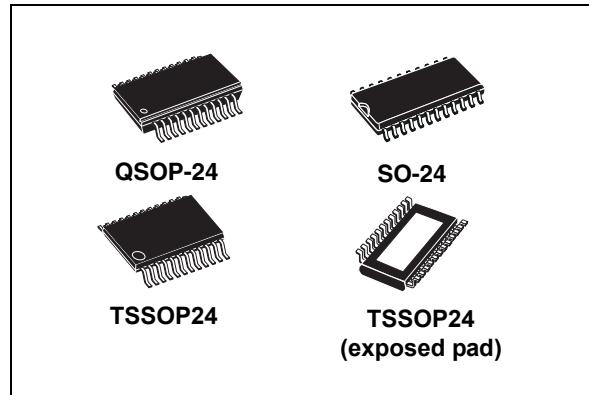


## Low voltage 16-bit constant current LED sink driver

### Features

- 16 constant current output channels
- Adjustable output current through external resistor
- Output current: 3-40 mA
- Serial data in/parallel data out
- 3.3 V or 5 V supply voltage
- Max clock frequency 30 MHz
- Schmitt-trigger input
- ESD protection 2 kV HBM
- Thermal shutdown



### Description

The STP16CPP05 is a monolithic, low voltage, low current power 16-bit shift register designed for LED panel displays. The STP16CPP05 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 3 mA to 40 mA constant current to drive the LEDs.

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 STP16CPP05 output current.

The STP16CPP05 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 micro controller.

**Table 1. Device summary**

Order codes	Package	Packaging
STP16CPP05MTR	SO-24	1000 parts per reel
STP16CPP05TTR	TSSOP24	2500 parts per reel
STP16CPP05XTTR	TSSOP24 exposed pad	2500 parts per reel
STP16CPP05PTR	QSOP-24	2500 parts per reel

## Contents

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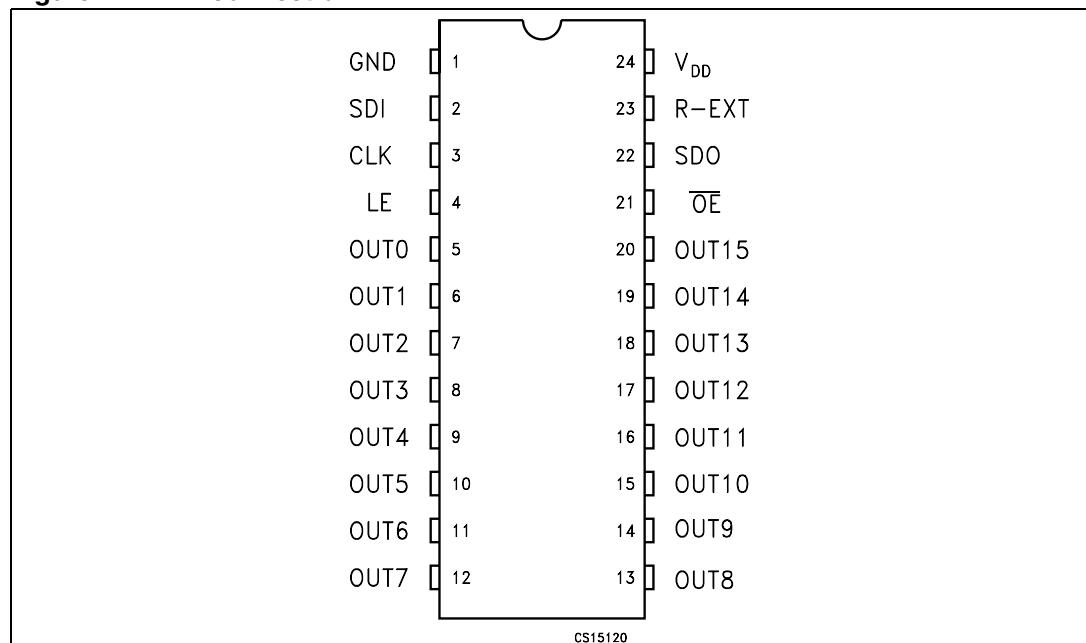
# 1 Summary description

**Table 2. Typical current accuracy**

Output voltage	Current accuracy		Output current	$V_{DD}$	Temperature
	Between bits	Between ICs			
$\geq 1.3 \text{ V}$	$\pm 1.2\%$	$\pm 5\%$	$\geq 5 \text{ to } 40 \text{ mA}$	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 ground.

**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	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 programing
24	$V_{DD}$	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	50	mA
$V_I$	Input voltage	-0.4 to $V_{DD}+0.4$	V
$I_{GND}$	GND terminal current	800	mA
$f_{CLK}$	Clock frequency	50	MHz

### 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	
$R_{thJC}$	Thermal resistance junction-case	SO-24	60	°C/W
		TSSOP24	85	°C/W
		TSSOP24 <sup>(1)</sup> Exposed Pad	37.5	°C/W
		QSOP-24	72	°C/W

1. 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	3		40	mA
$I_{OH}$	Output current	SERIAL-OUT			+1	mA
$I_{OL}$	Output current	SERIAL-OUT			-1	mA
$V_{IH}$	Input voltage		0.7 $V_{DD}$		$V_{DD}+0.3$	V
$V_{IL}$	Input voltage		-0.3		0.3 $V_{DD}$	V
$t_{wLAT}$	LE pulse width	$V_{DD} = 3.3 \text{ V to } 5.0 \text{ V}$	20			ns
$t_{wCLK}$	CLK pulse width		16			ns
$t_{wEN}$	$\overline{OE}$ pulse width		70			ns
$t_{\text{SETUP}(D)}$	Setup time for DATA		5			ns
$t_{\text{HOLD}(D)}$	Hold time for DATA		5			ns
$t_{\text{SETUP}(L)}$	Setup time for LATCH		15			ns
$f_{CLK}$	Clock frequency	Cascade operation <sup>(1)</sup>			30	MHz

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

### 3 Electrical characteristics

$V_{DD} = 3.3 \text{ V to } 5 \text{ V}$ ,  $T = 25^\circ\text{C}$ , unless otherwise specified.

**Table 7. Electrical characteristics**

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	$V_{OH} = 20 \text{ V}$		0.15	1	$\mu\text{A}$
$V_{OL}$	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	$V_O = 0.3 \text{ V}, R_{ext} = 4 \text{ k}\Omega$	4.75	5	5.25	mA
$I_{OL2}$		$V_O = 0.3 \text{ V}, R_{ext} = 980 \Omega$	19	20	21	
$I_{OL3}$		$V_O = 1.3 \text{ V}, R_{ext} = 490 \Omega$	38	40	42	
$\Delta I_{OL1}$	Output current error between bit (All Output ON)	$V_O = 0.3 \text{ V}, I_O = 5 \text{ mA}$ $R_{EXT} = 4 \text{ k}\Omega$		$\pm 1.2$	$\pm 5$	%
$\Delta I_{OL2}$		$V_O = 0.3 \text{ V}, I_O = 20 \text{ mA}$ $R_{EXT} = 980 \Omega$		$\pm 0.5$	$\pm 3$	
$\Delta I_{OL3}$		$V_O = 1.3 \text{ V}, I_O = 40 \text{ mA}$ $R_{EXT} = 490 \Omega$		$\pm 1.0$	$\pm 3$	
$R_{SIN(up)}$	Pull-up resistor		150	300	600	k $\Omega$
$R_{SIN(down)}$	Pull-down resistor		100	200	400	k $\Omega$
$I_{DD(OFF1)}$	Supply current (OFF)	$R_{EXT} = 980$ OUT 0 to 15 = OFF		5.4	7.5	mA
$I_{DD(OFF2)}$		$R_{EXT} = 490$ OUT 0 to 15 = OFF		8.0	9.5	
$I_{DD(ON1)}$	Supply current (ON)	$R_{EXT} = 980$ OUT 0 to 15 = ON		5.5	7.5	
$I_{DD(ON2)}$		$R_{EXT} = 490$ OUT 0 to 15 = ON		8.1	9.5	
Thermal	Thermal protection		170			°C

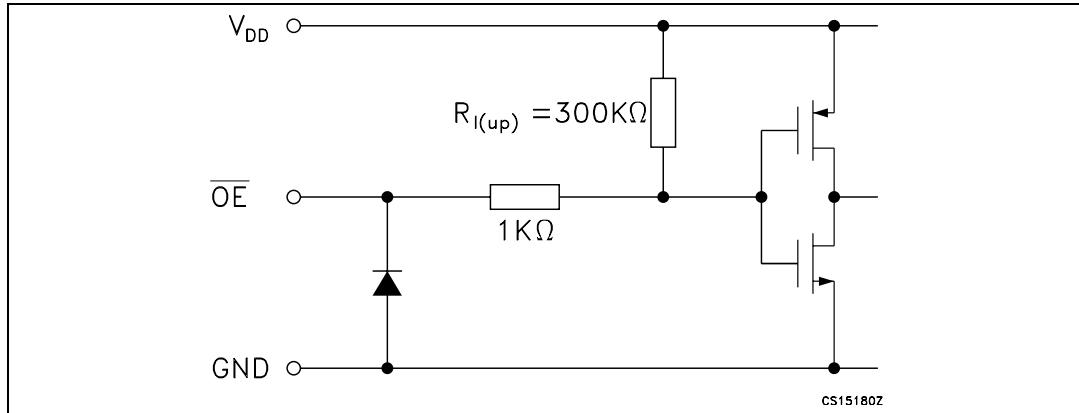
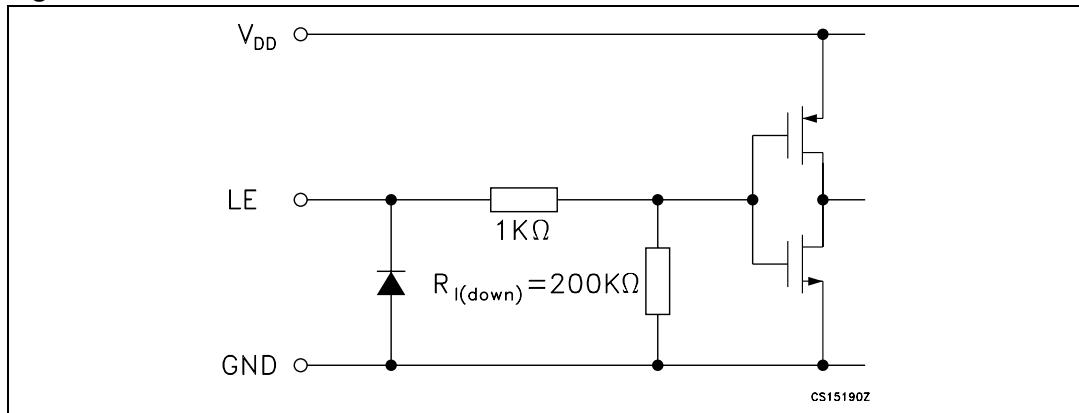
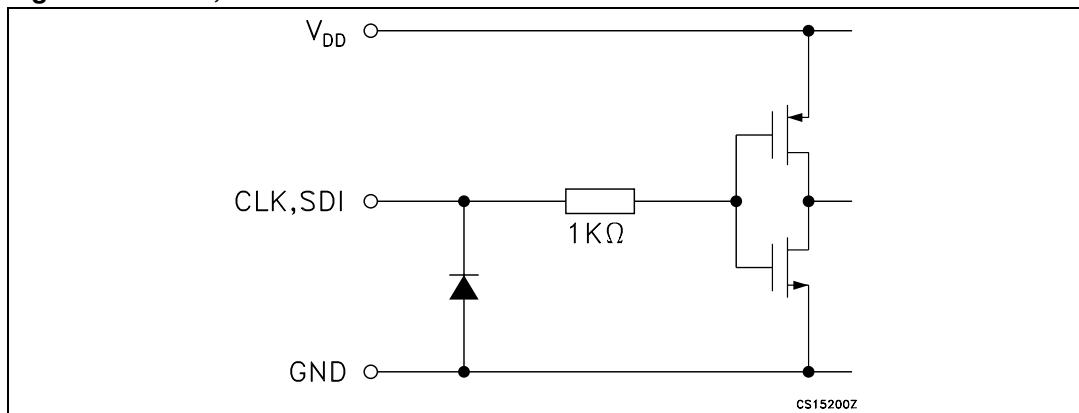
$V_{DD} = 5 \text{ V}$ ,  $T = 25^\circ\text{C}$ , unless otherwise specified.

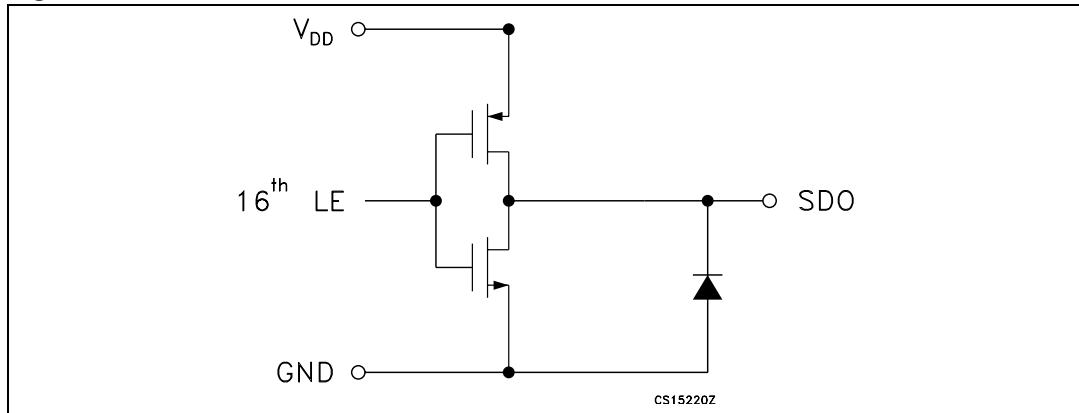
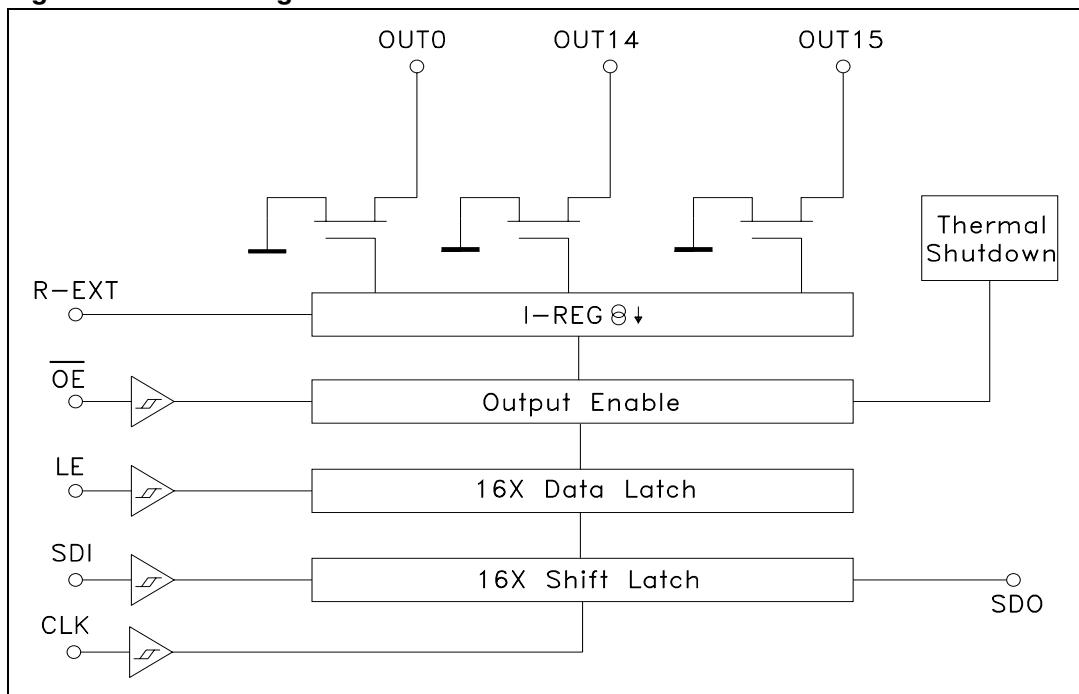
**Table 8. Switching characteristics**

Symbol	Parameter	Test conditions		Min	Typ	Max	Unit
$t_{PLH1}$	Propagation delay time, CLK-OUTn, LE = H, $\overline{OE} = L$	$V_{IH} = V_{DD}$ $V_{IL} = GND$ $I_O = 20 \text{ mA}$ $R_{EXT} = 1 \text{ k}\Omega$	$V_{DD} = 3.3 \text{ V}$	-	44	58	ns
$t_{PLH2}$	Propagation delay time, LE-OUTn, $\overline{OE} = L$		$V_{DD} = 5 \text{ V}$	-	24	32	ns
$t_{PLH3}$	Propagation delay time, $\overline{OE}$ -OUTn, LE = H		$V_{DD} = 3.3 \text{ V}$	-	43	56	ns
$t_{PLH}$	Propagation delay time, CLK-SDO		$V_{DD} = 5 \text{ V}$	-	24	32	ns
$t_{PHL1}$	Propagation delay time, CLK-OUTn, LE = H, $\overline{OE} = L$		$V_{DD} = 3.3 \text{ V}$	-	63	82	ns
$t_{PHL2}$	Propagation delay time, LE-OUTn, $\overline{OE} = L$		$V_{DD} = 5 \text{ V}$	-	37	48	ns
$t_{PHL3}$	Propagation delay time, $\overline{OE}$ -OUTn, LE = H		$V_{DD} = 3.3 \text{ V}$	-	17	22	ns
$t_{PHL}$	Propagation delay time, CLK-SDO		$V_{DD} = 5 \text{ V}$	-	11	14	ns
$t_{ON}$	Output rise time 10~90% of current waveform		$V_{DD} = 3.3 \text{ V}$	-	22	28	ns
$t_{OFF}$	Output fall time 90~10% of current waveform		$V_{DD} = 5 \text{ V}$	-	16	21	ns
$t_r$	CLK rise time (1)		$V_{DD} = 3.3 \text{ V}$	-	19	25	ns
$t_f$	CLK fall time (1)		$V_{DD} = 5 \text{ V}$	-	15	20	ns
			$V_{DD} = 3.3 \text{ V}$	-	16	21	ns
			$V_{DD} = 5 \text{ V}$	-	13	17	ns
			$V_{DD} = 3.3 \text{ V}$	-	21	27	ns
			$V_{DD} = 5 \text{ V}$	-	13	17	ns
			$V_{DD} = 3.3 \text{ V}$	-	26	35	ns
			$V_{DD} = 5 \text{ V}$	-	12	16	ns
			$V_{DD} = 3.3 \text{ V}$	-	4	6	ns
			$V_{DD} = 5 \text{ V}$	-	3	5	ns
				-		5000	ns
				-		5000	ns

1. In order to achieve high cascade data transfer, please consider tr/tf 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

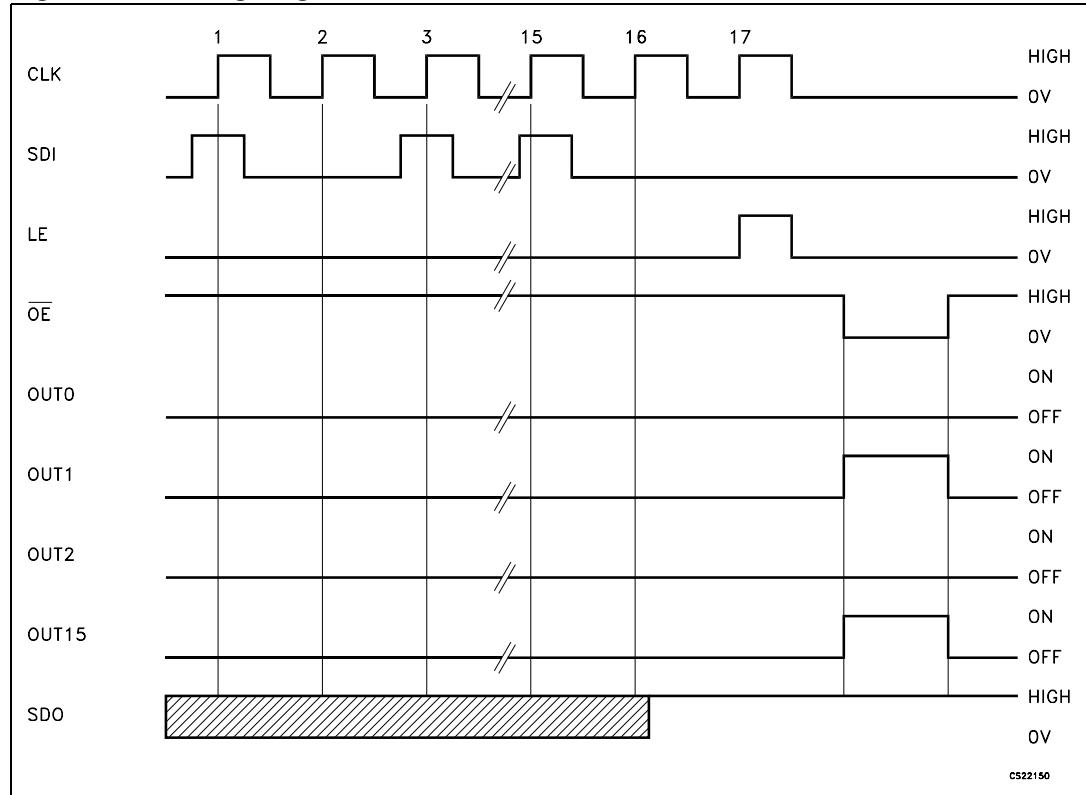
## 5 Timing diagrams

**Table 9. Truth table**

CLOCK	LE	$\overline{OE}$	SERIAL-IN	OUT0 ..... OUT7 ..... 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

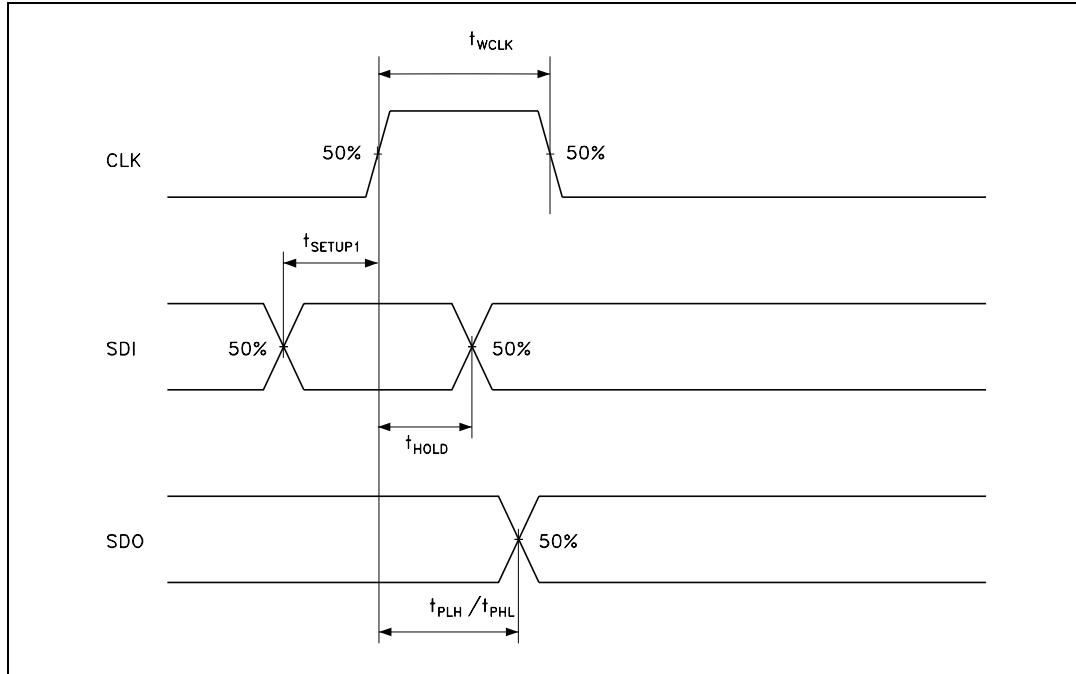
Note:  $OUTn = ON$  when  $Dn = H$   $OUTn = OFF$  when  $Dn = L$

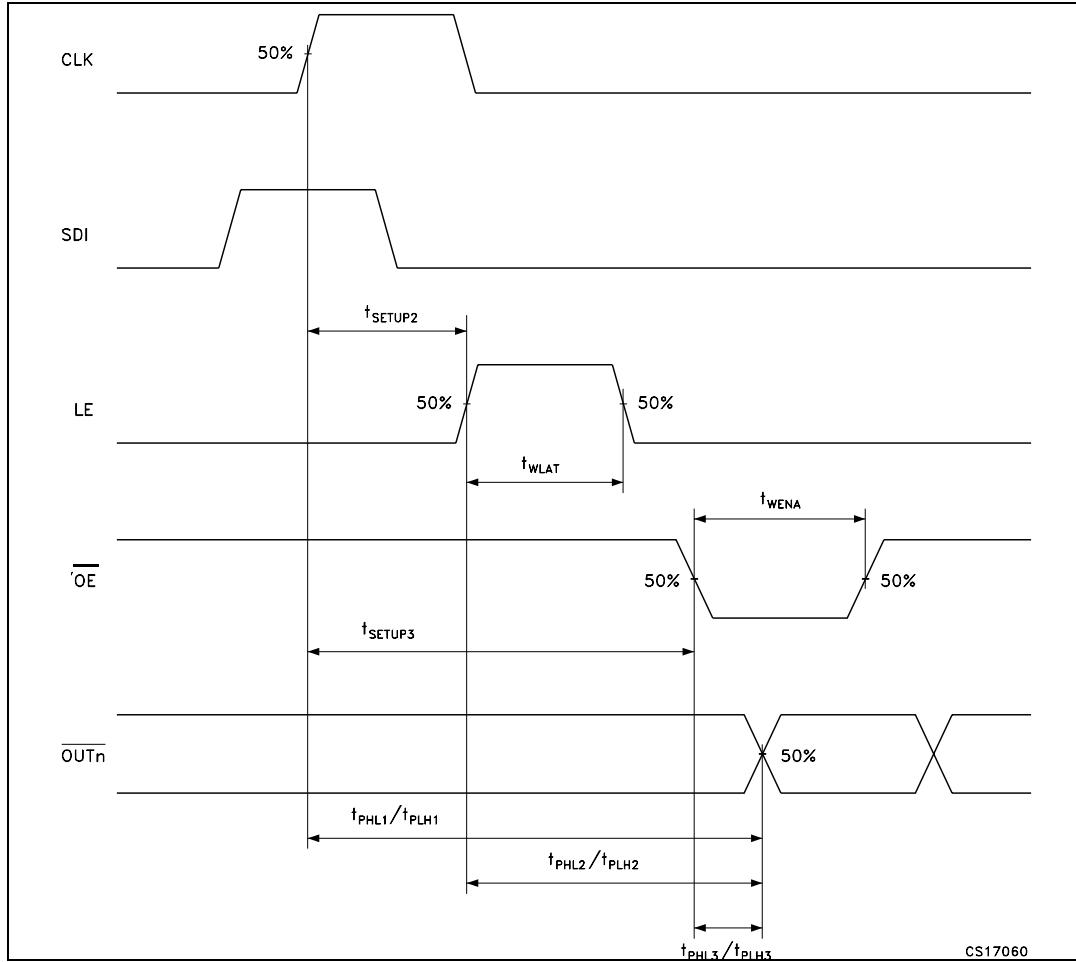
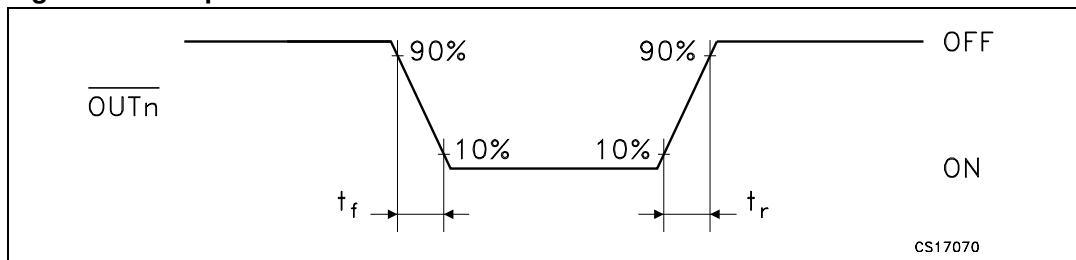
**Figure 7. Timing diagram**



Note: The latches circuit holds data when the LE terminal is Low.

- 1 When LE terminal is at high level, latch circuit does not hold the data it passes from the input to the output.
- 2 When  $\overline{OE}$  terminal is at low level, output terminals OUT0 to OUT15 respond to the data, either ON or OFF.
- 3 When  $\overline{OE}$  terminal is at high level, it switches off all the data on the output terminal.

**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 vs Rext resistor

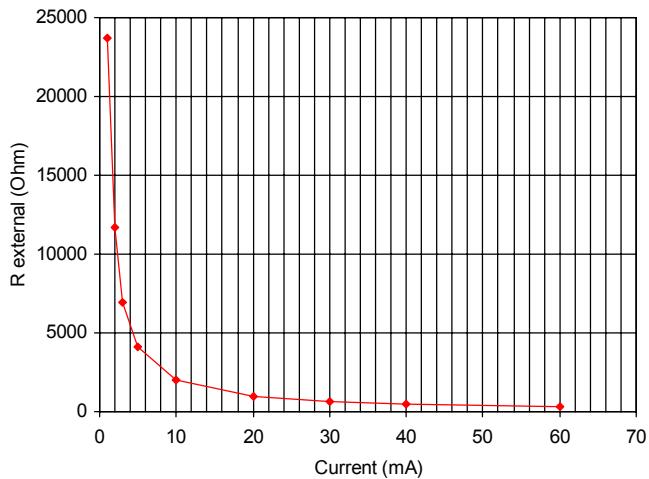
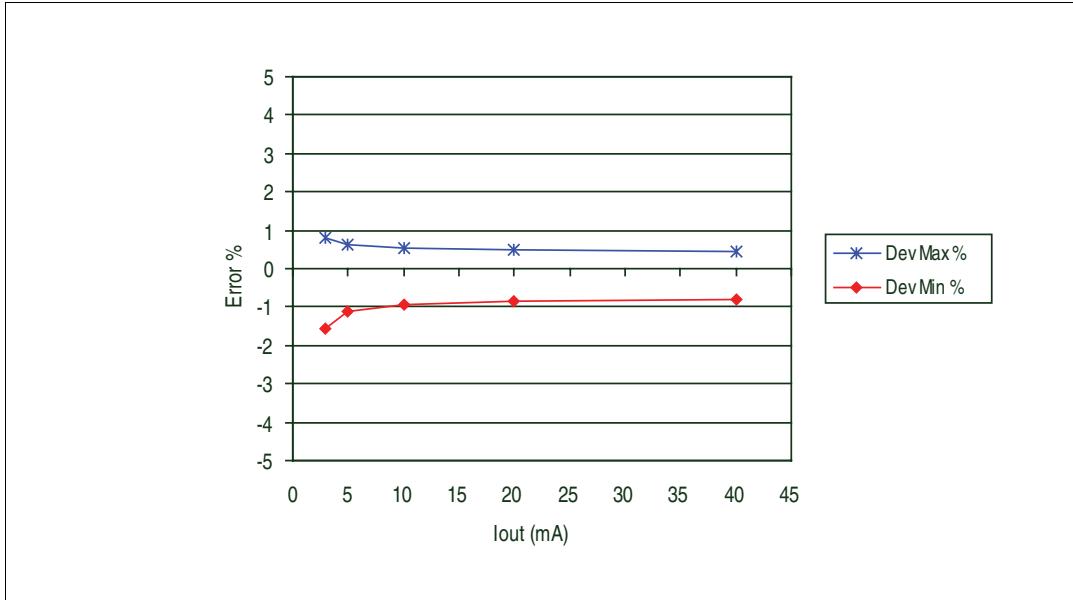
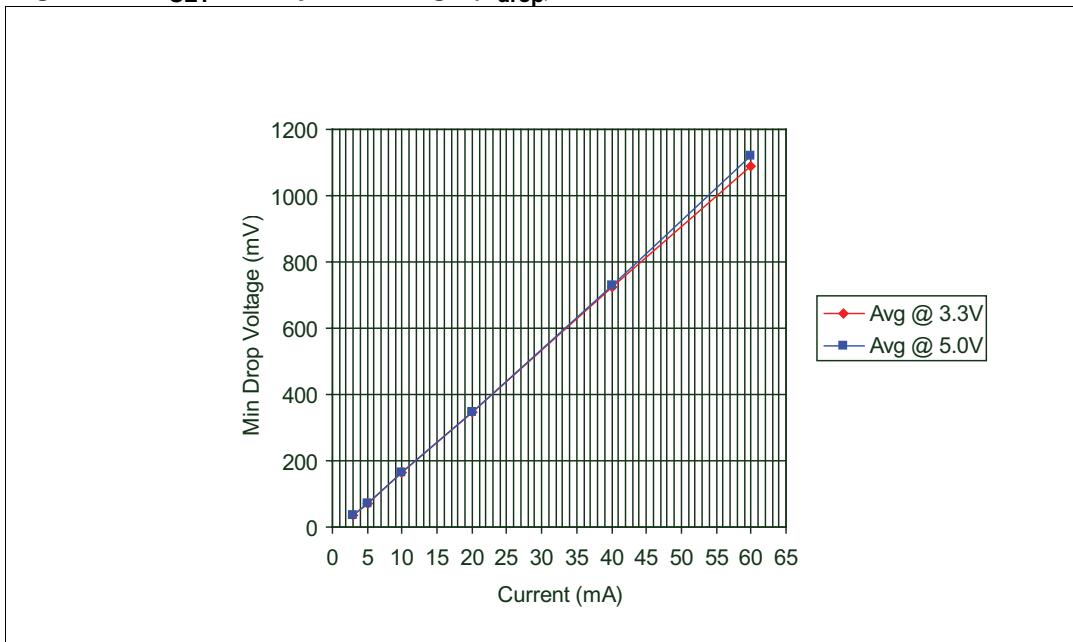


Table 10. Output current vs Rext resistor

R <sub>ext</sub> (Ω)	Output current (mA)
23700	1
11730	2
6930	3
4090	5
2025	10
1000	20
667	30
497	40
331	60

**Figure 12. Output current vs  $\pm \Delta I_{OL}(\%)$  (temp. = 25 °C, Vdd = 5 V, pin = all outputs)****Figure 13. I<sub>SET</sub> vs drop out voltage (V<sub>drop</sub>)**

**Table 11.** I<sub>SET</sub> vs drop out voltage (V<sub>drop</sub>)

Vdd (V)	Iset (mA)	Min (mV)	Max (mV)	Avg (mV)	Vdd (V)	Iset (mA)	Min (mV)	Max (mV)	Avg (mV)
3.3	3	35	37	36	5.0	3	37	37	37
	5	71	72	71		5	72	73	72
	10	162	165	163		10	162	164	163
	20	347	348	347		20	345	347	346
	40	724	724	724		40	725	728	726
	60	1080	1090	1080		60	1090	1140	1110

## 7 Test circuit

Figure 14. DC characteristic

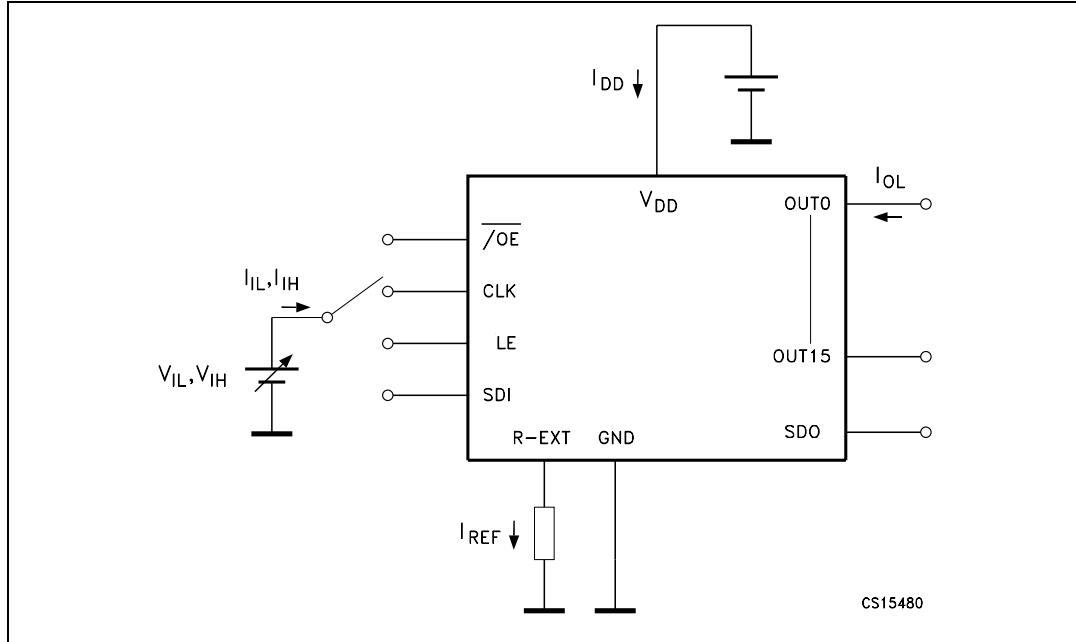
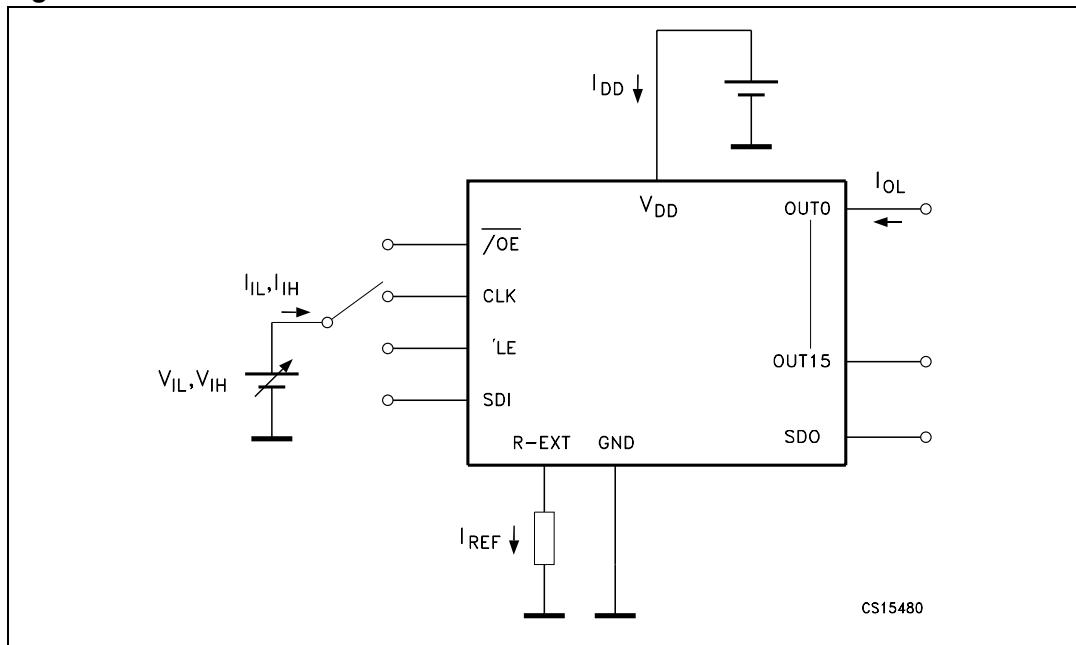
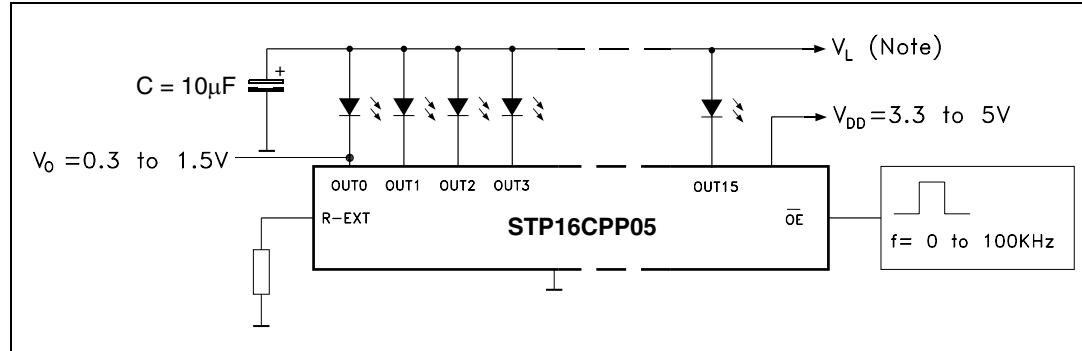


Figure 15. AC characteristic



**Figure 16.** Typical application schematic

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

Test condition: Temp. = 25 °C,  $V_{DD} = 3.3$  V,  $V_{IN} = V_{DD}$ ,  $C_L = 10$  pF, Freq. = 1 MHz,  
 Ch1 = CLK, Ch2 = SDI, Ch3 = OUTn, Ch4 =  $V_{OUT}$

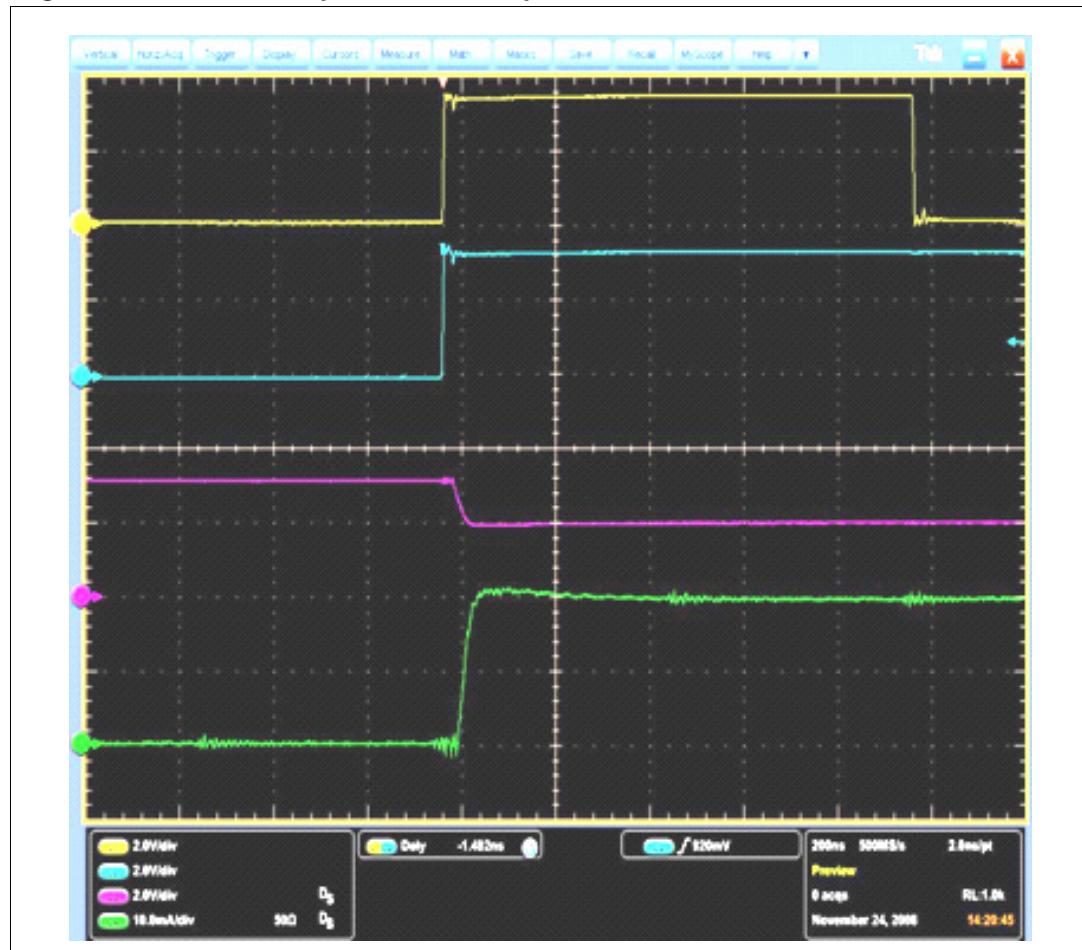
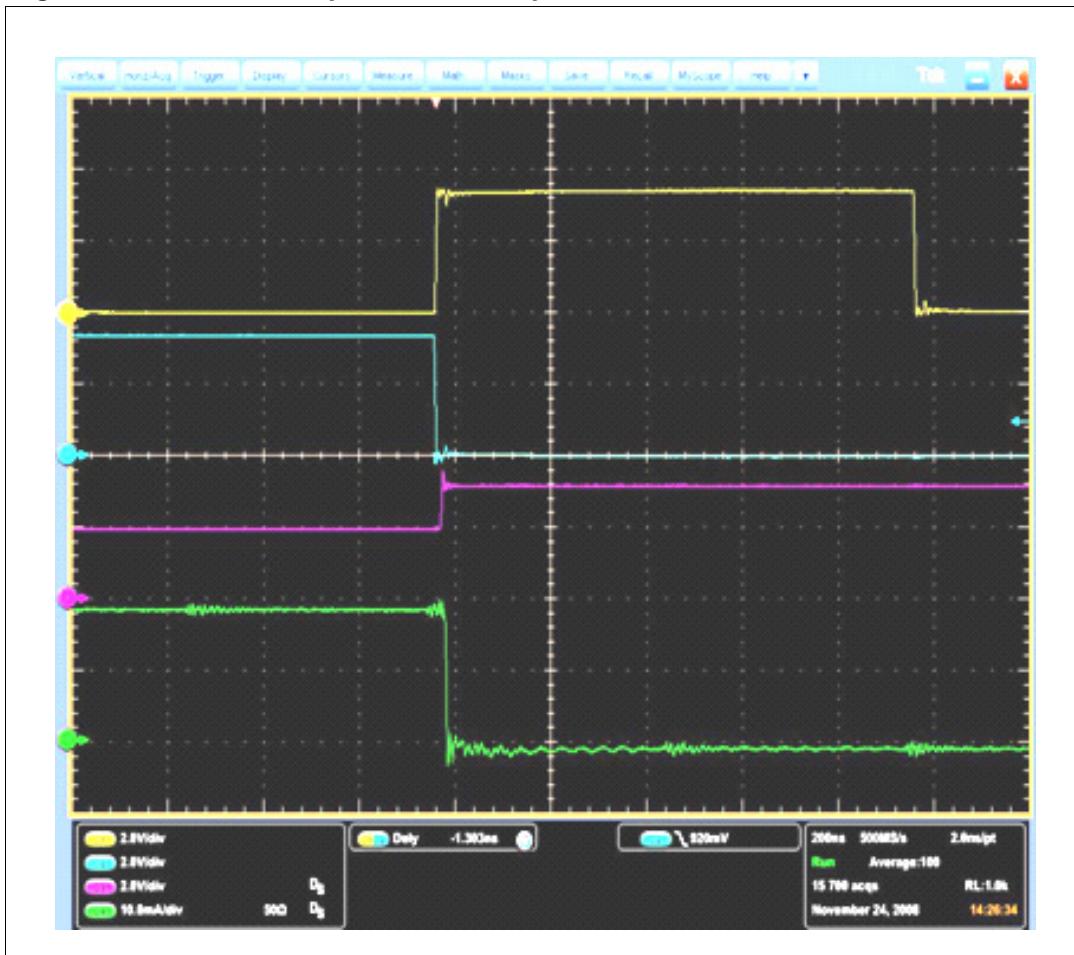
**Figure 17.** Turn ON output current setup

Figure 18. Turn OFF output current setup



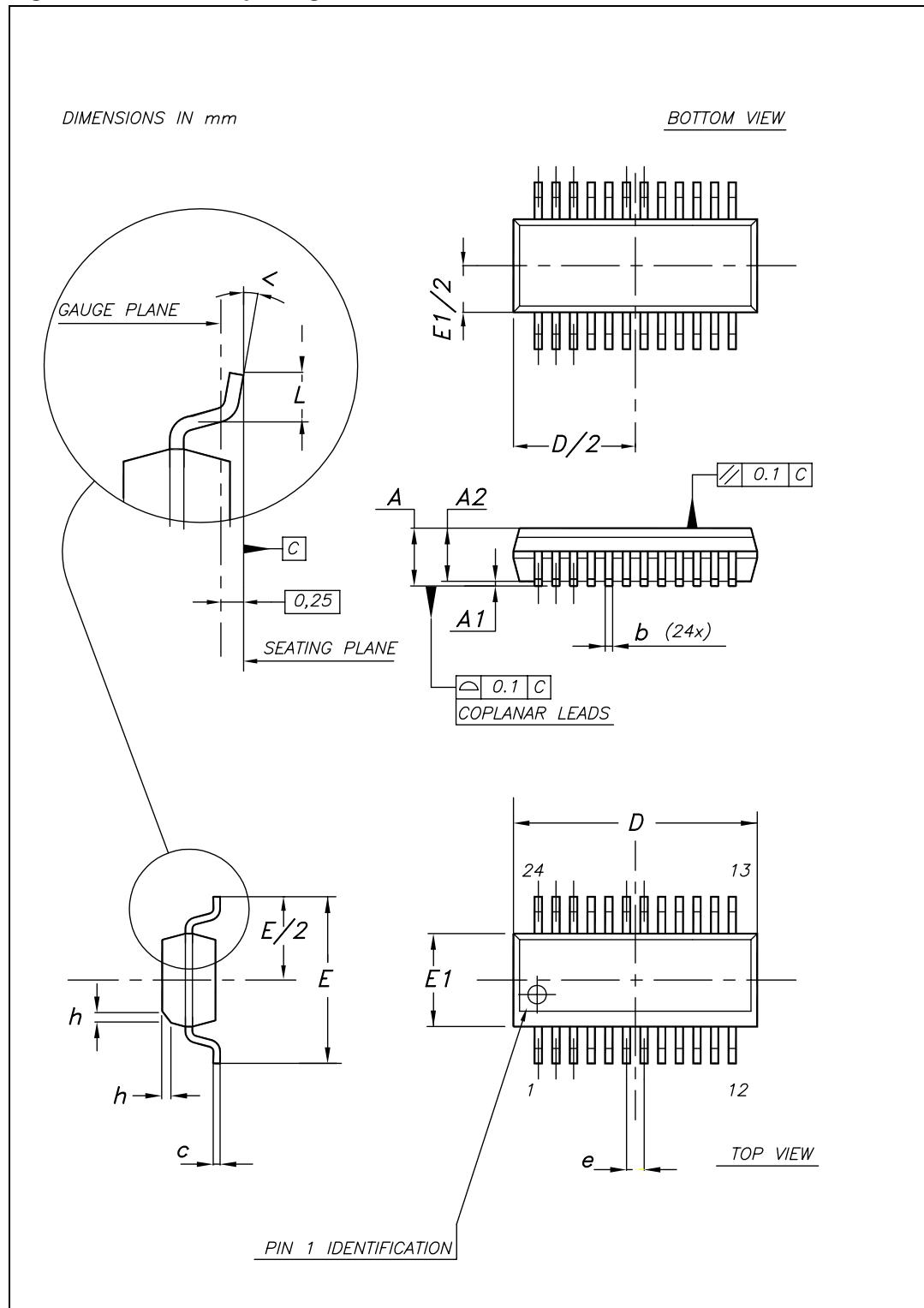
## 8 Package mechanical data

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.

**Table 12. QSOP-24 mechanical data**

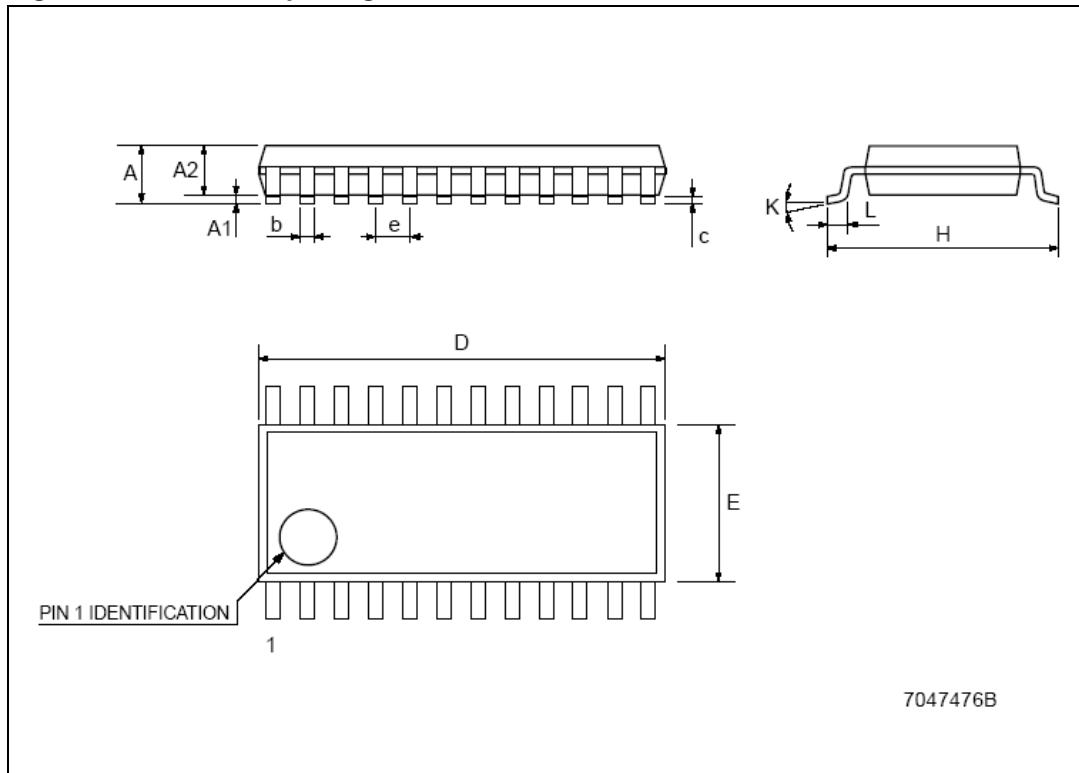
Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A	1.54	1.62	1.73	0.061	0.064	0.068
A1	0.1	0.15	0.25	0.004	0.006	0.010
A2		1.47			0.058	
b	0.31	0.2		0.012	0.008	
c	0.254	0.17		0.010	0.007	
D	8.56	8.66	8.76	0.337	0.341	0.345
E	5.8	6	6.2	0.228	0.236	0.244
E1	3.8	3.91	4.01	0.150	0.154	0.158
e		0.635			0.025	
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 19. QSOP-24 package dimensions



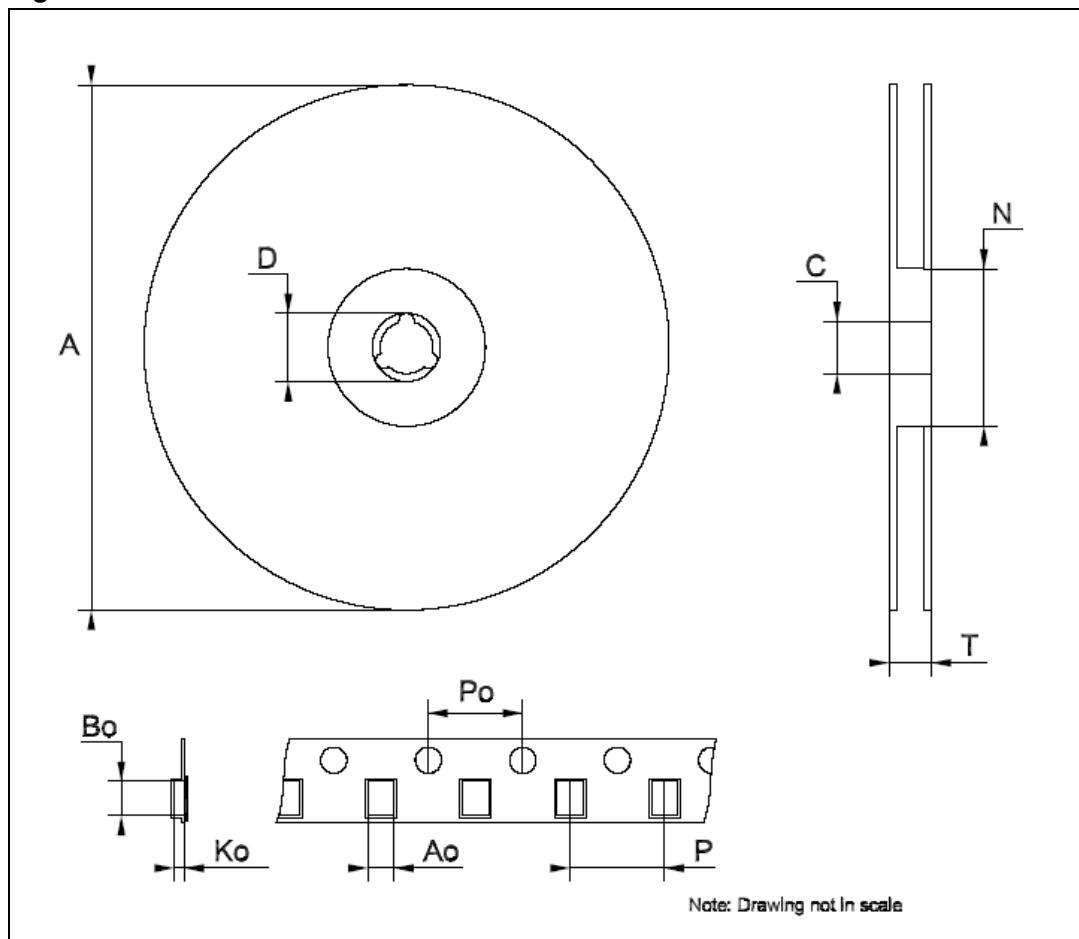
**Table 13.** TSSOP24 mechanical data

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 20.** TSSOP24 package dimensions

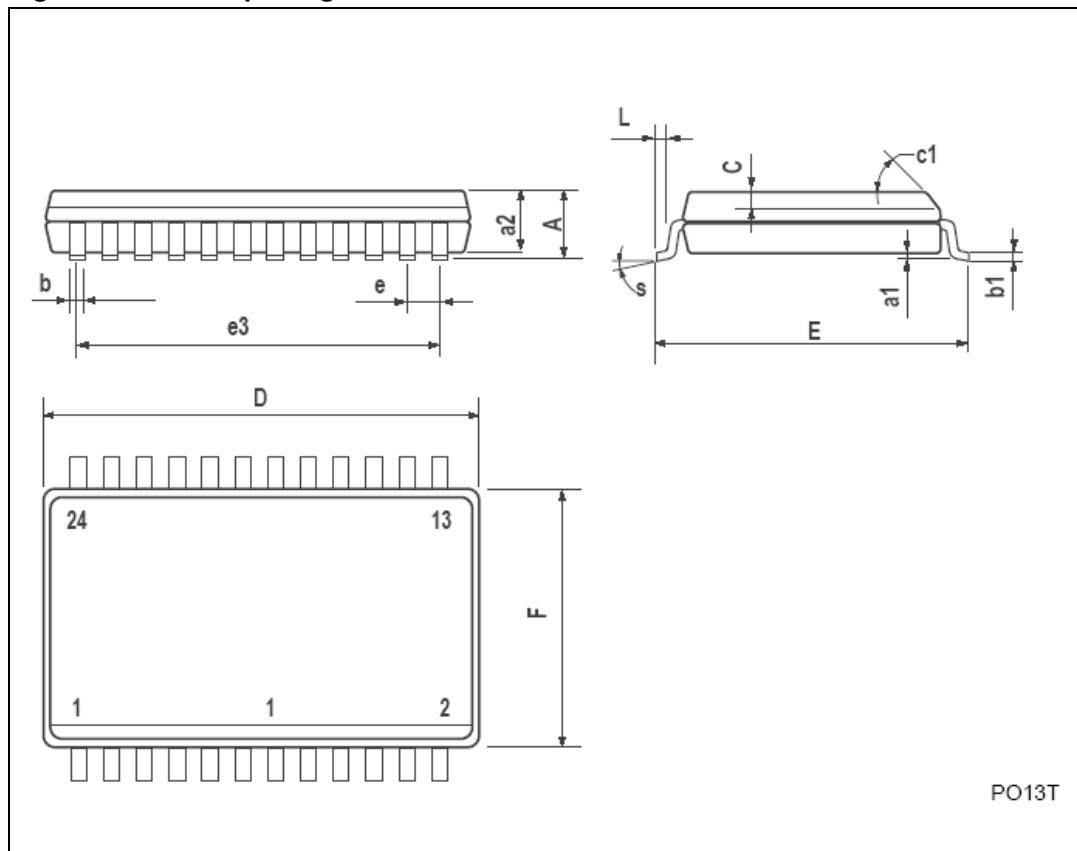
**Table 14. Tape and reel TSSOP24**

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			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 21. Reel dimensions**

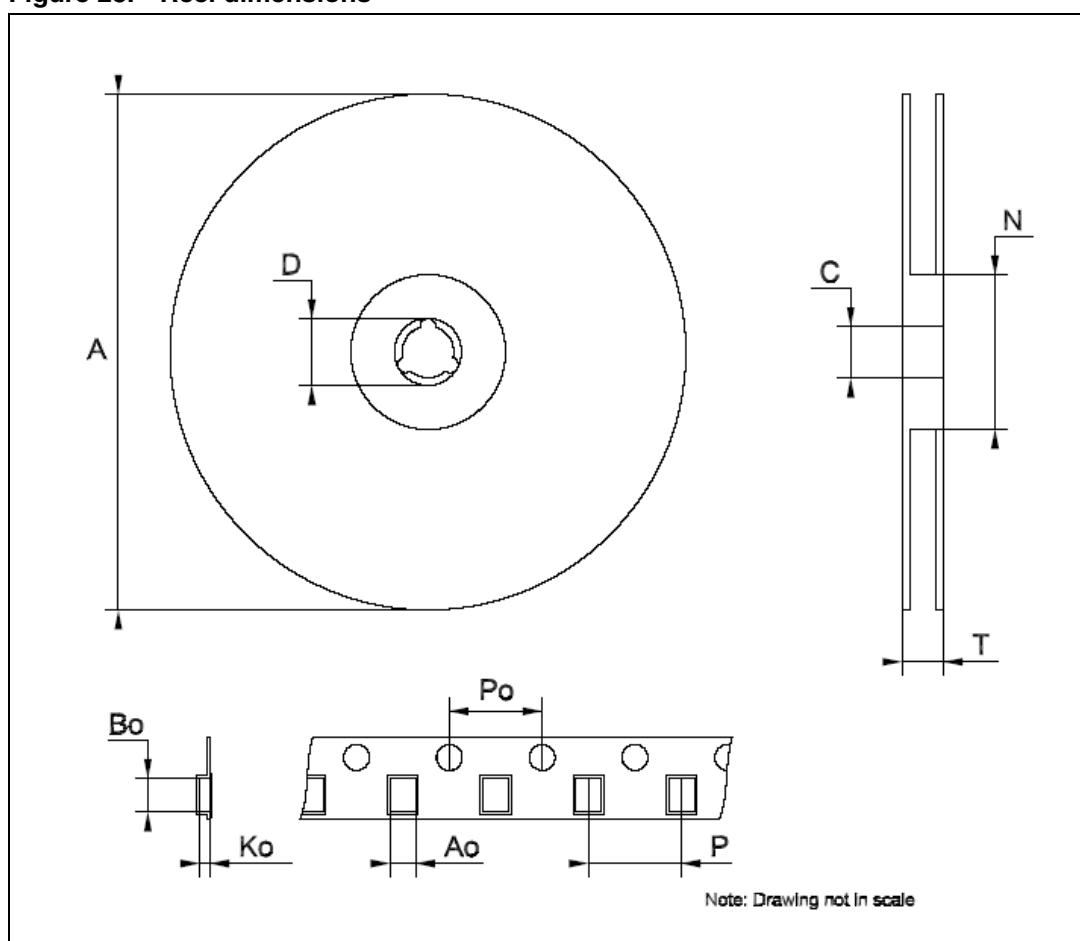
**Table 15.** SO-24 mechanical data

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 22.** SO-24 package dimensions

**Table 16. Tape and reel SO-24**

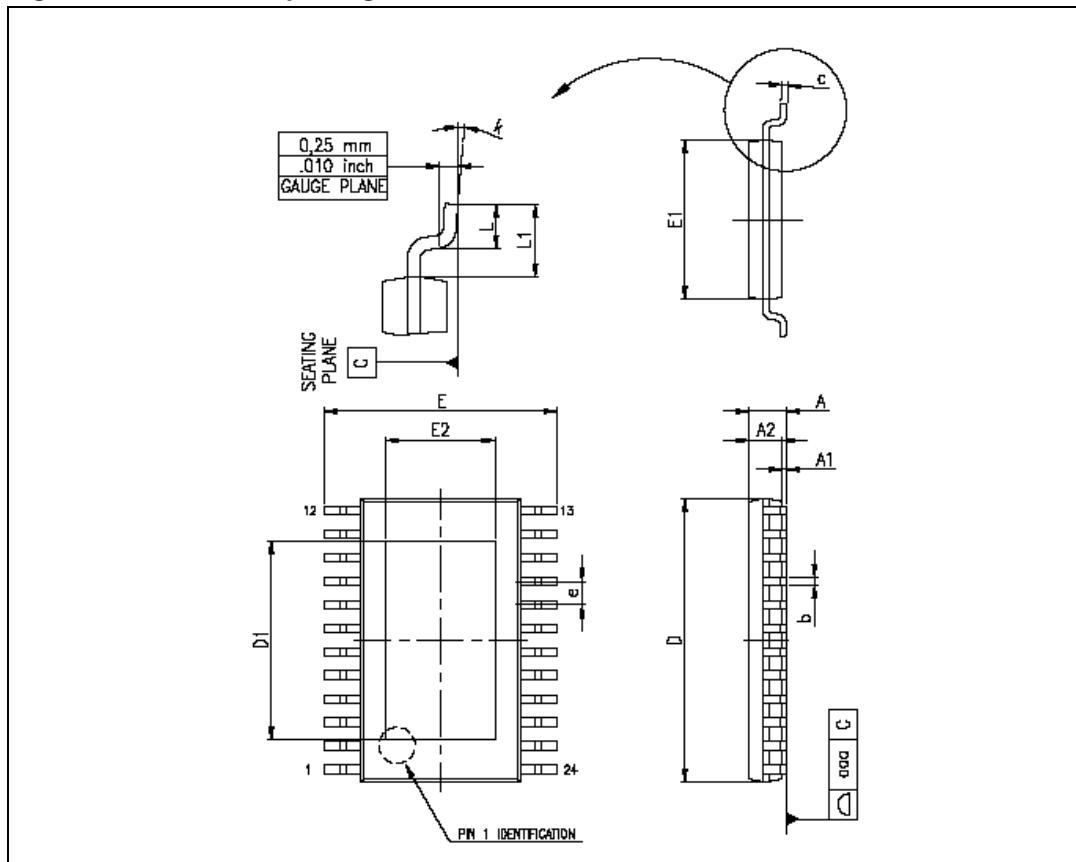
Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A		-	330		-	12.992
C	12.8	-	13.2	0.504	-	0.519
D	20.2	-		0.795	-	
N	60	-		2.362	-	
T		-	30.4		-	1.197
Ao	10.8	-	11.0	0.425	-	0.433
Bo	15.7	-	15.9	0.618	-	0.626
Ko	2.9	-	3.1	0.114	-	0.122
Po	3.9	-	4.1	0.153	-	0.161
P	11.9	-	12.1	0.468	-	0.476

**Figure 23. Reel dimensions**

**Table 17. TSSOP24 mechanical data 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 24. TSSOP24 package dimensions



## 9 Revision history

**Table 18. Document revision history**

Date	Revision	Changes
11-Feb-2009	1	First release
22-Oct-2009	2	Updated <a href="#">Figure 11 on page 13</a> and <a href="#">Figure 10 on page 13</a> .

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