OE}$  terminal

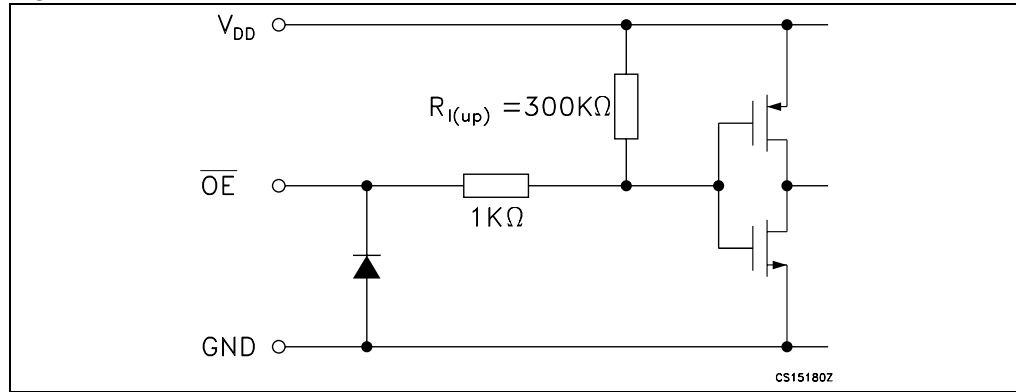


Figure 3. LE terminal

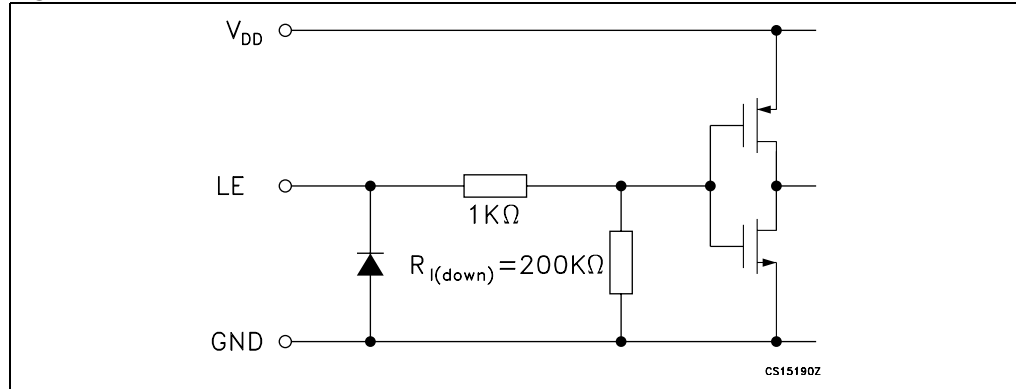


Figure 4. CLK, SDI terminal

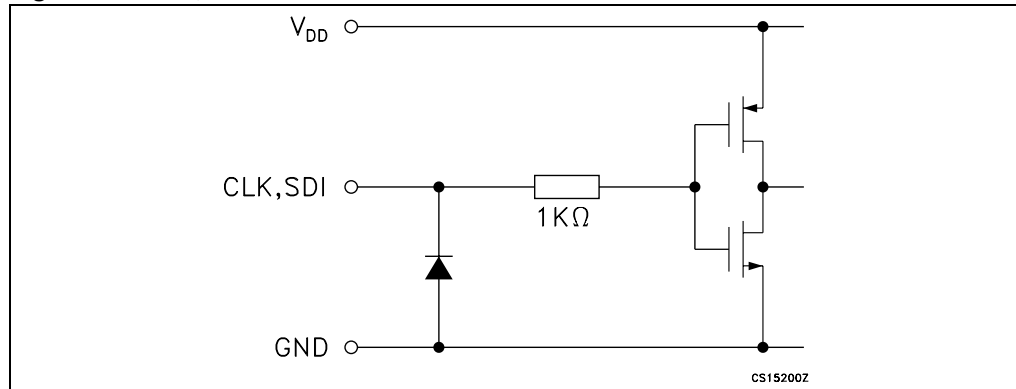




Figure 5. SDO terminal

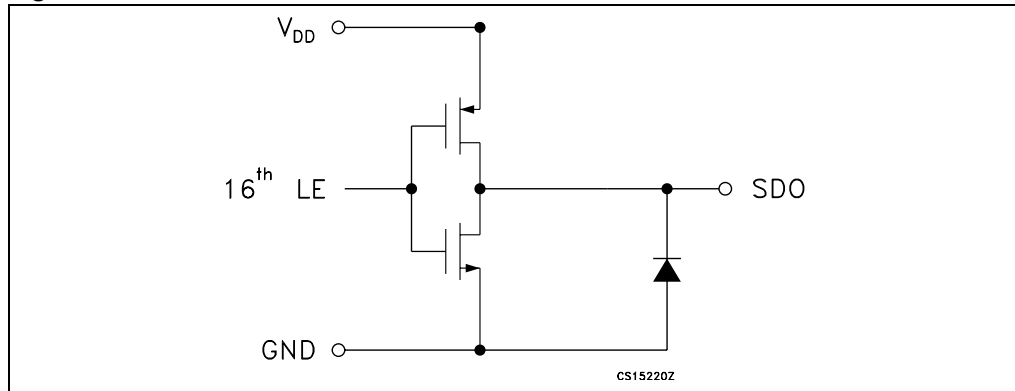
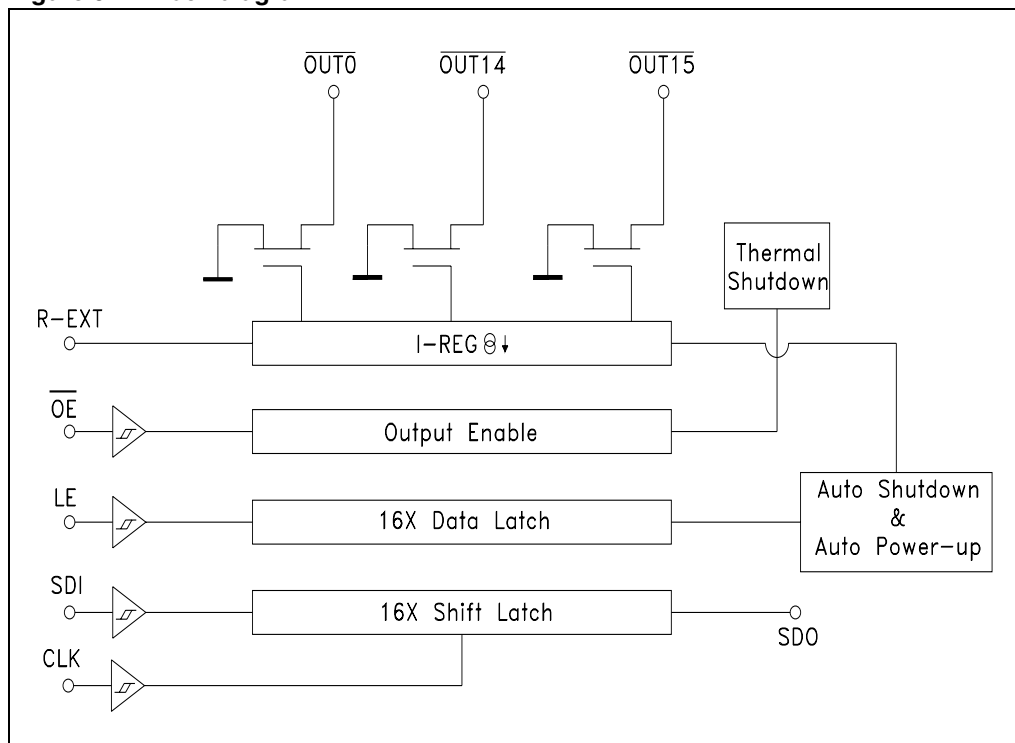


Figure 6. Block diagram



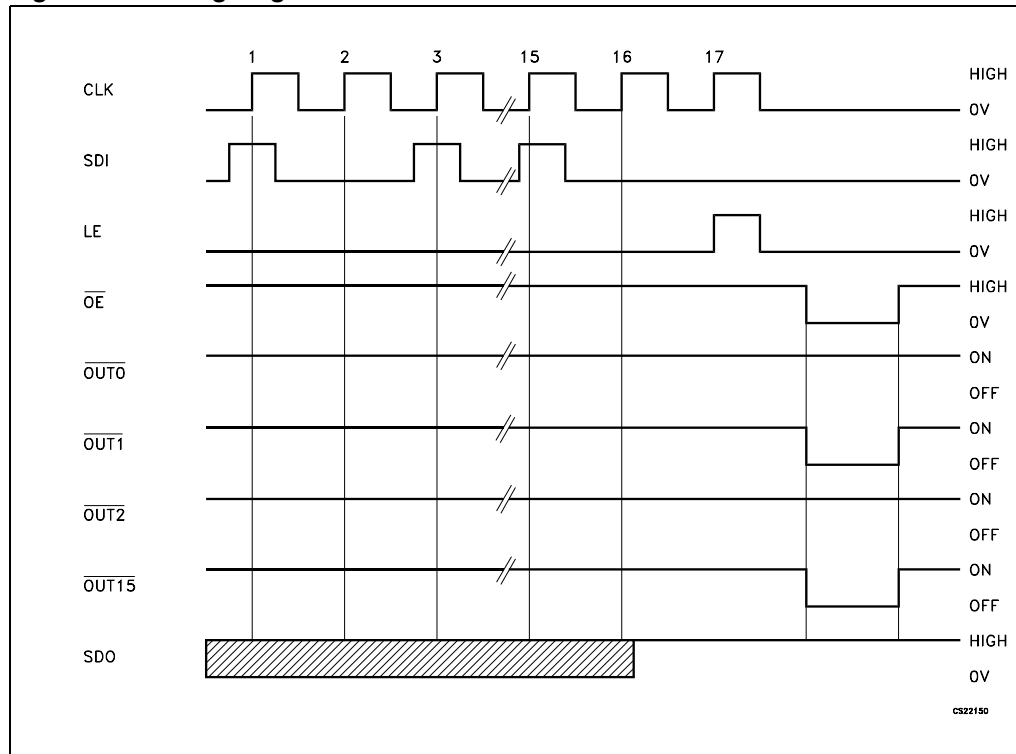
# 5 Timing diagrams

**Table 9. Truth table**

CLOCK	LE	$\overline{OE}$	SERIAL-IN	$\overline{OUT0}$ ..... $\overline{OUT7}$ ..... $\overline{OUT15}$	SDO
	H	L	Dn	Dn ..... Dn - 7 ..... Dn -15	Dn - 15
	L	L	Dn + 1	No change	Dn - 14
	H	L	Dn + 2	Dn + 2 ..... Dn - 5 ..... Dn -13	Dn - 13
	X	L	Dn + 3	Dn + 2 ..... Dn - 5 ..... Dn -13	Dn - 13
	X	H	Dn + 3	OFF	Dn - 13

Note:  $OUTn = ON$  when  $Dn = H$   $OUTn = OFF$  when  $Dn = L$

**Figure 7. Timing diagram**



- Note:
- 1 Latch and output enable terminals are Level-sensitive and are not synchronized with rising or falling edge of CLK signal
  - 2 When LE terminal is at low level, the latch circuit holds previous set of data
  - 3 When LE terminal is at high level, the latch circuit refreshes new set of data from SDI chain
  - 4 When  $\overline{OE}$  is at low level the output terminals Out 0 to Out 15 respond to data in the latch circuits, either '1' for ON or '0' for OFF.
  - 5 When  $\overline{OE}$  is at high level, all output terminals are switched OFF.

Table 10. Enable IO: shut-down truth table

CLOCK	LE	SDI <sub>0</sub> ..... SDI <sub>7</sub> ..... SDI <sub>15</sub>	SH	Auto Power-up	OUTn
	H	All = L	Active	Not active	OFF
	L	No change	No change	No change	No change
	H	One or more = H	Not active	Active	X

Note: At the power-up the device starts in shut-down mode.

Figure 8. Clock, serial-in, serial-out

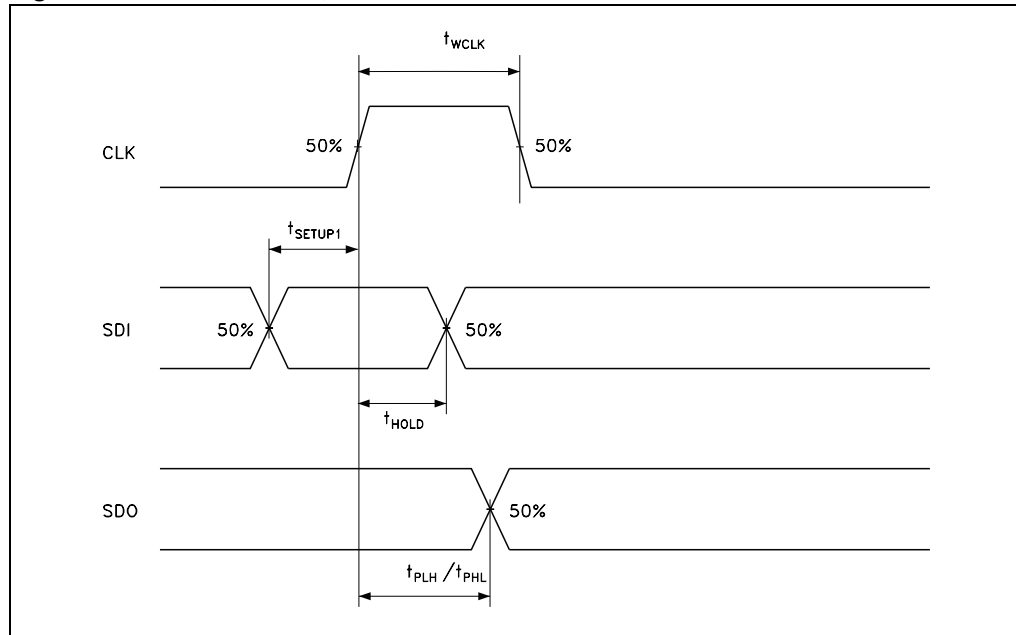


Figure 9. Clock, serial-in, latch, enable, outputs

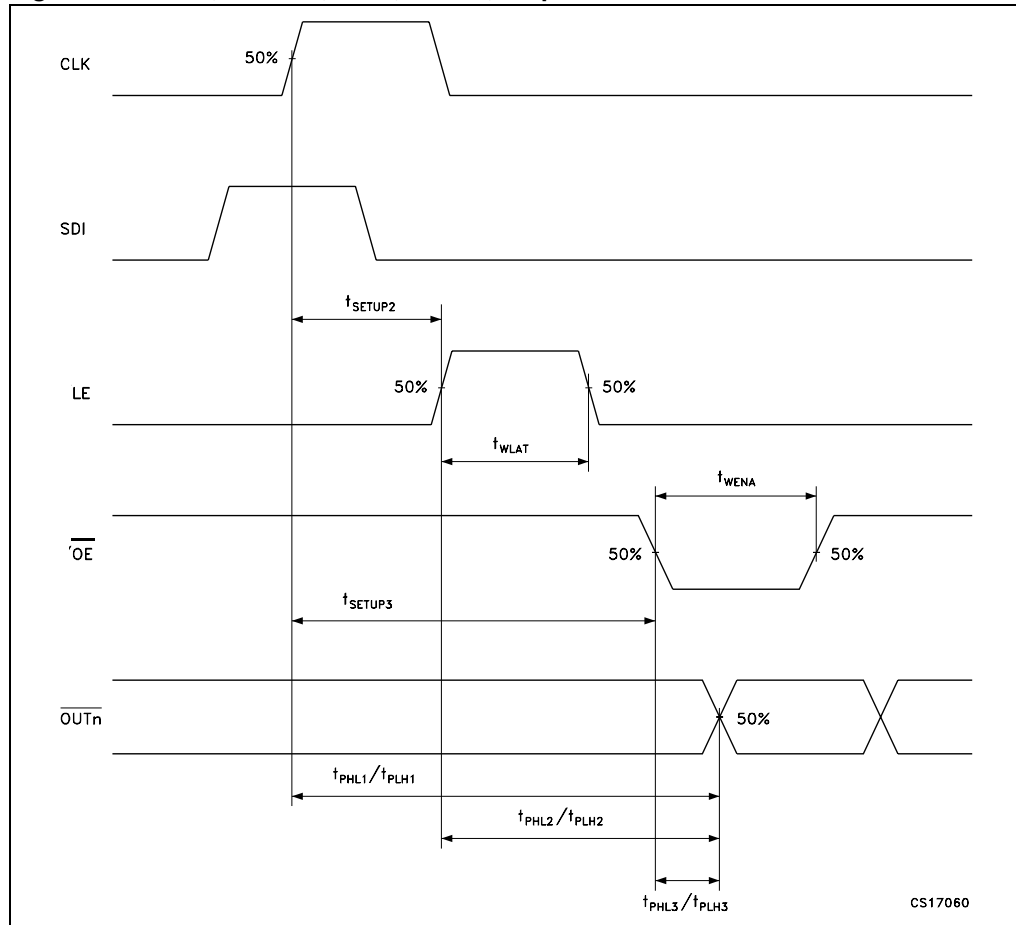
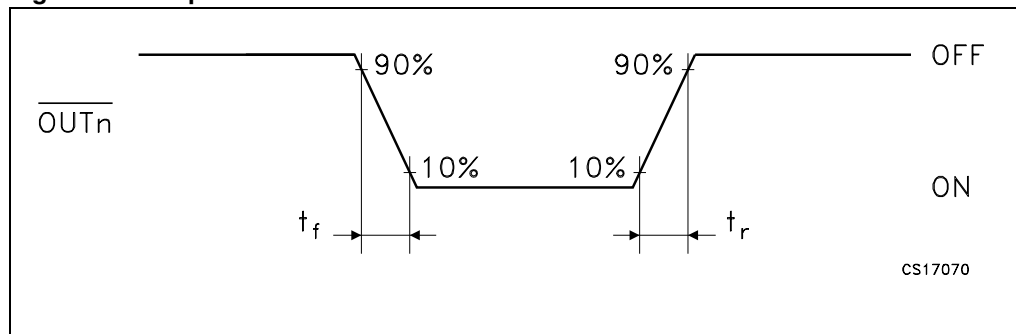


Figure 10. Outputs



## 6 Typical characteristics

Figure 11. Output current- $R_{EXT}$  resistor

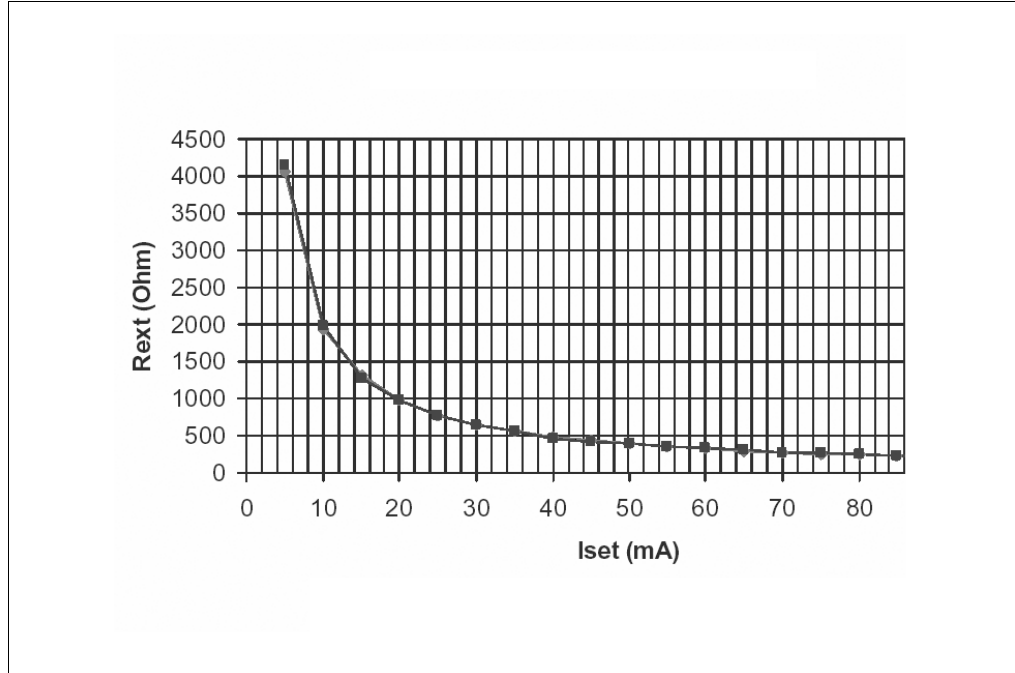


Table 11. Output current- $R_{EXT}$  resistor

$R_{ext}$ ( $\Omega$ )	Output current (mA)
976	20
780	25
652	30
560	35
488	40
433	45
389	50
354	55
325	60
300	65
278	70
259	75
241	80
229	85
215	90

Figure 12. Output current vs  $\pm \Delta I_{OL}(\%)$

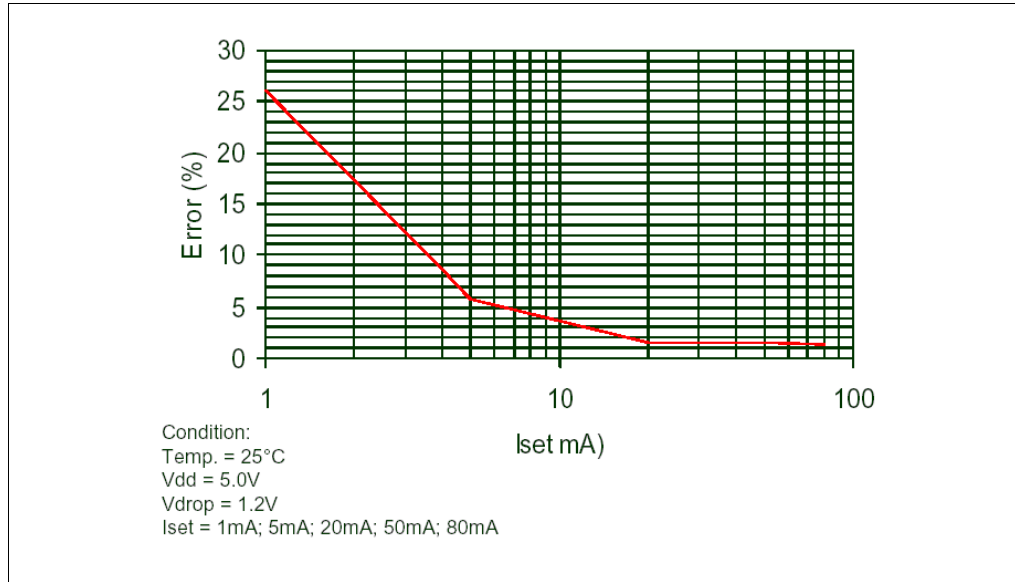


Figure 13. ISET vs drop out voltage ( $V_{drop}$ )

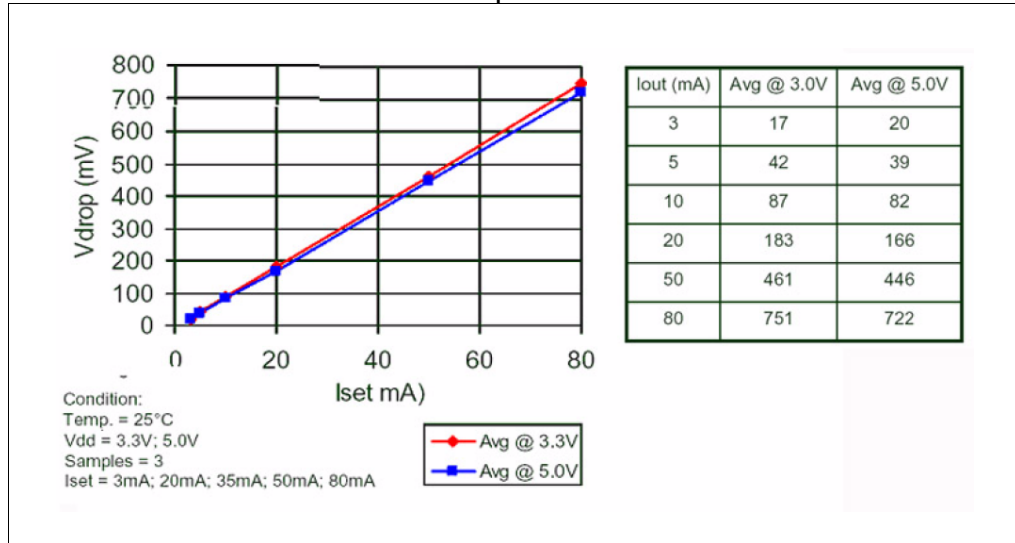


Figure 14.  $I_{DD}$  ON/OFF

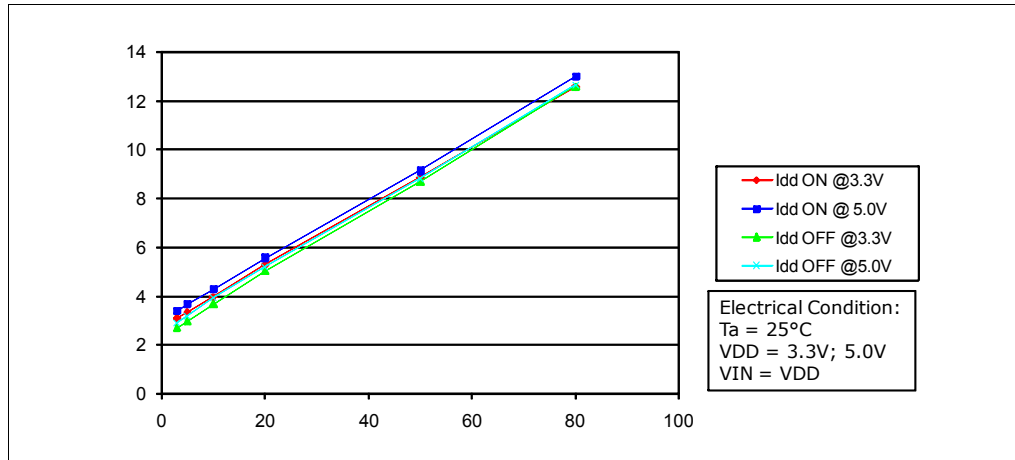
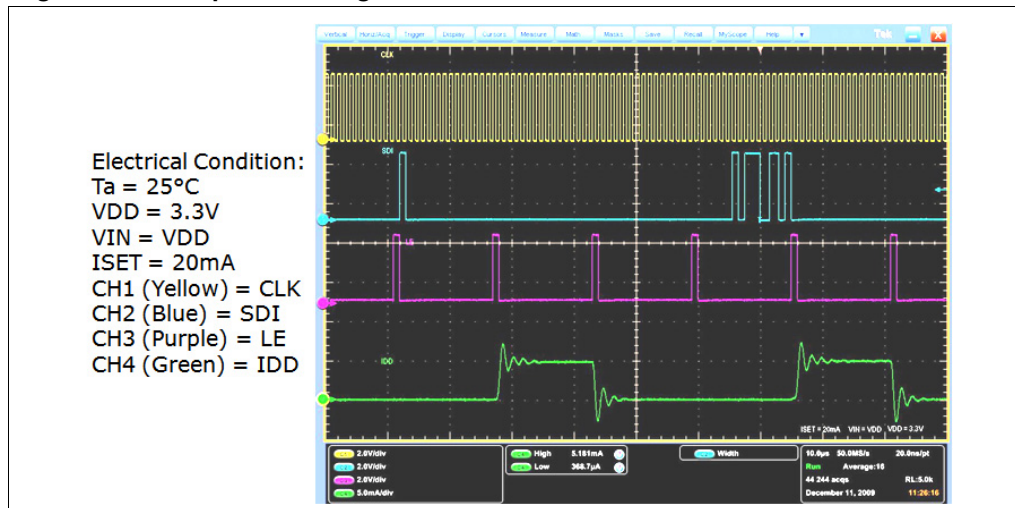
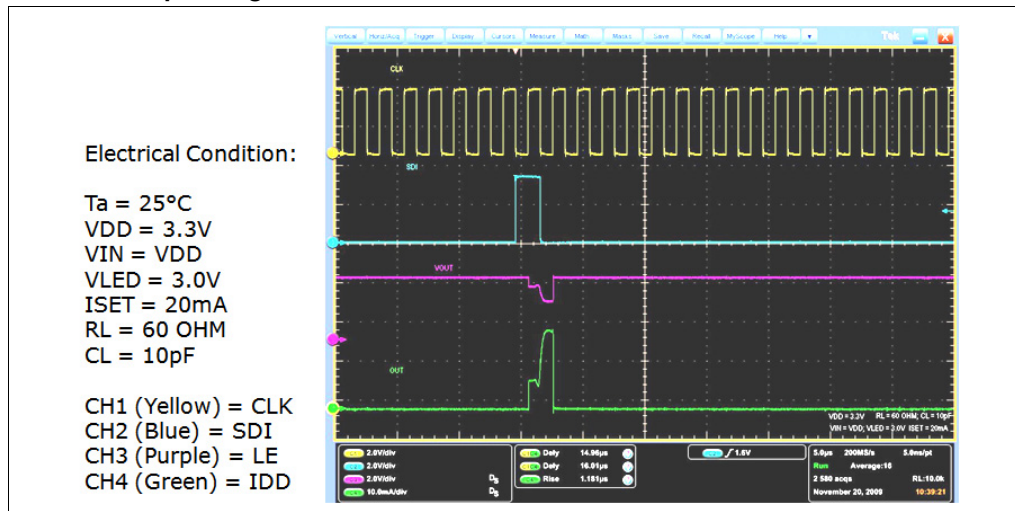


Figure 15. Auto power saving



Note: Auto power-saving feature minimizes the quiescent current if no active data is detected on the latches and auto-power-up the device at fist active data latched.

**Figure 16. First output ON after switching from auto power saving to normal mode operating condition**



*Note: When the device goes from auto power saving to normal operative condition, the first output that switch ON shows TON condition as seen in the plot above.*



## 7 Test circuit

Figure 17. DC characteristic

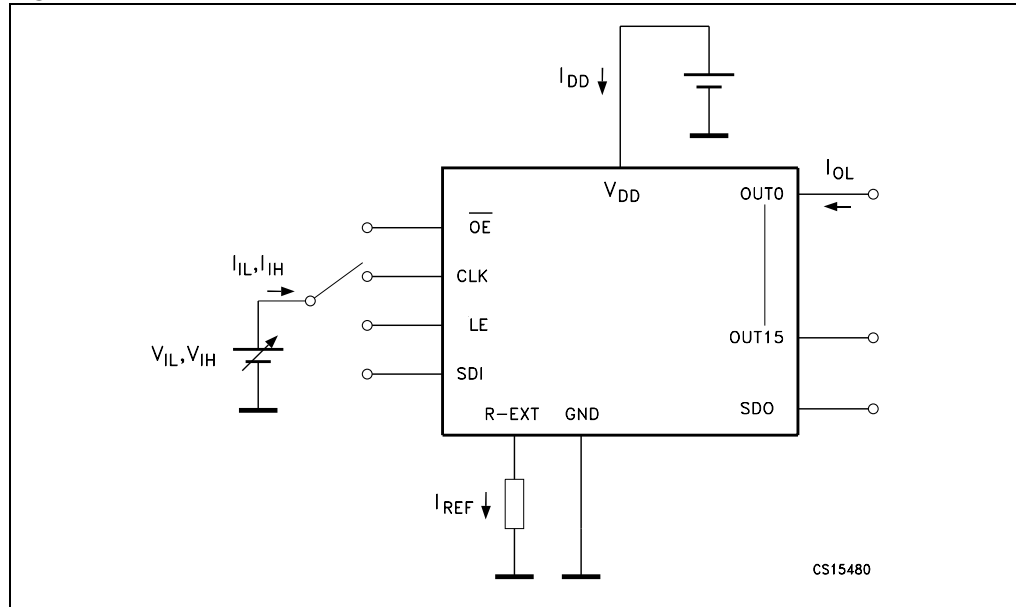


Figure 18. AC characteristic

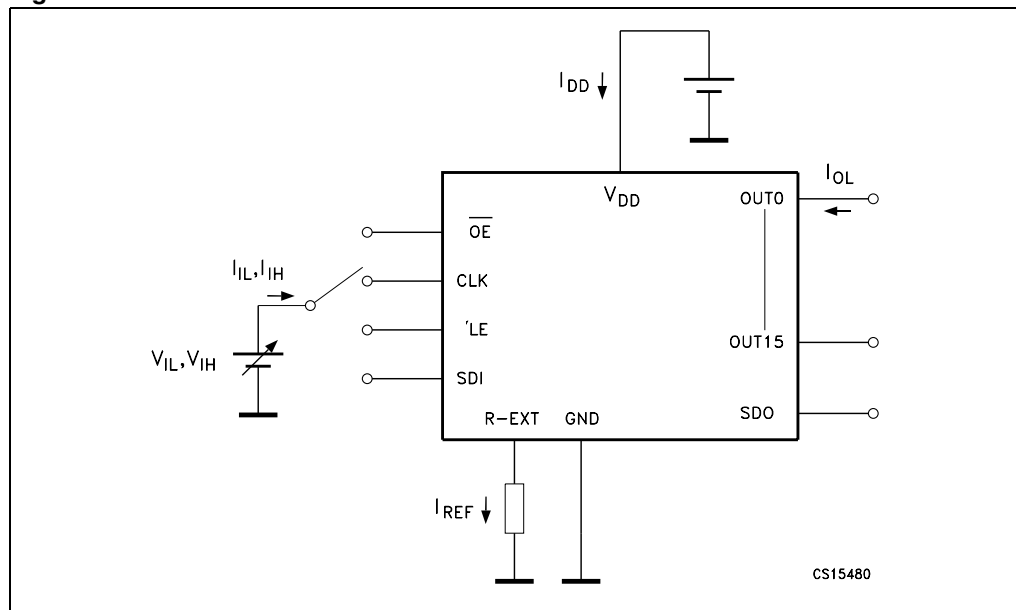
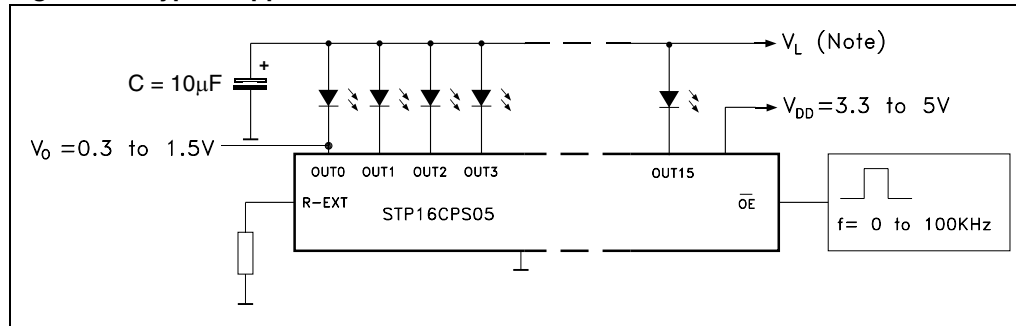


Figure 19. Typical application schematic



Note:  $V_L$  will be determined by the  $V_F$  of the LEDs

Table 12. Turn ON output current characteristics (1)

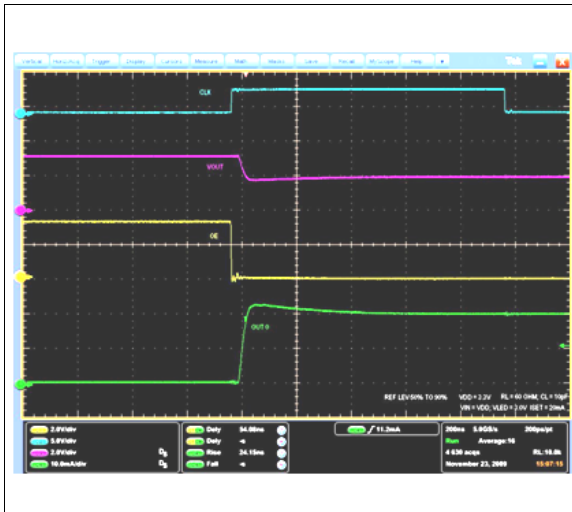
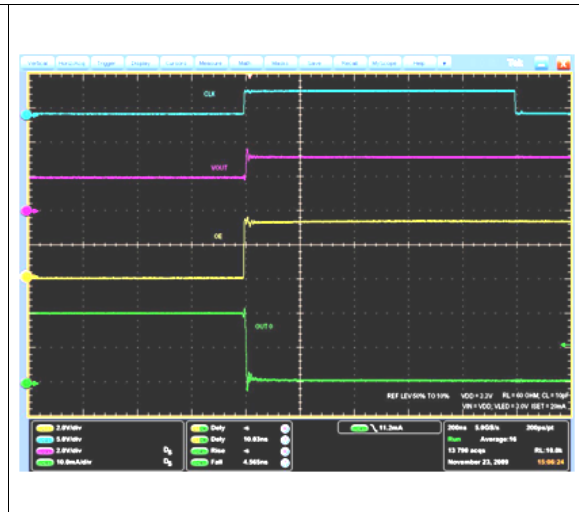


Table 13. Turn OFF output current characteristics (2)



1. Reference level for the  $T_{ON}$  characteristics is 50% of OE signal to 90% of output current
2. Reference level for the  $T_{OFF}$  characteristics is 50% of OE signal to 10% of output current

## 8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

**Table 14. QSOP-24 mechanical data**

Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A	1.54	1.62	1.73	0.061	0.064	0.068
A1	0.1	0.15	0.25	0.004	0.006	0.010
A2		1.47			0.058	
b	0.31	0.2		0.012	0.008	
c	0.254	0.17		0.010	0.007	
D	8.56	8.66	8.76	0.337	0.341	0.345
E	5.8	6	6.2	0.228	0.236	0.244
E1	3.8	3.91	4.01	0.150	0.154	0.158
e		0.635			0.025	
L	0.4	0.635	0.89	0.016	0.025	0.035
h	0.25	0.33	0.41	0.010	0.013	0.016
<	8°	0°				

Figure 20. QSOP-24 package dimensions

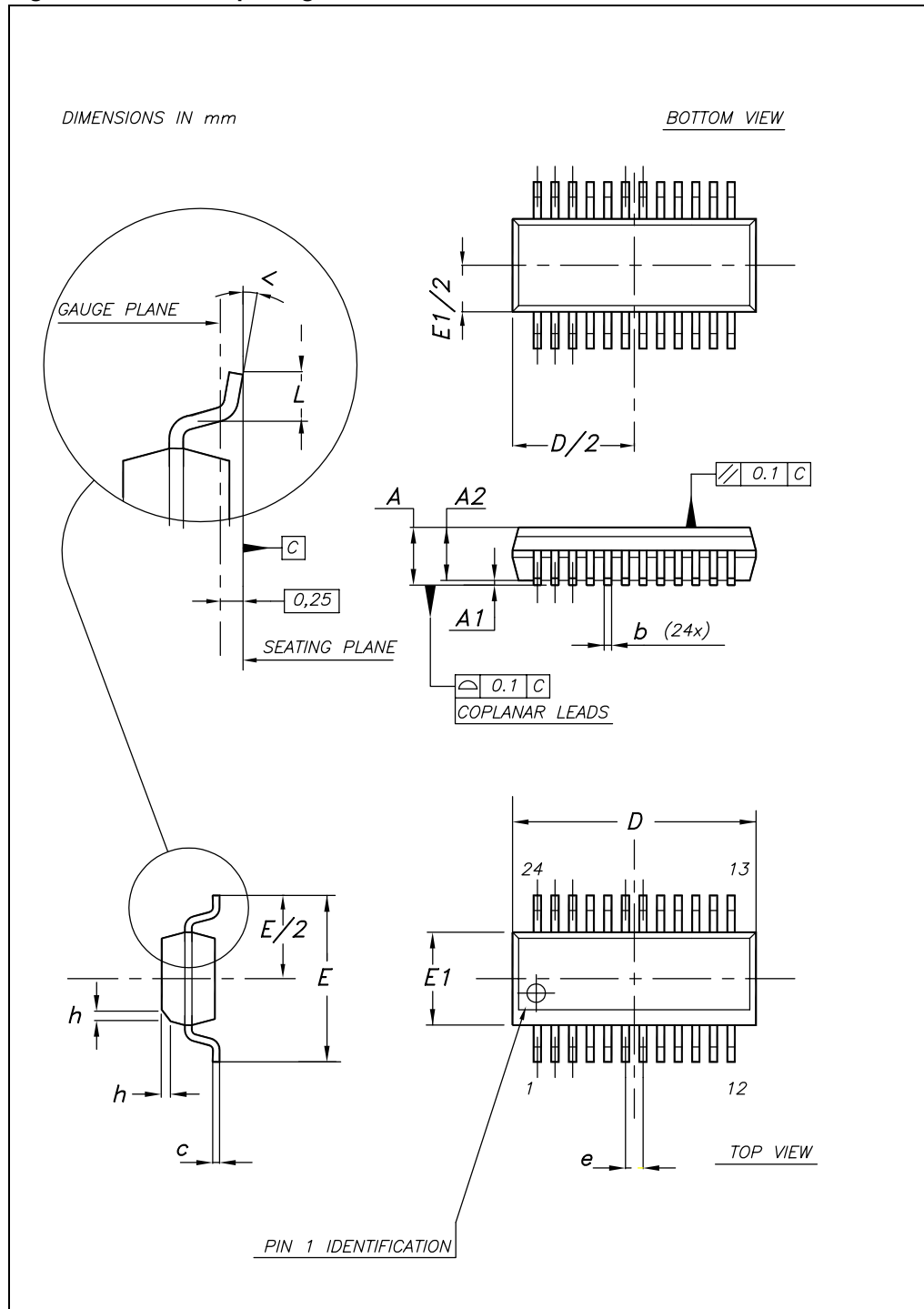


Table 15. TSSOP24 mechanical data

Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A			1.1			0.043
A1	0.05		0.15	0.002		0.006
A2		0.9			0.035	
b	0.19		0.30	0.0075		0.0118
c	0.09		0.20	0.0035		0.0079
D	7.7		7.9	0.303		0.311
E	4.3		4.5	0.169		0.177
e		0.65 BSC			0.0256 BSC	
H	6.25		6.5	0.246		0.256
K	0°		8°	0°		8°
L	0.50		0.70	0.020		0.028

Figure 21. TSSOP24 package dimensions

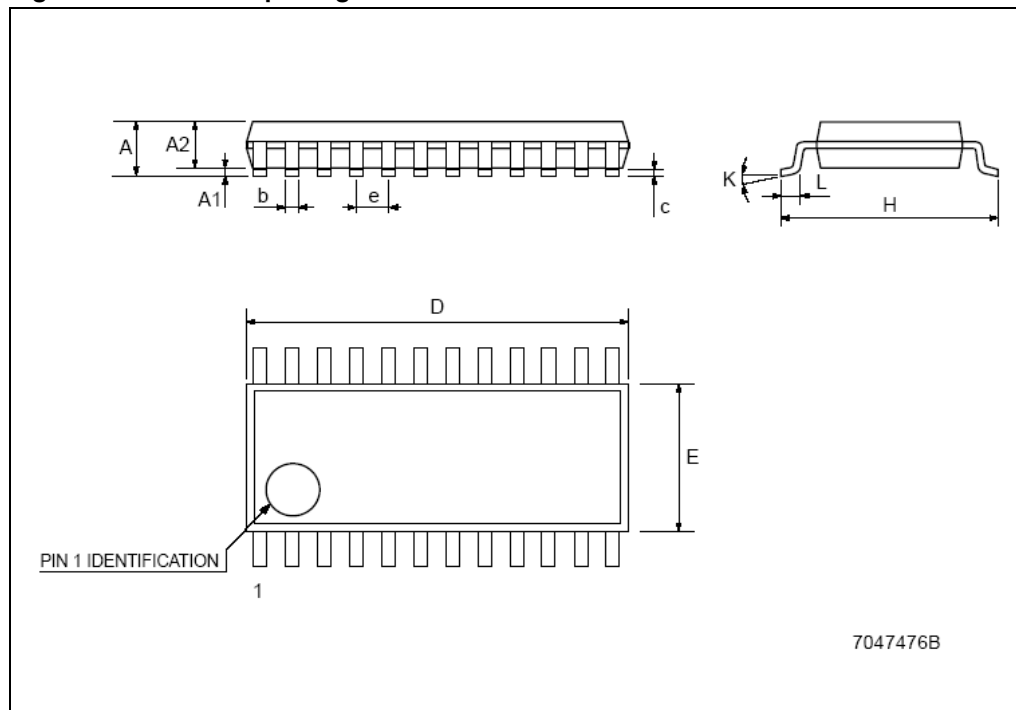


Table 16. Tape and reel TSSOP24

Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A			330			2.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.8		7	0.268		0.276
Bo	8.2		8.4	0.323		0.331
Ko	1.7		1.9	0.067		0.075
Po	3.9		4.1	0.153		0.161
P	11.9		12.1	0.468		0.476

Figure 22. Reel dimensions

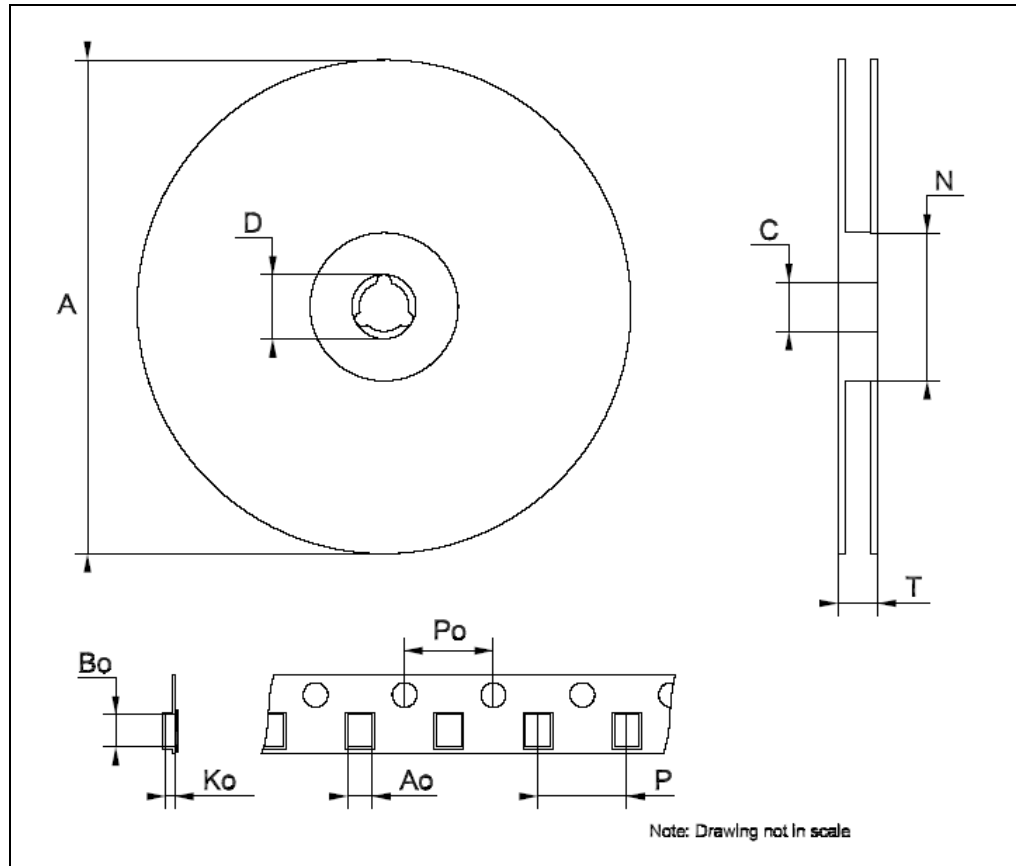


Table 17. SO-24 mechanical data

Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A			2.65			0.104
a1	0.1		0.2	0.004		0.008
a2			2.45			0.096
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.012
C		0.5			0.020	
c1	45°(typ.)					
D	15.20		15.60	0.598		0.614
E	10.00		10.65	0.393		0.419
e		1.27			0.050	
e3		13.97			0.550	
F	7.40		7.60	0.291		0.300
L	0.50		1.27	0.020		0.050
S	°(max.) 8					

Figure 23. SO-24 package dimensions

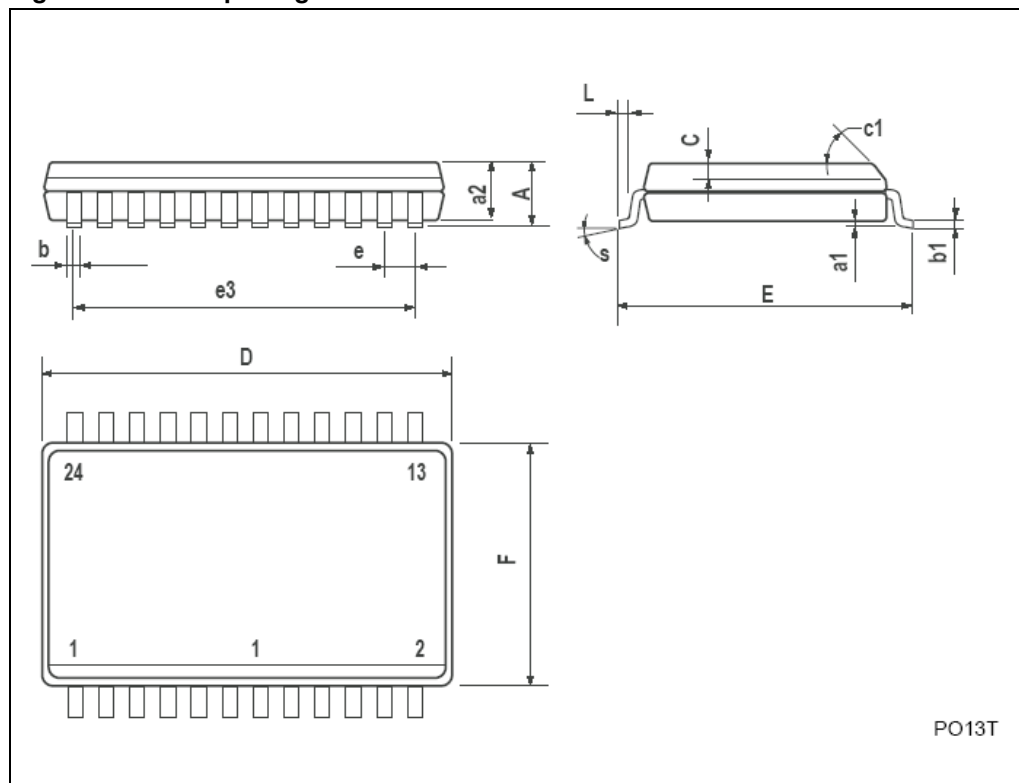


Table 18. Tape and reel SO-24

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			30.4			1.197
Ao	10.8		11.0	0.425		0.433
Bo	15.7		15.9	0.618		0.626
Ko	2.9		3.1	0.114		0.122
Po	3.9		4.1	0.153		0.161
P	11.9		12.1	0.468		0.476

Figure 24. Reel dimensions

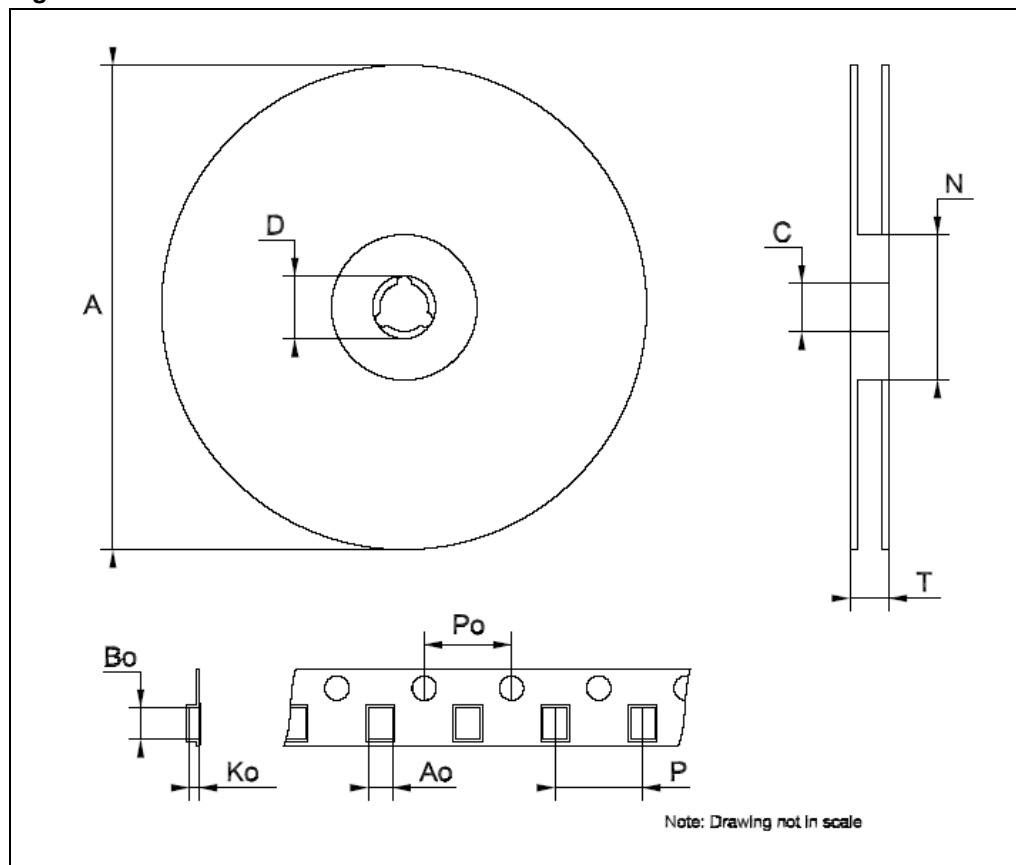
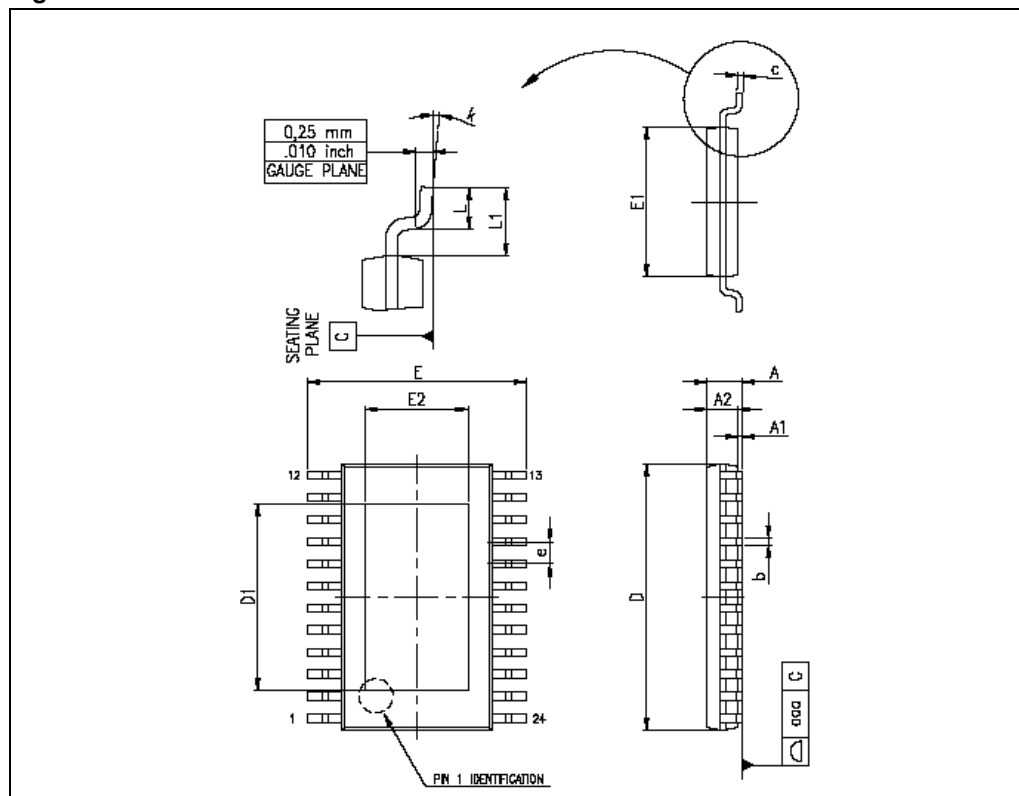




Table 19. TSSOP24 exposed pad

Dim.	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A			1.2			0.047
A1			0.15		0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	7.7	7.8	7.9	0.303	0.307	0.311
D1	4.7	5.0	5.3	0.185	0.197	0.209
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.5	0.169	0.173	0.177
E2	2.9	3.2	3.5	0.114	0.126	0.138
e		0.65			0.0256	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030

Figure 25. TSSOP24 dimensions



## 9 Revision history

**Table 20. Document revision history**

Date	Revision	Changes
28-Jul-2006	1	First release
22-Dec-2006	2	Final datasheet
17-May-2007	3	Updated <a href="#">Table 8 on page 7</a>
10-Jul-2007	4	Updated <a href="#">Table 9: Truth table on page 10</a>
28-Feb-2008	5	Updated <a href="#">Table 19: TSSOP24 exposed pad on page 25</a> Added QSOP-24 package information <a href="#">Table 14</a> and <a href="#">Figure 20 on page 20</a>
19-Jan-2010	6	Updated <a href="#">Table 6 on page 5</a>

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2010 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)

