Lower Noise Raises the Bar for Solid State Relays

The Crydom LN Series illustrates how SSRs generate less EMI noise.

The Crydom LN Series of solid state relays. (Image courtesy of Sensata.)

What's the difference between electromechanical relays and solid-state relays, and which one provides better electromagnetic interference (EMI) performance?

The answer: solid-state relays are the way to go. In this article, we'll take a look at solid state relays (SSRs), why they offer lower EMI noise and what applications they're best suited for.

Types of Relays

Relays are electrically operated switches used to control a high power electrical device (e.g. when the load current is higher than 10 A). Relays control high power loads by using low-power signals (typically 3 to 32 volts DC). For example, a 5 V microcontroller output can turn on/off a 2,400 W load.

There are two common types of relays: electromechanical relays (EMRs) and solid-state relays (SSRs).

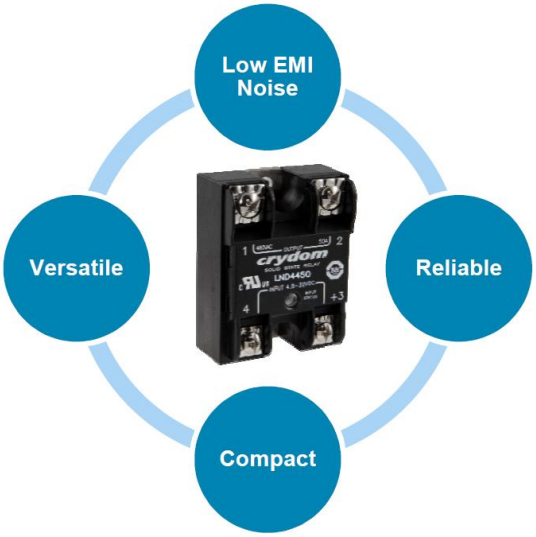
Unlike electromechanical relays, solid-state relays have no moving parts or mechanical contacts. Instead, they use semiconductors such as SCRs (silicon-controlled rectifiers), TRIACs (triodes for alternating current) or switching transistors for output.

Solid-state relays provide significant advantages over traditional electromechanical relays. SSR design enables completely silent switching and provides complete electrical isolation between input and output contacts. SSRs have a very low resistance when conducting and very high

(almost infinite) resistance when not conducting. Additionally, SSRs are much faster and smaller than their EMR counterparts.

Since they do not have mechanical contacts, SSRs do not have contact-wear issues and have a longer lifespan and high reliability than EMRs. SSRs are usable in combustible environments because their operation does not cause sparking. They are also immune to mechanical shocks as well as vibration, humidity and external magnetic fields.

The main drawback of solid-state relays is their vulnerability to overloads and relatively higher output on-resistance than electromechanical relays. The price of SSRs is also higher than EMRs.



Advantages of SSRs over EMRs. ((Image courtesy of Sensata.)

We'll look at the latest SSR technology through the example of the Crydom LN Series of SSRs, which are panel mounted SSRs that offer back-to-back SCR switching up to 75 Amps at 528 VAC, coupled with a patented trigger circuit design.

SSRs for Low EMI Noise

For many applications, it is crucial to have as little electromagnetic interference as possible. Generally, solid-state relays produce significantly lower EMI noise compared to electromechanical relays. SSRs use silicon-controlled rectifiers (SCRs), semiconductor devices triggered into a conduction state by applying a control signal into its gate terminal. The triggered SCR remains in the ON state (conducting the current) until the anode current decreases below the minimum SCR latch current. This means that the SCR switches off at a low current value, generating significantly less EMI noise compared to a typical switch.

However, this generates a low amount of EMI noise only in the case of low switching currents. Higher currents and pure resistive loads still result in high EMI noise that is unacceptable for many applications.

The market offers low noise SSRs, but these are usually limited to a low switching current (e.g. 5 A) or only low inductive loads, while pure resistive loads still have high emission noise.

The Crydom LN Series SSRs provide switching to resistive loads with a current rating up to 75 A in standard panel mountable hockey-puck style, without the need for an additional filter.

The LN (Low Noise) series includes a patented low noise circuit design to minimize EMI noise. This feature is important in a wide range of commercial, residential and medical applications that require compliance with low emission standards, such as IEC60947-4-3 Environment B. To comply with the low emission standards, devices must pass radio frequency tests. The test results for the Crydom LN Series are shown below.

<table>
<tr><td rowspan="5">IEC60947-4-3 Environment B Low voltage domestic, commercial and light industrial installations</td><td rowspan="5">Conducted Disturbances CISPR 11</td><td>Frequency, MHz</td><td>Quasi-peak, dB(uV)</td><td>Average, dB (uV)</td><td rowspan="5">Class B Group 1 & Group 2</td></tr>
<tr><td>0.15 – 0.5</td><td>66 – 56</td><td>56 – 46</td></tr>
<tr><td>0.5 – 5</td><td>56</td><td>46</td></tr>
<tr><td>5 – 30</td><td>60</td><td>50</td></tr>
<tr><td colspan="3">240VAC, 40A & 440VAC, 35A with resistive load</td></tr>
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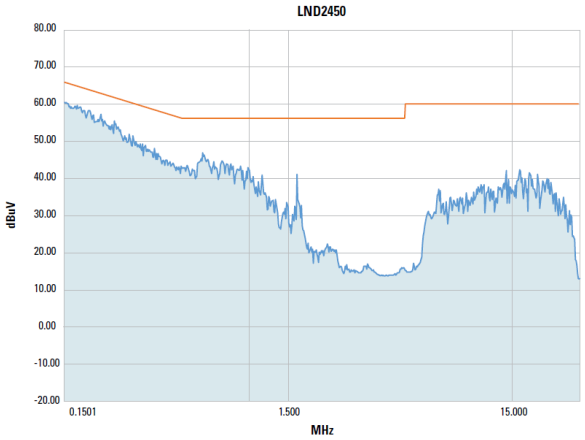

Radio frequency emission test for Crydom LND2450 SSR. (Image courtesy of Sensata.)

The low noise SSRs provide both zero-voltage switching on and zero-current switching off, reducing the EMI noise to a negligible amount. They switch on at the zero-crossing point of the sinusoidal AC signal, reducing high inrush currents when switching inductive/capacitive loads (the load current starts from a point close to 0 V). The AC load is switched off at the point of zero current, eliminating arcing and electrical noise because of the inherent zero current switch-off feature of the thyristor or TRIAC.

Once the input signal is removed, the SSR continues conducting until the current drops below its threshold value. A maximum possible switch-off delay (from the moment of input signal removal to the moment of the load current removal) is one-half cycle. The load current is never

switched-off in the middle of a sine wave peak. This is very important for inductive loads; otherwise, large voltage spikes can appear.

How to Select SSRs

To choose the right SSR for an application, designers should understand their design, operation, and specifications. The application requirements (input, output, load, noise level, thermal situation, etc.) must also be taken into consideration to ensure a successful design.

The Crydom LN Series is a suitable option for applications that require compliance with low emission standards, especially medical devices and professional culinary equipment (because of the need for precise, safe, and intelligent operation). The LN Series includes integrated protection such as input/output overvoltage protection. For harsh environment applications, there is an optional IP20 safety cover. The Sensata LN series is UL recognized and TUV certified.

The Crydom LND2450C SSR with an IP20 safety cover. (Image courtesy of Sensata.)

Applications for Low EMI Noise

The Crydom LN Series of SSRs offers unique features for products in medical, commercial and household equipment applications.

For example, hemodialysis machines are specialized medical devices that filter human blood when necessary. The function of SSRs in hemodialysis machines is to heat the fresh dialyzing solution from a tank. The typical power of a heating element is usually in the range of 1 to 1.5 kW. The switching current of SSRs is less than 25 A, which enables the SSRs to be mounted on a PCB with the backplate exposed to ambient air. Hemodialysis machines require very low EMI emissions to avoid affecting any nearby equipment.

The LN Series SSRs are a suitable solution for hemodialysis machines because they offer very low EMI emission, fast switching for good temperature control, a long lifespan, integrated overvoltage protection, PCB mounting and compliance with the IEC60947-4-3 Environment B standard for low voltage domestic, commercial and light industrial locations/installations.

Typical low noise SSRs applications are medical devices and professional culinary equipment.

For applications demanding low EMI performance, solid-state relays are the best option, and the latest Crydom LN Series aims to make them even better.