LB1947VC

Monolithic Digital IC
PWM Current Control Type
Forward/Reverse Motor Driver

ON Semiconductor®

http://onsemi.com

Overview

The LB1947VC is a PWM current control type forward/reverse motor driver IC. The IC is optimal for use in driving brushed DC motors for printers.

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 Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum motor supply voltage	V_{BB} max		50	V
Output peak current	I_O peak	$t_w \leq 20\mu s$	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	Pd max	Independent IC	1.3	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.

Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

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.

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Allowable Operating Ranges at Ta = 25°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 Ta = 25°C, V_{CC} = 5V

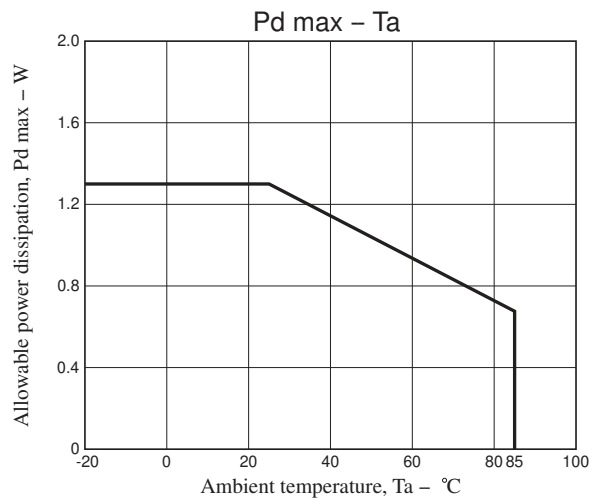| Parameter	Symbol	Conditions	min	typ	max	Unit
Output Block						
Output stage supply current	I_{BB} ON	No-load state, Forward	0.4	0.6	1.0	mA
	I_{BB} BR	No-load state, Brake	0.2	0.4	0.8	mA
	I_{BB} OFF	No-load state, Output off	0.2	0.4	0.8	mA
	I_{BB} wt	No-load state, Standby mode			0.1	mA
Output saturation voltage	$V_O$sat1	I_O = +1.0A, Sink		1.2	1.5	V
	$V_O$sat2	I_O = +2.0A, Sink		1.6	1.9	V
	$V_O$sat3	I_O = -1.0A, Source		1.8	2.2	V
	$V_O$sat4	I_O = -2.0A, Source		2.1	2.4	V
Output leak current	I_O1(leak)	V_O = V_{BB}, Sink			50	μA
	I_O2(leak)	V_O = 0V, Source	-50			μA
Output sustain voltage	V_{SUS}	L = 3.9mH, I_O = 2.0A, Design guarantee value*	50			V
Logic Block						
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
Logic pin input voltage (ST, IN1, IN2, VI)	V_{IN}H	High level voltage	2			V
	V_{IN}L	Low level voltage			0.8	V
Logic pin input current (ST, IN1, IN2, VI)	I_{IN}H	V_{IN} = 5V	60	90	120	μA
	I_{IN}L	V_{IN} = 0.8V	6	10	13	μA
Sensing voltage	V_E		0		1.1	V
Sensing voltage 25H	$V_{EH}25$	VI = High, V_{REF} = 2.5V	0.970	1.0	1.030	V
Sensing voltage 25L	$V_{EL}25$	VI = Low, V_{REF} = 2.5V	0.483	0.5	0.513	V
Sensing voltage 15H	$V_{EH}15$	VI = High, V_{REF} = 1.5V	0.385	0.4	0.410	V
Sensing voltage 15L	$V_{EL}15$	VI = Low, V_{REF} = 1.5V	0.190	0.2	0.210	V
Sensing voltage 05H	$V_{EH}05$	VI = High, V_{REF} = 0.5V	0.190	0.2	0.210	V
Sensing voltage 05L	$V_{EL}05$	VI = Low, V_{REF} = 0.5V	0.092	0.1	0.108	V
Reference current	Iref	V_{REF} = 1.0V	-0.5		+0.5	μA
CR pin current	I_{CR}	CR = 1.0V	-1.56	-1.3	-1.04	mA
MD pin input voltage	V_{MD}H	High level voltage	V_{CC}-0.3			V
	V_{MD}M	Middle level voltage	$0.3V_{CC}$		V_{CC}-1.0	V
	V_{MD}L	Low level voltage			.0.4	V
MD pin input current	I_{MD}H	MD = V_{CC}-0.5V, CR = 1.0V	-1.0		+1.0	μA
	I_{MD}L	MD = 0.4V, CR = 2.0V	-5.0			μA
Thermal shutdown temperature	TSD	Design guarantee value*		170		°C

* Design guarantee value, Do not measurement.

Package Dimensions

unit : mm (typ)

3336

HEAT SPREADER

HZIP15

Pd max – Ta

Pin Assignment

LB1947VC

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

OUT A | E | OUT A | VI | NC | ST | V_{BB} | V_{CC} | IN1 | IN2 | NC | V_{REF} | CR | MD | GND
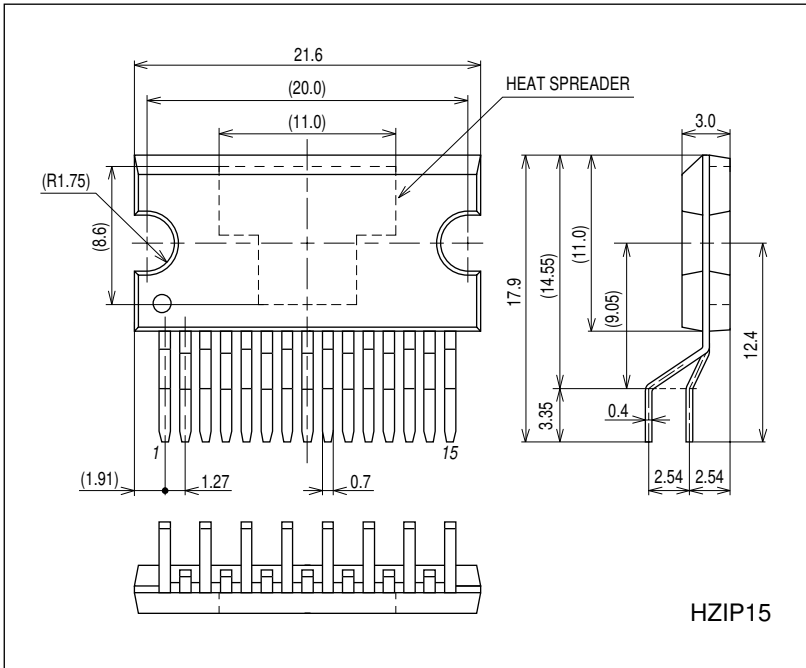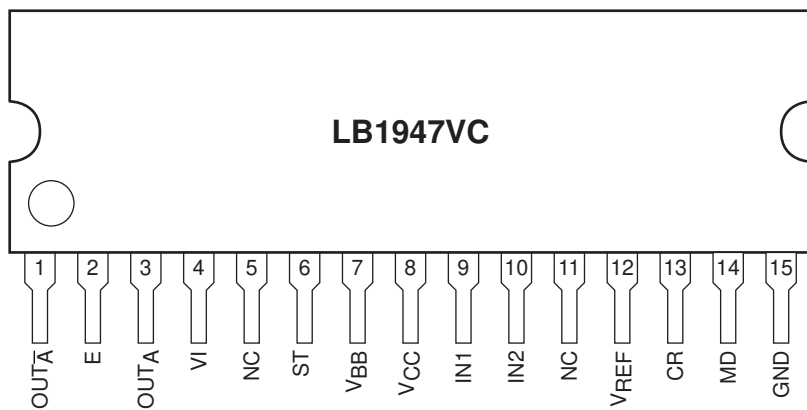
Top view

Block Diagram
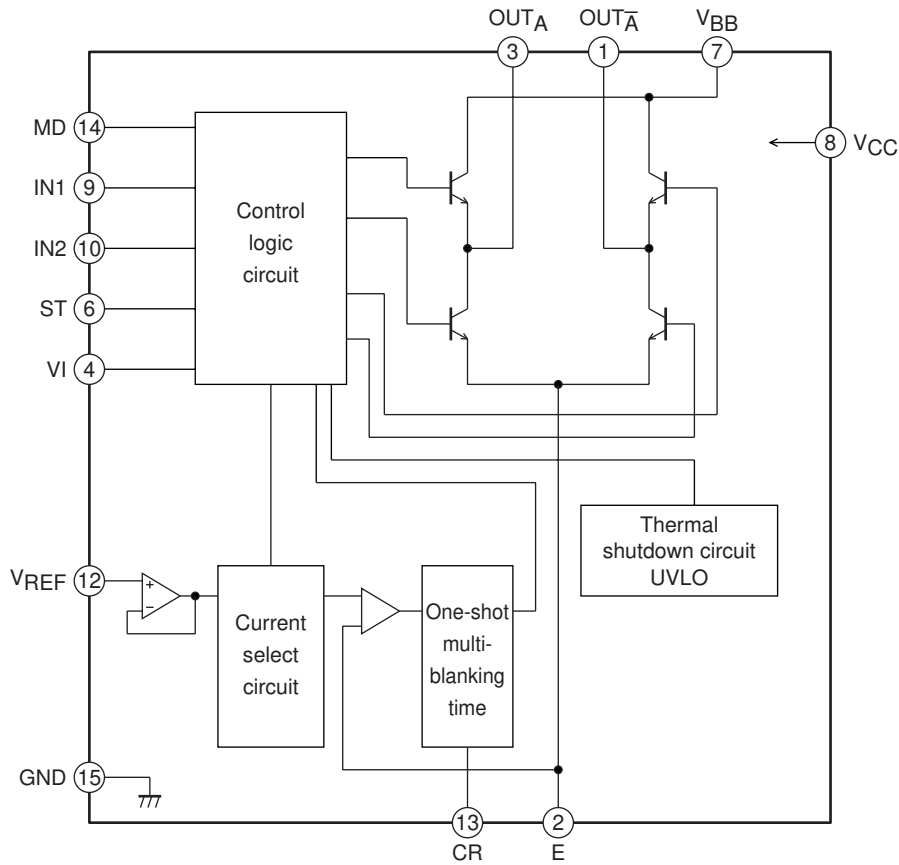
Truth Table

IN1	IN2	ST	VI	MD	OUT$_A$	OUT$_{\overline{A}}$	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.

Pin Function

Pin No.	Pin name	Function	Equivalent circuit
1 3	OUT$\overline{A}$ OUT$_A$	Output pin.	
2	E	Sense voltage control pin.	
4	VI	High: sense voltage is 2/5 of V_{REF} Low: sense voltage is 1/5 of V_{REF}	
6	ST	High: circuit operation ON Low: standby mode	
9	IN1	High: rotation mode Low: brake mode	
10	IN2	High: reverse mode Low: forward mode	
7	V_{BB}	Motor power supply voltage.	
8	V_{CC}	Logic power supply voltage.	
12	V_{REF}	Output current setting reference pin. Setting range: 0 to (V_{CC}−2V)	
13	CR	Oscillator with self-excitation.	
14	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	
15	GND	Ground pin	
5, 11	NC	No connect	

Sample Application Circuits

1. Forward/reverse motor with current limiter

*Schottky barrier type for external diodes.
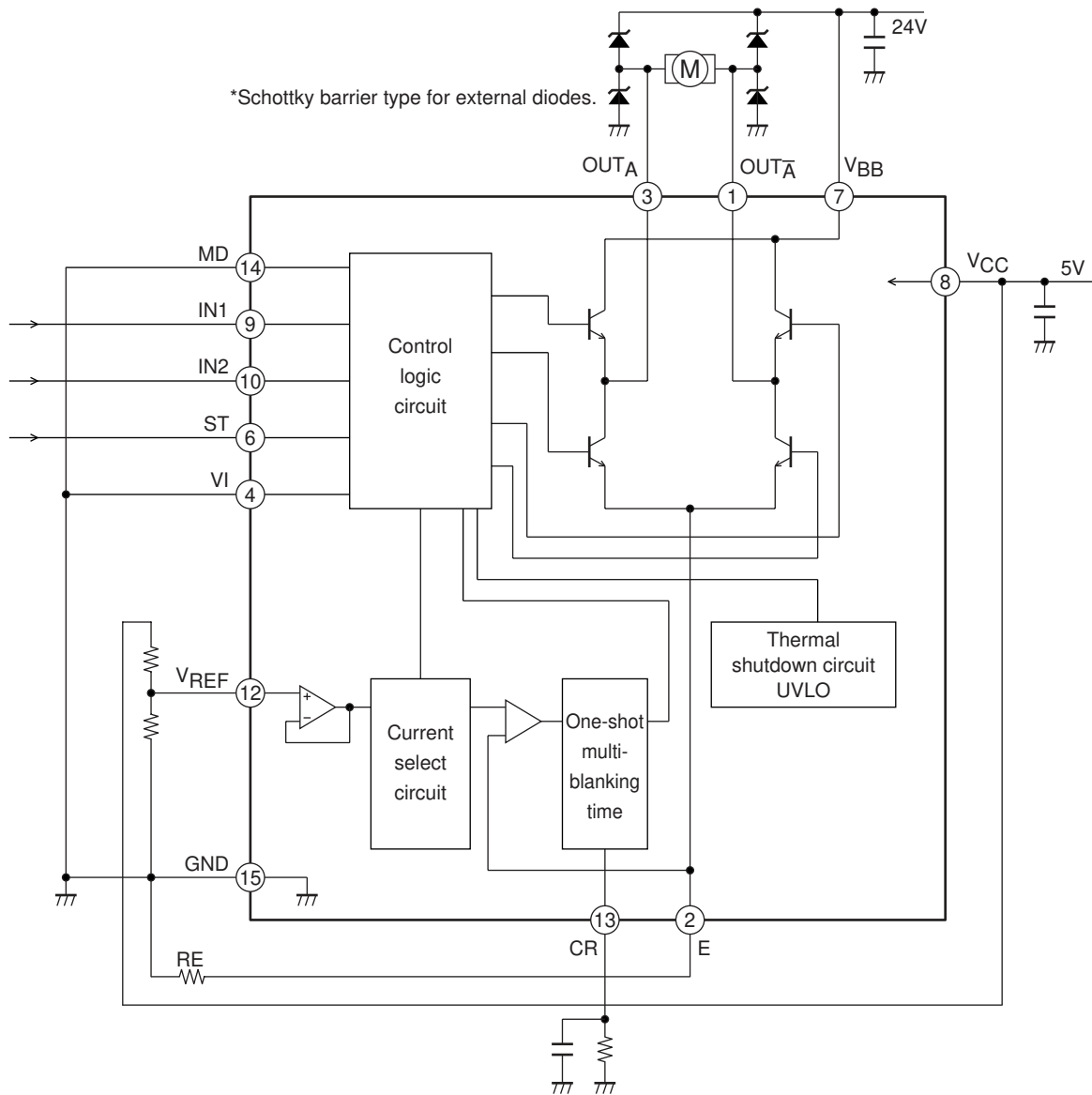
Limiter current setting method $I = V_{REF} / (5 \times RE)$

IN1	IN2	ST	OUT$_A$	OUT$_{\overline{A}}$	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

2. Forward/reverse motor
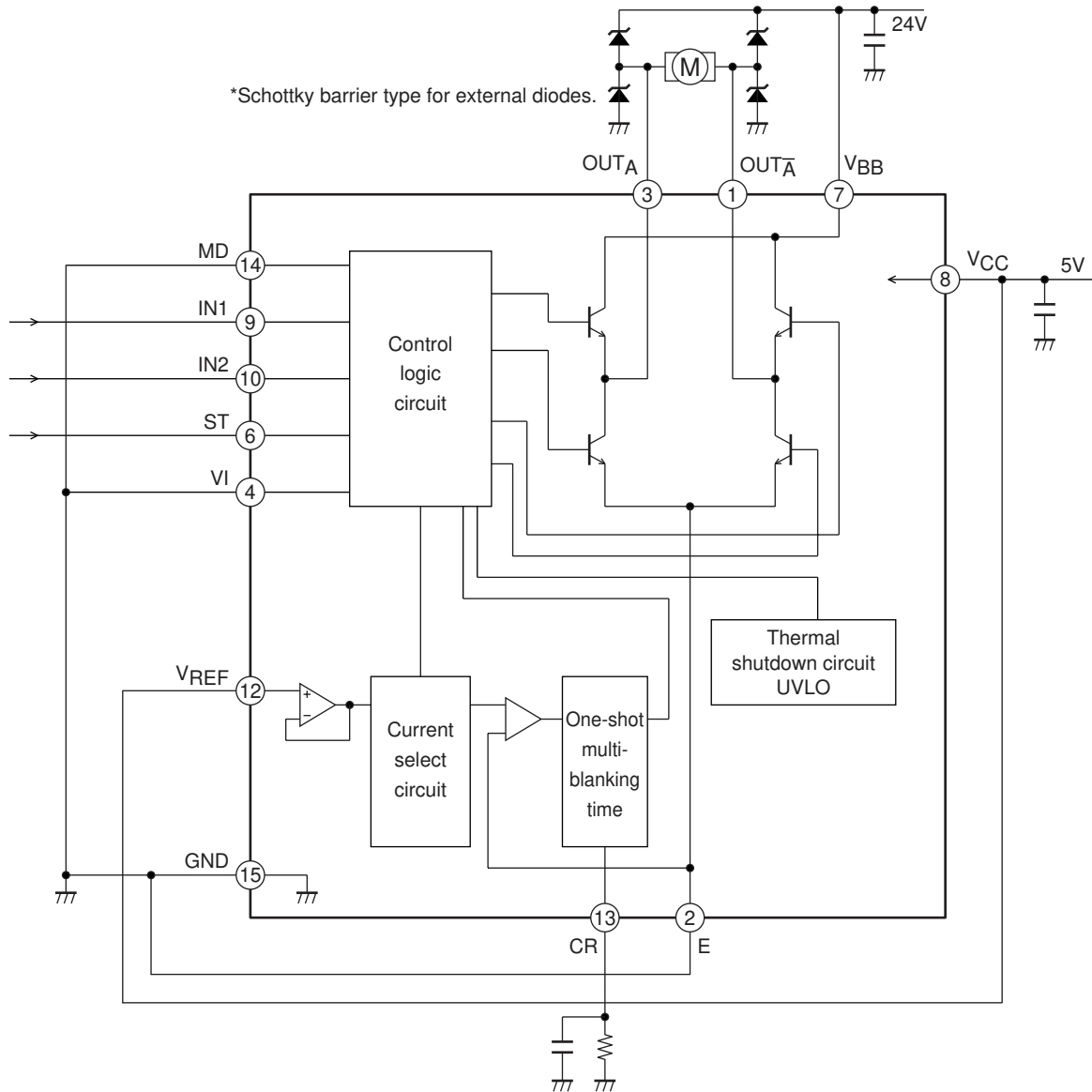
*Schottky barrier type for external diodes.

IN1	IN2	ST	OUT$_A$	OUT$_{\overline{A}}$	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

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

*Schottky barrier type for external diodes.
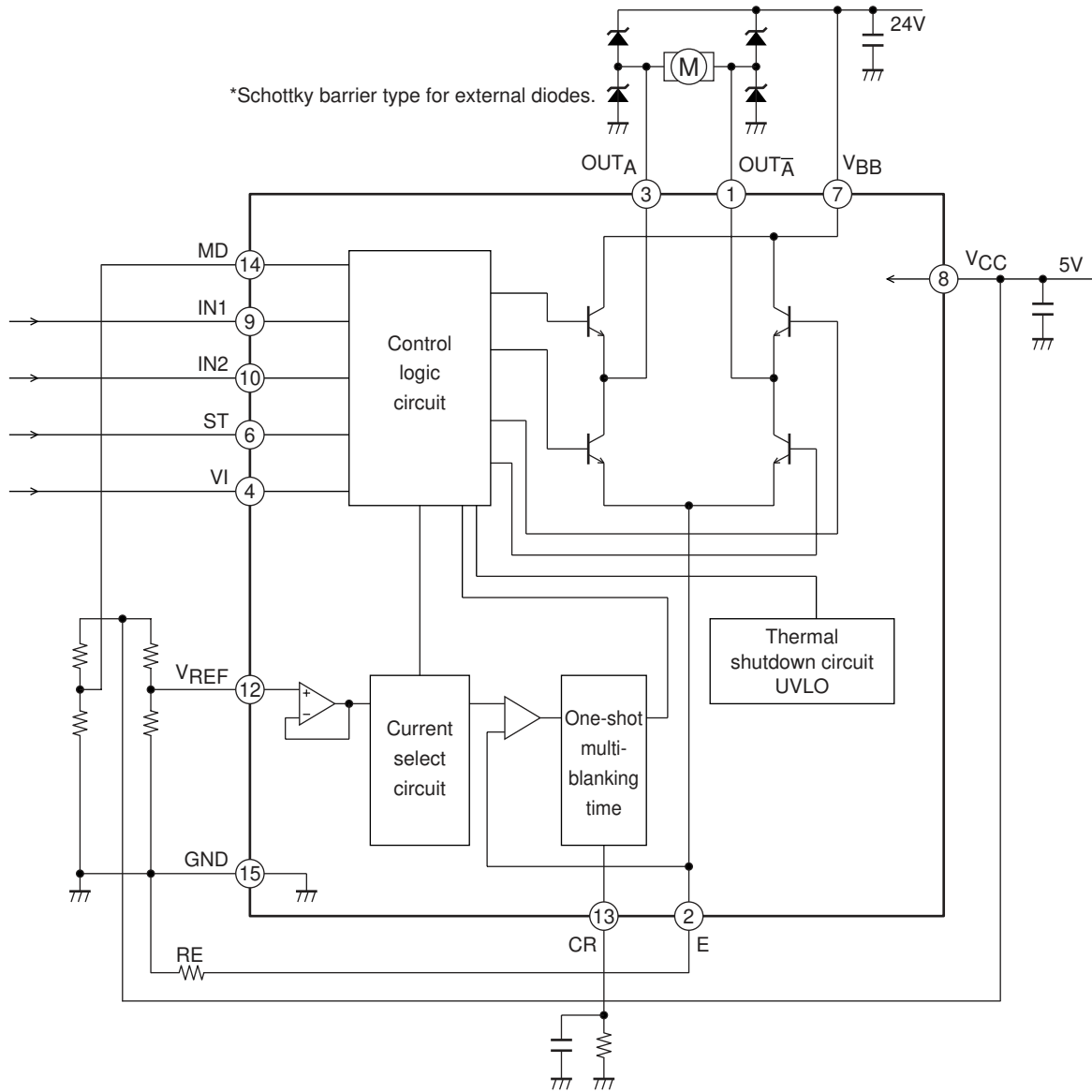
Notes on Usage

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 V_{CC} and ground, and V_{BB} and ground should be placed close to the V_{CC} and V_{BB} 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:

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

   CR charge current: 1.3mA

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

Internal configuration at CR pin
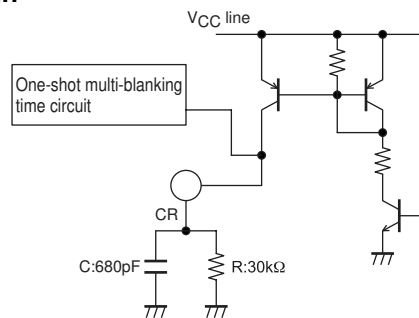
CR constant range: R = 4.7k to 100kΩ
C = 330pF to 2200pF

Heat sink attachment

Heat sinks are used to lower the semiconductor device junction temperature by leading the head generated by the device to the outer environment and dissipating that heat.

a. Unless otherwise specified, for power ICs with tabs and power ICs with attached heat sinks, solder must not be applied to the heat sink or tabs.

b. Heat sink attachment
   · Use flat-head screws to attach heat sinks.
   · Use also washer to protect the package.
   · Use tightening torques in the ranges 39-59Ncm(4-6kgcm) .
   · If tapping screws are used, do not use screws with a diameter larger than the holes in the semiconductor device itself.
   · Do not make gap, dust, or other contaminants to get between the semiconductor device and the tab or heat sink.
   · Take care a position of via hole .
   · Do not allow dirt, dust, or other contaminants to get between the semiconductor device and the tab or heat sink.
   · Verify that there are no press burrs or screw-hole burrs on the heat sink.
   · Warping in heat sinks and printed circuit boards must be no more than 0.05 mm between screw holes, for either concave or convex warping.
   · Twisting must be limited to under 0.05 mm.
   · Heat sink and semiconductor device are mounted in parallel. Take care of electric or compressed air drivers
   · The speed of these torque wrenches should never exceed 700 rpm, and should typically be about 400 rpm.
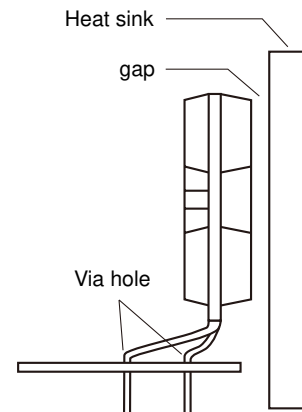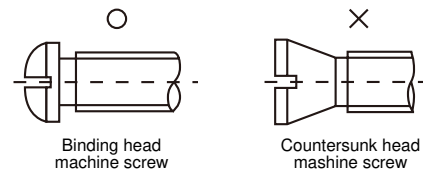
c. Silicone grease
   · Spread the silicone grease evenly when mounting heat sinks.
   · Our recommends YG-6260 (Momentive Performance Materials Japan LLC)

d. Mount
   · First mount the heat sink on the semiconductor device, and then mount that assembly on the printed circuit board.
   · When attaching a heat sink after mounting a semiconductor device into the printed circuit board, when tightening up a heat sink with the screw, the mechanical stress which is impossible to the semiconductor device and the pin doesn't hang.

e. When mounting the semiconductor device to the heat sink using jigs, etc.,
   · Take care not to allow the device to ride onto the jig or positioning dowel.
   · Design the jig so that no unreasonable mechanical stress is not applied to the semiconductor device.

f. Heat sink screw holes
   · Be sure that chamfering and shear drop of heat sinks must not be larger than the diameter of screw head used.
   · When using nuts, do not make the heat sink hole diameters larger than the diameter of the head of the screws used. A hole diameter about 15% larger than the diameter of the screw is desirable.
   · When tap screws are used, be sure that the diameter of the holes in the heat sink are not too small. A diameter about 15% smaller than the diameter of the screw is desirable.

g. There is a method to mount the semiconductor device to the heat sink by using a spring band. But this method is not recommended because of possible displacement due to fluctuation of the spring force with time or vibration.

○ ×

Binding head machine screw

Countersunk head mashine screw

Heat sink

gap

Via hole