



# LB1947

Monolithic Digital IC  
 PWM Current Control Type  
 Bidirectional Motor Driver

## Overview

The LB1947 is a PWM current control type bidirectional motor driver IC.

## Features

- PWM current control (fixed OFF time)
- Selectable current decay pattern (FAST, SLOW, and MIX DECAY modes)
- Simultaneous ON prevention function (feed-through current prevention)
- Built-in thermal shutdown circuit
- Built-in noise canceler

## Specifications

### Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum motor supply voltage	$V_{BB}$ max		50	V
Output peak current	$I_O$ peak	$t_w \leq 20\mu\text{s}$	2.25	A
Output continuous current	$I_O$ max		2.0	A
Logic supply voltage	$V_{CC}$ max		7.0	V
Logic input voltage range	$V_{IN}$		-0.3 to $V_{CC}$	V
Emitter output voltage	$V_E$ max		1.1	V
Reference voltage	$V_{REF}$		-0.3 to $V_{CC}$	V
Allowable power dissipation	$P_d$ max		1.6	W
Operating temperature	$T_{opr}$		-20 to +85	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^\circ\text{C}$

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## Allowable Operating Ranges at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage	$V_{BB}$		10 to 45	V
Logic supply voltage	$V_{CC}$		4.75 to 5.25	V
Reference voltage	$V_{REF}$		0 to $V_{CC}-2$	V

## Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{CC} = 5\text{V}$

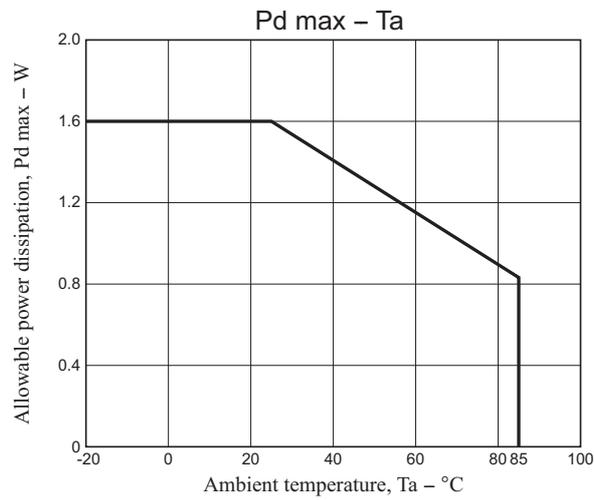
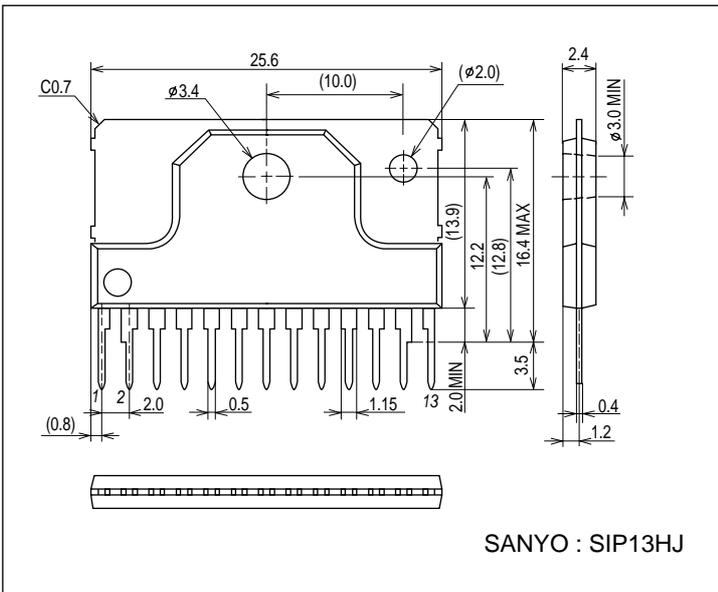
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Output Block</b>						
Output stage supply current	$I_{BB\ ON}$	No-load state, Forward	0.4	0.6	1.0	mA
	$I_{BB\ BR}$	No-load state, Brake	0.2	0.4	0.8	mA
	$I_{BB\ OFF}$	No-load state, Output off	0.2	0.4	0.8	mA
	$I_{BB\ wt}$	No-load state, Standby mode			0.1	mA
Output saturation voltage	$V_{Osat1}$	$I_O = +1.0\text{A}$ , Sink		1.2	1.5	V
	$V_{Osat2}$	$I_O = +2.0\text{A}$ , Sink		1.6	1.9	V
	$V_{Osat3}$	$I_O = -1.0\text{A}$ , Source		1.8	2.2	V
	$V_{Osat4}$	$I_O = -2.0\text{A}$ , Source		2.1	2.4	V
Output leak current	$I_{O1(Leak)}$	$V_O = V_{BB}$ , Sink			50	$\mu\text{A}$
	$I_{O2(Leak)}$	$V_O = 0\text{V}$ , Source	-50			$\mu\text{A}$
Output sustain voltage	$V_{SUS}$	$L = 3.9\text{mH}$ , $I_O = 2.0\text{A}$ , Design guarantee value*	50			V
<b>Logic Block</b>						
Logic supply current	$I_{CC\ ON}$	IN1: High, IN2: Low, ST: High	11	16	21	mA
	$I_{CC\ BR}$	IN1: Low, IN2: High, ST: High	11	16	21	mA
	$I_{CC\ OFF}$	IN1: Low, IN2: Low, ST: High	11	16	21	mA
	$I_{CC\ wt}$	ST: Low	1.0	2	3.0	mA
Input voltage	$V_{INH}$		2			V
	$V_{INL}$				0.8	V
Input current	$I_{INH}$	$V_{IN} = 5\text{V}$	60	90	120	$\mu\text{A}$
	$I_{INL}$	$V_{IN} = 0.8\text{V}$	6	10	13	$\mu\text{A}$
Sensing voltage	$V_E$		0		1.1	V
Sensing voltage 25H	$V_{EH25}$	$V_I = \text{High}$ , $V_{REF} = 2.5\text{V}$	0.970	1.0	1.030	V
Sensing voltage 25L	$V_{EL25}$	$V_I = \text{Low}$ , $V_{REF} = 2.5\text{V}$	0.483	0.5	0.513	V
Sensing voltage 15H	$V_{EH15}$	$V_I = \text{High}$ , $V_{REF} = 1.5\text{V}$	0.385	0.4	0.410	V
Sensing voltage 15L	$V_{EL15}$	$V_I = \text{Low}$ , $V_{REF} = 1.5\text{V}$	0.190	0.2	0.210	V
Sensing voltage 05H	$V_{EH05}$	$V_I = \text{High}$ , $V_{REF} = 0.5\text{V}$	0.190	0.2	0.210	V
Sensing voltage 05L	$V_{EL05}$	$V_I = \text{Low}$ , $V_{REF} = 0.5\text{V}$	0.092	0.1	0.108	V
Reference current	$I_{ref}$	$V_{REF} = 1.0\text{V}$	-0.5		+0.5	$\mu\text{A}$
CR pin current	$I_{CR}$		-1.56	-1.3	-1.04	mA
MD pin voltage	$V_{MDH}$		$V_{CC}-0.3$			V
	$V_{MDM}$		$0.3V_{CC}$		$V_{CC}-1.0$	V
	$V_{MDL}$				.04	V
MD input current	$I_{MDH}$	$MD = V_{CC}-0.5\text{V}$ , $CR = 1.0\text{V}$	-1.0		+1.0	$\mu\text{A}$
	$I_{MDL}$	$MD = 0.4\text{V}$ , $CR = 2.0\text{V}$	-5.0			$\mu\text{A}$
Thermal shutdown temperature	TSD	Design guarantee value*		170		$^\circ\text{C}$

\* Design guarantee value, Do not measurement.

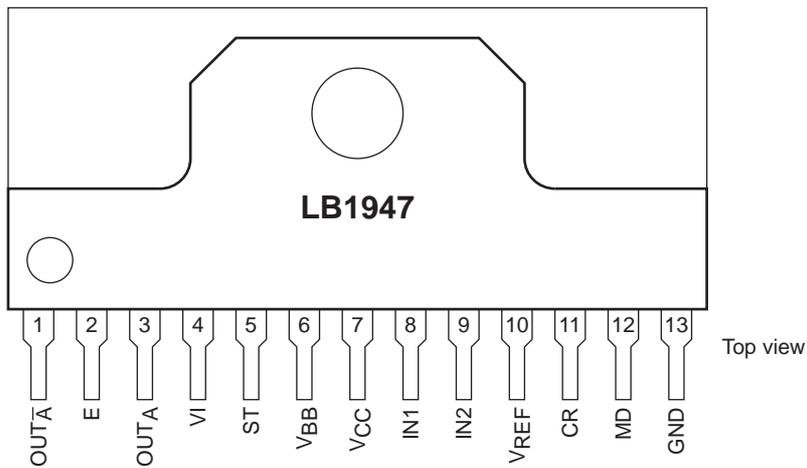
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## Package Dimensions

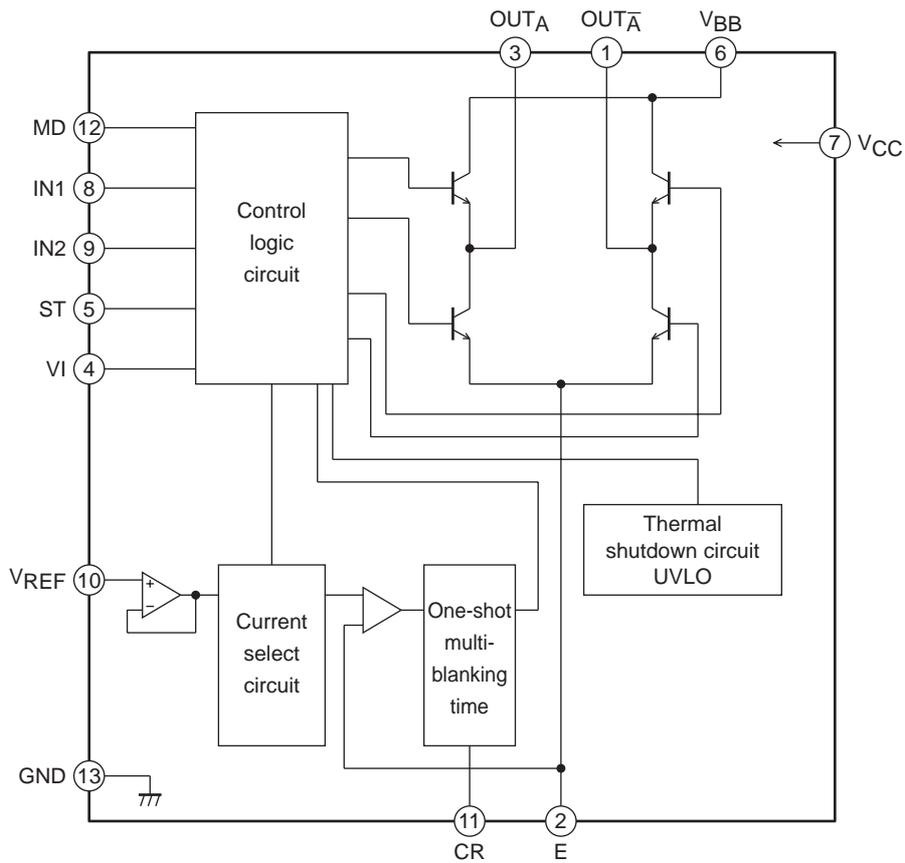
unit : mm (typ)  
3249



## Pin Assignment



Block Diagram



Truth Table

IN1	IN2	ST	VI	MD	OUT <sub>A</sub>	OUT <sub>A</sub> <sup>̄</sup>	Operating mode
H	L	H	H	L	H	L	Forward, 2/5 times, FAST
H	L	H	H	M	H	L	Forward, 2/5 times, MIX
H	L	H	H	H	H	L	Forward, 2/5 times, SLOW
H	L	H	L	L	H	L	Forward, 1/5 times, FAST
H	L	H	L	M	H	L	Forward, 1/5 times, MIX
H	L	H	L	H	H	L	Forward, 1/5 times, SLOW
H	H	H	H	L	L	H	Reverse, 2/5 times, FAST
H	H	H	H	M	L	H	Reverse, 2/5 times, MIX
H	H	H	H	H	L	H	Reverse, 2/5 times, SLOW
H	H	H	L	L	L	H	Reverse, 1/5 times, FAST
H	H	H	L	M	L	H	Reverse, 1/5 times, MIX
H	H	H	L	H	L	H	Reverse, 1/5 times, SLOW
L	H	H	H	L	L	L	Brake, 2/5 times, FAST
L	H	H	H	M	L	L	Brake, 2/5 times, MIX
L	H	H	L	L	L	L	Brake, 1/5 times, FAST
L	H	H	L	M	L	L	Brake, 1/5 times, MIX
L	H	H	X	H	L	L	Brake, no current limiting
L	L	H	X	X	OFF	OFF	Output OFF
X	X	L or OPEN	X	X	OFF	OFF	Standby mode (circuit OFF)

Except for MD pin, Low at input OPEN.

MD M: determined by external voltage.

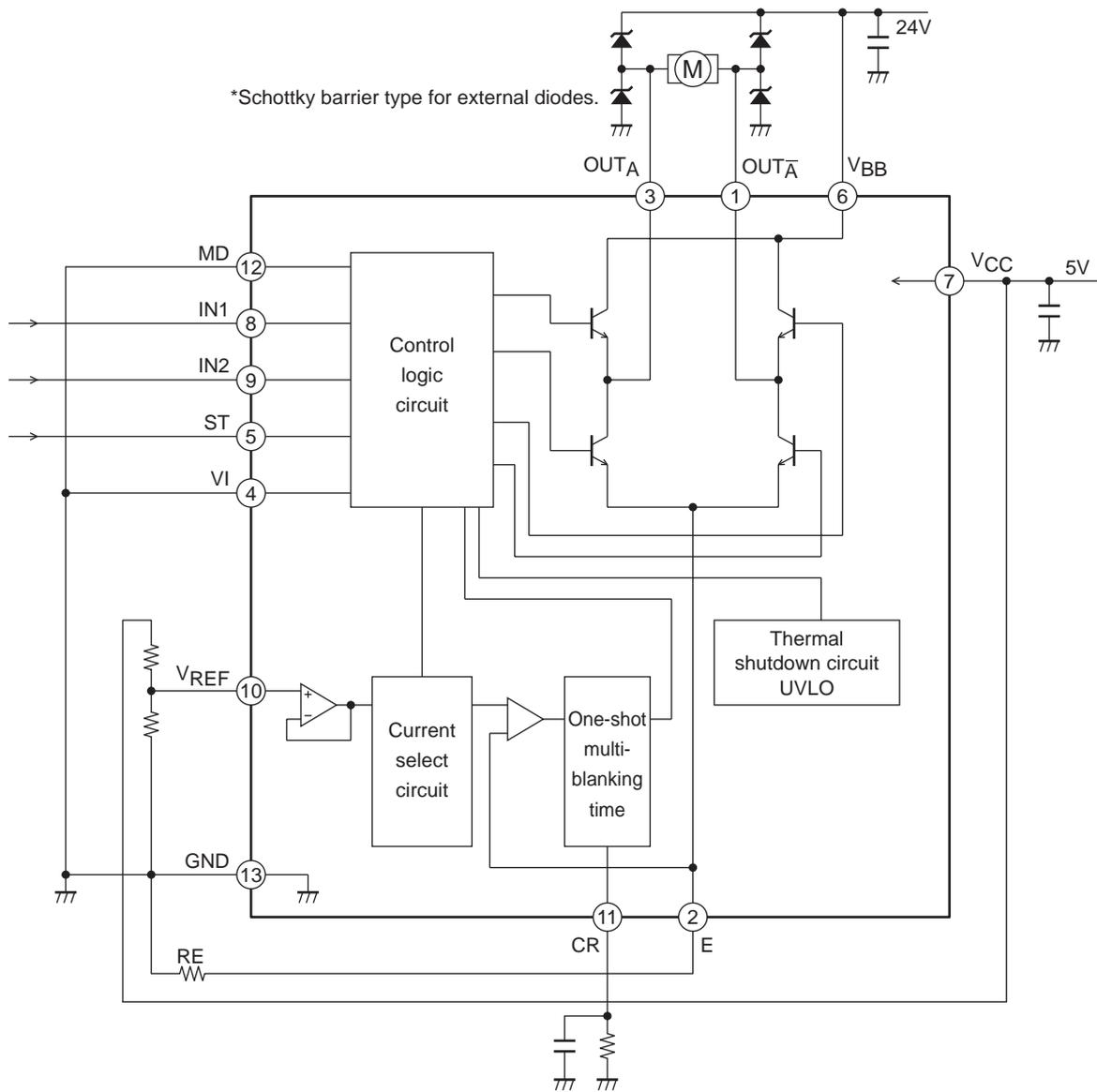
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## Pin Function

Pin No.	Pin name	Function	Equivalent circuit
1 3	OUT <sub>A</sub> OUT <sub>A</sub>	Output pin.	
2	E	Sense voltage control pin.	
4	VI	High: sense voltage is 2/5 of V <sub>REF</sub> Low: sense voltage is 1/5 of V <sub>REF</sub>	
5	ST	High: circuit operation ON Low: standby mode	
8	IN1	High: rotation mode Low: brake mode	
9	IN2	High: reverse mode Low: forward mode	
6	V <sub>BB</sub>	Motor power supply voltage.	
7	V <sub>CC</sub>	Logic power supply voltage.	
10	V <sub>REF</sub>	Output current setting reference pin. Setting range: 0 to (V <sub>CC</sub> -2V)	
11	CR	Oscillator with self-excitation.	
12	MD	Current attenuation switching pin. Low : FAST DECAY High: SLOW DECAY M : MIX DECAY M is set by external power supply voltage. Range : 1.1 to 4.0V	
13	GND	Ground pin	

Sample Application Circuits

1. Forward/reverse motor with current limiter



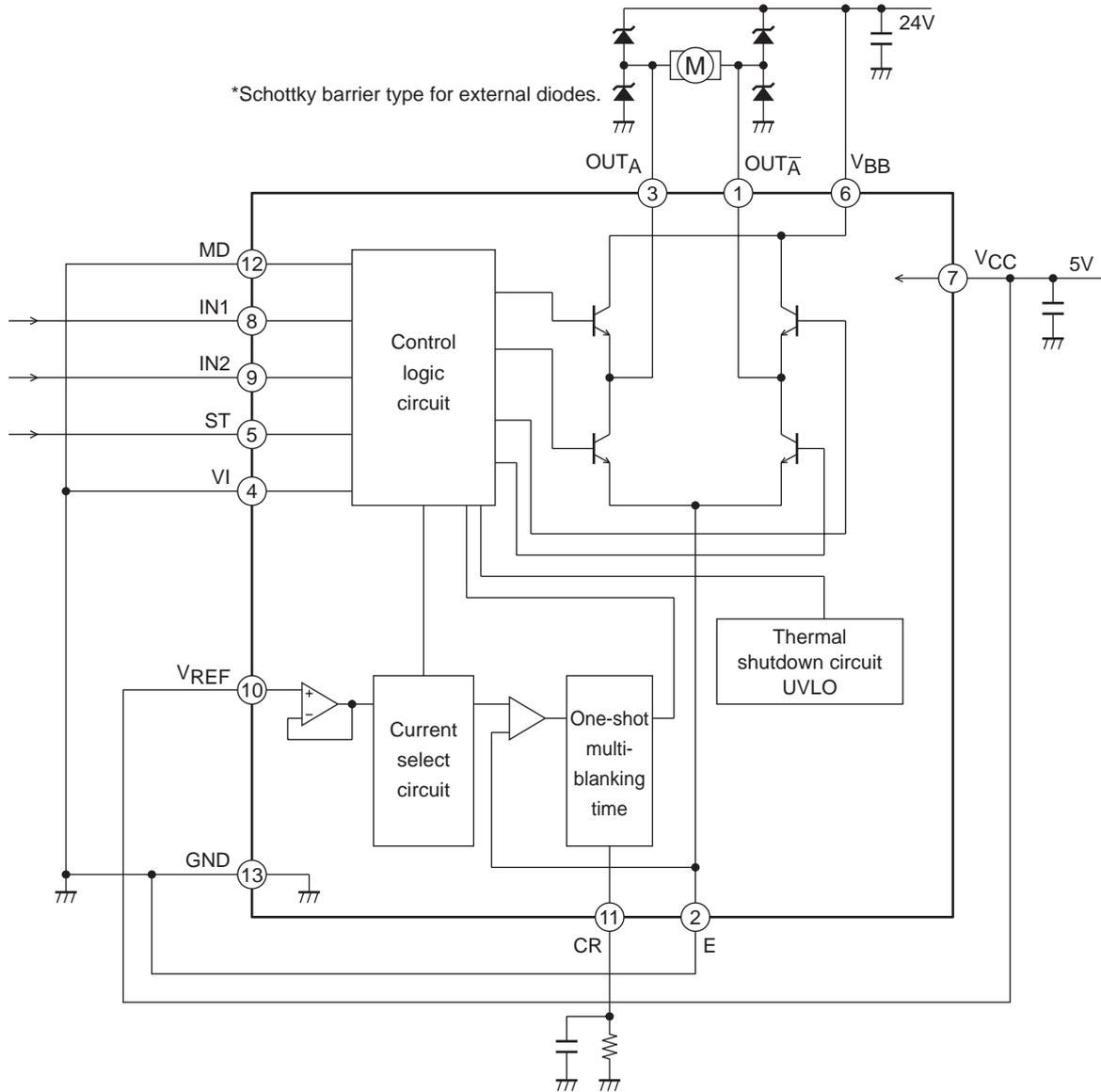
Limiter current setting method

$$I = V_{REF} / (5 \times RE)$$

IN1	IN2	ST	OUT <sub>A</sub>	OUT <sub>A</sub> <sup>̄</sup>	Mode
H	L	H	H	L	Forward
H	H	H	L	H	Reverse
L	H	H	L	L	Brake
L	L	H	OFF	OFF	Output OFF
-	-	L	OFF	OFF	Standby mode

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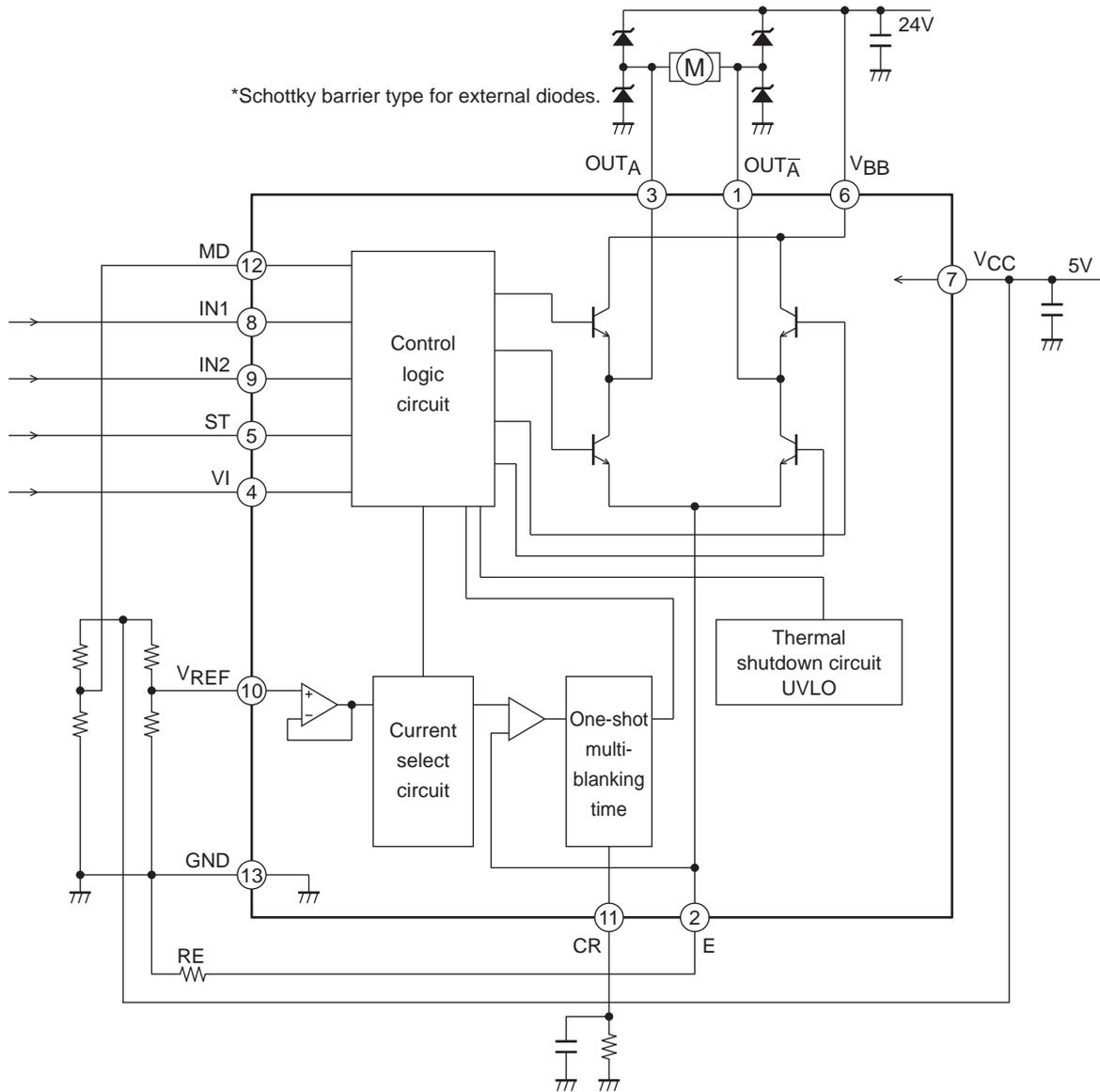
## 2. Forward/reverse motor



IN1	IN2	ST	OUT <sub>A</sub>	OUT <sub>A</sub> <sup>̄</sup>	Mode
H	L	H	H	L	Forward
H	H	H	L	H	Reverse
L	H	H	L	L	Brake
L	L	H	OFF	OFF	Output OFF
-	-	L	OFF	OFF	Standby mode

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## 3. PWM current control forward/reverse motor (MIX DECAY)



Notes on Usage

1. VREF pin

Because the VREF pin serves for input of the set current reference voltage, precautions against noise must be taken.

2. GND pin

The ground circuit for this IC must be designed so as to allow for high-current switching. Blocks where high current flows must use low-impedance patterns and must be removed from small-signal lines. Especially the ground connection for the sensing resistor RE at pin E, and the ground connection for the Schottky barrier diodes should be in close proximity to the IC ground.

The capacitors between VCC and ground, and VBB and ground should be placed close to the VCC and VBB pins, respectively.

3. CR pin setting (Switching off time, Noise cancel time)

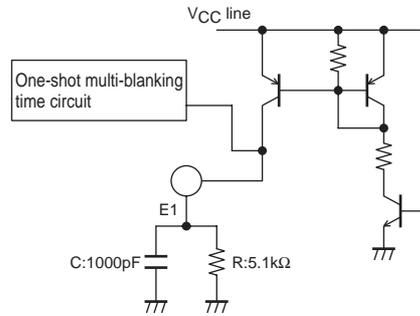
The noise cancel time (Tn) and the switching off time (Toff) are set by the following expressions:

$$\text{Noise cancel time: } T_n \approx C \times R \times \ln \{ (1.0 - RI) / (4.0 - RI) \} \text{ [sec]}$$

CR charge current: 1.3mA

$$\text{Switching off time: } T_{off} \approx -C \times R \times \ln (1.0 / 4.8) \text{ [sec]}$$

Internal configuration at CR pin



CR constant range: R = 4.7k to 100kΩ

C = 330pF to 2200pF

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