# DC-DC LED Constant Current Regulator

*8W 350mA High Efficiency Step Down LED Driver*

GlacialPower®
Power Your Idea

## Features

- RoHS-compliant 14 Pin DIL Package (Row Dist:5.08mm)
- Constant Current Output (± 5% Output Current Accuracy)
- LED Driver Current up to 350mA.
- Power LED Driver.
- Wide Input Voltage Range:7V to 30V (40V for 0.5sec.)
- Output Power to 8W.
- Driver LED Strings of up to 28V (2V to 28V).
- High Efficiency (up to 95%).
- PWM / Digital Dimming and Analog Voltage Dimming.
- Open and Short LED Protection.
- -40°C ~ 85°C Operation Temperature Range.


## Application

- 12V and 24V Lighting Systems
- Household/Commercial Lighting
- Suitable for High illumination LED
- Power Limited (battery) Lighting System

GP-LD3528-0M is a high efficiency step-down converter optimized to drive high current LEDs. The control algorithm allows highly efficient and accurate LED current regulation. The device operates from an input 7Vdc to 30Vdc and provides an externally adjustable output current of up to 350mA and output power up to 8 watts. Compact size of DIL14 allows designer to integrate this driver together with LED module. UL-94V0 grade molded case with high grade filling material provide excellent fire proof characteristics.

(Typical at Ta = +25°C, nominal input voltage, rated output current unless otherwise specified.)

### Electrical Specifications:

| | |
|---|---|
| Input Voltage (Vdc) | 7V ~ 30V (40V for 0.5 sec) |
| Input Filter | Capacitor |
| Output Voltage Range (Vin = 30V) | 2V to 28V |
| Output Current Range (Vin - Vout > 2V to 3V) | 350mA |
| Output Current Accuracy (Iout = 350mA) | ±5% |
| Ripple and Noise, (20 MHz bandwidth) | 200mVp-p Max. |
| Maximum Effiecieny at Full Load | 95% |
| Capacitive Load | 47uF |
| Operating Frequency | 40kHz ~ 370kHz |
| Short Circuit Protection | Regulated at Rated Output Current |
| Temperature Coefficient (Ta = -40°C to +85°C) | ±0.03%/°C Max. |
| Operating Temperature Range, Ta | -40°C to +85°C |
| Storage Temperature Range | -40°C to +125°C |
| Maximum Case Tempeature | +100°C |
| Thermal Impedance (Nature Convection) | +35°C/W |
| Case Material | Non-Conductive Black Plastic(UL94V-0 rated) |
| Potting Material | Epoxy (UL94-V0 rated) |
| Pin Material | ¨ 0.5mm Brass Solder-coated |
| Weight | 2.6g |
| Dimensions | 0.80"x0.40"x0.27" |
| Soldering Temperature (1.5mm from case 10 sec.) | +260°C |

### PWM Dimming and ON/OFF Control (Leave Open if Not Used):

| | |
|---|---|
| Remote ON/OFF | |
| DC/DC ON | Open or 0.3V < VADJ < 1.25V |
| DC/DC OFF (Shutdown) | VADJ < 0.15V |
| Remote Pin Drive Current (VADJ = 1.25V) | <1mA |
| Quiescent Input Current in Shutdown Mode (Vin = 30V) | 25uA Max. |
| PWM Dimming | |
| Recommended Maximum Operation Frequency | 1KHz |
| Minimum Switch 'ON' Time | 200ns |
| Minimum Switch 'OFF' Time | 200ns |

### Analog Dimming Control (Leave Open if Not Used):

| | |
|---|---|
| VADJ Input Voltage Range | 0.3V to 1.25V |
| Adjust Output Current | 25% to 100% |
| Control Voltage Range Limits | |
| On | 0.2V ~ 0.3V |
| Off | 0.15V ~ 0.25V |
| Analog Pin Drive Current (VADJ = 1.25V) | <1mA |

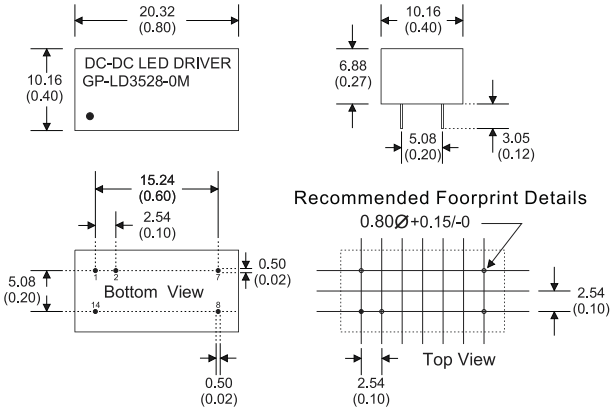
### Environmental:

| | |
|---|---|
| Humidity | 95% rel H |
| Reliability Calculated MTBF(MIL-HDBK-217 F) | >5 Mhrs |

### NOTE

1. Reversed power source damages the circuit, No connection is allowed between input ground and output .
2. DO NOT operate the driver over 8W output.
3. Leave pin VADJ open if not in use,ground pin to shut down the converter . Connecting V adj to Vin damages the circuit.
4. Maximum output open voltage is equal to input voltage .

### MECHANICAL DIMENSION



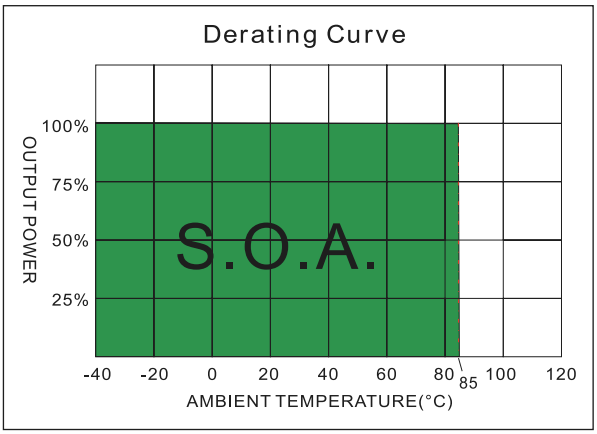

### 14 Pin DIL Package

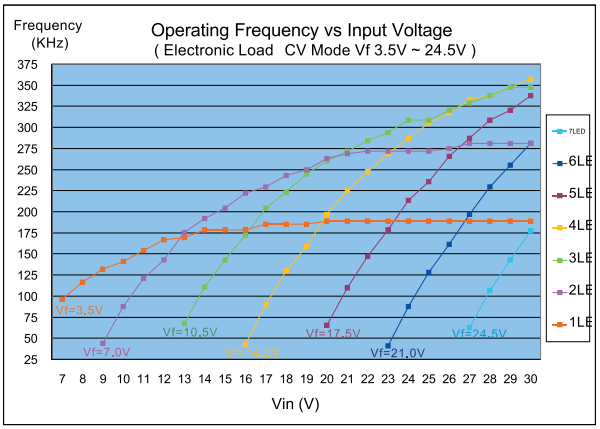
Notes : All dimensions are typical in millimeters ( inches ).
1. Pin diameter: 0.5±0.05 ( 0.02±0.002 )
2. Pin pitch tolerance: ±0.35 ( ±0.014 )
3. Case Tolerance: ±0.5 ( ±0.02 )

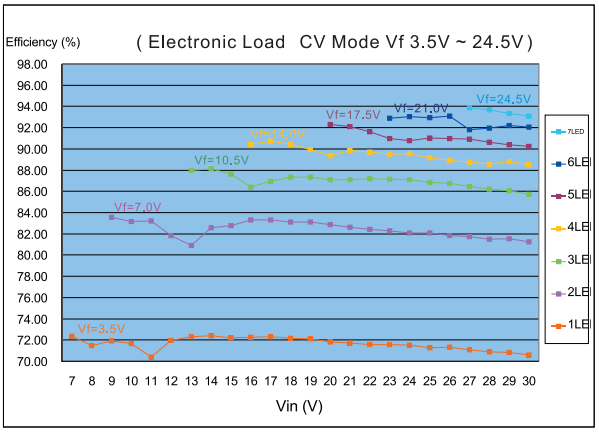
| Pin # | CONNECTIONS | |
|---|---|---|
| 1 | - V Input | - DC Supply |
| 2 | VADJ | PWM/ON/OFF or not used |
| 7 | - V Output | LED Cathode Connection |
| 8 | +V Output | LED Anode Connection |
| 14 | +V Input | +DC Supply |

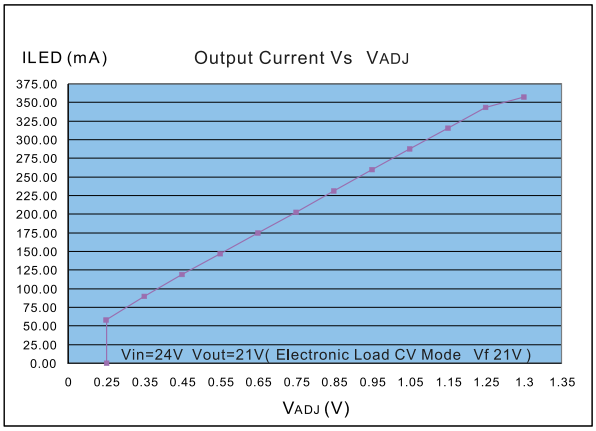
⚠ No connection is allowed between input and output

## Typical Operating Conditions

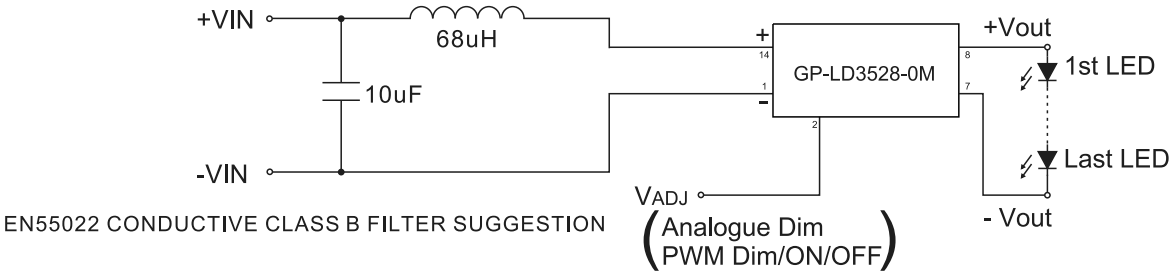


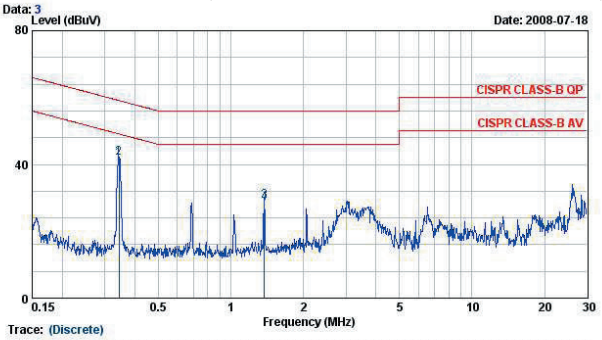




## Recommended additional input filter




EN55022 CONDUCTIVE CLASS B FILTER SUGGESTION

Vin=30V Vout=24.5V( Electronic Load CV Mode Vf 24.5V )

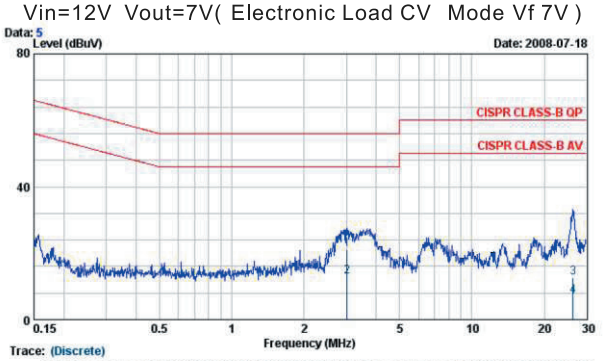



Trace: (Discrete)

| Freq. MHz | LISN Factor dB | Cable Loss dB | Meter Reading dBuV | Measured Level dBuV | Limits dBuV | Over Limits dBuV | Detector |
|---|---|---|---|---|---|---|---|
| 0.344 | 9.88 | 0.05 | 31.79 | 41.72 | 59.10 | -17.39 | QP |
| 0.344 | 9.88 | 0.05 | 32.04 | 41.97 | 49.10 | -7.14 | AVERAGE |
| 1.374 | 9.95 | 0.04 | 18.96 | 28.95 | 56.00 | -27.05 | QP |
| 1.374 | 9.95 | 0.04 | 18.44 | 28.43 | 46.00 | -17.57 | AVERAGE |

REMARKS: 1.Level(dBuV/m)=Read Level(dBuV)+Antenna Factor(dB/m)+Cable loss(dB)
2.Over Limit value(dB)=Level(dBuV/m)-Limit Line(dBuV/m)

Vin=12V Vout=7V( Electronic Load CV Mode Vf 7V )

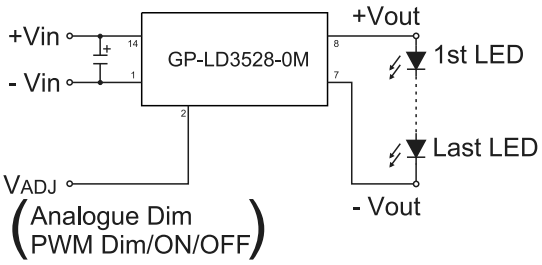


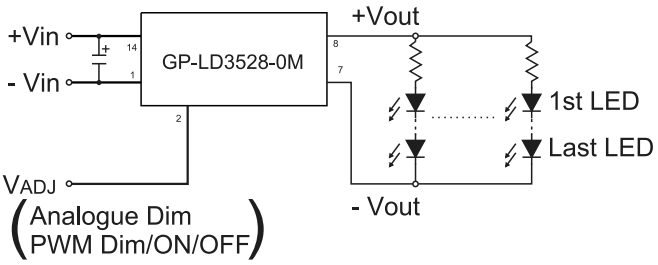

Trace: (Discrete)

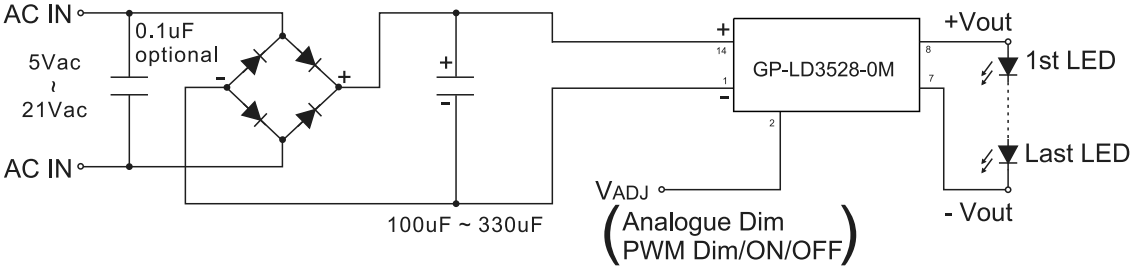
| Freq. MHz | LISN Factor dB | Cable Loss dB | Meter Reading dBuV | Measured Level dBuV | Limits dBuV | Over Limits dBuV | Detector |
|---|---|---|---|---|---|---|---|
| 3.025 | 9.88 | 0.09 | 11.10 | 21.07 | 56.00 | -34.93 | QP |
| 3.025 | 9.88 | 0.09 | 2.90 | 12.87 | 46.00 | -33.13 | AVERAGE |
| 26.418 | 10.03 | 0.51 | 2.05 | 12.59 | 60.00 | -47.41 | QP |
| 26.418 | 10.03 | 0.51 | -3.39 | 7.15 | 50.00 | -42.85 | AVERAGE |

REMARKS: 1.Level(dBuV/m)=Read Level(dBuV)+Antenna Factor(dB/m)+Cable loss(dB)
2.Over Limit value(dB)=Level(dBuV/m)-Limit Line(dBuV/m)

## Typical application



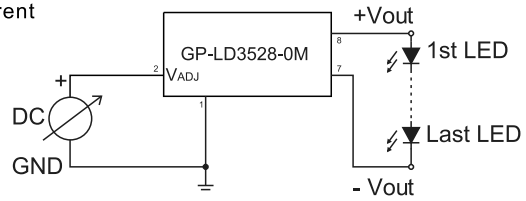



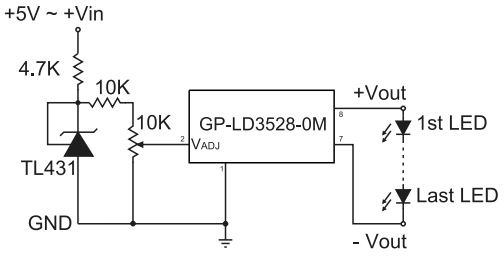



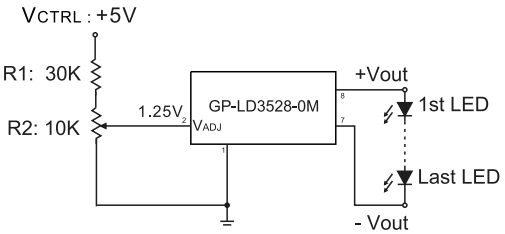

## Output Current Adjustment By External DC Control Voltage

The nominal output current is then given by:

$$Iout \approx \frac{0.08 \times V_{ADJ}}{0.28}$$



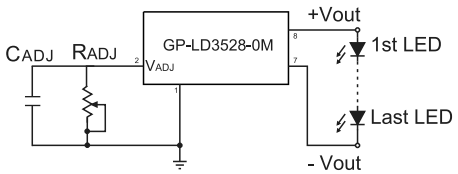




$$V_{ADJ} = \frac{R2}{R1 + R2} \times V_{CTRL}$$

## Resistor dimming

By connecting a variable resistor between ADJ and GND, simple dimming can be achieved. Capacitor $C_{ADJ}$ is optional for better AC mains interference and HF noise rejection. Recommend value of $C_{ADJ}$ is 0.22uF.




The current output can be determined using the equation:

$$Iout = \frac{(0.08 / 0.28) \times R_{ADJ}}{(R_{ADJ} + 200K)}$$

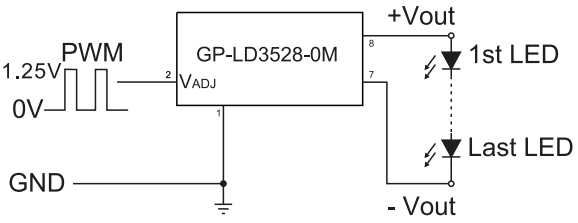
## Typical application

# Output Current Adjustment By PWM Control

Directly driving ADJ input

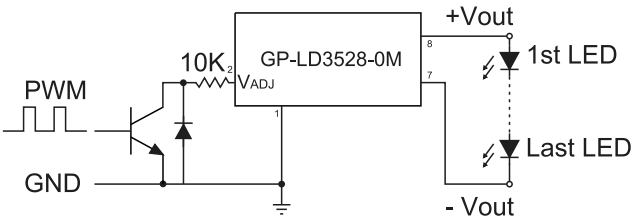
A Pulse Width Modulated (PWM) signal with duty cycle $D_{PWM}$ can be applied to the ADJ pin, as shown below

$$Iout \approx \frac{0.1 D_{PWM}}{0.28} \quad [for\ 0<D_{PWM}<1]$$



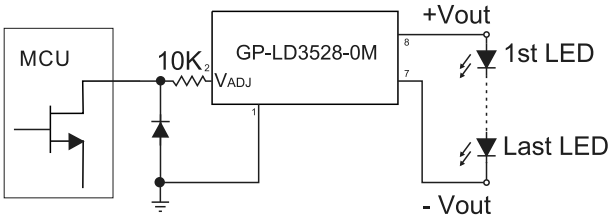

Driving the ADJ input via open collector transistor

The diode and resistor suppress possible high amplitude negative spikes on the ADJ input resulting from the drain-source capacitance of the transistor. Negative spikes at the input to the device should be avoided as they may cause errors in output current, or erratic device operation.




Driving the ADJ input from a microcontroller

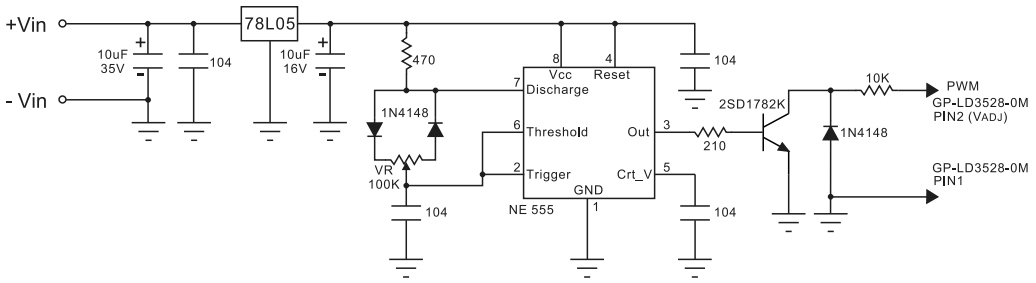
Another possibility is to drive the device from the open drain output of a microcontroller. The diagram below shows one method of doing this:



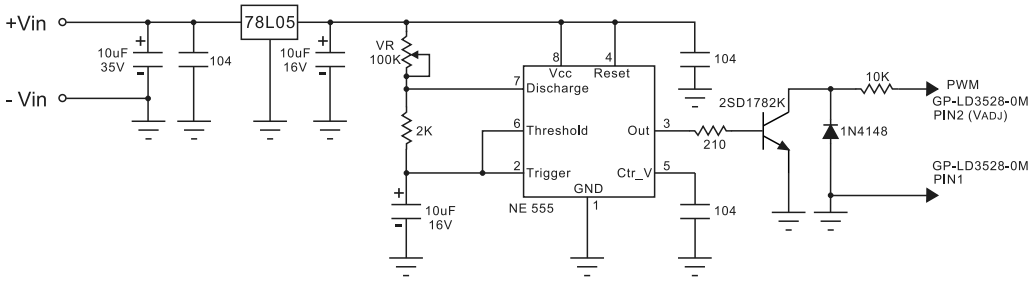

The diode and resistor suppress possible high amplitude negative spikes on the ADJ input resulting from the drain-source capacitance of the FET. Negative spikes at the input to the device should be avoided as they may cause errors in output current, or erratic device operation.

## Output Current Adjustment By PWM Control (Dimming)

To avoid visible flicker the PWM signal must be greater than 100Hz.

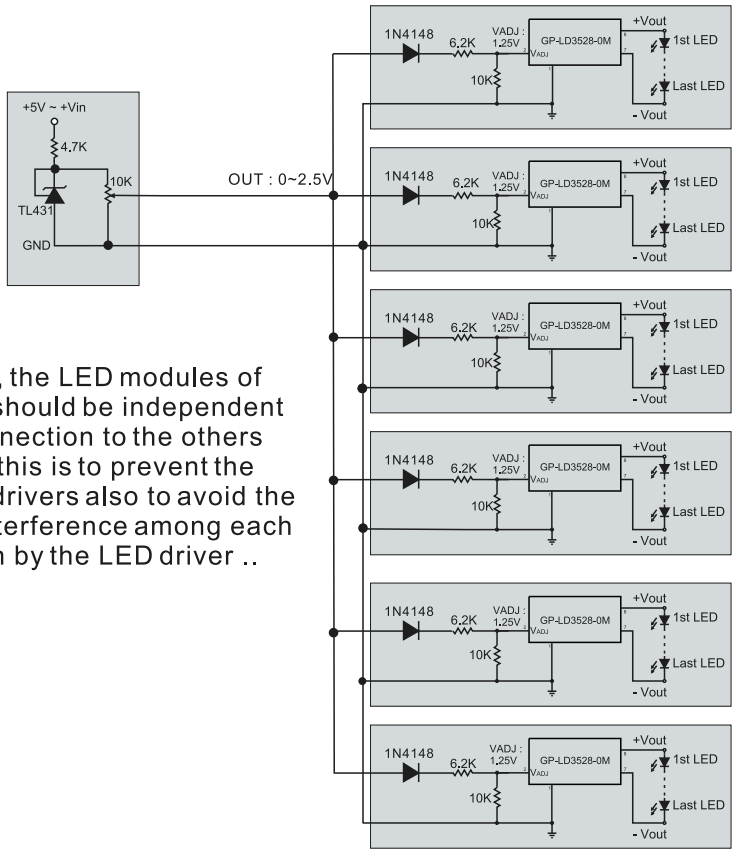



## Output Current Adjustment By PWM Control (Flash)



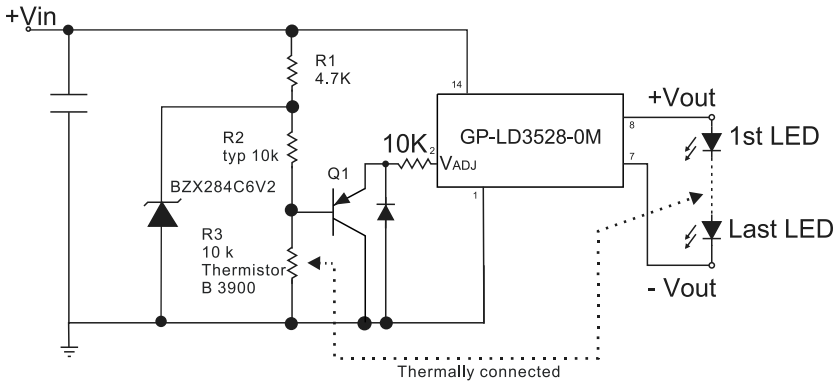
## Typical application

# Output Current Adjustment By External DC Control Voltage




In this application , the LED modules of each LED drivers should be independent from electrical connection to the others and input power - this is to prevent the damaging to LED drivers also to avoid the un-necessaried interference among each LED module driven by the LED driver ..

# Thermal feedback circuit




The selection of components for the thermal feedback circuit is not only dependent on the choice of R2 and R3, but also on the amount of heat sink area required to extract heat from the LEDs. To maximize the light output at high ambient or operating temperature conditions, the LEDs must have a sufficient thermal extraction path, otherwise the thermal control circuit will effect current drive reduction in non-optimal conditions. The thermal control threshold point is set by adjusting R2. For this design, three values (33k, 22k and 10k) were evaluated. These values were chosen to give break points at approximately 25°C, 40°C and 60°C.
Note that the light output will not continually dim to zero - the thermal control is applying DC control to the ADJ pin and therefore has a dimming ratio from maximum Current of approximately 5:1. Once the reduced DC level goes below the shutdown threshold of around 200mV, the LED drive current will fall to zero and the LEDs will be extinguished. The slope of the current reduction is determined by the beta value of the thermistor. The larger the beta value, the sharper will be the resultant current control response. The slope of the current reduction is also affected by Q1's base emitter voltage (VBE) variation with temperature.