

Summary of the Idea

Externally fed current into the BYPASS (BP) pin from a floating constant current source enables start-up of the controller for a wide range of input voltages.

Description

For many Power Integrations products, the data sheet limit for minimum Drain voltage to guarantee proper start-up and functionality is 50 V. However if current is externally fed into the BYPASS pin, the controller can be powered externally and can begin operating at even lower input voltages.

Description (continued)

The start-up circuit shown in Figure 1 is a floating constant current source and provides a constant current of about 600 μ A into the BYPASS pin of TinySwitch™-III over the complete input voltage range.

Resistor R2 together with VR1 determines the value of the constant current.

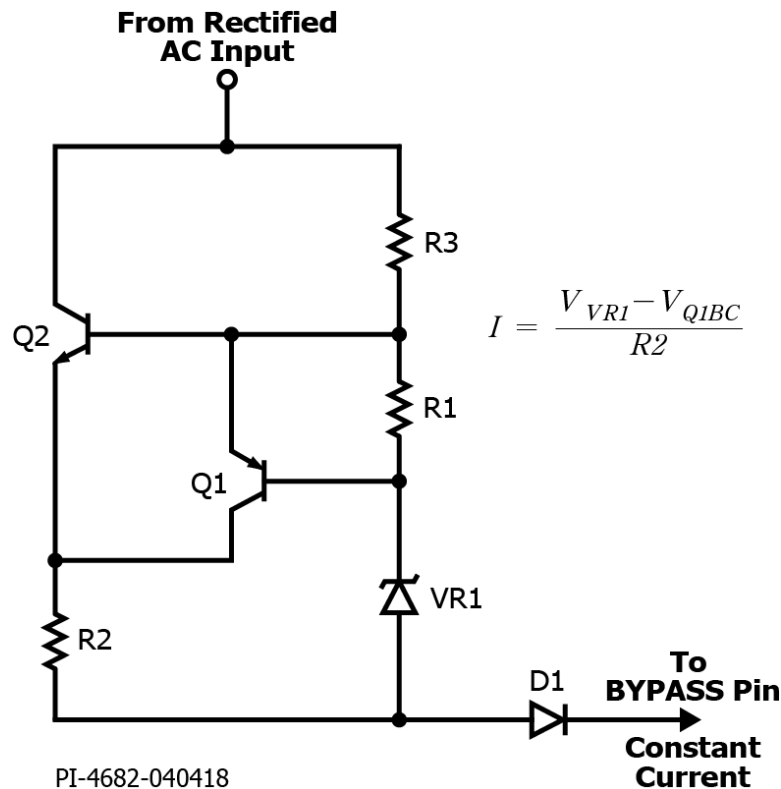


Figure 1. Floating constant current source circuit to provide constant current into the BP pin.

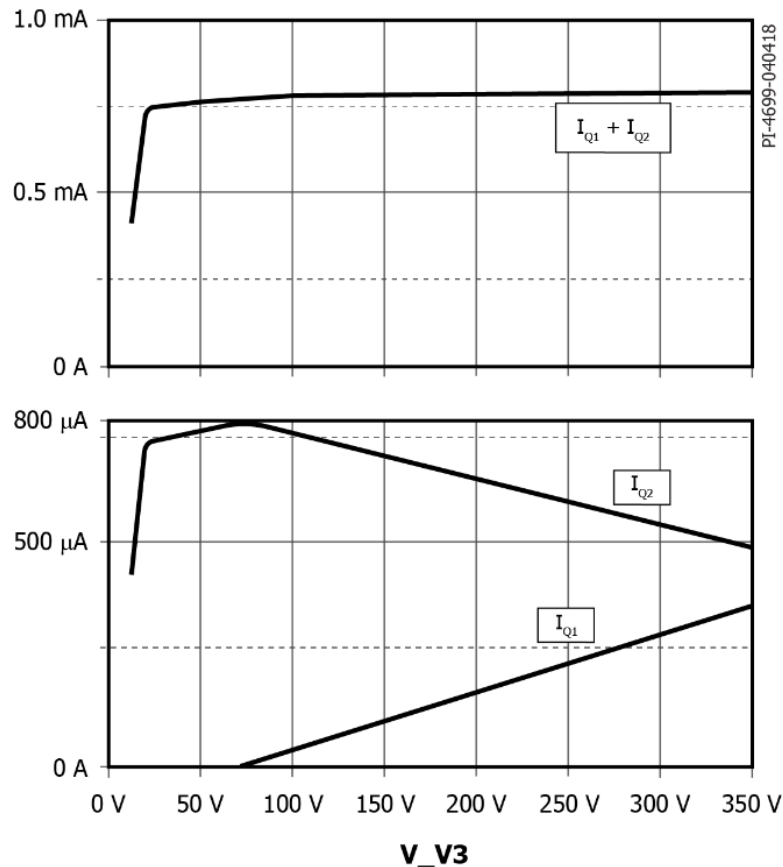


Figure 2. Transistor currents and total BP pin current over input voltage.

Description (continued)

The start-up circuit is derived from the basic single transistor current source, which uses a Zener diode to set the reference voltage for the base terminal of transistor Q2 (NPN) which in turn programs the fixed voltage across resistor R2, thus setting the constant current value. However, given the very wide range for the AC input voltage which supplies the start-up circuit, the bias current for the Zener diode varies over a large range. This causes both increased power dissipation as well as variances in the programmed constant current.

To overcome this difficulty, the bias current is provided by another current source formed by transistor Q1 (PNP) and resistor R1. The voltage across resistor R1 is a constant voltage equal to VBE of transistor Q1 which fixes the bias current into the Zener diode throughout the wide operating range for the AC input voltage.

Transistor Q2 delivers the constant current at lower input voltages while transistor Q1 delivers the constant current at higher input voltages. R3 is used to limit the input current of the whole circuit at maximum input voltage.

Figure 2 illustrates the simulation results of the current flow through transistor Q1 and Q2. Up to an input voltage of about 50 V DC, the constant current is supplied by transistor Q2. For input voltages from 50 V DC and above, the current through transistor Q2 will decrease, and the current through transistor Q1 linearly increases. At the maximum input voltage of 375 V DC, the constant current is provided primarily by transistor Q1.

The non-linear current rise is due to the non-linear behavior of the Zener diode VR1. At about 60 V DC input voltage, the Zener voltage is reached.