MT7605

Segmented, Linear Constant - Current LED Driver

DESCRIPTION

MT7605 is a segmented linear constant - current LED driver. It operates in linear mode, according to the segment LED voltage drop automatically turns on different LED string without external settings to simplify the system design. No electrolytic capacitor, Inductor, transformer are needed, low BOM cost is achieved.

MT7605 can drive three segment LED strings. When the input voltage varies, it lights up different segment LED strings automatically. In the one AC cycle, the LED light up time increases. This way, both efficiency and power factor improved. The PFC is as high as 0.99, THD can be less than 15%.

With Maxic's proprietary current regulation method, MT7605 achieves ±3% accuracy of LED current. In addition, each segment of LED current can be set differently by individual sense resistors.

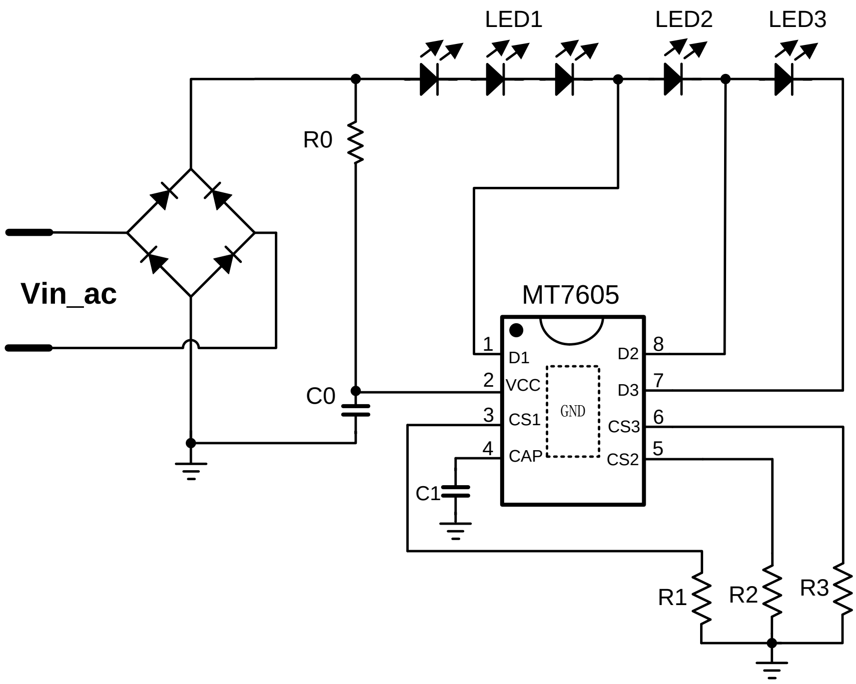
FEATURES

- Segmented linear constant - current LED driver
- Turns on different segment LED strings automatically based on LED voltage drop
- Each segment LED current can be flexibly setting with external sense resistor
- High precision constant LED current (±3%)
- Peak LED current: 60mA
- Highest PFC is 0.99, THD is less than 15%
- Over temperature protection
- Lower output current gradually at high temperature
- Built-in power MOSFET simplifies peripheral design
- Available in ESOP8 package

APPLICATION

- LED fluorescent light, panel light
- LED bulb light, decorative light
- Other compact LED Lighting Product

Typical Application Circuit



ABSOLUTE MAXIMUM RATINGS

VCC	-0.3V ~ 20V
CAP,CS1,CS2,CS3	-0.3V ~ 6V
D1,D2,D3	-0.3V ~ 500V
Storage Temperature	-55°C ~ 150°C
Junction Temperature (Tj)	150°C

RECOMMENDED OPERATING CONDITIONS

Supply voltage VCC	20V
Operating Temperature	-40°C ~ 105°C

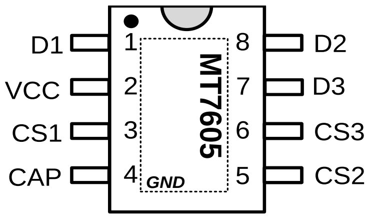
THERMAL RESISTANCE[①]

Junction to ambient ($R_{\theta JA}$)	90°C/W
Junction to Case ($R_{\theta JC}$)	55°C/W

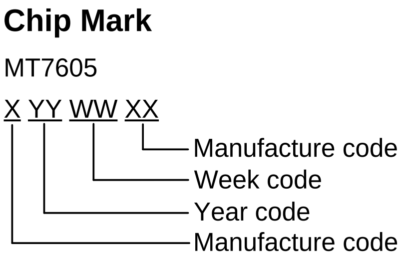
Note:

① *$R_{\theta JA}$, $R_{\theta JC}$ are measured in the natural convection at TA = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Test condition: Device mounted on 2" X 2" FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.*

PIN CONFIGURATIONS



ESOP8



Pin description

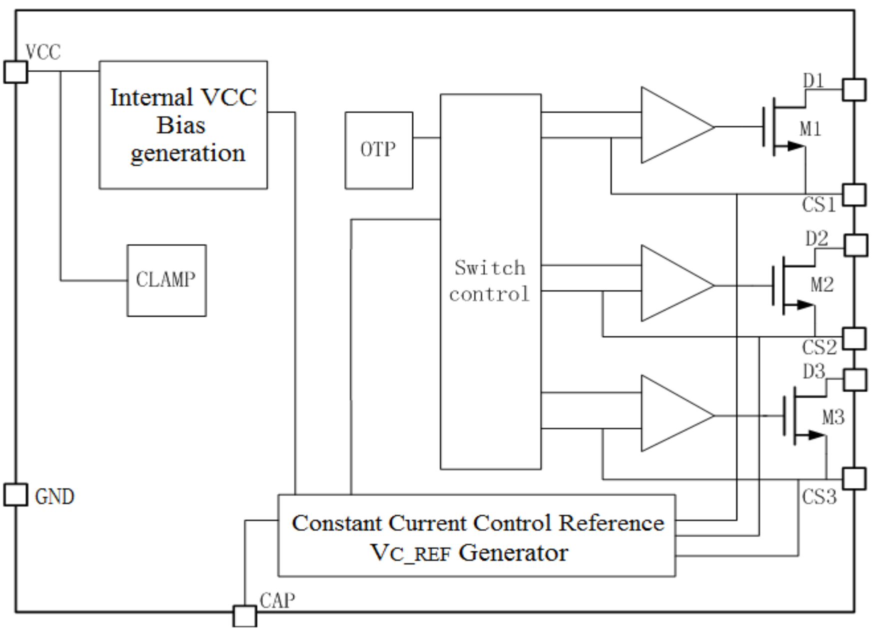
Name	Pin No	Description
D1	1	Drain of the first power MOS (M1).
VCC	2	Power supply pin.
CS1	3	Source of the first power MOS (M1) . The first current sense input, sense resistor(R1) is connected between CS1 and GND.
CAP	4	Capacitor for Constant - Current control circuit. Connect a 0.1uF ~ 1uF capacitor to ground.
CS2	5	Source of the second power MOS (M2). The second current sense input, sense resistor(R2) is connected between CS2 and GND.
CS3	6	Source of the third power MOS (M3). The third current sense input, sense resistor(R3) is connected between CS3 and GND.
D3	7	Drain of the third power MOS (M3).
D2	8	Drain of the second power MOS (M2).
GND	Back side Exposed Pad	Ground.

ELECTRICAL CHARACTERISTICS

(Test conditions: VDD=20V, TA=25°C unless otherwise stated)

Symbol	Parameter		Min	Typ	Max	Unit
Start-up & Power supply （VCC Pin）						
I_{START}	Start-up Current			40		μA
UVLO	Under Voltage Lockout of V_{CC}	V_{CC} Pin ramp down		12		V
V_{START}	Start-up Voltage	V_{CC} Pin ramp up		15		V
$V_{CC\text{-}CLAMP}$	VCC clamp voltage	I_{CC}=3mA		20		V
Operation Current						
I_Q	Operation Current			300		uA
LED Current						
$I_{LED,\ peak}$	LED peak current				60	mA
Current Sense						
V_{TH}	Internal reference voltage		490	500	510	mV
Constant - Current control internal reference voltage V_{C_REF}						
$V_{C\_REF\_MAX}$	Maximum V_{C_REF}			1.5		V
Over Temperature Protection						
OTP	Over temperature protection threshold			160		℃
	Over temperature protection release hysteresis			40		℃
T_{corner}	Output power ramp down temperature			130		℃

BLOCK DIAGRAM



APPLICATION INFORMATION

MT7605 is a segmented linear constant - current LED driver and works on the segmented automatic switching mode. With Maxic's proprietary constant current regulation and compensation technology, accurate LED output current is achieved with minimized external components.

Start Up

During start-up, VCC is charged through a start-up resistor. As VCC reaches 15V, the control logic starts to work. As VCC continue increases, the chip will clamp VCC at 20V, as shown in Fig.1.

MT7605 shuts down as VCC falls below 12V.

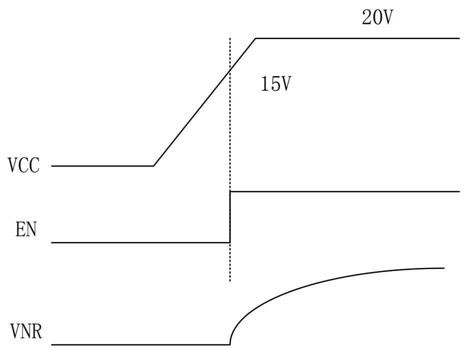


Fig.1 Start up sequence

Constant Current Control and Output Current Setup

MT7605 automatically turns on different LED string according to the input sine wave. When the input voltage rises and reaches the first segment LED string conducting voltage, M1 is turned on. LED1 string lights on. When the input voltage continues rising and reach the sum of the first and second segment LED string conducting voltage, M2 is turned on, M1 is switched off. Both LED1 and LED2 strings light on. When the input voltage continues to rise to the voltage at which three series segment LED string can conduct, M3 is turned on. M1 and M2 are switched off. LED1, LED2 and LED3 strings light on. As the input voltage drops, the procedure is reversed, as shown in Fig.2.

When Mi (i=1~3) is on, LED peak current is:

$$I_{peak\_i} = \frac{V_{C\_REF}}{Ri} (i = 1 \sim 3) \qquad (1)$$

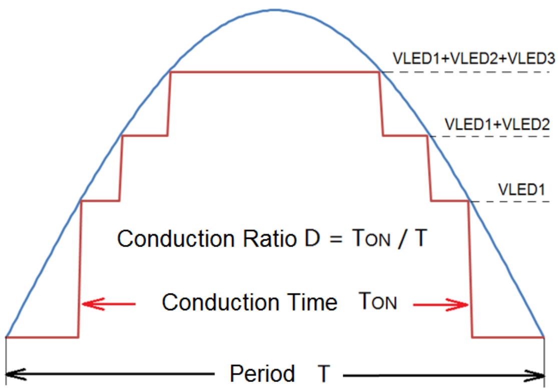


Fig.2 Segment conduction procedure

where Ri (i=1~3) is the current sensing resistor tie to CSi. V_{C_REF} is the internal reference voltage. Assuming LED string conduction ratio is D (refer to Fig.2), then

$$V_{C\_REF} = \frac{V_{TH}}{D} \qquad (2)$$

When all external resistor Ri (i=1~3) are the same. The average current of the LED is

$$I_{AVG} = \frac{V_{TH}}{Ri} = \frac{500mV}{Ri} \qquad (3)$$

where V_{TH} is the internal reference voltage of 500 mV.

In application cases, V_{C_REF} can't be higher than 1.5 V. As V_{C_REF} goes higher, it will be clamped to 1.5V. So during the system design, LED string voltage and segment assignment should be properly configured to guarantee the conduction ration D larger than 0.33.

For better tradeoff between efficiency and power factor (PF), the conduction ratio D should be greater than 0.66.

LED peak current I_{peak_i} cannot be larger than 60 mA.

Constant Current Control

With Maxic's proprietary constant current regulation and compensation technology, MT7605 regulates the average current through the LED string, keeps the average current stable even the AC voltage varies. Precision constant current output is achieved.

Constant current control is mainly implemented by the external 0.1uF – 1uF capacitor tie to CAP pin. In addition, this capacitor also helps to achieve soft start during power up.

Over Temperature Protection

When the internal temperature is higher than T_{corner}(130℃), MT7605 will automatically reduce the LED output current, lower the power consumption, refer to Fig.3

When internal temperature reaches the OTP (Over-Temperature Protection) threshold, MT7605 shuts down. As the temperature goes down about 40 ℃ hysteresis, it will restart.

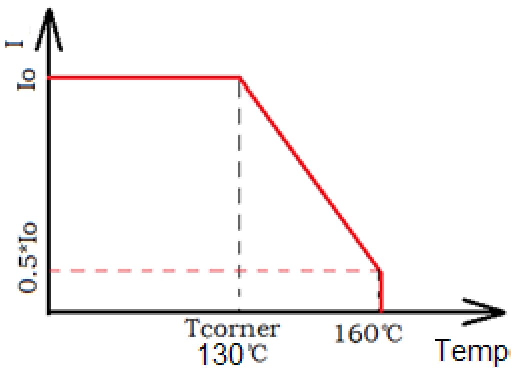


Fig. 3 Temperature compensation curve

Improve Power Factor Correction (PFC), Lower the THD

In MT7605 system，if three segment LED strings set at the same current, as long as the conduction ration D is greater than 0.66, PF can be larger than 0.95.

To further improve PF, lower the THD, the conduction ration D should be increased as much as possible, i.e. VLED1 string voltage should be lower. On the other hand, current waveform of segmented LED string should follow the input sine wave. Refer to Fig. 2, $I_{LED3} > I_{LED2} > I_{LED1}$, i.e. R3 < R2 < R1. $V_{LED3} : V_{LED2} : V_{LED1} =$ 1:1:2; $I_{LED3} : I_{LED2} : I_{LED1} = 1.6:1.3:1$ is recommended. In this case, THD can be less than 16%, PFC is as high as 0.99.

Methods to increase the output current

MT7605 embedded with temperature compensation scheme. In order to increase the output current, the system must have good heat dissipation to reduce the temperature of MT7605 chip.

1) Increase MT7605 backplane (GND) copper area;
2) Use aluminum substrate PCB;
3) Increase the heat dissipation base of the whole lamp.

If the peak LED current is greater than 60 mA, more than one MT7605 can be used in parallel. Refer to Fig. 4.

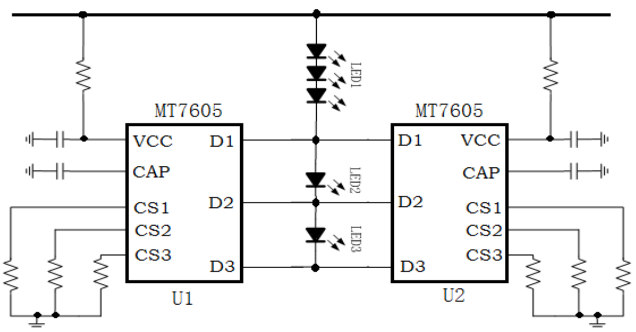
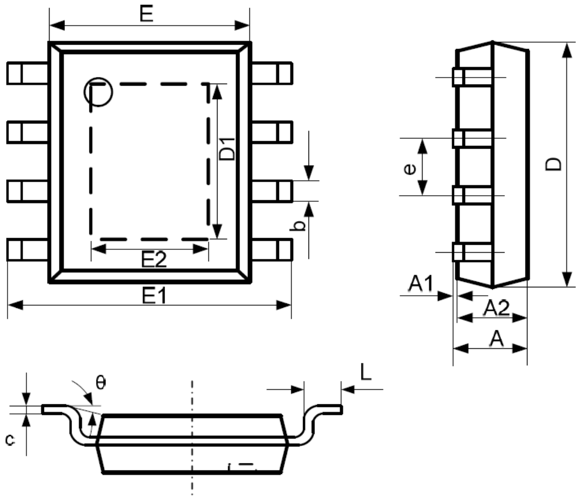


Fig. 4 Multi MT7605 in parallel to increase output current

PACKAGE INFORMATION

SOP-8/EP PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.002	0.006
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°