

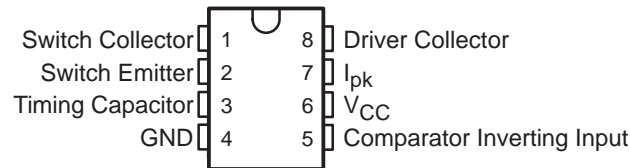
## 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

SLLS636D – DECEMBER 2004 – REVISED MARCH 2005

- Wide Input Voltage Range . . . 3 V to 40 V
- High Output Switch Current . . . Up to 1.5 A
- Adjustable Output Voltage
- Oscillator Frequency . . . Up to 100 kHz
- Precision Internal Reference . . . 2%
- Short-Circuit Current Limiting
- Low Standby Current

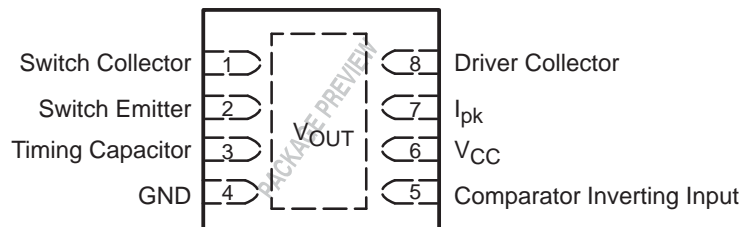
## D (SOIC) OR P (PDIP) PACKAGE

(TOP VIEW)



## DRJ (QFN) PACKAGE

(TOP VIEW)



## description/ordering information

The MC33063A and MC34063A are easy-to-use ICs containing all the primary circuitry needed for building simple dc-dc converters. These devices primarily consist of an internal temperature-compensated reference, a comparator, an oscillator, a PWM controller with active current limiting, a driver, and a high-current output switch; thus, the devices require minimal external components to build converters in the boost, buck, and inverting topologies.

The MC33063A is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , while the MC34063A is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

## ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	PDIP (P)	Tube of 50	MC33063AP	MC33063AP
	QFN (DRJ)	Reel of 1000	MC33063ADRJR	PREVIEW
	SOIC (D)	Tube of 75	MC33063AD	M33063A
		Reel of 2500	MC33063ADR	
$0^{\circ}\text{C}$ to $70^{\circ}\text{C}$	PDIP (P)	Tube of 50	MC34063AP	MC34063AP
	QFN (DRJ)	Reel of 1000	MC34063ADRJR	PREVIEW
	SOIC (D)	Tube of 75	MC34063AD	M34063A
		Reel of 2500	MC34063ADR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

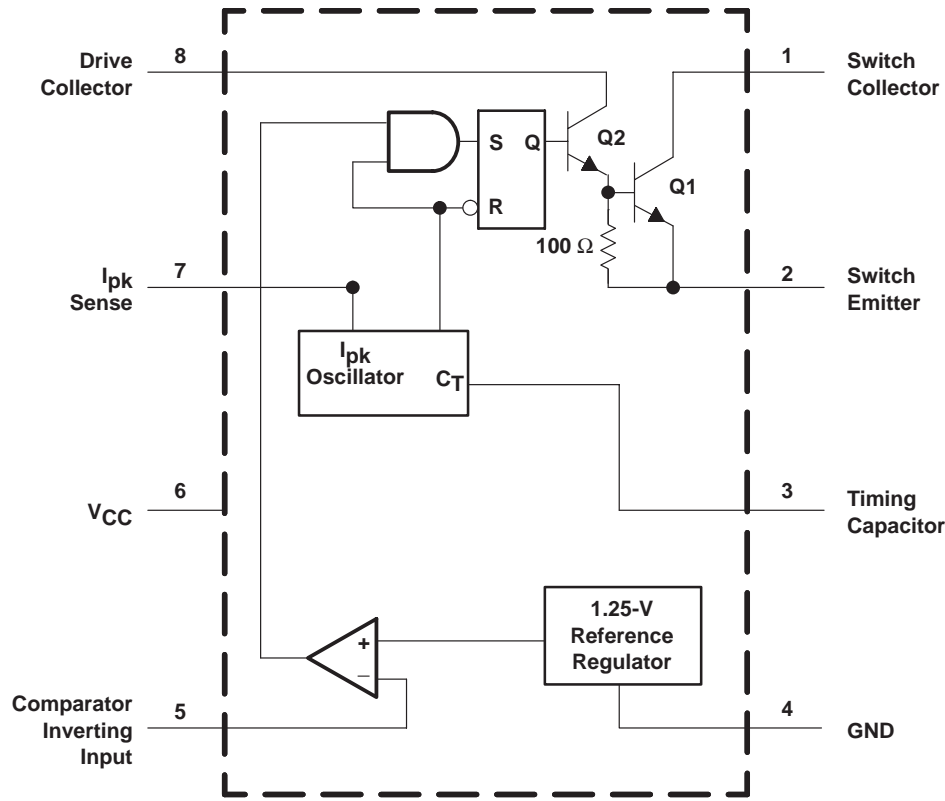
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# MC33063A, MC34063A 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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## functional block diagram



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC}$	40 V
Comparator Inverting Input voltage range, $V_{IR}$	-0.3 V to 40 V
Switch Collector voltage, $V_{C(\text{switch})}$	40V
Switch Emitter voltage ( $V_{PIN1} = 40\text{ V}$ ), $V_{E(\text{switch})}$	40V
Switch Collector to Switch Emitter voltage, $V_{CE(\text{switch})}$	40V
Driver Collector voltage, $V_{C(\text{driver})}$	40V
Driver Collector current, $I_{C(\text{driver})}$	100 mA
Switch current, $I_{SW}$	1.5 A
Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2):	
D package	97°C/W
DRJ package	TBD°C/W
P package	85°C/W
Operating virtual junction temperature, $T_J$	150°C
Storage temperature range, $T_{stg}$	-65°C to 150°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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.  
2. The package thermal impedance is calculated in accordance with JESD 51-7.

# MC33063A, MC34063A

## 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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### recommended operating conditions

		MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage	3	40	V	
T <sub>A</sub>	Operating free-air temperature range	MC33063A	-40	85	°C
		MC34063A	0	70	

electrical characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = full operating range (unless otherwise noted) (see block diagram)

### OSCILLATOR

PARAMETER	TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT	
f <sub>osc</sub>	Oscillator frequency	V <sub>PIN5</sub> = 0 V, C <sub>T</sub> = 1 nF	25°C	24	33	42	kHz
I <sub>chg</sub>	Charge current	V <sub>CC</sub> = 5 V to 40 V	25°C	24	35	42	μA
I <sub>dischg</sub>	Discharge current	V <sub>CC</sub> = 5 V to 40 V	25°C	140	220	260	μA
I <sub>dischg</sub> /I <sub>chg</sub>	Discharge-to-charge current ratio	V <sub>PIN7</sub> = V <sub>CC</sub>	25°C	5.2	6.5	7.5	
V <sub>lpk</sub>	Current-limit sense voltage	I <sub>dischg</sub> = I <sub>chg</sub>	25°C	250	300	350	mV

### OUTPUT SWITCH (see Note 3)

PARAMETER	TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
V <sub>CE(sat)</sub>	Saturation voltage – Darlington connection	I <sub>SW</sub> = 1 A, pins 1 and 8 connected	Full range	1	1.3	V
V <sub>CE(sat)</sub>	Saturation voltage – non-Darlington connection (see Note 4)	I <sub>SW</sub> = 1 A, R <sub>PIN8</sub> = 82 Ω to V <sub>CC</sub> , forced β ~ 20	Full range	0.45	0.7	V
h <sub>FE</sub>	DC current gain	I <sub>SW</sub> = 1 A, V <sub>CE</sub> = 5 V	25°C	50	75	
I <sub>C(off)</sub>	Collector off-state current	V <sub>CE</sub> = 40 V	Full range	0.01	100	μA

- NOTES: 3. Low duty-cycle pulse testing is used to maintain junction temperature as close to ambient temperature as possible.  
 4. In the non-Darlington configuration, if the output switch is driven into hard saturation at low switch currents (≤300 mA) and high driver currents (≥30 mA), it may take up to 2 μs for the switch to come out of saturation. This condition effectively shortens the off time at frequencies ≥30 kHz, becoming magnified as temperature increases. The following output drive condition is recommended in the non-Darlington configuration:  
 Forced β of output switch = I<sub>C,SW</sub> / (I<sub>C,driver</sub> - 7 mA) ≥ 10,  
 where ~ 7 mA is required by the 100-Ω resistor in the emitter of the driver to forward bias the V<sub>be</sub> of the switch.

### COMPARATOR

PARAMETER	TEST CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNIT
V <sub>th</sub>	Threshold voltage	25°C	1.225	1.25	1.275	V
		Full range	1.21		1.29	
ΔV <sub>th</sub>	Threshold-voltage line regulation	V <sub>CC</sub> = 5 V to 40 V	Full range	1.4	5	mV
I <sub>IB</sub>	Input bias current	V <sub>IN</sub> = 0 V	Full range	-20	-400	nA

### TOTAL DEVICE

PARAMETER	TEST CONDITIONS	T <sub>A</sub>	MIN	MAX	UNIT	
I <sub>CC</sub>	Supply current	V <sub>CC</sub> = 5 V to 40 V, C <sub>T</sub> = 1 nF, V <sub>PIN7</sub> = V <sub>CC</sub> , V <sub>PIN5</sub> > V <sub>th</sub> , V <sub>PIN2</sub> = GND, all other pins open	Full range	4		mA



# MC33063A, MC34063A 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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## TYPICAL CHARACTERISTICS

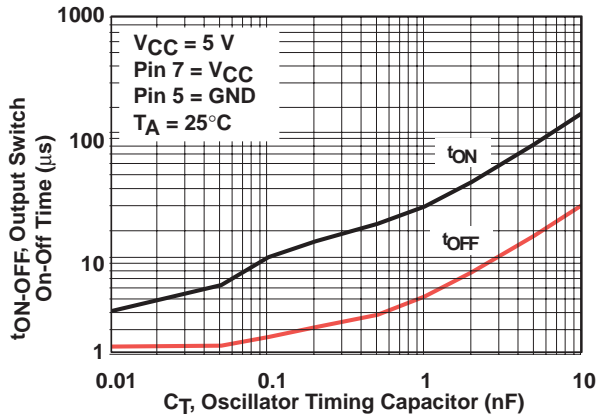


Figure 1. Output Switch On-Off Time vs Oscillator Timing Capacitor

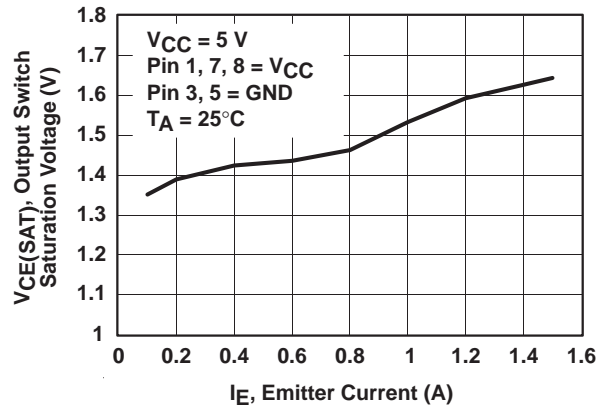


Figure 2. Output Switch Saturation Voltage vs Emitter Current (Emitter-Follower Configuration)

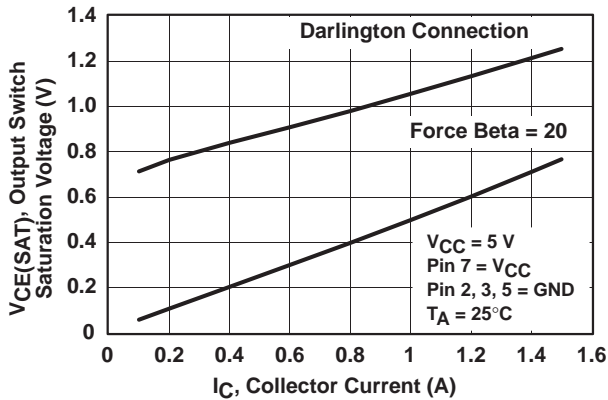


Figure 3. Output Switch Saturation Voltage vs Collector Current (Common-Emitter Configuration)

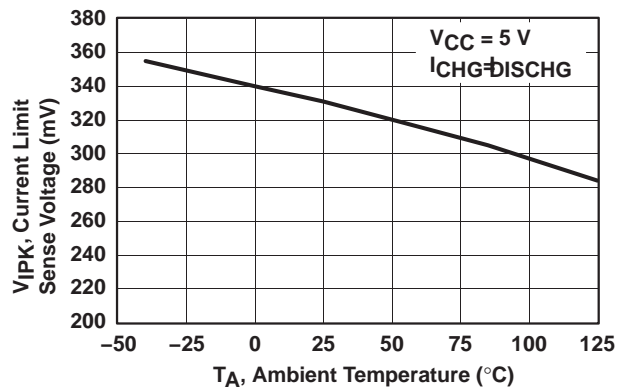


Figure 4. Current-Limit Sense Voltage vs Temperature

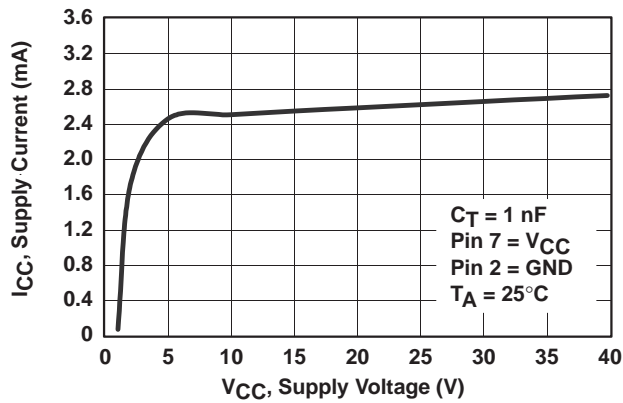
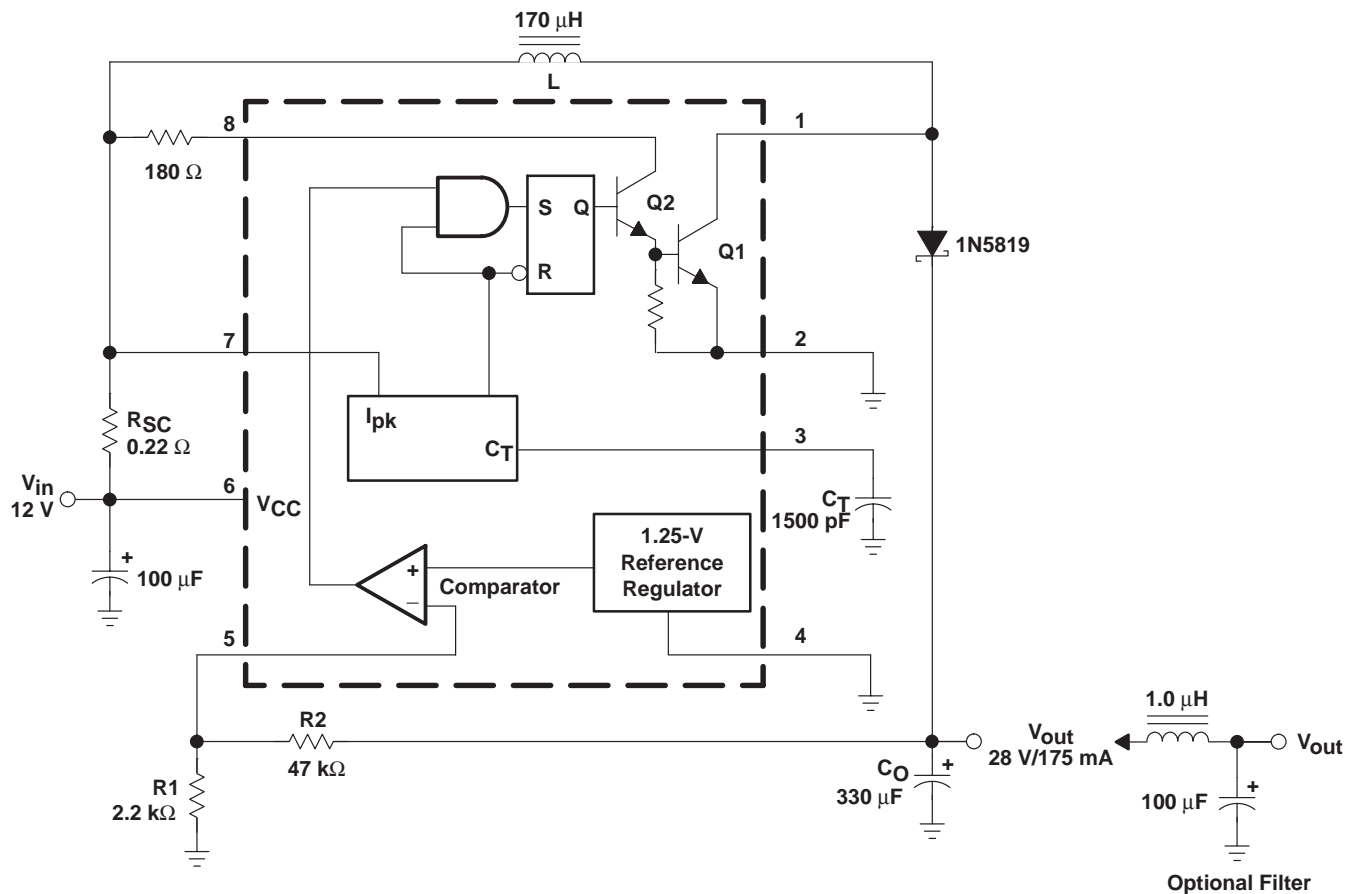


Figure 5. Standby Supply Current vs Supply Voltage

# MC33063A, MC34063A 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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## TYPICAL CHARACTERISTICS



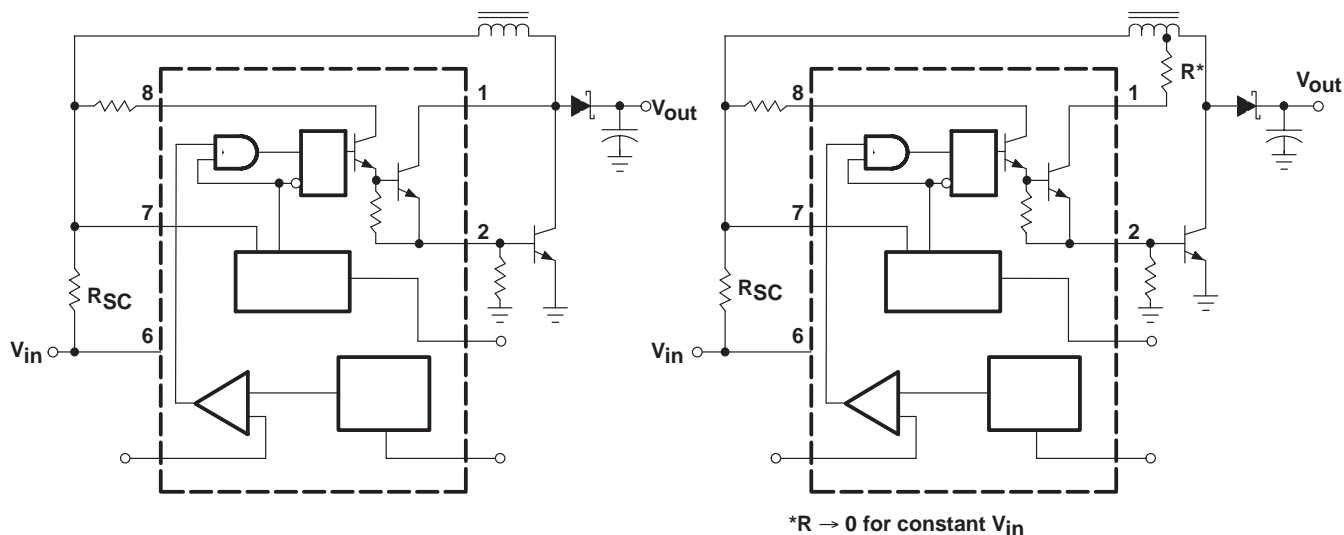
TEST	CONDITIONS	RESULTS
Line Regulation	$V_{IN} = 8\text{ V to }16\text{ V}, I_O = 175\text{ mA}$	$30\text{ mV} \pm 0.05\%$
Load Regulation	$V_{IN} = 12\text{ V}, I_O = 75\text{ mA to }175\text{ mA}$	$10\text{ mV} \pm 0.017\%$
Output Ripple	$V_{IN} = 12\text{ V}, I_O = 175\text{ mA}$	$400\text{ mV}_{pp}$
Efficiency	$V_{IN} = 12\text{ V}, I_O = 175\text{ mA}$	$87.7\%$
Output Ripple With Optional Filter	$V_{IN} = 12\text{ V}, I_O = 175\text{ mA}$	$40\text{ mV}_{pp}$

Figure 6. Step-Up Converter

# MC33063A, MC34063A 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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## TYPICAL CHARACTERISTICS



**2a. External npn Switch**

**2b. External pnp Saturated Switch (see Note 5)**

NOTE A: If the output switch is driven into hard saturation (non-Darlington configuration) at low switch currents ( $\leq 300$  mA) and high driver currents ( $\geq 30$  mA), it may take up to  $2 \mu\text{s}$  to come out of saturation. This condition will shorten the off time at frequencies  $\geq 30$  kHz and is magnified at high temperatures. This condition does not occur with a Darlington configuration because the output switch cannot saturate. If a non-Darlington configuration is used, the output drive configuration in Figure 2b is recommended.

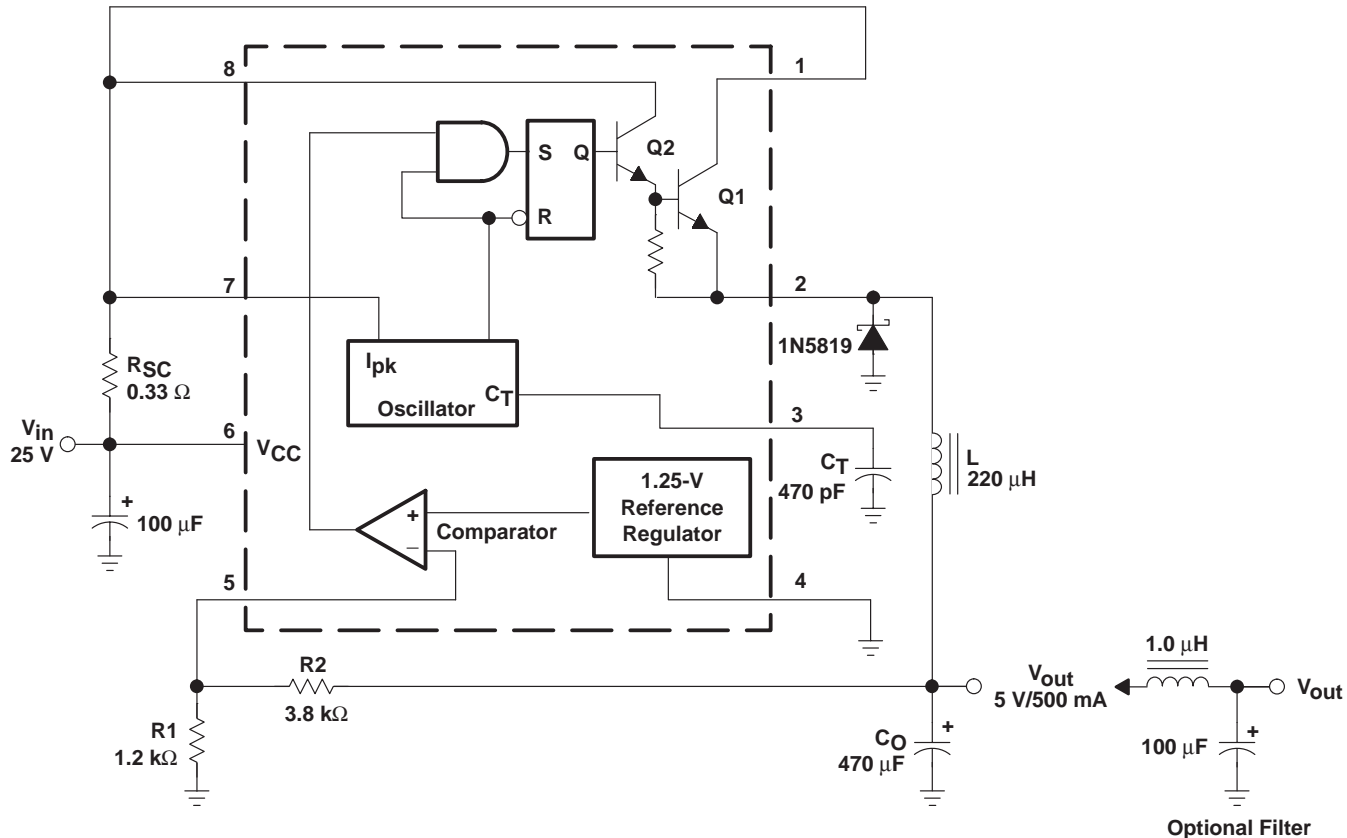
**Figure 7. External Current-Boost Connections for  $I_C$  Peak Greater Than 1.5 A**

# MC33063A, MC34063A

## 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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### TYPICAL CHARACTERISTICS



TEST	CONDITIONS	RESULTS
Line Regulation	$V_{IN} = 15\text{ V to }25\text{ V}, I_O = 500\text{ mA}$	$12\text{ mV} \pm 0.12\%$
Load Regulation	$V_{IN} = 25\text{ V}, I_O = 50\text{ mA to }500\text{ mA}$	$3\text{ mV} \pm 0.03\%$
Output Ripple	$V_{IN} = 25\text{ V}, I_O = 500\text{ mA}$	$120\text{ mV}_{pp}$
Short-Circuit Current	$V_{IN} = 25\text{ V}, R_L = 0.1\ \Omega$	$1.1\text{ A}$
Efficiency	$V_{IN} = 25\text{ V}, I_O = 500\text{ mA}$	$83.7\%$
Output Ripple With Optional Filter	$V_{IN} = 25\text{ V}, I_O = 500\text{ mA}$	$40\text{ mV}_{pp}$

**Figure 8. Step-Down Converter**

# MC33063A, MC34063A 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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## TYPICAL CHARACTERISTICS

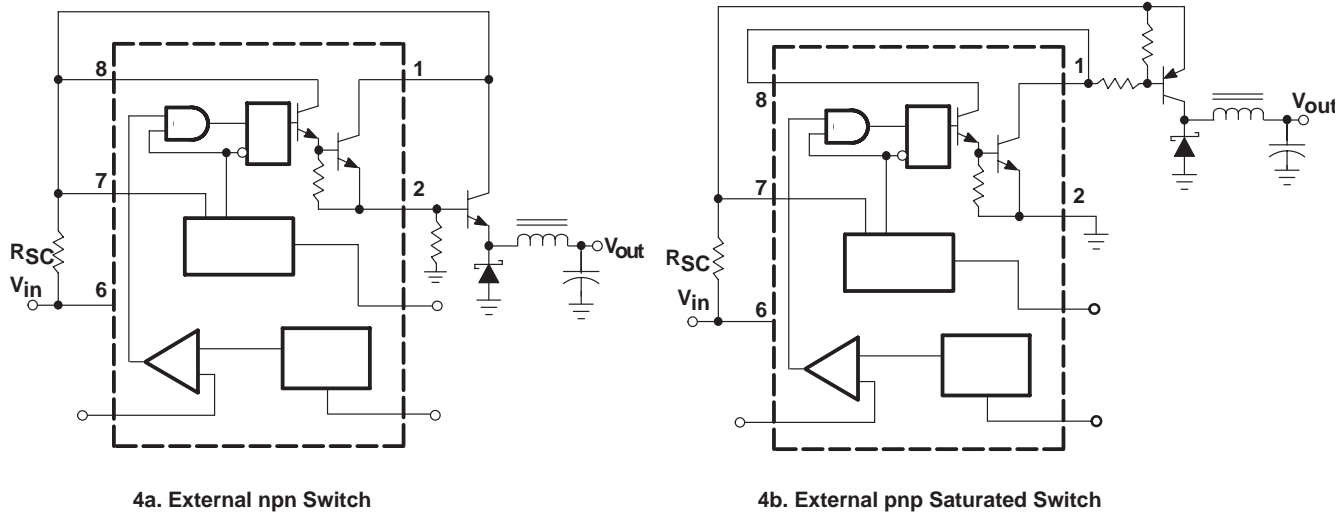
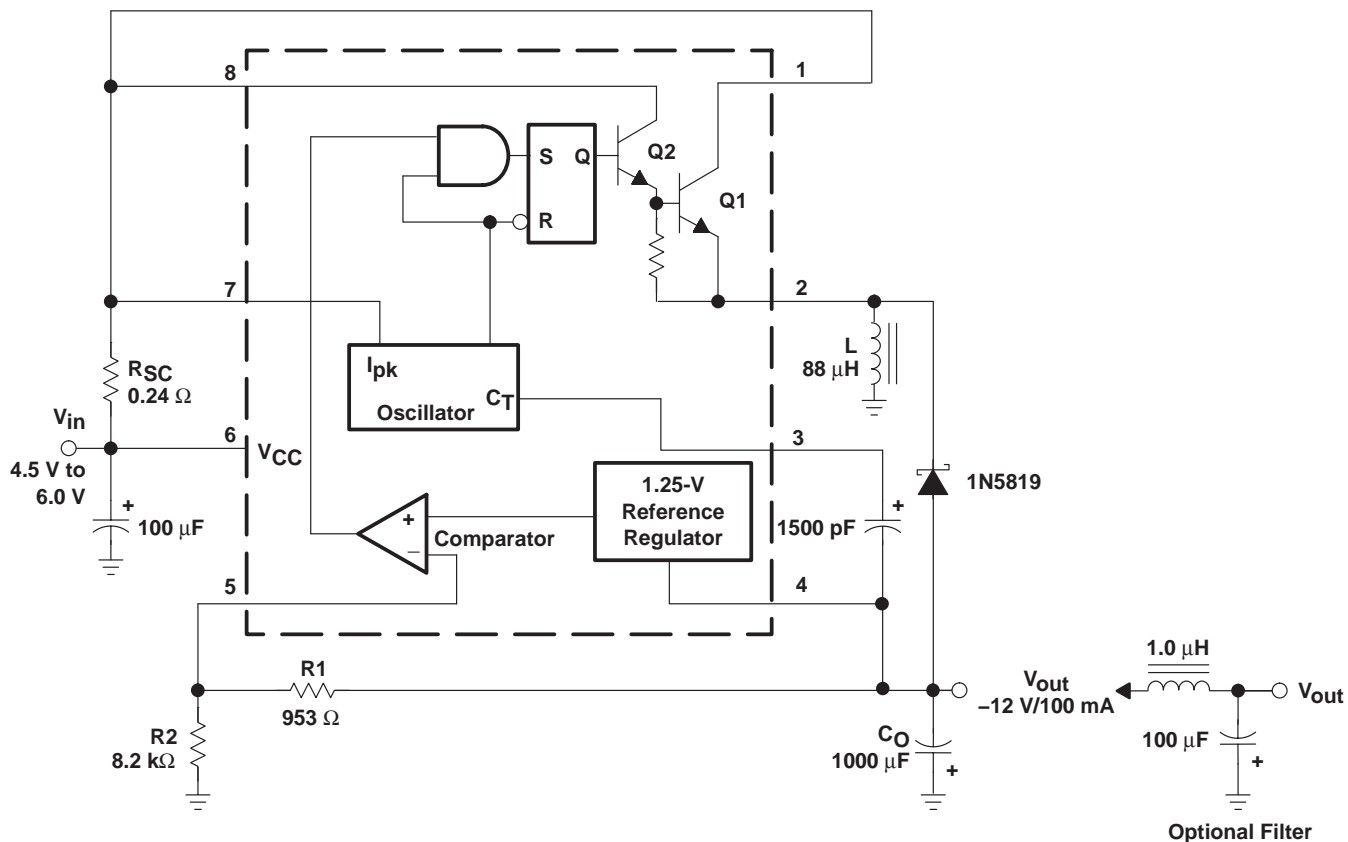


Figure 9. External Current-Boost Connections for  $I_C$  Peak Greater Than 1.5 A



TYPICAL CHARACTERISTICS



TEST	CONDITIONS	RESULTS
Line Regulation	$V_{IN} = 4.5 \text{ V to } 6 \text{ V}, I_O = 100 \text{ mA}$	$3 \text{ mV} \pm 0.12\%$
Load Regulation	$V_{IN} = 5 \text{ V}, I_O = 10 \text{ mA to } 100 \text{ mA}$	$0.022 \text{ V} \pm 0.09\%$
Output Ripple	$V_{IN} = 5 \text{ V}, I_O = 100 \text{ mA}$	$500 \text{ mV}_{PP}$
Short-Circuit Current	$V_{IN} = 5 \text{ V}, R_L = 0.1 \Omega$	$910 \text{ mA}$
Efficiency	$V_{IN} = 5 \text{ V}, I_O = 100 \text{ mA}$	$62.2\%$
Output Ripple With Optional Filter	$V_{IN} = 5 \text{ V}, I_O = 100 \text{ mA}$	$70 \text{ mV}_{PP}$

Figure 10. Voltage-Inverting Converter

# MC33063A, MC34063A 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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## TYPICAL CHARACTERISTICS

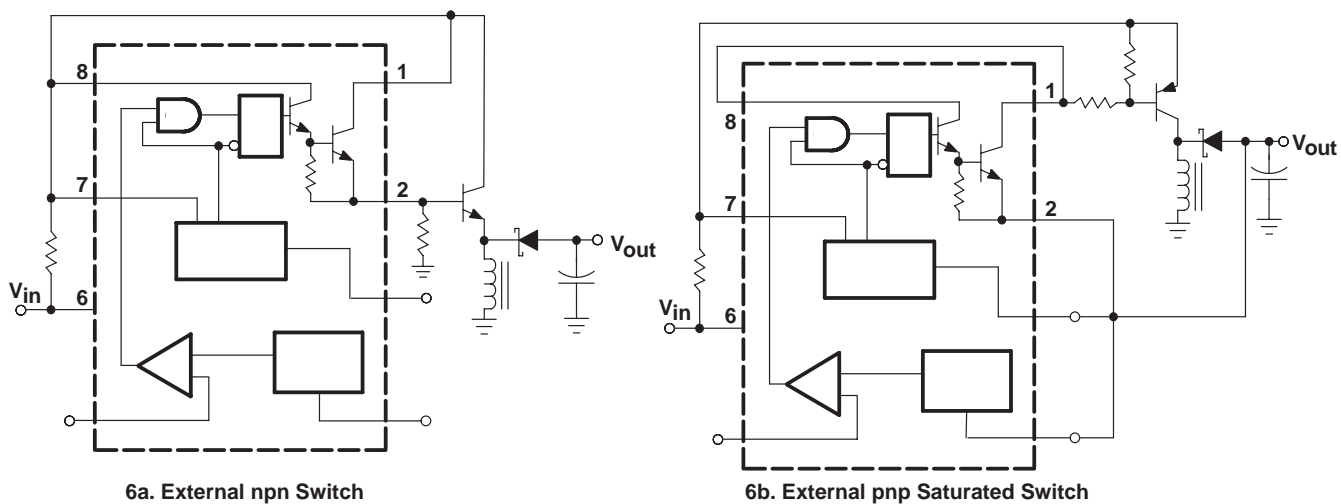


Figure 11. External Current-Boost Connections for  $I_C$  Peak Greater Than 1.5 A

# MC33063A, MC34063A

## 1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

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### APPLICATION INFORMATION

#### calculations of key parameters

CALCULATION	STEP UP	STEP DOWN	VOLTAGE INVERTING
$t_{on}/t_{off}$	$\frac{V_{out} + V_F - V_{in(min)}}{V_{in(min)} - V_{sat}}$	$\frac{V_{out} + V_F}{V_{in(min)} - V_{sat} - V_{out}}$	$\frac{ V_{out}  + V_F}{V_{in} - V_{sat}}$
$(t_{on} + t_{off})$	$\frac{1}{f}$	$\frac{1}{f}$	$\frac{1}{f}$
$t_{off}$	$\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$	$\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$	$\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$
$t_{on}$	$(t_{on} + t_{off}) - t_{off}$	$(t_{on} + t_{off}) - t_{off}$	$(t_{on} + t_{off}) - t_{off}$
$C_T$	$4 \times 10^{-5} t_{on}$	$4 \times 10^{-5} t_{on}$	$4 \times 10^{-5} t_{on}$
$I_{pk}(switch)$	$2I_{out(max)} \left( \frac{t_{on}}{t_{off}} + 1 \right)$	$2I_{out(max)}$	$2I_{out(max)} \left( \frac{t_{on}}{t_{off}} + 1 \right)$
$R_{sc}$	$\frac{0.3}{I_{pk}(switch)}$	$\frac{0.3}{I_{pk}(switch)}$	$\frac{0.3}{I_{pk}(switch)}$
$L_{(min)}$	$\left( \frac{(V_{in(min)} - V_{sat})}{I_{pk}(switch)} \right) t_{on(max)}$	$\left( \frac{(V_{in(min)} - V_{sat} - V_{out})}{I_{pk}(switch)} \right) t_{on(max)}$	$\left( \frac{(V_{in(min)} - V_{sat})}{I_{pk}(switch)} \right) t_{on(max)}$
$C_O$	$9 \frac{I_{out} t_{on}}{V_{ripple(pp)}}$	$\frac{I_{pk}(switch)(t_{on} + t_{off})}{8V_{ripple(pp)}}$	$9 \frac{I_{out} t_{on}}{V_{ripple(pp)}}$

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
MC33063AD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MC33063ADR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MC33063AP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
MC34063AD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MC34063ADR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MC34063AP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**None:** Not yet available Lead (Pb-Free).

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<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



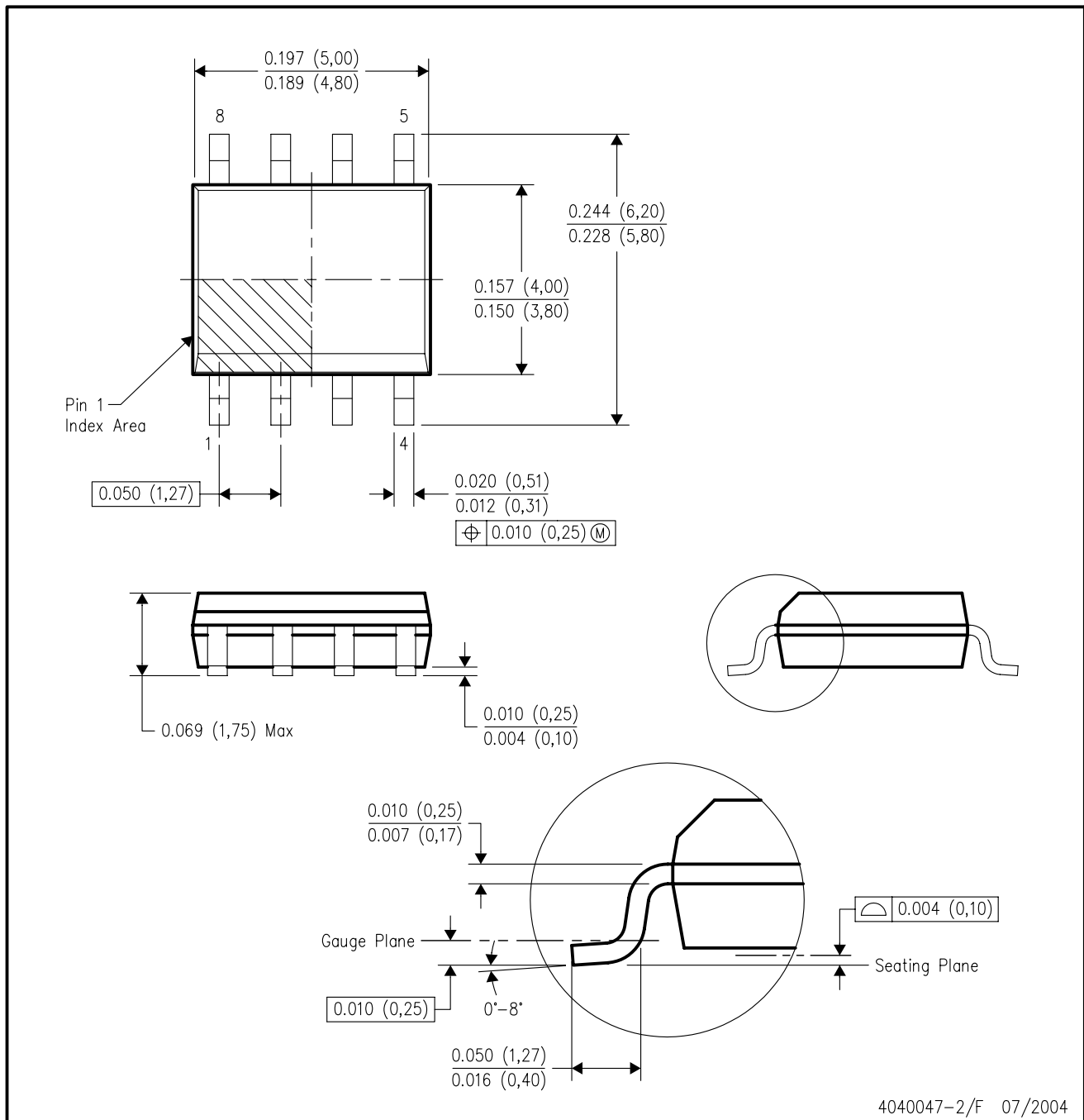
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)



D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-012 variation AA.

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