

Application Note #5

Latching Relays

1 Latching relays in general

Latching relays are commonly used in low power consumption or high temperature applications where applying coil power for a long time cannot be afforded due to power consumption or selfheating of the coil. Instead of a continuous voltage applied to the coil, they are operated with short voltage pulses instead. Latching relays change contact position when a coil voltage is applied and remain in that position even if the voltage is disconnected. (it is common to use the term SET for operating a latching relay). To reset a latching relay another voltage pulse needs to be applied. There are two basic designs for latching relays on the market:

1.1 Mechanical latching relays

They have features like mechanical locks or gears inside keeping the contacts in the switching position. Mechanical latching relays are not very common in recent telecom and signal relay designs and can be disregarded

1.2 Magnetical latching relays

This design is being used for telecommunication and signal relays. The relays are polarized and use an internal magnet instead of mechanical springs to apply mechanical forces to the relay armature when no voltage is applied to the relay coil. For non-latching relays the magnets are magnetized in a way that the flux, generating the drop-out force is much stronger then the flux on the pull-in side. To operate the non-latching relay a voltage is needed to be applied on the coil and the current through the coil in generating an additional flux on the pull-in side and overpowers the magnetic force on the drop-out side of the relay.

For latching relays the magnet needs to be charged in a different way. Both sides, pull-in and drop-out are magnetized equally. To move the armature from one position to the other the magnet's force needs to be overpowered by the coil. Once the armature changed positions (SET) a flux in the opposite direction is necessary to switch the relay back (RESET). This can be done by changing polarity on the coil (single coil latching relays) or operating separate SET and RESET coils (dual coil latching relays) (Figure 1)

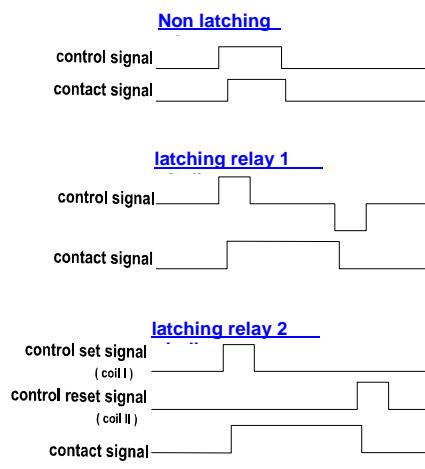


Figure 1: Coil and contact signals for latching relays

2 How to operate a latching relay

2.1 Single coil latching relays

2.1.1 Reverse voltage

This is the simplest way to operate a latching relay. Applying positive voltage by a push button set the relay. Applying the reverse polarity voltage by a push button reset the relay (Figure 2)

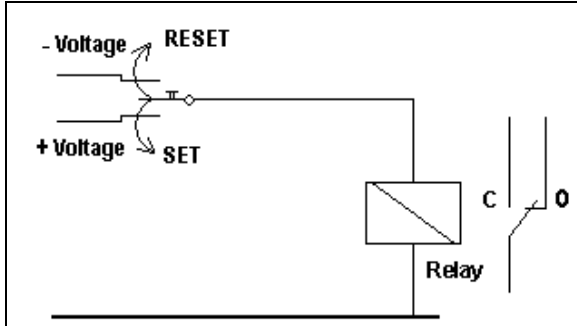


Figure 2: Simple latching relay circuit

2.1.2 "C"-circuit

A more advanced way to operate an one-coil latching relay is the "C"-circuit. A capacitor is used in the path of the relay coil.

The capacitor has to be discharged. If the voltage is applied to the coil, only the circuit's resistance limits the current (capacitor works like a short circuit). When the capacitor starts to be charged, the current decreases to almost zero (there might be a leakage current through the capacitor). The coil voltage can be applied all time, it is not necessary to pulse the relay. The almost zero current is responsible for the very low power consumption of the circuit (Figure 3).

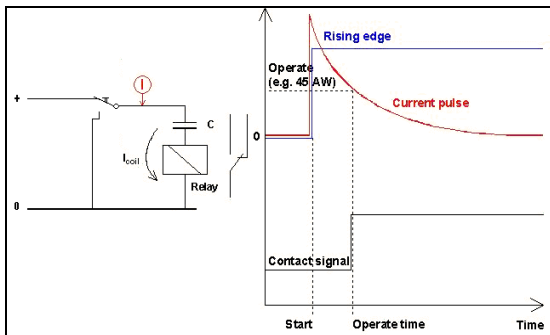


Figure 3: „C“-circuit – SET conditions

Resetting is very simple. The coil circuit needs to be opened and shortened to the coil's ground potential. The capacitor will be discharged through the coil and drives a current pulse with opposite polarity through the coil, that resets the relay (Figure 4).

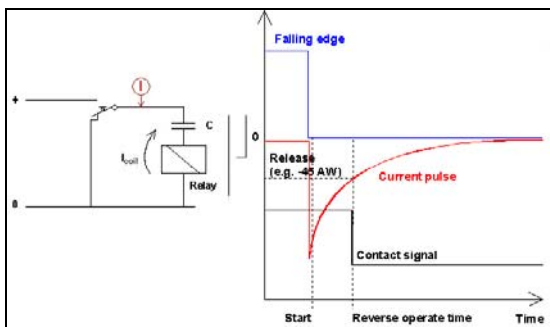


Figure 4: „C“-circuit – RESET conditions

Relay drivers can be used in those circuits instead of a switch. The circuit performance will be the same (Figure 5).

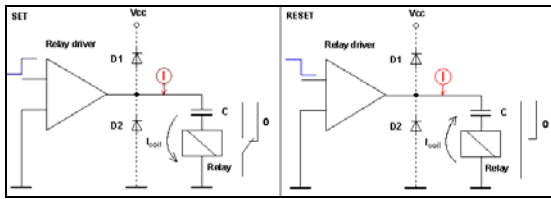


Figure 5: Circuits with relay drivers

The circuit capacity and timing is very important to drive the relay properly. Every relay has a certain operation time. A minimum magnetic force is necessary at this time to move the armature. This force is generated by the coil current. The capacitor has to allow that value of current within the operation time. Otherwise the relay might not pull through the armature.

The capacitor needs to be fully charged, too, to allow the maximum RESET current. During resetting, the discharge circuit should be closed until the capacitor is fully discharged. If not, the capacitor already has a certain resistance and there will be a lower current during the next relay set. The relay might not set.

An example for dimensioning the capacitor is shown in Figure 6 (simulation). The circuit has been simulated with a P2 relay (V23079C1111B301). The minimum value of the capacitor should be (Equation 1):

C_{min}: minimum capacitance

L: coil inductance

R_{coil}: coil resistance

$$C_{\min} > \frac{4 \cdot L}{R_{\text{coil}}^2}$$

Equation 1: Minimum capacitance

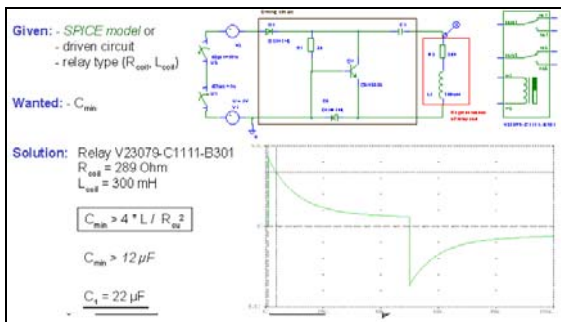
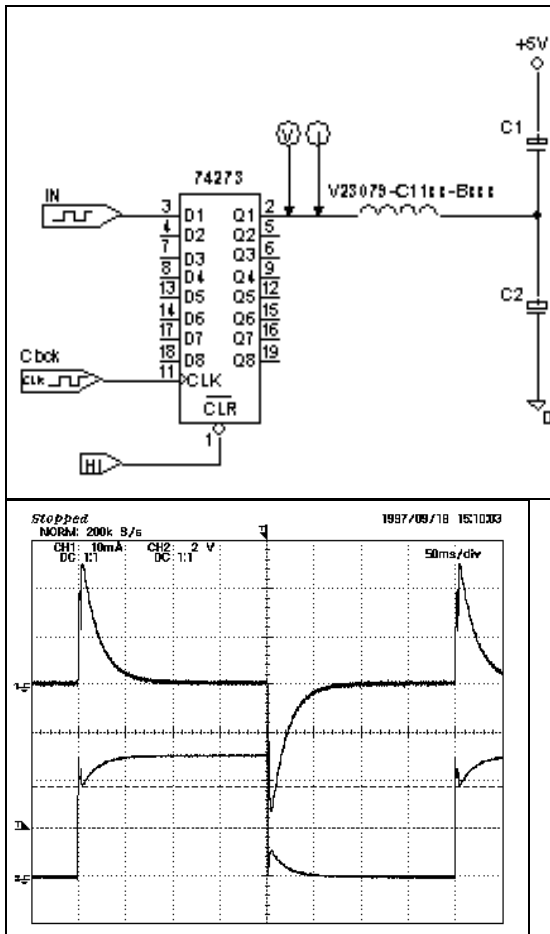


Figure 6: Capacitor calculation

2.1.3 IC-Circuit



2.2 Dual coil latching relays

Dual coil latching relays are being set and reset by two separated coils (Figure 7: Dual coil latching relay). Two independent circuits can drive the relay.

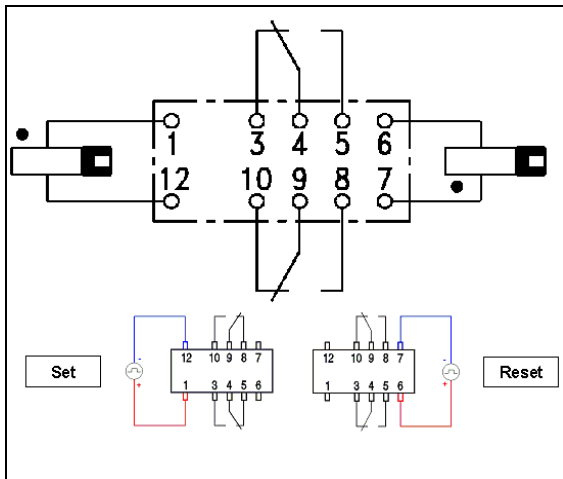


Figure 7: Dual coil latching relay

The unique feature of the Axicom P2 relay is, that no specific set or reset coil needs to be defined. In fact, both coils could operate the relay as single coil latching relays (Figure 8).

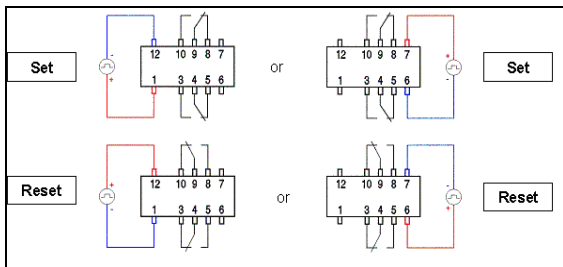


Figure 8: Variations of relay control

3 Remarks

Magnetic latching relays do not have the same armature forces than the non-latching counterparts during operation. Therefore, most of them are more sensitive against shock and vibration and probably have lower contact ratings. Some relays may change the armature position during transportation. It is recommended to RESET latching relays before testing or applying power to a circuit.