Technical Article

The Secret Life of MOSFET/IGBT Gate Drivers

Peter Meaney

While MOSFET/IGBT gate drivers are designed to drive capacitive loads at high frequencies with high peak currents of short duration, did you know that they can also drive inductive loads, such as power-relay coils? That's the secret life of a MOSFET/IGBT gate driver. This is not new concept. As they drive the inductive loads, they typically switch at much lower frequencies with drive currents limited by the coil resistance. Gate-drive ICs are already used to drive inductive loads such as gate-drive transformers, but at frequencies in the range of tens to hundreds of kilohertz.

With the increased use of power relays in automotive and industrial applications such as domestic electricity e-metering and smart grids, there is a need to be able to control high-power relays from microcontrollers. There are certain challenges towards doing this, all of which can be easily addressed by employing a gate driver. We'll talk about how gate driver devices can be used to control relays in this blog post.

Relay coils require much higher currents and voltages than a microcontroller can supply. In addition to providing power, it is also necessary to provide some form of level shift in terms of voltage to enable the microprocessor to control a high-power relay in applications such as e-metering.

The main function of a high-power latching relay is to safely connect and disconnect the power.

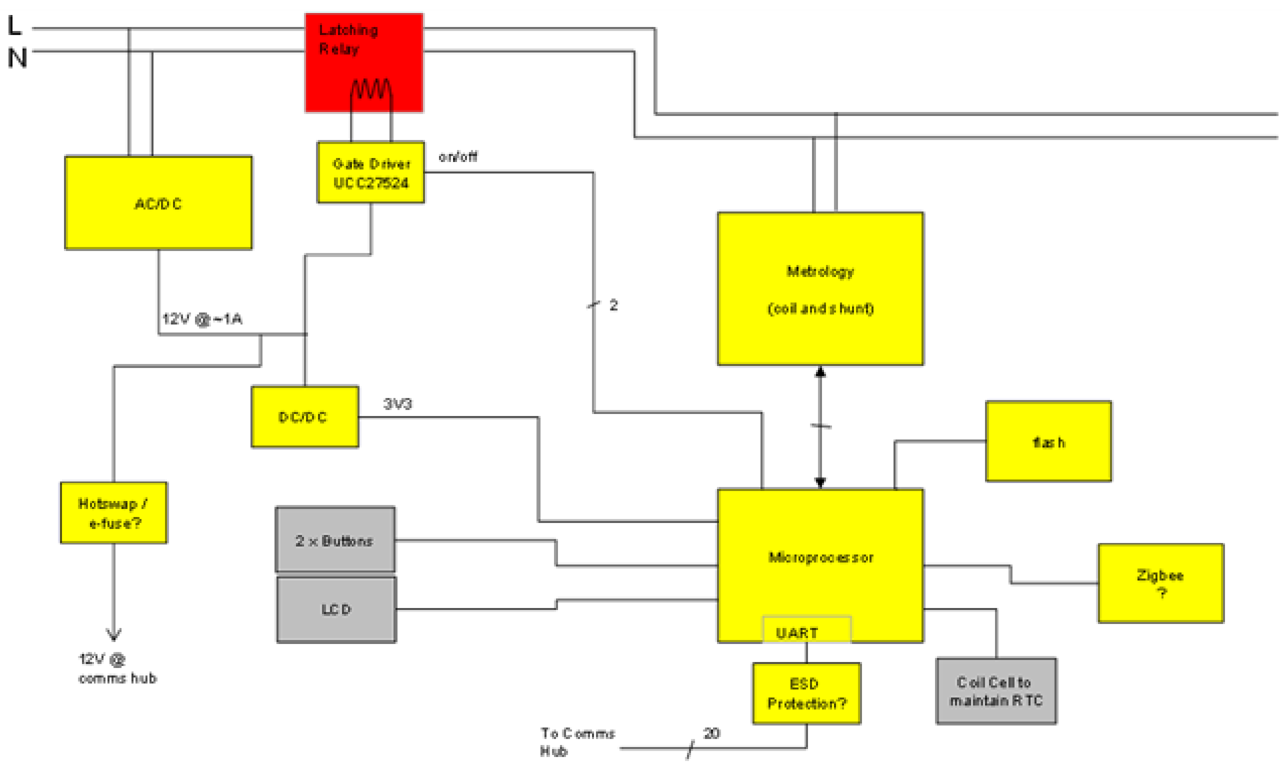
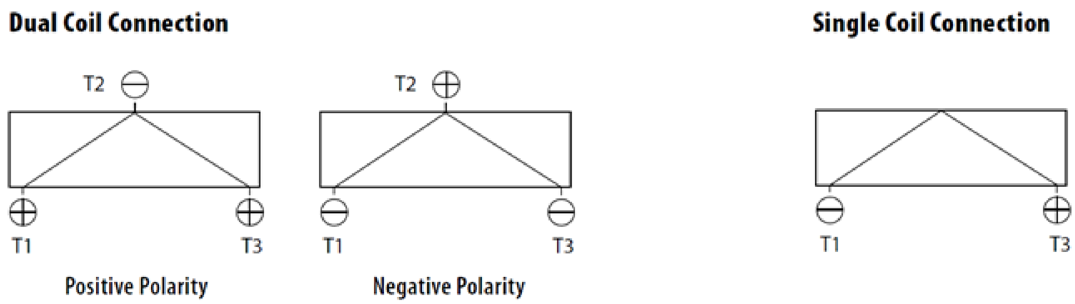


Figure 1. Single-phase E-meter

The UCC27524A is a dual-channel gate driver originally designed to drive capacitive loads in the form of MOSFETs and IGBTs. The device is capable of sourcing and sinking up to 5A peak for short periods. The Vdd range is 4.5V to 18V, allowing it to cover applications that use a 12V or 15V relay drive. The input pin thresholds are based on TTL (transistor–transistor logic) and CMOS (complementary metal-oxide semiconductor)-compatible low-voltage logic, which is fixed and independent of the supply-rail voltage. This allows direct interface to a microprocessor, and provides necessary level shift to drive the relay.

Let's look at how you can use the UCC27524A to drive a dual-coil latching relay like the K100. See Figure 2 & 3 for circuit details



Application Notes

Dual Coil – Positive Polarity: Place a negative connection on T2. Then apply a 50ms positive pulse to T1 to open the contacts or to T3 to close the contacts.

Dual Coil – Negative Polarity: Place a positive connection on T2. Then apply a 50ms negative pulse to T3 to open the contacts or to T1 to close the contacts.

Single Coil: Place a negative connection on T1. Then apply a 50ms positive pulse to T3 to close the contacts. Reversing polarity will open the contacts.

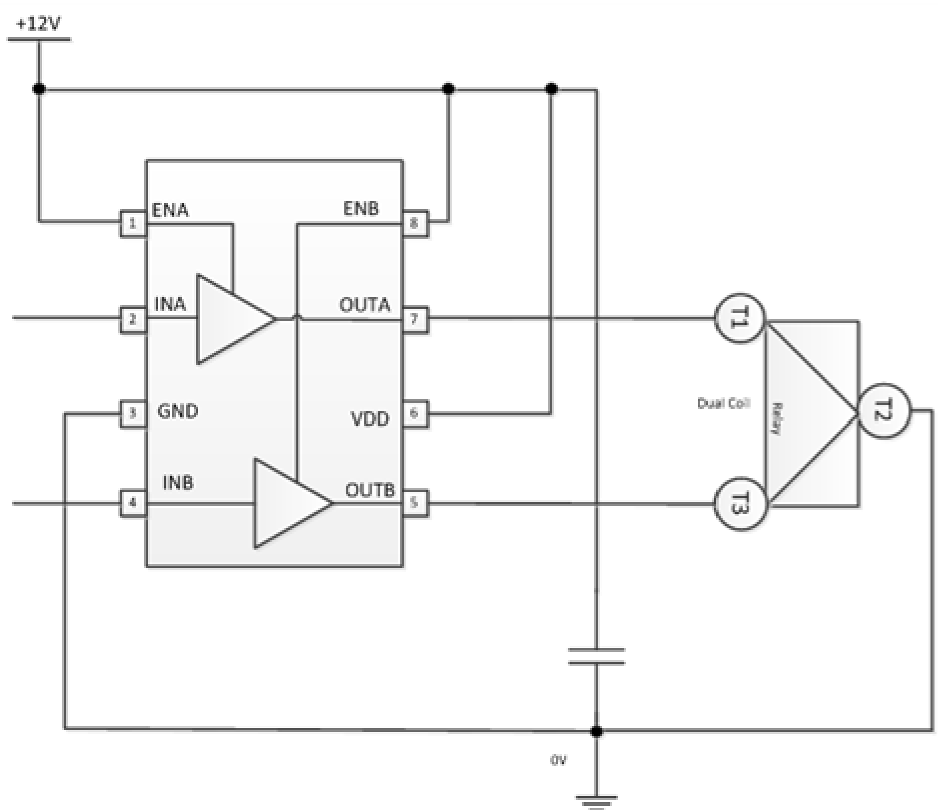


Figure 2. Simplified Schematic for Dual Coil Configuration Drive Circuit

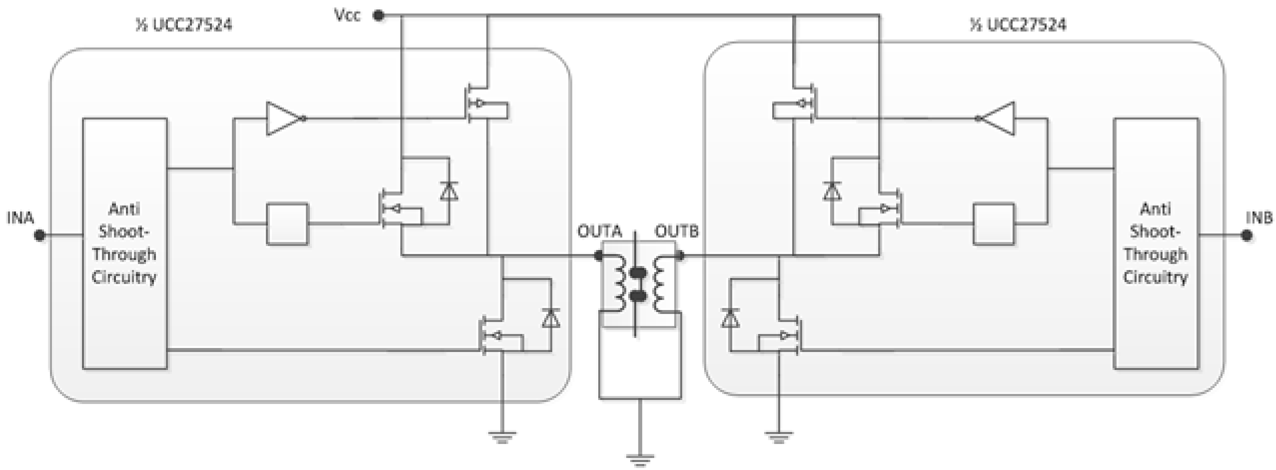


Figure 3. Dual-coil Configuration for a Latching Relay in E-metering Applications

I rigged up a simple test circuit to provide a 100ms-wide pulse to trigger the latching relay using the UCC25724A gate driver (Figure 4).

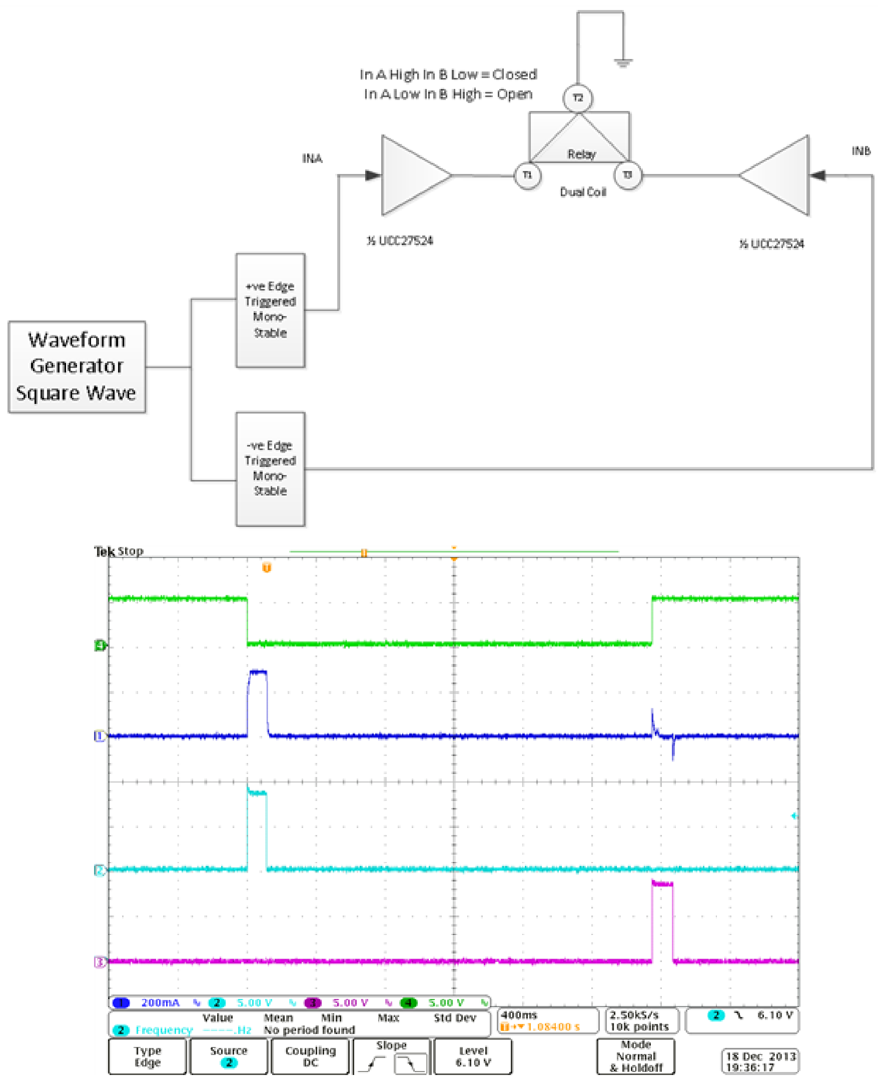


Figure 4. Test Circuit

K100 latching relay, 30R per coil
Ch1, Blue, Current OUTB
Ch2,Cyan, Voltage OUTB
Ch3, Pink, Voltage OUTA
Ch4, Green, Waveform Generator

Figure 5. Waveforms for Latching-relay Drive

Relay drives operate at low frequencies (sub 1Hz), with 20ms to 200ms durations like the waveforms shown in Figure 5 & 7. The coil resistance limits the peak current, and the operating voltage power dissipation is unlikely to be a concern. In addition, many gate-driver ICs are available with thermal-pad thermal management such as the MSOP-8 PowerPAD™ package.

The same concept applies to a single-coil latching relay:

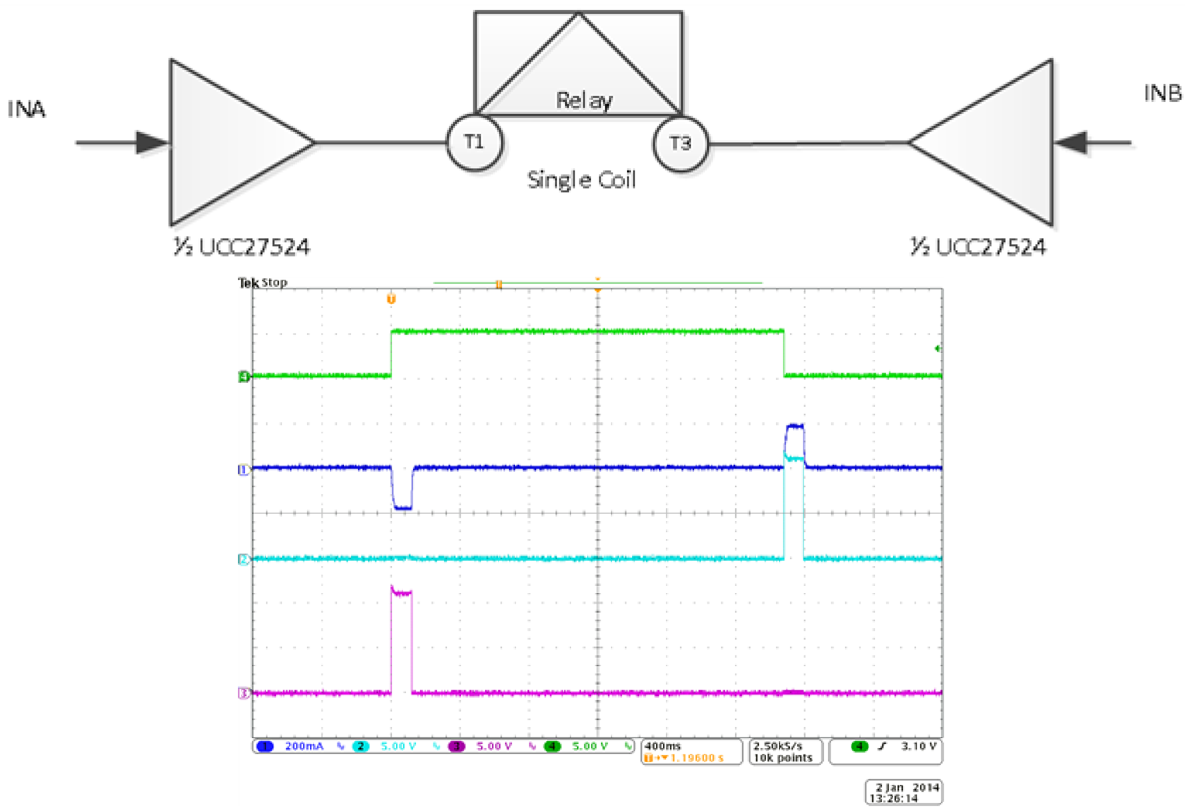


Figure 6. Simplified Schematic for Single Coil Configuration Drive Circuit

Single Coil Configuration
Ch1, Blue, Current OUTB
Ch2, Cyan, Voltage OUTB
Ch3, Pink, Voltage OUTA
Ch4, Green, INA & INB

Figure 7. Single-coil Configuration Waveforms

That's all there is to it: simplifying relay drive from microcontrollers using a MOSFET/IGBT gate driver. What alternative applications do you use MOSFET gate drivers for?

Additional Resources:

- Take a look at the UCD3138 digital resonant LLC converter evaluation module.
- Learn more about the UCC27524A MOSFET driver
- Simulate your UCC27524A design using PSpice and TINA-TI models

IMPORTANT NOTICE AND DISCLAIMER