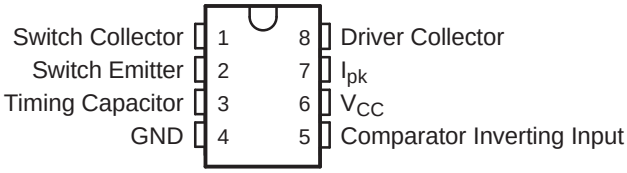
1.5-A PEAK BOOST/BUCK/INVERTING SWITCHING REGULATORS

Check for Samples: MC33063A, MC34063A

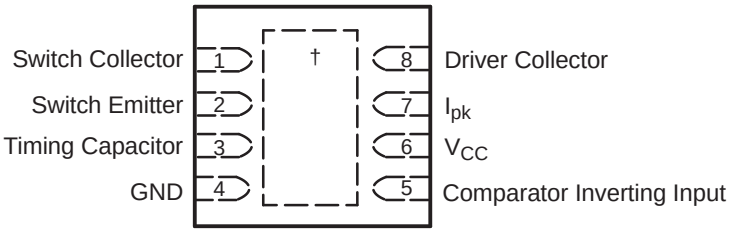
FEATURES

- **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)



† The exposed thermal pad is electrically bonded internally to pin 4 (GND) .

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°C to 85°C, while the MC34063A is characterized for operation from 0°C to 70°C.

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.

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

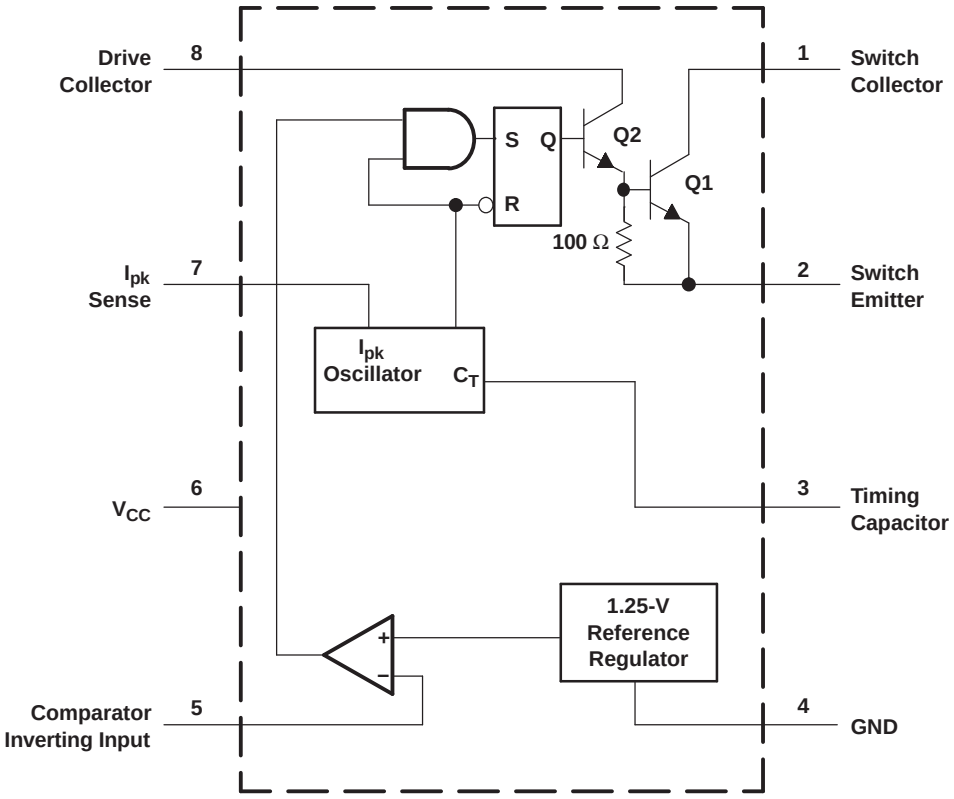
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ORDERING INFORMATION[1]

T_A	PACKAGE[2]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	PDIP – P	Tube of 50	MC33063AP	MC33063AP
	QFN – DRJ	Reel of 1000	MC33063ADRJR	ZYF
	SOIC – D	Tube of 75	MC33063AD	M33063A
		Reel of 2500	MC33063ADR	
0°C to 70°C	PDIP – P	Tube of 50	MC34063AP	MC34063AP
	QFN – DRJ	Reel of 1000	MC34063ADRJR	ZYG
	SOIC – D	Tube of 75	MC34063AD	M34063A
		Reel of 2500	MC34063ADR	

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

FUNCTIONAL BLOCK DIAGRAM



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Absolute Maximum Ratings(1)

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage			40	V
V_{IR}	Comparator Inverting Input voltage range		–0.3	40	V
$V_{C(switch)}$	Switch Collector voltage			40	V
$V_{E(switch)}$	Switch Emitter voltage	V_{PIN1} = 40 V		40	V
$V_{CE(switch)}$	Switch Collector to Switch Emitter voltage			40	V
$V_{C(driver)}$	Driver Collector voltage			40	V
$I_{C(driver)}$	Driver Collector current			100	mA
I_{SW}	Switch current			1.5	A
θ_{JA}	Package thermal impedance(2) (3)	D package		97	°C/W
		DRJ package		41	
		P package		85	
T_J	Operating virtual junction temperature			150	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) 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.
(2) 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 $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(3) 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	MC33063A	–40	85	°C
		MC34063A	0	70	

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

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Output Switch(1)

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(2)	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

(1) Low duty-cycle pulse testing is used to maintain junction temperature as close to ambient temperature as possible.
(2) 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

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TYPICAL CHARACTERISTICS

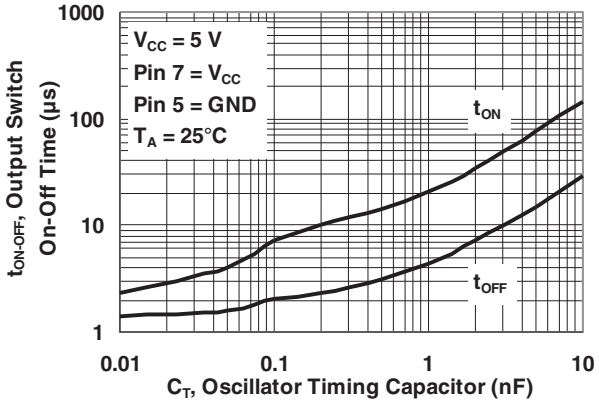


Figure 1. Output Switch On-Off Time vs Oscillator Timing Capacitor

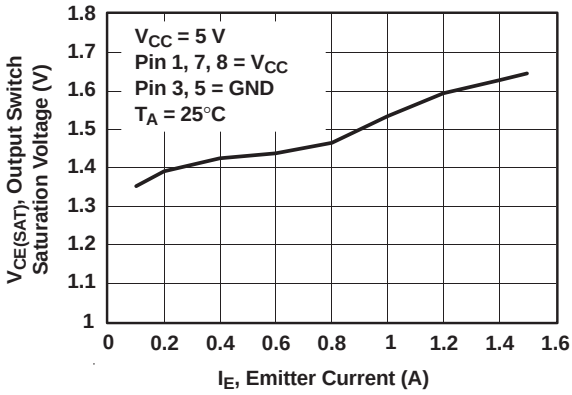


Figure 2. Output Switch Saturation Voltage vs Emitter Current (Emitter-Follower Configuration)

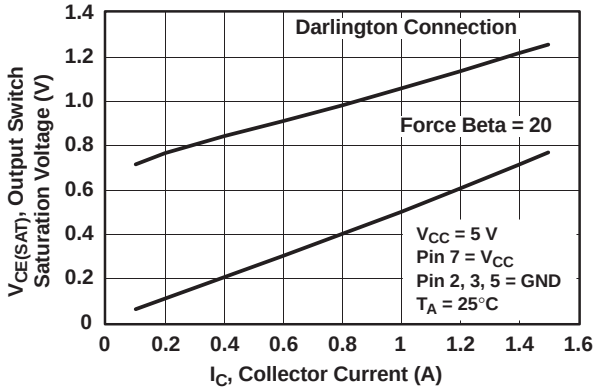


Figure 3. Output Switch Saturation Voltage vs Collector Current (Common-Emitter Configuration)

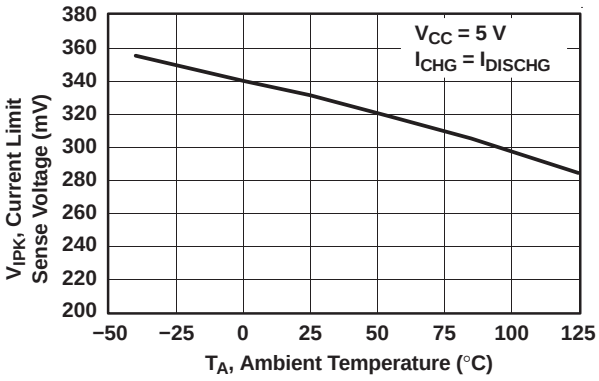


Figure 4. Current-Limit Sense Voltage vs Temperature

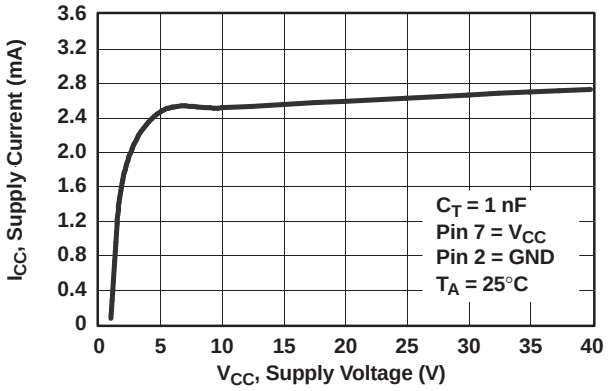


Figure 5. Standby Supply Current vs Supply Voltage

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TYPICAL CHARACTERISTICS (continued)

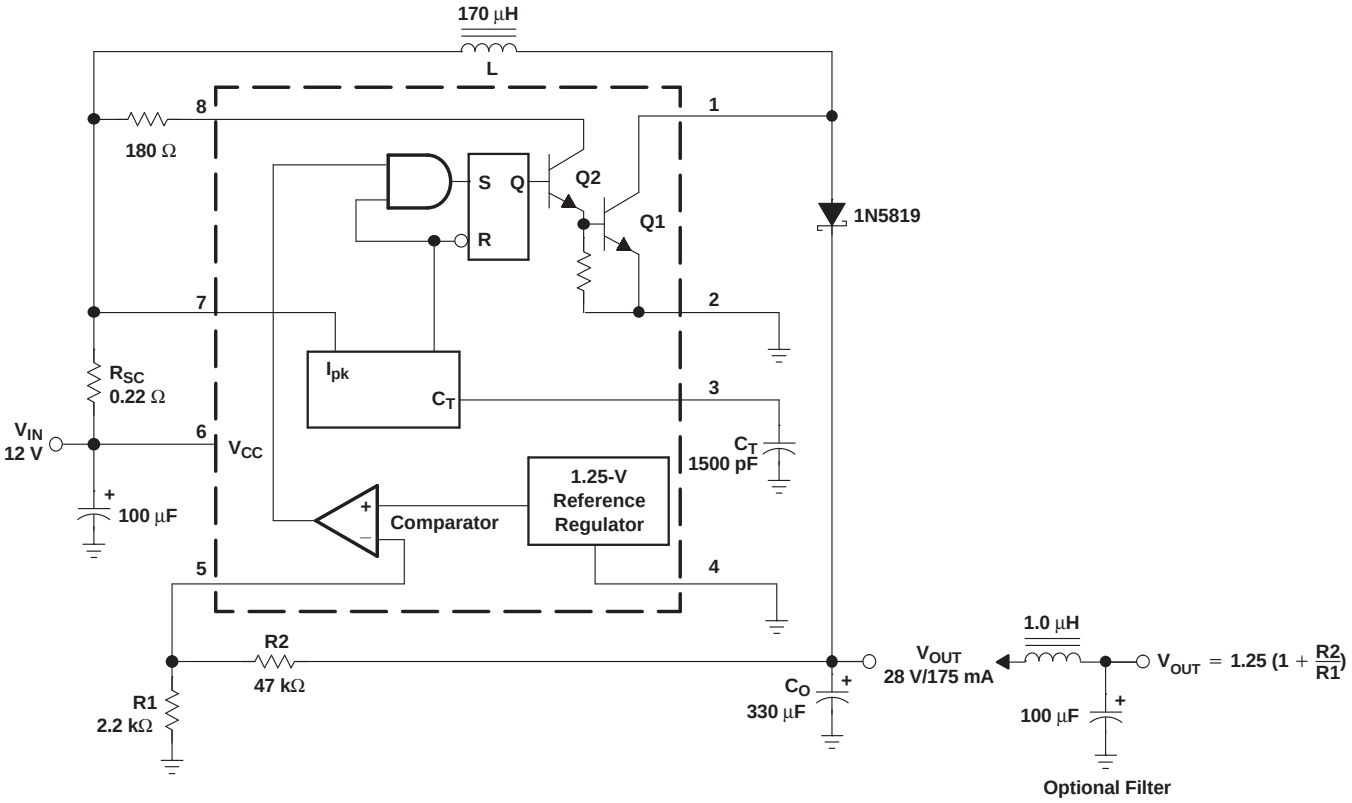
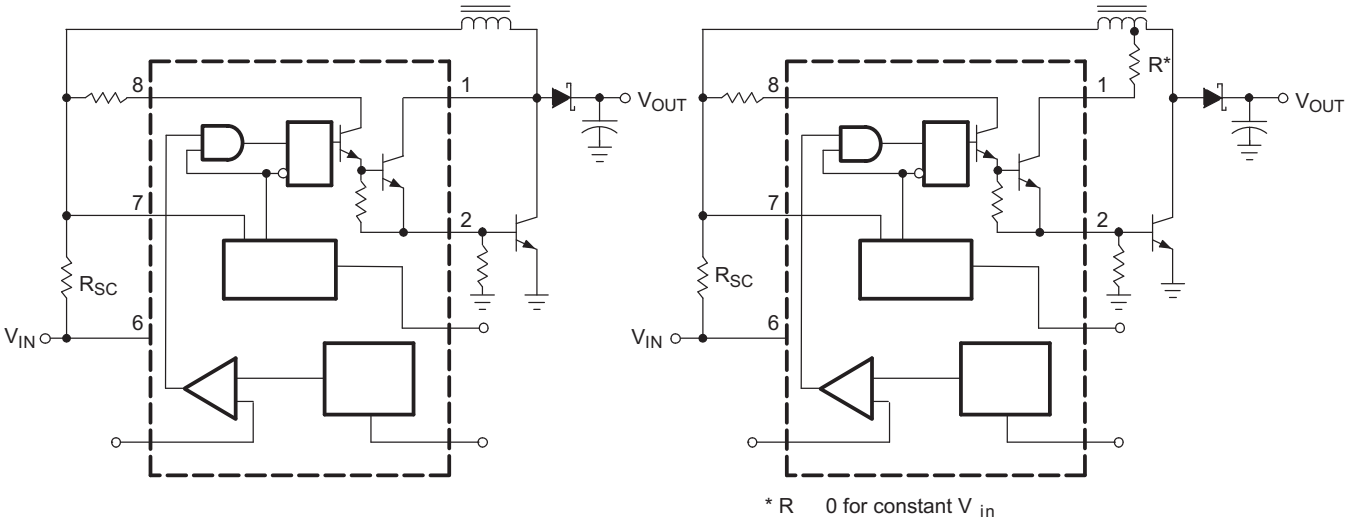


Figure 6. Step-Up Converter

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}

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a) EXTERNAL npn SWITCH

b) EXTERNAL npn SATURATED SWITCH (see Note A)

A. If the output switch is driven into hard saturation (non-Darlington configuration) at low switch currents (≤300 mA) and high driver currents (≥30 mA), it may take up to 2 µs to come out of saturation. This condition will shorten the off time at frequencies ≥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 7b is recommended.

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

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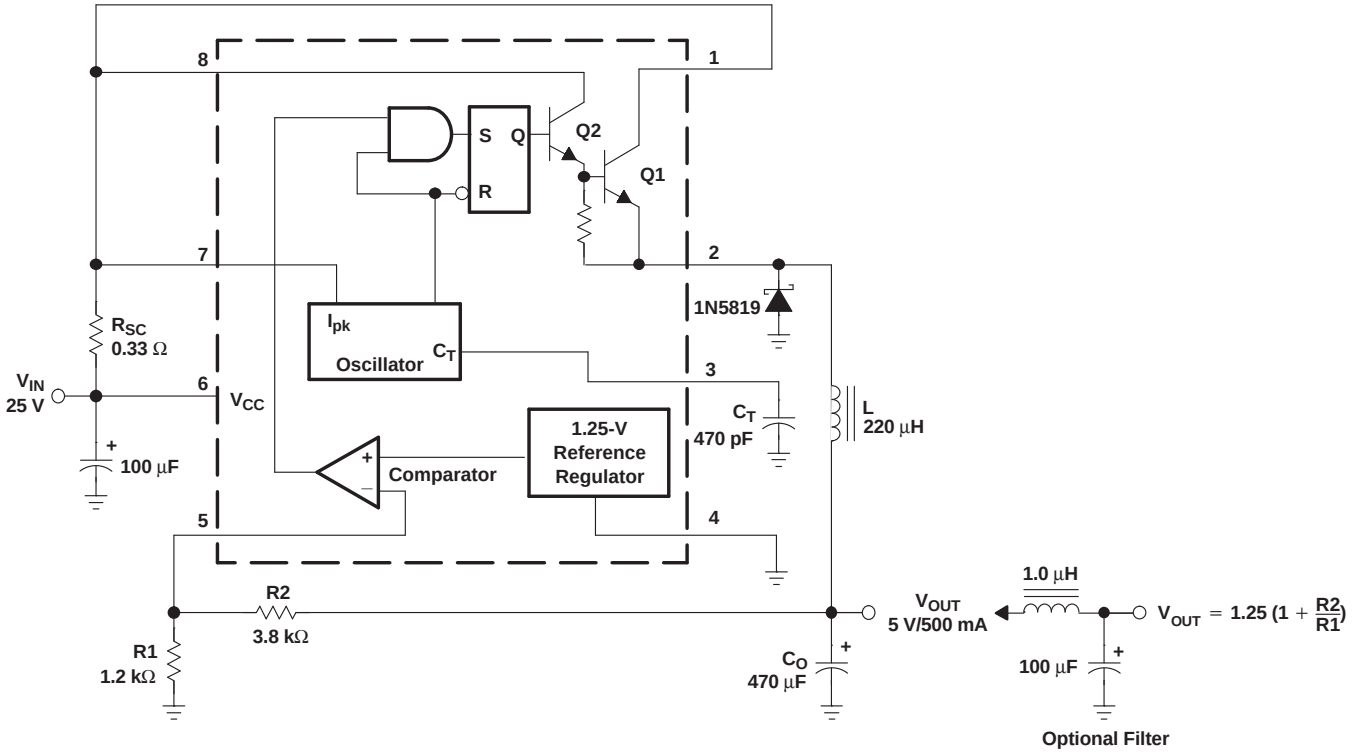
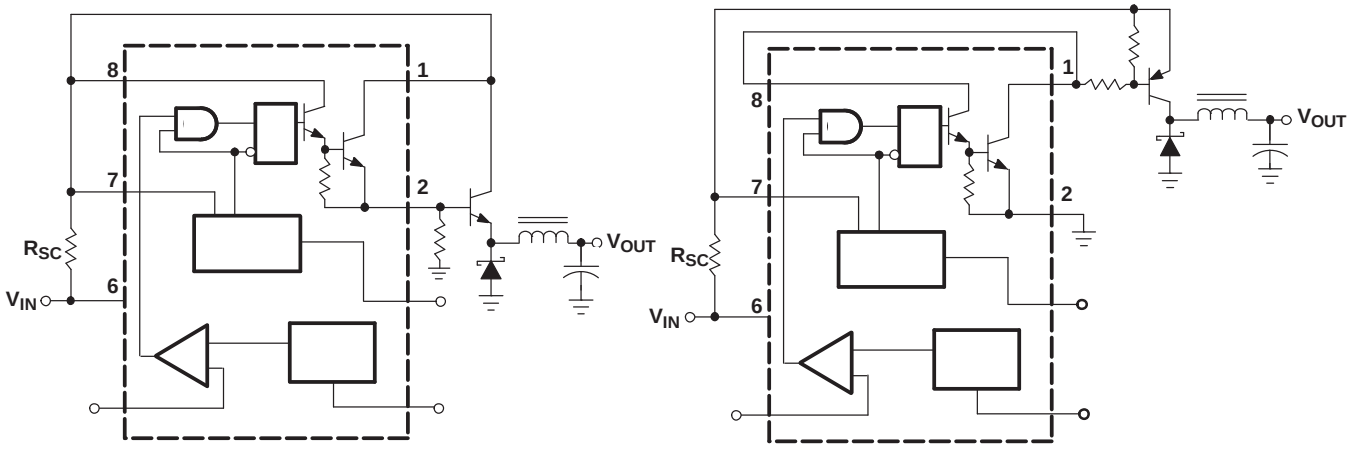


Figure 8. Step-Down Converter

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}



a) EXTERNAL npn SWITCH **b) EXTERNAL pnp SATURATED SWITCH**

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

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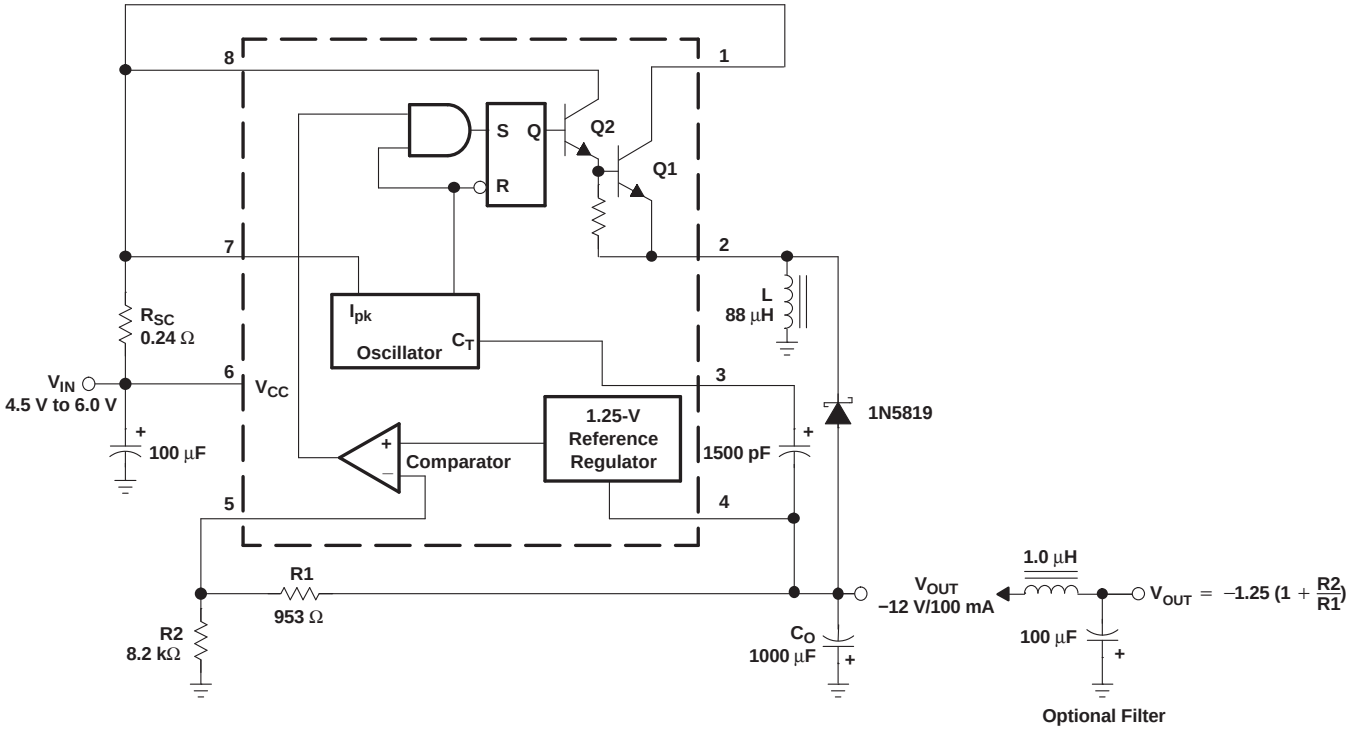


Figure 10. Voltage-Inverting Converter

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}

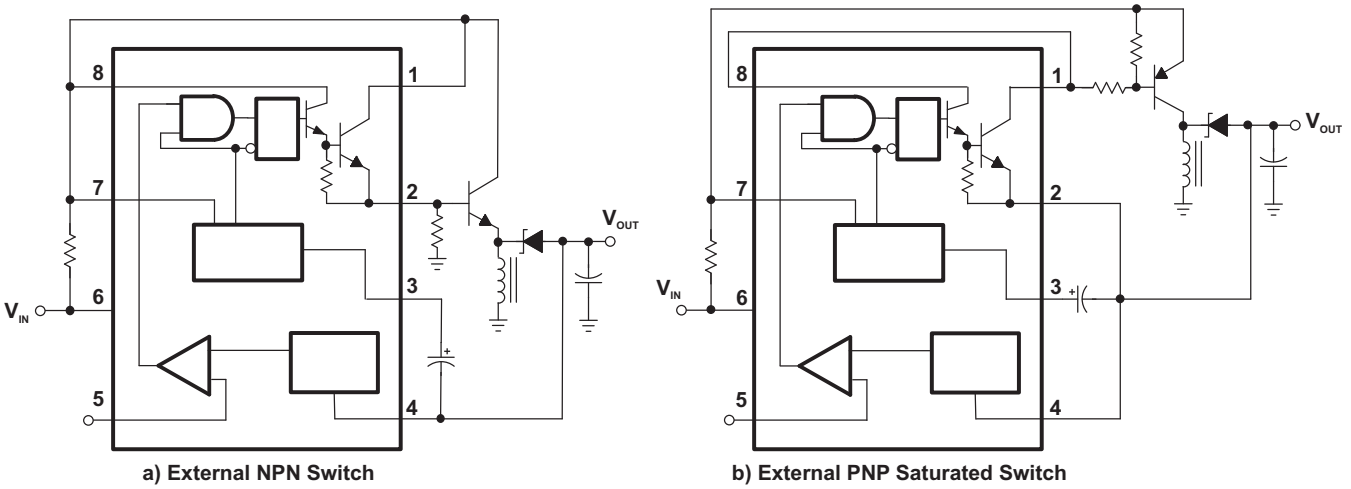


Figure 11. External Current-Boost Connections for I_C Peak Greater Than 1.5 A

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APPLICATION INFORMATION

CALCULATION	STEP UP	STEP DOWN	VOLTAGE INVERTING
t_{on}/t_{off}	$\frac{V_{out} + V_F - V_{in(min)}}{V_{in(min)} - V_{sat}}$	$\frac{V_{out} + V_F}{V_{in(min)} - V_{sat} - V_{out}}$	$\frac{\lvert V_{out}\rvert + V_F}{V_{in} - V_{sat}}$
$(t_{on} + t_{off})$	$\frac{1}{f}$	$\frac{1}{f}$	$\frac{1}{f}$
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}	$\left(t_{on} + t_{off}\right) - t_{off}$	$\left(t_{on} + t_{off}\right) - t_{off}$	$\left(t_{on} + t_{off}\right) - t_{off}$
C_T	$4 \times 10^{-5}\, t_{on}$	$4 \times 10^{-5}\, t_{on}$	$4 \times 10^{-5}\, t_{on}$
$I_{pk(switch)}$	$2I_{out(max)}\left(\frac{t_{on}}{t_{off}} + 1\right)$	$2I_{out(max)}$	$2I_{out(max)}\left(\frac{t_{on}}{t_{off}} + 1\right)$
R_{SC}	$\frac{0.3}{I_{pk(switch)}}$	$\frac{0.3}{I_{pk(switch)}}$	$\frac{0.3}{I_{pk(switch)}}$
$L_{(min)}$	$\left(\frac{\left(V_{in(min)} - V_{sat}\right)}{I_{pk(switch)}}\right)t_{on(max)}$	$\left(\frac{\left(V_{in(min)} - V_{sat} - V_{out}\right)}{I_{pk(switch)}}\right)t_{on(max)}$	$\left(\frac{\left(V_{in(min)} - V_{sat}\right)}{I_{pk(switch)}}\right)t_{on(max)}$
C_O	$9\,\frac{I_{out}t_{on}}{V_{ripple(pp)}}$	$\frac{I_{pk(switch)}\left(t_{on} + t_{off}\right)}{8V_{ripple(pp)}}$	$9\,\frac{I_{out}t_{on}}{V_{ripple(pp)}}$
V_{out}	$1.25(1 + \frac{R2}{R1})$ See Figure 6	$1.25(1 + \frac{R2}{R1})$ See Figure 8	$-1.25(1 + \frac{R2}{R1})$ See Figure 10

V_{sat} = Saturation voltage of the output switch

V_F = Forward voltage drop of the chosen output rectifier

The following power-supply parameters are set by the user:

V_{in} = Nominal input voltage

V_{out} = Desired output voltage

I_{out} = Desired output current

f_{min} = Minimum desired output switching frequency at the selected values of V_{in} and I_{out}

V_{ripple} = Desired peak-to-peak output ripple voltage. The ripple voltage directly affects the line and load regulation and, thus, must be considered. In practice, the actual capacitor value should be larger than the calculated value, to account for the capacitor's equivalent series resistance and board layout.

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REVISION HISTORY

Changes from Revision L (December 2009) to Revision M	Page
• Changed pnp to npn for figure 7b, text typo.	7
• Changed figure 11b schematic.	9

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
MC33063AD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC33063ADE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC33063ADG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC33063ADR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC33063ADRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC33063ADRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC33063ADRJR	ACTIVE	SON	DRJ	8	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
MC33063ADRJRG4	ACTIVE	SON	DRJ	8	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
MC33063AP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
MC33063AP-P	PREVIEW	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
MC33063APE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
MC34063AD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC34063ADE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC34063ADG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC34063ADR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC34063ADRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC34063ADRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
MC34063ADRJR	ACTIVE	SON	DRJ	8	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
MC34063ADRJRG4	ACTIVE	SON	DRJ	8	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
MC34063AP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
MC34063APE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	

(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.

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OTHER QUALIFIED VERSIONS OF MC33063A :

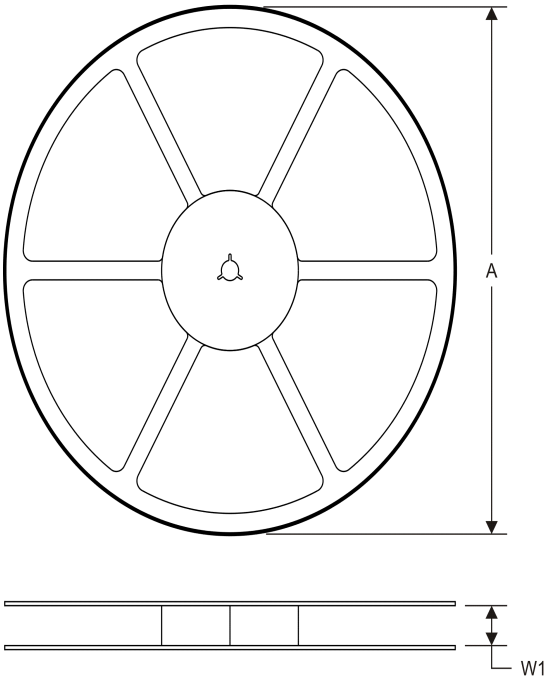
- Automotive: MC33063A-Q1

NOTE: Qualified Version Definitions:

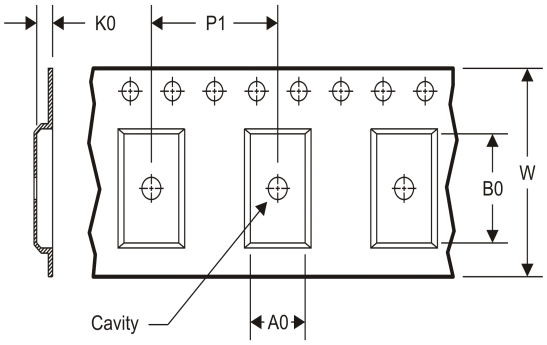
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



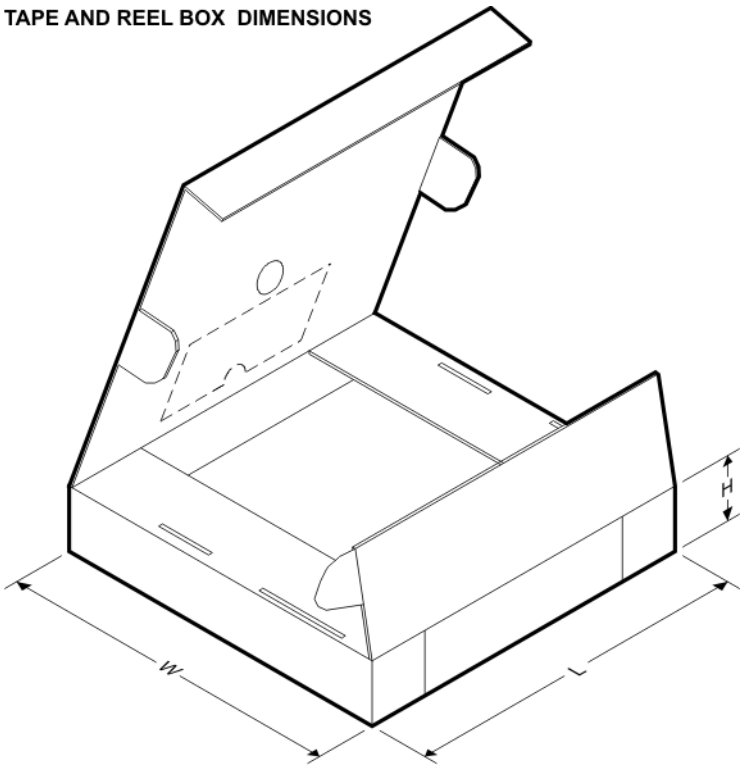
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
MC33063ADR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
MC33063ADRJR	SON	DRJ	8	1000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
MC34063ADR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
MC34063ADRJR	SON	DRJ	8	1000	180.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2

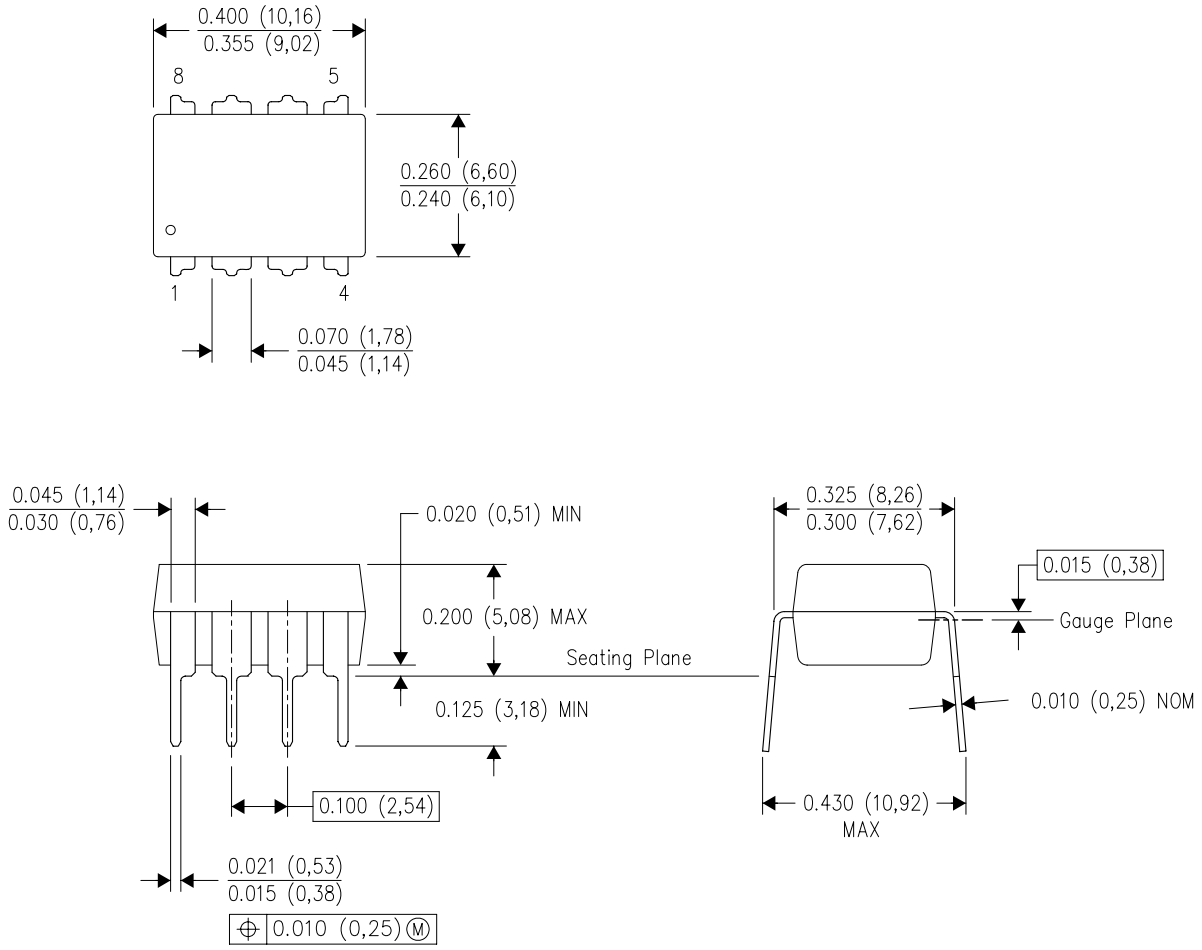
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

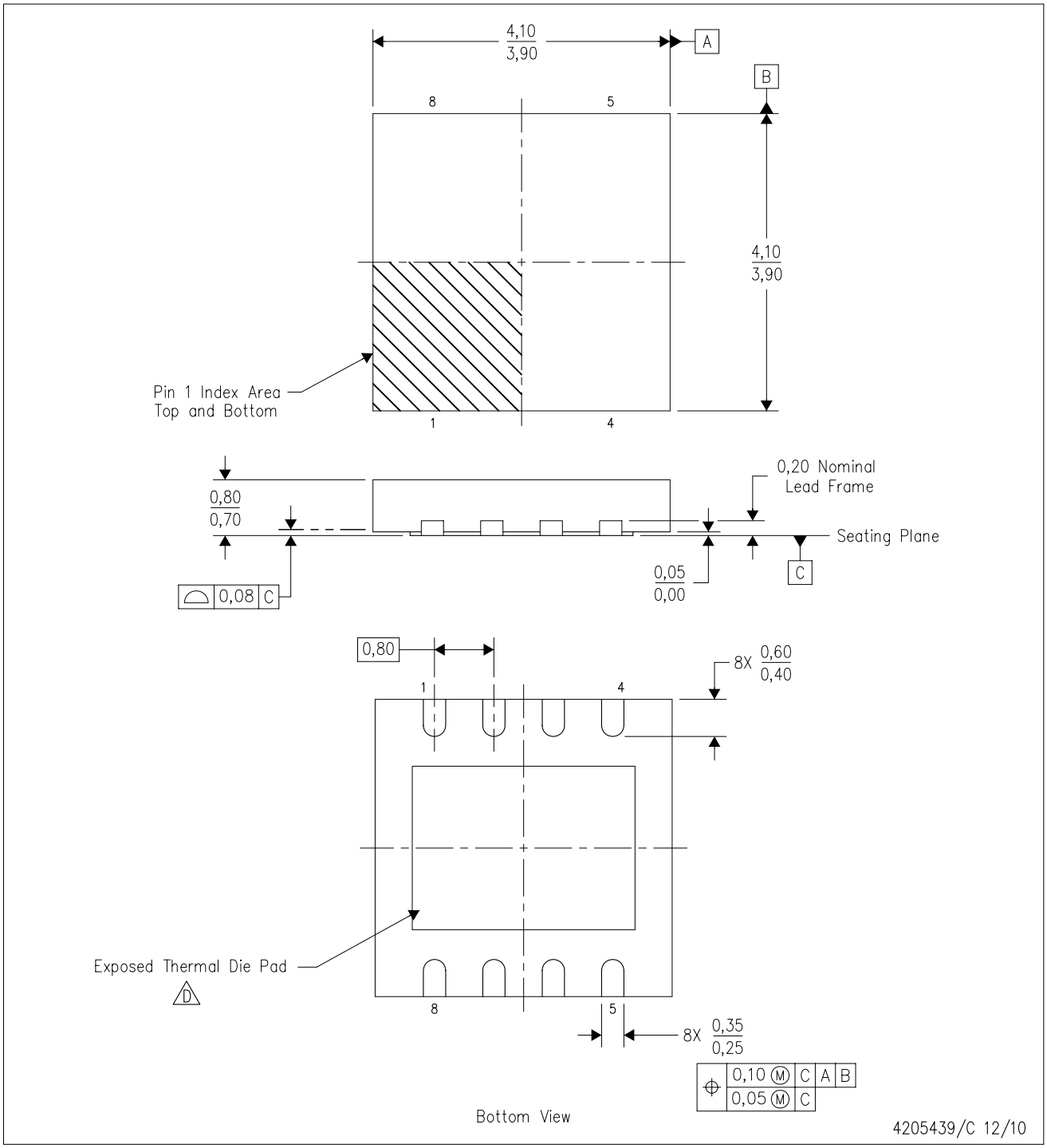
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MC33063ADR	SOIC	D	8	2500	340.5	338.1	20.6
MC33063ADRJR	SON	DRJ	8	1000	367.0	367.0	35.0
MC34063ADR	SOIC	D	8	2500	340.5	338.1	20.6
MC34063ADRJR	SON	DRJ	8	1000	210.0	185.0	35.0

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



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

DRJ (S–PWSON–N8) PLASTIC SMALL OUTLINE NO–LEAD



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. SON (Small Outline No–Lead) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
E. Package complies to JEDEC MO–229 variation WGGB.

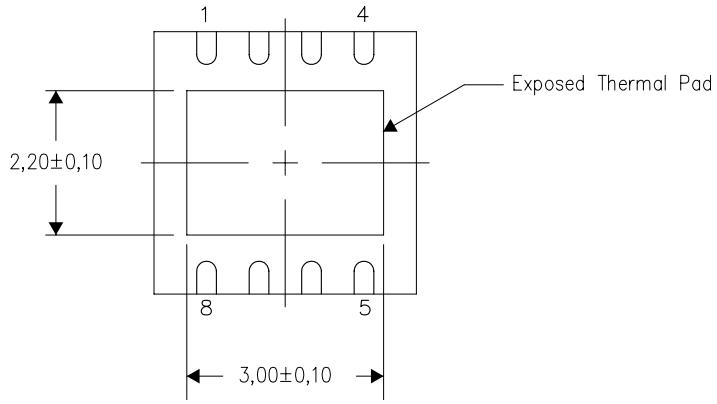
DRJ (S–PWSON–N8) PLASTIC SMALL OUTLINE NO–LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



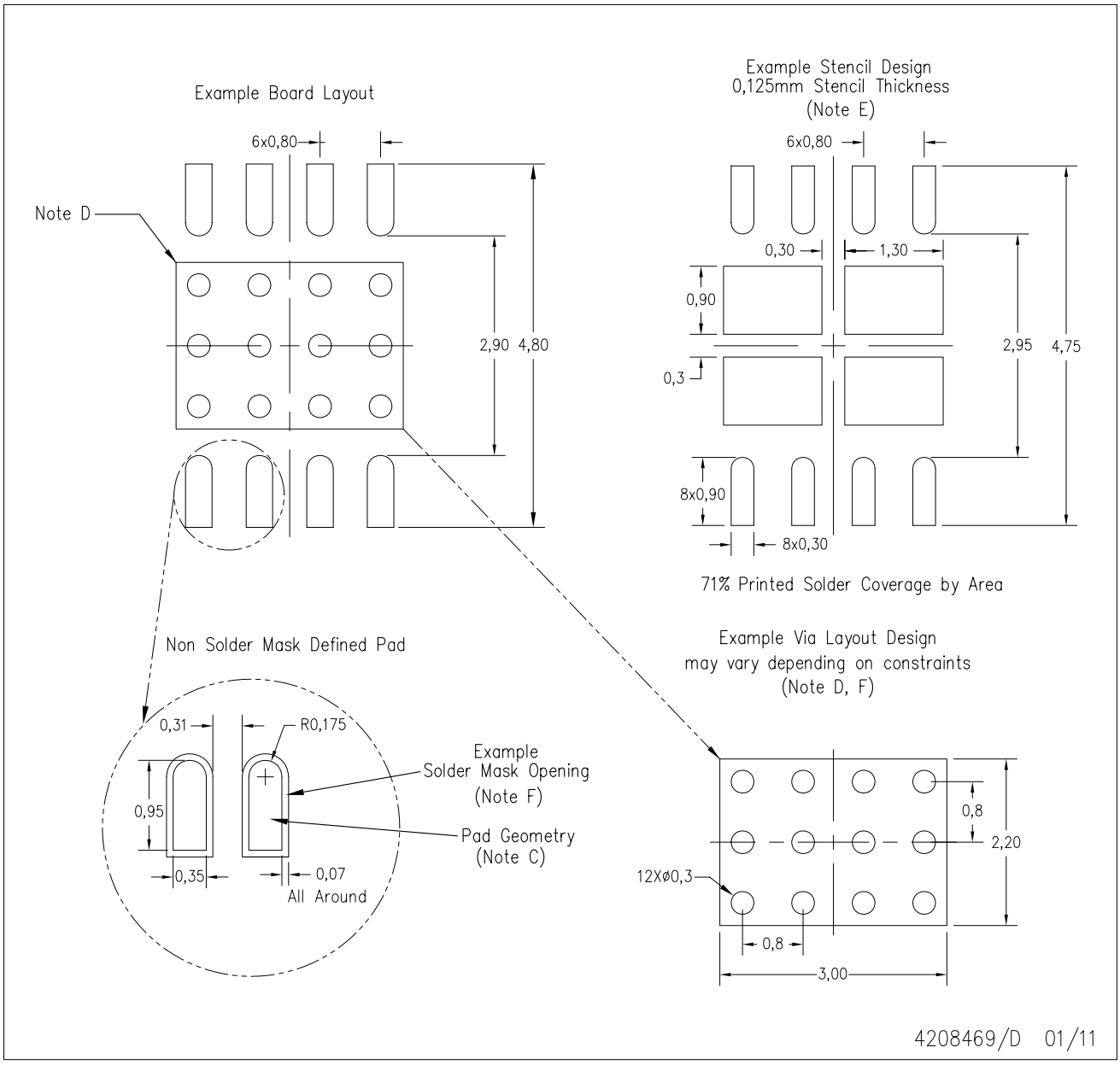
Bottom View

Exposed Thermal Pad Dimensions

4206882/F 01/11

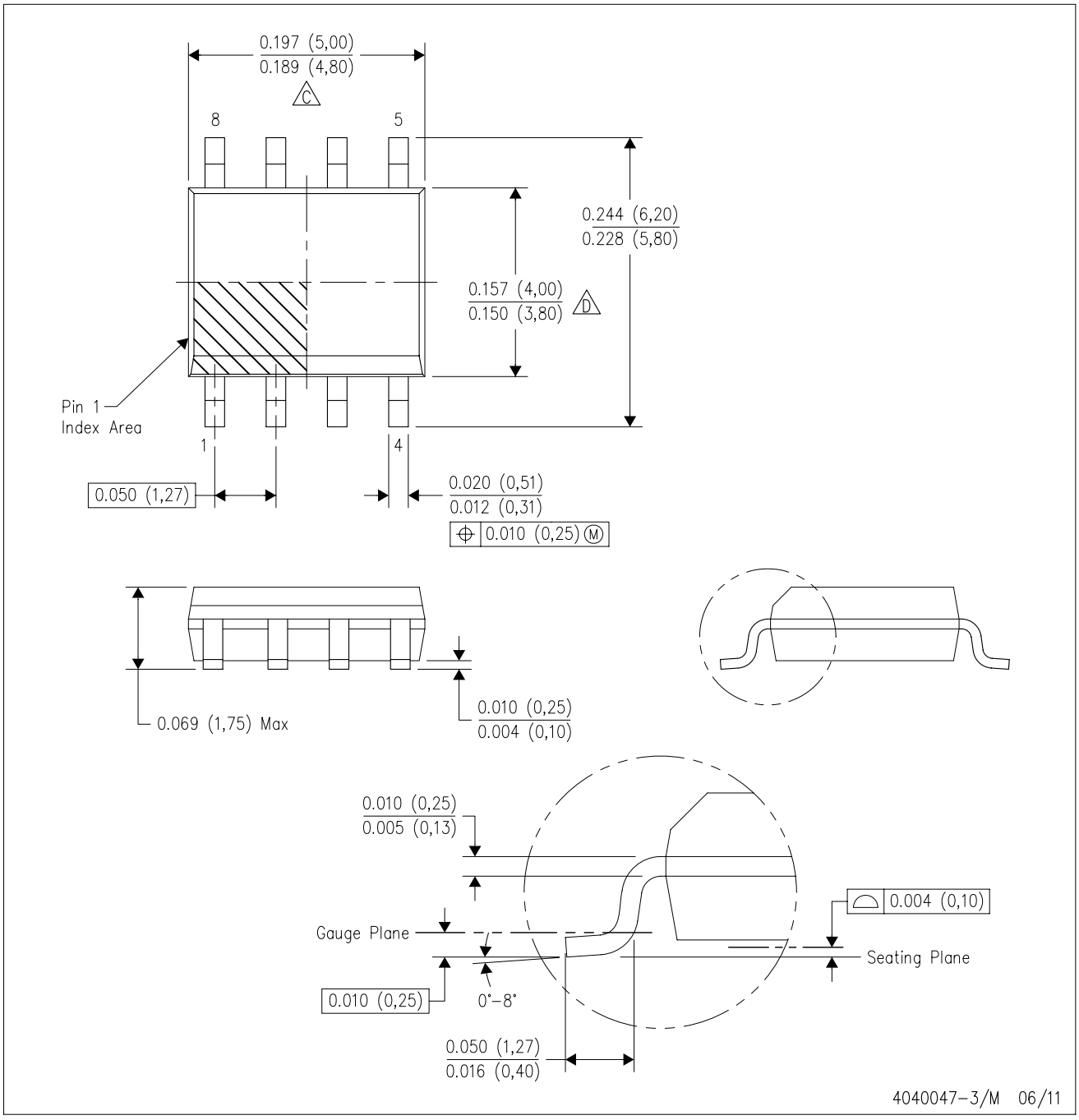
NOTE: All linear dimensions are in millimeters

DRJ (S–PWSON–N8) SMALL PACKAGE OUTLINE NO–LEAD



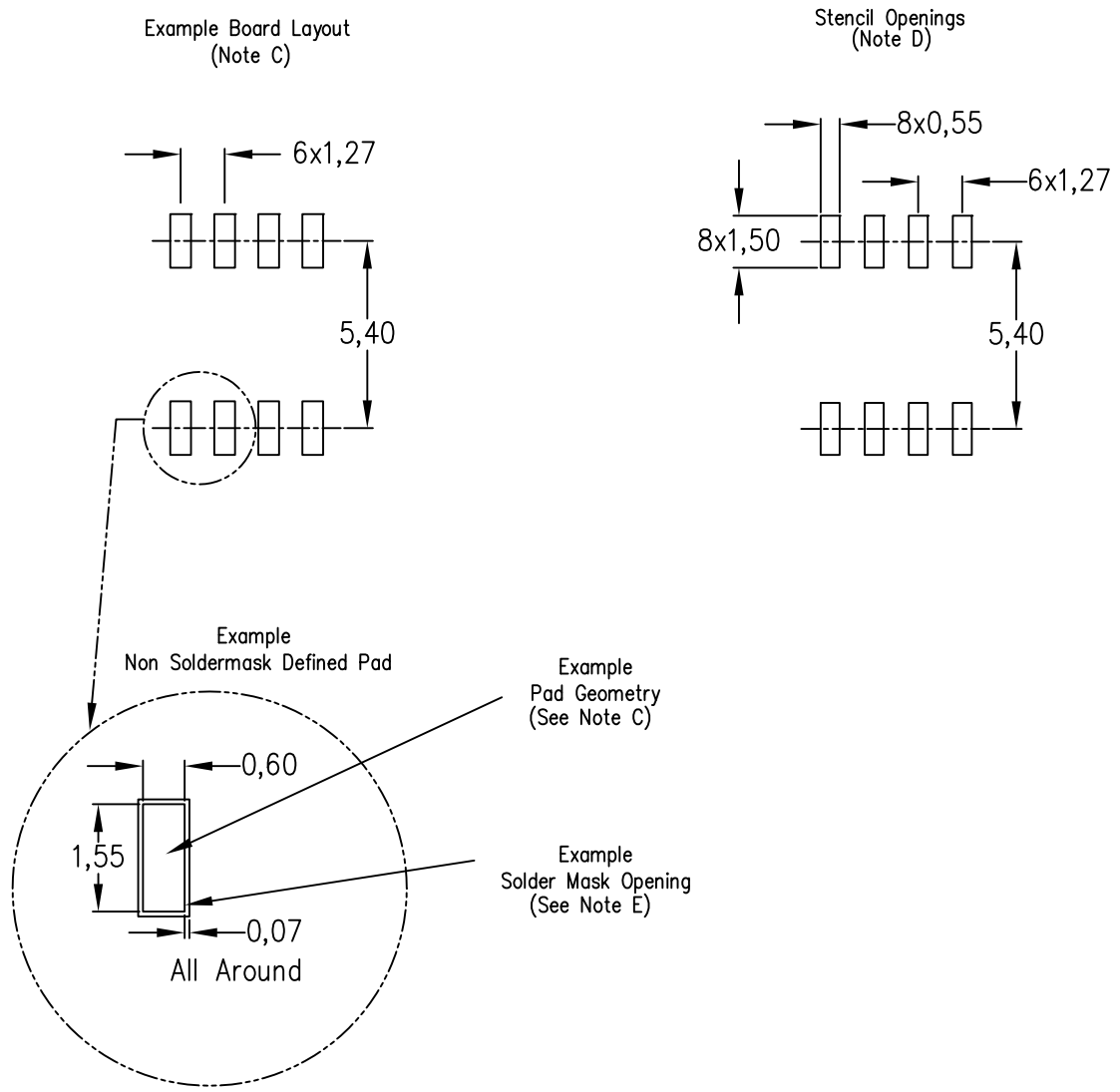
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat–Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
E. Laser cutting apertures with electropolish and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
F. Customers should contact their board fabrication site for solder mask tolerances and vias tenting recommendations for vias placed in the thermal pad.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



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 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AA.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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