## 200-V/160 Ohm, 1 Form A, Small-Signal Solid State Relay

## Technical Data

## Features

- Compact Solid-State Bidirectional Signal Switch
- Normally-Off Single-Pole Relay Function ( 1 Form A)
- Very High Output OffImpedance: $\mathbf{1 0 , 0 0 0}$ Gigaohms Typical at $\mathbf{2 5}{ }^{\circ} \mathrm{C}$
- Very Low Output Offset Voltage: < $0.5 \mu \mathrm{~V}$ at $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$
- 200-Volt Output Withstand Voltage at $25^{\circ} \mathrm{C}$
- High-Transient Immunity: $>2000 \mathrm{~V} / \mu \mathrm{s}$
- Monolithic High-Voltage IC
- Operating Range: $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$
- Very Low Input Current ( 1 mA ); CMOS Compatibility
- High-Speed Switching: $50 \mu \mathrm{~s}$ Typical
- 160-Ohm Maximum OnResistance at $25^{\circ} \mathrm{C}$
- Surface Mount Option
- 8-kV ESD Immunity: MIL-STD-883 Method 3015
- Input-to-Output Insulation Voltage: $\mathbf{2 5 0 0}$ Vac, 1 Minute
- UL 508 Recognized
- CSA Approved


## Applications

- Relay Scanners \& Analog Input Modules of Data Acquisition Systems
- Analog Input Modules of Programmable Logic Controllers
- Relay Multiplexers of HighPerformance Voltmeters
- Telecommunication Test Instruments
- Functional Tester of Board Test Equipment
- Analog Signal Multiplexer
- Flying Capacitor Multiplexer
- Reed Relay Replacement


## Functional Diagram



## HSSR-8200

## Description

The HSSR-8200 consists of a highvoltage integrated circuit optically coupled with a light emitting diode. This device is a solid-state replacement for single-pole, normally-open electromechanical relays used for general purpose switching of analog signals.

The light-emitting diode controls the ON/OFF function of the solidstate relay. The detector contains high voltage MOS transistors and a high speed photosensitive drive circuit. This relay has superior OFF impedance, very low output offset voltage and input drive current.


The electrical and switching characteristics of the HSSR-8200 are specified from $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$. The low $\mathrm{I}_{\mathrm{F}}$ allows compatibility with TTL, LSTTL, and CMOS logic resulting in low power consumption compared to other solid state and mechanical relays.

## Selection Guide

| $\begin{aligned} & \text { 6-Pin DIP } \\ & (300 \mathrm{Mil}) \end{aligned}$ | $\begin{aligned} & \text { 4-Pin DIP } \\ & \text { ( } 300 \mathrm{MH} \text { ) } \\ & \hline \end{aligned}$ | MaximumSpeedt(ON)msec$25^{\circ} \mathrm{C}$ | Maximum <br> ON <br> Resistance <br> R(ON) <br> $\Omega$ <br> $25^{\circ} \mathrm{C}$ <br> 10 | Maximum <br> Output <br> Voltage <br> VO(off) <br> V <br> $25^{\circ} \mathrm{C}$ | $\begin{gathered} \text { Maximum } \\ \text { Output } \\ \text { Current } \\ \text { Io(ON) } \\ \text { mA } \\ \mathbf{2 5}^{\circ} \mathrm{C} \end{gathered}$ | Minimum <br> Input <br> Current <br> mA | Hermetic 8-Pin |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Single Channel Package | Dual Channel Package |  |  |  |  |  | Single <br> Channel <br> Packages |
| HSSR-8400 ${ }^{[1]}$ |  | 0.95 | 10 | 400 | 150 | 5 |  |
| HSSR-8060[1] |  | 1.4 | 0.7 | 60 | 750 | 5 |  |
|  | HSSR-8200 | 1.5 | 200 | 200 | 40 | 1 |  |
|  |  | 6 | 1 | 90 | 800 | 5 | HSSR-7110 ${ }^{(1)}$ |

Note:

1. Technical data are on separate HP publication.

## Ordering Information

Specify part number followed by Option Number (if desired).


Option data sheets available. Contact your Hewlett-Packard sales representative or authorized distributor for information.

Schematic


## Package Outline Drawings

## 4-Pin DIP Package (HSSR-8200)



4-Pin DIP Package with Gull Wing Surface Mount Option 300


## Thermal Profile (Option \#300)



Figure 1. Maximum Solder Reflow Thermal Profile.
(Note: Use of non-chlorine activated fluxes is recommended.)

## Regulatory Information

The HSSR-8200 has been approved by the following organizations:

## UL

Recognized under UL 508, Component Recognition Program, Industrial Control Switches, File E142465.

## CSA

Approved under CAN/CSA-C22. 2 No. 14-95, Industrial Control Equipment, File LR 87683.

## Insulation and Safety Related Specifications

| Parameter | Symbol | Value | Units | Conditions |
| :--- | :---: | :---: | :---: | :--- |
| Min. External Air Gap <br> (External Clearance) | L(IO1) | 7.0 | mm | Measured from input terminals to output <br> terminals, shortest distance through air |
| Min. External Tracking Path <br> (External Creepage) | $\mathrm{L}(\mathrm{IO} 2)$ | 7.5 | mm | Measured from input terminals to output <br> terminals, shortest distance path along body |
| Min. Internal Plastic Gap <br> (Internal Clearance) |  | 0.5 | mm | Through insulation distance, conductor to <br> conductor, usually the direct distance <br> between the photoemitter and photodetector <br> inside the optocoupler cavity |
| Tracking Resistance <br> (Comparative Tracking Index) | CTI | 200 | Volts | DIN IEC 112/VDE 0303 PART 1 |
| Isolation Group |  | IIIa |  | Material Group (DIN VDE 0110, 1/89, Table 1) |

Option 300 - surface mount classification is Class A in accordance with CECC 00802.
Absolute Maximum Ratings
Storage Temperature $-55^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$
Operating Temperature $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$
Lead Solder Temperature $260^{\circ} \mathrm{C}$ for $10 \mathrm{~s}(1.6 \mathrm{~mm}$ below seating plane)
Average Input Current - $I_{F}$10 mA
Repetitive Peak Input Current - $\mathrm{I}_{\mathrm{F}}$ $20 \mathrm{~mA} ; 50 \%$ Duty Cycle
Transient Peak Input Current - $I_{F}$ ..... 100 mA
( $\leq 1 \mu \mathrm{~s}$ pulse width; 1 kHz Pulse Repetition Rate)
Reverse Input Voltage ..... 5 V
Average Output Current - $\mathrm{I}_{\mathrm{O}}$ ..... $40 \mathrm{~mA}^{[1]}$
Input Output Insulation Voltage ..... $2500 \mathrm{VAC}^{[8]}$
Output Power Dissipation ..... $320 \mathrm{~mW}^{[2]}$
Output Voltage - $\mathrm{V}_{\mathrm{O}}$ ..... -200 V to 200 V
Infrared and Vapor Phase Reflow Temperature(Option \#300)see Fig. 1, Thermal Profile
Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units |
| :--- | :---: | :---: | :---: | :---: |
| Input Current (ON) | $\mathrm{I}_{\text {F(ON) }}$ | 1 | 5 | mA |
| Input Voltage (OFF) | $\mathrm{V}_{\text {F(OFF) }}$ | 0 | 0.6 | Volt |
| Operating Temperature | $\mathrm{T}_{\mathrm{A}}$ | -40 | +85 | ${ }^{\circ} \mathrm{C}$ |
| Output Voltage | $\mathrm{V}_{\text {O(OFF) }}$ | -200 | 200 | Volt |
| Output Current | $\mathrm{I}_{\text {O(ON) }}$ | -40 | 40 | mA |

## DC Electrical Specifications

$-40^{\circ} \mathrm{C} \leq \mathrm{T}_{\mathrm{A}} \leq+85^{\circ} \mathrm{C}, 1 \mathrm{~mA} \leq \mathrm{I}_{\mathrm{F}(\mathrm{ON})} \leq 5 \mathrm{~mA}, 0 \mathrm{~V} \leq \mathrm{V}_{\mathrm{F}(\mathrm{OFF})} \leq 0.6 \mathrm{~V}$, and all Typicals at $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ unless otherwise specified.

| Parameter | Sym. | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Output Withstand Voltage | $\left\|\mathrm{V}_{\text {O(OFF) }}\right\|$ | 200 | 245 |  | V | $\mathrm{I}_{\mathrm{O}}=1 \mu \mathrm{~A}$ |  |  |
| Output On-Resistance | $\mathrm{R}_{(\mathrm{ON})}$ | 70 | 125 | 160 | $\Omega$ | $\begin{aligned} & \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}, \\ & \mathrm{I}_{\mathrm{O}}=1 \mathrm{MA} \\ & \hline \end{aligned}$ | $\begin{gathered} 3,4 \\ 5 \end{gathered}$ |  |
|  |  | 40 | 125 | 250 |  | $\mathrm{I}_{\mathrm{O}}=1 \mathrm{MA}$ |  |  |
|  |  | 30 | 100 | 200 |  | $\mathrm{I}_{\mathrm{O}}=40 \mathrm{~mA}$ |  |  |
| Output On-Current Rating | $\left\|I_{\text {O(ON) }}\right\|$ |  |  | 40 | mA | $\begin{aligned} & \mathrm{V}_{\mathrm{O}} \leq 8 \mathrm{~V} \\ & \mathrm{~T}_{\mathrm{A}} \leq 40^{\circ} \mathrm{C} \end{aligned}$ |  | 1 |
| Output Off-Resistance | $\mathrm{R}_{\text {(OFF) }}$ | 50 | 10,000 |  | $\mathrm{G} \Omega$ | $\mathrm{V}_{\mathrm{O}}=200 \mathrm{~V}$ | 6 | 6 |
| Output Off-Leakage Current | $\mathrm{I}_{\text {( }}^{\text {OFF }}$ ) |  | 0.02 | 4.0 | nA | $\mathrm{V}_{\mathrm{O}}=200 \mathrm{~V}$ | 6 |  |
| Output <br> Off-Capacitance | $\mathrm{C}_{\text {(OFF) }}$ |  |  | 4.5 | pF | $\begin{aligned} & \mathrm{V}_{\mathrm{O}}=0 \mathrm{~V} \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ | 7 |  |
| Output Offset Voltage | $\left.\mathrm{V}_{\mathrm{Of}} \mathrm{OS}\right)$ | Note <br> 3 | -0.2 | Note 3 | $\mu \mathrm{V}$ | $\mathrm{I}_{\mathrm{O}}=0 \mathrm{~A} ; \mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ | $\begin{gathered} 8,17 \\ 18 \\ \hline \end{gathered}$ | 3 |
|  |  |  | -1.3 |  |  | $\mathrm{I}_{0}=0 \mathrm{~A} ; \mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ |  |  |
| Input Reverse Breakdown Voltage | $\mathrm{V}_{\mathrm{R}}$ | 3 | 10 |  | V | $\mathrm{I}_{\mathrm{R}}=10 \mu \mathrm{~A}$ |  |  |
| Input Diode Temperature Coefficient | $\mathrm{dV}_{\mathrm{F}} / \mathrm{dT}$ |  | $-1.75$ |  | $\begin{gathered} \mathrm{mV} / \\ { }^{\circ} \mathrm{C} \end{gathered}$ | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ |  |  |
| Input Forward Voltage | $V_{F}$ |  | 1.5 | 2.0 | V | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ | 9 |  |
| Input Capacitance | $\mathrm{C}_{\text {IN }}$ |  | 21 |  | pF | $\begin{aligned} & \mathrm{V}_{\mathrm{F}}=0 \mathrm{~V} ; \\ & \mathrm{f}=1 \mathrm{MHz} \end{aligned}$ |  |  |

## Switching Specifications

$-40^{\circ} \mathrm{C} \leq \mathrm{T}_{\mathrm{A}} \leq+85^{\circ} \mathrm{C}, 1 \mathrm{~mA} \leq \mathrm{I}_{\mathrm{F}(\mathrm{ON})} \leq 5 \mathrm{~mA} .0 \mathrm{~V} \leq \mathrm{V}_{\mathrm{F}(\mathrm{OFF})} \leq 0.6 \mathrm{~V}$, and all Typicals at $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions |  | Fig. | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Turn On Time | $\mathrm{t}_{\mathrm{ON}}$ |  | 50 | 200 | $\mu \mathrm{s}$ | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ | $\mathrm{V}_{\mathrm{O}}=50 \mathrm{~V}$ | $\begin{gathered} 10,11 \\ 12,13 \end{gathered}$ |  |
|  |  |  | 300 | 1500 |  | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ |  |  |  |
| Turn Off Time | $\mathrm{t}_{\mathrm{OFF}}$ |  | 45 | 250 | $\mu \mathrm{s}$ | $\mathrm{I}_{\mathrm{F}}=5 \mathrm{~mA}$ | $\mathrm{V}_{\mathrm{O}}=50 \mathrm{~V}$ | $\begin{aligned} & 10,11, \\ & 12,13 \end{aligned}$ |  |
|  |  |  | 75 | 350 |  | $\mathrm{I}_{\mathrm{F}}=1 \mathrm{~mA}$ |  |  |  |
| Output Transient Rejection | $\mathrm{dV} \mathrm{V}_{0} / \mathrm{dt}$ |  | $\geq 7000$ |  | V/ $\mu \mathrm{s}$ | $\Delta \mathrm{V}_{\mathrm{O}}=200 \mathrm{~V}$ | $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ | 14 |  |
|  |  | 2000 |  |  |  | $\Delta \mathrm{V}_{\mathrm{O}}=50 \mathrm{~V}$ |  |  |  |
| Input-Output | $\mathrm{dV} \mathrm{V}_{\mathrm{I}-\mathrm{O}} / \mathrm{dt}$ |  | $\geq 7000$ |  | $\mathrm{V} / \mu \mathrm{s}$ | $\Delta \mathrm{V}_{1-0}=300 \mathrm{~V}$ | $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ | 15 |  |
| Transient <br> Rejection |  | 2000 |  |  |  | $\Delta \mathrm{V}_{\mathrm{L}-\mathrm{O}}=50 \mathrm{~V}$ |  |  |  |

## Package Characteristics

For $-40^{\circ} \mathrm{C} \leq \mathrm{T}_{\mathrm{A}} \leq+85^{\circ} \mathrm{C}$, unless otherwise specified. All Typicals at $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Notes |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Input-Output <br> Momentary With- <br> stand Voltage* | $\mathrm{V}_{\mathrm{ISO}}$ | 2500 |  |  | V rms | $\mathrm{RH}=45 \%, \mathrm{t}=1 \mathrm{~min}$, <br> $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ | 4,5 |  |
| Resistance <br> Input-Output | $\mathrm{R}_{\mathrm{L}-\mathrm{O}}$ | 100 | 100,000 |  | $\mathrm{G} \Omega$ | $\mathrm{V}_{\mathrm{L}-\mathrm{O}}=500 \mathrm{VDC}, \mathrm{t}=1 \mathrm{~min}$, <br> $\mathrm{RH}=45 \%$ | 4 |  |
| Capacitance <br> Input-Output | $\mathrm{C}_{\mathrm{L}-\mathrm{O}}$ |  | 0.6 | 1.0 | pF | $\mathrm{V}_{\mathrm{L}-\mathrm{O}}=0 \mathrm{~V}, \mathrm{f}=1 \mathrm{MHz}$, <br> $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ |  | 4 |

*The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating. For the continuous voltage rating refer to the VDE 0884 Insulation Characteristics Table (if applicable), your equipment level safety sperification, or HP Application Note 107.4. *Optocoupler Input-Output Endurance Voltage. ${ }^{\text {. }}$

## Notes:

1. Derate linearly above $40^{\circ} \mathrm{C}$ at a rate of $0.3 \mathrm{~mA}{ }^{\circ} \mathrm{C}$.
2. Derate linearly above $60^{\circ} \mathrm{C}$ at a rate of $5 \mathrm{~mW} /{ }^{\circ} \mathrm{C}$.
3. $V_{(0, O)}$ is a function of $\mathrm{I}_{\mathrm{F}(\mathrm{ON},}$ and is defined between pins 8 and 5 with pin 5
as reference. Vinos, must be merasured in a stable ambient. See Figure 8 for variation of $V_{\text {uncs }}$ around the typical value.
4. Device considered a two terminal device: pins 1 and 4 shorted together. and pins 5 and 8 shorted together.
5. This is a momentary withstand proof test. These parts are $100 \%$ tested in production at 3000 V rins. one second.
6. $\mathrm{R}_{\text {IUFF }}$ is defined as $\mathrm{V}_{\mathrm{OIOFF}} \mathrm{I}_{\mathrm{OI} \text { (OFF) }}$.


R1 - RECUIRED CURRENT-LIMTTHG RESISTOR $F O R I_{F_{(O N)}}=1 \mathrm{~mA}$
R2 - PULL-UP \&ESTSTOR FOR $V_{F(O F F)}<600 \mathrm{mV}$; IF $\left(V_{C C}-V_{\text {OW1 }}\right)<600 \mathrm{mV}$, OMIT R2
R3. C-OPTIONAL PEAKNG CIRCUTT $F O R I_{F}(P K)=5 \mathrm{~mA}, \mathrm{I}_{\mathrm{OH}} \times 200 \mu \mathrm{~s}$

Figure 2. Recommended Input Circuit.


Figure 3. Typical On State I-V Characteristics.


Figure 4. Typical Output Resistance vs. Input Current.


Figure 5. Typical Output Resistance vs. Temperature.


Figure 7. Typical Output Capacitance vs. Output Voltage.


Figure 6. Typical Output Leakage vs. Temperature.


Figure 8. Output Offset Voltage Distribution.


Figure 9. Typical Input Forward Current vs. Forward Voltage.


Figure 10. Switching Test Circuit for $t_{\text {ow }}, t_{\text {of }}$.


Figure 11. Typical $t_{\text {on }}$ and $t_{\text {orf }}$ vs. Input Current.


Figure 13. Normalized $t_{\text {on }}$ and $t_{\text {ofF }}$ vs. Temperature.


Figure 12. $\mathrm{t}_{\mathrm{oN}}$ and $\mathrm{t}_{\text {off }}$ vs. Output Voltage.


Figure 14. Output Transient Rejection Test Circuit.


Figure 15. Input-Output Transient Rejection.


EITHER-POLARITY INPUTS:
D: - DUAL POLARITY BREAKDOWN DEVICE, $V_{5}<0.5 V_{O}$ IOFFI
SINGLE-POLARITY IMPUTS:
$\mathrm{D}_{5}$ - UNI-POLAR BREAKDOWN DEVICE, $\mathbf{V}_{\mathbf{S}}<\mathrm{V}_{0}$ юFF;

Figure 16. Over-Voltage Protection in Multiplexer Applications.


Figure 17. Differential Output Connections to Minimize Offset Voltage Effects.


Figure 18. Voltage Offset Test Setup.

