# DESIGN NOTES

## 5V to 3.3V Regulator with Fail-Safe Switchover – Design Note 82

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Newer microprocessors in personal computers have low voltage chips which are designed to replace existing 5V units. In the past a processor swap was simply a matter of removing one IC and replacing it with an updated version. But now the upgrade path involves switching from a 5V chip to one that requires 3.xxV.
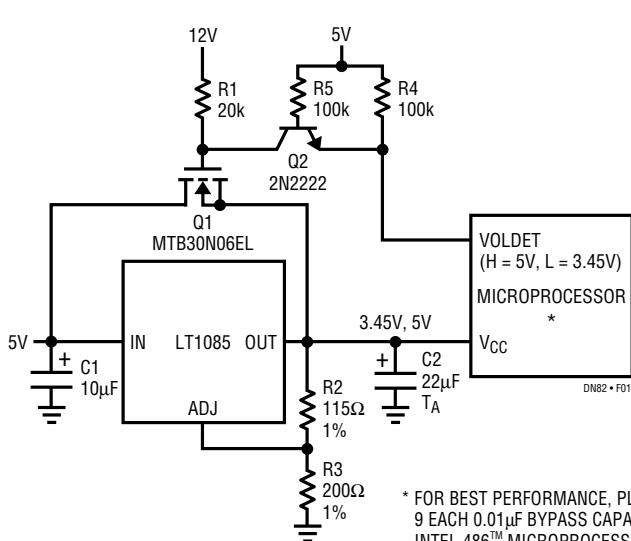
One means of changing supply voltage from 5V to 3.xxV is to clip a jumper that bypasses a local 3.xxV regulator. This is not a good solution since it leaves too much to chance. Failure to remove the jumper can result in the instant destruction of the new microprocessor upon application of power. A means of automatically sensing the presence of a 3.xxV or 5V processor is necessary.

Intel microprocessors include a special pin called "VOLDET" which can be used to determine whether or not a particular chip needs 3.xxV or 5V. Figure 1 shows a simple circuit that takes advantage of this pin to automatically "jumper out" a 3.xxV regulator whenever

a 5V processor is inserted into the socket. VOLDET is pulled low on 3.xx processors; it is buffered by transistor Q2 which grounds the gate of a bypassing switch (Q1). Q1 is turned off leaving the LT1085 to regulate the microprocessor's $V_{CC}$ line.

For 5V microprocessors the VOLDET pin is high; Q2 is turned off allowing Q1's gate to pull up to 12V, turning itself on. With the LT1085 shorted from input to output by the MOSFET, 5V flows directly to the microprocessor. No service intervention is required to ensure correct $V_{CC}$ potential.

The circuit in Figure 1 is fine for cases where 12V is available to enhance the MOSFET switch. However, in portable applications,12V is frequently not available or available only on an intermittent basis. Figure 2 shows a second solution using a high-side gate driver to control the MOSFET. A VOLDET pull-up resistor is required in both figures because in some cases VOLDET
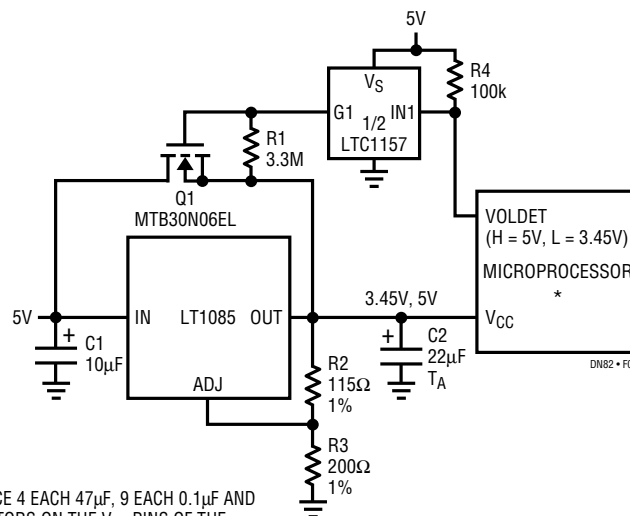


Figure 1. Bypass Circuit for 3.xxV and 5V Microprocessor Swaps Using Transistor Buffer



Figure 2. Bypass Circuit for 3.xxV and 5V Microprocessor Swaps Using High-Side Gate Driver (No 12V Supply Required)

* FOR BEST PERFORMANCE, PLACE 4 EACH 47µF, 9 EACH 0.1µF AND 9 EACH 0.01µF BYPASS CAPACITORS ON THE $V_{CC}$ PINS OF THE INTEL 486™ MICROPROCESSOR. ESR OF THE 47µF < 0.1Ω. INTEL 486 IS A TRADEMARK OF INTEL CORPORATION

is an open circuit or a shorting link, and in other cases it is an open-drain output.

VOLDET is pulled up to 5V in both circuits. This could pose a problem for 3.xxV processors with open-drain VOLDET pins, but for 3.xxV devices VOLDET is always pulled low and 5V never reaches it. The 5V reaches VOLDET only on 5V devices.

For certain families of microprocessors, 3.3V is required. The circuits shown in Figures 1 and 2 are fully compatible with 3.3V applications by simply substituting a fixed 3.3V version of the regulator (use an LT1085-3.3). Higher current operation is also possible. The LT1085 is suitable for 3A applications; use an LT1084 and an MTB50N06EL for up to 5A. Table 1 shows the wide range of linear regulators available at currents of up to 10A.

In some applications the complexity of a high efficiency switching regulator may be justified for reasons of battery life. Figure 3 shows a switcher that not only converts 5V to 3.45V but also acts as its own bypass switch for applications where a 5V output is required. An open drain or collector pulling the $V_{FB}$ pin low causes

the top side P-channel MOSFET to turn on 100%, effectively shorting the output to the 5V input. If the open collector is turned off, the LTC1148 operates as a high efficiency buck mode power converter, delivering a regulated 3.45V to the load. For 3.3V applications a fixed 3.3V version of the LTC1148 is available.

**Table 1. Linear Regulators for 5V to 3.3V Conversion**

| LOAD CURRENT | DEVICE | FEATURES |
|---|---|---|
| 150mA | LT1121-3.3 | Shutdown, Small Capacitors |
| 700mA | LT1129-3.3 | Shutdown, Small Capacitors |
| 800mA | LT1117-3.3 | SOT-223 |
| 1.5A | LT1086 | DD Package |
| 3A to 7.5A | LT1083 LT1084 LT1085 | High Current, Low Quiescent Current at High Loads |
| 10A | $2 \times$ LT1087 | Parallel, Kelvin Sensed |

The topic of powering low voltage microprocessors in a 5V environment is covered extensively in Application Note 58, available on request. Both linear and switching solutions are discussed.
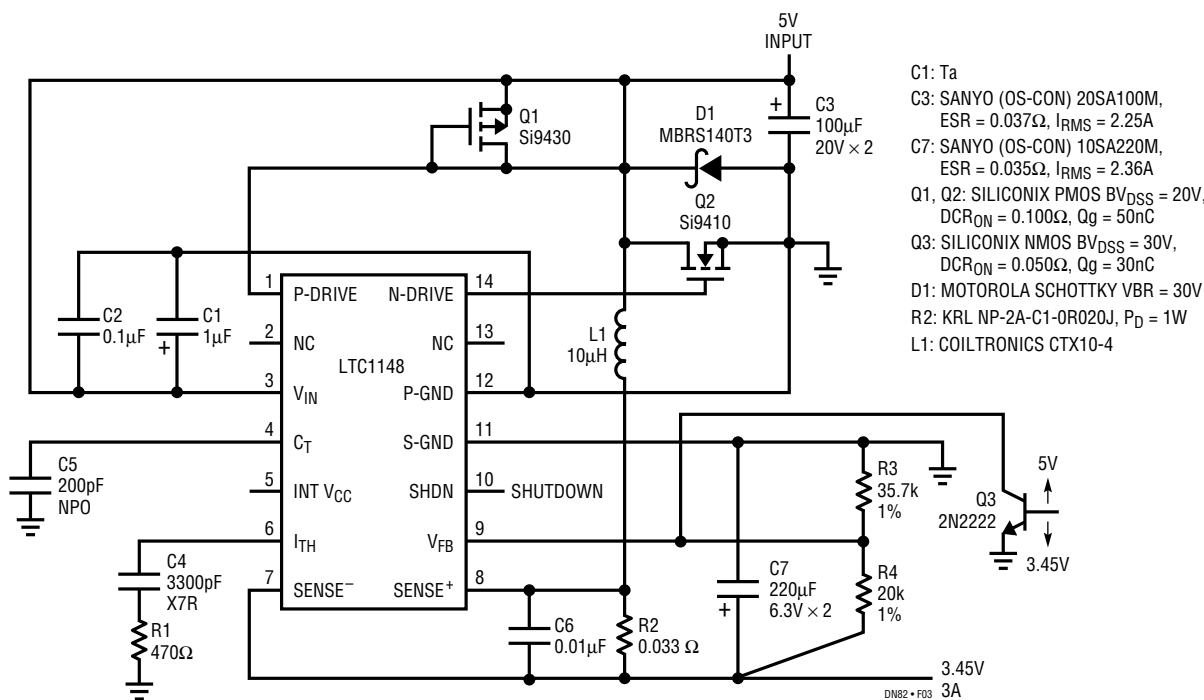


C1: Ta
C3: SANYO (OS-CON) 20SA100M, ESR = 0.037Ω, $I_{RMS}$ = 2.25A
C7: SANYO (OS-CON) 10SA220M, ESR = 0.035Ω, $I_{RMS}$ = 2.36A
Q1, Q2: SILICONIX PMOS $BV_{DSS}$ = 20V, $DCR_{ON}$ = 0.100Ω, Qg = 50nC
Q3: SILICONIX NMOS $BV_{DSS}$ = 30V, $DCR_{ON}$ = 0.050Ω, Qg = 30nC
D1: MOTOROLA SCHOTTKY VBR = 30V
R2: KRL NP-2A-C1-0R020J, $P_D$ = 1W
L1: COILTRONICS CTX10-4

**Figure 3**

For literature on our Linear Regulators, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 361

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