



**8-BIT CONSTANT CURRENT LED DRIVER**

**GENERAL DESCRIPTION**

The SM16705P/F/FN are specifically designed for LED display constant current drivers.

This constant current output circuits is able to setup by external resistor ( $I_{OUT} = 5 \sim 90mA$ ).

This IC is monolithic integrated circuit designed to be used together with Bi-CMOS process.

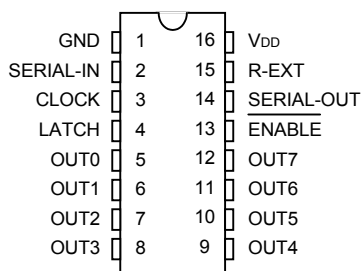
The devices consist of 8bit shift register, latch, AND-GATE and Constant Current Drivers.

**FEATURES**

- \* Constant Current Output :  
can setup all output current with one resistor for 5 to 90mA.
- \* Maximum Clock Frequency :  
 $f_{CLK} = 25$  (MHz)  
(Cascade Connect Operate,  
 $T_{opr} = 25^{\circ}C$ )
- \* 5V CMOS Compatible Input
- \* 16 pin DIP, SOP or SSOP package
- \* Constant Output Current Matching :

Output-GND Voltage	Current Matching	Output Current
$\geq 0.4V$	$\pm 6.0\%$	5 ~ 40mA
$\geq 0.7V$	$\pm 6.0\%$	5 ~ 90mA

**PIN ASSIGNMENTS**



SM16705

Part Number	Package Type
SM16705P	16pin DIP
SM16705F	16pin SOP
SM16705FN	16pin SSOP

**8-BIT CONSTANT CURRENT LED DRIVER****PIN DESCRIPTION**

Pin NO.	I / O	Pin Name	Function Description
1		GND	GND terminal
2	I	SERIAL-IN	Terminal of serial-data input to the shift register.
3	I	CLOCK	Input terminal of a clock for shift register on rising edge.
4	I	LATCH	Input terminal of data strobe. Latches pass data with "H" level input of LATCH-terminal, and hold data with "L" level input.
5~12	O	OUT0~7	Current-sinking output terminals.
13	I	$\overline{\text{ENABLE}}$	Input terminal of output enable. All outputs (OUT0~7) do off with "H" level input of $\overline{\text{ENABLE}}$ -terminal and do on with "L" level input.
14	O	SERIAL-OUT	Output terminal of serial-data for next SERIAL-IN terminal.
15	I / O	R-EXT	An external resistor at this terminal establishes all of the output current.
16		VDD	5V supply voltage terminal.



**8-BIT CONSTANT CURRENT LED DRIVER**

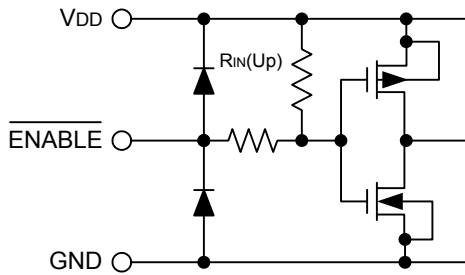
**TRUTH TABLE**

CLOCK	LATCH	ENABLE	SERIAL-IN	OUT0 ... OUT5 ... OUT7	SERIAL-OUT
UP	H	L	$D_n$	$D_n \dots D_{n-5} \dots D_{n-7}$	$D_{n-7}$
UP	L	L	$D_{n+1}$	No change	$D_{n-6}$
UP	H	L	$D_{n+2}$	$D_{n+2} \dots D_{n-3} \dots D_{n-5}$	$D_{n-5}$
DOWN	X	L	$D_{n+3}$	$D_{n+2} \dots D_{n-3} \dots D_{n-5}$	$D_{n-5}$
DOWN	X	H	$D_{n+3}$	Off	$D_{n-5}$

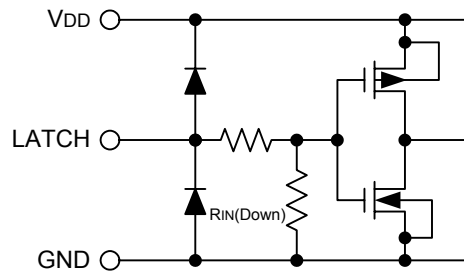
Note : 1. OUT0~7=on when Dn="H" ; OUT0~7=off when Dn="L".  
 2. In order to ensure that the level of the power supply voltage is correct, an external resistor must be connected between R-EXT and GND.

**EQUIVALENT CIRCUIT OF INPUTS AND OUTPUTS**

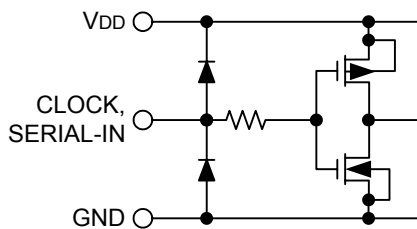
**1. ENABLE terminal**



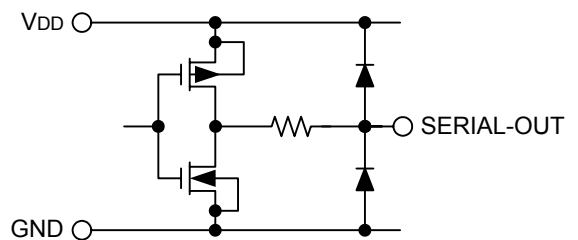
**2. LATCH terminal**



**3. CLOCK, SERIAL-IN terminal**



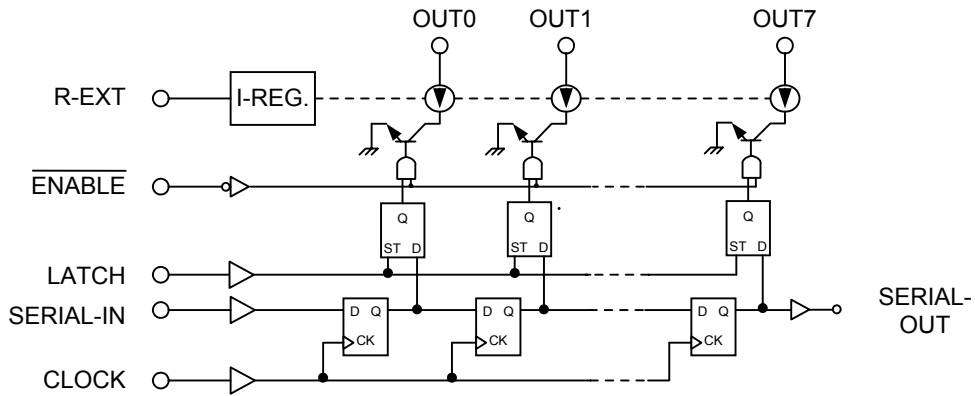
**4. SERIAL-OUT terminal**



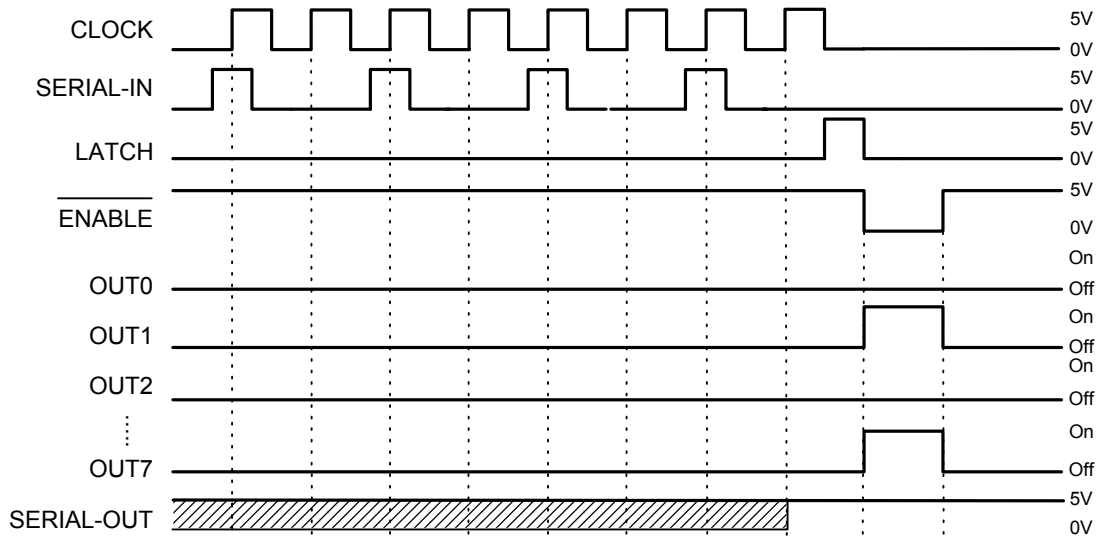


**8-BIT CONSTANT CURRENT LED DRIVER**

**BLOCK DIAGRAM**



**TIMING DIAGRAM**



Note : Latches are level sensitive, not rising edges sensitive and not synchronous CLOCK.  
Input of LATCH-terminal to H Level, data passes latches, and input of LATCH -terminal to L level, data hold latches.  
Input of ENABLE-terminal to H Level, all output (OUT0 ~ 7) do off.

**8-BIT CONSTANT CURRENT LED DRIVER****MAXIMUM RATINGS (Ta = 25°C)**

Characteristic	Symbol	Rating	Unit
Supply Voltage	VDD	0 ~ 7.0	V
Input Voltage	VIN	- 0.4 ~ VDD +0.4	V
Output Current	IOUT	90	mA
Output Voltage	VOUT	- 0.5 ~ 20.0	V
Clock Frequency	fCLK	25	MHz
GND Terminal Current	IGND	720	mA
Power Dissipation	PD	1.47 (DIP : FREE AIR, Ta = 25°C)	W
		0.78 (SOP/ SSOP : ON PCB, Ta = 25°C)	
Thermal Resistance	Rth (j-a)	85 (DIP : FREE AIR, Ta = 25°C)	°C / W
		160 (SOP/ SSOP : ON PCB, Ta = 25°C)	
Operating Termerature	Topr	-40 ~ 85	°C
Storage Temperature	Tstg	-55 ~ 150	°C

(Note) DIP : Ambient temperature derated above 25°C in the proportion of 11.8mW / °C  
 SOP/ SSOP: Ambient temperature derated above 25°C in the proportion of 6.3mW / °C

**RECOMMENDED OPERATING CONDITION (Ta = -40 ~ 85°C unless otherwise noted)**

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	–	4.5	5.0	5.5	V
Output Voltage	VOUT	–	–	–	15.0	V
Output Current	IO	OUTn,DC test circuit	5	–	88	mA
	IOH	SERIAL-OUT	–	–	1.0	
	IOL	SERIAL-OUT	–	–	-1.0	
Input Voltage	VIH	–	0.7 VDD	–	VDD +0.3	V
	VIL	–	-0.3	–	0.3 VDD	
LATCH Pulse Width	tw LAT	VDD = 4.5 ~ 5.5V	20	–	–	ns
CLOCK Pulse Width	tw CLK		20	–	–	ns
ENABLE Pulse Width	tw EN		2000	–	–	ns
Set-up Time for DATA	tsetup(D)		20	–	–	ns
Hold Time for DATA	t hold (D)		20	–	–	ns
Set-up Time for LATCH	tsetup(L)		20	–	–	ns
Clock Frequency	fCLK		Cascade operation	–	–	25
Power Dissipation	PD	Ta = 85°C(DIP FREE AIR)	–	–	0.82	W
		Ta = 85°C (SOP/ SSOP ON PCB)	–	–	0.40	



**8-BIT CONSTANT CURRENT LED DRIVER**

**ELECTRICAL CHARACTERISTICS (V<sub>DD</sub> = 5.0V, Ta = 25°C unless otherwise noted)**

Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit	
Input Voltage	"H" Level	V <sub>IH</sub>	–	0.7 V <sub>DD</sub>	–	V <sub>DD</sub>	V	
	"L" Level	V <sub>IL</sub>	–	GND	–	0.3 V <sub>DD</sub>		
Output Leakage Current		I <sub>OH</sub>	V <sub>OH</sub> = 15.0V	–	–	10	μA	
Output Voltage	SERIAL-OUT	V <sub>OL</sub>	I <sub>OL</sub> = 1.0mA	–	–	0.4	V	
		V <sub>OH</sub>	I <sub>OH</sub> = -1.0mA	4.6	–	–		
Output Current 1		I <sub>OL1</sub>	V <sub>CE</sub> = 0.7V	R <sub>EXT</sub> = 470Ω (Include skew)	34.1	40.0	45.9	mA
		I <sub>OL2</sub>	V <sub>CE</sub> = 0.4V		33.7	39.5	45.3	
	Current Skew	Δ I <sub>OL1</sub>	I <sub>OUT</sub> = 40mA V <sub>CE</sub> = 0.4V	R <sub>EXT</sub> = 470Ω	–	± 1.5	± 4.0	%
Output Current 2		I <sub>OL3</sub>	V <sub>CE</sub> = 0.7V	R <sub>EXT</sub> = 240Ω	66.3	78.0	89.7	mA
	Current Skew	Δ I <sub>OL2</sub>	I <sub>OUT</sub> = 75mA V <sub>CE</sub> = 0.7V	R <sub>EXT</sub> = 240Ω	–	± 1.5	± 4.0	%
Supply Voltage Regulation		% / V <sub>DD</sub>	R <sub>EXT</sub> = 470Ω, Ta = -40 ~ 85°C	–	2.5	5.0	% / V	
Pull-Up Resistor		R <sub>IN</sub> (up)	–	150	300	600	KΩ	
Pull-Down Resistor		R <sub>IN</sub> (down)	–	100	200	400	KΩ	
Supply Current	"OFF"	I <sub>DD</sub> (off) 1	R <sub>EXT</sub> = OPEN, OUT0 ~ 7 = off	–	0.6	1.2	mA	
		I <sub>DD</sub> (off) 2	R <sub>EXT</sub> = 470Ω, OUT0 ~ 7 = off	3.5	5.0	8.0		
		I <sub>DD</sub> (off) 3	R <sub>EXT</sub> = 240Ω, OUT0 ~ 7 = off	6.5	8.0	15.0		
	"ON"	I <sub>DD</sub> (on) 1	R <sub>EXT</sub> = 470Ω, OUT0 ~ 7 = on	7.0	8.0	18.0		
		V <sub>DD</sub> (on) 2	R <sub>EXT</sub> = 240Ω, OUT0 ~ 7 = on	10.0	15.0	32.0		



**8-BIT CONSTANT CURRENT LED DRIVER**

**SWITCHING CHARACTERISTICS (Ta = 25 °C unless otherwise noted)**

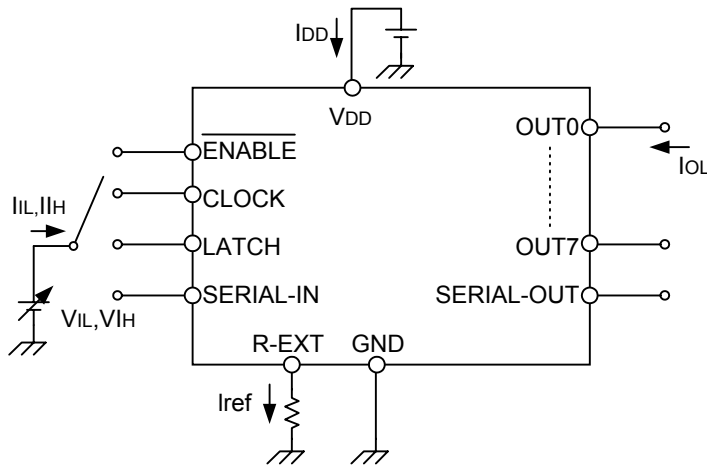
Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit	
Propagation Delay Time ("L" to "H")	SERIAL-IN-OUTn	tpLH	VDD = 5.0V REXT = 470Ω VL = 3.0V RL = 62Ω CL = 10 pF	–	400	800	ns	
	LATCH-OUTn			–	400	800		
	ENABLE-OUTn			–	400	800		
	CLOCK -SERIAL-OUT			–	20	40		
Propagation Delay Time ("H" to "L")	SERIAL-IN-OUTn	tpHL		VDD = 5.0V REXT = 470Ω VL = 3.0V RL = 62Ω CL = 10 pF	–	200	400	ns
	LATCH-OUTn				–	200	400	
	ENABLE-OUTn				–	200	400	
	CLOCK -SERIAL-OUT				–	20	40	
Output Rise Time		tor	VDD = 5.0V REXT = 470Ω VL = 3.0V RL = 62Ω CL = 10 pF		150	300	600	ns
Output Fall Time		tof			150	300	600	



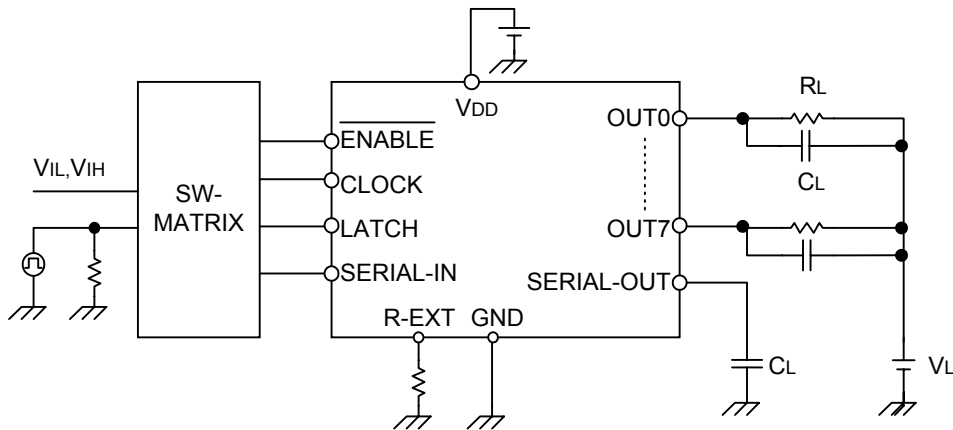
**8-BIT CONSTANT CURRENT LED DRIVER**

**TEST CIRCUIT**

DC Characteristic



AC Characteristic



**PRECAUTIONS FOR USING**

Utmost care is necessary in the design of the output line, VDD and GND line, since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

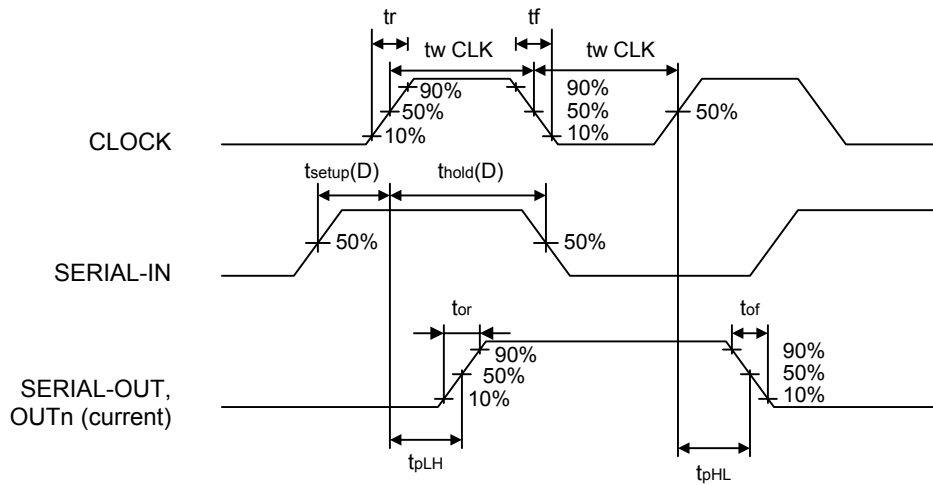




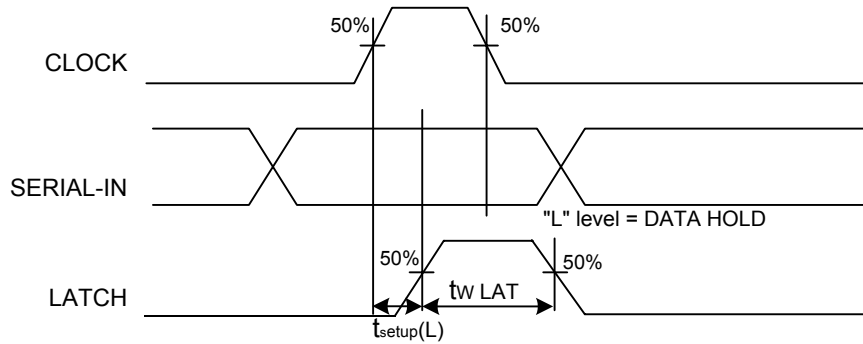
8-BIT CONSTANT CURRENT LED DRIVER

TIMING WAVEFORM

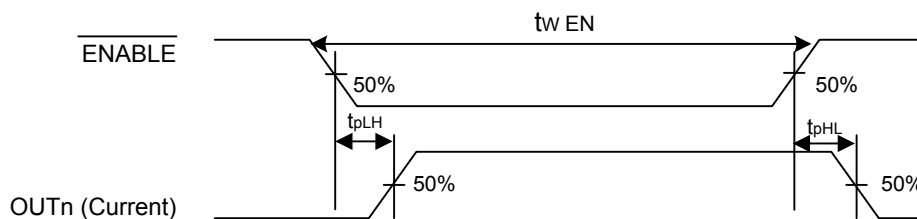
1. CLOCK, SERIAL-IN, SERIAL-OUT, OUTn



2. CLOCK-LATCH



3. ENABLE-OUTn

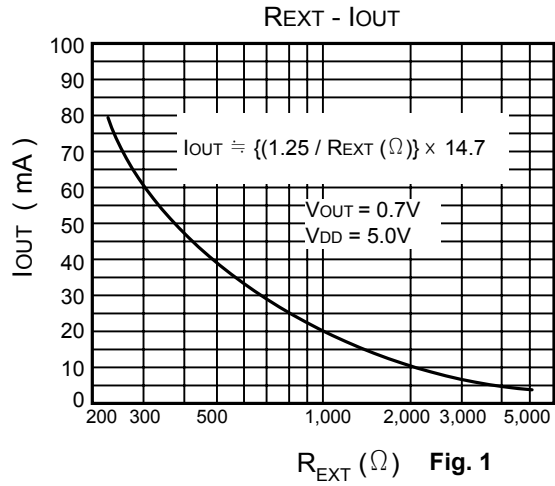
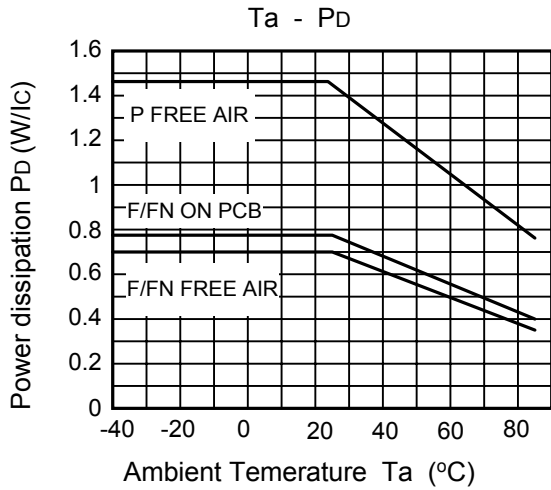




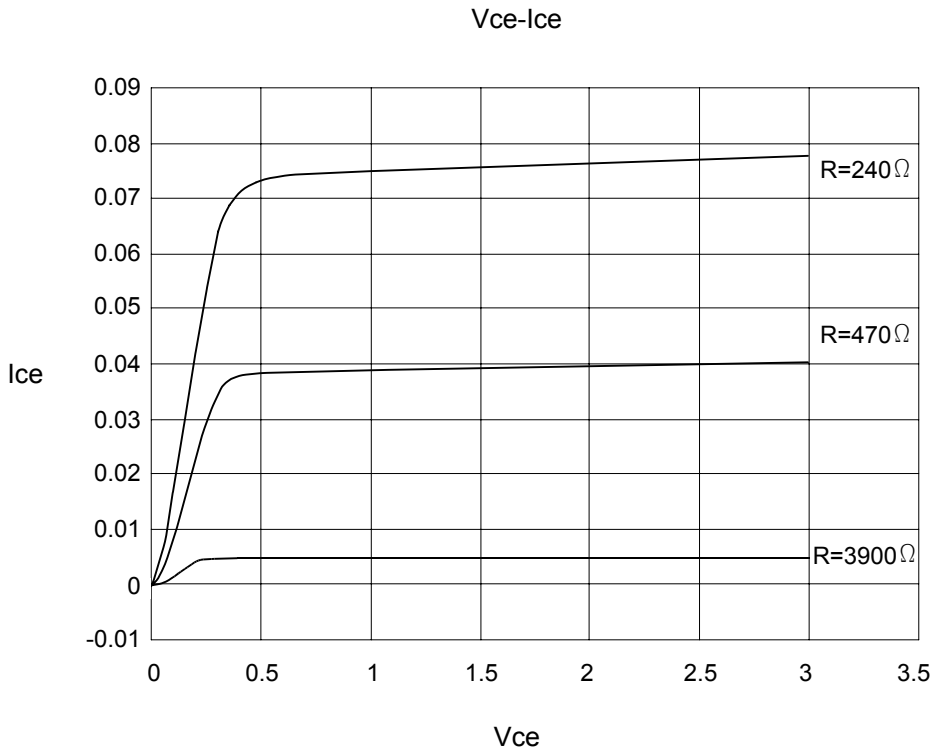
**8-BIT CONSTANT CURRENT LED DRIVER**

**Output Current - Duty (LED turn-on rate)**

**Output Current - R<sub>EXT</sub> Resistor**



**Output Current - Output Voltage**



**8-BIT CONSTANT CURRENT LED DRIVER****[1] Output Current (I<sub>OUT</sub>)**

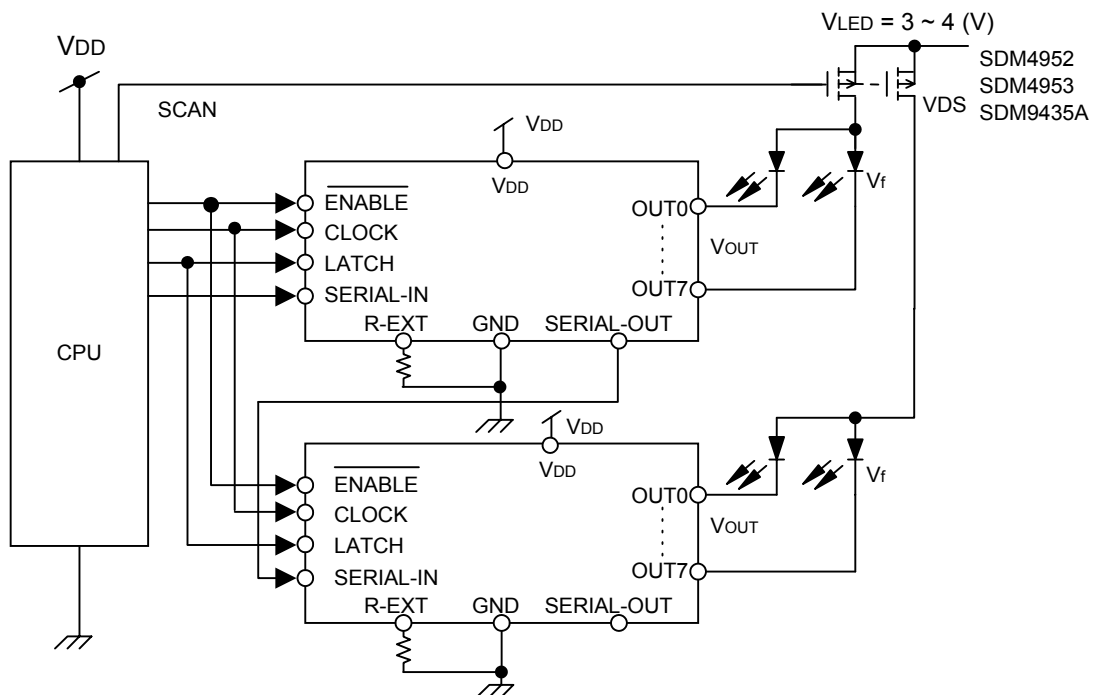
I<sub>OUT</sub> is set by the external resistor (R-EXT) as shown in Figure 1.

**[2] Total supply voltage (V<sub>LED</sub>)**

This device can operate at 0.4~0.7V (V<sub>OUT</sub>). When a higher voltage is input to the device, the excess voltage is consumed inside the device, that leads to more power dissipation. In order to minimize power dissipation and loss, we would like to recommend to set the total supply voltage as shown below,

$$V_{LED} \text{ (total supply voltage)} = V_{OUT} \text{ (IC Supply Voltage)} + V_f \text{ (LED Forward voltage)} + V_{DS} \text{ (MOSFET Voltage Drop)}$$

When the total supply is too high considering the power dissipation of this device, an additional R can decrease the supply voltage (V<sub>OUT</sub>).

**PATTERN LAYOUT****[3] Pattern Layout**

This device has only one ground pin that means signal ground pin and power ground pin are common. If ground pattern layout contains large inductance and impedance, and the voltage between ground and LATCH, CLOCK terminals exceeds 2.5V by switching noise during operation, this device may miss-operate. So we would advise you to pay attention to pattern layout to minimize ground inductance.

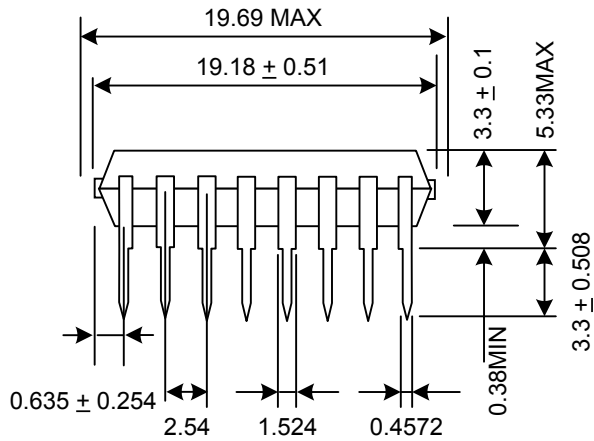
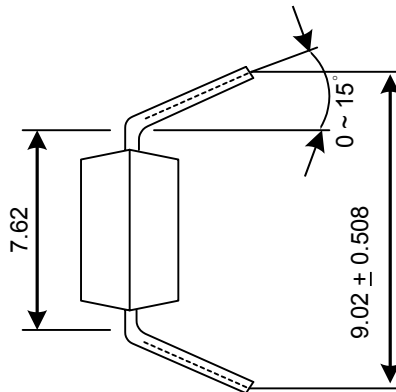
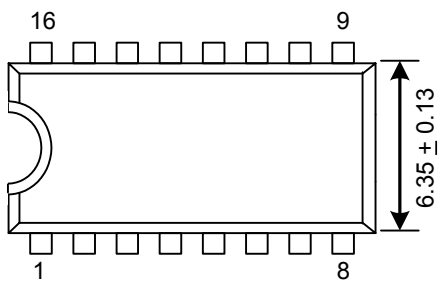


**8-BIT CONSTANT CURRENT LED DRIVER**

**PACKAGE OUTLINE**

SM16705P 16 PIN DIP

Unit : mm



Weight: 1.11g(Type)

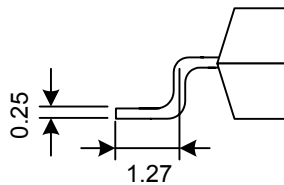
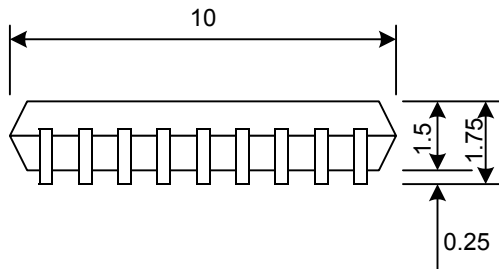
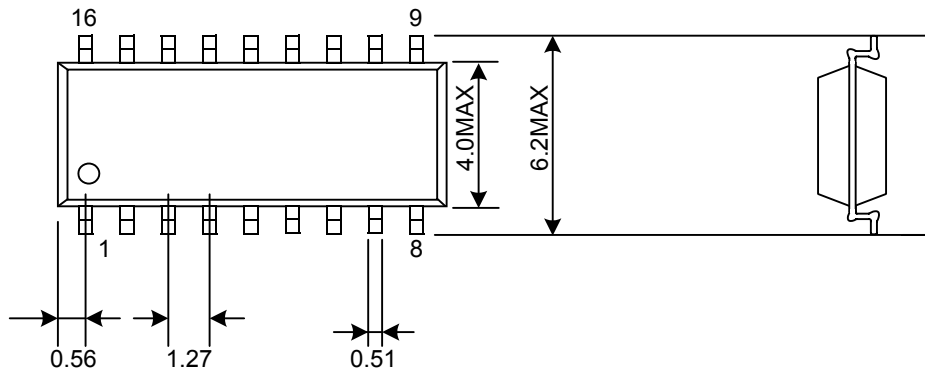


**8-BIT CONSTANT CURRENT LED DRIVER**

**PACKAGE OUTLINE**

SM16705F 16 PIN SOP

Unit : mm





**8-BIT CONSTANT CURRENT LED DRIVER**

**PACKAGE OUTLINE**

SM16705FN 16 PIN SSOP

Unit : mm

