

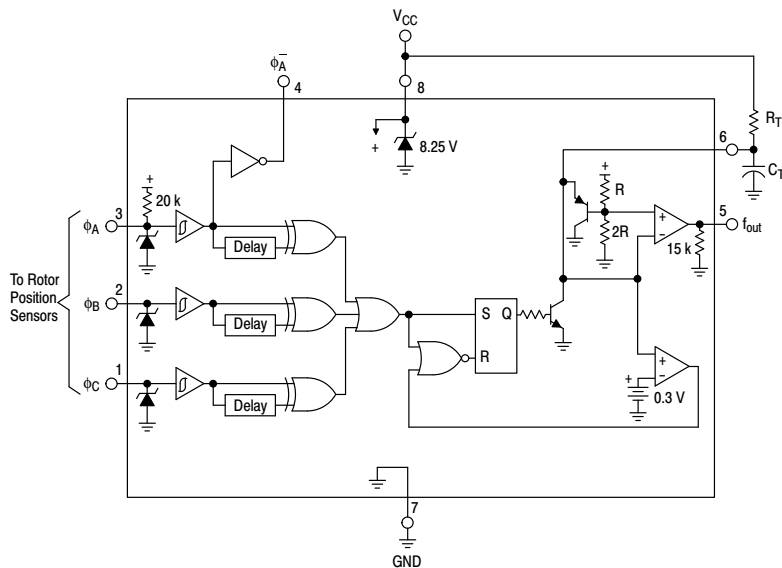
# MC33039, NCV33039

## Closed Loop Brushless Motor Adapter

The MC33039 is a high performance closed-loop speed control adapter specifically designed for use in brushless DC motor control systems. Implementation will allow precise speed regulation without the need for a magnetic or optical tachometer. This device contains three input buffers each with hysteresis for noise immunity, three digital edge detectors, a programmable monostable, and an internal shunt regulator. Also included is an inverter output for use in systems that require conversion of sensor phasing. Although this device is primarily intended for use with the MC33035 brushless motor controller, it can be used cost effectively in many other closed-loop speed control applications.

### Features

- Digital Detection of Each Input Transition for Improved Low Speed Motor Operation
- TTL Compatible Inputs With Hysteresis
- Operation Down to 5.5 V for Direct Powering from MC33035 Reference
- Internal Shunt Regulator Allows Operation from a Non-Regulated Voltage Source
- Inverter Output for Easy Conversion between 60°/300° and 120°/240° Sensor Phasing Conventions
- Pb-Free Packages are Available



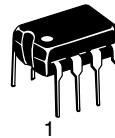
Representative Block Diagram



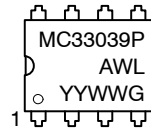
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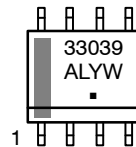
### MARKING DIAGRAMS



**PDIP-8  
P SUFFIX  
CASE 626**

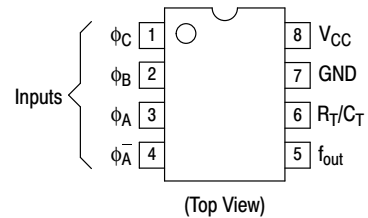


**SOIC-8  
D SUFFIX  
CASE 751**



A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

# MC33039, NCV33039

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
V <sub>CC</sub> Zener Current	I <sub>Z</sub> (V <sub>CC</sub> )	30	mA
Logic Input Current (Pins 1, 2, 3)	I <sub>IH</sub>	5.0	mA
Output Current (Pins 4, 5), Sink or Source	I <sub>DRV</sub>	20	mA
Power Dissipation and Thermal Characteristics Maximum Power Dissipation @ T <sub>A</sub> = +85°C Thermal Resistance, Junction-to-Air	P <sub>D</sub> R <sub>θJA</sub>	650 100	mW °C/W
Operating Junction Temperature	T <sub>J</sub>	+150	°C
Operating Ambient Temperature Range MC33039 NCV33039	T <sub>A</sub>	-40 to +85 -40 to +125	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 6.25 V, R<sub>T</sub> = 10 k, C<sub>T</sub> = 22 nF, T<sub>A</sub> = 25°C, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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### LOGIC INPUTS

Input Threshold Voltage High State	V <sub>IH</sub>	2.4	2.1	-	V
Low State	V <sub>IL</sub>	-	1.4	1.0	
Hysteresis	V <sub>H</sub>	0.4	0.7	0.9	
Input Current High State (V <sub>IH</sub> = 5.0 V)	I <sub>IH</sub>				μA
φ <sub>A</sub>		-40	-60	-80	
φ <sub>B</sub> , φ <sub>C</sub>		-	-0.3	-5.0	
Low State (V <sub>IL</sub> = 0 V)	I <sub>IL</sub>				
φ <sub>A</sub>		-190	-300	-380	
φ <sub>B</sub> , φ <sub>C</sub>		-	-0.3	-5.0	

### MONOSTABLE AND OUTPUT SECTIONS

Output Voltage High State	V <sub>OH</sub>				V
f <sub>out</sub> (I <sub>source</sub> = 5.0 mA)		3.60	3.95	4.20	
φ <sub>A</sub> (I <sub>source</sub> = 2.0 mA)		4.20	4.75	-	
Low State	V <sub>OL</sub>				
f <sub>out</sub> (I <sub>sink</sub> = 10 mA)		-	0.25	0.50	
φ <sub>A</sub> (I <sub>sink</sub> = 10 mA)		-	0.25	0.50	
Capacitor C <sub>T</sub> Discharge Current	I <sub>dischg</sub>	20	35	60	mA
Output Pulse Width (Pin 5)	t <sub>PW</sub>	205	225	245	μs

### POWER SUPPLY SECTION

Power Supply Operating Voltage Range MC33039 (T <sub>A</sub> = -40° to +85°C) NCV33039 (T <sub>A</sub> = -40° to +125°C)	V <sub>CC</sub>	5.5	-	V <sub>Z</sub>	V
Power Supply Current	I <sub>CC</sub>	1.8	3.9	5.0	mA
Zener Voltage (I <sub>Z</sub> = 10 mA)	V <sub>Z</sub>	7.5	8.25	9.0	V
Zener Dynamic Impedance (ΔI <sub>Z</sub> = 10 mA to 20 mA, f ≤ 1.0 kHz)	Z <sub>ka</sub>	-	2.0	5.0	Ω

# MC33039, NCV33039

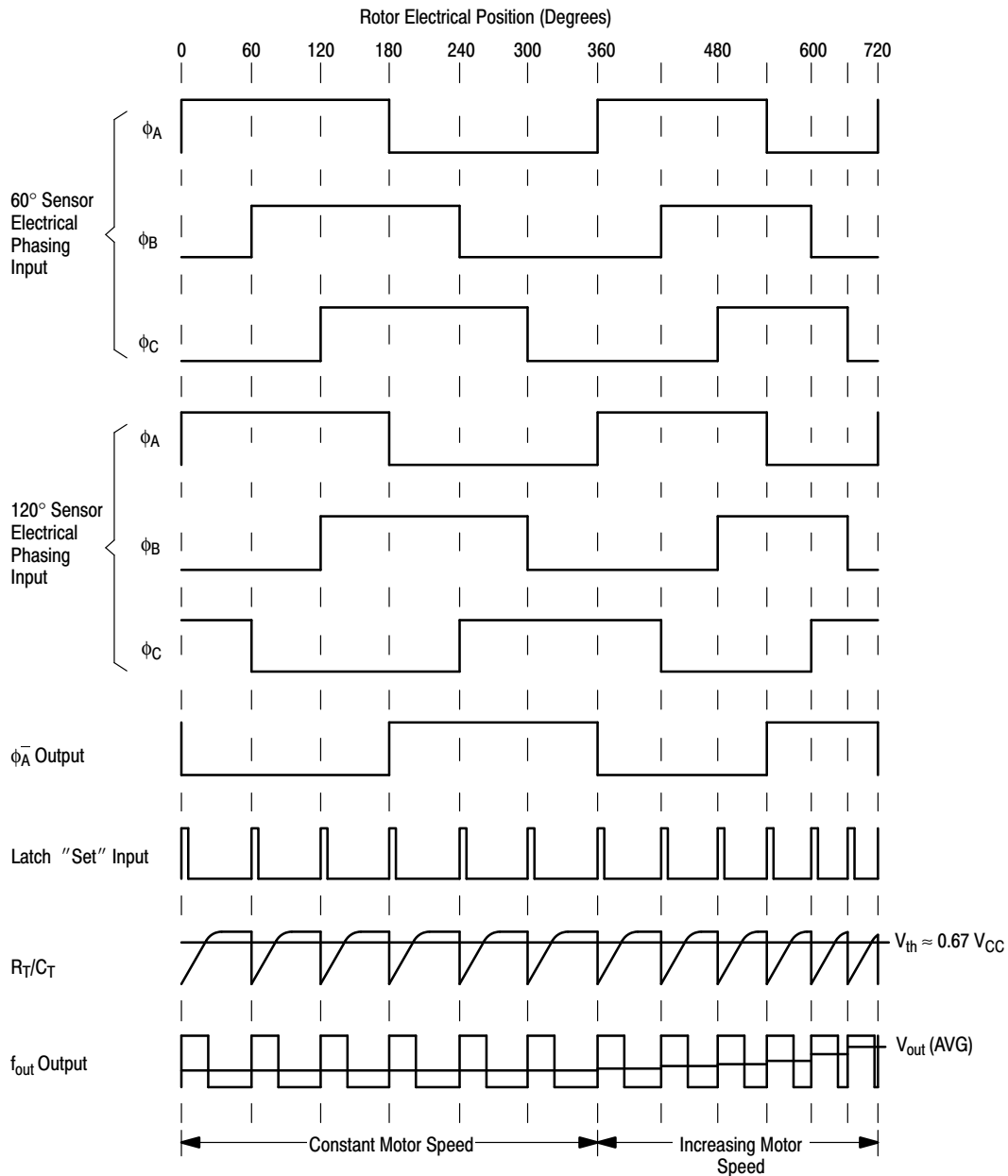


Figure 1. Typical Three Phase, Six Step Motor Application

## OPERATING DESCRIPTION

The MC33039 provides an economical method of implementing closed-loop speed control of brushless DC motors by eliminating the need for a magnetic or optical tachometer. Shown in the timing diagram of Figure 1, the three inputs (Pins 1, 2, 3) monitor the brushless motor rotor position sensors. Each sensor signal transition is digitally detected, OR'ed at the Latch 'Set' Input, and causes  $C_T$  to discharge. A corresponding output pulse is generated at  $f_{out}$  (Pin 5) of a defined amplitude, and programmable width determined by the values selected for  $R_T$  and  $C_T$  (Pin 6). The average voltage of the output pulse train increases with motor speed. When fed through a low pass filter or integrator, a DC voltage proportional to speed is generated. Figure 2 shows the proper connections for a typical closed

loop application using the MC33035 brushless motor controller. Constant speed operation down to 100 RPM is possible with economical three phase four pole motors.

The  $\phi_A$  inverter output (Pin 4) is used in systems where the controller and motor sensor phasing conventions are not compatible. A method of converting from either convention to the other is shown in Figure 3. For a more detailed explanation of this subject, refer to the text above Figure 39 on the MC33035 data sheet.

The output pulse amplitude  $V_{OH}$  is constant with temperature and controlled by the supply voltage on  $V_{CC}$  (Pin 8). Operation down to 5.5 V is guaranteed over temperature. For systems without a regulated power supply, an internal 8.25 V shunt regulator is provided.

# MC33039, NCV33039

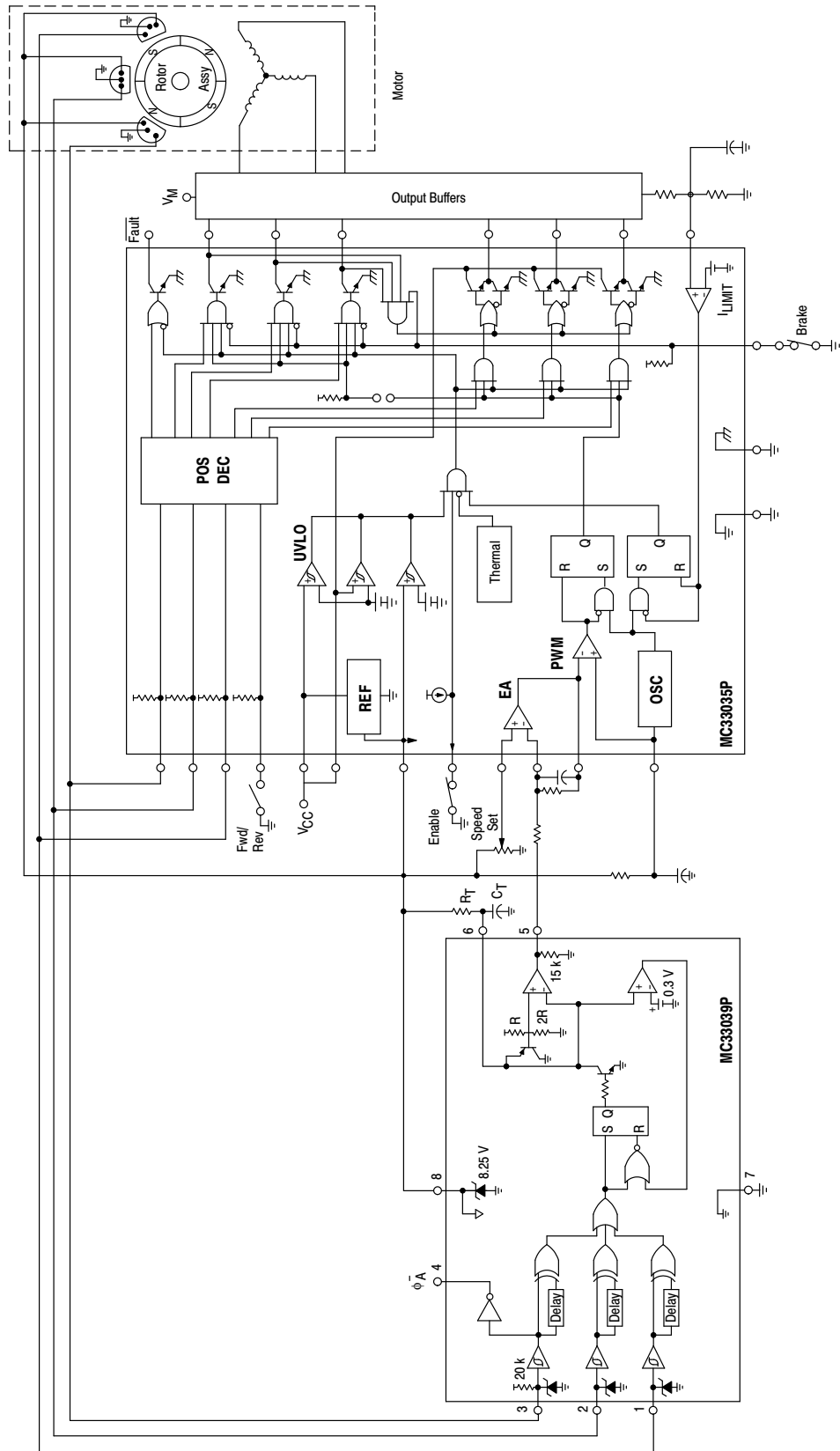


Figure 2. Typical Closed Loop Speed Control Application

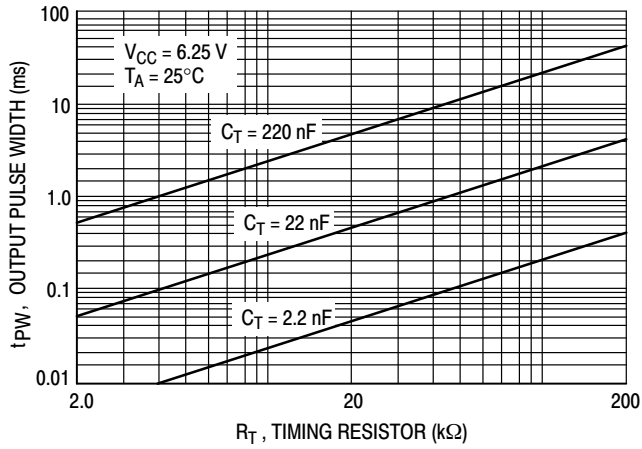


Figure 3.  $f_{out}$ , Pulse Width versus Timing Resistor

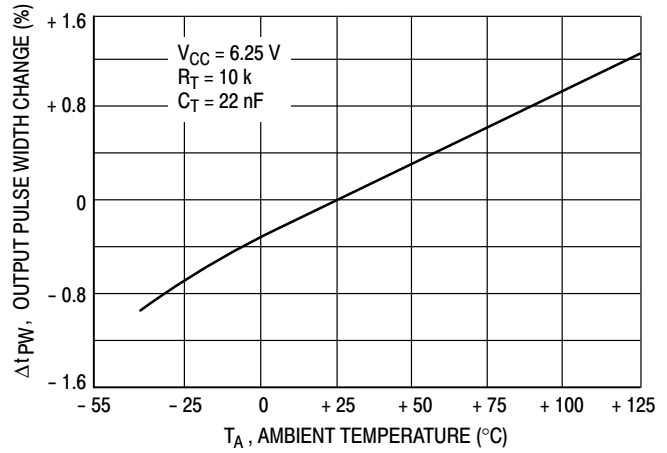


Figure 4.  $f_{out}$ , Pulse Width Change versus Temperature

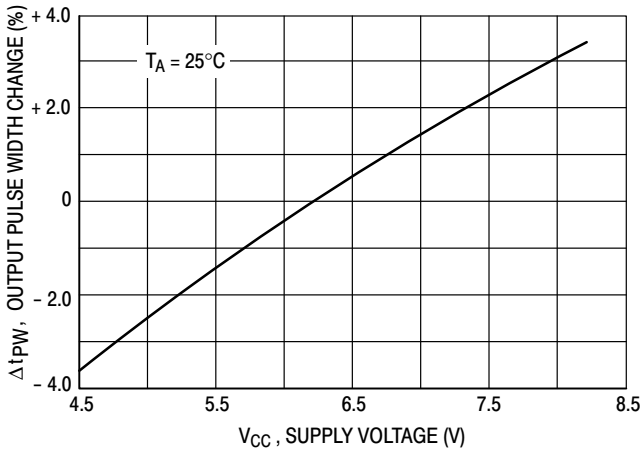


Figure 5.  $f_{out}$ , Pulse Width Change versus Supply Voltage

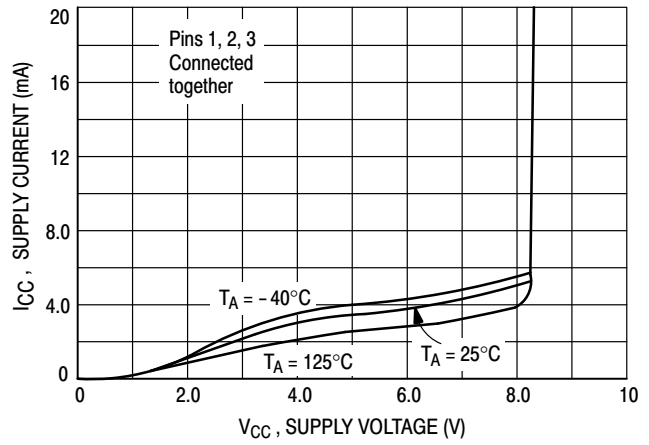


Figure 6. Supply Current versus Supply Voltage

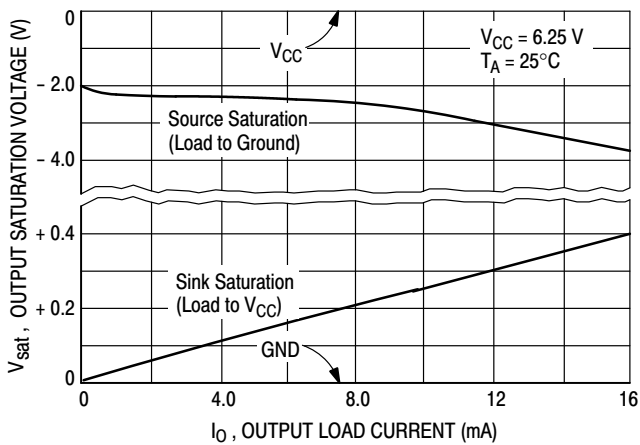


Figure 7.  $f_{out}$ , Saturation versus Load Current

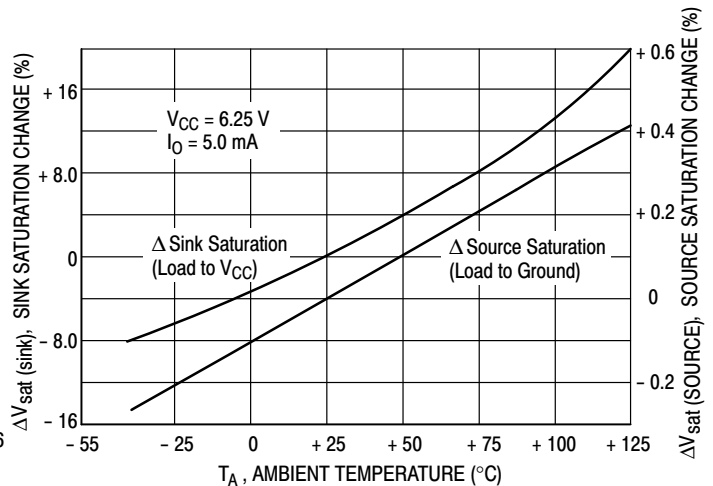


Figure 8.  $f_{out}$ , Saturation Change versus Temperature

# MC33039, NCV33039

## ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping <sup>†</sup>
MC33039D	T <sub>A</sub> = -40°C to +85°C	SOIC-8	98 Units / Rail
MC33039DG			2500 / Tape & Reel
MC33039DR2			
MC33039DR2G		PDIP-8	50 Units / Rail
MC33039P			
MC33039PG			
NCV33039DR2*	T <sub>A</sub> = -40°C to +125°C	SOIC-8	2500 / Tape & Reel
NCV33039DR2G*			

<sup>†</sup>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.

\*NCV33039: T<sub>low</sub> = -40C, T<sub>high</sub> = +125C. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and change control.

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®



SCALE 1:1

PDIP-8  
CASE 626-05  
ISSUE P

DATE 22 APR 2015



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	----	0.210	----	5.33
A1	0.015	----	0.38	----
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.35	0.56
b2	0.060 TYP		1.52 TYP	
C	0.008	0.014	0.20	0.36
D	0.355	0.400	9.02	10.16
D1	0.005	----	0.13	----
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
eB	----	0.430	----	10.92
L	0.115	0.150	2.92	3.81
M	----	10°	----	10°

GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- YY = 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.

- STYLE 1:  
PIN 1. AC IN  
2. DC + IN  
3. DC - IN  
4. AC IN  
5. GROUND  
6. OUTPUT  
7. AUXILIARY  
8. V<sub>CC</sub>

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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

DATE 16 FEB 2011



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

### SOLDERING FOOTPRINT\*



\*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\*



XXXXXX = Specific Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package

XXXXXX = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ■ = 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-8 NB**  
**CASE 751-07**  
**ISSUE AK**

DATE 16 FEB 2011

- |  |   |   |   |
|--|---|---|---|
| <p><b>STYLE 1:</b><br/>         PIN 1. EMITTER<br/>         2. COLLECTOR<br/>         3. COLLECTOR<br/>         4. EMITTER<br/>         5. EMITTER<br/>         6. BASE<br/>         7. BASE<br/>         8. EMITTER</p>   | <p><b>STYLE 2:</b><br/>         PIN 1. COLLECTOR, DIE, #1<br/>         2. COLLECTOR, #1<br/>         3. COLLECTOR, #2<br/>         4. COLLECTOR, #2<br/>         5. BASE, #2<br/>         6. EMITTER, #2<br/>         7. BASE, #1<br/>         8. EMITTER, #1</p>               | <p><b>STYLE 3:</b><br/>         PIN 1. DRAIN, DIE #1<br/>         2. DRAIN, #1<br/>         3. DRAIN, #2<br/>         4. DRAIN, #2<br/>         5. GATE, #2<br/>         6. SOURCE, #2<br/>         7. GATE, #1<br/>         8. SOURCE, #1</p>                            | <p><b>STYLE 4:</b><br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. ANODE<br/>         4. ANODE<br/>         5. ANODE<br/>         6. ANODE<br/>         7. ANODE<br/>         8. COMMON CATHODE</p>   |
| <p><b>STYLE 5:</b><br/>         PIN 1. DRAIN<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. DRAIN<br/>         5. GATE<br/>         6. GATE<br/>         7. SOURCE<br/>         8. SOURCE</p>   | <p><b>STYLE 6:</b><br/>         PIN 1. SOURCE<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. SOURCE<br/>         5. SOURCE<br/>         6. GATE<br/>         7. GATE<br/>         8. SOURCE</p>  | <p><b>STYLE 7:</b><br/>         PIN 1. INPUT<br/>         2. EXTERNAL BYPASS<br/>         3. THIRD STAGE SOURCE<br/>         4. GROUND<br/>         5. DRAIN<br/>         6. GATE 3<br/>         7. SECOND STAGE Vd<br/>         8. FIRST STAGE Vd</p>                    | <p><b>STYLE 8:</b><br/>         PIN 1. COLLECTOR, DIE #1<br/>         2. BASE, #1<br/>         3. BASE, #2<br/>         4. COLLECTOR, #2<br/>         5. COLLECTOR, #2<br/>         6. EMITTER, #2<br/>         7. EMITTER, #1<br/>         8. COLLECTOR, #1</p>                              |
| <p><b>STYLE 9:</b><br/>         PIN 1. EMITTER, COMMON<br/>         2. COLLECTOR, DIE #1<br/>         3. COLLECTOR, DIE #2<br/>         4. EMITTER, COMMON<br/>         5. EMITTER, COMMON<br/>         6. BASE, DIE #2<br/>         7. BASE, DIE #1<br/>         8. EMITTER, COMMON</p> | <p><b>STYLE 10:</b><br/>         PIN 1. GROUND<br/>         2. BIAS 1<br/>         3. OUTPUT<br/>         4. GROUND<br/>         5. GROUND<br/>         6. BIAS 2<br/>         7. INPUT<br/>         8. GROUND</p>  | <p><b>STYLE 11:</b><br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. DRAIN 2<br/>         7. DRAIN 1<br/>         8. DRAIN 1</p>   | <p><b>STYLE 12:</b><br/>         PIN 1. SOURCE<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p><b>STYLE 13:</b><br/>         PIN 1. N.C.<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>  | <p><b>STYLE 14:</b><br/>         PIN 1. N-SOURCE<br/>         2. N-GATE<br/>         3. P-SOURCE<br/>         4. P-GATE<br/>         5. P-DRAIN<br/>         6. P-DRAIN<br/>         7. N-DRAIN<br/>         8. N-DRAIN</p>   | <p><b>STYLE 15:</b><br/>         PIN 1. ANODE 1<br/>         2. ANODE 1<br/>         3. ANODE 1<br/>         4. ANODE 1<br/>         5. CATHODE, COMMON<br/>         6. CATHODE, COMMON<br/>         7. CATHODE, COMMON<br/>         8. CATHODE, COMMON</p>               | <p><b>STYLE 16:</b><br/>         PIN 1. EMITTER, DIE #1<br/>         2. BASE, DIE #1<br/>         3. EMITTER, DIE #2<br/>         4. BASE, DIE #2<br/>         5. COLLECTOR, DIE #2<br/>         6. COLLECTOR, DIE #2<br/>         7. COLLECTOR, DIE #1<br/>         8. COLLECTOR, DIE #1</p> |
| <p><b>STYLE 17:</b><br/>         PIN 1. VCC<br/>         2. V2OUT<br/>         3. V1OUT<br/>         4. TXE<br/>         5. RXE<br/>         6. VEE<br/>         7. GND<br/>         8. ACC</p>  | <p><b>STYLE 18:</b><br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. CATHODE<br/>         8. CATHODE</p>   | <p><b>STYLE 19:</b><br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. MIRROR 2<br/>         7. DRAIN 1<br/>         8. MIRROR 1</p>   | <p><b>STYLE 20:</b><br/>         PIN 1. SOURCE (N)<br/>         2. GATE (N)<br/>         3. SOURCE (P)<br/>         4. GATE (P)<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p><b>STYLE 21:</b><br/>         PIN 1. CATHODE 1<br/>         2. CATHODE 2<br/>         3. CATHODE 3<br/>         4. CATHODE 4<br/>         5. CATHODE 5<br/>         6. COMMON ANODE<br/>         7. COMMON ANODE<br/>         8. CATHODE 6</p>  | <p><b>STYLE 22:</b><br/>         PIN 1. I/O LINE 1<br/>         2. COMMON CATHODE/VCC<br/>         3. COMMON CATHODE/VCC<br/>         4. I/O LINE 3<br/>         5. COMMON ANODE/GND<br/>         6. I/O LINE 4<br/>         7. I/O LINE 5<br/>         8. COMMON ANODE/GND</p> | <p><b>STYLE 23:</b><br/>         PIN 1. LINE 1 IN<br/>         2. COMMON ANODE/GND<br/>         3. COMMON ANODE/GND<br/>         4. LINE 2 IN<br/>         5. LINE 2 OUT<br/>         6. COMMON ANODE/GND<br/>         7. COMMON ANODE/GND<br/>         8. LINE 1 OUT</p> | <p><b>STYLE 24:</b><br/>         PIN 1. BASE<br/>         2. EMITTER<br/>         3. COLLECTOR/ANODE<br/>         4. COLLECTOR/ANODE<br/>         5. CATHODE<br/>         6. CATHODE<br/>         7. COLLECTOR/ANODE<br/>         8. COLLECTOR/ANODE</p>                                      |
| <p><b>STYLE 25:</b><br/>         PIN 1. VIN<br/>         2. N/C<br/>         3. REXT<br/>         4. GND<br/>         5. IOUT<br/>         6. IOUT<br/>         7. IOUT<br/>         8. IOUT</p>   | <p><b>STYLE 26:</b><br/>         PIN 1. GND<br/>         2. dv/dt<br/>         3. ENABLE<br/>         4. ILIMIT<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. VCC</p>  | <p><b>STYLE 27:</b><br/>         PIN 1. ILIMIT<br/>         2. OVLO<br/>         3. UVLO<br/>         4. INPUT+<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. DRAIN</p>  | <p><b>STYLE 28:</b><br/>         PIN 1. SW_TO_GND<br/>         2. DASIC OFF<br/>         3. DASIC_SW_DET<br/>         4. GND<br/>         5. V_MON<br/>         6. VBULK<br/>         7. VBULK<br/>         8. VIN</p>  |
| <p><b>STYLE 29:</b><br/>         PIN 1. BASE, DIE #1<br/>         2. EMITTER, #1<br/>         3. BASE, #2<br/>         4. EMITTER, #2<br/>         5. COLLECTOR, #2<br/>         6. COLLECTOR, #2<br/>         7. COLLECTOR, #1<br/>         8. COLLECTOR, #1</p>                        | <p><b>STYLE 30:</b><br/>         PIN 1. DRAIN 1<br/>         2. DRAIN 1<br/>         3. GATE 2<br/>         4. SOURCE 2<br/>         5. SOURCE 1/DRAIN 2<br/>         6. SOURCE 1/DRAIN 2<br/>         7. SOURCE 1/DRAIN 2<br/>         8. GATE 1</p>                           |   |   |

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