Ordering number : ENA1483A

SANYO Semiconductors
DATA SHEET

An ON Semiconductor Company

LV8732V — Bi-CMOS LSI 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_O = 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

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	VM max		36	V
Output peak current	I_O peak	tw ≤ 10ms, duty 20%	2.5	A
Output current	I_O max		2	A
Logic input voltage	V_{IN}		-0.3 to +6	V
MONI/EMO input voltage	Vmoni/Vemo		-0.3 to +6	V

Continued on next page.

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

Continued from preceding page.

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°C

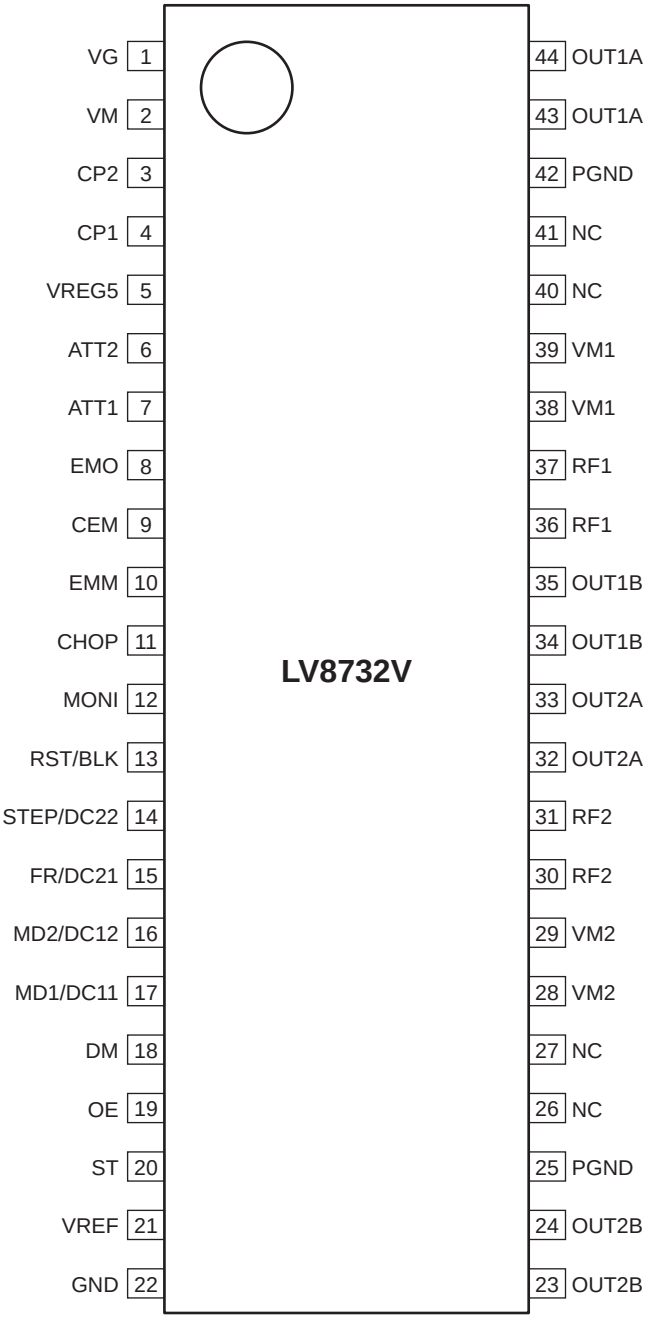
Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	VM		9 to 32	V
Logic input voltage	V_{IN}		0 to 5.5	V
VREF input voltage range	VREF		0 to 3	V

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

Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
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 voltage		Vreg5	I_O = -1mA	4.5	5	5.5	V
Thermal shutdown temperature		TSD	Design guarantee	150	180	200	°C
Thermal hysteresis width		ΔTSD	Design guarantee		40		°C
Motor driver							
Output on resistance		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 current		$I_O$leak				50	μA
Diode forward voltage		VD	ID = -2A		1.2	1.4	V
Logic pin input current		I_{IN}L	V_{IN} = 0.8V	4	8	12	μA
		I_{IN}H	V_{IN} = 5V	30	50	70	μA
Logic high-level input voltage		V_{IN}H		2.0			V
Logic low-level input voltage		V_{IN}L				0.8	V
Current setting comparator threshold voltage (current step switching)	2W1-2-phase drive	Vtdac0_2W	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac1_2W	Step 1 (Initial state+1)	0.285	0.294	0.303	V
		Vtdac2_2W	Step 2 (Initial state+2)	0.267	0.276	0.285	V
		Vtdac3_2W	Step 3 (Initial state+3)	0.240	0.249	0.258	V
		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 comparator threshold voltage (current attenuation rate switching)		Vtatt00	ATT1 = L, ATT2 = L	0.291	0.3	0.309	V
		Vtatt01	ATT1 = H, ATT2 = L	0.232	0.24	0.248	V
		Vtatt10	ATT1 = L, ATT2 = H	0.143	0.15	0.157	V
		Vtatt11	ATT1 = H, ATT2 = H	0.053	0.06	0.067	V

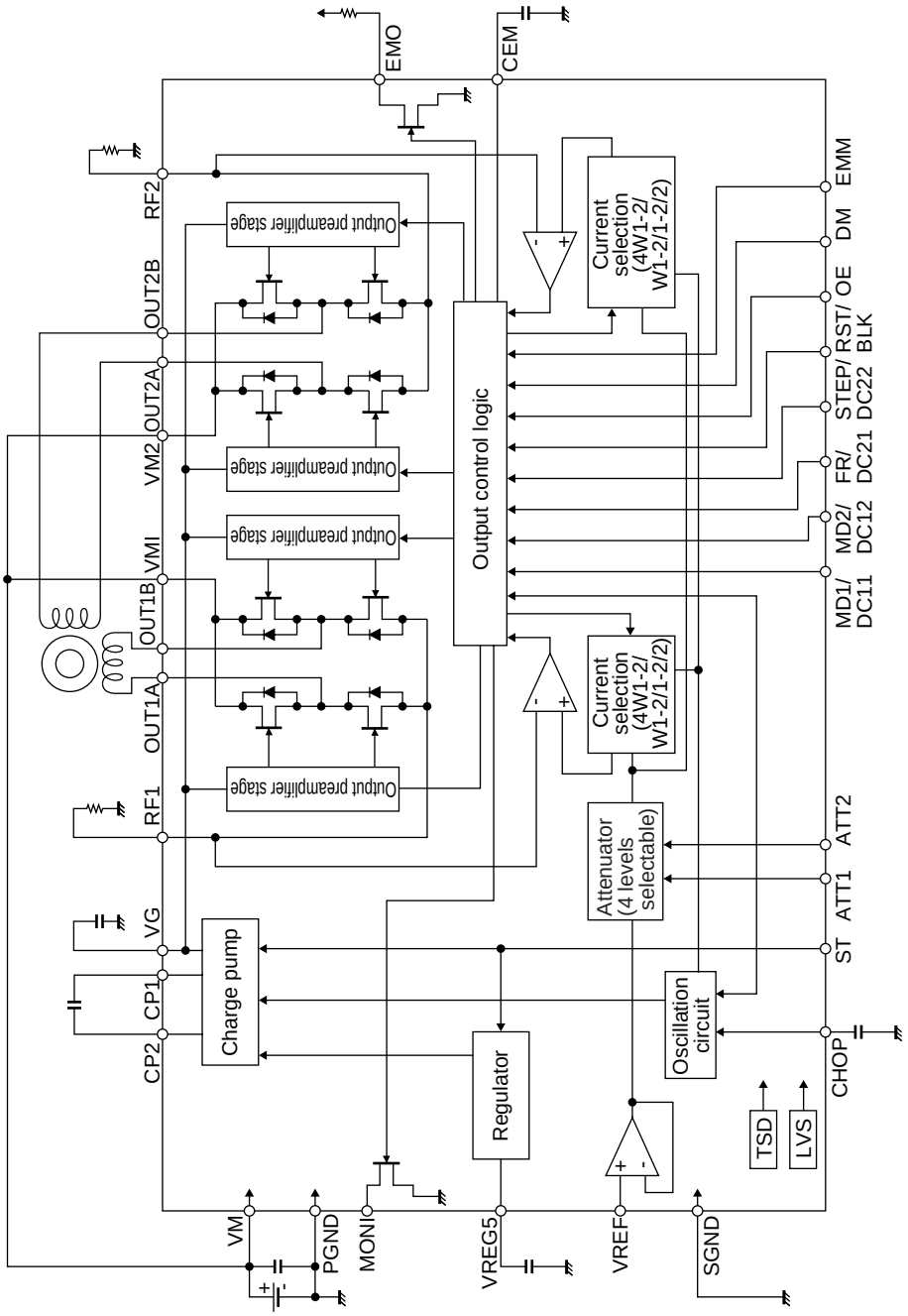
Continued on next page.

Pin Assignment

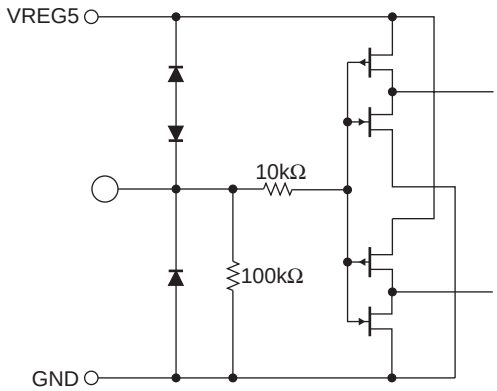
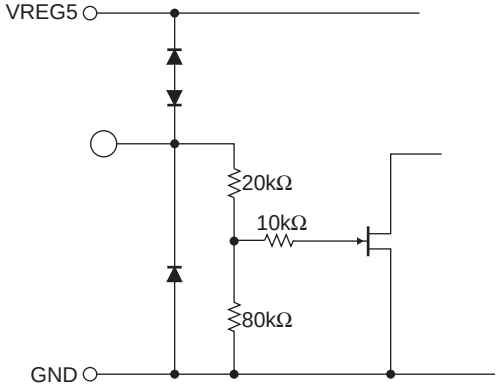
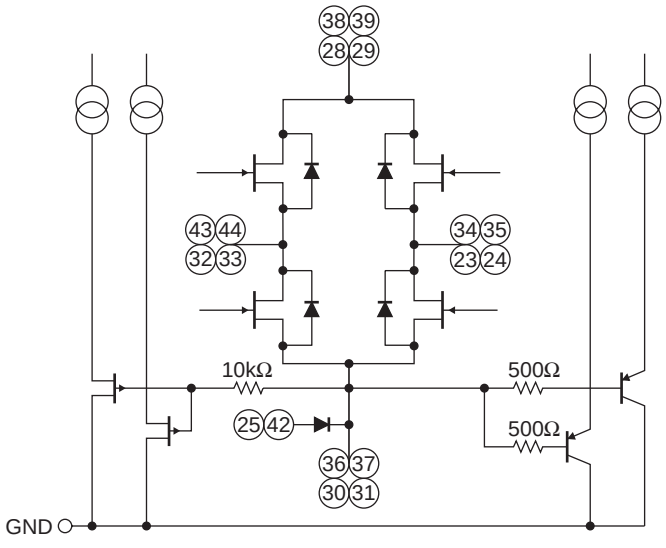


Top view

Block Diagram

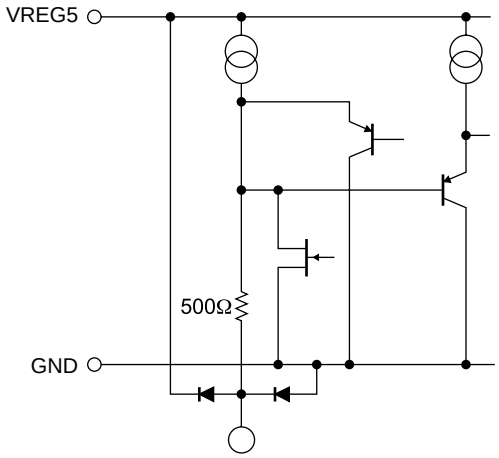
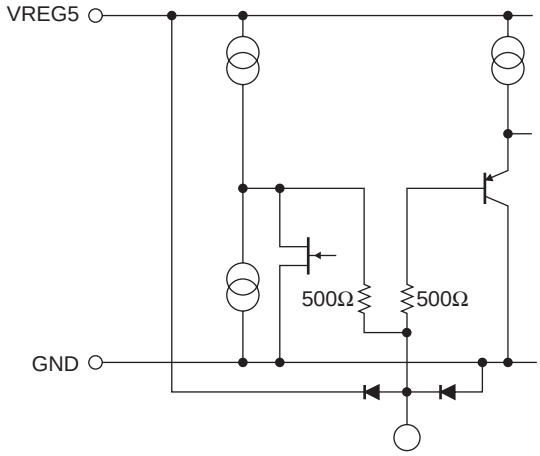


Pin Functions

Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
6	ATT2	Motor holding current switching pin.	
7	ATT1	Motor holding current switching pin.	
10	EMM	Output short-circuit protection mode switching pin.	
13	RST/BLK	RESET input pin (STM) / Blanking time switching pin (DCM).	
14	STEP/DC22	STEP signal input pin (STM) / Channel 2 output control input pin 2 (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 2 (DCM).	
17	MD1/DC11	Excitation mode switching pin 1 (STM) / Channel 1 output control input pin 1 (DCM).	
18	DM	Drive mode (STM/DCM) switching pin.	
19	OE	Output enable signal input pin.	
20	ST	Chip enable pin.	
23, 24	OUT2B	Channel 2 OUTB output pin.	
25, 42	PGND	Power system ground.	
28, 29	VM2	Channel 2 motor power supply connection pin.	
30, 31	RF2	Channel 2 current-sense resistor connection pin.	
32, 33	OUT2A	Channel 2 OUTA output pin.	
34, 35	OUT1B	Channel 1 OUTB output pin.	
36, 37	RF1	Channel 1 current-sense resistor connection pin.	
38, 39	VM1	Channel 1 motor power supply pin.	
43, 44	OUT1A	Channel 1 OUTA output pin.	

Continued on next page.

Continued 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.	
11	CHOP	Chopping frequency setting capacitor connection pin.	
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

Input		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.

Attenuation function for VREF input voltage

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

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) × (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 × 100%/0.3Ω = 1.0A

If, in this state, (ATT1, ATT2) is set to (H, H), IOUT will be as follows :

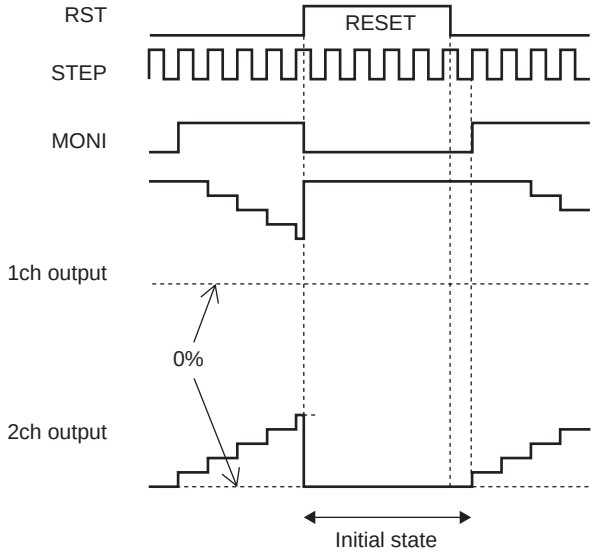
I_{OUT} = 1.0A × 20% = 200mA

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

(5) Blanking period

(6) Reset function

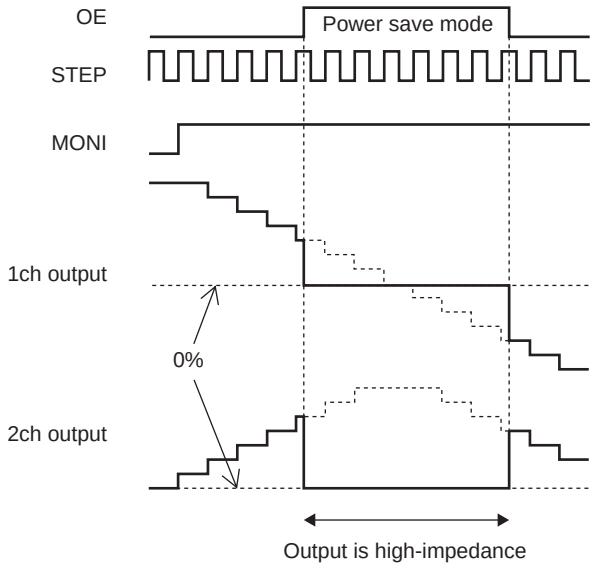
RST	Operating mode
Low	Normal operation
High	Reset state



When the RST pin is set to High, the excitation position of the output is forcibly set to the initial state, 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

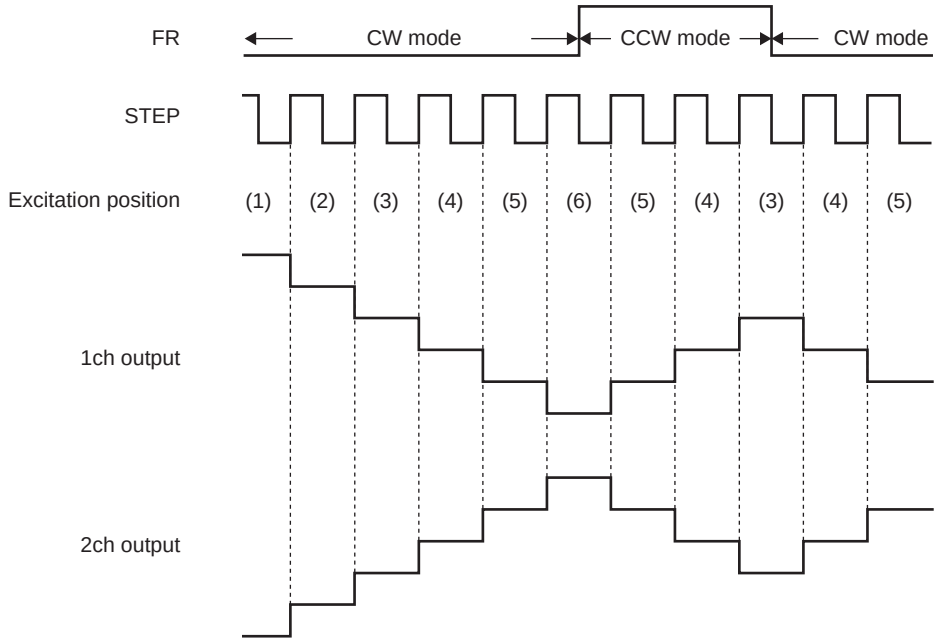
OE	Operating mode
Low	Output ON
High	Output OFF



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.

(8) Forward/reverse switching function

FR	Operating mode
Low	Clockwise (CW)
High	Counter-clockwise (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° 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.

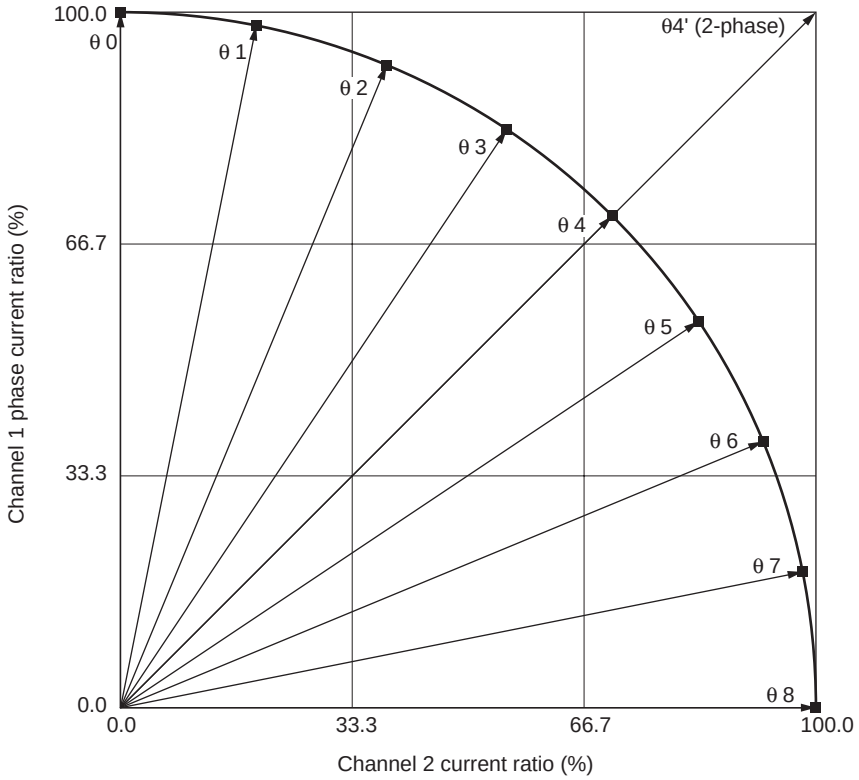
$$Fchop = Ichop / (Cchop \times Vtchop \times 2) \ (Hz)$$

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)

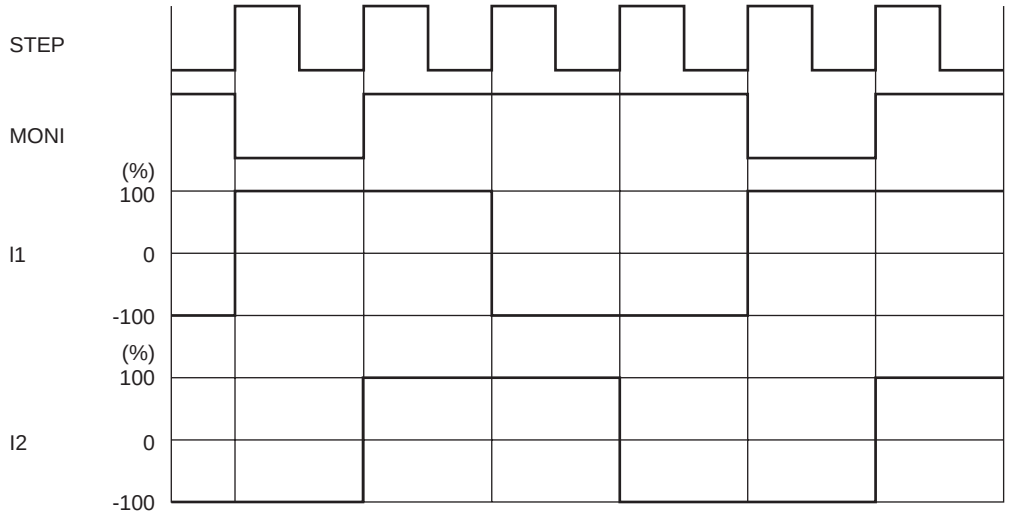


Setting current ration in each excitation mode

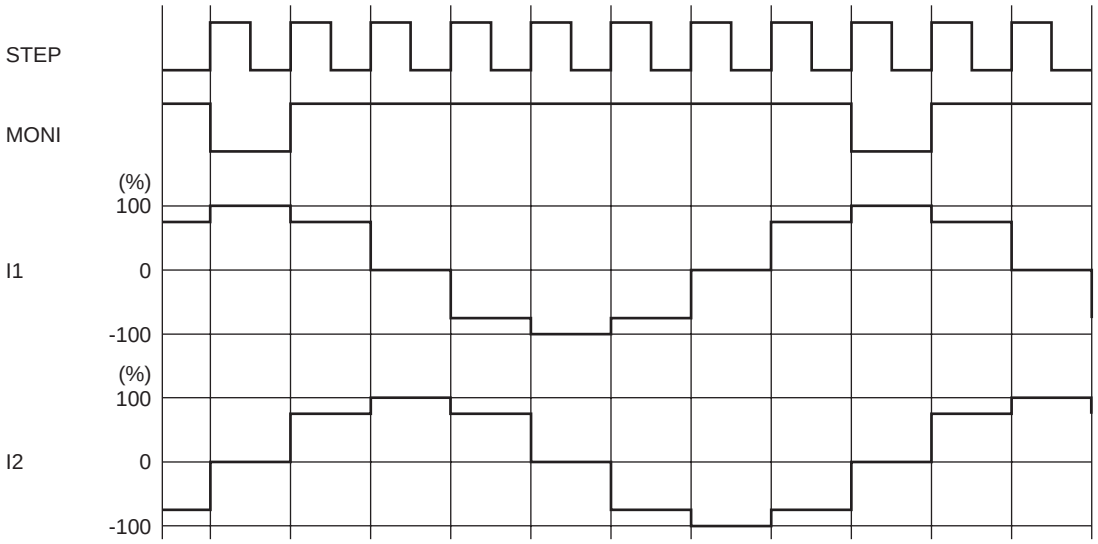
STEP	2W1-2 phase (%)		W1-2 phase (%)		1-2 phase (%)		2-phase (%)	
	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2
θ0	100	0	100	0	100	0		
θ1	98	20						
θ2	92	38	92	38				
θ3	83	55						
θ4	70	70	70	70	70	70	100	100
θ5	55	83						
θ6	38	92	38	92				
θ7	20	98						
θ8	0	100	0	100	0	100		

(11) Typical current waveform in each excitation mode

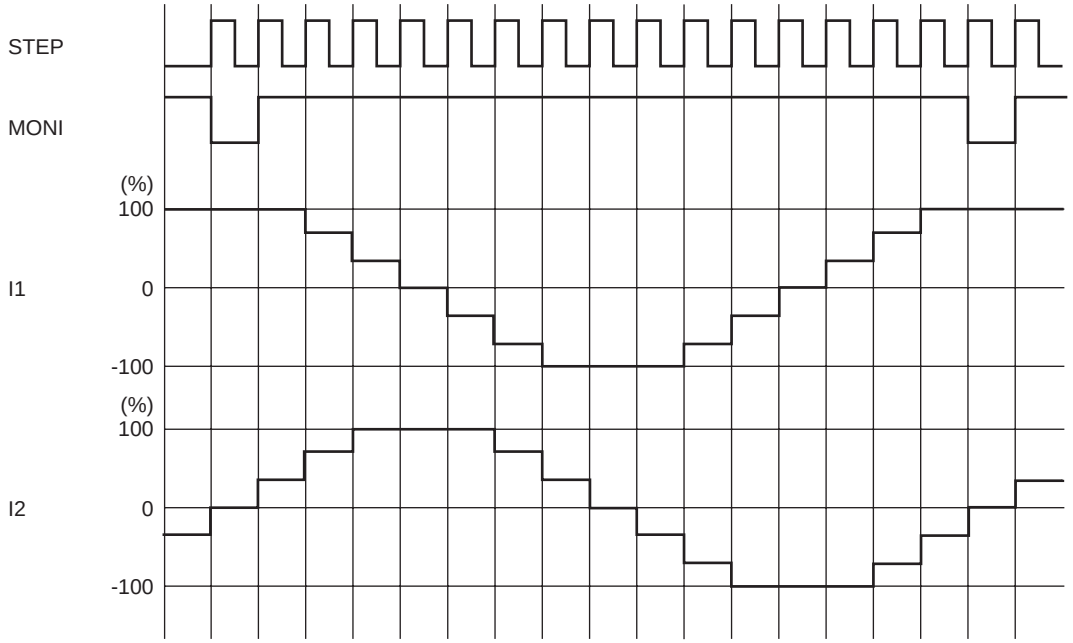
2-phase excitation (CW mode)



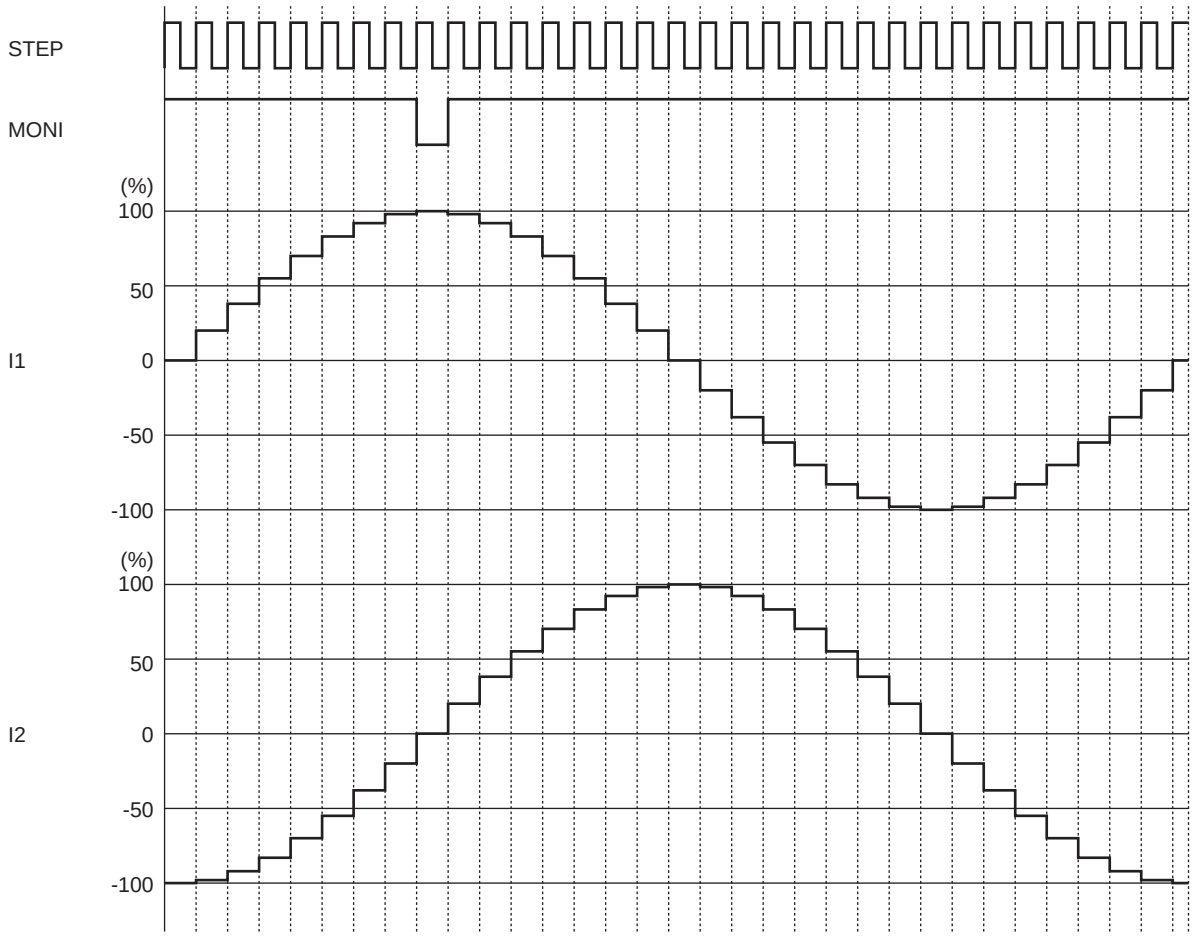
1-2 phase excitation (CW mode)



W1-2 phase excitation (CW mode)

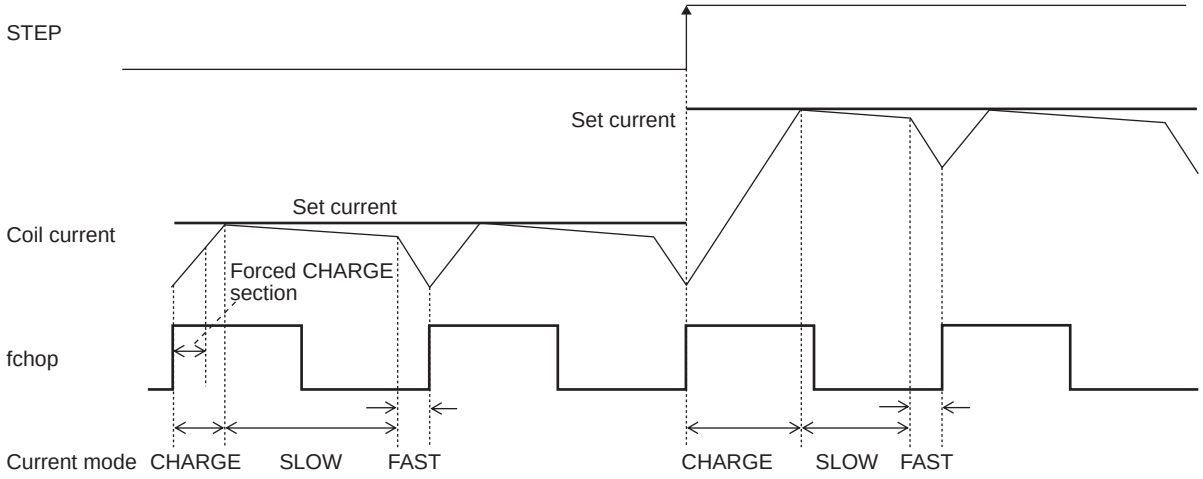


2W1-2 phase excitation (CW mode)

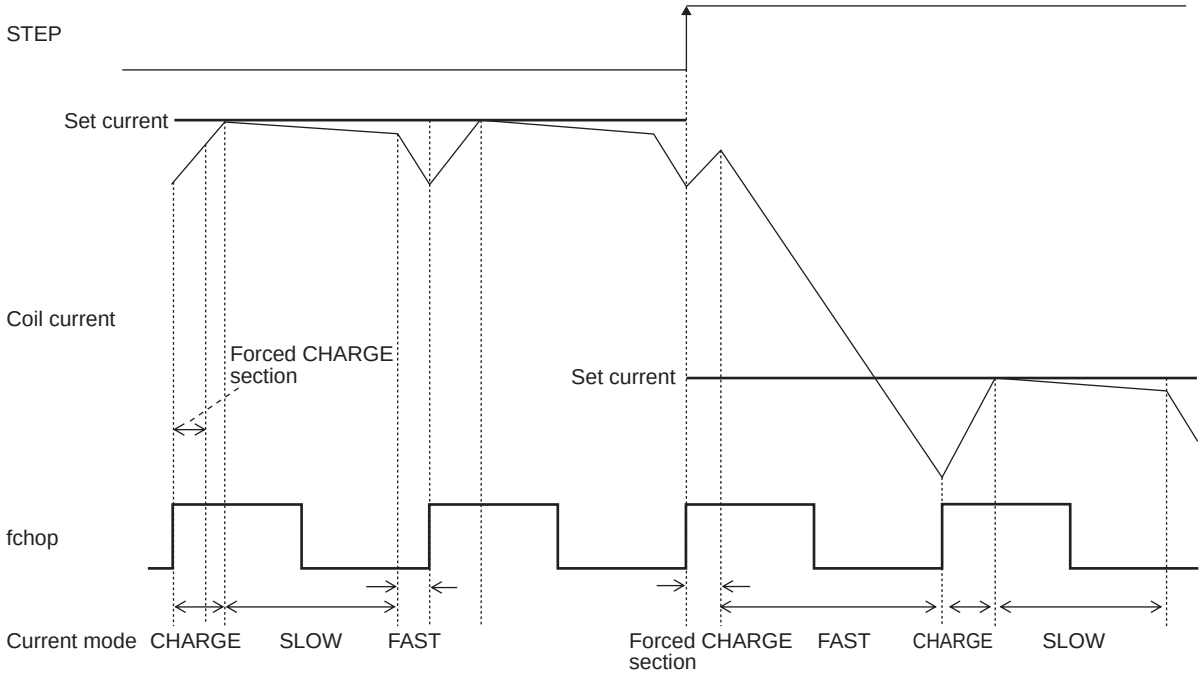


(12) Current control operation specification

(Sine wave increasing direction)



(Sine wave decreasing 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 ≥ 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		Output		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

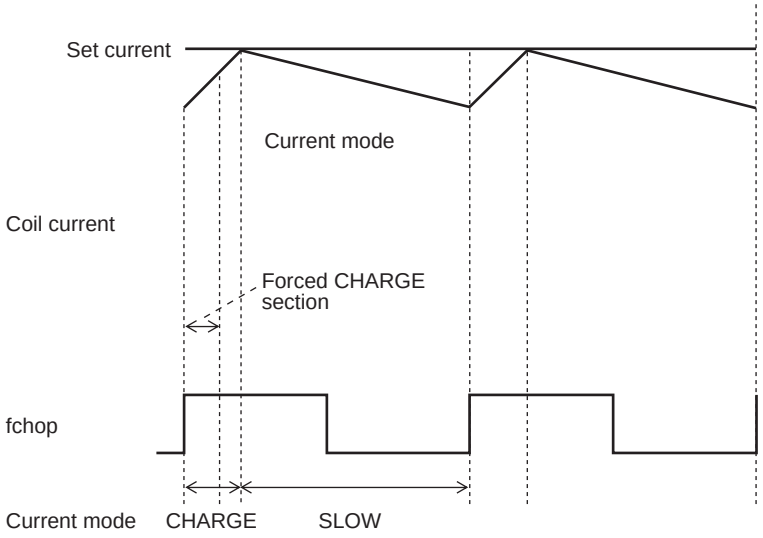
OE	Operating mode
Low	Output ON
High	Output OFF

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.

Function for attenuating VREF input voltage

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

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

Ilimit = (VREF/5) × (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.

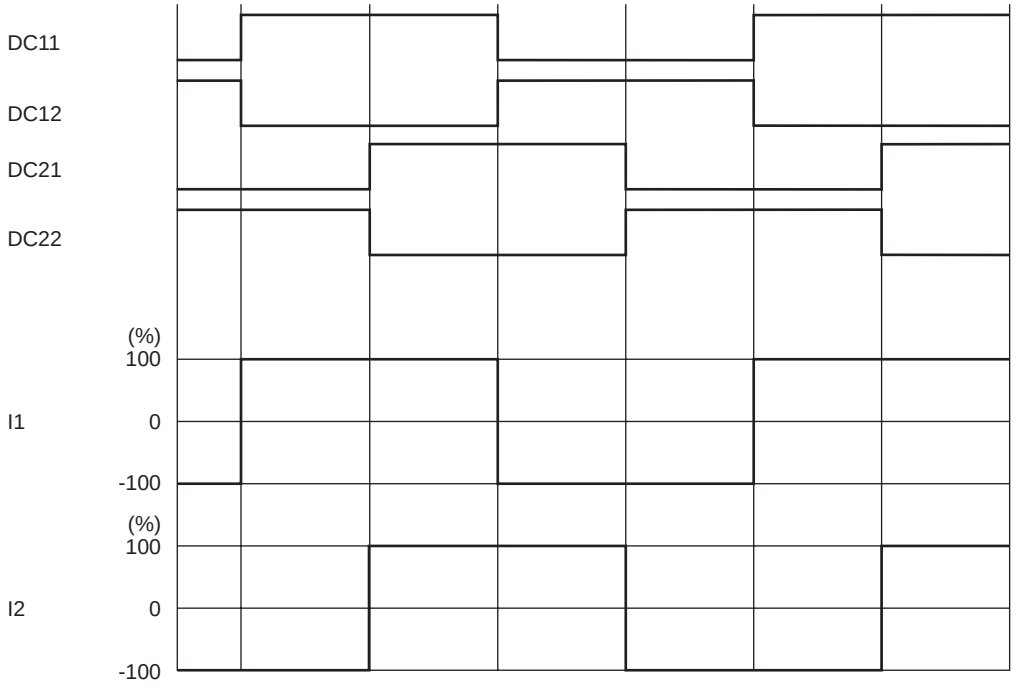
Ilimit = 1.5V/5 × 100%/0.3Ω = 1.0A

If, in this state, (ATT1, ATT2) has been set to (H, H), Ilimit will be as follows :

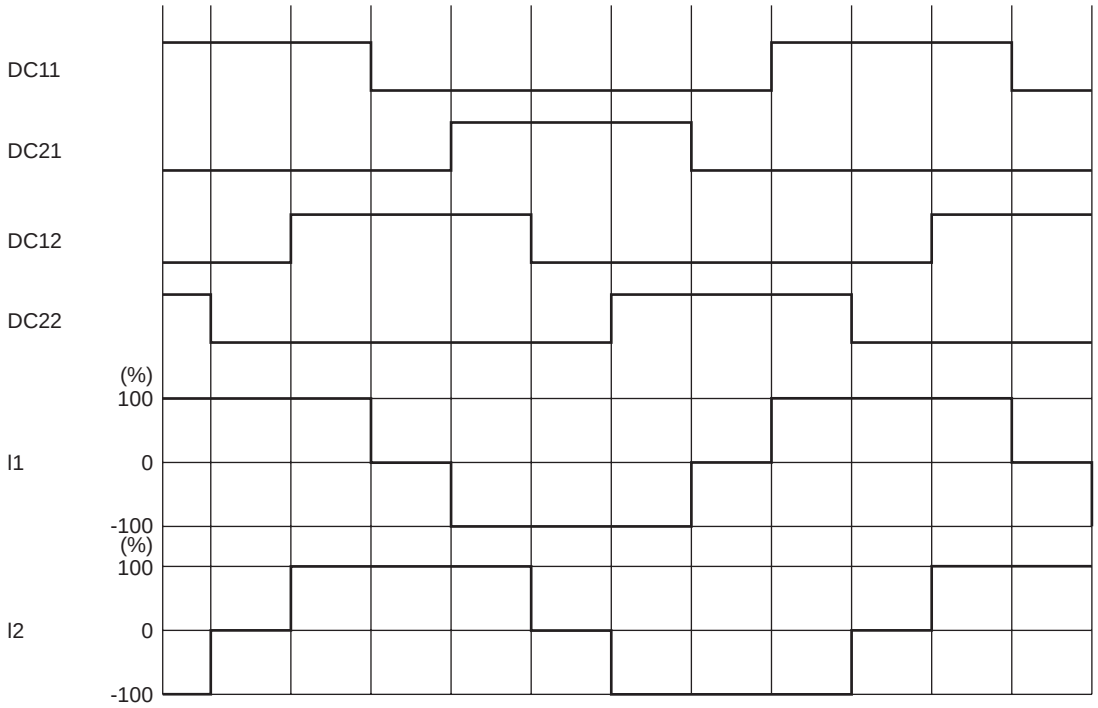
Ilimit = 1.0A × 20% = 200mA

(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

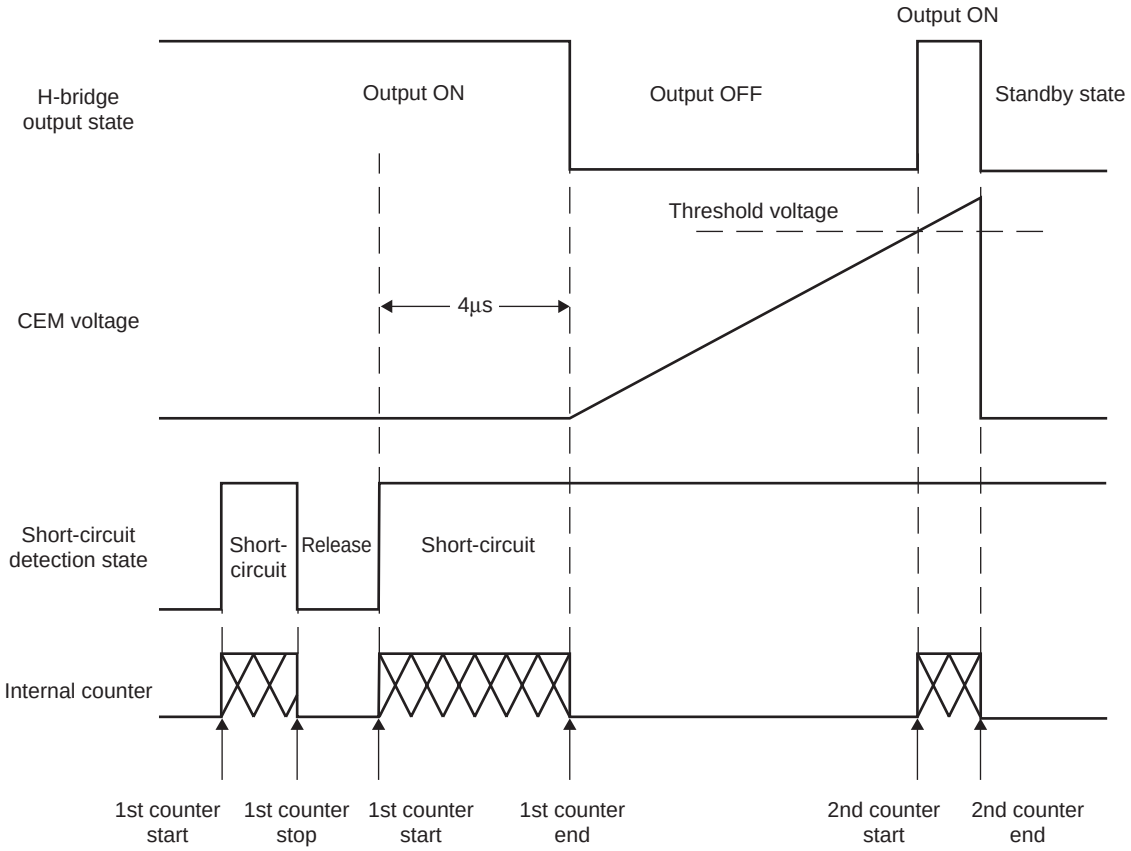
(2) Latch type

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 4μs), 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)

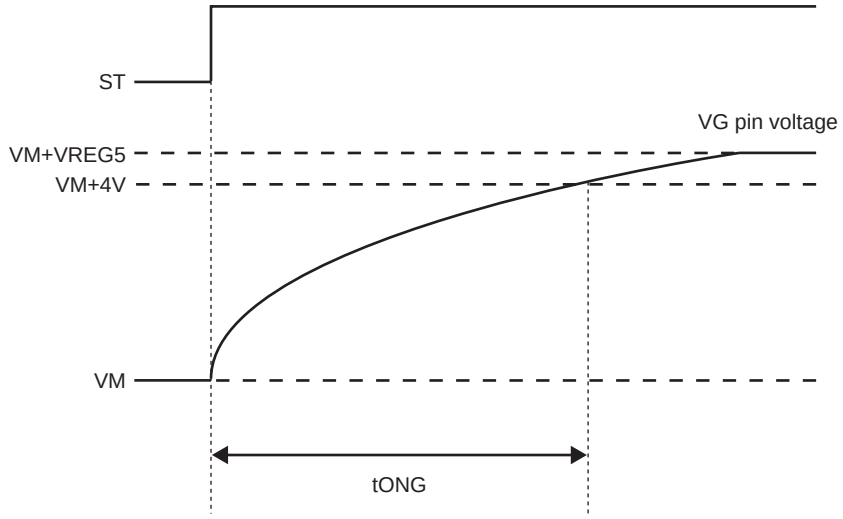
The time taken for the output to be set to OFF when the output has been short-circuited can be set using capacitor Ccem, connected between the CEM pin and GND. The value of capacitor Ccem is determined by the formula given below.

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

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

Charge Pump Circuit

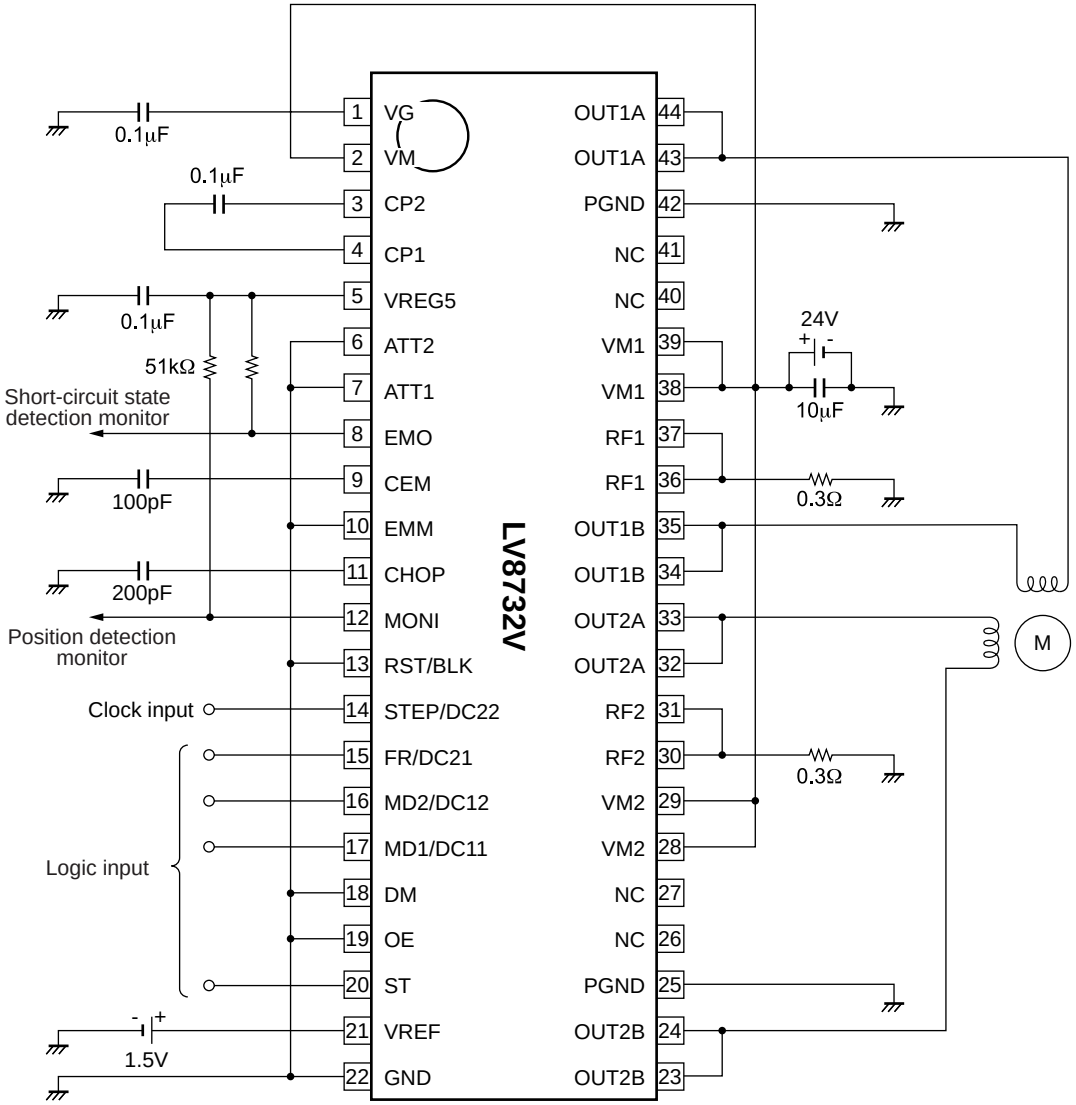
When the ST pin is set High, the charge pump circuit operates and the VG pin voltage is boosted from the VM voltage to the VM + VREG5 voltage. If the VG pin voltage is not boosted sufficiently, the output cannot be controlled, so be sure to provide a wait time of tONG or more after setting the ST pin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



VG Pin Voltage Schematic View

Application Circuit Example

• 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

I_{OUT} = VREF/5/RF resistance

= 1.5V/5/0.3Ω = 1.0A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

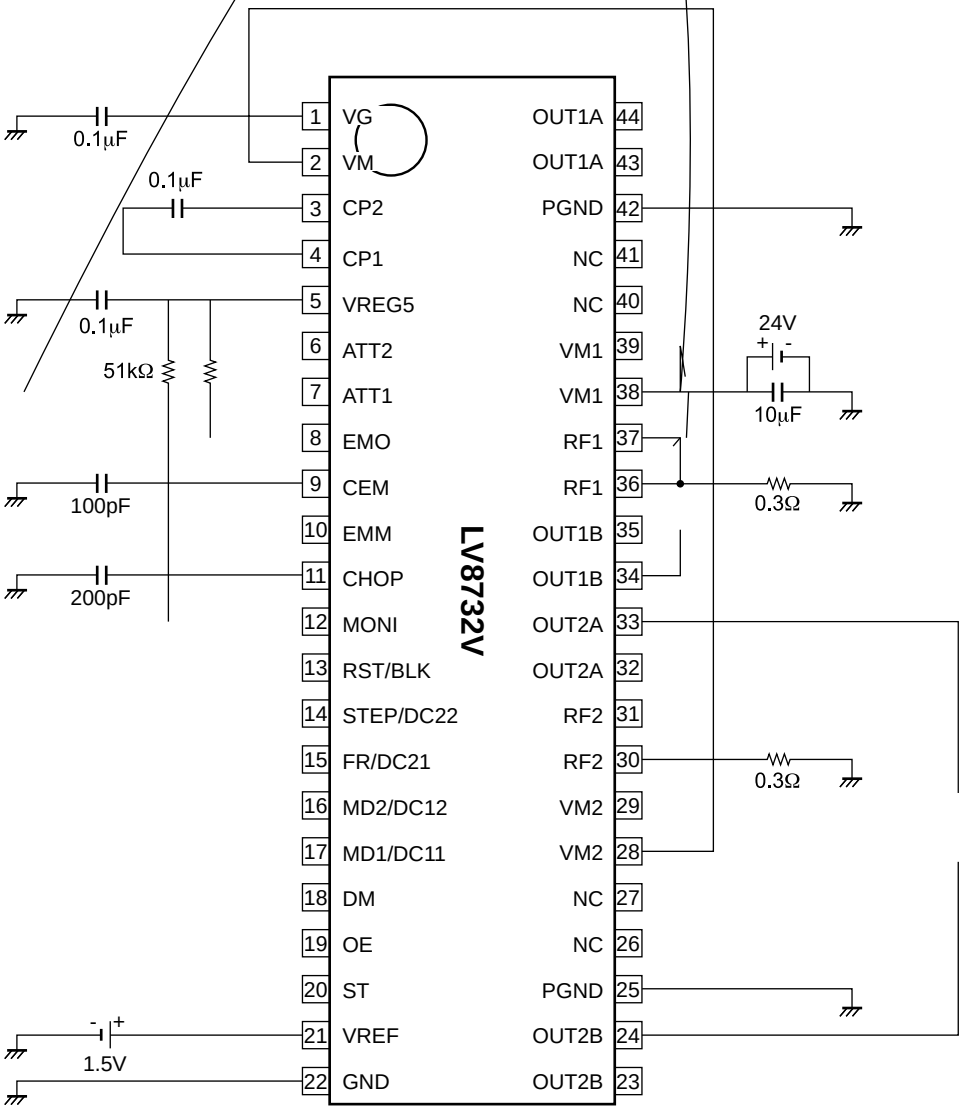
= 10μA/ (200pF × 0.5V × 2) = 50kHz

Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

= 100pF × 1V/10μA = 10μs

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



- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellctual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of December, 2009. Specifications and information herein are subject to change without notice.