File name : CS8903 Application Note

Version: V1.0

Issue Date : 2009/6/24

Total Pages : 13

1. What is LED Constant Current Driver IC?

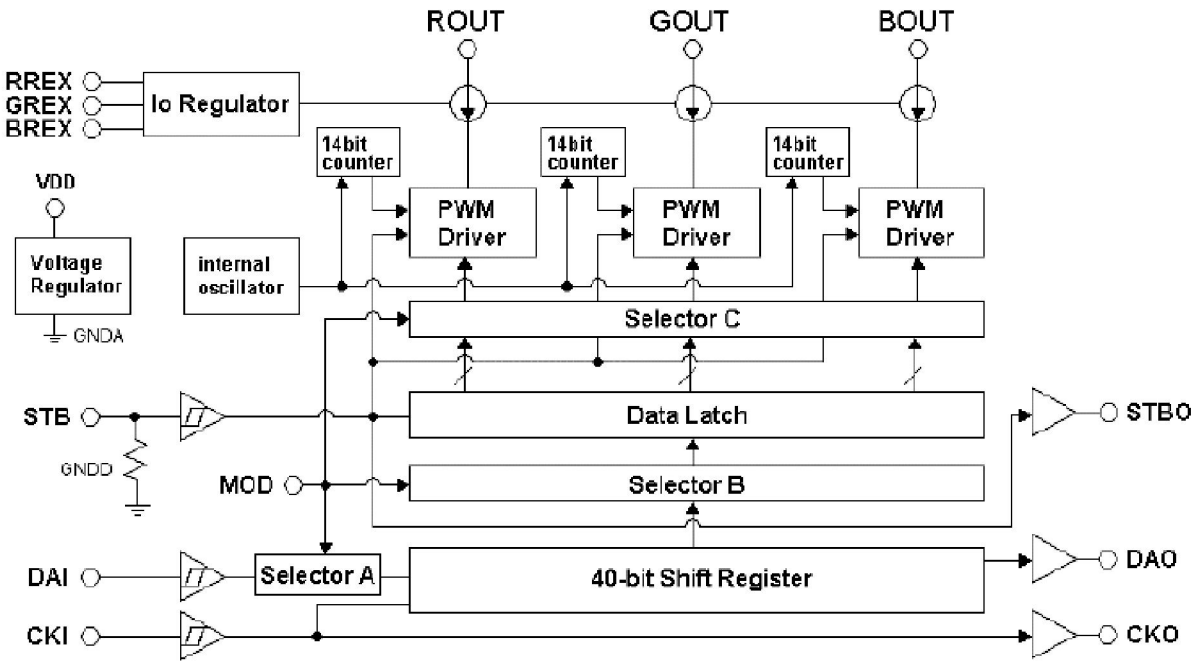
CS8903 is an integrated PWM(Pulse Width Modulation) circuitry designed for LED applications, specifically suitable for LED Lighting .

CS8903 is a 3-Channel Constant-Current RGB LED driver IC, which is designed for LED lighting applications. At CS8803 have 3 output channel, 3-channel current value is adjustable with three corresponding external resistors, and Vdd and output channel voltage provides the maximum Operating Voltage is DC24.0V.
The PWM Function of CS8903 is same as Part No-DM413

** Why need **LED Constant Current** Driver ICs?

The prominent characteristic of CS8903 is to provide the Constant Current Source,
which is able to guarantee the LED stable actuation, eliminates LED the scintillation, is LED demonstrates the high quality brightness the premise.
The chip has 3 kind of characteristics ： **Current matching**, **Current Regulation**, and **Transient Response**.

*CS8903 Block Diagram is as below--



2. How to test/ use LED Constant Driver ?

CHIPLUS provide 2 kinds of measure methods with check CS8903 as below.

Method 1.

Between Vss and Pin 4 of CS8903 is set by the External Capacitor-4.7uF and force 6~24V to Vdd of CS8903. CAP(Pin 4) terminal can keep Constant Voltage level of output control terminal.

By using Digital Meter to measure Voltage of CAP. If Cap Voltage of CS8903 is 4.5~6V(typical value=5.0V), this IC is working properly. If Vcap isn't equal to 4.5~6.0V, this IC might not work normally.

Method 2.

CS8903 have 3 Rext(Pin 9~11) pin to setup Red/Green/Blue LED Output Current.

Pin 9 Rext could be setting Pin 5-Red Output. Pin 10 Rext could be setting Pin6-Green Output.

Pin 11 Rext could be setting Pin7-Blue Output.

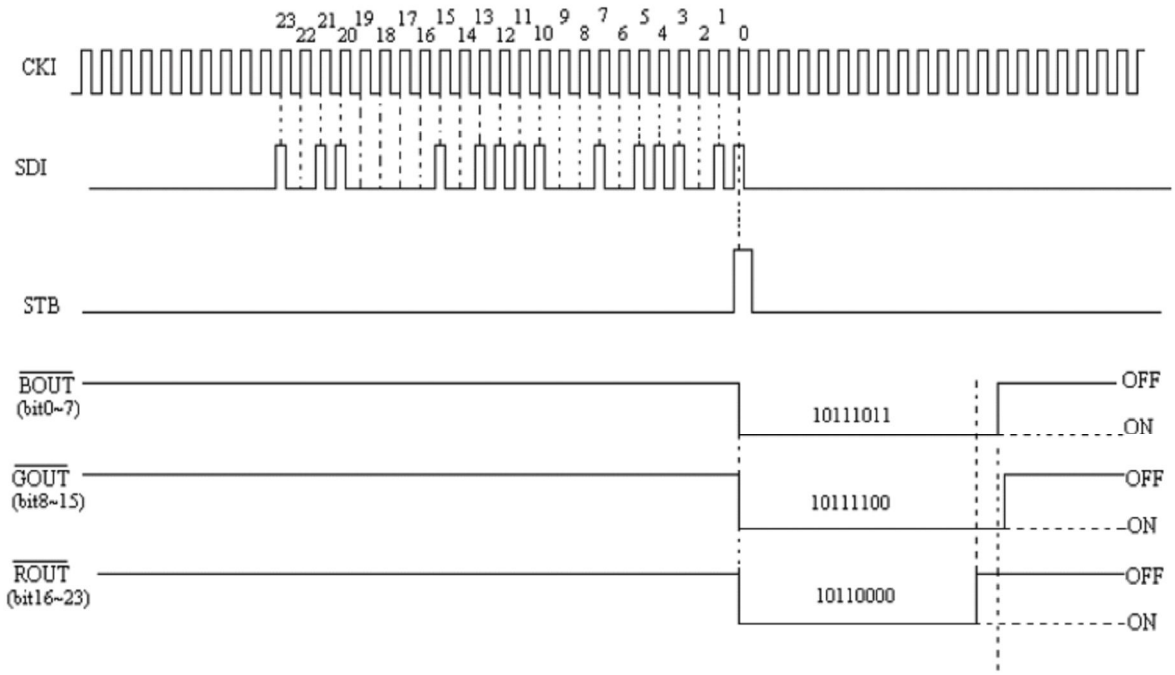
CHIPLUS give an example for check on Red Rext(Pin 9).

Measurement of other Rext is the same as setup procedure of Red Rext as below.

Between Vss and Pin 9 of CS8903 is set by the External Resistor(Rext) and force 6~24V to Vdd of CS8903. By using digital meter to measure voltage of Red-Rext. If Red-Rext Voltage of CS8903 is1.22V, this IC is working properly. If Red-Rext Voltage isn't equal to 1.22V, this IC might not work normally.

**How to control LED output current on/off?

Excluding Red, Green and Blue Vrext=1.22V and Vcap=5.0V, format of input signal Pin goes as below—(Example.8-bits PWM mode)



CS8903 control output channel turn on/off by PWM.

CS8903 build in 3 kinds of PWM mode as below.

A.8-Bits Mode

If you use the 8-bits PWM mode, MOD pin(pin 3) is setting floating.

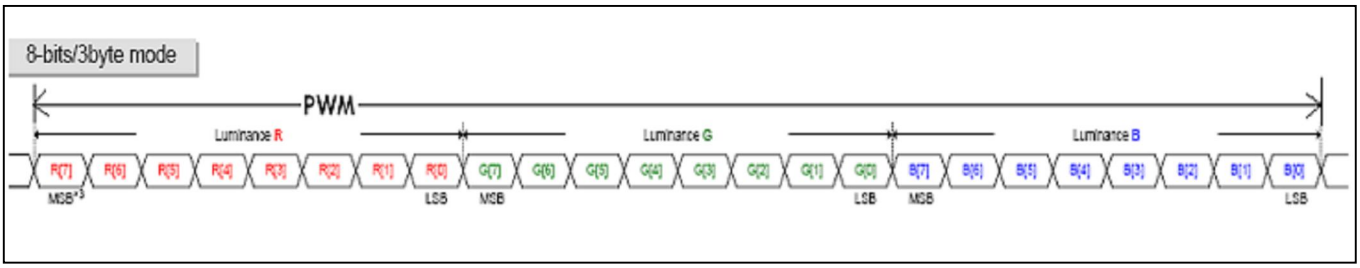
The mode only control LED Luminance of each output channel.

The mode means that each output channel has 255 kinds of PWM combinations.

8-bits mode using format is as below.

1. CLK pin：Input 24 Clocks at each cycle.
2. Serial Data-in(SDI)：Input 24 Data at 24 Clocks.
3. Strobe Input(STB)：STB is active-hi at 24th Clock.

Data format is as below.



How to check Serial Data-in status ?

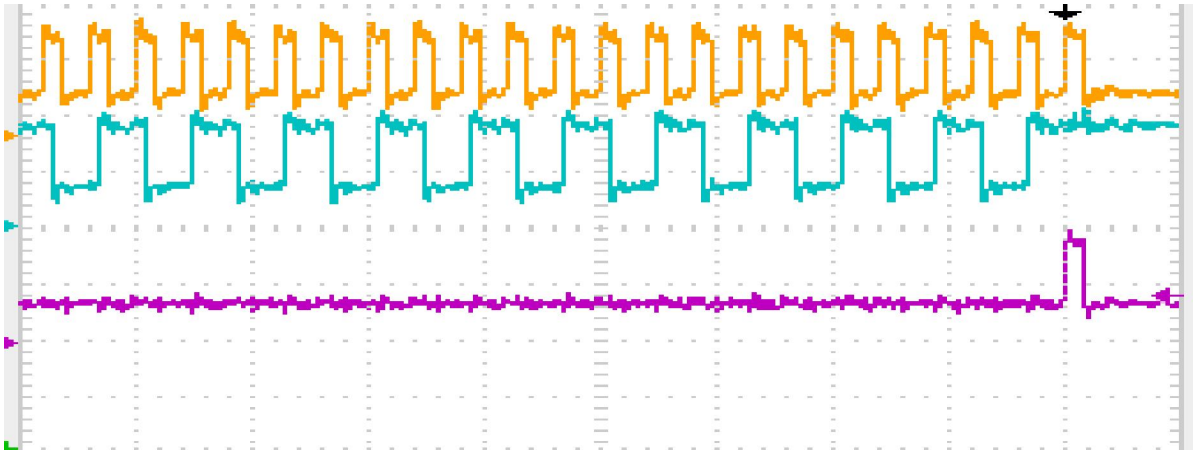
If the clock rise edge is corresponding SDI to 1 , the data status of the clock is “1”.

If the clock rise edge is corresponding SDI to 0 , the data status of the clock is “0”.

When above control pin(CLK,SDI and STB) using format conform to datasheet , each output channel show active-low waveform. Output channel active low indicate that has current to LED. LED luminescence time is decided by Serial Data-in value.

Give an example 8-bit PWM input waveform as below.

a. Yellow waveform is 24 clocks.
b. Blue waveform is 24 SDI (Example waveform=010101010101010101010101)
c. Red waveform is STB pin active-hi.



B.14-Bits Mode

If you use the 14-bits PWM mode, MOD pin(pin 3) is setting 0V.

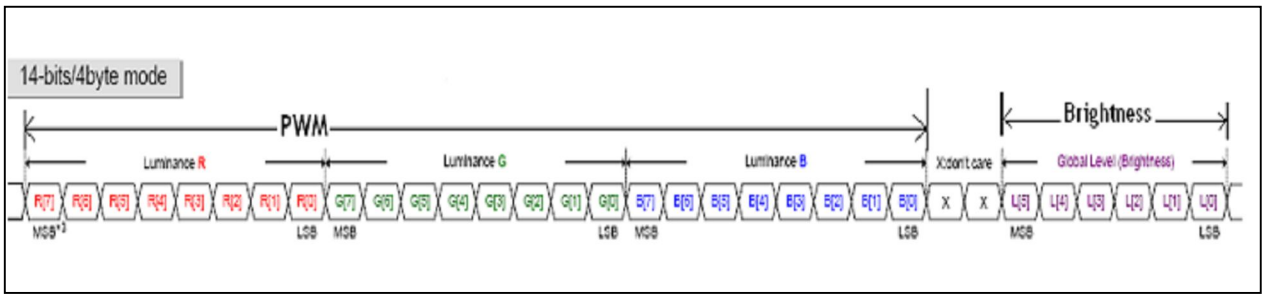
The mode can control LED Luminance and Brightness of each output channel.

The mode means that each output channel has kinds of PWM combinations.

14-bits mode using format is as below.

1. CLK pin：Input 32 Clocks at each cycle.
2. Serial Data-in(SDI)：Input 32 Data at 32 Clocks.
3. Strobe Input(STB)：STB is active-hi at 32th Clock.

Data format is as below.



How to check Serial Data-in status ?

If the clock rise edge is corresponding SDI to 1 , the data status of the clock is “1”.

If the clock rise edge is corresponding SDI to 0 , the data status of the clock is “0”.

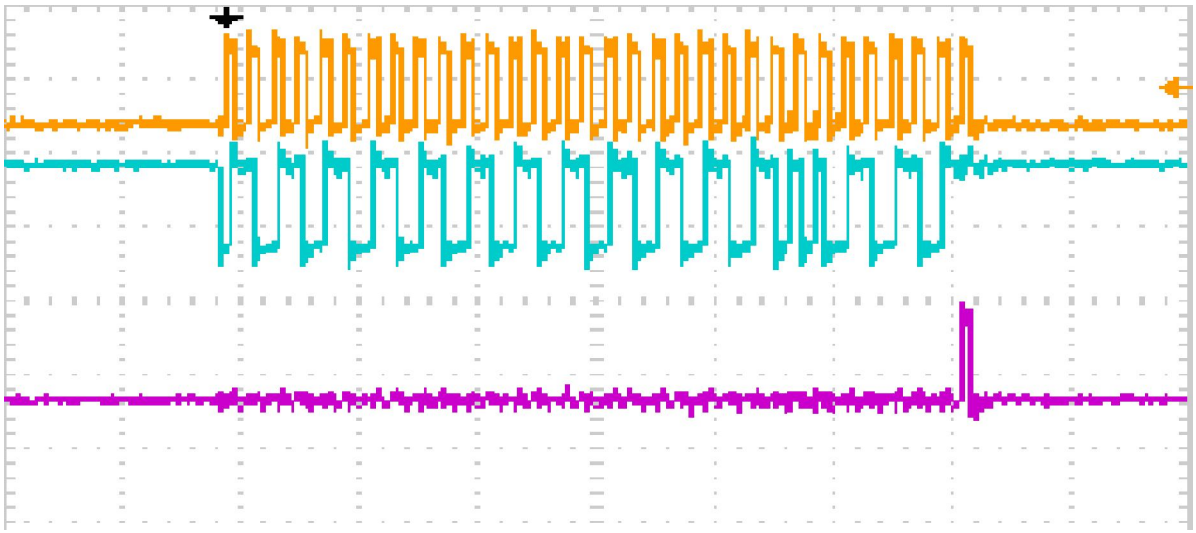
When above control pin(CLK,SDI and STB) using format conform to datasheet , each output channel show active-lo waveform. Output channel active low indicate that has current to LED. LED Luminescence time is decided by Serial Data-in value.

Give an example 14-bit PWM input waveform as below.

a. Yellow waveform is 32 clocks.

b. Blue waveform is 32 SDI (example waveform=01010101010101010101010111010101)

c. Red waveform is STB pin active-hi.



C.13-Bits Mode

If you use the 13-bits PWM mode, MOD pin(pin 3) is setting 5V.

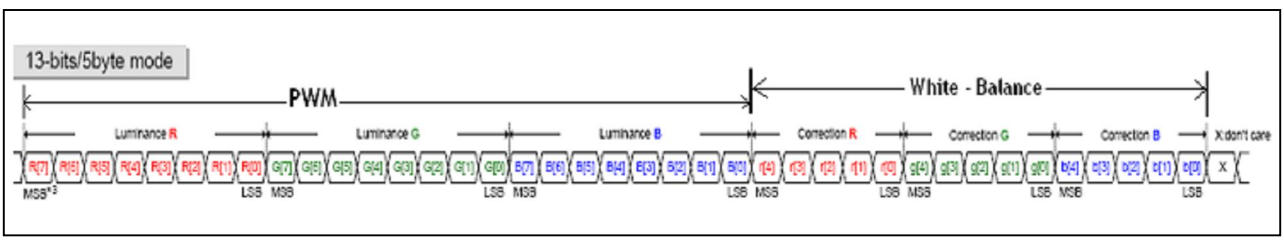
The mode can control LED Luminance and White Balance of each output channel.

The mode means that each output channel has kinds of PWM combinations.

13-bits mode using format is as below.

4. CLK pin：Input 40 Clocks at each cycle.
5. Serial Data-in(SDI)：Input 40 Data at 40 Clocks.
6. Strobe Input(STB)：STB is active-hi at 40th Clock.

Data format is as below.



How to check Serial Data-in status ?

If the clock rise edge is corresponding SDI to 1 , the data status of the clock is “1”.

If the clock rise edge is corresponding SDI to 0 , the data status of the clock is “0”.

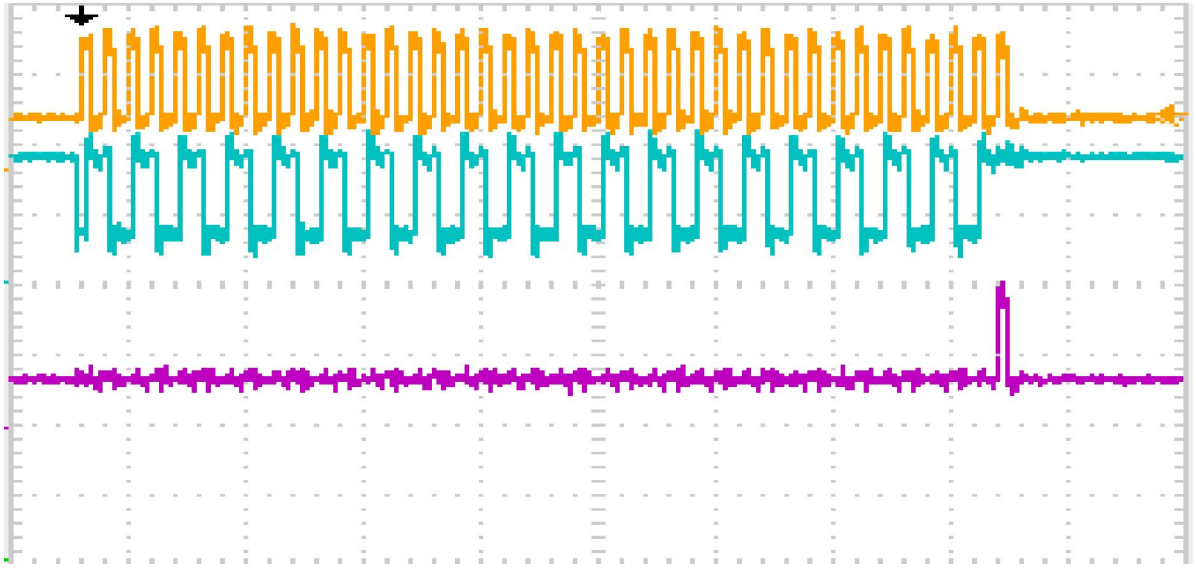
When above control pin(CLK,SDI and STB) using format conform to datasheet , each output channel show active-lo waveform. Output channel active low indicate that has current to LED. LED Luminescence time is decided by Serial Data-in value.

Give an example input waveform as below.

a. Yellow waveform is 40 clocks.

b. Blue waveform is 40 SDI(example waveform=0101010101010101010101010101010101010101)

c. Red waveform is STB active-hi.



3.How to select output current of LED Constant Current Driver ?

The intensity of output current is set by the external resistor(Rext).
The external resistor(Rext) is a key that determines the current flowing to each output.
which current flow then continues the excursion passing the output pins to the ground.

Different resistor correspond to different scales of output current (Iout).
The Output Constant Current range of CS8903 is 5~60mA.

The relationship between Iout and Rext is shown in the following Figure 4.

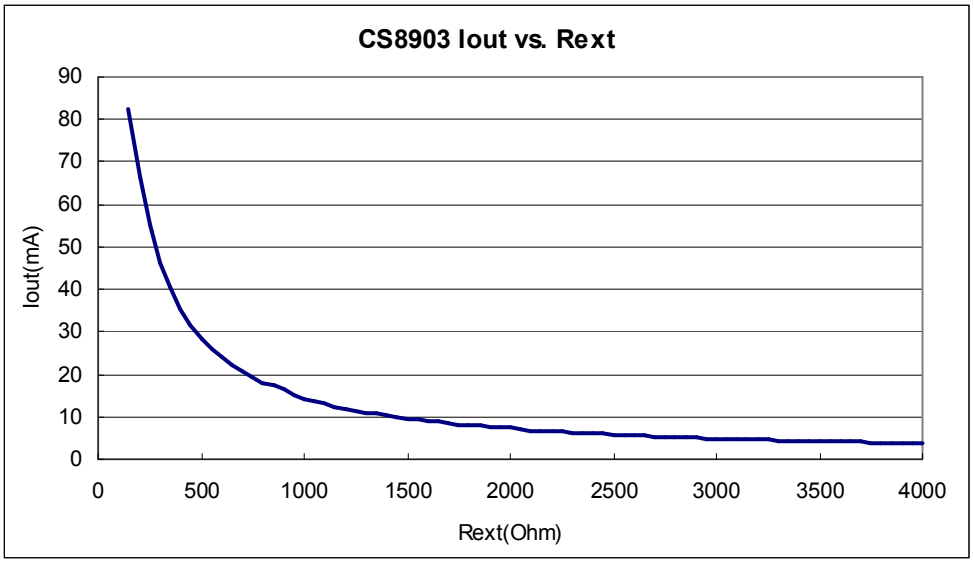


Figure 4: Iout and Rext Relationship Curve

Also, the output current can be calculated from the following equation ：

Iout = (VRext / Rext) x Current Gain

Vrext=1.22V ； Current Gain=11.8 (These value are both constant.)

Rext ： It is the resistance of the external resistor between REXT pin and ground.

Vrext ： It is the voltage of R-EXT to Ground terminal.

The magnitude of current(as a function of Rext) is around 20mA at 714Ω and 30mA at 475Ω.

CS8903 Rext V.S Iout Relationship Table is as below.

Iout(mA)	5	6	7	8	9	10	11	12
Rext(Ω)	2.88K	2.4K	2.05K	1.8K	1.6K	1.4K	1.31K	1.2K
Iout(mA)	13	14	15	16	17	18	19	20
Rext(Ω)	1.1K	1.03K	960	900	847	800	758	720
Iout(mA)	21	22	23	24	25	26	27	28
Rext(Ω)	686	654	626	600	576	554	533	514
Iout(mA)	29	30	31	32	33	34	35	36
Rext(Ω)	496	480	464	450	436	423	411	400
Iout(mA)	37	38	39	40	41	42	43	44
Rext(Ω)	389	379	369	360	351	343	335	327
Iout(mA)	45	46	47	48	49	50	51	52
Rext(Ω)	320	313	306	300	294	288	282	277
Iout(mA)	53	54	55	56	57	58	59	60
Rext(Ω)	272	267	262	257	253	248	244	240

After appropriate Iout value is selected, an adequate scale of Vds(Output LED power) is then required to ensure the stable operation at saturation.

In general, for programmed current 20mA and 30mA, a minimum Vds of 0.7V is highly recommended for proper current regulation. For programmed currents of 20mA or above，a minimum Vds of 1.0V is in instead suggested. Figure 5 illustrates the relationship between Vds and Iout curve.

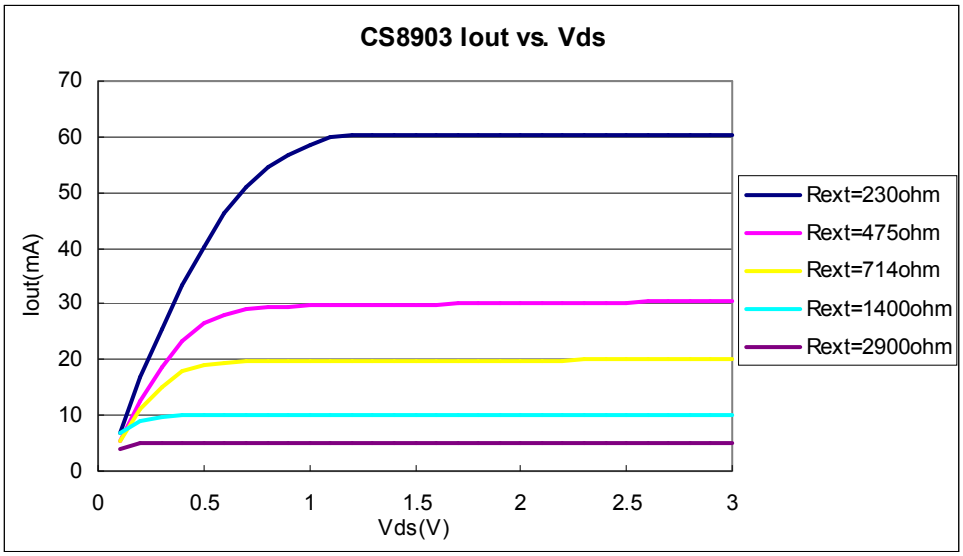


Figure 5 Iout vs Vds Relationship Curve

4. Notice for Signal Transmission

The quality of the signals on the transmission lines depends on the stability of supplied voltage and the length of transmission lines. When several clusters are powered by a single power supply, the voltage could be applied to the CS8903 usually ripples or spikes and thus impacts the voltage stability. In addition, the length of transmission lines also influences the signal quality.

CHIPLUS verify Signal Transmission Distance Test Result of CS8903 as below.

Clock=20Mhz and VDD=24.0V				
Transmission Distance	Vcc	CLK	Vcap	Transmission Test Result
0.5m	Pass	Pass	Pass	Pass
1m	Pass	Pass	Pass	Pass
1.5m	Pass	Pass	Pass	Pass
2.0m	Pass	Pass	Pass	Pass

5. Notice for PCB layout:

In this case, if you would like to replace DM413 with CS8903.

The 3 Items take notice of CS8903 as below.

1. VDD Pin of CS8903 is 6~24V. VDD Pin of DM413 is 3.3~5.5V
2. CS8903 just support Positive Output. Pin No.4 of CS8903 remove external capacitor-4.7uF and apply 5.0V to conform with Pin No.4-PWM Output Polarity selection of DM413
3. CS8903 just support Rising Edge of Clock Output. Pin No.12 of CS8903 apply 0V to conform with Pin No.12 –Serial Data Output Trigger Mode selection of DM413.

About CS8903 Example Circuitry, please refer to the image as below.