# CS3341, CS3351, CS387

# Alternator Voltage Regulator Darlington Driver

The CS3341/3351/387 integral alternator regulator integrated circuit provides the voltage regulation for automotive, 3−phase alternators.

It drives an external power Darlington for control of the alternator field current. In the event of a charge fault, a lamp output pin is provided to drive an external darlington transistor capable of switching on a fault indicator lamp. An overvoltage or no STATOR signal condition activates the lamp output.

The CS3341 and CS3351 are available in SOIC−14 packages. The CS387 is available as a Flip Chip.

For FET driver applications use the CS3361. Use of the CS3341, CS3351 or CS387 with external FETs may result in oscillations.

### Features

- Drives NPN Darlington
- Short Circuit Protection
- 80 V Load Dump
- Temperature Compensated Regulation Voltage
- Shorted Field Protection Duty Cycle, Self Clearing
- Pb−Free Packages are Available*

### MAXIMUM RATINGS

| Rating | Value | Unit |
|---|---|---|
| Storage Temperature Range, $T_S$ | −55 to +165 | °C |
| Junction Temperature Range | −40 to 150 | °C |
| Continuous Supply | 27 | V |
| $I_{CC}$ Load Dump | 400 | mA |
| Lead Temperature Soldering: Reflow: (SMD styles only) (Note 1) | 230 peak | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. 60 second maximum above 183°C.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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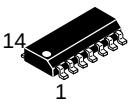
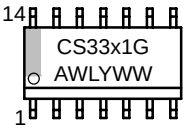
### MARKING DIAGRAM



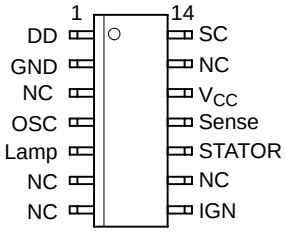

**SOIC−14**
**D SUFFIX**
**CASE 751A**



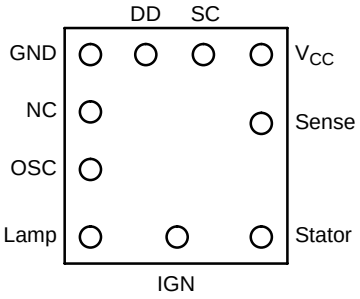

| | | |
|---|---|---|
| CS33x1 | = | Specific Device Code |
| x | | 4 or 5 |
| A | = | Assembly Location |
| WL | = | Wafer Lot |
| Y | = | Year |
| WW | = | Work Week |
| G | = | Pb−Free Package |

### PIN CONNECTIONS

**SOIC−14**




**Flip Chip, Bump Side Up**




### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

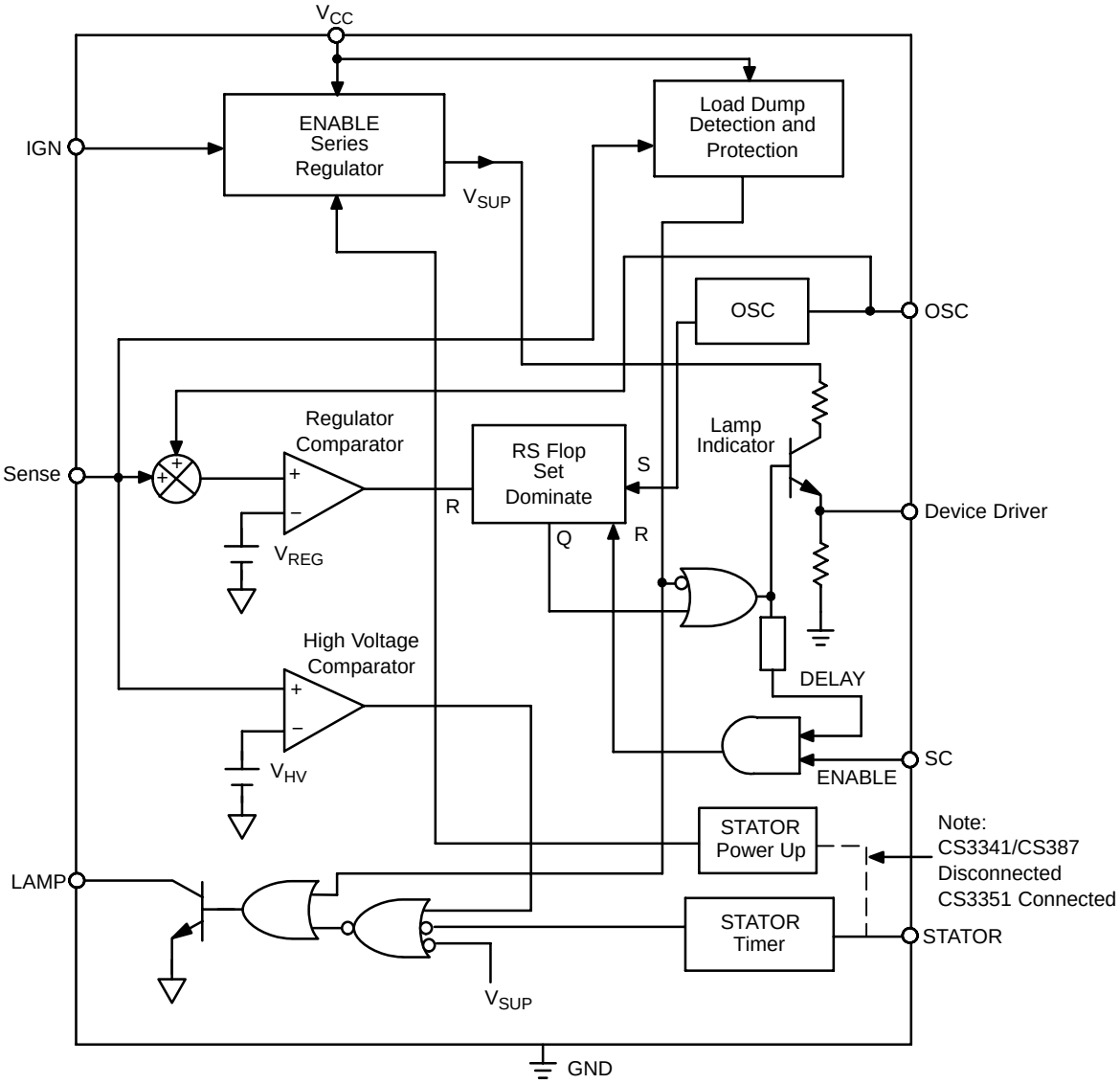



**Figure 1. Block Diagram**

**ELECTRICAL CHARACTERISTICS** ($-40°C < T_A < 125°C$, $-40°C < T_J < 150°C$, $9.0\ V \le V_{CC} \le 17\ V$; unless otherwise specified.)

| Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Supply** | | | | | |
| Supply Current Enabled | – | – | 12 | 25 | mA |
| Supply Current Disabled | – | – | – | 50 | μA |
| **Driver Stage** | | | | | |
| Output High Current | $V_{DD}$ = 1.2 V | −10 | −6.0 | −4.0 | mA |
| Output Low Voltage | $I_{OL}$ = 25 μA | – | – | 0.35 | V |
| Minimum ON Time | – | 200 | – | – | μs |
| Minimum Duty Cycle | – | – | 6.0 | 10 | % |
| Short Circuit Duty Cycle | – | 1.0 | – | 5.0 | % |
| Field Switch Turn On Rise Time | – | 30 | – | 90 | μs |
| Field Switch Turn On Fall Time | – | 30 | – | 90 | μs |
| **Stator** | | | | | |
| Input High Voltage | – | 10 | – | – | V |
| Input Low Voltage | – | – | – | 6.0 | V |
| Stator Time Out | High to Low | 6.0 | 100 | 600 | ms |
| Stator Power−Up Input High | CS3351 only | 10 | – | – | V |
| Stator Power−Up Input Low | CS3351 only | – | – | 6.0 | V |
| **Lamp** | | | | | |
| Output High Current | $V_{LAMP}$ @ 3.0 V | – | – | 50 | μA |
| Output Low Voltage | $I_{LAMP}$ @ 30 mA | – | – | 0.35 | V |
| **Ignition** | | | | | |
| Input High Voltage | $I_{CC}$ > 1.0 mA | 1.8 | – | – | V |
| Input Low Voltage | $I_{CC}$ < 100 μA | – | – | 0.5 | V |
| **Oscillator** | | | | | |
| Oscillator Frequency | $C_{OSC}$ = 0.22 μF | 65 | – | 325 | Hz |
| Rise Time/Fall Time | $C_{OSC}$ = 0.22 μF | – | 17 | – | – |
| Oscillator High Threshold | $C_{OSC}$ = 0.22 μF | – | – | 6.0 | V |
| **Battery Sense** | | | | | |
| Input Current | – | −10 | – | +10 | μA |
| Regulation Voltage | @25°C, $R_1$ = 100 kΩ, $R_2$ = 50 kΩ | 13.5 | – | 16 | V |
| Proportional Control | – | 0.050 | – | 0.400 | V |
| High Voltage Threshold Ratio | $\frac{V_{\text{High Voltage @ LampOn}}}{V_{\text{Regulation @ 50\%Duty Cycle}}}$ | 1.083 | – | 1.190 | – |
| High Voltage Hysteresis | – | 0.020 | – | 0.600 | V |

## PACKAGE PIN DESCRIPTION

| PACKAGE PIN # | | PIN SYMBOL | FUNCTION |
|---|---|---|---|
| SOIC−14 | Flip Chip | | |
| 1 | 1 | Driver | Output driver for external power switch−Darlington |
| 2 | 2 | GND | Ground |
| 3, 6, 7, 9, 13 | 3 | NC | No Connection |
| 4 | 4 | OSC | Timing capacitor for oscillator |
| 5 | 5 | Lamp | Base driver for lamp driver indicates no stator signal or overvoltage condition |
| 8 | 6 | IGN | Switched ignition powerup |
| 10 | 7 | Stator | Stator signal input for stator timer (CS3351 also powerup) |
| 11 | 8 | Sense | Battery sense voltage regulator comparator input and protection |
| 12 | 9 | $V_{CC}$ | Supply for IC |
| 14 | 10 | SC | Short circuit sensing |

## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| CS3341YD14 | SOIC−14 | 55 Units/Rail |
| CS3341YD14G | SOIC−14 (Pb−Free) | 55 Units/Rail |
| CS3341YDR14 | SOIC−14 | 2500 Tape & Reel |
| CS3341YDR14G | SOIC−14 (Pb−Free) | 2500 Tape & Reel |
| CS3351YD14 | SOIC−14 | 55 Units/Rail |
| CS3351YD14G | SOIC−14 (Pb−Free) | 55 Units/Rail |
| CS3351YDR14 | SOIC−14 | 2500 Tape & Reel |
| CS3351YDR14G | SOIC−14 (Pb−Free) | 2500 Tape & Reel |
| CS387H | Flip Chip | Contact Sales |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## TYPICAL PERFORMANCE CHARACTERISTICS

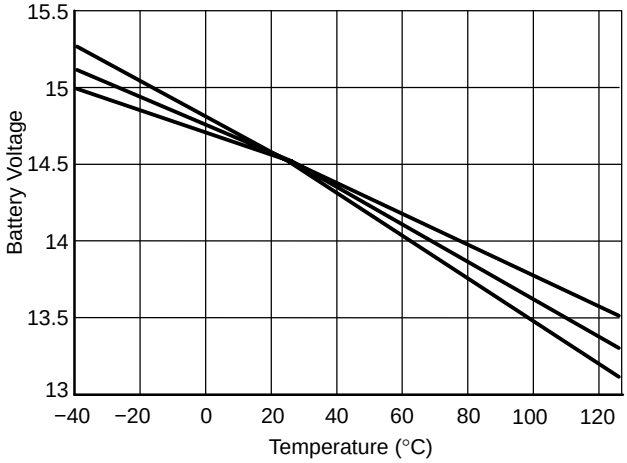



**Figure 2. Battery Voltage vs. Temperature (°C) Over Process Variation**

## APPLICATIONS INFORMATION

The CS3341 and CS3351 IC's are designed for use in an alternator charging system. The circuit is also available in flip−chip form as the CS387.

In a standard alternator design (Figure 3), the rotor carries the field winding. An alternator rotor usually has several N and S poles. The magnetic field for the rotor is produced by forcing current through a field or rotor winding. The Stator windings are formed into a number of coils spaced around a cylindrical core. The number of coils equals the number of pairs of N and S poles on the rotor. The alternating current in the Stator windings is rectified by the diodes and applied to the regulator. By controlling the amount of field current, the magnetic field strength is controlled and hence the output voltage of the alternator.

Referring to Figure 7, a typical application diagram, the oscillator frequency is set by an external capacitor connected between OSC and ground. The sawtooth waveform ramps between 1.0 V and 3.0 V and provides the timing for the system. For the circuit shown the oscillator frequency is approximately 140 Hz. The alternator voltage is sensed at Terminal A via the resistor divider network R1/R2 on the Sense pin of the IC. The voltage at the sense pin determines the duty cycle for the regulator. The voltage is adjusted by potentiometer R2. A relatively low voltage on the sense pin causes a long duty cycle that increases the Field current. A high voltage results in a short duty cycle.

The ignition Terminal (I) switches power to the IC through the $V_{CC}$ pin. In the CS3351 the Stator pin senses the voltage from the stator. This will keep the device powered while the voltage is high, and it also senses a stopped engine condition and drives the Lamp pin high after the stator timeout expires. The Lamp pin also goes high when an overvoltage condition is detected on the sense pin. This causes the darlington lamp drive transistor to switch on and pull current through the lamp. If the system voltage continues to increase, the field and lamp output turn off as in an overvoltage or load dump condition.

The SC or Short Circuit pin monitors the field voltage. If the drive output and the SC voltage are simultaneously high for a predetermined period, a short circuit condition is assumed and the output is disabled. The regulator is forced to a minimum short circuit duty cycle.

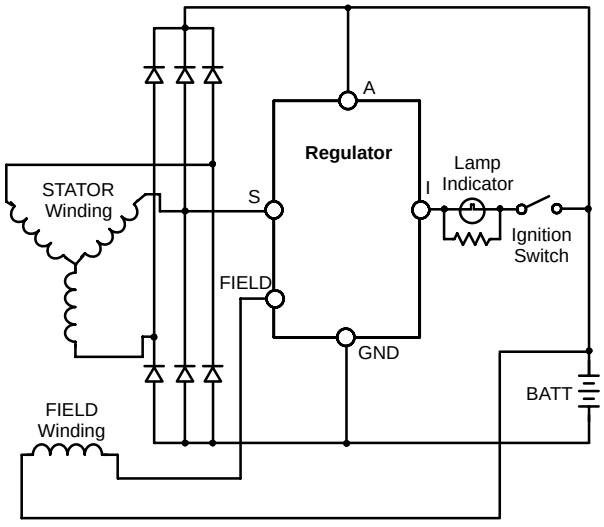



**Figure 3. IAR System Block Diagram**

## REGULATION WAVEFORMS

The CS3341/3351/387 utilizes proportion control to maintain regulation. Waveforms depicting operation are shown in Figures 4, 5 and 6, where $V_{BAT/N}$ is the divided down voltage present on the Sense pin using R1 and R2 (Figure 7). A sawtooth waveform is generated internally. The amplitude of this waveform is listed in the electric parameter section as proportion control. The oscillator voltage is summed with $V_{BAT/N}$, and compared with the internal voltage regulator ($V_{REG}$) in the regulation comparator which controls the field through the output "Device Driver."

Figure 4 shows typical steady−state operation. A 50% duty cycle is maintained.

Figure 5 shows the effect of a drop in voltage on ($V_{BAT/N}$ + $V_{OSC}$). Notice the duty cycle increase to the field drive.

Figure 6 shows the effect of an increase in voltage (above the regulation voltage) on ($V_{BAT/N}$ + $V_{OSC}$). Notice the decrease in field drive.

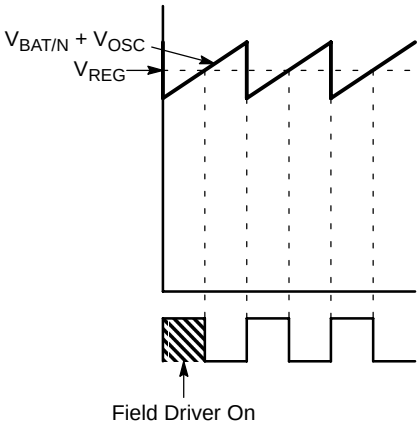



**Figure 4. 50% Duty Cycle, Steady State**

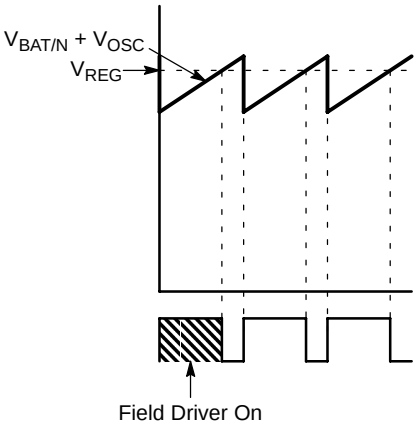



**Figure 5. > 50% Duty Cycle, Increased Load**

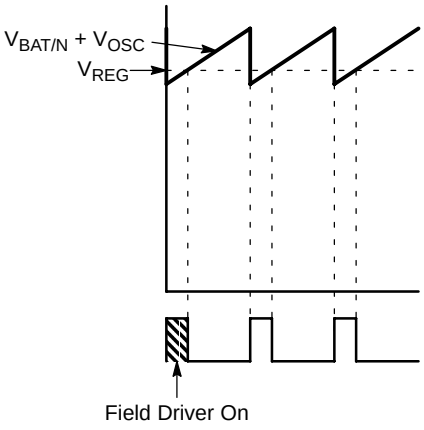



**Figure 6. < 50% Duty Cycle, Decreased Load**

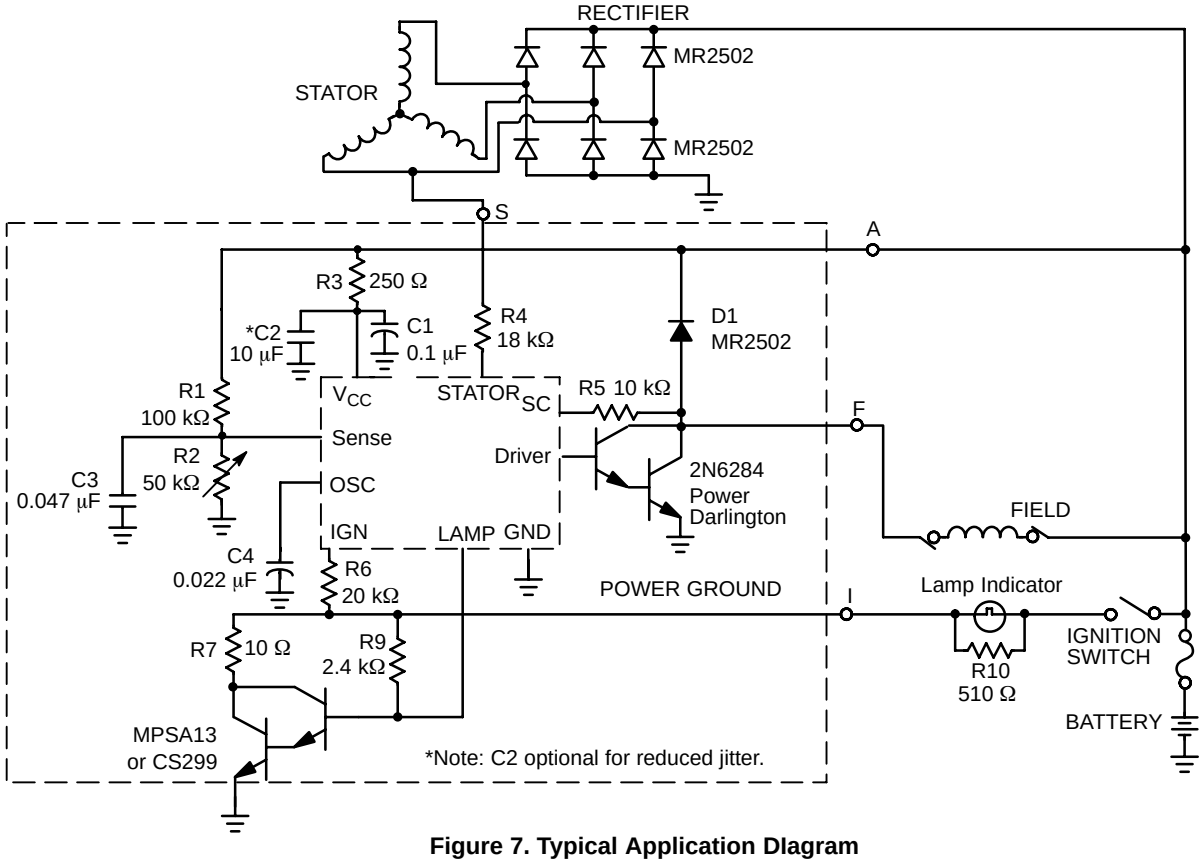



**Figure 7. Typical Application Diagram**

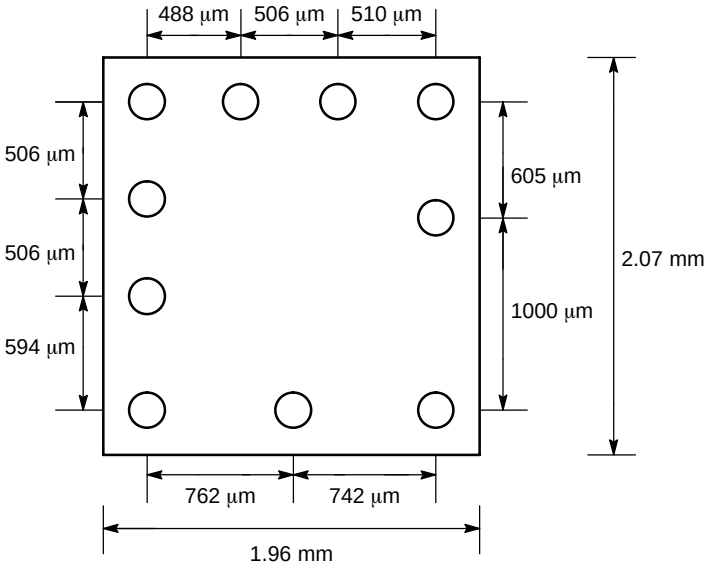
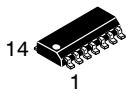



**Figure 8. Flip Chip Dimensions and Solder Bump Locations, Bump Side Up**

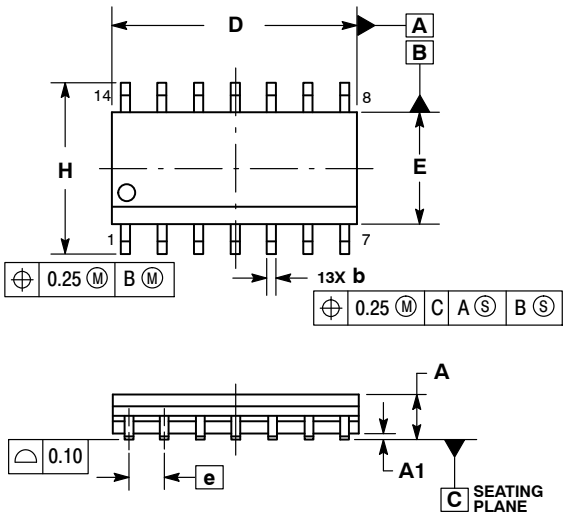
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

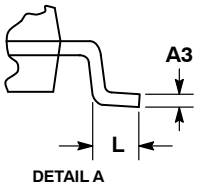


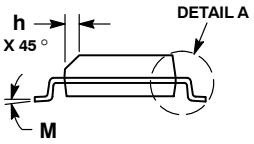

**SCALE 1:1**

**SOIC−14 NB**
CASE 751A−03
ISSUE L

DATE 03 FEB 2016



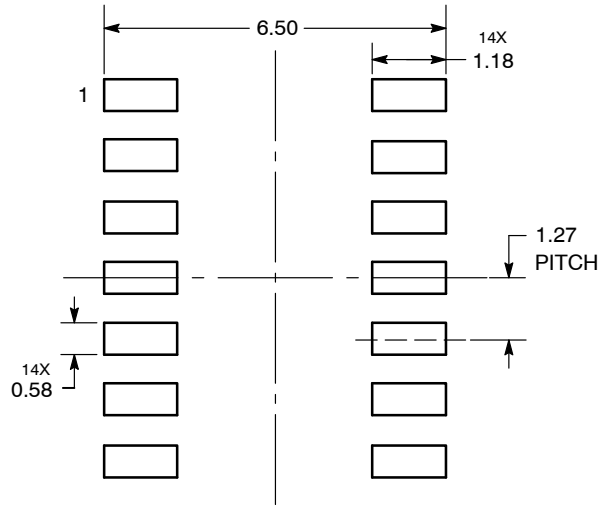




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.35 | 1.75 | 0.054 | 0.068 |
| A1 | 0.10 | 0.25 | 0.004 | 0.010 |
| A3 | 0.19 | 0.25 | 0.008 | 0.010 |
| b | 0.35 | 0.49 | 0.014 | 0.019 |
| D | 8.55 | 8.75 | 0.337 | 0.344 |
| E | 3.80 | 4.00 | 0.150 | 0.157 |
| e | 1.27 BSC | | 0.050 BSC | |
| H | 5.80 | 6.20 | 0.228 | 0.244 |
| h | 0.25 | 0.50 | 0.010 | 0.019 |
| L | 0.40 | 1.25 | 0.016 | 0.049 |
| M | 0 ° | 7 ° | 0 ° | 7 ° |

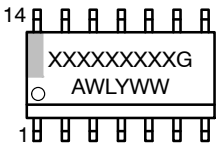
### SOLDERING FOOTPRINT*




DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### GENERIC MARKING DIAGRAM*




XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

**STYLES ON PAGE 2**

| | | | |
|---|---|---|---|
| **DOCUMENT NUMBER:** | **98ASB42565B** | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red. | |
| **DESCRIPTION:** | **SOIC−14 NB** | | **PAGE 1 OF 2** |

**SOIC−14**
CASE 751A−03
ISSUE L

DATE 03 FEB 2016

STYLE 1:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. NO CONNECTION
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. NO CONNECTION
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 2:
CANCELLED

STYLE 3:
PIN 1. NO CONNECTION
2. ANODE
3. ANODE
4. NO CONNECTION
5. ANODE
6. NO CONNECTION
7. ANODE
8. ANODE
9. ANODE
10. NO CONNECTION
11. ANODE
12. ANODE
13. NO CONNECTION
14. COMMON CATHODE

STYLE 4:
PIN 1. NO CONNECTION
2. CATHODE
3. CATHODE
4. NO CONNECTION
5. CATHODE
6. NO CONNECTION
7. CATHODE
8. CATHODE
9. CATHODE
10. NO CONNECTION
11. CATHODE
12. CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 5:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. NO CONNECTION
7. COMMON ANODE
8. COMMON CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 6:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. ANODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE

STYLE 7:
PIN 1. ANODE/CATHODE
2. COMMON ANODE
3. COMMON CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. ANODE/CATHODE
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. COMMON CATHODE
12. COMMON ANODE
13. ANODE/CATHODE
14. ANODE/CATHODE

STYLE 8:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. ANODE/CATHODE
7. COMMON ANODE
8. COMMON ANODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. NO CONNECTION
12. ANODE/CATHODE
13. ANODE/CATHODE
14. COMMON CATHODE

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