GreenPOS™ LED Driver
GP8000 Series
AC Direct Drive Solution
(GP8100ESO)

v1.6

SPECIFICATION

GREENCHIP

REVISION HISTORY

Version	Date	Revision Contents
V1.0	November 2013	Release version
V1.1	February 2014	Revised application circuit parameter
V1.2	March 2014	Revised application circuit parameter
V1.3	May 2014	Revised application circuit parameter(RS,CLD)
V1.4	July 2014	Add Package
V1.5	November 2014	Discontinue production of 20QFN package
V1.6	June 2015	Revised application circuit parameter(RIN,RP,C1,R1)

GP8100

5 TAP DIRECT AC LINE LED DRIVER

GENERAL DESCRIPTION

GP8100 is a Direct AC Line Driver IC that is designed to meet the most stringent power efficiency and PF(power factor) requirements and can be optimized by adding various features for a low cost LED lighting system in a small PCB space.

It just requires a minimum of 1 bridge diode and 1 resistor(RCS) to ensure its stable operation, and .it does not need an external smoothing electrolytic condenser thanks to its stable built-in shunt regulator

Power, THD, Power Compensation, OVP, Linear Dimming (0-10V Dimming), Triac Dimming circuit can be designed with a minimum number of external components and a stable thermal design at high power can be achieved with the use of external power MOSFET (GVH TR) which is also provided by Greenchip.

GP8100 offers not only the basic standard functions needed to design efficient LED lighting systems but also other various optional functions to meet various needs of LED lighting designers.

First, it uses a very simple sequential driving method. A very low cost lighting system can be realized in a limited PCB space with a minimum number of external components.

Secondly, control circuits can be easily added according to the system specifications. If the designer wants to further lower THD, to reduce the power variations caused by input voltage fluctuations or to add dimming circuits, these functions can be implemented with a minimum number of external components

Thirdly, its power can be distributed to the external MOSFET. In order to prevent the excessive temperature increase, GHV TR, which is also available from Greenchip can be connected in parallel with IC's internal TR, and it can prevent IC from excessive heating and malfunctions and also help to design the system with a higher input power capacity than a single IC has.

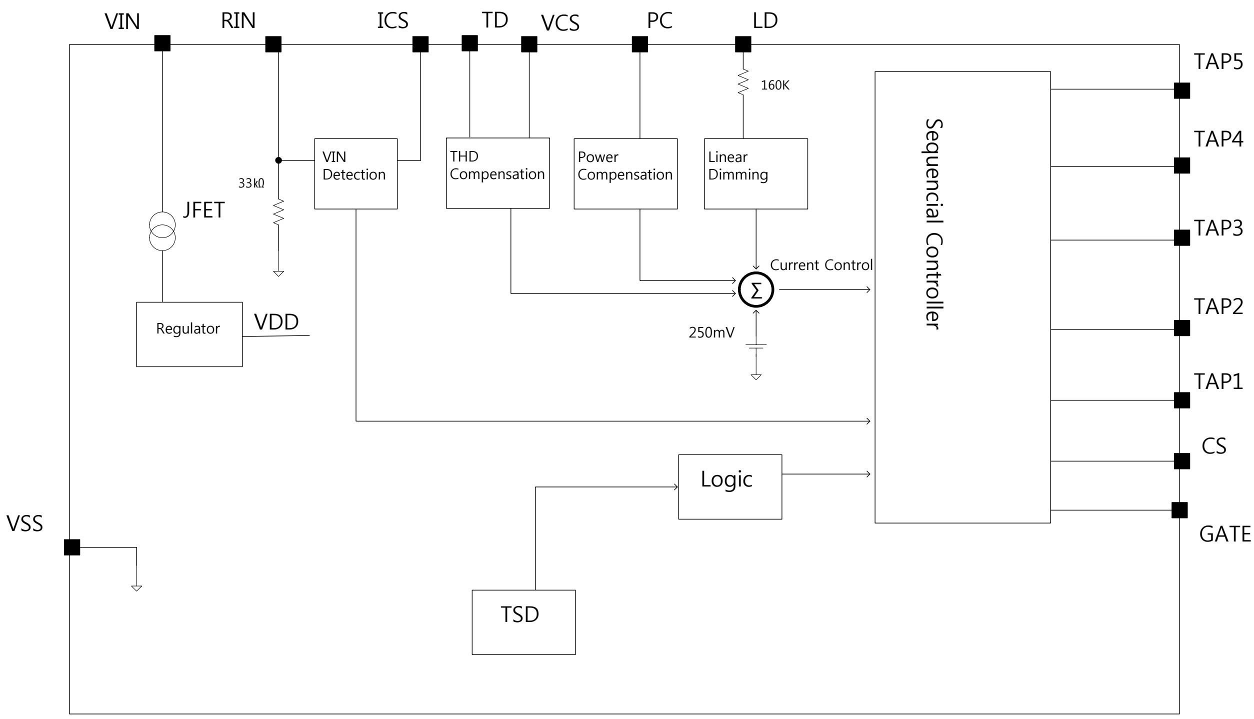
FEATURES

- Direct AC Line 5TAP LED Driver with max. 200mA Constant Current
- No Transformer, no condenser
- Wide input Voltage Design : 85 ~ 265Vac
  - Typ.110VAC, 120VAC, 220VAC, 230VAC
- Minimum number of external components
- High Efficiency more than 90%
- High Power Factor over 0.95
- Programmable LED current with Ext. Resistor(RCS)
- THD Compensation using RTD : under 20%
  - trade-off with Power Compensation using RIN
- Triac, Linear dimmable
- Up to 20W with Ext. GHV TR
- Protection : OVP, TSD
- Operating Temperature : -40℃ ~ 125 ℃
- Small Package : ESOP16L
- Driving Method
  - Sequential type
- Option Selection
  - Power Compensation using RIN (trade-off with THD)
  - THD Control using RTD
  - Linear Dimmable with RLD
  - TRIAC Dimmable

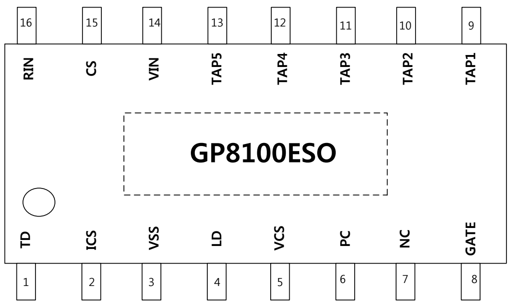
APPLICATIONS

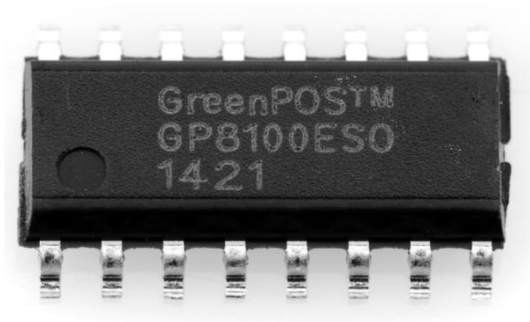
- Direct AC Line LED Driver up to 20W
- Bulb & Down Lighting
- Street Lighting
- Parking lot, tube, bar etc

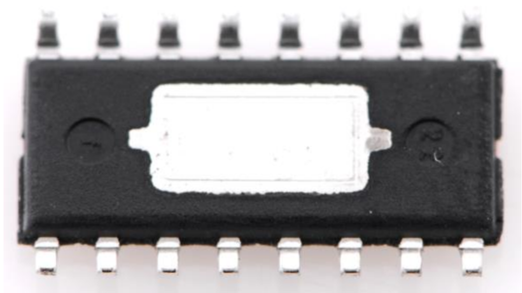
BLOCK DIAGRAM



PKG PIN MAP / Marking SPEC







MARKING INFORMATION (16ESOP)

GreenPOS™
GP8100ESO
YYWW

- GreenPOS™ : GreenPOS logo
- GP8100ESO : Device Code
- YY : Year Code / WW: Week Code

PIN DESCRIPTION

PIN Name	PIN No.	Description
TD	1	THD control pin
ICS	2	Compensation circuit(THD, Power) control pin
VSS	3	Ground Pin
LD	4	0-10V Linear dimming pin
VCS	5	Reference voltage for LED current setting
PC	6	Power compensation pin. Connected to ICS pin through RP resistor
NC	7	-
GATE	8	Gate pin used for power distribution when external power TR is connected
TAP1	9	IC's 1st internal Power TR drain pin
TAP2	10	IC's 2nd internal Power TR drain pin
TAP3	11	IC's 3rd internal Power TR drain pin
TAP4	12	IC's 4th internal Power TR drain pin
TAP5	13	IC's 5th internal Power TR drain pin
VIN	14	Input supply voltage pin. AC LINE voltage is full wave rectified and connected to VIN
CS	15	Current sensing pin. It's used to set LED's static current by connecting RCS resistor
RIN	16	Input supply voltage sensing pin. Used for internal control circuit

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS	Symbol	Value	Unit
Line Voltage	VIN	-0.3 ~ +450	V
TAP Voltage	TAP1~TAP5	-0.3 ~ +450	V
Current Sensing Voltage	CS	-0.3 ~ +6.5	V
All other pins voltage except VIN,TAP,CS	-	-0.3 ~ 16	V
TAP Current 1	TAP1~TAP3	200	mA
TAP Current 2	TAP4,5	80	mA
Junction Temperature	TJ	150	℃
Operating Temperature	Topr	-40 ~ +125	℃
Storage Temperature Range	Tstg	-65 ~ +150	℃

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DC ELECTRICAL CHARACTERISTICS

◎ Ta=25℃, VIN=40V, RIN=2 MΩ, RCS=25Ω unless otherwise specified

No	Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Unit
1	Internal Regulation Voltage	VDD	VIN=40V, 400V	14	15	16	V
2	Input Current1	IIN1	VIN=40V	0.6	0.75	-	mA
3	Input Current2	IIN2	VIN=400V	0.75	1.2	-	mA
4	Internal VDD Sink Current	IDD_sink	VIN=40V	-	-300	-	uA
5	Current Sensing Voltage1	V(VCS)	VIN=40V	-4%	250	+4%-	mV
6	Current Sensing Voltage2	V(VCS)	VIN=400V	-4%	250	+4%-	mV
7	ICS Voltage	V(ICS)	VIN=100V	-	0.35	-	V
8	CS Voltage1	V(CS)1	VIN=40V, Vtap=10V	-2%	250	+2%	mV
9	CS Voltage2	V(CS)2	VIN=400V, Vtap=10V	-2%	250	+2%-	mV
10	PC Threshold Voltage	V(PC)	V(VCS)=V(VCS)-10mV	-	0.9	-	V
11	TD Threshold Voltage	V(TD)	V(CS)=200mV		7.5		V
12	LD Threshold Voltage	V(LD)	V(CS)=200mV		2.4		V
13	Thermal Shut Down	TSD	-	-	150	-	℃
14	TAP1,2,3,4,5 Leakage Current	ITAP_LEAK	VIN=40V, V(LD)=VDD V(TAP)=400V	-	-	10	uA

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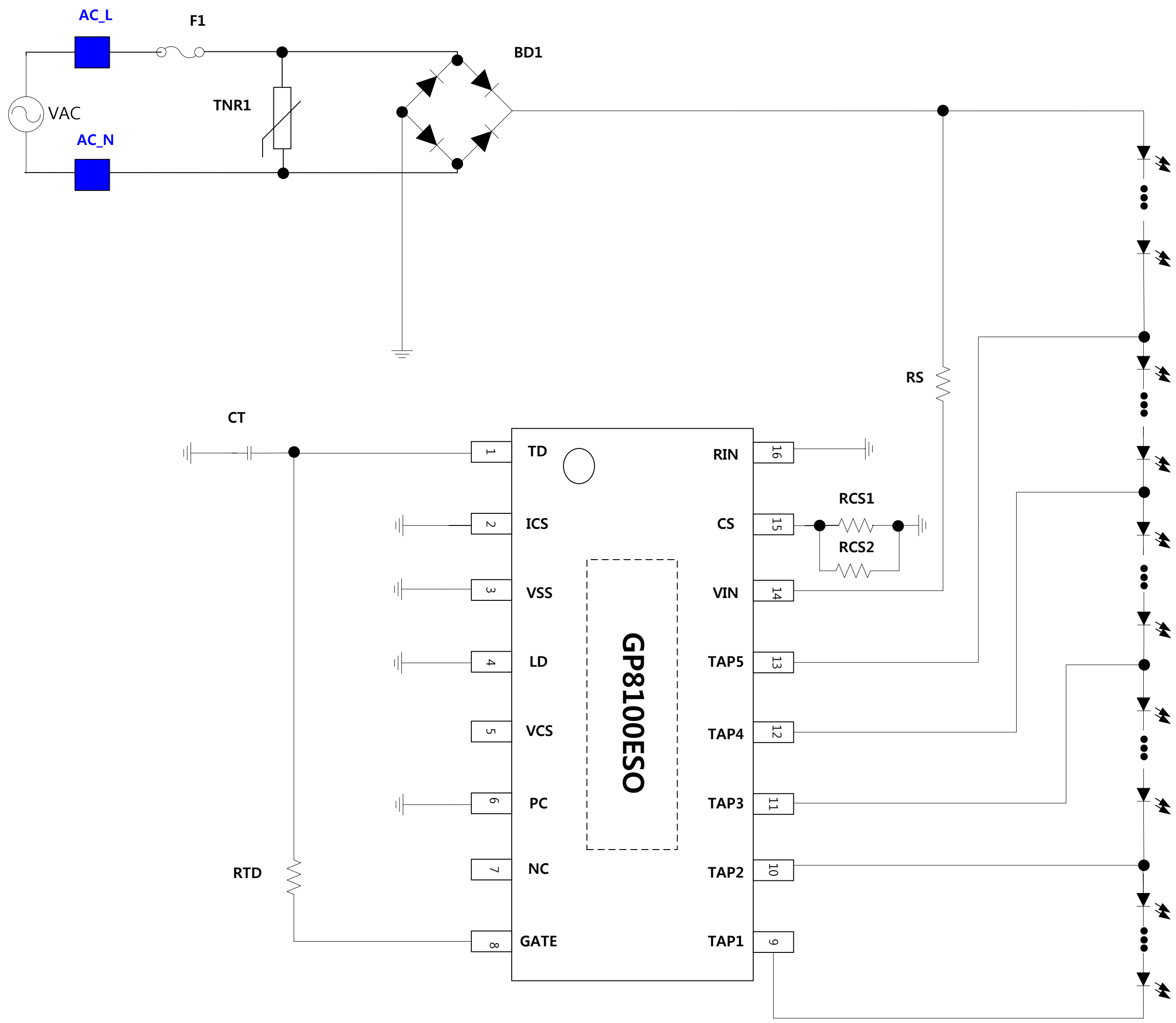
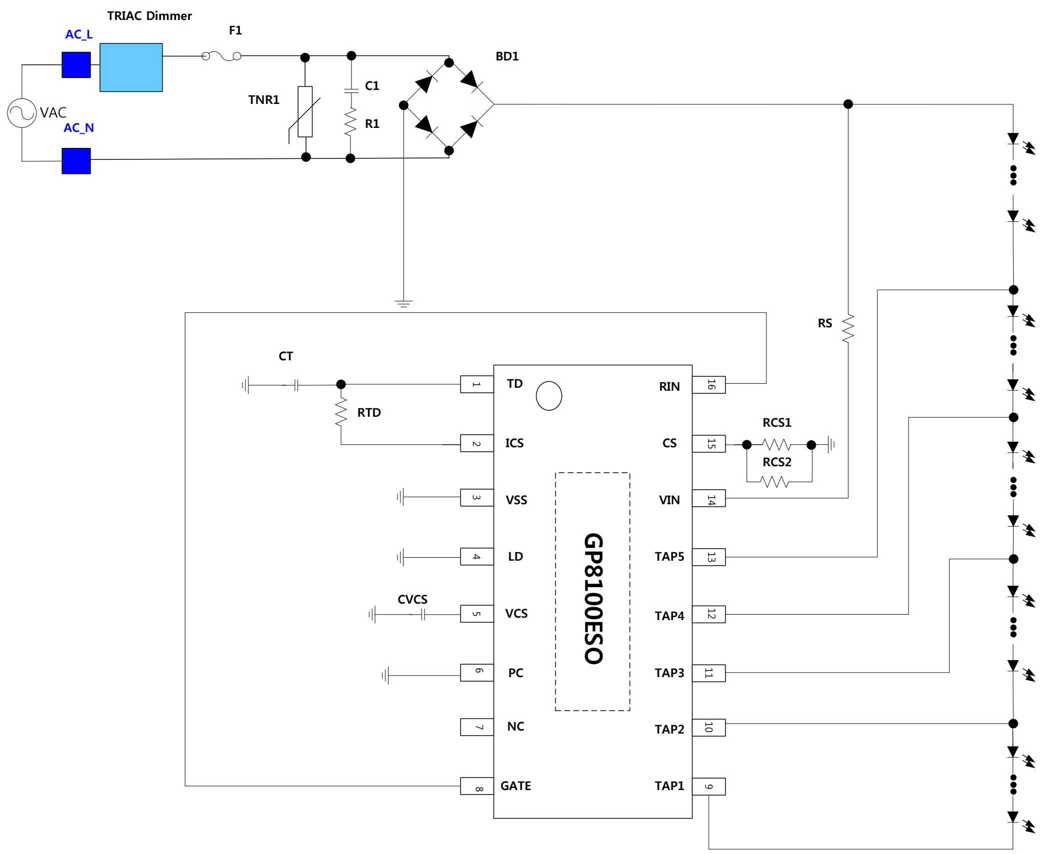
TYPICAL APPLICATION CIRCUIT 1

Highlight	Simple & Low Cost Solution 1 → PF, THD			
VAC	110, 220VAC (±10% or ±20%)		Input Power	Programmable using RCS
PF / THD	0.95↑/ 20%↓with RTD		Surge Protect	RS 30kΩ↑(typ. 47kΩ)
Power Comp.	-		Dimming	-
Power Decent.	-			



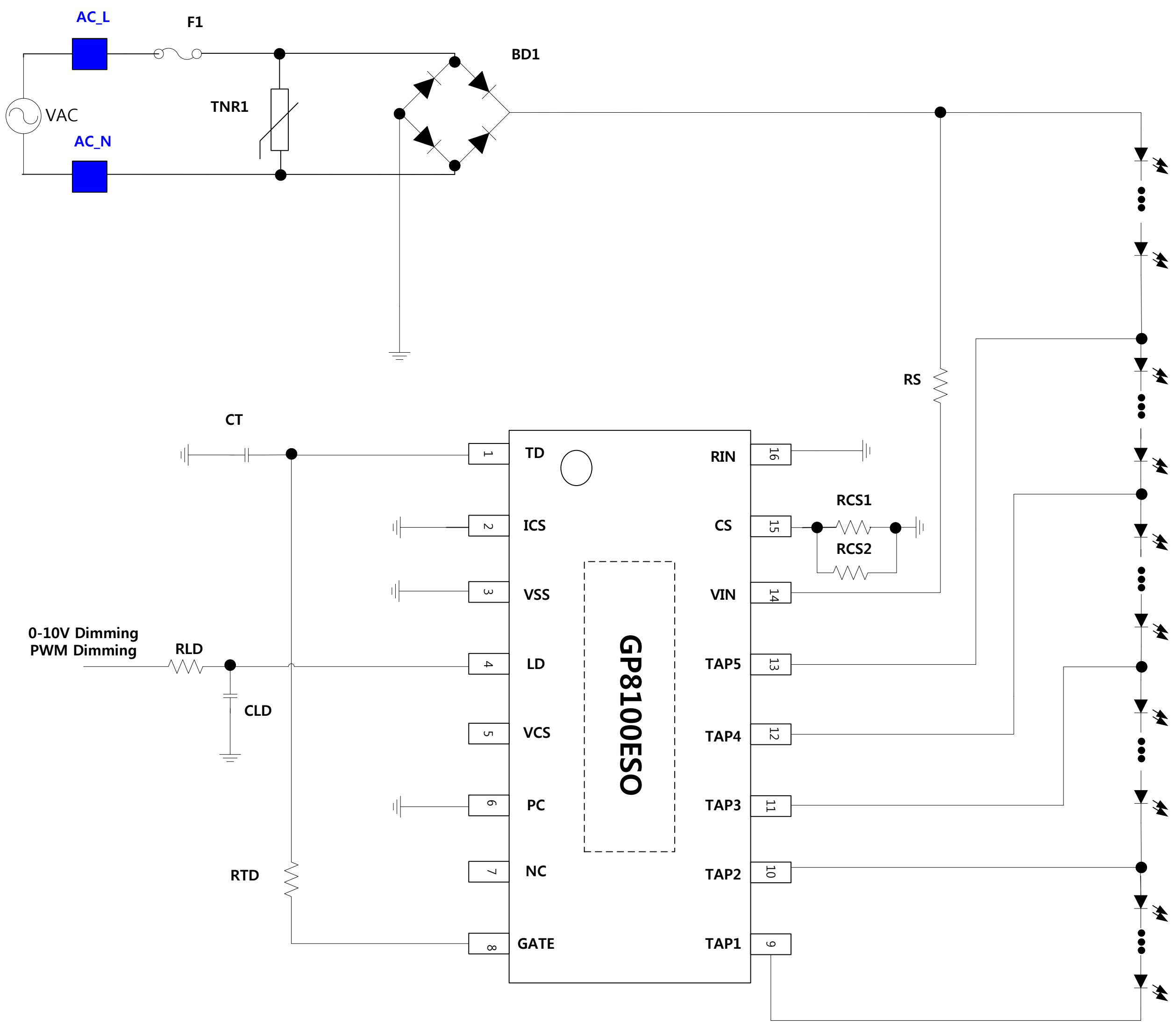
TYPICAL APPLICATION CIRCUIT 2

Highlight	Simple & Low Cost Solution 2 → PF, THD, Triac Dimming			
VAC	110, 220VAC (±10% or ±20%)		Input Power	Programmable using RCS
PF / THD	0.95↑/ 20%↓with RTD		Surge Protect	RS 30kΩ↑(typ. 47kΩ)
Power Comp.	-		Dimming	Triac dimming
Power Decent.	-			



TYPICAL APPLICATION CIRCUIT 3

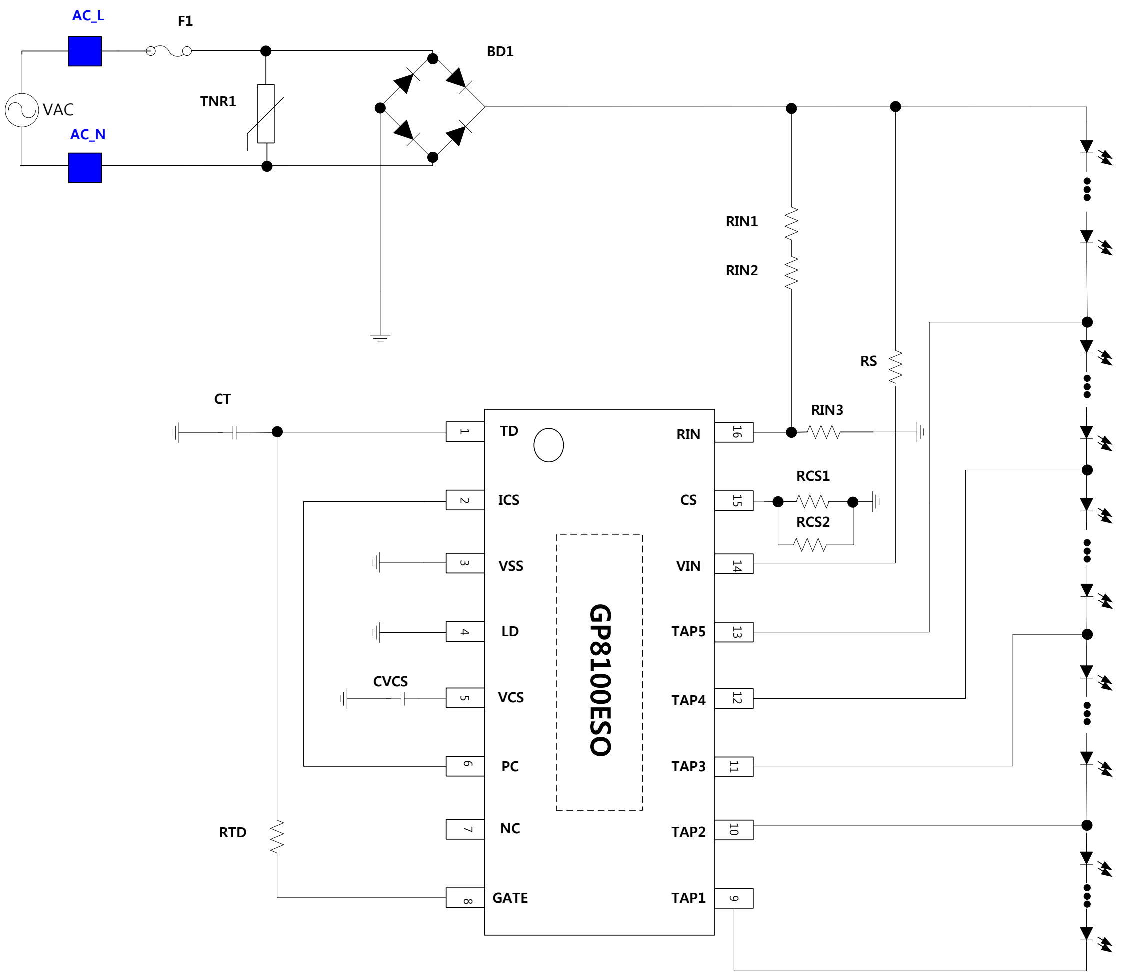
Highlight	Simple & Low Cost Solution 3 → PF, THD, Linear Dimming			
VAC	110, 220VAC (±10% or ±20%)		Input Power	Programmable using RCS
PF / THD	0.95↑/ 20%↓with RTD		Surge Protect	RS 30㏀↑(typ. 47㏀)
Power Comp.	-		Dimming	Linear dimming(0-10V) with RLD
Power Decent.	-			



TYPICAL APPLICATION CIRCUIT 4

Highlight	**Optimized Solution 1** **→ PF, THD, Power Compensation**		
VAC	110, 220VAC (±10% or ±20%)	Input Power	Programmable using RCS
PF / THD	0.95↑/ 20%↓with RTD (trade-off with PC*)	Surge Protect	RS 30㏀↑(typ. 47㏀)
Power Comp.	Input Power ±10%↓ with RIN	Dimming	-
Power Decent.	-		

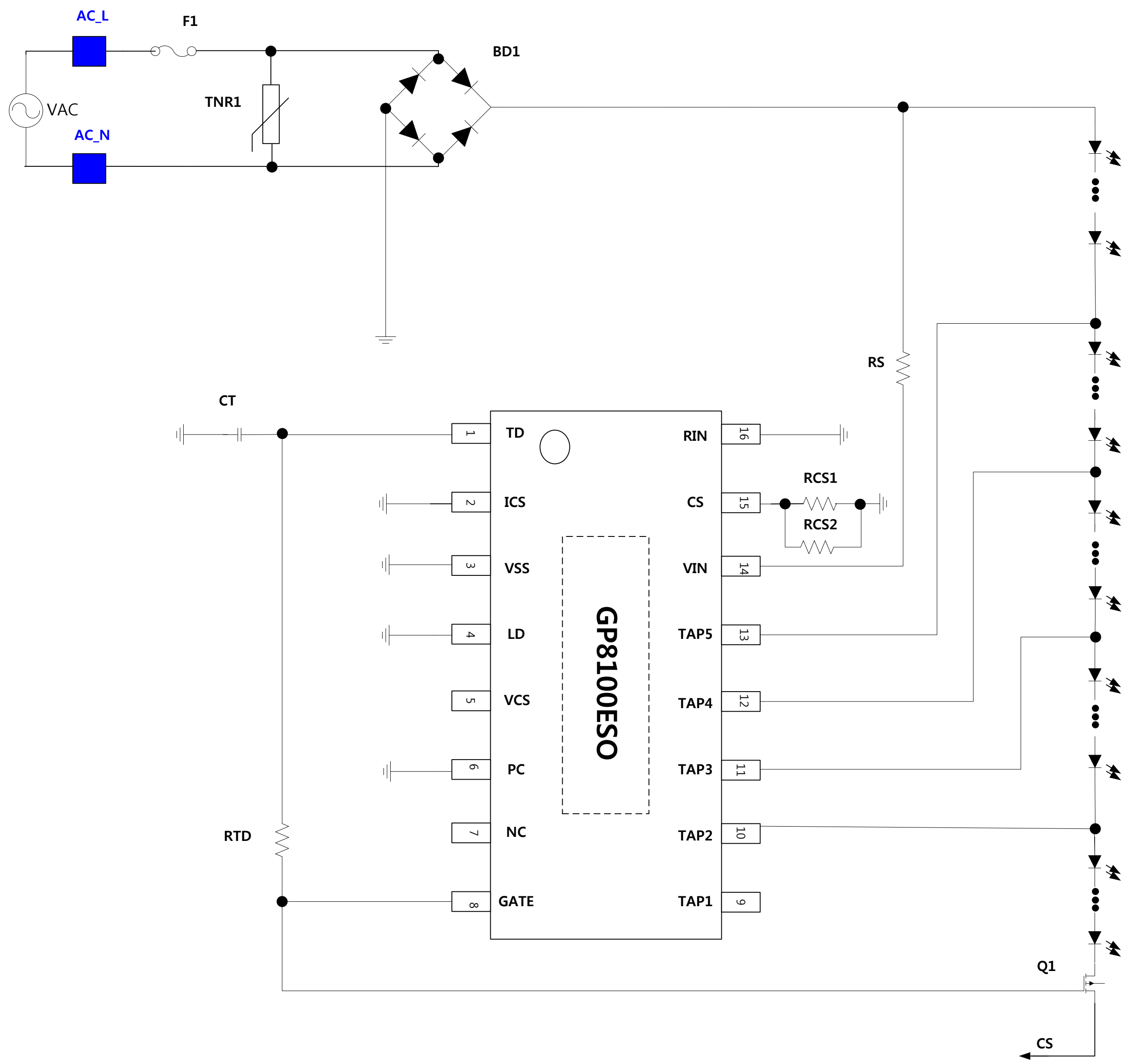
* PC : Power Compensation



TYPICAL APPLICATION CIRCUIT 5

Highlight	**Optimized Solution 2** **→ PF, THD, Power Decentralization**			
VAC	110, 220VAC (±10% or ±20%)		Input Power	Programmable using RCS
PF / THD	0.95 ↑ / 20% ↓ with RTD		Surge Protect	RS 30㏀ ↑ (typ. 47㏀)
Power Comp.	-		Dimming	-
Power Decent.	Thermal Decentralization with GHV TR*			

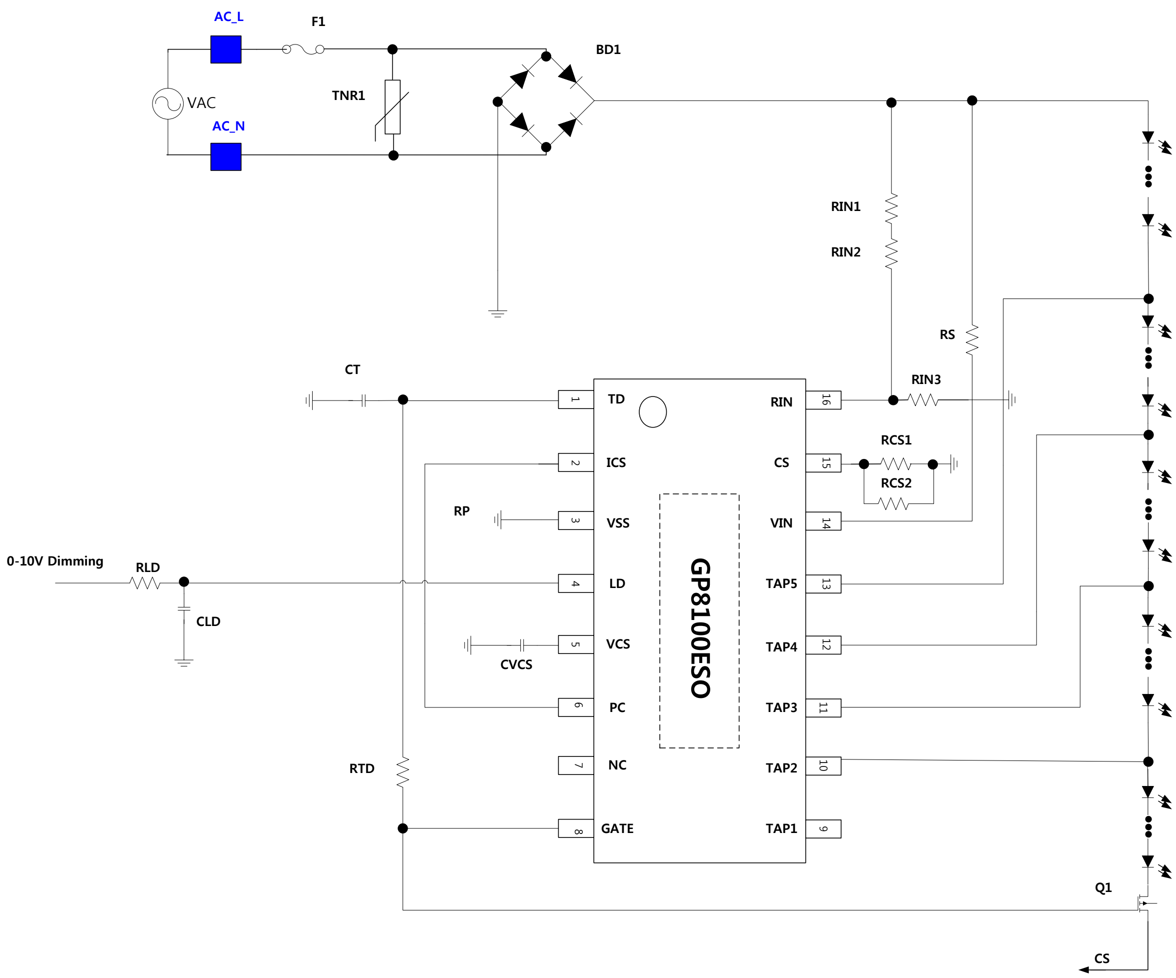
* GHV TR : High voltage power MOSFET (Provided by GreenChip Inc.)



TYPICAL APPLICATION CIRCUIT 6

Highlight	**Optimized Solution 3** **→ PF, THD, Power Compensation, Power Decentralization, Linear Dimming**			
VAC	110, 220VAC (±10% or ±20%)		Input Power	Programmable using RCS
PF / THD	0.95↑/ 20%↓ with RTD (trade-off with PC*)		Surge Protect	RS 30㏀↑(typ. 47㏀)
Power Comp.	Input Power ±10%↓ with RIN		Dimming	Linear dimming(0-10V)
Power Decent.	Thermal Decentralization with GHV TR**			

* PC : Power Compensation
** GHV TR : High voltage power MOSFET (Provided by GreenChip Inc.)

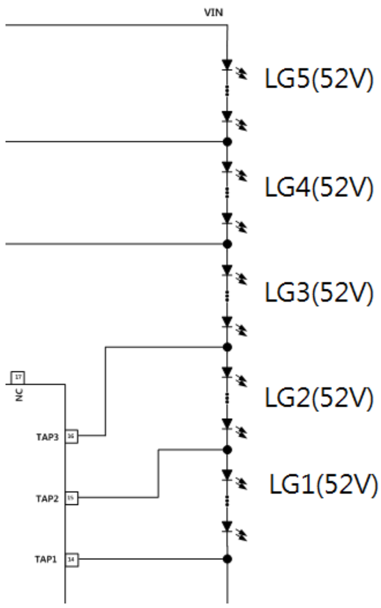


OPERATION

GP8100 is a Direct AC Line 5 TAP LED Driver IC which is developed using Greenchip's proprietary GreenPOS™ control technology.
GP8100 uses sequential driving method and needs a very small number of external components which allows low cost LED lighting system designs.
A single IC can handle up to 15W of power and a system with more than 20W of power can also be designed if Case thermal resistance design and additional external Power NMOS TR(GHV4502) is used.

The method of designing LED driving circuit using GP8100ESO is as follows.

1. AC input voltage setting
    1) AC220V(±10%) : Full wave rectified DC 280V~340
    2) AC110V(±10%) : Full wave rectified DC 140V~172
2. Total number of LED setting
    1) Set Total LED VF(Max) as -14% of AC Typical voltage.
        - Approximately 270V in case of 220V AC, 133V in case of 110V AC
    2) VF(Max) is VF with the current at peak voltage.
    3) Number of LED, N is
        - 270V/LED VF(Max) in case of AC220V
        - 133V/LED VF(Max).in case of AC110V
    4) If 90% of typical AC voltage is used, more than 90% of power efficiency can be achieved, but in some extreme circumstances under low temperature and unstable AC input voltage, stable operation of the circuit can't be guaranteed. Because of this, if the Total LED VF is kept below 86% of typical AC voltage, a stable operation of the circuit can be guaranteed under even very high or low temperature and unstable AC line voltage though efficiency will suffer.



3. Number of LED per channel
    1) Once the number of total LEDs is set as above, the number of LEDs per channel must be determined
    2) If the number of LEDs in the 1st LED Group(LG5), which operate under low input voltage, is too big, power factor and THD will be degraded due to longer All LED Off period, but power efficiency and light efficiency will have improved characteristics
    3) On the contrary, if the number of LEDs in the 1st LED Group(LG5), which operate under low input voltage, is too small, the number of LEDs must be carefully optimized for target characteristics as its shorter All LED Off period can increase power factor and THD while decrease power efficiency and light efficiency
    4) Even if the number of LEDs in LG1 and LG5 are changed, the variations are too small to be noticed when the circuit is configured and tested. It is recommended to use the same number of LEDs for LG1~LG5.

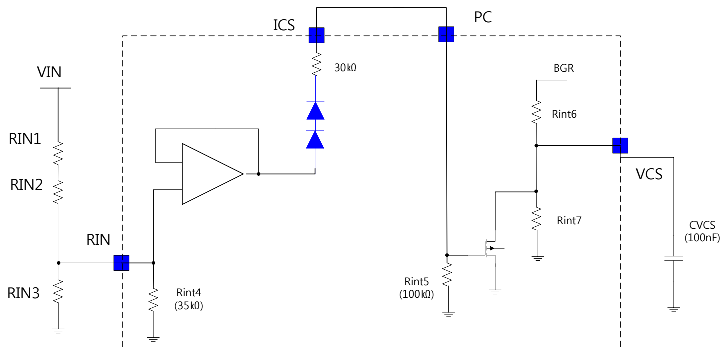
4. RIN resistor setting

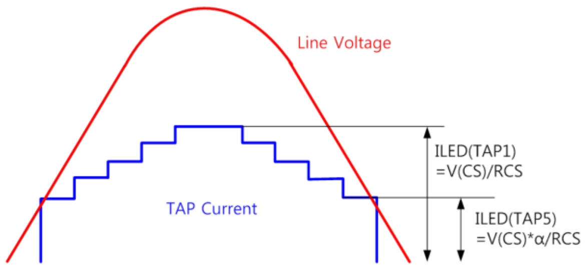
1) In the circuit diagram below, VCS is the BGR voltage which determines the LED current.
ICS voltage has the same waveform as input LINE voltage but RIN resistor reduces its magnitude as 1/180 of the input LINE voltage
Internal MOSFET will be turned on by RIN1,2,3 resistors in a region where VIN is high.
Hence, in a region where TAP1 is working, power compensation circuit is activated to lower VCS voltage as VIN voltage increases.

2) RIN1,2 resistor is used to determine the degree of power compensation, and if the resistor value is too small, the compensation is too big so that current waveform will be distorted yielding in higher THD.
Typically, proper power compensation is done in such a way that the input power also varies by 10% when VAC changes by 10%, so that the luminance doesn’t change, Recommended RIN1,2,3 resistor values for GP8100 are as follows

- RIN1 1 MΩ, RIN2 1 MΩ, RIN3 33 kΩ at AC 220V
- RIN1 500 kΩ, RIN2 500 kΩ, RIN3 33 kΩ at AC 110V

(100nF capacitor must be connected to CVCS to prevent noise)

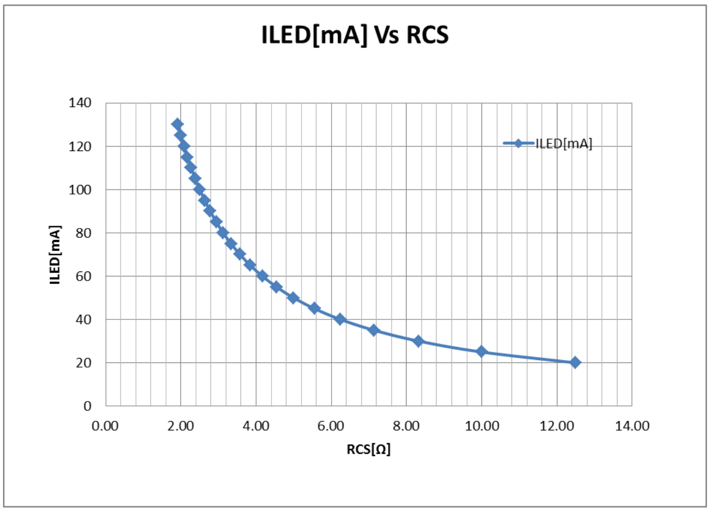


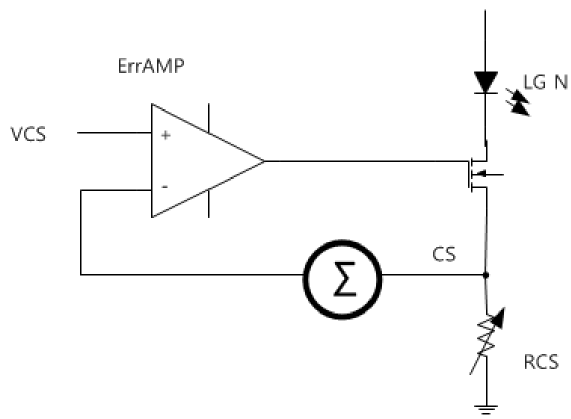


6. RCS resistor setting

1) It’s been explained earlier that target VF(Max) and current must be determined in order to set the number of total LEDs.
LED current at TAP1 is determined by V(CS) Max.and RCS.
For example, since VCS Max. is 250mV and ILED is V(CS)Max./RCS when TAP1 is active, RCS value can be determined when target ILED.is fixed.

2) RCS – ILED graph is shown below at VCS of 250mV





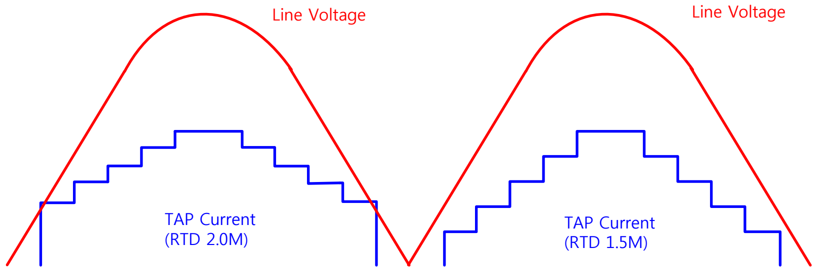
3) When target power is determined, an approximate value of RCS must be chosen by calculating Max.(ILED).
One can start with an approximate value of RCS and the final value must be determined experimentally with further fine tuning.
Approximate value of RCS can be determined as follows.

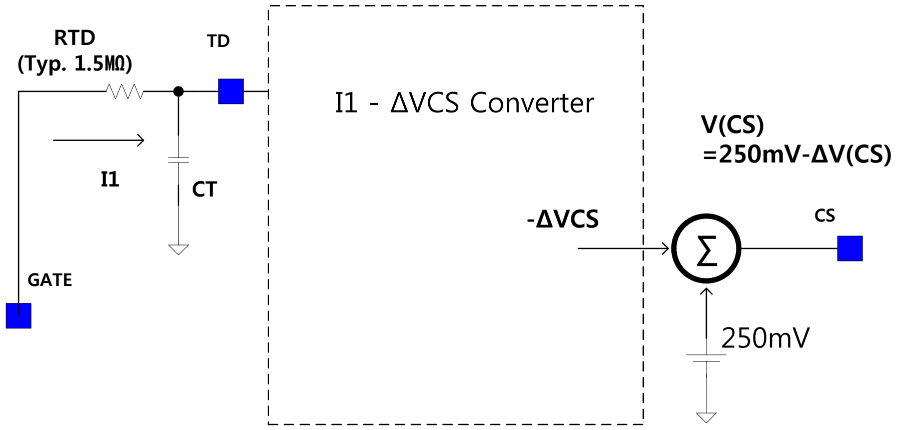
$$I(LED)max = \frac{Power}{VAC} \times 1.414$$

For example, to design VAC=220V, 10W power system, I(LED)max=64mA.
RCS is approximately 3.9ohm at 64mA of I(LED) from the ILED Vs RCS graph above, for 10W LED lighting, RCS=3.9Ω±α.

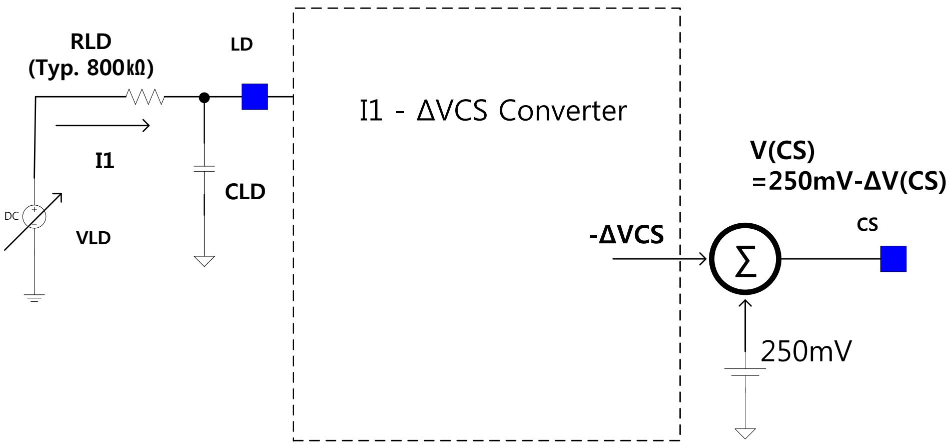
6. RTD resistor setting

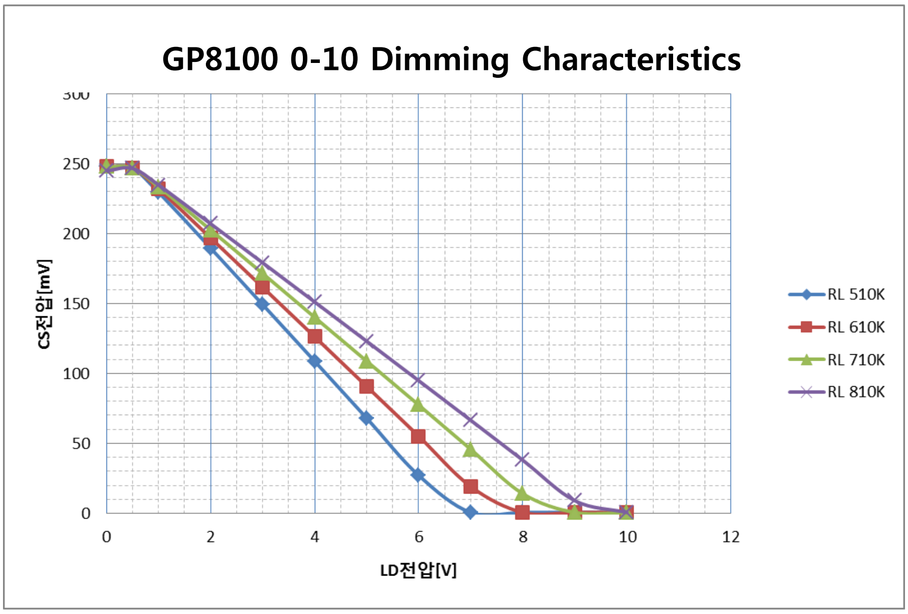
1) GP8100 is designed to have THD of less than 20% by selectively setting the different current for each TAP, and external RTD resistor is used to fine-tune THD by adjusting the slope of current for each TAP
2) From TAP1 to TAP5, because MOSFET's gate potential is different for each TAP, CS voltage, which sets the LED current, can be designed to have a proper slope by connecting RTD resistor with an appropriate value between Gate pin and TD pin, THD is determined accordingly
3) CT condenser with minimum of 100pF must be connected for Noise Bypass (Typ. 100pF)
The greater the CT value is, the higher the slope of step waveform of TAP current will be.
4) In the diagram below, it is shown the slope of TAP Current changes with different values of RTD resistor
It's recommended to use 1.5Mohm for RTD resistor for GP8100, and it can be fine-tuned depending on the application





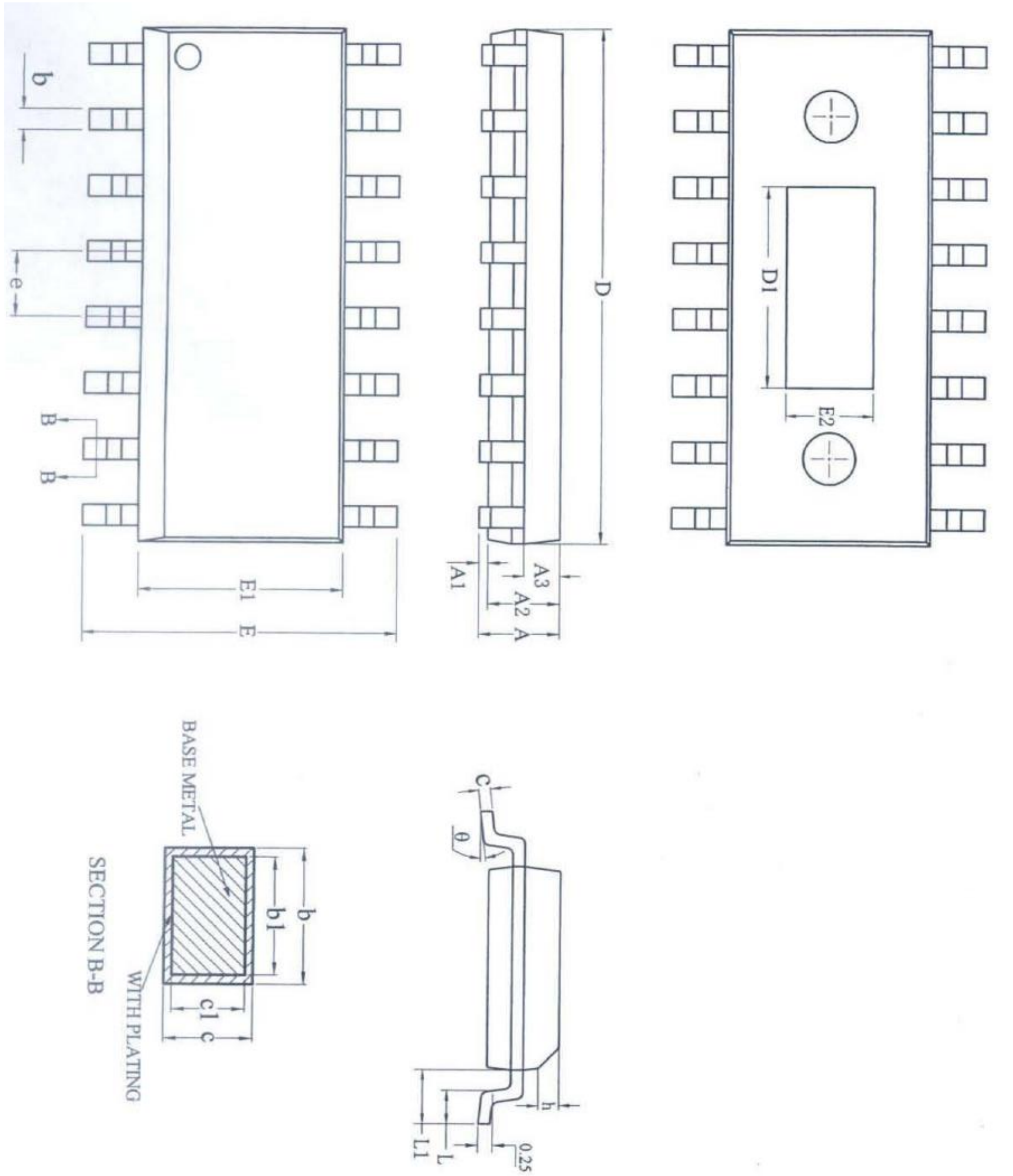
7. Linear Dimming
  1) GP8100 provides 0-10V Linear Dimming.
  2) RLD resistor value setting
    (1) Dimming can be controlled by decreasing CS voltage when LD voltage increases
    (2) It's recommended to use 810 ㏀ RLD resistor for 0-10V Dimming
    (3) Dimming voltage range can be controlled by changing RLD resistor value and LD voltage-Vs-CS voltage graph for different values of RLD resistor is shown below.
  3) CLD condenser with an approximate value of 100nF must be connected for Noise Bypass (Typ. 100nF)
  4) When 0-10V characteristics are well understood, ON/OFF and PWM Dimming with 1~10Khz operation can be easily designed.





8. Others
GP8100 can be used with external GHV TR for TRIAC Dimming and Power(Thermal) Decentralization and related application note and demo board can be made available upon requests.

PKG Dimensions (16ESOP)



SYMBOL	MILLIMETER MIN	MILLIMETER NOM	MILLIMETER MAX
A	—	—	1.75
A1	0.05	—	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.48
b1	0.38	0.41	0.43
c	0.21	—	0.26
c1	0.19	0.20	0.21
D	9.70	9.90	10.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05BSC		
θ	0	—	8°

L/F载体尺寸 (mil)	D1	E2
95*180	4.57REF	2.41REF
90*110	2.49REF	1.99REF