

SANYO Semiconductors DATA SHEET





PWM Constant-Current Control Stepping Motor Driver

Overview

The LV8732V is a 2-channel H-bridge driver IC that can switch a stepping motor driver, which is capable of micro-step drive and supports 2W 1-2 phase excitation, and two channels of a brushed motor driver, which supports forward, reverse, brake, and standby of a motor. It is ideally suited for driving brushed DC motors and stepping motors used in office equipment and amusement applications.

Features

- Single-channel PWM current control stepping motor driver (selectable with DC motor driver channel 2) incorporated.
- BiCDMOS process IC
- Low on resistance (upper side : 0.3Ω ; lower side : 0.25Ω ; total of upper and lower : 0.55Ω ; Ta = 25°C, I $_{\Omega}$ = 2A)
- Excitation mode can be set to 2-phase, 1-2 phase, W1-2 phase , or 2W1-2 phase
- Excitation step proceeds only by step signal input
- 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

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Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	VM max		36	V
Output peak current	I _O peak	tw \leq 10ms, duty 20%	2.5	А
Output current	I _O max		2	А
Logic input voltage	V _{IN}		-0.3 to +6	V
MONI/EMO input voltage	Vmoni/Vemo		-0.3 to +6	V

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Parameter	Symbol	Conditions	Ratings	Unit
Allowable power dissipation	Pd max	Ta ≤ 85°C *	3.25	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

* Specified circuit board : 90.0mm×90.0mm×1.6mm, glass epoxy 2-layer board, with backside mounting.

Allowable Operating Ratings at $Ta = 25^{\circ}C$

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	VM		9 to 32	V
Logic input voltage	V _{IN}		0 to 5.5	V
VREF input voltage range	VREF		0 to 3	V

Electrical Characteristics at $Ta = 25^{\circ}C$, VM = 24V, VREF = 1.5V

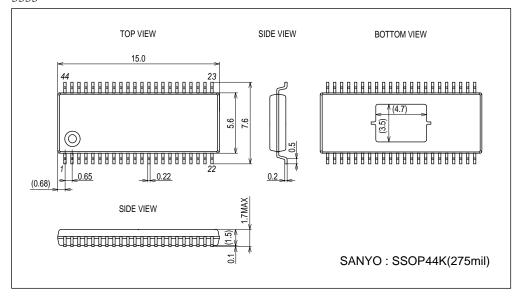
Para	meter	Symbol	Conditions	<u> </u>	Ratings		Unit
		Conditions		min	typ	max	01111
Standby mode current drain		IMst	ST = "L"		100	400	μA
Current drain		IM	ST = "H", OE = "L", with no load		3.2	5	mA
VREG5 output vo	ltage	Vreg5	I _O = -1mA	4.5	5	5.5	V
Thermal shutdow	n temperature	TSD	Design guarantee	150	180	200	°C
Thermal hysteres	is width	∆TSD	Design guarantee		40		°C
Motor driver							
Output on resista	nce	Ronu	I_{O} = 2A, Upper-side on resistance		0.3	0.4	Ω
		Rond	I_{O} = 2A, Lower-side on resistance		0.25	0.33	Ω
Output leakage c	urrent	lOleak				50	μA
Diode forward vol	Itage	VD	ID = -2A		1.2	1.4	V
Logic pin input cu	irrent	I _{IN} L	V _{IN} = 0.8V	4	8	12	μA
		I _{IN} H	V _{IN} = 5V	30	50	70	μA
Logic high-level ir	nput voltage	V _{IN} H		2.0			V
Logic low-level in	put voltage	VINL				0.8	V
Current setting comparator	2W1-2-phase drive	Vtdac0_2W	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
threshold		Vtdac1_2W	Step 1 (Initial state+1)	0.285	0.294	0.303	V
voltage		Vtdac2_2W	Step 2 (Initial state+2)	0.267	0.276	0.285	V
(current step		Vtdac3_2W	Step 3 (Initial state+3)	0.240	0.249	0.258	V
switching)		Vtdac4_2W	Step 4 (Initial state+4)	0.201	0.21	0.219	V
		Vtdac5_2W	Step 5 (Initial state+5)	0.157	0.165	0.173	V
		Vtdac6_2W	Step 6 (Initial state+6)	0.107	0.114	0.121	V
		Vtdac7_2W	Step 7 (Initial state+7)	0.053	0.06	0.067	V
		Vtdac8_4W	Step 8 (Initial state+8)	0.201	0.21	0.219	V
	W1-2-phase drive	Vtdac0_W	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac2_W	Step 2 (Initial state+1)	0.267	0.276	0.285	V
		Vtdac4_W	Step 4 (Initial state+2)	0.201	0.21	0.219	V
		Vtdac6_W	Step 6 (Initial state+3)	0.107	0.114	0.121	V
	1-2 phase drive	Vtdac0_H	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac4_H	Step 4 (Initial state+1)	0.201	0.21	0.219	V
	2 phase drive	Vtdac4_F	Step 4' (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
Current setting co	omparator	Vtatt00	ATT1 = L, ATT2 = L	0.291	0.3	0.309	V
threshold voltage		Vtatt01	ATT1 = H, ATT2 = L	0.232	0.24	0.248	V
(current attenuation	on rate switching)	Vtatt10	ATT1 = L, ATT2 = H	0.143	0.15	0.157	V
		Vtatt11	ATT1 = H, ATT2 = H	0.053	0.06	0.067	V

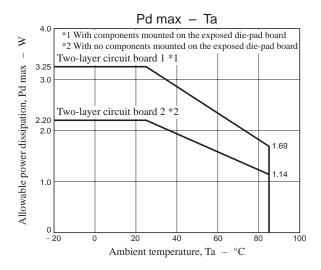
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Deveryortex	Questi al	Ratings			1.1		
Parameter	Symbol	Conditions	min	typ	max	Unit	
Chopping frequency	Fchop	Cchop = 200pF	40	50	60	kHz	
CHOP pin charge/discharge current	Ichop		7	10	13	μA	
Chopping oscillation circuit threshold voltage	Vtup		0.8	1	1.2	V	
VREF pin input current	Iref	VREF = 1.5V	-0.5			μA	
MONI pin saturation voltage	Vsatmon	Imoni = 1mA			400	mV	
Charge pump		·					
VG output voltage	VG		28	28.7	29.8	V	
Rise time	tONG	VG = 0.1µF		200		μS	
Oscillator frequency	Fosc		90	125	150	kHz	
Output short-circuit protection							
EMO pin saturation voltage	Vsatemo	lemo = 1mA			400	mV	
CEM pin charge current	Icem	Vcem = 0V	7	10	13	μA	
CEM pin threshold voltage	Vtcem		0.8	1	1.2	V	

Package Dimensions

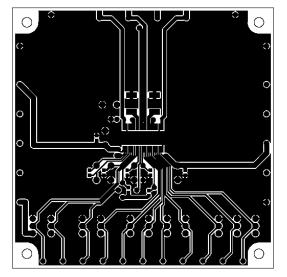
unit : mm (typ) 3333



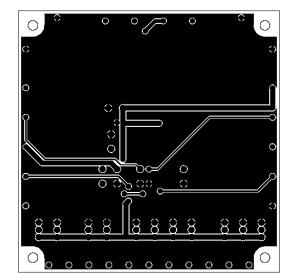


Substrate Specifications (Substrate recommended for operation of LV8732V)

 $\begin{array}{ll} Size & : 90mm \times 90mm \times 1.6mm \mbox{ (two-layer substrate [2S0P])} \\ Material & : Glass epoxy \\ Copper wiring density & : L1 = 85\% \mbox{ / } L2 = 90\% \\ \end{array}$



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.

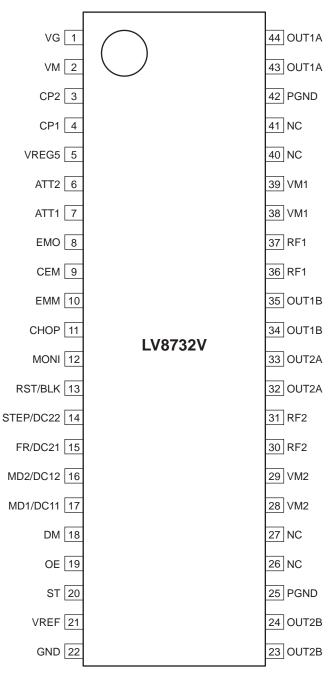
2) For the set design, employ the derating design with sufficient margin.

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

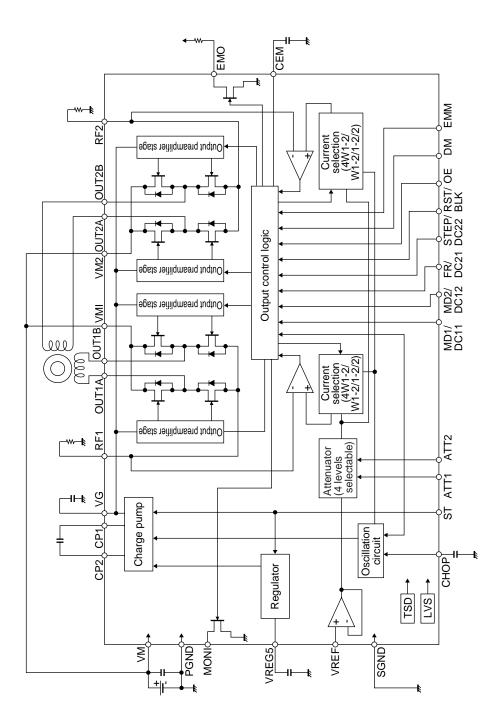
3) After the set design, be sure to verify the design with the actual product. Confirm the solder joint state and verify also the reliability of solder joint for the Exposed Die-Pad, etc. Any void or deterioration, if observed in the solder joint of these parts, causes deteriorated thermal conduction, possibly resulting in thermal destruction of IC.

Pin Assignment



Top view

Block Diagram



Pin Name Pin Name Pin Name Pin Name Equivalent Circuit 6 ATT2 Motor hedding current switching pin. Output short-circuit protection mode watching pin. VREGS 0	Pin Fu	Inctions		
7 ATT1 10 Motor holding current switching pin. 13 RST/BLK RESET input pin (STM) / Banking time switching pin. 14 STEP/C22 STEP signal input pin (STM) / Channel z output control input pin 2 (COM), Channel 1 output control input pin 1 (STM) / Channel 1 output control input pin 2 (STM) / Channel 1 output control input pin 2 (STM) / Channel 1 output control input pin 1 (STM) / Channel 1 output control input pin 1 (STM) / Channel 1 output control input pin 2 (STM) / Channel 1 output control input pin 1 (STM) / Channel 2 OutT8 upput pin. 20 ST Chip enable pin. 21, 24 22, 24 23, 24 24, 24 24, 24 25, 24 24, 25 34, 25 34, 25 34, 25 35, 37 35, 37 3	Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
10 EMM Output short-iccut protection mode switching pin. 13 RST/BLK 14 STEP/DC22 15 FR/DC21 16 MD2/DC12 17 MD1/DC11 18 DM 19 OE 19 OE 20 ST 21 Channel 2 OUTB output pin. 19 OE 20 ST 21 Channel 2 OUTB output pin. 22 ST 23, 24 OUT28 24, 42 PGND 25, 42 PGND 26, 42 PGND 23, 33 OUT2A 30, 31 RF2 Channel 2 OUTB output pin. 23, 35 OUT2A 36, 37 RF1 Channel 1 OUTB output pin. 23, 34 OUT1A 36, 37 RF1 Channel 1 OUTB output pin. 24, 44 OUT1A Channel 2 OUTB output pin.	6	ATT2	Motor holding current switching pin.	
13 RST/BLK Rest Timp in (STM) / Blanking time switching pin (STM) / Channel 2 subject ortrol input pin 2 (DCM). 14 STEP/C22 STEP signal input pin (STM) / Channel 2 august control input pin 2 (DCM). 15 FR/DC21 CW / CCW signal input pin (STM) / Channel 2 (STM) / Channel 1 august control input pin 2 (DCM). 16 MD2DC12 Excitation mode switching pin 1 (STM) / Channel 1 august control input pin 1 (DCM). 17 MD1/DC11 Excitation mode switching pin 1 (STM) / Drannel 1 august control input pin 1 (DCM). 18 DM Drive mode (STM/DCM) switching pin. 19 OE Output enable signal input pin. 19 OE Output enable signal input pin. 20 ST Chip enable pin. 22, 24 PGND Channel 2 OUTB output pin. 24, 24 PGND Power system ground. 25, 24 PGND Channel 2 OUTB output pin. 23, 33 OUTPA Channel 2 OUTB output pin. 24, 33 RFZ Channel 2 OUTB output pin. 24, 42 PGND Power system ground. 24, 34 PGND Channel 2 OUTB output pin. 24, 33 RFZ Channel 1 OUTA output pin.	7	ATT1	Motor holding current switching pin.	
13 RST/BLK RESET input jn (STM) / Blanking time switching jn in (STM) / Blanking time switching jn in (STM) / Blanking time switching jn in (STM) / Channel 2 output control input pin 1 (COM). 15 FR/DC21 CW / COM / Signal input pin (STM) / Channel 2 output control input pin 1 (COM). 16 MD2/DC12 Excitation mode switching pin 2 (STM) / Channel 1 output control input pin 1 (COM). 17 MD1/DC11 Excitation mode switching pin 1 (STM) / Channel 1 output control input pin 1 (COM). 18 DM Drive mode (STM/COM) switching pin. 20 ST Chip enable gina. 23 ST Chip enable gina. 24 OUT28 Channel 2 OUTB output pin. 25.24 OUT28 Channel 2 OUTB output pin. 26.25 VM2 Channel 2 OUTB output pin. 26.35 TO Power system ground. Power system ground. 30.31 RF2 Channel 2 OUTB output pin. 27.34 OUT28 Channel 2 OUTB output pin. 28.35 OUT24 Channel 2 OUTB output pin. 28.35 OUT24 Channel 1 OUTB output pin. 28.35 OUT24 Channel 1 OUTB output pin. 28.39 OUT24 Channel 1 output pin.	10	EMM	Output short-circuit protection mode	
14 STEP/DC22 STEP isgnal input pin (STM) / Channel 2 output control input pin 1 (DCM), Channel 1 output control input pin 1 (DCM), 16 MD2/DC12 Excitation mode switching pin 2 (STM) / Channel 1 output control input pin 1 (DCM), 17 MD1/DC11 Excitation mode switching pin 1 (DCM), 18 DM Drive mode (STMDCM) switching pin. (DCM), 20 ST Chip enable signal input pin. (DCM), 21 ST Chip enable signal input pin. (DCM), 22 ST Chip enable pin. 23 ST Chip enable pin. 24, 2 PSND Channel 2 OUTB output pin. (DCM), 25, 42 PSND Power system ground. Connection pin. 28, 29 VM2 Channel 2 OUTB output pin. Power system ground. Connection pin. 28, 39 OUT2A Channel 2 OUTB output pin. Power system ground. Connection pin. Connection pin. Connection pin. Stars 7 Channel 1 output pin. Channel 1 OUTA output pin. Channel 1 OUTA output pin. 38, 39 VM1 Channel 1 OUTA output pin. Channel 1 OUTA output pin. Channel 1 OUTA output pin. Channel 1 OUTA output pin.			switching pin.	VREG50
14 STEP signal input pin (STM) / Channel 2 output control input pin 2 (DCM), CW / CCW signal input pin 1 (STM) / Channel 2 output control input pin 1 (DCM), Channel 1 output control input pin 2 (DCM). 16 MD2/DC12 Excitation mode switching pin 1 (STM) / Channel 1 output control input pin 1 (DCM). 17 MD1/DC11 Excitation mode switching pin 1 (STM) / Channel 1 output control input pin 1 (DCM). 18 DM Drive mode (STMDCK) switching pin. 20 ST Chip enable pin. 21 Channel 2 OUTB output pin. 22.5.4 OUT2B 23.33 OUT2A 33.31 RF2 Channel 2 OUTB output pin. 7 Power system ground. Channel 2 OUTB output pin. 23.33 OUT2A 34.45 OUT1A Channel 1 OUTB output pin. 35.33 Outrate insere resistor connection pin. 35.33 OUT1A Channel 1 OUTA output pin. 43.44 OUT1A Channel 1 OUTA output pin. Channel 1 OUT	13	RST/BLK	RESET input pin (STM) / Blanking time	
15 FR/DC21 CW/ CW signal input pin (STM) / (CM/) 16 MD2/DC12 Excitation mode switching pin 2 (STM) (DAnnel 1 output control input pin 1 (DCM). 17 MD1/DC11 Excitation mode switching pin 1 (DCM). 18 DM Drive mode (STMDCM) switching pin. 19 OE Output enable signal input pin. 20 ST Channel 2 Output pin. 21 Channel 2 Output pin. 22 ST Chip enable pin.			switching pin (DCM).	
15 FR/DC21 CW/ CCW signal input pin (STM) / Channel 2 output control input pin 1 (DCM). 16 MD2/DC12 Excitation mode switching pin 2 (STM) / Channel 1 output control input pin 1 (DCM). Image: Control input pin 1 (DCM). 17 MD1/DC11 Excitation mode switching pin 1 (STM) / Channel 1 output control input pin 1 (DCM). Image: Control input pin 1 (DCM). Image: Control input pin 1 (DCM). 18 DM Drive mode (STM/DCM) switching pin. Image: Control input pin. 20 ST Chip enable pin. VREGS 0 20 ST Channel 2 OUTB output pin. Image: Control input pin. 20 ST Channel 2 OUTB output pin. Image: Control input pin. 20 ST Channel 2 OUTB output pin. Image: Control input pin. 28, 29 VM2 Channel 2 OUTB output pin. Image: Control input pin. 28, 39 VM2 Channel 2 OUTA output pin. Image: Control input pin. 28, 33 OUT2A Channel 2 OUTA output pin. Image: Control input pin. 38, 39 VM1 Channel 1 OUTA output pin. Image: Control input pin. 38, 39 VM1 Channel 1 OUTA output pin. Image: Contrelinp pin. Image: Control input pin. <td>14</td> <td>STEP/DC22</td> <td>STEP signal input pin (STM) / Channel 2</td> <td></td>	14	STEP/DC22	STEP signal input pin (STM) / Channel 2	
16 MD2/DC12 Channel 2 output control input pin 1 (iCOM), Excitation mode switching pin 2 (STM)/ (ICOM), 17 MD1/DC11 Excitation mode switching pin 1 (STM)/ (ICOM), 10(CM), 000 Excitation mode switching pin 1 (ICOM), 000 MD1/DC11 Excitation mode switching pin 1 (ICOM), 000 Image: Statistic input pin 1 (ICOM), 000 MD1/DC11 Excitation mode switching pin 1 (ICOM), 000 Image: Statistic input pin 1 (ICOM), 000 Image:				Ĭ Î Î Î Î Î Î Î Î Î Î Î Î Î Î Î Î Î Î Î
16 MD2/DC12 (DCM), Excitation mode switching pin 2 (STM)/ Channel 1 output control input pin 2 (DCM), Drive mode (STM/DCM) switching pin. Image: Control input pin 1 (DCM), Drive mode (STM/DCM) switching pin. 17 MD1/DC11 Excitation mode switching pin 1 (STM)/ Channel 1 output control input pin 1 (DCM), Image: Control input pin 1 (DCM), 18 DM Dive mode (STM/DCM) switching pin. Image: Control input pin 1 (DCM), 19 OE Output enable signal input pin. Image: Control input pin. 20 ST Chip enable pin. VREG5 Output pin. 20, ST Channel 2 OUTB output pin. Image: Control input pin. 28, 24 PGND Power system ground. Channel 2 motor power supply connection pin. Channel 2 current-sense resistor connection pin. 22, 33 OUT2A Channel 1 current-sense resistor connection pin. 38, 37 RF1 Channel 1 current-sense resistor connection pin. 38, 33 VM1 Channel 1 current-sense resistor connection pin. 38, 33 VM1 Channel 1 current-sense resistor connection pin. 38, 33 VM1 Channel 1 outra output pin. Channel 1 current-sense resistor connection pin. Channel 1 outra output pin. Channel 1 c	15	FR/DC21	• • • • •	
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Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
1 2 3 4	VG VM CP2 CP1	Charge pump capacitor connection pin. Motor power supply connection pin. Charge pump capacitor connection pin. Charge pump capacitor connection pin.	VREG5 O (4) (2) (3) (1) (1000) (
21	VREF	Constant current control reference voltage input pin.	VREG5 O
5	VREG5	Internal power supply capacitor connection pin.	VM 0 + + - - - - - - - - - - - - -
8	EMO MONI	Output short-circuit state warning output pin. Position detection monitor pin.	

Continued on next page.

	ontinued from preceding page.					
Pin No.	Pin Name	Pin Functtion	Equivalent Circuit			
9	CEM	Pin to connect the output short-circuit state detection time setting capacitor.	VREG5 O			
11	СНОР	Chopping frequency setting capacitor connection pin.	VREG5 O			
22	GND	Ground.				
26, 27 40, 41	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) Drive mode switching pin function

The IC drive mode is switched by setting the DM pin. In STM mode, stepping motor channel 1 can be controlled by the CLK-IN input. In DCM mode, DC motor channel 2 or stepping motor channel 1 can be controlled by parallel input. Stepping motor control using parallel input is 2-phase or 1-2 phase full torque.

DM	Drive mode	Application
Low or Open	STM mode	Stepping motor channel 1 (CLK-IN)
High	DCM mode	DC motor channel 2 or stepping motor channel 1 (parallel)

STM mode (DM = Low or Open)

(1) STEP pin function

In	out	Operating mode
ST	STP	
Low	*	Standby mode
High		Excitation step proceeds
High		Excitation step is kept

(2) Excitation mode setting function

MD1	MD2	Excitation mode	Initial position	
			Channel 1 Channel 2	
Low	Low	2 phase excitation	100%	-100%
High	Low	1-2 phase excitation	100%	0%
Low	High	W1-2 phase excitation	100%	0%
High	High	2W1-2 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) Position detection monitoring function

The MONI position detection monitoring pin is of an open drian type. When the excitation position is in the initial position, the MONI output is placed in the ON state. (Refer to "Examples of current waveforms in each of the excitation modes.")

(4) Setting constant-current control reference current

This IC is designed to automatically exercise PWM constant-current chopping control for the motor current by setting the output current. Based on the voltage input to the VREF pin and the resistance connected between RF and GND, the output current that is subject to the constant-current control is set using the calculation formula below :

 $I_{OUT} = (VREF/5)/RF$ resistance

* The above setting is the output current at 100% of each excitation mode.

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.

		1
ATT1	ATT2	Current setting reference voltage attenuation ratio
Low	Low	100%
High	Low	80%
Low	High	50%
High	High	20%

Attenuation function for VREF input voltage

The formula used to calculate the output current when using the function for attenuating the VREF input voltage is given below.

 $I_{OUT} = (VREF/5) \times (attenuation ratio)/RF$ resistance

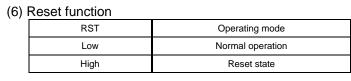
Example : At VREF of 1.5V, a reference voltage setting of 100% [(ATT1, ATT2) = (L, L)] and an RF resistance of 0.3Ω , the output current is set as shown below.

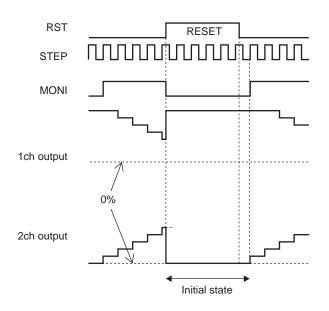
 $I_{OUT} = 1.5V/5 \times 100\%/0.3\Omega = 1.0A$

If, in this state, (ATT1, ATT2) is set to (H, H), IOUT will be as follows : $I_{OUT} = 1.0A \times 20\% = 200mA$

In this way, the output current is attenuated when the motor holding current is supplied so that power can be conserved.

(5) Blanking period

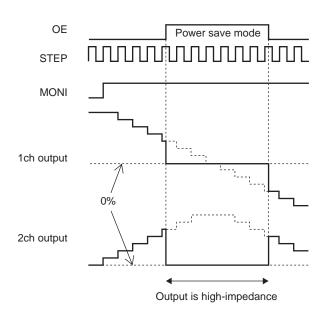




When the RST pin is set to High, the excitation position of the output is forcibly set to the initial state, and the MONI output is placed in the ON state. When RST is then set to Low, the excitation position is advanced by the next STEP input.

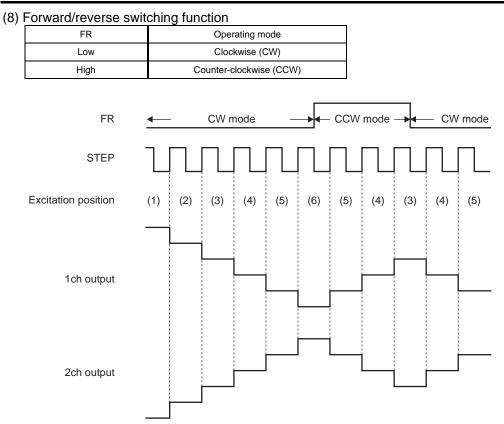
(7) Output enable function

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.



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° relative to the channel 1 current. In CCW mode, the channel 2 current phase is advanced by 90° relative to the channel 1 current.

(9) Chopping frequency setting

For constant-current control, this IC performs chopping operations at the frequency determined by the capacitor (Cchop) connected between the CHOP pin and GND.

The chopping frequency is set as shown below by the capacitor (Cchop) connected between the CHOP pin and GND.

Fchop = Ichop/ (Cchop \times Vtchop \times 2) (Hz)

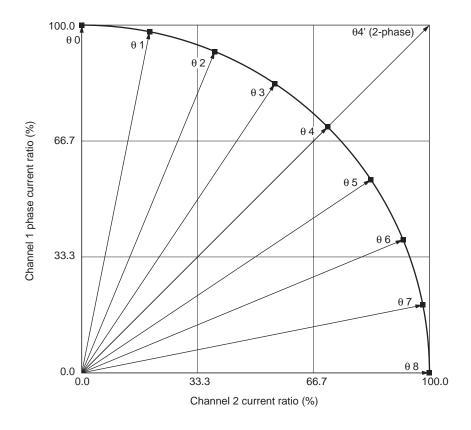
Ichop : Capacitor charge/discharge current, typ 10µA

Vtchop : Charge/discharge hysteresis voltage (Vtup-Vtdown), typ 0.5V

For instance, when Cchop is 200pF, the chopping frequency will be as follows :

 $Fchop = 10\mu A / (200pF \times 0.5V \times 2) = 50kHz$

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

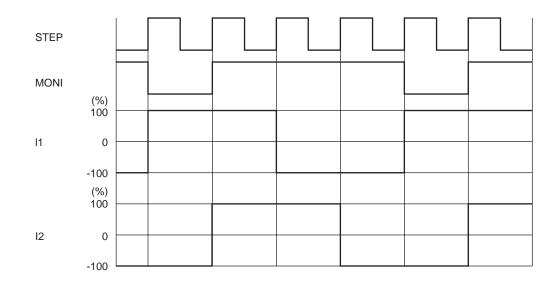


Setting current ration in each excitation mode

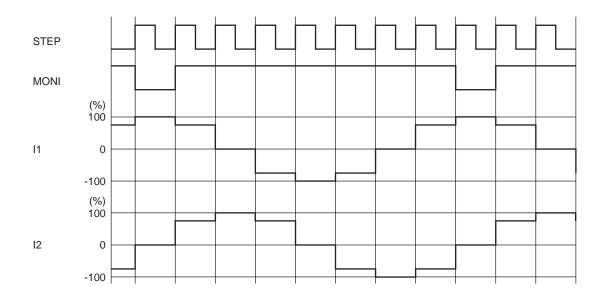
STEP	2W1-2 phase (%)		W1-2 phase (%)		1-2 phase (%)		2-phase (%)	
	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2
θ0	100	0	100	0	100	0		
θ1	98	20						
θ2	92	38	92	38				
θ3	83	55						
θ4	70	70	70	70	70	70	100	100
θ5	55	83						
06	38	92	38	92				
θ7	20	98						
θ8	0	100	0	100	0	100		

(11) Typical current waveform in each excitation mode

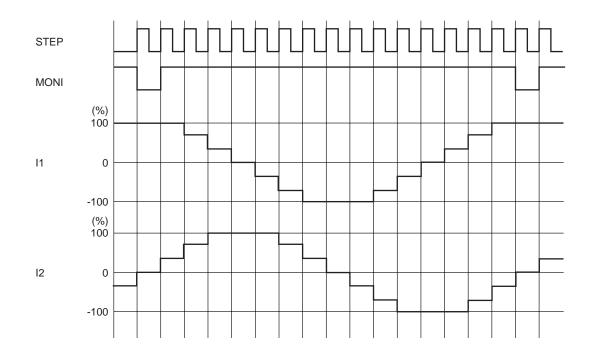
2-phase excitation (CW mode)



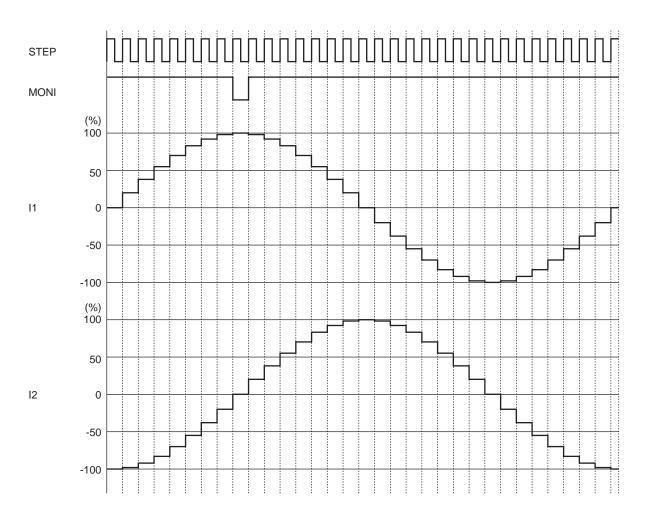
1-2 phase excitation (CW mode)



W1-2 phase excitation (CW mode)

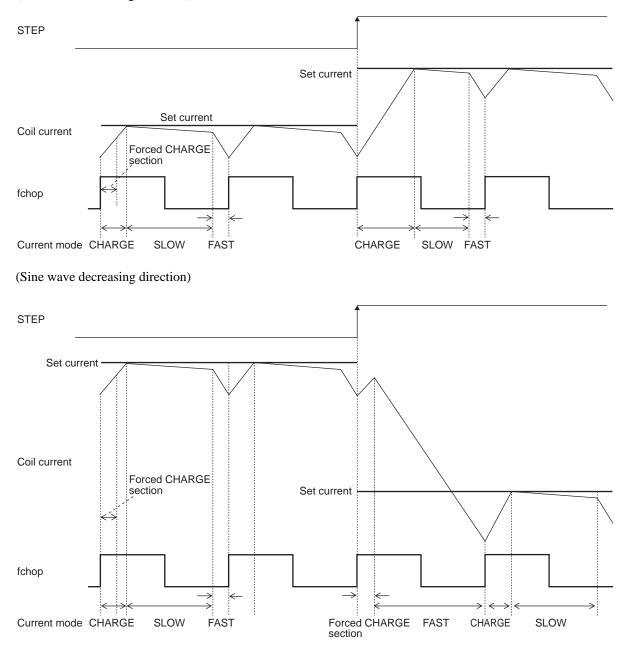


²W1-2 phase excitation (CW mode)



(12) Current control operation specification

(Sine wave increasing direction)



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

- At rise of chopping frequency, the CHARGE mode begins. (In the time defined as the "blanking time," the CHARGE mode is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF).)
- The coil current (ICOIL) and set current (IREF) are compared in this blanking time.
 - When (ICOIL < IREF) state exists ;

The CHARGE mode up to ICOIL \geq IREF, then followed by changeover to the SLOW DECAY mode, and finally by the FAST DECAY mode for approximately 1µs.

When (ICOIL < IREF) state does not exist;

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.

DCM Mode (DM-High)

(1) DCM mode output control logic

Parallel input		Ou	tput	Mode
DC11 (21)	DC12 (22)	OUT1 (2) A	OUT1 (2) B	
Low	Low	OFF	OFF	Standby
High	Low	High	Low	CW (Forward)
Low	High	Low	High	CCW (Reverse)
High	High	Low	Low	Brake

(2) Blanking time switching function

BLK	Blanking time	
Low	2µs	
High	3µs	

(3) Output enable function

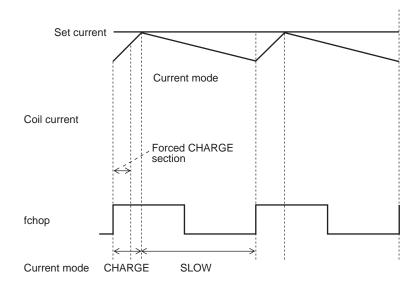
OE	Operating mode	
Low	Output ON	
High	Output OFF	

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

(4) Current limit reference voltage setting function

By setting a current limit, this IC automatically exercises short braking control to ensure that when the motor current has reached this limit, the current will not exceed it.

(Current limit control time chart)



The limit current is set as calculated on the basis of the voltage input to the VREF pin and the resistance between the RF pin and GND using the formula given below.

Ilimit = (VREF/5) /RF resistance

The voltage applied to the VREF pin can be switched to any of the four setting levels depending on the statuses of the two inputs, ATT1 and ATT2.

ATT1	ATT2	Current setting reference voltage attenuation ratio			
Low	Low	100%			
High	Low	80%			
Low	High	50%			
High	High	20%			

Function for attenuating VREF input voltage

The formula used to calculate the output current when using the function for attenuating the VREF input voltage is given below.

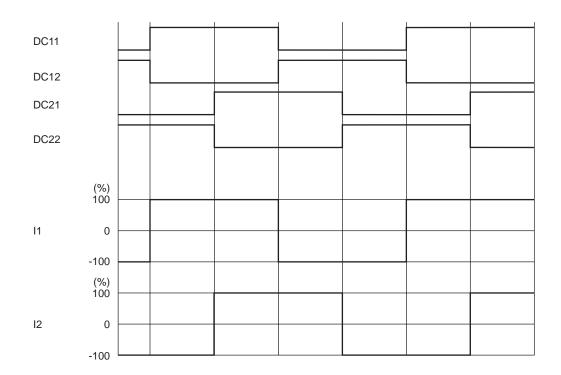
Ilimit = $(VREF/5) \times (attenuation ratio) /RF$ resistance

Example : At VREF of 1.5V, a reference voltage setting of 100% [(ATT1, ATT2) = (L, L)] and an RF resistance of 0.3Ω , the output current is set as shown below.

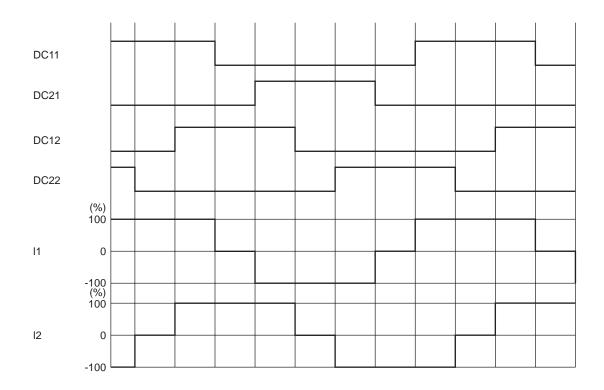
Ilimit = $1.5V/5 \times 100\%/0.3\Omega = 1.0A$

If, in this state, (ATT1, ATT2) has been set to (H, H), Ilimit will be as follows : Ilimit = $1.0A \times 20\% = 200mA$

(5) 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, sets the output to the standby mode and turns on the warning output in order to prevent the IC from being damaged. In the stepping motor driver (STM) mode (DM = Low), this function sets the output to the standby mode for both channels by detecting the short-circuiting in one of the channels. In the DC motor driver mode (DM = High), channels 1 and 2 operate independently. (Even if the output of channel 1 has been short-circuited, channel 2 will operate normally.)

(1) Output short-circuit protection operation changeover function

Changeover to the output short-circuit protection of IC is made by the setting of EMM pin.

EMM	State	
Low or Open	Auto reset method	
High	Latch method	

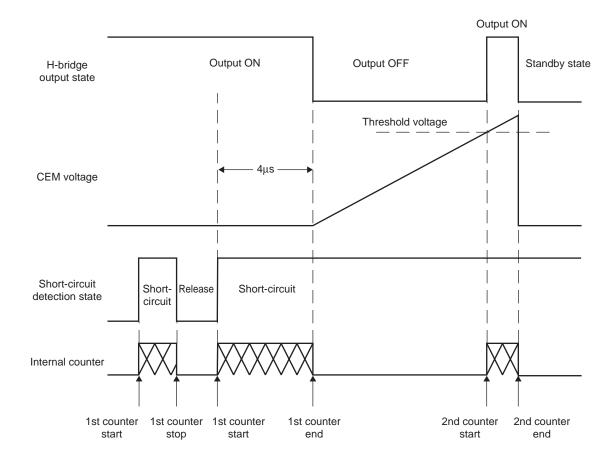
(2) Latch type

In the latch mode, when the output current exceeds the detection current level, the output is turned OFF, and this state is held.

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 4μ 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.



(3) Auto reset type

In the automatic reset mode, when the output current exceeds the detection current level, the output waveform changes to the switching waveform.

As with the latch system, when the output short-circuited state is detected, the short-circuit protection circuit is activated. When the operation of the short-circuit detection circuit exceeds the timer latch time (Tcem) described later, the output is changed over to the standby mode and is reset to the ON mode again in 2ms (typ). In this event, if the overcurrent mode still continues, the switching mode described above is repeated until the overcurrent mode is canceled.

(4) Unusual condition warning output pins (EMO, MONI)

The LV8731V 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. In the DC motor driver mode (DM = High), the MONI pin also functions as a warning output pin.

The functions of the EMO pin and MONI pin change as shown below depending on the state of the DM pin.

When the DM is low (STM mode) :

EMO : Unusual condition warning output pin MONI : Excitation initial position detection monitoring

When the DM is high (DCM) mode) : EMO : Channel 1 warning output pin MONI : Channel 2 warning output pin

Furthermore, the EMO (MONI) 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.

Unusual condition	DM = L (STM mode)		DM = H (DCM mode)	
	EMO	MONI	EMO	MONI
Channel 1 short-circuit detected	ON	-	ON	-
Channel 2 short-circuit detected	ON	-	-	ON
Overheating condition detected	ON	-	ON	ON

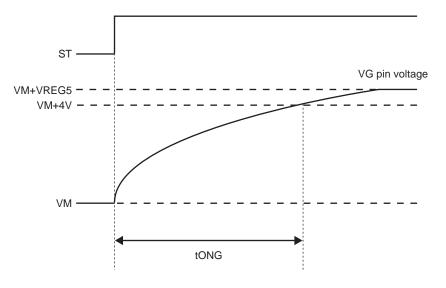
(5) Timer latch time (Tcem)

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 Tcem ≈ Ccem × Vtcem/Icem [sec] Vtcem : Comparator threshold voltage, typ 1V Icem : CEM pin charge current, typ 10µA

Charge Pump Circuit

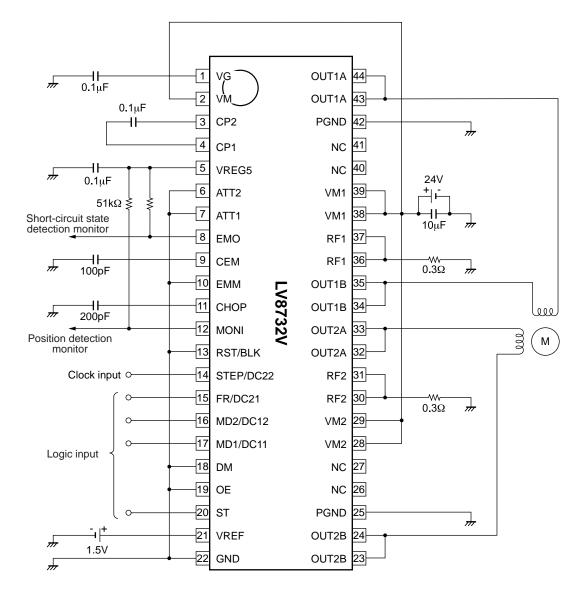
When the ST pin is set High, the charge pump circuit operates and the VG pin voltage is boosted from the VM voltage to the VM + VREG5 voltage. If the VG pin voltage is not boosted sufficiently, the output cannot be controlled, so be sure to provide a wait time of tONG or more after setting the ST pin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





Application Circuit Example

• Stepping motor driver circuit (DM = Low)



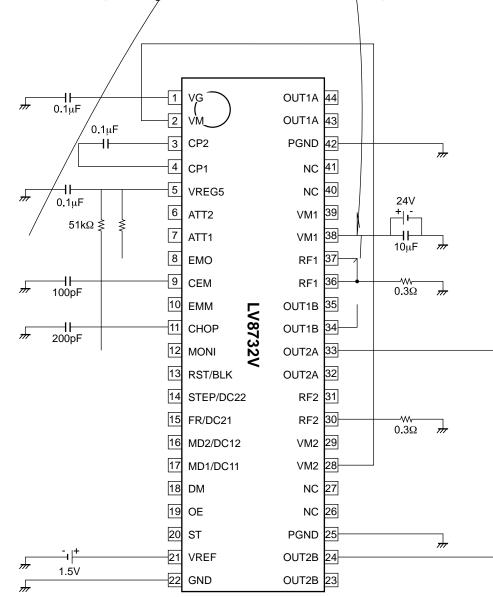
The formulae for setting the constants in the examples of the application circuits above are as follows : Constant current (100%) setting

When VREF = 1.5V

$$\begin{split} I_{OUT} &= VREF/5/RF \ resistance \\ &= 1.5V/5/0.3\Omega = 1.0A \\ Chopping \ frequency \ setting \\ Fchop &= Ichop/ \ (Cchop \times Vtchop \times 2) \\ &= 10 \mu A/ \ (200 pF \times 0.5V \times 2) = 50 kHz \\ Timer \ latch \ time \ when \ the \ output \ is \ short-circuited \\ Tcem &= Ccem \times Vtcem/Icem \\ &= 100 pF \times 1V/10 \mu A = 10 \mu s \end{split}$$



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



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