FEATURES

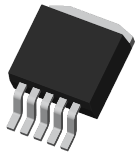
- Guaranteed Output Current of 3.0A
- Very Low Dropout Voltage
- 1% Initial Accuracy
- Good Line and Load Regulation
- Fast Transient Response
- Adjustable Output Voltage up to 15V
- TTL/CMOS Compatible Enable Logic
- Over-Temperature/Over-Current Protection
- −40°C to 125°C Junction Temperature Range
- Available in TO-263-5L Package
- Moisture Sensitivity Level 3

APPLICATIONS

- Battery Powered Equipment
- Motherboards and Graphic Cards
- Microprocessor Power Supplies
- Peripheral Cards
- High Efficiency Linear Regulators
- Battery Chargers

DESCRIPTION

The TPS75701 is 3.0A low-dropout linear voltage regulators that provide a low voltage, high-current output with a minimum of external components. The TPS75701 offers extremely low dropout (typically 400mV at 3.0A) and low ground current (typically 36mA at 3.0A). The TPS75701 is ideal for PC add-in cards that need to convert from standard 5V or 3.3V down to new, lower core voltages. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the TPS75701 to provide 2.5V from a supply as low as 3V. The TPS75701 also has fast transient response for heavy switching applications. The device requires only 47μF of output capacitance to maintain stability and achieve fast transient response. The TPS75701 is fully protected with over current limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The TPS75701 offers a TTL-logic compatible enable pin. The TPS75701 comes in the TO-263 package and is an ideal upgrade to older, NPN-based linear voltage regulators.



TO-263-5

ORDERING INFORMATION

Device	Package
TPS75701R	TO-263-5L

ABSOLUTE MAXIMUM RATINGS (Note 1)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Input Supply Voltage (Survival)	V_{IN}	−0.3	20	V
Enable Input Voltage (Survival)	V_{EN}	−0.3	20	V
Output Voltage (Survival)	V_{OUT}	−0.3	V_{IN} + 0.3	V
Storage Temperature Range	T_{STG}	−65	150	°C
Package Thermal Resistance*	$\Theta_{JA\text{-}TO\text{-}263}$	80		°C/W

* No Heat Sink, No Air Flow, No Adjacent Heat Source, 20 mm^2 Copper Area (T_A = 25°C)

RECOMMENDED OPERATING RATINGS (Note 2)

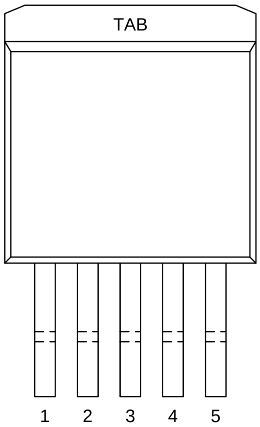
CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Input Supply Voltage	V_{IN}	2.5	16	V
Enable Input Voltage	V_{EN}	0	16	V
Operating Junction Temperature Range	T_{JOPR}	−40	125	°C

ORDERING INFORMATION

Package	Order No.	Description	Supplied As	Status
TO-263-5L	TPS75701R	3.0A, Adjustable, Enable	Tape & Reel	Active

PIN CONFIGURATION

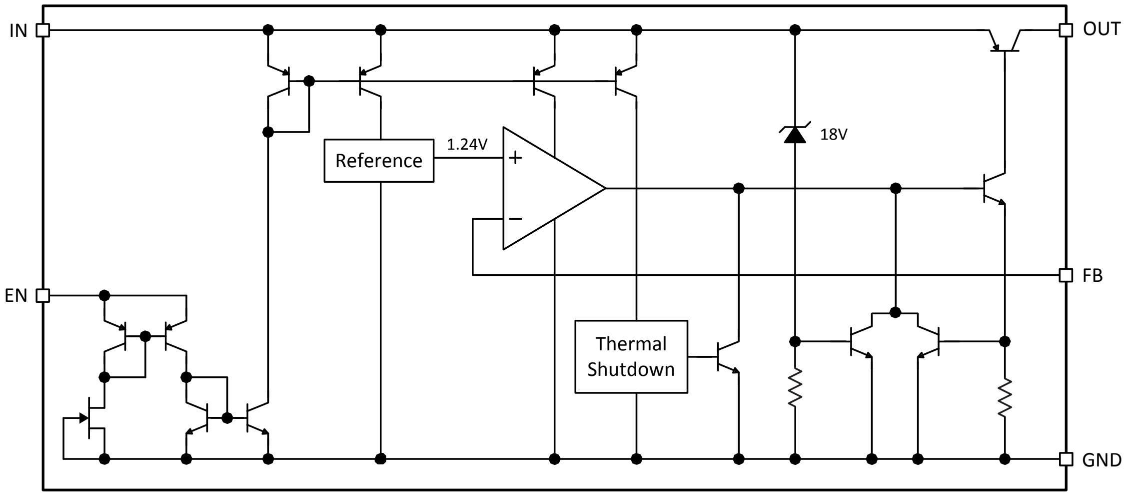
TO-263-5



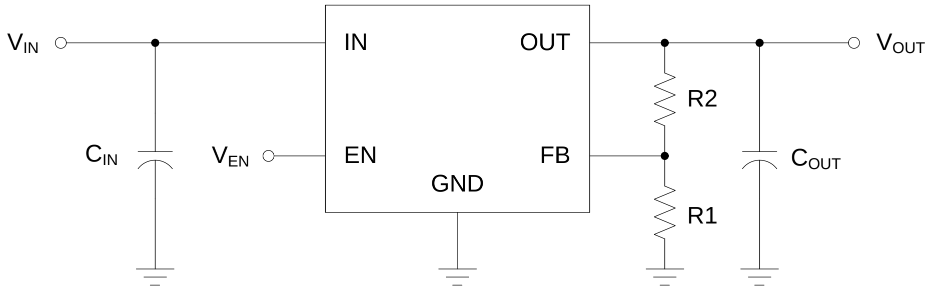
PIN DESCRIPTION

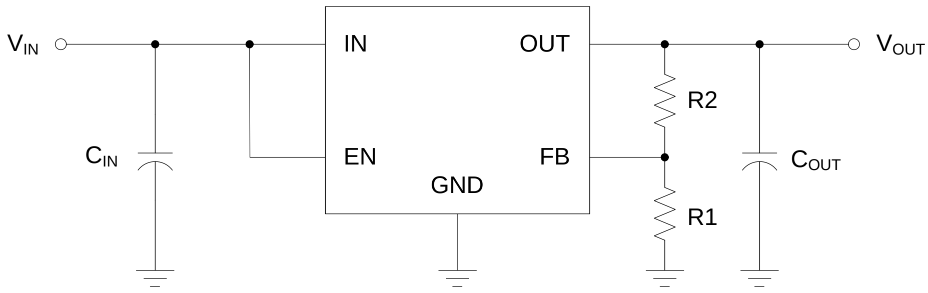
Pin No.	Pin Name	Pin Function
1	EN ($\overline{SHDN}$)	Chip Enable. Do not float. Logic high will turn on the device.
2	IN	Input Supply.
3	GND	Ground.
4	OUT	Output Voltage.
5	FB	Output Voltage Adjust Input. Connect an external voltage divider to determine the output voltage.
TAB	GND	Connect to GND. Put a copper plane connected to this pin as a thermal relief.

BLOCK DIAGRAM



TYPICAL APPLICATION CIRCUIT





* For the details, refer to the Application Information.

ELECTRICAL CHARACTERISTICS

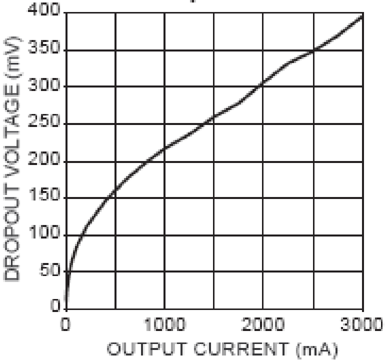
Limits in standard typeface are for $T_J = 25ºC$, and limits in **boldface type** apply over the **full operating temperature range**.
Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 1.0$ V (Note 3), $V_{EN} = 2.5$ V

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Adjustable Voltage (Note 4)	V_{FB}	I_{OUT} = 10mA	1.228 **1.215**	1.24	1.252 **1.265**	V
		10 mA ≤ I_{OUT} ≤ 3.0 A, 2.5 V ≤ V_{IN} ≤ 8.0 V	**1.203**	-	**1.277**	
Line Regulation	LNR	I_{OUT} = 10 mA, V_{OUT} +1.0V ≤ V_{IN} ≤ 8.0V	-	0.06	0.5	%
Load Regulation	LDR	10mA ≤ I_{OUT} ≤ 3.0A	-	0.2	1.0	%
FB Pin Bias Current	I_{FB}		-	40	80	nA
Dropout Voltage (Note 5)	V_{DROP}	I_{OUT} = 100 mA	-	80	**200**	mV
		I_{OUT} = 750 mA	-	200	-	
		I_{OUT} = 1.5 A	-	320	**-**	
		I_{OUT} = 3.0 A	-	400	**550**	
Ground Current (Note 6)	I_{GND}	I_{OUT} = 750 mA	-	10	20	mA
		I_{OUT} = 1.5 A	-	17	-	
		I_{OUT} = 3.0 A	-	45	-	
		V_{IN} ≤ $V_{OUT(NOM)}$ − 0.5 V, I_{OUT} = 10 mA	-	6.0	-	
Current Limit	I_{CL}	V_{OUT} = 0 V	-	4.5	-	A
Enable Input Voltage	V_{ENL}	Logic Low (Output Low)	-	-	**0.8**	V
	V_{ENH}	Logic High (Output High)	**2.5**	-	-	V
Enable Input Current	I_{ENL}	V_{EN} = 2.5 V	-	15	30 **75**	μA
	I_{ENH}	V_{EN} = 0.8 V	-	-	2.0 **4.0**	μA
Shutdown Output Current	I_{SHDN}	V_{IN} ≤ 8.0 V, V_{EN} ≤ 0.8 V, V_{OUT} = 0 V	-	10	**20**	μA

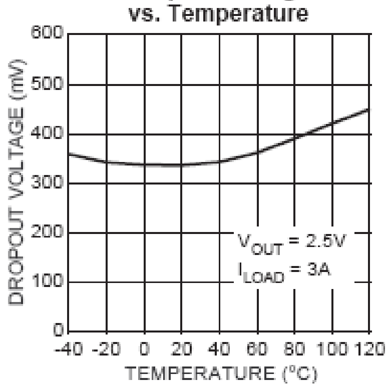
Note 1. Exceeding the Absolute Maximum Ratings may damage the device.
Note 2. The device is not guaranteed to function outside its Operating Ratings.
Note 3. The minimum operating value for input voltage is equal to either ($V_{OUT(NOM)} + V_{DROP}$) or 2.5 V, whichever is greater.
Note 4. $V_{FB} \le V_{OUT} \le (V_{IN} – 1.0\ V)$
Note 5. $V_{DROP} = V_{IN} − V_{OUT}$ when V_{OUT} decreases to 99% of its nominal output voltage with $V_{IN} = V_{OUT} + 1.0$ V. For output voltages below 2.5 V, dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.5 V.
Note 6. Ground current, or quiescent current, is the difference between input and output currents. It's defined by $I_{GND} = I_{IN} − I_{OUT}$ under the given loading condition.

TYPICAL OPERATING CHARACTERISTICS

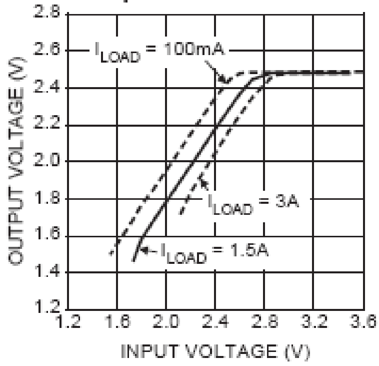
Dropout Voltage vs. Output Current



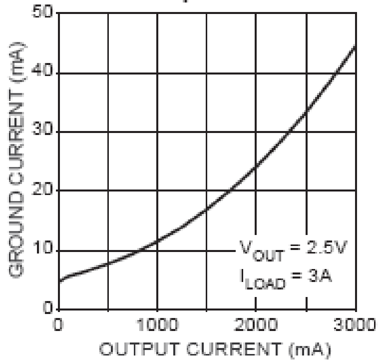
Dropout Voltage vs. Temperature



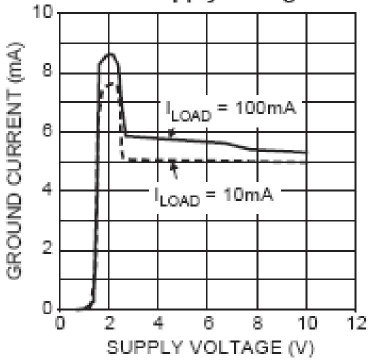
Dropout Characteristics



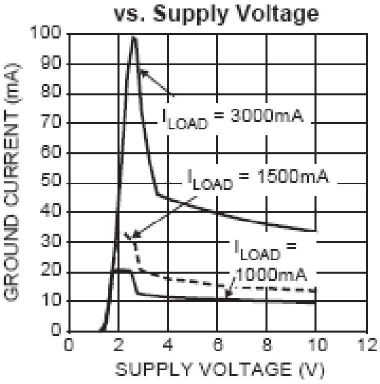
Ground Current vs. Output Current



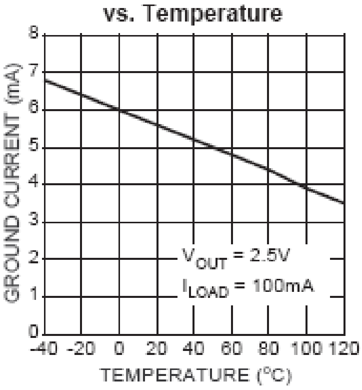
Ground Current vs. Supply Voltage



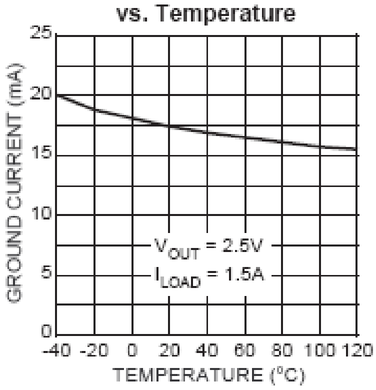
Ground Current vs. Supply Voltage



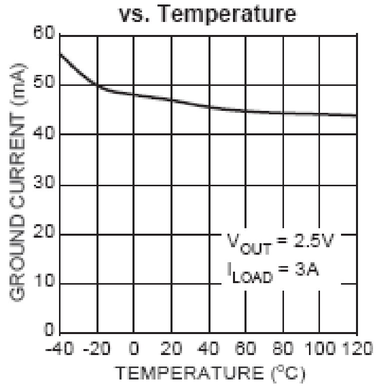
Ground Current vs. Temperature



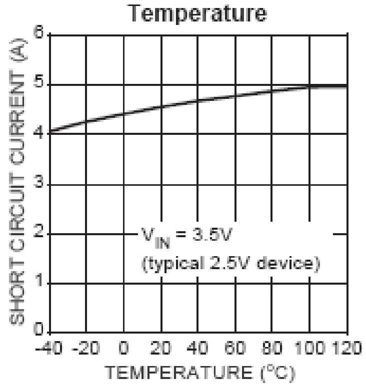
Ground Current vs. Temperature



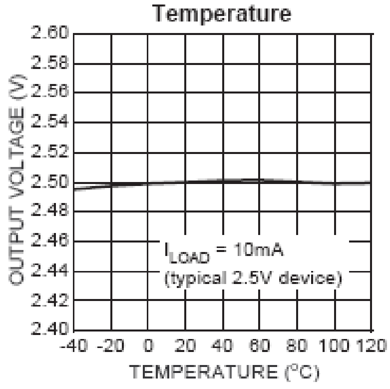
Ground Current vs. Temperature



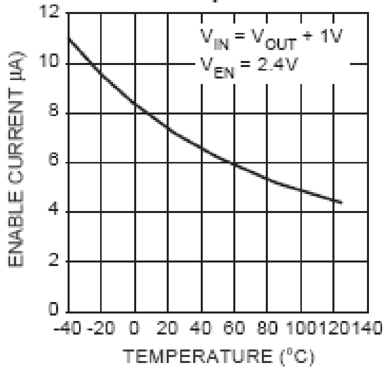
Short Circuit vs. Temperature



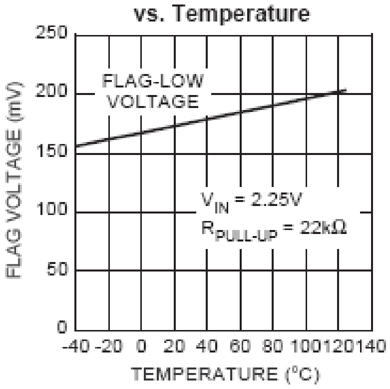
Output Voltage vs. Temperature



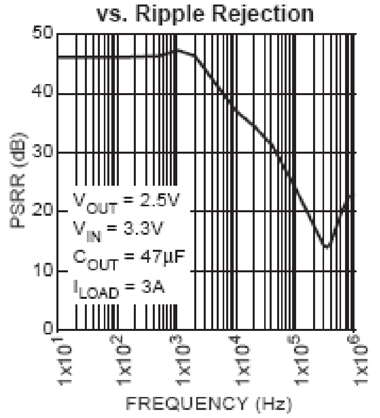
Enable Current vs. Temperature



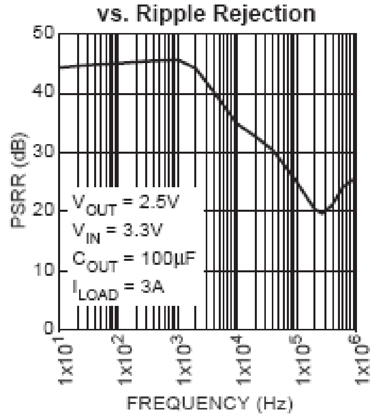
Flag-Low Voltage vs. Temperature



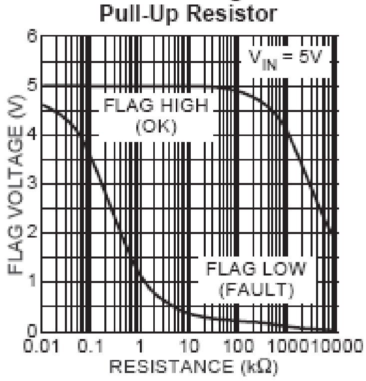
Power Supply vs. Ripple Rejection



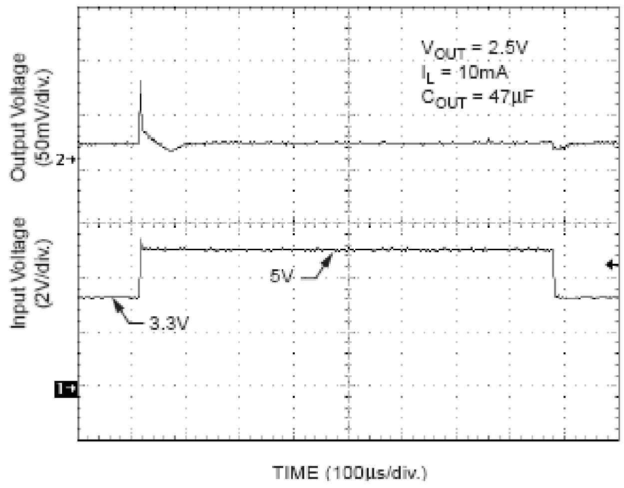
Power Supply vs. Ripple Rejection



Error Flag Pull-Up Resistor



Line Transient Response



APPLICATION INFORMATION

INTRODUCTION

The TPS75701 is a high-performance low-dropout voltage regulator suitable for moderate to high-current voltage regulator applications. Its 500mV dropout voltage at full load makes it especially valuable in battery-powered systems and as a high-efficiency noise filter in post-regulator applications.

Unlike older NPN-pass transistor designs, where the mini-mum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of the PNP output of these devices is limited only by the low V_{CE} saturation voltage. A trade-off for the low dropout voltage is a varying base drive requirement.

The TPS75701 regulator is fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear output current during overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device (and load) survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.

INPUT CAPACITOR

An input capacitor of 1.0 µF or greater is recommended when the device is more than 4 inches away from the bulk and is used as a supply capacitance, or when the supply is a battery. Small, surface-mount, ceramic chip capacitors can be used for the bypassing. Larger values will help to improve ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage.

OUTPUT CAPACITOR

The TPS75701 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The TPS75701 output capacitor selection is dependent upon the equivalent series resistance (ESR) of the output capacitor to maintain stability. When the output capacitor is 47 µF or greater, the output capacitor should have less than 1.0 Ohm of ESR. This will improve transient response as well as promote stability. Very low ESR capacitors, such as ceramic chip capacitors may promote instability. These very low ESR levels may cause an oscillation and/or under damped transient response. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature. Aluminum electrolytic can also be used, as long as the ESR of the capacitor is less than 1.0 Ohm.

The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

MINIMUM LOAD CURRENT

The TPS75701 regulator is specified to operate in-between finite loads. If the output current is too small, leakage currents dominate and the output voltage rises. A 10mA minimum load current is necessary for proper regulation.

ENABLE INPUT

The TPS75701 features an enable input for On/Off control of the device. Its shutdown state draws “zero” current (only microamperes of leakage). The enable input is TTL/ CMOS compatible for simple logic interface, but can be connected to up to its maximum voltage. When enabled, it draws approximately 15 µA.

TRANSIENT RESPONSE AND VOLATGE CONVERSION

The TPS75701 has excellent transient response to variations in input voltage and load current. The device has been designed to respond quickly to load current variations and input voltage variations. Large output capacitors are not required to obtain this performance. A standard 47 µF output capacitor, preferably tantalum, is all that is required. Larger values help to improve performance even further.

By virtue of its low-dropout voltage, this device does not saturate into dropout as readily as similar NPN-based designs.

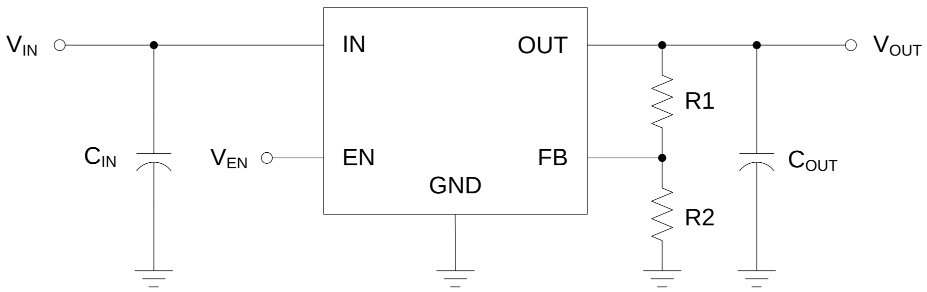
The TPS75701 regulator will provide excellent performance with an input as low as 2.5V. This gives the PNP-based regulators a distinct advantage over older NPN-based linear regulator.

OUTPUT ADJUSTMENT

The TPS75701 allows programming the output voltage any-where between 1.24V and the 15V. Two resistors are used. Resistors can be quite large, up to hundreds of thousands of Ohms, because of the very high input impedance and low bias current of the sense comparator. These resistor values are calculated by:

$$R1 = R2\left(\frac{V_{OUT}}{1.24} - 1\right)$$

Where V_{OUT} is desired output voltage. Figure 1 shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see below).



$$V_{OUT} = 1.24\left(1 + \frac{R1}{R2}\right)$$

Fig. 1. Application for Adjustable Output Voltage

MAXIMUM OUPUT CURRENT CAPABILITY

The TPS75701 can deliver a continuous current of 3A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation of package. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 3A may be still undeliverable due to the restriction of the power dissipation of TPS75701. Under all possible conditions, the junction temperature must be within the range specified under operating conditions.

The temperatures over the device are given by:

$$T_C = T_A + P_D \times \theta_{CA}$$
$$T_J = T_C + P_D \times \theta_{JC}$$
$$T_J = T_A + P_D \times \theta_{JA}$$

where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient.
The total power dissipation of the device is given by:

$$P_D = P_{IN} – P_{OUT} = (V_{IN} \times I_{IN}) – (V_{OUT} \times I_{OUT})$$
$$= (V_{IN} \times (I_{OUT} + I_{GND})) – (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} – T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D$$

If proper cooling solution such as copper plane area, heat sink or air flow is applied, the maximum allowable power dissipation could be increased. However, if the ambient temperature is increased, the allowable power dissipation would be decreased.

REVISION NOTICE

The description in this datasheet is subject to change without any notice to describe its electrical characteristics properly.