

Model 53647 Solid State Relay

Application Notes

The 53647 series are single channel, SPST normally open, radiation hardened, magnetically isolated control, solid-state FET relays (SSRs) using MDI's patented 100K+^(TM) technology. For superior radiation tolerance, no optical couplers are used.

This series has four variations for input voltage. Model numbers are prefixed with a 5, 7, 8 or 9 denoting 28, 50, 70 and 100VDC nominal input variants respectively. They coordinate with all popular satellite bus voltages and harmonize with MDI's comprehensive line of 100K+TM Proton Rad Hard DC-DC converters. The SSRs excel in standalone applications as well. The information in this application note that references model 53647 applies to all models in the series.

The 53647 has two types of command inputs; a nominal 5 VDC bias supply input, and a low current logic level input compatible with both 3.3 and 5 VDC logic. The SSR may be commanded by one or both inputs, making circuit implementation readily achievable without additional components. The isolated FET output (normally open) closes when commanded by the input.

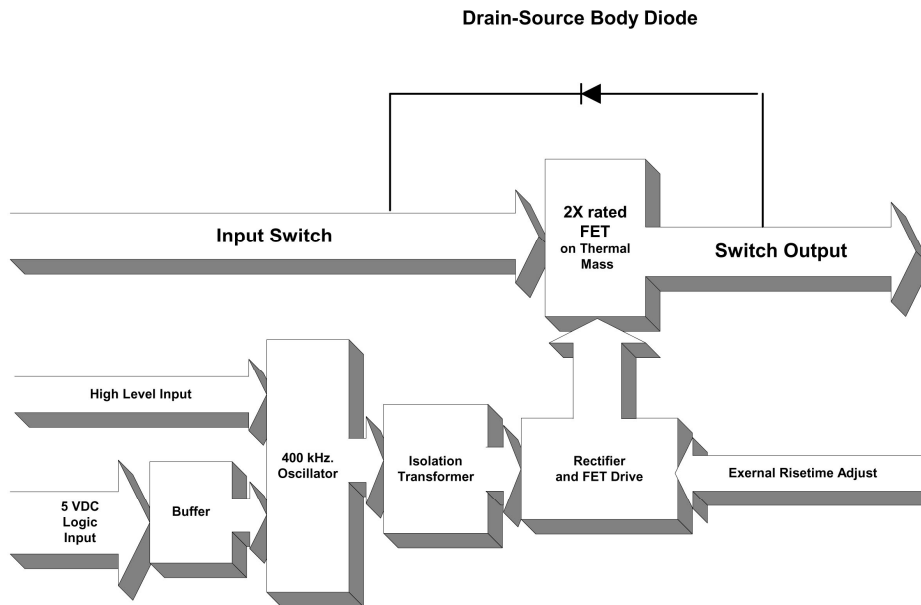
Superior stress derating is achieved by close coupling the SSR FET to an intrinsic thermal mass. The energy pulse to charge capacitive loads, described as $1/2CV^2$ divided by the time constant, can create significant thermal dissipation in the FET. Close thermal coupling to the intrinsic mass integrates the temperature rise effects in the FET caused by transient power dissipation.

Another feature unique to the 53647 SSR is programmable turn on time. By connecting an external capacitor between the Cext pin and either output pin, the user may control the output turn on ramp from nominally 50 through 400uS, effectively tailoring the rate of rise of output current. The function, which is essentially constant over temperature, life and radiation, is particularly useful in controlling inrush current effects of capacitive loads.

As shown in the block diagram, an internal RF oscillator supplies transformer-coupled gate drive to the FET switch. The oscillator is powered by the Vdd input (pin 9). The SSR is commanded on (closed) by bringing the buffered command input (pin 7) to a logic "high". In this configuration, pin 8 is the common return of pins 7 and 9. If the logic level input is not desired, the switch can be commanded on by applying only the Vdd input. In this configuration, the buffered command logic level input is strapped to the Vdd input terminal (pin 7 wired to pin 9).



Simplified Block Diagram



Pin Functions

Pin 1	NC
Pin 2	NC
Pin 3	NC
Pin 4	Case Ground
Pin 5	NC
Pin 6	NC
Pin 7	Buffered Command Input: Logic high turns on output switch
Pin 8	Command Common, Vdd return
Pin 9	Vdd Command Supply (5 VDC nominal)
Pin 10	NC
Pin 11	NC
Pin 12	NC
Pin 13	NC
Pin 14	Switch Output
Pin 15	Switch Output
Pin 16	Cext: Rise time control; connect capacitor between pins 16 and 15
Pin 17	Switch Positive Input
Pin 18	Switch Positive Input



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Vdd Input

Vdd input bias power is applied positive on pin 9 and the return on pin 8.

Vdd powers an internal RF oscillator that supplies gate drive to the FET. A DC voltage in the range of 4.6 VDC to 5.4 VDC is suitable. The current drawn by the bias input is approximately 30 mA.

On special order, the 53467 SSR is available with a 3.3 VDC nominal Vdd voltage.

CMD Control Input:

There are two ways to close (turn on) the 53467 SSR.

One way is to connect the buffered command input pin (pin 7) to the Vdd pin (pin 9). Opening the connection opens the SSR (turn-off).

The second way is to bring the buffered command input (pin 7) to a logic high. The SSR is turned off when pin 7 is a logic low. The buffered command pin 7 is dual input; either 3.3 or 5 volt logic inputs may be used. The nominal control trip point is 1.5Vdc such that CMD OFF is 1VDC maximum and CMD ON is 2VDC minimum.

Pin 7 draws approximately 1 mA when connected to a 5 VDC source.

Cext:

Output turn-on rise time may be user programmed via an externally mounted capacitor connected between Cext (pin 16) and either of the output (pins 14,15). Output rise time will increase linearly from 50 to 400 uSecs. as the capacitance increases from zero (none connected) to 2000pF. The voltage rating of the capacitor should at least equal the maximum voltage rating of the SSR.

Switch Ratings:

The 53467 Solid State Relays are available with different voltage ratings, as shown in the ratings table. The models are arranged by satellite application bus voltage to coordinate with MDI's 100K+™ Proton Rad Hard DC-DC converter inputs. The maximum input voltage is the recommended maximum for other applications.

The FET switch in the 53467 is polarized and the positive input pins should be connected to the positive external circuit point. A body diode is internally connected in the reverse direction. The current rating of the body diode is the same as the switch current rating.

53467 SSRs may be paralleled for increased current capability or lower voltage drop at any given current. Two 53467 SSRs may also be used in series for redundancy.

AC waveforms within the rating of the switch may be controlled by placing two switch sections back-to-back.

Switch parameters are given in the tables.



Table 1: SSR Ratings and Static Characteristics

Model Number	Application Bus Voltage	Max. Recommended Input Voltage	Max. Rated Input Voltage	Peak Current	Steady State Current	On Resistance	Leakage Current at Max Rated Input Voltage	Leakage Current at Application Bus Voltage
	Vdc	Vdc	Vdc	A	A	Ohms	μA	μA
93647	100	120	250	7	1.5	0.75	20	10
83647	70	120	250	7	1.5	0.75	20	10
73647	50	75	150	15	4	0.15	200	100
53647	28	75	150	15	4	0.15	200	100

- Application Bus Voltage in the commonly available satellite bus voltage ranges. These ratings harmonize with the input voltage ranges for MDI 5000, 7000, 8000 and 9000 series converters.
- Maximum Recommended Input Voltage is the maximum factory recommendation considering single event radiation effects
- Maximum Rated Input Voltage is the maximum Vds rating of the FET switch
- Peak Current - Maximum transient current
- Steady State Current - Maximum continuous steady state current
- On Resistance - Typical in ohms, 25 °C. Increases linearly to 2X at 125 °C.
- Leakage Current at Max Rated Input Voltage OFF State - Typical values
- Leakage Current at Application Bus Voltage OFF State - Typical values

Table 2: SSR Dynamic Response, Pre-Radiation, 25 °C, nominal values

Model Number	Turn On Delay	Turn Off Delay	Rise Time no Cext	Rise Time Cext 2000pF	Fall Time
	μSec	μSec	μSec	μSec	μSec
93647	200	50	50	400	50
83647	200	50	50	400	35
73647	300	50	50	400	25
53647	450	50	50	400	25

Table 3: SSR Dynamic Response, Post 100K Radiation, 25 °C, nominal values

Model Number	Turn On Delay	Turn Off Delay	Rise Time no Cext	Rise Time Cext 2000pF	Fall Time
	μSec	μSec	μSec	μSec	μSec
93647	600	100	75	1000	50
83647	600	100	75	1000	35
73647	750	100	75	1000	25
53647	1100	100	75	1000	25



Power Dissipation:

Total continuous steady state power dissipation of the model 53467 package is limited to 4 watts.

Switching External Load Capacitance

Turning on into a capacitance causes an inrush current. However, the controlled turn on time feature of the model 53467 SSR limits this inrush current. For transient turn on conditions the rated steady state current of the switch may be increased by 100%. The on-off repetition rate should not be more frequent than 25mSecs.

Output Switch Temperature Coefficients

Switch section resistances are shown at 25 degrees C case temperature. As the case temperature rises, switch resistance increases. The temperature coefficient of this increase is approximately 0.4 percent per degree C. At case temperatures below 25 C, the resistance decreases by the same coefficient.

Short Circuit and Overload Protection

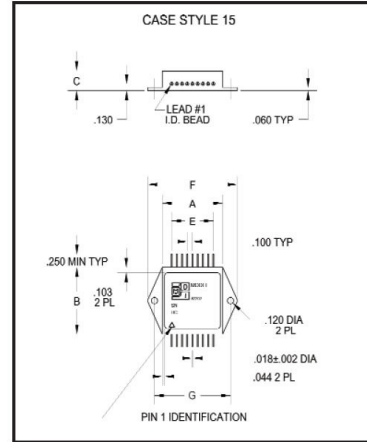
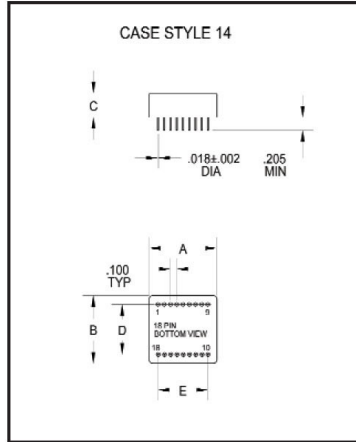
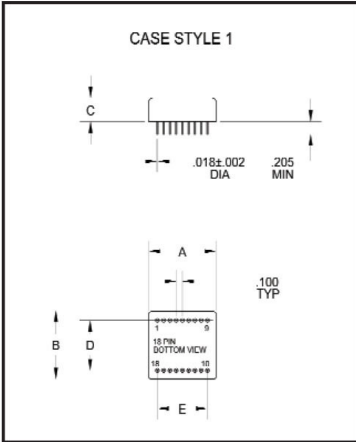
Similar to mechanical relays, Model 53467 solid-state relays do not contain current limiting for protection against inadvertent output short circuits and overloads. Current limiting, if required, must be externally provided by the user.

53467 Heat Removal and Mounting Recommendations

See MDI application notes on mounting considerations for DC/DC Converters.



Model No.	Case Style	Pin Count	Mounting
*3647	1	18	Solder Sealed Flangeless PCB Mount
*3647 D	14	18	Seam Weld Flangeless PCB Mount
*3647 TF	15	18	Seam Weld Chassis Mount with Flange



Case Dimensions

Units: inches | millimeters

Case Style	A	B	C	D	E	F	G
1	1.080 27.432	1.080 27.432	0.380 9.652	0.800 20.320	0.800 20.320	— —	— —
14 D	1.090 27.686	1.090 27.686	0.380 0.380	0.800 20.320	0.800 20.320	— —	— —
15 TF	1.160 29.464	1.293 32.588	0.380 9.652	— —	0.800 20.320	1.754 44.552	1.460 37.084

Pin Out Chart

Pin 1	N/C	Pin 6	N/C	Pin 10	N/C	Pin 15	Switch output
Pin 2	N/C	Pin 7	Buffered CMD input +	Pin 11	N/C	Pin 16	Cext rise time capacitor
Pin 3	N/C	Pin 8	CMD input common, Bias input return	Pin 12	N/C	Pin 17	Switch Input +
Pin 4	Case	Pin 9	Bias input and command supply +	Pin 13	N/C	Pin 18	Switch Input +
Pin 5	N/C			Pin 14	Switch output		

Part Numbering System

The model 53647 part numbering system is coordinated with that used for MDI DC/DC converters. For example:

53647SE-TF

53647= Model number for a 28 VDC bus input SSR

SE= Grade (available as EU, R, RE, S and SE)

TF= Seam welded chassis mount package with flange (also available in D and case style 1 packages)



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Features

SPST NO configuration, single channel
Close coupled intrinsic thermal mass
User programmable output rise time
Dual logic level command input
Patented 100K+™ Proton Rad Hard Technology
No optocouplers used

Specifications

SSR Ratings and Static Characteristics:

Input Voltage – See Table

R on - See Table

I max - See Table

Leakage current, Off state - See Table

SSR Dynamic Response Characteristics:

Rise Time - See Table

Fall Time - See Table

Delay Time - See Table

Radiation Life – See Table

Vdd Bias Voltage – 5VDC nominal (4.60 VDC \leq Vdd \leq 5.4 VDC)

Vdd Bias Current 30 mA typical

Buffer Command Input Current - 1 mA typical at 5 VDC

Control Trip Point - 1.5 VDC nominal (OFF 1V max., ON 2V min.)

Isolation - Pins to Case 500 VDC

Isolation- Switch to Vdd Bias Supply 500 VDC

Pin4 is Case

Operating temperature Range -55°C to 85°C (R or S) or 125°C (RE or SE)

Storage temperature Range -65°C to 150°C

Steady State Power Dissipation - 4 watts

Total Ionizing Dose - 100K+™

SEE - 82 MEV*CM²/mG

Weight – 45g Typical

Specifications subject to change
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