Application Hint 9

Low Voltage Operation of the MIC5014 Family

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Introduction

The current trend for more efficient use of power has led to a new standard in logic based systems: the use of 3.3V logic as opposed to 5V logic. Efficient power management is especially important in battery based systems such as portable laptop/notebook PCs and cellular phones where maximum use time is determined by battery life. **The MIC5014 family has a minimum required supply rail of 2.75V, which is the lowest required voltage of any high side driver in the industry!** This makes the MIC5014 family ideal for use in any low voltage environment where power switching is necessary. This note briefly describes the characteristics of these devices at low voltages, and shows several example applications where the low voltage feature is used.

Typical Parameters at V^+ = 3.3V

Table I shows the typical parameters expected at a 3.3V supply voltage. At 15µA quiescent current and 35µA operating current, we offer very little battery drain at this voltage. Also worthy of attention is the fact that these devices offer a full 4.5V gate enhancement with a supply voltage of only 3.0V! Perhaps the only drawback is the rise time at these low voltages, which is on the order of 35 to 40ms. For most power switching applications in this voltage range, this has not been seen to present difficulties and is a small price to pay for the greatly lowered battery drain. If faster switching speeds are desired, the rise time can be improved to 20 to 30ms by bootstrapping off the positive supply, as shown in figure 1. Faster times than this can be attained by increasing the size of the bootstrap capacitor at the expense of the additional space required. Fall times remain on the order of 6 to10µs.

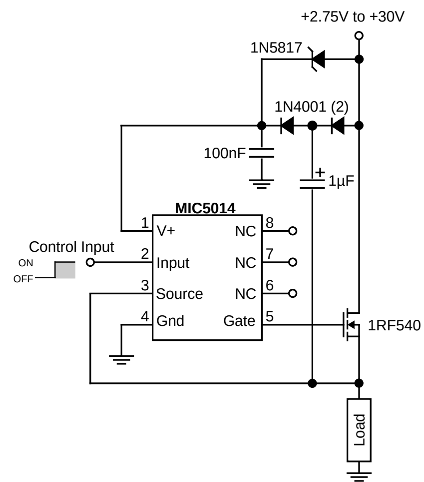

Figure 1. Low Voltage Bootstrapped High Side Switch

Table 1: Typical Parameters at V^+ = 3.3V

Parameter	Typical Value	Units
Supply Current,Off State	15	µA
Supply Current,On State	35	µA
High Side Turn-On Time (C_L = 1300 pF)	35	ms
Turn-Off Time	6	µs
Gate Enhancement (V_{GATE} - V_{SUPPLY})	4.5	V
Logic Input Current (High State)	1	µA

Typical Low Voltage Applications

Sleep Mode Switching

One commonly employed technique for extending battery life is the use of a "sleep mode" switch, in which the microprocessor shuts down all the functions that represent power drain after a preset time of nonuse while maintaining the system memory. This type of a switch must typically be a high side switch, or a switch that controls the availabllity of the positive supply, as standard computer or logic based systems often have common ground busses and /or shielding.

The MIC5016 plus two logic level FETs make an ideal dual sleep mode switch (figure 2) without the bulk and unreliability of relays or the voltage drop of bipolar transistors (See Application Hint 5 for more information plus a board layout for sleep mode switching with regards to our MIC5011 high side driver).

A logic level FET is very similar to a regular power FET except for the threshold voltage requirements, which are VGS = 4 V for turn-on and 5 V for full enhancement. A regular power FET would require a minimum of 10V for full enhancement. This feature makes the logic level FET ideal for this kind of switching. The only drawback it has is that it's gate cannot withstand more than 10V of enhancement. The MIC5014/5016 devices are equipped with an internal zener clamp, but at 15V it will not save us here! We recommend that an external zener clamp or regular power FET be used if a supply higher than 4V is required.

As the MIC5014 is pin to pin compatible with the MIC5011, the board layout for a single sleep mode switch as featured in Application Hint 5 will also work for the MIC5014.

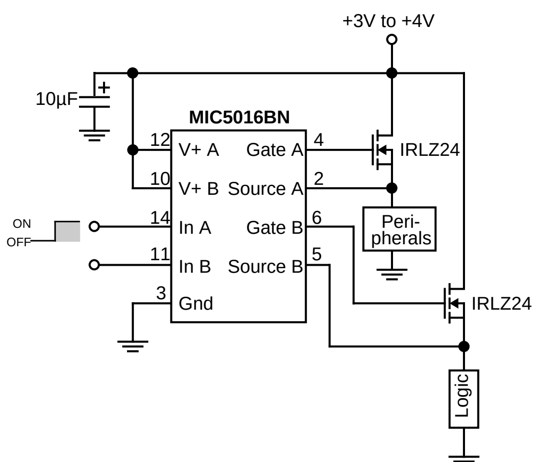

Figure 2: 3 to 4 V Dual Sleep Mode Switch

Low Battery Sense and Disconnect

When a battery is discharged to the point that the load goes significantly out of regulation, it is often beneficial to disconnect the load from the battery to prevent further discharge. In the case of NiCd or NiMH batteries, repeated deep discharging has a negative impact on battery life. A simple scheme can be formulated using the MIC2951 super low drop out regulator to generate a well regulated 3.3V supply from four 1.2V battery cells. When the output drops to below 5% of the rated value, the ERROR flag goes low, pulling down the RESETof the latch which shuts down the control input to the MIC5014. This turns off the MOSFET switch connecting the battery to the regulator. It is important to hold the SET input to the latch low for 30 to 40ms on start-up to allow the regulator to kick in. This output can also be fed to a microcontroller, signalling the user that it is time to charge his batteries.

Although it is possible to use feedback from the ERROR output to the shutdown input of the MIC2951 to perform this function, the addition of the MIC5014 and FET switch results in less current drain (20 to 25µA extra for the MIC5014 plus latch as opposed to the current required to bias and drive a bipolar transistor). It also allows the MIC2951 to act as the central controlling point for shutdown in applications where the unregulated battery voltage is fed to other subsystems, such as an SMPS converter, in addition to the MIC2951.

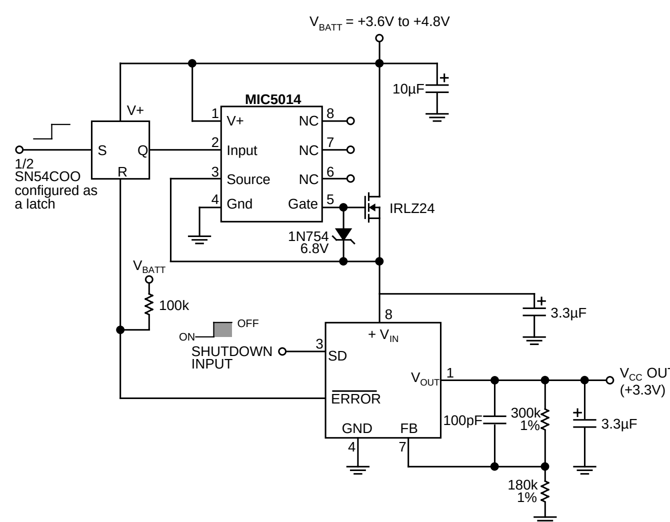

Figure 3: Low Battery Shutdown Switch