ST2221A

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8-Bit CONSTANT CURRENT LED DRIVERS

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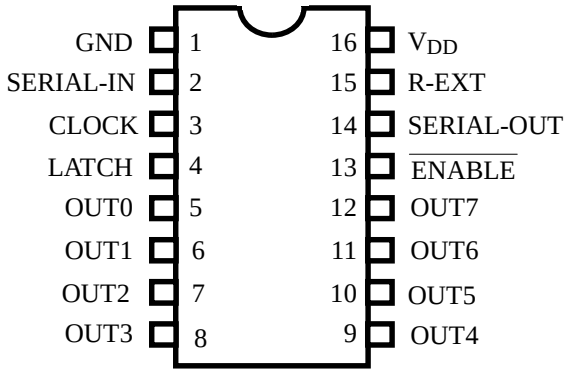
General Description

The ST2221A is specifically designed for LED and LED DISPLAY constant current drivers. The value of constant current can be varied using an external resistor (I_{out} = 5 ~90mA). The devices include an 8-bit shift registers, latches, and constant current drivers on a single Silicon CMOS chip.

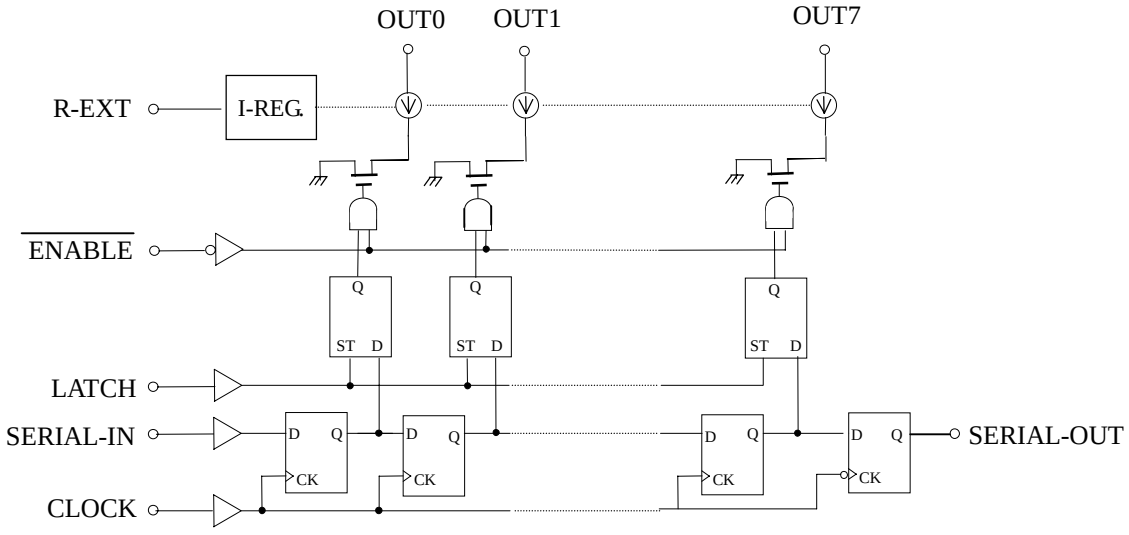
Features

- Constant Current Output : Current with one resistor for 5mA to 90mA
- Maximum Clock Frequency : 25MHz (Cascade Operation)
- 5V CMOS Compatible Input
- Package : PDIP16,SOP16,SSOP16
- Constant Current Matching: (Ta = 25°C、V_{DD} = 5.0V)
  Bit-to-Bit : ± 6%、Chip-to-Chip : ± 10%、
  @ I_{OUT} = 5 ~ 40mA
  Bit-to-Bit : ± 6%、Chip-to-Chip : ± 10%、
  @ I_{OUT} = 40 ~ 90mA

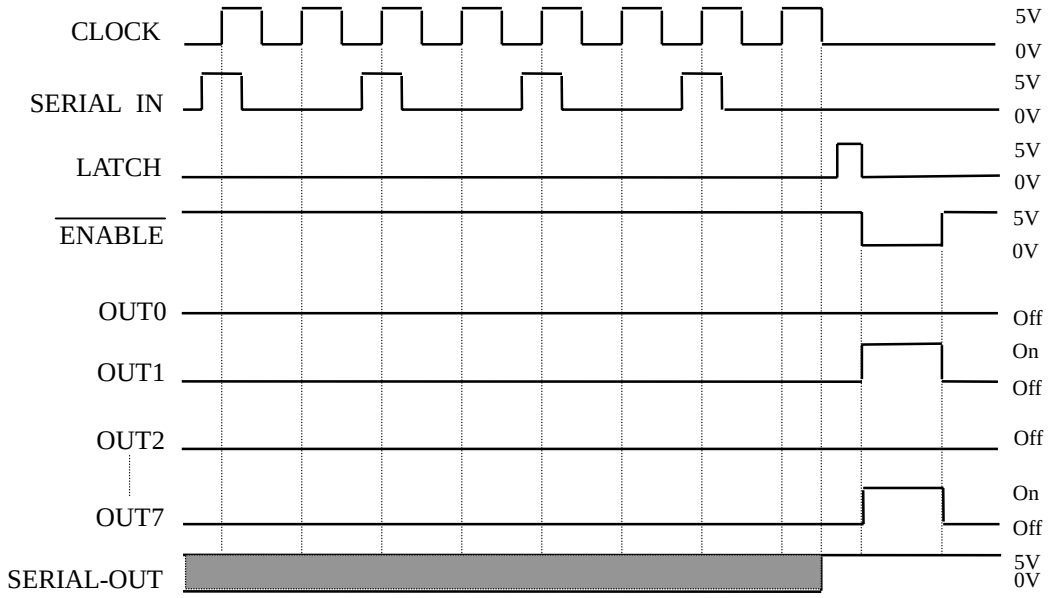
Pin Connection (Top view)



Block Diagram



Timing Diagram



(Note) Latches are level sensitive (not edge triggered).

LATCH-terminal = H level, latches become transparent; LATCH-terminal = L level, latches hold data.

ENABLE-terminal = H level, all outputs (OUT0~7) are off.

An external resistor is connected between R-EXT and GND for setting up the value of constant current.

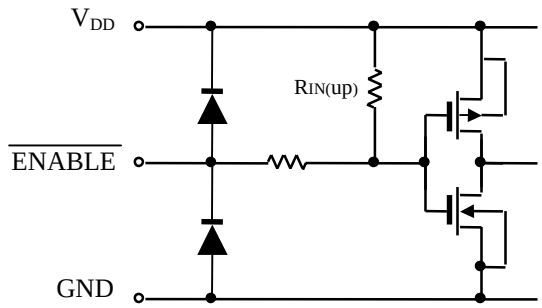
SERIAL-OUT changes state on the falling edges of clock.

Pin Description

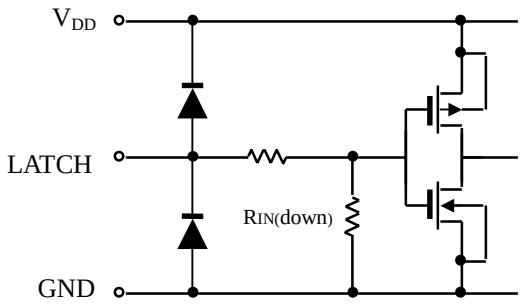
PIN No.	PIN NAME	FUNCTION
1	GND	GND terminal
2	SERIAL-IN	Input terminal of a data shift register
3	CLOCK	Input terminal of a clock for shift register
4	LATCH	Input terminal for data strobe
5~12	OUT0~7	Output terminals
13	$\overline{\text{ENABLE}}$	Input terminal for output enable (active low)
14	SERIAL-OUT	Output terminal of a data shift register
15	R-EXT	Input terminal of an external resistor
16	V_{DD}	5V Supply voltage terminal

Equivalent Circuit of Inputs and Outputs

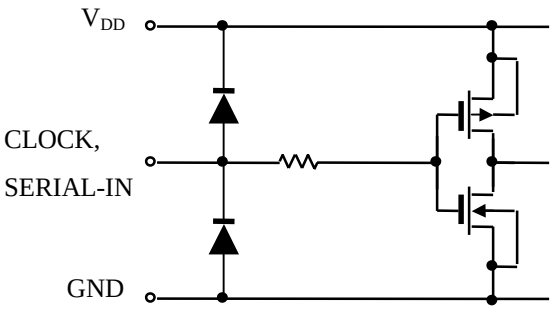
1. $\overline{\text{ENABLE}}$ terminal



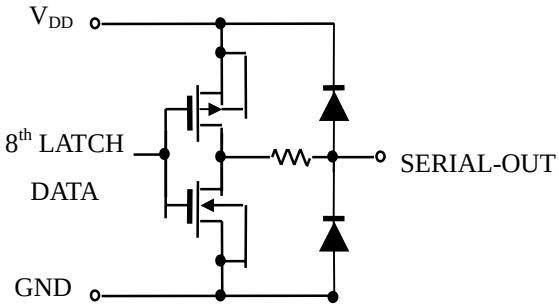
2. LATCH terminal



3. CLOCK, SERIAL-IN terminal



4. SERIAL-OUT terminal



Maximum Ratings (Ta=25°C, Tj(max) = 140°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	0 ~ 7.0	V
Input Voltage	V_{IN}	-0.4 ~ VDD+0.4	V
Output Current	I_{OUT}	90	mA
Output Voltage	V_{OUT}	-0.5 ~ 9.5	V
Clock Frequency	f_{CLK}	25	MHz
GND Terminal Current	I_{GND}	720	mA
Power Dissipation	P_D	1.12 (PDIP-16 : Ta=25°C)	W
		0.86 (SOP-16 : Ta=25°C)	
		0.82 (SSOP-16 : Ta=25°C)	
Thermal Resistance	$R_{th(j-a)}$	85 (PDIP-16)	°C/W
		110.9 (SOP-16)	
		115.9 (SSOP-16)	
Storage Temperature	T_{stg}	-55 ~ 150	°C

Recommended Operating Condition

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	—	4.5	5.0	5.5	V
Output Voltage	V_{OUT}	—	—	—	9	V
Operating temperature	T_{OPR}	—	-40	—	85	℃
Output Current	I_O	OUTn	5	—	88	mA
	I_{OH}	SERIAL-OUT	—	—	1.0	
	I_{OL}	SERIAL-OUT	—	—	-1.0	
Input Voltage	V_{IH}	—	0.7VDD	—	VDD+0.3	V
	V_{IL}	—	-0.3	—	0.3VDD	
LATCH Pulse Width	tw LAT	V_{DD} = 4.5 ~ 5.5 V	15	—	—	ns
CLOCK Pulse Width	tw CLK		15	—	—	ns
Set-up Time for DATA	tsetup(D)		20	—	—	ns
Hold Time for DATA	thold(D)		20	—	—	ns
Set-up Time for LATCH	tsetup(L)		15	—	—	ns
Clock Frequency	f_{CLK}	Cascade operation	—	—	25	MHz
Power Dissipation	P_D	Ta = 85°C(PDIP-16)	—	—	0.41	W
		Ta = 85°C(SOP-16)	—	—	0.32	
		Ta = 85°C(SSOP-16)	—	—	0.30	

Electrical Characteristics (VDD = 5.0 V, Ta = 25°C unless otherwise noted)

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage "H" Level	V_{IH}	—	0.7VDD	—	VDD	V
Input Voltage "L" Level	V_{IL}	—	GND	—	0.3VDD	
Output Leakage Current	I_{OH}	VOH = 7.5 V	—	—	1.0	uA
Output Voltage (S - OUT)	V_{OL}	IOL = 1.0 mA	—	—	0.4	V
	V_{OH}	IOH = -1.0 mA	4.6	—	—	
Output Current (Bit-Bit)	I_{OL1}	V_{OUT} = 0.7±0.25V REXT = 910Ω	—	3	6	%
	I_{OL2}	V_{OUT} = 0.7±0.25V REXT = 360Ω	—	3	6	%
Output Current (Chip-Chip)	I_{OL3}	V_{OUT} = 0.7V REXT = 910Ω	—	5	10	%
	I_{OL4}	V_{OUT} = 0.7V REXT = 360Ω	—	5	10	%
Supply Voltage Regulation	% / V_{DD}	R_{EXT} = 470Ω, Ta = -40 ~ 85°C	—	1.5	5.0	% / V
Pull-Up Resistor	$R_{IN(up)}$	—	150	300	600	KΩ
Pull-Down Resistor	$R_{IN(down)}$	—	100	200	400	KΩ
Supply Current "OFF"	$I_{DD(off)1}$	R_{EXT} = OPEN, OUT0~7 = off	—	0.3	0.6	mA
	$I_{DD(0ff)2}$	R_{EXT} = 470Ω, OUT0~7 = off	4.0	5.6	7.8	
	$I_{DD(off)3}$	R_{EXT} = 250Ω, OUT0~7 = off	7.3	10.2	14.3	
Supply Current "ON"	$I_{DD(on)1}$	R_{EXT} = 470Ω, OUT0~7 = on	4.0	5.6	7.8	
	$I_{DD(on)2}$	R_{EXT} = 250Ω, OUT0~7 = on	7.3	10.2	14.3	

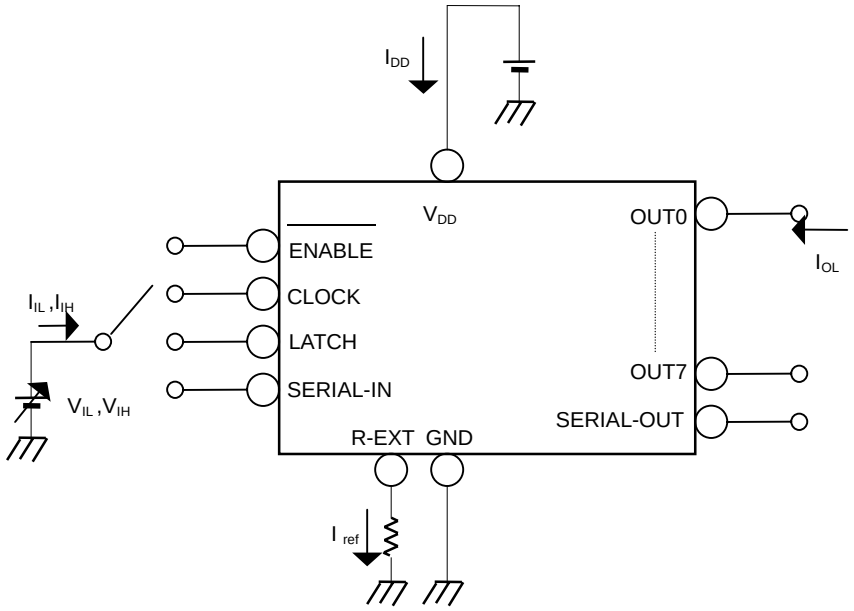
Switching Characteristics (Ta = 25 °C unless otherwise noted)

CHARACTERISTIC		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time ("L" to "H")	SIN-OUTn	t_{pLH}	V_{DD}=5.0V V_{IH}=VDD V_{IL}=GND R_{EXT}=470Ω[1] V_L=3.0V R_L=65Ω C_L=13pF	—	115	230	ns
	LATCH-OUTn			—	115	230	
	ENABLE-OUTn			—	115	230	
	CLK-SOUT			—	15	20	
Propagation Delay Time ("H" to "L")	SIN-OUTn	t_{pHL}		—	120	160	ns
	LATCH-OUTn			—	120	160	
	ENABLE-OUTn			—	120	160	
	CLK-SOUT			—	15	20	
Output Current Rise Time		tor		70	140	280	ns
Output Current Fall Time		tof		55	110	220	ns

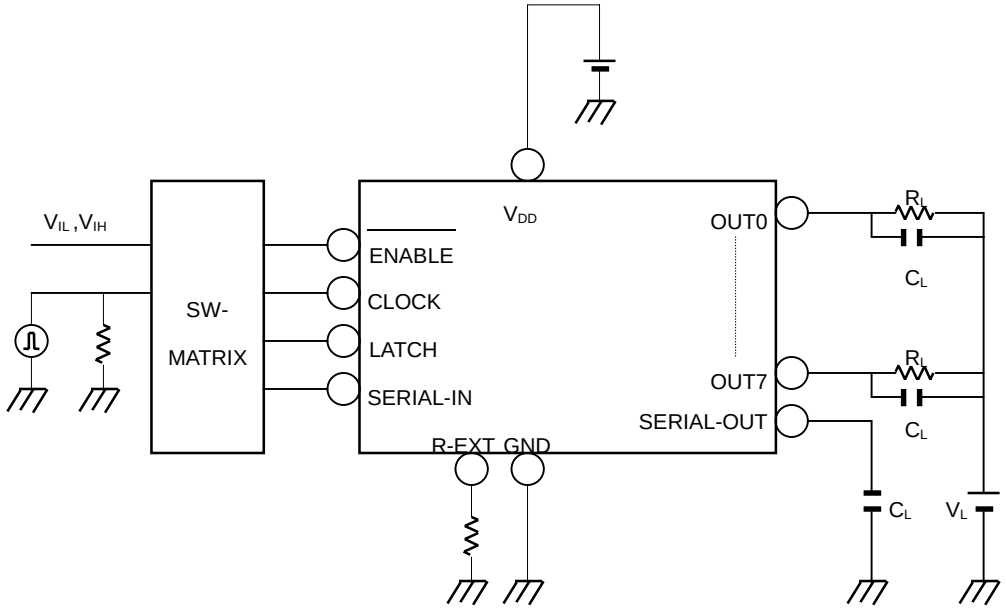
[1] Delay Time t_{pLH} and Rise Time tor will both increase as the Rext value increased.

Test Circuit

DC characteristic

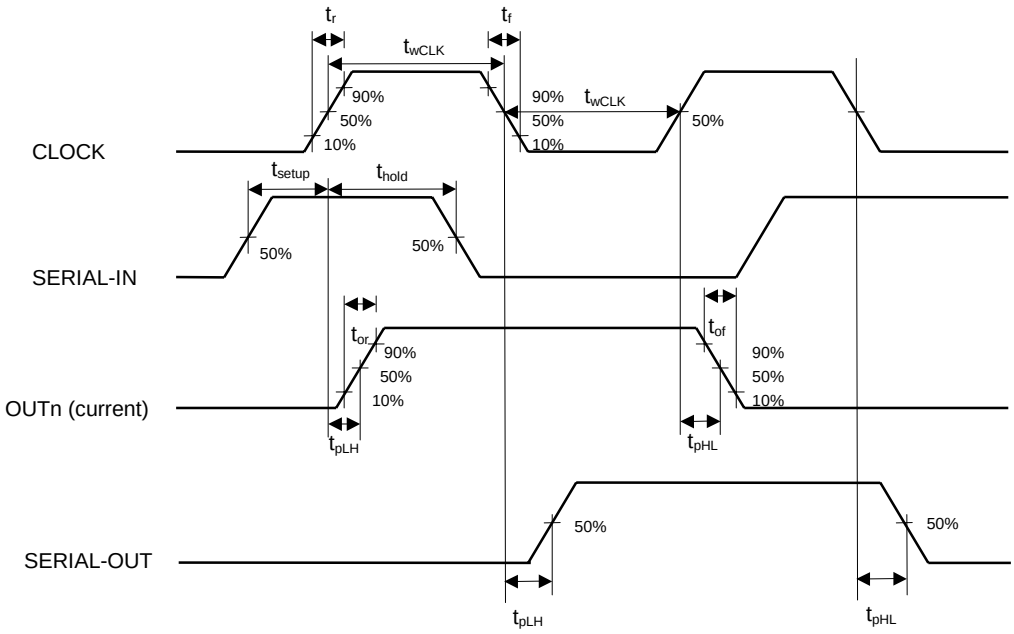


AC characteristic

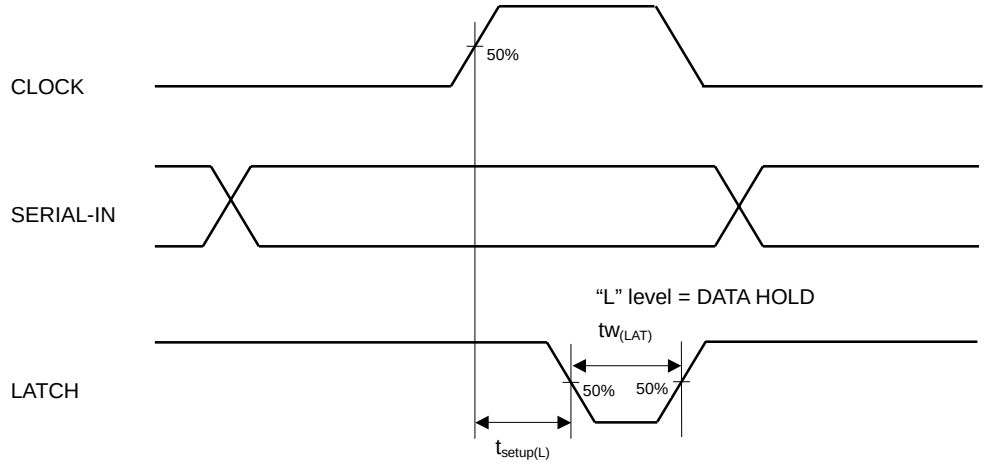


Timing Diagram

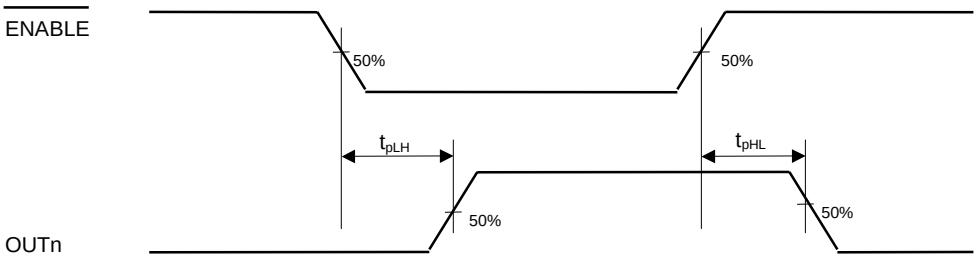
1. CLOCK-SERIAL OUT, OUTn

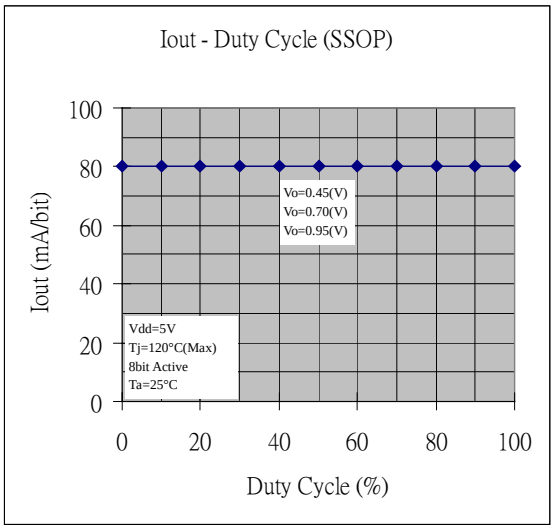


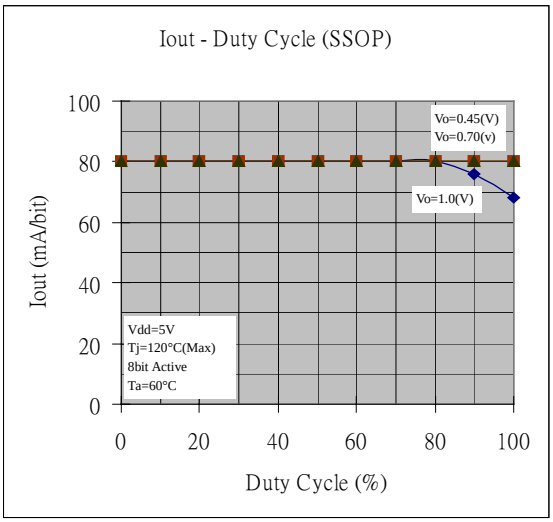
2. CLOCK-LATCH

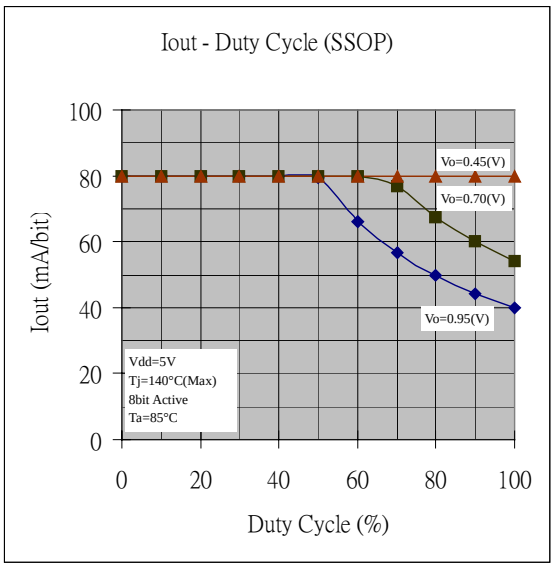


3. $\overline{\text{ENABLE}}$-OUTn




Iout - Duty Cycle (SSOP)
Iout (mA/bit)
Duty Cycle (%)
Vo=0.45(V)
Vo=0.70(V)
Vo=0.95(V)
Vdd=5V
Tj=120°C(Max)
8bit Active
Ta=25°C


Iout - Duty Cycle (SSOP)
Iout (mA/bit)
Duty Cycle (%)
Vo=0.45(V)
Vo=0.70(v)
Vo=1.0(V)
Vdd=5V
Tj=120°C(Max)
8bit Active
Ta=60°C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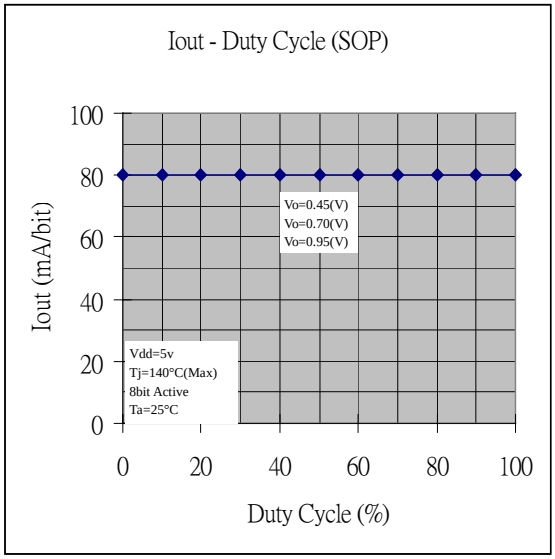
Iout (mA/bit)
Duty Cycle (%)
Vo=0.45(V)
Vo=0.70(V)
Vo=0.95(V)
Vdd=5V
Tj=140°C(Max)
8bit Active
Ta=85°C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8bit Active
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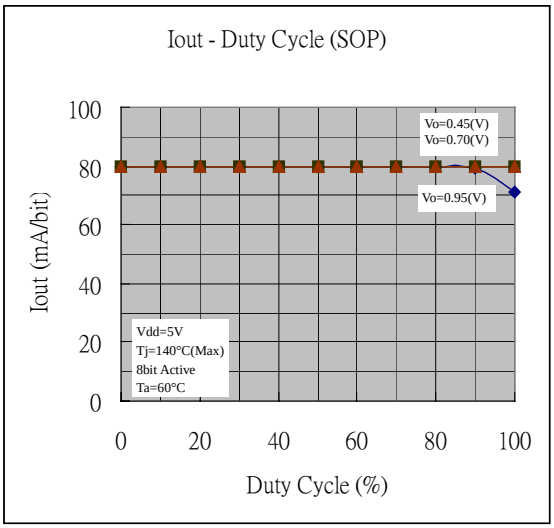
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8bit Active
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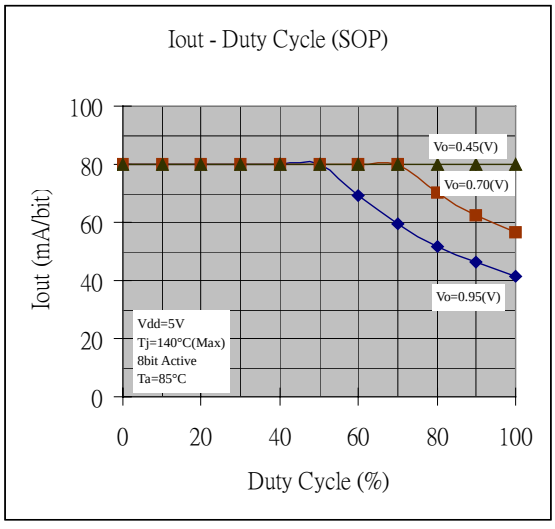
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Iout (mA/bit)
Duty Cycle (%)
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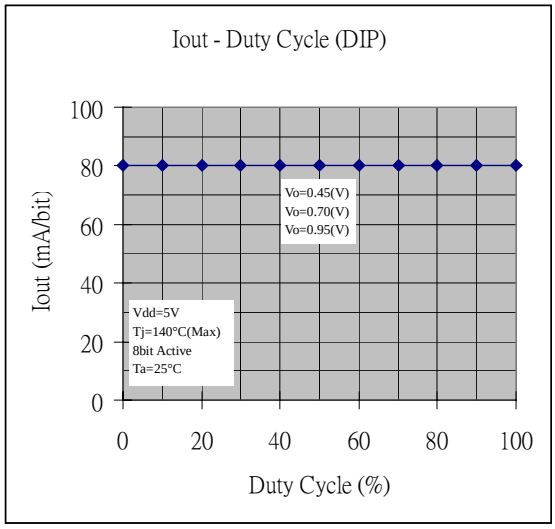
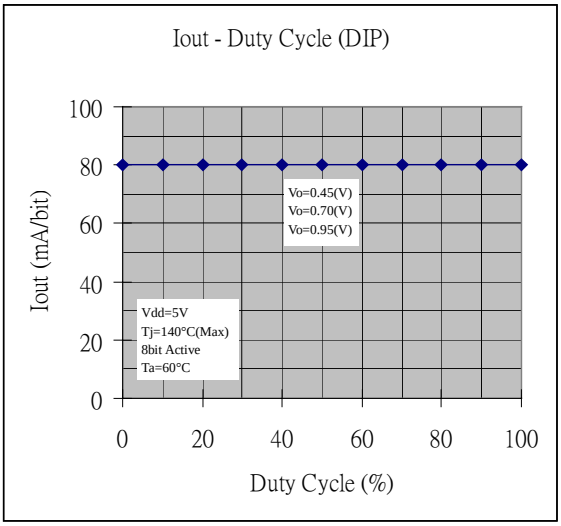
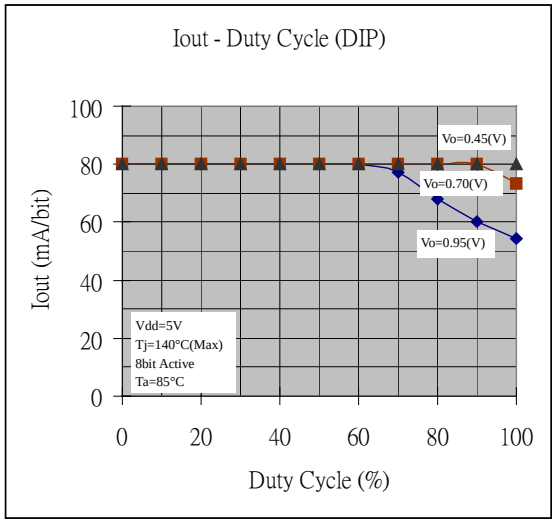
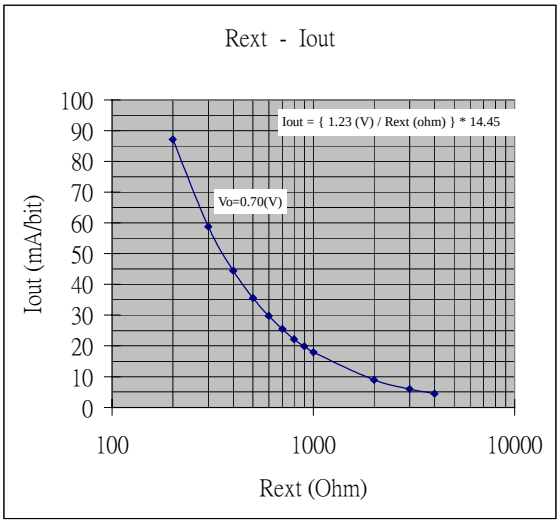
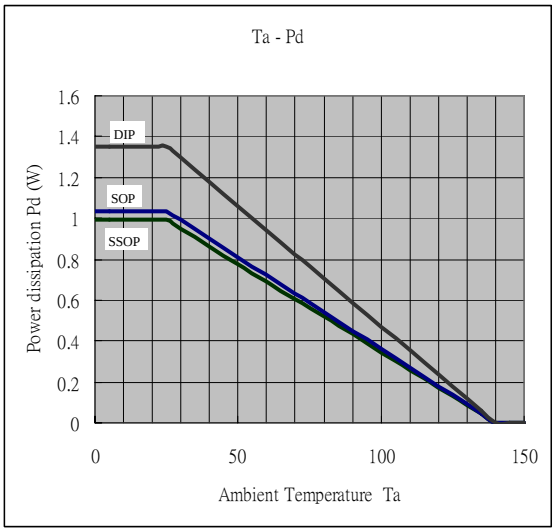
Vdd=5V
Tj=140°C(Max)
8bit Active
Ta=85°C

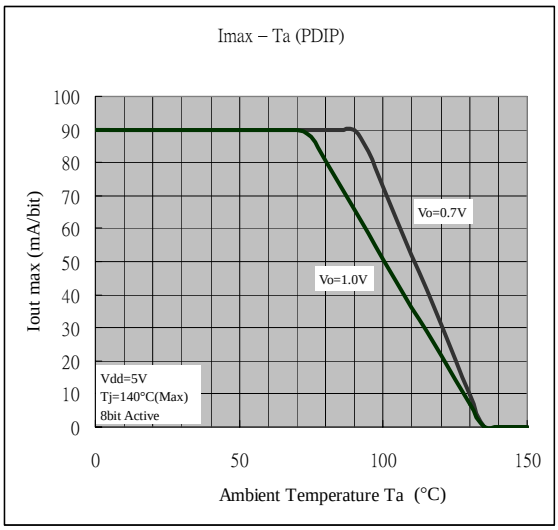

Iout - Duty Cycle (DIP)
Iout (mA/bit)
100
80
60
40
20
0
0
20
40
60
80
100
Duty Cycle (%)
Vo=0.45(V)
Vo=0.70(V)
Vo=0.95(V)
Vdd=5V
Tj=140°C(Max)
8bit Active
Ta=25°C

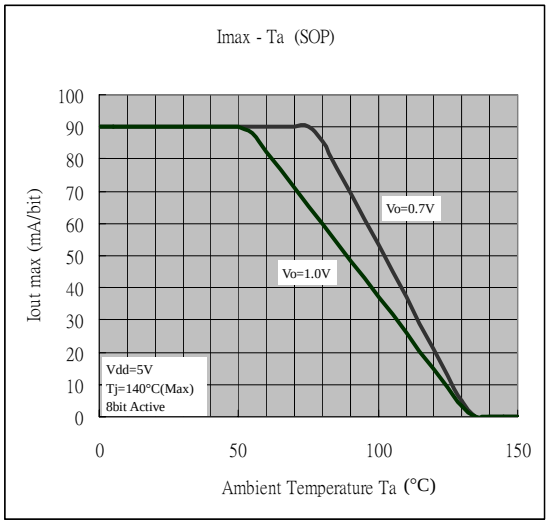

Iout - Duty Cycle (DIP)
Iout (mA/bit)
100
80
60
40
20
0
0
20
40
60
80
100
Duty Cycle (%)
Vo=0.45(V)
Vo=0.70(V)
Vo=0.95(V)
Vdd=5V
Tj=140°C(Max)
8bit Active
Ta=60°C

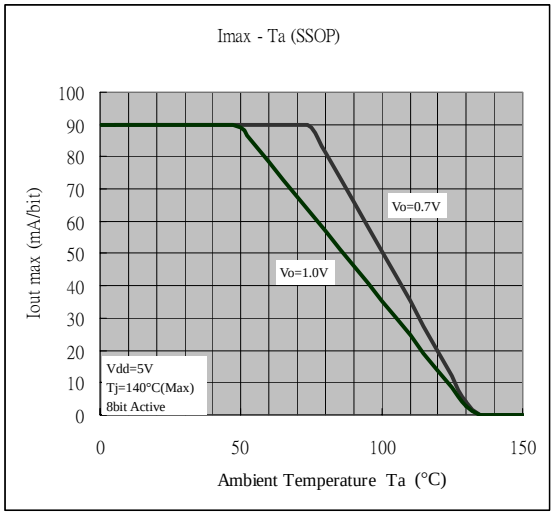

Iout - Duty Cycle (DIP)
Iout (mA/bit)
100
80
60
40
20
0
0
20
40
60
80
100
Duty Cycle (%)
Vo=0.45(V)
Vo=0.70(V)
Vo=0.95(V)
Vdd=5V
Tj=140°C(Max)
8bit Active
Ta=85°C


Rext - Iout
Iout (mA/bit)
100
90
80
70
60
50
40
30
20
10
0
100
1000
10000
Rext (Ohm)
Iout = { 1.23 (V) / Rext (ohm) } * 14.45
Vo=0.70(V)


Ta - Pd
Power dissipation Pd (W)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
Ambient Temperature Ta
DIP
SOP
SSOP







Note

As the power dissipation of a semiconductor chip is limited its package and ambient temperature, this device requires a maximum output current be calculated for a given operating condition. The maximum allowable power consumption (Pd (max)) of this device is calculated as follows:

$$Pd(\max)(Watt) = \frac{(\text{Tj (junction temperature) (max)} - \text{Ta (ambient temperature)})(^{\circ}C)}{\text{Rth}\ (^{\circ}C/Watt)}$$

Based on the Pd (max), the maximum allowable current can be calculated as follows:

$$\text{Iout} = (\text{Pd} - V_{DD} \cdot I_{DD}) / (\#\ \text{outputs} \cdot \text{Vo} \cdot \text{Duty})$$

System Configuration Example

[1] Output current (I_{OUT})

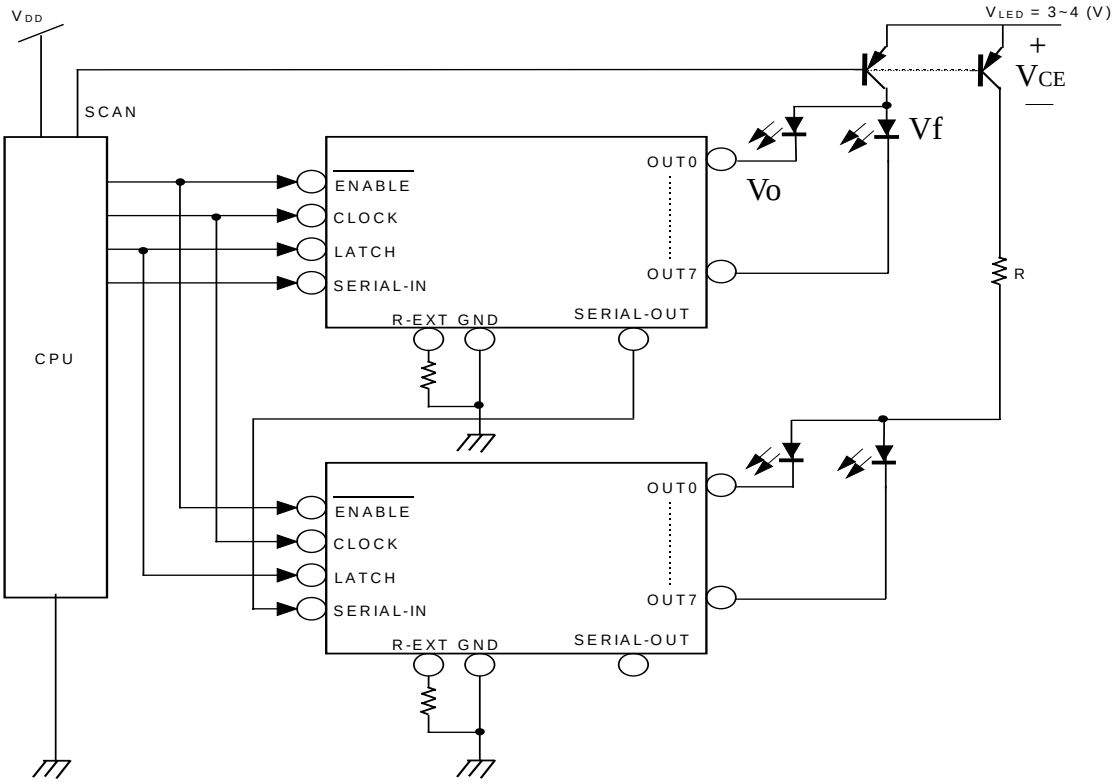
Sink current is set by the external resistor as shown in figure (Iout vs. Rext).

[2] LED supply voltage (V_{LED}) setup

$$V_{LED} = V_{CE}\ (\mathrm{T_r}\ V_{sat}) + V_f\ (\text{LED forward voltage}) + V_O\ (\text{IC supply voltage})$$

To prevent too much power dissipated by the device due to higher V_{LED} , an additional R can be used to reduce the Vout when the outputs consume current:

$$R = \frac{V_{LED} - V_f - V_O(\min)}{I_O(\max) \bullet Bit(\max)}$$



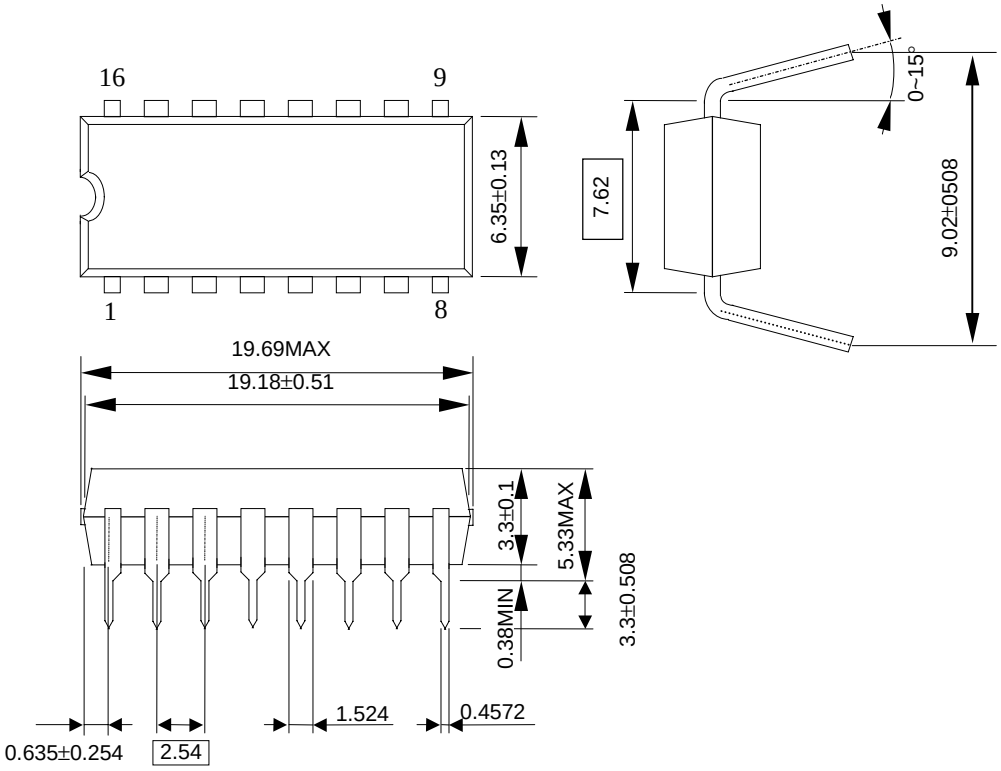
Note

This device has only one ground pin shared by signal, output sink current, and power ground. It is advisable to pattern the ground layout with minimized inductance such that the switching noise induced by the input signals and the output sink current would not cause chip malfunction. To prevent the drivers' outputs from damage by overshoot stress, it is also advisable not to turn off the drivers and scan transistors simultaneously.

Package Outline

PDIP16 (ST2221A-1)

Unit: mm

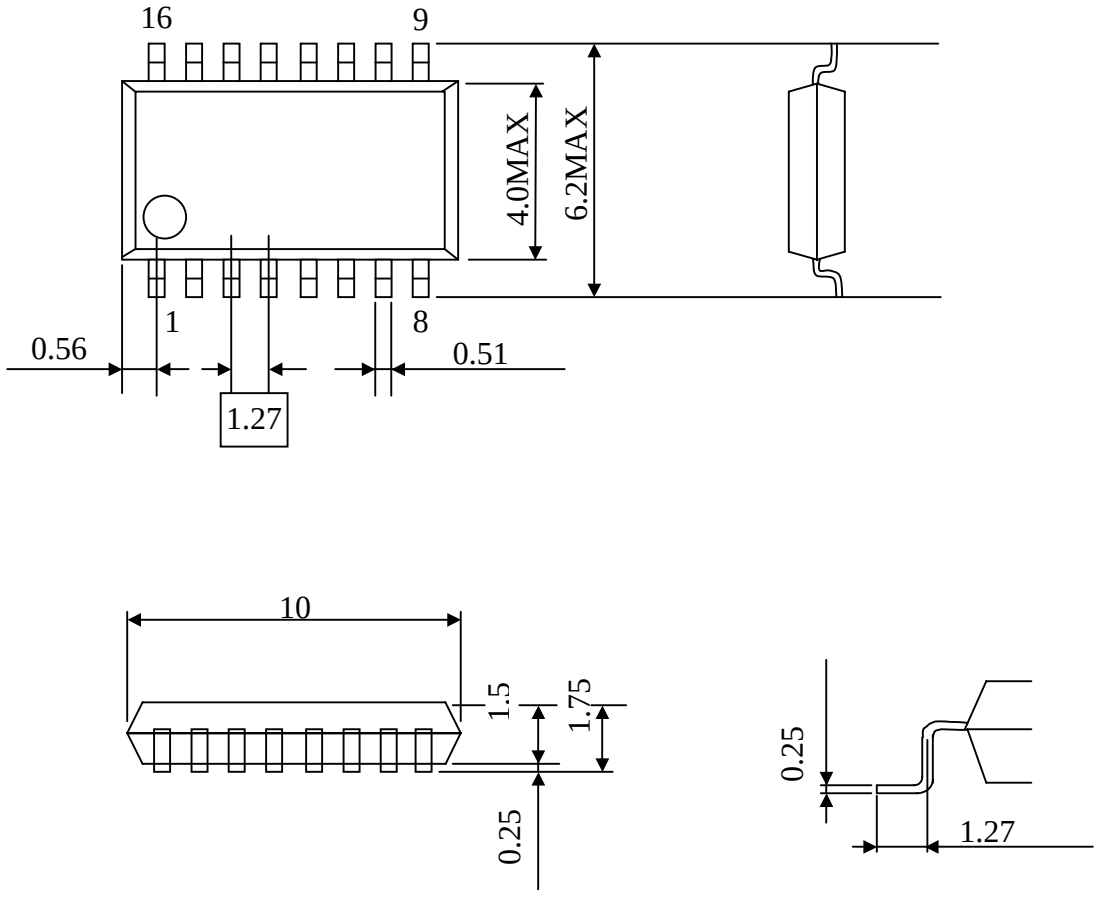


Weight : 1.11g(Typ.)

Package Outline

SOP16 (ST2221A-3)

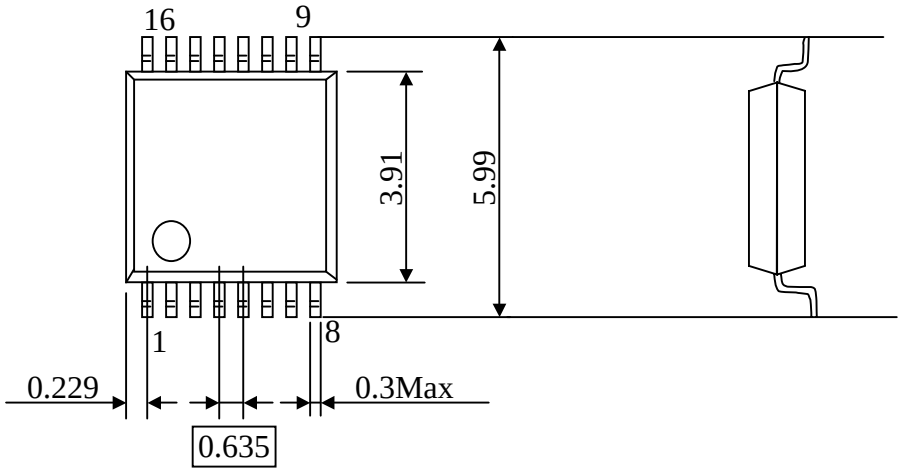
Unit: mm

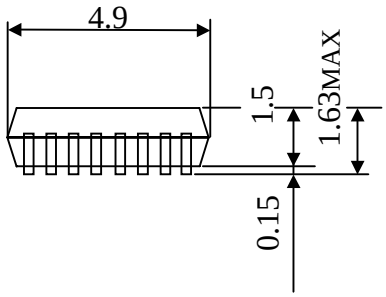


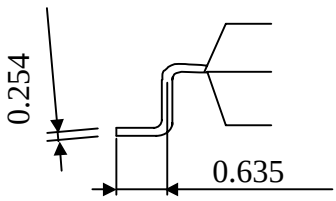
Package Outline

SSOP16 (ST2221A-2)

Unit: mm







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