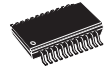


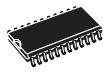
Low voltage 16-bit constant current LED sink driver



QSOP-24



TSSOP24



SO-24



TSSOP24
(exposed pad)

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 to 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.

Maturity status link

[STP16CP05](#)

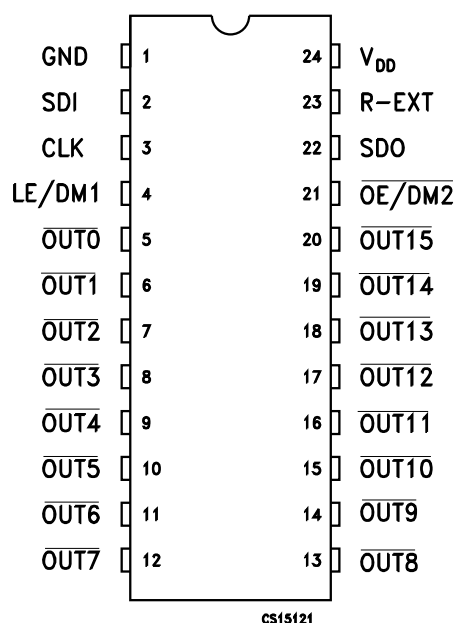
1 Summary description

Table 1. 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 1. Pin connection



GIPD280920150957MT

Note: The exposed pad should be electrically connected to a metal land electrically isolated or connected to ground.

Table 2. 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	$\overline{\text{OE/DM2}}$	Input terminal of output enable (active low)
22	SDO	Serial data out terminal
23	R-EXT	Input terminal for an external resistor for constant current programming
24	V _{DD}	Supply voltage terminal

2 Electrical ratings

2.1 Absolute maximum ratings

Stressing the device above the ratings 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 condition 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 3. 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 4. 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 exposed pad ⁽²⁾	37.5	°C/W
		QSOP-24	55	°C/W

1. According with JEDEC standard 51-7.

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

2.3 Recommended operating conditions

@ $T_A = 25\text{ }^{\circ}\text{C}$

Table 5. 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		$0.7 V_{DD}$	-	V_{DD}	V
V_{IL}	Input voltage		-0.3	-	$0.3 V_{DD}$	V
t_{wLAT}	LE/DM1 pulse width	$V_{DD} = 3.0\text{ V to }5.0\text{ V}$	6	-		ns
t_{wCLK}	CLK pulse width		8	-		ns
t_{wEN}	$\overline{OE}/\overline{DM2}$ 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 $V_{DD} = 5\text{ V}$ ⁽¹⁾		-	30	MHz

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

3 Electrical characteristics

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

Table 6. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IH}	Input voltage high level		$0.7 V_{DD}$		V_{DD}	V
V_{IL}	Input voltage low level		GND		$0.3 V_{DD}$	V
I_{OH}	Output leakage current	$V_{OH} = 20 \text{ V}$			1	μA
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	$V_O = 0.3 \text{ V}$, $R_{ext} = 4.2 \text{ k}\Omega$	4.25	5	5.75	mA
I_{OL2}		$V_O = 0.3 \text{ V}$, $R_{ext} = 1 \text{ k}\Omega$	19	20	21	
I_{OL3}		$V_O = 1.3 \text{ V}$, $R_{ext} = 200 \Omega$	96	100	104	
ΔI_{OL1}	Output current error between bit (all output ON)	$V_O = 0.3 \text{ V}$, $R_{ext} = 4.2 \text{ k}\Omega$		± 5	± 8	%
ΔI_{OL2}		$V_O = 0.3 \text{ V}$, $R_{ext} = 1 \text{ k}\Omega$		± 1.5	± 3	
ΔI_{OL3}		$V_O = 1.3 \text{ V}$, $R_{ext} = 200 \Omega$		± 1.2	± 3	
$R_{SIN(up)}$	Pull-up resistor		150	300	600	$\text{k}\Omega$
$R_{SIN(down)}$	Pull-down resistor		100	200	400	$\text{k}\Omega$
$I_{DD(OFF1)}$	Supply current (OFF)	$R_{ext} = 1 \text{ k}\Omega$, OUT 0 to 15 = OFF		4		mA
$I_{DD(OFF2)}$		$R_{ext} = 250 \Omega$, OUT 0 to 15 = OFF		11.2		
$I_{DD(ON1)}$	Supply current (ON)	$R_{ext} = 1 \text{ k}\Omega$, OUT 0 to 15 = ON		4.5		
$I_{DD(ON2)}$		$R_{ext} = 250 \Omega$, OUT 0 to 15 = ON		11.7		
Thermal	Thermal protection			170		$^\circ\text{C}$

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

Table 7. Switching characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{PLH1}	Propagation delay time, CLK-OUT _n , LE/DM1 = H, OE/DM2 = L	$V_{DD} = 3.3 \text{ V}$	-	45	74	ns
		$V_{DD} = 5 \text{ V}$	-	24	38	
t_{PLH2}	Propagation delay time, LE/DM1-OUT _n , OE/DM2 = L	$V_{DD} = 3.3 \text{ V}$	-	48	77	ns
		$V_{DD} = 5 \text{ V}$	-	27	46	
t_{PLH3}	Propagation delay time, OE/DM2-OUT _n , LE/DM1 = H	$V_{DD} = 3.3 \text{ V}$	-	75	128	ns
		$V_{DD} = 5 \text{ V}$	-	43	64	
t_{PLH}	Propagation delay time, CLK-SDO	$V_{DD} = 3.3 \text{ V}$	-	19	28	ns
		$V_{DD} = 5 \text{ V}$	-	11	16.5	
t_{PHL1}	Propagation delay time, CLK-OUT _n , LE/DM1 = H, OE/DM2 = L	$V_{DD} = 3.3 \text{ V}$	-	15	23	

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
t _{PHL1}	Propagation delay time, CLK-OUT _n , LE/DM1 = H, OE/DM2 = L	V _{IH} = V _{DD} V _{IL} = GND C _L = 10 pF I _O = 20 mA V _L = 3.0 V R _{ext} = 1 KΩ R _L = 60 Ω	V _{DD} = 5 V	-	10	14	ns
t _{PHL2}	Propagation delay time, LE/DM1 -OUT _n , OE/DM2 = L		V _{DD} = 3.3 V	-	13	18.5	
			V _{DD} = 5 V	-	9	12	ns
t _{PHL3}	Propagation delay time, OE/DM2 -OUT _n , LE/DM1 = H		V _{DD} = 3.3 V	-	17	24.5	
			V _{DD} = 5 V	-	14	19.5	ns
t _{PHL}	Propagation delay time, CLK-SDO		V _{DD} = 3.3 V	-	23	35	
			V _{DD} = 5 V	-	14	21	ns
t _{ON}	Output rise time 10~90% of voltage waveform		V _{DD} = 3.3 V	-	35	68	
			V _{DD} = 5 V	-	21	31.5	ns
t _{OFF}	Output fall time 90~10% of voltage waveform		V _{DD} = 3.3 V	-	10.5	15	
		V _{DD} = 5 V	-	11	15.5	ns	
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 of inputs and outputs

Figure 2. $\overline{\text{OE}}/\text{DM2}$ terminal

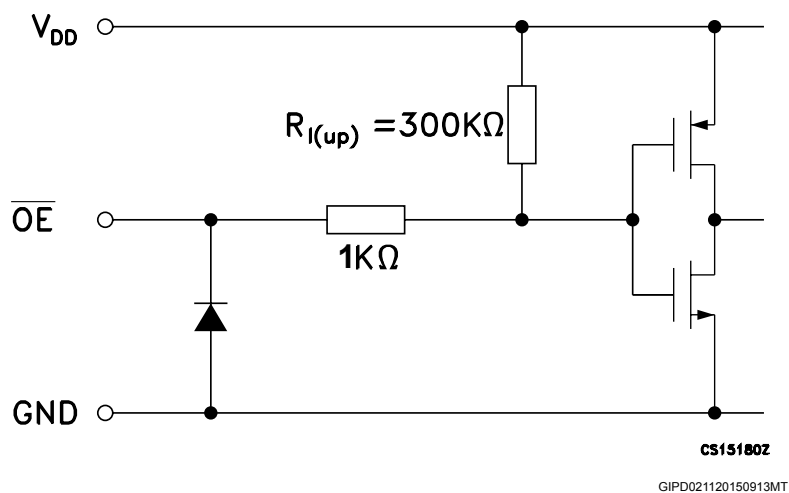


Figure 3. LE/DM1 terminal

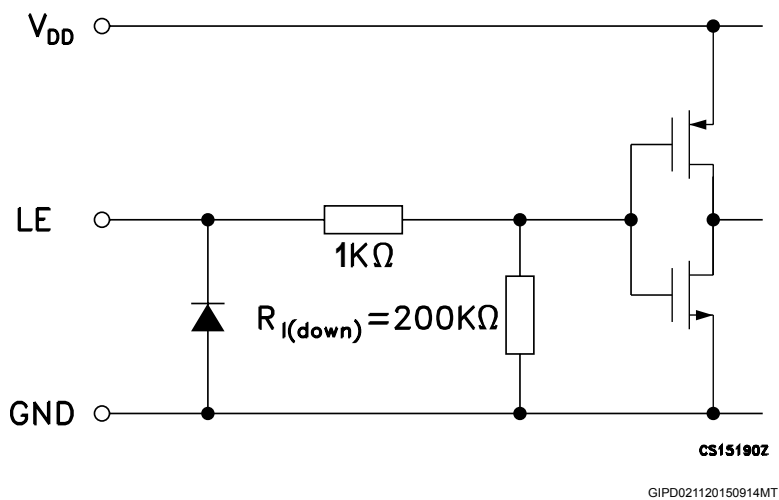
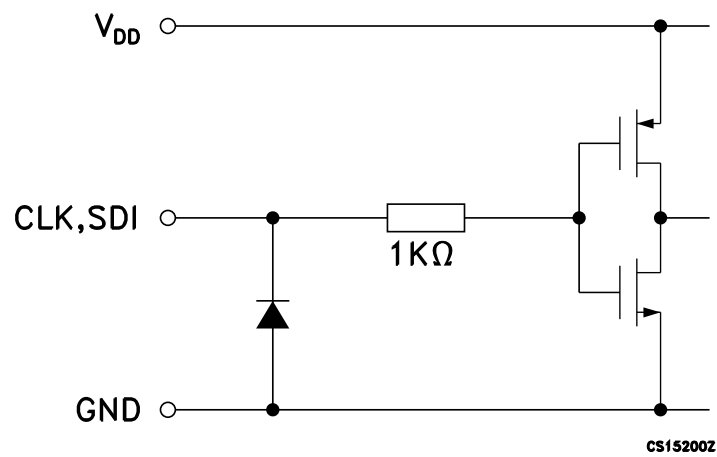
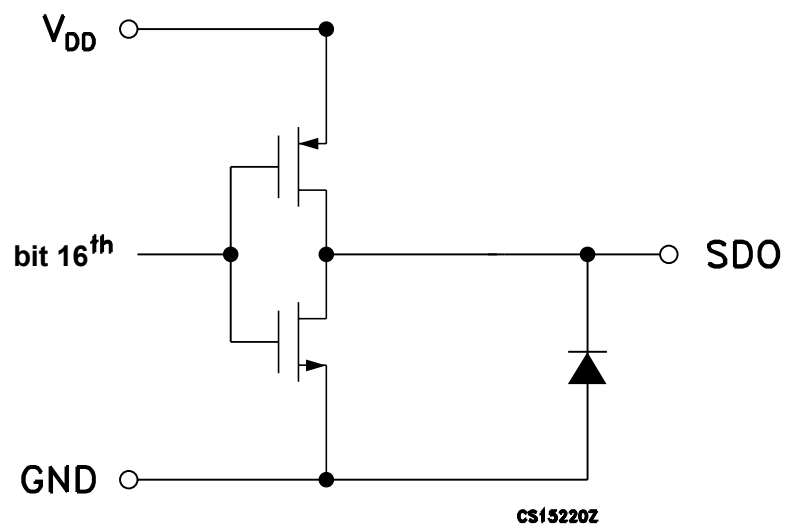


Figure 4. CLK, SDI terminal



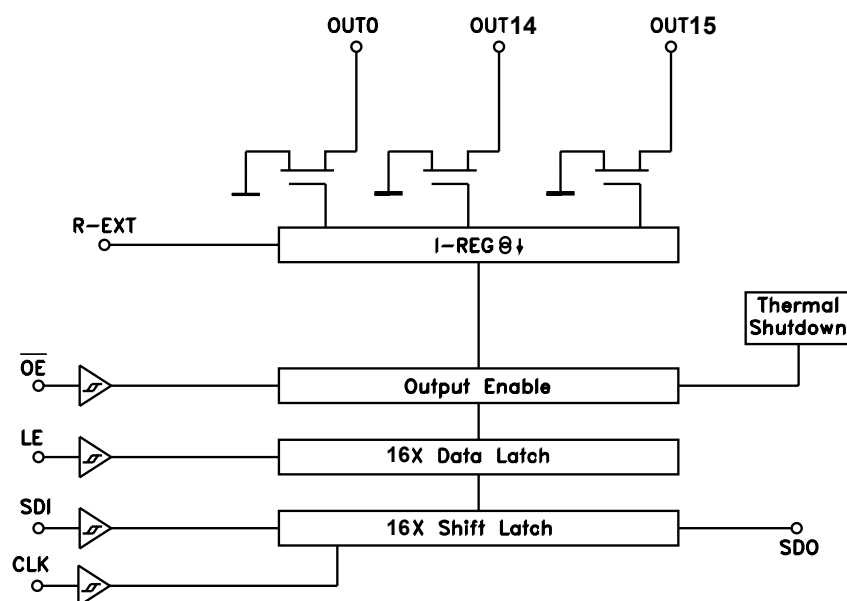
GIPD290920151407MT

Figure 5. SDO terminal



AMG130220170700MT

Figure 6. Block diagram



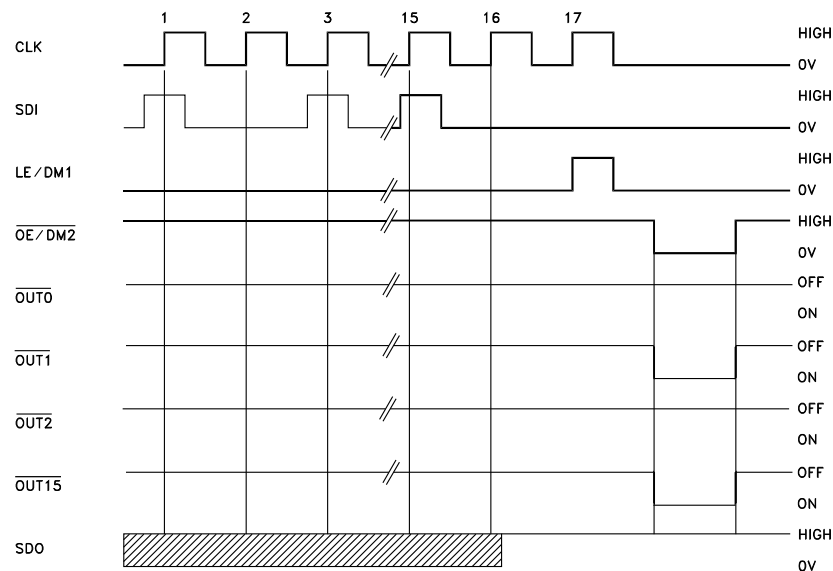
GIPD021120151028MT

5 Timing diagrams

Table 8. Truth table

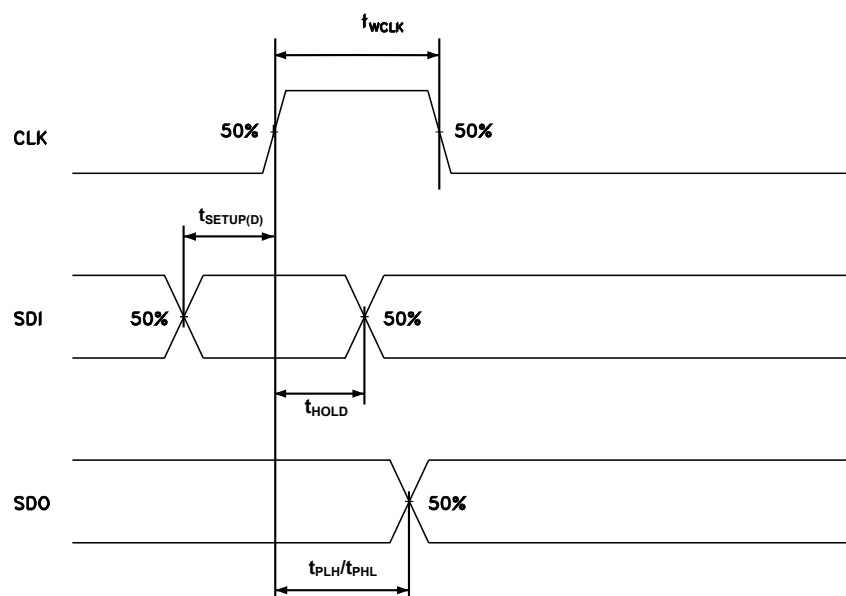
CLOCK	LE/DM1	OE/DM2	SERIAL-IN	OUT0 OUT7 OUT15	SDO
	H	L	Dn	Dn Dn - 7 Dn -15	Dn - 15
	L	L	Dn + 1	No change	Dn - 14
	H	L	Dn + 2	Dn + 2 Dn - 5 Dn -13	Dn - 13
	X	L	Dn + 3	Dn + 2 Dn - 5 Dn -13	Dn - 13
	X	H	Dn + 3	OFF	Dn - 13

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

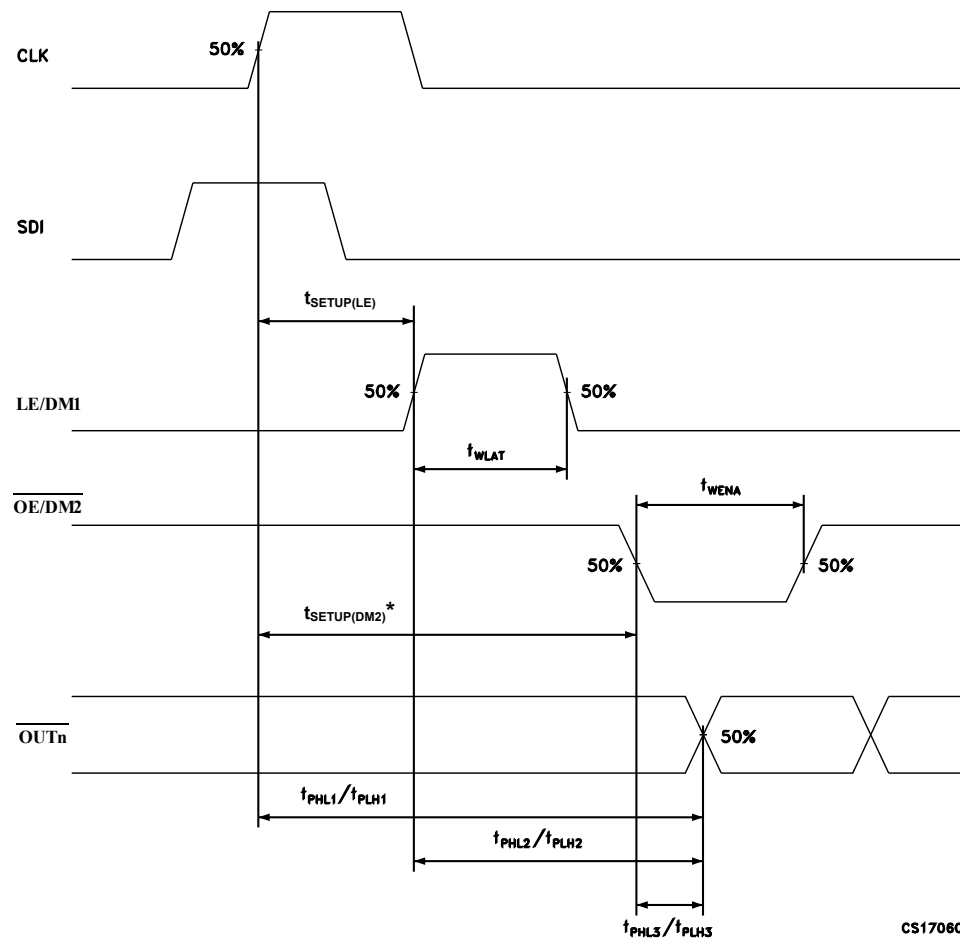
Figure 7. Timing diagram


GIPD300920151126MT

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/DM1 terminal is low level, the latch circuit holds previous set of data. 3 When LE/DM1 terminal is high level, the latch circuit refreshes new set of data from SDI chain. 4 When OE/DM2 terminal 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 OE/DM2 terminal is at high level, all output terminals are switched OFF.

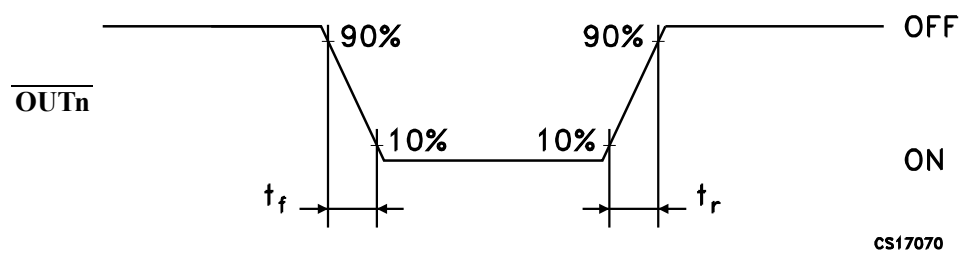
Figure 8. Clock, serial-in, serial-out


AMG130220170701MT

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


* Only for detection feature.

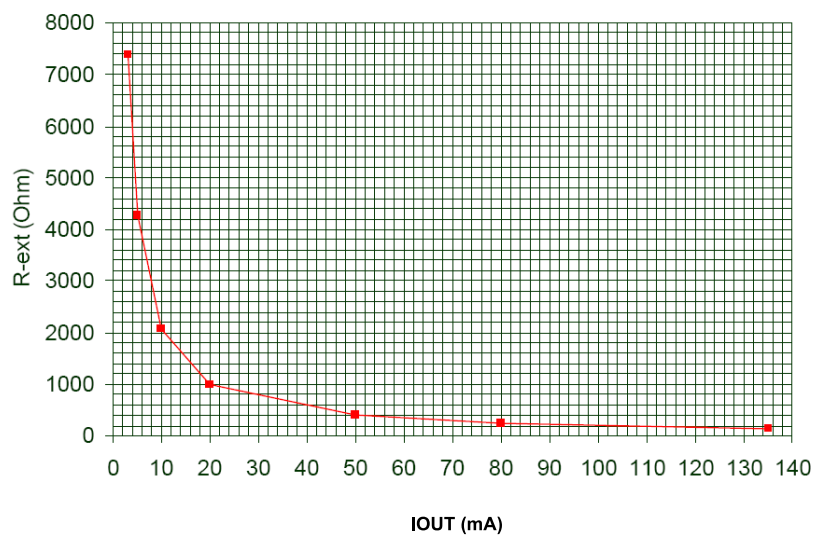
AMG130220170702MT

Figure 10. Outputs


GIPD300920151146MT

6 Typical characteristics

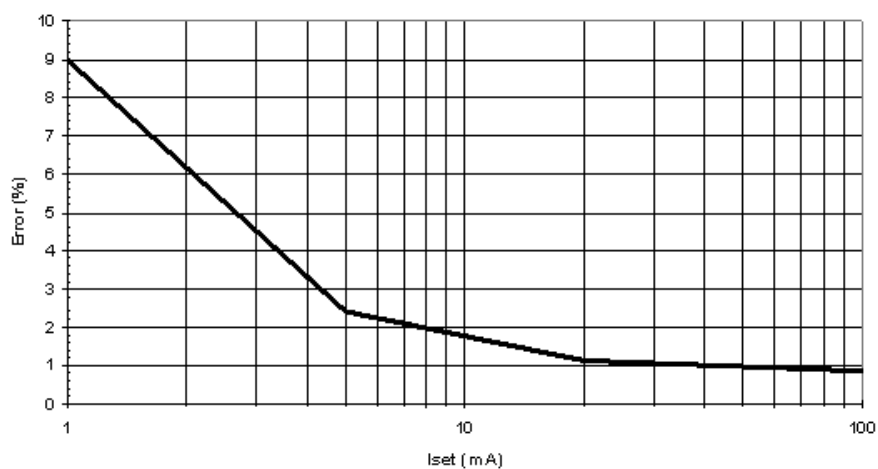
Figure 11. Output current- R_{EXT} resistor



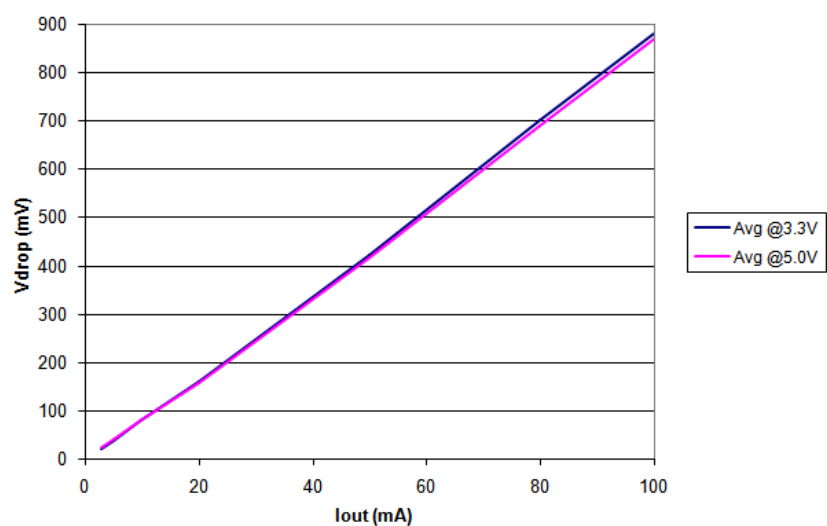
GIPD051020151340MT

Table 9. 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 12. Output current vs $\pm \Delta I_{OL}(\%)$ $T_A = 25^\circ\text{C}$


GIPD051020151346MT

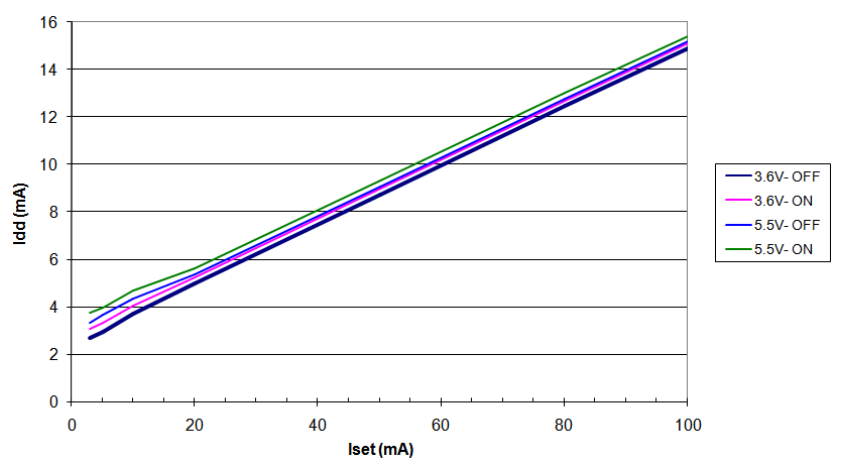
Figure 13. I_{SET} vs drop out voltage (V_{drop}) $T_A = 25^\circ\text{C}$


GIPD051020151348MT

Table 10. I_{SET} vs. dropout voltage (V_{drop})

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

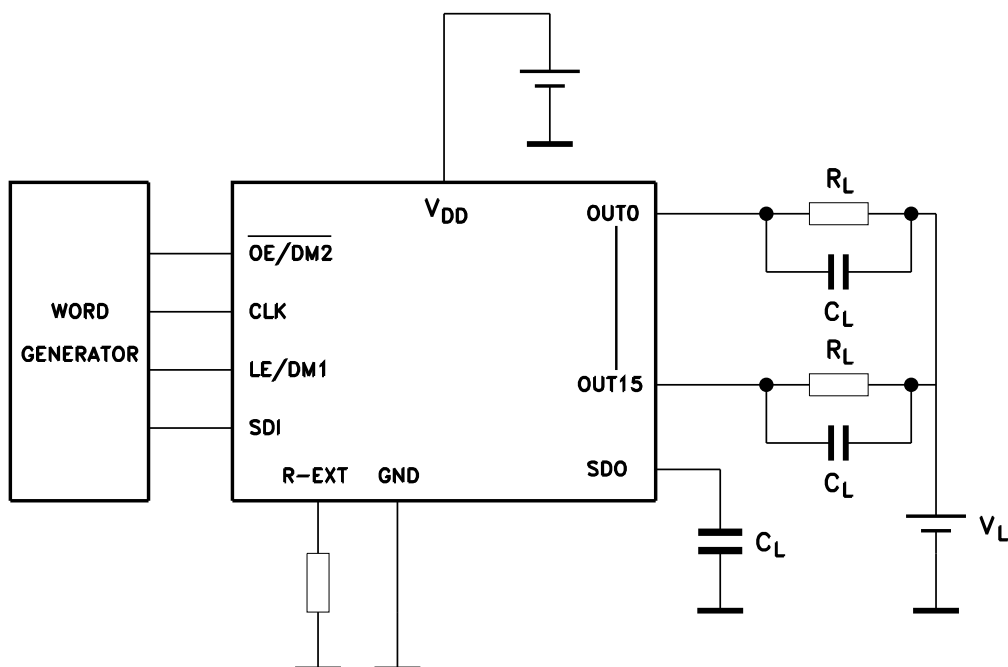
Figure 14. I_{DD} ON/OFF, $T_A = 25\text{ °C}$



GIPD051020151353MT

7 Test circuit

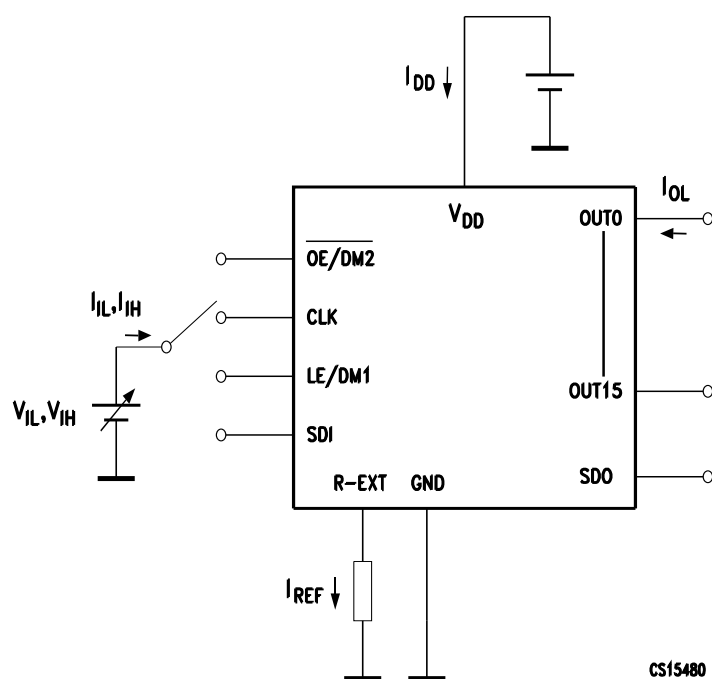
Figure 15. DC characteristic



CS15470

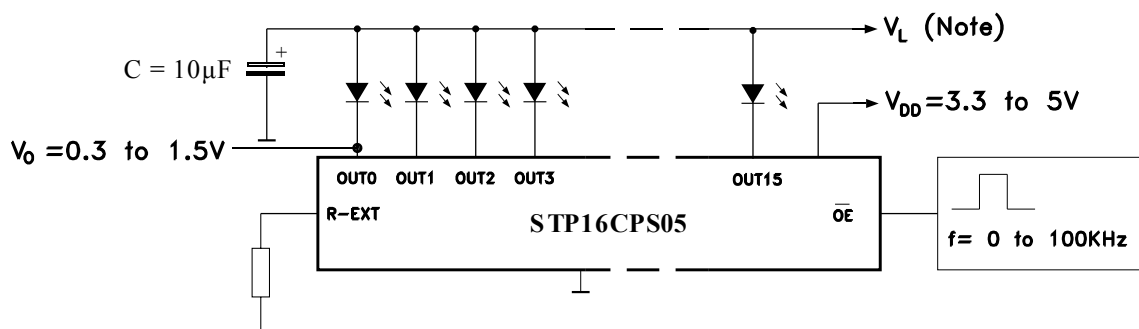
GIPD051020151408MT

Figure 16. AC characteristic



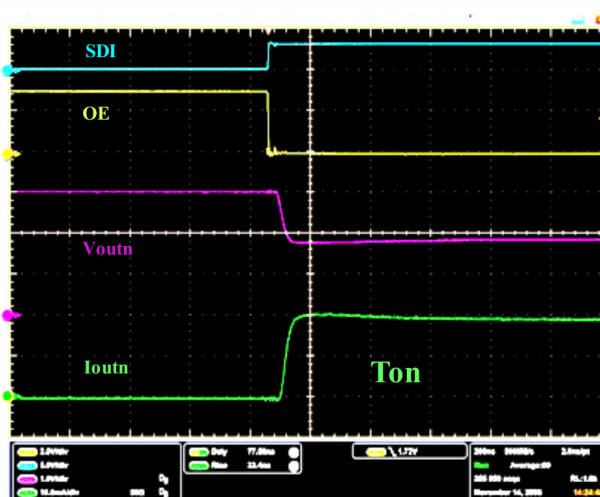
CS15480

GIPD051020151411MT

Figure 17. Typical application schematic


GIPD051020151415MT

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 18. Turn ON output current setup


GIPD081020151217MT

[illegible]

GIPD081020151225MT

8 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.

8.1 QSOP-24 package information

Figure 20. QSOP-24 package outline

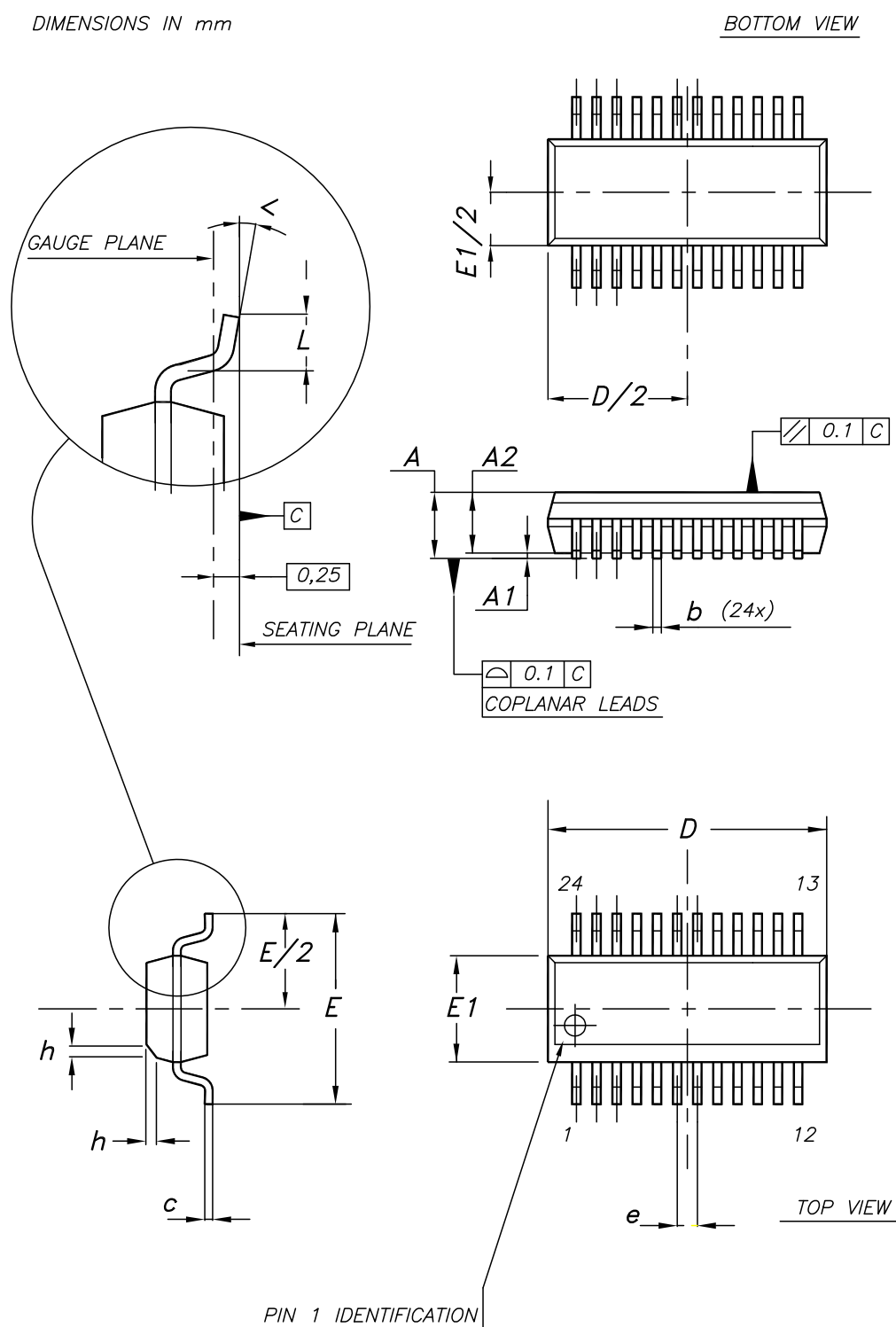
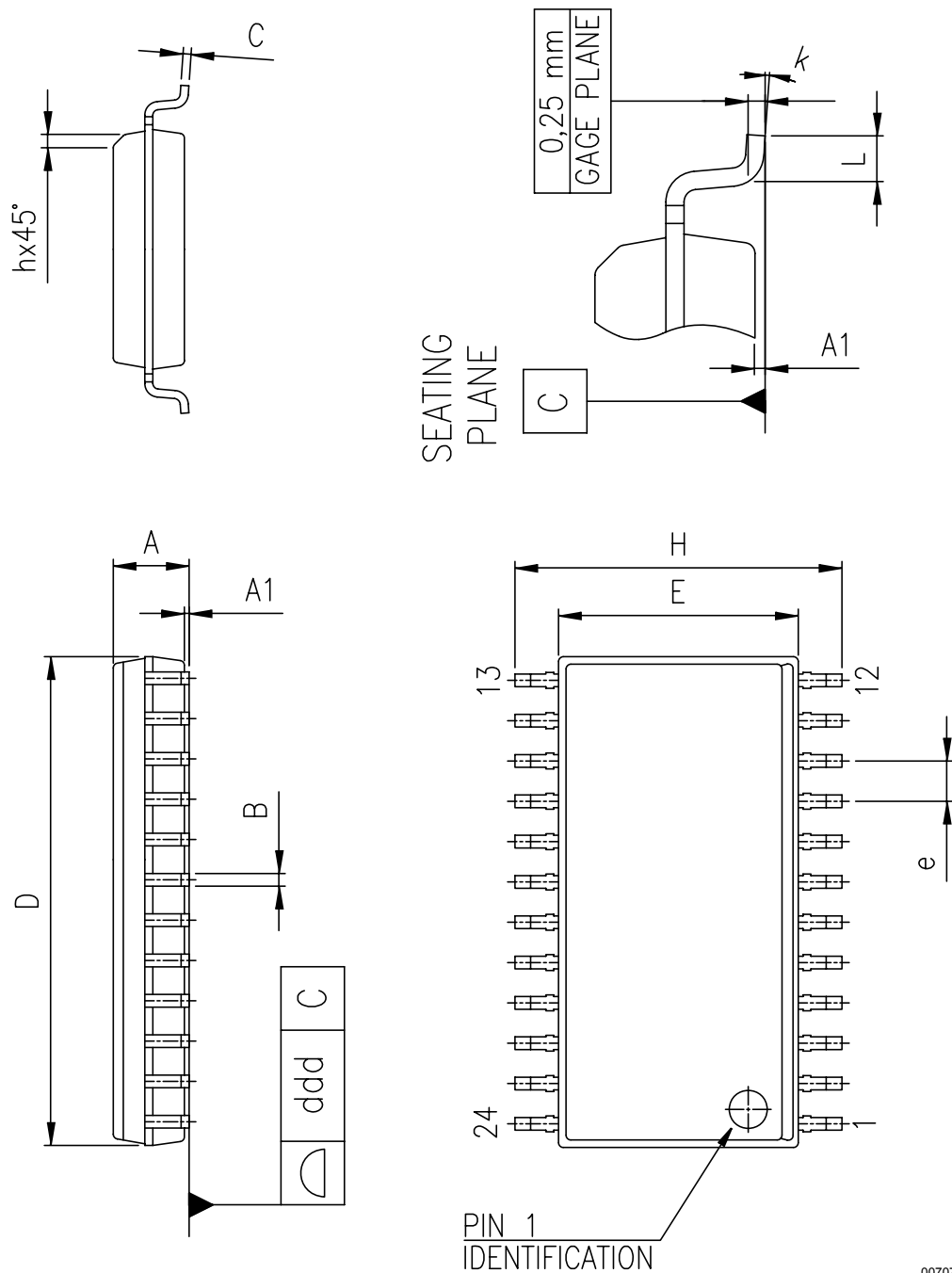


Table 11. QSOP-24 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	1.54	1.62	1.73
A1	0.10	0.15	0.25
A2		1.47	
b	0.20		0.31
c	0.17		0.254
D	8.56	8.66	8.76
E	5.80	6.00	6.20
E1	3.80	3.91	4.01
e		0.635	
L	0.40	0.635	0.89
h	0.25	0.33	0.41
<	0°		8°

8.2 SO-24 0070769 package information

Figure 21. SO-24 package outline



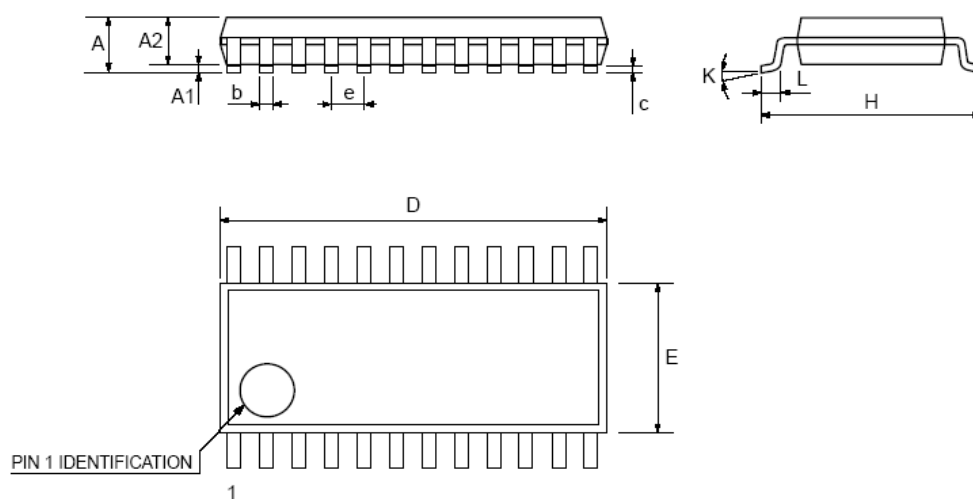
0070769

Table 12. SO-24 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.35		2.65
A1	0.10		0.30
B	0.33		0.51
C	0.23		0.32
D	15.20		15.60
E	7.40		7.60
e		1.27	
H	10.00		10.65
h	0.25		0.75
L	0.40		1.27
k	0		8
ddd			0.10

8.3 TSSOP24 package information

Figure 22. TSSOP24 package outline



7047476B

Table 13. TSSOP24 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.1
A1	0.05		0.15
A2		0.9	
b	0.19		0.30
c	0.09		0.20
D	7.7		7.9
E	4.3		4.5
e		0.65 BSC	
H	6.25		6.5
K	0°		8°
L	0.50		0.70

8.4 TSSOP24 exposed pad package information

Figure 23. TSSOP24 exposed pad package outline

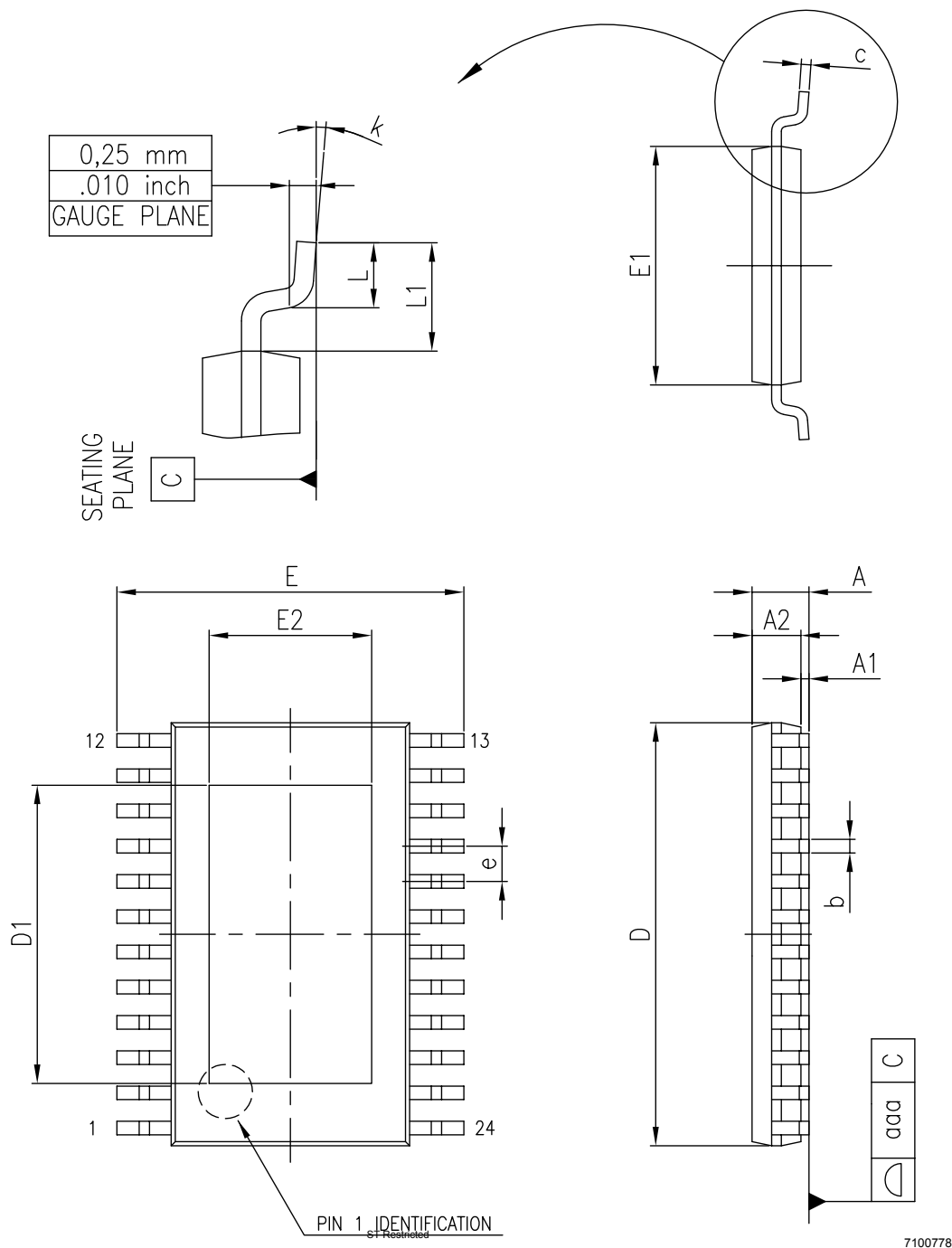


Table 14. TSSOP24 exposed pad mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.20
A1			0.15
A2	0.80	1.00	1.05
b	0.19		0.30
c	0.09		0.20
D	7.70	7.80	7.90
D1	4.80	5.00	5.20
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
E2	3.00	3.20	3.40
e			
L	0.45	0.60	0.75
L1		1.00	
K	0		8
aaa			0.10

8.5 TSSOP24, TSSOP24 exposed pad and SO-24 packing information

Figure 24. TSSOP24, TSSOP24 exposed pad and SO-24 reel outline

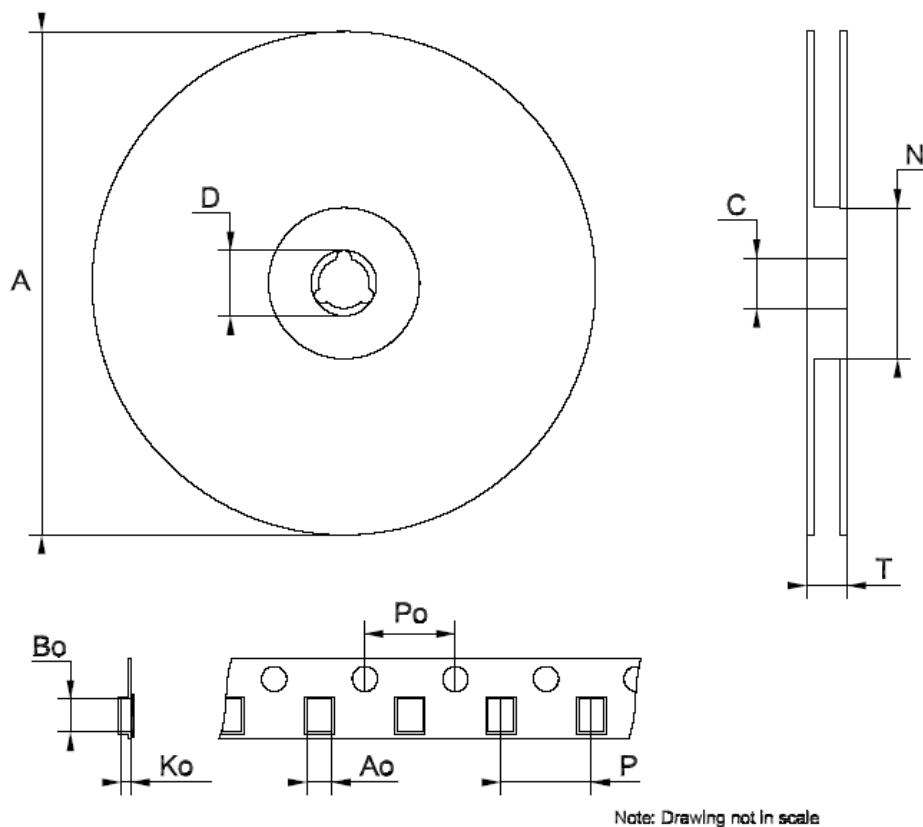


Table 15. TSSOP24 and TSSOP24 exposed pad tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	330	-	331
C	13.0	-	14.0
D	18.7	-	
N	100	-	
T	16.5	-	18.5
Ao	6.85	-	7.05
Bo	8.20	-	8.40
Ko	1.5	-	1.7
Po	3.9	-	4.1
P	7.9	-	8.1

Table 16. SO-24 tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A		-	330
C	12.8	-	13.2
D	20.2	-	
N	60	-	
T		-	30.4
Ao	10.8	-	11.0
Bo	15.7	-	15.9
Ko	2.9	-	3.1
Po	3.9	-	4.1
P	11.9	-	12.1

9 Device summary

Table 17. Device summary

Order code	Package	Packing
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

Revision history

Table 18. 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-24Table 12 and Figure 2 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 2 on page 13, Table 10 on page 13, Figure 2, 2, and Figure 2 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
18-Jun-2014	11	Updated Section 8: Package mechanical data and Section 9: Packaging mechanical data.
01-Apr-2016	12	Updated <i>Table 12: "QSOP-24 mechanical data"</i> . Minor text changes.
08-Mar-2017	13	Updated SDO terminal, Clock, serial/in, serial/out and Clock, serial/in, latch, enable, outputs. Minor text changes.
21-Feb-2024	14	Updated <i>Table 15. TSSOP24 and TSSOP24 exposed pad tape and reel mechanical data.</i>

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