*Application Report*
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# *Achieving Stable VGS Using LM5050-1 with Low Current and Noisy Input Supply*

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**ABSTRACT**

TI's LM5050-1 turns off the gate voltage (VGS) in about 50 ns, when there is a reverse current flow detected from VOUT to VIN. The reverse current flow prevention is important and desirable for any OR-ing controller to achieve the ideal diode functionality. Sometimes reverse current can flow undesirably, subjected to load current value and input supply voltage and noise conditions (rise time, fall time), and so forth, which may give rise to unstable an gate voltage on the LM5050-1.

The focus of this application report is to solve the VGS drop problem, when LM5050-1 is used in an environment where input supply is subjected to wide fluctuations/fast input transients (EFT)/audio noise over the DC input voltage.

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# 1 LM5050 Operation With Higher Load Current (Normal Operation)

The circuit in Figure 1 shows the Power OR-ing controller with the LM5050-1 and configured for the 1.2-A load current with stable and noise-free input power supply. In this case, LM5050-1 perfectly enables the VGS of the FET as expected and shown in Figure 2.

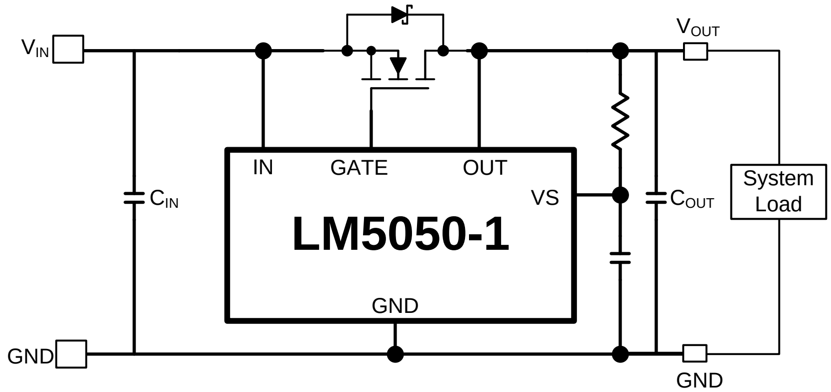


**Figure 1. LM5050-1 Application Circuit**

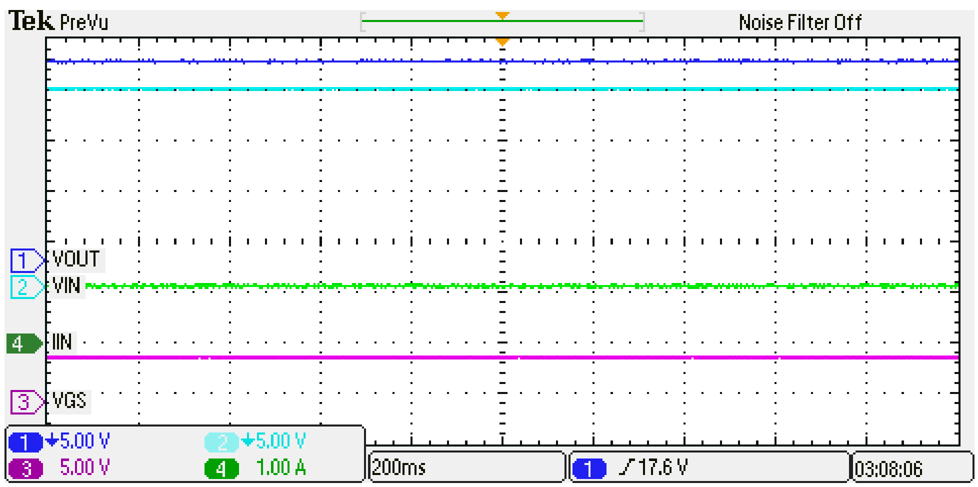


**Figure 2. LM5050-1 Operation Showing VIN (20 VDC), VOUT, VGS, and IIN (1.2 A)**

## 2 LM5050-1 Operation With Pulsating VIN and With Lower Load

The same circuit as shown in Figure 1 is connected with 14-VDC input voltage with audio noise, these kind of inputs are possible when there is AC signal (noise) rides over the DC input (VIN), as shown in Figure 2 where input voltage fluctuates between 10 V to 18 V. Since the output load current is low (48 mA), and the output voltage dV/dt is lower than the input dV/dt, this causes VOUT to be higher than VIN at some point and when this happens, there will be a reverse current flow detected by the LM5050-1, which disables the gate signal (VGS-Gate-Source Voltage in Figure 3), the gate voltage falls and rises with VIN. This unstable VGS is not desirable which fluctuates with VIN.

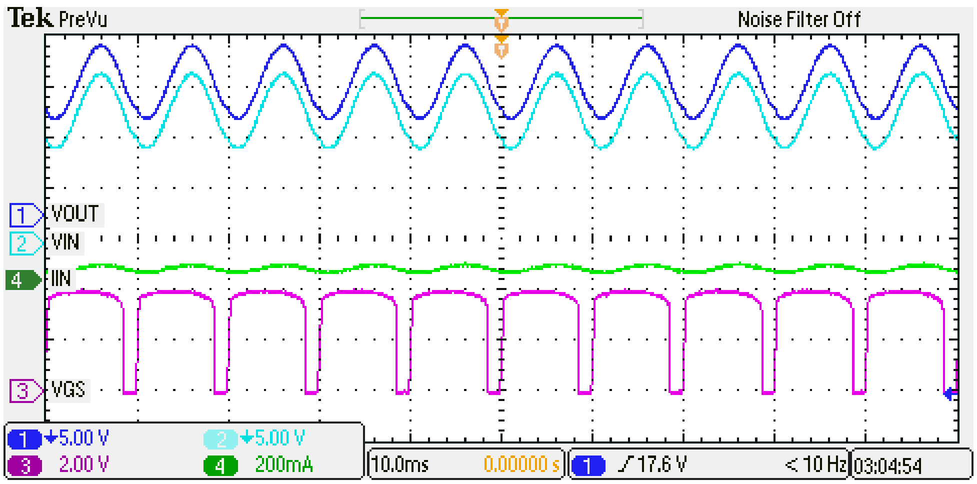


**Figure 3. VGS Drops With Low IOUT (48 mA) and Noisy Input Voltage**

## 3 LM5050-1 With Unbalanced Input and Output Capacitor With Same Load

It is clear that if the VIN dV/dt (falling rate) can be made equal or lower than VOUT dV/dt (falling rate), the reverse current from VOUT to VIN is avoided and hence the VGS fluctuations along with VIN can be eliminated.

There are three possibilities to achieve the balanced dV/dt:

1. Reduce the VOUT capacitor
2. Increase the VIN capacitor
3. Increase the load current so that:

   (dV/dt) falling at VIN ≤ (dV/dt) falling at VOUT

To prove this theory, the experiment is done with increased input capacitance (CIN) and the circuit in Figure 1 is updated with 10x higher input capacitance than output, with 48-mA load current and tested. The results in Figure 4 show this small modification keeps VGS pretty constant.

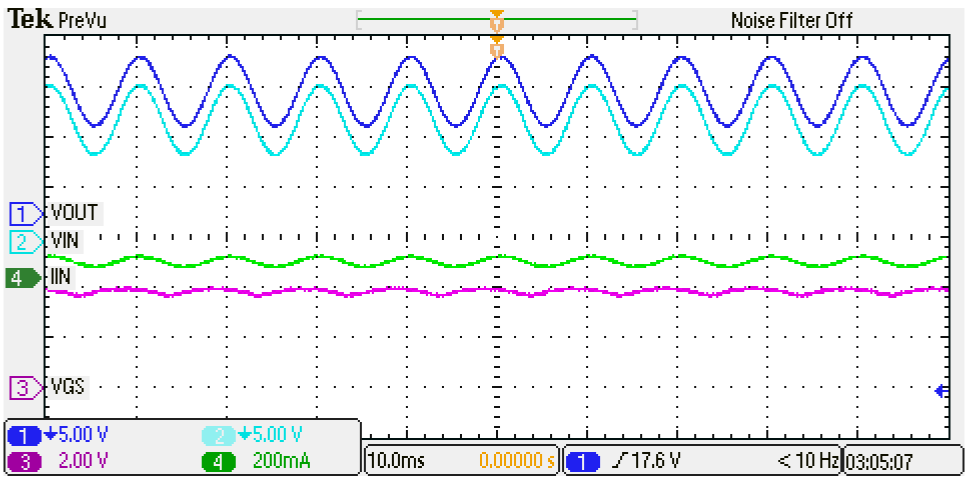


**Figure 4. Stable VGS With 1-μF Input Capacitor and 0.1-μF Output Capacitor**

The 10x capacitor ratio solves the problem in this case, but this ratio depends on the load current and how quick the input variations are.

The faster input variation would need a larger input capacitor if load current is lower. In other words, the higher load current would need a lower input capacitor.

## 4 Conclusion

The low cost LM5050-1 is the most widely used part for Power OR-ing Application. This device operates in the sub-threshold regions when used in lower load current systems. The changes of VGS drop goes higher when input supply voltage is subjected with frequent voltage fluctuations like audio noise over the DC supply. These input variations may cause the reverse current flow from the load side to VIN, which forces VGS drop. What really matters here is to avoid the reverse current flow to get the stable VGS. This is achieved by making the falling rate of VIN slower than VOUT, by using a larger CIN than COUT.

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