Customizing the Linear Circuitry Response of the HV91 Family PWM ICs via the Bias Resistor

The data sheets for the HV91 family of devices state that a resistor is required between the BIAS terminal on the chip and VSS for operation of the part, and the resistor should have the value given on the data sheet. Although the first part of that statement is correct, the second part is not necessarily true.

For a specific application the best value for the bias resistor may be quite different from the value stated on the data sheet, particularly if the circuit under development has requirements for response speed, or quiescent power dissipation that differ from the values stated on the data sheet, or if the HV91xx will be operated at a V_{DD} other than 10V.

The performance of the analog sections of the HV91xx depends on a series of internal current sources (one or more per analog block) that are controlled by the external current that travels from the bias terminal of the IC to VSS. According to the data sheets, this current should be 7.5µA for an HV9105, or 15µA for the other devices in this family. These data sheet numbers reflect test conditions used to test the parts. For operation by the customer, however, bias current can be set to any value from 2.5 to > 70µA, if the performance of the part with that bias current reflects the performance desired from the system.

Figure 1

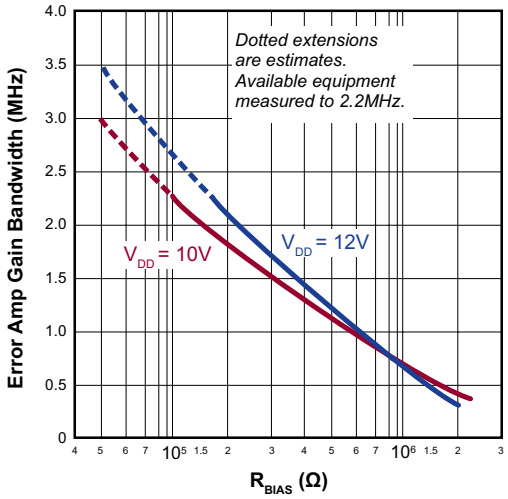


Figure 2

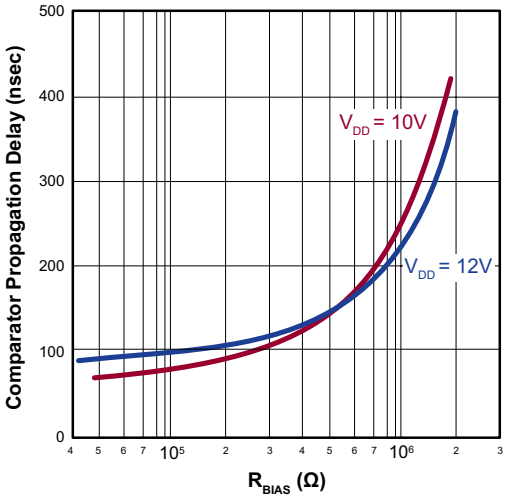


Figure 3

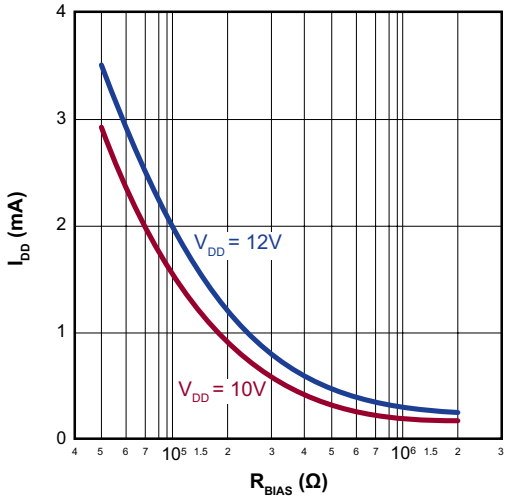
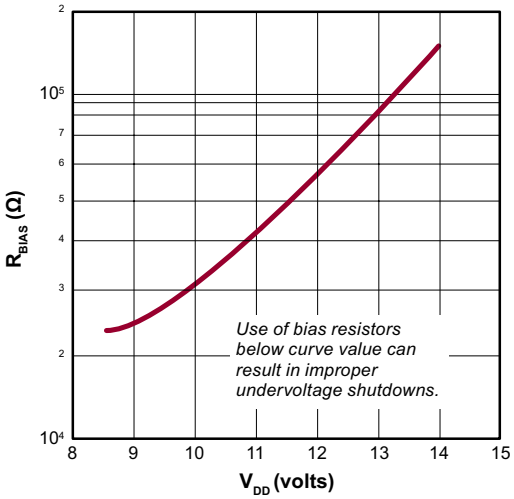


Figure 4



In an HV91 series PWM, reducing the value of the bias resistor (to increase the bias current), increases the bandwidth of the error amplifier and the speed of the current limit and modulation comparators. It also increases the supply current drawn by the IC. Because the comparators may be acceptably fast even at very low bias currents, the trade-off with bias control usually works out to be error amplifier bandwidth vs. supply current. The primary place where low supply current is important is in ultra-efficient converters which, to reduce switching losses, operate at low frequencies and therefore need less error amp bandwidth. Also, current-mode operation tends to reduce error amplifier bandwidth requirements. The primary application where high error amplifier and comparator speeds are needed is in high frequency supplies, where absolute minimum quiescent current may not be as important.

There are, however, limits to the range of bias resistors that will result in acceptable performance. If the bias resistor is made too small, the undervoltage shutdown circuit becomes sensitive to extremely small changes in V_{DD} and can disrupt circuit operations (see Figure 4). Likewise, if the bias resistor becomes too large, not only does the bandwidth of the error amplifier go down, open loop gain is also reduced (to about 50dB at I_{BIAS} = 3.0µA). This can reduce regulation accuracy, and may not be acceptable for some circuits. A bias current of 3.0µA corresponds to a bias resistor of approximately 2.2MΩ with VDD = 10V, or approximately 3MΩ with V_{DD} = 12V. To accurately relate bias current to bias resistor value, use the graph of bias resistance vs. bias current in the HV91xx data sheet. The curves printed with this note provide data on performance vs. bias resistor value.

The accompanying graphs show the relationship between comparator speed, error amplifier gain bandwidth, supply current, and bias resistor value for V_{DD} = 10V and 12V. These should allow users to optimize the performance of HV91 series PWMs for whatever performance goals the user finds important. Note that over most of the bias current range, the changes in speed and supply current occur slowly. Thus, for most circuits, precision resistors will not be required. Also note that even at the high speed end of the bias current range (75µA), supply current only increase to a little over 2.5mA, meaning that power dissipation in the chip can still be quite low.

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