Ordering number : ENN7318

Monolithic Digital IC

LB11947

PWM Current Control DC Motor Driver/ 5 V Switching Regulator

Overview

The LB11947 is a PWM current control DC motor driver with 5-V switching regulator. This IC can simultaneously drive two DC motors. It is especially suitable for the applications of DC motors that control motor speed with direct PWM technique using external control signals.

Functions

(DC motor drive)

- Driving two DC motors
- External PWM control function
- Internal PWM current control (OFF time fixed)
- Current decay switching function (SLOW DECAY and FAST DECAY modes)
- Noise canceling function
- Output Tr upper diode incorporated (with external lower side Schottky diode)
- Thermal shutdown circuit incorporated (with a heat generation warning function)
- Logic low-voltage OFF circuit incorporated

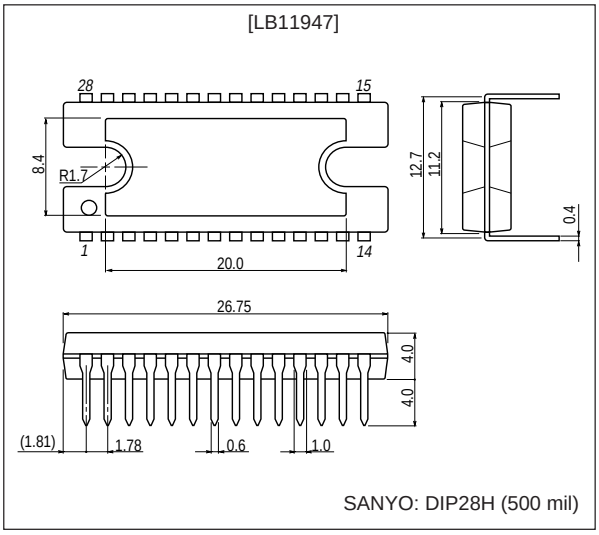
(Switching regulator)

- PWM oscillation frequency variable (external C necessary)
- Soft start function (external C necessary)
- Over-current protection function

Package Dimensions

unit: mm

3147C-DIP28H



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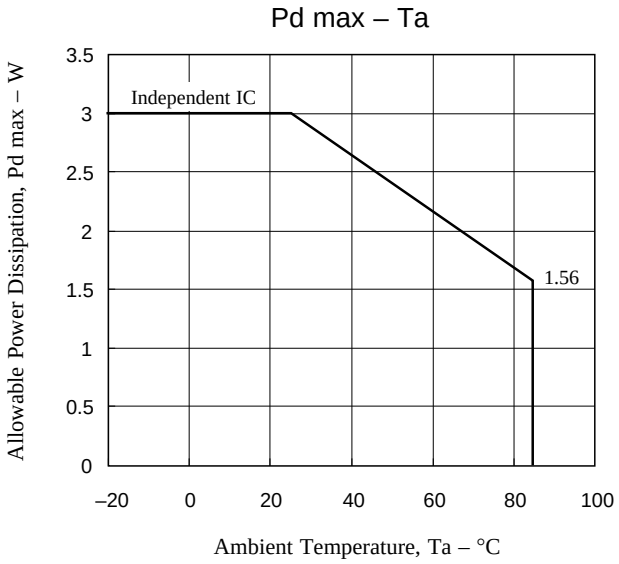
Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	VBBmax		50	V
Output peak current	IOPEAK	Tw ≤ 20μs	1.75	A
Output continuous current	Iomax		1.5	A
Logic input voltage range	VIN		–0.3 to V_{CC} + 0.3	V
Emitter output maximum voltage	VEmax		1.0	V
VREF pin input voltage range	VREF	PWM = "L", Motor driver not operating	–0.3 to V_{CC} + 0.3	V
Operating temperature	Topr		–20 to +85	°C
Storage temperature	Tstg		–55 to +150	°C
Allowable internal loss	Pdmax	Independent IC	3.0	W

Recommended Operating Conditions at Ta = 25°C

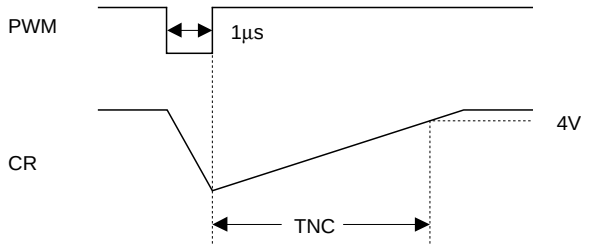
Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	VBB		10 to 45	V
Reference voltage	VREF		0.0 to 3.0	V
OSC oscillation frequency	fosc		50 to 100	kHz



Electrical Characteristics at Ta = 25°C, VBB = 45 V, VREF = 1.0 V

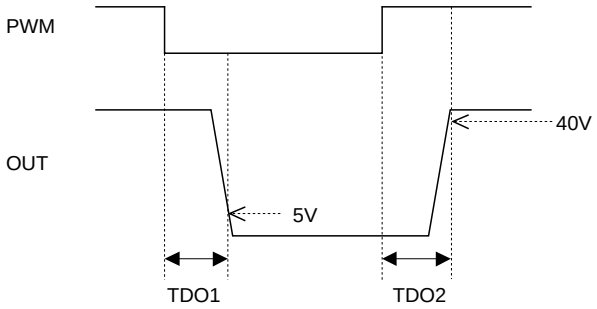
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Standby current dissipation	IBB ST	ST = L	3	4.5	6	mA
Operating current dissipation	IBB ON	ST = H, Motor driver no-load	7	10	13	mA
Motor Driver Block						
Output saturation voltage 1	VOSAT 1	I_O = +1.0 A, sink		1.2	1.5	V
Output saturation voltage 2	VOSAT 2	I_O = +1.5 A, sink		1.5	1.8	V
Output saturation voltage 3	VOSAT 3	I_O = –1.0 A, source		1.9	2.3	V
Output saturation voltage 4	VOSAT 4	I_O = –1.5 A, source		2.2	2.5	V
Output leak current	I_O1 (leak)	ST = 0 V, V_O = VBB, sink			50	µA
	I_O2 (leak)	ST = 0 V, V_O = 0 V, source	–50			µA
Output sustaining voltage	VSUS	L = 26.6 mH, I_O = 1.5 A *1	50			V
Logic input voltage (PWM,PHASE,MD,ST)	VIH	Ta = 25°C	2			V
	VIL	Ta = 25°C			0.8	V
	VIHT	Ta = –20 to 85°C *1	2			V
	VILT	Ta = –20 to 85°C *1			0.8	V
Logic input current (PWM,PHASE,MD,ST)	IIH	VIH = V_{CC}	60	90	120	µA
	IIL	VIL = 0.8 V	5	10	15	µA
	IIHT	VIH = V_{CC}, Ta = –20 to 85°C *1	40		150	µA
	IILT	VIH = 0.8 V, Ta = –20 to 85°C *1	3		20	µA
Sense voltage	VE25	VREF = 2.5 V	0.483	0.5	0.513	V
	VE10	VREF = 1.0 V	0.190	0.2	0.210	V
	VE05	VREF = 0.5 V	0.092	0.1	0.108	V
Reference current	Iref	Vref = 1.0 V	–0.5		0.5	µA
CR pin current	ICR	CR = 1.0 V	–1.38	–1.15	–0.92	mA
Minimum noise cancel time	tNC	C = 2200pF, R = 16 kΩ *2	5			µs
Output delay time	tDO	PWM → output delay time *3			1.2	µs
	tDOT	Ta = –20 to 85°C *1			1.2	µs
Measurement of through current	ITR	Pulse width of 500 ns or more *4			1	A
Logic OFF voltage	VLSDOFF		6.4	8	9.6	V
LVSD hysteresis width	VLHIS		0.77	1.1	1.43	V
TEO pin saturation voltage	VsatTEO	Iload = –3 mA, Ta = 150°C *1			0.45	V
Heat-generation warning temperature	TE	*1		135		°C
Thermal shutdown temperature	TSD	*1		180		°C
Switching Regulator Block						
Output voltage	V_{CC}		4.85	5.0	5.15	V
Fluctuation of supply voltage	ΔV_{CC}1	VBB = 10 to 45 V			50	mV
Load fluctuation	ΔV_{CC}2	I_O = 0 to 0.5 A			50	mV
Output over-current Detection threshold voltage	VtIP		0.45	0.5	0.55	V
Over-current detection delay time	TdIP	fosc = 50kHz		80		µs
OSC pin charge current	Icosc	V(OSC) = 1.0 V	–24	–20	–16	µA
OSC pin discharge current	Idosc	V(OSC) = 2.5 V	16	20	24	µA
OSC maximum oscillation frequency	Foscmax				100	kHz
Soft start charge current	Iss	V(CSS) = 0 V	2	3	4	µA

* Note 1: Design guarantee
* Note 2: Measurement of minimum noise canceling time



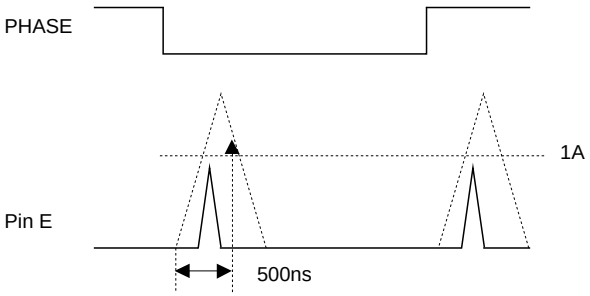
VM = 45 V, VREF = 2.5 V, C = 2200pF, R = 16 kΩ
Enter the PWM "L" pulse width of 1µs and measure the time TNC from PWM rise to the CR pin voltage of 4 V.

* Note 3: Output delay time measurement



VM = 45 V, PH = "H", CR = 0V
Measure the time TDO1 from PWM = "H" → "L" fall to the output fall to 5 V and TDO2 from PWM = "L" → "H" rise to the output rise to 40 V. Measure these times for OUTA, OUTAB, OUTB, and OUTBB respectively.

* Note 4: Measurement of through current

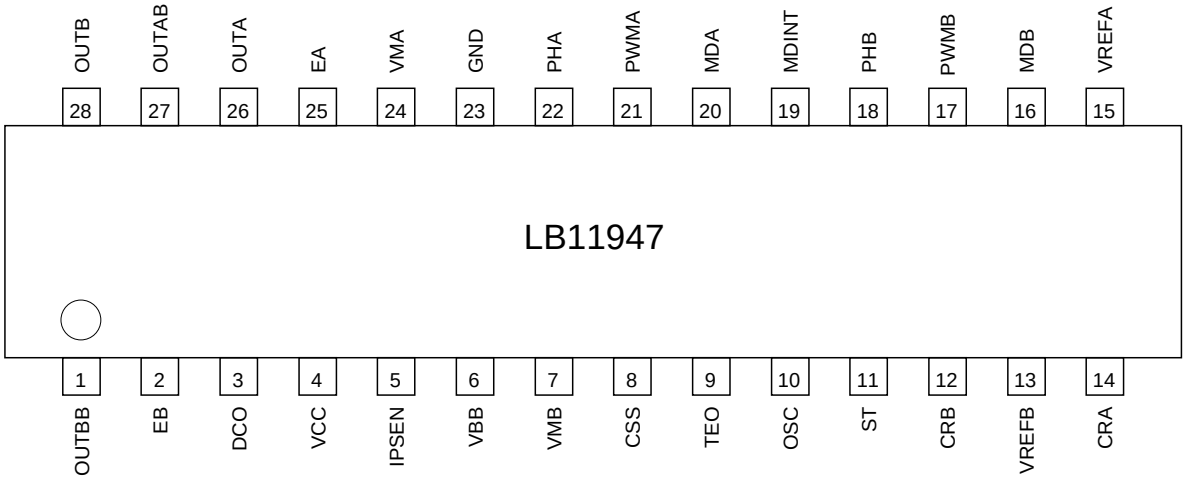


Measure the current flowing to pin E during phase switching of "H" → "L" and "L" → "H" after its conversion to the voltage with a detection resistor.
The current exceeding the current value of 1A at the pulse width of 500 ns or more is judged to be NG as the through current.

Pin functions description

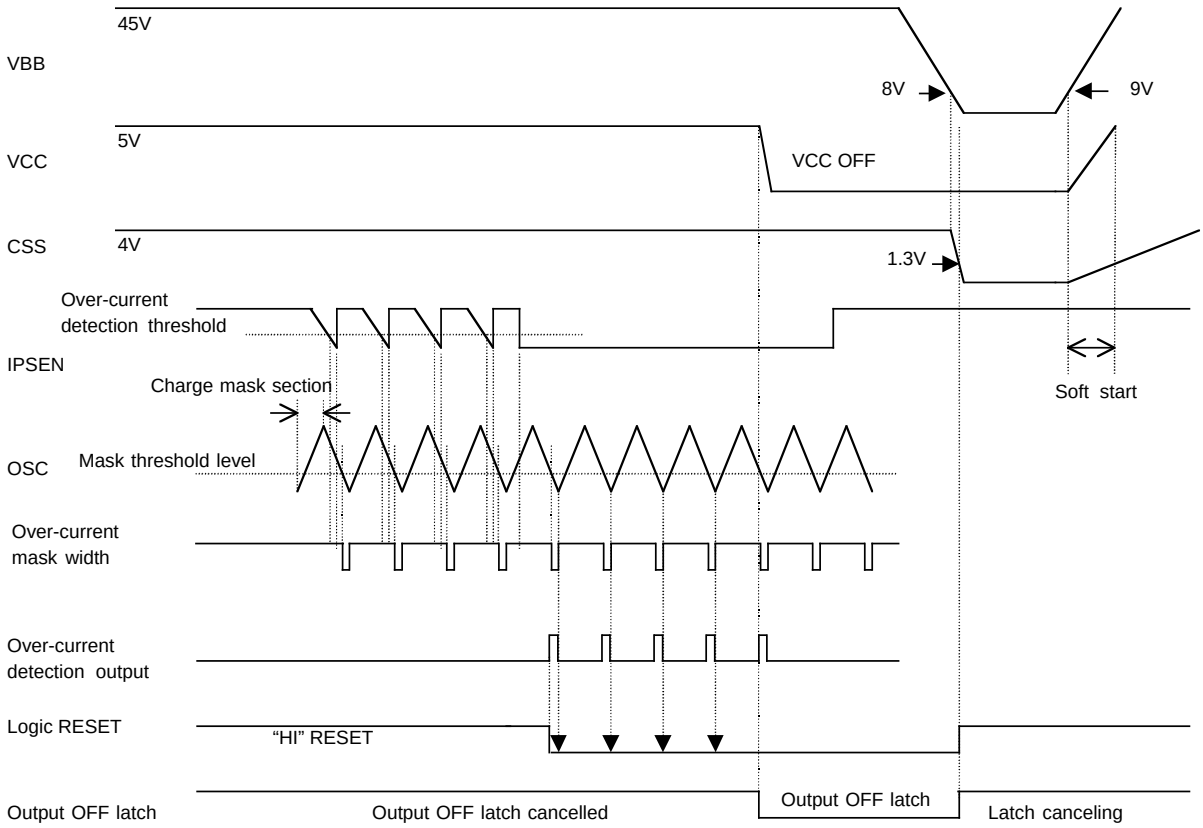
Pin Name	Pin No.	Functions
OUTBB	1	DC motor, BB output pin
EB	2	DC motor Bch, current sense resistor connection pin
DCO	3	Switching regulator, control transistor output pin
VCC	4	Switching regulator, 5 V voltage output pin
IPSEN	5	Switching regulator, over-current detection resistor connection pin
VBB	6	Supply voltage connection pin
VMB	7	DC motor Bch, motor load current supply power connection pin
CSS	8	Switching regulator, soft start capacitor connection pin
TEO	9	Heat generation warning output, open collector pin
OSC	10	Switching regulator, switching frequency decesion capacitor connection pin
ST	11	DC motor, standby input pin
CRB	12	DC motor Bch, noise cancel, TOFF time setting C and R connection pin
VREFB	13	DC motor Bch, current setting reference voltage input pin
CRA	14	DC motor Ach, noise cancel, TOFF time setting C and R connection pin
VREFA	15	DC motor Ach, current setting reference voltage input pin
MDB	16	DC motor Bch, current decay mode switching pin (for PWM = “L” only)
PWMB	17	DC motor Bch, PWM input pin
PHB	18	DC motor Bch, phase switching input pin
MDINT	19	DC motor, current decay mode switching pin (for PWM = “H” only)
MDA	20	DC motor Ach, current decay mode switching pin (for PWM = “L” only)
PWMA	21	DC motor Ach, PWM input pin
PHA	22	DC motor Ach, phase switching input pin
GND	23	GND connection pin
VMA	24	DC motor Ach, motor load current supply power connection pin
EA	25	DC motor Ach, current sense resistor connection pin
OUTA	26	DC motor, A output pin
OUTAB	27	DC motor, AB output pin
OUTB	28	DC motor, B output pin

Pin Assignment



Descriptions of Each Function

(Switching regulator, over-current limit operation time chart)



The DC/DC over-current limit value is determined from the resistor connected between VBB and current sense pin.

Current limit value = 0.5(V)/RL

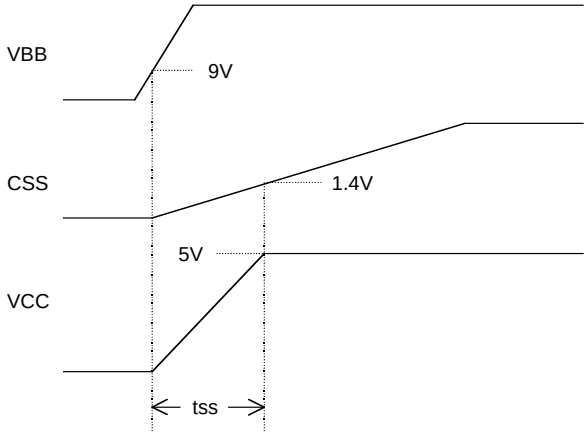
Using about 75% from the upper threshold to lower threshold of the OSC triangular oscillation waveform and using the mask circuit within the OSC charge section, the output of the over-current detection comparator is masked. This can prevent detection error due to output switching noise.

When over-current flows through the output transistor, this over-current is detected if the ON width exceeding the over-current detection threshold of IPSEN pin is more than the mask width. The counter is activated when over-current is detected. If over-current is detected further after counting of four shots of OSC oscillation frequency, the output transistor is turned OFF and latched in this condition. If no over-current is detected up to the eighth shot after counting of four shots, the over-current condition is determined to be cancelled and the counter is reset, but the output transistor is not turned OFF.

If the output transistor is latched to the OFF condition, recharge of VBB power supply causes canceling of the latch condition.

(Switching regulator, soft start function)

When the VCC output is about to rise to the target voltage of 5 V instantaneously at start of switching regulator (at VBB power ON), the IC output pulse operates with the maximum duty, causing the rush current to flow to the output transistor. It is therefore necessary to raise the VCC target voltage gradually so that the output does not operate with the maximum duty.
Connection of a capacitor between the CSS pin (pin 8) and GND allows slow rising of VCC output (soft start) when VBB power is applied.
The soft start time (tss) is approximately set by the following equation.



$tss \fallingdotseq 1.4 \times C/Iss$

tss: Soft start time	[s]
Iss: Soft start charge current	[μA]
C: CSS pin capacitor	[μF]

(Switching regulator, switching frequency set time)

The switching frequency of switching regulator is varied by changing the capacitor connected between the OSC pin (pin 10) and GND.
The switching frequency (fosc) is set approximately by the following equation. Since this equation is the approximate expression, check it in the mounted condition when it is to be used at a particularly high frequency.

$fosc \fallingdotseq \{1/C(1/Icosc+1/Idosc)\} \times 10^{-3}$

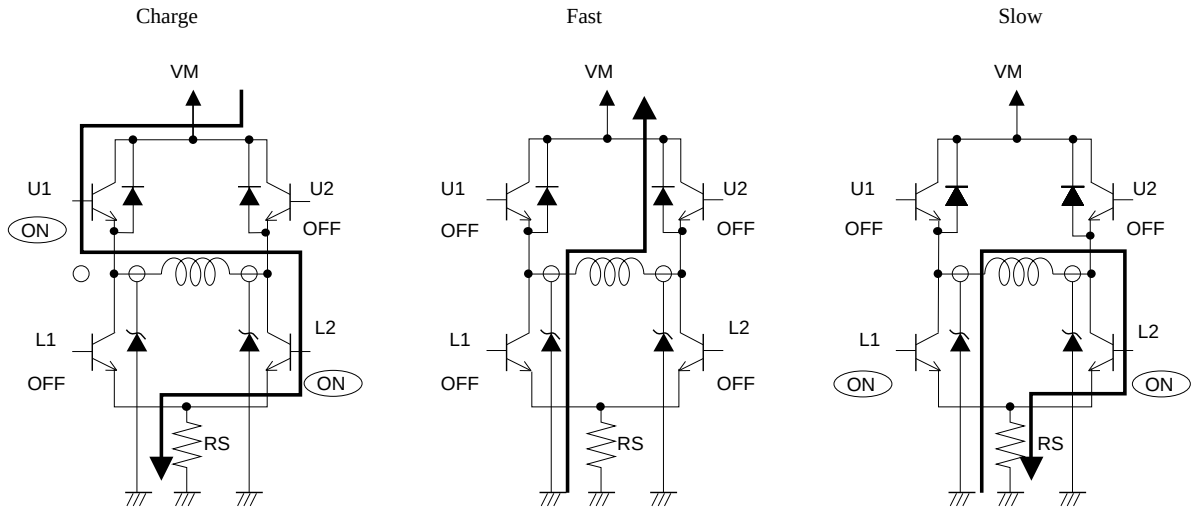
fosc: Switching frequency	[kHz]
Icosc: OSC pin charge current	[μA]
Idosc: OSC pin discharge current	[μA]
C: OSC pin capacitor	[pF]

(Motor driver, logic input truth table)

ST	PWM	MD	MDINT	PH	OUT	OUT-	Operation mode
L	*	*	*	*	OFF	OFF	Standby mode (circuit OFF)
H	H	*	H	H	H	L	SLOW (short brake) at power ON, forward rotation, and at the current limit
H	H	*	L	H	H	L	FAST (all OFF) at power ON, forward rotation, and at current limit
H	H	*	H	L	L	H	SLOW (short brake) at power ON, reverse rotation, and at current limit
H	H	*	L	L	L	H	FAST (all OFF) at power ON, reverse rotation, and at current limit
H	L	H	*	*	L	L	Current decay at SLOW (short brake)
H	L	L	*	*	OFF	OFF	Current decay at FAST (all OFF)

(*) Don't care.

(Motor driver, output stage transistor operation mode)



The figure above shows the current direction at PH = "H."
Note that the upper diode is incorporated and the lower diode is an external Schottky diode.

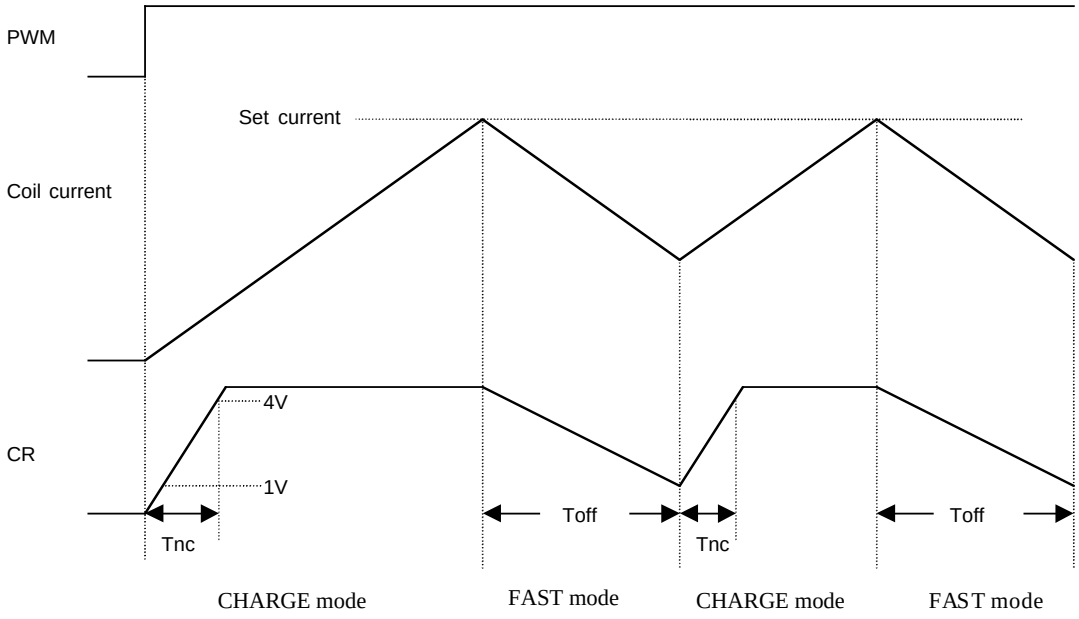
(Motor driver, output stage transistor operation function)

Mode	U1	U2	L1	L2
CHARGE(PH = "H")	ON	OFF	OFF	ON
CHARGE(PH = "L")	OFF	ON	ON	OFF
FAST	OFF	OFF	OFF	OFF
SLOW	OFF	OFF	ON	ON

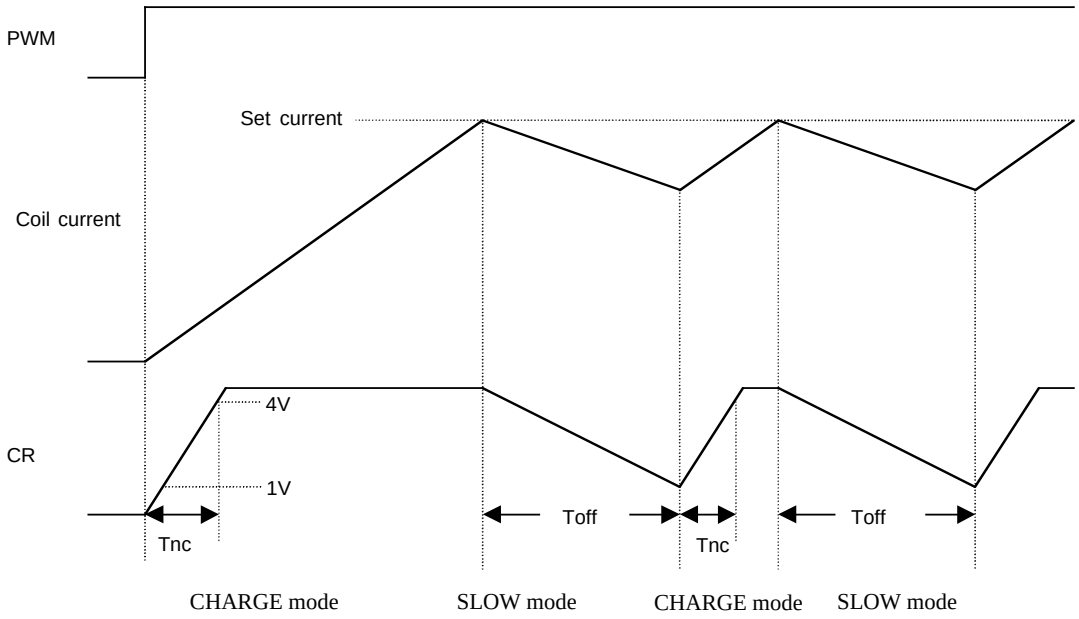
(Motor driver, internal PWM current control operation mode)

PWM current control is made, so that the peak current flowing through the motor coil with PWM = “H” does not exceed the current level swt with VREF pins (pin 15 (Ach) and pin 13 (Bch)).

<MDINT = “L” (FAST mode>



<MDINT = “H” (SLOW mode)>



Tnc: Noise canceling time [s]
Toff: Switching OFF time [s]

(Switching OFF time and noise canceling time set method)
Connection of C and R between CRA pin (pin 14), CRB pin (pin 12) and GND allows setting of the switching OFF time and noise canceling time.
The noise canceling time Tnc and switching OFF time Toff is set approximately by the following equation.
[Noise canceling time Tnc]

$$Tnc \fallingdotseq C \cdot R \cdot \ln\{(1-RI)/(4-RI)\}[s]$$

[Switching OFF time Toff]

$$Toff \fallingdotseq -C \cdot R \cdot \ln(1/4.8)\ [s]$$

I	: CR pin charge current	[A]
C	: CR pin external capacitor	[F]
R	: CR pin external resistor	[Ω]

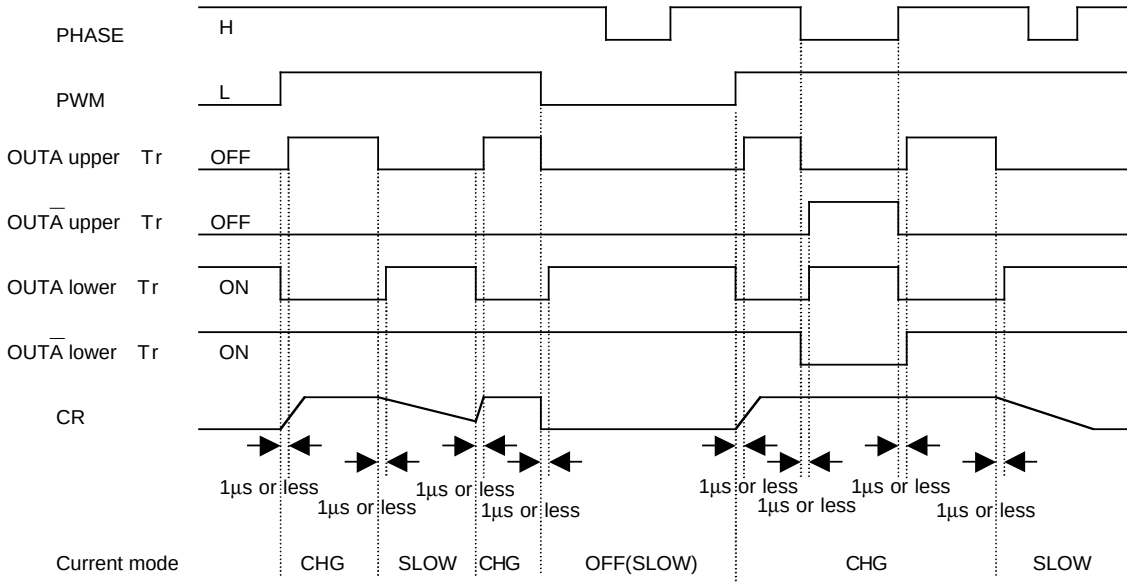
(Peak coil current set method)
The peak current value (set current) flowing through the motor coil is set by the sense resistor to sense the current connected between EA pin (pin 25), EB pin (pin 2) and GND and by the reference voltage applied to VREFA pin (pin 15) and VREFB pin (pin 13).

$$Ipeak = Vref/(5 \times Rs)$$

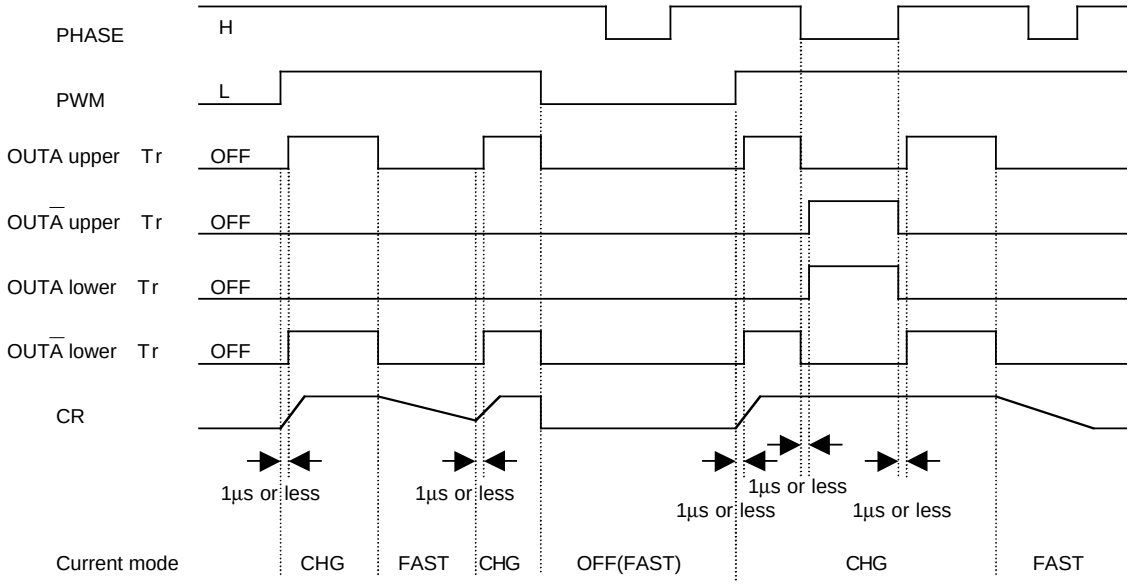
Ipeak	: Set current	[A]
Vref	: VREF pin application voltage	[V]
Rs	: Current sense resistor	[Ω]

(Motor driver, output transistor operation time chart)

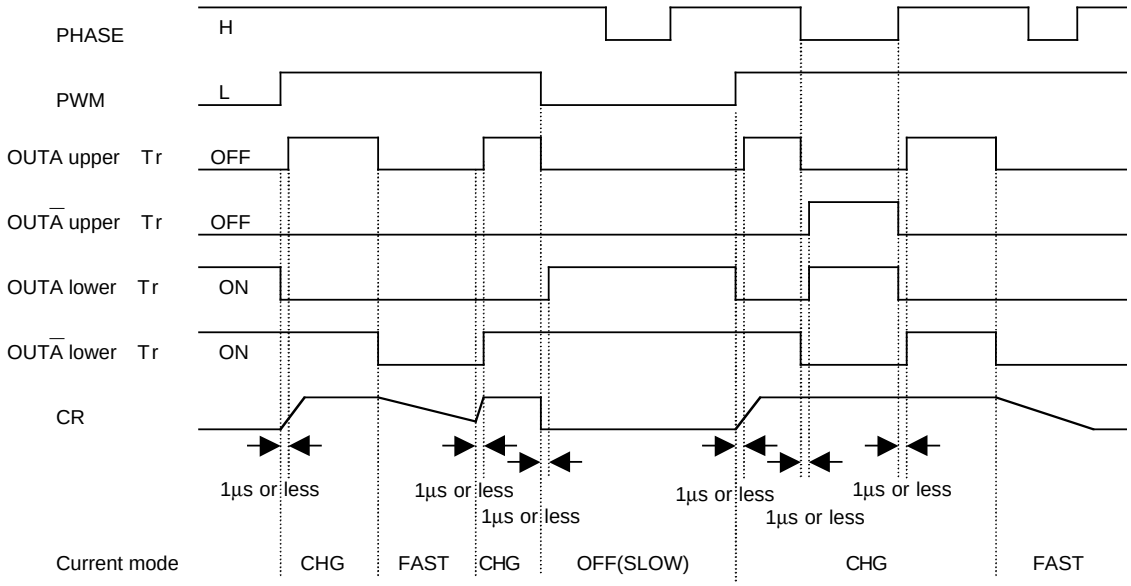
MDINT = “H”, MD = “H” (SLOW, SLOW)



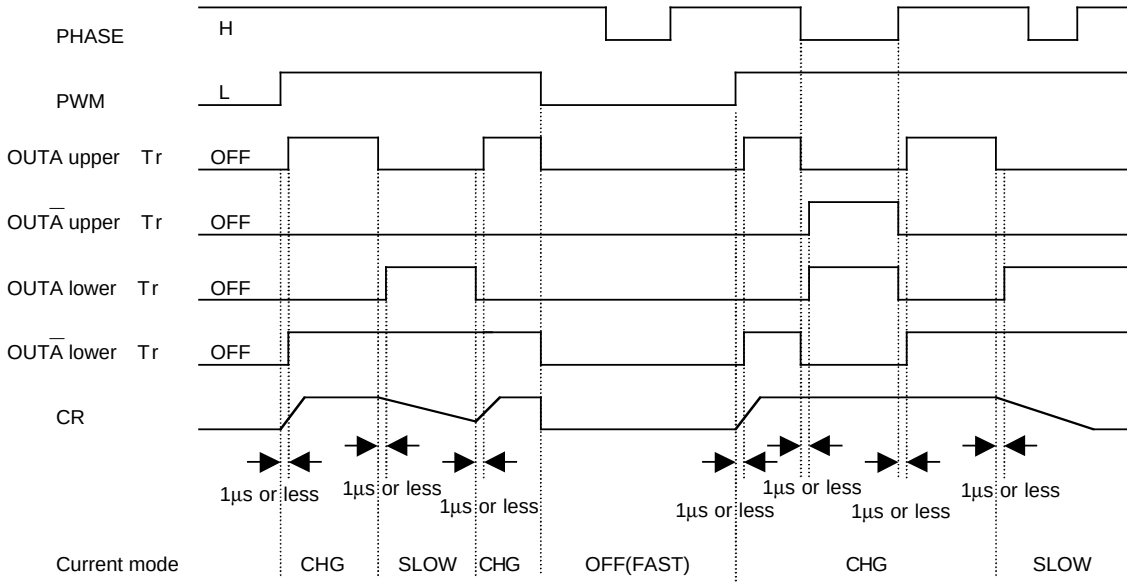
MDINT = “L”, MD = “L” (FAST, FAST)



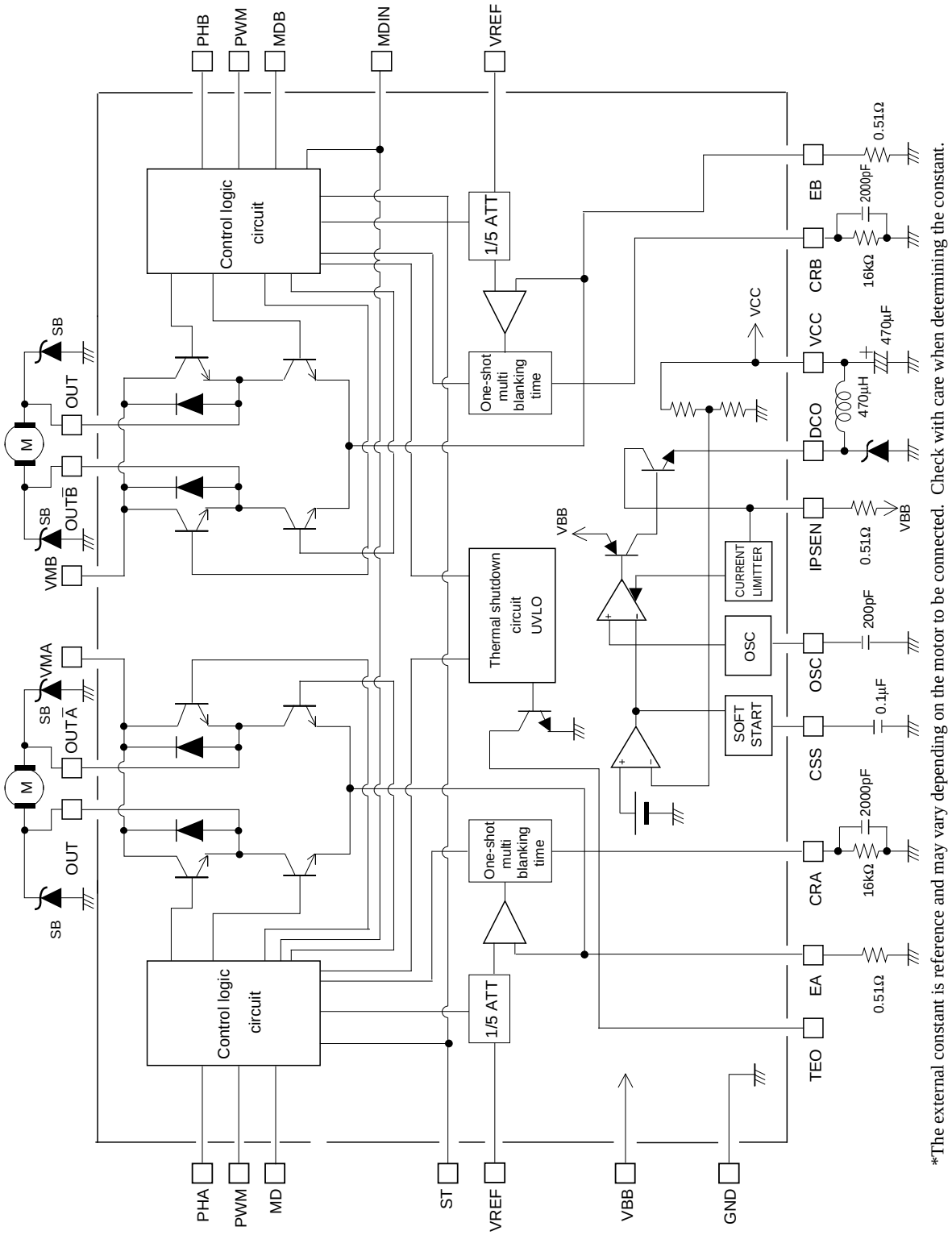
MDINT = “L”, MD = “H” (FAST, SLOW)



MDINT = “H”, MD = “L” (SLOW, FAST)



Block Diagram



*The external constant is reference and may vary depending on the motor to be connected. Check with care when determining the constant.

This catalog provides information as of February, 2003. Specifications and information herein are subject to change without notice.