## Description

The S942-X is a bi-directional, single-pole, single-throw, normally open multipurpose solid-state relay. The circuit is composed of one input IR LED with a series limiting resistor which activates an optically coupled IC on the output that controls the firing angle of two back-to-back SCRs. This circuit assures no false triggering under most adverse conditions, and a tight zero-volt switching window not exceeding 5V. The S942-X provides high peak load voltage ( $800 \mathrm{~V}+$ ) and high input-to-output isolation voltage (up to $5 \mathrm{k} \mathrm{V}_{\mathrm{Rms}}$ ).

The S942-X comes in a compact 16 pin DIP package, makina it ideal for hiah-densitv board applications.

## Applications

- Valve Control
- Solenoid Control
- Home Appliances
- Metering Equipment
- Heating Elements
- Gas Pump Control Circuitry


## Schematic Diagram



## Features

- Zero-Volt Cross Switching
- Input Series Limiting Resistor (300 TYP)
- High Blocking Voltage (800V MIN)
- High Transient Immunity
- 1.2A Maximum Continuous Current
- Low Input Control Current
- Long Life / High Reliability
- RoHS / Pb-Free / REACH Compliant


## Agency Approvals

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UL/C-UL: File # E90096
VDE: File # 40035191 (EN 60747-5-2)
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## Absolute Maximum Ratings

The values indicated are absolute stress ratings. Functional operation of the device is not implied at these or any conditions in excess of those defined in electrical characteristics section of this document. Exposure to absolute Maximum Ratings may cause permanent damage to the device and may adversely affect reliability.

Storage Temperature ...............................-55 to $+125^{\circ} \mathrm{C}$

Continuous Input Current....................................... 50 mA
Transient Input Current ......................................... 500 mA
Reverse Input Control Voltage ....................................5V
Input Power Dissipation ...................................... 40 mW
Total Power Dissipation ........................................1.2W
Solder Temperature - Wave (10sec)....................... $260^{\circ} \mathrm{C}$
Solder Temperature - IR Reflow (10sec)................... $260^{\circ} \mathrm{C}$

## Ordering Information

| Part Number | Description |
| :--- | :--- |
|  |  |
| S942-X | 16 pin DIP, (25/Tube) |
| S942-XH | $5 \mathrm{k} V_{\text {RMS }} V_{\text {ISO, }} 16$ pin DIP, (25/Tube) |
| S942-XS | 16 pin SMD, (25/Tube) |
| S942-XHS | $5 \mathrm{k} V_{\text {RMS }} V_{\text {ISO }}, 16$ pin SMD, (25/Tube) |

NOTE: Suffixes listed above are not included in marking on device for part number identification

Electrical Characteristics, $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ (unless otherwise specified)

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| Input Specifications |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| LED Forward Voltage | $\mathrm{V}_{\mathrm{F}}$ | - | 1.2 | 1.5 | V | $\mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ |
| LED Reverse Voltage | $\mathrm{BV}_{\mathrm{R}}$ | 5 | - | - | V | $\mathrm{I}_{\mathrm{R}}=10 \mu \mathrm{~A}$ |
| Input Resistor | $\mathrm{R}_{\text {IN }}$ | - | 300 | - | $\Omega$ |  |
| Trigger (Must Operate) Current ${ }^{1}$ | $\mathrm{I}_{\mathrm{F}}$ | - | 3 | 5 | mA | $\mathrm{I}_{0}=\mathrm{l}_{\text {(MAX) }}$ [Resistive Load] |
| Junction Capacitance | C | - | 5 | - | pF | $\mathrm{I}_{\mathrm{F}}=0 \mathrm{~mA}$ |
| Output Specifications |  |  |  |  |  |  |
| Blocking Voltage | $V_{B}$ | 800 | - | - | V | $\mathrm{I}_{\mathrm{F}}=0 \mathrm{~mA}, \mathrm{I}_{\mathrm{O}}=1 \mu \mathrm{~A}$ |
| Continuous Load Current | $\mathrm{l}_{\text {(max) }}$ | - | - | 1.2 | A | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |
| Surge Current | $\mathrm{I}_{\text {(SURGE) }}$ | - | - | 10 | A | $\mathrm{T} \leq 16 \mathrm{mS}$ |
| Holding Current | $\mathrm{I}_{\text {HoLD }}$ | - | - | 10 | mA | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |
| On Voltage | $\mathrm{V}_{\text {ON }}$ | - | - | 1.2 | V | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{mAV}, \mathrm{I}_{\mathrm{O}}=1.2 \mathrm{~A}$ |
| Voltage Across Load at Turn On | - | - | - | 5 | V | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |
| Leakage Current | Ioleak | - | 100 | 250 | $\mu \mathrm{A}$ | $\mathrm{I}_{\mathrm{F}}=0 \mathrm{~mA}, \mathrm{~V}_{\mathrm{O}}=250 \mathrm{~V}$ |
| Thermal Resistance | - | - | 80 | - | ${ }^{\circ} \mathrm{C} / \mathrm{W}$ |  |
| Power Factor ${ }^{2}$ | - | - | 0.3 | - | - |  |
| Critical Rate of Rise (dV/dt) ${ }^{3}$ | dV/dt | 400 | - | - | $\mathrm{V} / \mu \mathrm{S}$ |  |
| Coupled Specifications |  |  |  |  |  |  |
| Turn-On Time | Ton | - | - | 0.5 | Cycles | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |
| Turn-Off Time | TofF | - | - | 0.5 | Cycles | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |
| Coupled Capacitance | $\mathrm{C}_{\text {coupled }}$ | - | 2 | - | pF |  |
| Contact Transient Ratio | - | 2,000 | 7,000 | 0 | $\mathrm{V} / \mu \mathrm{S}$ | $\mathrm{dV}=50 \mathrm{~V}$ |
| Isolation Specifications |  |  |  |  |  |  |
| Isolation Voltage <br> (-H Option) | $\mathrm{V}_{\text {ISO }}$ | 3750 | - | - | $\mathrm{V}_{\text {RMS }}$ | $\mathrm{RH} \leq 50 \%, \mathrm{t}=1 \mathrm{~min}$ |
|  |  | 5000 | - | - |  |  |
| Input-Output Resistance | $\mathrm{R}_{\text {-O }}$ | - | $10^{12}$ | - | $\Omega$ | $\mathrm{V}_{\text {I-O }}=500 \mathrm{~V}_{\mathrm{DC}}$ |

## NOTES:

1) Resistive load. For inductive loads, higher drive current is recommended
2) Snubber circuits may be required for lower power factors
3) This is for static $d V / d t$.

S942-X Performance \& Characteristics Plots, $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ (unless otherwise specified)


## ZERO-VOLT SWITCHING

This solid state relay has been designed with a driver circuit that controls the operation of two back-to-back silicon controlled rectifiers (SCRs), each responsible for one half of the AC cycle. If an AC signal is examined, the turn on, turn off and zero-volt switching can be seen. Figure 3 shows a typical $60 \mathrm{HZ}, 120 \mathrm{VAC}$ signal with a corresponding relay input signal:


Figure 3: Zero-Volt Switching Cycle

Figure 3 shows the sequence of zero-volt switching operation. At Stage 1, an input signal is applied to the relay. The relay will not turn on until the threshold voltage of 5V is reached. Once this point is reached (Stage 2), SCR \#1 (designated as the SCR which controls positive AC voltage) turns on. However, SCR \#1 only conducts for an instant, as the cycle quickly crosses zero. At this point (Stage 3), SCR \#1 will turn off and SCR \#2 (negative AC voltage) turns on. Likewise, at the next zero cross (Stage 4), SCR \#2 will turn off and SCR \#1 conducts again. Even though the input signal is terminated at Stage 5, the relay will continue to conduct (typical SCR behavior) until Stage 6, when SCR \#1 crosses zero and ceases to conduct. Please note that turn on can likewise begin on the negative phase of the AC cycle with a -5 V threshold, though only the positive phase is shown here.

## S942-X Solder Reflow Temperature Profile Recommendations

## (1) Infrared Reflow:

Refer to the following figure as an example of an optimal temperature profile for single occurrence infrared reflow. Soldering process should not exceed temperature or time limits expressed herein. Surface temperature of device package should not exceed $250^{\circ} \mathrm{C}$ :


| Process <br> Step | Description | Parameter |
| :---: | :--- | :--- |
| $\mathbf{A}$ | Preheat Start Temperature $\left({ }^{\circ} \mathrm{C}\right)$ | $150^{\circ} \mathrm{C}$ |
| $\mathbf{B}$ | Preheat Finish Temperature $\left({ }^{\circ} \mathrm{C}\right)$ | $180^{\circ} \mathrm{C}$ |
| $\mathbf{C}$ | Preheat Time (s) | $90-120 \mathrm{~s}$ |
| D | Melting Temperature $\left({ }^{\circ} \mathrm{C}\right)$ | $230^{\circ} \mathrm{C}$ |
| E | Time above Melting Temperature $(\mathrm{s})$ | 30 s |
| F | Peak Temperature, at Terminal $\left({ }^{\circ} \mathrm{C}\right)$ | $260^{\circ} \mathrm{C}$ |
| $\mathbf{G}$ | Dwell Time at Peak Temperature $(\mathrm{s})$ | 10 s |
| $\mathbf{H}$ | Cool-down $\left({ }^{\circ} \mathrm{C} / \mathrm{s}\right)$ | $<6^{\circ} \mathrm{C} / \mathrm{s}$ |

(2) Wave Solder:

Maximum Temperature:
Maximum Time:
Pre-heating:
Single Occurrence
(3) Hand Solder:

Maximum Temperature
Maximum Time:
Single Occurrence
$260^{\circ} \mathrm{C}$ (at terminal)
10s
100-150ㅇ (30-90s)
$350^{\circ} \mathrm{C}$ (at tip of soldering iron) 3s

## S942-X Package Dimensions

16 PIN DIP Package
Note: All dimensions in inches ["] with millimeters in parenthesis ()


END VIEW


## TOP VIEW

## S942-X Package Dimensions

16 PIN SMD Package (-S)
Note: All dimensions in inches ["] with millimeters in parenthesis ()


END VIEW


## TOP VIEW

## S942-X Package Marking



## S942-X Package Weights

| Device | Single Unit | Full Tube <br> (25pcs) | Full Pouch <br> (10 tubes) |
| :--- | :---: | :---: | :---: |
| S942-X(H) | 0.88 | 35 | 370 |
| S942-X(H)S | 0.88 | 35 | 370 |

Note: All weights above are in GRAMS, and include packaging materials where applicable

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