

# LB1668M

## 2-phase Unipolar Brushless Motor Driver

### Monolithic Digital IC

#### Overview

The LB1668M is 2-phase unipolar drive brushless motor driver that features a wide usable voltage range and a minimal number of required external components. It also supports the formation of motor lock protection and automatic recovery circuits.

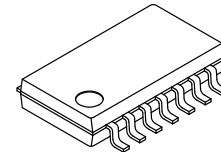
#### Features

- Output protection Zener Diodes with Variable Breakdown Voltages
  - ◆ When the Z1 and Z2 Pins are Open:  $V_{OLM} = 57\text{ V}$
  - ◆ When the Z1 and Z2 Pins are Shorted:  $V_{OLM} = 32\text{ V}$
  - ◆ An External Zener Diode can be Connected between Z1 and  $V_{CC}$
- Can Support Both 12 V and 24 V Power Supplies by Changing an External Resistor
- Hall Elements can be Connected Directly
- 1.5 A Output Current Output Transistors Built in
- Built-in Rotation Detection Function that Outputs Low when Driven and High when Stopped
- Motor Lock Protection and Automatic Recovery Functions Built in
- Thermal Shutdown Function



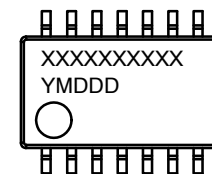
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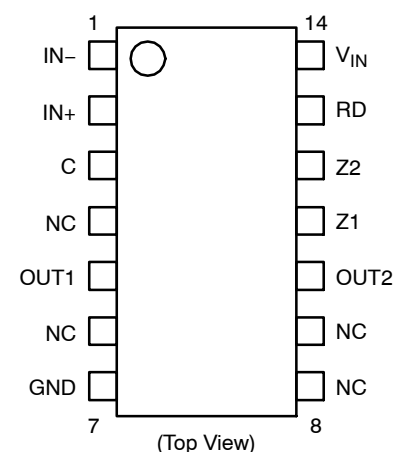
MFP14S  
CASE 751CB

#### MARKING DIAGRAM



XXXXX = Specific Device Code  
Y = Year  
M = Month  
DDD = Additional Traceability Data

#### PIN ASSIGNMENT



#### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

# LB1668M

## SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ )

Symbol	Parameter	Conditions	Ratings	Unit
$I_{CC}$ max	Maximum Input Current	$t \leq 20$ ms	200	mA
$V_{OUT}$	Output Supply Voltage		Internal	V
$I_{OUT}$	Output Current		1.5	A
$I_{RD}/I_{FG}$	RD/FG Flow-in Current		10	mA
$V_{RD}/V_{FG}$	RD/FG Supply Voltage		30	V
$P_d$ max	Allowable Power Dissipation	With specified board (Note 1)	0.8	W
$T_{opr}$	Operating Temperature		-30 to +80	$^\circ\text{C}$
$T_{stg}$	Storage Temperature		-55 to +150	$^\circ\text{C}$

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. Specified board: 20 mm × 15 mm × 1.5 mm, glass epoxy.

### ALLOWABLE OPERATING RANGES ( $T_A = 25^\circ\text{C}$ )

Symbol	Parameter	Conditions	Ratings	Unit
$I_{CC}$	Input Current Range		6.0 to 50	mA
$V_{ICM}$	Common-mode Input Voltage Range		0 to $V_{IN}-1.5$	V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , $I_{CC} = 10$ mA)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{OLM1}$	Output Limit Voltage	Z1, Z2 open	54	57	60	V
$V_{OLM2}$		Z1, Z2 short	31	33	35	V
$V_{O(sat)1}$	Output Saturation Voltage	$I_O = 0.5$ A	-	0.95	1.2	V
$V_{O(sat)2}$		$I_O = 1.0$ A	-	1.15	1.5	V
$V_{O(sat)3}$		$I_O = 1.5$ A	-	1.4	2.0	V
$V_{IN}$	$V_{IN}$ Input Voltage	$I_{CC} = 7.0$ mA	6.4	6.7	7.0	V
$V_{OFF}$	Amp Input Offset Voltage		-7.0	0	+7.0	mV
$I_{BA}$	Amp Input Bias Current		-250	-	-	nA
$V_{RD(sat)}$	RD Output Saturation Voltage	$I_{RD} = 5$ mA	-	0.1	0.3	V
$I_{C1}$	C Flow-out Current		2.1	3.0	3.9	$\mu\text{A}$
$I_{C2}$	C Discharge Current		0.31	0.44	0.59	$\mu\text{A}$
$V_{TH1}$	Comparator Input Threshold Voltage		0.77	$0.8 V_{IN}$	0.83	V
$V_{TH2}$			0.42	$0.45 V_{IN}$	0.48	V
TSD	Thermal Shutdown Current Operating Temperature	Design target value (Note 2)	-	180	-	$^\circ\text{C}$
$\Delta\text{TSD}$	Thermal Shutdown Circuit Hysteresis	Design target value (Note 2)	-	40	-	$^\circ\text{C}$

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.

2. Design target value and si not measured.

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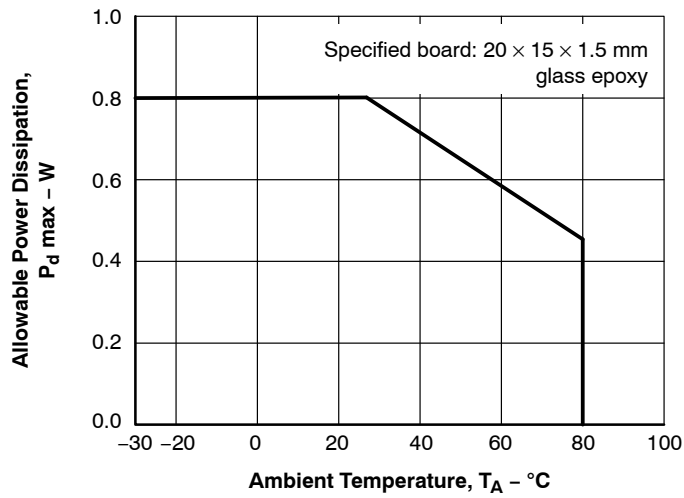


Figure 1.  $P_d$  max -  $T_A$

## TRUTH TABLE

IN+	IN-	C	OUT1	OUT2	RD
H	L	L	H	L	L
L	H	L	L	H	L
H	L	H	H	H	H
L	H	H	H	H	H

## BLOCK DIAGRAM

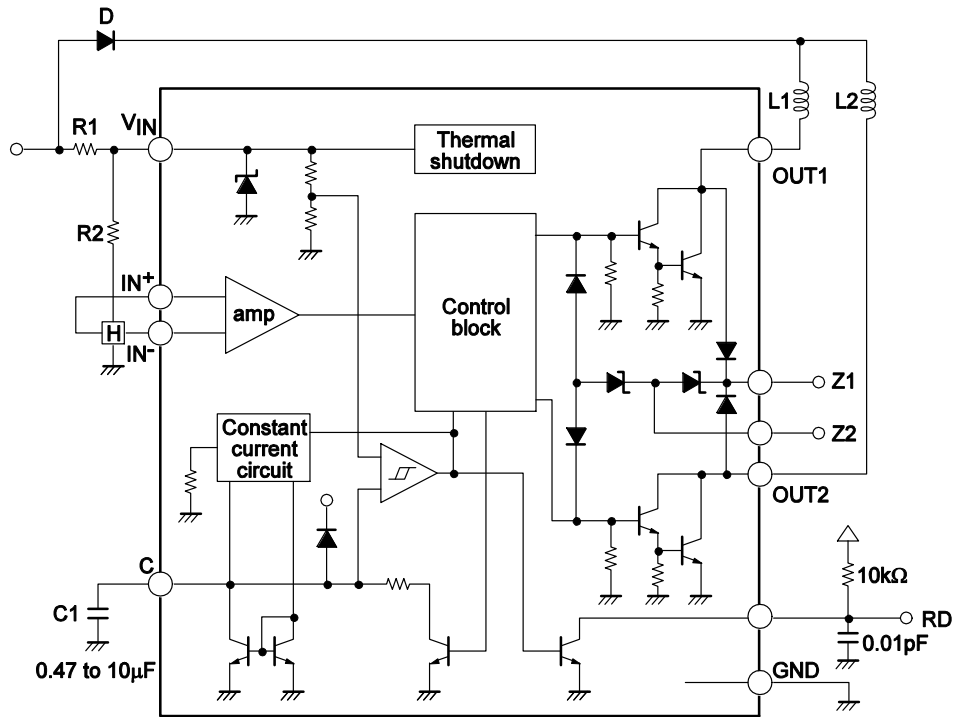


Figure 2. Block Diagram

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## APPLICATION CIRCUITS

### 1. 12 V Power Supply Type

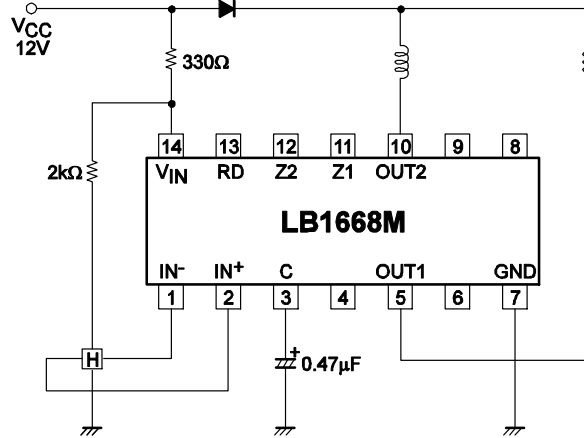


Figure 3. 12 V Power Supply Type

### 2. 24 V Power Supply Type

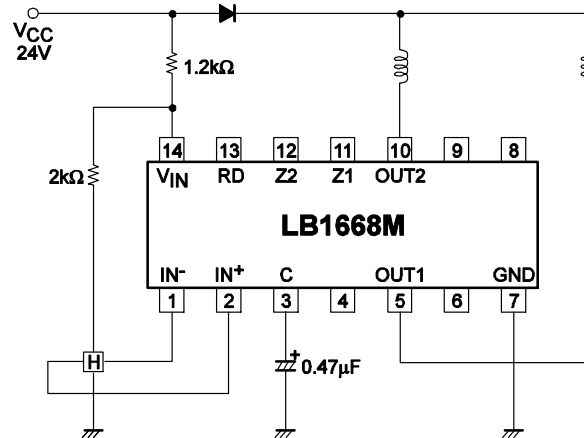


Figure 4. 24 V Power Supply Type

### 3. Circuit for use when large output currents are required and heat dissipation is high.

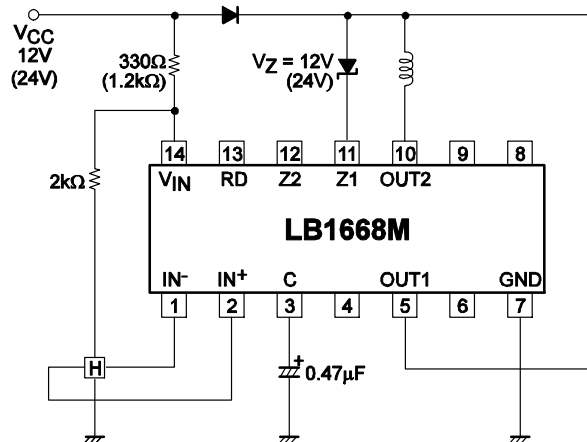


Figure 5. Circuit for Use when Large Output Currents are Required and Heat Dissipation is High

DESIGN DOCUMENTATION

(See the Sample Application Circuits)

1. Power Supply Voltage ( $V_{IN}$  pin):  
 The resistor R1 (when  $V_{CC} = 12\text{ V}$ ,  $R1 = 330\ \Omega$ , and when  $V_{CC} = 24$ ,  $R1 =$  about  $1.2\text{ k}\Omega$ ) is inserted between  $V_{IN}$  and the power supply  $V_{CC}$  pin. When the  $I_{CC}$  current is set in the range 6 to 50 mA, the  $V_{IN}$  pin will be regulated to be 6.7 V. Not only does this provide stability with respect to power supply voltage variations and motor kickback, but it also provides adequate strength to withstand surges.

2. Output Transistors (OUT1 and OUT2 Pins)  
 A Zener diodes with the following characteristics is inserted between the collector and base of each output transistor to absorb kickback voltages at 57 V (typical) and provide output protection.

- Sustained output voltage:  
 $V_O = 65\text{ V}$  minimum (design guarantee)
- Output current:  
 $I_O = 1.5\text{ A}$  maximum
- Output saturation voltage:  
 $V_O\text{ sat} = 1.25\text{ V}/1.0\text{ A}$  (typical)
- Safe operating range:  
 $I_O = 1.0\text{ A}$ ,  $V_{OLM} = 57\text{ V}$ ,  $t = 200\ \mu\text{s}$

3. Output Circuit Kickback Voltage Protection ( $Z1$  and  $Z2$  pins):  
 These ICs support output protection that minimizes kickback noise by changing the kickback absorption voltage and absorption method according to the output current and power supply voltage used.

- 1) When the  $Z1$  and  $Z2$  pins are shorted:  
 The output protection voltage will be 32 V (typical) using a  $V_{CC} = 12\text{ V}$  power supply.
- 2) When the  $Z1$  and  $Z2$  pins are open:  
 The output protection voltage will be 57 V (typical) using a  $V_{CC} = 24\text{ V}$  power supply.

3) With a Zener diode inserted between  $Z1$  and  $V_{CC}$  or between  $Z1$  and ground:  
 This technique handles 120mm square H speed applications which require large output currents and involve large amounts of heat generated in the IC by dissipating the motor coil switching loss in external Zener diodes.

4. Output Protection when the Motor is Lock (C and FG pins):  
 This circuit detects motor stopping due to, for example, overloading, and cuts the coil current. It also automatically recovers drive and motor turning from the output stopped state when the load returns to an appropriate level. The lock detection time is set with the value of an external capacitor.

- When  $C = 0.47\ \mu\text{F}$
- Lock detection time: about 1 s
  - Lock protection time:  
 about 0.5 s (output on)  
 about 3 s (output off)

The RD pin is an open collector output and outputs a low level during drive and a high level when stopped.

5. Thermal Shutdown:  
 This circuit turns the output off in response to coil shorting or IC overheating.

6. In applications that use an external transistor to turn the cooling fan power on and off, connect a capacitor of about 0.47 to 10  $\mu\text{F}$  between the fan power supply  $V_{CC}$  and ground to provide a regenerative route for the fan motor coil current.

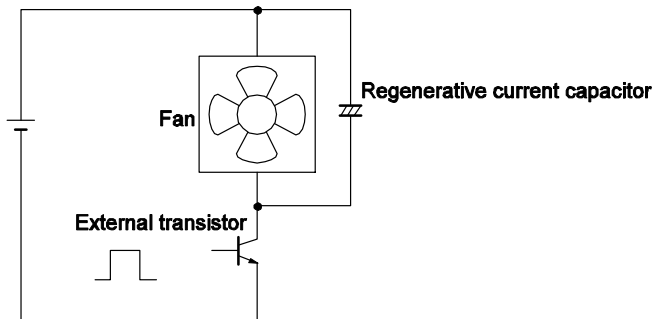


Figure 6.

AUTOMATIC RECOVERY CIRCUIT C-PIN VOLTAGE

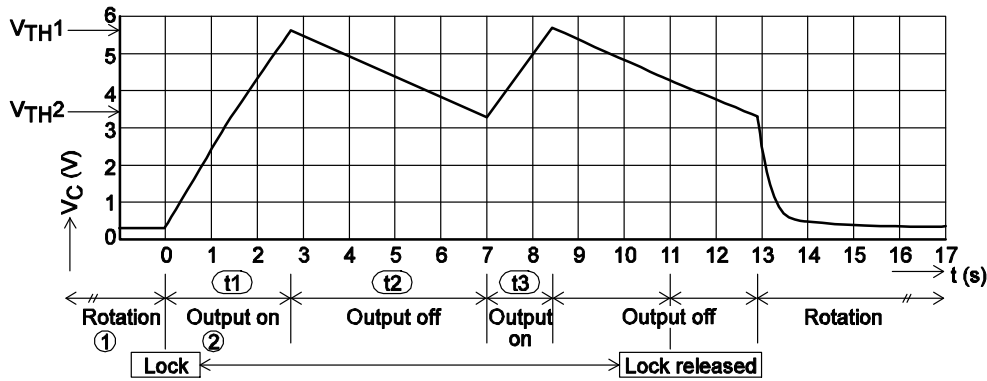


Figure 7. Automatic Return Circuit C-pin Voltage

1. While the blades are turning, the capacitor is charged with a current of about 3  $\mu$ A (typical), and C is discharged by pulses that correspond to the motor speed.
2. When the blades lock, the capacitor is no longer discharged, and the voltage across the capacitor increases. The output is turned off when that voltage reaches  $0.8 \times V_{IN}$ .
3. When the output is turned off, the capacitor is discharged at about 0.44  $\mu$ A (typical). When the

capacitor voltage falls under  $V_{TH2}$ , if the lock state is not yet cleared the capacitor continues discharging until  $V_{TH1}$ . (Note that the output is turned on at this time.)

These operations, i.e. items 2. and 3., are repeated with a ton:toff ratio of about 1 : 6 to protect the motor.

4. If the lock is cleared at the point the capacitor voltage reaches  $V_{TH2}$ , motor rotation is started by turning the output on.

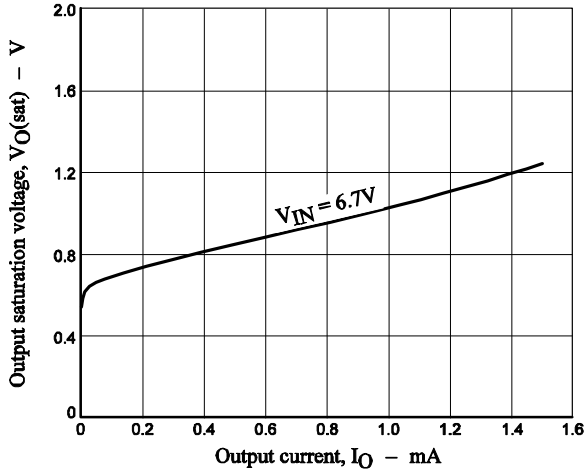


Figure 8.  $V_{O(sat)} - I_O$

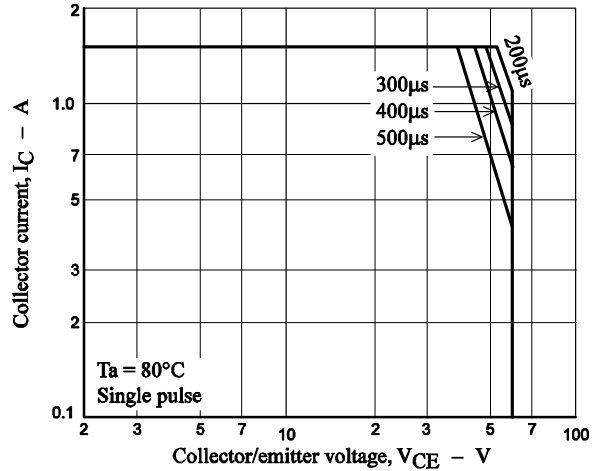


Figure 9. ASO

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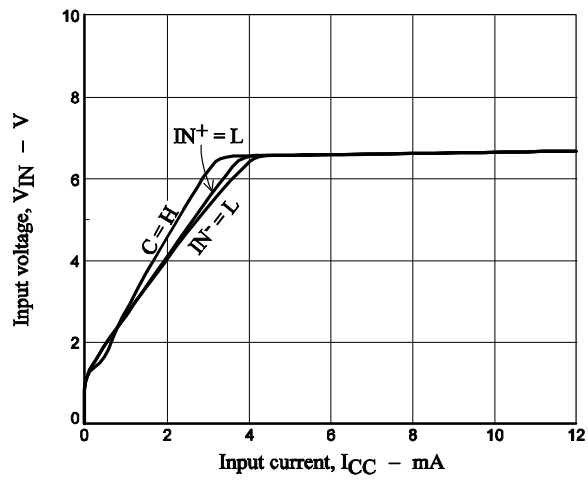


Figure 10.  $V_{IN} - I_{CC}$

## ORDERING INFORMATION

Device	Package	Wire Bond	Shipping† (Qty / Packing)
LB1668M-TLM-E	MFP14S (225mil) (Pb-Free)	Au-wire	1,000 / Tape & Reel
LB1668M-TLM-H	MFP14S (225mil) (Pb-Free / Halogen Free)	Au-wire	1,000 / Tape & Reel
LB1668M-W-AH	MFP14S (225mil) (Pb-Free / Halogen Free)	Cu-wire	1,000 / Tape & Reel

†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](#).

# MECHANICAL CASE OUTLINE

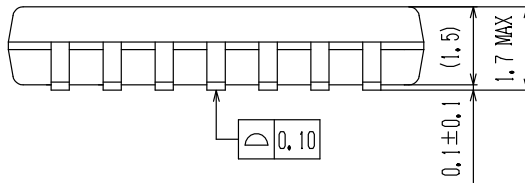
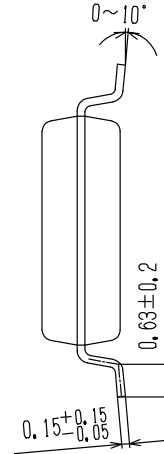
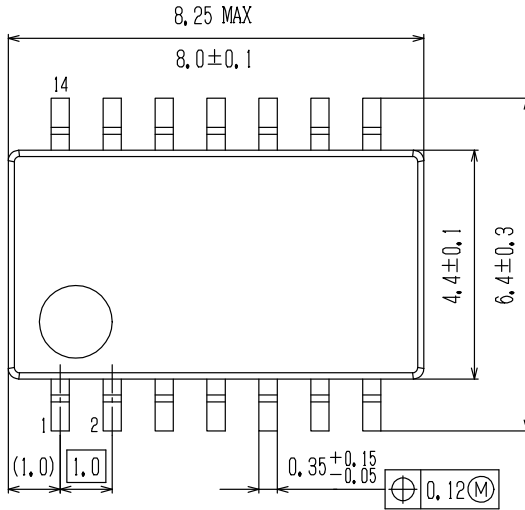
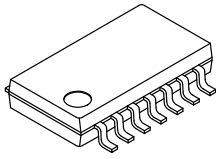
## PACKAGE DIMENSIONS

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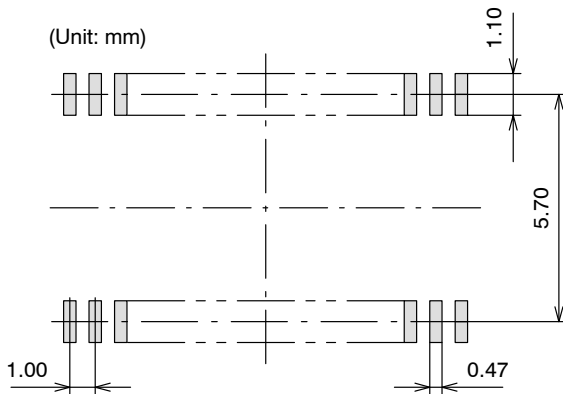


SOIC14 W / MFP14S (225 mil)  
CASE 751CB  
ISSUE A

DATE 25 OCT 2013



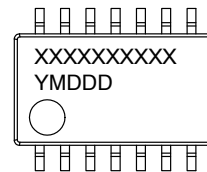
### SOLDERING FOOTPRINT\*



NOTE: The measurements are not to guarantee but for reference only.

\*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  
Y = Year  
M = Month  
DDD = Additional Traceability Data

\*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.

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