

# Overvoltage-Protection Controllers with Status **FLAG**

## ABSOLUTE MAXIMUM RATINGS

IN to GND .....	-0.3V to +30V
GATE to GND .....	-0.3V to +12V
$\overline{\text{EN}}$ , $\overline{\text{FLAG}}$ to GND .....	-0.3V to +6V
Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )	
6-Pin SC70 (derate 3.1mW/°C above +70°C) .....	245mW
6-Pin $\mu\text{DFN}$ (derate 2.1mW/°C above +70°C) .....	477mW

Operating Temperature Range .....	-40°C to +85°C
Junction Temperature .....	+150°C
Storage Temperature Range .....	-65°C to +150°C
Lead Temperature (soldering, 10s) .....	+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

( $V_{\text{IN}} = +5\text{V}$  (MAX4838A/MAX4840A),  $V_{\text{IN}} = +4\text{V}$  (MAX4842A),  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range	$V_{\text{IN}}$			1.2		28.0	V
Undervoltage-Lockout Threshold	UVLO	$V_{\text{IN}}$ falling	MAX4838A/MAX4840A	3.0	3.25	3.5	V
			MAX4842A	2.3	2.5	2.7	
Undervoltage-Lockout Hysteresis					50		mV
Overvoltage Trip Level	OVLO	$V_{\text{IN}}$ rising	MAX4838A	7.0	7.4	7.8	V
		$V_{\text{IN}}$ rising	MAX4840A	5.5	5.8	6.1	
		$V_{\text{IN}}$ rising	MAX4842A	4.4	4.7	5.0	
Overvoltage Trip Level Hysteresis			MAX4838A	100		mV	
			MAX4840A	80			
			MAX4842A	50			
IN Supply Current	$I_{\text{IN}}$	No load, $\overline{\text{EN}} = \text{GND}$ or 5V, $V_{\text{IN}} = 5\text{V}$ (MAX4838A/MAX4840A)			80	200	$\mu\text{A}$
		No load, $\overline{\text{EN}} = \text{GND}$ or 4.0V, $V_{\text{IN}} = 4\text{V}$ (MAX4842A)			75	160	
UVLO Supply Current	$I_{\text{UVLO}}$	$V_{\text{IN}} = 2.9\text{V}$ (MAX4838A/MAX4840A)				30	$\mu\text{A}$
		$V_{\text{IN}} = 2.2\text{V}$ (MAX4842A)				22	
GATE Voltage	$V_{\text{GATE}}$	$I_{\text{GATE}}$ sourcing 1 $\mu\text{A}$	MAX4838A/MAX4840A	9		10	V
			MAX4842A	7.5		8.0	
GATE Pulldown Current	$I_{\text{PD}}$	$V_{\text{IN}} > V_{\text{OVLO}}$ , $V_{\text{GATE}} = 5.5\text{V}$			27		mA
$\overline{\text{FLAG}}$ Output Low Voltage	$V_{\text{OL}}$	$\overline{\text{FLAG}}$ asserted	$1.2\text{V} \leq V_{\text{IN}} < \text{UVLO}$ , $I_{\text{SINK}} = 50\mu\text{A}$			0.4	V
			$V_{\text{IN}} \geq \text{OVLO}$ , $I_{\text{SINK}} = 1\text{mA}$			0.4	
$\overline{\text{FLAG}}$ Output High Leakage	$I_{\text{OH}}$	$V_{\overline{\text{FLAG}}} = 5.5\text{V}$ , $\overline{\text{FLAG}}$ deasserted				1	$\mu\text{A}$
$\overline{\text{EN}}$ Input High Voltage	$V_{\text{IH}}$			1.5			V
$\overline{\text{EN}}$ Input Low Voltage	$V_{\text{IL}}$					0.4	V
$\overline{\text{EN}}$ Input Leakage	$I_{\text{LKG}}$	$\overline{\text{EN}} = \text{GND}$ or 5.5V				1	$\mu\text{A}$

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MAX4838A/MAX4840A/MAX4842A

## ELECTRICAL CHARACTERISTICS (continued)

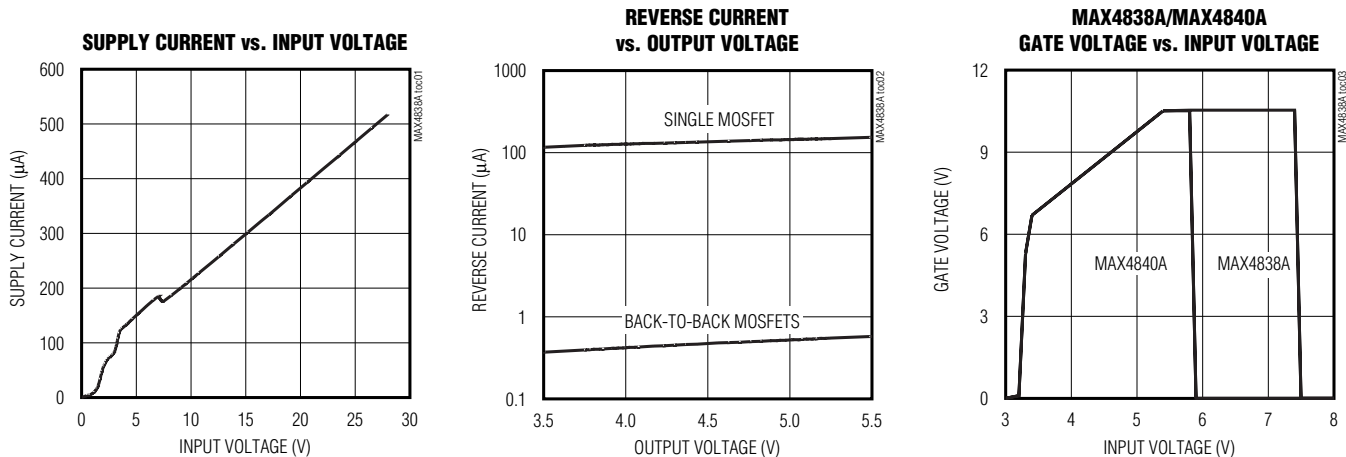
( $V_{IN} = +5V$  (MAX4838A/MAX4840A),  $V_{IN} = +4V$  (MAX4842A),  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>TIMING</b>						
Startup Delay	$t_{START}$	$V_{IN} > V_{UVLO}$ , $V_{GATE} > 0.3V$ , Figure 1	20	50	80	ms
FLAG Blanking Time	$t_{BLANK}$	$V_{GATE} > 0.3V$ , $V_{FLAG} > 2.4V$ , Figure 1	20	50	80	ms
GATE Turn-On Time	$t_{GON}$	$V_{GATE} = 0.3V$ to $8V$ (MAX4838A/MAX4840A), $V_{GATE} = 0.3V$ to $6V$ (MAX4842A), $C_{GATE} = 1500pF$ , Figure 1		10		ms
GATE Turn-Off Time	$t_{GOFF}$	$V_{IN}$ increasing from $5V$ to $8V$ at $3V/\mu s$ (MAX4838A/MAX4840A), $V_{IN}$ increasing from $4V$ to $6V$ at $3V/\mu s$ (MAX4842A), $V_{GATE} = 0.3V$ , $C_{GATE} = 1500pF$ , Figure 2		6	20	$\mu s$
FLAG Assertion Delay	$t_{FLAG}$	$V_{IN}$ increasing from $5V$ to $8V$ at $3V/\mu s$ (MAX4838A/MAX4840A), $V_{IN}$ increasing from $4V$ to $6V$ at $3V/\mu s$ (MAX4842A), $V_{FLAG} = 0.4V$ , Figure 2		5.8		$\mu s$
Initial Overvoltage Fault Delay	$t_{OVP}$	$V_{IN}$ increasing from $0$ to $8V$ (MAX4838A/MAX4840A), $V_{IN}$ increasing from $0V$ to $6V$ (MAX4842A), $I_{GATE} = 80\%$ of $I_{PD}$ , Figure 3		1.5		$\mu s$
Disable Time	$t_{DIS}$	$V_{EN} = 2.4V$ , $V_{GATE} = 0.3V$ , Figure 4		2		$\mu s$

**Note 1:** All parts are 100% tested at  $+25^{\circ}C$ . Electrical limits across the full temperature range are guaranteed by design and correlation.

## Typical Operating Characteristics

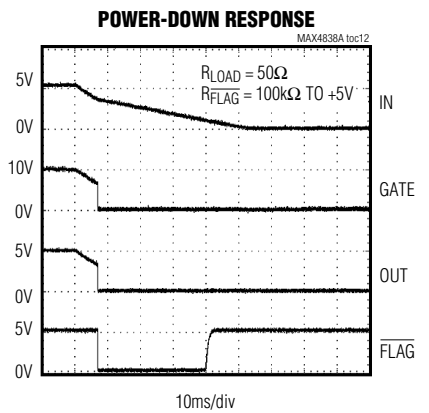
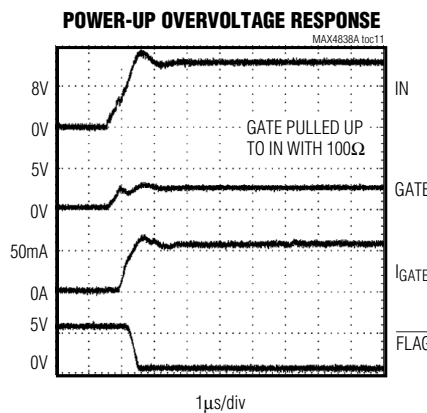
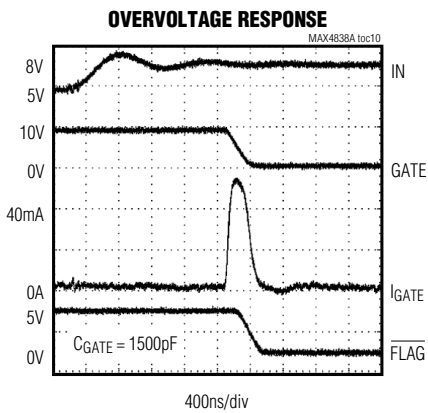
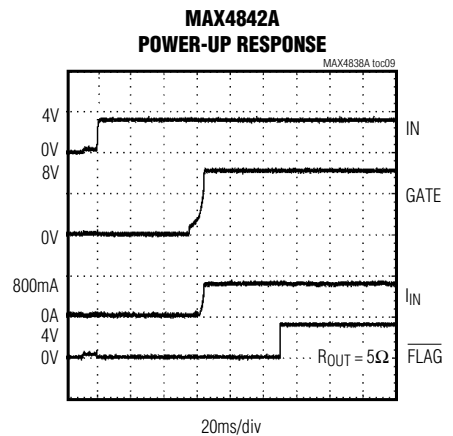
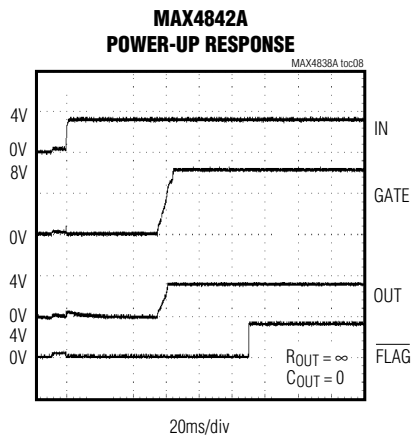
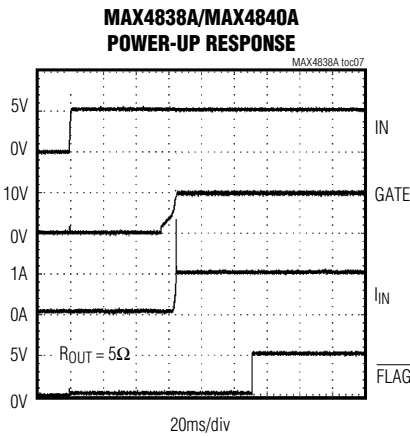
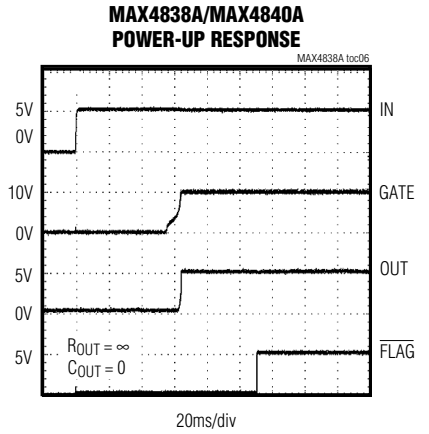
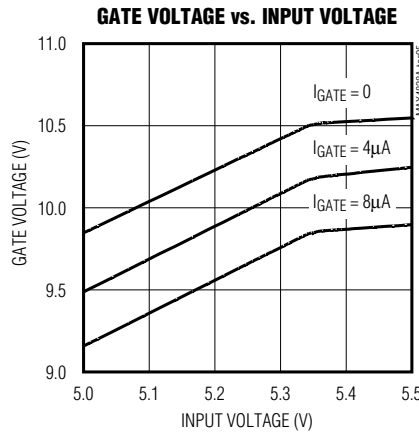
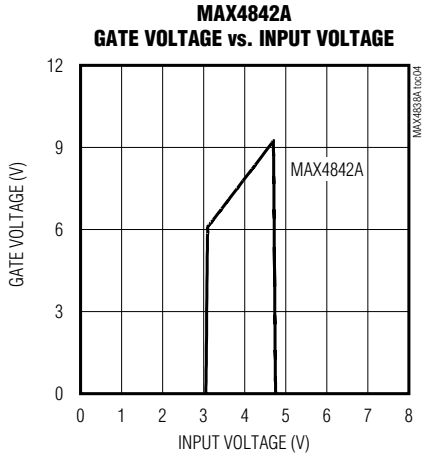
( $V_{IN} = +5V$  (MAX4838A/MAX4840A),  $V_{IN} = +4V$  (MAX4842A); Si9936DY external MOSFET in back-to-back configuration;  $T_A = +25^{\circ}C$ , unless otherwise noted.)



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## Typical Operating Characteristics (continued)

( $V_{IN} = +5V$  (MAX4838A/MAX4840A),  $V_{IN} = +4V$  (MAX4842A); Si9936DY external MOSFET in back-to-back configuration;  $T_A = +25^\circ C$ , unless otherwise noted.)



# Overvoltage-Protection Controllers with Status FLAG

## Pin Description

PIN	NAME	FUNCTION
1	IN	Input. IN is both the power-supply input and the overvoltage sense input. Bypass IN to GND with a 1 $\mu$ F capacitor or larger.
2	GND	Ground
3	$\overline{\text{FLAG}}$	Fault Indication Output, Open-Drain, Active Low. $\overline{\text{FLAG}}$ is asserted low during undervoltage-lockout and overvoltage-lockout conditions. $\overline{\text{FLAG}}$ is deasserted during normal operation.
4	GATE	Gate-Drive Output. GATE is the output of an on-chip charge pump. When $V_{\text{UVLO}} < V_{\text{IN}} < V_{\text{OVLO}}$ , GATE is driven high to turn on the external n-channel MOSFET(s).
5	N.C.	No Connection. Not internally connected for $\mu$ DFN package. Connected to ground for SC70 6-pin package; connect to ground or leave unconnected.
6	$\overline{\text{EN}}$	Device Enable Input, Active Low. Drive $\overline{\text{EN}}$ low or connect to ground to allow normal device operation. Drive $\overline{\text{EN}}$ high to turn off the external MOSFET.

## Timing Diagrams

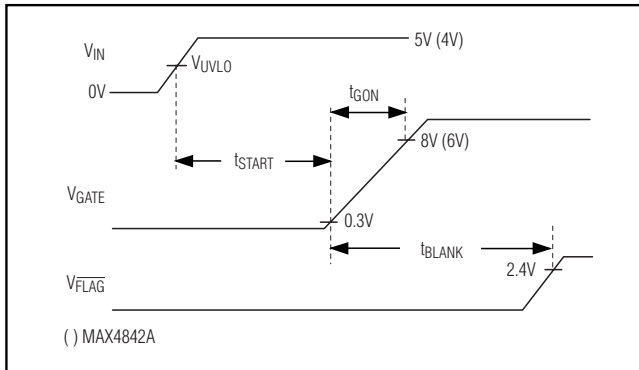


Figure 1. Startup Timing Diagram

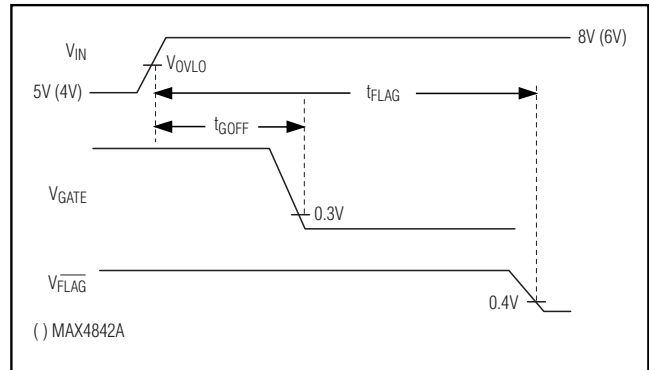


Figure 2. Shutdown Timing Diagram

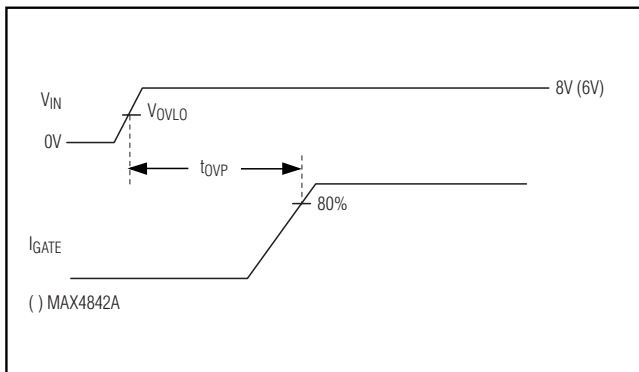


Figure 3. Power-Up Overvoltage Timing Diagram

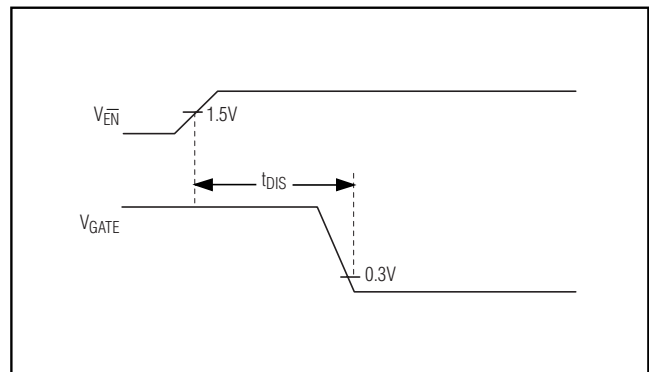


Figure 4. Disable Timing Diagram

MAX4838A/MAX4840A/MAX4842A

# Overvoltage-Protection Controllers with Status $\overline{FLAG}$

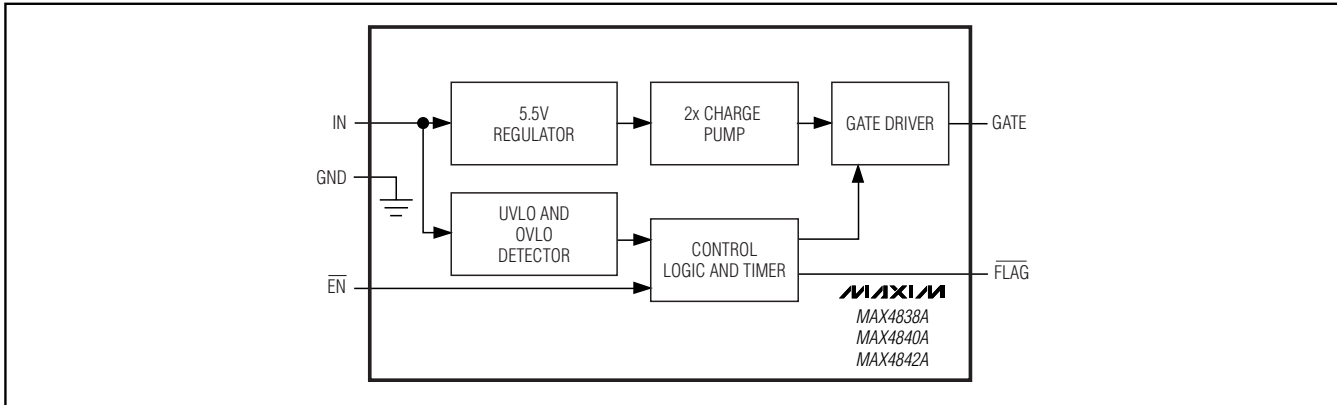


Figure 5. Functional Diagram

## Detailed Description

The MAX4838A/MAX4840A/MAX4842A provide up to +28V overvoltage protection for low-voltage systems. When the input voltage exceeds the overvoltage trip level, the MAX4838A/MAX4840A/MAX4842A turn off a low-cost external n-channel FET(s) to prevent damage to the protected components. An internal charge pump (Figure 5) drives the FET gate for a simple, robust solution.

### Undervoltage Lockout (UVLO)

The MAX4838A/MAX4840A have a fixed 3.25V typical undervoltage-lockout level (UVLO) while the MAX4842A has a 2.5V typical UVLO. When  $V_{IN}$  is less than the UVLO, the GATE driver is held low and  $\overline{FLAG}$  is asserted.

### Overvoltage Lockout (OVLO)

The MAX4838A has a 7.4V typical overvoltage threshold (OVLO), and the MAX4840A has a 5.8V typical overvoltage threshold. The MAX4842A has a 4.7V typical overvoltage threshold. When  $V_{IN}$  is greater than OVLO, the GATE driver is held low and  $\overline{FLAG}$  is asserted.

### $\overline{FLAG}$ Output

The  $\overline{FLAG}$  output is used to signal the host system there is a fault with the input voltage.  $\overline{FLAG}$  asserts immediately to an overvoltage fault.  $\overline{FLAG}$  is held low for 50ms after GATE turns on before deasserting.

All devices have an open-drain  $\overline{FLAG}$  output. Connect a pullup resistor from  $\overline{FLAG}$  to the logic I/O voltage of the host system.

### $\overline{EN}$ Enable Input

$\overline{EN}$  is an active-low enable input. Drive  $\overline{EN}$  low or connect to ground to enable normal device operation. Drive  $\overline{EN}$  high to force the external MOSFET(s) off.  $\overline{EN}$  does not override an OVLO or UVLO fault.

## GATE Driver

An on-chip charge pump is used to drive GATE above  $V_{IN}$ , allowing the use of low-cost n-channel MOSFETS. The charge pump operates from the internal 5.5V regulator.

The actual GATE output voltage tracks approximately two times  $V_{IN}$  until  $V_{IN}$  exceeds 5.5V or the OVLO trip level is exceeded, whichever comes first. The MAX4838A has a 7.4V typical OVLO; therefore GATE remains relatively constant at approximately 10.5V for  $5.5V < V_{IN} < 7.4V$ . The MAX4840A has a 5.8V typical OVLO, but this can be as low as 5.5V. The MAX4840A in practice may never actually achieve the full 10.5V GATE output. The MAX4842A has a 4.7V (typ) OVLO, and the GATE output voltage is 2x the input voltage. The GATE output voltage as a function of input voltage is shown in the *Typical Operating Characteristics*.

## Device Operation

The MAX4838A/MAX4840A/MAX4842A have an on-board state machine to control device operation. A flowchart is shown in Figure 6. On initial power-up, if  $V_{IN} < UVLO$  or if  $V_{IN} > OVLO$ , GATE is held at 0V, and  $\overline{FLAG}$  is low.

If  $UVLO < V_{IN} < OVLO$  and  $\overline{EN}$  is low, the device enters startup after a 50ms internal delay. The internal charge pump is enabled, and GATE begins to be driven above  $V_{IN}$  by the internal charge pump.  $\overline{FLAG}$  is held low during startup until the  $\overline{FLAG}$  blanking period expires, typically 50ms after the GATE starts going high. At this point the device is in its on state.

At any time if  $V_{IN}$  drops below UVLO,  $\overline{FLAG}$  is driven low and GATE is driven to ground.

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MAX4838A/MAX4840A/MAX4842A

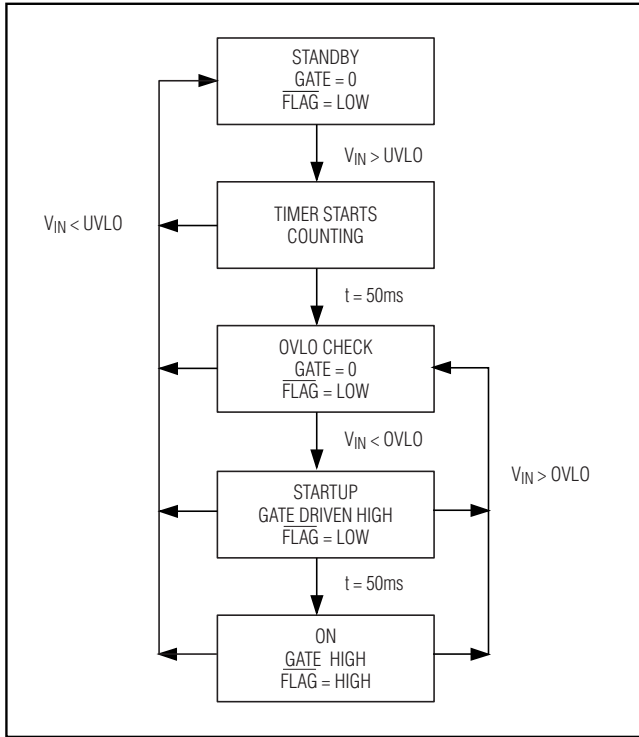


Figure 6. State Diagram

## Applications Information

### MOSFET Configuration

The MAX4838A/MAX4840A/MAX4842A can be used with either a single MOSFET configuration as shown in the *Typical Operating Circuit*, or can be configured with a back-to-back MOSFET as shown in Figure 7. The back-to-back configuration has almost zero reverse current when the input supply is below the output.

If reverse current leakage is not a concern, a single MOSFET can be used. This approach has half the loss of the back-to-back configuration when used with similar MOSFET types, and is a lower cost solution. Note that if the input is actually pulled low, the output is pulled low as well due to the parasitic body diode in the MOSFET. If this is a concern, then the back-to-back configuration should be used.

### MOSFET Selection

The MAX4838A/MAX4840A/MAX4842A are designed for use with either a single n-channel MOSFET or dual back-to-back n-channel MOSFETs. In most situations, MOSFETs with  $R_{DS(ON)}$  specified for a  $V_{GS}$  of 4.5V work well. If the input supply is near the UVLO maximum of

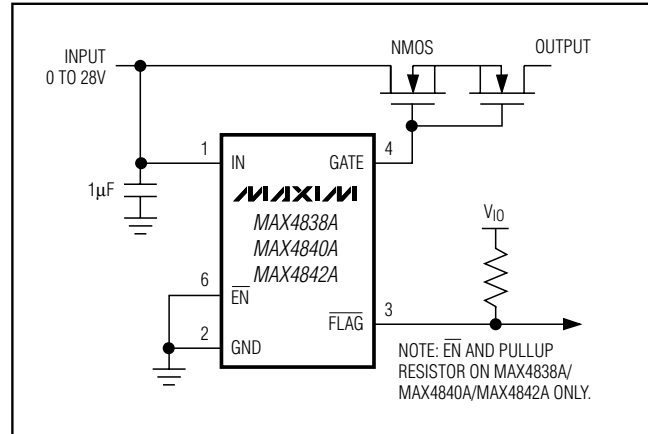


Figure 7. Back-to-Back External MOSFET Configuration

3.5V, consider using a MOSFET specified for a lower  $V_{GS}$  voltage. Also, the  $V_{DS}$  should be 30V for the MOSFET to withstand the full 28V IN range of all devices. Table 1 shows a selection of MOSFETs appropriate for use with the MAX4838A/MAX4840A/MAX4842A.

### IN Bypass Considerations

For most applications, bypass IN to GND with a 1µF ceramic capacitor. If the power source has significant inductance due to long lead length, take care to prevent overshoots due to the LC tank circuit and provide protection if necessary to prevent exceeding the 30V absolute maximum rating on IN.

The MAX4838A/MAX4840A/MAX4842A provide protection against voltage faults up to 28V, but this does not include negative voltages. If negative voltages are a concern, connect a Schottky diode from IN to GND to clamp negative input voltages.

### ESD Test Conditions

ESD performance depends on a number of conditions. The MAX4838A/MAX4840A/MAX4842A are specified for ±15kV typical ESD resistance on IN when IN is bypassed to ground with a 1µF ceramic capacitor. Contact Maxim for a reliability report that documents test setup, methodology, and results.

### Human Body Model

Figure 8 shows the Human Body Model, and Figure 9 shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the device through a 1.5kΩ resistor.

# Overvoltage-Protection Controllers with Status **FLAG**

**Table 1. MOSFET Suggestions**

PART	CONFIGURATION/ PACKAGE	V <sub>DS</sub> MAX (V)	R <sub>ON</sub> AT 4.5V (mΩ)	MANUFACTURER
Si5902DC	Dual/1206-8	30	143	Vishay Silconix www.vishay.com 402-563-6866
Si1426DH	Single/SC70-6	30	115	
FDC6305N	Dual/SSOT-6	20	80	Fairchild Semiconductor www.fairchildsemi.com 207-775-8100
FDC6561AN	Dual/ SSOT-6	30	145	
FDG315N	Single/SC70-6	30	160	

**IEC 61000-4-2**

Since January 1996, all equipment manufactured and/or sold in the European community has been required to meet the stringent IEC 61000-4-2 specification. The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX4838A/MAX4840A/MAX4842A help users design equipment that meets Level 3 of IEC 61000-4-2, without additional ESD-protection components.

The main difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2. Because series resistance is lower in the IEC 61000-4-2 ESD test model (Figure 10),

the ESD-withstand voltage measured to this standard is generally lower than that measured using the Human Body Model. Figure 11 shows the current waveform for the ±8kV IEC 61000-4-2 Level 4 ESD Contact Discharge test. The Air-Gap test involves approaching the device with a charger probe. The Contact Discharge method connects the probe to the device before the probe is energized.

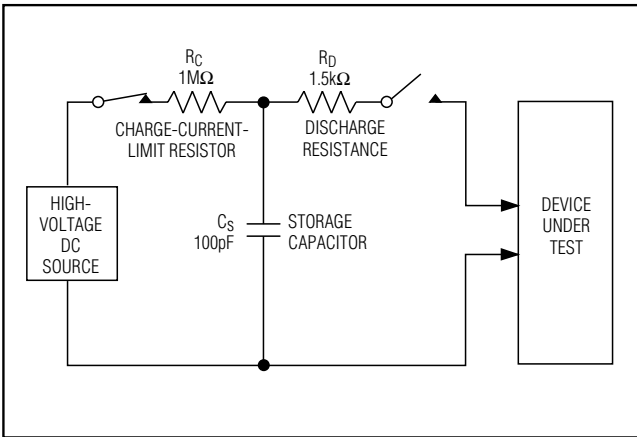


Figure 8. Human Body ESD Test Model

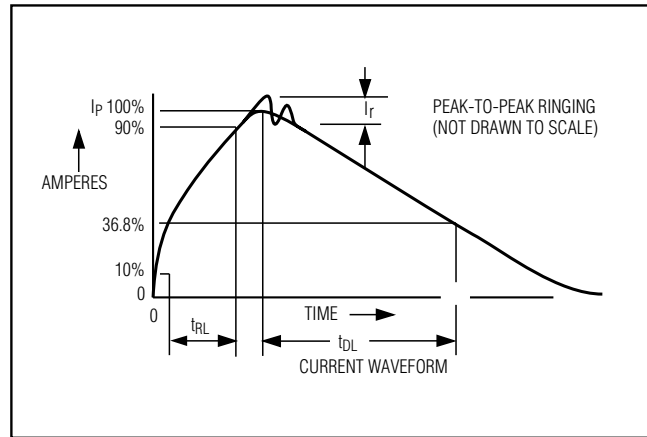


Figure 9. Human Body Model Current Waveform

# Overvoltage-Protection Controllers with Status **FLAG**

**MAX4838A/MAX4840A/MAX4842A**

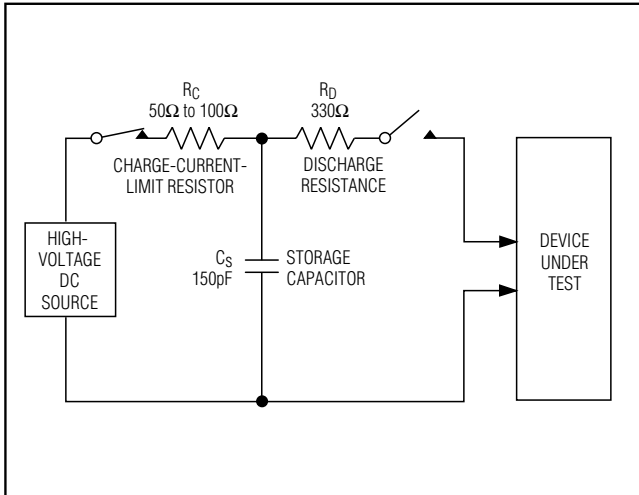


Figure 10. IEC 61000-4-2 ESD Test Model

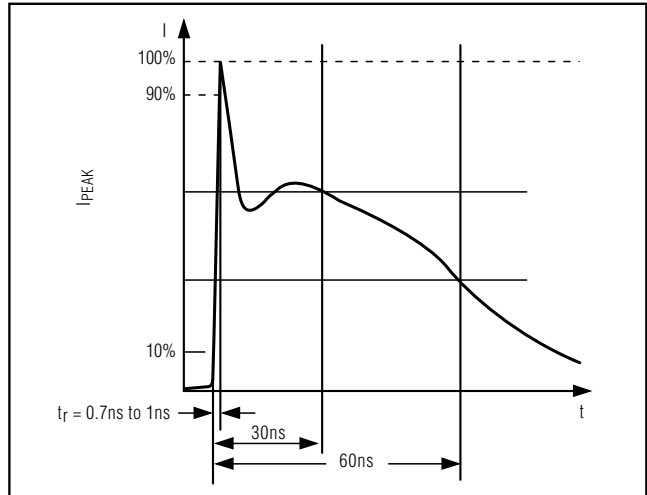
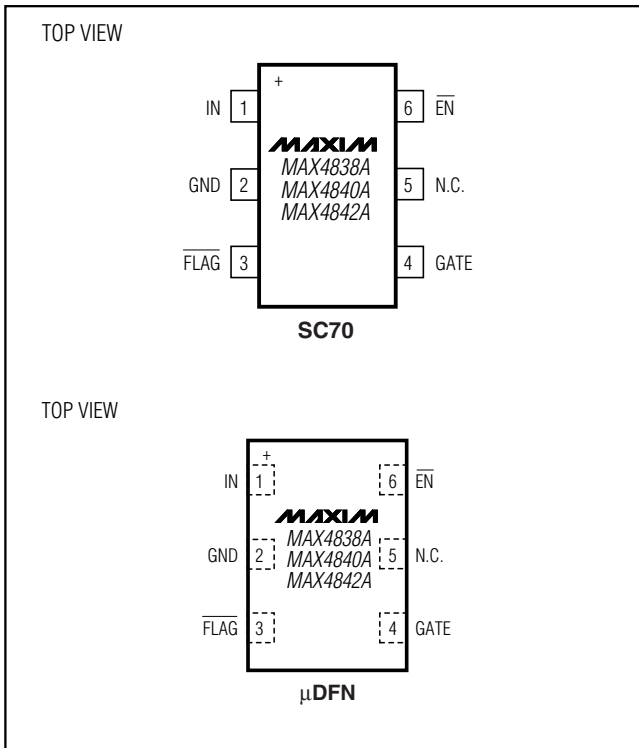


Figure 11. IEC 61000-4-2 ESD Generator Current

## Pin Configurations



## Chip Information

PROCESS: BiCMOS



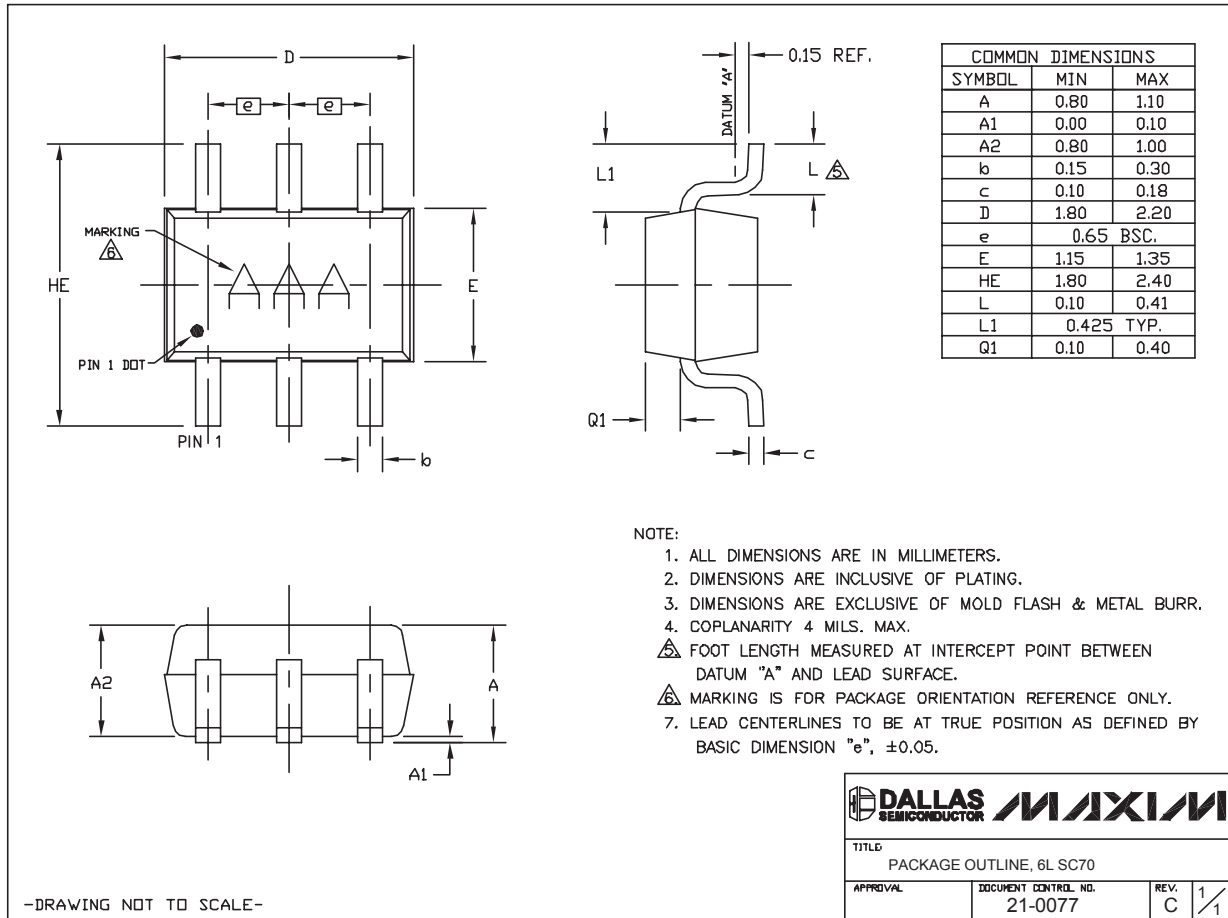


# Overvoltage-Protection Controllers with Status FLAG

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX4838A/MAX4840A/MAX4842A



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