013

Power MOSFET Bridge Rectifier

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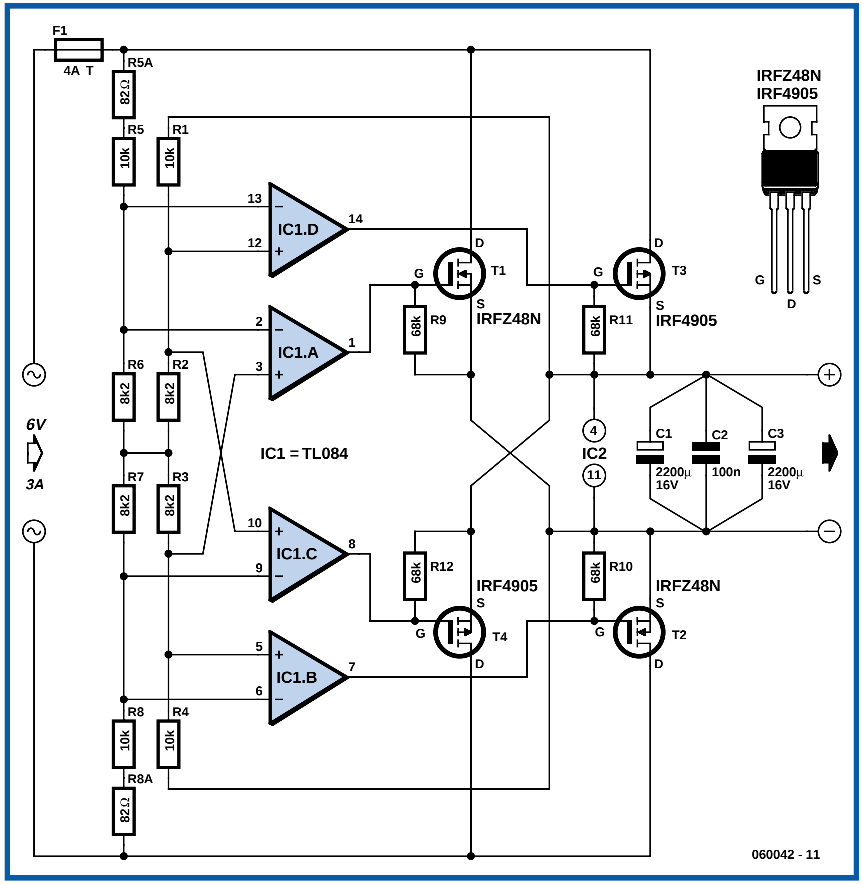
The losses in a bridge rectifier can easily become significant when low voltages are being rectified. The voltage drop across the bridge is a good 1.5 V, which is a hefty 25% with an input voltage of 6 V. The loss can be reduced by around 50% by using Schottky diodes, but it would naturally be even nicer to reduce it to practically zero. That's possible with a synchronous rectifier. What that means is using an active switching system instead of a 'passive' bridge rectifier.

The principle is simple: whenever the instantaneous value of the input AC voltage is greater than the rectified output voltage, a MOSFET is switched on to allow current to flow from the input to the output. As we want to have a full-wave rectifier, we need four FETs instead of four diodes, just as in a bridge rectifier. R1–R4 form a voltage divider for the rectified voltage, and R5–R8 do the same for the AC input voltage. As soon as the input voltage is a bit higher than the rectified voltage, IC1d switches on MOSFET T3. Just as in a normal bridge rectifier, the MOSFET diagonally opposite T3 must also be switched on at the same time. That's taken care of by IC1b. The polarity of the AC voltage is reversed during the



next half-wave, so IC1c and IC1a switch on T4 and T1, respectively.

As you can see, the voltage dividers are not fully symmetrical. The input voltage is reduced slightly to cause a slight delay in switching on the FETs. That is better than switching them on too soon, which would increase the losses. Be sure to use 1% resistors for the dividers, or (if you can get them) even 0.1% resistors.

The control circuit around the TL084 is powered from the rectified voltage, so an auxiliary supply is not necessary. Naturally, that raises the question of how that can work. At the beginning, there won't be any voltage, so the rectifier won't work and there never will be any voltage...

Fortunately, we have a bit of luck here. Due to their internal structures, all FETs have internal diodes, which are shown in dashed outline here for clarity. They allow the circuit to start up (with losses).

There's not much that has to be said about the choice of FETs – it's not critical. You can use whatever you can put your hands on, but bear in mind that the loss depends on the internal resistance. Nowadays, a value of 20 to 50 mW is quite common. Such FETs can handle currents on the order of 50 A. That sounds like a lot, but an *average* current of 5 A can easily result in peak currents of 50 A in the FETs. The IRFZ48N (55 V @ 64 A, 16 mW) specified by the author is no longer made, but you might still be able to buy it, or you can use a different type. For instance, the IRF4905 can handle 55 V @ 74 A and has an internal resistance of 20 mΩ.

At voltages above 6 V, it is recommended to increase the value of the 8.2-kΩ resistors, for example to 15 kΩ for 9 V or 22 kΩ for 12 V.

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