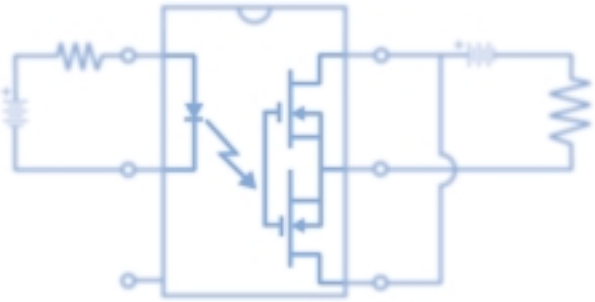
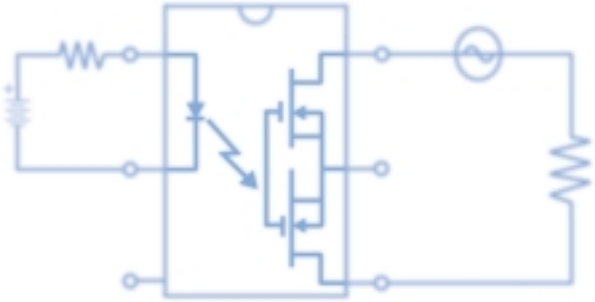
Solid State Relays

December 2001





Features

- 4,000 VRMS Isolation
- Wide Operating Voltage Range
- Solid State Reliability
- Bounce-Free Operation

Applications

- On/Off Hook Switch
- Dial-Out Relay Switching
- Ring Injection Relay
- General Switching
- Ground Start

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Solid State Relays
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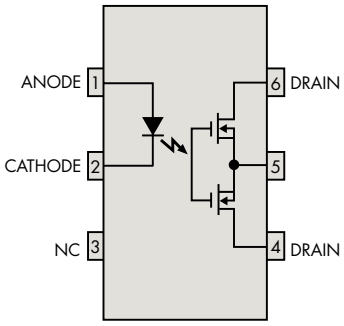
Schematic and General Description



Solid State Relays are available in four models: HSR312, HSR412, HSR312L and HSR412L. All models consist of an AlGaAs infrared LED optically coupled to a photovoltaic generator that drives a power MOSFET detector, all feature 4,000 V_{RMS} isolation, and all are housed in 6-pin, through-hole and surface-mount dual in-line packages. The HSR312 and HSR312L have a wide 250 V operating range, and the HSR412 and HSR412L have an even wider 400 V operating range. The HSR312L and HSR412L employ active current limit circuitry that enables the devices to withstand current surge transients.

The Benefits of Solid State Relays

Figure 1 is a basic modem schematic incorporating an electro-mechanical relay. Because such relays inherently cause contact bounce upon contact closure, R1 and C1 debouncing circuitry is required. Additionally, there are two fusible resistors, R2 and R3, in series with the tip and ring lines that are required for this circuitry to pass the FCC Part 68 lightning surge test. Without these resistors the relay would almost certainly be destroyed due to contact welding during such a surge.

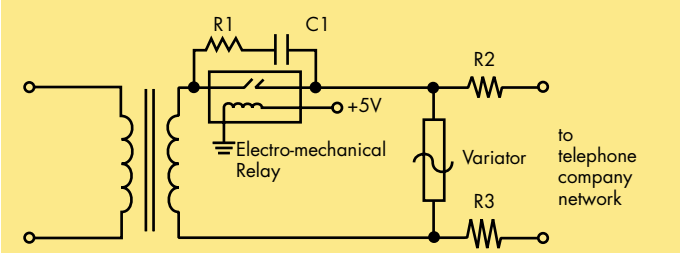


Figure 1

In **Figure 2**, the electro-mechanical relay is replaced with our HSR412L solid state relay. R1 and C1 debouncing circuitry is no longer needed, because there are no physical contacts with solid state switching, making it bounce-free.

Additionally, R2 and R3 fusible resistors are no longer required because the HSR412L includes active, current-limiting circuitry. More important than the space and cost savings is the fact that should one or both of the fusible resistors open in a power surge, the modem would fail to operate until it was repaired.

Replacing an electro-mechanical relay with a solid state relay reduces component count, thereby reducing cost and saving space.

Furthermore, selecting a solid state relay with active, current-limiting circuitry increases reliability, reduces the possibility of costly repair or replacement, and further reduces component count.

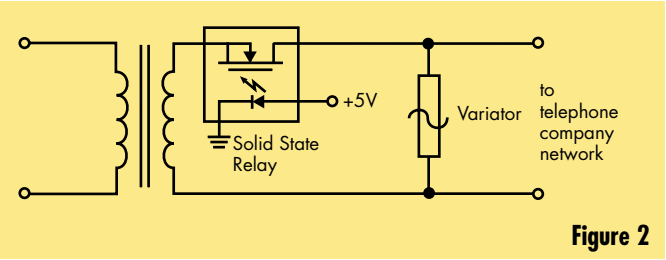


Figure 2

Cross-Reference

Fairchild	Aromat	Clare	Infineon/Vishay	Toshiba
HSR312	AQV217, AQV253(H)	LCA120, LCA127		
HSR312L		LCA120L, LCA127L	LH1510, LH1518	
HSR412	AQV210(E), AQV210(H)	LCA110, XCA110, XCA120	LH1530	TLP596G, TLP597G
HSR412L		LCA110L	LH1056, LH1191, LH1504, LH1540, LH1546	

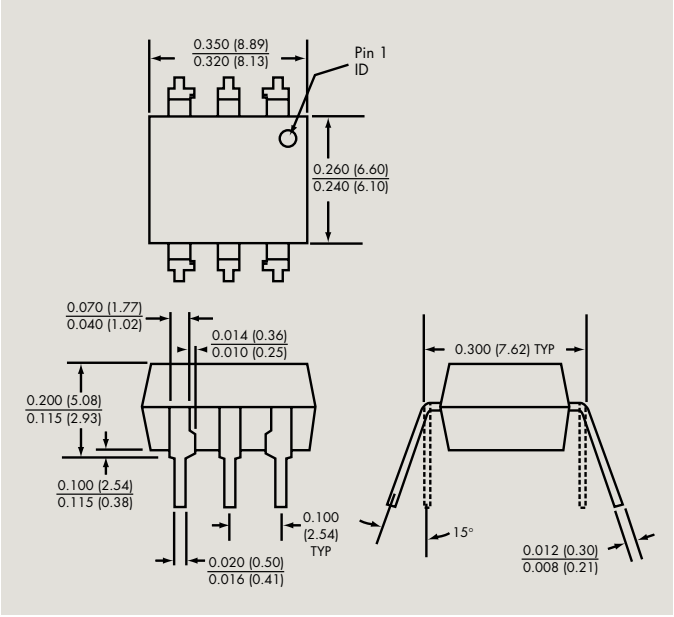
6-Pin Dual In-Line Package Specifications

Through Hole Package

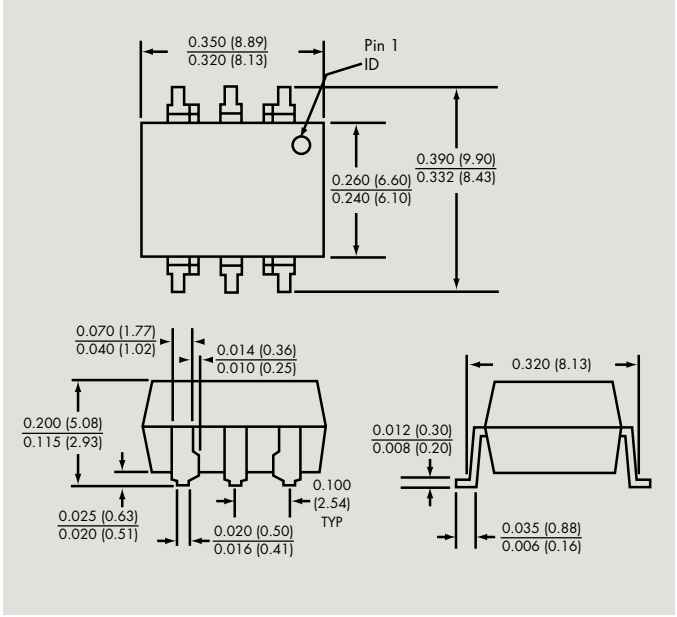
Solid State Relays are available in either a 6-pin through hole or a 6-pin surface mount dual in-line package.

Configuration options include lead bend and tape and reel with 1,000 devices on a 13-inch (330 mm) diameter reel.

Surface Mount Package

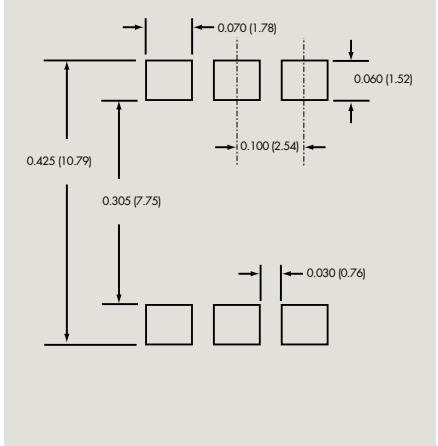


Dimensions are in inches (mm).



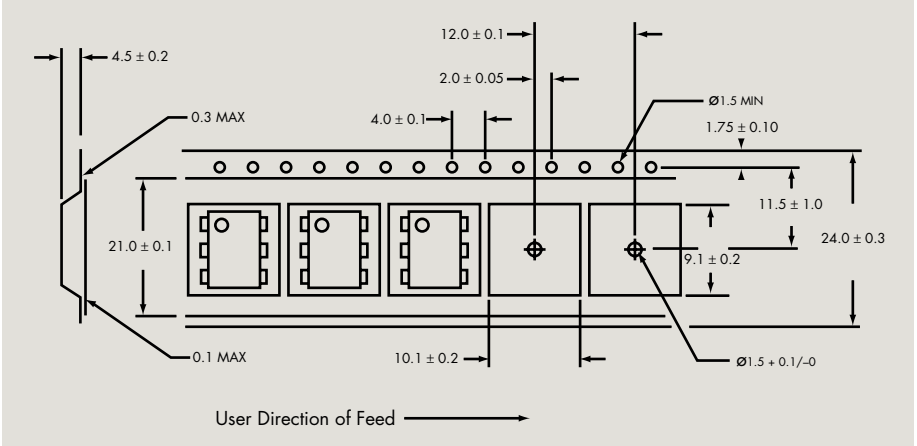
Dimensions are in inches (mm).

Footprint for PCB Layout



Dimensions are in inches (mm).

Carrier Tape Specifications



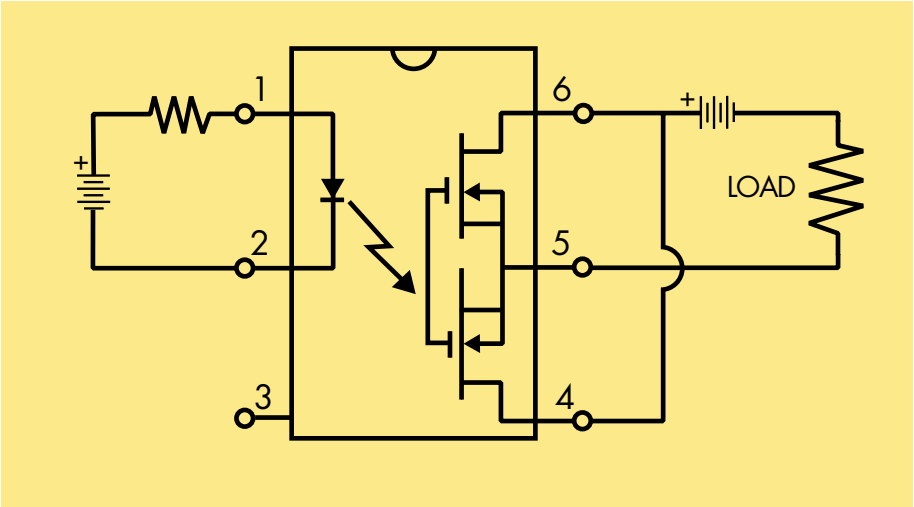
Dimensions are in mm.

Connection Option 1

Parallel Dual Relay Connection

The dual MOSFET configuration allows multiple connection options for optimizing output resistance and current parameters to meet your specific application requirements.

Connection of both MOSFETs in parallel for dc operation allows for the lowest maximum on-state resistance and the highest maximum load current.



Electrical Characteristics

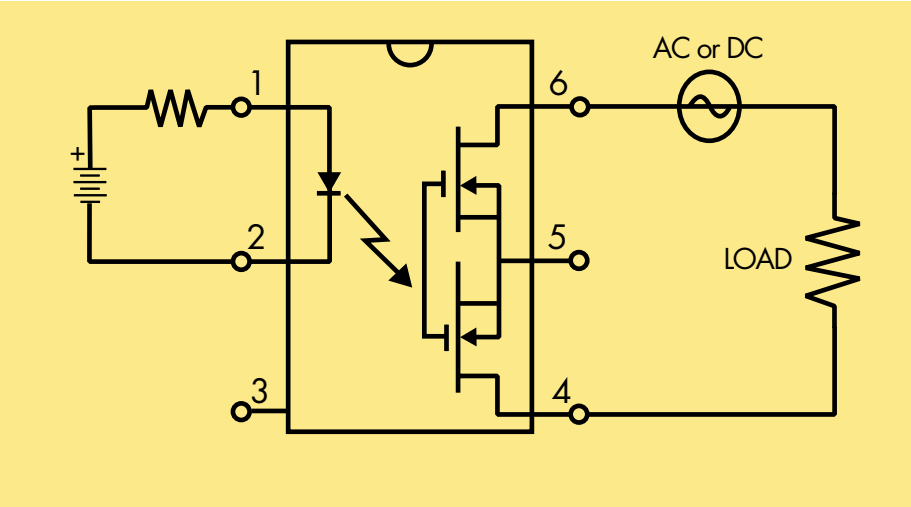
Characteristic	Parameter	Test Conditions	Limit	HSR312	HSR312L	HSR412	HSR412L	Unit
INPUT	Control Current	T_A = –40 to +85°C	Min	2.0	2.0	3.0	3.0	mA
	Control Current for Off-State Resistance	T_A = –40 to +85°C	Max	0.4	0.4	0.4	0.4	mA
	Control Current Range (I_F)	T_A = –40 to +85°C	Min	2.0	2.0	3.0	3.0	mA
			Max	25	25	25	25	
	Reverse Voltage (V_R)	T_A = –40 to +85°C	Max	7	7	7	7	V
	Forward Voltage (V_F)	I_L = 10 mA, T_A = –40 to +85°C	Max	1.6	1.6	1.6	1.6	V
OUTPUT	Operating Voltage Range (V_{OPR})	T_A = –40 to +85°C	Max	250	250	400	400	V_{DC}
	Load Current (I_L)	5 mA control, T_A = +40°C	Max	320	300	210	200	mA
	On-State Resistance (R_{ON})	50 mA pulsed load, 5 mA control, T_A = +25°C	Max	3	4.25	7	9	Ω
	Off-State Leakage Current	±250 V, T_A = +25°C	Max	1.0	1.0	NA	NA	µA
		±400 V, T_A = +25°C	Max	NA	NA	1.0	1.0	
	Current Limit	5 mA control, T_A = +25°C	Min	NA	330	NA	260	mA
			Max	NA	560	NA	440	
	Turn-On Time (T_{ON})	100 V_{DC} load, 5 mA control, T_A = +25°C for 5 mA	Max	3.0	3.0	2.0	2.0	mS
	Turn-Off Time (T_{OFF})	100 V_{DC} load, 5 mA control, T_A = +25°C for 5 mA	Max	0.5	0.5	0.5	0.5	mS
	Thermal Offset Voltage	5 mA control, T_A = –40 to +85°C	Max	NA	NA	0.5	0.5	µV
	Output Capacitance (C_O)	5 V_{DC} , T_A = –40 to +85°C	Max	50	50	12	12	pF
ISOLATION	Input-Output Isolation Voltage (V_{ISO})	T_A = –40 to +85°C	Max	4,000	4,000	4,000	4,000	V

Connection Option 2

Serial Dual Relay Connection

The dual MOSFET configuration allows multiple connection options for optimizing output resistance and current parameters to meet your specific application requirements.

Connection of both MOSFETs in serial for ac or dc operation provides the lowest (best) active current limit for the HSR312L and HSR412L.



Electrical Characteristics

Characteristic	Parameter	Test Conditions	Limit	HSR312	HSR312L	HSR412	HSR412L	Unit
INPUT	Control Current	T_A = –40 to +85°C	Min	2.0	2.0	3.0	3.0	mA
	Control Current for Off-State Resistance	T_A = –40 to +85°C	Max	0.4	0.4	0.4	0.4	mA
	Control Current Range (I_F)	T_A = –40 to +85°C	Min	2.0	2.0	3.0	3.0	mA
			Max	25	25	25	25	
	Reverse Voltage (V_R)	T_A = –40 to +85°C	Max	7	7	7	7	V
	Forward Voltage (V_F)	I_L = 10 mA, T_A = –40 to +85°C	Max	1.6	1.6	1.6	1.6	V
OUTPUT	Operating Voltage Range (V_{OPR})	T_A = –40 to +85°C	Max	250	250	400	400	V_{DC}
	Load Current (I_L)	5 mA control, T_A = +40°C	Max	190	170	140	120	mA
	On-State Resistance (R_{ON})	50 mA pulsed load, 5 mA control, T_A = +25°C	Max	10	15	27	35	Ω
	Off-State Leakage Current	±250 V, T_A = +25°C	Max	1.0	1.0	NA	NA	µA
		±400 V, T_A = +25°C	Max	NA	NA	1.0	1.0	
	Current Limit	5 mA control, T_A = +25°C	Min	NA	190	NA	130	mA
			Max	NA	300	NA	220	
	Turn-On Time (T_{ON})	100 V_{DC} load, 5 mA control, T_A = +25°C for 5 mA	Max	3.0	3.0	2.0	2.0	mS
	Turn-Off Time (T_{OFF})	100 V_{DC} load, 5 mA control, T_A = +25°C for 5 mA	Max	0.5	0.5	0.5	0.5	mS
	Thermal Offset Voltage	5 mA control, T_A = –40 to +85°C	Max	NA	NA	0.5	0.5	µV
	Output Capacitance (C_O)	5 V_{DC} , T_A = –40 to +85°C	Max	50	50	12	12	pF
ISOLATION	Input-Output Isolation Voltage (V_{ISO})	T_A = –40 to +85°C	Max	4,000	4,000	4,000	4,000	V