



*The Infinite Bandwidth Company™*

## MIC2546/2547

### Dual Programmable Current Limit Switch

#### Final Information

### General Description

The MIC2546 and MIC2547 are integrated high-side dual power switches optimized for low loss dc power switching and other power management applications, including Advanced Configuration and Power Interface (ACPI). The MIC2546/47 is a cost-effective, highly integrated solution that requires few external components to satisfy USB and ACPI requirements.

Load current management features include a precision resistor-programmable output current-limit and a soft-start circuit which minimizes inrush current when the switch is enabled. Thermal shutdown, along with current-limit, protects the switch and the attached device.

The MIC2546/47's open-drain flag outputs are used to indicate current-limiting or thermal shutdown to a local controller. The MIC2547 has an additional internal latch which turns the output off upon thermal shutdown providing robust fault control. The enable signal is compatible with both 3V and 5V logic, and is also used as the thermal shutdown latch reset for the MIC2547.

The MIC2546 and MIC2547 are available in active-high and active-low enable versions in 16-pin TSSOP and SOP packages.

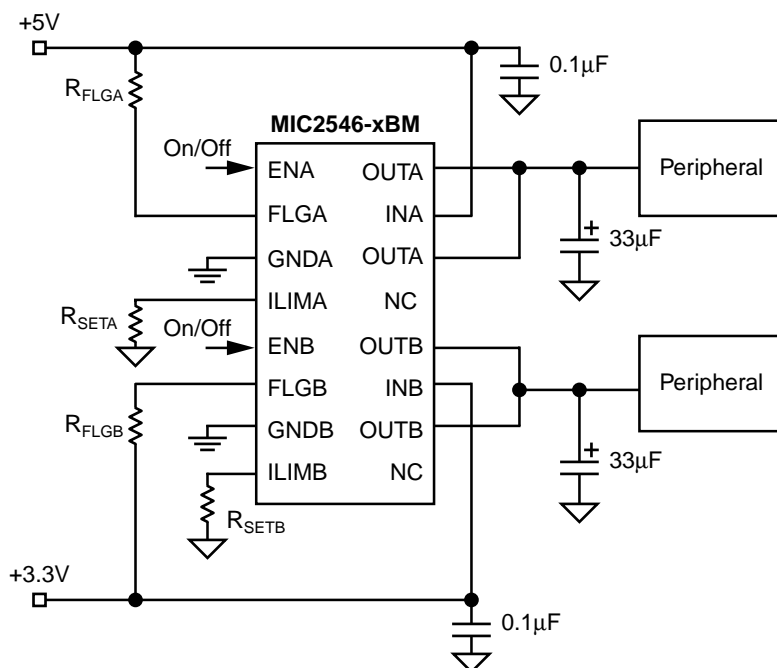
### Features

- 2.7V to 5.5V input
- Adjustable current-limit up to 1.5A
- Reverse current flow blocking (no "body diode")
- 100 $\mu$ A typical on-state supply current per channel
- 2 $\mu$ A typical off-state supply current
- 120m $\Omega$  maximum on-resistance
- Open-drain fault flag
- Thermal shutdown
- Thermal shutdown output latch (MIC2547)
- 2ms (slow) turn-on and fast turnoff
- Available with active-high or active-low enable

### Applications

- USB power distribution
- PCI Bus Power Switching
- Notebook PC
- ACPI power distribution
- PC card hot swap applications
- Inrush current-limiting
- Ideal for dual supply applications

### Typical Application



Typical Advanced Configuration and Power Interface (ACPI) Application



UL Recognized Component

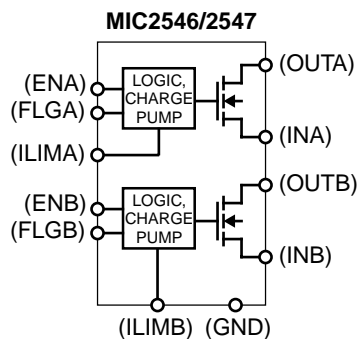
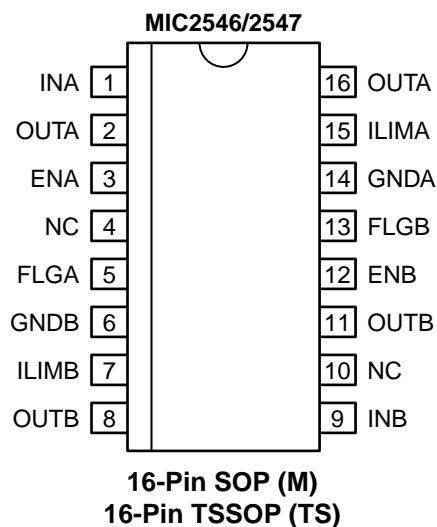
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## Ordering Information

Part Number	Enable	Latch*	Temperature Range	Package
MIC2546-1BM	Active High		–40°C to +85°C	16-pin SOP
MIC2546-1BTS	Active High		–40°C to +85°C	16-pin TSSOP
MIC2546-2BM	Active Low		–40°C to +85°C	16-pin SOP
MIC2546-2BTS	Active Low		–40°C to +85°C	16-pin TSSOP
MIC2547-1BM	Active High	•	–40°C to +85°C	16-pin SOP
MIC2547-1BTS	Active High	•	–40°C to +85°C	16-pin TSSOP
MIC2547-2BM	Active Low	•	–40°C to +85°C	16-pin SOP
MIC2547-2BTS	Active Low	•	–40°C to +85°C	16-pin TSSOP

\* Thermal Shutdown Latch

## Pin Configuration



**Functional Pinout**

## Pin Description

Pin Number	Pin Name	Pin Function
1	INA	Input A: Output A MOSFET drain. Also supplies internal circuitry.
2, 16	OUTA	Switch A (Output): Output A MOSFET source. Pins 2 and 16 must be externally connected.
3	ENA	Enable A (Input): Logic-compatible enable input. Active-high (–1) or active-low (–2). High input >1.7V typical; low input <1.5V typical. Do not float. MIC2547 only: Also resets thermal shutdown latch.
4, 10	NC	Not internally connected.
5	FLGA	Fault Flag A (Output): Active-low, open-drain output. Indicates overcurrent or thermal shutdown conditions. MIC2547 only: latched low on thermal shutdown.
6, 14	GNDB, GNDA	Ground. Both pins must be connected to GND.
7	ILIMB	Current Limit Channel B: Sets current-limit threshold using an external resistor, $R_{SET}$ , connected to ground. $154\Omega < R_{SET} < 2.29k\Omega$ .
8, 11	OUTB	Switch B (Output): Pins 8 and 11 must be externally connected.
9	INB	Input B
12	ENB	Enable B (Input)
13	FLGB	Fault Flag B (Output)
15	ILIMA	Current Limit Channel A.

**Absolute Maximum Ratings (Note 1)**

Supply Voltage ( $V_{IN}$ )	+6.0V
Output Voltage ( $V_{OUT}$ )	+6.0V
Output Current ( $I_{OUT}$ )	Internally Limited
Enable Input ( $V_{EN}$ )	-0.3V to $V_{IN}$ +0.3V
Fault Flag Voltage ( $V_{FLG}$ )	+6.0V
Fault Flag Current ( $I_{FLG}$ )	50mA
Storage Temperature ( $T_S$ )	-65°C to +150°C
Junction Temperature ( $T_J$ )	Internally Limited
Lead Temperature (soldering 5 sec.)	260°C
ESD Rating, <b>Note 3</b>	2kV

**Operating Ratings (Note 2)**

Supply Voltage ( $V_{IN}$ )	+2.7V to +5.5V
Current Limit Set Range	0.1 to 1.5A
Ambient Temperature Range ( $T_A$ )	-40°C to +85°C
Package Thermal Resistance	
SOP ( $\theta_{JA}$ )	120°C/W
TSSOP ( $\theta_{JA}$ )	100°C/W

**Electrical Characteristics**

$V_{IN} = +5V$ ;  $T_A = 25^\circ C$ , **bold** indicates -40°C to +85°C; unless noted

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Supply Current	Switch off, OUT = open, <b>Note 4</b>		1.5	<b>10</b>	$\mu A$
		Switch on, OUT = open, <b>Note 4</b>		200	<b>320</b>	$\mu A$
$V_{EN}$	Enable Input Voltage	Enable High, <b>Note 4</b>	<b>2.4</b>	1.7		V
		Enable Low, <b>Note 4</b>		1.5	<b>0.8</b>	V
	Enable Input Current	$V_{EN} = V_{OH(min)} = 2.4V$		.01	1	$\mu A$
		$V_{EN} = V_{OL(max)} = 0.8V$		.01	1	$\mu A$
	Enable Input Capacitance	<b>Note 5</b>		1		pF
$R_{DS(on)}$	Switch Resistance	$I_{OUT} = 500mA$		80	<b>120</b>	m $\Omega$
	Current Limit Factor, <b>Note 6</b>	$I_{OUT} = 100mA$ to 1.5A, $V_{OUT} = 1.0V$ to 4.0V, <b>Note 6</b>	184	230	276	V
	Output Leakage Current	Switch off		1	<b>10</b>	$\mu A$
$t_{ON}$	Output Turn-On Delay	$R_L = 10\Omega$ , $C_L = 1\mu F$ , <b>Figure 1a and 1b</b>	1	2	5	ms
$t_R$	Output Turn-On Rise Time	$R_L = 10\Omega$ , $C_L = 1\mu F$ , <b>Figure 1a and 1b</b>	1	2	5	ms
$t_{OFF}$	Output Turnoff Delay	$R_L = 10\Omega$ , $C_L = 1\mu F$ , <b>Figure 1a and 1b</b>		22		$\mu s$
$t_F$	Output Turnoff Fall Time	$R_L = 10\Omega$ , $C_L = 1\mu F$ , <b>Figure 1a and 1b</b>		21		$\mu s$
	Overtemperature Threshold Shutdown	$T_J$ increasing		140		$^\circ C$
		$T_J$ decreasing		130		$^\circ C$
	Error Flag Output Resistance	$V_{IN} = 5V$ , $I_L = 10\mu A$		4	<b>15</b>	$\Omega$
		$V_{IN} = 3.3V$ , $I_L = 10\mu A$		5	<b>20</b>	$\Omega$
	Error Flag Off Current	$V_{FLG} = 5V$		0.01	<b>1</b>	$\mu A$
	EN Pulse Reset Width	MIC2547 Thermal Shutdown Latch	5			$\mu s$
	$V_{IN}$ to EN Set-Up	MIC2547, <b>Note 5</b>	0			$\mu s$
	Current-Limit Response Time	$V_{OUT} = 0V$		25		$\mu s$
	Overcurrent FLG Response Time	$V_{OUT} = V_{IN}/2$ to FLG low		5		$\mu s$

**Note 1.** Exceeding the absolute maximum rating may damage the device.

**Note 2.** The device is not guaranteed to function outside its operating rating.

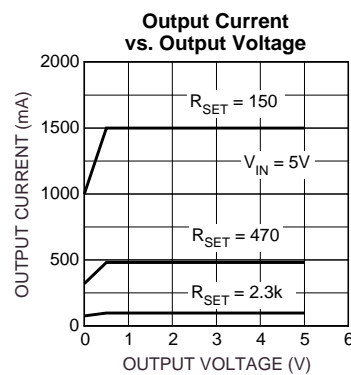
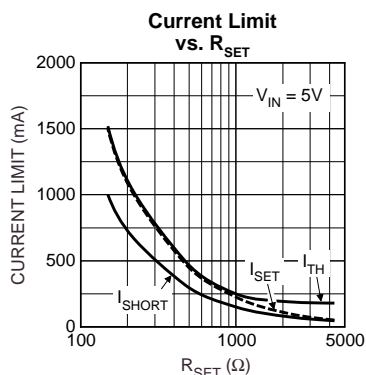
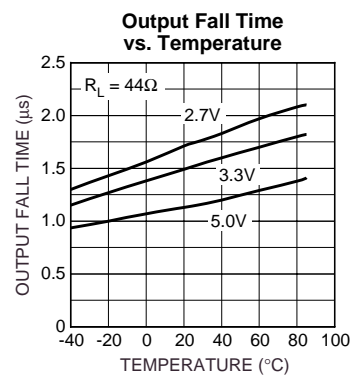
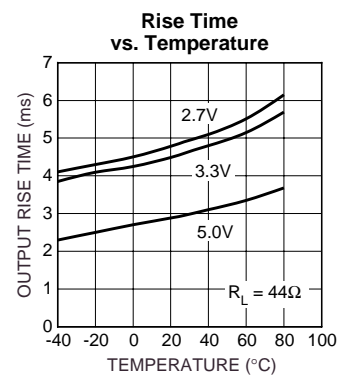
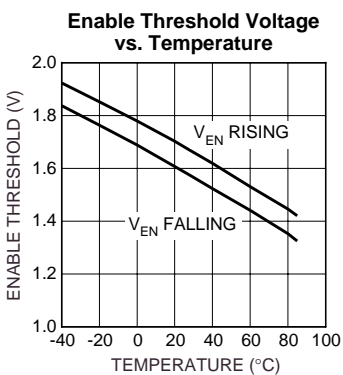
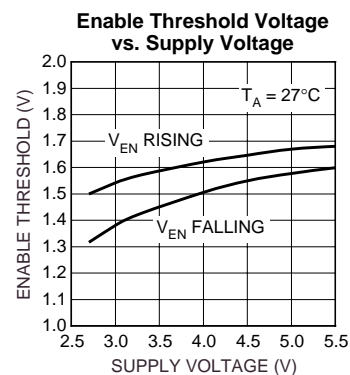
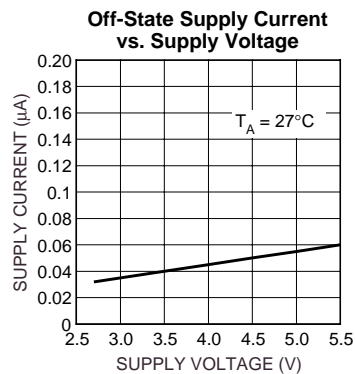
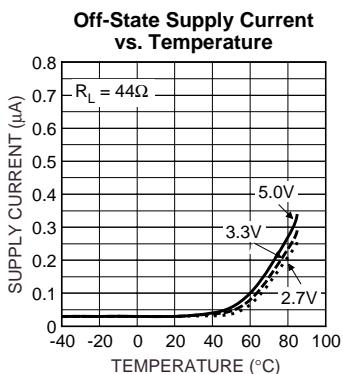
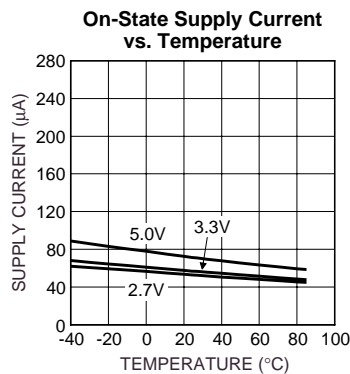
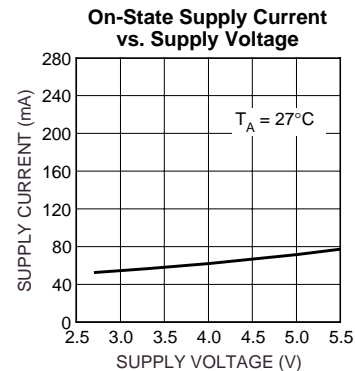
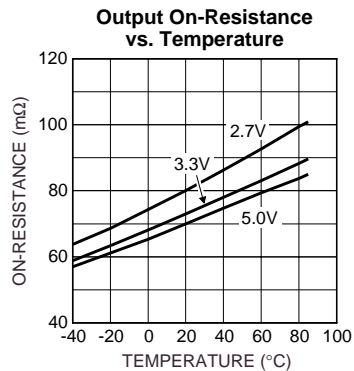
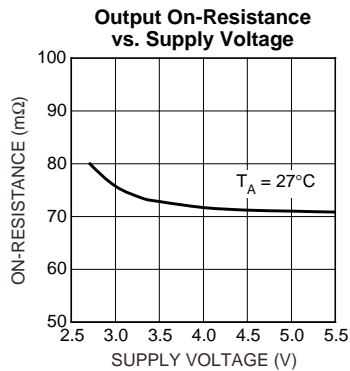
**Note 3.** Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.

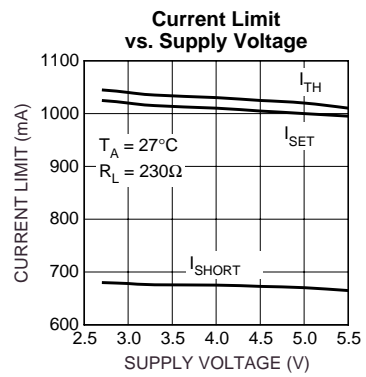
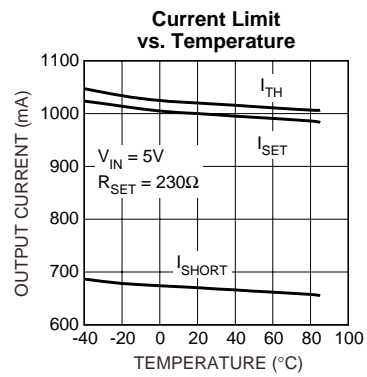
**Note 4.** Off is  $\leq 0.8V$  and on is  $\geq 2.4V$  for the MIC2546-1 and MIC2547-1. Off is  $\geq 2.4V$  and on is  $\leq 0.8V$  for the MIC2546-2 and MIC2547-2. The enable input has about 200mV of hysteresis.

**Note 5.** Guaranteed by design, but not production tested.

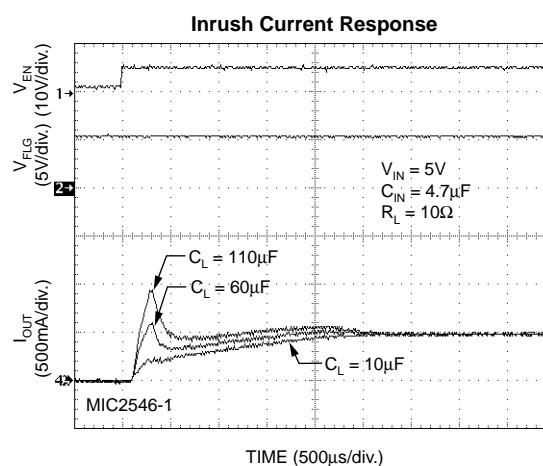
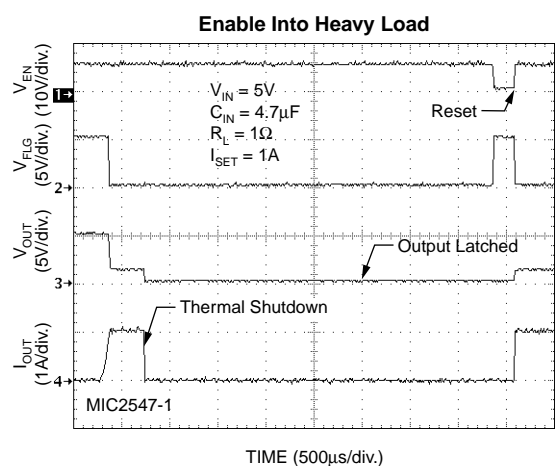
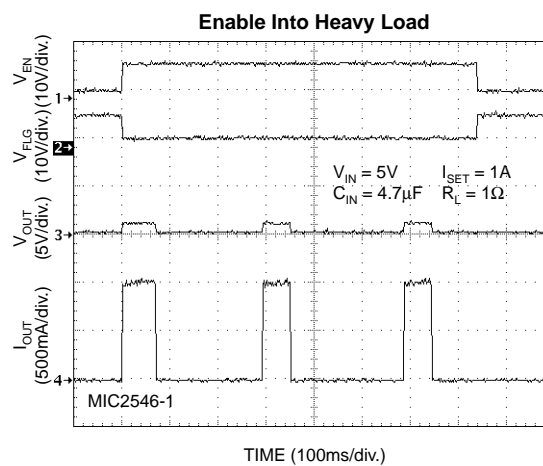
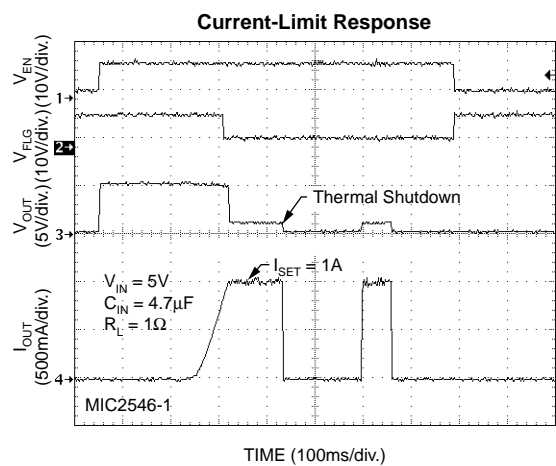
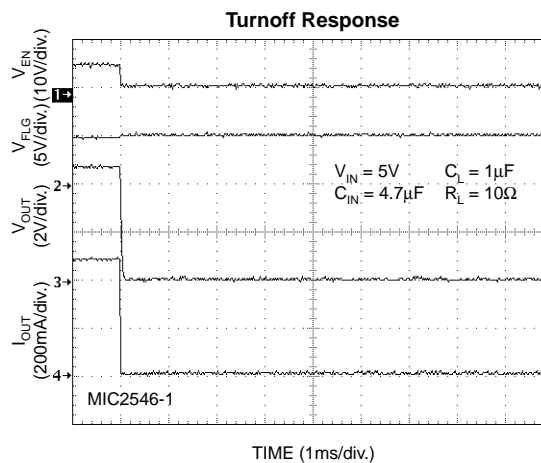
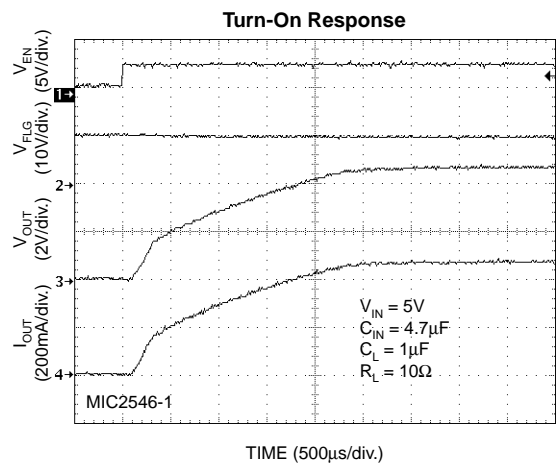
**Note 6.** Current limit threshold is determined by:  $I_{LIMIT} = \frac{230V}{R_{SET}}$ , where  $R_{SET}$  is in ohms.

# Typical Characteristics

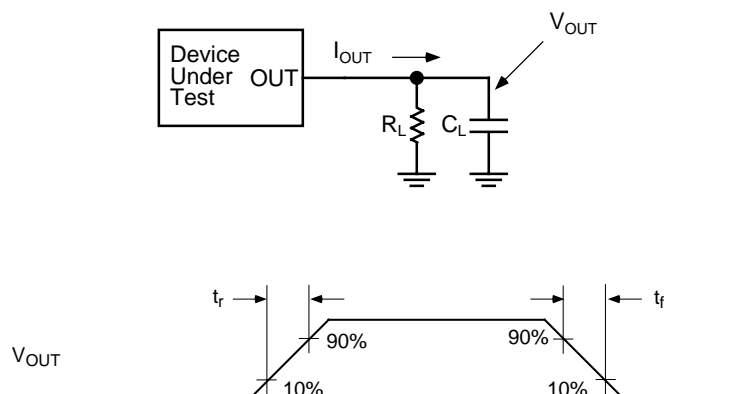




## Functional Characteristics



## Test Circuit



## Functional Characteristics Test Circuit

## Timing Diagrams

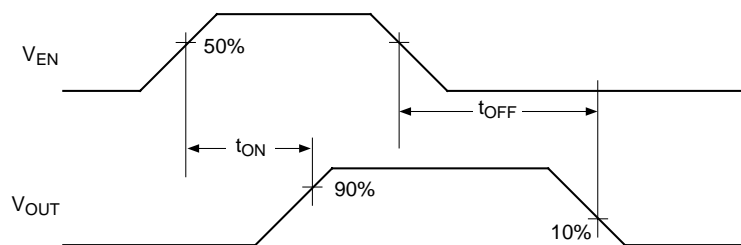


Figure 1a. MIC2546/47-1

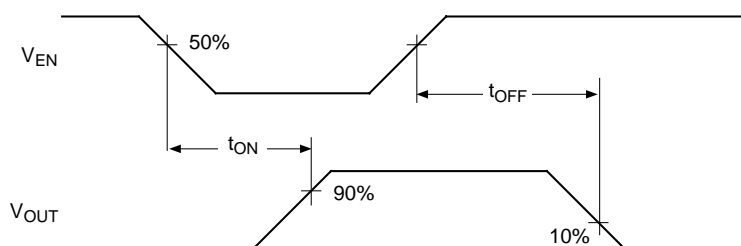
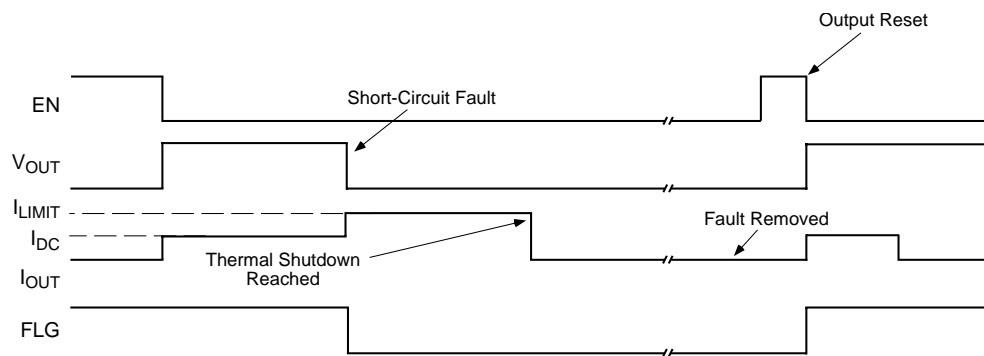
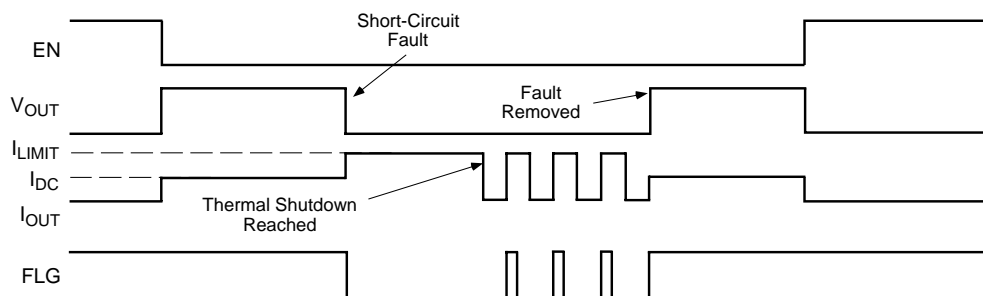


Figure 1b. MIC2546/47-2



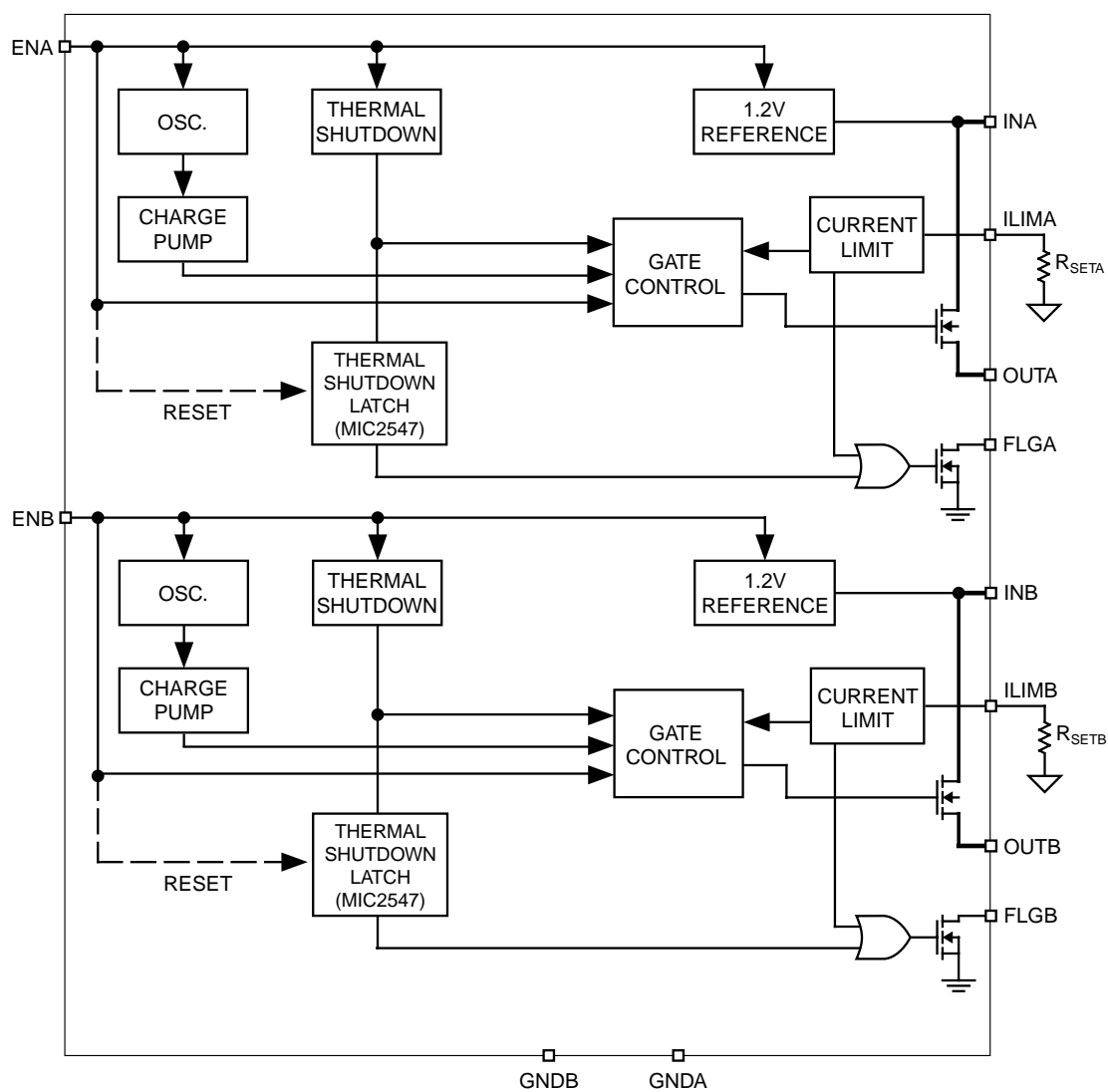
**Figure 2a. MIC2547-2 Timing: Output is reset by toggling EN**



**Figure 2b. MIC2546-2 Timing**



# Block Diagram



## Functional Description

The MIC2546 and MIC2547 are dual high-side N-channel switches available with active-high or active-low enable inputs. Fault conditions turn off or inhibit turn-on of the output transistor and activate the open-drain error flag transistor making it sink current to ground.

### Input and Output

INX is the power supply connection to the logic circuitry and the drain of the output MOSFET. OUTX is the source of the output MOSFET. In a typical circuit, current flows from INX to OUTX toward the load. If  $V_{OUT}$  is greater than  $V_{IN}$ , current will flow from OUTX to INX since the switch is bidirectional when enabled. The output MOSFET and driver circuitry are also designed to allow the MOSFET source to be externally forced to a higher voltage than the drain ( $V_{OUT} > V_{IN}$ ) when the switch is disabled. In this situation, the MIC2546/47 avoids undesirable current flow from OUTX to INX. Both OUT pins for a given channel must be connected together.

### Thermal Shutdown

Thermal shutdown shuts off the output MOSFET and signals the fault flag if the die temperature exceeds 140°C. 10°C of hysteresis prevents the switch from turning on until the die temperature drops to 130°C. Overtemperature detection functions only when the switch is enabled.

The MIC2547 features an internal latch which causes the part to remain off after thermal shutdown until a reset pulse is provided via the enable pin. While in current-limit, the thermal shutdown latch prevents on/off cycling of the output. Refer to Figure 2 for timing diagram. The flag remains low until reset.

### Enable Input

ENX must be driven logic high or logic low, or be pulled high or low for a clearly defined input. Floating the input may cause unpredictable operation. ENX should not be allowed to go negative with respect to GND, and  $V_{ENX}$  should be less than or equal to  $V_{INX}$ .

## Adjustable Current-Limit

The short-circuit current-limit is user-adjustable with an external set resistor. Current-limit in the range of 100mA to 1.5A is available with a set point accuracy of better than  $\pm 20\%$ . The current-limit circuit prevents damage to the output MOSFET and external load.

The nominal current-limit value is set with an external resistor between ILIMX and GND. For a desired current-limit, the value of the external set resistor is given by:

$$R_{SETX} = \left( \frac{230V}{I_{LIMITX}} \right)$$

where:

$$154\Omega < R_{SET} < 2.29k\Omega$$

For example, to set a 1A nominal current-limit,  $R_{SET}$  is calculated as:

$$\left( \frac{230V}{1A} \right) = 230\Omega$$

Current through  $R_{SETX}$  increases with OUT current. The voltage across  $R_{SETX}$  could be monitored with a high impedance comparator to provide an indication of output current.  $R_{SETX}$  should be between 154 $\Omega$  and 2.29k $\Omega$  (0.5% resistor value).

### Short-Circuit Protection

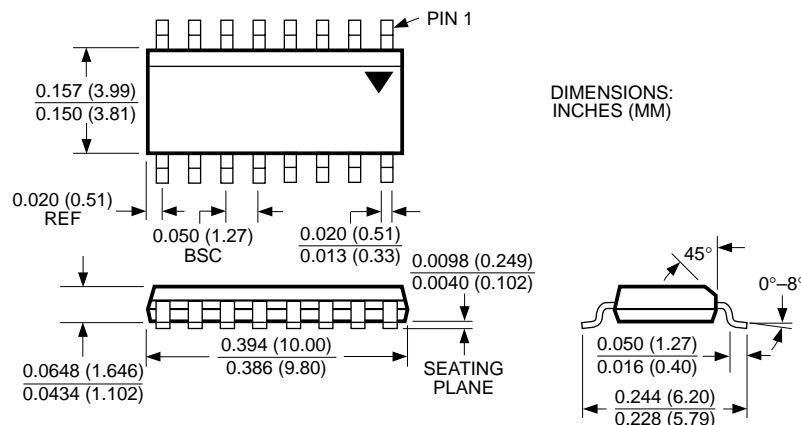
In the event of a short-circuit, the output current will fold back to approximately 80% of the short-circuit current-limit.

### Fault Flag

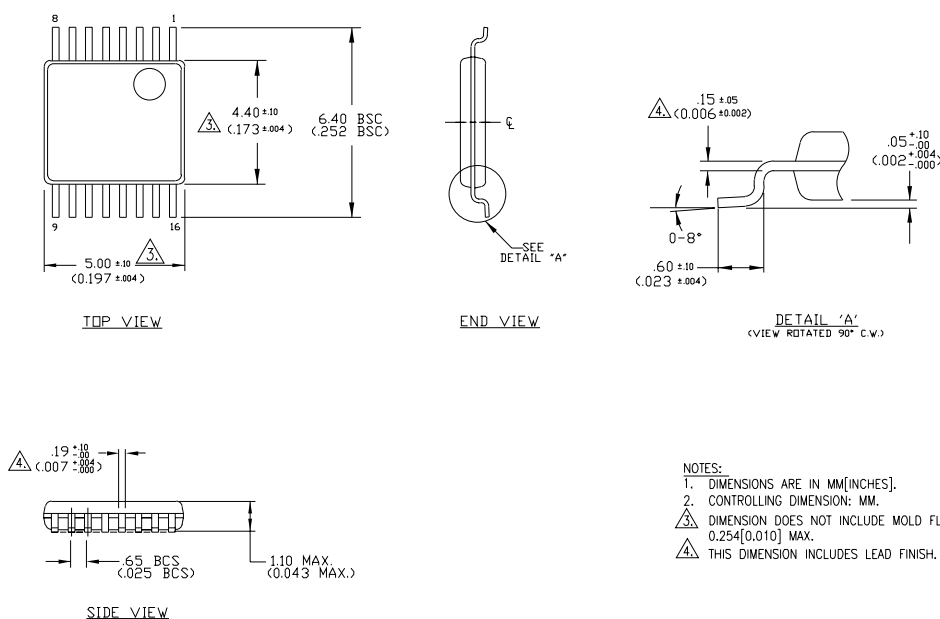
FLGX is an N-channel, open-drain MOSFET output. The fault-flag is active (low) for current-limit or thermal shutdown conditions. The flag output MOSFET is capable of sinking a 10mA load to typically 100mV above ground.



## Package Information



**16-Pin SOP (M)**



**16-Pin TSSOP (TS)**

Rev. 01

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