Constant Current and Voltage Controller

DESCRIPTION

GP5221 is a monolithic Constant Current and Voltage controller. It is a highly integrated solution for SMPS applications requiring CC (constant current) and CV (constant voltage) mode.
GP5221 integrates one 1% precision voltage reference and two operational amplifiers (with ORed outputs – common collectors), and a current sense circuit. The voltage reference comined with one operational amplifier makes it an ideal voltage controller, and the other low voltage reference combined with the other operational amplifier makes it an ideal current limiter for output low side current sensing. The current threshold is fixed and precise.
The only external components are :

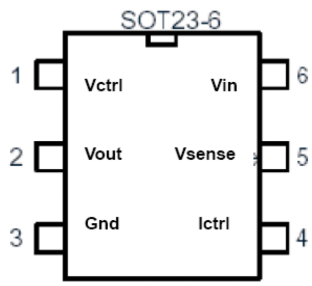
- a resistor bridge to be connected to the output of the power supply (LED driver, adapter, SMPS) to set the voltage regulation by dividing the desired output voltage to match the internal voltage reference value.
- A sense resistor having a value and allowable dissipation power which need to be chose according to the internal voltage threshold.

Optional external compensation components (R and C). GP5221 packaged with a space saving SOT23-6 package.

FEATURES

- **constant Current and Voltage controller**
- **Precision internal voltage reference**
- **Less external component count**
- **Low voltage operation**
- **Current sink output stage**
- **Easy compensation**
- **Low AC mains voltage rejection**
- **Tiny SOT23-6 package**

PACKAGE PIN OUT



APPLICATIONS

- LED Driver Power Module
- SMPS
- Adaptor

TYPICAL APPLICATION CIRCUIT

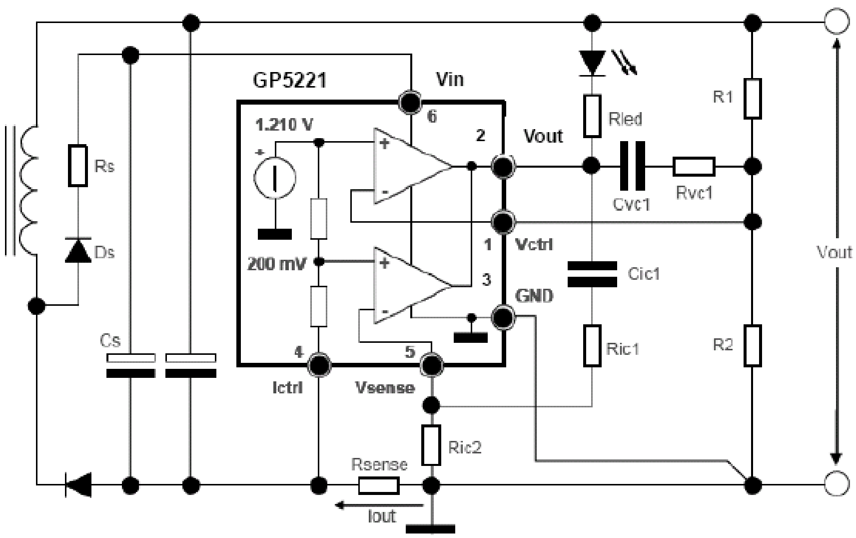


Figure. 1

ORDER INFORMATION

Lead Free Part Number	Package	Quantity
GP5221	SOT23-6	3,000 Units/ Tape & Reel

Top Marking Information

5221
YWWA : Y : Year
WW : production week code
A : package site code

GPS Pb-free plus anneal products employ with molding compounds, die attach material and and 100% matte tin plate termination finish which are RoHs compliant and compatible with both SnPb and Pb-free soldering operations.

BLOCK DIAGRAM

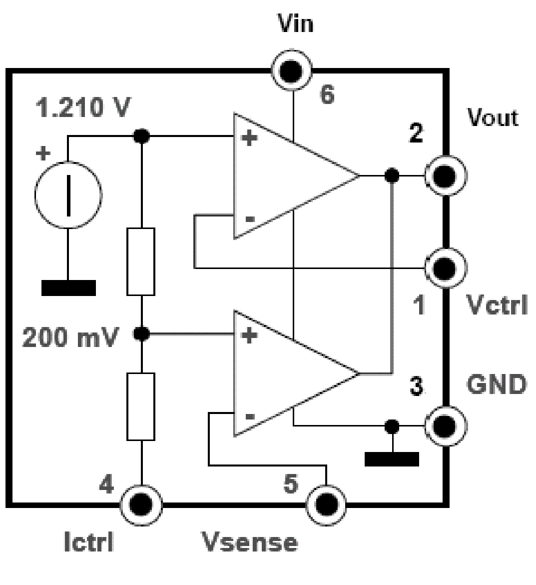


Figure 2

Pin Description

Pin	Pin Name	Description
1	V_{ctrl}	Input pin of the voltage control loop
2	Vout	Output pin, Sink current only
3	Gnd	Power ground, 0V for all voltages
4	Ictrl	Input pin of the current control loop
5	Vsense	Input pin of the current control loop
6	V_{in}	Positive Power supply input

ABSOLUTE MAXIMUM RATINGS (Note a)	
Vin Supply Voltage	14V
V_i input Voltage	-0.3 to Vin
Operating Junction Temperature Range	-40℃ to 125℃
Storage Temperature Range	-55℃ to 150℃
Package Thermal Resistance, SOT23-6, θ_{JA}	250℃/W
Lead Temperature (Soldering, 5 sec.)	260℃

Note a: Exceeding these ratings could cause damage to the device.
All voltages are with respect to Ground.

Characterization

Vin = 5V, Tamb = 25 ℃ (unless otherwise specified)

Symbol	Description	Test Conditions	Min	Typ	Max	Units
Vin	Input DC supply voltage range	Tamb 0 < Tamb < 85 ℃	2.5		12	V
Iin	Total supply current, not taking the output sinking current into account	Tamb 0 < Tamb < 85 ℃		1.1 1.2	2,0	mA
Current Control Loop						
Gmi	Trans-conduction Gain (Ictrl). Sink current only. Note1	Tamb 0 < Tamb < 85 ℃	1.5	7		mA/mV
Vsense	Current control loop reference Note 2	Tamb 0 < Tamb < 85 ℃	196 192	200	204 208	mV
Iibi	Current out of Pin Ictrl at -200mV	Tamb 0 < Tamb < 85 ℃		25 50		uA
Voltage Control Loop						
Gmv	Trans-conduction Gain (Vctrl). Sink current only Note 3	Tamb 0 < Tamb < 85 ℃	1	3.5 2.5	1.0	mA/mV
Vref	Voltage control loop reference Note 4	Tamb 0 < Tamb < 85 ℃	1.198 1.186	1.21	1.222 1.234	V
Iibv	Input bias current (Vctrl)	Tamb 0 < Tamb < 85 ℃		50 100		nA
Output Stage						
Vol	Low output voltage at 10mA sinking current	Tamb 0 < Tamb < 85 ℃		200	V_{DD}	mV
Ios	Output short circuit current. Output to Vin sink current only	Tamb 0 < Tamb < 85 ℃		27 35		mA

1. Note 1: When the positive input at Icrtl is lower than -200mV, and the voltage is decreased by 1mV, the sinking current at the output pin Vout will be increased by 7mA.
2. Note 2: The internal current sense threshold is set to -200mV. The current control loop precision takes into account the cumulative effects of the internal voltage reference deviation as well as the input offset voltage of the trans-conduction operational amplifier.
3. Note 3: In case of the voltage on Vctrl (the negative input of the amplifier) is higher than the positive amplifier input (Vref = 1.210V), and it is increased by 1mV, the sinking current at the output pin Vout will be increased by 3.5mA.
4. Note 4: The internal precision trimmed 1.210V voltage reference. The voltage control loop precision takes into account the cumulative effects of the internal voltage reference deviation as well as the input offset voltage of the trans-conductance operation amplifier. The internal voltage reference is fixed by Bandgap voltage and trimmed to 0.5% accuracy at room temperature.

Description

The GP5221 is a highly integrated but low cost solution for LED Driver module and SMPS applications which requiring CC (Constant Current) and CV (Constant Voltage) mode.

Current Control operation

The GP5221 current loop is controlled via the trans-conductance operational amplifier, the sense resistor Rsense and the opto-coupler.
The control equation is to verify:

Rsense x I_{lim} = Vsense
Rsense = Vsense / I_{lim}

Where the Ilim is the desired limited current, and Vsense is the threshold voltage for the current control loop.
For instance, Vsense = -200mV, Rsense = 200mΩ, then the I_{lim} = 1A.
Note that the Rsense resistor should be chosen taking into account the maximum power dissipation (P_{lim}) through it during full load operation.

Plim = Vsense x I_{lim}

For instance, with Vsense = -200mV, I_{lim} = 1A, P_{lim} = 200mW.
In most of 1A current limit applications, a quarter-watt or half-watt resistor to make the current sense function is sufficient.
Vsense threshold is achieved internally by a resistor bridge tied to the Vref Bandgap voltage reference. Its middle point is tied to the positive input of the current control operational amplifier, and its foot is to be connected to lower potential point of the sense resistor as shown on the figure . The resistors of this bridge are matched to provide the best precision possible.
The current sinking outputs of the two trans-conductance operational amplifiers are common (to the output of the IC). This makes an ORing function which ensures that whenever the current or the voltage reaches too high values, the opto-coupler will be activated.
The relation between the controlled current and the controlled output voltage can be described with a square characteristic as shown in the following V / I output-power graph.

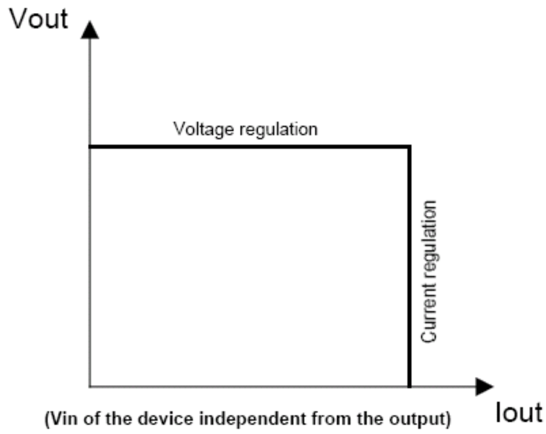


Figure 3

Voltage control operation

The voltage loop is connected via a trans-conductance operational amplifier, the resistor bridge R1, opto-couple which is directly connected to the output.
The relation between the values or R1 and R2 should be chosen as written in the following equation

R1 = R2 x Vref / (Vout – Vref)

Vout is the desired output voltage.
To avoid the discharge of the load, the resistor bridge R1, R2 should be highly resistive. For this type of application value of the 100kΩ (or more) would be appropriate for the resistors R1 and R2.
For instance, with R2=110KΩ, Vout = 4.10V, Vref = 1.210V, then R1 = 41.9kΩ.
Note that in case of the low drop diode should be inserted between the load and the voltage regulation resistor bridge to avoid current flowing from the load through the resistor bridge, this drop should be taken into account in the above calculations by replacing Vout by (Vout + Vdrop).

Compensation

The voltage-control trans-conductance operational amplifier can be fully compensated. Both of its output and negative input are directly accessible for external compensation components.

An example of a compensation network is shown in Fig. 2. It consists of a resistor Rcv1 = 470kΩ and a capacitor Cvc1 = 2.2nF in series, connected in parallel with another capacitor Cvc2 = 22pF.
The current-control trans-conductance operation can be fully compensated. Both of its output and the current-control trans-conductance operational amplifier can be fully compensated. Both of its output and negative input are directly accessible for external compensation components.
An example of a compensation network is shown in Fig. 2. It is consists of a resistor Ric1 = 22kΩ and a capacitor Cic1 = 2.2nF in series.
When the Vin voltage reaches 12V it could be interesting to limit the current coming through the output in the aim to reduce the dissipation of the device and increase the stability performances of the whole application. For instance, a suitable Rout value could be 330Ω in series with the opto-coupler in case of Vin = 12V.

Start Up and Short Circuit Condition

Under start-up or short-circuit conditions the GP5221 is not provided with a high enough supply voltage. This is due to the fact that the chip has its power supply line in common with the power supply line of the system. Therefore the current limitation can only be ensured by the primary PWM module, which should be chosen carefully.
In case of the primary current limitation is considered not to be precise enough for the application, then a sufficient supply for the GP5221 has to be ensured under any condition. It would be then be necessary to add some circuitry to supply the chip with a separate power line. This can be achieved in numerous ways, including an additional winding on the transformer.

Application Circuit

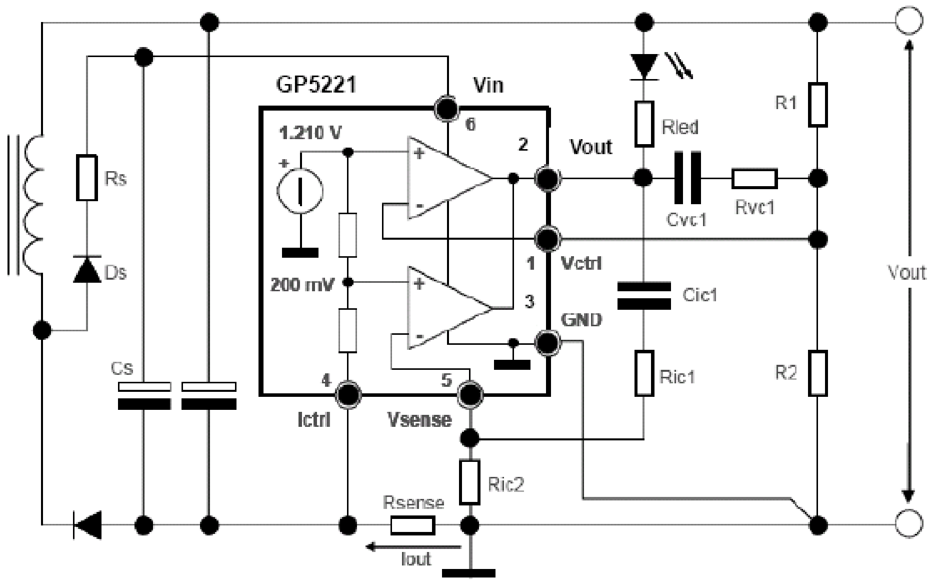
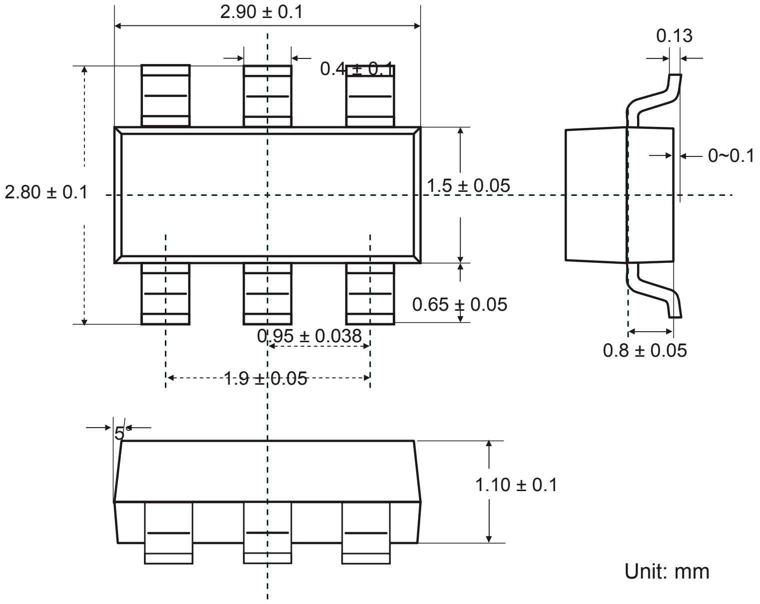
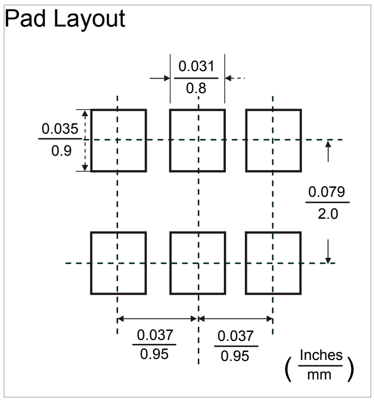


Figure. 4, Typical adaptor application circuit

Package Information

SOT23-6 Package Dimension





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