Low-Noise, Fixed Output Voltage, 350mA LDO Regulator

Description

The TQ6465 is a 350mA low dropout and low noise micropower regulator suitable for portable applications. The output voltages range from 1.5V to 5.0V in 100mV increments and 2% accuracy. The TQ6465 is designed for use with very low ESR capacitors. The output remains stable even with 1μF ceramic output capacitor.

The TQ6465 uses an internal PMOS as the pass device, which does not cause extra GND current in heavy load and dropout conditions. The 'C' types with shutdown mode of nearly zero operation current makes the IC suitable for battery-powered devices.

The other features include 4μA ultra-low quiescent, low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio.

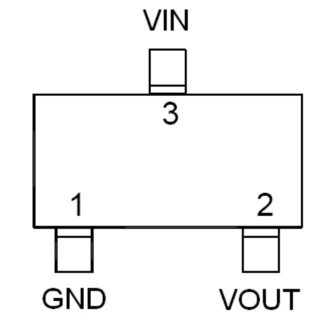
Features

+Stable with Low-ESR Output Capacitor
+Low Dropout Voltage (350mV @ 300mA)
+Low Operation Current 30μA Typical
+'C' Types with shutdown Function
+Low Noise Output
+Low Temperature Coefficient
+Current and Thermal Limiting
+Custom Voltage Available
+SOT-23 and SOT23-5 Packages

Application

+Cellular Telephones
+Laptop, Notebook, and Palmtop Computers
+Battery-powered Equipment
+Hand-held Equipment

Pin Configuration



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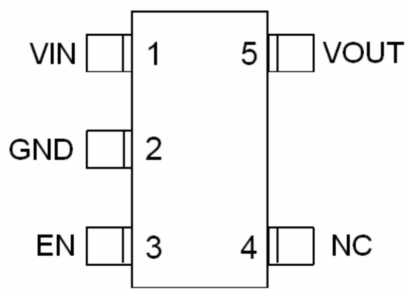

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Order Information

TQ6465 A XX X

PRODUCT NAME — TQ6465

PACKAGE: M3 : SOT23
M5: SOT23-5

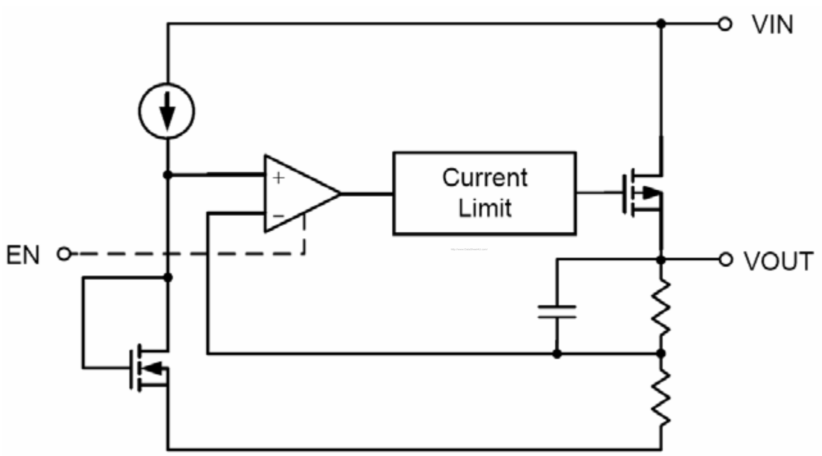
OUTPUT VOLTAGE:
25: 2.5V
30: 3.0V

VERSION CODE:
A: SOT23 without ENABLE
C: SOT23-5 with ENABLE

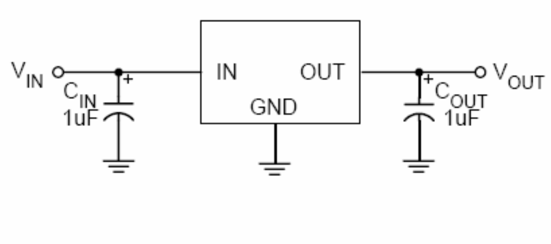
Pin Function

Pin Name.	SOT23 Pin No.	SOT23-5 Pin No.	Function Description
VIN	3	1	Power Input
GND	1	2	Ground
EN	---	3	Chip Enable Control Input
NC	---	4	No Connection
VOUT	2	5	Output Voltage

Function Block Diagram



Typical Application Circuit



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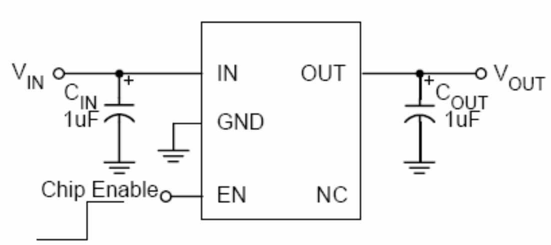

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Absolute Maximum Ratings†

Vcc(Input Supply Voltage) 7V
All Inputs and Outputs w.r.t. VSS .... -0.3 to (VIN+0.3)V
Output Current... 500mA
BAT Pin Current …………….. 800mA
All Inputs and Outputs w.r.t. VSS .... -0.3 to (VDD+0.3)V
Storage temperature ....-55°C to +125°C

† **Notice:** Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

V_{IN} = 5V; C_{IN} = 1μF; C_{OUT} = 1μF; T_J = 25°C; unless otherwise specified.

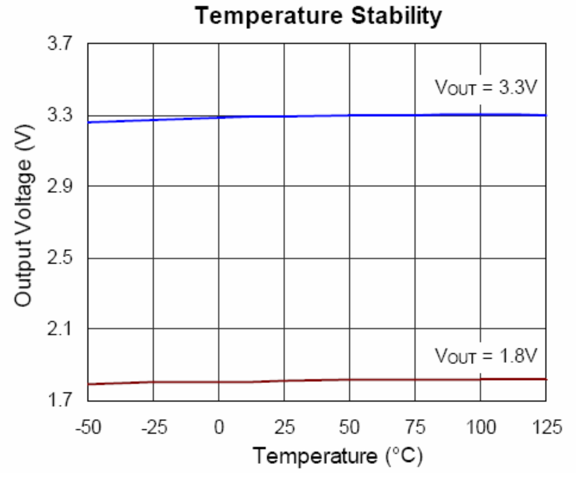
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}		2.9	--	7	V
		I_L = 50mA	2.7	--	7	
Output Voltage Accuracy	ΔV_{OUT}	I_L = 1mA	-2	--	+2	%
Maximum Output Current	I_{MAX}		300	--	--	mA
Current Limit	I_{LIMIT}	R_{LOAD} = 1Ω	400	--	--	mA
Quiescent Current	I_G	No Load	--	80	150	μA
		I_{OUT} = 300mA	--	90	150	
		I_{OUT} = 500mA	--	90	150	
Dropout Voltage (2) ($V_{OUT(Normal)}$ = 3.0V Version)	V_{DROP}	I_{OUT} = 1mA	--	1.1	5	mV
		I_{OUT} = 50mA	--	55	100	
		I_{OUT} = 300mA	--	350	0	
		I_{OUT} = 500mA	--	600	750	
Line Regulation	ΔV_{LINE}	V_{IN}= (V_{OUT}+0.15) to 7V, I_{OUT} =1mA	--	--	6	mV/V
Load Regulation	ΔV_{LOAD}	I_{OUT} = 0mA to 300mA	--	--	30	mV
		I_{OUT} = 0mA to 500mA	--	--	35	
EN Input High Threshold	V_{IH}	V_{IN}= 3V to 5.5V	1.6	--	--	V
EN Input Low Threshold	V_{IL}	V_{IN} = 3V to 5.5V	--	--	0.4	V
EN Bias Current	I_{SD}		--	--	100	nA
Shutdown Supply Current	I_{GSD}	V_{OUT} = 0V	--	0.01	1	μA
Thermal Shutdown Temperature	T_{SD}		--	155	--	°C
Ripple Rejection	PSRR	F = 100Hz, C_{BP} = 10nF, C_{OUT} = 10μF	--	58	--	dB

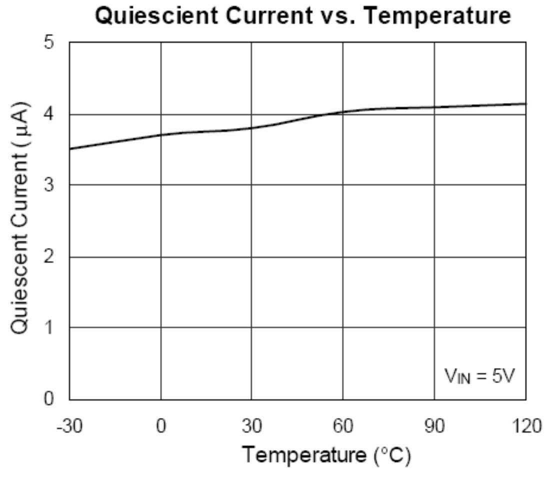
Note 1. θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

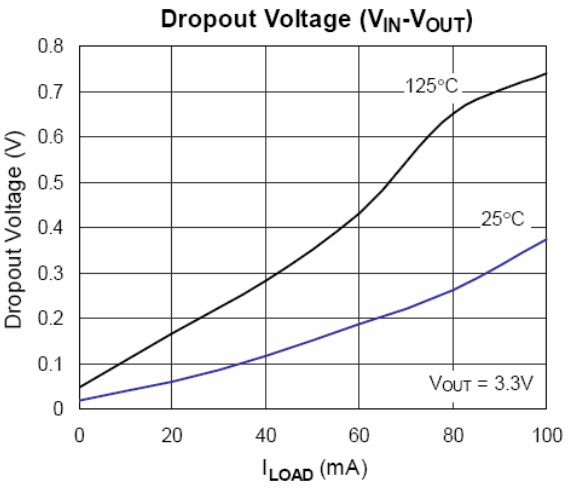
Note 2. The dropout voltage is defined as V_{IN} -V_{OUT}, which is measured when V_{OUT} is $V_{OUT(NORMAL)}$ – 100mV.

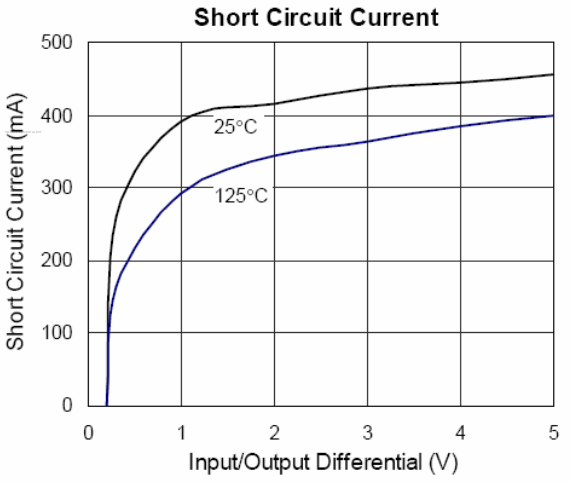
Typical Performance Curves

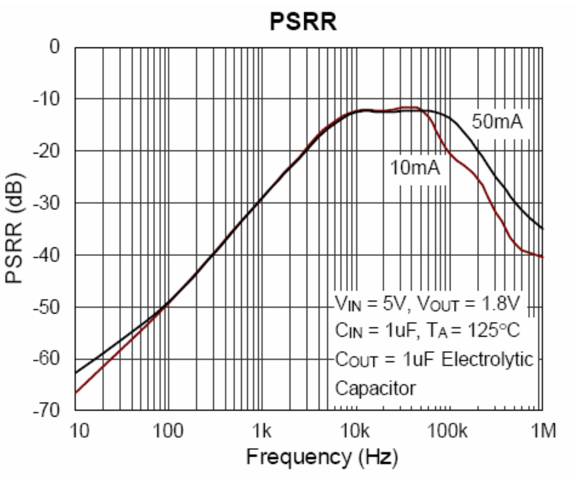
Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

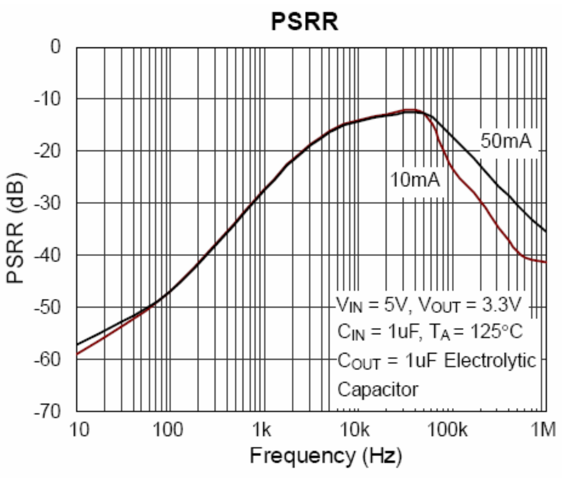












Capacitor Selection and Regulator Stability

Like any low-dropout regulator, the external capacitors used with the TQ6465 must be carefully selected for regulator stability and performance. Using a capacitor whose value is > 1μF on the TQ6465 input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5" from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR provides better PSRR and line-transient response.

The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDOs application. The TQ6465 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1μF with ESR is > 5mΩ on the TQ6465 output ensures stability. The TQ6465 still works well with output capacitor of other types due to the wide stable ESR range. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located not more than 0.5 inch from the VOUT pin of the TQ6465 and returned to a clean analog ground.

Note that some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. It may be necessary to use 2.2μF or more to ensure stability at temperatures below -10°C in this case. Also, tantalum capacitors, 2.2μF or more may be needed to maintain capacitance and ESR in the stable region for strict application environment. Tantalum capacitors maybe suffer failure due to surge current when it is connected to a low-impedance source of power (like a battery or very large capacitor). If a tantalum capacitor is used at the input, it must be guaranteed to have a surge current rating sufficient for the application by the manufacture.

Shutdown Input Operation

The TQ6465 is shutdown by pulling the EN input low, and turned on by driving the input high. If this feature is not to be used, the EN input should be tied to VIN to keep the regulator on at all times (the EN input must **not** be left floating). To ensure proper operation, the signal source used to drive the EN input must be able to swing above and below the specified turn-on/turn-off voltage thresholds which guarantee an ON or OFF state (see Electrical Characteristics). The ON/OFF signal may come from either CMOS output, or an open-collector output with pull-up resistor to the TQ6465 input voltage or another logic supply. The high-level voltage may exceed the TQ6465 input voltage, but must remain within the absolute maximum ratings for the EN pin.

Internal P-Channel Pass Transistor

The TQ6465 features a typical 1.1Ω P-Channel MOSFET pass transistor. It provides several advantages over similar designs using PNP pass transistors, including longer battery life. The P-channel MOSFET requires no base drive, which reduces quiescent current considerably. The TQ6465 consume only 30μA of quiescent current whether in dropout, light-load, or heavy load applications.

Input-Output (Dropout) Voltage

A regulator's minimum dropout voltage determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the TQ6465 uses a P-Channel MOSFET pass transistor, the dropout voltage is a function of drain-to-source on-resistance[$R_{DS(ON)}$] multiplied by the load current.

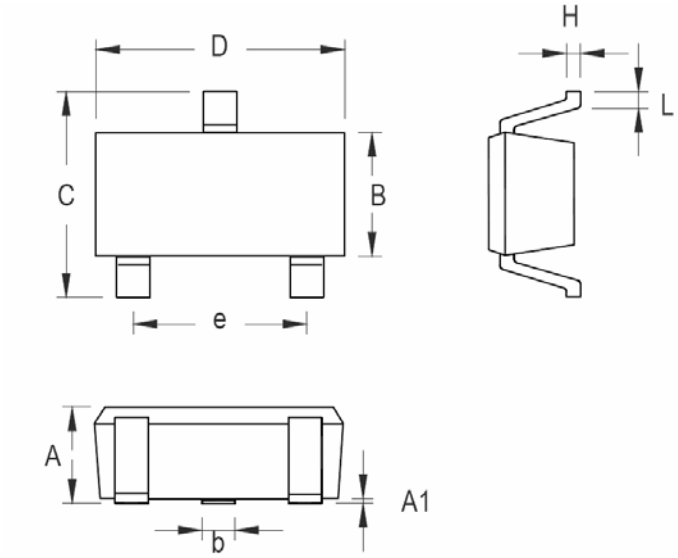
Operating Region and Power Dissipation

The maximum power dissipation of TQ6465 depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipation across the device is $P = I_{OUT} (V_{IN} - V_{OUT})$. The maximum power dissipation is: $PMAX = (T_J - T_A) / \theta_{JA}$ where $T_J - T_A$ is the temperature difference between the TQ6465 die junction and the surrounding environment, θ_{JA} is the thermal resistance from the junction to the surrounding environment. The GND pin of the TQ6465 performs the dual function of providing an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane.

Current Limit and Thermal Protection

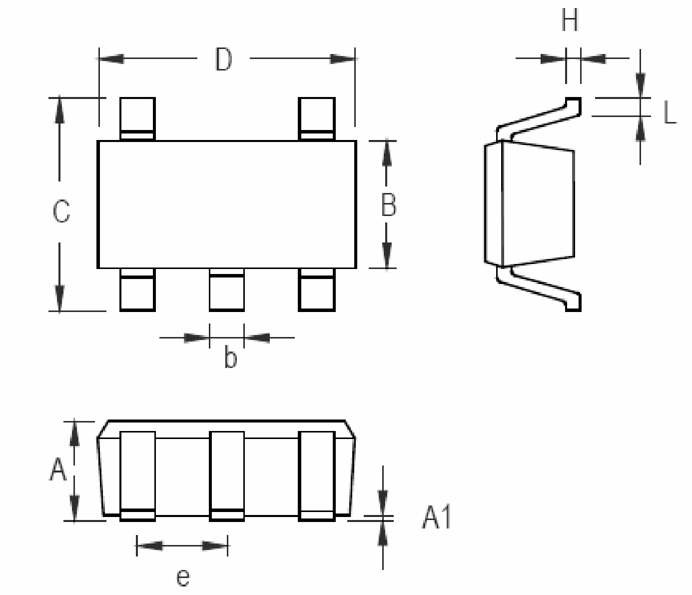
TQ6465 includes a current limit which monitors and controls the pass transistor's gate voltage limiting the output current to 350mA Typ. Thermal overload protection limits total power dissipation in the TQ6465. When the junction temperature exceeds $T_J = +155°C$, the thermal sensor signals the shutdown logic turning off the pass transistor and allowing the IC to cool. The thermal sensor will turn the pass transistor on again after the IC's junction temperature cools by 10°C, resulting in a pulsed output during continuous thermal overload conditions. Thermal overloaded protection is designed to protect the TQ6465 in the event of fault conditions. Do not exceed the absolute maximum junction temperature rating of $T_J = +150°C$ for continuous operation. The output can be shorted to ground for an indefinite amount of time without damaging the part by cooperation of current limit and thermal protection.

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.356	0.559	0.014	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT23 Package



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