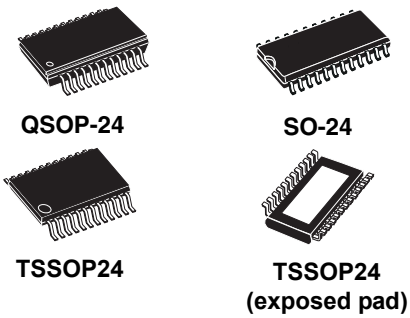
STP16CP05

Low voltage 16-bit constant current LED sink driver

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
- Can be driven by a 3.3 V microcontroller
- Output current: 5-100 mA
- Max clock frequency 30 MHz
- ESD protection 2 kV HBM, 200 V MM



Description

The STP16CP05 is a monolithic, low voltage, low current power 16-bit shift register designed for LED panel displays. The STP16CP05 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 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 STP16CP05 output current.

The STP16CP05 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
STP16CP05MTR	SO-24	1000 parts per reel
STP16CP05TTR	TSSOP24	2500 parts per reel
STP16CP05XTTR	TSSOP24 exposed pad	2500 parts per reel
STP16CP05PTR	QSOP-24	2500 parts per reel

Contents

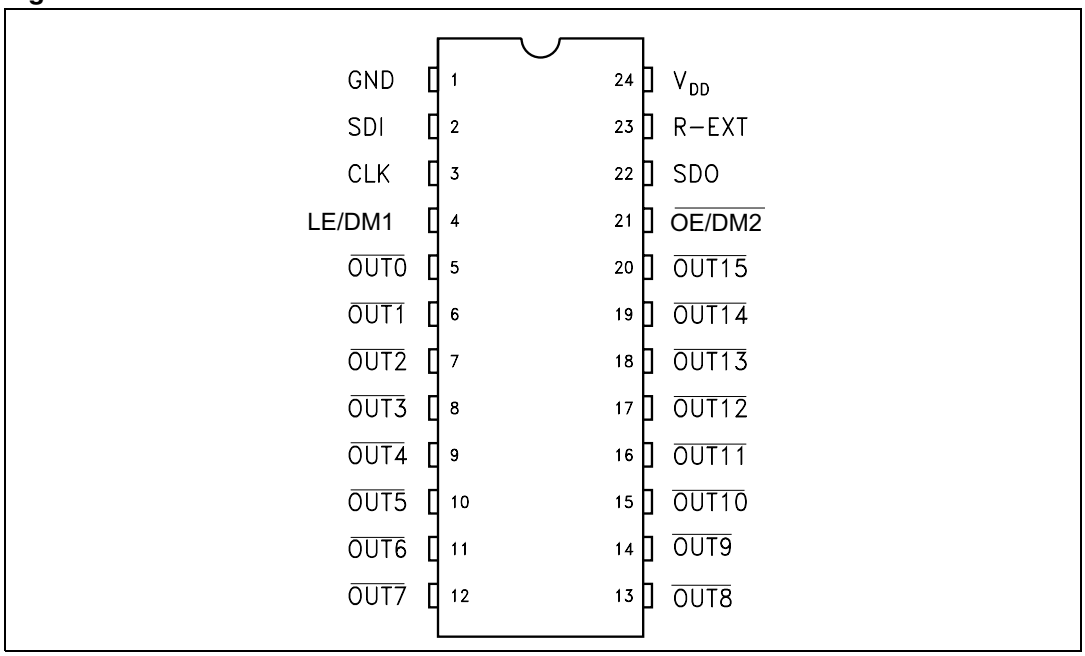
1 Summary description

Table 2. Typical current accuracy

Output voltage	Current accuracy		Output current	V_{DD}	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 2. 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/DM1	Latch input terminal
5-20	OUT 0-15	Output terminal
21	$\overline{OE/DM2}$	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	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	-40 to +170	°C

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-ambient (1)	SO-24	42.7	°C/W
		TSSOP24	55	°C/W
		TSSOP24(2) exposed pad	37.5	°C/W
		QSOP-24	55	°C/W

1. According with Jedec 51-7
2. The exposed pad should be soldered directly to the PCB to realize the thermal benefits.

2.3 Recommended operating conditions

T_A = 25 °C

Table 6. Recommended operating conditions

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	-	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/DM1 pulse width	V_{DD} = 3.3 V to 5.0 V	6	-		ns
t_{wCLK}	CLK pulse width		8	-		ns
t_{wEN}	$\overline{OE}$/DM2 pulse width		100	-		ns
$t_{SETUP(D)}$	Setup time for DATA		5	-		ns
$t_{HOLD(D)}$	Hold time for DATA		3	-		ns
$t_{SETUP(L)}$	Setup time for LATCH		18	-		ns
f_{CLK}	Clock frequency	Cascade operation (1) V_{DD} = 5 V		-	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 V to 5 V, T_A = 25 °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 V			1	µA
V_{OL}	Output voltage (Serial-OUT)	I_{OL} = 1 mA			0.4	V
V_{OH}	Output voltage (Serial-OUT)	I_{OH} = -1 mA	V_{DD}-0.4V			V
I_{OL1}	Output current	V_O = 0.3 V, R_{ext} = 4.2 kΩ	4.25	5	5.75	mA
I_{OL2}		V_O = 0.3 V, R_{ext} = 1 kΩ	19	20	21	
I_{OL3}		V_O = 1.3 V, R_{ext} = 200 Ω	96	100	104	
ΔI_{OL1}	Output current error between bit (All Output ON)	V_O = 0.3 V, R_{ext} = 4.2 kΩ		± 5	± 8	%
ΔI_{OL2}		V_O = 0.3 V, R_{ext} = 1 kΩ		± 1.5	± 3	
ΔI_{OL3}		V_O = 1.3 V, R_{ext} = 200 Ω		± 1.2	± 3	
$R_{SIN(up)}$	Pull-up resistor		150	300	600	kΩ
$R_{SIN(down)}$	Pull-down resistor		100	200	400	kΩ
$I_{DD(OFF1)}$	Supply current (OFF)	R_{EXT} = 1 kΩ OUT 0 to 15 = OFF		4		mA
$I_{DD(OFF2)}$		R_{EXT} = 250Ω OUT 0 to 15 = OFF		11.2		
$I_{DD(ON1)}$	Supply current (ON)	R_{EXT} = 1 kΩ OUT 0 to 15 = ON		4.5		
$I_{DD(ON2)}$		R_{EXT} = 250Ω OUT 0 to 15 = ON		11.7		
Thermal	Thermal protection			170		°C

V_{DD} = 5 V, T = 25 °C, unless otherwise specified

Table 8. Switching characteristics

Symbol	Parameter	Test conditions			Min.	Typ.	Max.	Unit
t_{PLH1}	Propagation delay time, CLK-$\overline{OUTn}$, LE/DM1 = H, $\overline{OE/DM2}$ = L	V_{IH} = V_{DD} V_{IL} = GND I_O = 20 mA R_{EXT} = 1 KΩ	C_L = 10 pF V_L = 3.0 V R_L = 60 Ω	V_{DD} = 3.3 V	-	45	74	ns
				V_{DD} = 5 V	-	24	38	
t_{PLH2}	Propagation delay time, LE/DM1-$\overline{OUTn}$, $\overline{OE/DM2}$ = L			V_{DD} = 3.3 V	-	48	77	ns
				V_{DD} = 5 V	-	27	46	
t_{PLH3}	Propagation delay time, $\overline{OE/DM2}$-$\overline{OUTn}$, LE/DM1 = H			V_{DD} = 3.3 V	-	75	128	ns
				V_{DD} = 5 V	-	43	64	
t_{PLH}	Propagation delay time, CLK-SDO			V_{DD} = 3.3 V	-	19	28	ns
				V_{DD} = 5 V	-	11	16.5	
t_{PHL1}	Propagation delay time, CLK-$\overline{OUTn}$, LE/DM1 = H, $\overline{OE/DM2}$ = L			V_{DD} = 3.3 V	-	15	23	ns
				V_{DD} = 5 V	-	10	14	
t_{PHL2}	Propagation delay time, LE/DM1-$\overline{OUTn}$, $\overline{OE/DM2}$ = L			V_{DD} = 3.3 V	-	13	18.5	ns
				V_{DD} = 5 V	-	9	12	
t_{PHL3}	Propagation delay time, $\overline{OE/DM2}$-$\overline{OUTn}$, LE/DM1 = H			V_{DD} = 3.3 V	-	17	24.5	ns
				V_{DD} = 5 V	-	14	19.5	
t_{PHL}	Propagation delay time, CLK-SDO			V_{DD} = 3.3 V	-	23	35	ns
				V_{DD} = 5 V	-	14	21	
t_{ON}	Output rise time 10~90% of voltage waveform			V_{DD} = 3.3 V	-	35	68	ns
				V_{DD} = 5 V	-	21	31.5	
t_{OFF}	Output fall time 90~10% of voltage waveform			V_{DD} = 3.3 V	-	10.5	15	ns
				V_{DD} = 5 V	-	11	15.5	
t_r	CLK rise time (1)				-		5000	ns
t_f	CLK fall time (1)				-		5000	ns

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

4 Equivalent circuit and outputs

Figure 3. $\overline{\text{OE/DM2}}$ terminal

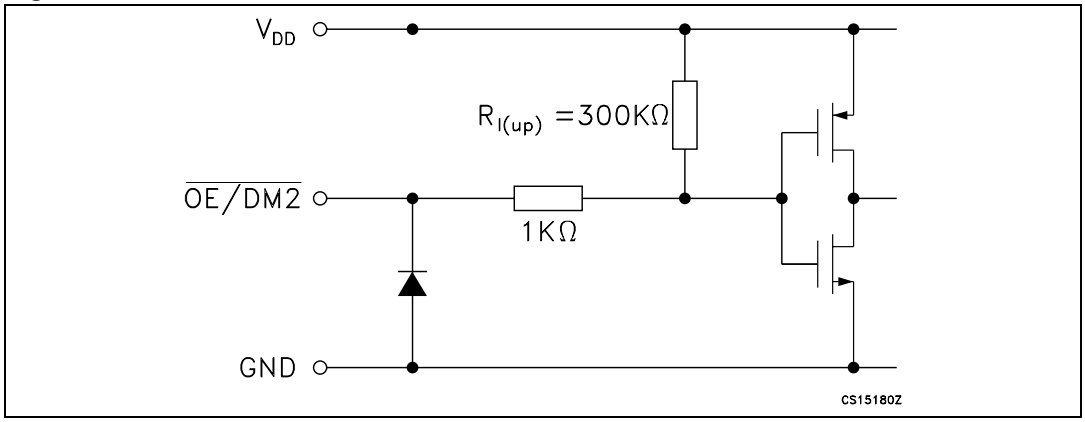


Figure 4. LE/DM1 terminal

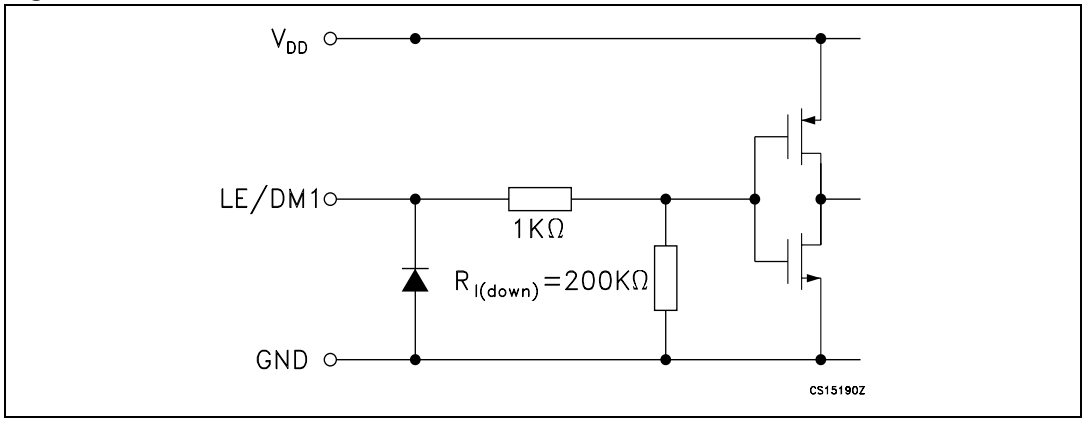


Figure 5. CLK, SDI terminal

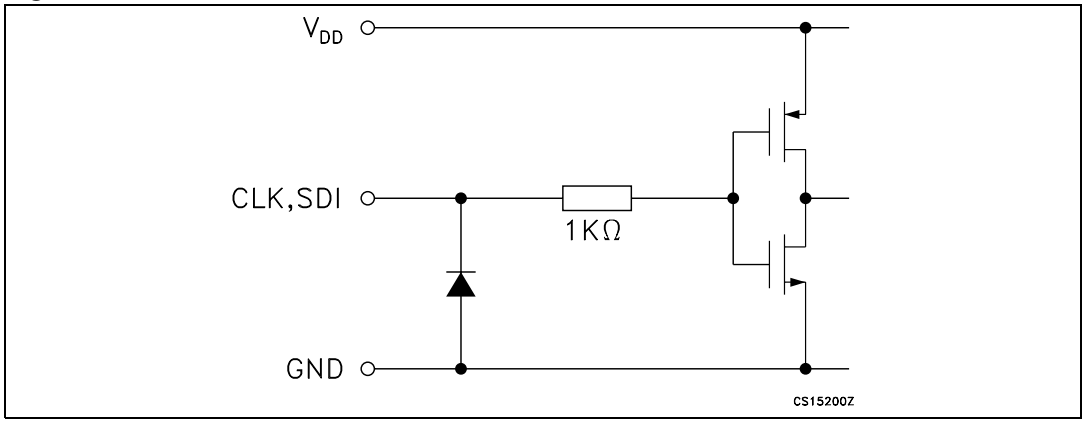


Figure 6. SDO terminal

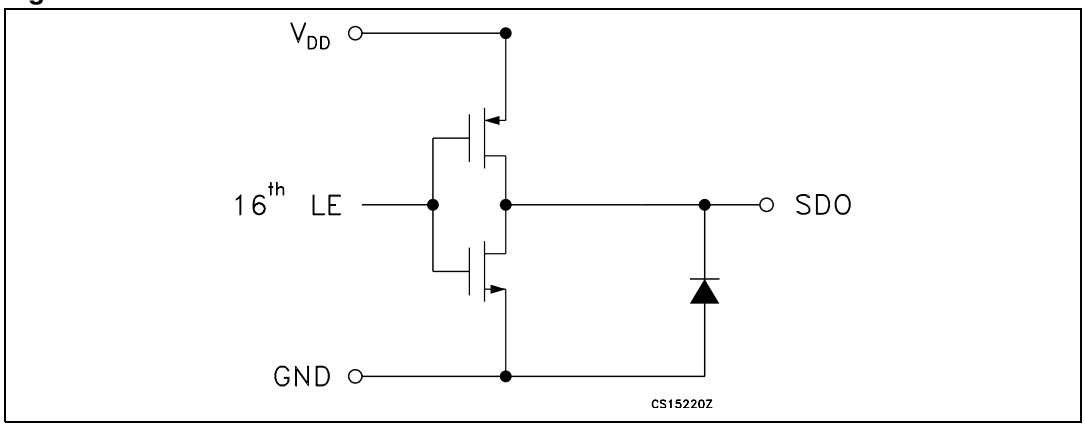
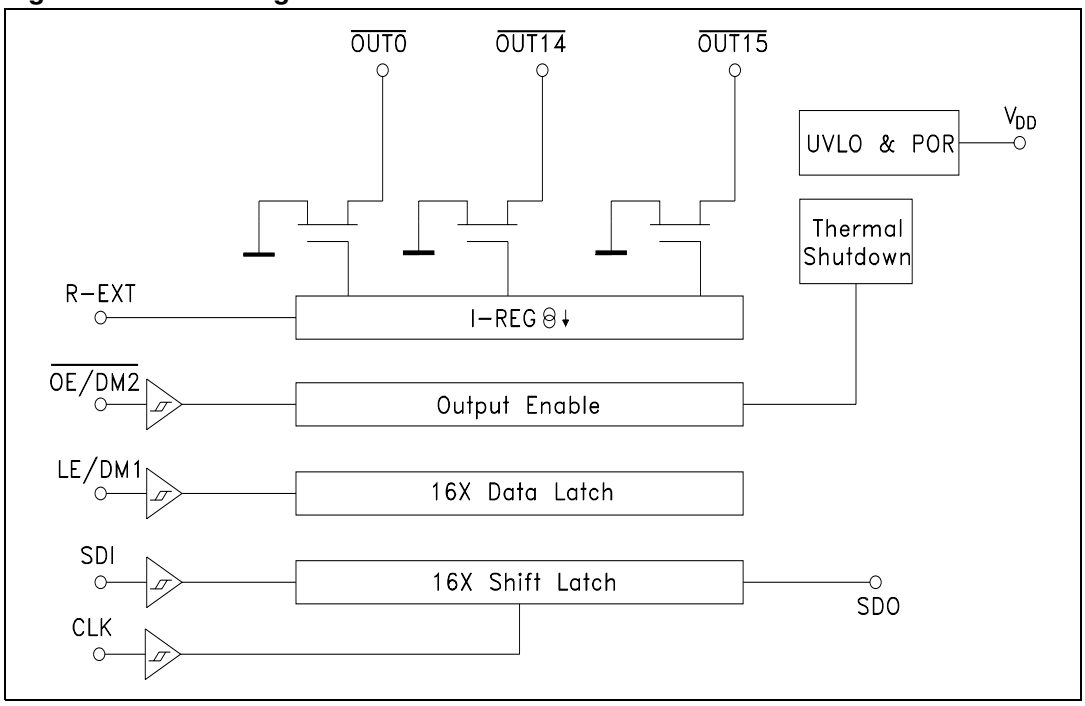


Figure 7. Block diagram



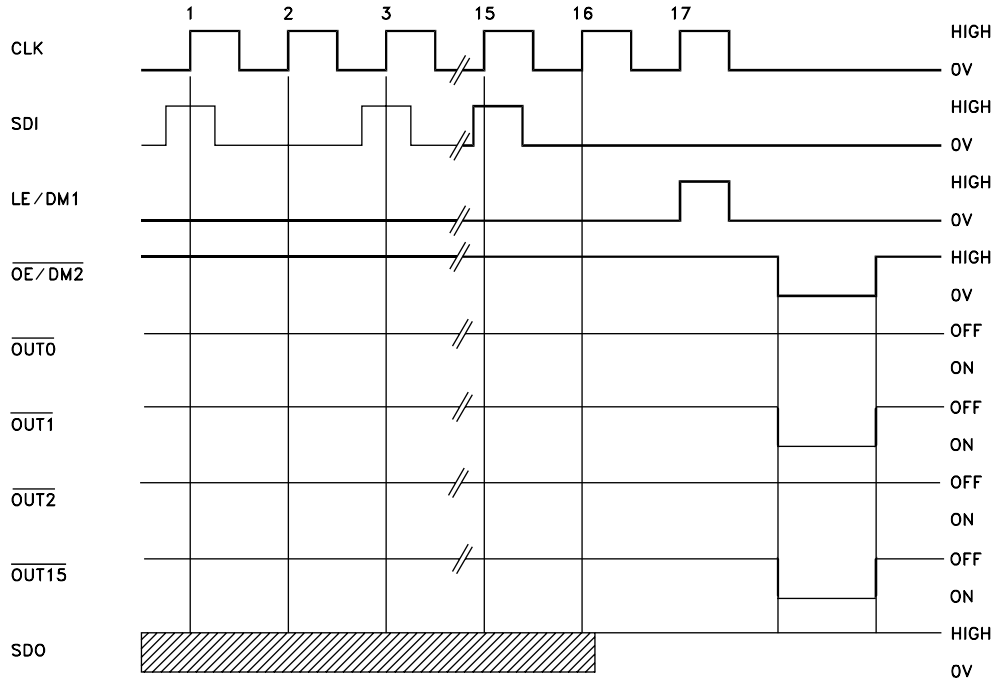
5 Timing diagrams

Table 9. Truth table

CLOCK	LE/DM1	$\overline{OE}$/DM2	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 8. Timing diagram



Note: 1 Latch and Output Enable are level sensitive and ARE NOT synchronized with rising-or-falling edge of CLK signal.

2 When LE/DM1 terminal is low level, the latch circuits hold previous set of data

3 When LE/DM1 terminal is high level, the latch circuits refresh new set of data from SDI chain.

4 When $\overline{OE}$/DM2 terminal is low level, the output terminals - Out0 to Out15 respond to data in the latch circuits, either '1' for ON or '0' for OFF

5 When $\overline{OE}$/DM2 terminal is at high level, all output terminals will be switched OFF.

Figure 9. Clock, serial-in, serial-out

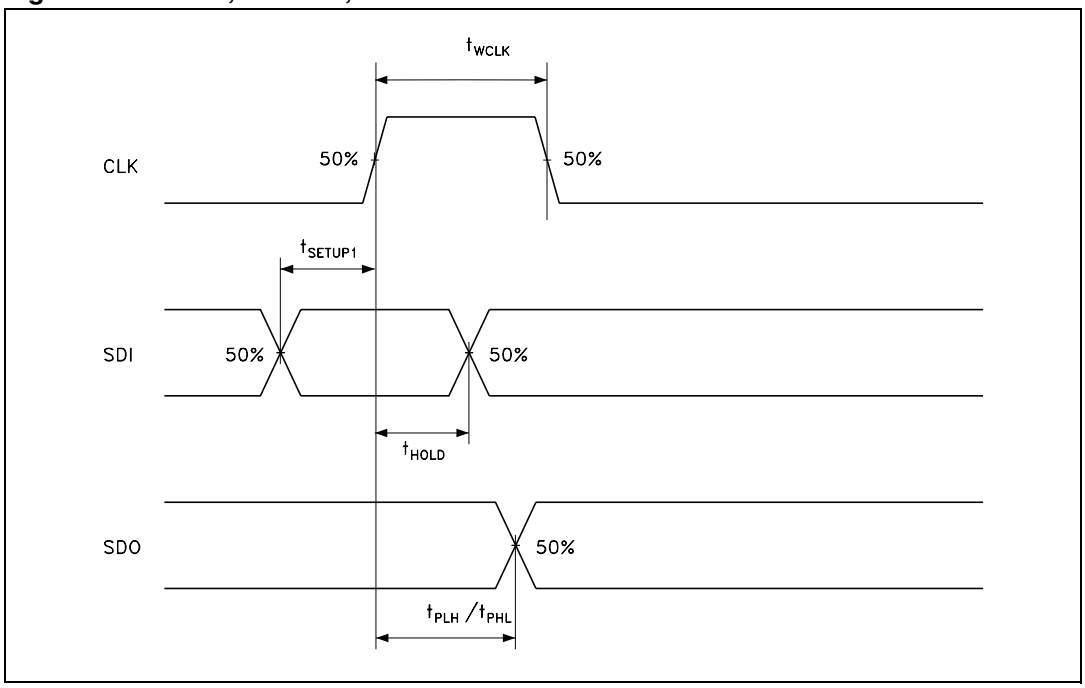


Figure 10. Clock, serial-in, latch, enable, outputs

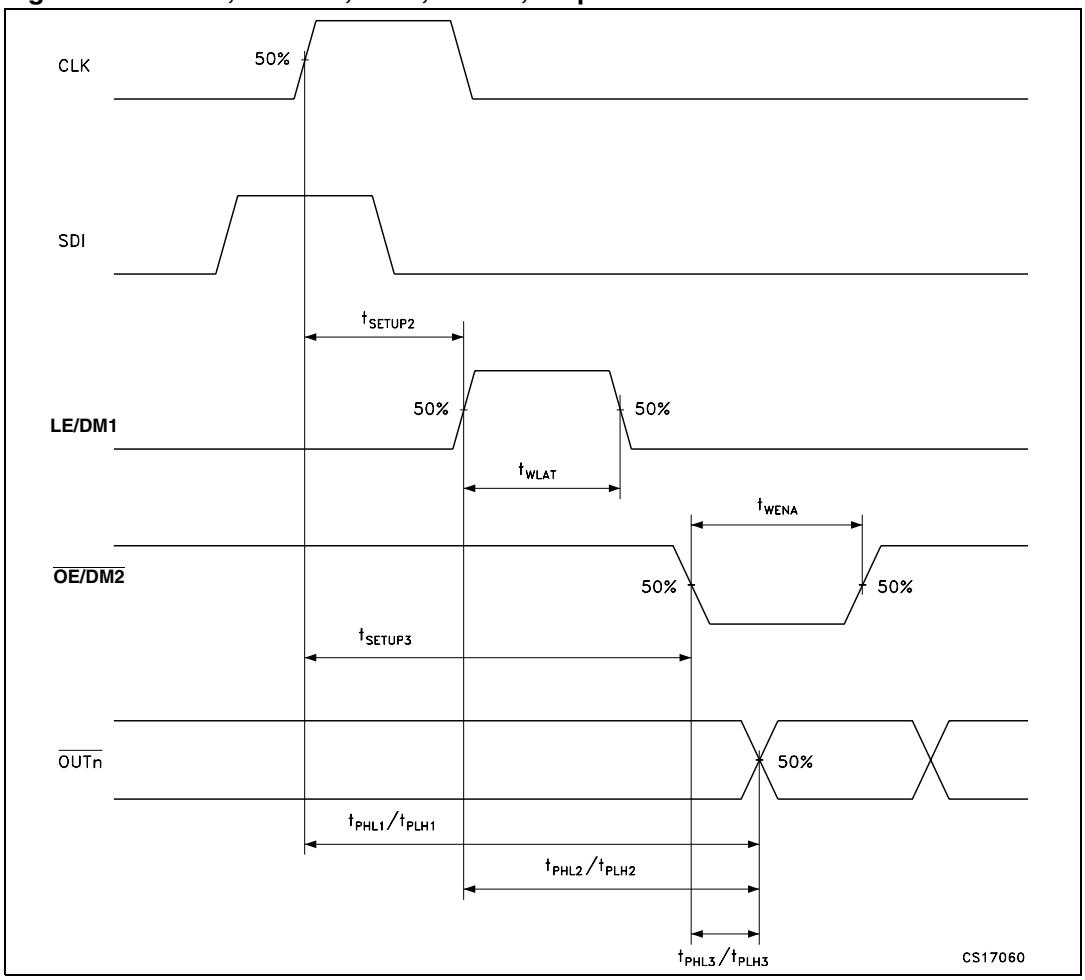
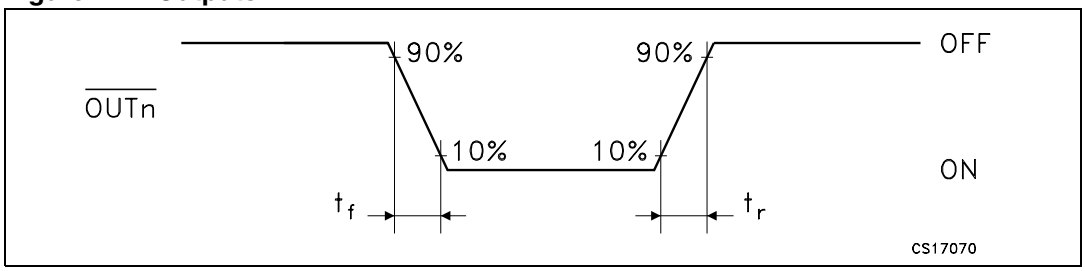


Figure 11. Outputs



6 Typical characteristics

Figure 12. Output current-R_{EXT} resistor

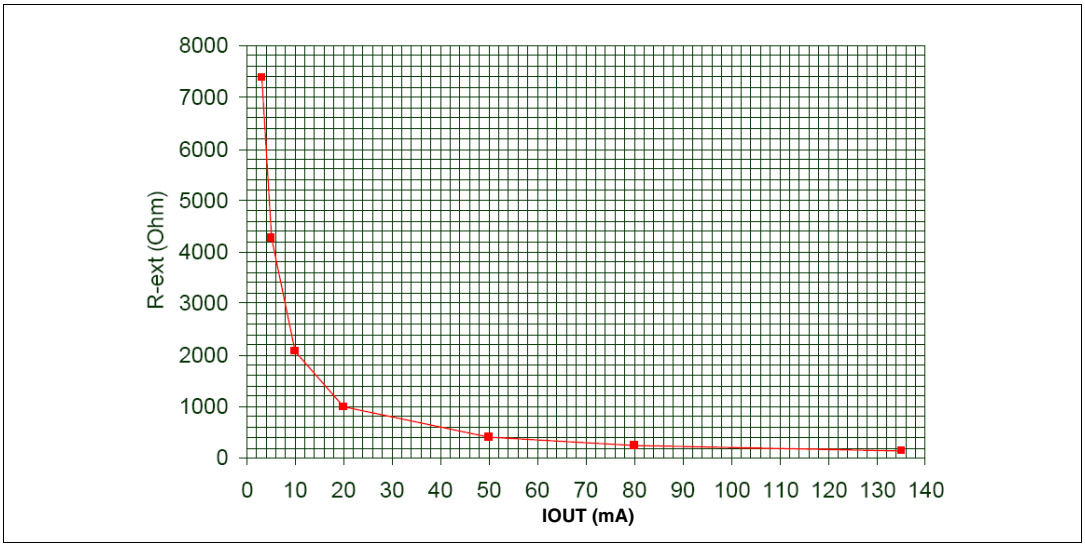


Table 10. Output current-R-EXT resistor

R-EXT (Ω)	Output current (mA)
7370	3
4270	5
2056	10
1006	20
382	50
251	80
200	100

Figure 13. Output current vs $\pm \Delta I_{OL}$(%) T_A = 25 °C

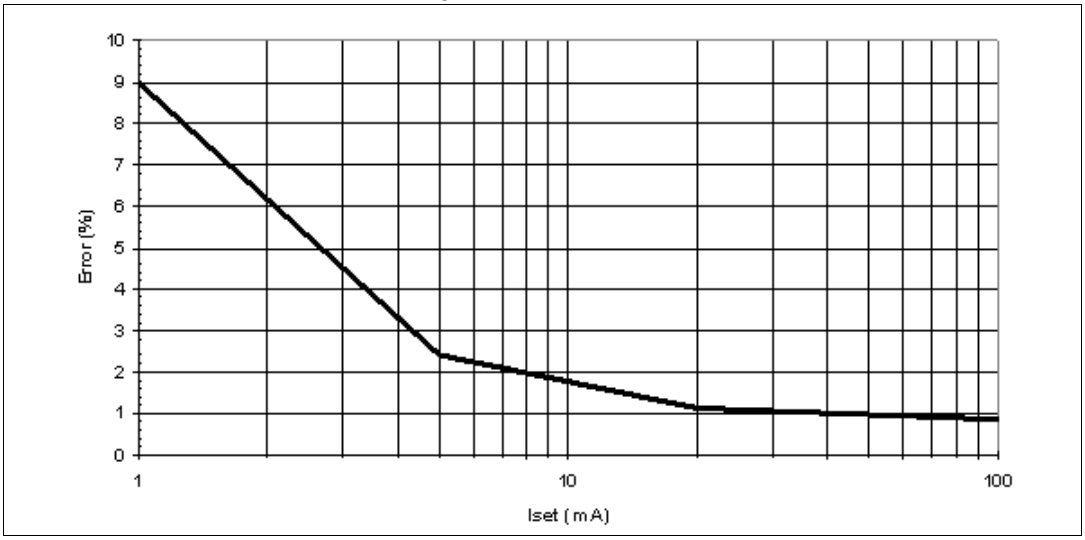


Figure 14. I_{SET} vs drop out voltage (V_{drop}) T_A = 25 °C

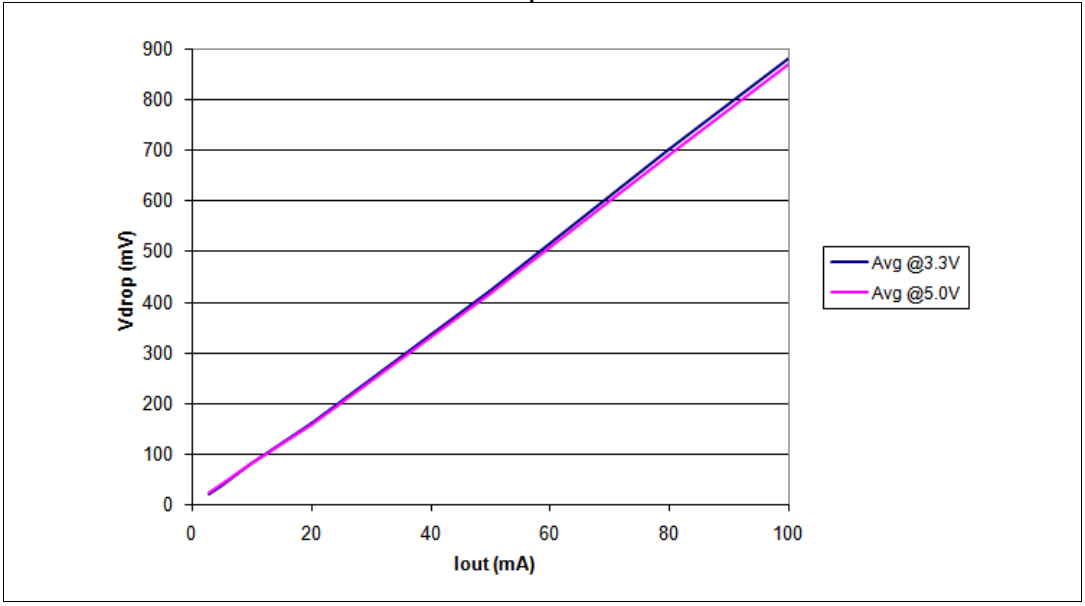
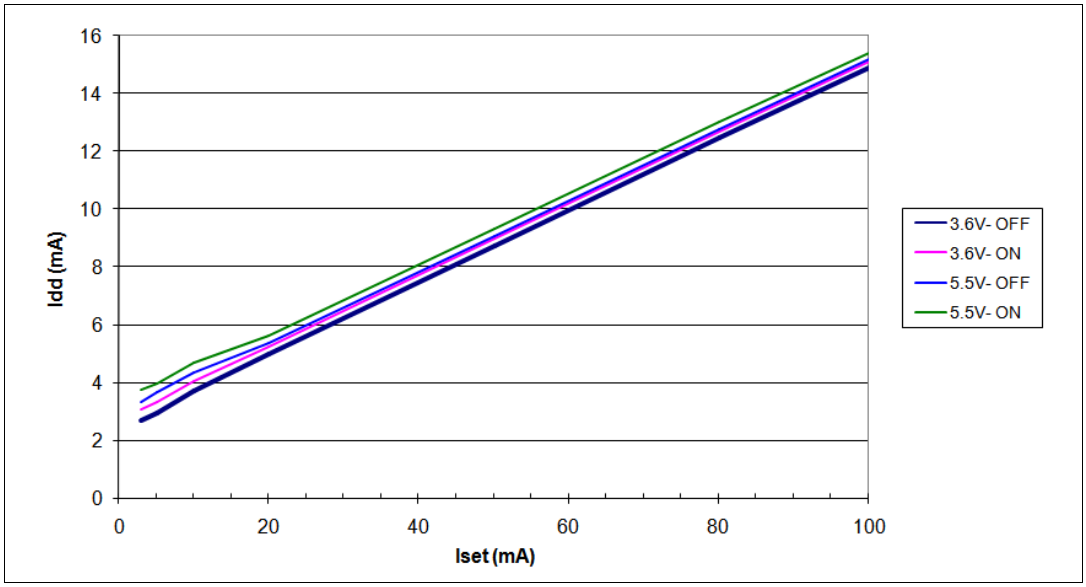


Table 11. I_{SET} vs drop out voltage (V_{drop})

Iout (mA)	Avg @3.3 V	Avg @5.0 V
3	20	22
5	37	40
10	79	79
20	160	158
50	422	415
80	700	690
100	880	870

Figure 15. I_{DD} ON/OFF, T_A = 25 °C



7 Test circuit

Figure 16. DC characteristic

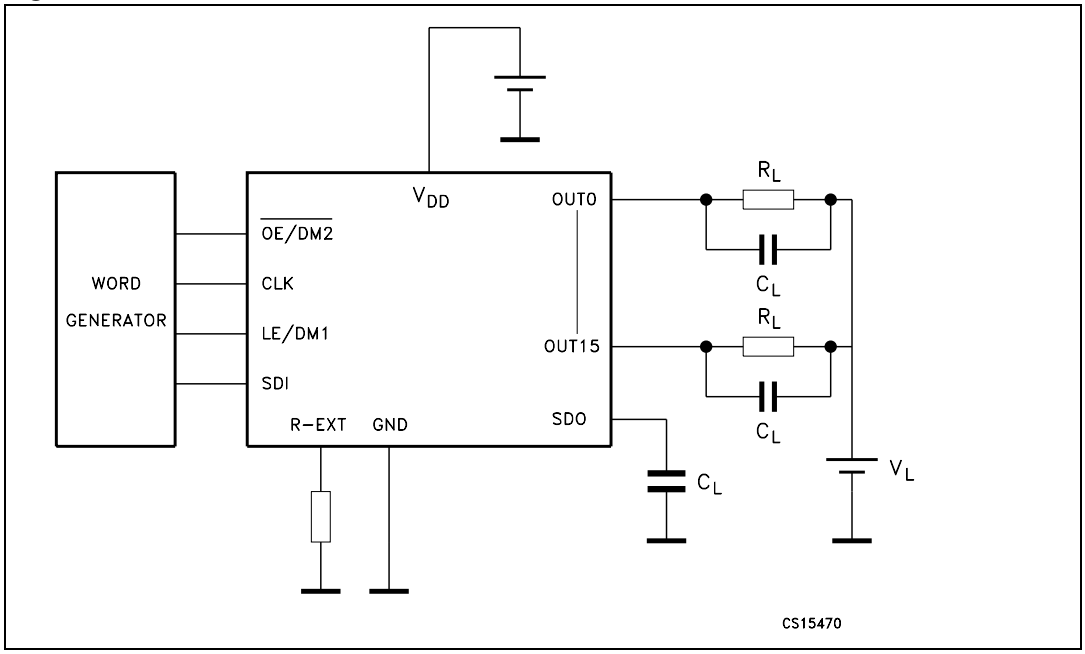


Figure 17. AC characteristic

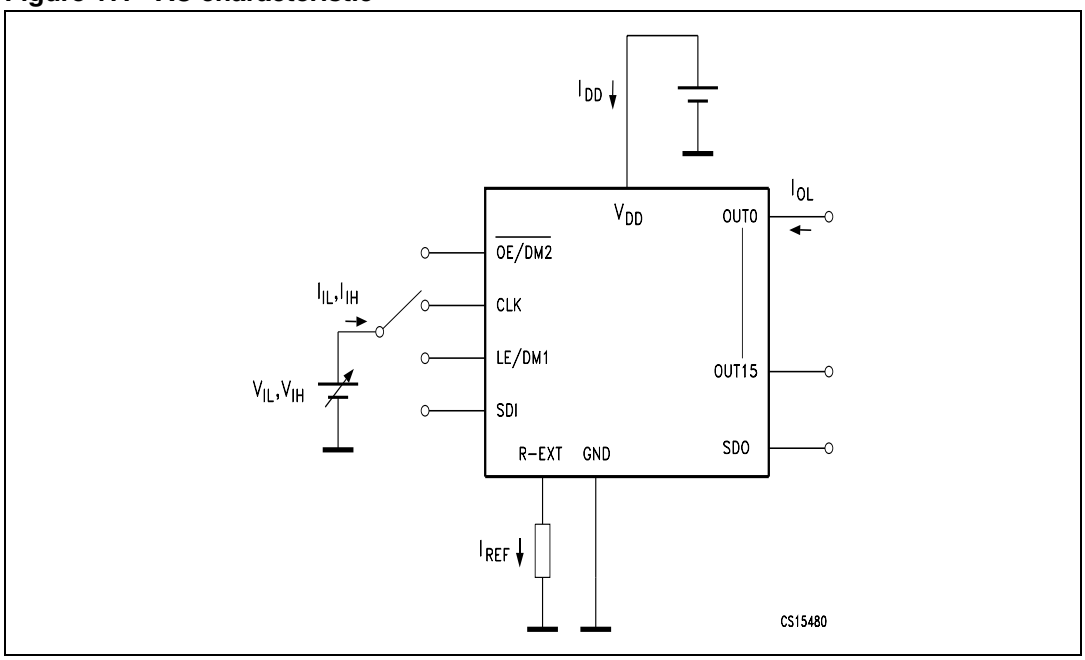
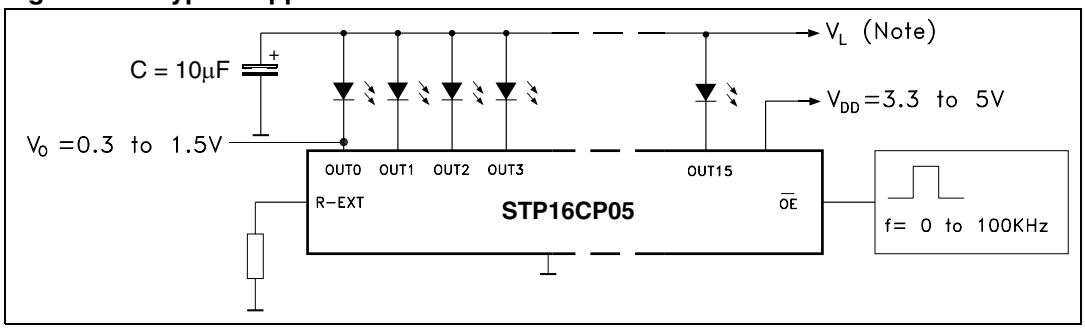


Figure 18. Typical application schematic



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

Test condition: Temp. = 25 °C, V_{DD} = 3.0 V, V_{IN} = V_{DD}, C_L = 10 pF, Freq. = 1 MHz, Ch1 = $\overline{OE}$/DM2, Ch2 = SDI, Ch3 = V_{OUT}, Ch4 = I_{OUT}

Figure 19. Turn ON output current setup

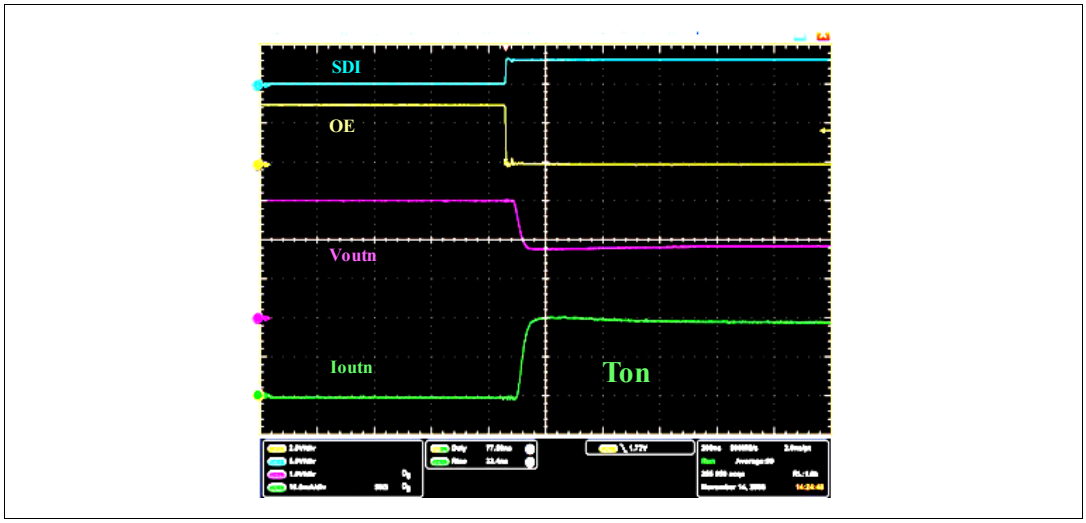
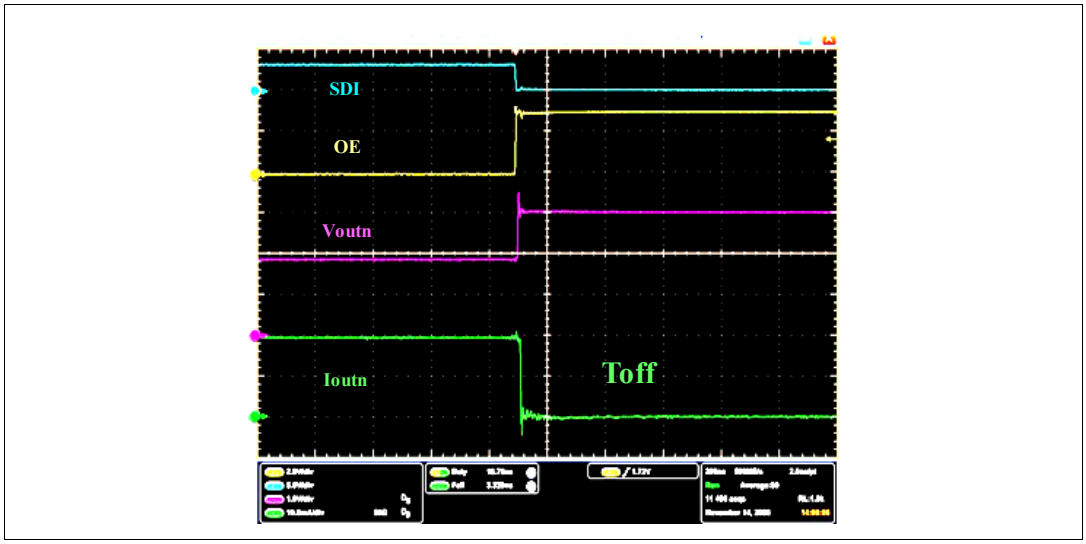


Figure 20. Turn OFF output current setup



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. 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 21. QSOP-24 package dimensions

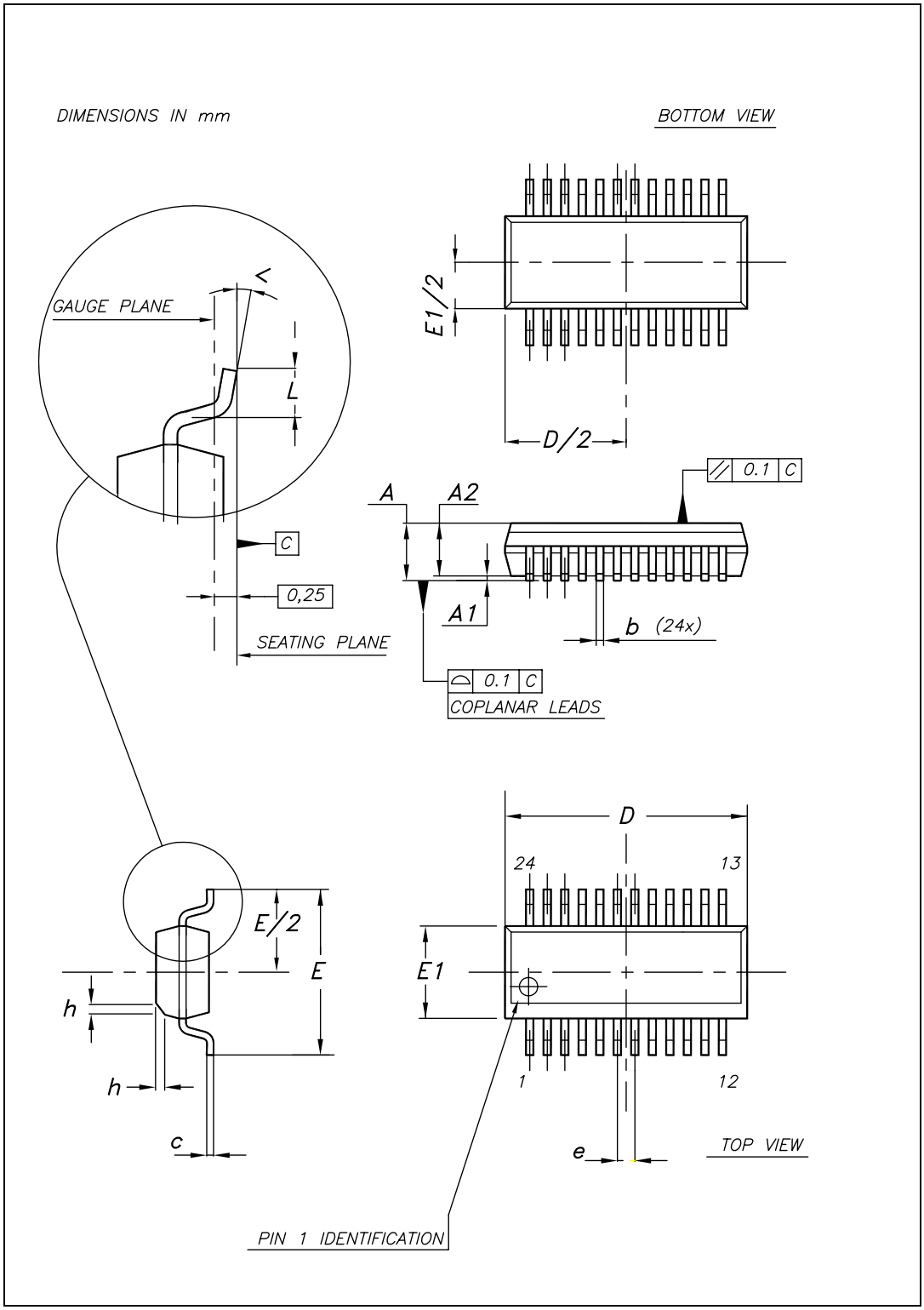


Table 13. QSOP-24 tape and reel

Dim.	mm.			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
R1	12.8	13	13.5	5.039	5.118	5.315
R2		330			129.921	
R3		100			39.37	
eint		16.4			6.457	
e1	1.5	2	2.5	0.591	0.787	0.984

Table 14. QSOP-24 tape and reel dimensions

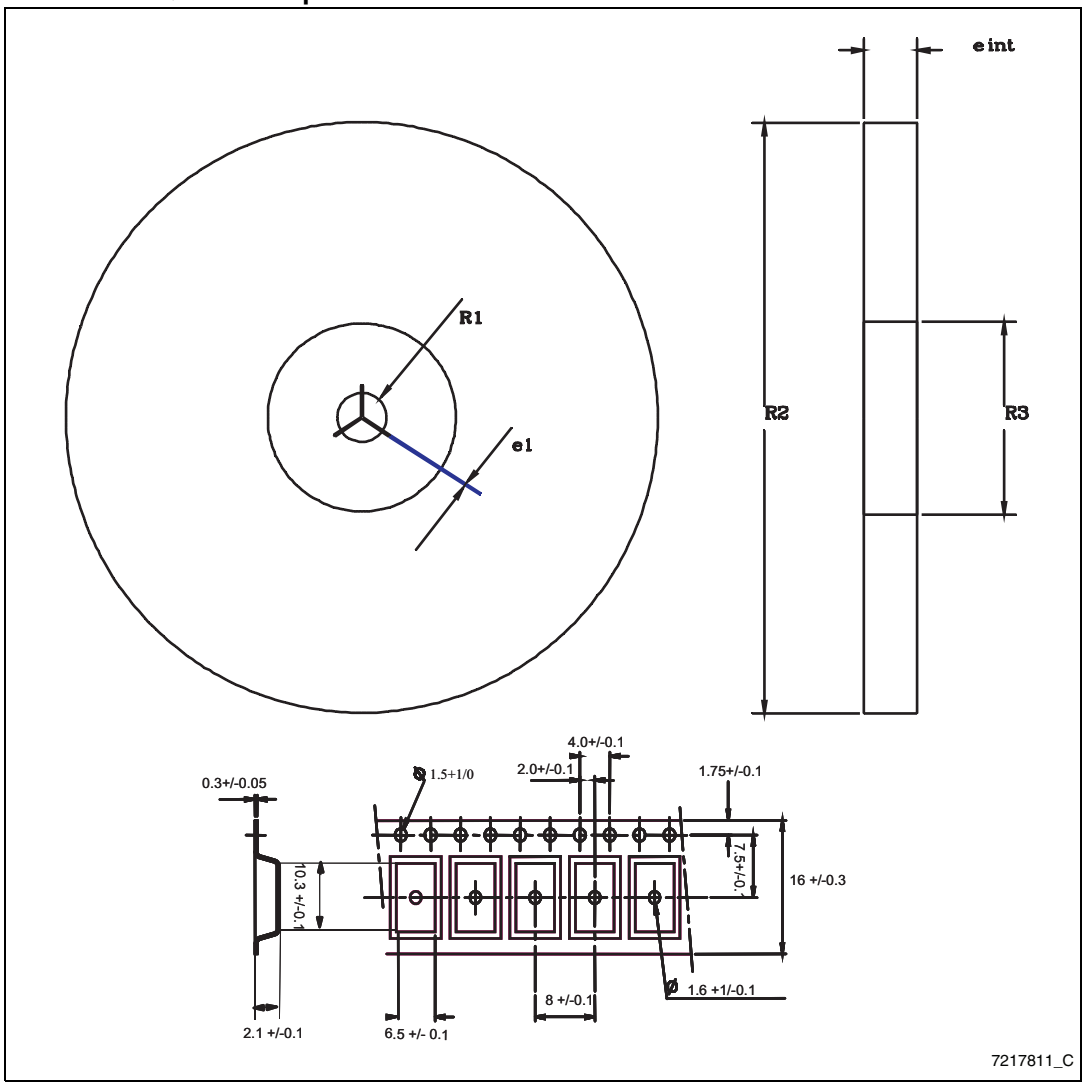


Table 15. TSSOP24 mechanical data

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 22. TSSOP24 package dimensions

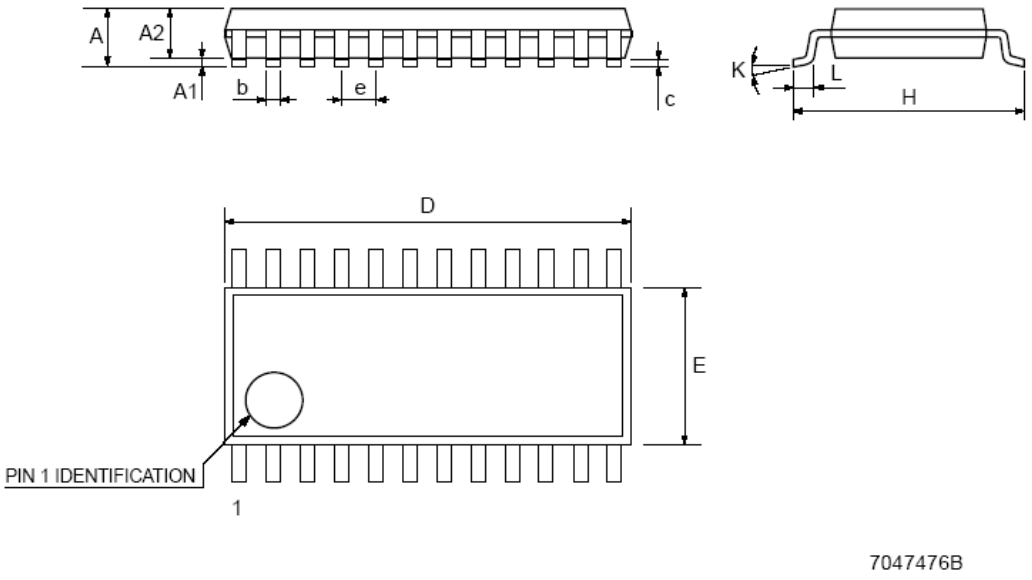


Table 16. Tape and reel TSSOP24

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 23. TSSOP24 reel dimensions

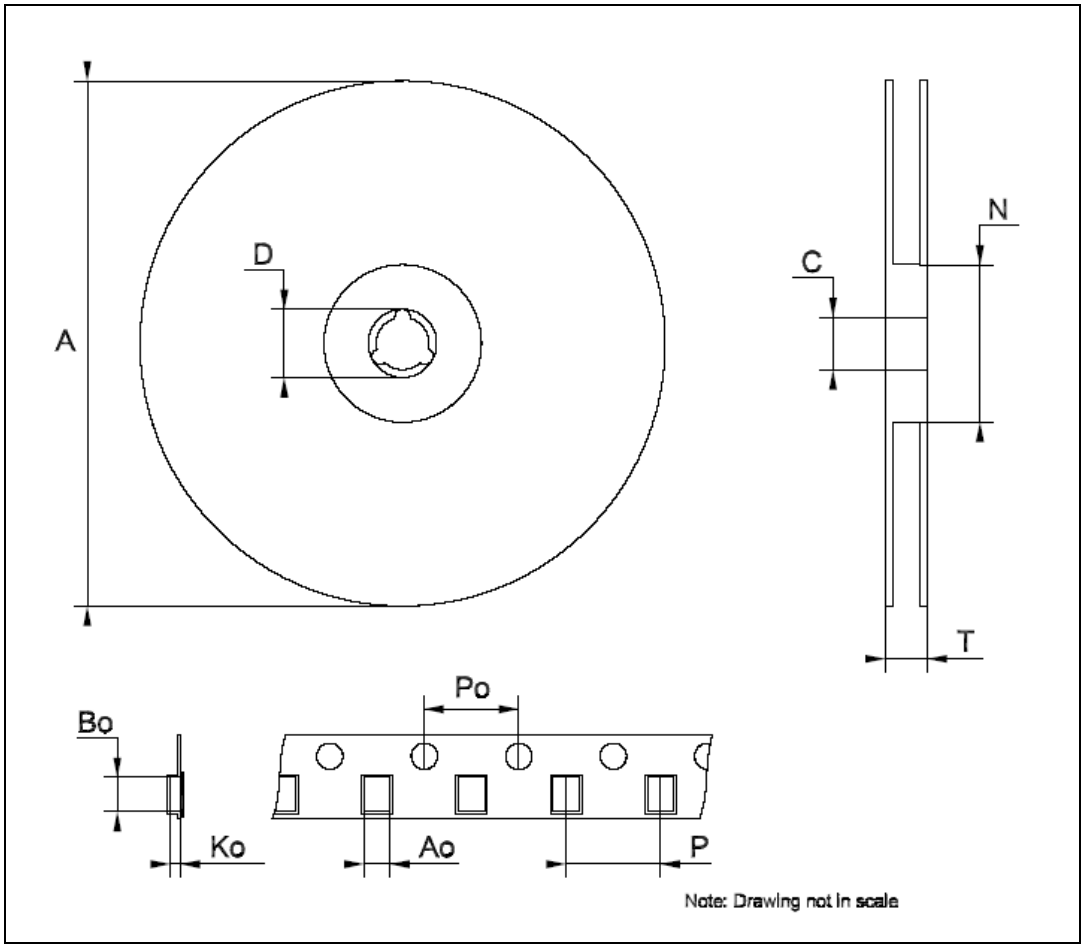


Table 17. SO-24 mechanical data

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 24. SO-24 package dimensions

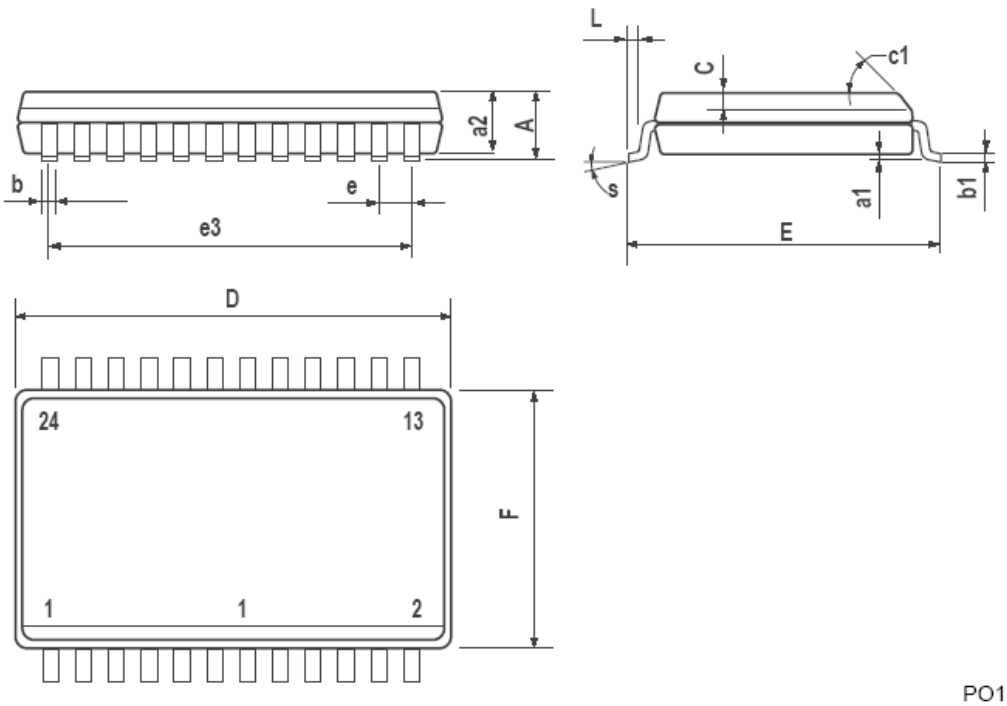


Table 18. Tape and reel SO-24

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 25. Reel dimensions SO-24

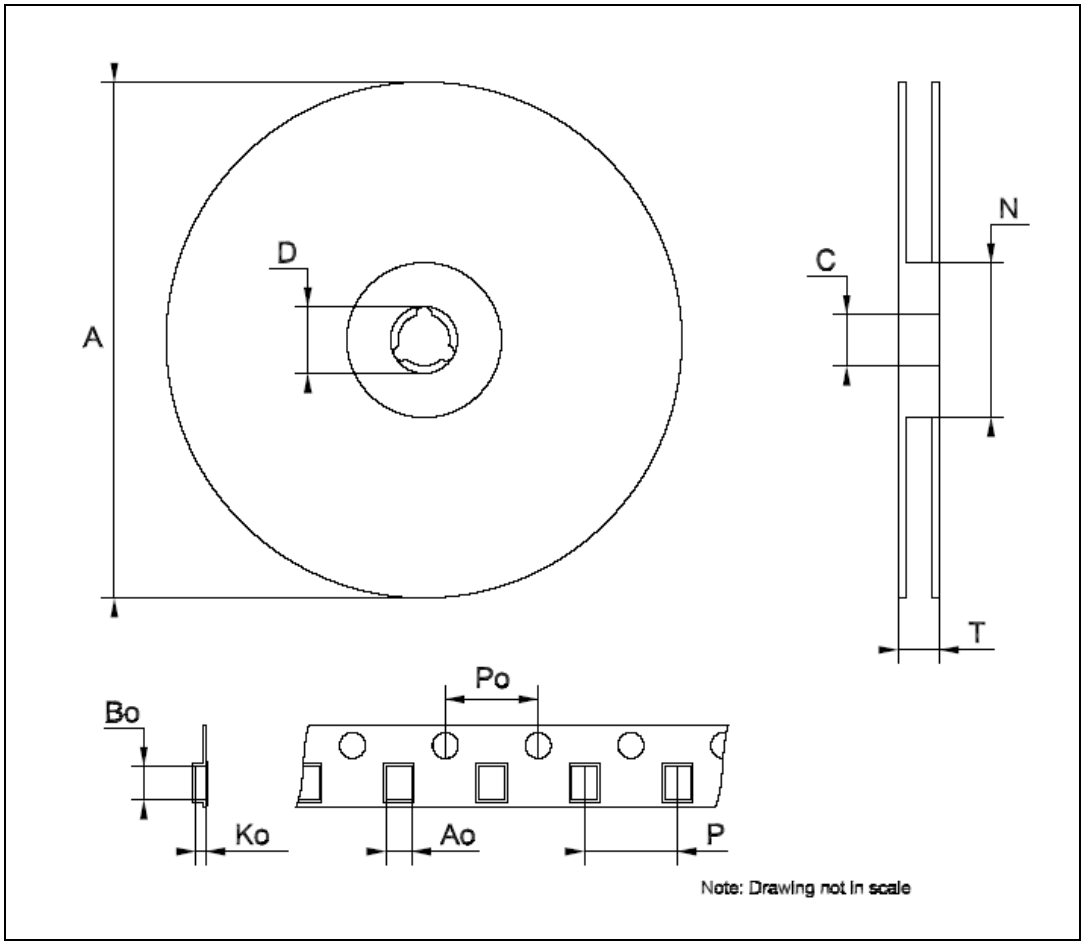
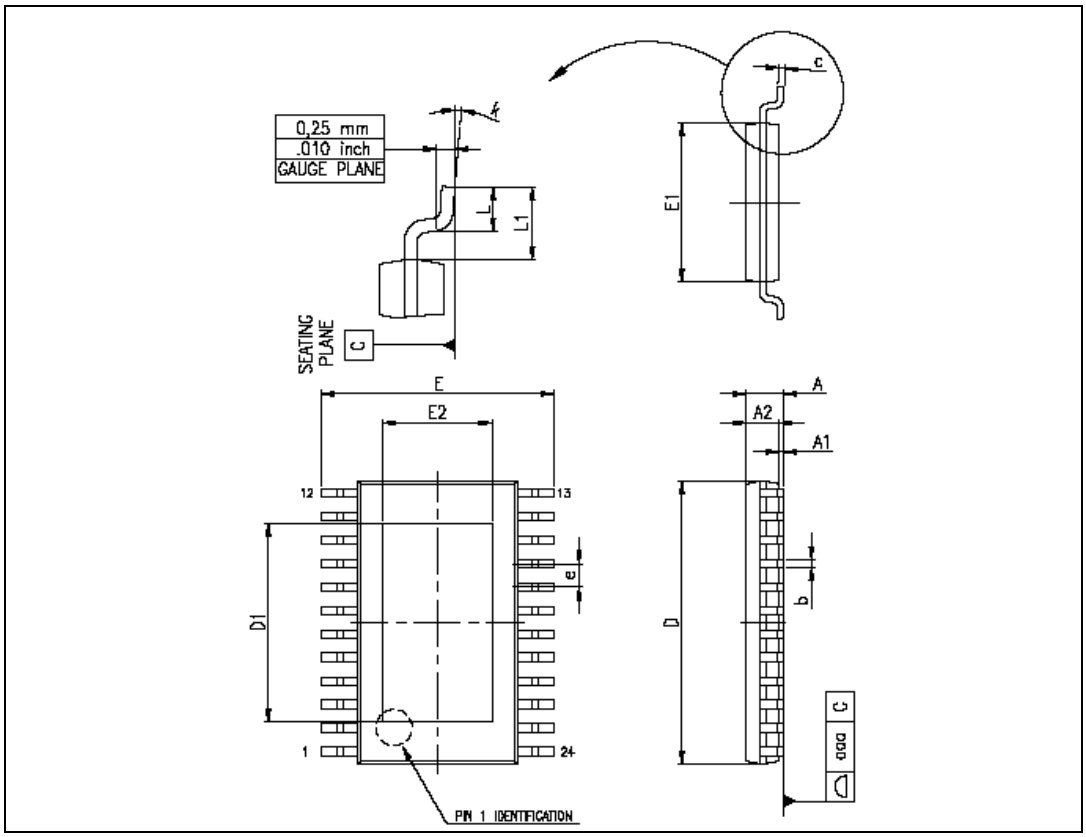


Table 19. TSSOP24 exposed-pad

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 26. TSSOP24 dimensions



9 Revision history

Table 20. Document revision history

Date	Revision	Changes
28-Jul-2006	1	First release
21-Dec-2006	2	Final datasheet
17-May-2007	3	Updated *Table 7 on page 6*
10-Jul-2007	4	Updated *Table 9: Truth table on page 10*
12-Mar-2008	5	Updated *Table 15: TSSOP24 exposed-pad on page 23*, added QSOP-24*Table 12* and *Figure 21 on page 19*
07-May-2008	6	Updated *Section 5 on page 10*
03-Dec-2008	7	Updated cover page, *Table 6 on page 5*, *Table 7 on page 6*, *Table 8 on page 7*, *Figure 12 on page 13*, *Table 10 on page 13*, *Figure 13*, *14*, and *Figure 15 on page 15*
12-May-2009	8	Updated cover page, *Table 6 on page 5*, *Table 7 on page 6*, *Table 8 on page 7*
22-Oct-2009	9	Updated *Note: on page 3*
20-Jan-2010	10	Updated *Table 5 on page 4*

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