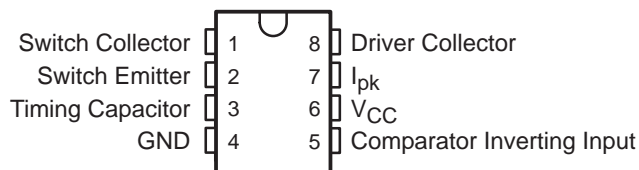- **Qualification in Accordance With AEC-Q100†**
- **Qualified for Automotive Applications**
- **Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval**
- **Wide Input Voltage Range . . . 3 V to 40 V**
- **High Output Switch Current . . . Up to 1.5 A**
- **Adjustable Output Voltage**
- **Oscillator Frequency . . . Up to 100 kHz**
- **Precision Internal Reference . . . 2%**
- **Short-Circuit Current Limiting**
- **Low Standby Current**

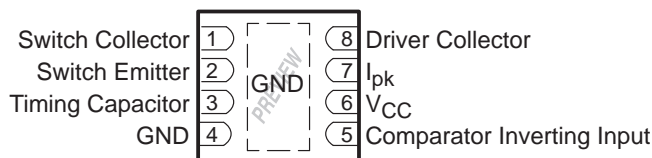† Contact factory for details. Q100 qualification data available on request.

D (SOIC) PACKAGE
(TOP VIEW)

Switch Collector	1	8	Driver Collector
Switch Emitter	2	7	I_{pk}
Timing Capacitor	3	6	V_{CC}
GND	4	5	Comparator Inverting Input

DRJ (QFN) PACKAGE
(TOP VIEW)

Switch Collector	1	8	Driver Collector
Switch Emitter	2	7	I_{pk}
Timing Capacitor	3	6	V_{CC}
GND	4	5	Comparator Inverting Input

GND

description/ordering information

The MC33063A is an easy-to-use IC containing all the primary circuitry needed for building simple dc-dc converters. This device primarily consists 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 device requires minimal external components to build converters in the boost, buck, and inverting topologies.

The MC33063A is characterized for operation from −40°C to 125°C.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 125°C	QFN (DRJ)	Reel of 1000	MC33063AQDRJR	PREVIEW
	SOIC (D)	Reel of 2500	MC33063AQDR	33063AQ

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

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

TEXAS INSTRUMENTS

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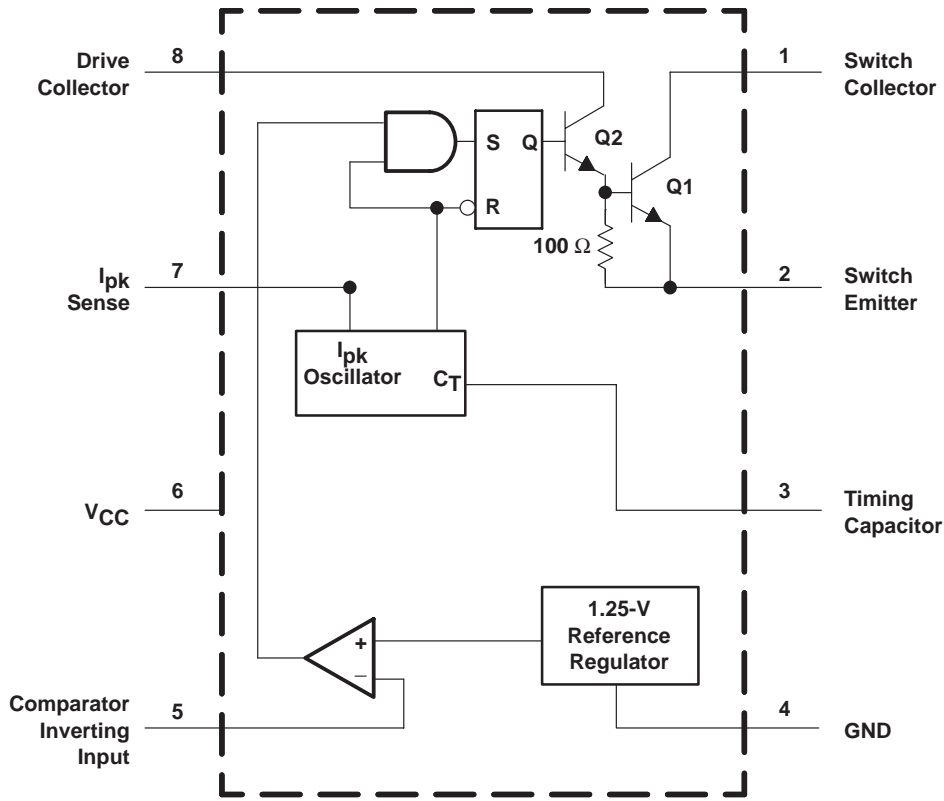
absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} .... 40 V
Comparator Inverting Input voltage range, V_{IR} .... −0.3 V to 40 V
Switch Collector voltage, $V_{C(switch)}$ 40V
Switch Emitter voltage (V_{PIN1} = 40 V), $V_{E(switch)}$ 40V
Switch Collector to Switch Emitter voltage, $V_{CE(switch)}$ 40V
Driver Collector voltage, $V_{C(driver)}$ 40V
Driver Collector current, $I_{C(driver)}$ .... 100 mA
Switch current, I_{SW} .... 1.5 A
Package thermal impedance, θ_{JA} (see Notes 1 and 2): D package .... 97°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(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_J(max) − T_A)/θ_{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.

recommended operating conditions

			MIN	MAX	UNIT
V_{CC}	Supply voltage		3	40	V
T_A	Operating free-air temperature range	MC33063A	−40	125	°C

electrical characteristics, V_{CC} = 5 V, T_A = full operating range (unless otherwise noted) (see block diagram)

OSCILLATOR

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
f_{osc}	Oscillator frequency	V_{PIN5} = 0 V, C_T = 1 nF	25°C	24	33	42	kHz
I_{chg}	Charge current	V_{CC} = 5 V to 40 V	25°C	24	35	42	μA
I_{dischg}	Discharge current	V_{CC} = 5 V to 40 V	25°C	140	220	260	μA
I_{dischg}/I_{chg}	Discharge-to-charge current ratio	V_{PIN7} = V_{CC}	25°C	5.2	6.5	7.5	
V_{Ipk}	Current-limit sense voltage	I_{dischg} = I_{chg}	25°C	250	300	350	mV

OUTPUT SWITCH (see Note 3)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
$V_{CE(sat)}$	Saturation voltage – Darlington connection	I_{SW} = 1 A, pins 1 and 8 connected	Full range		1	1.3	V
$V_{CE(sat)}$	Saturation voltage – non-Darlington connection (see Note 4)	I_{SW} = 1 A, R_{PIN8} = 82 Ω to V_{CC}, forced β ~ 20	Full range		0.45	0.7	V
h_{FE}	DC current gain	I_{SW} = 1 A, V_{CE} = 5 V	25°C	50	75		
$I_{C(off)}$	Collector off-state current	V_{CE} = 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 = $I_{C,SW}$ / ($I_{C,driver}$ − 7 mA) ≥ 10,
where ~ 7 mA is required by the 100-Ω resistor in the emitter of the driver to forward bias the V_{be} of the switch.

COMPARATOR

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
V_{th}	Threshold voltage		25°C	1.225	1.25	1.275	V
			Full range	1.21		1.29	
ΔV_{th}	Threshold-voltage line regulation	V_{CC} = 5 V to 40 V	Full range		1.4	5	mV
I_{IB}	Input bias current	V_{IN} = 0 V	Full range		−20	−400	nA

TOTAL DEVICE

PARAMETER		TEST CONDITIONS	T_A	MIN	MAX	UNIT
I_{CC}	Supply current	V_{CC} = 5 V to 40 V, C_T = 1 nF, V_{PIN7} = V_{CC}, V_{PIN5} > V_{th}, V_{PIN2} = GND, all other pins open	Full range		4	mA

**TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
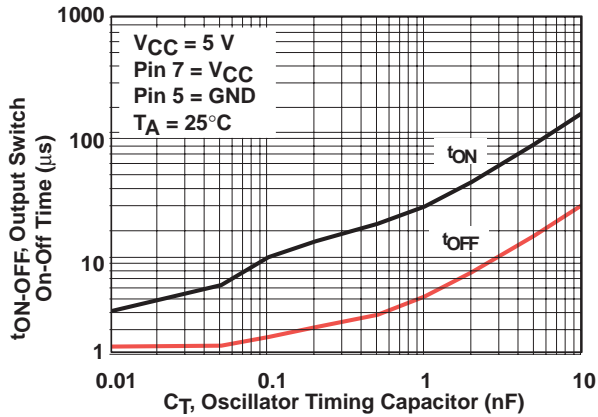
TYPICAL CHARACTERISTICS

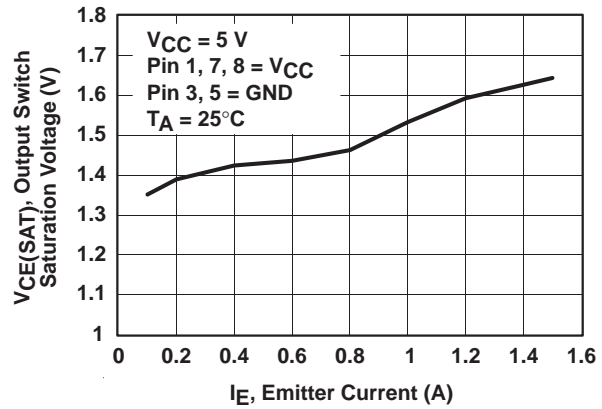Figure 1. Output Switch On-Off Time vs Oscillator Timing Capacitor

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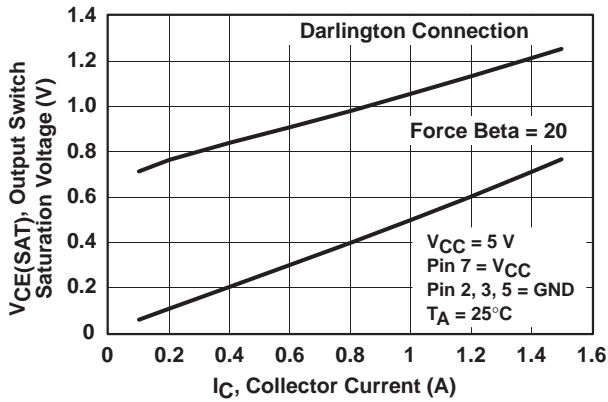

Figure 3. Output Switch Saturation Voltage vs Collector Current (Common-Emitter Configuration)
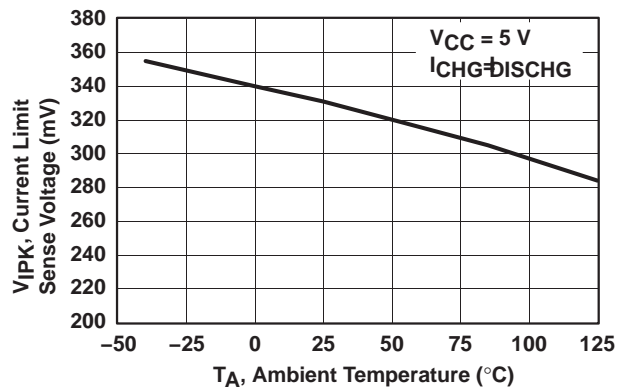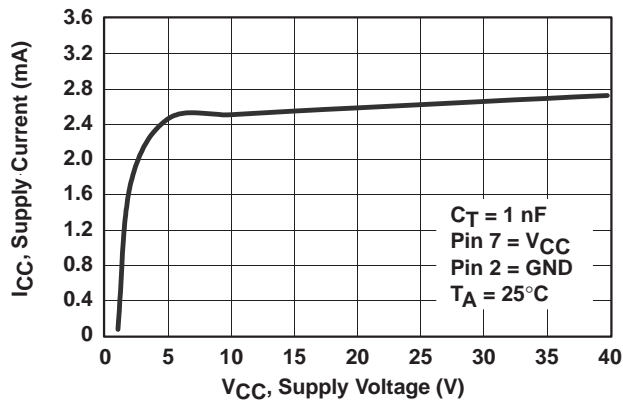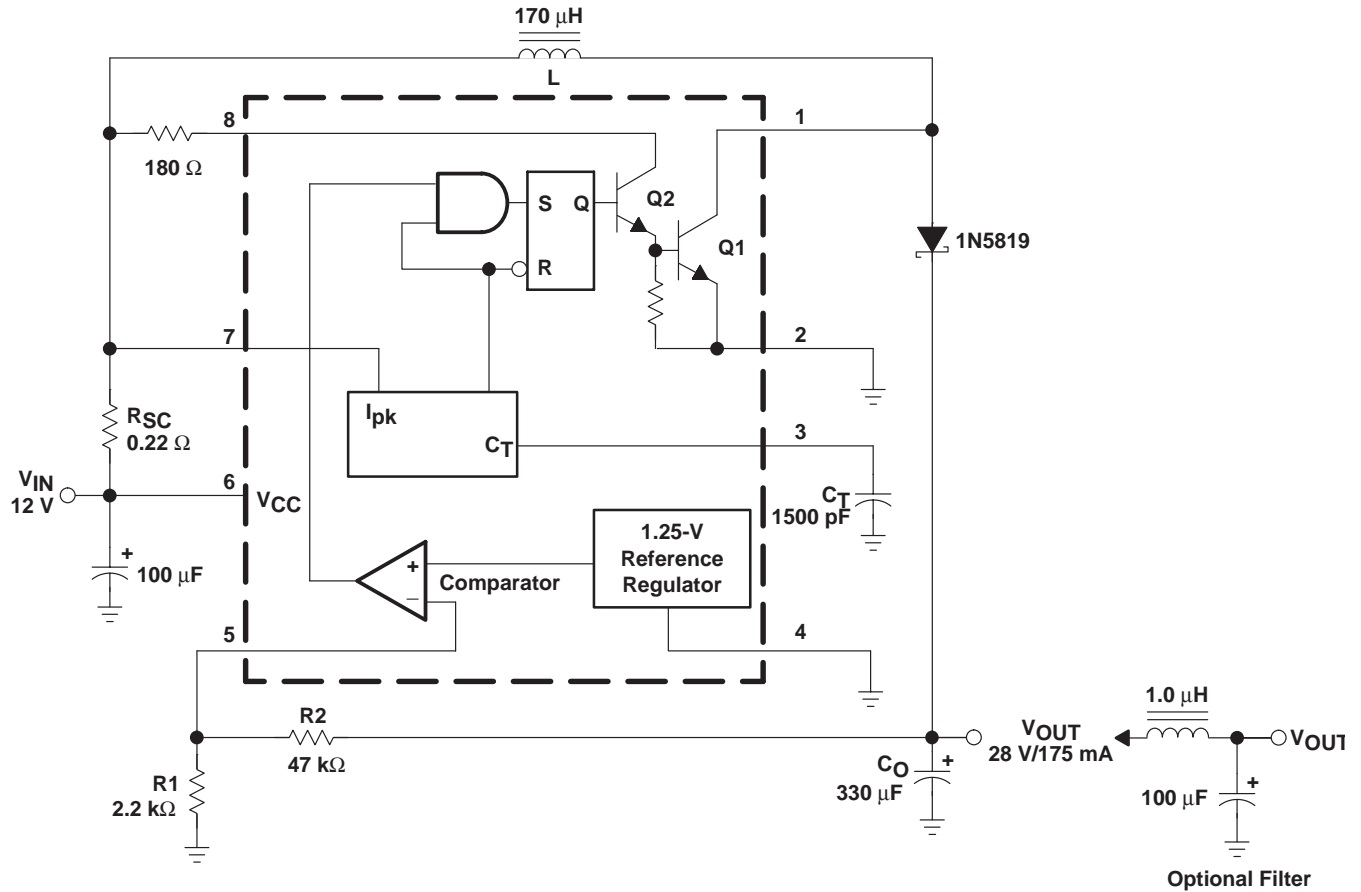

Figure 4. Current-Limit Sense Voltage vs Temperature

Figure 5. Standby Supply Current vs Supply Voltage

TYPICAL CHARACTERISTICS

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

Figure 6. Step-Up Converter

TYPICAL CHARACTERISTICS
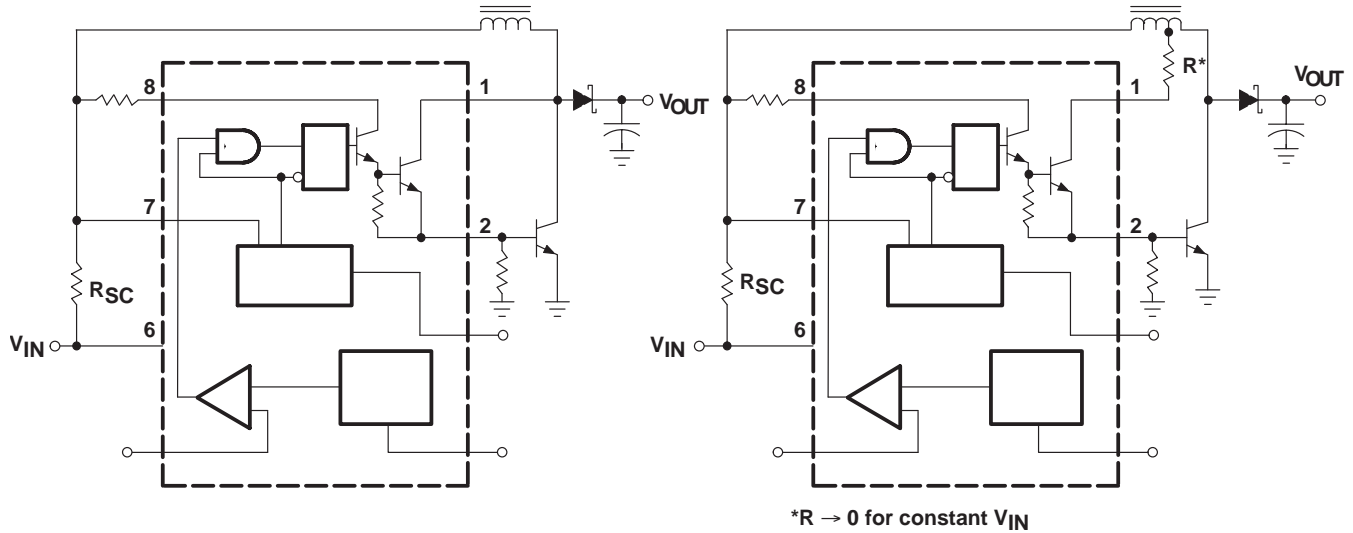
2a. External npn Switch

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

*R → 0 for constant V_{IN}

NOTE 5: 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 μs 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.
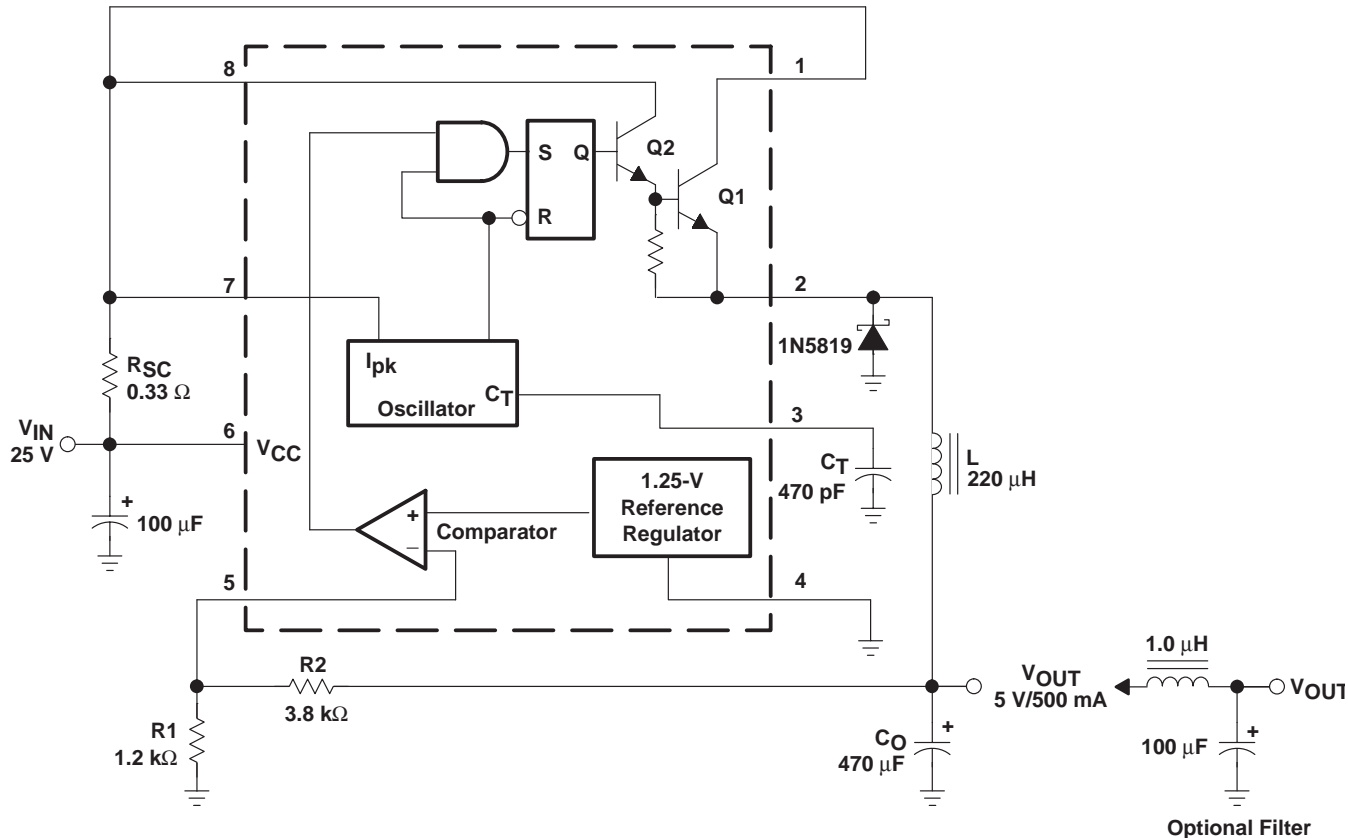
Figure 7. External Current-Boost Connections for I_C Peak Greater Than 1.5 A

TYPICAL CHARACTERISTICS

TEST	CONDITIONS	RESULTS
Line Regulation	V_{IN} = 15 V to 25 V, I_O = 500 mA	12 mV ± 0.12%
Load Regulation	V_{IN} = 25 V, I_O = 50 mA to 500 mA	3 mV ± 0.03%
Output Ripple	V_{IN} = 25 V, I_O = 500 mA	120 mV_{PP}
Short-Circuit Current	V_{IN} = 25 V, R_L = 0.1 Ω	1.1 A
Efficiency	V_{IN} = 25 V, I_O = 500 mA	83.7%
Output Ripple With Optional Filter	V_{IN} = 25 V, I_O = 500 mA	40 mV_{PP}

Figure 8. Step-Down Converter

TYPICAL CHARACTERISTICS

4a. External npn Switch

4b. External pnp Saturated Switch
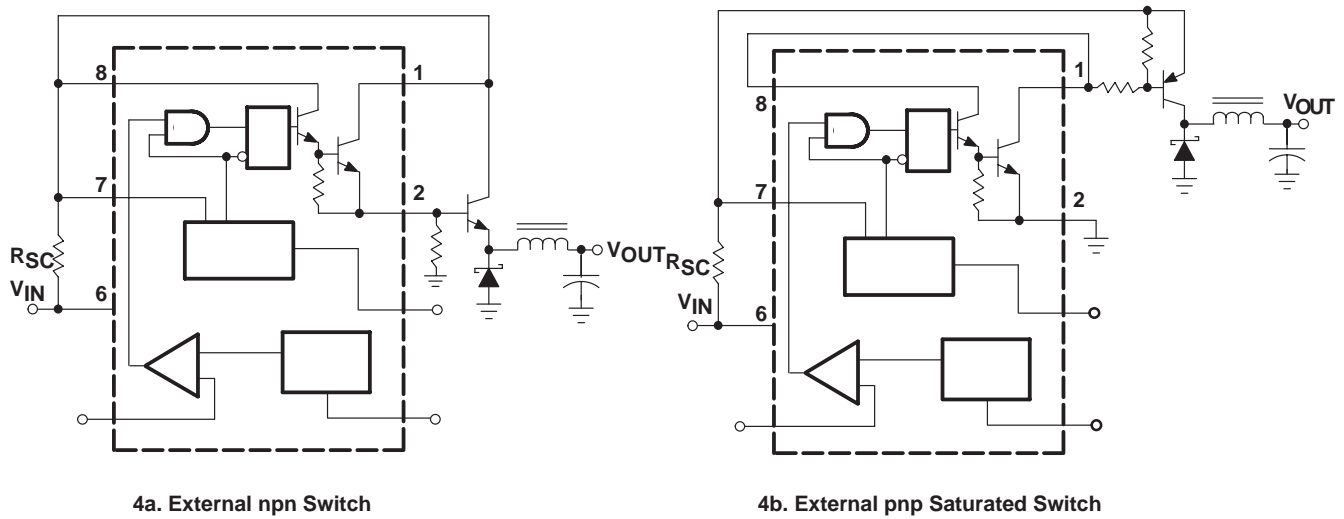
Figure 9. External Current-Boost Connections for I$_C$ Peak Greater Than 1.5 A

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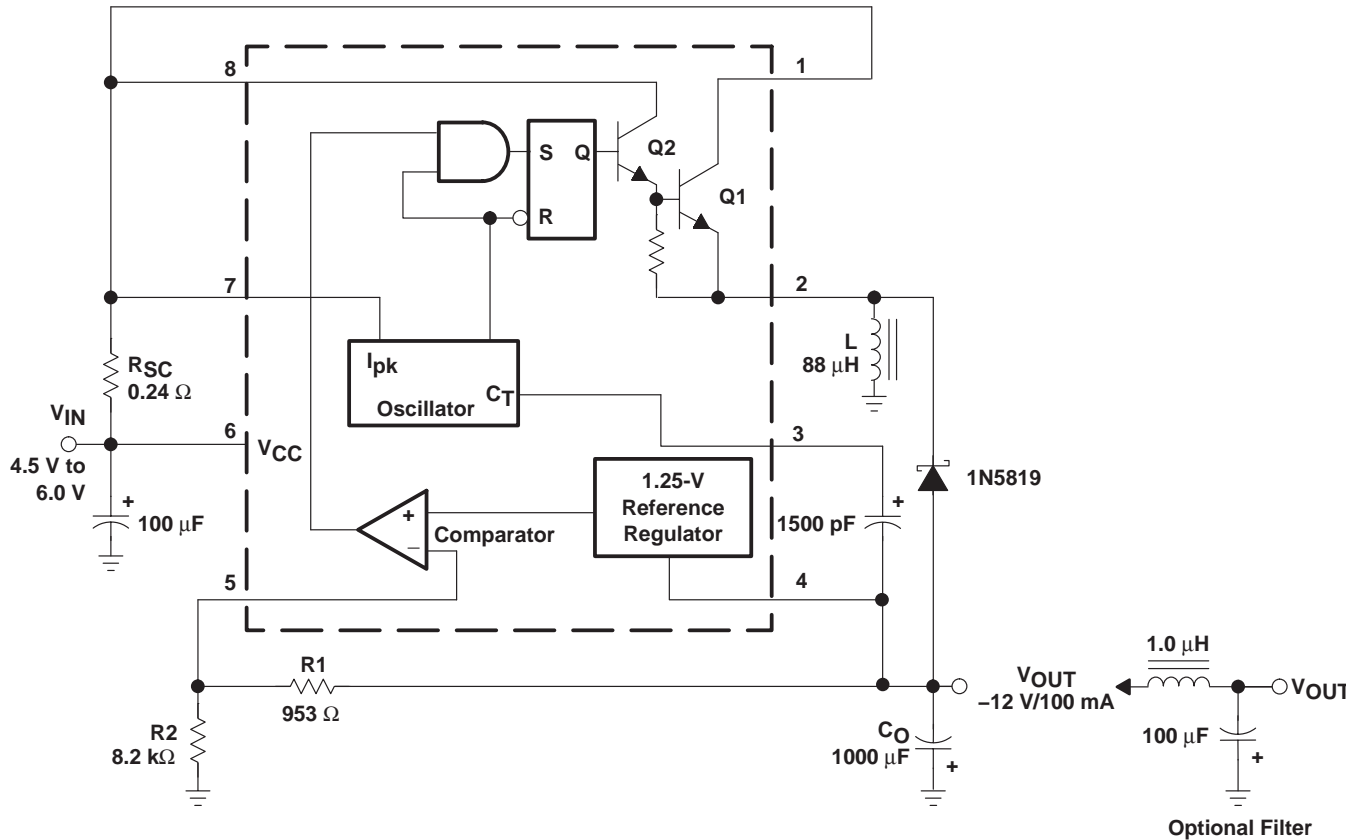
TEST	CONDITIONS	RESULTS
Line Regulation	V_{IN} = 4.5 V to 6 V, I_O = 100 mA	3 mV ± 0.12%
Load Regulation	V_{IN} = 5 V, I_O = 10 mA to 100 mA	0.022 V ± 0.09%
Output Ripple	V_{IN} = 5 V, I_O = 100 mA	500 mV$_{PP}$
Short-Circuit Current	V_{IN} = 5 V, R_L = 0.1 Ω	910 mA
Efficiency	V_{IN} = 5 V, I_O = 100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

Figure 10. Voltage-Inverting Converter

TYPICAL CHARACTERISTICS

6a. External npn Switch

6b. External pnp Saturated Switch
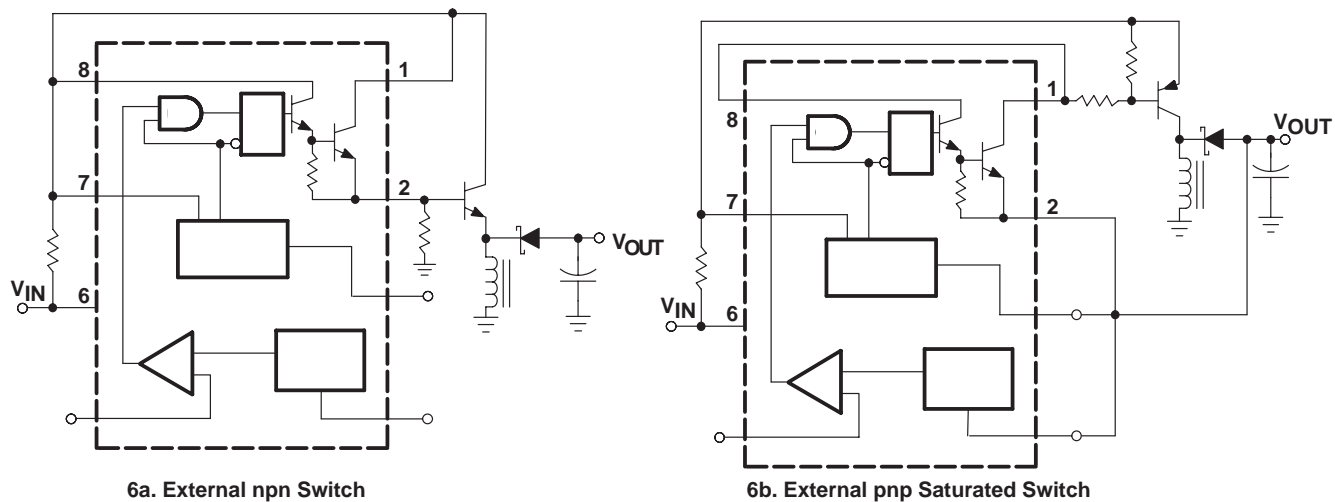
Figure 11. External Current-Boost Connections for I_C Peak Greater Than 1.5 A

APPLICATION INFORMATION

calculations of key parameters

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

TEXAS INSTRUMENTS

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
MC33063AQDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

[1] 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.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)
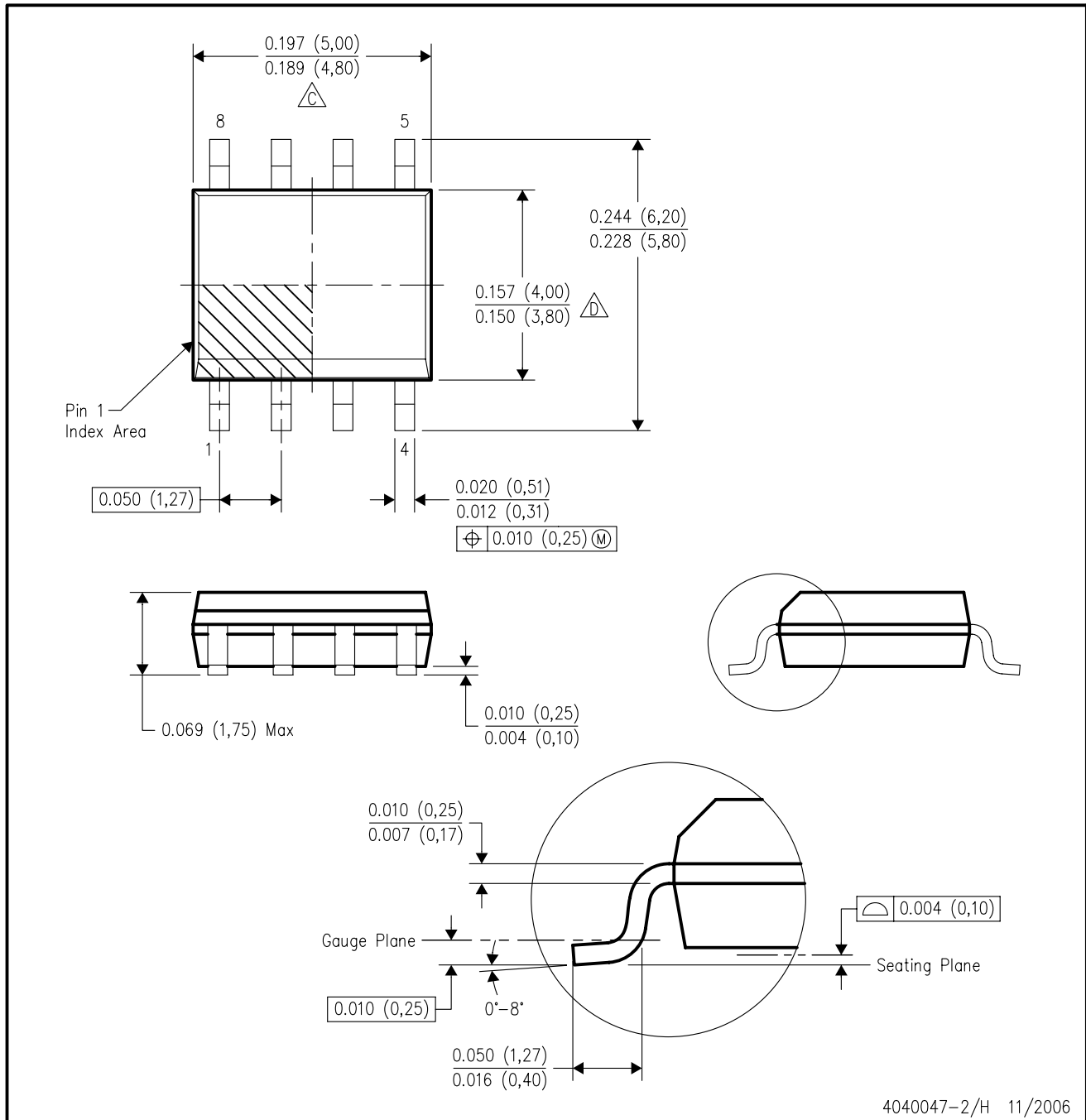
[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

D (R−PDSO−G8) PLASTIC SMALL−OUTLINE PACKAGE

0.197 (5,00)
0.189 (4,80)
⟨C⟩

8   5

0.244 (6,20)
0.228 (5,80)

0.157 (4,00)
0.150 (3,80) ⟨D⟩

Pin 1
Index Area

1   4

0.050 (1,27)

0.020 (0,51)
0.012 (0,31)

⊕ | 0.010 (0,25) | Ⓜ

0.069 (1,75) Max

0.010 (0,25)
0.004 (0,10)

0.010 (0,25)
0.007 (0,17)

⌂ | 0.004 (0,10)

Gauge Plane

Seating Plane

0.010 (0,25)

0°−8°

0.050 (1,27)
0.016 (0,40)

4040047−2/H   11/2006

NOTES: A.   All linear dimensions are in inches (millimeters).
         B.   This drawing is subject to change without notice.
         ⟨C⟩ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
         ⟨D⟩ Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
         E.   Reference JEDEC MS−012 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated