



# 450mA/500mA Current-Limit Switches

MAX4795-MAX4798

## General Description

The MAX4795-MAX4798 family of switches feature internal current limiting to prevent damage to host devices due to faulty load conditions. These analog switches have a low  $0.2\Omega$  on-resistance and operate from a 2.0V to 4.5V input voltage range. They are available with guaranteed 450mA and 500mA current limits, making them ideal for SDIO and other load-switching applications.

When the switch is on and a load is connected to the port, a guaranteed blanking time of 14ms ensures the transient voltages settle down. If after this blanking time, the load current is greater than the current limit, the MAX4795 and MAX4797 switches are turned off and FLAG is issued to the microprocessor. The switch can be turned on again by cycling the power or the ON input.

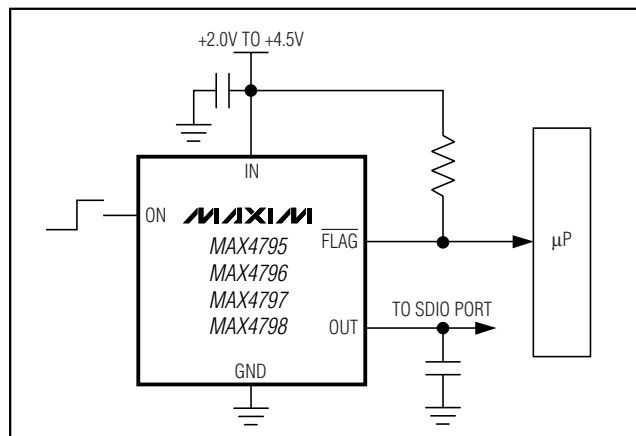
The MAX4796 and MAX4798 have an autoretry feature where the switch turns off and issues a FLAG to the microprocessor after the blanking time and then continuously checks to see if the overload condition is present. The switch remains on after the overload condition disappears and FLAG deasserts.

The MAX4795-MAX4798 are available in tiny, space-saving, 5-pin SOT23 and 6-pin TDFN (3mm x 3mm) packages.

## Applications

SDIO  
PDAs and Palmtop Devices  
Cell Phones  
GPS Systems  
Hand-Held Devices

## Typical Operating Circuit



## Features

- ◆ Guaranteed Current Limit: 450mA and 500mA
- ◆ Thermal-Shutdown Protection
- ◆ Reverse-Current Protection
- ◆  $0.2\Omega$  On-Resistance
- ◆ 14ms Guaranteed Blanking Time
- ◆ FLAG Function
- ◆ Autoretry (MAX4796/MAX4798)
- ◆ 80μA Supply Current
- ◆ 6μA Latchoff Current (MAX4795/MAX4797)
- ◆ 0.01μA Shutdown Current
- ◆ +2V to +4.5V Supply Range
- ◆ Fast Current-Limit Response Time
- ◆ Tiny SOT23 and TDFN Packages
- ◆ UL Certification Pending

## Ordering Information

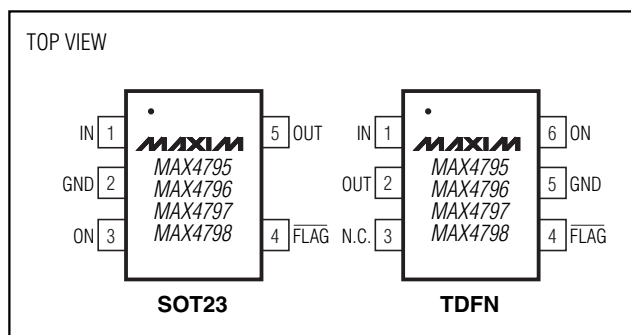
| PART         | TEMP RANGE     | PIN-PACKAGE | TOP MARK |
|--------------|----------------|-------------|----------|
| MAX4795EUK-T | -40°C to +85°C | 5 SOT23-5   | AEDI     |
| MAX4795ETT*  | 40°C to +85°C  | 6 TDFN-EP** | —        |
| MAX4796EUK-T | -40°C to +85°C | 5 SOT23-5   | AEDJ     |
| MAX4796ETT*  | -40°C to +85°C | 6 TDFN-EP** | —        |
| MAX4797EUK-T | -40°C to +85°C | 5 SOT23-5   | AEDK     |
| MAX4797ETT*  | -40°C to +85°C | 6 TDFN-EP** | —        |
| MAX4798EUK-T | -40°C to +85°C | 5 SOT23-5   | AEDL     |
| MAX4798ETT*  | -40°C to +85°C | 6 TDFN-EP** | —        |

\*Future product—contact factory for availability.

\*\*EP = Exposed pad.

Selector Guide appears at end of data sheet.

## Pin Configurations



Maxim Integrated Products 1

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# 450mA/500mA Current-Limit Switches

## ABSOLUTE MAXIMUM RATINGS

IN, ON,  $\overline{\text{FLAG}}$ , OUT to GND ..... -0.3V to +6V  
 OUT Short Circuit to GND ..... Internally Limited  
 Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )  
   5-Pin SOT23 (derate 7.1mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ) ..... 571mW  
   6-Pin TDFN (derate 24.4mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ) ..... 1951mW

Operating Temperature Range .....  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$   
 Junction Temperature .....  $+150^\circ\text{C}$   
 Storage Temperature Range .....  $-65^\circ\text{C}$  to  $+150^\circ\text{C}$   
 Lead Temperature (soldering, 10s) .....  $+300^\circ\text{C}$

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

( $V_{IN} = +2.0\text{V}$  to  $+4.5\text{V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise noted. Typical values are at  $V_{IN} = 3.3\text{V}$ ,  $T_A = +25^\circ\text{C}$ .) (Note 1)

| PARAMETER                                            | SYMBOL      | CONDITIONS                                                                                           | MIN | TYP  | MAX  | UNITS            |
|------------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------|-----|------|------|------------------|
| Operating Voltage                                    | $V_{IN}$    |                                                                                                      | 2.0 |      | 4.5  | V                |
| Quiescent Current                                    | $I_Q$       | $V_{ON} = V_{IN}$ , $I_{OUT} = 0$ , switch on<br>$V_{IN} = +3.3\text{V}$                             |     | 80   | 125  | $\mu\text{A}$    |
| Latch-Off Current                                    | $I_{LATCH}$ | $V_{ON} = V_{IN}$ , after an overcurrent fault (MAX4795/MAX4797) (Note 2)<br>$V_{IN} = +3.3\text{V}$ |     | 6    | 10   | $\mu\text{A}$    |
| Shutdown Current                                     | $I_{SHDN}$  | $V_{ON} = 0\text{V}$                                                                                 |     | 0.03 | 1    | $\mu\text{A}$    |
| Forward Current Limit                                |             | MAX4795/MAX4796, $V_{IN} = 3.3\text{V}$ , $V_{OUT} = \text{GND}$                                     |     | 450  | 720  | mA               |
|                                                      |             | MAX4797/MAX4798, $V_{IN} = 3.3\text{V}$ , $V_{OUT} = \text{GND}$                                     |     | 500  | 800  |                  |
| Reverse Current Limit                                |             | MAX4795/MAX4796                                                                                      |     |      | 720  | mA               |
|                                                      |             | MAX4797/MAX4798                                                                                      |     |      | 800  |                  |
| ON Input Leakage                                     |             |                                                                                                      | -1  |      | +1   | $\mu\text{A}$    |
| Shutdown Forward Leakage                             |             | $V_{ON} = 0\text{V}$ , $V_{OUT} = 0\text{V}$                                                         |     | 0.01 | 1    | $\mu\text{A}$    |
| Shutdown Reverse Leakage                             |             | $V_{ON} = 0\text{V}$ , $V_{IN} = 2\text{V}$ , $V_{OUT} = 4.5\text{V}$                                |     |      | 1    | $\mu\text{A}$    |
| On-Resistance (Note 3)                               | $R_{ON}$    | MAX4795/MAX4796, $I_{LOAD} = 100\text{mA}$                                                           |     | 0.2  | 0.4  | $\Omega$         |
|                                                      |             | MAX4797/MAX4798, $I_{LOAD} = 100\text{mA}$                                                           |     | 0.18 | 0.36 |                  |
| ON Input Logic High Voltage                          | $V_{IH}$    | $V_{IN} = +2\text{V}$ to $+3.6\text{V}$                                                              | 1.4 |      |      | V                |
|                                                      |             | $V_{IN} > 3.6\text{V}$                                                                               | 2   |      |      |                  |
| ON Input Logic Low Voltage                           | $V_{IL}$    |                                                                                                      |     |      | 0.5  | V                |
| $\overline{\text{FLAG}}$ Output Logic Low Voltage    |             | $I_{SINK} = 1\text{mA}$                                                                              |     |      | 0.4  | V                |
| $\overline{\text{FLAG}}$ Output High Leakage Current |             | $V_{IN} = V_{\overline{\text{FLAG}}} = V_{ON} = 4.5\text{V}$                                         |     |      | 1    | $\mu\text{A}$    |
| Thermal Shutdown                                     |             |                                                                                                      |     | 150  |      | $^\circ\text{C}$ |
| Thermal-Shutdown Hysteresis                          |             |                                                                                                      |     | 15   |      | $^\circ\text{C}$ |
| <b>DYNAMIC</b>                                       |             |                                                                                                      |     |      |      |                  |
| Turn-On Time                                         |             | $V_{ON}$ from low to high; $I_{OUT} = 10\text{mA}$ , $C_L = 0.1\mu\text{F}$ (Note 4)                 |     | 120  |      | $\mu\text{s}$    |
| Turn-Off Time                                        |             | $V_{ON}$ from high to low; $I_{OUT} = 10\text{mA}$ , $C_L = 0.1\mu\text{F}$ (Note 4)                 |     | 100  |      | ns               |
| Blanking Time                                        | $t_{BLANK}$ | Overcurrent fault; Figures 2, 3                                                                      | 14  |      | 60   | ms               |
| Short-Circuit Current-Limit Response Time            |             | $V_{ON} = V_{IN}$ , short circuit applied to OUT                                                     |     | 5    |      | $\mu\text{s}$    |
| Retry Time                                           | $t_{RETRY}$ | MAX4796/MAX4798, Figure 2 (Note 5)                                                                   | 210 |      | 900  | ms               |

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

**Note 2:** Latch-off current does not include the current flowing into  $\overline{\text{FLAG}}$ .

**Note 3:** TDFN packages are guaranteed by design.

**Note 4:** The on-time is defined as the time taken for the current through the switch to go from 0mA to full load. The off-time is defined as the time taken for the current through the switch to go from full load to 0mA.

**Note 5:** Retry time is typically 15 times the blanking time.

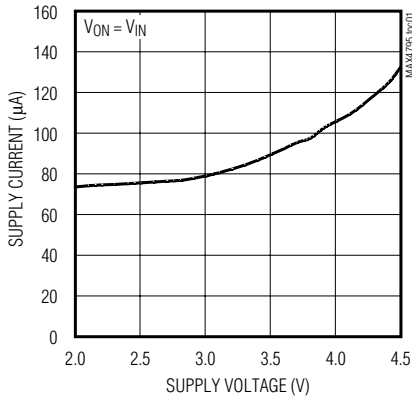
# 450mA/500mA Current-Limit Switches

## Typical Operating Characteristics

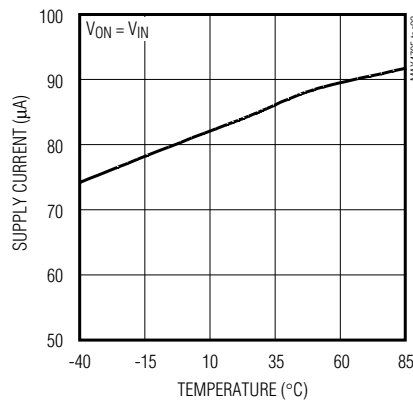
( $V_{IN} = 3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX4795-MAX4798

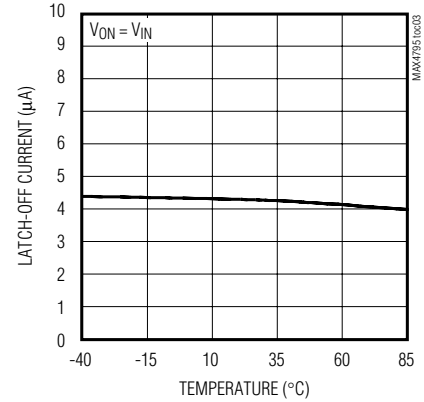
**QUIESCENT SUPPLY CURRENT  
vs. SUPPLY VOLTAGE**



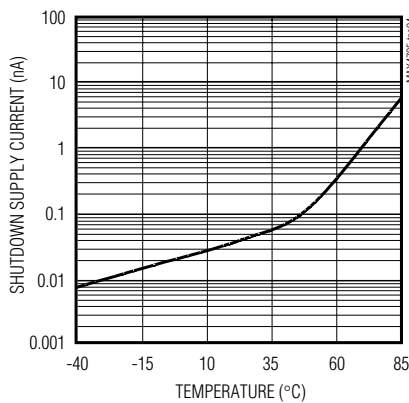
**SUPPLY CURRENT vs. TEMPERATURE**



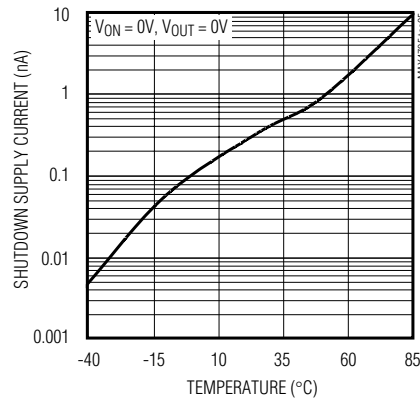
**LATCH-OFF CURRENT  
vs. TEMPERATURE**



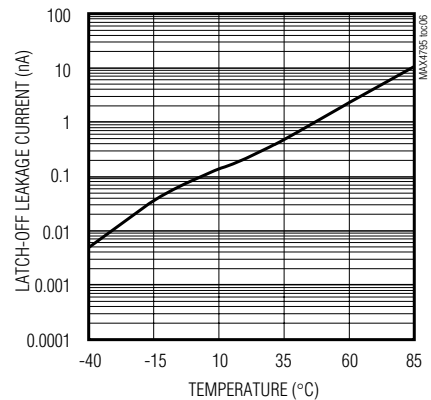
**SHUTDOWN SUPPLY CURRENT  
vs. TEMPERATURE**



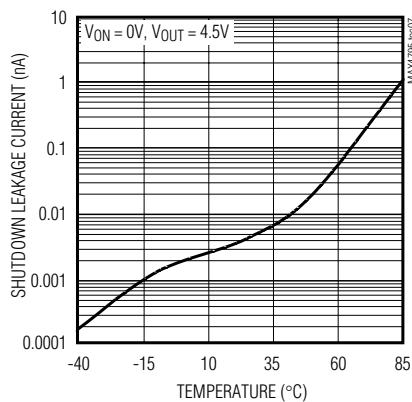
**SHUTDOWN LEAKAGE CURRENT  
vs. TEMPERATURE**



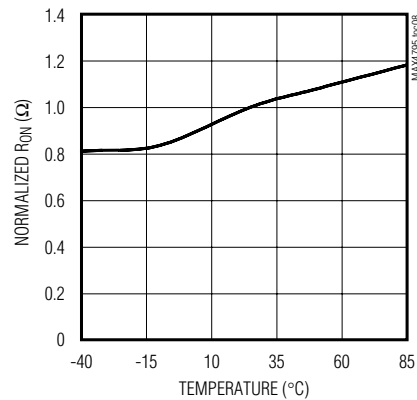
**LATCH-OFF LEAKAGE CURRENT  
vs. TEMPERATURE**



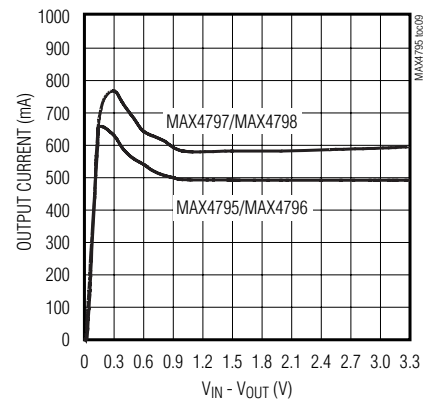
**SHUTDOWN REVERSE LEAKAGE CURRENT  
vs. TEMPERATURE**



**NORMALIZED ON-RESISTANCE  
vs. TEMPERATURE**



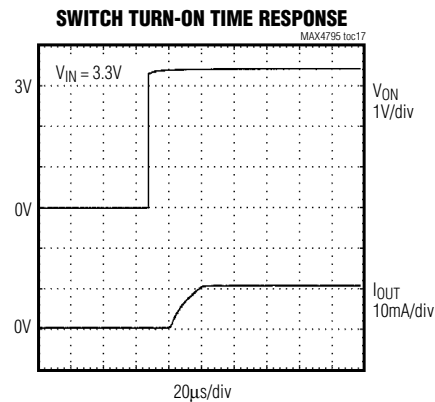
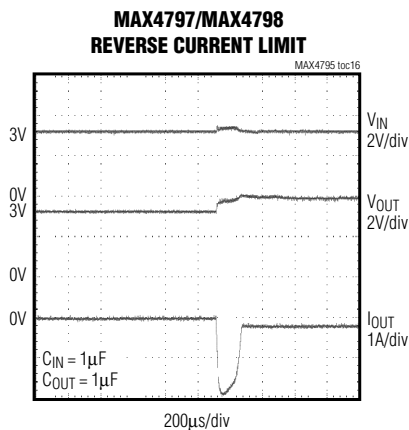
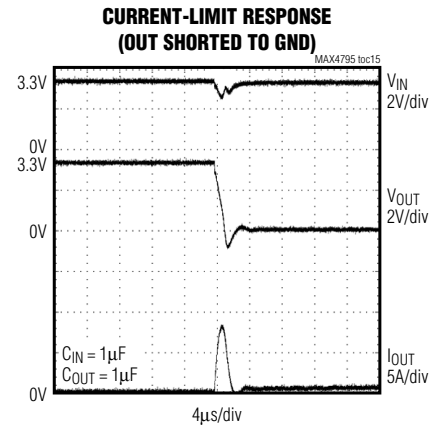
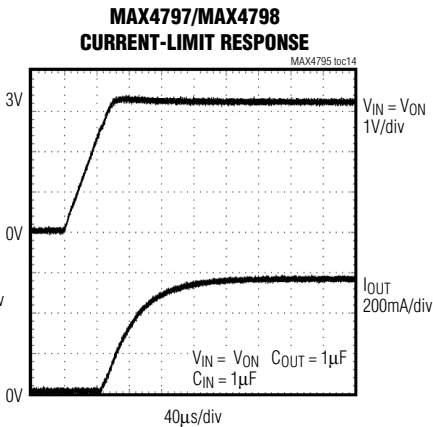
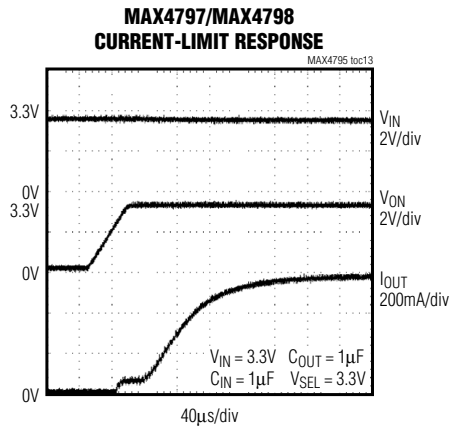
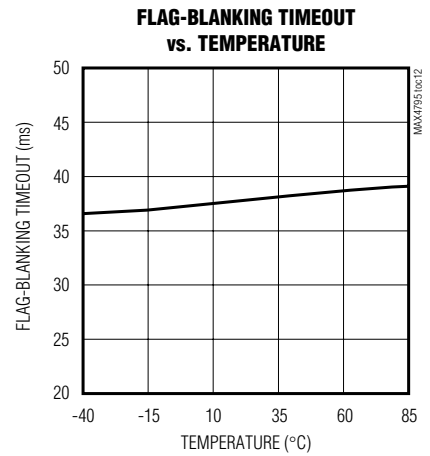
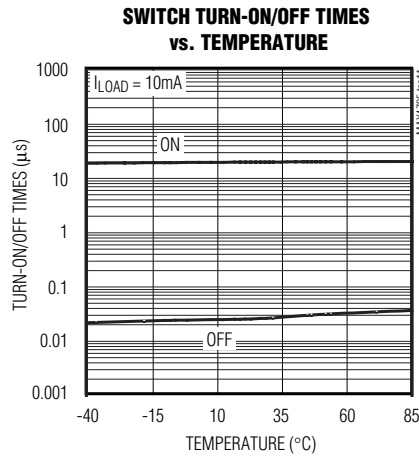
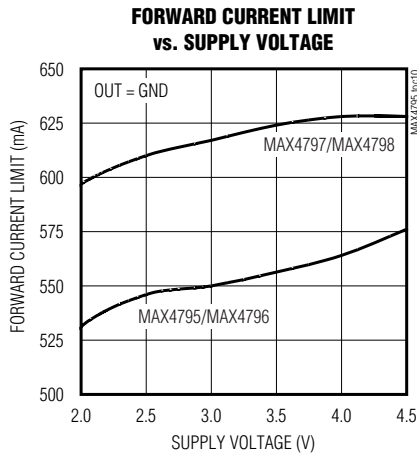
**OUTPUT CURRENT  
vs. OUTPUT VOLTAGE**



# 450mA/500mA Current-Limit Switches

## Typical Operating Characteristics (continued)

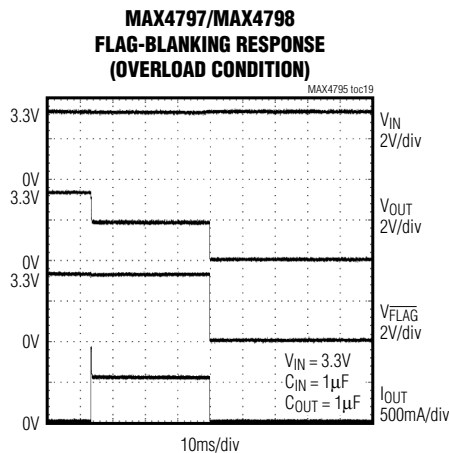
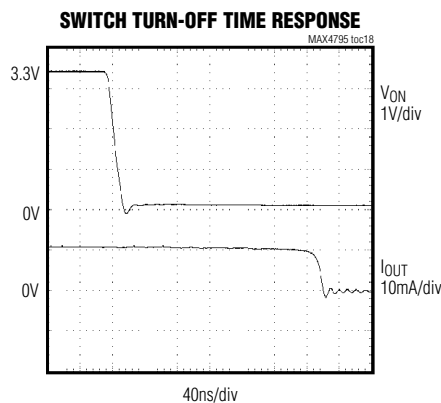
( $V_{IN} = 3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# 450mA/500mA Current-Limit Switches

## Typical Operating Characteristics (continued)

( $V_{IN} = 3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



## Pin Description

| PIN   |      | NAME | FUNCTION                                                                                                                                                                                                              |
|-------|------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOT23 | TDFN |      |                                                                                                                                                                                                                       |
| 1     | 1    | IN   | Input. Bypass with a 0.1μF ceramic capacitor to ground.                                                                                                                                                               |
| 2     | 5    | GND  | Ground                                                                                                                                                                                                                |
| 3     | 6    | ON   | Active-High Switch On Input. A logic high turns the switch on.                                                                                                                                                        |
| 4     | 4    | FLAG | Fault Output. This open-drain output goes low when the device stays in forward or reverse current limit for more than the blanking time period. FLAG is high impedance when a fault is not present or when ON is low. |
| 5     | 2    | OUT  | Switch Output. Bypass with a 0.1μF ceramic capacitor to ground.                                                                                                                                                       |
| —     | 3    | N.C. | No Connection. Not internally connected.                                                                                                                                                                              |

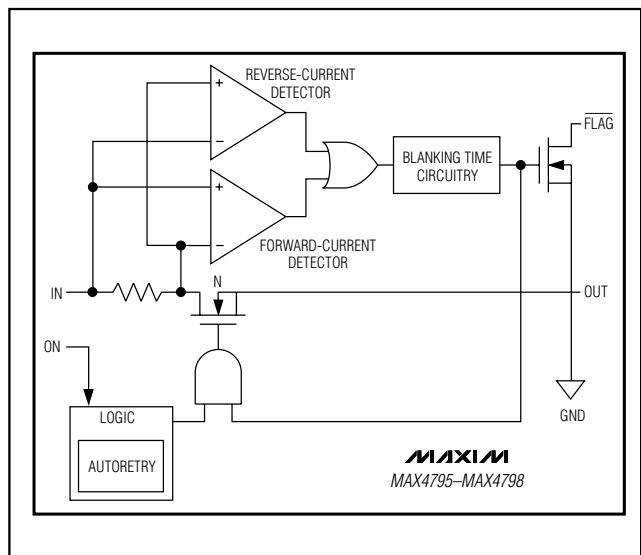


Figure 1. Functional Diagram

# 450mA/500mA Current-Limit Switches

## Detailed Description

The MAX4795–MAX4798 are forward/reverse current-limited switches that operate from a 2V to 4.5V input voltage range and guarantee a 450mA and 500mA minimum current-limit threshold for different options. The voltage drop across an internal sense resistor is compared to two reference voltages to indicate a forward or reverse current-limit fault. When the load current exceeds the preset current limit for greater than the fault-blanking time, the switch opens.

The MAX4796 and MAX4798 have an autoretry function that turns on the switch again after an internal retry time expires. If the faulty load condition is still present after the blanking time, the switch turns off again and the cycle is repeated. If the faulty load condition is not present, the switch remains on.

The MAX4795 and MAX4797 do not have the autoretry option and the switch remains in latch-off mode until the ON pin or the input power is cycled from high to low and then high again.

## Reverse-Current Protection

The MAX4795–MAX4798 limit the reverse current ( $V_{OUT}$  to  $V_{IN}$ ) from exceeding the maximum  $I_{REV}$  value. The switch is shut off and  $\overline{FLAG}$  is asserted if the reverse current-limit condition persists for more than the blanking time. This feature prevents excessive reverse currents from flowing through the device.

## Switch-On/Off Control

Toggle ON high to enable the current-limited switches. The switches are continuously on if there is no fault. When a forward/reverse current fault is present or the die exceeds the thermal-shutdown temperature of +150°C, OUT is internally disconnected from IN and the supply current decreases to 8 $\mu$ A (latch off). The switch is now operating in one of its off states. The switch-off state also occurs when driving ON low, thus reducing the supply current (shutdown) to 0.01 $\mu$ A. Table 1 illustrates the ON/OFF state of the MAX4795–MAX4798 current-limit switches.

## $\overline{FLAG}$ Indicator

The MAX4795–MAX4798 feature a latched output ( $\overline{FLAG}$ ). Whenever an overcurrent condition is encountered, the MAX4795/MAX4797 latch  $\overline{FLAG}$  low and turn the switch off. The MAX4796/MAX4798 latch  $\overline{FLAG}$  low and keep it low until the overcurrent condition is removed. During this time, the switch cycles on and off in the autoretry mode. When the overcurrent condition is removed,  $\overline{FLAG}$  deasserts and the switch turns on (Figure 2).  $\overline{FLAG}$  is an open-drain output transistor and requires an external pullup resistor from  $\overline{FLAG}$  to IN. During shutdown (ON is low), the pulldown on  $\overline{FLAG}$  output is released to limit power dissipation.  $\overline{FLAG}$  goes low when any of the following conditions occur:

- The die temperature exceeds the thermal-shutdown temperature limit of +150°C.
- The device is in current limit for more than the fault-blanking period.
- The switch is in autoretry.

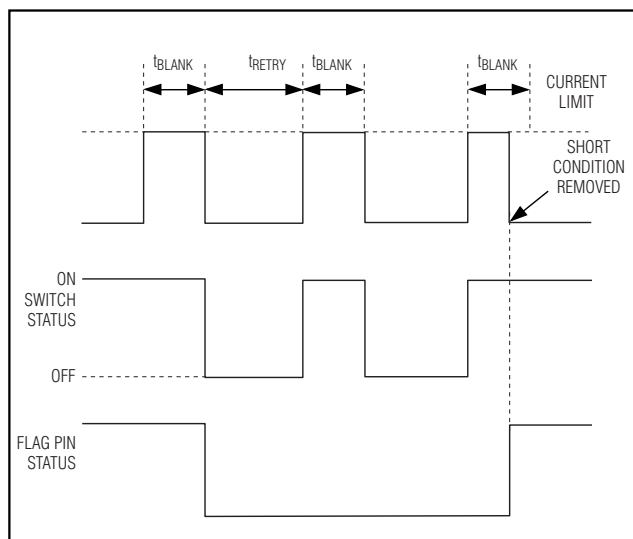


Figure 2. MAX4796/MAX4798 Autoretry Fault-Blanking Diagram

Table 1. MAX4795–MAX4798 Switch Truth Table

| ON   | FAULT         | SWITCH ON/OFF                                                                                                                 | SUPPLY CURRENT MODE       |
|------|---------------|-------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Low  | X             | OFF                                                                                                                           | Shutdown                  |
| High | Thermal       | OFF immediately ( $t_{BLANK}$ period does not apply)                                                                          | Latchoff                  |
| High | Current limit | OFF after $t_{BLANK}$ period has elapsed                                                                                      | Latchoff                  |
| High | Current limit | ON during $t_{BLANK}$ period, OFF during $t_{RETRY}$ period for the MAX4796 and MAX4798; cycle repeats until fault is removed | See the Autoretry section |

# 450mA/500mA Current-Limit Switches

## Autoretry (MAX4796/MAX4798)

When the forward or reverse current-limit threshold is exceeded,  $t_{BLANK}$  timer begins counting (Figure 2). The timer resets if the overcurrent condition disappears before  $t_{BLANK}$  has elapsed. A retry time delay,  $t_{RETRY}$ , is started immediately after  $t_{BLANK}$  has elapsed and during that time, the switch is latched off and  $\overline{FLAG}$  asserts. At the end of  $t_{RETRY}$ , the switch is turned on again. If the fault still exists, the cycle is repeated. If the fault has been removed, the switch stays on and  $\overline{FLAG}$  deasserts.

The autoretry feature saves system power in the case of an overcurrent or short-circuit condition. During  $t_{BLANK}$ , when the switch is on, the supply current is at the current limit. During  $t_{RETRY}$ , when the switch is off, the current through the switch is zero. Instead of observing the full load current, the switch sees the equivalent load current times duty cycle or  $I_{SUPPLY} = I_{LOAD} \times t_{BLANK} / (t_{BLANK} + t_{RETRY})$ . With a typical  $t_{BLANK} = 37\text{ms}$  and typical  $t_{RETRY} = 555\text{ms}$ , the duty cycle is 6%, which results in a 94% power savings over the switch being on the entire time. The duty cycle is consistent across the process and devices.

## Latchoff (MAX4795/MAX4797)

When the forward or reverse current-limit threshold is exceeded,  $t_{BLANK}$  timer begins counting. The timer resets if the overcurrent condition disappears before  $t_{BLANK}$  has elapsed. The switch is shut off and  $\overline{FLAG}$  asserts if the overcurrent condition continues up to the end of the blanking time. Reset the switch by either toggling ON (Figure 3) or cycling the input voltage.

## Fault Blanking

The MAX4795–MAX4798 feature 14ms (min) fault blanking. Fault blanking allows current-limit faults, including momentary short-circuit faults that occur when hot swapping a capacitive load, and also ensures that no fault is issued during power-up. When a load transient causes the device to enter current limit, an internal counter starts. If the load-transient fault persists beyond the fault-blanking timeout,  $\overline{FLAG}$  asserts low. Load-transient faults less than  $t_{BLANK}$  do not cause a  $\overline{FLAG}$  output assertion. Only current-limit faults are blanked.

A thermal fault causes  $\overline{FLAG}$  to assert immediately and does not wait for the blanking time.

## Thermal Shutdown

The MAX4795–MAX4798 have a thermal-shutdown feature to protect the devices from overheating. The switch

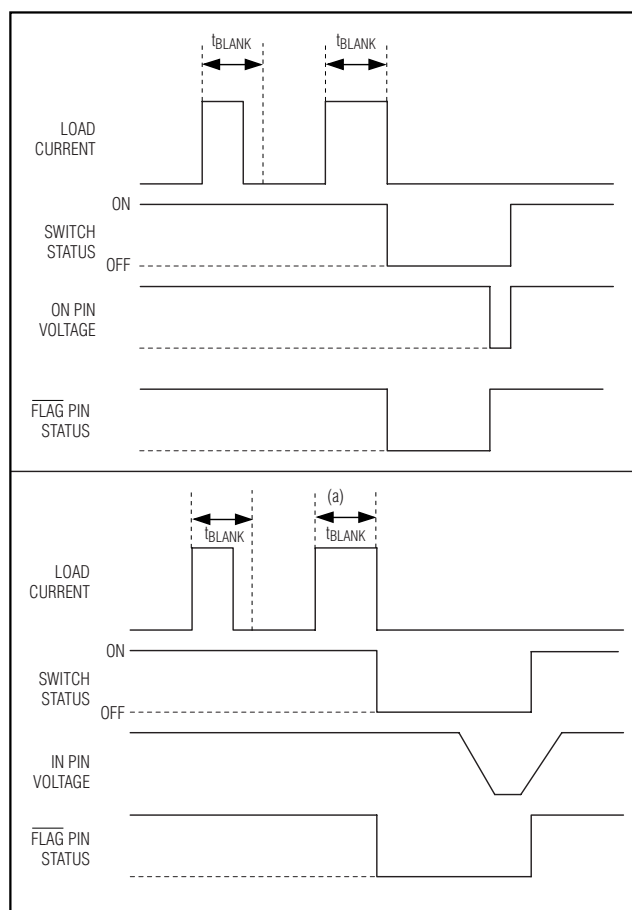


Figure 3. MAX4795/MAX4797 Latch-Off Fault Blanking

turns off and  $\overline{FLAG}$  goes low immediately (no fault blanking) when the junction temperature exceeds  $+150^{\circ}\text{C}$ . The switches with autoretry turn back on when the device temperature drops approximately  $15^{\circ}\text{C}$ . The switches with latchoff require ON cycling.

## Applications Information

### Input Capacitor

To limit the input voltage drop during momentary output short-circuit conditions, connect a capacitor from IN to GND. A  $0.1\mu\text{F}$  ceramic capacitor is adequate for most applications; however, higher capacitor values further reduce the voltage drop at the input and are recommended for lower voltage applications.



## 450mA/500mA Current-Limit Switches

### Output Capacitance

Connect a 0.1μF capacitor from OUT to GND. This capacitor helps prevent inductive parasitics from pulling OUT negative during turn off, thus preventing the MAX4795–MAX4798 from tripping erroneously. If the load capacitance is too large, then current may not have enough time to charge the capacitor and the device assumes that there is a faulty load condition. The maximum capacitive load value that can be driven from OUT is obtained by the following formula:

$$C_{\text{MAX}} < \frac{I_{\text{FWD\_MIN}} \times t_{\text{BLANK\_MIN}}}{V_{\text{IN}}}$$

### Layout and Thermal Dissipation

To optimize the switch response time to output short-circuit conditions, it is very important to keep all traces as short as possible to reduce the effect of undesirable parasitic inductance. Place input and output capacitors as close as possible to the device (no more than 5mm). IN and OUT pins must be connected with short traces to the power bus.

### Selector Guide

| PART         | CURRENT LIMIT (mA) | AUTORETRY |
|--------------|--------------------|-----------|
| MAX4795EUK-T | 450                | No        |
| MAX4795ETT   | 450                | No        |
| MAX4796EUK-T | 450                | Yes       |
| MAX4796ETT   | 450                | Yes       |
| MAX4797EUK-T | 500                | No        |
| MAX4797ETT   | 500                | No        |
| MAX4798EUK-T | 500                | Yes       |
| MAX4798ETT   | 500                | Yes       |

During normal operation, the power dissipation is small and the package temperature change is minimal. If the output is continuously shorted to ground at the maximum supply voltage, the operation of the switches with the autoretry option does not cause problems because the total power dissipated during the short is scaled by the duty cycle:

$$P_{\text{MAX}} = \frac{V_{\text{IN\_MAX}} \times I_{\text{OUT\_MAX}} \times t_{\text{BLANK}}}{t_{\text{RETRY}} + t_{\text{BLANK}}} = 211\text{mW}$$

where  $V_{\text{IN}} = 4.5\text{V}$ ,  $I_{\text{OUT}} = 750\text{mA}$ ,  $t_{\text{BLANK}} = 14\text{ms}$ , and  $t_{\text{RETRY}} = 210\text{ms}$ .

Attention must be given to the MAX4795 and MAX4797 where the latchoff condition must be manually reset by toggling ON from high to low. If the latchoff time duration is not sufficiently high, it is possible for the device to reach the thermal-shutdown threshold and never be able to turn the device on until it cools down.

### Chip Information

TRANSISTOR COUNT: 2539

PROCESS: BiCMOS

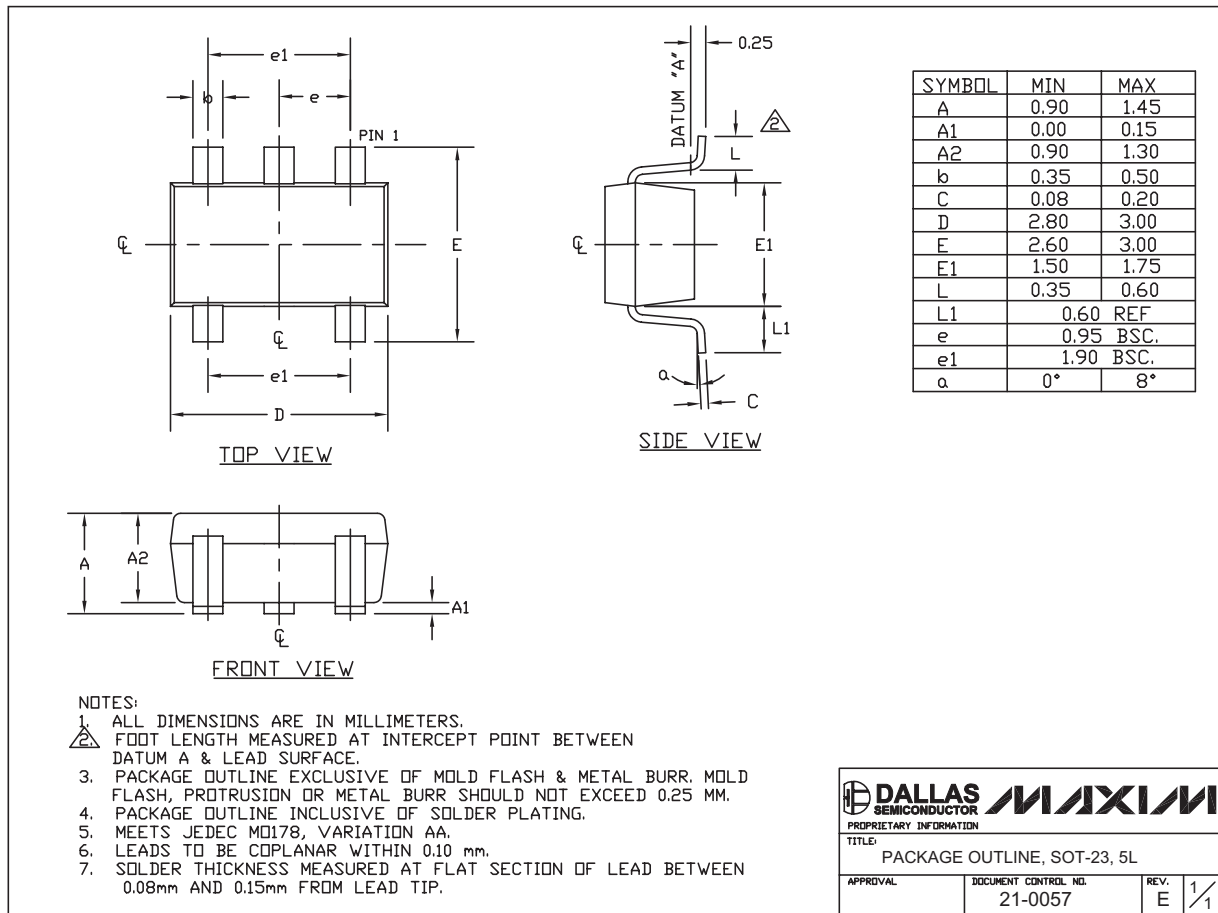


# 450mA/500mA Current-Limit Switches

## Package Information

(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).)

MAX4795-MAX4798



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