



Revision History

<u>Rev. No.</u>	<u>History</u>	<u>Issue Date</u>
1.0	New issue	June 1, 2009
1.1	Format modify	Oct. 20, 2010

CS8903(AD)

3-Channel Constant-Current LED Driver with Built-In PWM Control

■ **Description**

CS8903 is a 3-channel PWM enabled LED driver IC, which is designed for LED lighting or display applications. At CS8903 output channel, 3-channel constant current value set is adjustable with 3 corresponding external resistors and the internal PWM control circuitry to match RGB color characteristics. CS8903 built in a voltage regulator, which provides supply voltage range from 6.0V to 24V, and built in an oscillator for PWM functioning. Data (DAO) and clock (CKO) buffer outputs are designed for cascading another chip. In addition, CS8903 guarantees to stand maximum 24V at the output channel.

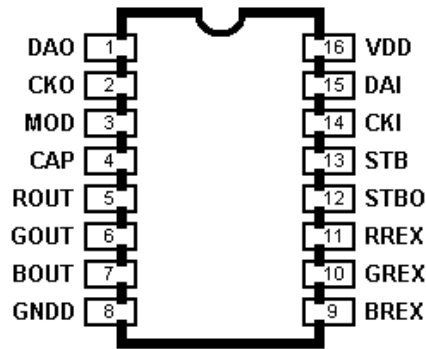
■ **Feature**

- 3 constant current channels for RGB each
- Maximum output current capability: 60mA each channel
- Range of constant current for every channel: 5mA ~ 60mA
- Maximum series-in clock frequency: 20MHz
- Built-in buffers for cascading control signal data (DAO) and clock (CKO) to next driver IC
- Built-in voltage regulator working with supply voltage ranging from 6V to 24V
- PWM free-running capability: refresh rate 290Hz with internal oscillator 4.76MHz.
- Selectable modes for PWM control:
 - ◆ 8-bits luminance data with PWM current outputs (8 bits mode)
 - ◆ 8-bits luminance data and 6-bits global brightness data (14 bits mode)
 - ◆ 8-bits luminance data and 5-bits individual color correction data (13 bits mode)
- Output current accuracy:
 - ◆ Bit-bit skew: <+/-6%
 - ◆ IC-IC skew: <+/-6%
- Maximum output drain voltage: 24V
- For common anode LED application
- CMOS/TTL compatible input

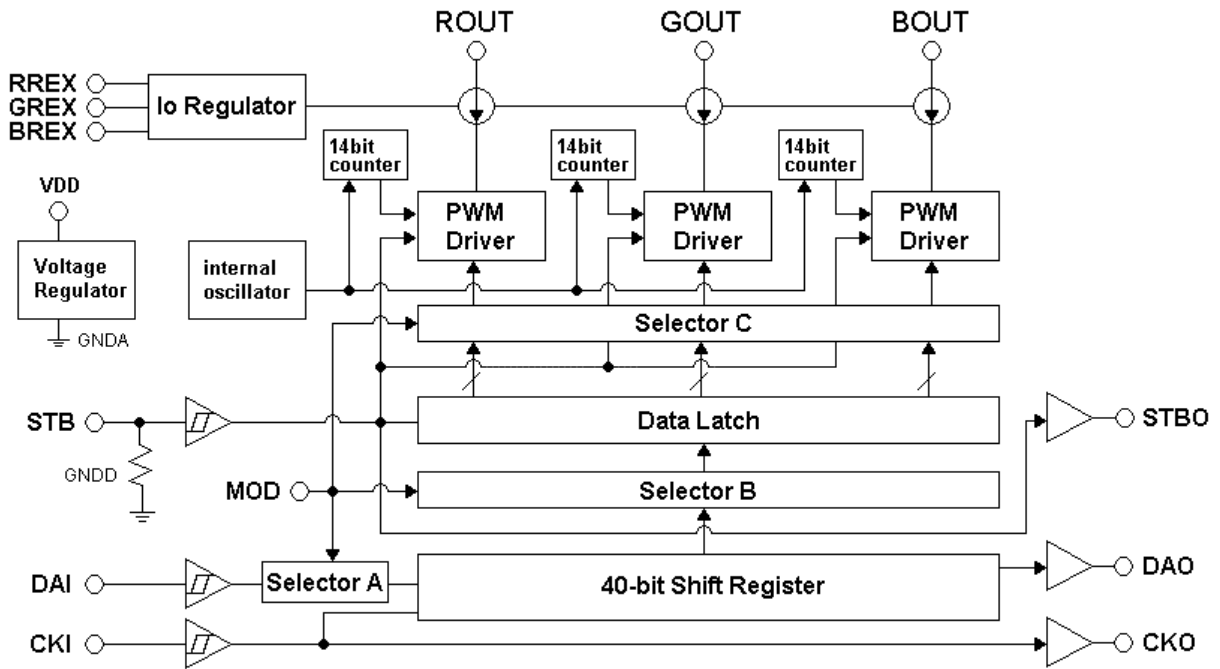
■ **Product Family**

CS8903AD ----- 16SSOP-150mil

■ Pin Assignment

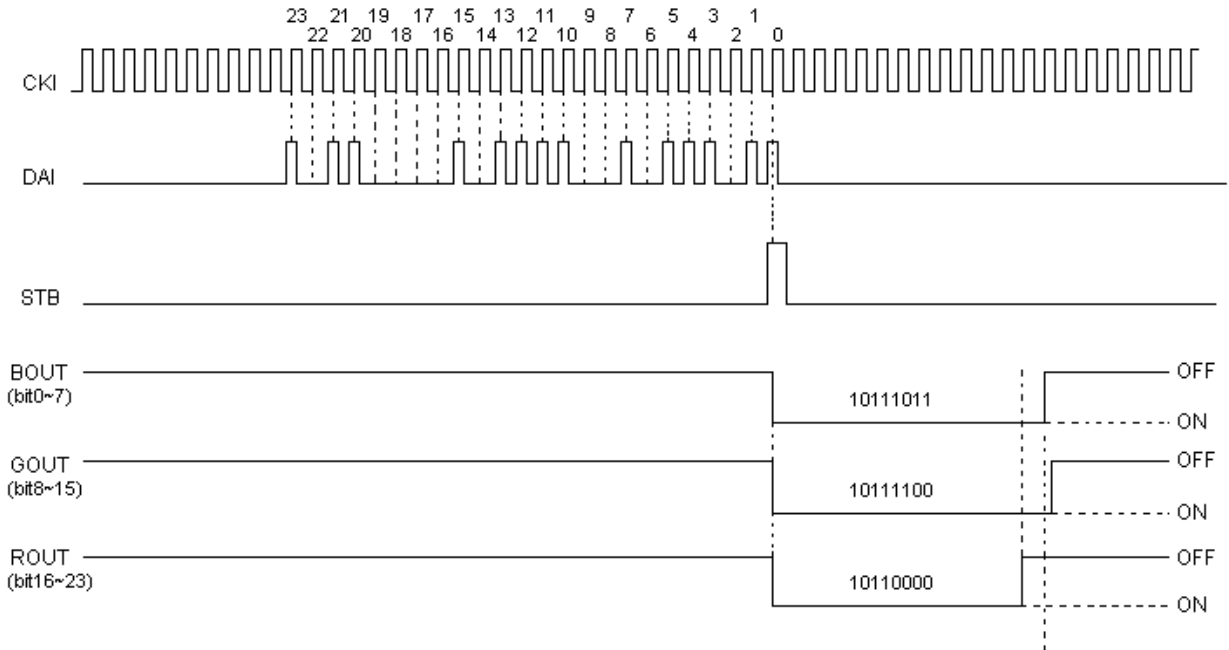


■ Block Diagram

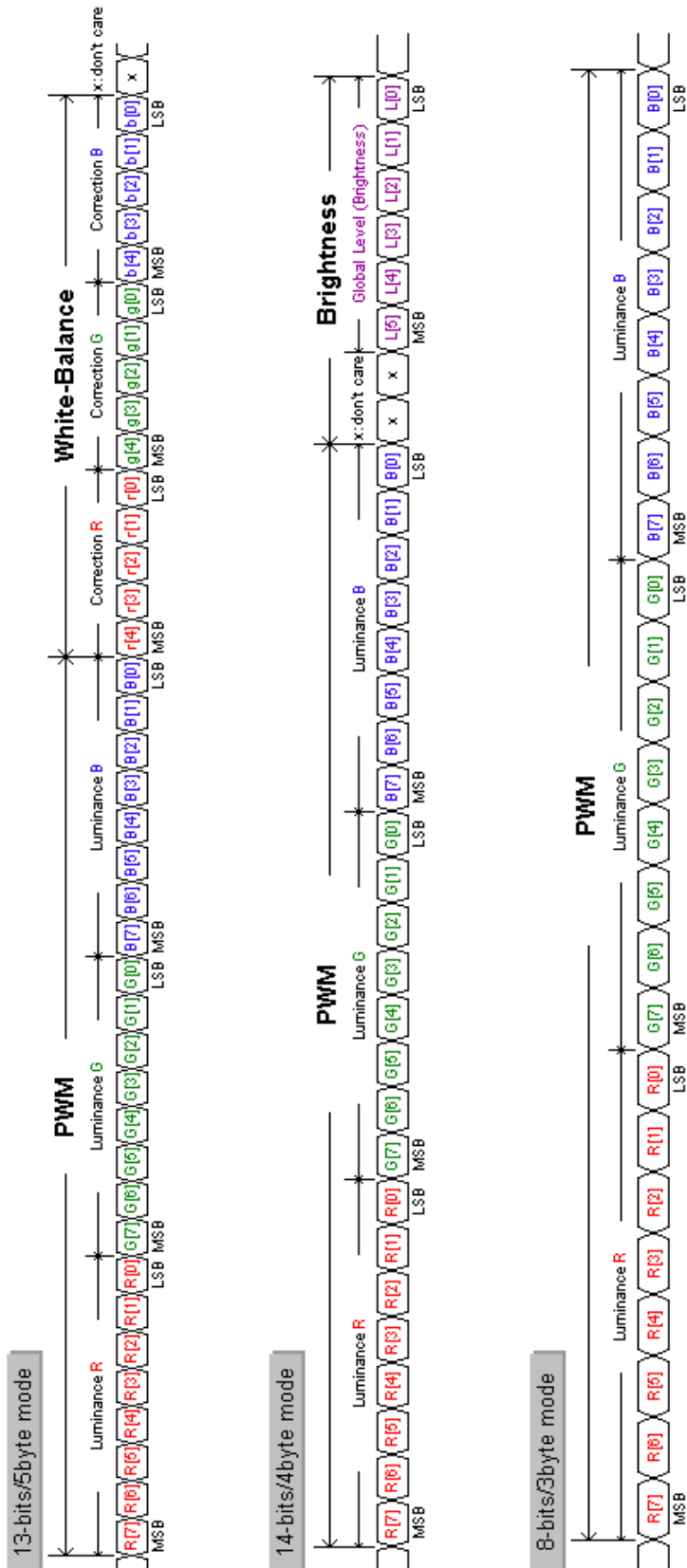


■ Timing Diagram

(e.g.) 8-bits/3 bytes mode:



■ Data Format



■ Pin Description

Pin No.	Pin Name	Function
1	DAO	Serial data output terminal to be connected to the DAI of the next driver IC.
2	CKO	Clock output terminal, connected to the next CKI.
3	MOD	Input mode selection: 'H' for 13bits/5byte mode. (*1) 'L' for 14bits/4byte mode. 'Floating' for 8bits/3byte mode. (*2)
4	CAP	Terminal of Internal regulated power supply. (*3)
5~7	R(G,B)OUT	Constant current output terminal.
8	GNDD	Digital ground terminal.
9~11	R(G,B)REX	Input terminal used to connect an external resistor for setting up output current for all output channels.
12	STBO	Data strobe output terminal.
13	STB	Data strobe input terminal.
14	CKI	Clock input terminal for data shift on rising edge.
15	DAI	Serial data input terminal to the shift register.
16	VDD	Supply voltage terminal.

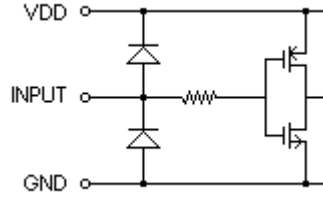
*1. 'H': CAP pin voltage

*2. When choosing "floating" mode, a capacitor (>100pF) should be connected between MOD and GND.

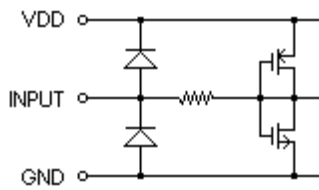
*3. a capacitor (>=4.7uF) is connected between pin4 and GND.

■ Equivalent Circuits of I/O Pins

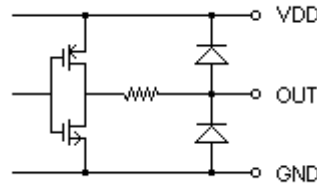
1. CKI, DAI, STB, DAO terminals



2. MOD



3. CKO, DAO terminals



■ Absolute Maximum Ratings

Characteristics	Symbol	Rating	Unit
Supply Voltage	V_{DD}	+28	V
Input Voltage	V_{IN}	-0.4~ V_{DD} +0.4	V
Output Current per Output Channel	I_{OUT}	+60	mA
Sustaining Voltage at OUT port	V_{DS}	24.0	V
GND Terminal Current	I_{GND}	180	mA
Power Dissipation at 25°C	P_D	1.2	W
Thermal Resistance	$R_{th(j-a)}$	74.43	°C/W
Operating Junction Temperature	$T_{j,max}$	150	°C
Operating Temperature	T_{opr}	-40~+85	°C
Storage Temperature	T_{stg}	-55~+150	°C



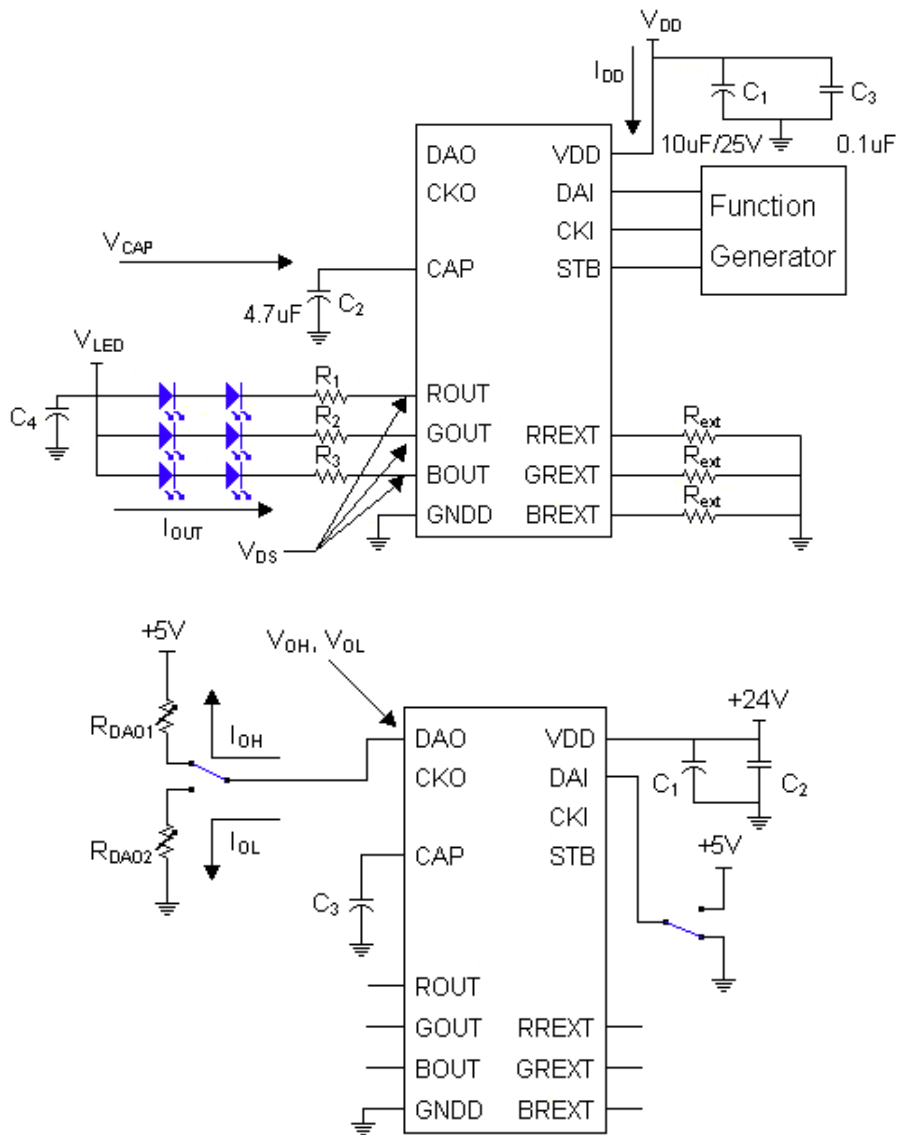
3 Bit 24V RGB LED Driver with PWM

CS8903

■ **Electrical Characteristics** (TA=25°C and V_{DD}=6.0~24.0V)

Characteristics		Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage		V _{DD}	-	6.0	-	24	V
Output Voltage of CAP		V _{CAP}	When V _{DD} =6V~24V	4.5	5	6.0	V
Input Voltage	“H” level	V _{IH}	V _{CAP} =5V under I _{OUT} ≤0.5μA	3.5	-	5	V
	“L” level	V _{IL}	V _{CAP} =5V under I _{OUT} ≤0.5μA	GND	-	1.4	V
Output Current		I _{OH}	DAO, CKO, STBO at V _{OH} =3.5V	-17	-	-	mA
		I _{OL}	DAO, CKO, STBO at V _{OL} =1.5V	20	-	-	mA
Sustaining Voltage		V _{DS,SUS}	ROUT~BOUT	-	-	24.0	V
Output Leakage Current		I _{OUT,LEAK}	V _{DD} =24V	-	-	1.0	μA
Voltage at signal output terminals	DAO, CKO,	V _{OL}	I _{OL} =+3.0mA	-	-	0.3	V
	STBO	V _{OH}	I _{OH} =-3.0mA	4	-	-	V
Output Current		I _{OUT}	DC Test Circuit, ROUT~BOUT	5	-	60	mA
Output Current 1		I _{OUT1}	V _{DS} =1.0V R _{ext} =590Ω	-	24	-	mA
Current Skew 1		dI _{OUT1}	I _{OUT} =24mA, V _{DS} =1.0V R _{ext} =590Ω	-	-	±6	%
Output Current 2		I _{OUT2}	V _{DS} =1.0V R _{ext} =1.22KΩ	-	12	-	mA
Current Skew 2		dI _{OUT2}	I _{OUT} =12mA, V _{DS} =1.0V R _{ext} =1.22KΩ	-	-	±6	%
Regulation of Output Current vs. Voltage at Output Ports		%/dV _{DS}	When V _{DS} is within 1.0V and 3.0V	-	±2	-	%/V
Regulation of Output Current vs. Supply Voltage Change		%/dV _{DD}	When V _{DD} is within 6.0V and 24.0V	-	±0.1	-	%/V
Voltage at RREXT,GREXT,BREXT pins		V _{REXT}	When V _{DD} is within 6.0V and 24.0V	1.1	1.2	1.3	V
Pull-down Resistor		R _{IN(down)}	STB, R _{IN(down)} =R _{IN1(down)} +R _{IN2(down)}	-	-	130	KΩ
Supply Current	“OFF”	I _{DD(off)1}	R _{ext} =Open, ROUT~BOUT=Off	-	-	10	mA
		I _{DD(off)2}	R _{ext} =350Ω, ROUT~BOUT=Off	-	-	33	
		I _{DD(off)3}	R _{ext} =590Ω, ROUT~BOUT=Off	-	-	24	
		I _{DD(off)4}	R _{ext} =1.22kΩ, ROUT~BOUT=Off	-	-	17	
	“ON”	I _{DD(on)1}	R _{ext} =350Ω, ROUT~BOUT=On	-	-	42	
		I _{DD(on)2}	R _{ext} =590Ω, ROUT~BOUT=On	-	-	35	
I _{DD(on)3}		R _{ext} =1.22kΩ, ROUT~BOUT=On	-	-	30		
Internal Oscillator Frequency		FOSC	-	-	4.76	-	MHz

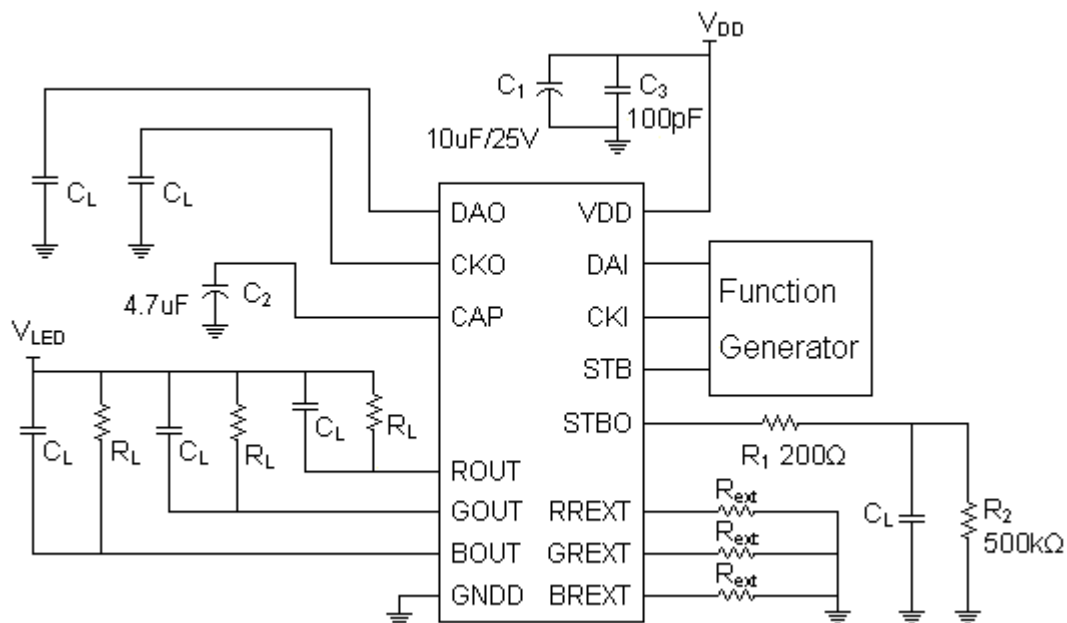
■ Test Circuit for Electrical Characteristics



■ Switching Characteristics

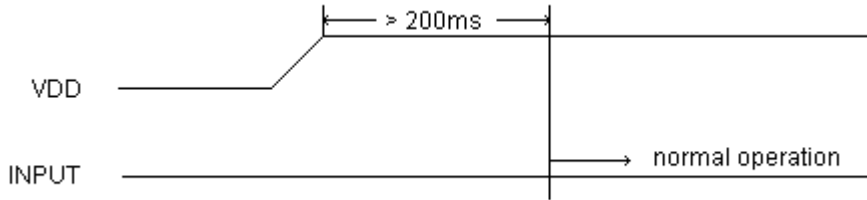
Characteristics		Symbol	Condition	Min	Typ	Max	Unit
Delay time ("L" to "H")	STB-STBO	t_{pLH1}	$T_A=25^{\circ}\text{C}$ $V_{DD}=24\text{V}$ $R_{ext}=700\Omega$ $(I_{OUT}=20\text{mA})$ $V_L=5\text{V}$ $R_L=180\Omega$ $C_L=10\text{pF}$	35	-	-	ns
	CKI-CKO			15	-	-	ns
Delay time ("H" to "L")	STB-STBO	t_{pHL1}		20	-	-	ns
	CKO-DAO	t_{pHL3}		-	3	10	ns
Rise Time	STBO	$t_{r(LT)}$		-	5	10	ns
	CKO	$t_{r(CK)}$		-	5	10	ns
	DAO	$t_{r(SDO)}$		-	180	220	ns
	Output Ports	t_{or}		-	3	10	ns
Fall Time	STBO	$t_{f(LT)}$		-	5	10	ns
	CKO	$t_{f(CK)}$		-	5	10	ns
	DAO	$t_{f(SDO)}$		-	6	100	ns
	Output Ports	t_{of}		0	-	-	ns
Hold Time	STB	$t_{h(L)}$		0	-	-	ns
	DAI	$t_{h(D)}$		0	-	-	ns
Setup Time	STB	$t_{su(L)}$	15	-	-	ns	
	DAI	$t_{su(D)}$	20	-	-	ns	
Pulse Width	STB	$t_{w(L)}$	15	-	-	ns	
	CKI	$t_{w(CK)}$	20	-	-	ns	
	CKO	$t_{w(CKO)}$	20	-	-	ns	
Frequency	CKI	F_{CK}	-	-	20	MHz	
Maximum CKI Rise Time		t_r	-	-	500	ns	
Maximum CKI Fall Time		t_f	-	-	500	ns	

■ Test Circuit for Switching Characteristics

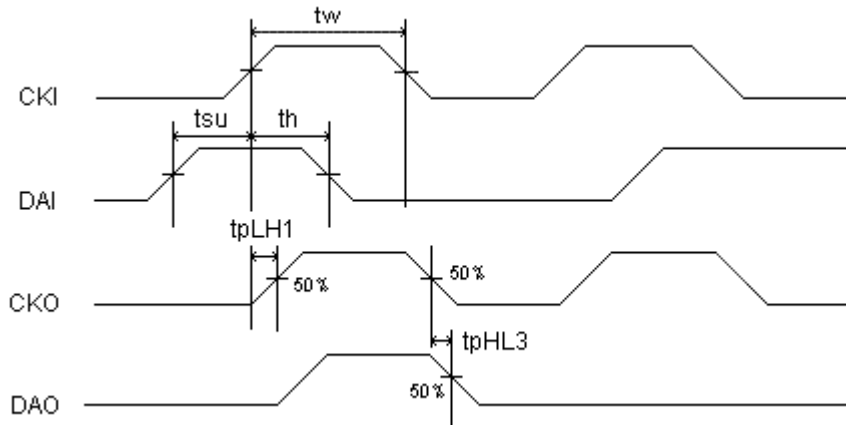


■ Timing Waveform

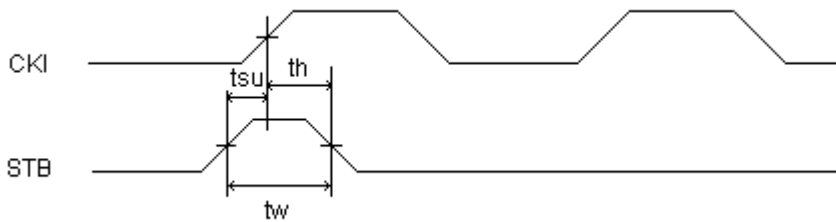
1. VDD, CKI, DAI, STB



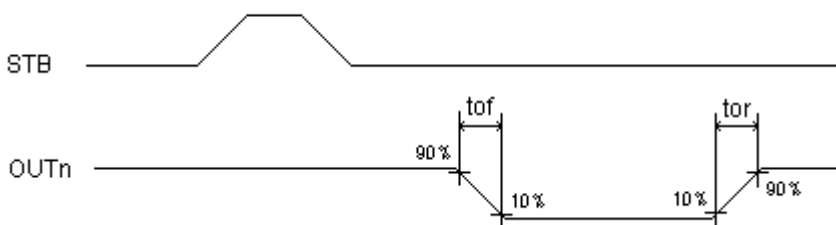
2. CKI, DAI, CKO, DAO



3. CKI, STB



4. STB, OUTn

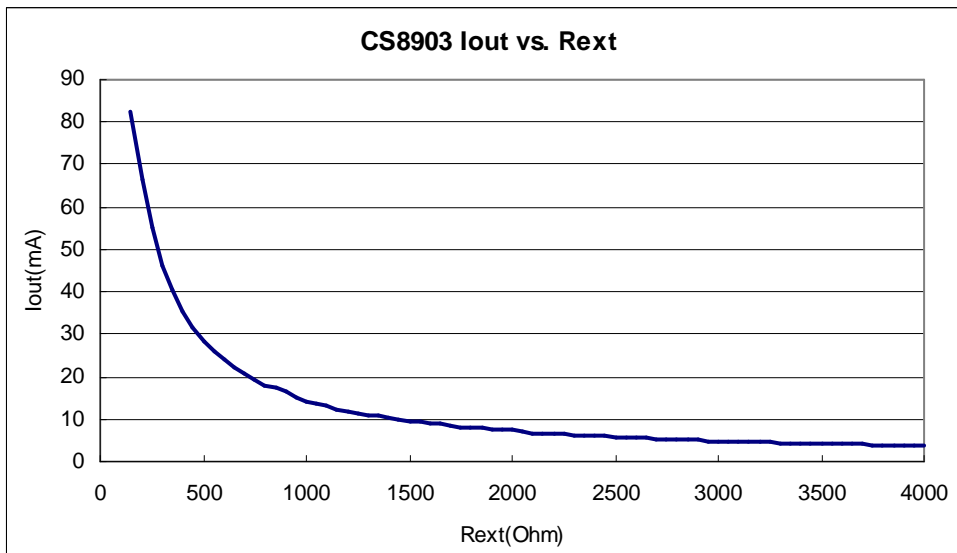
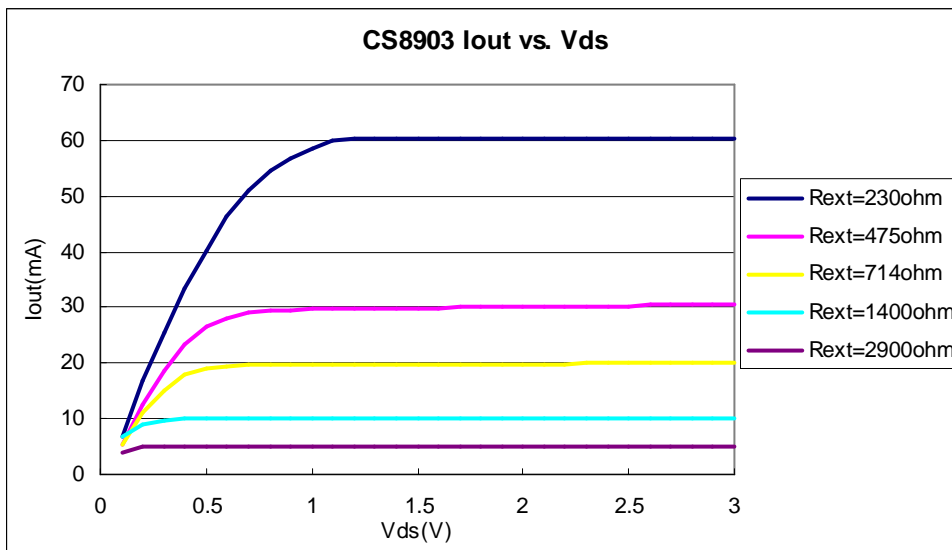


■ Output Current vs. R-EXT

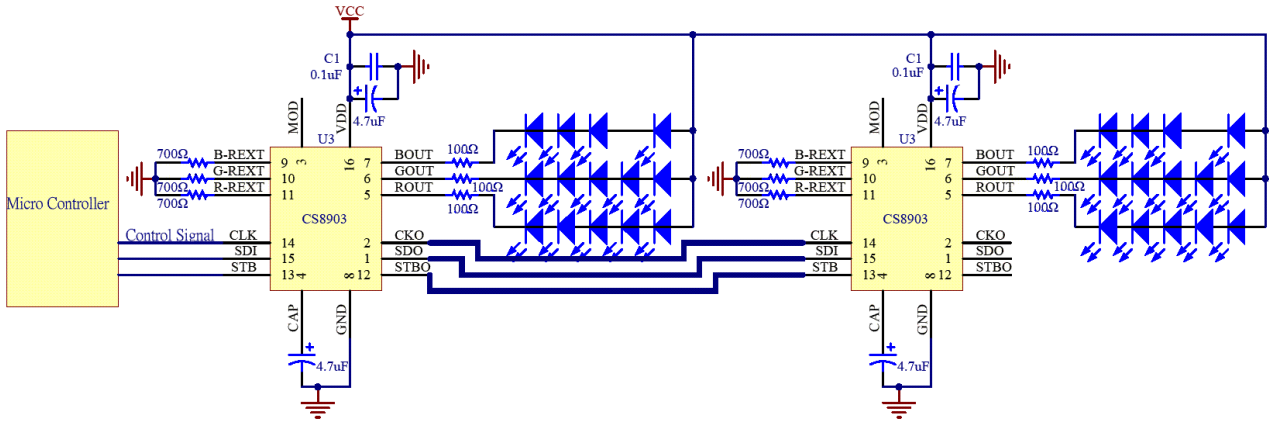
Constant-current value of each output channel is set by an external resistor connected between the pin 9~11 and GND individually. Varying the resistor value can adjust the current scale ranging from 5mA to 60mA. The output current value is calculated roughly by the following equation:

$$I_{OUT} = (1.22V / R_{EXT}) * 11.8$$

where R_{EXT} is the resistance of the external resistor connected to REXT terminal and in case $V_{DD} = 6V$.



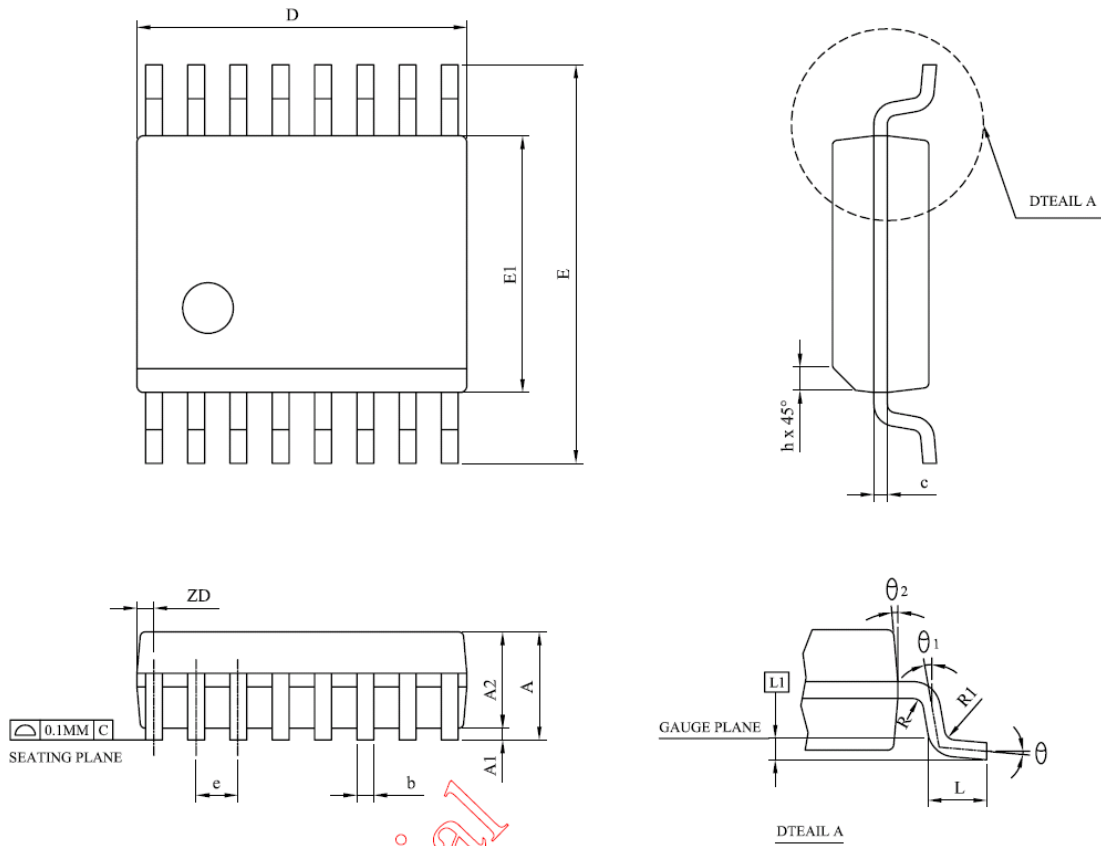
■ Typical Application



■ Order Information

Part No.	Package Type	Lead Pitch
CS8903AD	16SSOP(150mil)	0.64mm

Title: Package outline for 16L SSOP-150mil



Note:

- 1.Dimension D does not include mold protrusions or gate burrs.
- 2.Mold protrusions and gate burrs shall not exceed 0.006 inch per side.
3. JEDEC : MO-137(AB).
- 3.Plating thickness : 0.3 ~ 0.8 mil.

SYMBOL UNIT		A	A1	A2	b	c	e	D	E	E1	L	h	L1	ZD	R1	R	θ	θ1	θ2			
		MM	Min.	1.35	0.10	—	0.20	0.18	0.635 BASIC	4.80	5.79	3.81	0.41	0.25	0.254 BASIC	0.229 REF	0.20	0.20	0°	0°	5°	
Nor.	1.63		0.15	—	—	—	4.90	5.99		3.91	0.635	—	—	—			—	—	—	—	—	10°
Max.	1.75		0.25	1.50	0.30	0.25	5.00	6.20		3.99	1.27	0.50	0.33	—			8°	—	—	—	—	15°
INCH	Min.	0.053	0.004	—	0.008	0.007	0.025 BASIC	0.189	0.228	0.150	0.016	0.010	0.010 BASIC	0.009 REF	0.008	0.008	0°	0°	5°			
	Nor.	0.064	0.006	—	—	—		0.193	0.236	0.154	0.025	—			—	—	—	—	—	—	—	10°
	Max.	0.069	0.010	0.059	0.012	0.010		0.197	0.244	0.157	0.050	0.020			0.013	—	8°	—	—	—	—	15°