G5103 White LED Demo Board V1.0

Introduction

G5103 is a step-up (boost) DC/DC converter, using constant peak inductor current and minimum OFF time PFM topology. It could output up to 16V and drive 20mA from a 2.5V ~ 5.5V input power source, such as a Li-Ion battery. G5103 is suitable for series 2~4 white LED driver application because its maximum 16V output capability. This solution possess high efficiency about 84% when drive 4 white LED at 20mA output LED current with a 3.6V Li-Ion battery power input.

This demo board could demonstration:

1. Drive 2 ~ 4 white LED @ 20mA.
2. 200Hz PWM dimming control.
3. Only need 3.0V ~ 5.5V power source. A Li-Ion battery is a good power source.

200Hz PWM Dimming White LED Driver Demo Schematic

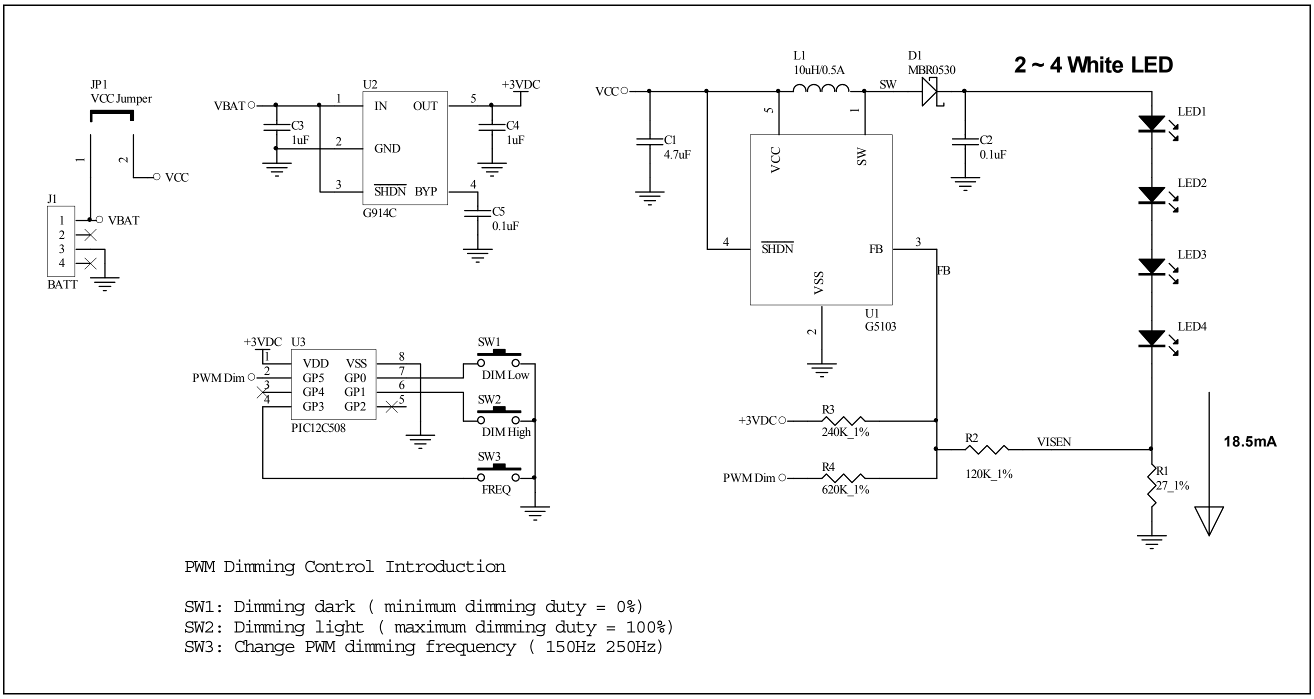

Fig.1

Components List

Designation	Qty	Value& P/N	Description	Vendor
R1	1	27Ω_1%	Current Sense Resistor	Std
R2	1	120KΩ_1%	Feedback Resistor (recommend)	
R3	1	240KΩ_1%	PWM Dimming Control Bias Resistor	
R4	1	620KΩ_1%	PWM Dimming Control Mixer Resistor	
C1	1	4.7µF	Input Capacitor	TAIYO YUDEN
C2	1	0.1µF	Output Capacitor	
C3	1	1µF	Input Capacitor	
C4	1	1µF	Output Capacitor	
C5	1	0.1µF	Bypass Capacitor	
L1	1	10µH/0.5A IDC (LQH32CN100K31)	Inductor	MURATA
		10µH/0.5A IDC (976AS-100M)	Inductor	TOKO
D1	1	0.5A/30V(MBR0530)	Schottky Diode	ON Semi
U1	1	G5103	Micro Power Step-up DC/DC Converter	**Global Mixed-Mode Technology**
U2	1	G914C	Mirco power LDO regulator. V_{OUT}=3.0V	**http://www.gmt.com.tw**
U3	1	PIC12C509A	8 bits micro-controller	Miocrochip
SW1~3	3		Push button switch	Std
LED1~4	4	NSCW100	White LED	NICHIA corporation

Circuit Description

The demo board is configured as a constant current supply. Current regulation is accomplished by regulating the voltage across a current sense resistor R1. For dimming the LEDs is to inject a pulse width modulated (PWM) voltage for analog dimming. With this method, the PWM control voltage is converted to its equivalent analog control voltage. The demo board is designed so that the negative duty cycle from 0% to 100% varies the LED current from 0mA to 20mA. The output current increases as the duty cycle increases. Use the equation below to calculate the correctly resistor values.

V_{BAT}: Li-Ion battery power input, bypass to ground with a 4.7µF MLCC capacitor.
V_{BIAS}: +3.0VDC provide a PWM dimming DC bias voltage. It is generated by G914C from V_{BAT}.
R1: is LED current sense resistor. R1= 0.60V / $I_{LED,MAX}$ = 0.60V / 20mA = 30Ω
R2: is feedback resistor, 120KΩ is recommended.
R4: is PWM dimming control mixer resistor. The value is depended on PWM dimming control signal amplitude. R4= (V_H - V_L) / (0.6V / 120KΩ). (maximum value, a little small value could be used)
For 3.0V PWM control signal: R4= 3V / (0.6V / 120KΩ) = 600KΩ.
For 3.3V PWM control signal: R4= 3.3V / (0.6V / 120KΩ) = 660KΩ.
For 5.0V PWM control signal: R4= 5V / (0.6V / 120KΩ) = 1MΩ.
R3: is PWM dimming control bias resistor. The value is depended on V_{BIAS} voltage.
R3=(V_{BIAS}– V_{FB}) /[(0.6V/120 KΩ)+(V_{FB} / R4)].
For 3VDC V_{BIAS}:= (3.0V – 1.2V) / [(0.6V/120 KΩ)+(1.2V / 600 KΩ)] = 257 KΩ.
For 3.3VDC V_{BIAS}:= (3.3V – 1.2V) / [(0.6V/120 KΩ)+(1.2V / 660 KΩ)] = 308 KΩ
For 5VDC V_{BIAS}:= (5.0V – 1.2V) / [(0.6V/120 KΩ)+(1.2V / 1000 KΩ)] = 612 KΩ
After choose suitable resistors, designer should check I_{LED} again.

When PWM dimming signal is low (almost equal to 0V):

$I_{LED} = V_{R1} / R1$

$V_{R1} = V_{FB} – V_{R2}$

$V_{R2} = I_{R2} \times R2$

$I_{R2} = I_{R3} – I_{R4} - I_{FB} = (V_{R3} / R3) – (V_{R4} / R4) - I_{FB} = ((V_{BIAS} – V_{FB})/R3) – (V_{FB}/R4) - I_{FB}$

$I_{LED} = (V_{FB} – R2 \times (((V_{BIAS} – V_{FB})/R3) – (V_{FB}/R4) - I_{FB})) / R1$

I_{LED} should be the design full current.

When PWM dimming signal is high (almost equal to V_{PWM_H}):

$I_{LED} = V_{R1} / R1$

$V_{R1} = V_{FB} – V_{R2}$

$V_{R2} = I_{R2} \times R2$

$I_{R2} = I_{R3} – I_{R4} - I_{FB} = (V_{R3} / R3) – (V_{R4} / R4) - I_{FB} = ((V_{BIAS} – V_{FB})/R3) – ((V_{FB} - V_{PWM\_H})/R4) - I_{FB}$

$I_{LED} = (V_{FB} – R2 \times (((V_{BIAS} – V_{FB})/R3) – ((V_{FB} - V_{PWM\_H})/R4) - I_{FB})) / R1$

I_{LED} should be a little negative current to make sure that LED is full dark.

In this demo board, GMT choose R1 = 27Ω, R2=120 KΩ, R3=240KΩ, R4=620KΩ.

When PWM signal is low:

$I_{LED} = (1.2V – 120KΩ \times (((3V – 1.2V)/240KΩ) – (1.2V/620KΩ) – 30nA)) / 27Ω = 19.7mA$

When PWM signal is high:

$I_{LED} = (1.2V – 120KΩ \times (((3V – 1.2V)/240KΩ) – ((1.2V-3V)/620KΩ) – 30nA)) / 27Ω = -1.79mA$

U2: G914C is a micro power LDO regulator that make by GMT. It could regulate a +3VDC from a +3V ~ +5.5V power source. The +3VDC provide as V_{BIAS} for PWM dimming bias voltage, and provide as the power of U3.

U3: PIC12C509A is a 8bit micro controller that make by Microship. It is programmed as a PWM dimming signal generator, and monitor 3 push button to change PWM duty and frequency for dimming control.

Note: You need download the hex code to program a blank new PIC12C509A before solder it on demo board. You could download this hex code from GMT web site http://www.gmt.com.tw

How to Use This Demo Board

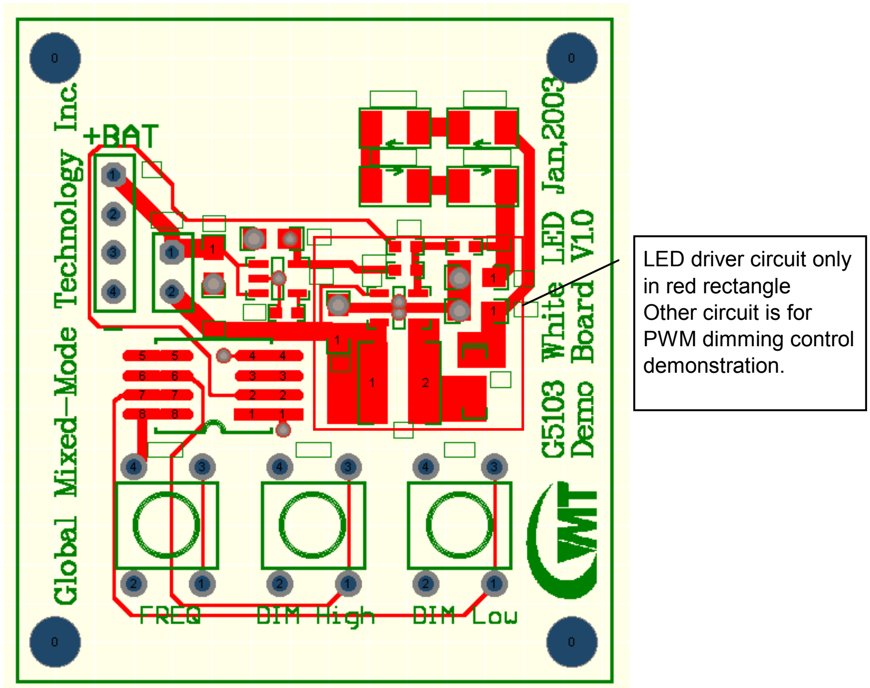

Fig.2

J1:	is an input power connector. +BAT means positive side. The valid voltage range is from +3.0 to +5.5V. one cell Li-Ion battery or 3 cell NiCd or NiMH battery or adjustable power supply are good power source.
SW1:	is a push button switch, every click makes LEDs a little darker until 100% light.
SW2:	is a push button switch, every click makes LEDs a little lighten until full dark.
SW3:	is a push button switch, every click change dimming PWM frequency from 200Hz → 210Hz → 220Hz → 230Hz → 240Hz → 250Hz → 150Hz → 160Hz → 170Hz → 180Hz → 190Hz → 200Hz. But the change could not be observed be human eyes. Only a oscilloscope could shows the difference.
JP1:	is a jumper, which must be close for normal operating. You should open this jumper to measure input current if you want to measure the efficiency of this demo board.
LEDs:	LED1 ~ LED4 has solder with white LED.