

## SANYO Semiconductors DATA SHEET

An ON Semiconductor Company

## LV8746V — PWM Constant-C

# PWM Constant-Current Control Stepping Motor Driver

#### Overview

The LV8746V is a stepping motor driver corresponding to the W1-2 aspect excitation drive that the selection of CLK-IN input and a parallel input is possible. It is ideally suited for driving brushed DC motors and stepping motors used in office equipment and amusement applications.

#### **Features**

- PWM current control stepping motor driver incorporated.
- BiCDMOS process IC
- Low on resistance (upper side :  $0.84\Omega$ ; lower side :  $0.7\Omega$ ; total of upper and lower :  $1.54\Omega$ ; Ta =  $25^{\circ}$ C, I<sub>O</sub> = 1A)
- Excitation mode can be set to 2-phase, 1-2 phase Full torque, 1-2 phase, or W1-2 phase
- CLK-IN input and a parallel input can be selected.
- Motor current selectable in four steps
- Output short-circuit protection circuit (selectable from latch-type or auto-reset-type) incorporated
- Unusual condition warning output pins
- No control power supply required

#### **Specifications**

#### **Absolute Maximum Ratings** at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	VM max		38	V
Output peak current	I <sub>O</sub> peak	tw ≤ 10ms, duty 20%	1.2	Α
Output current	I <sub>O</sub> max		1	Α
Logic input voltage	V <sub>IN</sub>		-0.3 to +6	٧
EMO input voltage	Vemo		-0.3 to +6	V

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## LV8746V

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Parameter	Symbol	Conditions	Ratings	Unit
Allowable power dissipation	Pd max	Ta ≤ 85°C *	3.1	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

<sup>\*</sup> Specified circuit board : 90.0mm×90.0mm×1.6mm, glass epoxy 2-layer board, with backside mounting.

## Allowable Operating Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	VM		9 to 35	V
Logic input voltage	V <sub>IN</sub>		0 to 5.5	V
VREF input voltage range	VREF		0 to 3	V

## **Electrical Characteristics** at Ta = 25 °C, VM = 24V, VREF = 1.5V

Parameter   Symbol   Conditions	Parameter		Cumbal	Conditions		Ratings		Linit	
Current drain         IM         ST = "H", OE = "L", with no load         3.3         5         mA           VREGS output voltage         Vreg5         I <sub>O</sub> = -1mA         4.5         5         5.5         V           Thermal shutdown temperature         TSD         Design guarantee         150         180         210         °C           Motor driver           Output on resistance         0.84         1.1         Ω           Rond         I <sub>O</sub> = 1A, Upper-side on resistance         0.7         0.9         Ω           Output leakage current         I <sub>O</sub> log IA, Lower-side on resistance         0.7         0.9         Ω           Diode forward voltage         VD         ID = -1A         1.0         1.3         V           Logic pin input current(other ST)         II <sub>IN</sub> L         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic pin input current(other ST)         II <sub>IN</sub> L         V <sub>IN</sub> = 5V         50         78         110         µA           Logic pin input current(other ST)         II <sub>IN</sub> L         V <sub>IN</sub> = 5V         3         8         15         µA           Logic pin input current(other ST)         II <sub>IN</sub> L         V <sub>IN</sub> = 5V         30	Para	meter	Symbol	Conditions	min	typ	max	UTIIL	
VregS   10 = -1mA	Standby mode cu	ırrent drain	IMst	ST = "L"		190	300	μΑ	
Thermal shutdow temperature   TSD   Design guarantee   150   180   210   °C	Current drain		IM	ST = "H", OE = "L", with no load		3.3	5	mA	
Thermal hysteresis width	VREG5 output vo	oltage	Vreg5	I <sub>O</sub> = -1mA	4.5	5	5.5	V	
Motor driver           Output on resistance         0.84         1.1         Ω           Cutput leakage current         Ic)eak         Ic) = 1A, Lower-side on resistance         0.7         0.9         Ω           Diode forward voltage         VD         ID = -1A         1.0         1.3         V           Logic pin input current(ST)         I <sub>IN</sub> L         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic pin input current(other ST)         I <sub>IN</sub> L         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic high-level input voltage         V <sub>IN</sub> H         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic high-level input voltage         V <sub>IN</sub> H         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic tow-level input voltage         V <sub>IN</sub> H         V <sub>IN</sub> = 0.0         3         0.0         7         µA           Logic tow-level input voltage         V <sub>IN</sub> L         Step 0 (When initialized : channel 1         0.29         0.3         0.31         V           Current setting comparator threshold voltage         Vidac2_W         Step 2 ((Initial state+1)         0.29         0.3         0.31         V           Vidac2_W <td>Thermal shutdow</td> <td>n temperature</td> <td>TSD</td> <td>Design guarantee</td> <td>150</td> <td>180</td> <td>210</td> <td>°C</td>	Thermal shutdow	n temperature	TSD	Design guarantee	150	180	210	°C	
Output on resistance         Ronu         I <sub>Q</sub> = 1A, Upper-side on resistance         0.84         1.1         Ω           Output leakage current         I <sub>Q</sub> leak         50         µA           Diode forward voltage         VD         ID = -1A         1.0         1.3         V           Logic pin input current(ST)         I <sub>IIN</sub> L         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic pin input current(other ST)         I <sub>IIN</sub> L         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic high-level input voltage         V <sub>IN</sub> H         V <sub>IN</sub> = 0.8V         3         8         15         µA           Logic low-level input voltage         V <sub>IN</sub> H         V <sub>IN</sub> = 0.8V         30         50         70         µA           Logic low-level input voltage         V <sub>IN</sub> H         2.0         V         V           Logic low-level input voltage         V <sub>IN</sub> L         Step 0 (When initialized : channel 1         0.29         0.3         0.31         V           Current setting comparator trestiting comparator threshold voltage         Vidac2_W         Step 1 (Initial state+1)         0.29         0.3         0.31         V           Current setting comparator         Vidac2_M         Step 2 (Initial state+1	Thermal hysteres	sis width	ΔTSD	Design guarantee		40		°C	
Rond   I_O = 1A, Lower-side on resistance   0.7   0.9   Ω	Motor driver								
Output leakage current   Ioleak   Io	Output on resista	nce	Ronu	I <sub>O</sub> = 1A, Upper-side on resistance		0.84	1.1	Ω	
Diode forward voltage   VD   ID = -1A   1.0   1.3   V			Rond	I <sub>O</sub> = 1A, Lower-side on resistance		0.7	0.9	Ω	
Logic pin input current(ST)	Output leakage o	urrent	l <sub>O</sub> leak				50	μА	
In   N   N   N   N   N   N   N   N   N	Diode forward vo	Itage	VD	ID = -1A		1.0	1.3	V	
Logic pin input current (other ST)         IN/L IN/H         V/IN = 0.8V         3         8         15         μA           Logic high-level input voltage         VIN/H         2.0         V         V           Logic low-level input voltage         VIN/L         0.8         V           Logic low-level input voltage         VIN/L         0.8         V           W1-2-phase drive drive         Vtdac0_W         Step 0 (When initialized : channel 1 o.29         0.3         0.31         V           Current setting comparator threshold voltage         Vtdac1_W         Step 2 (Initial state+1)         0.29         0.3         0.31         V           Vtdac2_W         Step 2 (Initial state+2)         0.185         0.2         0.215         V           Vtdac3_W         Step 3 (Initial state+3)         0.09         0.1         0.11         V           Vtdac2_M         Step 2 (Initial state+1)         0.29         0.3         0.31         V           Vtdac2_M         Step 2 (Initial state+1)         0.185         0.2         0.215         V           Vtdac2_M         Step 2 (Initial state+1)         0.185         0.2         0.215         V           Current setting comparator (Full torque)         Vtdac2_M         Step 2 (Initi	Logic pin input cu	ırrent(ST)	I <sub>IN</sub> L	V <sub>IN</sub> = 0.8V	3	8	15	μА	
In   In   In   In   In   In   In   In			I <sub>IN</sub> H	V <sub>IN</sub> = 5V	50	78	110	μА	
Logic high-level input voltage   Vinh	Logic pin input cu	ırrent(other ST)	I <sub>IN</sub> L	V <sub>IN</sub> = 0.8V	3	8	15	μА	
Logic low-level input voltage   VinL   Step 0 (When initialized : channel 1   0.29   0.3   0.31   V			I <sub>IN</sub> H	V <sub>IN</sub> = 5V	30	50	70	μА	
Current setting comparator threshold voltage (parallel input)   Vidac2_H   Vidac2_F   Step 2 (Initial state+1)   0.29   0.3   0.31   V   Vidac2_H   Vidac2_H   Step 2 (Initial state+1)   0.29   0.3   0.31   V   Vidac2_H   Vidac2_H   Step 2 (Initial state+3)   0.09   0.1   0.11   V   Vidac2_H   Vidac2_H   Step 2 (Initial state+1)   0.185   0.2   0.215   V   Vidac2_H   Vidac2_H   Step 2 (Initial state+3)   0.09   0.1   0.11   V   V   Vidac2_H   Vidac2_H   Step 2 (Initial state+1)   0.185   0.2   0.215   V   V   Vidac2_H   Step 2 (Initial state+1)   0.185   0.2   0.215   V   V   Vidac2_H   Step 2 (Initial state+1)   0.29   0.3   0.31   V   V   Vidac2_H   Step 2 (Initial state+1)   0.29   0.3   0.31   V   V   V   V   V   V   V   V   V	Logic high-level i	nput voltage	V <sub>IN</sub> H		2.0			V	
Current setting comparator threshold voltage (CLK-IN input)   2 phase drive   Vtdac2_H   Step 2 (Initial state+1)   0.29   0.3   0.31   V   Vtdac2_H   Step 2 (Initial state+2)   0.185   0.2   0.215   V   Vtdac2_M   Step 3 (Initial state+3)   0.09   0.1   0.11   V   Vtdac2_M   Vtdac2_M   Step 0 (When initialized : channel 1   0.29   0.3   0.31   V   Vtdac2_M   Step 2 (Initial state+1)   0.185   0.2   0.215   V   Vtdac2_M   Step 2 (Initial state+1)   0.185   0.2   0.215   V   Vtdac2_H   Step 0 (When initialized : channel 1   0.29   0.3   0.31   V   Vtdac2_H   Step 0 (When initialized : channel 1   0.29   0.3   0.31   V   Vtdac2_H   Step 2 (Initial state+1)   0.29   0.3   0	Logic low-level in	put voltage	V <sub>IN</sub> L				0.8	V	
Current setting comparator threshold voltage (CLK-IN input)         Vidac2_W         Step 2 (Initial state+2)         0.185         0.2         0.215         V           Current setting comparator threshold voltage (CLK-IN input)         1-2 phase drive (Full torque)         Vtdac0_M         Step 0 (When initialized : channel 1 comparator level)         0.29         0.3         0.31         V           V Vdac2_M         Step 2 (Initial state+1)         0.185         0.2         0.215         V           V Vdac2_M         Step 2 (Initial state+1)         0.185         0.2         0.215         V           Vdac2_M         Step 0 (When initialized : channel 1 comparator level)         0.29         0.3         0.31         V           Vdac2_H         Step 0 (When initialized : channel 1 comparator level)         0.29         0.3         0.31         V           Vdac2_H         Step 2 (Initial state+1)         0.29         0.3         0.31         V           Current setting comparator threshold voltage (parallel input)         Vdac11         101 = H, 111 = H         0.185         0.2         0.215         V           Vdac10         102 = H, 111 = L         0.09         0.1         0.11         V		· ·	Vtdac0_W	' '	0.29	0.3	0.31	V	
Current setting comparator threshold voltage (CLK-IN input)         Vtdac3_W         Step 3 (Initial state+3)         0.09         0.1         0.11         V comparator threshold voltage (CLK-IN input)           Current setting comparator threshold voltage (CLK-IN input)         1-2 phase drive (Full torque)         Vtdac2_M         Step 2 (Initial state+1)         0.185         0.2         0.215         V           Current setting comparator threshold voltage (parallel input)         Vtdac2_H         Step 2 (Initial state+1)         0.29         0.3         0.31         V           Current setting comparator threshold voltage (parallel input)         Vtdac11         I01 = H , I11 = H         0.29         0.3         0.31         V           Current setting comparator threshold voltage (parallel input)         Vtdac01         I01 = H , I11 = H         0.185         0.2         0.215         V           Current setting comparator threshold voltage (parallel input)         Vtdac01         I01 = H , I11 = H         0.185         0.2         0.215         V           Current setting comparator threshold voltage (parallel input)         Vtatt00         ATT1 = L, ATT2 = L         0.29         0.3         0.31         V           Current setting comparator threshold voltage (current attenuation rate switching)         Vtatt00         AT			Vtdac1_W	Step 1 (Initial state+1)	0.29	0.3	0.31	V	
comparator threshold voltage (CLK-IN input)         1-2 phase drive (Full torque)         Vidac2_M         Step 0 (When initialized : channel 1 comparator level)         0.09         0.31         V volum (V volum (V volum)         V volum (V volum) <th< td=""><td></td><td></td><td>Vtdac2_W</td><td>Step 2 (Initial state+2)</td><td>0.185</td><td>0.2</td><td>0.215</td><td>V</td></th<>			Vtdac2_W	Step 2 (Initial state+2)	0.185	0.2	0.215	V	
threshold voltage (CLK-IN input)    1-2 phase drive   Vtdac2_M   Step 0 (When initialized : channel 1   0.29   0.3   0.31   V	J		Vtdac3_W	Step 3 (Initial state+3)	0.09	0.1	0.11	V	
(CLK-IN input)         Vtdac2_M         Step 2 (Initial state+1)         0.185         0.2         0.215         V           1-2 phase drive (Full torque)         Vtdac0_H         Step 0 (When initialized : channel 1         0.29         0.3         0.31         V           Current setting comparator threshold voltage (parallel input)         Vtdac11         I01 = H, I11 = H         0.29         0.3         0.31         V           Current setting comparator threshold voltage (parallel input)         Vtdac01         I01 = H, I11 = H         0.185         0.2         0.215         V           Current setting comparator threshold voltage (current attenuation rate switching)         Vtatt00         ATT1 = L, ATT2 = L         0.185         0.2         0.215         V           Vtatt10         ATT1 = H, ATT2 = H         0.135         0.15         0.165         V           Chopping frequency         Fchop         Rchop = 20KΩ         45         62.5         75         kHz	threshold	1-2 phase drive	Vtdac0_M	. ,	0.29	0.3	0.31	V	
1-2 phase drive (Full torque)	•		Vtdac2_M	Step 2 (Initial state+1)	0.185	0.2	0.215	V	
2 phase drive   Vtdac2_F   Step 2   0.29   0.3   0.31   V	(OLIC III III pat)		Vtdac0_H	' '	0.29	0.3	0.31	V	
Current setting comparator threshold voltage (parallel input)         Vtdac11         I01 = H , I11 = H         0.29         0.3         0.31         V           Current setting comparator threshold voltage (current attenuation rate switching)         Vtdac01         I01 = L , I11 = H         0.185         0.2         0.215         V           Current setting comparator threshold voltage (current attenuation rate switching)         Vtatt00         ATT1 = L , ATT2 = L         0.29         0.3         0.31         V           Vtatt01         ATT1 = H , ATT2 = L         0.185         0.2         0.215         V           Vtatt10         ATT1 = L , ATT2 = H         0.135         0.15         0.165         V           Vtatt11         ATT1 = H , ATT2 = H         0.09         0.1         0.11         V           Chopping frequency         Fchop         Rchop = 20KΩ         45         62.5         75         kHz			Vtdac2_H	Step 2 (Initial state+1)	0.29	0.3	0.31	V	
threshold voltage (parallel input)         Vtdac01         I01 = L , I11 = H         0.185         0.2         0.215         V           Current setting comparator threshold voltage (current attenuation rate switching)         Vtatt00         ATT1 = L, ATT2 = L         0.29         0.3         0.31         V           Vtatt01         ATT1 = H, ATT2 = L         0.185         0.2         0.215         V           Vtatt10         ATT1 = L, ATT2 = H         0.135         0.15         0.165         V           Vtatt11         ATT1 = H, ATT2 = H         0.09         0.1         0.11         V           Chopping frequency         Fchop         Rchop = 20KΩ         45         62.5         75         kHz		2 phase drive	Vtdac2_F	Step 2	0.29	0.3	0.31	V	
(parallel input)         Vidac10         I01 = H , I11 = L         0.09         0.11         V           Current setting comparator         Vtatt00         ATT1 = L, ATT2 = L         0.29         0.3         0.31         V           threshold voltage         Vtatt01         ATT1 = H, ATT2 = L         0.185         0.2         0.215         V           Vtatt10         ATT1 = L, ATT2 = H         0.135         0.15         0.165         V           Vtatt11         ATT1 = H, ATT2 = H         0.09         0.1         0.11         V           Chopping frequency         Fchop         Rchop = 20KΩ         45         62.5         75         kHz	Current setting co	omparator	Vtdac11	I01 = H , I11 = H	0.29	0.3	0.31	V	
Current setting comparator threshold voltage (current attenuation rate switching)         Vtatt00         ATT1 = L, ATT2 = L         0.29         0.3         0.31         V           Vtatt01         ATT1 = H, ATT2 = L         0.185         0.2         0.215         V           Vtatt10         ATT1 = L, ATT2 = H         0.135         0.15         0.165         V           Vtatt11         ATT1 = H, ATT2 = H         0.09         0.1         0.11         V           Chopping frequency         Fchop         Rchop = 20KΩ         45         62.5         75         kHz	•		Vtdac01	I01 = L , I11 = H	0.185	0.2	0.215	V	
threshold voltage (current attenuation rate switching)         Vtatt01         ATT1 = H, ATT2 = L         0.185         0.2         0.215         V           Vtatt10         ATT1 = L, ATT2 = H         0.135         0.15         0.165         V           Vtatt11         ATT1 = H, ATT2 = H         0.09         0.1         0.11         V           Chopping frequency         Fchop         Rchop = 20KΩ         45         62.5         75         kHz	(parallel input)		Vtdac10	I01 = H , I11 = L	0.09	0.1	0.11	V	
(current attenuation rate switching)         Vtatt10       ATT1 = L, ATT2 = H       0.135       0.15       0.165       V         Vtatt11       ATT1 = H, ATT2 = H       0.09       0.1       0.11       V         Chopping frequency       Fchop       Rchop = $20$ K $\Omega$ 45       62.5       75       kHz	Current setting co	omparator	Vtatt00	ATT1 = L, ATT2 = L	0.29	0.3	0.31	V	
Vtatt10       ATT1 = L, ATT2 = H       0.135       0.15       0.165       V         Vtatt11       ATT1 = H, ATT2 = H       0.09       0.1       0.11       V         Chopping frequency       Fchop       Rchop = 20KΩ       45       62.5       75       kHz	•	threshold voltage		ATT1 = H, ATT2 = L	0.185	0.2	0.215	V	
Chopping frequency Fchop Rchop = $20K\Omega$ 45 62.5 75 kHz	(current attenuation rate switching)		Vtatt10	ATT1 = L, ATT2 = H	0.135	0.15	0.165	V	
			Vtatt11	ATT1 = H, ATT2 = H	0.09	0.1	0.11	V	
VREF pin input current         Iref         VREF = 1.5V         -0.5         μA	Chopping freque	ncy	Fchop	Rchop = $20$ K $\Omega$	45	62.5	75	kHz	
	VREF pin input c	urrent	Iref	VREF = 1.5V	-0.5			μА	

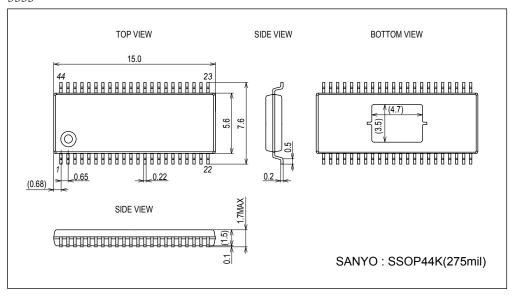
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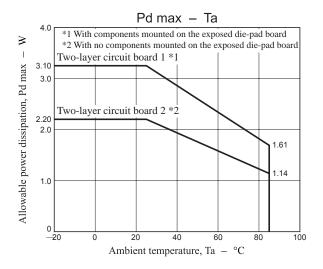
## LV8746V

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Parameter	Cymphal	Conditions	Ratings			11.2
Parameter	Symbol	Conditions	min	typ	max	Unit
Charge pump						
VG output voltage	VG		28	28.75	30	V
Rise time	tONG	VG = 0.1μF			0.5	mS
Oscillator frequency	Fosc	Rchop = $20K\Omega$	90	125	150	kHz
Output short-circuit protection						
EMO pin saturation voltage	Vsatemo	lemo = 1mA		80	160	mV
CEM pin charge current	Icem	Vcem = 0V	7	10	13	μА
CEM pin threshold voltage	Vthcem		0.8	1.0	1.2	V

## **Package Dimensions**

unit : mm (typ) 3333



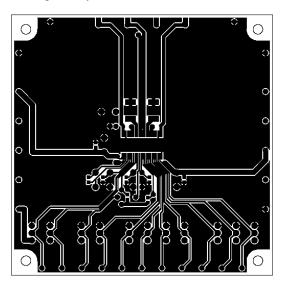


**Substrate Specifications** (Substrate recommended for operation of LV8746V)

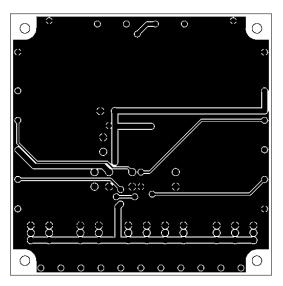
Size :  $90\text{mm} \times 90\text{mm} \times 1.6\text{mm}$  (two-layer substrate [2SOP])

Material : Glass epoxy

Copper wiring density : L1 = 85% / L2 = 90%



L1: Copper wiring pattern diagram



L2 : Copper wiring pattern diagram

#### **Cautions**

- 1) The data for the case with the Exposed Die-Pad substrate mounted shows the values when 90% or more of the Exposed Die-Pad is wet.
- 2) For the set design, employ the derating design with sufficient margin.

Stresses to be derated include the voltage, current, junction temperature, power loss, and mechanical stresses such as vibration, impact, and tension.

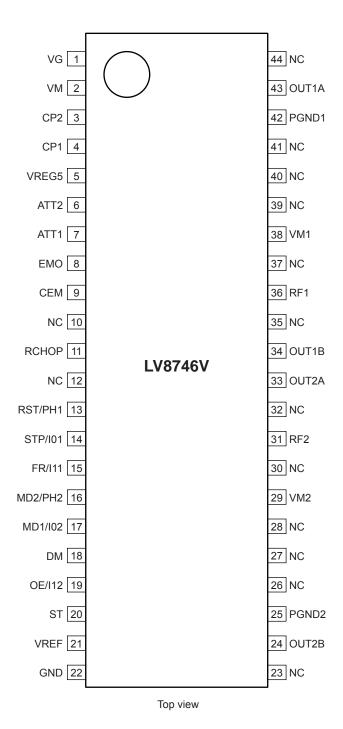
Accordingly, the design must ensure these stresses to be as low or small as possible.

The guideline for ordinary derating is shown below:

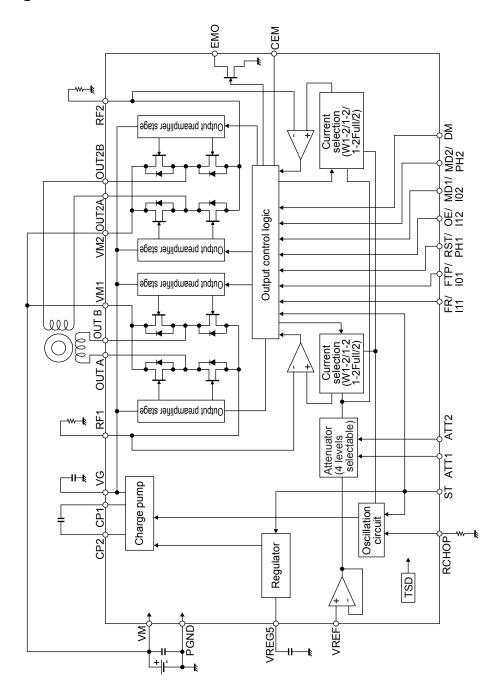
- (1)Maximum value 80% or less for the voltage rating
- (2)Maximum value 80% or less for the current rating
- (3)Maximum value 80% or less for the temperature rating
- 3) After the set design, be sure to verify the design with the actual product.

Confirm the solder joint state and verify also the reliability of solder joint for the Exposed Die-Pad, etc. Any void or deterioration, if observed in the solder joint of these parts, causes deteriorated thermal conduction, possibly resulting in thermal destruction of IC.

## **Pin Assignment**



## **Block Diagram**



## LV8746V

#### **Pin Functions**

FILLEC	inctions	T	
Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
6	ATT2	Motor holding current switching pin.	
7	ATT1	Motor holding current switching pin.	
13	RST/PH1	CLK-IN is input , RESET input pin /	
13	KOI/FIII	1	
		Parallel is input , Channel 1	VREG5 ○ ◆ ◆
		forward/reverse rotation pin.	
14	STP/I01	CLK-IN is input , STEP signal input pin /	<u> </u>
		Parallel is input , Channel 1 output	↑
		control input pin.	<mark>↓</mark> ∳₊ᡛ │
15	FR/I11	CLK-IN is input , forward/reverse signal	<del> </del>
		input pin / Parallel is input , Channel 1	6kΩ
		output control input pin.	
16	MD2/PH2	CLK-IN is input , Excitation mode	
		switching pin / Parallel is input, Channel	
		2 forward/reverse rotation pin.	<b>‡</b> §100kΩ <b>†</b>
17	MD1/I02	CLK-IN is input , Excitation mode	
1 ''	1000	switching pin / Parallel is input , Channel	
		2 output control input pin.	GNDO
10	DM		GNDO
18	DM OF/112	Drive mode switching pin.	
19	OE/I12	CLK-IN is input , output enable signal	
		input pin / Parallel is input , Channel 2	
		output control input pin.	
20	ST	Chip enable pin.	VREG5 ○
			<b>T</b>
			<b>↓</b>
			Ť I
			∑ \$ 50kΩ
			10kΩ
			10kΩ
			<b>★ →      →        </b>
			\\$50kΩ
			GNDO
			CAD C
24	OUT2B	Channel 2 OUTB output pin.	(38)
25	PGND2	Power system ground pin2.	
42	PGND1	Power system ground pin1.	
29	VM2	Channel 2 motor power supply	
		connection pin.	
31	RF2	Channel 2 current-sense resistor	
		connection pin.	▎  │ │  ───────────────────────────────
33	OUT2A	Channel 2 OUTA output pin.	
34	OUT1B	Channel 1 OUTB output pin.	(3)(3) (3)(24)
36	RF1	' '	
30	KF1	Channel 1 current-sense resistor	
00	\/N.4.4	connection pin.	▎  │ │  ───────────────────────────────
38	VM1	Channel 1 motor power supply pin.	
43	OUT1A	Channel 1 OUTA output pin.	2kΩ 560Ω
1			25/42 N S S S S S S S S S S S S S S S S S S
			$\begin{bmatrix} 1 & 1 & 2k\Omega \end{bmatrix}$
			<u>।                              </u>
			GND O • •
Ī		1	

Continued on next page.

Continued from preceding page. Pin No. Pin Name Pin Functtion Equivalent Circuit 1 VG Charge pump capacitor connection pin. (3) (4) (1) 2 VM Motor power supply connection pin. VREG5 O-3 CP2 Charge pump capacitor connection pin. 4 CP1 Charge pump capacitor connection pin. ≱100Ω GND C 21 VREF Constant current control reference VREG5 Ovoltage input pin. 560Ω GND ○ 5 VREG5 Internal power supply capacitor VM Oconnection pin. -⁄⁄⁄√-2kΩ **⋚**71kΩ ≶26kΩ GND ○ 8 EMO Output short-circuit state warning output VREG5 ○

GND O-

Continued on next page.

## LV8746V

	from preceding p		
Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
9	CEM	Pin to connect the output short-circuit state detection time setting capacitor.	VREG5 ○  560Ω  GND ○
11	RCHOP	Chopping frequency setting resistor connection pin.	VREG5 O SOUTH OF THE PROPERTY
22	GND	Ground.	
10,12 23,26 27,28 30,32 35,37 39,40 41,44	NC	No Connection (No internal connection to the IC)	

#### **Description of operation**

#### **Input Pin Function**

#### (1) Chip enable function

This IC is switched between standby and operating mode by setting the ST pin. In standby mode, the IC is set to power-save mode and all logic is reset. In addition, the internal regulator circuit and charge pump circuit do not operate in standby mode.

ST	Mode	Internal regulator	Charge pump
Low or Open	Standby mode	Standby	Standby
High	Operating mode	Operating	Operating

#### (2) Input control method switching pin function

The IC input control method is switched by setting the DM pin. The CLK-IN input control and the parallel input control can be selected by setting the DM pin.

DM	Input control method
Low or Open	CLK-IN input control
High	Parallel input control

#### CLK-IN input control (DM = Low or Open)

#### (1) STEP pin function

Inj	out	Operating mode
ST	STP	
Low	*	Standby mode
High		Excitation step proceeds
High	<b>—</b>	Excitation step is kept

#### (2) Excitation mode setting function

MD1	MD2	Excitation mode	Initial p	osition
			Channel 1	Channel 2
Low	Low	2 phase excitation	100%	-100%
High	Low	1-2 phase excitation (Full torque)	100%	0%
Low	High	1-2 phase excitation	100%	0%
High	High	W1-2 phase excitation	100%	0%

This is the initial position of each excitation mode in the initial state after power-on and when the counter is reset.

#### (3) Setting constant-current control reference voltage

County Contain Control Control Control					
ATT1	ATT2	Current setting reference voltage			
Low	Low	VREF / 5 x 100%			
High	Low	VREF / 5 x 67%			
Low	High	VREF / 5 x 50%			
High	High	VREF / 5 x 33%			

The voltage input to the VREF pin can be switched to four-step settings depending on the statuses of the two inputs, ATT1 and ATT2. This is effective for reducing power consumption when motor holding current is supplied.

#### Set current value calculation method.

The reference voltage is set by the voltage applied to the VREF pin and the two inputs ATT1 and ATT2. The output current (output current at a constant-current drive current ratio of 100%) can be set from this reference voltage and the RF resistance value.

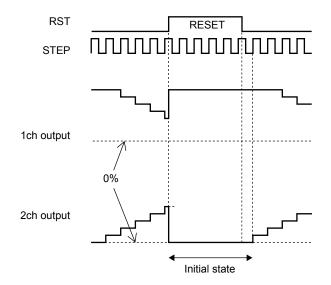
IOUT = (VREF/5) ×(current attenuation ratio)/ RF resistance

Example : At VREF of 1.5V, a reference voltage setting of 100% [(ATT1, ATT2) = (L, L)] and an RF resistance of  $0.5\Omega$ , the output current is set as shown below.

$$I_{OUT} = 1.5 V/5 \times 100\%/0.5\Omega = 0.6 A$$

#### (4) Reset function

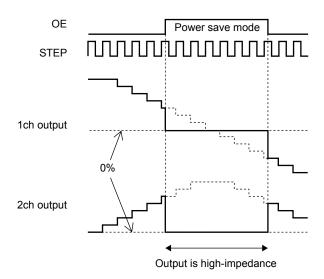
RST	Operating mode
Low	Normal operation
High	Reset state



When the RST pin is set to High, the excitation position of the output is forcibly set to the initial state. When RST is then set to Low, the excitation position is advanced by the next STEP input.

(5) Output enable function

OE	Operating mode
Low	Output ON
High	Output OFF

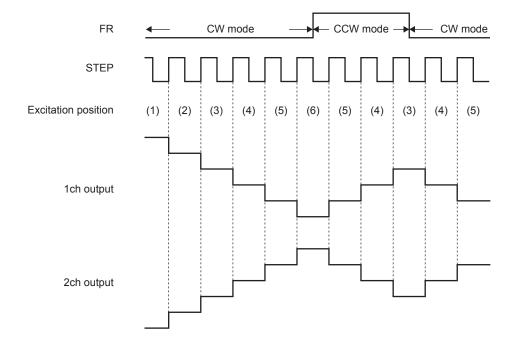


When the OE pin is set High, the output is forced OFF and goes to high impedance.

However, the internal logic circuits are operating, so the excitation position proceeds when the STEP signal is input. Therefore, when OE is returned to Low, the output level conforms to the excitation position proceeded by the STEP input.

(6) Forward/reverse switching function

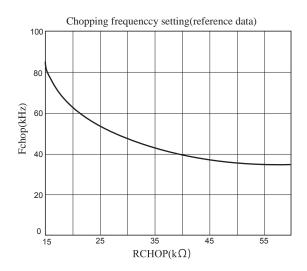
FR	Operating mode
Low	CW
High	CCW



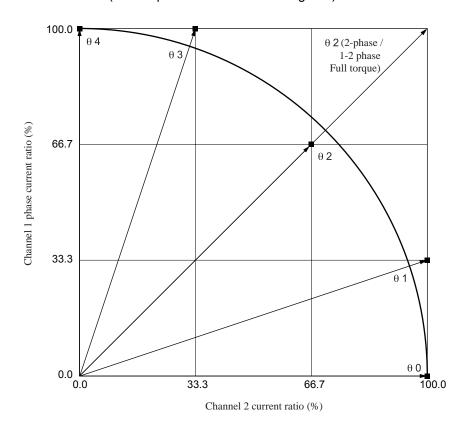
The internal D/A converter proceeds by one bit at the rising edge of the input STEP pulse. In addition, CW and CCW mode are switched by setting the FR pin. In CW mode, the channel 2 current phase is delayed by  $90^{\circ}$  relative to the channel 1 current. In CCW mode, the channel 2 current phase is advanced by  $90^{\circ}$  relative to the channel 1 current.

#### (7) Chopping frequency setting

For constant-current control, chopping operation is made with the frequency determined by the external resistor The chopping frequency to be set with the resistance connected to the RCHOP pin (pin 11) is as shown below.



## (8) Output current vector locus (one step is normalized to 90 degrees)

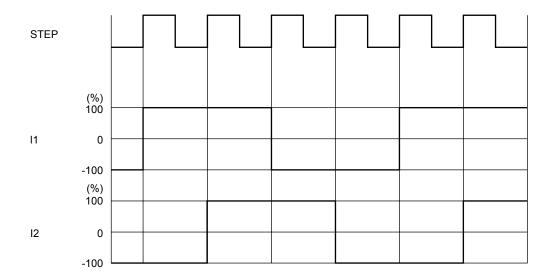


## Setting current ration in each excitation mode

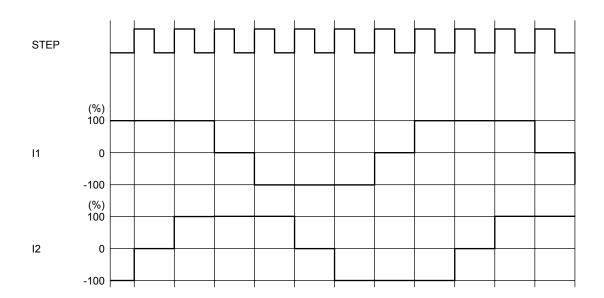
STEP	W1-2 ph	ase (%)	1-2 pha	ase (%)	1-2 phase fu	Il torque (%)	2-phas	e (%)
	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2
θ0	0	100	0	100	0	100		
θ1	33.3	100						
θ2	66.7	66.7	66.7	66.7	100	100	100	100
θ3	100	33.3						
θ4	100	0	100	0	100	0		

## (9) Typical current waveform in each excitation mode

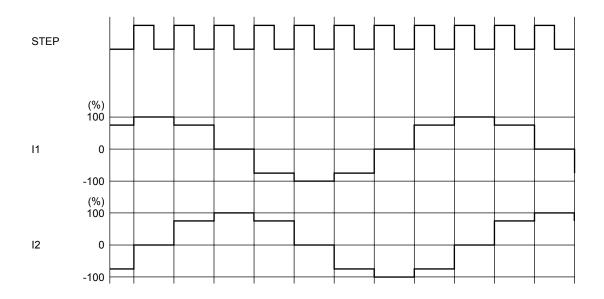
2-phase excitation (CW mode)



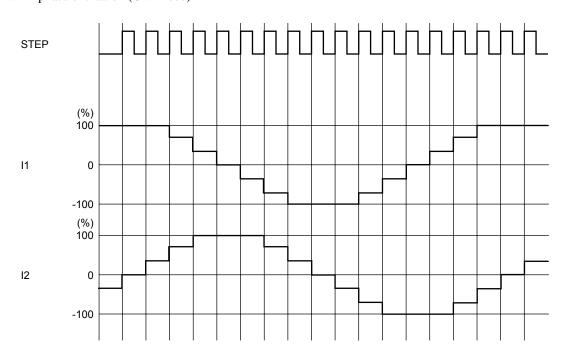
## 1-2 phase excitation Full torque (CW mode)



## 1-2 phase excitation Full torque (CW mode)

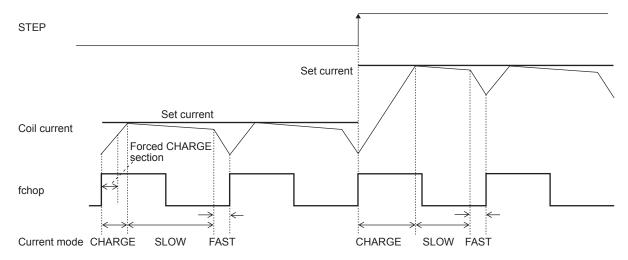


## W1-2 phase excitation (CW mode)

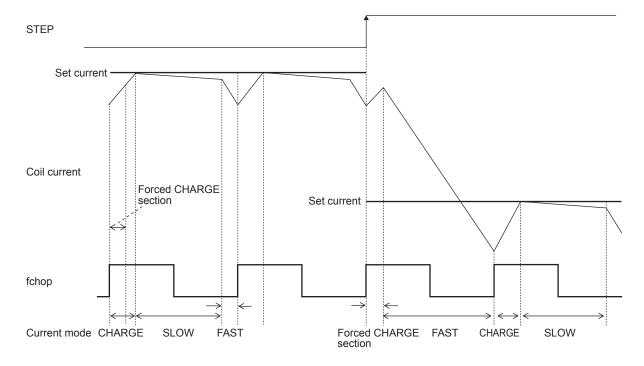


#### (10) Current control operation specification

(Sine wave increasing direction)



(Sine wave decreasing direction)



In each current mode, the operation sequence is as described below:

- At rise of chopping frequency, the CHARGE mode begins. (The section in which the CHARGE mode is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF) exists for 1/16 of one chopping cycle.)
- The coil current (ICOIL) and set current (IREF) are compared in this forced CHARGE section.

When (ICOIL<IREF) state exists in the forced CHARGE section;

CHARGE mode up to ICOIL  $\geq$  IREF, then followed by changeover to the SLOW DECAY mode, and finally by the FAST DECAY mode for the 1/16 portion of one chopping cycle.

When (ICOIL<IREF) state does not exist in the forced CHARGE section;

The FAST DECAY mode begins. The coil current is attenuated in the FAST DECAY mode till one cycle of chopping is over.

Above operations are repeated. Normally, the SLOW (+FAST) DECAY mode continues in the sine wave increasing direction, then entering the FAST DECAY mode till the current is attenuated to the set level and followed by the SLOW DECAY mode.

## Parallel input control (DM-High)

## (1) Parallel input control logic

I01(02)	I11(12)	Output current (IO)
Low	Low	0
High	Low	$I_O = ((VREF/5)/RF) \times 1/3$
Low	High	$I_O = ((VREF/5)/RF) \times 2/3$
High	High	I <sub>O</sub> = (VREF/5)/RF

PH1(2)	current direction
Low	$OUTB \to OUTA$
High	$OUTA \to OUTB$

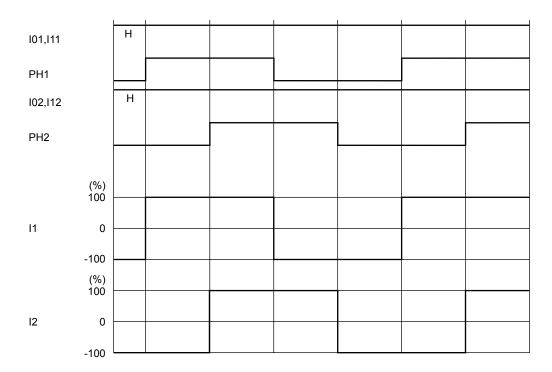
#### (2) Setting constant-current control reference voltage

The constant current control standard voltage setting function is the same specification as the CLK-IN input control.

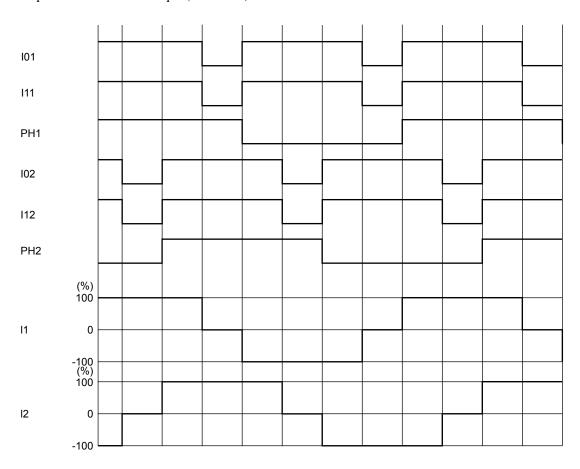
#### (3) Current control function

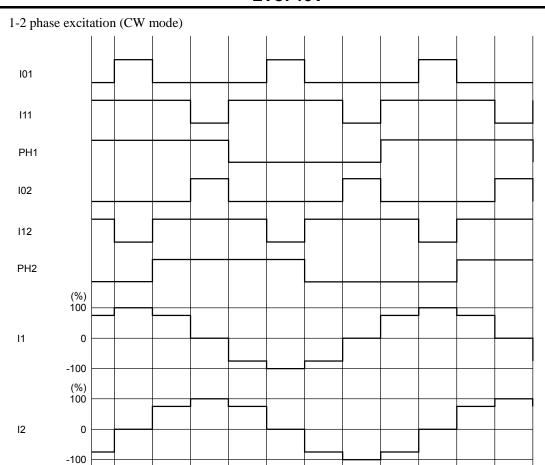
The current control function is the same use as the CLK-IN input control.

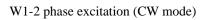
(4) Typical current waveform in each excitation mode when stepping motor parallel input control 2-phase excitation (CW mode)

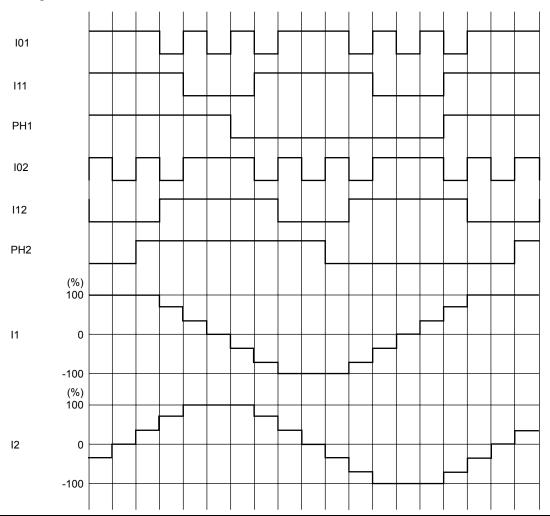


1-2 phase excitation full torque (CW mode)









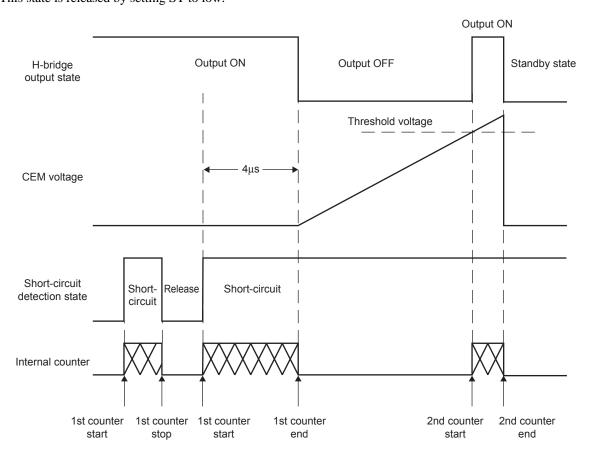
#### **Output short-circuit protection function**

This IC incorporates an output short-circuit protection circuit that, when the output has been shorted by an event such as shorting to power or shorting to ground, to prevent the thing that IC destroys, the output short-circuit protection circuit that turns off the output is built into.

#### (1) Protection function operation(Latch type)

The detection of the output short-circuited state by the IC causes the output short-circuit protection circuit to be activated.

When the short-circuited state continues for the period of time set using the internal timer (approximately  $4\mu$ s), the output in which the short-circuiting has been detected is first set to OFF. After this, the output is set to ON again as soon as the timer latch time (Tcem) described later has been exceeded, and if the short-circuited state is still detected, all the outputs of the channel concerned are switched to the standby mode, and this state is held. This state is released by setting ST to low.



#### (2) Unusual condition warning output pins (EMO)

IC is provided with the EMO pin which notifies the CPU of an unusual condition if the protection circuit operates by detecting an unusual condition of the IC. This pin is of the open-drain output type and when an unusual condition is detected, the EMO output is placed in the ON (EMO = Low) state.

Furthermore, the EMO pin is placed in the ON state when one of the following conditions occurs.

- 1. Shorting-to-power, shorting-to-ground, or shorting-to-load occurs at the output pin and the output short-circuit protection circuit is activated.
- 2. The IC junction temperature rises and the thermal protection circuit is activated.

#### (3) Timer latch time (Tcem)

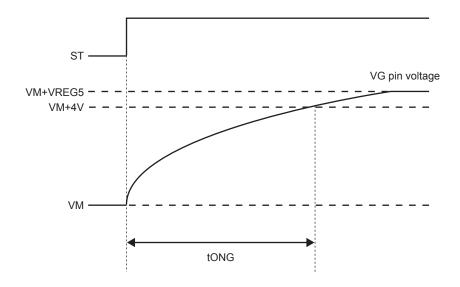
The time taken for the output to be set to OFF when the output has been short-circuited can be set using capacitor Ccem, connected between the CEM pin and GND. The value of capacitor Ccem is determined by the formula given below.

Timer latch : Tcem  $\sim$  Ccem  $\times$  Vtcem/Icem [sec]

Vtcem : Comparator threshold voltage, typ 1V Icem : CEM pin charge current, typ 10µA

#### **Charge Pump Circuit**

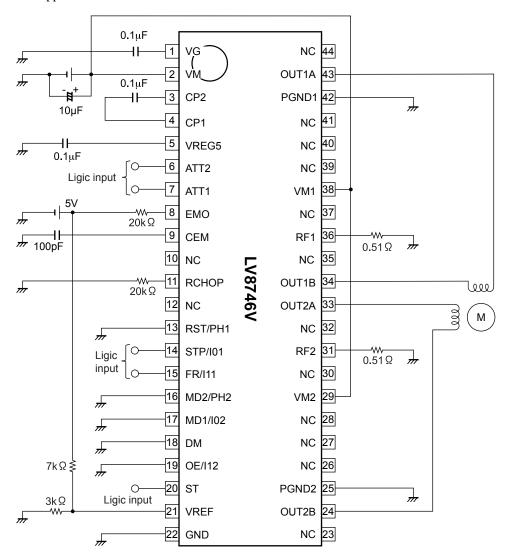
When the ST pin is set High, the charge pump circuit operates and the VG pin voltage is boosted from the VM voltage to the VM + VREG5 voltage. If the VG pin voltage is not boosted sufficiently, the output cannot be controlled, so be sure to provide a wait time of tONG or more after setting the ST pin High before starting to drive the motor.



VG Pin Voltage Schematic View

## **Application Circuit Example**

• Clock Inn mode application circuit



The setting conditions for the above circuit diagram example are as follows:

- 2-phase excitation (MD1/I02 = Low, MD2/PH2 = Low)
- Reset function fixed to normal operation (RST = Low)
- Chopping frequency : 62.5kHz (RCHOP = 20k $\Omega$ )

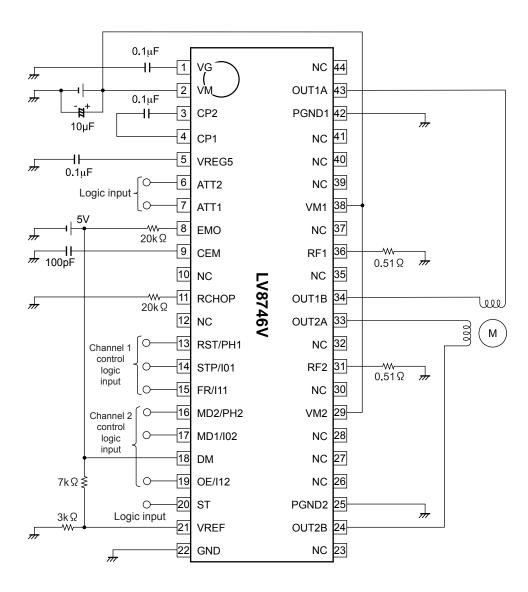
ATT1	ATT2	Current setting reference voltage
Low	Low	VREF/5×100%
High	Low	VREF/5×67%
Low	High	VREF/5×50%
High	High	VREF/5×33%

The set current value is as follows:

 $I_{OUT} = (VREF/5 \times Voltage setting ratio) / RF$ 

Example ) When ATT=Low,ATT2=Low (VREF = 1.5V,RF=0.51 
$$\Omega$$
 ) 
$$I_{OUT} = (1.5V \ / \ 5 \times 1 \ ) \ / \ 0.51 \Omega = 0.6 A$$

• DC motor driver circuit (DM = High, and the current limit function is in use.)



The setting conditions for the above circuit diagram example are as follows:

• Chopping frequency : 62.5kHz (RCHOP = 20k $\Omega$ )

101(02)	I11(12)	Output current (I <sub>O</sub> )
Low	Low	0
High	Low	$I_{O} = ((VREF/5) / RF) \times 1/3$
Low	High	$I_{O} = ((VREF/5) / RF) \times 2/3$
High	High	$I_O = (VREF/5) / RF$

Example ) When ATT=Low,ATT2=Low,I01(02)=High,I11(12)=High (VREF = 1.5V,RF=0.51\Omega)  $I_{OUT}$  = (1.5V / 5 × 1 ) / 0.51 $\Omega$  = 0.6A

PH1(2)	Electrical current direction
Low	$OUTB \rightarrow OUTA$
High	$OUTA \rightarrow OUTB$

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