Maximizing Start-up Loads with the LM3352 Regulated Buck/Boost Switched Capacitor Converter

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Intoduction

The LM3352 is a regulated switched capacitor voltage converter. It achieves Buck/Boost operation by using a variety of different switching schemes to produce seven different gains between a minimum of ½ and a maximum of 2. At any given time the input and output comparators determine the required gain to give a regulated output voltage. The switching scheme used does however pose some minor restrictions regarding start-up of the IC with the output loaded. For the majority of applications a power-on reset circuit will be used. In these cases the restrictions are of no concern regardless of the type of load presented to the LM3352. For applications not using a power-on reset circuit the restrictions are described below.

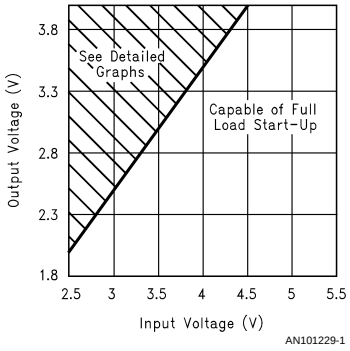
As the part starts up, it cycles through the necessary gain regions (gains) until regulation is reached. Each gain region has an associated output impedance which may be greater than or less than its neighboring gain region. The greater the output impedance, the less current the part is able to supply without losing regulation. Therefore the weakest gain region (the gain with the highest output impedance) sets the maximum start up current for the part. For the LM3352, the weakest region is from $V_{IN} = V_{OUT}$ to $V_{IN} = V_{OUT} + 200mV$. For some output voltage options, the part will never cycle through this region and therefore maximum start up current will be equal to the maximum rated load current.

The datasheet shows a maximum start up current of 45 mA. This number is a worst case number encompassing all voltage options across all input voltages as well as the worst case condition of $T_A = 85^{\circ}C$. As mentioned above, the weakest region is setting this limit. If the input range is more limited than the datasheet limits, the circuit may start up with loads greater than 45 mA. This effect can also change with different load types. For example, some CMOS loads will not draw significant current until a certain operational threshold voltage is reached. If this threshold voltage occurs after the LM3352 has cycled through the gain region of 1 there will be no start-up restrictions. However, systems with resistive loads will draw current as soon as voltage is applied. A description of the limitations for a resistive load follows.

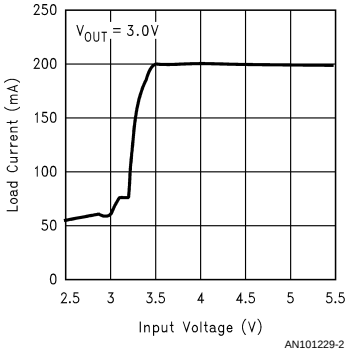
Because the maximum load current during start-up is input voltage dependent *(See graph titled Start-up Regions)*, lower input voltages will need to use the gain of 1 during start-up and therefore will have decreased current capabilities. Due to the added effect of the R_{OUT}, input voltages slightly higher than the output will be affected as well *(See graphs titled Maximum Start-up Load Current vs. Input Voltage)*. These graphs are taken using a resistive load on the output.

With higher input voltages that do not need to use or go through the weakest gain region during start-up, the maximum load during start-up is dramatically increased. As the graphs show, much higher loads than 45 mA can be tolerated during start-up with high input voltage conditions. The graphs are also at the worst case condition of $T_A = 85^{\circ}C$. This should clarify the start-up issues involved with the LM3352 and allow more possibilities of use for those who are unable to use the part with the low stated maximum of 45 mA in the datasheet. If larger start-up currrents are expected for an application that has a minimum input voltage lower than the minimum input required, a power-on reset circuit such as the LP3470 is still recommended.

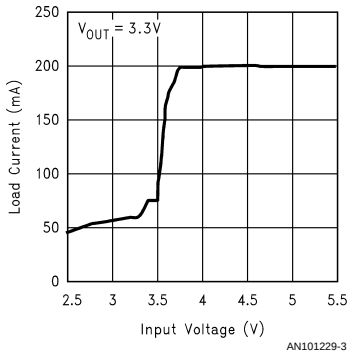
Start-up Regions



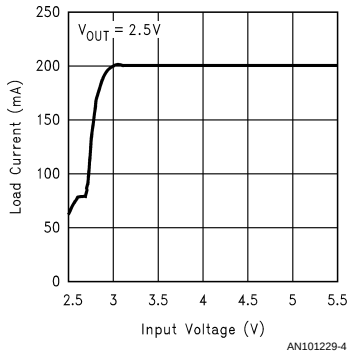
Maximum Start-up Load Current vs. Input Voltage



Maximum Start-up Load Current vs. Input Voltage



Maximum Start-up Load Current vs. Input Voltage



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