Questions to consider when selecting relays

When purchasing relay products there are several different technologies available. At times it can be confusing which type of relay to select.

To help make this decision, we'll review two primary types of relays, mention a third, and provide some questions that can be asked to determine which relays are best for your application.

The two major technologies of relays are Solid State Relays (SSR), and Electromechanical Relays (EMR). SSR come in high-side switching and low-side switching, while EMR can be divided into a variety of types. Some of them will be normally open (NO) and some normally closed (NC). EMRs can also be distinguished based on the number of "poles", "throws", and "forms".

High Side Switching SSRs:

High side SSRs are typically used in new installation applications so the load will only be connected to ground when it is not energized. This is the most common SSR type, and is the kind used on our PCI-IDIO-XX, PCI-IDO-XX, 104-IDIO-XX and USB-IDIO-XX series products.

Low Side Switching SSRs:

Low side SSRs are used mainly in legacy applications where the architecture is already established and switching to ground is required to energize a load. This is similar to open collector switching. The positive voltage of the system is always connected to the load (The load is always hot). This is inherently less safe than a high-side switched system. That's why new designs tend to use high side switches.

Single-Throw EMRs:

A single-throw relay has an output (NO), an input (common), and a control line that connects or disconnects the input to the output when commanded. If the input is connected to the output by default, even if the power is off, this type of relay is a Form A relay. If the input is disconnected while the power is off, it is a Form B relay.

Double-Throw EMRs:

A double-throw relay has two outputs, an input (common), and a control line. One output is the "Normally Open" (NO) output; the other is the "Normally Closed" (NC) output. While power is removed the input will be connected to the NC output pin. This is known as a Form C relay, and the connection between the input and the output is broken before the new connection is made during switching (break-before-make).

A word about Poles:

Relays can have any number of Poles, from one on up. A Pole is simply another set of input/output pins that cannot be controlled separately - all Poles of the same relay share a single control line.

Advantages of SSRs over EMRs:

- Faster than EMRs, generally taking only microseconds to activate/deactivate vs milliseconds for EMRs
- Higher reliability, as there are no moving parts
- Output resistance remains constant regardless of type or amount of use
- "bounceless" operation. EMRs' physical component typically experiences "contact bounce" introducing a type of noise into the output signal for a short time after switching
- Cannot generate a spark, important in combustible environments
- Silent, no physical contact clicking

• Less sensitive to storage and operating environmental factors such as shock, vibration, humidity, and external magnetic fields
• Higher extended temperature range (-40C to +85C)

Disadvantages of SSRs vs EMRs:

• Voltage/current characteristic of semiconductor rather than mechanical contacts:
• When closed, SSRs have higher resistance (generating heat), and increased electrical noise.
• When open, SSRs have lower resistance, and reverse leakage current (typically, in μA range)
• SSR characteristics are not linear (not purely resistive), distorting switched waveforms to some extent. An electromechanical relay has the low ohmic (linear) resistance of the associated mechanical switch when activated, and the exceedingly high resistance of the air gap and insulating materials when open.
• Some types of SSRs have polarity-sensitive output circuits, meaning they can't switch AC
• SSRs have the possibility of spurious switching due to voltage transients (due to much faster switching than mechanical relay)
• Higher transient reverse recovery time (TRR) due to the presence of Body diode
• SSRs tend to fail "shorted" on their outputs, while EMR contacts tend to fail "open".

In addition to the SSR and EMR we've discussed above, EMR are available in an additional technology: "reed relay." Reed relays use a very different internal mechanical architecture, consisting of two small, parallel, contact reeds inside a coil. When the coil activates, the reeds are pressed together; when the coil deactivates, the reeds' internal springiness pulls the reeds apart. Because the distance and sizes of the mechanical parts are smaller, reed relays are faster than typical Form C relays. However, they are more susceptible to failure over time and tend to fail "closed".

So, with this information, here are questions we ask:

• How will the relays be used in the application?
• What are they connected to?
• How often will they be actuated?
• If in the more than 100k of operations, the SSRs are preferred
• Will the system be battery powered?
• Form C might be preferred as the leakage current of the SSRs might be an issue
• What temperature range do the relays need to operate in?
• Form C relays are typically limited to -40C through +70C
• What voltage needs to be switched?
• How much current does the relay need to carry?
• Some of our relays handle up to 1 amp, some handle up to 2 amps
• If using SSRs, will the load be connected to VCC (Low-side) or to Ground (High-Side)?
• Do they need debounced operation? (SSR preferred)