

XC62FP Series Positive Voltage Regulators

Application Notes

=====**Index**=====

Introduction	P-2
Load / Input Capacitors	P-2
Notes on Use	P-4
Characteristics (please also refer to catalog)	P-9
Appendix	P-13
Operating Principles	
Electrical Characteristic's Terminology Explanation	

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WARNING

As the voltage regulator depends on not only the IC's characteristics but also on those of the load / Input capacitors and the surrounding circuitry, please fully ensure that the 'notes on use' provided are followed.

In actual operation we suggest that you allow ample margins above the recommended specifications and take the IC's and the peripheral's absolute maximum ratings into consideration.

○ Introduction

The XC62FP series is a group of positive voltage output, three-pin regulators, that provide a high current even when the input/output voltage differential is small. Low power consumption and high accuracy is achieved through CMOS and laser trimming technologies.

The series consists of a high-precision voltage reference, an error correction circuit and a current limited output driver. Transient response to load variations have improved in comparison to the previous series.

SOT-23 (150mW) and SOT-89 (500mW) packages are available.

○ Load / Input Capacitors

The following explanation concerns the large influence that the load and input capacitors have on the voltage regulator.

1. Load Capacitor CL

In general, the connection of a load capacitor CL is necessary when using voltage regulators in order to safeguard operations, protect against oscillation and provide a high quality output.

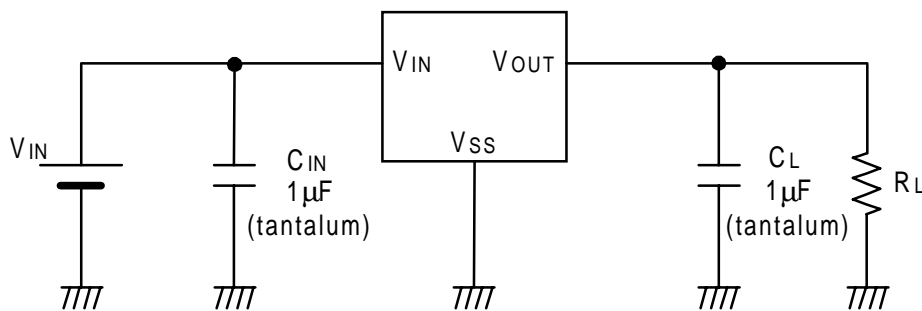


Diagram 1. XC62FP series standard circuit

With the XC62FP series, the capacitance of the load capacitor CL is standardized at 1µF (Tantalum). Should there be no capacitor or only a capacitor with a relatively small capacitance value, the phase margin will become smaller and

oscillation may occur. Do not use ceramic capacitors and capacitors where the ESR value is small as there is again the possibility that the phase margin will become smaller and oscillation could occur. The load capacitor is regulated by load current. Should the value of the current exceed 100mA or should there be a large load change in the region of between 10mA to 100mA, stability can be improved by increasing load capacitance by between 3.3 to 22 μ F (Tantalum).

2. Input Capacitor C_{IN}

It is recommended that an input capacitor be connected to the input side of the IC in order to prevent oscillation that may occur as a result of input voltage changes, and to lower the level of impedance between the IC's input pin and the power supply.

It is further recommended that an input capacitor with a C_{IN} capacitance value of more than 1.0 μ F be used as when the level of impedance up to the IC's input is high, operation may become unstable and oscillation could occur.

Please note that it is possible to use a ceramic condenser of low ESR with input capacitor C_{IN} .

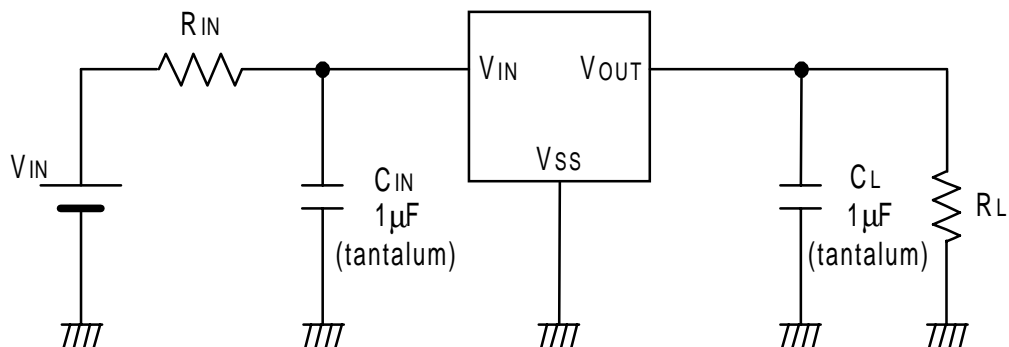


Diagram 2. Input impedance circuit example

○ Notes on Use

1. Oscillation

There is a possibility that oscillation may occur as a result of the impedance present between the power supply and the IC's input. Where impedance is 10Ω or more, please use a capacitor C_{IN} (Tantalum) of at least $1.0\mu F$. Further, with large output currents, operations can be stabilized by increasing the capacitance value of C_{IN} . If C_{IN} is small and the capacitance value of C_L is increased, there exists the possibility of oscillation occurring due to input impedance. In such cases, operations can be stabilized by either increasing the value of C_{IN} or decreasing the value of C_L .

2. Power Dissipation Pd

Please take ample care not to exceed the stipulated power dissipation P_d for the package. Ensure that output current (I_{OUT}) is less than $P_d \div (V_{IN} - V_{OUT})$.

The XC62FP comes in SOT-23 and SOT-89 packages with respective power dissipation values of 150mW and 500mW. Please also note that these figures represent P_d values when $T_a=25^\circ C$. Be aware that the value for P_d will fall should ambient temperature rise.

Ex.) SOT-23 package : $V_{IN}=4V, V_{OUT}=3V$ (XC62FP3002MR)

It is possible to use this particular set-up within the ranges shown below :

Ambient Temperature = $25^\circ C$: $I_{OUT} < 150mA$ [(4V-3V) x 150mA=150mW]
= $60^\circ C$: $I_{OUT} < 100mA$ [(4V-3V) x 100mA=100mW]

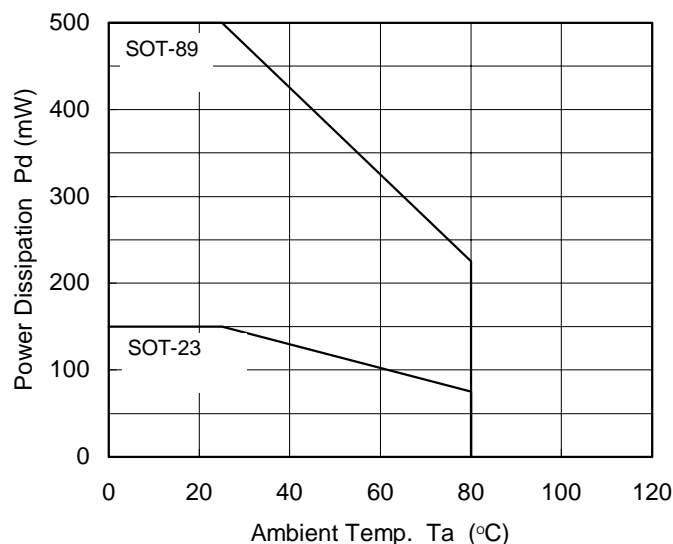


Diagram 3. Package Power Dissipation vs. Ambient Temperature

3. Peripheral Layout

Please locate the input capacitor C_{IN} and the load capacitor C_L as close to the IC as is possible and use short, thick wires in order to reduce wiring impedance and stabilize operations.

Should the distance between the IC and the load circuit be too great, output may become unstable if large current fluctuations exist on the load circuit side. Therefore, in order to stabilize output, it is recommended that a capacitor be connected close to both the IC and the load circuit.

4. High Temperature Leak Current

A large output driver is built into the series in order to realize large output currents. As such, output voltage may exceed the established output voltage value during extremely light loads, or at times of no load. This is due to the internal Pch output driver's leak current (particularly at high temperatures) and ample precautions should therefore be taken if the IC is used with light loads or at high temperatures.

5. Oscillation and Application Circuits

Should you wish to use a current boost circuit such as the one shown below (Diagram 4) with the XC62FP series, then please be aware of the possibility of oscillation due to the influence of impedance on the input side.

Should you wish to produce an output current higher than the IC's recommended maximum output current, or to have the capability to exceed the stated power dissipation level it is recommended that a boost type regulator (such as the Torex XC62EP series) be used. (Please refer to Diagram 5).

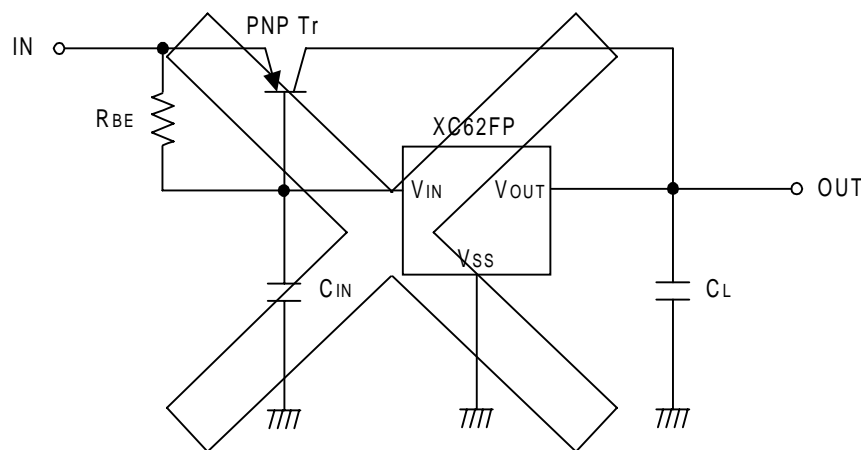


Diagram 4. How **not** to use a current boost circuit

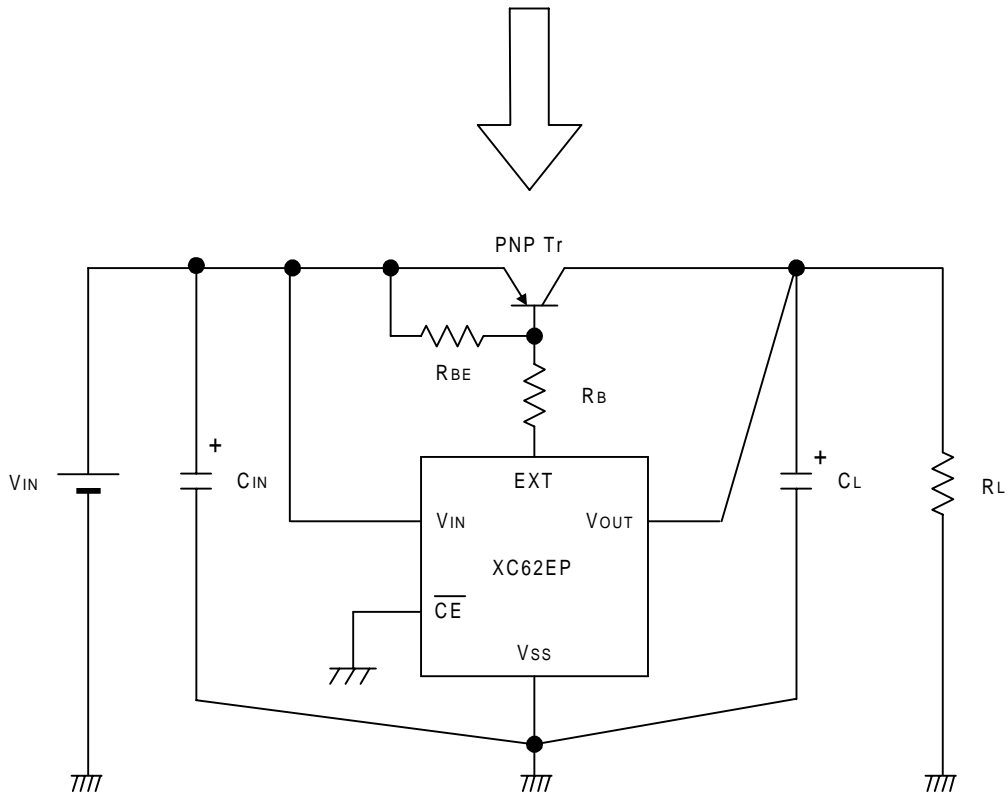


Diagram 5. XC62EP standard circuit

If using a circuit like the one in diagram 6 below, with a diode connected to the input side, please be aware that oscillation may occur due to input impedance at the diode. Should the IC be used with such a circuit, it is recommended that an input capacitor C_{IN} , with a capacitance value of more than 10 times that of the output capacitor C_L , be used.

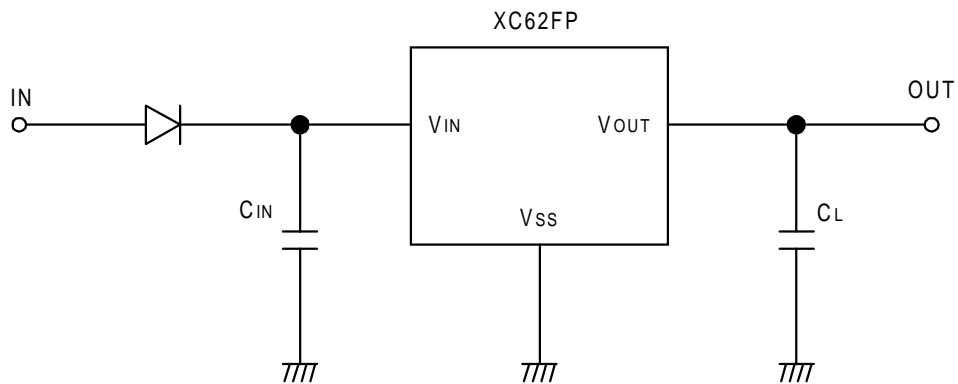


Diagram 6. A circuit using a diode on the input side

If using a circuit like the one in diagram 7 below, with a switch on the input side, please be aware of the possibility of oscillation due to the existence of impedance at the input side. If using such a circuit it is recommended that a positive voltage regulator with a built-in output on/off function be used. (The Torex XC62HR series for example)

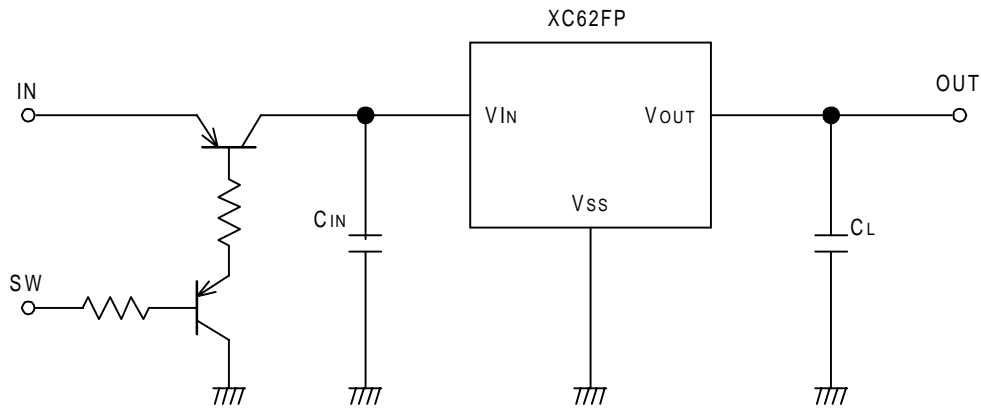


Diagram 7. A circuit using a switch on the input side

Should you wish to increase output voltage then using divided external resistors (as in diagram 8) is not recommended as the IC's VSS voltage level will become unstable due to changes to the IC's output voltage and supply current. Oscillation may occur. Please do not use such a circuit.

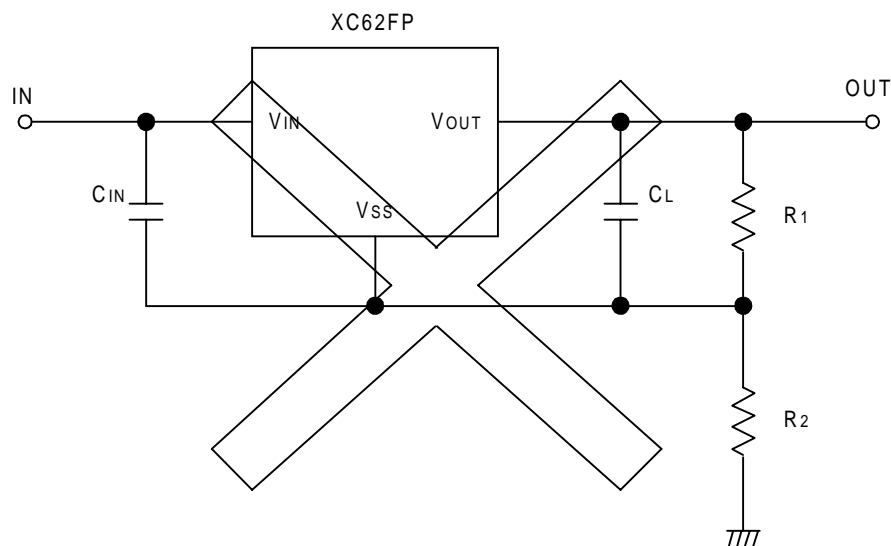


Diagram 8. How **not** to use externally divided resistors.

6. Current Limited Circuit

Should the output pin be short-circuited to the VSS pin with the XC62FP series, a current limited circuit is built-in in order to control output current during overload. This circuit operates in such a way that no current other than the output current flows (please refer to the characteristics below). Note that input voltage, radiant heat and the IC's dispersion will cause fluctuations in current limited values.

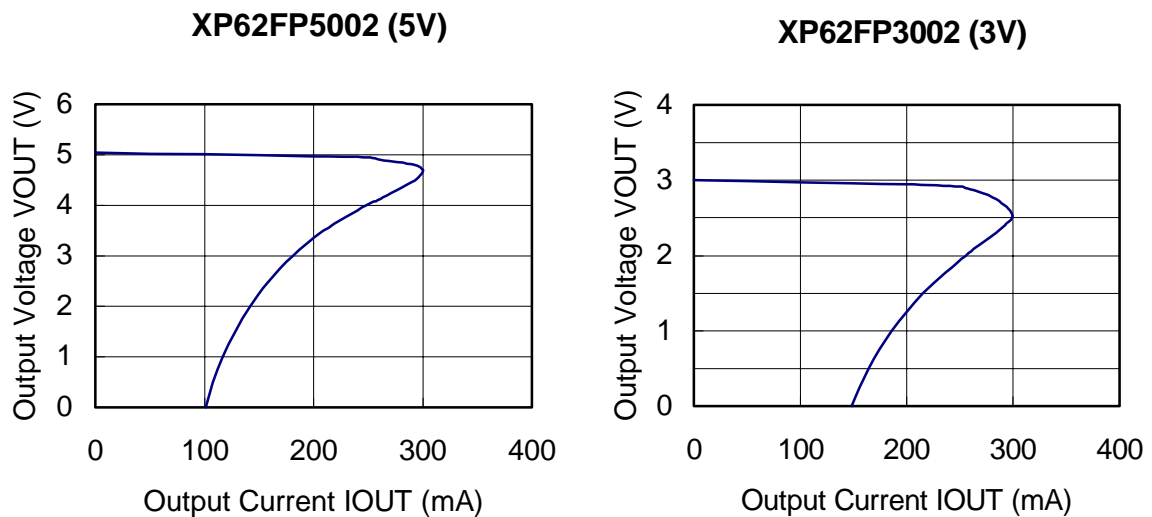


Diagram 9. Current limited circuit characteristics

Please note that the IC may be damaged if output is short-circuited and the packages' power dissipation is exceeded. Output current will continue to flow (as characterized in diagram 9 above) even if output has been short-circuited.

The IC's dissipation at times of output short-circuit :

$$\begin{aligned} \text{Dissipation} &= (V_{IN} - V_{OUT}) \times I_{OUT} \\ &= (V_{IN} - 0V) \times I_{OUT} \\ &= V_{IN} \times I_{OUT} \end{aligned}$$

Please also note that power dissipation is easily exceeded should input voltage be high.

Ex.) Output short-circuit when established output voltage = 5V, $V_{IN} = 6V$

The diagram 9 characteristics above show that in such circumstances $I_{OUT} = 100mA$.

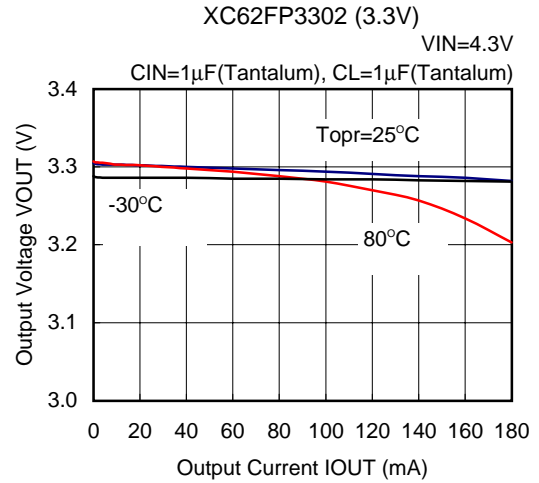
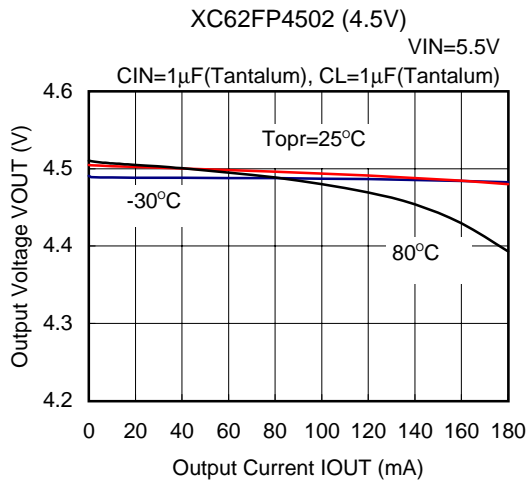
Therefore, dissipation can be calculated as follows :

$$\begin{aligned} \text{Dissipation} &= V_{IN} \times I_{OUT} \\ &= 6V \times 100mA \\ &= 600mW > 500mW. \end{aligned}$$

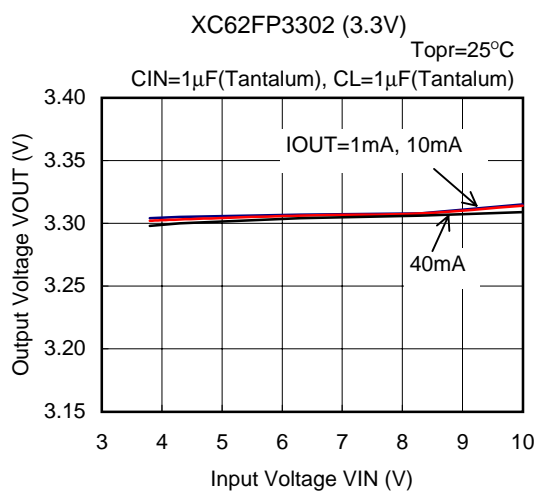
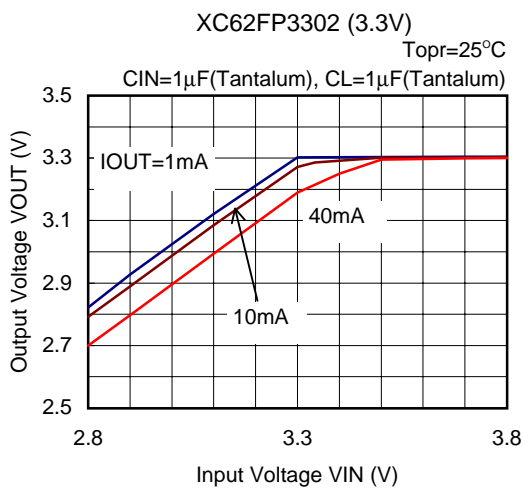
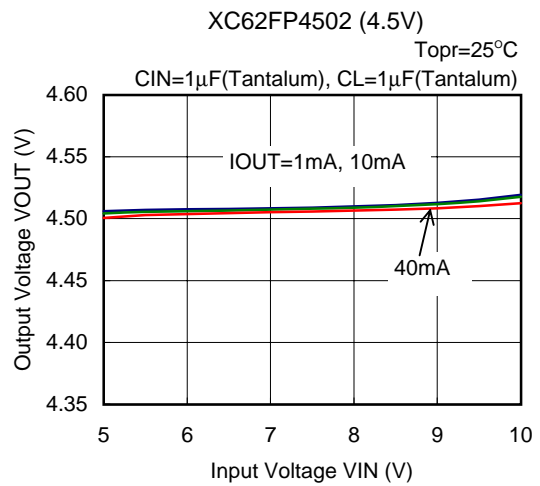
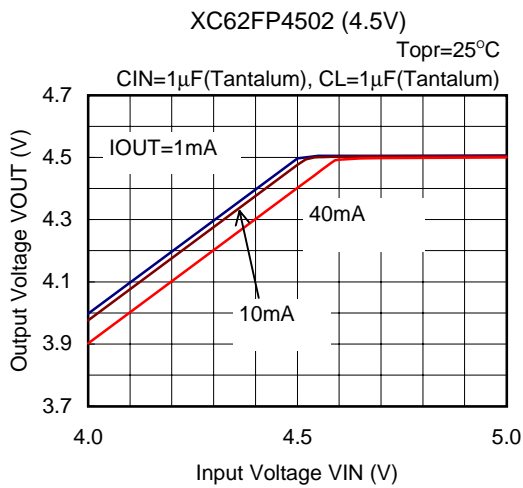
Note that this figure exceeds the power dissipation limit for the SOT-89 package type.

■ Characteristics

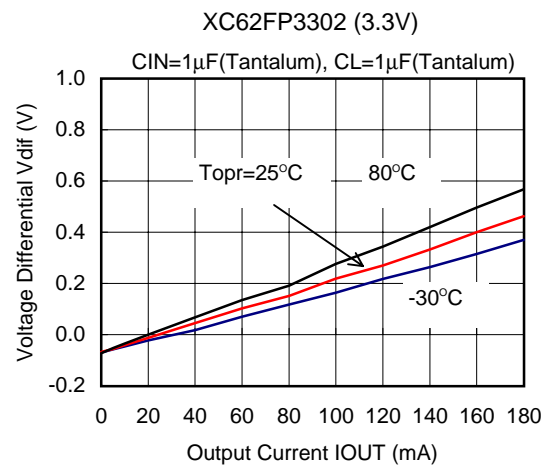
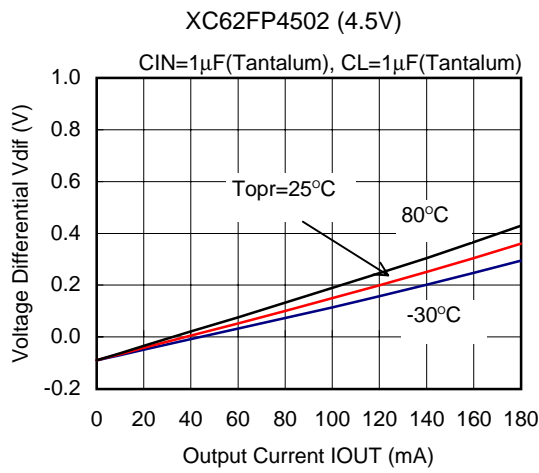
1. Output Voltage vs. Output Current



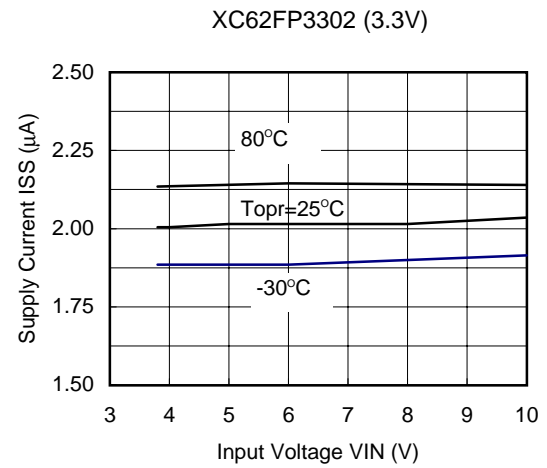
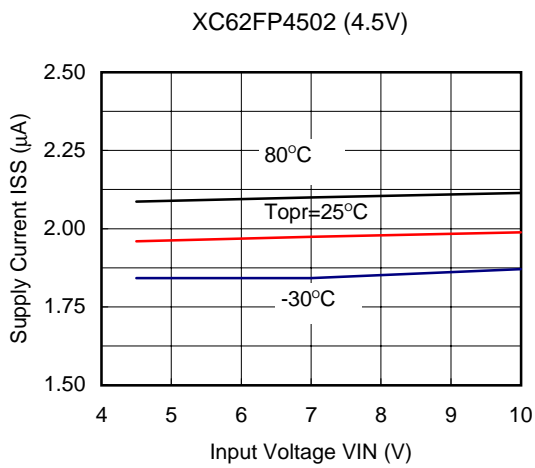
2. Output Voltage vs. Input Voltage



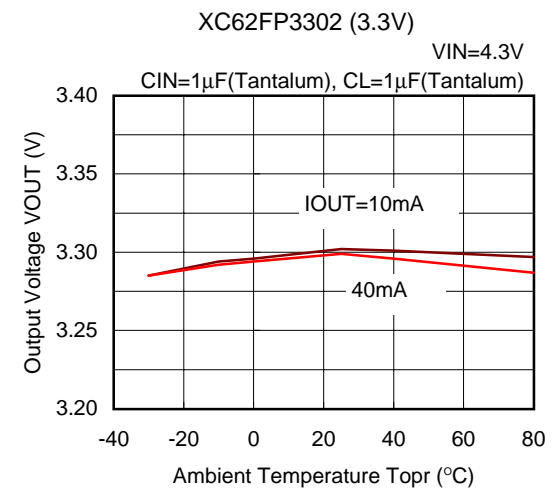
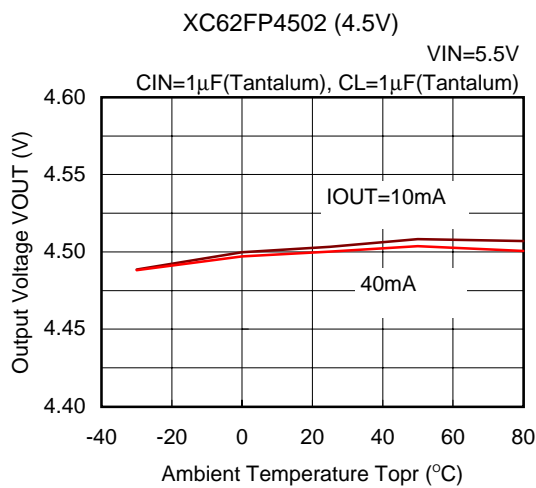
3. Input / Output Voltage Differential vs. Output Current



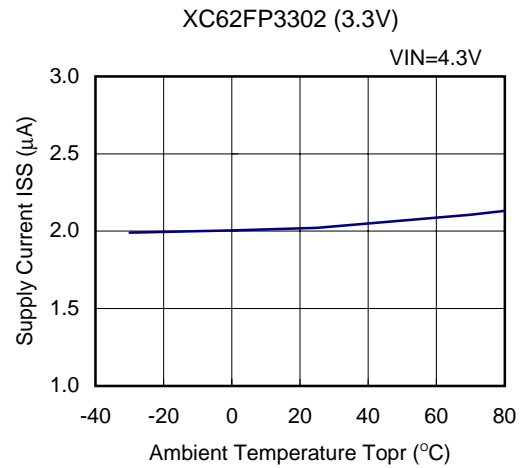
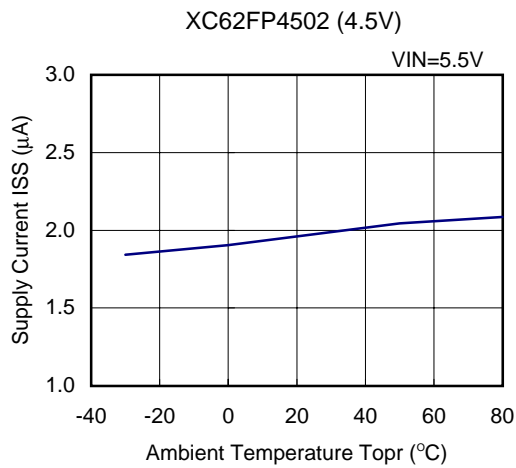
4. Supply Current vs. Input Voltage



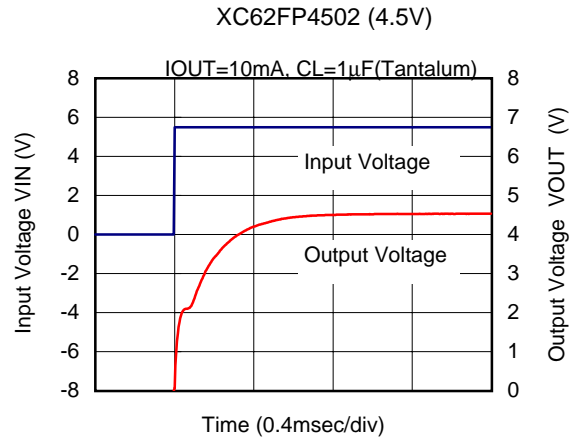
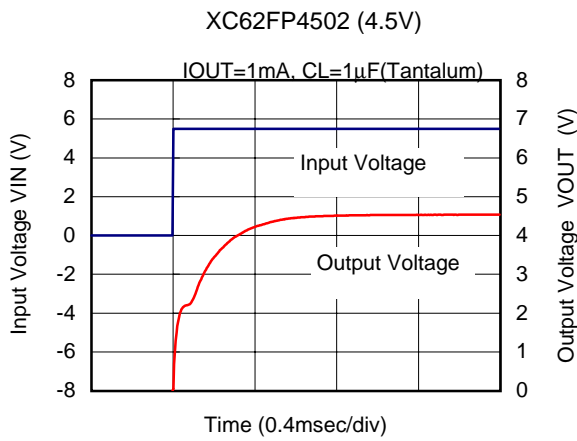
5. Output Voltage vs. Ambient Temperature



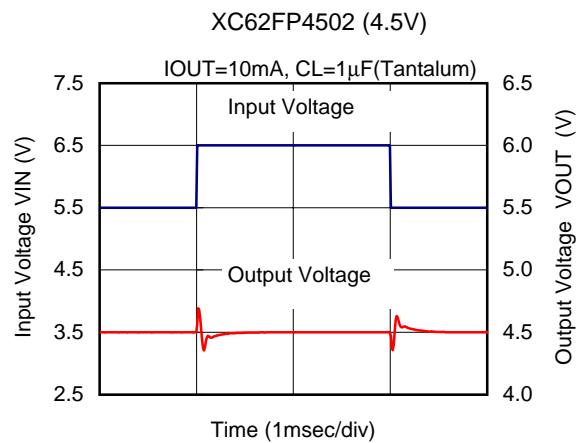
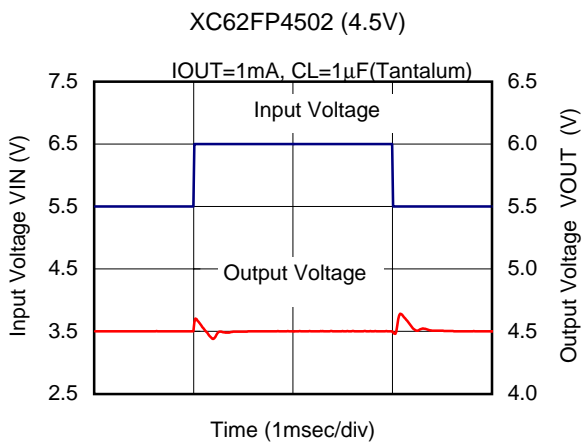
6. Supply Current vs. Ambient Temperature



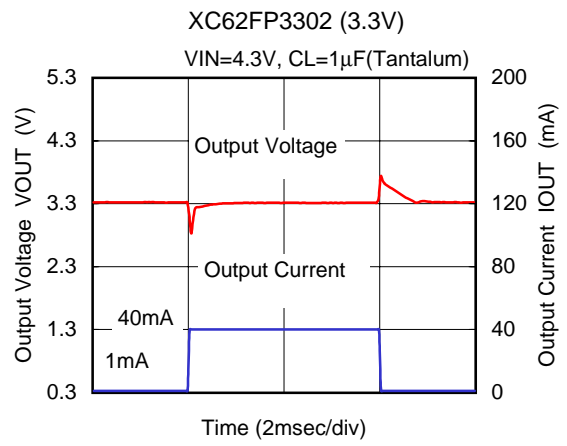
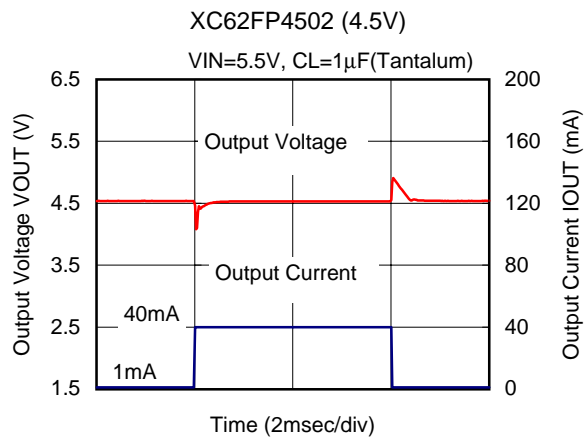
7. Input Transient Response 1



8. Input Transient Response 2



9. Load Transient Response



○ Appendix

1. Operating Principles

Voltage regulators, in general, output a voltage that is the input voltage V_{IN} which has been divided by an output driver resistor and a load resistor R_L (please refer to diagram A1-1 below). The voltage regulator maintains a fixed output voltage by changing the output driver's resistance value via the load resistor R_L (output current I_{OUT}) and input voltage.

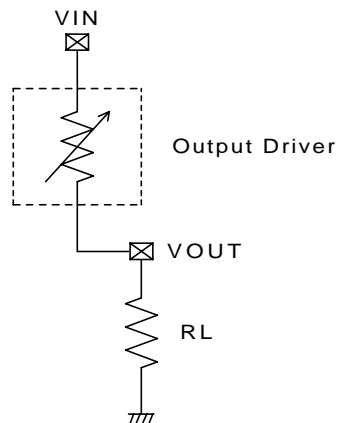


Diagram A1-1. Operating Principles

Diagram A1-2 is an internal block diagram of the XC62FP series. Reference voltage V_{ref} is connected to the inverted input of the error amplifier and the difference between V_{ref} and the feedback voltage, which exists as a result of the IC's internally divided resistors, is amplified. Thus, the Pch FET driver's gate voltage is controlled by the error amplifier's output and output voltage is stabilized.

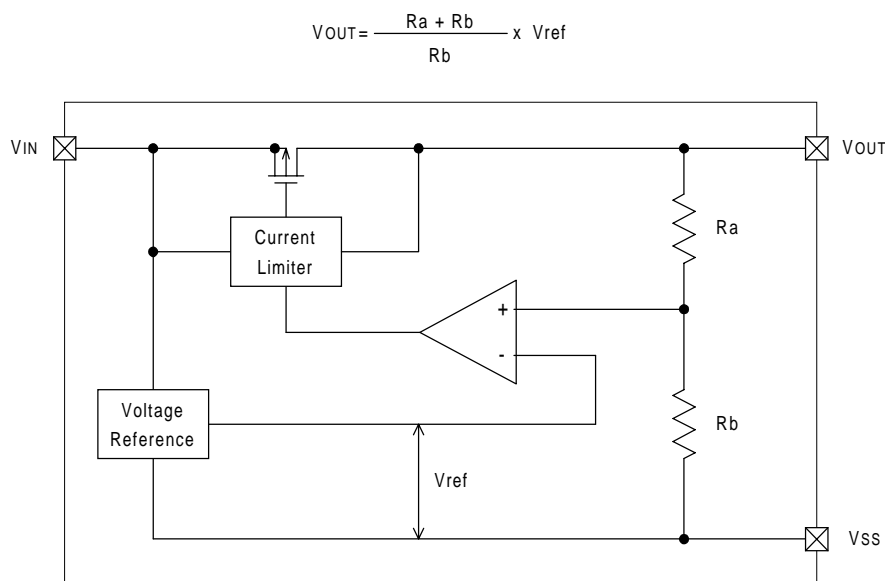


Diagram A1-2. XC62FP Series Internal Block Diagram

2. Electrical Characteristic's Terminology Explanation

2-1. Output Voltage V_{OUT}

This is the voltage that is output from the V_{OUT} pin when a stable input voltage is input at the IC's input pin V_{IN} . The output voltage with this series (as per the conditions set out below) is a specified output voltage value with $\pm 2\%$ accuracy (please refer to the specification catalog for details). The output voltage value fluctuates depending on the conditions of output current, input voltage etc. (please refer to electrical characteristics).

$V_{OUT}(T)$ = Specified output voltage value

$V_{OUT}(E)$ = Effective output voltage value

i.e. the output voltage when a stable " $V_{OUT}(T)+1.0V$ " is provided at the V_{IN} pin while maintaining a certain I_{OUT} value.

2-2. Input-Output Voltage Differential V_{dif}

This represents the difference between the required input voltage V_{IN1} and $V_{OUT}(E)$ in order to output $V_{OUT}(E) \times 98\%$. In other words, by applying a voltage (which is the input-output voltage differential added to $V_{OUT}(E)$) to V_{IN} , an output of more than $V_{OUT}(E) \times 98\%$ can be realized.

$$V_{dif} = \{ V_{IN1} - V_{OUT}(E) \}$$

V_{IN1} = the input voltage at the time 98% of $V_{OUT}(E)$ is output (input voltage has been gradually reduced)

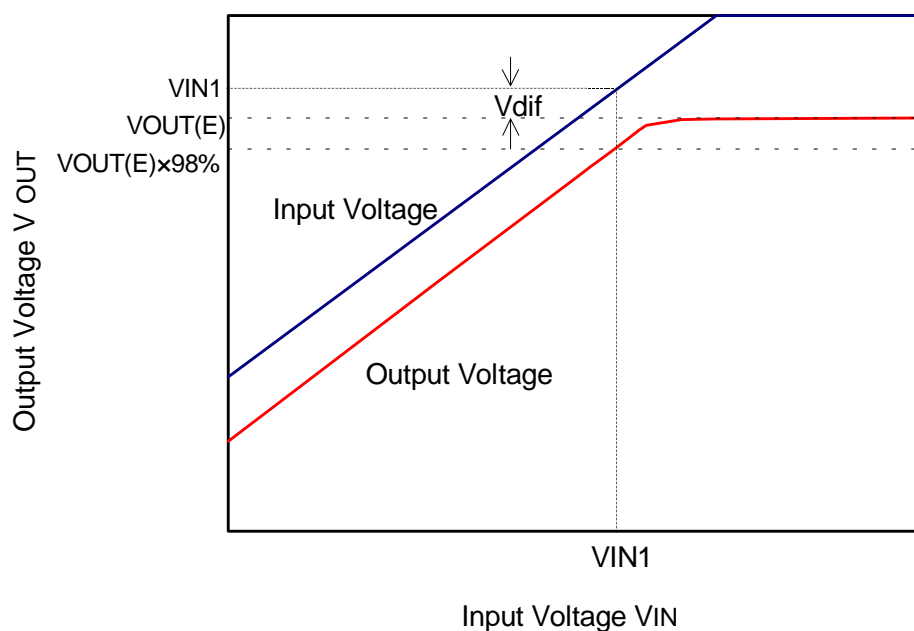


Diagram A2-1. Input-Output Voltage Differential

2-3. Load Stability ΔV_{OUT}

With input voltage fixed, this represents the amount of output voltage change when output current is altered (please refer to diagram A2-2 below).

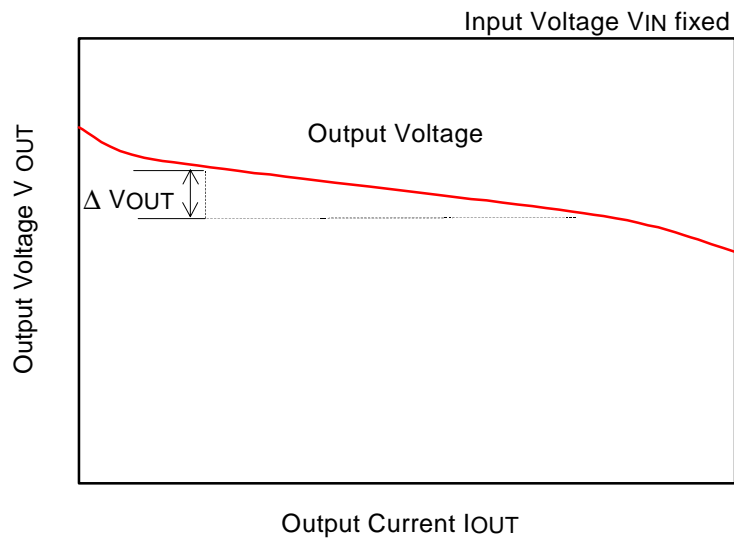


Diagram A2-2. Load Stability

2-4. Input Stability $\Delta V_{OUT} / (\Delta V_{IN} \times V_{OUT})$

With output current fixed, this represents the amount of output voltage change when input voltage is altered (please refer to diagram A2-3 below).

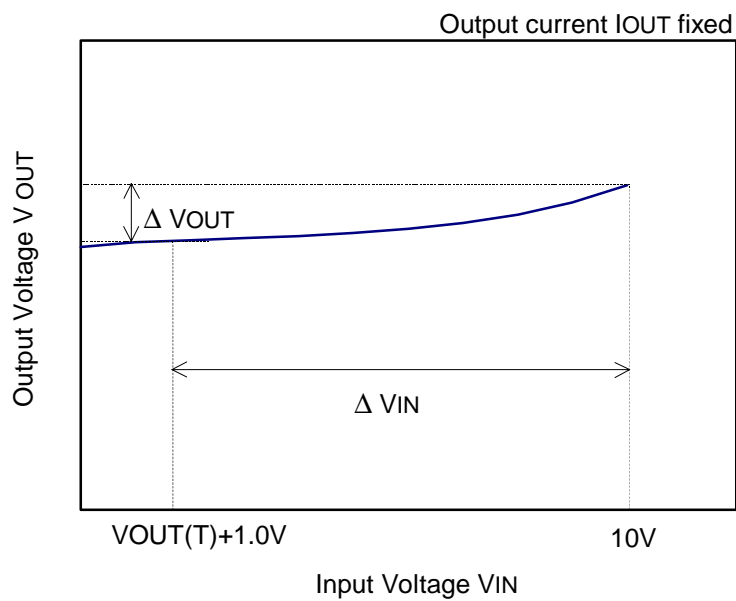


Diagram A2-3. Input Stability

2-5. Maximum Output Current IOUTMAX

With input voltage fixed, this represents the output current value when 90% of specified voltage $V_{OUT}(T)$ is output (please refer to diagram A2-4 below).

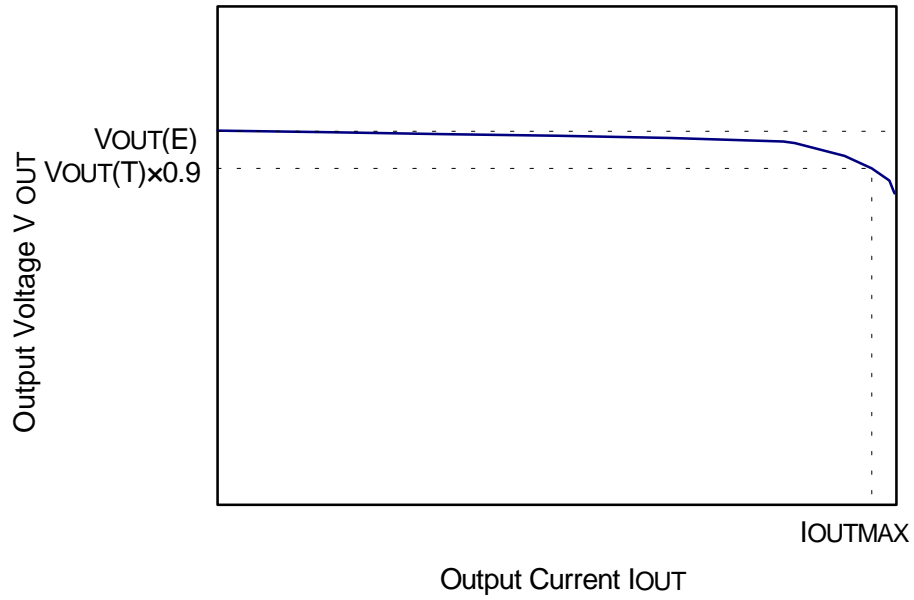


Diagram A2-4. Maximum Output Current