

# Alternator Voltage Regulator FET Driver

## CS3361

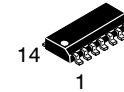
The CS3361 integral alternator regulator integrated circuit provides the voltage regulation for automotive, 3-phase alternators.

It drives an external logic level N channel enhancement power FET 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.

This IC has customized current sense circuitry enabling it to drive FET transistors. The CS3361 is available in an SOIC-14 package.

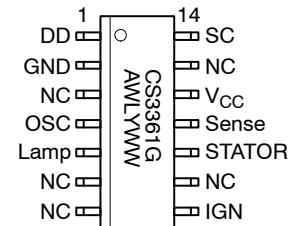
### Features

- Drives Logic Level Power NFET
- 80 V Load Dump
- Temperature Compensated Regulation Voltage
- Shorted Field Protection Duty Cycle, Self Clearing
- This is a Pb-Free Device



SOIC-14  
D SUFFIX  
CASE 751A

### PIN CONNECTIONS AND MARKING DIAGRAM



A = Assembly Location  
 WL = Wafer Lot  
 YY = Year  
 WW = Work Week  
 G = Pb-Free Package

### ORDERING INFORMATION

| Device       | Package           | Shipping <sup>†</sup> |
|--------------|-------------------|-----------------------|
| CS3361YDR14G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel    |

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

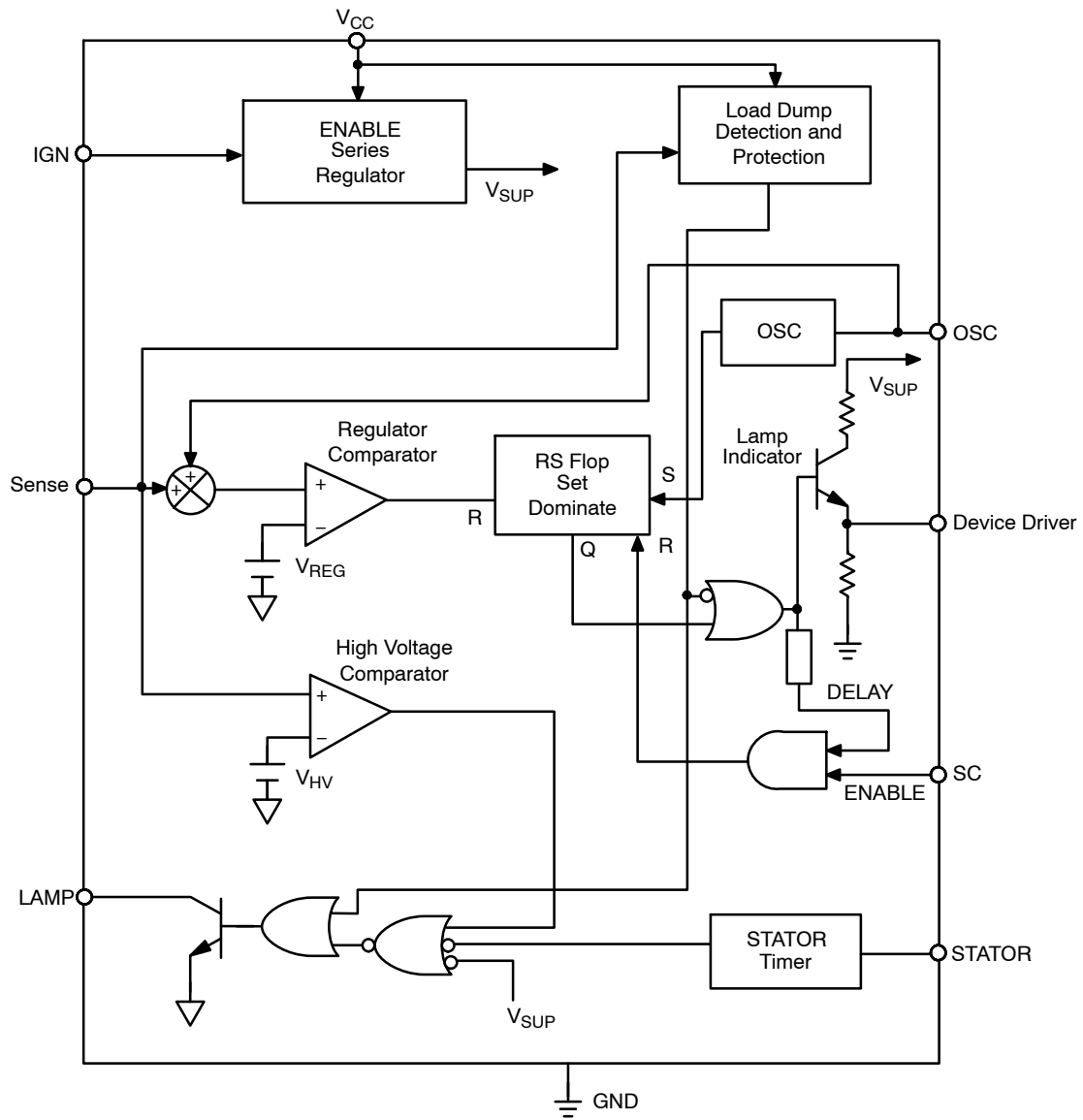


Figure 1. Block Diagram

## PACKAGE PIN DESCRIPTION

| PIN NO.        | PIN SYMBOL      | FUNCTION                                                                         |
|----------------|-----------------|----------------------------------------------------------------------------------|
| 1              | Driver          | Output driver for external power switch.                                         |
| 2              | GND             | Ground.                                                                          |
| 3, 6, 7, 9, 13 | NC              | No Connection.                                                                   |
| 4              | OSC             | Timing capacitor for oscillator.                                                 |
| 5              | Lamp            | Base driver for lamp driver indicates no stator signal or overvoltage condition. |
| 8              | IGN             | Switched ignition power up.                                                      |
| 10             | Stator          | Stator signal input for stator timer.                                            |
| 11             | Sense           | Battery sense voltage regulator comparator input and protection.                 |
| 12             | V <sub>CC</sub> | Supply for IC.                                                                   |
| 14             | SC              | Short circuit sensing.                                                           |

## MAXIMUM RATINGS

| Rating                                                                | Value                                          | Unit |
|-----------------------------------------------------------------------|------------------------------------------------|------|
| Storage Temperature Range, T <sub>S</sub>                             | –55 to +165                                    | °C   |
| Junction Temperature Range                                            | –40 to 150                                     | °C   |
| Continuous Supply                                                     | 27                                             | V    |
| I <sub>CC</sub> Load Dump (@ V <sub>CC</sub> = 80 V <sub>peak</sub> ) | 400                                            | mA   |
| Lead Temperature Soldering:                                           | Reflow: (SMD styles only) (Note 1)<br>260 peak | °C   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. 60 second maximum above 183°C.

## PACKAGE THERMAL DATA

| Parameter        |         | SO–14 | Unit |
|------------------|---------|-------|------|
| R <sub>θJC</sub> | Typical | 30    | °C/W |
| R <sub>θJA</sub> | Typical | 125   | °C/W |

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

| Characteristic | Test Conditions | Min | Typ | Max | Unit |
|----------------|-----------------|-----|-----|-----|------|
|----------------|-----------------|-----|-----|-----|------|

**Supply**

|                         |   |   |   |    |               |
|-------------------------|---|---|---|----|---------------|
| Supply Current Enabled  | – | – | – | 10 | mA            |
| Supply Current Disabled | – | – | – | 50 | $\mu\text{A}$ |

**Driver Stage**

|                                |                                      |     |      |      |               |
|--------------------------------|--------------------------------------|-----|------|------|---------------|
| Output High Voltage            | –                                    | 5.5 | –    | 12   | V             |
| Output Low Voltage             | $I_{OL} = 25\text{ }\mu\text{A}$     | –   | –    | 0.35 | V             |
| Output High Current            | $V_{DD} = 1.2\text{ V}$              | –10 | –6.0 | –4.0 | mA            |
| Minimum ON Time                | $C_{OSC} = 0.022\text{ }\mu\text{F}$ | 200 | –    | –    | $\mu\text{s}$ |
| Minimum Duty Cycle             | –                                    | –   | 6.0  | 10   | %             |
| Short Circuit Duty Cycle       | –                                    | 1.0 | –    | 5.0  | %             |
| Field Switch Turn On Rise Time | –                                    | 15  | –    | 75   | $\mu\text{s}$ |
| Field Switch Turn On Fall Time | –                                    | 15  | –    | 75   | $\mu\text{s}$ |

**Stator**

|                    |             |     |     |     |    |
|--------------------|-------------|-----|-----|-----|----|
| Input High Voltage | –           | 10  | –   | –   | V  |
| Input Low Voltage  | –           | –   | –   | 6.0 | V  |
| Stator Time Out    | High to Low | 6.0 | 100 | 600 | ms |

**Lamp**

|                     |                           |   |   |      |               |
|---------------------|---------------------------|---|---|------|---------------|
| Output High Current | $V_{LAMP} @ 3.0\text{ V}$ | – | – | 50   | $\mu\text{A}$ |
| Output Low Voltage  | $I_{LAMP} @ 30\text{ mA}$ | – | – | 0.35 | V             |

**Ignition**

|                    |                                   |     |   |     |   |
|--------------------|-----------------------------------|-----|---|-----|---|
| Input High Voltage | $I_{CC} > 1.0\text{ mA}$          | 1.8 | – | –   | V |
| Input Low Voltage  | $I_{CC} < 100\text{ }\mu\text{A}$ | –   | – | 0.5 | V |

**Oscillator**

|                           |                                      |    |    |     |    |
|---------------------------|--------------------------------------|----|----|-----|----|
| Oscillator Frequency      | $C_{OSC} = 0.022\text{ }\mu\text{F}$ | 90 | –  | 210 | Hz |
| Rise Time/Fall Time       | $C_{OSC} = 0.022\text{ }\mu\text{F}$ | –  | 17 | –   | –  |
| Oscillator High Threshold | $C_{OSC} = 0.022\text{ }\mu\text{F}$ | –  | –  | 4.5 | V  |

**Battery Sense**

|                              |                                                                               |       |   |       |               |
|------------------------------|-------------------------------------------------------------------------------|-------|---|-------|---------------|
| Input Current                | –                                                                             | –10   | – | +10   | $\mu\text{A}$ |
| Regulation Voltage           | @25°C, $R_1 = 100\text{ k}\Omega$ , $R_2 = 50\text{ k}\Omega$                 | 13.8  | – | 15.8  | V             |
| Proportional Control         | –                                                                             | 0.10  | – | 0.25  | V             |
| High Voltage Threshold Ratio | $\frac{V_{\text{High Voltage@LampOn}}}{V_{\text{Regulation@50\%Duty Cycle}}}$ | 1.083 | – | 1.190 | V/V           |
| High Voltage Hysteresis      | –                                                                             | 0.020 | – | 0.600 | V             |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

TYPICAL PERFORMANCE CHARACTERISTICS

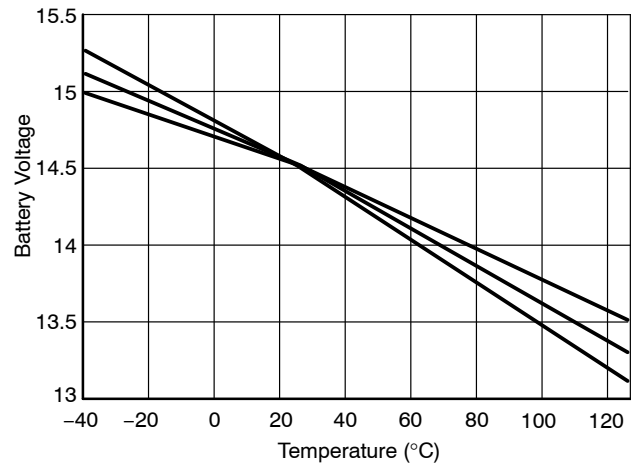


Figure 2. CS3361 Battery Voltage vs. Temperature (°C) Over Process Variation

## APPLICATIONS INFORMATION

The CS3361 is designed for use in an alternator charging system.

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. The Stator pin monitors the voltage from the stator and senses a stopped engine condition. It 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.

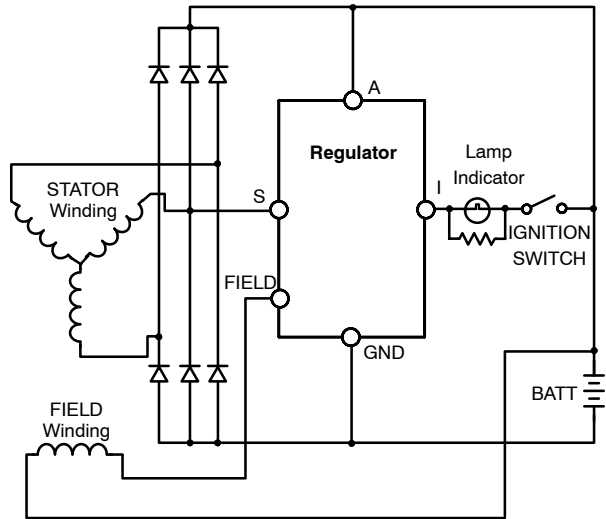


Figure 3. IAR System Block Diagram

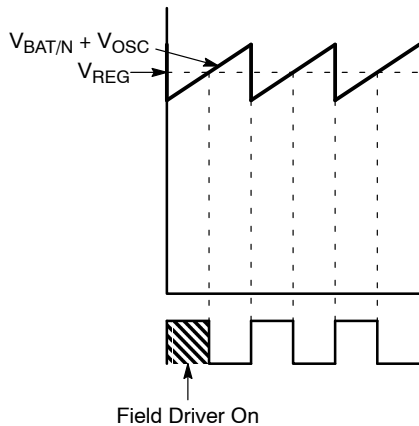
## REGULATION WAVEFORMS

The CS3361 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."

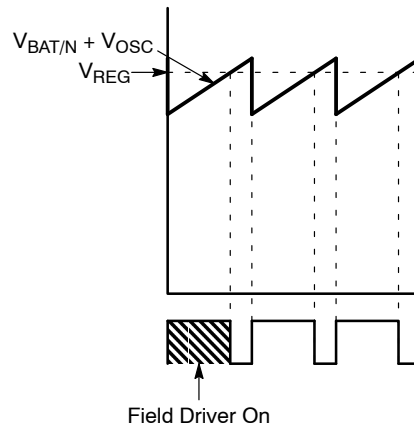
Figure 4 shows typical steady-state operation. A 50% duty cycle is maintained.

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.

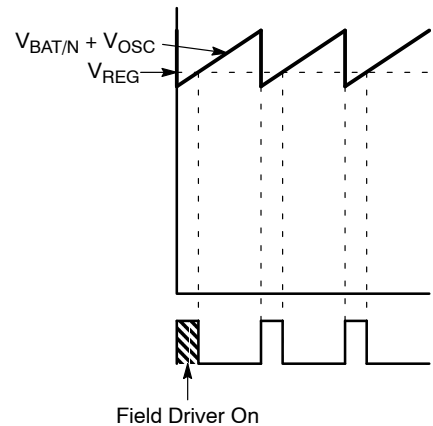
Figure 6 shows the effect of an increase in voltage (above the regulation voltage) on ( $V_{BAT/N} + V_{OSC}$ ). Notice the decrease in field drive.



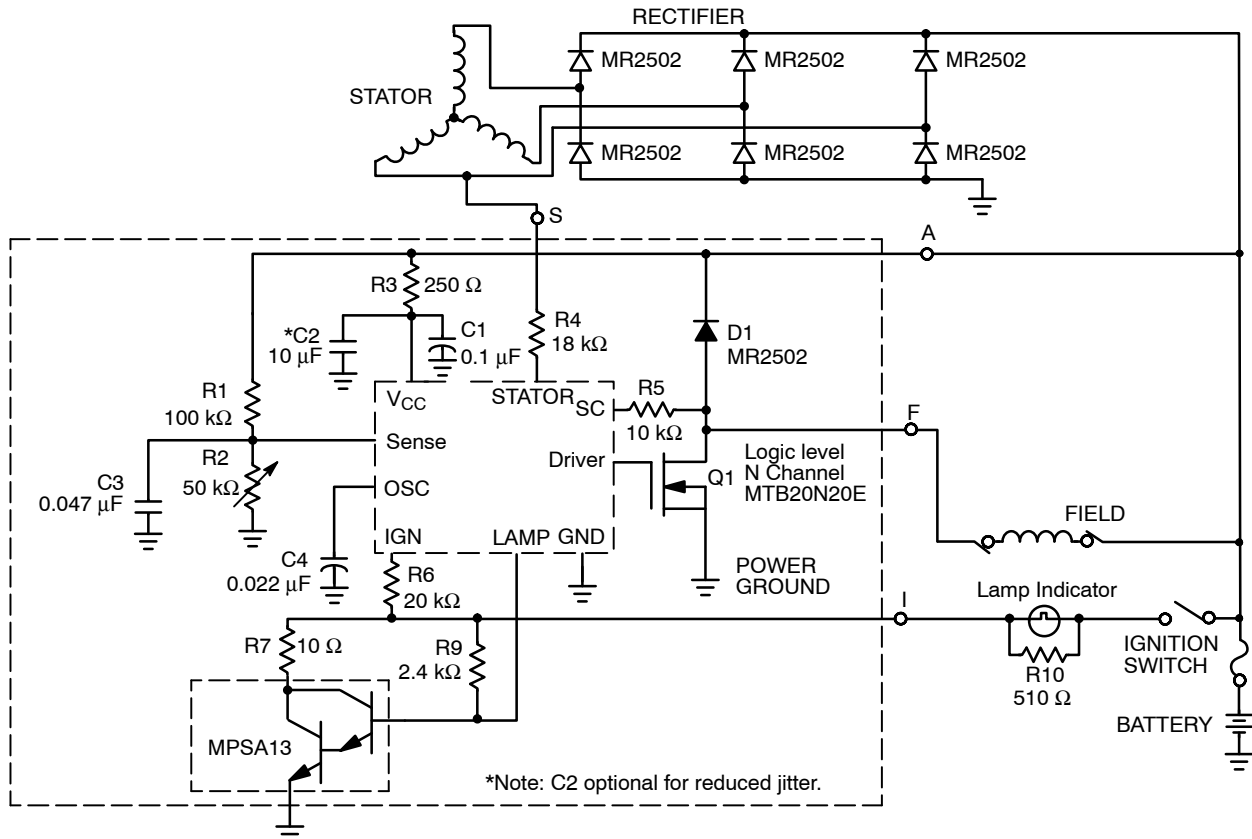
**Figure 4. 50% Duty Cycle, Steady State**



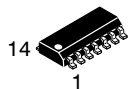
**Figure 5. > 50% Duty Cycle, Increased Load**



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



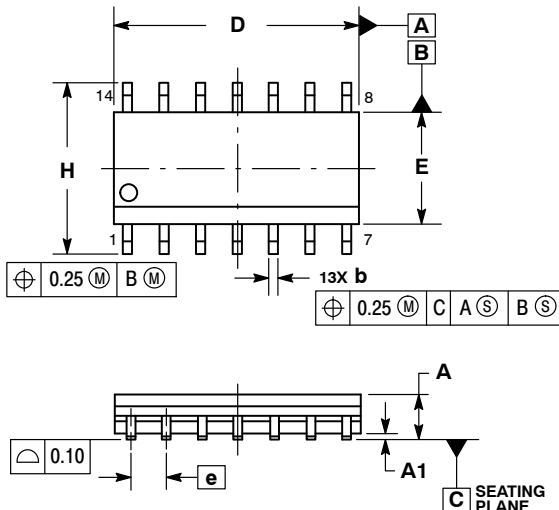
**Figure 7. Typical Application Diagram**



SCALE 1:1

SOIC-14 NB  
CASE 751A-03  
ISSUE L

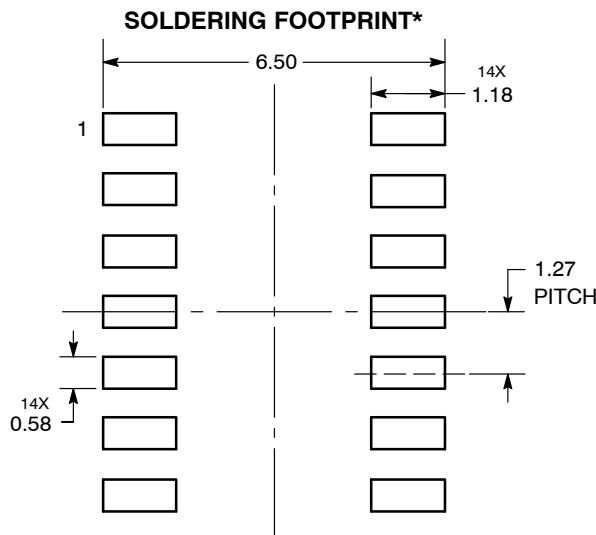
DATE 03 FEB 2016



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.

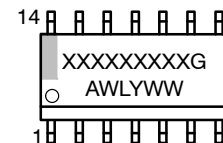
| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 1.35        | 1.75 | 0.054     | 0.068 |
| A1  | 0.10        | 0.25 | 0.004     | 0.010 |
| A3  | 0.19        | 0.25 | 0.008     | 0.010 |
| b   | 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°    |



DIMENSIONS: MILLIMETERS

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

GENERIC  
MARKING DIAGRAM\*



XXXXXX = 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

|                  |             |                                                                                                                                                                                     |
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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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