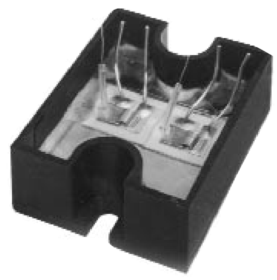
Solid State Relays
General Information

Types of SSRs

Control input
In most SSRs galvanic separation is achieved by optocouplers. These optocouplers, equipped with integrated trigger circuit (optotriac), provide the switching function required for the corresponding load type.

We distinguish between:

- ZS: Zero Switching
- IO: Instant-on Switching
- PS: Peak Switching
- AS: Analog Switching
- DCS: DC Switching
- FS: Full Cycle Switching



Type

Zero Switching SSR (ZS)
For resistive, inductive or capacitive loads

Instant-on Switching SSR (IO)
For inductive loads

Description

Zero Switching SSR (ZS)

When applying the control voltage, the AC SSR output is activated at the first zero crossing of the line voltage. The response time is hereafter less than a halfperiod, i.e. typically below 10 ms at 50 Hz.

ZS SSRs are employed in a host of applications with resistive loads (temperature control) and control of incandescent lamps. The ZS types are the most commonly used SSRs due to their extensive use with plastic moulding machines, packing machines, soldering machines as well as machines for the food processing industry.

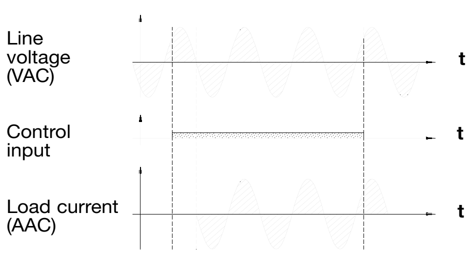
ZS SSRs are used in various applications, such as interfacing resistive loads or lighting installations. Due to high surge current- and blocking voltage capabilities, SSRs of this switching type will also perform successfully with most inductive and capacitive loads.

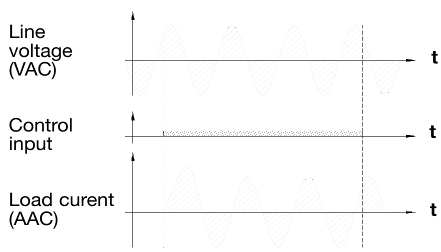
Instant-on Switching SSR (IO)

The SSR output is activated immediately after applying control voltage. Consequently, this relay can turn on anywhere along the AC sinusoidal voltage curve. The typical response time is thus less than 1 ms. (Relays equipped with reed contacts are inherently instant-on types.)

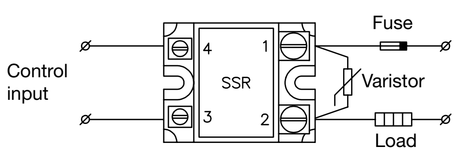
This SSR is particularly suitable in applications where a fast response time or phase angle control is desired.

Function

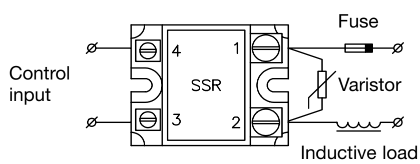




Application



Note: For SSR without integrated voltage protection



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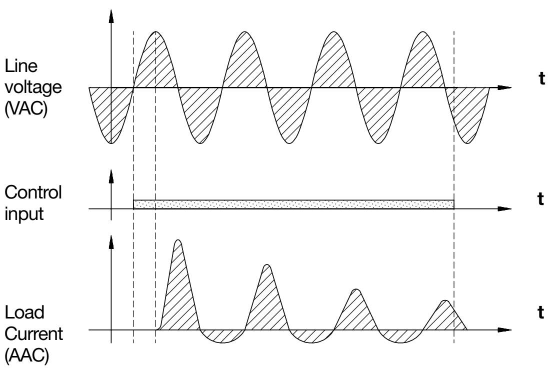
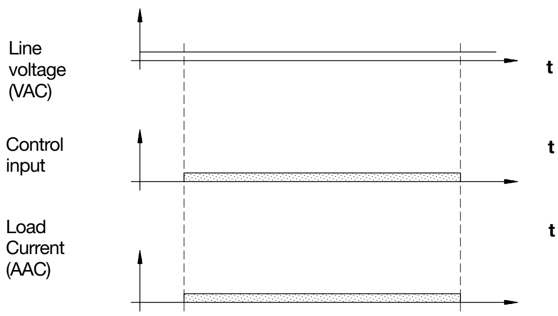
Types of SSRs (cont.)

<table>
<tr><td>Type</td><td>Peak Switching SSR (PS)
For inductive loads with remanent iron core</td><td>DC Switching SSR (DCS)
For resistive and inductive loads</td></tr>
<tr><td>Description</td><td>The peak switching SSR is designed in a way that the power output is activated at the first peak of the line voltage upon application of the control voltage. After the first half period the PS SSR operates as an ordinary ZS relay. The peak of the inrush current could hereafter be reduced during the first half-period for inductive loads.</td><td>The power semiconductor in the DC switching relay operates in accordance with the control input status. The response time is less than 100 µs.

DCS SSRs are used with resistive and inductive loads for the control of DC motors and valves.

When switching inductive loads it will be necessary to interconnect a free wheeling diode surplus voltage parallel to the load as protection.</td></tr>
<tr><td>Function</td><td>
</td><td>
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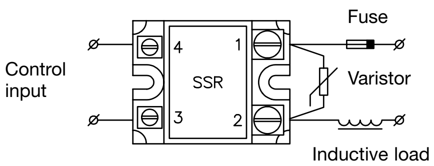
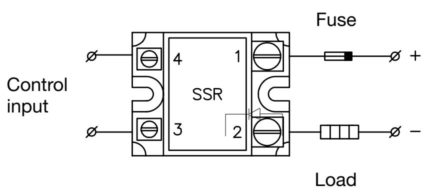
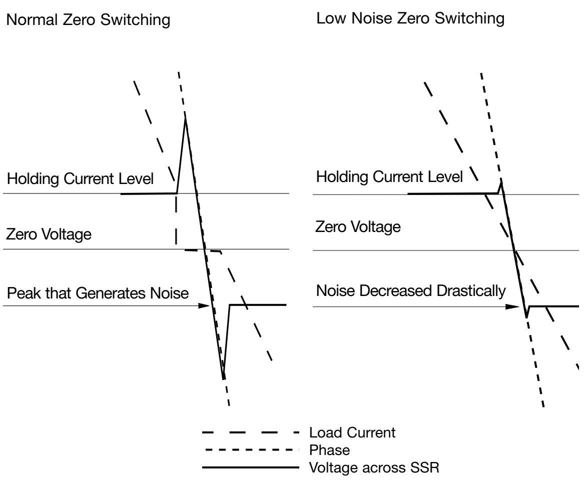
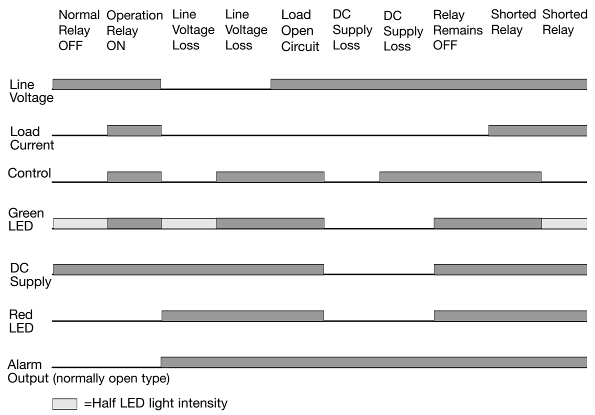
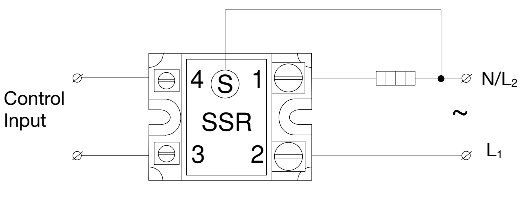
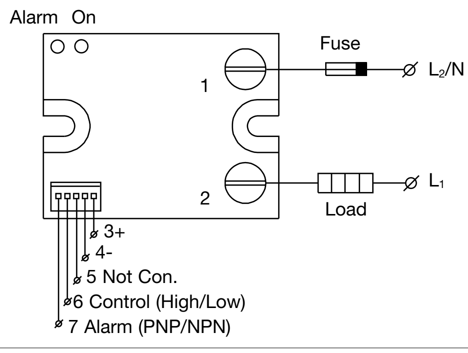
<tr><td>Application</td><td>
</td><td>
</td></tr>
</table>

Types of SSRs (cont.)

	Low Noise SSR (LN)	System Monitoring SSR (SM)
Type	**Low Noise SSR (LN)** For resistive and inductive loads	**System Monitoring SSR (SM)** For resistive and inductive loads
Description	The Low Noise SSR is designed for light industrial environments and fulfills the generic emission standard EN50081-1. By controlling the switching mode of the semiconductors, the peak level of the zero voltage turn-on is minimised, thus reducing the noise emitted by the SSR. Low Noise SSRs are particularly suitable for applications where electromagnetic noise must be limited to avoid interference with other equipment. In this kind of environment, noise generated by standard SSRs is considered critical or unsafe. Low noise SSRs can be used with both resistive and inductive loads.	The system monitoring (sense) SSR provides an alarm output in the event of a circuit failure. Internal circuits monitor: - line voltage - load current - correction functioning of the SSR - SSR input status. The relay is designed for applications where immediate fault detection is required. An alarm output signal is available to determine fault status.
Function		
Application	 Note: Connection "S" does not apply to SSRs with integrated heatsink	

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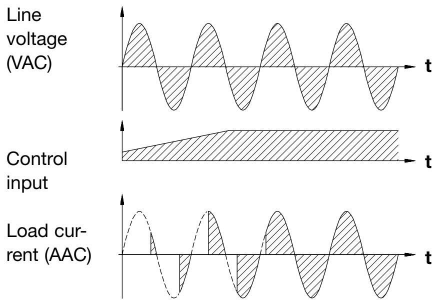
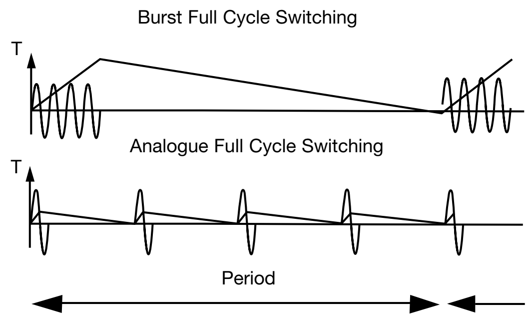
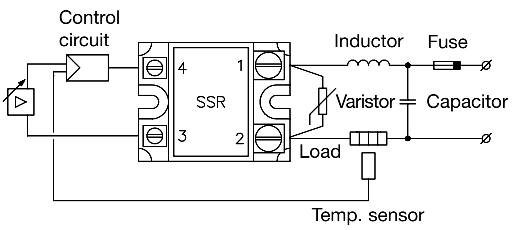
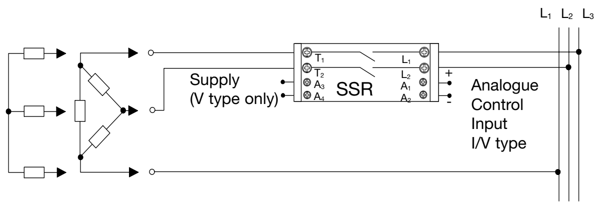
Types of SSRs (cont.)

Type	**Analog Switching SSR (AS)** For resistive, inductive or capacitive loads	**Full Cycle SSR (FC)** For resistive loads
Description	Since the control input of the analog relay - according to specifications 4 to 20 mADC - can be varied, the output operates in accordance with the phase control principle. The relay is equipped with a built-in synchronization circuit in order to achieve phase angle control. The output is proportional to the input voltage or input current. The transfer function is linearized and reproducible. These SSRs are highly advantageous in closed loop applications or where soft starting can limit high inrush currents.	The Full Cycle SSR uses an analogue switching principle that provides a number of full cycles that are evenly distributed over a fixed time period. The number of cycles switched during the time period is directly proportional to the control input applied to the SSR. Since the full cycles are distributed, this SSR provides high accuracy in temperature control and creates less noise. Compared to conventional Burst control, the Full Cycle SSR reduces the stress on the load by limiting the band within which the load cycles.
Function		
Application		

Power output
Depending on the application, various questions concerning the power output of the SSR need to be clarified. The most important parameters are

- Line voltage (load voltage)
- Load current
- Type of load (application)

in order to be able to select the correct SSR. To avoid unnecessary maintenance expenses, the selection needs to be as accurate as possible.

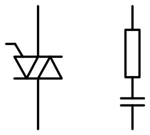
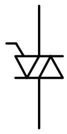
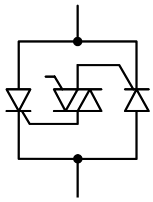
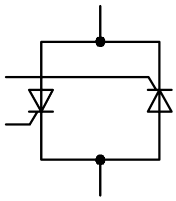
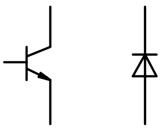
Line voltage
The voltage range of an SSR must be selected according to the line voltage in the application. For the non-repetitive peak transient voltage of the SSR, both transients from the mains and voltage peaks from the application need to be considered.

A corresponding protective element like a freewheeling diode (only DC), a varistor or a snubber (RC) can be incorporated in order to protect the output semiconductor.

Load current
The relay must be selected in a way that the continuous load current in the application does not exceed the corresponding nominal value of the relay. It is important to take into consideration the continuous load current in relation to the ambient temperature. With inductive loads, such as motors, valves, etc., the SSR must be sized or selected according to the highest expected surge current.

Solid State Relays
General Information

Types of SSRs (cont.)

Load switching component	Symbol	Application
Triac The triac consists of two antiparallel thyristors mounted on the same chip in order to give full-wave operation at a single gate. A snubber is often mounted across the SSR in order to reduce the dV/dt.		The triac SSR is the most cost-effective solution in applications with low dV/dt demands, e.g. applications with heating elements with almost constant resistance.
Snubberless Triac The snubberless triac is a further development of the triac in which the two thyristors on the chip are well separated. Consequently, a higher dV/dt capability is achieved. In this way the internal snubber can be eliminated.		The snubberless triac is one of the latest improvements from semiconductor manufacturers. The elimination of the snubbers also reduces the leakage current in the switching circuit. The snubberless triac is common in resistive and inductive applications (up to 25 A) .
Alternistor The alternistor is developed especially for industrial use. The alternistor consists of two antiparallel thyristors and a gate triac integrated in the same chip. The thyristors are well separated. The triac will block uncontrolled turn-on during commutation.		The alternistor output is widely used in SSRs for resistive and inductive loads.
Thyristor (SCR) The antiparallel thyristor solution is most common for industrial SSRs. The solution requires two separate SCRs and two trigger circuits, which give optimum dV/dt capability.		The antiparallel SCR SSR is used for all load types, such as resistive, inductive and even capacitive loads. An SCR in a diode bridge is only used in PCB relays with load currents of less than 2 A.
Transistor The transistor option - often the open collector configuration - is used in the DC SSRs. A free-wheeling diode is normally mounted across the transistor to avoid damage from back-EMV from inductive loads.		The transistor is used for DC loads such as DC motors, solenoids or valves.

Advantages and Limitations

SSRs offer the user many outstanding features and should be treated as a separate class of relay. However, due to the design of SSRs, the user is always faced with a few limitations which are different from those of electromechanical relays (EMR). The following outline of advantages and limitations of SSRs will serve as a guide to the professional use of these devices.

Advantages

* Long life and high reliability - more than 10^9 operations
* No contact arcing, low EMI, high surge capability
* High resistance to shock and vibration
* High resistance to aggressive chemicals and dust
* No electromechanical noise
* Logic compatibility
* Fast switching
* Low coupling capacitance

Long life and high reliability
In SSRs from Carlo Gavazzi an optimized thermal design is achieved by applying the "Direct Copper Bonding" technology. This technology finally eliminates the thermal fatigue between chip (silicon) and terminals (copper). Furthermore, it reduces the thermal resistance between junction and ambient.

The DCB substrate, on which the chip is soldered, consists of a ceramic insulator (Al_2O_3) with a layer of copper (Cu) on both sides. The copper is bonded with the ceramic material in order to get similar thermal expansion conditions for both materials. Thereby the mechanical stress between silicon chip and copper will be minimized while the relay is in operation.

The ceramic material provides a 4 kV insulation between copper leads and heatsink. A lower temperature difference (ΔT) on the junction will increase the lifetime of the relay, and an increase of the switching frequency can help to achieve a more reliable application.

No contact arcing
No contact arcing will occur since switching takes place inside the semiconductor material, which changes from a non-conductor to a conductor at the signal of the control input. Line and load radiation are reduced considerably because the SCRs, alternistors or triacs are basically current latching devices, which will turn off as soon as the current is near zero. This is known as "zero crossing turn off". This greatly reduces the radiated electromagnetic interference (EMI), and this reduction of EMI is often well received by the equipment designers.

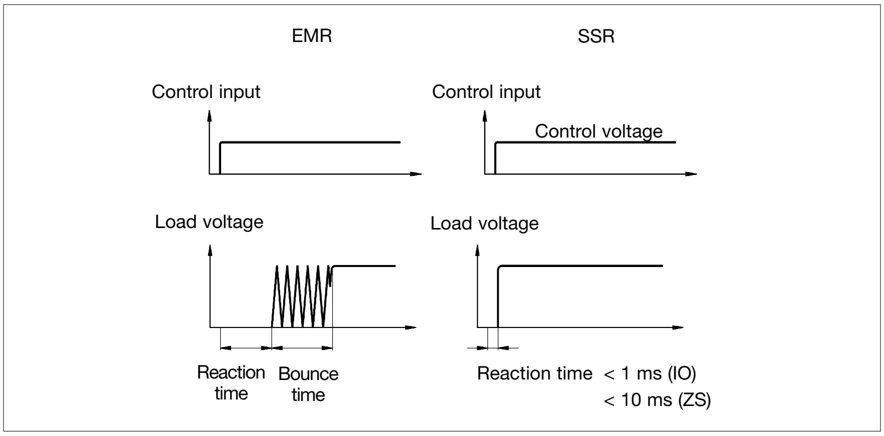
High resistance
SSRs with optocoupler inputs are fully embedded in the housing material and consequently, since no moving parts are used, they are highly resistant to vibrations and shock.

Advantages and Limitations (cont.)

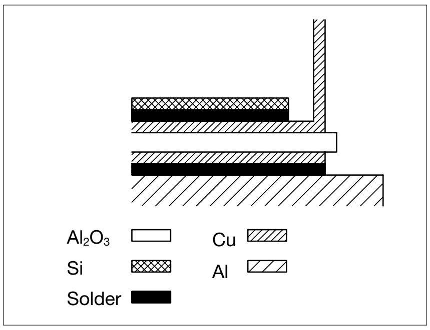
High resistance to aggressive chemicals and dust
Neither sand, dust nor aggressive chemicals can disrupt the trouble-free operation of a Solid State Relay.

No electromechanical noise
SSRs do not create mechanical noise since everything is controlled entirely electronically. In applications such as office machinery or in medical equipment this is for the benefit of the user.

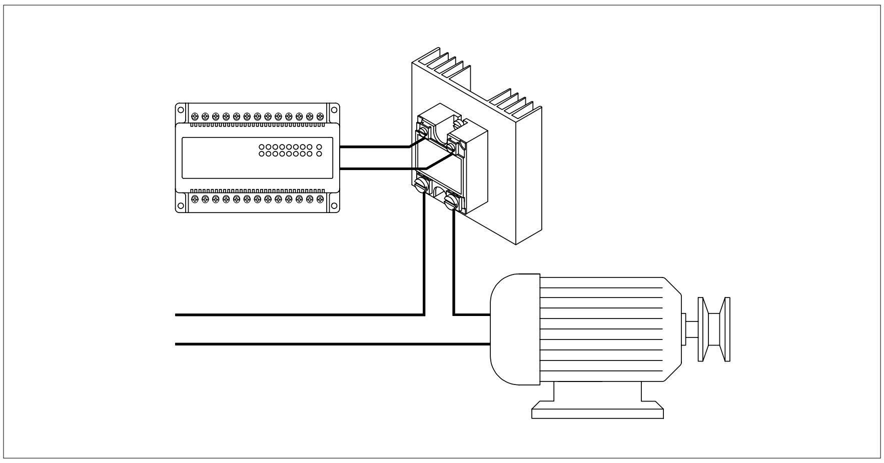
Logic compatibility
SSRs are available with input circuits which are directly compatible with logic components for CMOS, TTL, microprocessors or analog circuits.Logic compatibility is important since SSRs are often directly controlled by PLCs or other logic outputs. High-current SSRs can be driven with minimal currents of less than 10 mA @ 24 VDC.



Switching characteristics of EMR and SSR



The direct copper bonding technology



Logic compatibility to PC/PLC

Fast switching
Instant-on SSRs feature a turn-on time of less than 1 ms. This fast switching capability makes it possible to phase angle control the power output by means of an external control circuit. In the analog switching relay this function is already built-in.

Low coupling capacitance
The very low coupling capacitance between input and output of SSRs is inherent in the optocoupler used in most SSR designs. The resulting lower off-state leakage current is important in medical applications, office machinery, household appliances or in industrial applications.

Limitations

* Contact voltage drop
* Finite transient voltage resistance and dV/dt limitations
* Leakage currents and dI/dt limitations

Contact voltage drop
The contact voltage drop across the thyristor is usually 1 to 1.6 V. Voltage drop together with load current are basic figures for the calculation of the power losses. Excessive heat can easily destroy the power semiconductor. It is therefore indispensable to calculate the power dissipation and to use adequate heatsinking.

Finite transient voltage resistance
The AC mains contains all kinds of voltage spikes and transients. These transients may result from other components like motors, solenoids, switches, transformers or contactors - not to mention external sources such as lightning.

If overvoltage protection is not provided, the thyristors used in SSRs might exceed their breakdown voltage and will turn on for less than a halfperiod. The non-repetitive peak voltage is the maximum off-state voltage which the output switching device can withstand without switching on.

Whenever they are not built-in, varistors for transient voltage protection should be fitted across the output. The varistors must be rated for the line voltage in the application. The energy absorption of a disc varistor is always proportional to its size. Therefore it is recommended to use varistors with a diameter of minimum 14 mm for PCB SSRs and 20 mm relays for chassis mounting.

Limitations due to rapid voltage change
The junction of any semiconductor exhibits some capacitance. An alternating voltage imposes capacitance on this junction, which results in a current where I = C x dV/dt.

If this current is sufficiently high, a regenerative action may occur causing the SCR to turn on. This regenerative action is similar to the gate turn-on.

The expression "dV/dt" defines a voltage change in relation to time. It is usually given in volts per microsecond (V/µs).

Solid State Relays
General Information

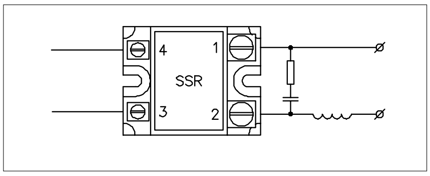
Advantages and Limitations (cont.)

Off-state dV/dt
The off-state dV/dt is the parameter defining the voltage rise capability of the SSR, i.e. the max. allowable rate of increase in voltage across the output terminals which will not switch on the SSR. Typically it lies within the range of 100 to 1000 V/µs.

Commutating dV/dt
The dV/dt is expressed in volts per microsecond (V/µs) and indicates the rate of voltage rise which the SSR output switching device can withstand without being turned on again as long as the load is off. The commutating dV/dt rating of an SSR is a measure of its ability to switch off an inductive load.

With the current crossing zero and turning off the load, the voltage rise across the output semiconductor could, due to too high dV/dt, immediately turn on the SSR (without applying control voltage). Consequently, with inductive loads, where the phase shift between current and voltage is large, the chance of an exceptional dV/dt value is very high.

Snubber
With a high load inductance, a very common method to eliminate random firing through interference, or spontaneous refiring through commutating dV/dt, is to connect an RC network, known as "snubber", across the SSR terminals. The capacitance (C) in conjunction with the impedance of the load attenuates the voltage waveforms transmitted via the mains or occuring when switching on an inductive load.



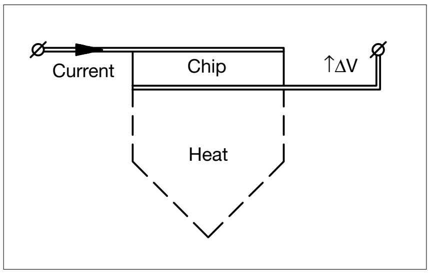
Snubber circuit

Standard values are:
R < 100 Ω, C < 0.22 µF.

Most of the modern SSRs from Carlo Gavazzi have such a high dV/dt capability that the snubber can be eliminated.

Off-state leakage current
SSRs always have off-state leakage currents. The thyristors, control circuitry and snubber network all supply small off-state currents, which usually total from about 1 to 10 mA rms.

These leakage currents should be taken into account when either indicators are

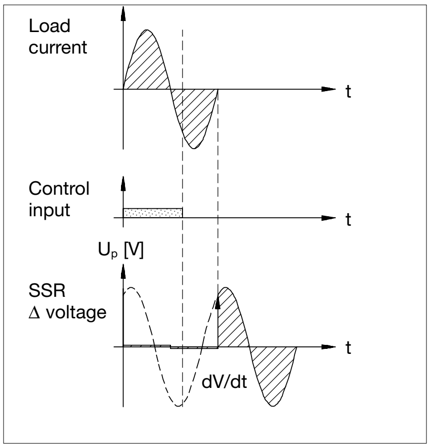


Heat dissipation from contact voltage drop

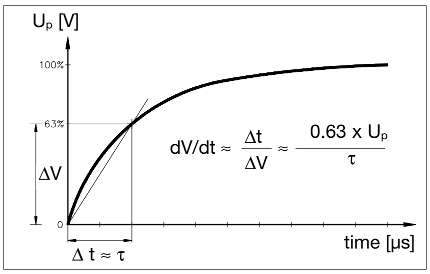
used, or the circuit may actually be touched, say for servicing. A resistor across the indicator and a line safety breaker are the standard means by which these limitations can be overcome.

dI/dt limitation
The rate of rise of current (dI/dt) is normally assumed to be low compared with the time required for the thyristor to reach full on-state conduction. In installations there is a certain amount of inductance which limits the rate of rise of current. In the SSR data sheet the dI/dt is given. The dI/dt usually lies within the range of 10 to 100 A/µs. The necessary inductance can be calculated as follows:

The inductance of the load, the supply and all power cables in between need to be considered as well.



The dV/dt caused by phase shift



Rate of rise of voltage - the dV/dt

Remedies

In order to achieve proper function and a reliable application the user should consider:

1. A heatsink to remove the dissipated power

2. A varistor to protect against overvoltage transients

3. A fuse to limit current passing through the SSR thus resulting in:
a. short-circuit protection
b. overload protection

4. Self-induction in the system must be sufficiently high, in order to limit dI/dt.

5. A circuit breaker to disconnect mechanically the SSR application from the mains (safety measure).

Solid State Relays General Information

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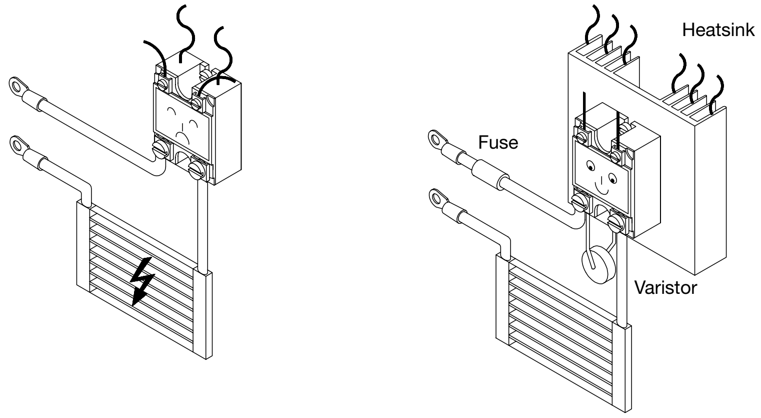
Application

When looking for a relay to solve your switching application requirements, you should consider the advantages of SSRs and how to deal with the limitations.



When installed properly, the Solid State Relay will last millions of operations

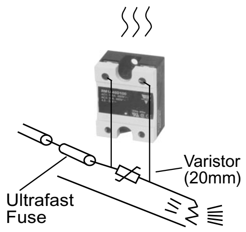
A. Heating systems
Electric ovens
Soldering systems
Plastic processing systems
Galvanic systems (electro-plating)
Film developing systems
Packaging industry
Rubber industry
Cooking systems

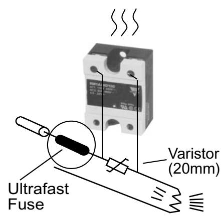
B. Optical equipment and systems
Photocopiers
Light equipment
Traffic light controls

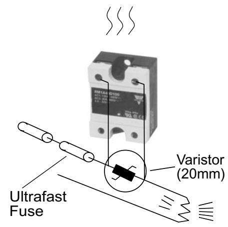
C. Electric motor drives
Position control X-Y
Valve positioning
Soft starting, braking, reversing

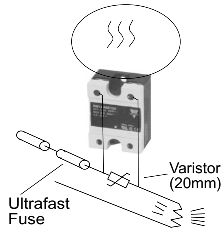
D. Transformer supply
Welding equipment
Light systems with transformer supply

Important matters to be observed when installing an SSR:









1. General Information

Load current, line voltage, ambient temperature and load type are crucial factors when using Solid State Relays. It is necessary to carry out a critical analysis of the application and perform proper calculations when using all Carlo Gavazzi Solid State Relay products.

2. Overload Protection

The relay must be protected against overload (short-circuit) by means of an external semiconductor fuse. Carlo Gavazzi provides the basic calculation to help you select the right fuse.

3. Voltage Transient Protection

Ideal protection is achieved through varistors (metal oxide varistors) mounted across the power semiconductor. The varistor voltage has to match with the line voltage in your application. Wrong selection can cause limited protection or a hazardous situation. On a number of models, the varistor is already mounted internally.

4. Overheat Protection

The relay must be protected effectively against excessive heat. Thermal stress will reduce the lifetime of your SSR drastically. Therefore it is necessary to choose the appropriate heatsinks, taking into account ambient temperature, load current and duty cycle. A thin film of thermally conducting compound will reduce the thermal resistance between the relay and the heatsink.

Solid State Relays General Information

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Insulation

Insulation resistance (output to case)

This is the rated insulation and, consequently, when the SSR is mounted on an external heatsink, the heatsink must be connected to protective earth (PE).

Insulation resistance (input to output)
Depending on the applied input voltage, the input voltage insulation is either **reinforced** or **rated insulation**.

A. When the input voltage is ≤ 25 VACrms or ≤ 60 VDC, there is **reinforced insulation** between input and output. This means that the input voltage can either be PELV (protected extra low voltage, PE connected) or SELV (special extra low voltage, unprotected).

B. When the input voltage is higher than the voltages defined under A and ≤ 50 VAC or ≤ 120 VDC, there is **reinforced insulation** between input and output. This means that the input voltage can be FELV (functional extra low voltage, PE connected).

C. When input voltages are higher than those mentioned under A and B, they are regarded as line voltage inputs and, consequently, there is only **rated insulation** between input and output in this case.

Protective earth connection (PE)
Where protective earth (PE) is connected to the input, either of the two input terminals can be used. In the case of heatsink mounting versions the heatsink must be connected to protective earth (PE) due to the rated insulation. This procedure is in accordance with IEC 60204-1, EN 60204-1, VDE 0113T1 and other important international application standards.

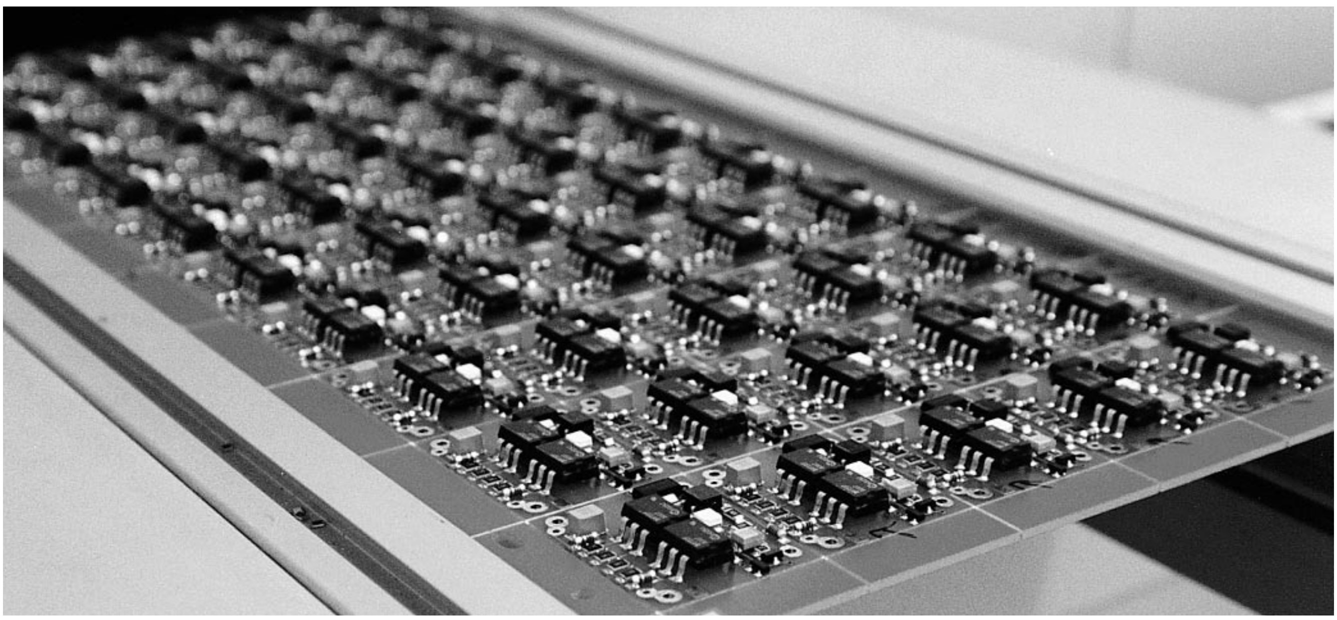
Electrical build-up
Safety regarding clearance, creepage and insulation barriers is based on the latest international coordination standards IEC 60664, 60664-1.

Insulation

Rated insulation voltage Input to output	≥ 4000 VACrms
Rated insulation voltage Output to case	≥ 2500 VACrms
Insulation resistance Input to output	≤ 10^{10} Ω
Insulation resistance Output to case	≤ 10^{10} Ω
Insulation capacitance Output to case	≤ 8 pF
Insulation capacitance Input to output	≤ 50

Insulation resistance output to case
Dielectrical strength and insulation resistance, capacitance from output to case (heatsink).

Insulation resistance input to output
Dielectrical strength and insulation resistance, capacitance between input and output.



Solid State Relays
General Information

General Specifications

General Specifications

Operational voltage range	24 to 280 VACrms
Non-rep. peak voltage	≥ 650 Vp
Zero voltage turn-on	≤ 20 V
Operational frequency range	45 to 65 Hz
Power factor	≥ 0.5
Approvals	CSA, UL, CUL VDE, TUV

Approvals
CSA, UL, CUL VDE, TUV

Standards
To ensure the widest possible scope of application in electrical equipment and machinery, Carlo Gavazzi's SSRs are designed in accordance with the following standards:

IEC 60158-2, 60204-1, 60947-1, 60947-4,60529
CSA C.22.2.14
UL 0508, 0840
VDE 0805, 0750, 0700

USA, Underwriters Laboratories Inc.
(UL 508 & UL 840)

Canada, Canadian Standards Association
(C 22.2 NO 14)

Germany, Verband der Elektronik Informationstechnik e.v.
(VDE 0805, 0700, 0750)

Germany, Rheinland/Berlin - Brandenburg
(VDE 0805, 0700, 0750)

Housing Specifications

Material
Housings and potting compound are UL-approved and flame, heat and impact resistant.

Housing Specifications

Weight	Approx. 110 g
Housing material	Noryl GFN 1, black
Base plate	Aluminium
Potting compound	Polyurethane
Relay Mounting screws Mounting torque	 M5 ≤ 1.5 Nm
Control terminal Mounting screws Mounting torque	 M3 x 6 ≤ 0.5 Nm
Power terminal	

Material
Housings: Noryl GFN 1
Potting compound:
Polyurethane.

Protection against electric shock
Terminal protection against direct contact.

Degree of protection (IEC 60529)
IP 00 Non-protected
IP 10 Back-of-hand protected
IP 20 Finger-protected

The technical specifications of the degree of protection are in accordance with IEC 60529 (IEC 60947-1).

CARLO GAVAZZI

Rated operational load current and Standards

Output Specifications

Rated operational load current		
AC1	@Ta=40°C	25 A
	@Ta=50°C	21 A
	@Ta=60°C	18 A
AC3	@Ta=40°C	4 A
Zero crossing detection		Yes

Standards

according to IEC 60947-4-1, EN60947

Standards according to IEC 60947-4-1, EN60947

Type of Current	Utilization Category	Typical Applications I = Making current Ic = Breaking current Ie = Rated operational current U = Voltage before make Ue = Rated operational voltage Ur = Recovery voltage	Ie	Make			Break		
				I / Ie	U / Ue	Cos j	Ic / Ie	Ur / Ue	Cos j
AC current	AC-1	Non inductive or slightly inductive loads, resistance furnaces	All values	1	1	0.95	1	1	0.95
	AC-3	Squirrel-cage motor: Starting, switching off during running	Ie ≤17A Ie ≥17A	6 6	1 1	0.65 0.35	1 1	0.17 0.17	0.65 0.35
	AC-4	Squirrel-cage motor: Starting, plugging, inching	Ie ≤17A Ie ≥17A	6 6	1 1	0.65 0.35	6 6	1 1	0.65 0.35
	AC-53b	Control of squirrel cage motors with the control bypassed during running	Ie ≤100A Ie ≥100A	8 8	1.05 1.05	0.45 0.35	8 8	1.05 1.05	0.45 0.35
				I / Ie	U / Ue	L/R	Ic / Ie	Ur / Ue	L/R
	DC-1	Non-inductive or slightly inductive loads, resistance furnaces	All values	1	1	1	1	1	1
DC current	DC-3	Shunt-motors: starting, plugging, inching. Dynamic braking of d.c. motors	All values	2.5	1	2	2.5	1	2
	DC-5	Series motors: starting, plugging, inching. Dynamicbraking of d.c. motors	All values	2.5	1	7.5	2.5	1	7.5
				I / Ie	U / Ue	Cos j	Ic / Ie	Ur / Ue	Cos j
	DC-13	Control of d.c. electromagnets	All values	1	1	6P*	1	1	6P*

* The value "6P" results from an empirical relationship which is found to represent most d.c. magnetic loads to an upper limit of P = 50W, viz. 6 x P = 300ms. Loads having power-consumption greater than 50W are assumed to consist of smaller loads in parallel. Therefore, 300ms is to be an upper limit, irrespective of the power-consumption value.

Solid State Relays
General Information

CARLO GAVAZZI

Norms

Carlo Gavazzi products are designed in accordance to both CE and various third party norms. Typical third party approval bodies are UL, CSA, VDE and TUV. Whereas the CE mark is self regulatory, the other approvals are governed by third party test labs.

CE is divided into 2 separate sections; the EMC directive and the LVD directive. The following is a list of EMC generic norms which Carlo Gavazzi Solid State Relays are designed in accordance with:

EN 50081-1	EMC - Generic Emission Standard Part 1 : Residential, Commercial and Light Industry
EN 50081-2	EMC - Generic Emission Standard Part 2 : Industrial Environment
EN 50082-1	EMC Generic Immunity Standard Part 1 : Residential, Commercial and Light Industry
EN 61000-6-2	EMC - Generic Immunity Standard Part 2 : Industrial Environment

These generic emc norms give a list of limits which our products must reach when tested according to the various tests. These tests are done according to the following norms:

EN 61000-4-2	Electrostatic discharge immunity test
EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4	Electrical fast transient / burst immunity test
EN 61000-4-5	Surge immunity test
EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields
EN 55011 / 22	Radiated and conducted electro magnetic emission
IEC 68-2-6	Vibration test

Apart from EMC norms, our products are also designed according to the Low Voltage Directive norms. Solid state relays are designed in accordance with some of the following:

EN 60947-1	Low Voltage switchgear and controlgear. Part 1 – General Rules
EN 60947-4-1	Low Voltage switchgear and controlgear. Part 4 – Contactors and motor starters. Section 1 – Electromechanical contactors and motor starters.
EN 60947-4-2	Low Voltage switchgear and controlgear. Part 4 – Contactors and motor starters. Section 2 – AC semiconductor motor controllers and starters.
IEC 529	Degrees of protection provided by enclosures.
HD 419.2S1(BS5424-2)	Low-voltage control gear – Specification for semiconductor contactor.
IEC 664-1	Insulation coordination for equipment within low voltage systems. Part 1 – Priciples, requirements and tests.
IEC 664-3	Insulation coordination for equipment within low voltage systems. Part 3 – Use of coatings to achieve insulation coordination of printed board assemblies.

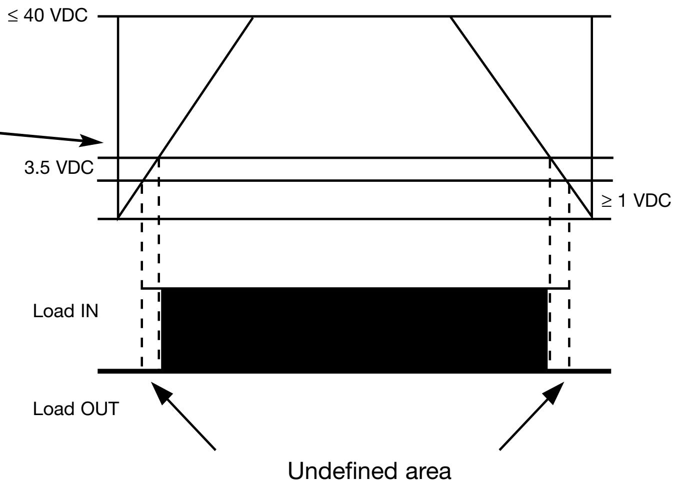
Apart from the LVD norms, other third party approval bodies also require the device to be constructed in accordance to their own norms. The UL approval requires the device to be according to UL508 (Industrial control equipment) and UL840 (Insulation Coordination including clearance and creepage distances for electrical equipment). The CSA approval require conformity to C22.2 No 14-95 (Industrial Control Equipment – Industrial Products). VDE and TUV approvals are given in accordance with EN 60950 (VDE 0805) – Safety of information technology equipment, EN60335-1 (VDE 0700) – Safety of household and similar electrical appliances. Part1- General requirements, EN60601-1 (VDE 0750) – Medical Electrical Equipment. Part 1- General Requirements for safety.

Solid State Relays
General Information

Control voltage

Input Specifications

Control voltage range	3.5 V to 40 VDC
Pick up voltage	≤ 3.5 VDC
Drop out voltage	≥ 1 VDC
Reverse voltage	≤ 0 VDC
Response time pick up	≤ 1/2 cycle
Response time drop out	≤ 1/[illegible]
Input current (through current limit[illegible]	



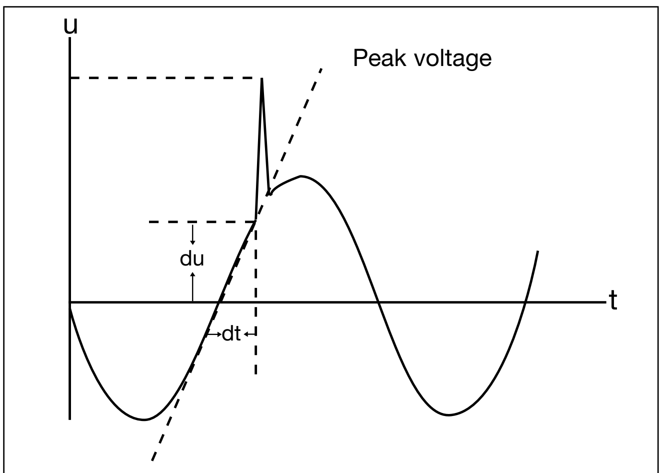
General Specifications

	RAP 40 A .	RA
Operational voltage range	10 V to 440 VAC_{rms}	20 V
Non-rep. peak voltage	≥ 1000 V_S	≥
Zero voltage turn-on	≤ 20 V	
Operational frequency range	45 to 65 Hz	
Power factor	≥ 0.2	
Approvals	CSA, UL, VDE	

Operational voltage range
The voltage range within which correct operation by the SSR is possible (rms-value).

Non-rep. peak voltage
When this voltage limit is exceeded, the SSR will switch through without being triggered.

Transient Voltage Suppression



AC voltage with transient overvoltage protection

As prescribed by the standard DIN VDE 0160, electrical equipment in power installations must ensure undisturbed operation for 1.3 ms in case of a transient overvoltage, which may be up to 2.3 x nominal voltage. The max. allowable operational voltage is thus dependent on the non-repetitive peak voltage.

Solid State Relays
General Information
Heatsink Selection

The max. thermal resistance from the backplate of the SSR to ambient (R_{thSA}) is calculated for different current levels and different ambient temperature values.

These calculations are given in a chart as shown below (fig. 1). The table also includes the calculated power dissipation at a given nominal current.

Important notice:

Use silicone-based thermal grease between heatsink and SSR. If non-silicone thermal grease is used, you should check if the chemical replacing the silicone is harmful to the material used in the SSR housing. Recommended silicone-based types: Dow Corning.

Example:

Current = 20 A resistive load

$T_{ambient}$ = 50° C (measured in the panel when the system is running)

Selected relay: RM1A40D25

In the chart (fig. 1) the maximum thermal resistance for the heatsink is found to be 2.18 K/W.

In the heatsink selection table (fig. 2) the standard heatsink with the next lower thermal resistance is selected. This is RHS 45B with R_{thSA} = 2.00 K/W.

RM....25

Load current [A]	Thermal resistance [K/W]						Power dissipation [W]
25	2.70	2.34	1.98	1.61	1.25	0.89	28
22.5	3.10	2.69	2.28	1.86	1.45	1.04	24
20	3.61	3.13	2.65	2.18	1.70	1.23	21
17.5	4.26	3.70	3.14	2.59	2.03	1.47	18
15	5.14	4.47	3.80	3.14	2.47	1.80	15
12.5	6.38	5.56	4.73	3.91	3.09	2.27	12
10	8.25	7.19	6.14	5.08	4.02	2.97	9
7.5	11.4	9.94	8.49	7.04	5.59	4.14	7
5	17.7	15.4	13.2	11.0	8.74	6.51	4
2.5	-	-	-	-	18.2	13.6	2
T_A Ambient temp. [°C]	20	30	40	50	60	70	

Fig. 1

Together with the calculation charts for the different SSR families the standard heatsinks of the Carlo Gavazzi product range are also given for easy selection:

Carlo Gavazzi Heatsink (see Accessories)	Thermal resistance...	...for power dissipation
No heatsink required	---	N/A
RHS 300	5.00 K/W	> 0 W
RHS 100	3.00 K/W	> 25 W
RHS 45A	2.70 K/W	> 60 W
RHS 45B	2.00 K/W	> 60 W
RHS 90	1.35 K/W	> 60 W
RHS 45A plus fan	1.25 K/W	> 0 W
RHS 45B plus fan	1.20 K/W	> 0 W
RHS 112	1.10 K/W	> 100 W
RHS 301	0.80 K/W	> 70 W
RHS 90 plus fan	0.45 K/W	> 0 W
RHS 112 plus fan	0.40 K/W	> 0 W
RHS 301 plus fan	0.25 K/W	> 0 W
Consult your distribution	> 0.25 K/W	N/A
Infinite heatsink - No solution	---	N/A

Fig. 2

Thermal protection

For the 3-phase SSRs, e.g. the RZ .. 25.., it is possible to mount a temperature limit switch, UP 62 -.., for thermal protection of the relay.

The charts for the 3-phase SSRs are calculated in such a way that the chip temperature lies within the specification. In order not to exceed these limitations one can easily mount a temperature switch (Klixon) at the back of the relay near the built-in heatsink.

The TLS can be ordered for three different temperature ranges. The standard selections are 70, 80 and 90°C.

Solid State Relays
Technical Information

CARLO GAVAZZI

Introduction
The demands upon modules applied as interfaces between open or closed loop controls and loads is growing steadily within industrial automation as well as for machines and in building automation. The modules must guarantee increased reliability, additional features or, due to their switching frequency, increased production throughput.

This means that in numerous applications where electromechanical relays together with protective components used to be installed, power semiconductor devices with corresponding protective electronic circuits, so-called SOLID STATE RELAYS (SSRs), are used.

Carlo Gavazzi has a dedicated manufacturing plant for Solid State Switching products

Reliability
An SSR does not incorporate any mov-ing parts in the load switching circuit and is therefore insensitive to shock and vibration. As long as it is not exposed to excessive thermal stress, an SSR will outlast an electromechanical relay by millions of operations.

Features
High-quality optocouplers ensure galvanic separation between control input and power output. The switching function of the SSR, which is to be selected according to the load type, is either integrated in an optotriac or made by a combination of classic components together with an optocoupler. In order to increase the noise immunity in certain applications (motor control/electronic reversing), reed relays are incorporated as interfaces between control input and power output. Apart from a very long lifetime (> 10 million operations), the reed relay features a high blocking voltage of ≥ 2000 Vp.

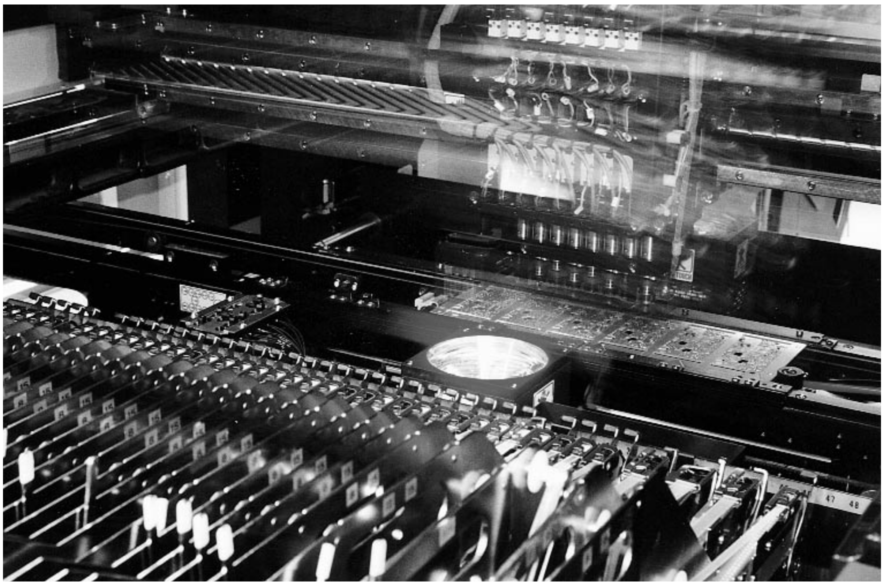
Switching inductive loads will not give additional application problems due to bounce-free switching of the power semiconductors. Thus, there is no contact wear nor arcing between contacts!

SSRs have a very low power consumption (low input current), even when switching high load currents. Consequently, most SSRs are logic-compatible and can operate directly together with a programmable controller or a TTL-signal.

Production through-put
High operating frequency and fast reaction time enable the user to increase the efficiency of the application (machine). New possibilities arise for optimized use of resistive as well as inductive loads.

The life expectancy of SSRs has been improved thanks to consistent use of state-of-the-art technology, the so-called direct copper bonding (DCB) technology, as well as to the use of the latest optoelectronic designs.

With a product range comprising PCB relays, 1- and 3-phase SSRs for fitting into control panels and cabinets as well as a wide selection of motor controllers, the user is offered the possibility of selecting the correct relay for the application in question.



Surface mount technology in action

Solid State Relays
Technical Information

CARLO GAVAZZI

Selection Guide

Application / Relay	Heater (resistive)	Lamp (resistive)	Lamp (Halogen)	1-phase Motor	3-phase Motor	Small Trans-former	Trans-former 1-ph/3-ph*	Contactor, Coil, Valve DC 13

PCB-mounting

Switching mode	ZS	ZS	ZS	ZS (IO)	ZS (IO)	ZS (IO)	PS	ZS (IO)
3 A Triac	3 A	1.5 A		2 A	2 A	0.5 A		1.5 A
5 A Triac	5A	4A		3A	3A	0.8A		3A
5.5 A Triac	5.5A	4.5A		5A	5 A	0.8 A		3 A
5 A SCR - Alternistor	4 A	3A		3A	3A	0.8A		3A

Chassis mounting

10 A Triac	8 A	5 A	2 A	2 A		2 A		
25 A Triac	16 A	10 A	4 A	4 A		4 A		
10 A SCR - antiparallel/ Alternistor	10 A	8 A	3 A	3 A	3 A		3 A	
25 A SCR - antiparallel/ Alternistor	25 A	15 A	6 A	5 A	6 A		6 A	
40 A Alternistor	40 A	25 A	12 A	12 A	10 A			
50 A SCR - antiparallel	50 A	30 A	15 A	15 A	12 A		15 A	
55 A Alternistor	55 A	33 A	16 A	16 A	15 A			
75 A antiparallel	75 A*	50 A	25 A	20A	24 A			
90 A SCR - antiparallel	90 A*	50 A	25 A	20 A	24 A			
100 A SCR antiparallel	100 A*	60 A	30 A	30 A	40 A			
110 A SCR - antiparallel	110 A*	60 A	30 A	30 A	40 A			

ZS: Zero switching
IO: Instant-on switching
PS: Peak switching

*Terminals designed for 63 A max.

Data for Ta_{max} = 25˚C (77˚F)