# +65V Simple Swapper Hot-Swap Switches

## ABSOLUTE MAXIMUM RATINGS

$V_{IN}$, $V_{OUT}$ to GND .....-0.3V to +70.0V
ENABLE to GND .....-0.3V to +12.0V
PGOOD, IFAULT to GND .....-0.3V to +12.0V
UVLO to GND .....-0.3V to ($V_{IN}$ + 0.3V)
PGOOD, IFAULT Sink Current .....10mA
Continuous Power Dissipation ($T_A$ = +70°C)
8-Pin SO (derate 5.9mW/°C above +70°C).....470mW
16-Pin SO (derate 12.9mW/°C above +70°C).....1039mW

Operating Temperature Range .....-40°C to +85°C
Maximum Junction Temperature .....+150°C
Storage Temperature Range .....-60°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

($V_{IN}$ = +42V, GND = 0, UVLO = open circuit, $V_{ENABLE}$ = +3.3V, and $T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | | | 10 | | 65 | V |
| Supply Current | $I_{IN}$ | $V_{IN}$ = 10V to 65V (Note 1) | | | 1.2 | 2.5 | mA |
| Output Current Limit | $I_{LIM}$ | $V_{OUT}$ = $V_{IN}$ - 5V, $V_{IN}$ = 10V to 65V | MAX5910 | 250 | 280 | 310 | mA |
| | | | MAX5917A | 510 | 567 | 623 | |
| | | | MAX5917B | 370 | 420 | 470 | |
| Continuous Operating Output Current | $I_{OUT}$ | (Note 2) | MAX5910 | | | 240 | mA |
| | | | MAX5917A | | | 400 | |
| | | | MAX5917B | | | 350 | |
| DMOS On-Resistance | $R_{DS(ON)}$ | $V_{IN}$ = 10V to 65V, MAX5910, $I_{OUT}$ = 200mA, MAX5917A, $I_{OUT}$ = 400mA, MAX5917B, $I_{OUT}$ = 300mA | | | 2.2 | 4 | Ω |
| ENABLE Voltage Logic Low | $V_{LOW}$ | | | | | 0.8 | V |
| ENABLE Voltage Logic High | $V_{HIGH}$ | | | 2.4 | | | V |
| ENABLE High Input Current | $I_{IH}$ | $V_{ENABLE}$ = +5V | | | | 1 | µA |
| IFAULT Output Leakage Current | $I_{OH}$ | $\overline{IFAULT}$ = 10V, $I_{OH}$ > ($IF_{TH}$ + $IF_{HYS}$) | | | | 1 | µA |
| PGOOD Output Leakage Current | $IL_{PGOOD}$ | PGOOD = 10V, $V_{OUT}$ > $V_{PG}$ | | | | 1 | µA |
| $V_{IN}$ to $V_{OUT}$ Leakage Current | $IL_{IN/OUT}$ | ENABLE = 0, $V_{IN}$ = +65V | | | | 1 | µA |
| PGOOD/$\overline{IFAULT}$ Output Logic Low | $V_{OL}$ | Sink current = 3mA | | | | 0.4 | V |
| PGOOD Threshold | $V_{PG}$ | Percentage of $V_{IN}$, $V_{OUT}$ rising | | 71 | 78 | 85 | % |
| PGOOD Hysteresis | $PG_{HYS}$ | Percentage of $V_{IN}$ | | | 10 | | % |
| Zero-Current Detection Threshold | $IF_{TH}$ | Decreasing output current | MAX5910 | 2 | 12 | 25 | mA |
| | | | MAX5917A | 2 | 6 | 10 | |
| | | | MAX5917B | 2 | 12 | 25 | |

## ELECTRICAL CHARACTERISTICS (continued)

($V_{IN}$ = +42V, GND = 0, UVLO = open circuit, $V_{ENABLE}$ = +3.3V, and $T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Zero-Current Detection Threshold Hysteresis | $IF_{HYS}$ | Percentage of $IF_{TH}$ | | 10 | | % |
| $\overline{IFAULT}$ Output Delay | $t_{IFD}$ | (Figure 1) | 7 | 12 | 17 | ms |
| PGOOD Output Delay | $t_{PGD}$ | (Figure 2) | 7 | 12 | 17 | ms |
| Thermal Shutdown Temperature | $T_J$ | Die temperature increasing | | 140 | | °C |
| Thermal Shutdown Hysteresis | $T_{JHYS}$ | | | 3.5 | | °C |
| Default Undervoltage Lockout | $V_{UVLO}$ | $V_{IN}$ decreasing | 24.5 | 26.5 | 28.5 | V |
| Undervoltage Lockout Hysteresis | $UVLO_{HYS}$ | Percentage of $V_{UVLO}$ | | 11 | | % |
| Minimum Undervoltage Lockout Threshold | $V_{UVLO}$ (MIN) | UVLO connected to $V_{IN}$, $V_{IN}$ decreasing | 7 | 7.5 | 8 | V |
| Undervoltage Lockout Input Resistance | $R_{UVLO}$ | Force I = 5µA into UVLO pin | 260 | | | kΩ |

**Note 1:** Measured at GND pin at the end of the output voltage slew.
**Note 2:** Guaranteed by $R_{DSON}$ test. Limited by package power dissipation.

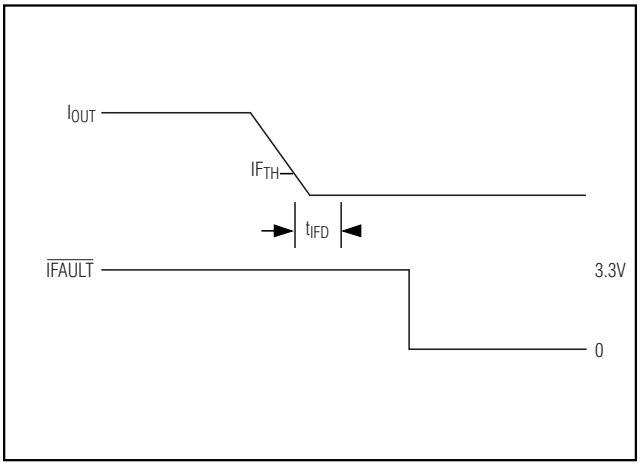



*Figure 1. $\overline{IFAULT}$ Delay*

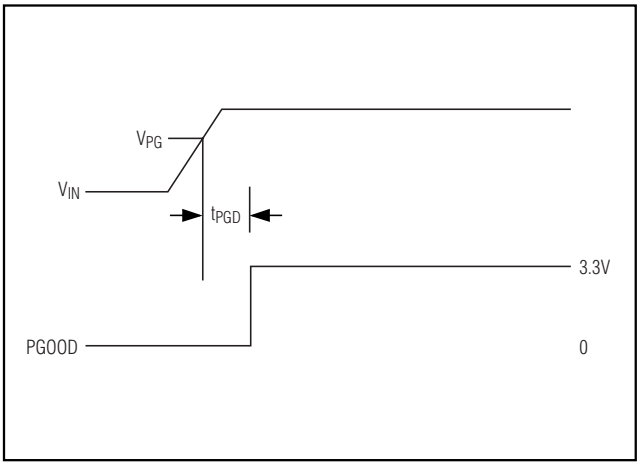


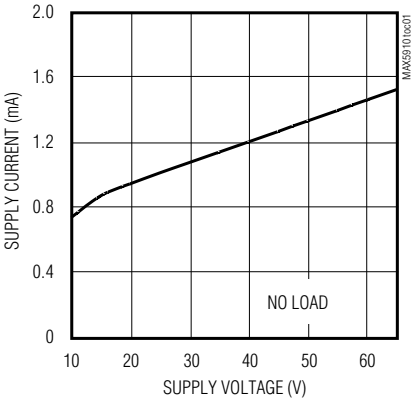

*Figure 2. Power-Good Delay*

# +65V Simple Swapper Hot-Swap Switches

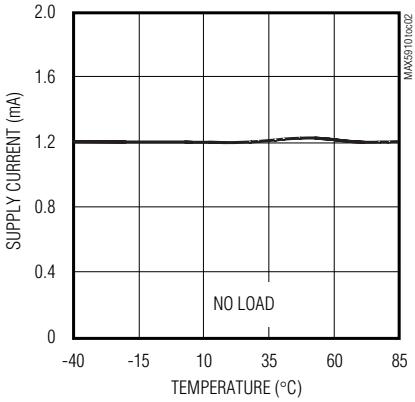
## Typical Operating Characteristics

($V_{IN}$ = +42V, GND = 0, UVLO = open circuit, $V_{ENABLE}$ = 3.3V, $R_L$ = 1.8kΩ, $T_A$ = +25°C, unless otherwise noted).

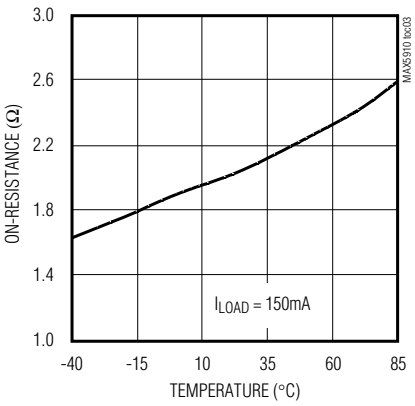
**SUPPLY CURRENT vs. SUPPLY VOLTAGE**



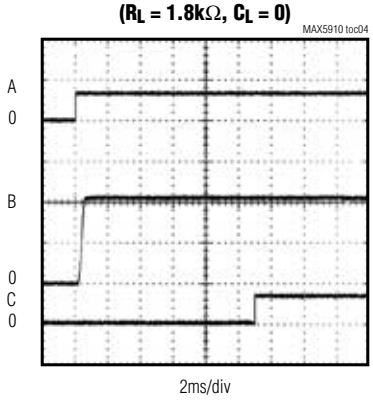

**SUPPLY CURRENT vs. TEMPERATURE**




**ON-RESISTANCE vs. TEMPERATURE**

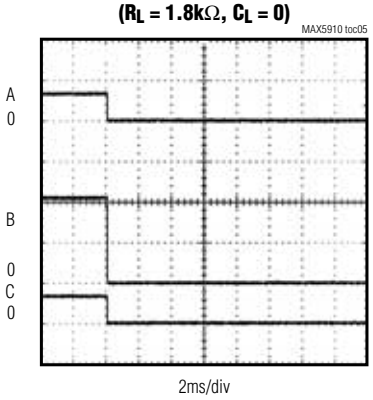



**MAX5910 TURN-ON WAVEFORMS ($R_L$ = 1.8kΩ, $C_L$ = 0)**



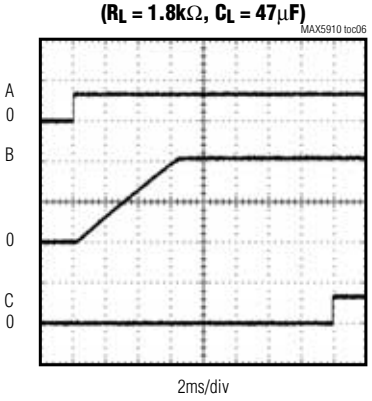

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5910 TURN-OFF WAVEFORMS ($R_L$ = 1.8kΩ, $C_L$ = 0)**




A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5910 TURN-ON WAVEFORMS ($R_L$ = 1.8kΩ, $C_L$ = 47μF)**

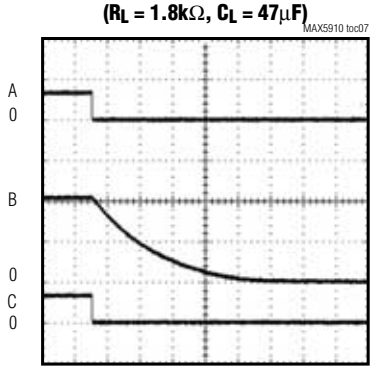



A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

## Typical Operating Characteristics (continued)

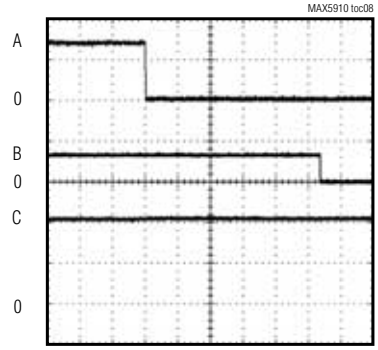
($V_{IN}$ = +42V, GND = 0, UVLO = open circuit, $V_{ENABLE}$ = 3.3V, $R_L$ = 1.8kΩ, $T_A$ = +25°C, unless otherwise noted).

**MAX5910 TURN-OFF WAVEFORMS**
**($R_L$ = 1.8kΩ, $C_L$ = 47µF)**



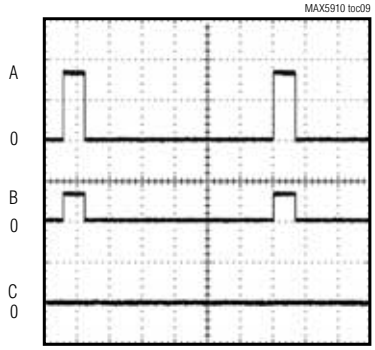

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5910 ZERO-CURRENT RESPONSE**



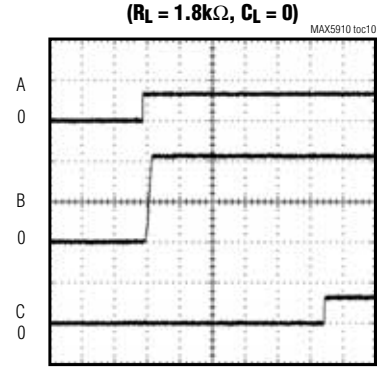

A: $I_{OUT}$, 100mA/div
B: IFAULT, 5V/div
C: $V_{OUT}$, 20V/div

**MAX5910 OVER-CURRENT RESPONSE**



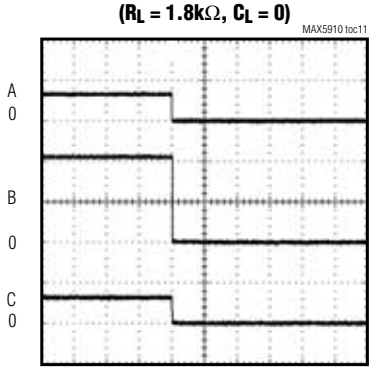

A: $I_{OUT}$, 200mA/div
B: IFAULT, 5V/div
C: $V_{OUT}$, 20V/div (SHORTED TO GND)

**MAX5917B TURN-ON WAVEFORMS**
**($R_L$ = 1.8kΩ, $C_L$ = 0)**



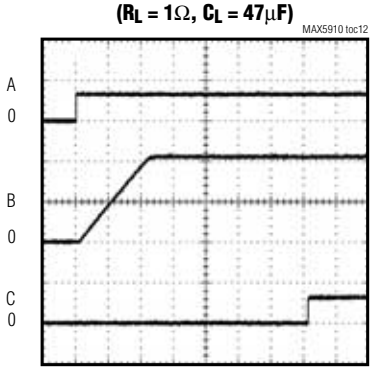

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5917B TURN-OFF WAVEFORMS**
**($R_L$ = 1.8kΩ, $C_L$ = 0)**




A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5917B TURN-ON WAVEFORMS**
**($R_L$ = 1Ω, $C_L$ = 47µF)**



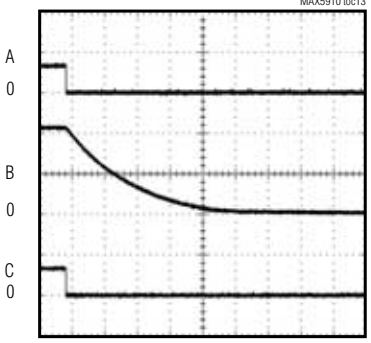

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

# +65V Simple Swapper Hot-Swap Switches

## Typical Operating Characteristics (continued)

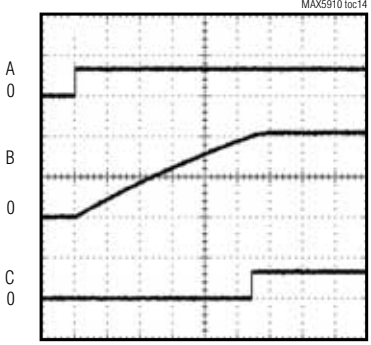
($V_{IN}$ = +42V, GND = 0, UVLO = open circuit, $V_{ENABLE}$ = 3.3V, $R_L$ = 1.8kΩ, $T_A$ = +25°C, unless otherwise noted).

**MAX5917B TURN-OFF WAVEFORMS**
**($R_L$ = 1.8kΩ, $C_L$ = 47μF)**



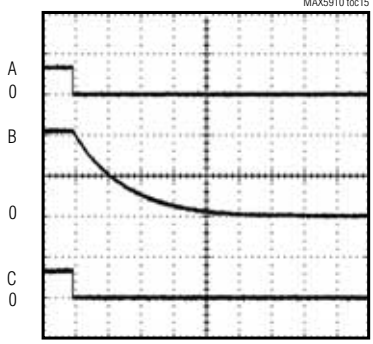

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5917B TURN-ON WAVEFORMS**
**($R_L$ = 300Ω, $C_L$ = 500μF)**



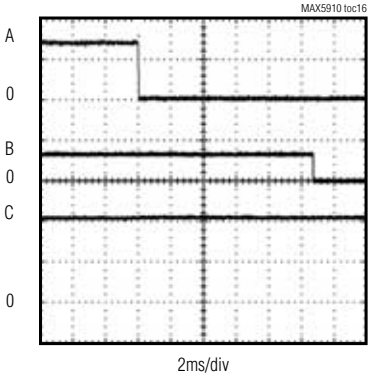

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5917B TURN-OFF WAVEFORMS**
**($R_L$ = 300Ω, $C_L$ = 500μF)**



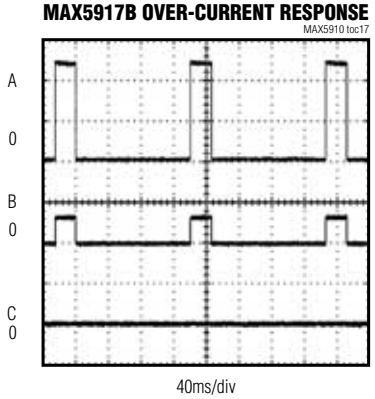

A: ENABLE, 5V/div
B: $V_{OUT}$, 20V/div
C: PGOOD, 5V/div

**MAX5917B ZERO-CURRENT RESPONSE**



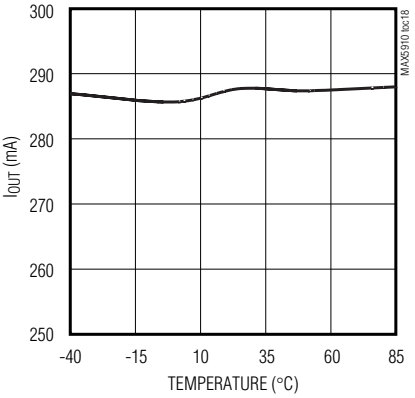

A: $I_{OUT}$, 100mA/div
B: IFAULT, 5V/div
C: $V_{OUT}$, 20V/div

**MAX5917B OVER-CURRENT RESPONSE**




A: $I_{OUT}$, 200mA/div
B: IFAULT, 5V/div
C: $V_{OUT}$, 20V/div (SHORTED TO GND)

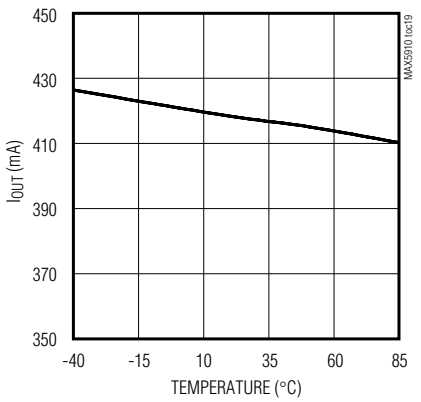
**MAX5910 $I_{OUT}$ vs. TEMPERATURE**



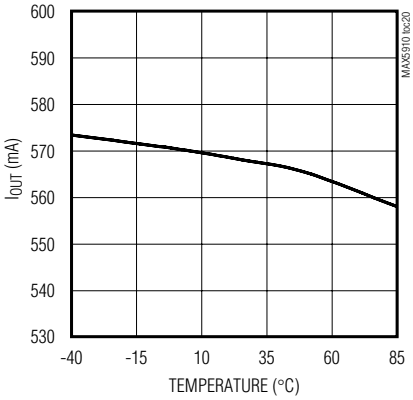
## Typical Operating Characteristics (continued)

($V_{IN}$ = +42V, GND = 0, UVLO = open circuit, $V_{ENABLE}$ = 3.3V, $R_L$ = 1.8kΩ, $T_A$ = +25°C, unless otherwise noted).

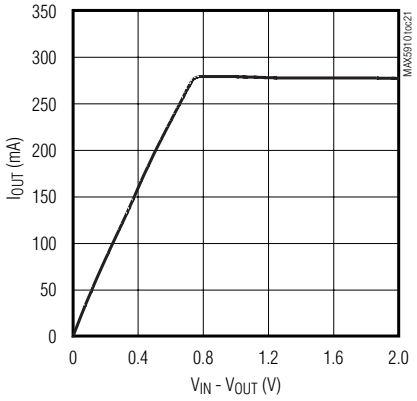
**MAX5917B $I_{OUT}$ vs. TEMPERATURE**



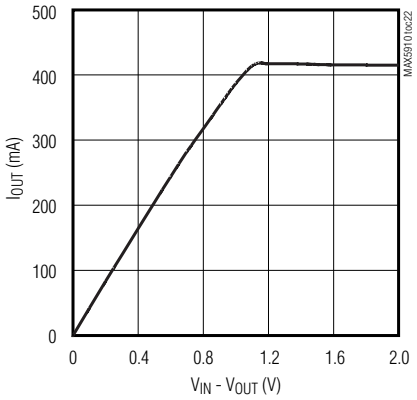

**MAX5917A $I_{OUT}$ vs. TEMPERATURE**



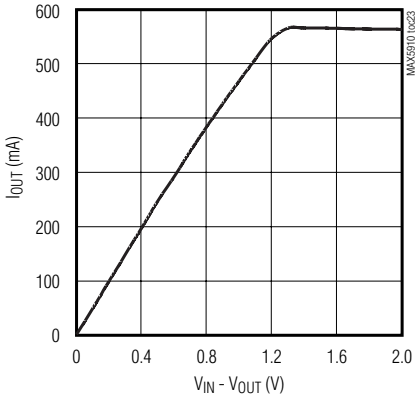

**MAX5910 $I_{OUT}$ vs. ($V_{IN}$ - $V_{OUT}$)**




**MAX5917B $I_{OUT}$ vs. ($V_{IN}$ - $V_{OUT}$)**




**MAX5917A $I_{OUT}$ vs. ($V_{IN}$ - $V_{OUT}$)**



# +65V Simple Swapper Hot-Swap Switches

## Pin Description

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| MAX5910 | MAX5917A/B | | |
| 1 | 2 | UVLO | Undervoltage Lockout Input. Leave UVLO open circuit for the default setting of 26.5V. Alternatively, UVLO can be connected to a resistive-divider to set a desired lockout voltage. See the *Changing the Undervoltage Lockout Setting* section. |
| 2 | 3 | $V_{IN}$ | Voltage Input Terminal. Bypass $V_{IN}$ to GND with a 0.1µF capacitor to improve noise immunity. |
| 3 | 1, 6, 8, 9, 15, 16 | N.C. | No Connection. Not internally connected. |
| 4 | 7 | ENABLE | 3.3V Logic Input (TTL compatible), Active-High. Turns the internal FET on or off. Drive ENABLE high to enable $V_{OUT}$. Drive ENABLE low to disable $V_{OUT}$. |
| 5 | 10 | PGOOD | Open-Drain Logic Output, Active-High. PGOOD signals that the output is within specification. When the output is less than 70% of the input, the PGOOD signal is pulled low. Connect a 10kΩ pullup resistor (R) to 3.3V. |
| 6 | 11 | $\overline{IFAULT}$ | Open-Drain Logic Output, Active-Low. $\overline{IFAULT}$ is asserted when the output current falls below the $IF_{TH}$ nominal threshold or when the switch is off. Connect a 10kΩ pullup resistor (R) to 3.3V. |
| 7 | 4, 5, 12, 13 | GND | Ground |
| 8 | 14 | $V_{OUT}$ | Voltage Output Terminal |

## Detailed Description

The MAX5910/MAX5917 are fully integrated hot-swap switches for positive power-supply rails. The devices allow safe insertion and removal of circuit cards into live backplanes or ports without causing glitches on the backplane power-supply rail. During startup these devices act as current regulators using their on-board FET to limit the amount of current drawn by the load to 280mA for MAX5910, 567mA for MAX5917A, and 420mA for MAX5917B. If the required load current exceeds that current limit, the internal switch behaves like a constant current source.

The MAX5910/MAX5917 monitor the input voltage, the output voltage, the output current, and the die temperature. They assert $\overline{IFAULT}$ and PGOOD accordingly if they detect an error condition.

A zero-current load detection feature activates if the load current drops below $IF_{TH}$ for over 12ms. The MAX5910/MAX5917 also include an ENABLE input allowing the host system to turn the FET on or off.

## Normal Operation

### Startup

When power is first applied with ENABLE high, or when ENABLE is asserted, the MAX5910/MAX5917A/MAX5917B limit the current to the load to 280mA/567mA/420mA. PGOOD is asserted high 12ms after the output voltage exceeds the power-good threshold. PGOOD is pulled low if $V_{OUT}$ is less than 70% $V_{IN}$.

### Zero-Current Load Fault

A zero-current load detection feature activates if the load current drops below $IF_{TH}$ for more than 12ms. The MAX5910/MAX5917 flag the zero-current condition but do not disconnect the load. $\overline{IFAULT}$ is deasserted whenever the load current exceeds the $IF_{TH}$ + $IF_{HYS}$ zero-current detection threshold.

### Undervoltage Lockout Fault

If $V_{IN} \leq$ UVLO, where UVLO is the desired voltage at which the UVLO fault occurs, the internal FET is turned off and $\overline{IFAULT}$ and PGOOD are pulled low. The default UVLO voltage is 26.5V, but it can be adjusted using an external resistive-divider (see the *Changing the Undervoltage Lockout Setting* section).

### Thermal Shutdown Fault

The MAX5910/MAX5917 monitor their internal die temperature. If the temperature of the die exceeds +140°C, the internal FET is turned off and $\overline{IFAULT}$ and PGOOD are pulled low. The output is enabled again only when the die temperature is below the thermal shutdown temperature by 3.5°C typically.

### Power-Good (PGOOD)

Power-good (PGOOD) logic output signals when the output has exceeded the PGOOD threshold. When the output voltage is below 70% of the input voltage, PGOOD is pulled low. When the output voltage is larger than 80% of the input voltage for more than 12ms, PGOOD is asserted.

## Applications Information

### Choosing a Device

The MAX5910 can output 280mA, the MAX5917B can output 420mA, and the MAX5917A can output up to 567mA. In applications where high power is expected, use the MAX5917 for its superior heat dissipation properties, and always solder all of its GND pins to a large section of circuit board copper.

### Logic Control

The enable input (ENABLE) responds to 3.3V logic signals and will force the internal FET off if ENABLE is pulled low. This feature allows the host to disconnect the load from the power bus if required. Drive ENABLE high to enable $V_{OUT}$.

### Changing the Undervoltage Lockout Setting

The undervoltage lockout (UVLO) value defaults to 26.5V if the UVLO pin is left open circuit (Figure 3). Connect UVLO to $V_{IN}$ to set the undervoltage lockout to a minimum of 7.5V (Figure 4). This lockout voltage can also be changed with a resistive-divider from $V_{IN}$ to GND. The center node of the divider is connected to the UVLO pin (Figure 5). The values of R1 and R2 must satisfy the condition R1//R2 << 260kΩ and R2 << 1.65MΩ. R2 can be calculated as follows:

$$R2 = R1 \times [(V_{UVLO} / 7.5V) - 1]$$

where $V_{IN\ (UVLO)}$ is the desired lockout voltage.

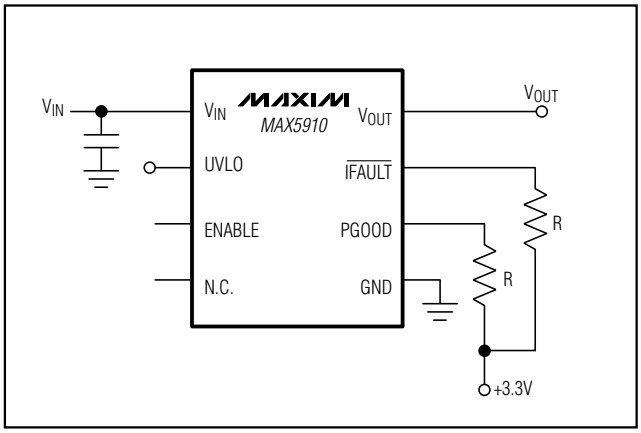



*Figure 3. UVLO is Set Internally to its +26.5V Default Value*

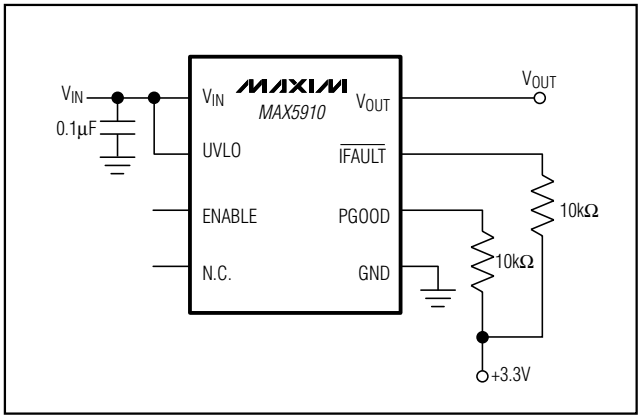



*Figure 4. Minimum +7.5V UVLO Configuration*

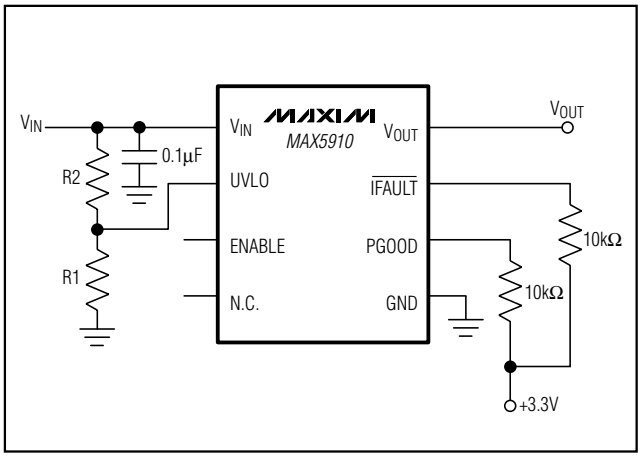
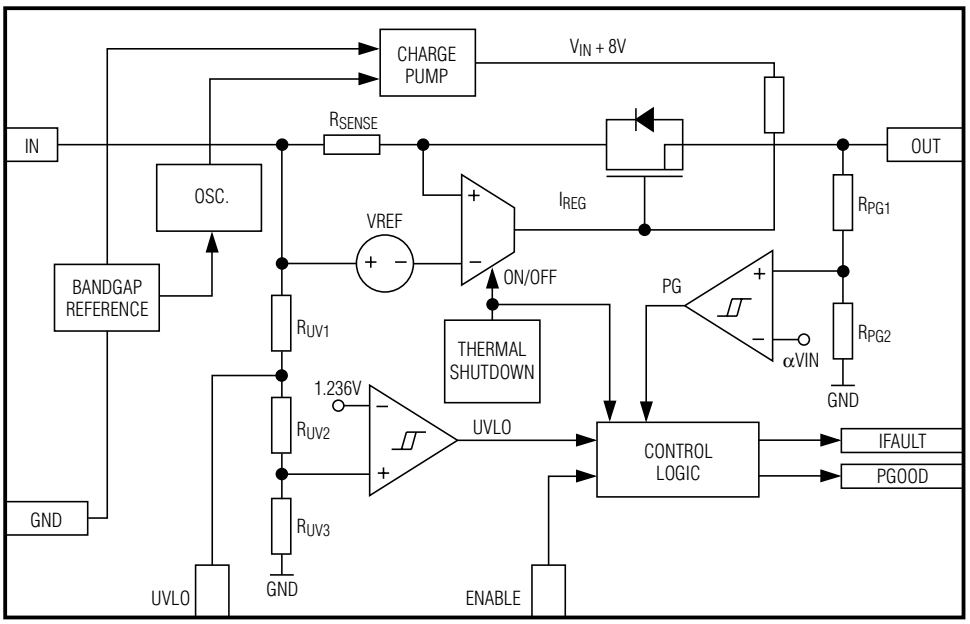



*Figure 5. Adjusting UVLO with an External Resistive-Divider*

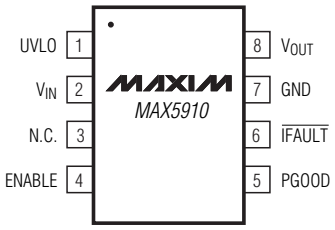
# +65V Simple Swapper Hot-Swap Switches

## Functional Diagram

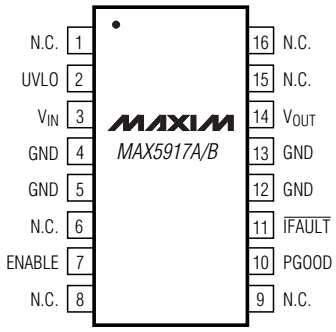



## Pin Configurations

TOP VIEW




**8 SO**




**16 SO**

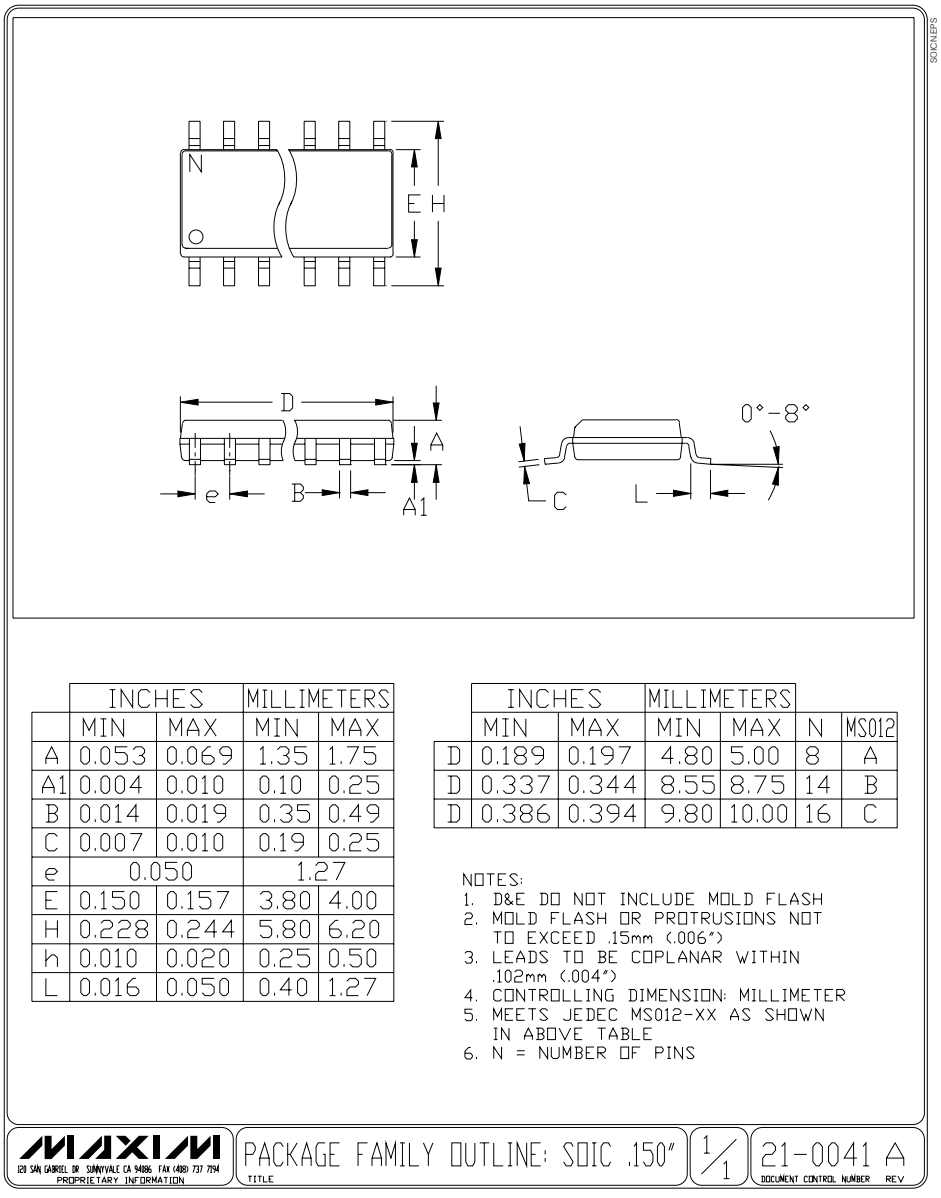
# +65V Simple Swapper Hot-Swap Switches

## Chip Information

TRANSISTOR COUNT: 1003

PROCESS: SG3ISO

## Package Information




| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.053 | 0.069 | 1.35 | 1.75 |
| A1 | 0.004 | 0.010 | 0.10 | 0.25 |
| B | 0.014 | 0.019 | 0.35 | 0.49 |
| C | 0.007 | 0.010 | 0.19 | 0.25 |
| e | 0.050 | | 1.27 | |
| E | 0.150 | 0.157 | 3.80 | 4.00 |
| H | 0.228 | 0.244 | 5.80 | 6.20 |
| h | 0.010 | 0.020 | 0.25 | 0.50 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

| | INCHES | | MILLIMETERS | | | |
|---|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | N | MS012 |
| D | 0.189 | 0.197 | 4.80 | 5.00 | 8 | A |
| D | 0.337 | 0.344 | 8.55 | 8.75 | 14 | B |
| D | 0.386 | 0.394 | 9.80 | 10.00 | 16 | C |

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194 PROPRIETARY INFORMATION | PACKAGE FAMILY OUTLINE: SOIC .150" TITLE | 1/1 | 21-0041 A DOCUMENT CONTROL NUMBER REV