Ordering number : ENA1918

SANYO Semiconductors
DATA SHEET
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LV8713T — Bi-CMOS LSI PWM Constant-Current Control Stepping Motor Driver

Overview

The LV8713T is a stepping motor driver of the micro-step drive corresponding to supports 8W 1-2 phase excitation. It is the best for the drive of the stepping motor for a scanner and a small printer.

Features

- Single-channel PWM constant-current control stepping motor driver incorporated.
- Control mode can be set to 2-phase, 1-2 phase, 4W1-2 phase , or 8W1-2 phase
- Microstep can control easily by the CLK-IN input.
- Power-supply voltage of motor : VM max = 18V
- Output current : I_O max = 0.8A
- Output ON resistance : R_{ON} = 1.1Ω (upper and lower total, typical, Ta = 25°C)
- A thermal shutdown circuit and a low voltage detecting circuit are built into.

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage	VM max		18	V
Logic supply voltage	V_{CC} max		6	V
Output peak current	I_O peak	Each 1ch, tw ≤ 10ms, duty 20%	1.0	A
Output continuousness current	I_O max	Each 1ch	800	mA
Logic input voltage	V_{IN}		-0.3 to V_{CC} + 0.3	V
Allowable power dissipation	Pd max	*	1.35	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

* Specified circuit board : 57.0mm×57.0mm×1.7mm, glass epoxy 2-layer board.

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Allowable Operating Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage range	VM		4 to 16	V
Logic supply voltage range	V_{CC}		2.7 to 5.5	V
Logic input voltage	V_{IN}		-0.3 tp V_{CC}+0.3	V
VREF input voltage range	VREF		0 to V_{CC}-1.8	V

Electrical Characteristics at Ta = 25°C, VM = 12V, V_{CC} = 3.3VVREF = 1.0V

Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Standby mode current drain		IMstn	PS = "L", no load			1	μA
		I_{CC}stn	PS = "L", no load			1	μA
Current drain		IM	PS = "H", no load	0.3	0.5	0.7	mA
		I_{CC}	PS = "H", no load	0.9	1.3	1.7	mA
Thermal shutdown temperature		TSD	Design guarantee		180		°C
Thermal hysteresis width		ΔTSD	Design guarantee		40		°C
V_{CC} low voltage cutting voltage		VthV_{CC}		2.1	2.4	2.7	V
Low voltage hysteresis voltage		VthHIS		100	130	160	mV
REG5 output voltage		Vreg5	I_O = -1mA	4.5	5	5.5	V
Output on resistance		RonU	I_O = -800mA, Source-side on resistance		0.78	1.0	Ω
		RonD	I_O = 800mA, Sink-side on resistance		0.32	0.43	Ω
Output leakage current		$I_O$leak	V_O = 15V			10	μA
Diode forward voltage		VD	ID = -800mA		1.0	1.2	V
Logic pin input current		I_{IN}L	V_{IN} = 0.8V	4	8	12	μA
		I_{IN}H	V_{IN} = 3.3V	22	33	45	μA
Logic high-level input voltage		V_{IN}H		2.0			V
Logic low-level input voltage		V_{IN}L				0.8	V
VREF input current		I_{REF}	VREF = 1.0V	-0.5			μA
Current setting comparator threshold voltage (current attenuation rate switching)		Vtatt00	ATT1 = L, ATT2 = L	0.191	0.200	0.209	V
		Vtatt01	ATT1 = H, ATT2 = L	0.152	0.160	0.168	V
		Vtatt10	ATT1 = L, ATT2 = H	0.112	0.120	0.128	V
		Vtatt11	ATT1 = H, ATT2 = H	0.072	0.080	0.088	V
Chopping frequency		Fchop	Cchop = 220pF	36	45	54	kHz
CHOP pin threshold voltage		V_{CHOP}H		0.6	0.7	0.8	V
		V_{CHOP}L		0.17	0.2	0.23	V
CHOP pin charge/discharge current		Ichop		7	10	13	μA
MONI pin saturation voltage		Vsatmon	Imoni = 1mA		250	400	mV
Current setting comparator threshold voltage (current step switching)	8W1-2-phase drive	Vtdac0_2W	Step 0 (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V
		Vtdac1_8W	Step 1 (Initial state+1)	0.191	0.200	0.209	V
		Vtdac2_8W	Step 2 (Initial state+2)	0.191	0.200	0.209	V
		Vtdac3_8W	Step 3 (Initial state+3)	0.189	0.198	0.207	V
		Vtdac4_8W	Step 4 (Initial state+4)	0.187	0.196	0.205	V
		Vtdac5_8W	Step 5 (Initial state+5)	0.185	0.194	0.203	V
		Vtdac6_8W	Step 6 (Initial state+6)	0.183	0.192	0.201	V
		Vtdac7_8W	Step 7 (Initial state+7)	0.179	0.188	0.197	V
		Vtdac8_8W	Step 8 (Initial state+8)	0.175	0.184	0.193	V
		Vtdac9_8W	Step 9 (Initial state+9)	0.171	0.180	0.189	V
		Vtdac10_8W	Step 10 (Initial state+10)	0.167	0.176	0.185	V
		Vtdac11_8W	Step 11 (Initial state+11)	0.163	0.172	0.181	V
		Vtdac12_8W	Step 12 (Initial state+12)	0.158	0.166	0.174	V
		Vtdac13_8W	Step 13 (Initial state+13)	0.152	0.160	0.168	V
		Vtdac14_8W	Step 14 (Initial state+14)	0.146	0.154	0.162	V
		Vtdac15_8W	Step 15 (Initial state+15)	0.140	0.148	0.156	V
		Vtdac16_8W	Step 16 (Initial state+16)	0.132	0.140	0.148	V

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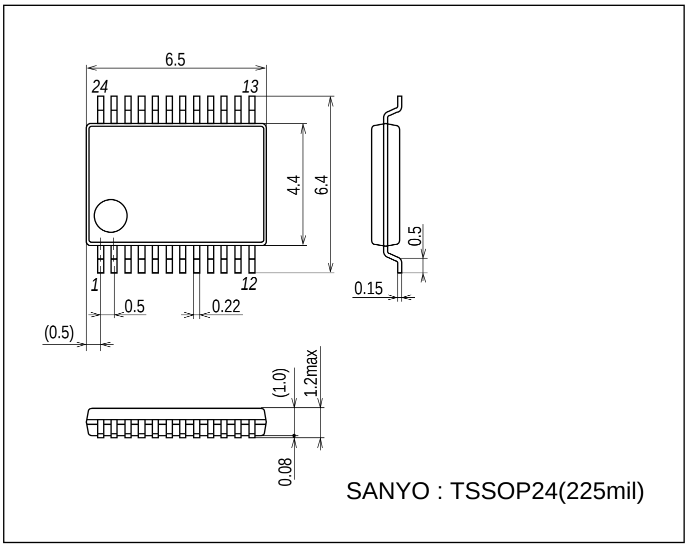
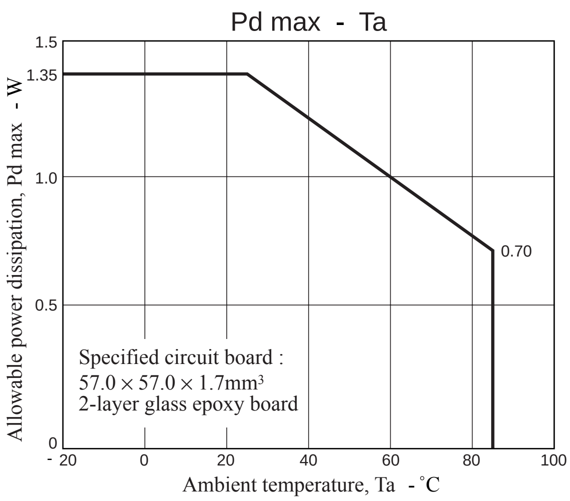
Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Current setting comparator threshold voltage (current step switching)	8W1-2-phase drive	Vtdac17_8W	Step 17 (Initial state+17)	0.126	0.134	0.142	V
		Vtdac18_8W	Step 18 (Initial state+18)	0.118	0.126	0.134	V
		Vtdac19_8W	Step 19 (Initial state+19)	0.112	0.120	0.128	V
		Vtdac20_8W	Step 20 (Initial state+20)	0.102	0.110	0.118	V
		Vtdac21_8W	Step 21 (Initial state+21)	0.094	0.102	0.110	V
		Vtdac22_8W	Step 22 (Initial state+22)	0.086	0.094	0.102	V
		Vtdac23_8W	Step 23 (Initial state+23)	0.078	0.086	0.094	V
		Vtdac24_8W	Step 24 (Initial state+24)	0.068	0.076	0.084	V
		Vtdac25_8W	Step 25 (Initial state+25)	0.060	0.068	0.076	V
		Vtdac26_8W	Step 26 (Initial state+26)	0.050	0.058	0.066	V
		Vtdac27_8W	Step 27 (Initial state+27)	0.040	0.048	0.056	V
		Vtdac28_8W	Step 28 (Initial state+28)	0.032	0.040	0.048	V
		Vtdac29_8W	Step 29 (Initial state+29)	0.022	0.030	0.038	V
		Vtdac30_8W	Step 30 (Initial state+30)	0.012	0.020	0.028	V
		Vtdac31_8W	Step 31 (Initial state+31)	0.002	0.010	0.018	V
	4W1-2-phase drive	Vtdac0_4W	Step 0 (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V
		Vtdac2_4W	Step 2 (Initial state+1)	0.191	0.200	0.209	V
		Vtdac4_4W	Step 4 (Initial state+2)	0.187	0.196	0.205	V
		Vtdac6_4W	Step 6 (Initial state+3)	0.183	0.192	0.201	V
		Vtdac8_4W	Step 8 (Initial state+4)	0.175	0.184	0.193	V
		Vtdac10_4W	Step 10 (Initial state+5)	0.167	0.176	0.185	V
		Vtdac12_4W	Step 12 (Initial state+6)	0.158	0.166	0.174	V
		Vtdac14_4W	Step 14 (Initial state+7)	0.146	0.154	0.162	V
		Vtdac16_4W	Step 16 (Initial state+8)	0.132	0.140	0.148	V
		Vtdac18_4W	Step 18 (Initial state+9)	0.118	0.126	0.134	V
		Vtdac20_4W	Step 20 (Initial state+10)	0.102	0.110	0.118	V
		Vtdac22_4W	Step 22 (Initial state+11)	0.086	0.094	0.102	V
		Vtdac24_4W	Step 24 (Initial state+12)	0.068	0.076	0.084	V
		Vtdac26_4W	Step 26 (Initial state+13)	0.050	0.058	0.066	V
		Vtdac28_4W	Step 28 (Initial state+14)	0.032	0.040	0.048	V
		Vtdac30_4W	Step 30 (Initial state+15)	0.012	0.020	0.028	V
	1-2 phase drive	Vtdac0_H	Step 0 (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V
		Vtdac16_H	Step 4 (Initial state+1)	0.132	0.140	0.148	V
	2 phase drive	Vtdac16_F	Step 4' (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V

Package Dimensions

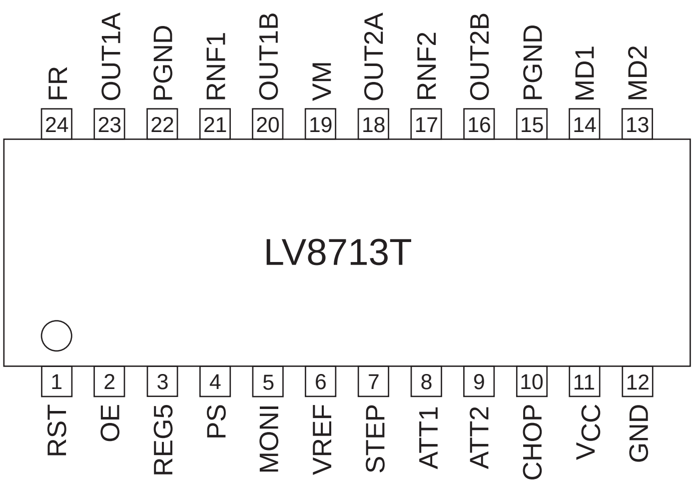
unit : mm (typ)

3260A

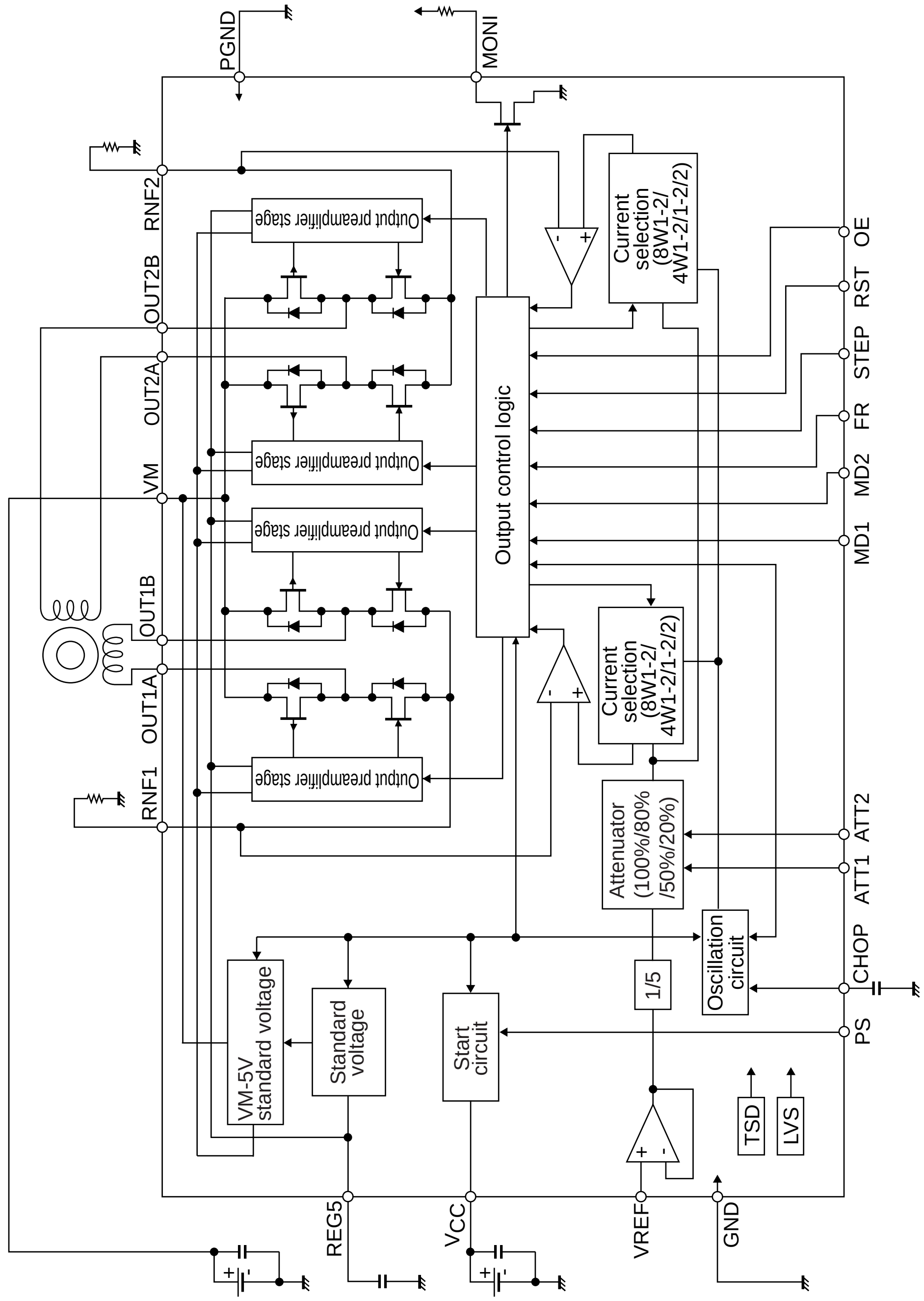




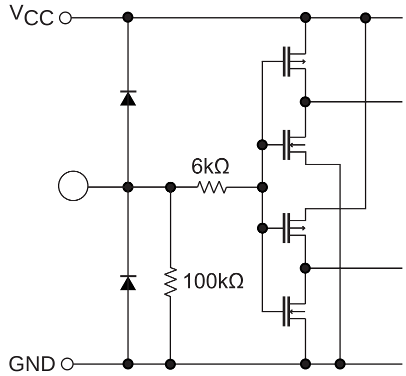
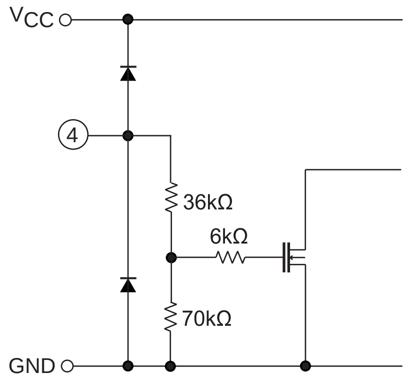
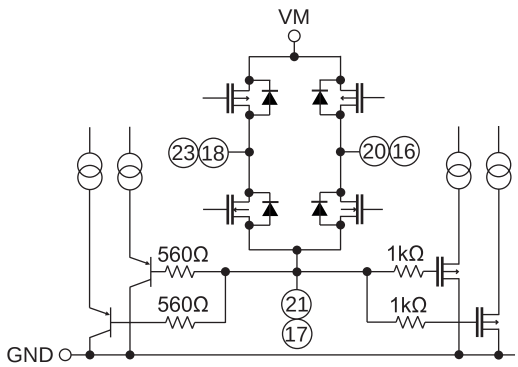
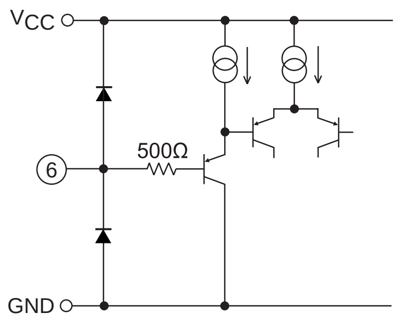
Pin Assignment



Block Diagram



Pin Functions

Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
1	RST	Excitation reset signal input pin.	
2	OE	Output enable signal input pin.	
7	STEP	STEP signal input pin.	
8	ATT1	Motor holding current switching pin.	
9	ATT2	Motor holding current switching pin.	
13	MD2	Excitation mode switching pin 2.	
14	MD1	Excitation mode switching pin 1.	
24	FR	CW / CCW switching signal input pin.	
4	PS	Power save signal input pin.	
16	OUT2B	Channel 2 OUTB output pin.	
17	RNF2	Channel 2 current-sense resistor connection pin.	
18	OUT2A	Channel 2 OUTA output pin.	
20	OUT1B	Channel 1 OUTB output pin.	
21	RNF1	Channel 1 current-sense resistor connection pin.	
23	OUT1A	Channel 1 OUTA output pin.Power	
6	VREF	Constant current control reference voltage input pin.	

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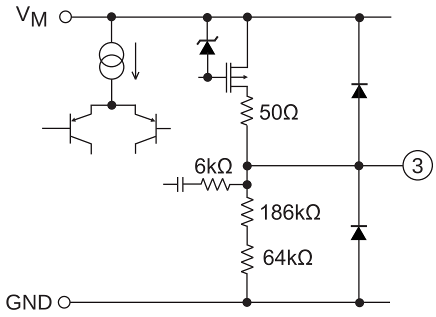
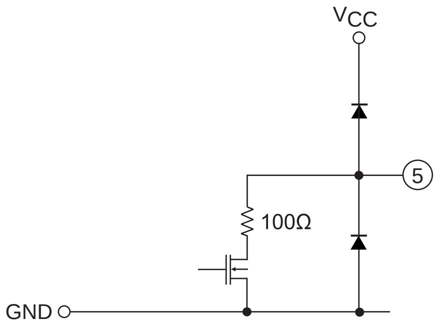
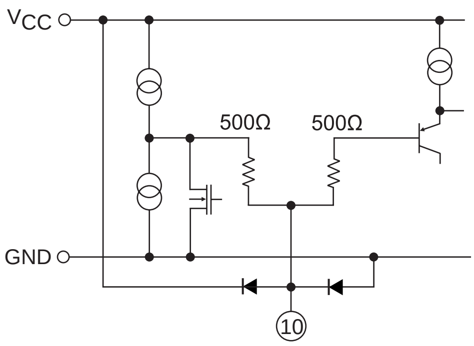
Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
3	REG5	Internal power supply capacitor connection pin.	
5	MONI	Position detection monitor pin.	
10	CHOP	Chopping frequency setting capacitor connection pin.	

Description of operation

Stepping motor control

(1) Power save function

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

PS	Mode	Internal regulator
Low or Open	Standby mode	Standby
High	Operating mode	Operating

(2) The order of turning on recommended power supply

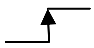
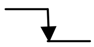
The order of turning on each power supply recommends the following.

VCC power supply order → VM power supply order → PS pin = High

It becomes the above-mentioned opposite for power supply OFF.

However, the above-mentioned is a recommendation, the overcurrent is not caused by not having defended this, and IC is destroyed.

(3) STEP pin function

Input		Operating mode
PS	STP	
Low	*	Standby mode
High		Excitation step proceeds
High		Excitation step is kept

(4) Excitation mode setting function(initial position)

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	4W1-2 phase excitation	100%	0%
High	High	8W1-2 phase excitation	100%	0%

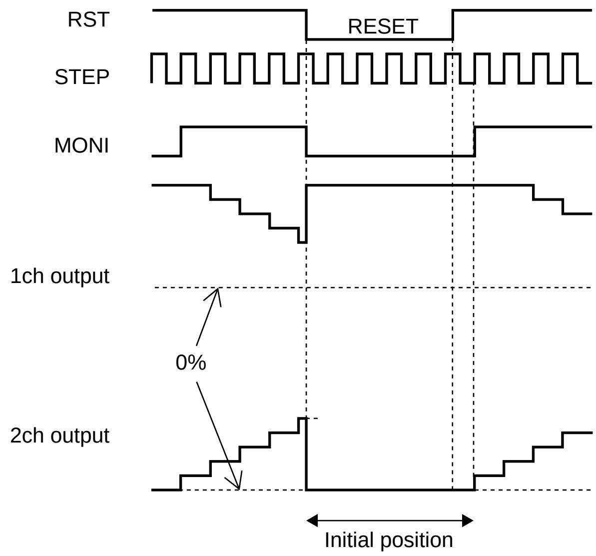
This is the initial position of each excitation mode in the initial state after power-on and when the counter is reset.

(5) 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 "(12) Examples of current waveforms in each of the excitation modes.")

(6) Reset function

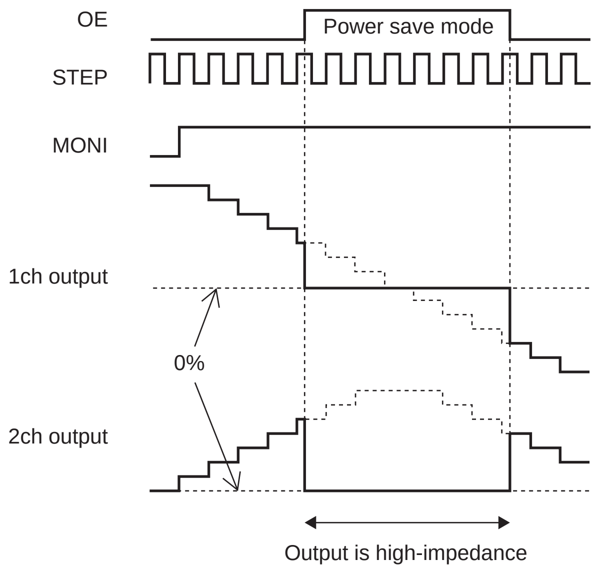
RST	Operating mode
High	Normal operation
Low	Reset state



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

(7) Output enable function

OE	Operating mode
Low	Output ON
High	Output OFF

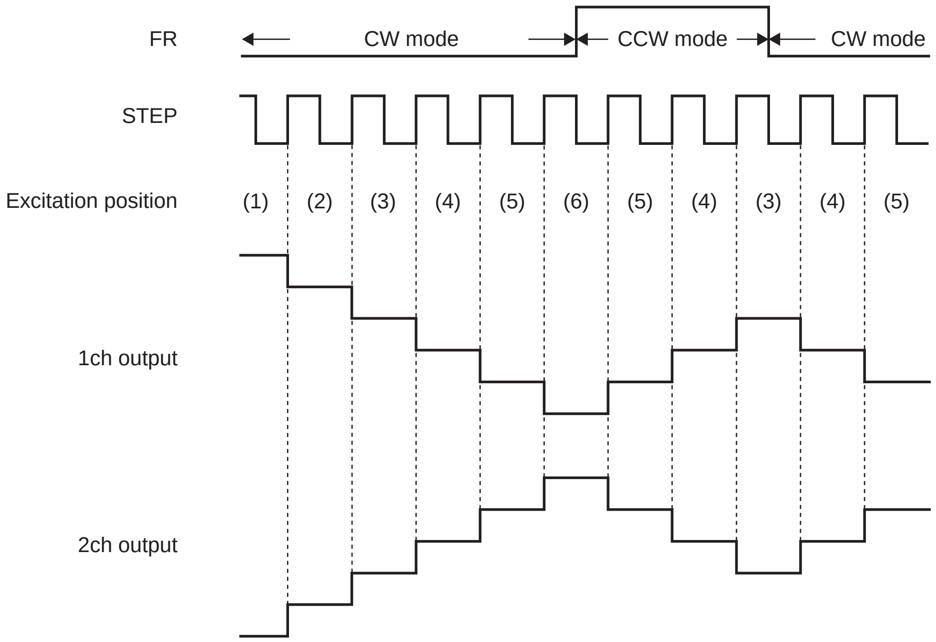


When the OE pin is set High, the output is forced OFF and goes to high impedance.
However, the internal logic circuits are operating, so the excitation position proceeds when the STEP signal is input.

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) Setting constant-current control

The setting of STM driver's constant current control is decided the VREF voltage from the resistance connected between RNF and GND by the following expression.

I_{OUT} = (VREF/5)/RNF 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	60%
High	High	40%

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)/RNF resistance

Example : At VREF of 1.0V, a reference voltage setting of 100% [(ATT1, ATT2) = (L, L)] and an RNF resistance of 0.5Ω, the output current is set as shown below.

I_{OUT} = 1.0V/5 × 100%/0.5Ω = 400mA

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

I_{OUT} = 400mA × 40% = 160mA

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

(10) 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.

$$Tchop \fallingdotseq C \times V \times 2 / I \ \ (s)$$

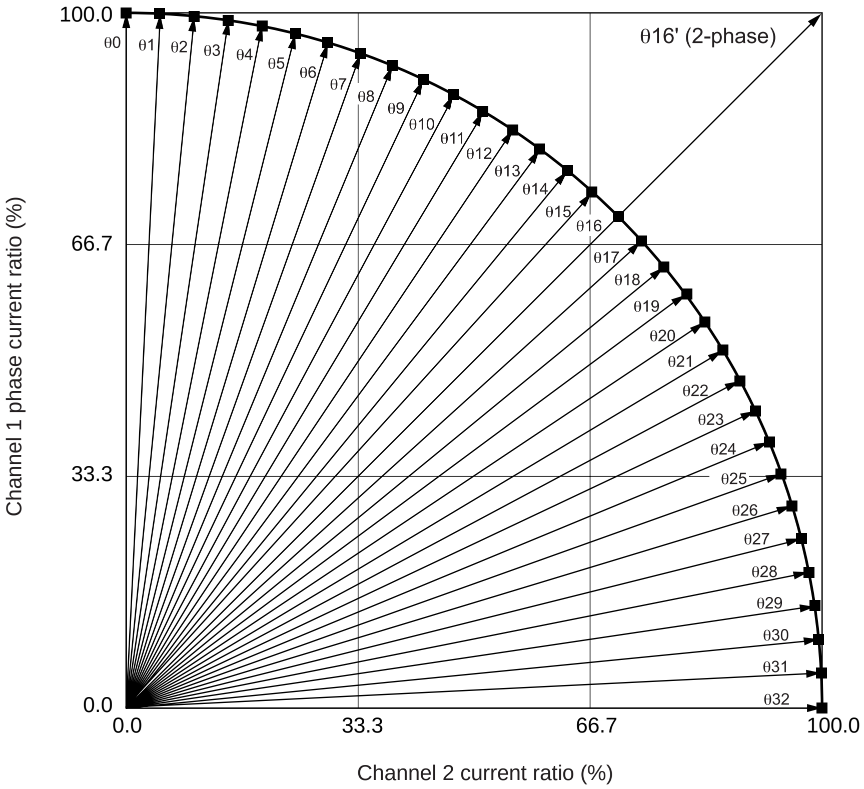
V : Width of suresshu voltage, typ 0.5V

I : Charge/discharge current, typ 10μA

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

$$Fchop \fallingdotseq 1 / Tchop \ \ (Hz)$$

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

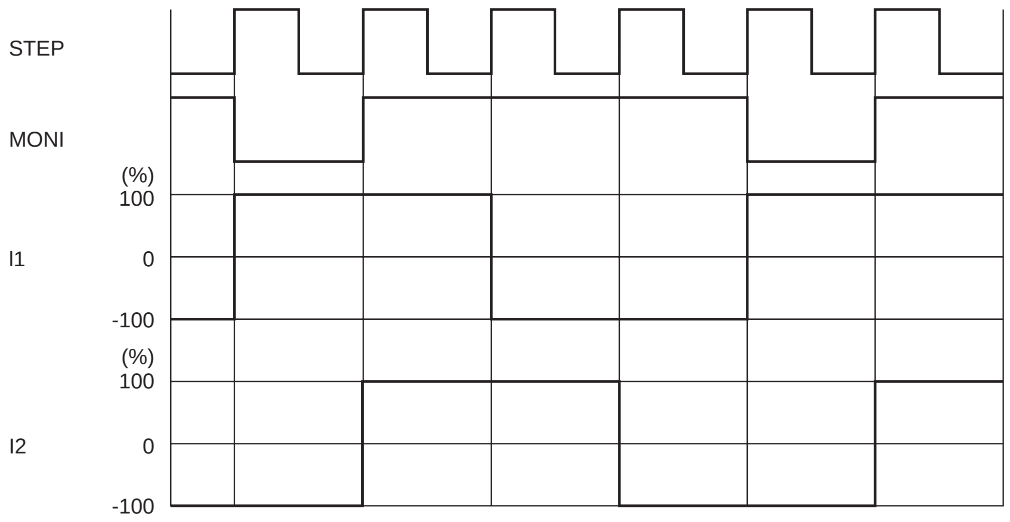


Setting current ration in each excitation mode

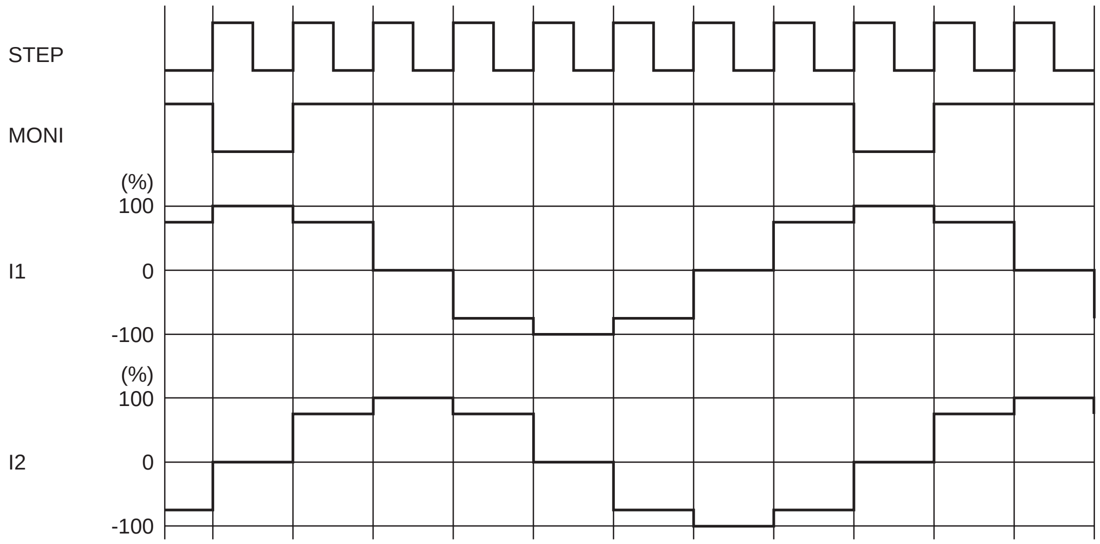
STEP	8W1-2 phase (%)		4W1-2 phase (%)		1-2 phase (%)		2-phase (%)	
	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2
θ0	100	0	100	0	100	0		
θ1	100	5						
θ2	100	10	100	10				
θ3	99	15						
θ4	98	20	98	20				
θ5	97	24						
θ6	96	29	96	29				
θ7	94	34						
θ8	92	38	92	38				
θ9	90	43						
θ10	88	47	88	47				
θ11	86	51						
θ12	83	55	83	55				
θ13	80	60						
θ14	77	63	77	63				
θ15	74	67						
θ16	70	70	70	70	70	70	100	100
θ17	67	74						
θ18	63	77	63	77				
θ19	60	80						
θ20	55	83	55	83				
θ21	51	86						
θ22	47	88	47	88				
θ23	43	90						
θ24	38	92	38	92				
θ25	34	94						
θ26	29	96	29	96				
θ27	24	97						
θ28	20	98	20	98				
θ29	15	99						
θ30	10	100	10	100				
θ31	5	100						
θ32	0	100	0	100	0	100		

(12) Typical current waveform in each excitation mode

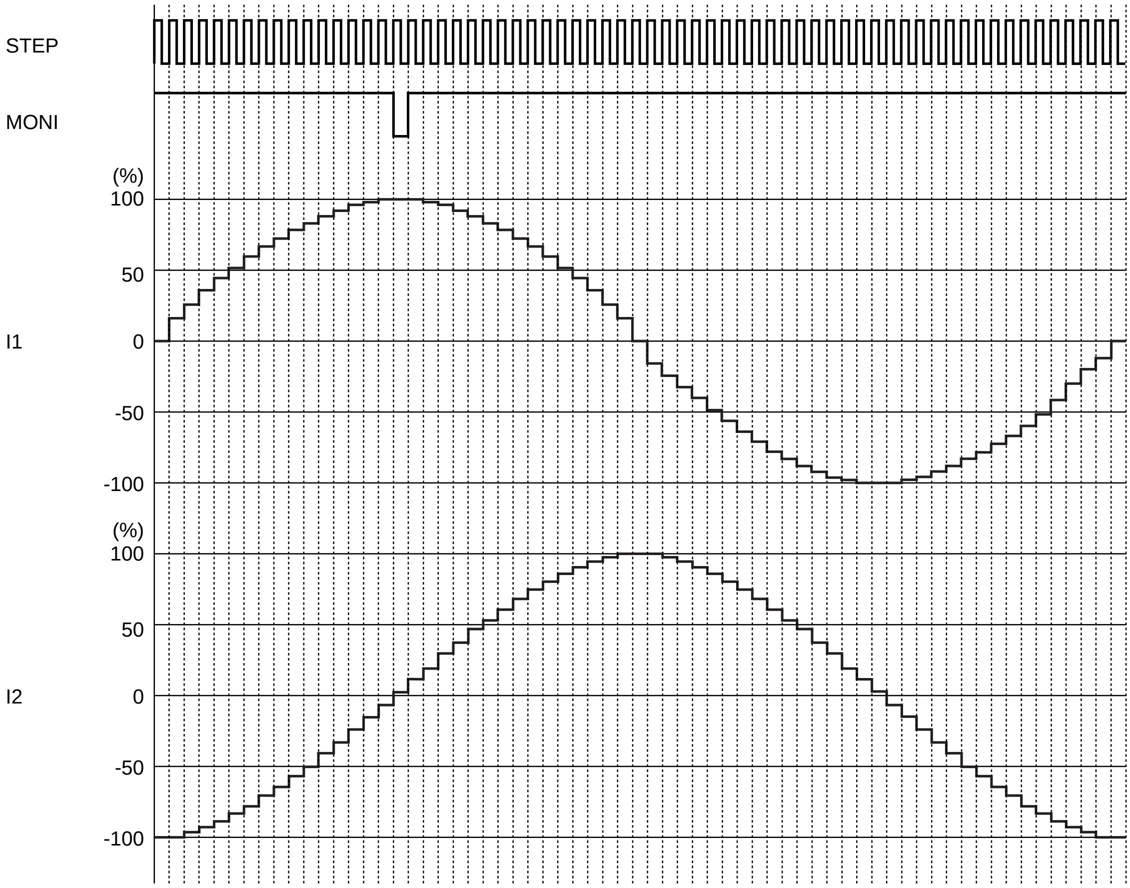
2-phase excitation (CW mode)



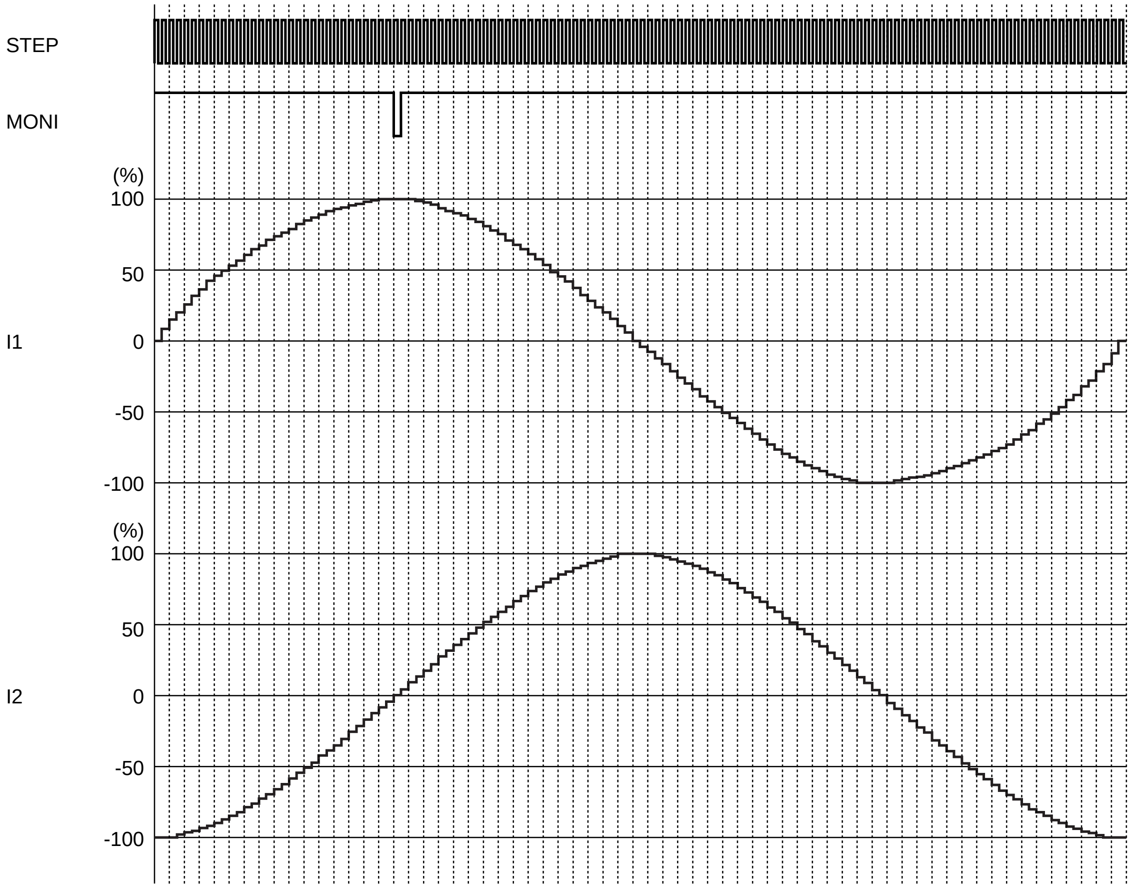
1-2 phase excitation (CW mode)



4W1-2 phase excitation (CW mode)

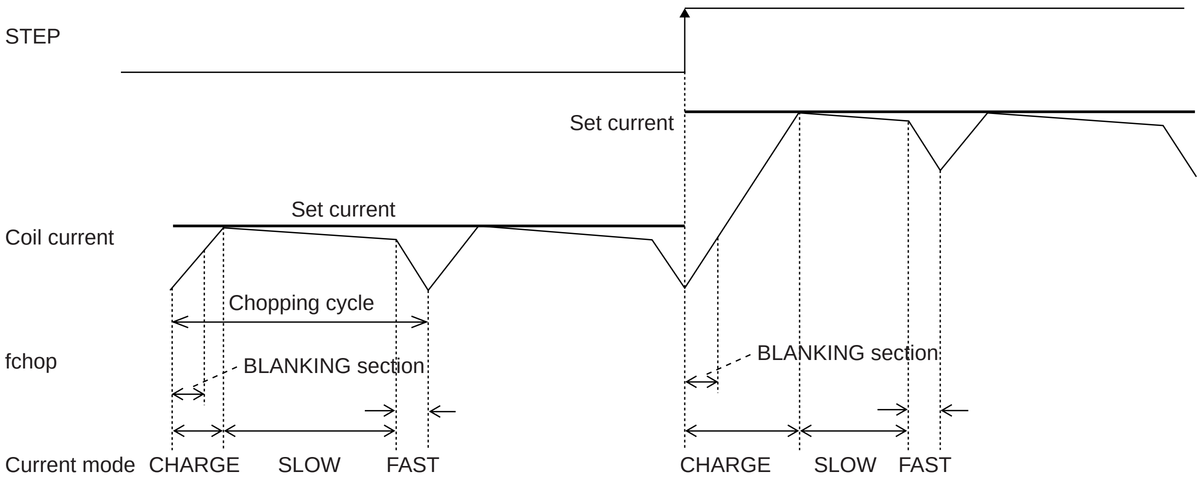


8W1-2 phase excitation (CW mode)

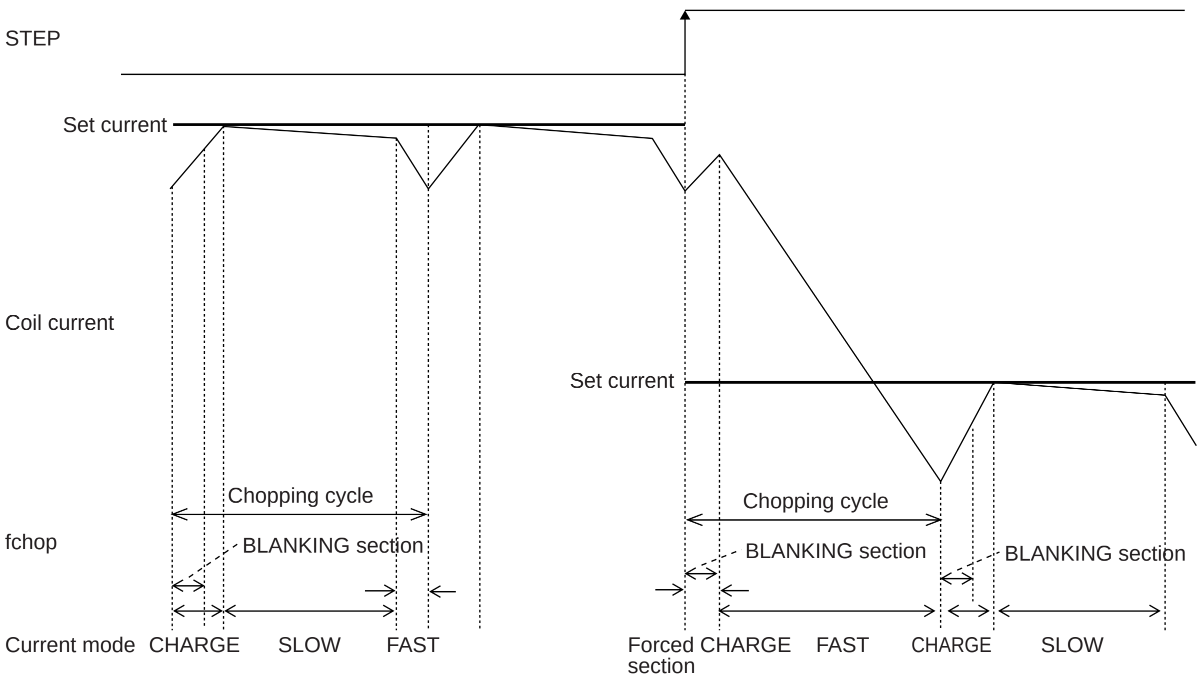


(13) Current control timing chart(Chopping operation)

(Sine wave increasing direction)



(Sine wave decreasing direction)

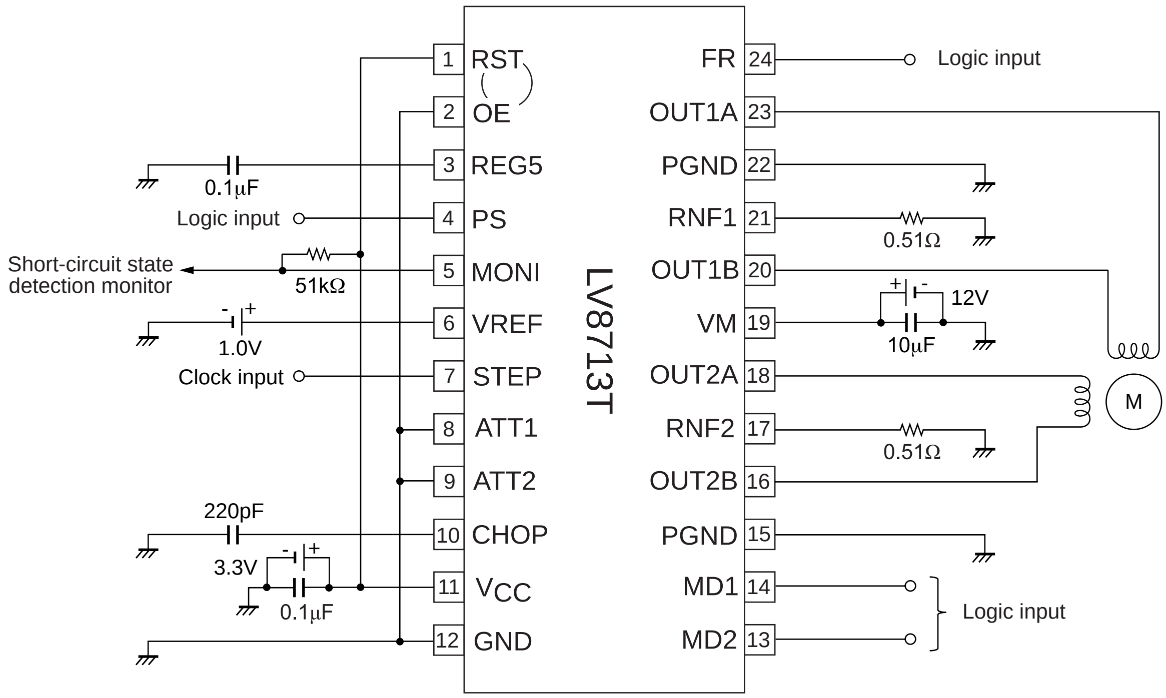


In each current mode, the operation sequence is as described below :

- At rise of chopping frequency, the CHARGE mode begins. (The Blanking section in which the CHARGE mode is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF) exists for 1µs.)
- 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.

Application Circuit Example



The formulae for setting the constants in the examples of the application circuits above are as follows :

Constant current (100%) setting

When VREF = 1.0V

I_{OUT} = VREF/5/RNF resistance

= 1.0V/5/0.51Ω = 0.392A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (220pF × 0.5V × 2) = 45kHz

This catalog provides information as of February, 2011. Specifications and information herein are subject to change without notice.