Document Number: MC3334
Rev. 2.0, 2/2007

High Energy Ignition Circuit

The MC3334 high energy ignition circuit was designed to serve aftermarket five terminal ignition applications. This device, driving a high voltage darlington transistor, offers an ignition system which optimizes spark energy at minimum power dissipation. The IC is pinned out to permit thick film or printed circuit module design without any crossovers.

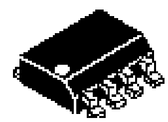
This device is designed to use the signal from a reluctor type ignition pickup to produce a well controlled output from a power darlington output transistor.

Features

- Very Low Peripheral Component Count
- No Critical System Resistors
- Wide Supply Voltage Operating Range (4.0 V to 24 V)
- Overvoltage Shutdown (30 V)
- Dwell Automatically Adjusts to Produce Optimum Stored Energy without Waste
- Externally Adjustable Peak Current
- Available in Chip and Flip Chip Form
- Pb-Free Packaging Designated by Suffix Code “EF”

3334

IGNITION CIRCUIT



D SUFFIX
EF SUFFIX (PB-FREE)
98ASB42420B
SOICN 8

ORDERING INFORMATION		
Device	**Temperature Range (T_A)**	**Package**
MC3334D/R2	-40°C to 125°C	SOICN 8
MCZ3334EF/R2		

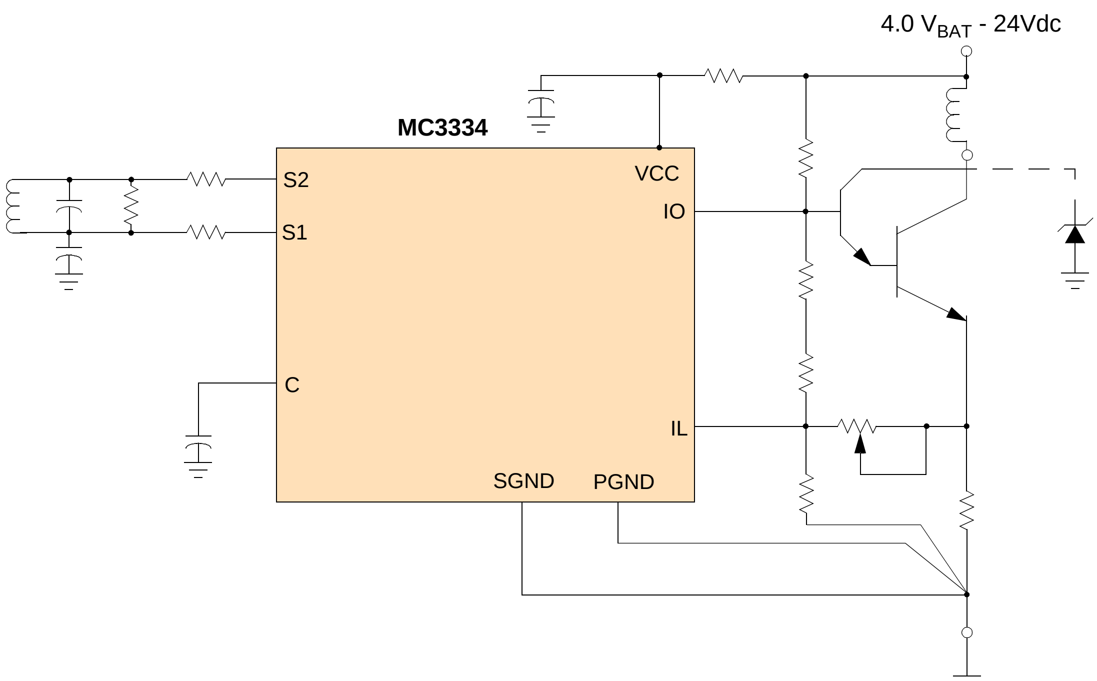


Figure 1. 3334 Simplified Application Diagram

INTERNAL BLOCK DIAGRAM

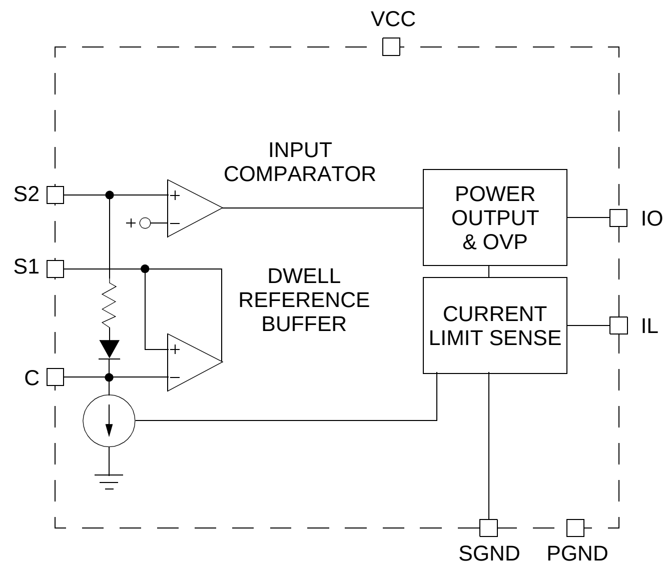


Figure 2. 3334 Simplified Internal Block Diagram

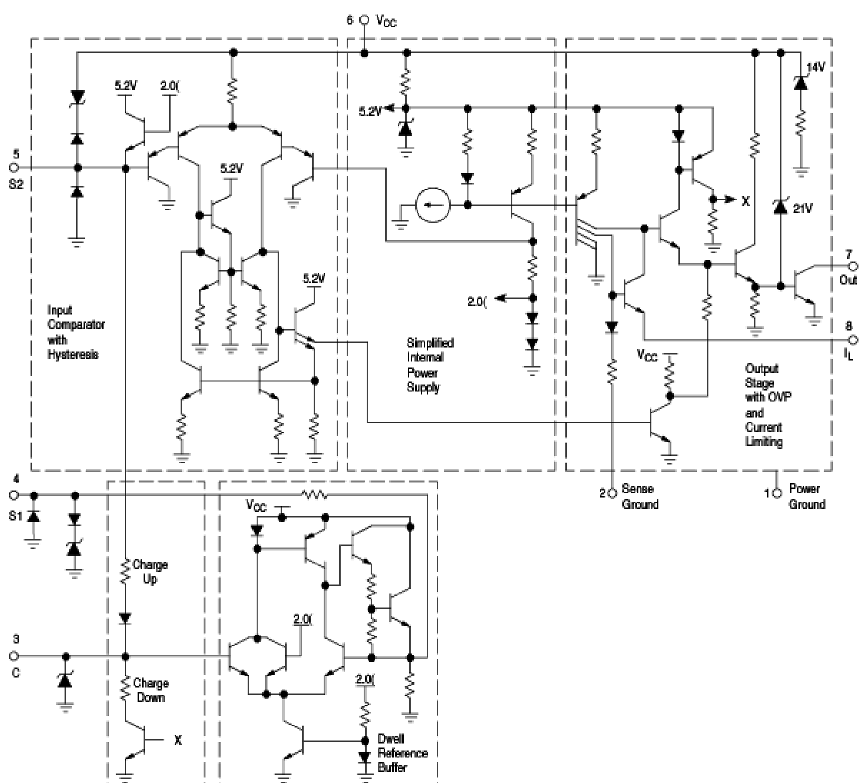


Figure 3. 3334 Internal Schematic

PIN CONNECTIONS

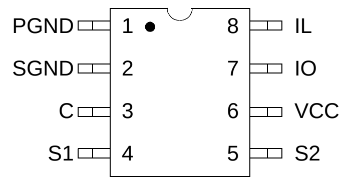


Figure 4. 3334 Pin Connections

Table 1. 3334 Pin Definitions

Pin Number	Pin Name	Pin Function	Pin Name	Definition
1	PGND	Ground	Power Ground	Die ground connection
2	SGND	Ground	Sense Ground	Sense circuit ground connection
3	C	Input	Dwell Reference	Dwell voltage reference
4	S1	Output	Dwell Output	Dwell reference signal
5	S2	Input	Sensor Input	Input signal from reluctance pickup coil
6	VCC	Input	Supply Voltage	Vbattery connection
7	IO	Output	Darlington Base Drive	Ignition coil primary transistor drive
8	IL	Input	Current Limit Sense	Reference voltage to monitor ignition coil current

ELECTRICAL CHARACTERISTICS

MAXIMUM RATINGS

Table 2. Maximum Ratings

All voltages are with respect to ground unless otherwise noted. Exceeding these ratings may cause a malfunction or permanent damage to the device.

Ratings	Symbol	Value	Unit
ELECTRICAL RATINGS			
Power Supply Voltage Steady State Transient 300 ms or less	Vbat	24 90	V
Output Sink Current Steady State Transient 300 ms or less	IO(Sink)	300 1.0	mA A
Junction Temperature	T_J(max)	150	°C
Operating Temperature Range	T_A	40 to +125	°C
Storage Temperature Range	Tstg	65 to +150	°C
Power Dissipation, Plastic Package, Case 626 Derate above 25°C	PD	1.25 10	W mW/°C
Peak Package Reflow Temperature During Reflow [(1)], [(2)]	T_{PPRT}	Note 2	°C

Notes

1. Pin soldering temperature limit is for 10 seconds maximum duration. Not designed for immersion soldering. Exceeding these limits may cause malfunction or permanent damage to the device.
2. Freescale's Package Reflow capability meets Pb-free requirements for JEDEC standard J-STD-020C. For Peak Package Reflow Temperature and Moisture Sensitivity Levels (MSL),
Go to www.freescale.com, search by part number [e.g. remove prefixes/suffixes and enter the core ID to view all orderable parts. (i.e. MC33xxxD enter 33xxx), and review parametrics.

STATIC ELECTRICAL CHARACTERISTICS

Table 3. Static Electrical Characteristics

Characteristics noted under conditions T_{A} = -40° to 125°C, Vbat = 13.2 Vdc unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
POWER INPUT					
Internal supply voltage VBAT = 4.0 8.0 12.0 14.0	V_{CC}	 - - - -	 3.5 7.2 10.4 11.8	 - - - -	Vdc
Ignition coil current peak, cranking RPM 2.0 Hz to 27 Hz VBAT = 4.0 8.0 12.0 14.0	$I_{o(pk)}$	 3.0 4.0 4.6 5.1	 3.4 5.2 5.3 5.4	 - - - -	A pk
Ignition coil current peak, normal RPM Frequency = 33 Hz 133 Hz 200 Hz 267 Hz 333 Hz	$I_{o(pk)}$	 5.1 5.1 4.2 3.4 2.7	 5.5 5.5 5.4 4.4 3.4	 - - - -	A pk
Shutdown voltage	V_{BAT}	25	30	35	Vdc
Input threshold (static test) Turn-on Turn-off	V_{S2}-V_{S1}	 - -	 360 90	 - -	mVdc
Input threshold Hysteresis	V_{S2}-V_{S1}	75	–	-	mVdc
Input threshold (active operation) Turn-on Turn-off	V_{S2}	 - -	 1.8 1.5	 - -	Vdc
Saturation voltage IC output (pin 7)(R_{DRIVE} = 100Ω) VBAT = 10 Vdc 30 Vdc 50 Vdc	$I_{o(pk)}$	 - - -	 120 280 540	 - - -	mVdc
Current limit reference, Pin 8	Vref	120	160	190	mVdc

DYNAMIC ELECTRICAL CHARACTERISTICS

Table 4. Dynamic Electrical Characteristics

Characteristics noted under conditions $T_A =$ -40° to 125°C, Vbat = 13.2 Vdc unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
Ignition coil on-time, normal RPM range	$I_{o(pk)}$				ms
Frequency = 33 Hz		-	7.5	14.0	
133 Hz		-	5.0	5.9	
200 Hz		-	4.0	4.6	
267 Hz		-	3.0	3.6	
333 Hz		-	2.3	2.8	
Total circuit lag from t_S (Figure 6) until ignition coil current falls to 10%		-	60	120	µs
Ignition coil current fall time (90 to 10%)		-	4.0	-	µs

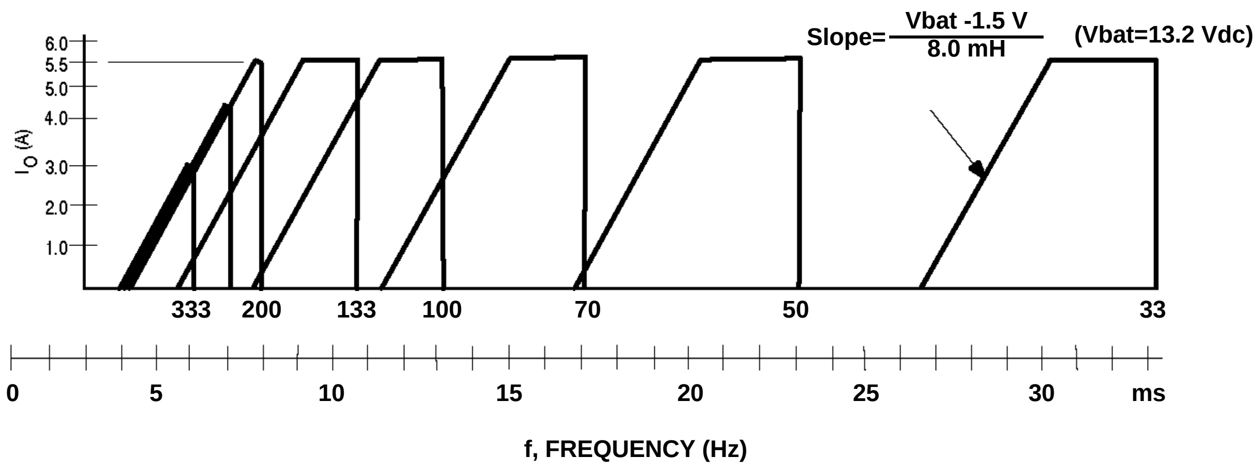


Figure 5. Ignition Coil Current vs. Frequency/Period

FUNCTIONAL DESCRIPTION

INTRODUCTION

The MC3334 high energy ignition circuit was designed to serve aftermarket five terminal ignition applications. This device, driving a high voltage darlington transistor, offers an ignition system which optimizes spark energy at minimum power dissipation. The IC is pinned out to permit thick film or printed circuit module design without any crossovers.

The basic function of an ignition circuit is to permit build up of current in the primary of a spark coil, and then to interrupt the flow at the proper firing time. The resulting flyback action in the ignition coil induces the required high secondary voltage needed for the spark. In the simplest systems, fixed dwell angle produces a fixed duty cycle, which can result in too little stored energy at high RPM, and/or wasted power at low RPM.

FUNCTIONAL PIN DESCRIPTION

SUPPLY VOLTAGE (VCC)

Supply voltage from Vbattery supply

SENSOR INPUT (S2)

Input from distributor reluctance sensor/pickup coil. Signal determines the ignition coil charge and discharge timing.

DWELL OUTPUT (S1)

Dwell reference signal to reluctance coil

DWELL REFERENCE (C)

Input voltage to determine dwell timing based on capacitor size and charge.

SENSE GROUND (SGND)

External ground connection for the on-chip overvoltage and current limit sense circuitry.

POWER GROUND (PGND)

Ground connection for the die circuitry.

CURRENT LIMIT SENSE (IL)

Input for current limit sense circuitry.

DARLINGTON BASE DRIVE (IO)

Output drive connection. Drives the base of the Darlington transistor which charges the ignition coil primary winding.

FUNCTIONAL DEVICE OPERATION

OPERATIONAL MODES

The MC3334 uses a variable DC voltage reference, stored on CDwell, and buffered to the bottom end of the reluctor pickup (S1) to vary the duty cycle at the spark coil. At high RPM, the MC3334 holds the output "off" for approximately 1.0 ms to permit full energy discharge from the previous spark; then it switches the output darlington transistor into full saturation. The current ramps up at a slope dictated by Vbat and the coil L. At very high RPM the peak current may be less than desired, but it is limited by the coil itself.

As the RPM decreases, the ignition coil current builds up and would be limited only by series resistance losses. The MC3334 provides adjustable peak current regulation sensed by RS and set by RD1, in this case at 5.5 A, as shown in Figure 5. As the RPM decreases further, the coil current is held at 5.5 A for a short period. This provides a reserve for sudden acceleration, when discharge may suddenly occur earlier than expected. The peak hold period is about 20% at medium RPM, decreasing to about 10% at very low RPM. (Note: 333 Hz = 5000 RPM for an eight cylinder four stroke engine.) At lower Vbat, the "on" period automatically stretches to accommodate the slower current build up. At very low Vbat and low RPM, a common condition during cold starting, the "on" period is nearly the full cycle to permit as much coil current as possible.

The output stage of the IC is designed with an OVP circuit which turns it on at Vbat ˜ 30 V (VCC ˜ 22 V), holding the output darlington off. This protects the IC and the darlington from damage due to load dump or other causes of excessive Vbat.

Component Values (See Figure 6)

Pickup - series resistance = 800 Ω ± 10% @ 25°C
inductance = 1.35 H @ 1.0 kHz @ 15 Vrms

Coil - leakage L = 0.6 mH
primary R = 0.43 Ω ±5% @ 25°C
primary L = 7.5 mH to 8.5 mH @ 5.0 A

R_L - load resistor for pickup = 10 kΩ ± 20%

R_A,R_B - input buffer resistors provide additional transient protection to the already clamped inputs = 20 kΩ ± 20%

C1, C2 - for reduction of high frequency noise and spark transients induced in pick up and leads; optional and non critical

R_{bat} - provides load dump protection (but small enough to allow operation at Vbat = 4.0 V) = 300 Ω ± 20%

C_{Filter} - transient filter on VCC, non critical

C_{Dwell} - stores reference, circuit designed for 0.1 µF ±20%

R_{Gain} - R_{Gain}/R_{D1} sets the DC gain of the current regulator = 5.0 kΩ ±20%

R_{D2} - R_{D2}/R_{D1} set up voltage feedback from R_S, R_{D2} = 100 Ω

R_S - sense resistor (PdAg in thick film techniques) = 0.075 Ω ± 30%

R_{Drive} - low enough to supply drive to the output darlington, high enough to keep VCE(sat) of the IC below darlington turn on during load dump = 100 Ω ±20%, 5.0 W

R_{D1} - starting with 35 Ω assures less than 5.5 A, increasing as required to set 5.5 A

$$R_{D1} = \frac{I_O(pk)\,R_S - V_{ref}}{\frac{V_{ref}}{R_{D2}} - \frac{1.4}{R_{Gain}}} - (\approx 100\ \Omega)$$

General Layout Notes

The major concern in the substrate design should be to reduce ground resistance problems. The first area of concern is the metallization resistance in the power ground to module ground and the output to the Rdrive resistor. This resistance directly adds to the VCE(sat) of the IC power device and if not minimized could cause failure in load dump. The second concern is to reference the sense ground as close to the ground end of the sense resistor as possible in order to further remove the sensitivity of ignition coil current to ground I.R. drops.

All versions were designed to provide the same pin out order viewed from the top (component side) of the board or substrate. This was done to eliminate conductor cross overs. The standard MC3334 plastic device is numbered in the industry convention, counter clockwise viewed from the top, or bonding pad side.

TYPICAL APPLICATIONS

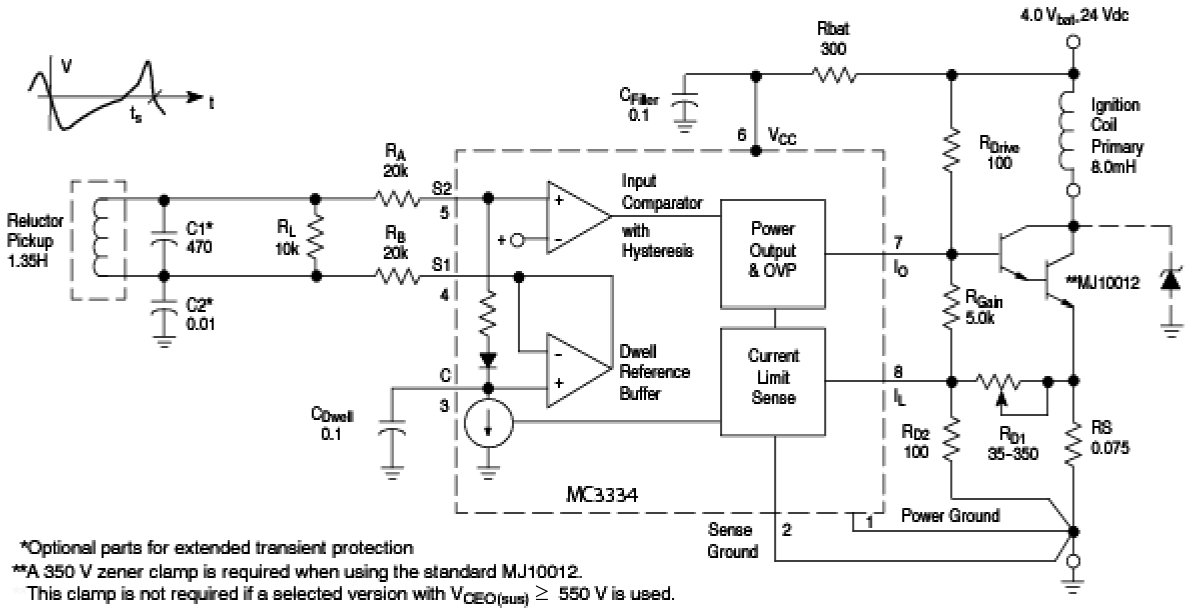
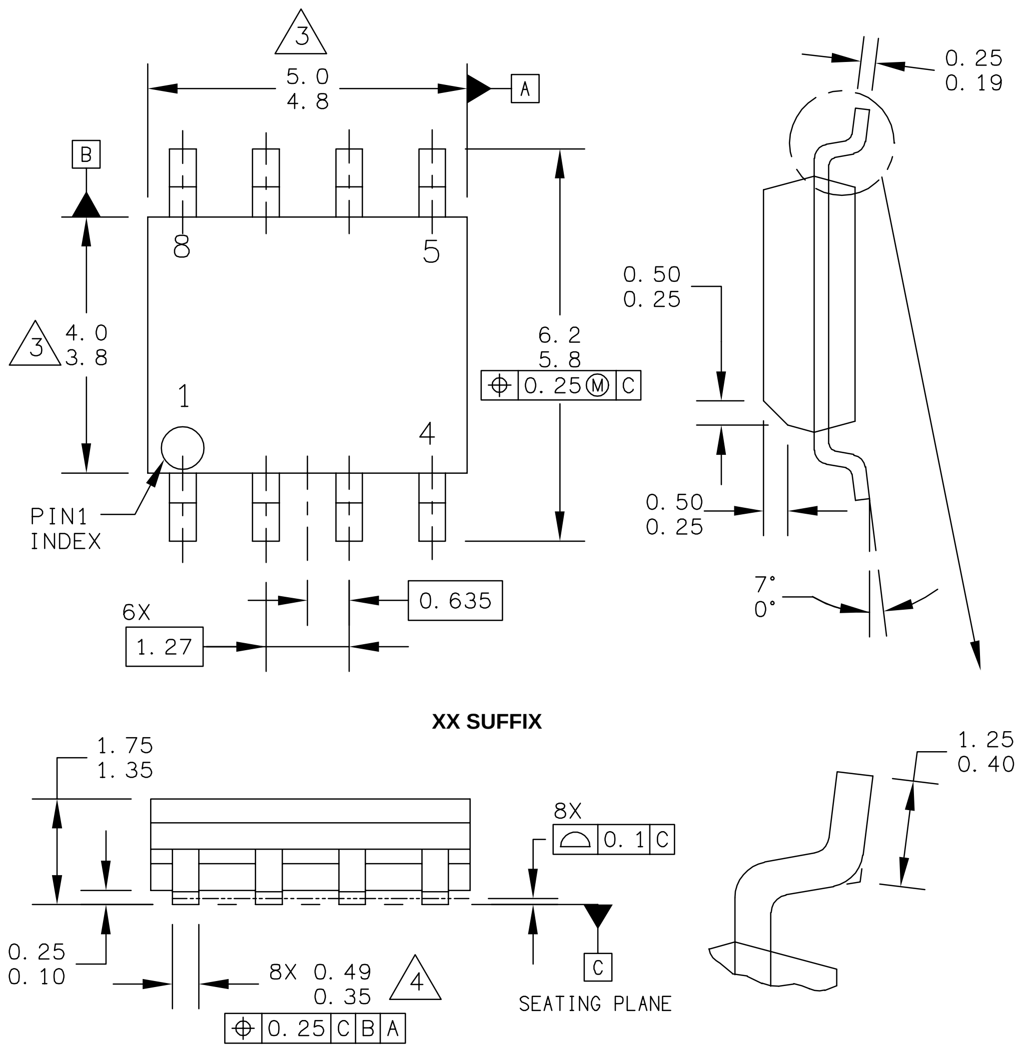


Figure 6. 3334 Typical Application

PACKAGING

PACKAGE DIMENSIONS

For the most current package revision, visit **www.freescale.com** and perform a keyword search using the “98A” listed below.



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		STANDARD: JEDEC MS-012AA	

D SUFFIX
EF (PB-FREE) SUFFIX
8-LEAD SOICN
98ASB42564B
ISSUE U

REVISION HISTORY

REVISION	DATE	DESCRIPTION OF CHANGES
1.0	9/2006	• Implemented Revision History page • Converted to Freescale format • Removed Part Numbers MC3334P, MCC3334 and MCCF3334 and added Part Number MCZ3334EF to Ordering Information
2.0	2/2007	• Added Peak Package Reflow Temperature During Reflow (1), (2) • Added notes (1) and (2)

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