LV8731V
LV8732V
LV8734V
LV8735V
LV8736V

Bi-CMOS LSI

PWM Constant-Current Control Stepping Motor Driver

Overview

The LV873x series is a 2-channel H-bridge driver IC that can switch a stepping motor driver, which is capable of micro-step drive and supports 1/16-step resolution, and two channels of a brushed motor driver, which supports forward, reverse, brake, and standby of a motor.

Features

- Single-channel PWM current control stepping motor driver (selectable with DC motor driver channel 2) incorporated.
- BiCDMOS process IC
- Low on resistance (total of upper and lower: 0.55Ω=LV8731/32, 0.8Ω=LV8734, 1.25Ω=LV8735/36, Ta=25°C)
- Micro-step mode can be set to Full-step, Half-step, Quarter-step, 1/8-step, or 1/16-step
- 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
- Built-in thermal shutdown circuit
- No control power supply required
- Pin compatibility series

Typical Applications

- MFP (Multi Function Printer)
- PPC (Plain Paper Copier)
- LBP (Laser Beam Printer)
- Photo printer
- Scanner
- Industrial
- Cash Machine
- Amusement
- Textile

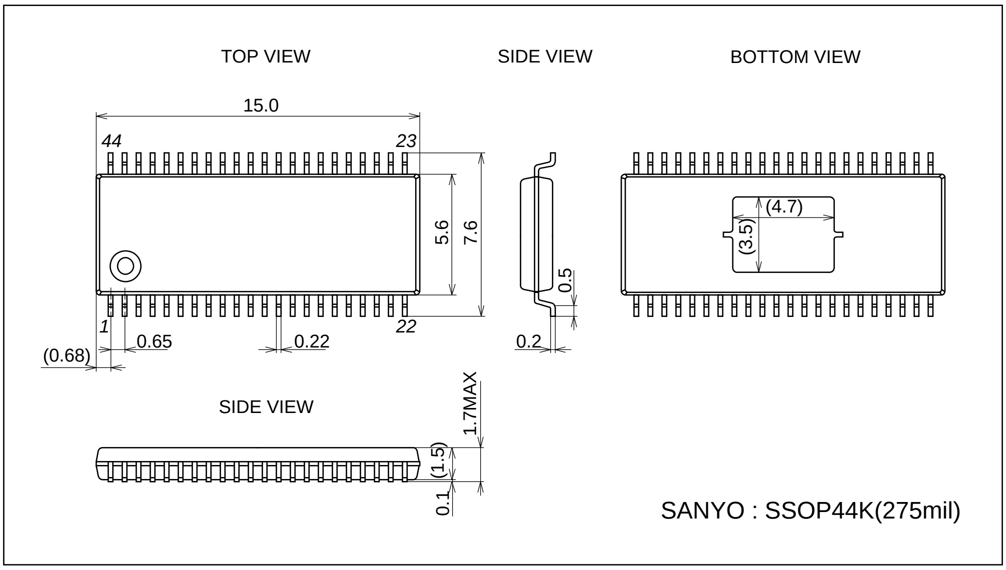
Selection Guide

Parameter	LV8731V	LV8732V	LV8734V	LV8735V	LV8736V
Output current	2A	2A	1.5A	1A	1A
Micro-step resolution	Full step	Full step	Full step	Full step	Full step
	Half step	Half step	Half step	Half step	Half step
	Quarter step	Quarter step	Quarter step	1/8 step	Quarter step
	1/16 step	1/8 step	1/8 step	1/16 step	1/8 step
Current limit mask function	None	None	Included	Included	Included

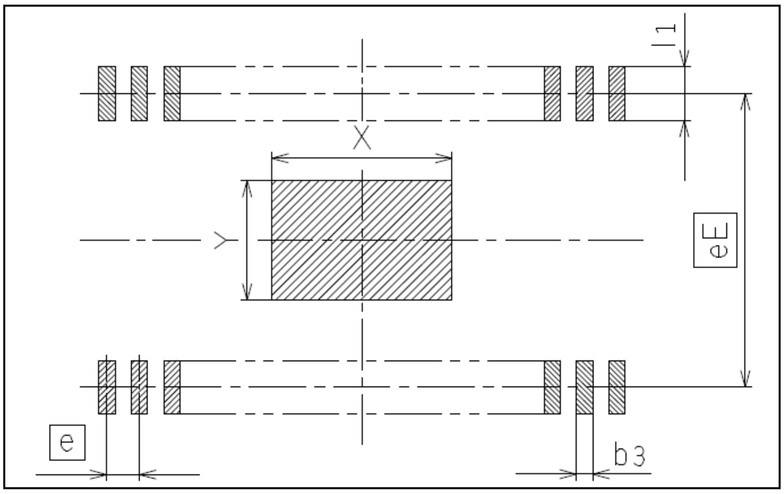
Package Dimensions

unit : mm (typ)

3333



Mounting Pad Sketch

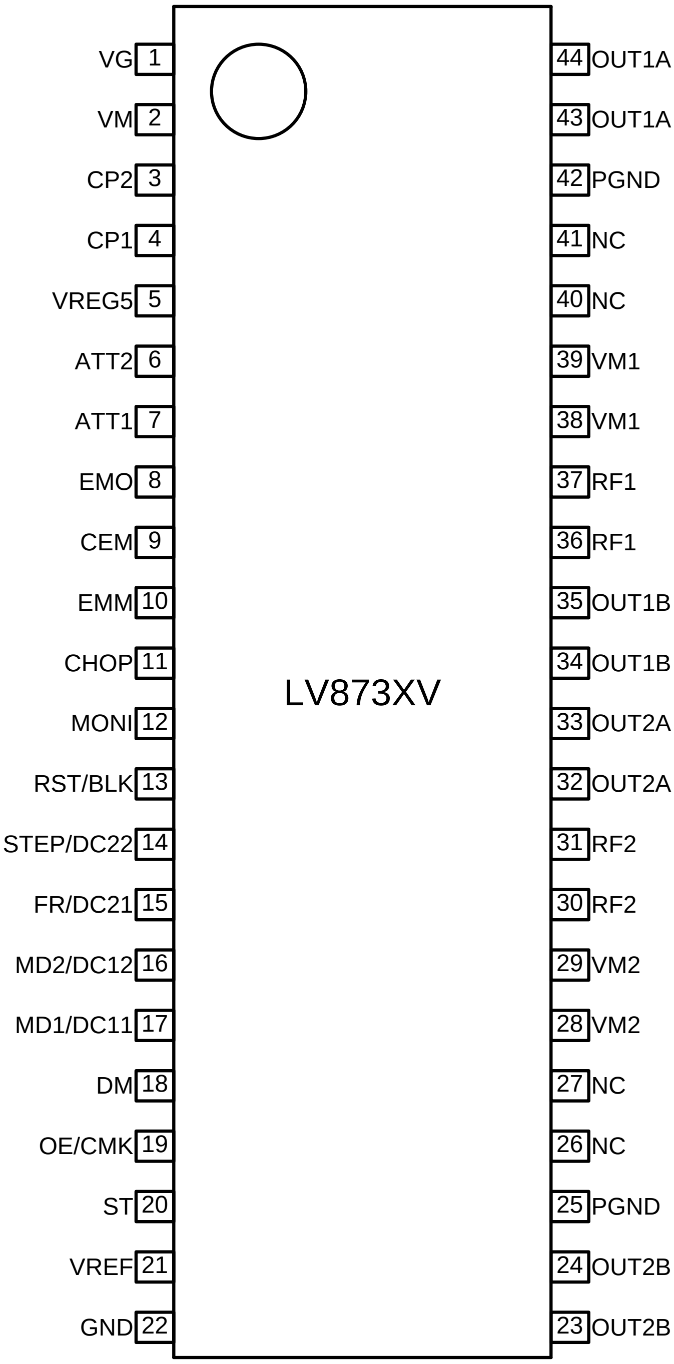


(Unit:mm)

Reference symbol	SSOP44K(275mil)
eE	7.00
e	0.65
b3	0.32
l1	1.00
X	(4.7)
Y	(3.5)

Caution: The package dimension is a reference value, which is not a guaranteed value.

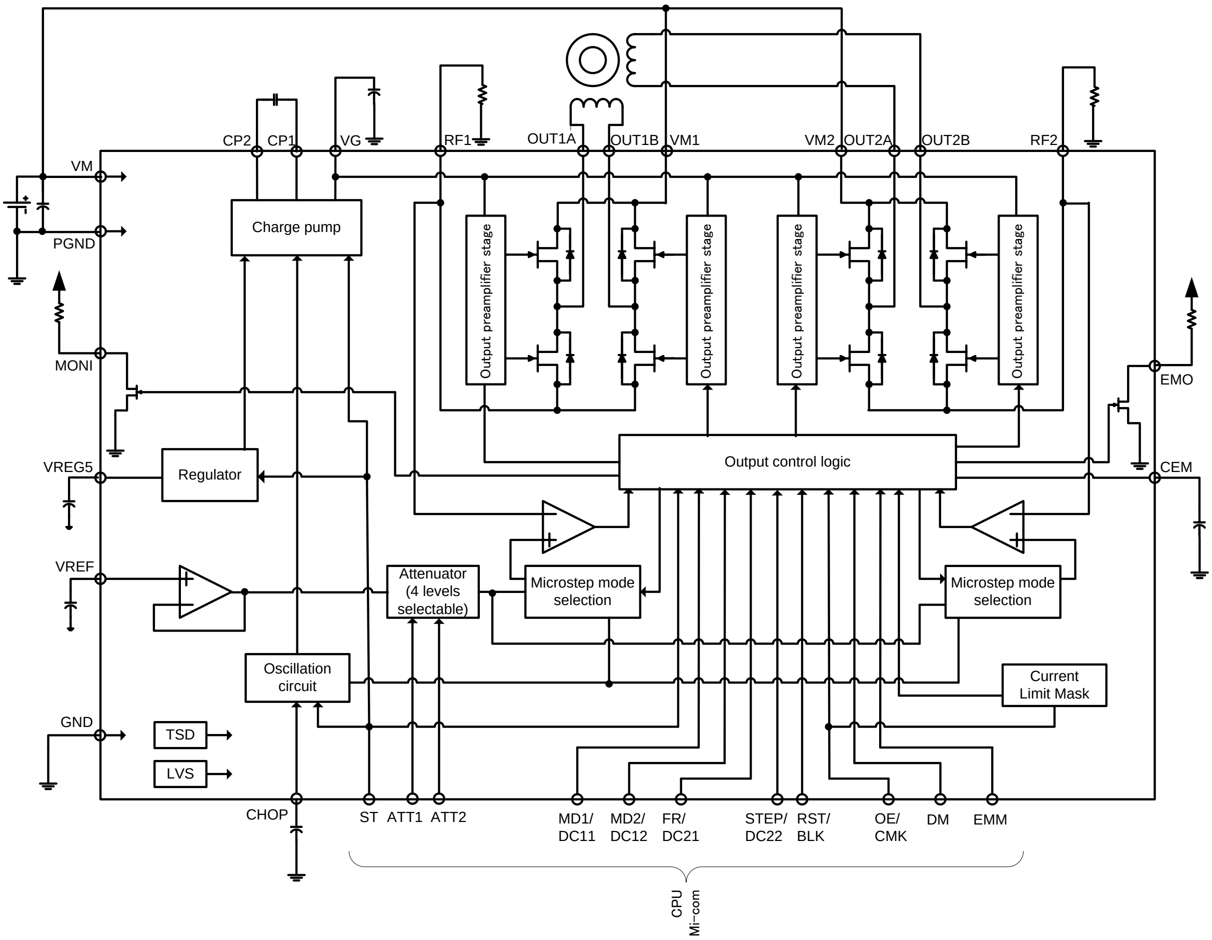
Pin Assignment



Top view

It is short-circuited in IC though there are VM1, VM2, OUT1A, OUT1B, OUT2A, OUT2B, RF1 and RF2 of each of two pins.

Block Diagram



Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	LV8731/32	LV8734	LV8735/36	Unit
Supply voltage	VM max				36	V
Output peak current	I_O peak	tw ≤ 10ms, duty 20%	2.5	1.75	1.5	A
Output current	I_O max		2	1.5	1	A
Logic input voltage	V_{IN} max				-0.3 to +6	V
MONI/EMO input voltage	Vmo/Vemo				-0.3 to +6	V
Allowable power dissipation	Pd max	*	3.25	3.25	3.05	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 (LV8731/32)	Ronu1	I_O = 2A, Upper-side on resistance		0.3	0.4	Ω
	Rond1	I_O = 2A, Lower-side on resistance		0.25	0.33	Ω
Output on resistance (LV8734)	Ronu2	I_O = 1.5A, Upper-side on resistance		0.48	0.63	Ω
	Rond2	I_O = 1.5A, Lower-side on resistance		0.32	0.42	Ω
Output on resistance (LV8735/36)	Ronu3	I_O = 1A, Upper-side on resistance		0.75	0.97	Ω
	Rond3	I_O = 1A, Lower-side on resistance		0.5	0.65	Ω
Output leakage current	$I_O$leak				50	μA
Diode forward voltage	VD	ID = -2A (LV8731/32) /-1.5A (LV8734) -1A (LV8735/36)		1.2	1.4	V
Logic high-level input voltage	V_{IN}H		2.0			V
Logic low-level input voltage	V_{IN}L				0.8	V
Logic pin input current other OE/CMK pin	I_{IN}L	V_{IN} = 0.8V	4	8	12	μA
	I_{IN}H	V_{IN} = 5V	30	50	70	μA
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
OE / CMK pin input current (LV8734/35/36)	I_{CMK}L	DM = “L”, OE/CMK = 0.8V	4	8	12	μA
	I_{CMK}H	DM = “L”, OE/CMK = 5V	30	50	70	μA
	I_{CMK}	DM = “H”, OE/CMK = 0V	-32	-25	-18	μA
OE/CMK pin current LIMIT mask threshold voltage. (LV8734/35/36)	Vt_{CMK}	DM = “H”	1.2	1.5	1.8	V

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Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Current setting comparator threshold voltage (current step switching)	1/16 step resolution (LV8731/35)	Vtdac0_4W	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac1_4W	Step 1 (Initial state+1)	0.291	0.3	0.309	V
		Vtdac2_4W	Step 2 (Initial state+2)	0.285	0.294	0.303	V
		Vtdac3_4W	Step 3 (Initial state+3)	0.279	0.288	0.297	V
		Vtdac4_4W	Step 4 (Initial state+4)	0.267	0.276	0.285	V
		Vtdac5_4W	Step 5 (Initial state+5)	0.255	0.264	0.273	V
		Vtdac6_4W	Step 6 (Initial state+6)	0.240	0.249	0.258	V
		Vtdac7_4W	Step 7 (Initial state+7)	0.222	0.231	0.240	V
		Vtdac8_4W	Step 8 (Initial state+8)	0.201	0.21	0.219	V
		Vtdac9_4W	Step 9 (Initial state+9)	0.180	0.189	0.198	V
		Vtdac10_4W	Step 10 (Initial state+10)	0.157	0.165	0.173	V
		Vtdac11_4W	Step 11 (Initial state+11)	0.134	0.141	0.148	V
		Vtdac12_4W	Step 12 (Initial state+12)	0.107	0.114	0.121	V
		Vtdac13_4W	Step 13 (Initial state+13)	0.080	0.087	0.094	V
		Vtdac14_4W	Step 14 (Initial state+14)	0.053	0.06	0.067	V
		Vtdac15_4W	Step 15 (Initial state+15)	0.023	0.03	0.037	V
	1/8 step resolution (LV8732/34/35/36)	Vtdac0_2W	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac2_2W	Step 2 (Initial state+1)	0.285	0.294	0.303	V
		Vtdac4_2W	Step 4 (Initial state+2)	0.267	0.276	0.285	V
		Vtdac6_2W	Step 6 (Initial state+3)	0.240	0.249	0.258	V
		Vtdac8_2W	Step 8 (Initial state+4)	0.201	0.21	0.219	V
		Vtdac10_2W	Step 10 (Initial state+5)	0.157	0.165	0.173	V
		Vtdac12_2W	Step 12 (Initial state+6)	0.107	0.114	0.121	V
		Vtdac14_2W	Step 14 (Initial state+7)	0.053	0.06	0.067	V
	Quarter step resolution (LV8731/32/34/36)	Vtdac0_W	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac4_W	Step 4 (Initial state+1)	0.267	0.276	0.285	V
		Vtdac8_W	Step 8 (Initial state+2)	0.201	0.21	0.219	V
		Vtdac12_W	Step 12 (Initial state+3)	0.107	0.114	0.121	V
	Half step resolution	Vtdac0_H	Step 0 (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V
		Vtdac8_H	Step 8 (Initial state+1)	0.201	0.21	0.219	V
	Full step resolution	Vtdac8_F	Step 8' (When initialized : channel 1 comparator level)	0.291	0.3	0.309	V

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
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
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	500	μS
Oscillator frequency	Fosc		90	125	150	kHz
Output short-circuit protection						
EMO pin saturation voltage	Vsatemo	Iemo = 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

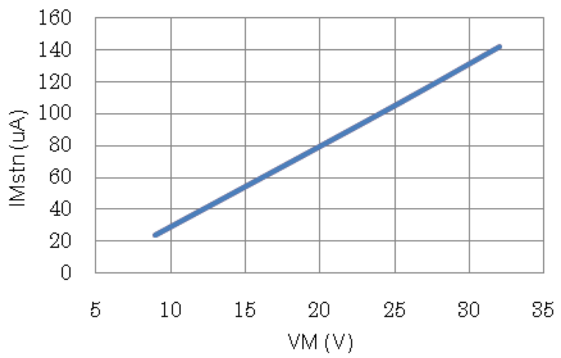


Figure 1. Standby Mode Current Drain vs VM Voltage

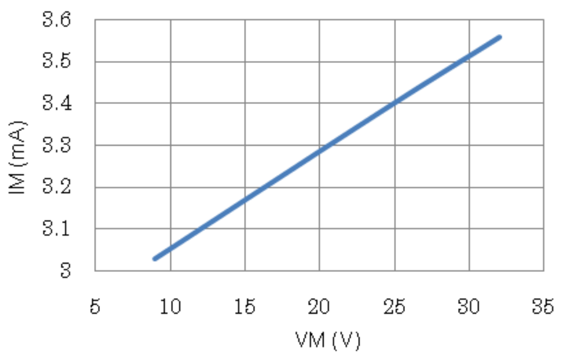


Figure 2. Current Drain vs VM Voltage

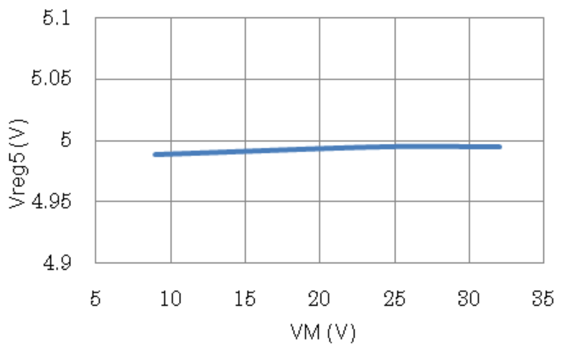


Figure 3. VREG5 Output Voltage vs VM Voltage

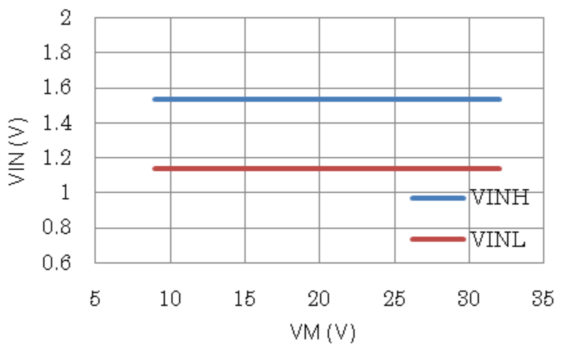


Figure 4. Logic High/Low-Level Input Voltage vs Output Current

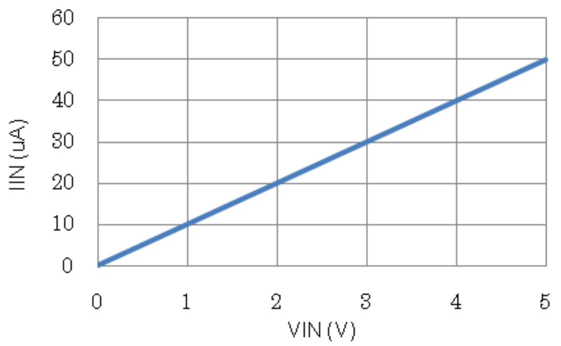


Figure 5. Logic Pin Input Current vs Input Voltage

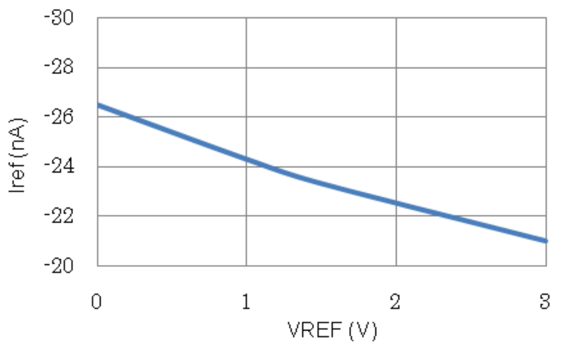


Figure 6. VREF Pin Input Current vs VREF Voltage

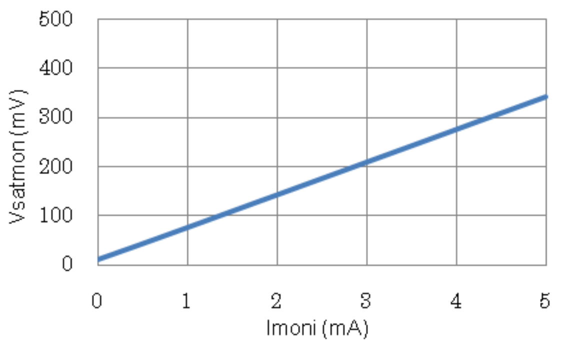


Figure 7. MONI Pin Saturation Voltage vs MONI Current

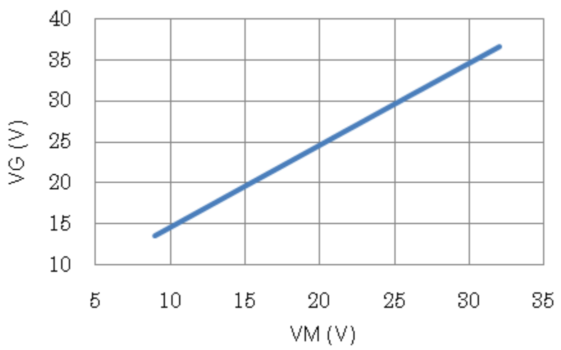


Figure 8. VG Output Voltage vs VM Voltage

LV8731/LV8732

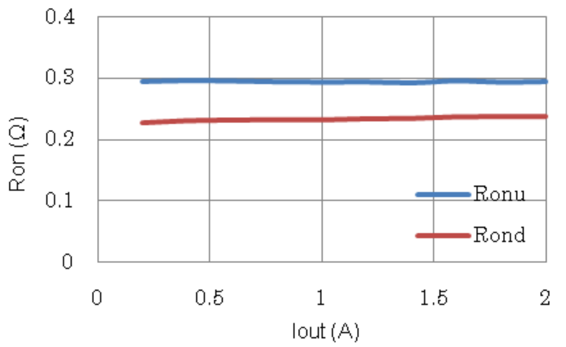


Figure 9. Output on Resistance vs Output Current of LV8731/32

LV8734

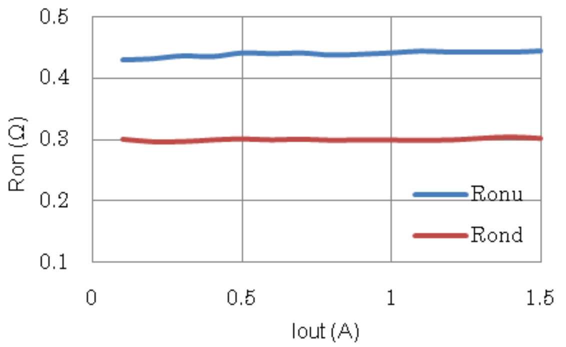


Figure 10. Output on Resistance vs Output Current of LV8734

LV8735/LV8736

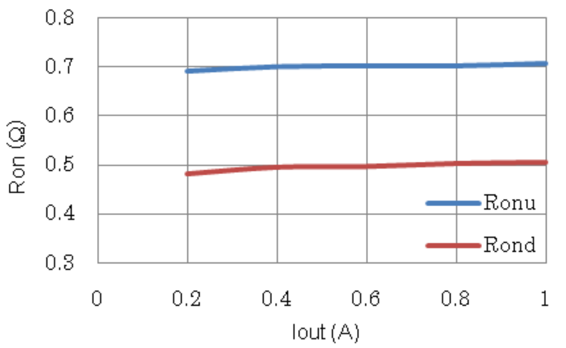


Figure 11. Output on Resistance vs Output Current of LV8735/36

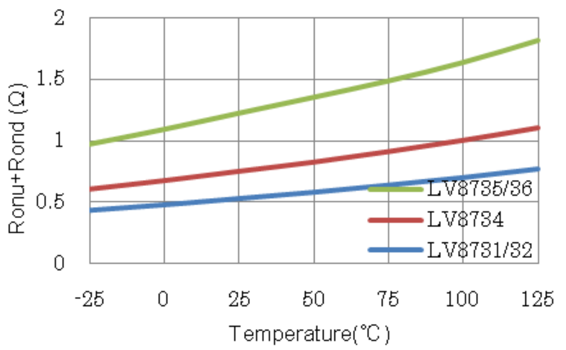


Figure 12. Output on Resistance vs Temperature

LV8731/LV8732

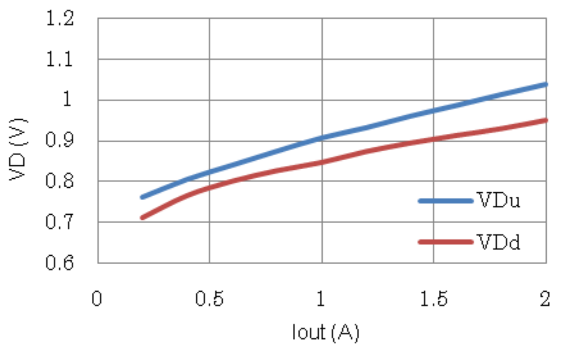


Figure 13. Diode Forward Voltage vs Output Current of LV8731/32

LV8734

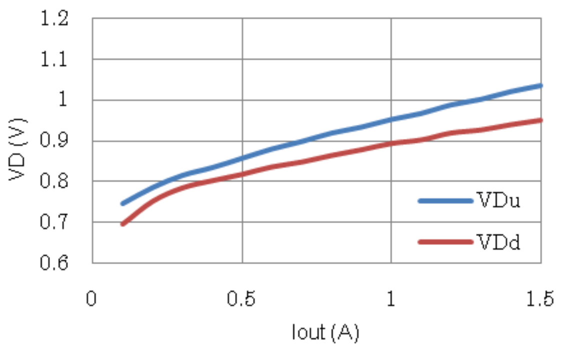


Figure 14. Diode Forward Voltage vs Output Current of LV8734

LV8735/LV8736

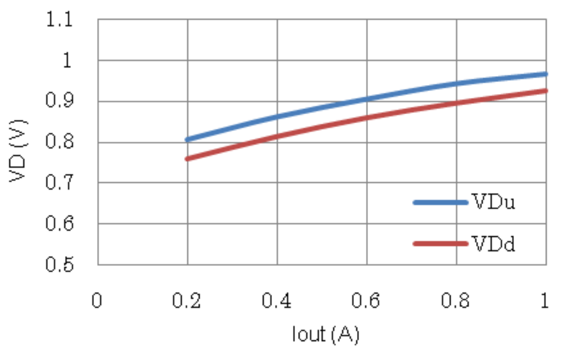
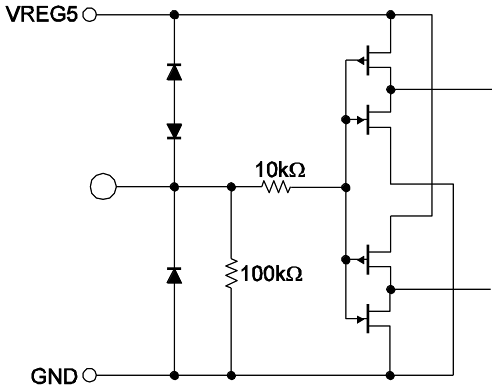
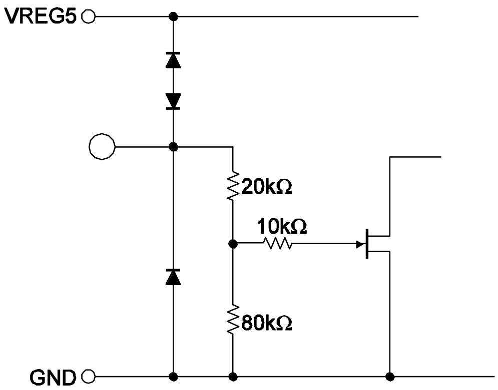
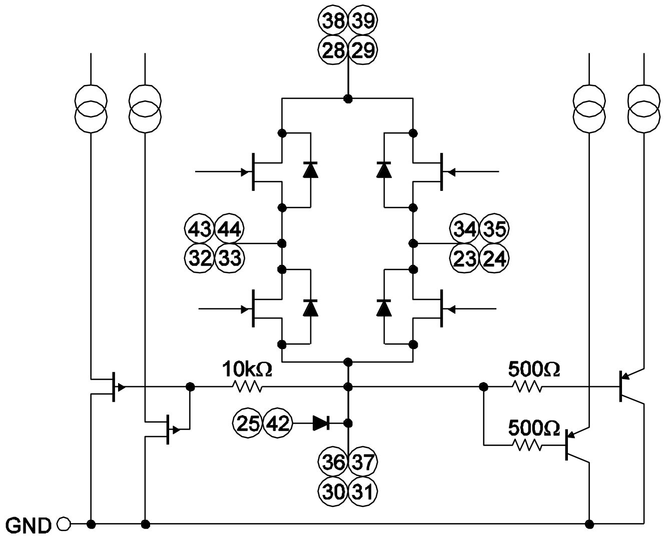


Figure 15. Diode Forward Voltage vs Output Current of LV8735/36

Pin Functions

Pin No.	Pin Name	Pin Function	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	LV8731/32 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.	

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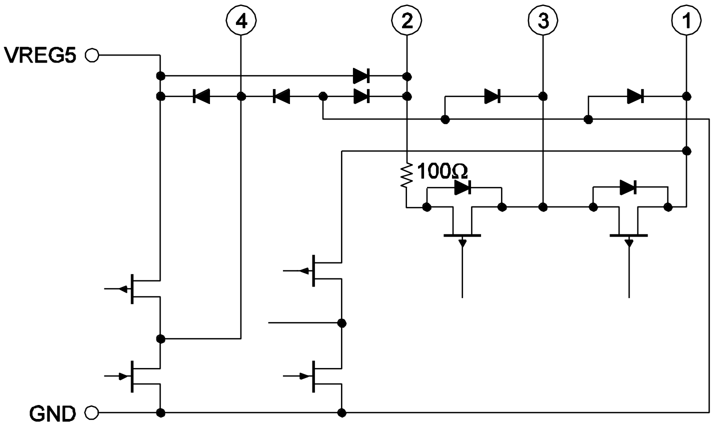
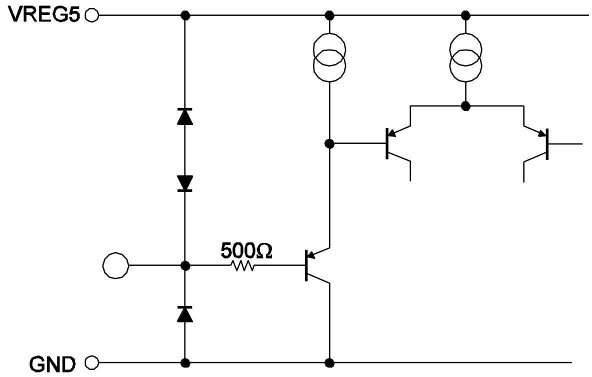
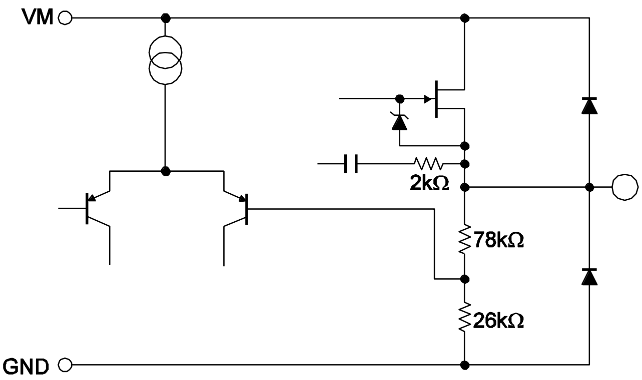
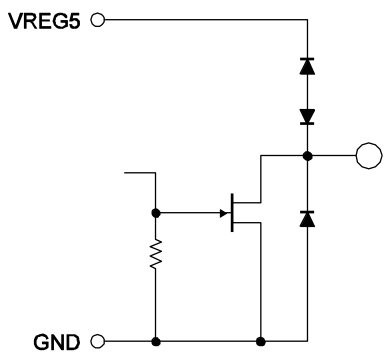
Pin No.	Pin Name	Pin Function	Equivalent Circuit
1 2 3 4	VG VM CP2 CP1	Charge pump capacitor connection pin. Motor power supply connection pin. Charge pump capacitor connection pin. Charge pump capacitor connection pin.	
21	VREF	Constant current control reference voltage input pin.	
5	VREG5	Internal power supply capacitor connection pin.	
8 12	EMO MONI	Output short-circuit state warning output pin. Position detection monitor pin.	

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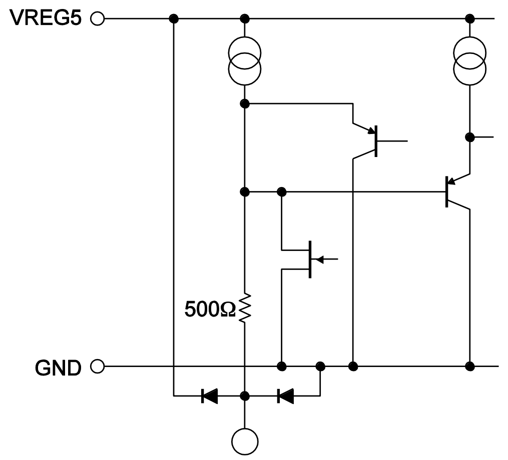
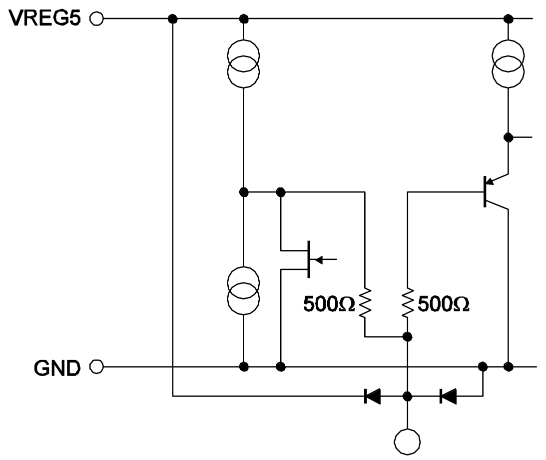
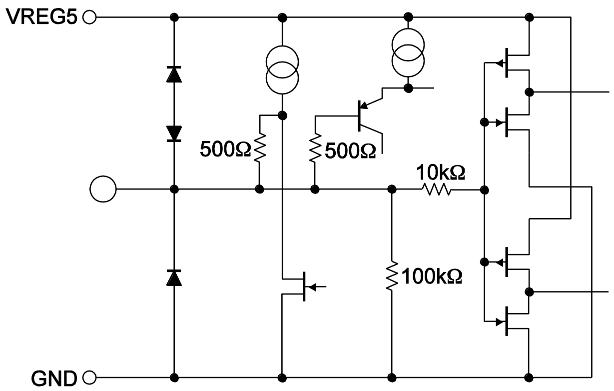
Pin No.	Pin Name	Pin Function	Equivalent Circuit
9	CEM	Pin to connect the output short-circuit state detection time setting capacitor.	
11	CHOP	Chopping frequency setting capacitor connection pin.	
19	LV8734/35/ 36 OE/CMK	Output enable signal input pin (STM) / Set capacitor connection pin of time of current LIMIT mask (DCM) .	
22	GND	Ground.	
26, 27 40, 41	NC	No Connection (No internal connection to the IC)	

Description of operation

Input Pin Function

The function to prevent including the turn from the input to the power supply is built into each input pin. Therefore, the current turns to the power supply even if power supply (VM) is turned off with the voltage impressed to the input pin and there is not crowding.

(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 Full step or Half step 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

STEP input advances electrical angle at every rising edge (advances step by step) .

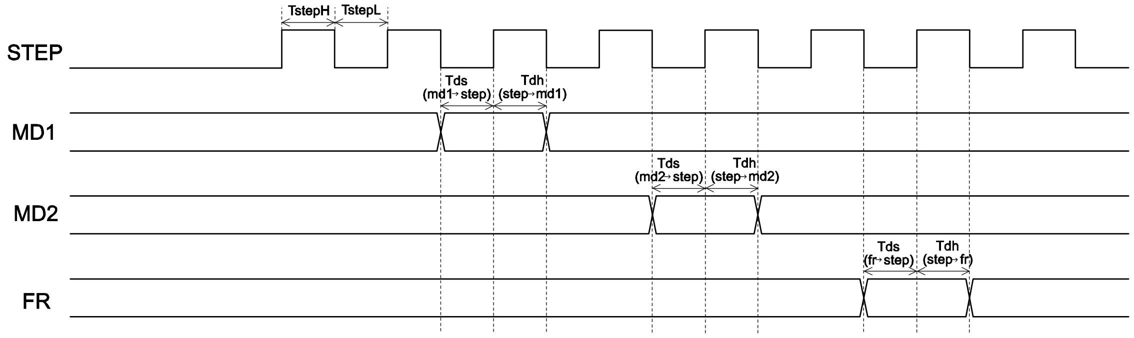
Input		Operating mode
ST	STEP	
Low	*	Standby mode
High	↑	Excitation step proceeds
High	↓	Excitation step is kept

STEP input MIN pulse width (common in H/L): 500ns (MAX input frequency: 1MHz)

However, constant current control is performed by PWM during chopping period, which is set by the capacitor connected between CHOP and GND. You need to perform chopping more than once per step. For this reason, for the actual STEP frequency, you need to take chopping frequency and chopping count into consideration.

For example, if chopping frequency is 50kHz (20μs) and chopping is performed twice per step, the maximum STEP frequency is obtained as follows: f＝1/(20μs×2) = 25kHz.

(2) Input timing



TstepH/TstepL : Clock H/L pulse width (min 500ns)

Tds : Data set-up time (min 500ns)

Tdh : Data hold time (min 500ns)

Figure 16. Input timing chart

(3) Position detection monitoring function

The MONI position detection monitoring pin is of an open drain 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.

If VREF is open or the setting is out of the recommendation operating range, output current will increase and you cannot set constant current under normal condition. Hence, make sure that VREF is set in accordance with the specification.
However, if current control is not performed (if the IC is used by saturation drive or used without current limit at DCM) make sure that the setting is as follows: VREF=5V or VREF=VREG5

Power dissipation of RF resistor is obtained as follows: $Pd=Iout^2 \times RF$. Make sure to take allowable power dissipation into consideration when you select RF resistor.

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%

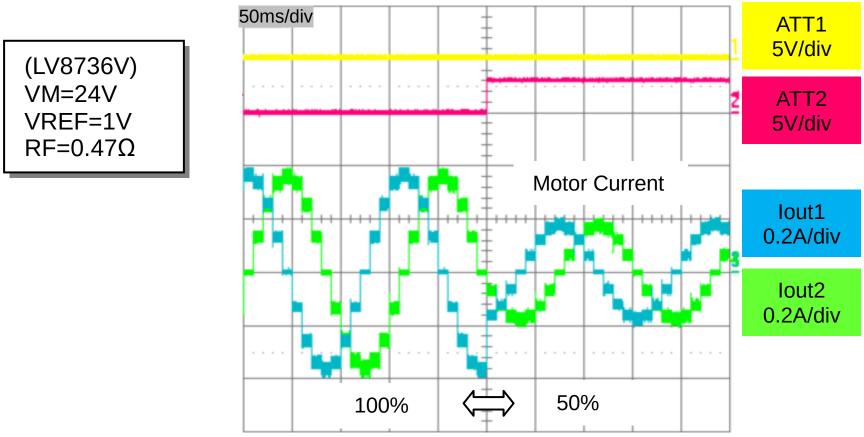


Figure 17. Attenuation operation

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 0.5Ω, the output current is set as shown below.

I_{OUT} = 1.5V/5 × 100%/0.5Ω = 0.6A

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

I_{OUT} = 0.6A × 20% = 120mA

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

(5) Reset function

Only STM mode is pin at the DCM mode BLK: It operates as a switch function of the time of the branking.

RST	Operating mode
Low	Normal operation
High	Reset state

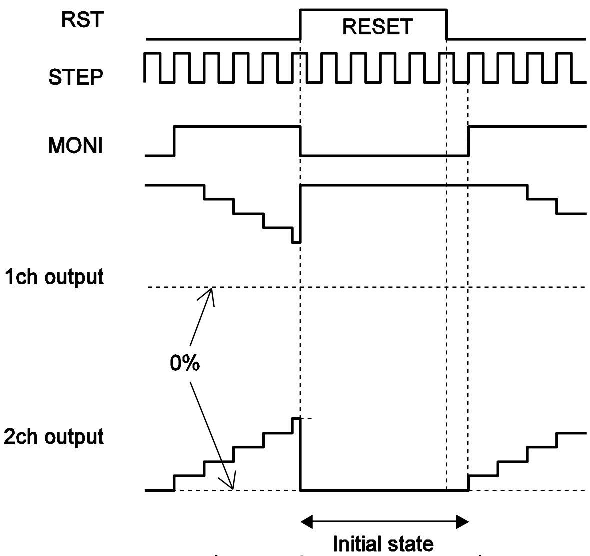


Figure 18. Reset operation

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.

(6) Output enable function

Only STM mode is pin at the DCM mode CMK: It operates as current LIMIT mask function.

OE	Operating mode
Low	Output ON
High	Output OFF

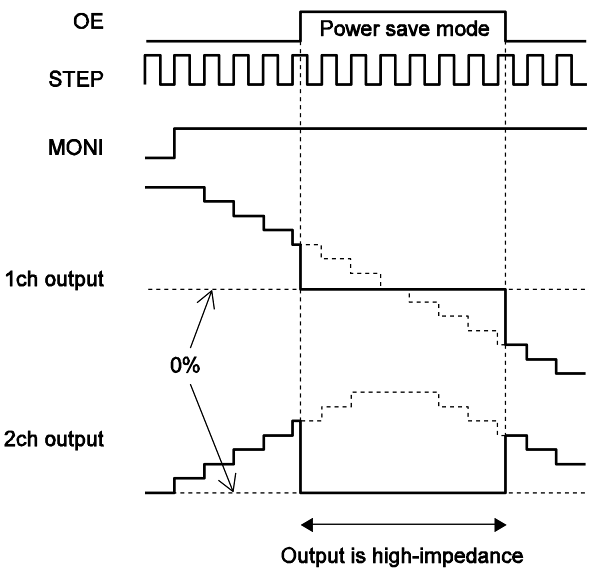


Figure 19. Output enable operation

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.

(7) Forward/reverse switching function

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

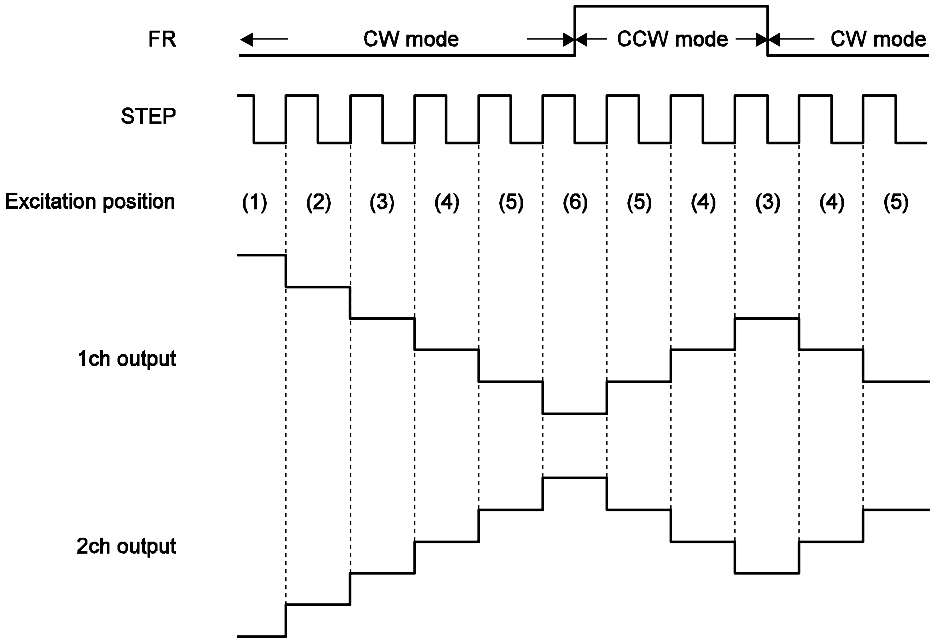


Figure 20. FR operation

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.

(8) 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 × Vtchop × 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 = 10μA/ (200pF × 0.5V × 2) = 50kHz

The higher the chopping frequency is, the greater the output switching loss becomes. As a result, heat generation issue arises. The lower the chopping frequency is, the lesser the heat generation becomes. However, current ripple occurs. Since noise increases when switching of chopping takes place, you need to adjust frequency with the influence to the other devices into consideration. The frequency range should be between 40kHz and 125kHz.

(9) Blanking period

If, when exercising PWM constant-current chopping control over the motor current, the mode is switched from decay to charge, the recovery current of the parasitic diode may flow to the current sensing resistance, causing noise to be carried on the current sensing resistance pin, and this may result in erroneous detection. To prevent this erroneous detection, a blanking period is provided to prevent the noise occurring during mode switching from being received. During this period, the mode is not switched from charge to decay even if noise is carried on the current sensing resistance pin.
In the stepping motor driver mode (DM = Low or Open) of this IC, the blanking time is fixed at approximately 1μs. In the DC motor driver mode (DM = High) , the blanking time can be switched to one of two levels using the RST/BLK pin. (Refer to "Blanking time switching function.")

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

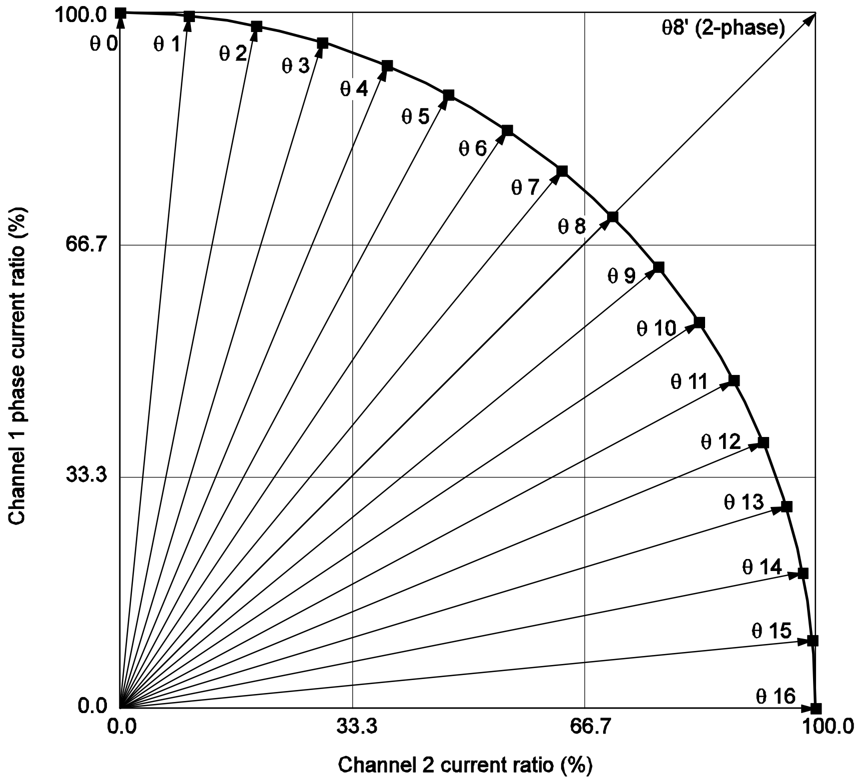


Figure 21. Current vector position

Setting current ration in each Micro-step mode

STEP	1/16 step (%)		1/8 step (%)		Quarter step (%)		Half step (%)		Full step (%)	
	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2
θ0	100	0	100	0	100	0	100	0		
θ1	100	10								
θ2	98	20	98	20						
θ3	96	29								
θ4	92	38	92	38	92	38				
θ5	88	47								
θ6	83	55	83	55						
θ7	77	63								
θ8	70	70	70	70	70	70	70	70	100	100
θ9	63	77								
θ10	55	83	55	83						
θ11	47	88								
θ12	38	92	38	92	38	92				
θ13	29	96								
θ14	20	98	20	98						
θ15	10	100								
θ16	0	100	0	100	0	100	0	100		

(11) Excitation mode setting function

MD1	MD2	Micro-step resolution (Excitation mode)			Initial position	
		LV8731	LV8732/34/36	LV8735	Channel 1	Channel 2
Low	Low	Full step (2 phase excitation)			100%	-100%
High	Low	Half step (1-2 phase excitation)			100%	0%
Low	High	Quarter step (W1-2 phase excitation)		1/8 Step (2W1-2 phase excitation)	100%	0%
High	High	1/16 step (4W1-2 phase excitation)	1/8 step (2W1-2 phase excitation)	1/16 step (4W1-2 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.

(12) Micro-step mode switching operation

When micro-step mode is switched while the motor is rotating, each drive mode operates with the following sequence.

Clockwise mode

Before the micro-step mode changes		Position after the micro-step mode is changed				
Micro-step mode	Position	1/16 step	1/8 step	Quarter step	Half step	Full step
1/16 step	θ0-θ1		θ2	θ4	θ8	θ8’
	θ2-θ3		θ4	θ4	θ8	θ8’
	θ4-θ5		θ6	θ8	θ8	θ8’
	θ6-θ7		θ8	θ8	θ8	θ8’
	θ8-θ9		θ10	θ12	θ16	θ8’
	θ10-θ11		θ12	θ12	θ16	θ8’
	θ12-θ13		θ14	θ16	θ16	θ8’
	θ14-θ15		θ16	θ16	θ16	θ8’
	θ16		-θ14	-θ12	-θ8	-θ8’
1/8 step	θ0	θ1		θ4	θ8	θ8’
	θ2	θ3		θ4	θ8	θ8’
	θ4	θ5		θ8	θ8	θ8’
	θ6	θ7		θ8	θ8	θ8’
	θ8	θ9		θ12	θ16	θ8’
	θ10	θ11		θ12	θ16	θ8’
	θ12	θ13		θ16	θ16	θ8’
	θ14	θ15		θ16	θ16	θ8’
	θ16	-θ15		-θ12	-θ8	-θ8’
Quarter step	θ0	θ1	θ2		θ8	θ8’
	θ4	θ5	θ6		θ8	θ8’
	θ8	θ9	θ10		θ16	θ8’
	θ12	θ13	θ14		θ16	θ8’
	θ16	-θ15	-θ14		-θ8	-θ8’
Half step	θ0	θ1	θ2	θ4		θ8’
	θ8	θ9	θ10	θ12		θ8’
	θ16	-θ15	-θ14	-θ12		-θ8’
Full step	θ8’	θ9	θ10	θ12	θ16	

*As for θ0 to θ16, please refer to the step position of current ratio setting.

If you switch micro-step mode while the motor is driving, the mode setting will be reflected from the next STEP and the motor advances to the closest excitation position at switching operation.

(13) Typical current waveform in each micro-step mode

Full step (CW mode)

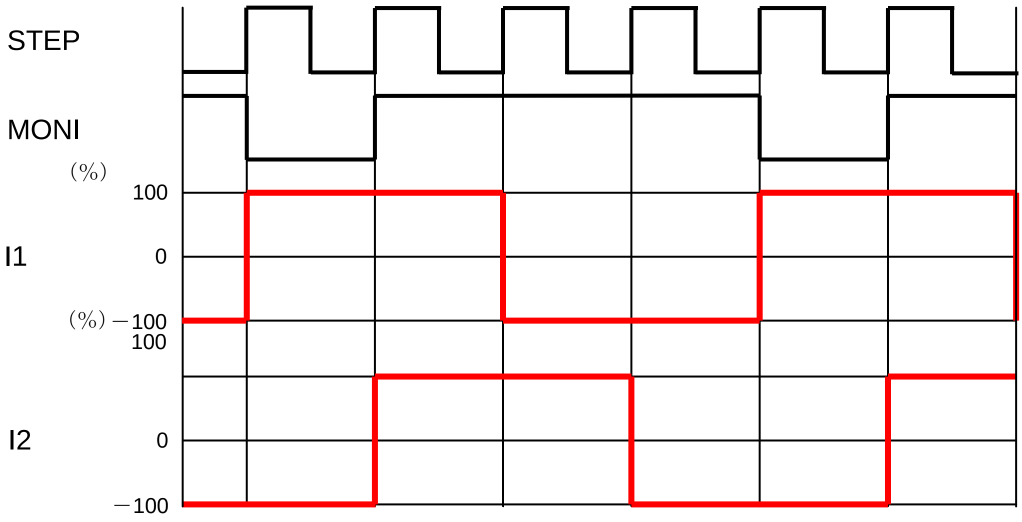


Figure 22. Current waveform of Full step in CLK-IN

Half step (CW mode)

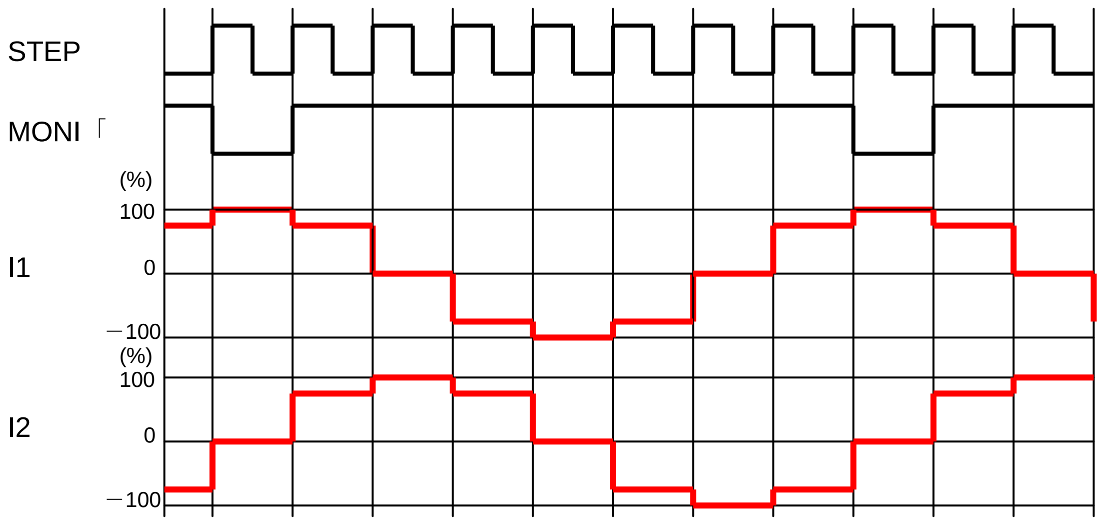


Figure 23. Current waveform of Half step in CLK-IN

Quarter step (CW mode) (Only LV8731/LV8732/LV8734/LV8736)

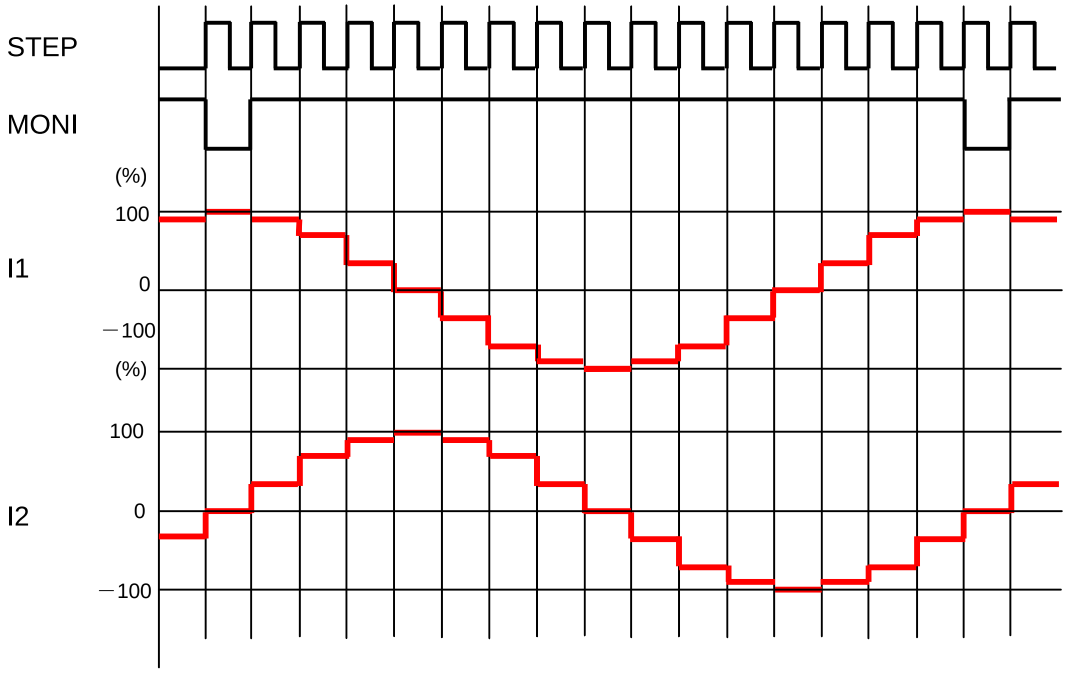


Figure 24. Current waveform of Quarter step in CLK-IN

1/8 step (CW mode) (Only LV8732/LV8734/LV8735/LV8736)

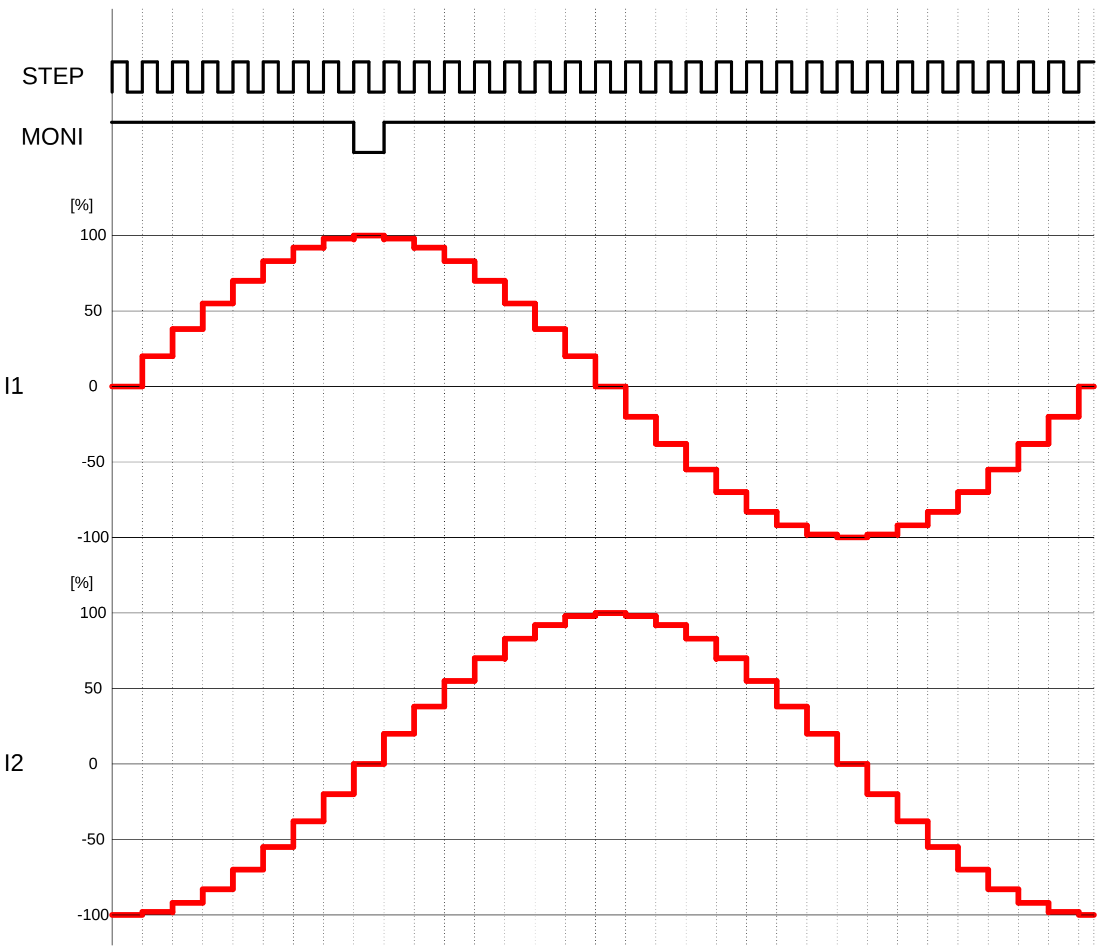


Figure 25. Current waveform of 1/8 step in CLK-IN

1/16 step (CW mode) (Only LV8731/LV8735)

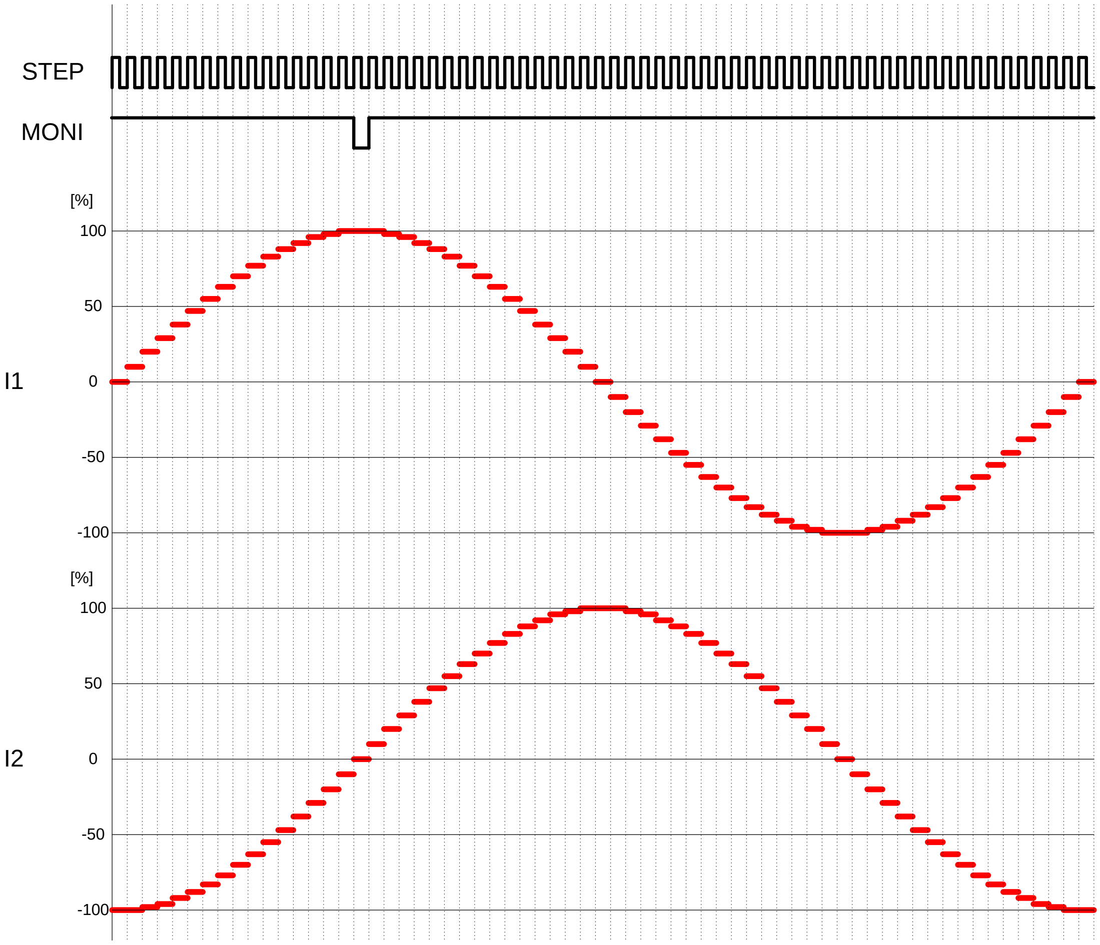
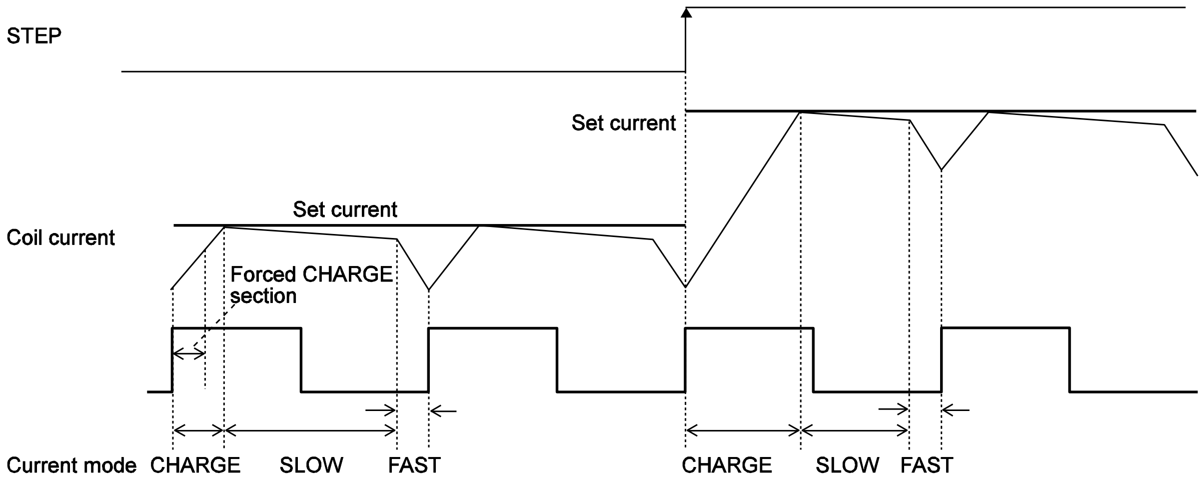


Figure 26. Current waveform of 1/16 step in CLK-IN

(14) Current control operation specification

(Sine wave increasing direction)



(Sine wave decreasing direction)

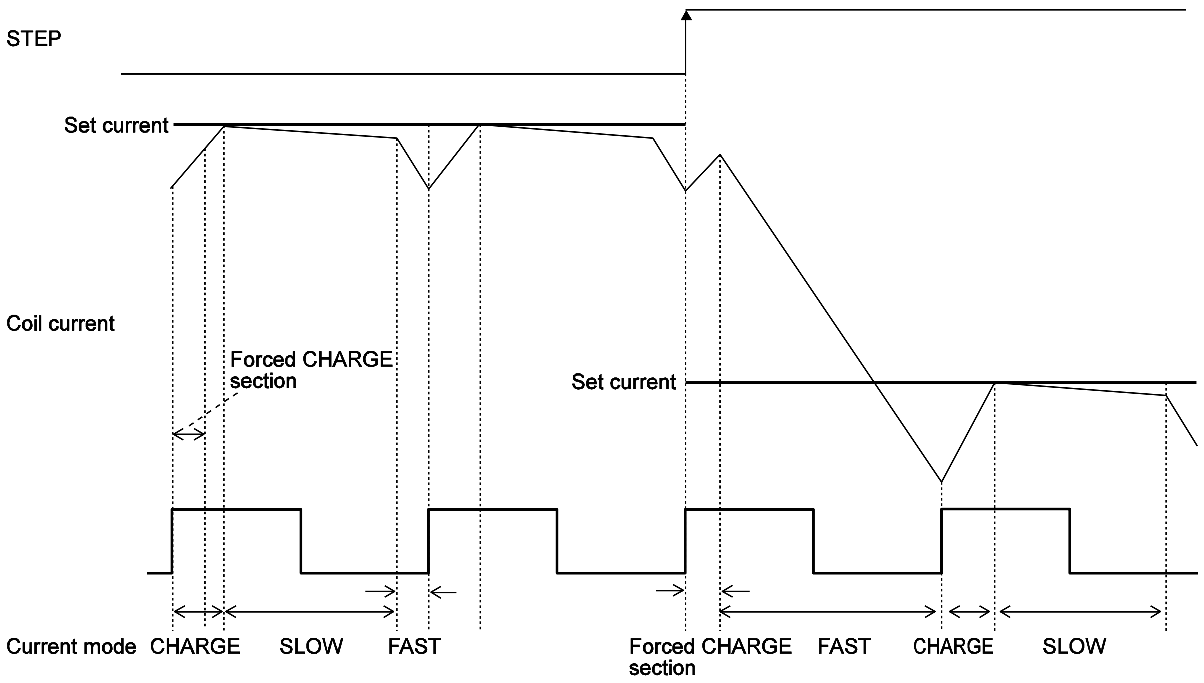


Figure 27. Current control operation

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 Triangle 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.

(15) Output transistor operation mode

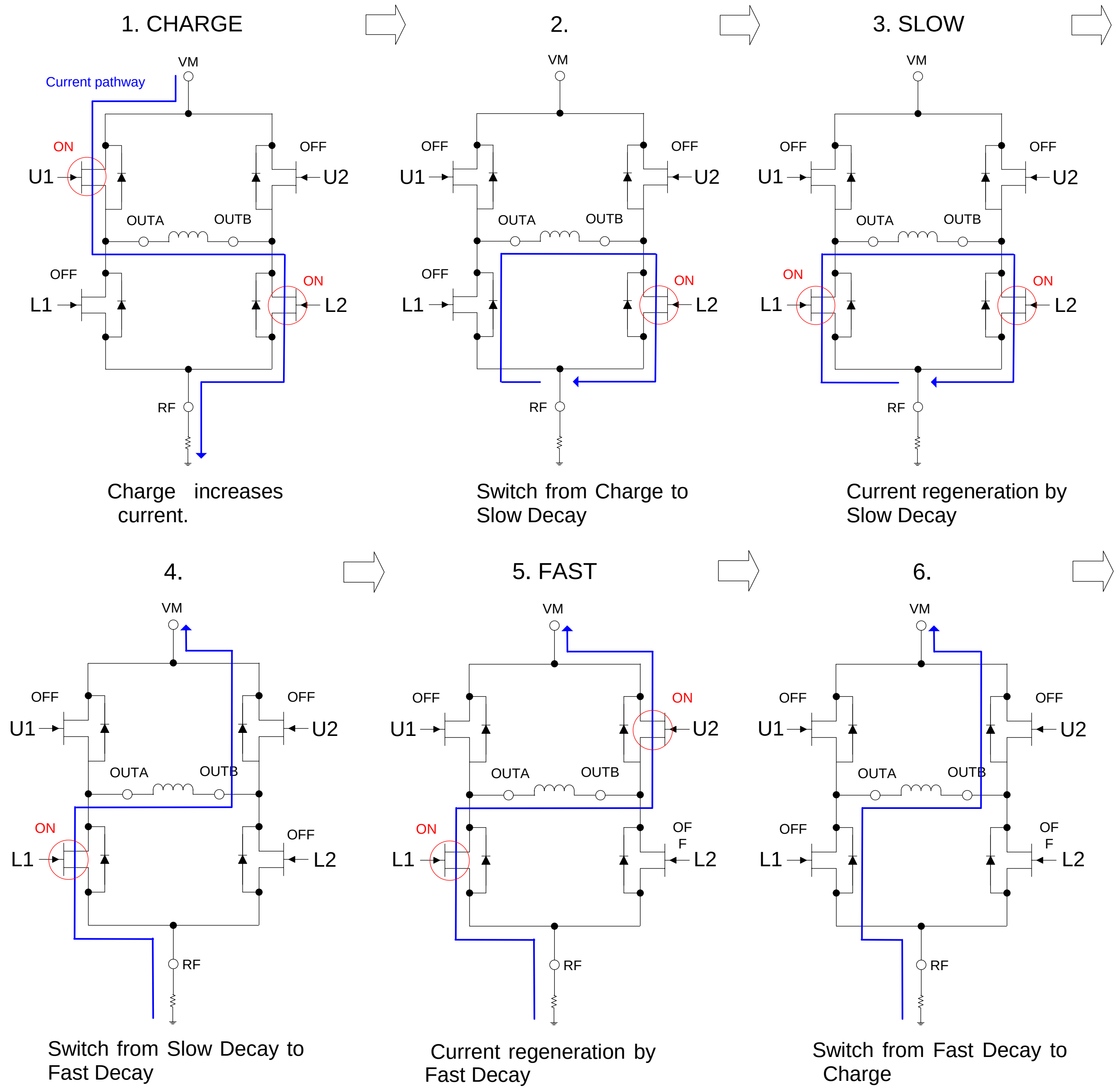


Figure 28. Switching operation

This IC controls constant current by performing chopping to output transistor.
As shown above, by repeating the process from 1 to 6, setting current is maintained.
Chopping consists of 3 modes: Charge/ Slow decay/ Fast decay. In this IC, for switching mode (No.2, 4, 6), there are "off period" in upper and lower transistor to prevent crossover current between the transistors. This off period is set to be constant (≈ 0.375μs) which is controlled by the internal logic. The diagrams show parasitic diode generated due to structure of MOS transistor. When the transistor is off, output current is regenerated through this parasitic diode.

Output Transistor Operation Function

OUTA→OUTB (CHARGE)

Output Tr	**CHARGE**	**SLOW**	**FAST**
U1	ON	OFF	OFF
U2	OFF	OFF	ON
L1	OFF	ON	ON
L2	ON	ON	OFF

OUTB→OUTA (CHARGE)

Output Tr	**CHARGE**	**SLOW**	**FAST**
U1	OFF	OFF	ON
U2	ON	OFF	OFF
L1	ON	ON	OFF
L2	OFF	ON	ON

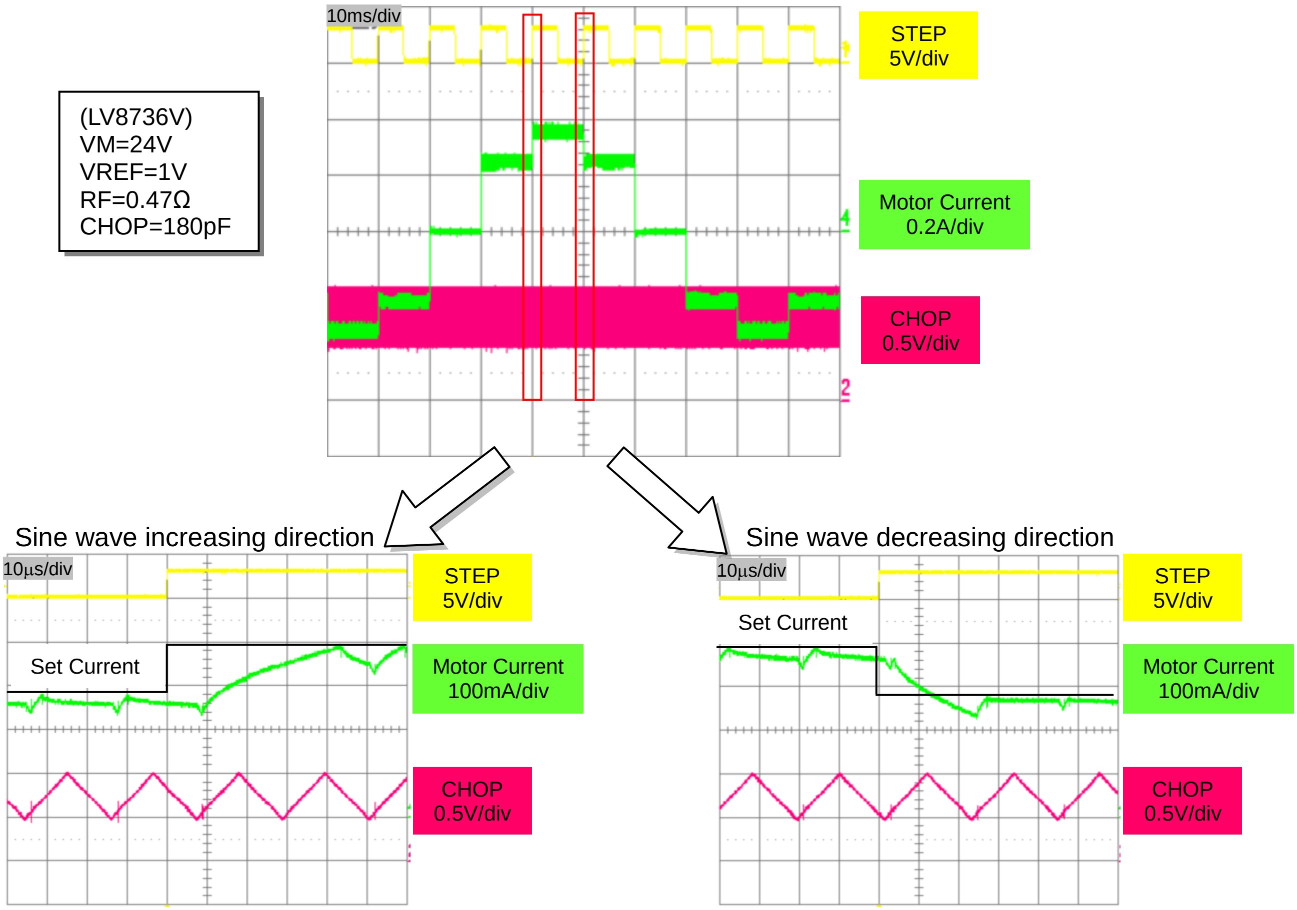


Figure 29. Current control operation waveform

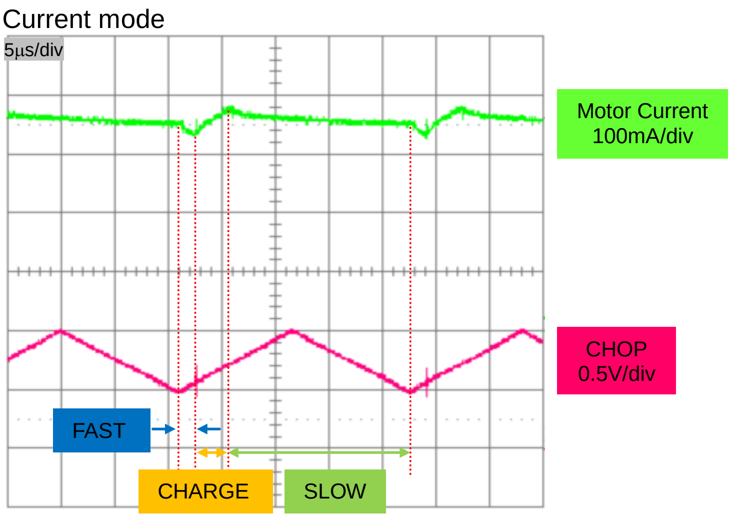


Figure 30. Chopping waveform

Motor current switches to Fast Decay mode when triangle wave (CHOP) switches from Discharge to Charge. Approximately after 1μs, the motor current switches to Charge mode. When the current reaches to the setting current, it is switched to Slow Decay mode which continues over the Discharge period of triangle wave.

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) PWM control

You can perform H-Bridge direct PWM control to DC11, DC12, DC21, and DC22 by inputting PWM signal. The maximum frequency of PWM signal is 200kHz. However, dead zone is generated when On-Duty is around 0%. Make sure to select optimum PWM frequency according to the target control range.

Input-Output Characteristics of H-Bridge (Reference data)
VM=24V,VREF=1.5V
Forward/Reverse↔Brake

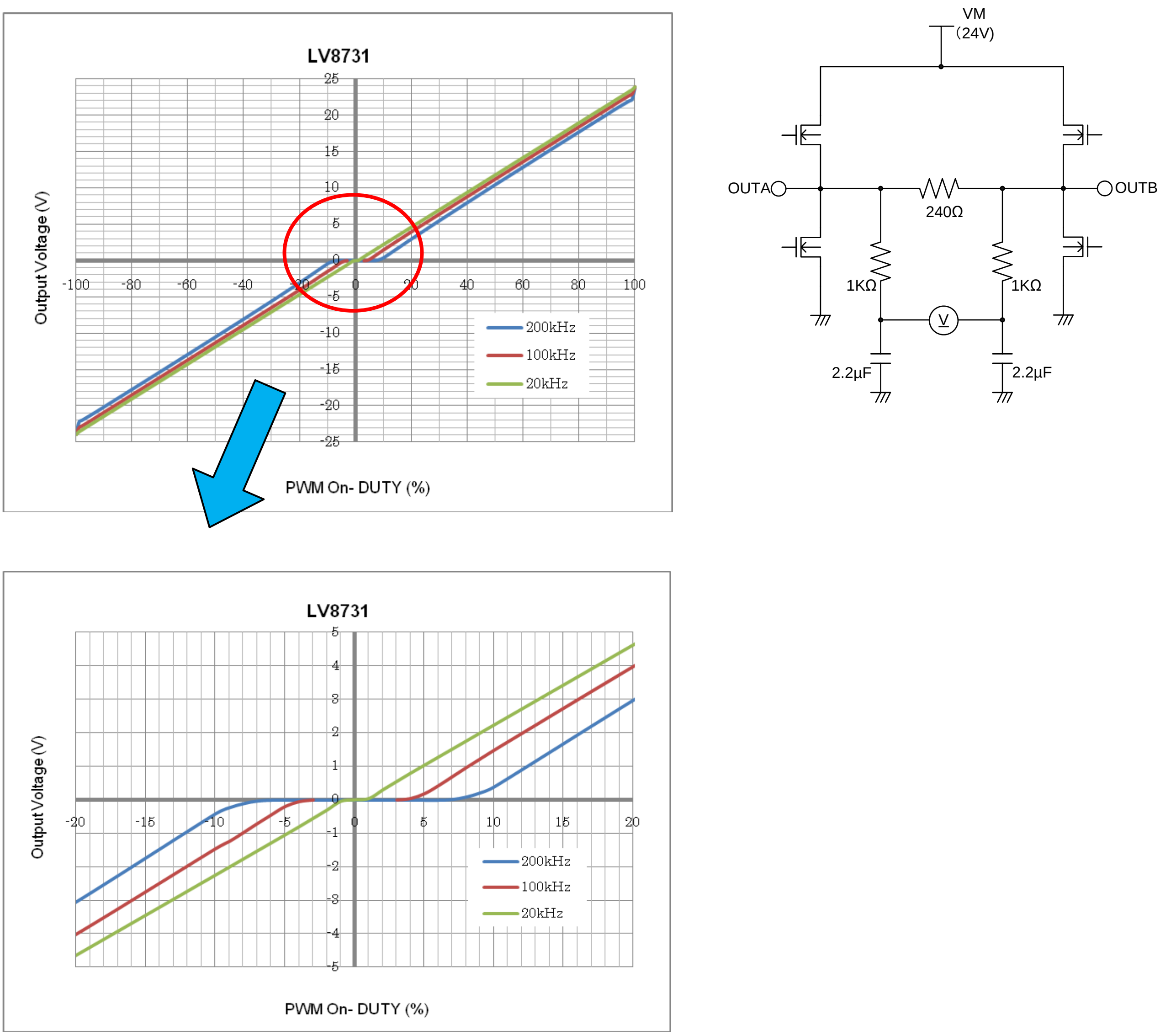


Figure 31. PWM control characteristic

Forward ↔ Brake

No load , VM=24V , DC12=10kHz (DC11=H)

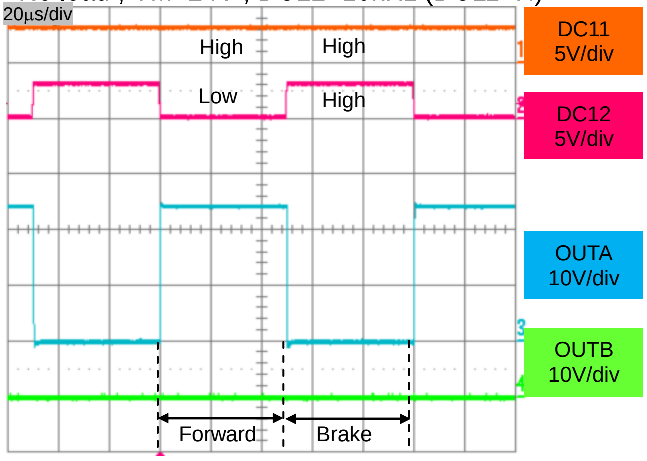
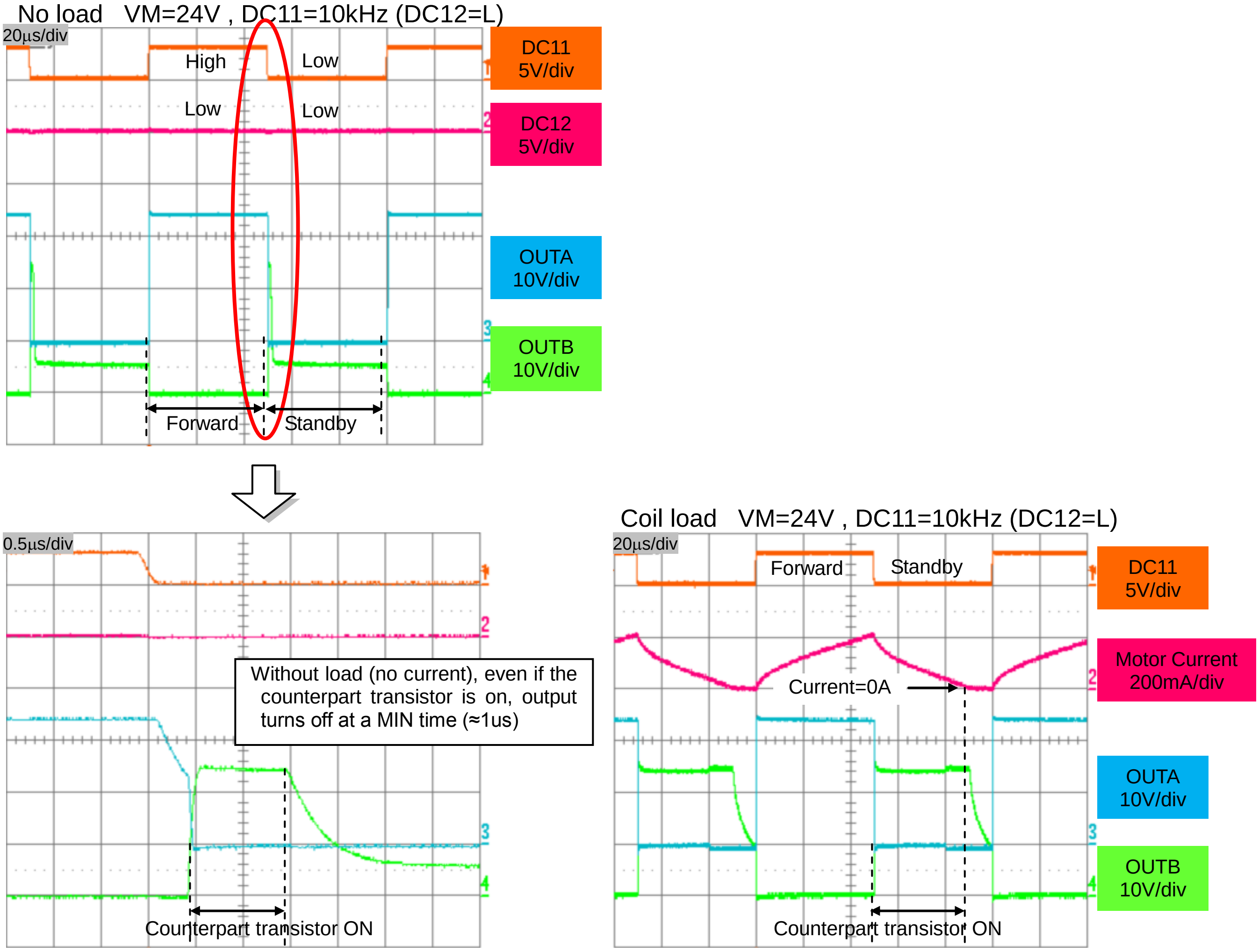


Figure 32. Forward ↔ Brake control waveform

Forward ↔ Standby

No load VM=24V , DC11=10kHz (DC12=L)



Standby mode turns on the counterpart transistor
(synchronous rectification) . After motor current fades off, output turns off.
Synchronous rectification reduces heat generation compared to diode regeneration.

Figure 33. Forward ↔ Standby control waveform

When you drive DC motor, caution is required to switch motor rotation from forward to reverse because when doing so, electromotive force (EMF) is generated and in some cases, current can exceed the ratings which may lead to the destruction and malfunction of the IC .
Coil current (Iout) for each operation is obtained as follows when switching motor rotation from forward to reverse.

・Starting up motor operation
Coil current Iout = (VCC – EMF) / coil resistance
At startup, Iout is high because EMF is 0. As the motor starts to rotate, EMF becomes higher and Iout becomes lower.

・When switching motor rotation from forward to reverse:
Coil current Iout = (VCC + EMF) / coil resistance
When EMF is nearly equal to VCC at a max, make sure that the current does not exceed Iomax since a current which is about double the startup current may flow at reverse brake.

・Short brake:
Coil current: Iout = EMF / coil resistance
Since EMF is 0 when the rotation of motor stops, Iout is 0 as well.

When you switch motor rotation form forward to reverse, if Iout is higher than Iomax, you can operate short brake mode between forward and reverse either to slow down or stop the motor.

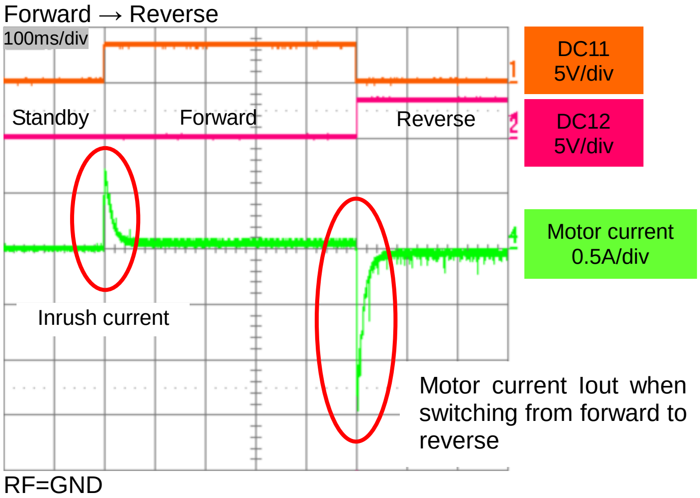


Figure 34. Without Brake mode

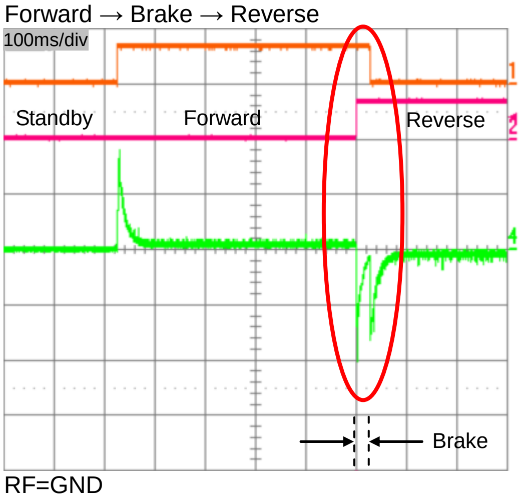
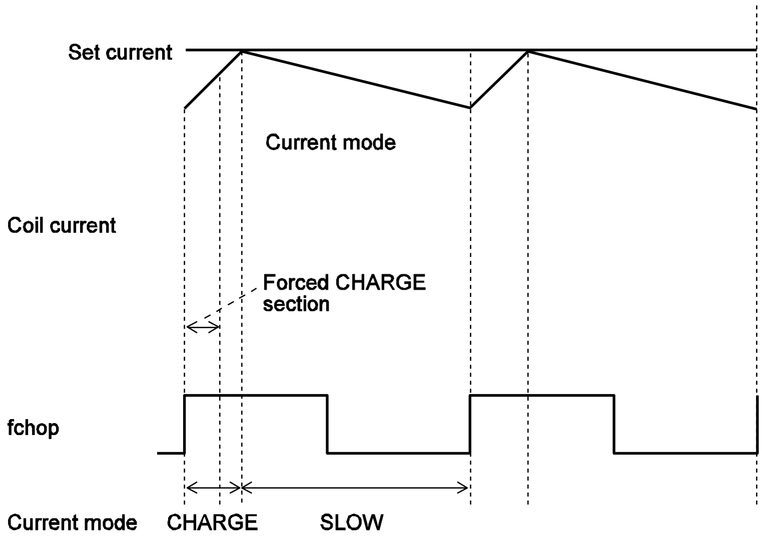


Figure 35. With Brake mode

(3) 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)



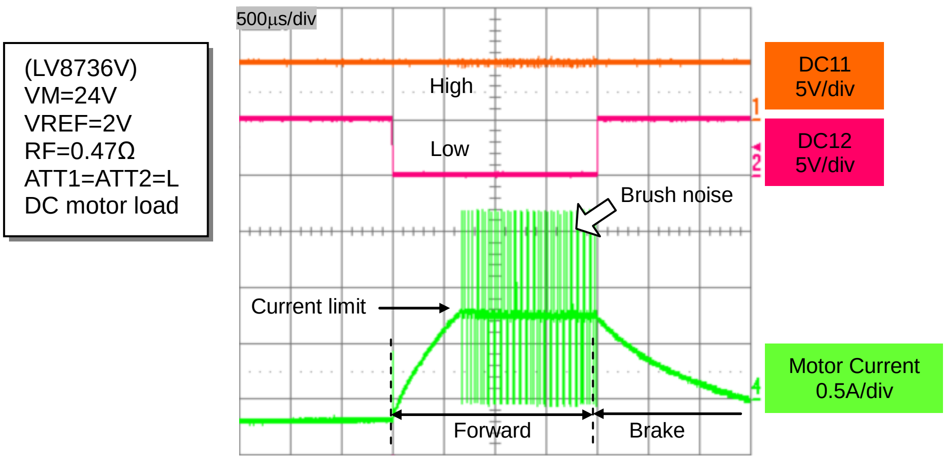


Figure 36. Current limit operation

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 0.5Ω, the output current is set as shown below.

Ilimit = 1.5V/5 × 100%/0.5Ω = 0.6A

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

Ilimit = 0.6A × 20% = 120mA

(4) Current LIMIT mask function (Only LV8734/LV8735/LV8736)

Only the DCM mode. At STM mode OE pin : It operates as output enable function.

The mask can do current LIMIT function during the fixed time set with the CMK pin at the DCM mode. It is effective to make it not hang to the limiter by the start current of the motor to set current LIMIT low.

The charge is begun, current LIMIT function is done to the CMK capacitor meanwhile when switching to forward/ reverse mode, and the mask is done. Afterwards, the mask is released when the voltage of the CMK pin reaches set voltage (typ 1.5V) , and the current limit function works.

When 2ch side begins forward (reverse) operation while the mask on 1ch side is operating, the CMK pin is discharged one degree up to a constant voltage, and begins charging again because the CMK pin becomes 2ch using combinedly. Meanwhile, 1ch side and 2ch side enter the state of the mask.

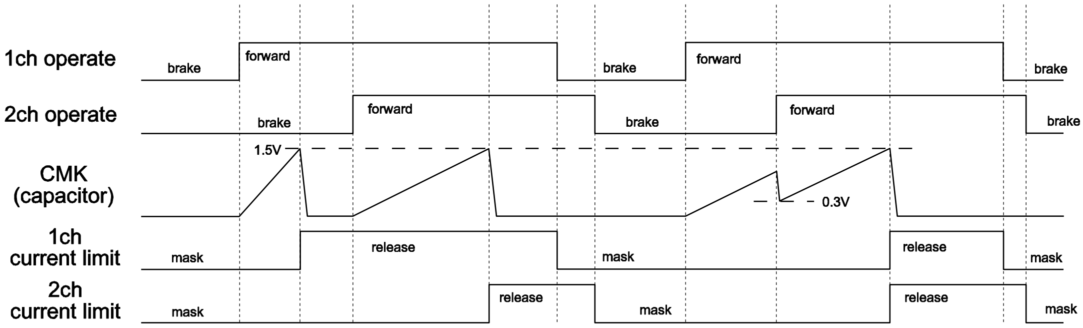


Figure 37. Current limit mask function timing chart

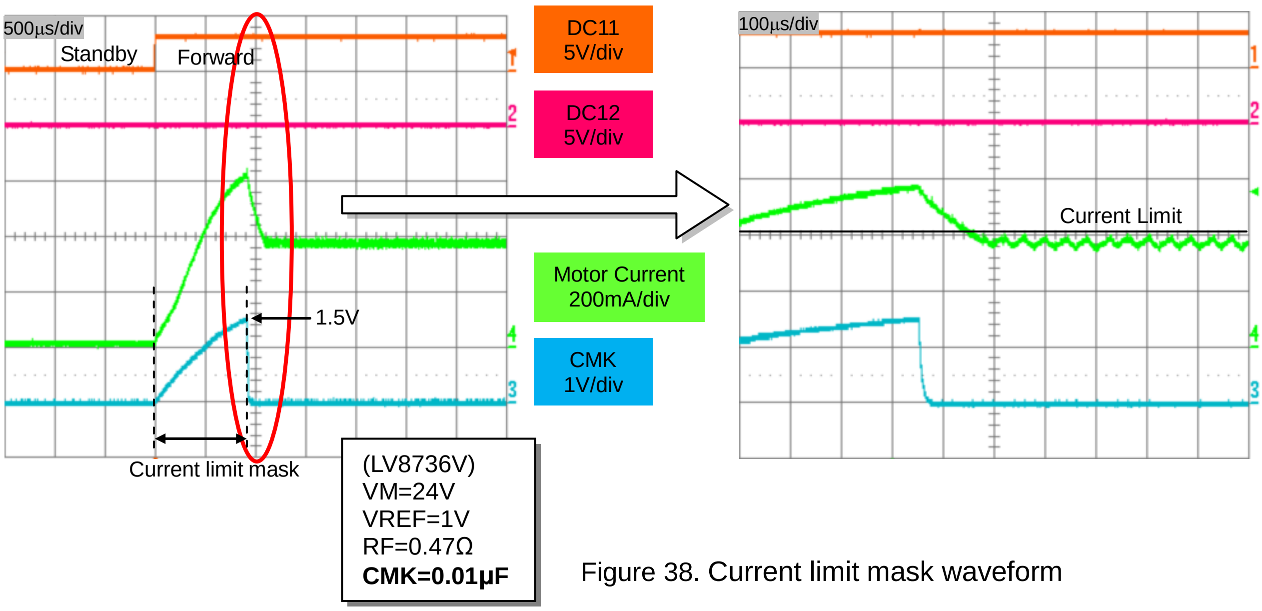


Figure 38. Current limit mask waveform

When the capacitor is not connected, the function of LIMIT in the current can be switched to operation/non-operating state by the state of the input of the CMK pin.

CMK	Current LIMIT function
"L"	Non-operating
"H" or OPEN	Operation

(5) Current LIMIT mask time (Tcmk) (Only LV8734/LV8735/LV8736)

The time of the mask of current LIMIT function can be set by connecting capacitor C_{CMK} between CMK pin - GND. Decide the value of capacitor C_{CMK} according to the following expressions.

Mask time : T_{CMK} $T_{CMK} \approx -C_{CMK} \times R \times 1n\ (1 - Vt_{CMK} / (I_{CMK} \times R))$ (sec)

Vt_{CMK} : LIMIT mask threshold voltage typ. 1.5V

I_{CMK} : CMK pin charge current typ. 25µA

R : Internal resistance typ. 100kΩ

(6) Blanking time switching function

Only the DCM mode. At STM mode RST pin : It operates as RESET function.

BLK	Blanking time
Low	2μs
High	3μs

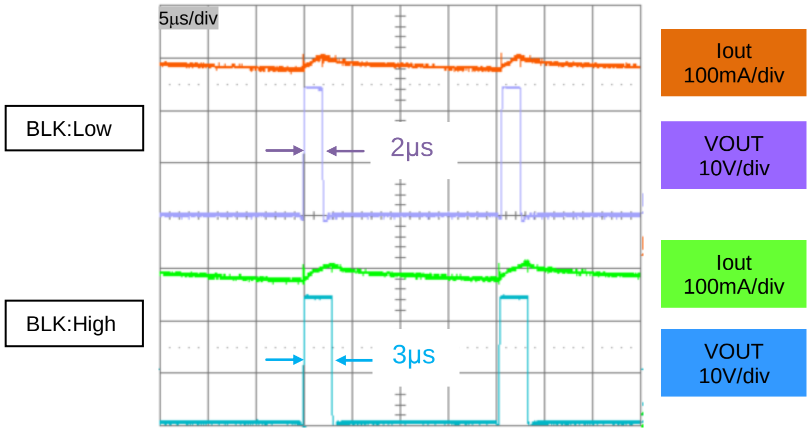


Figure 39. Blanking time waveform

(7) DC motor parallel connection

By connecting OUT1A and OUT2A as well as OUT2A and OUT2B, you can double the current capability. However, you cannot use current limit function. (RF=GND)

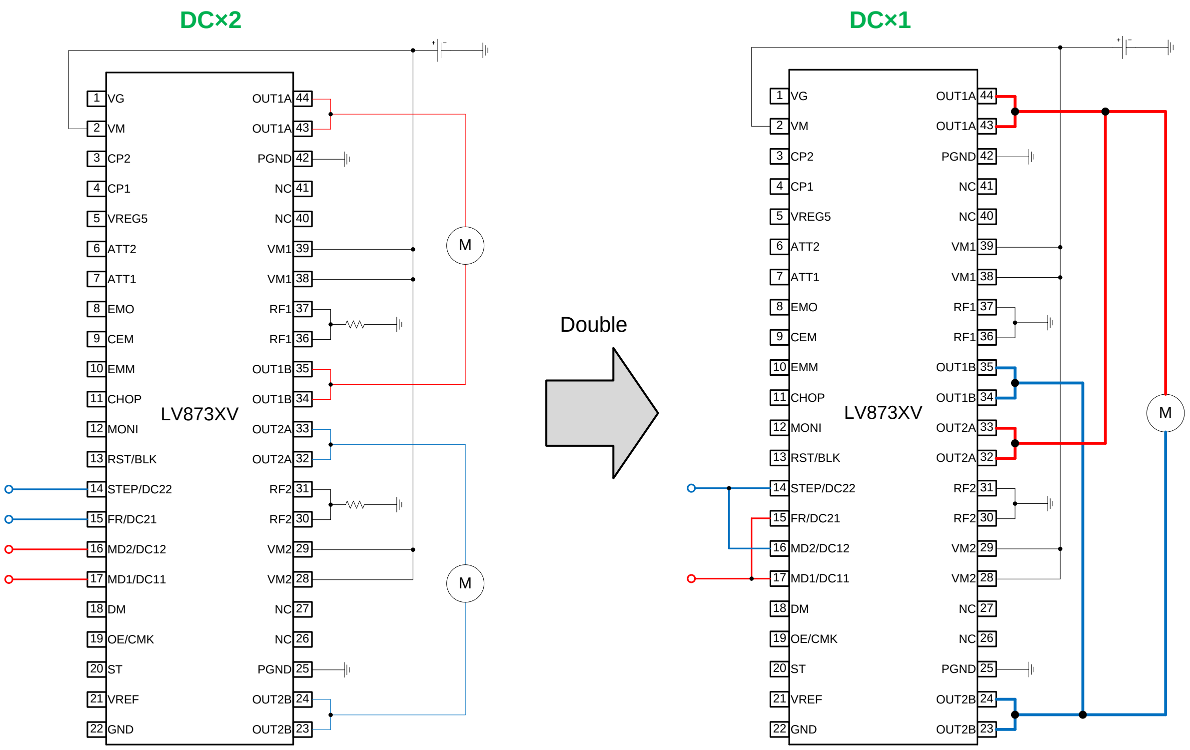


Figure 40. Parallel connection at DCM

Current Ability (Iomax)

	OUT1	OUT2	OUT1/2 (Parallel Connect)
LV8731	2A	2A	4A
LV8732	2A	2A	4A
LV8734	1.5A	1.5A	3A
LV8735	1A	1A	2A
LV8736	1A	1A	2A

(8) Typical current waveform in each micro-step mode when stepping motor parallel input control

Full step (CW mode)

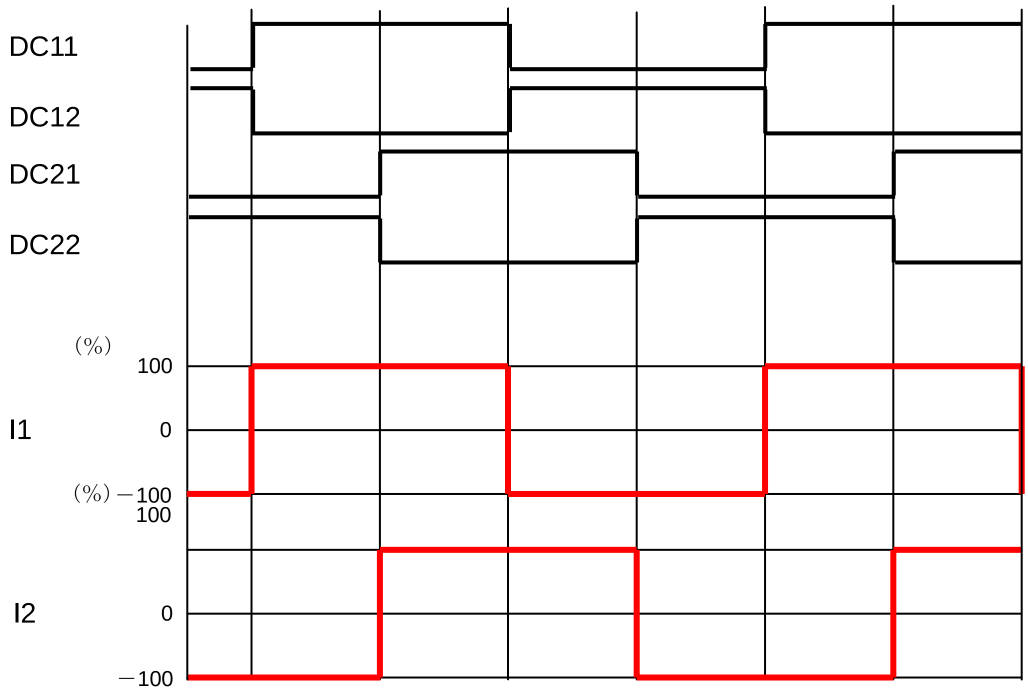


Figure 41. Current waveform of Full step in Parallel input

Half step full torque (CW mode)

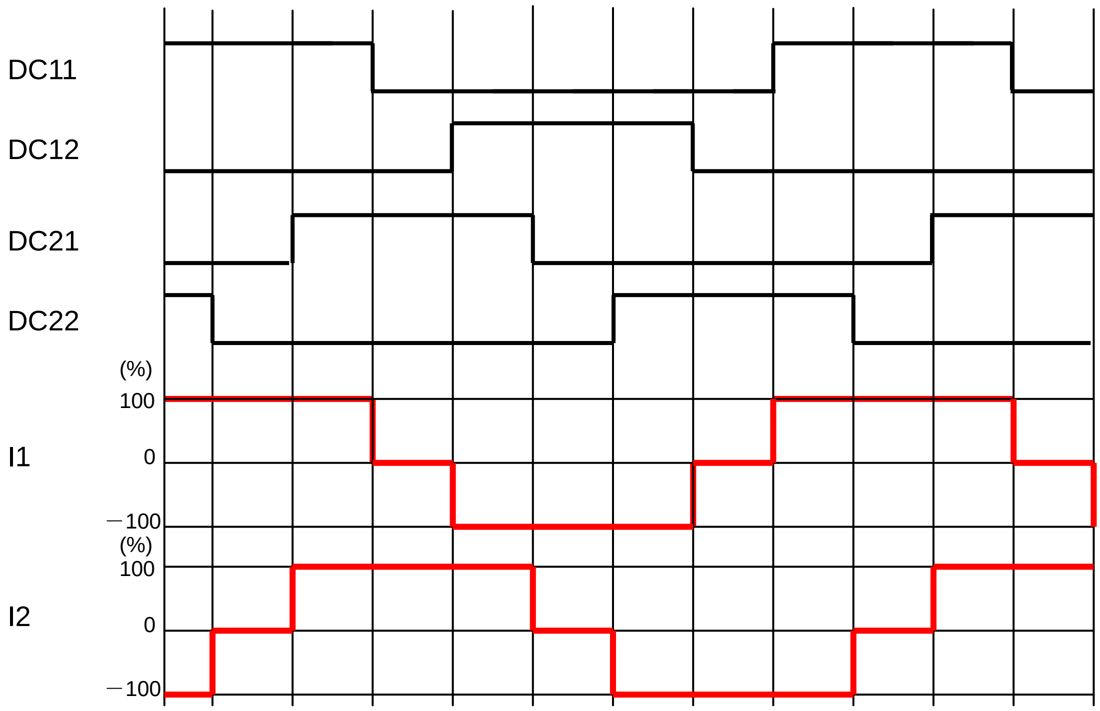


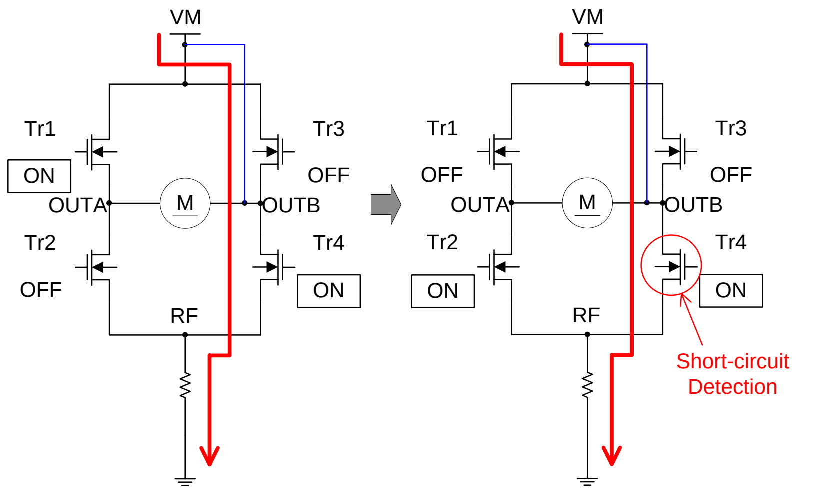
Figure 42. Current waveform of Half step in Parallel input

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.)

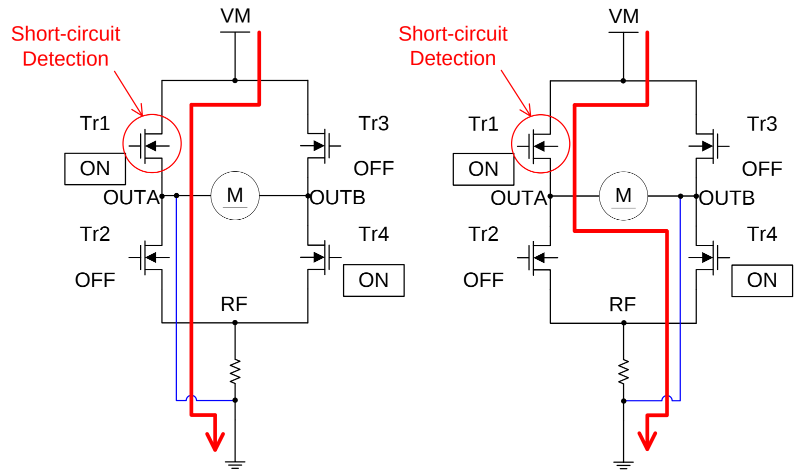
(1) Output short-circuit detection operation

Short to Power



1.High current flows if OUTB short to VM and Tr4 are ON.
2.If RF voltage> setting voltage, then the mode switches to SLOW decay.
3.If the voltage between D and S of Tr4 exceeds the reference voltage for 2μs, short status is detected.

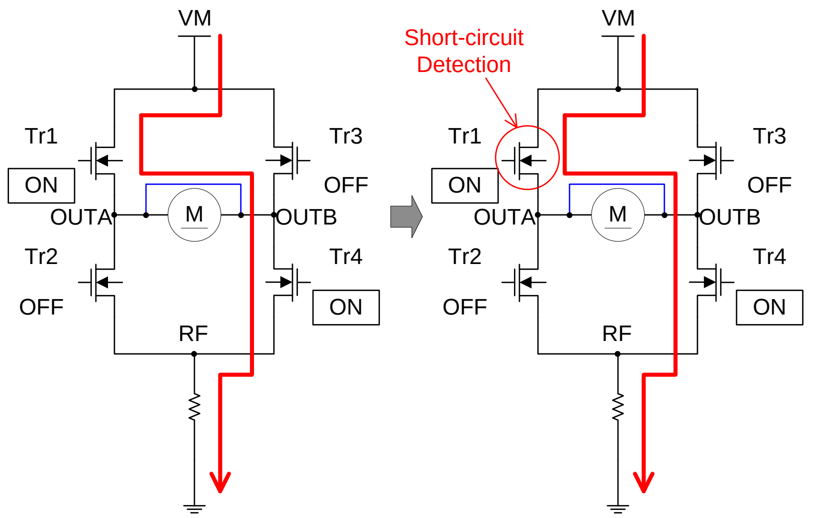
Short to GND



(left schematic)
1.High current flows if OUTA short to GND and Tr1 are ON
2. If the voltage between D and S of Tr1 exceeds the reference voltage for 2μs, short status is detected.

(right schematic)
1.Without going through RF resistor, current control does not operate and current will continue to increase in CHARGE mode.
2. If the voltage between D and S of Tr1 exceeds the reference voltage for 2μs, short status is detected.

Load short



1.Without L load, high current flows.
2. If RF voltage> setting voltage, then the mode switches to SLOW decay.
3.During load short stay in SLOW decay mode, current does not flow and over current state is not detected. Then the mode is switched to FAST decay according to chopping cycle.
4. Since FAST state is short (≈1μs), switches to CHARGE mode before short is detected.
5.If voltage between D and S exceeds the reference voltage continuously during blanking time at the start of CHARGE mode (Tr1), CHARGE state is fixed (even if RF voltage exceeds the setting voltage, the mode is not switched to SLOW decay). After 2us or so, short is detected.

(2) Output short-circuit protection detect current (Reference value)

Short protector operates when abnormal current flows into the output transistor.

Ta = 25°C (typ)

Output Transistor	LV8731/LV8732	LV8734	LV8735/LV8736
Upper-side Transistor	4.0A	2.5A	2.5A
Lower-side Transistor	3.6A	2.5A	2.6A

*RF=GND

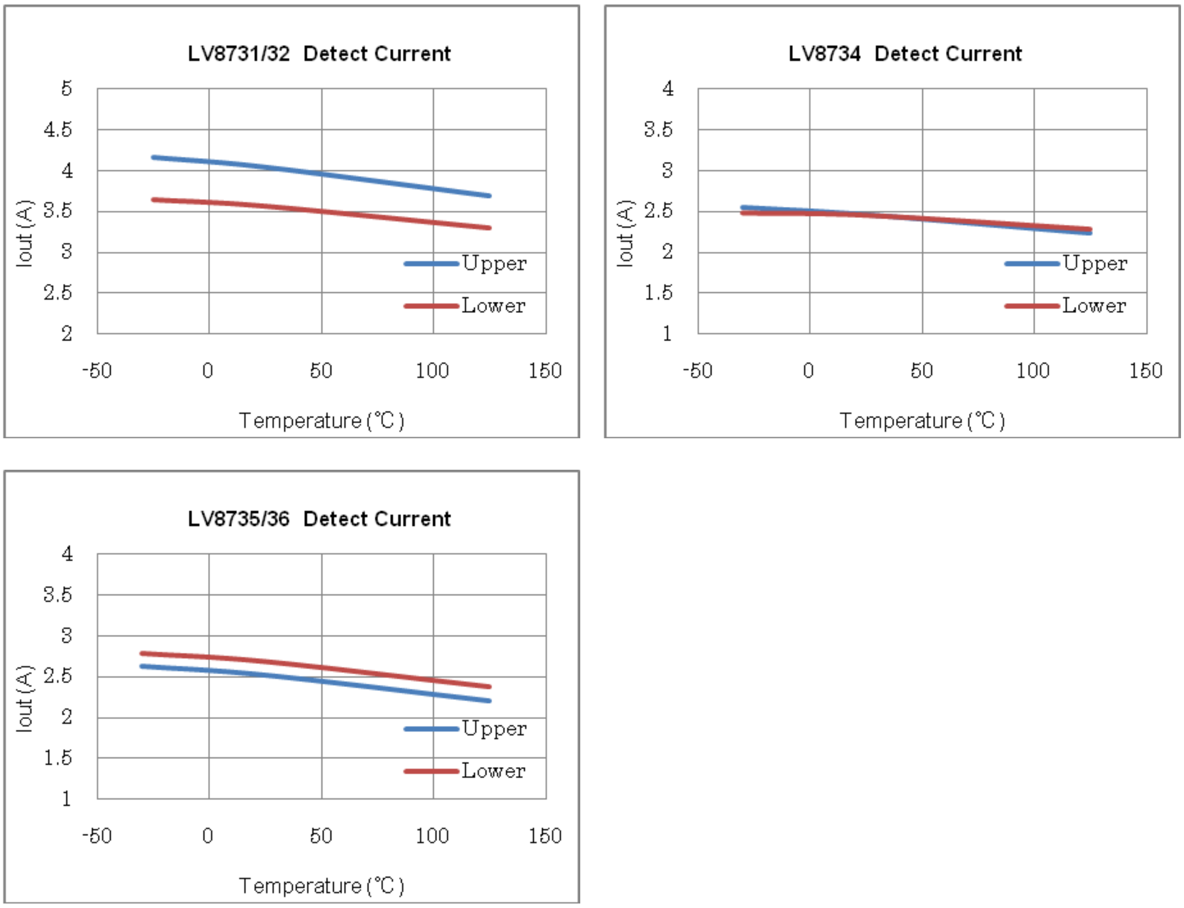


Figure 43. Detect current vs temperature

(3) 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	Latch method
High	Auto reset method

(4) 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 2μs) , 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.

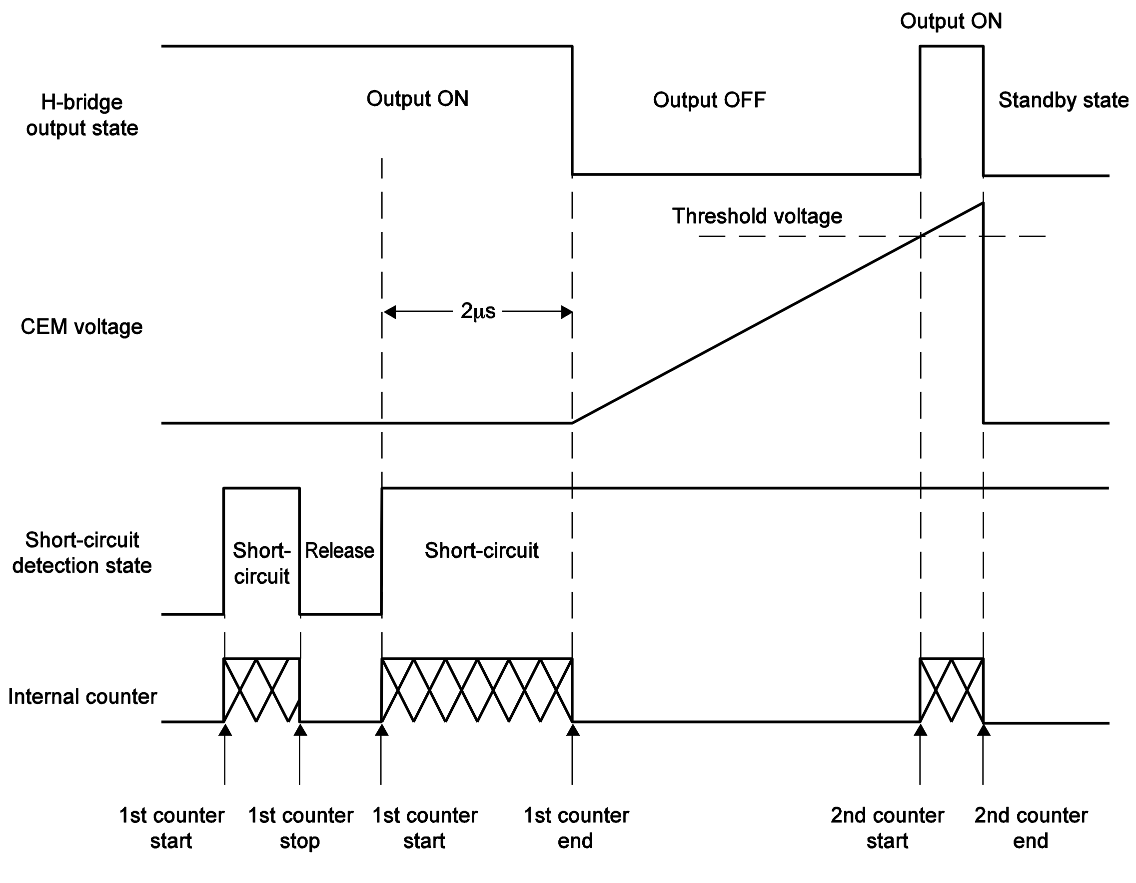


Figure 44. CEM operation timing chart in latch type

(5) 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 over current mode still continues, the switching mode described above is repeated until the over current mode is canceled.

(6) 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

When you do not connect CEM capacitor (CEM=open) and short state continues for 2us, output turns OFF. Standby mode is set if short state continues even after the output is turn ON again.

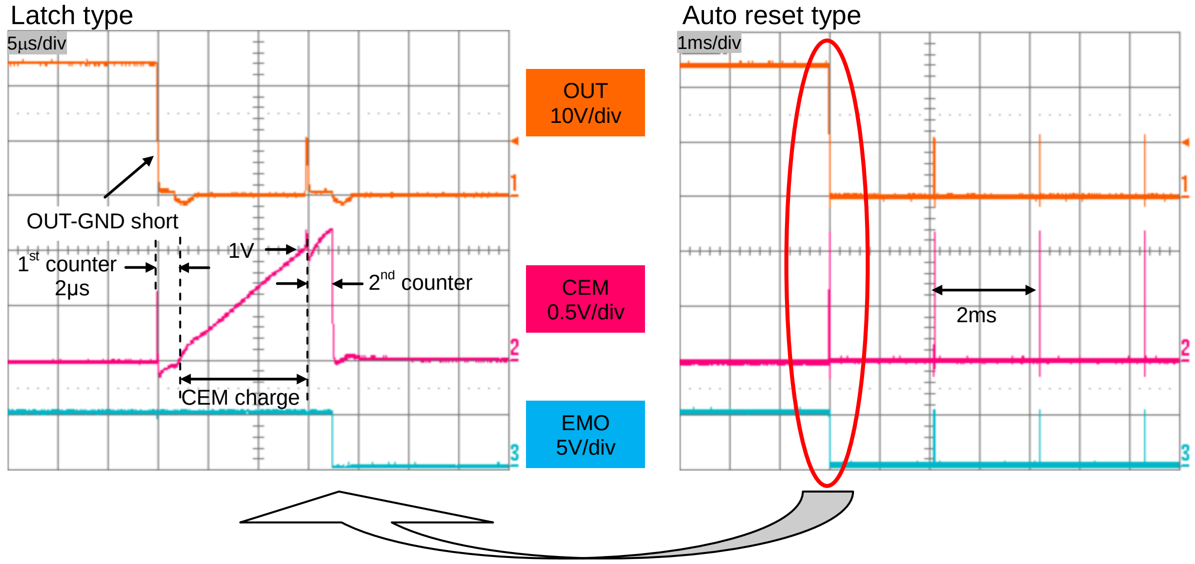


Figure 45. CEM operation waveform

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

This 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.

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

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. Because the output is not turned on if VM+4V or more is not pressured, the voltage of the VG pin recommends the drive of the motor to put the time of t_{ONG} or more, and to begin.

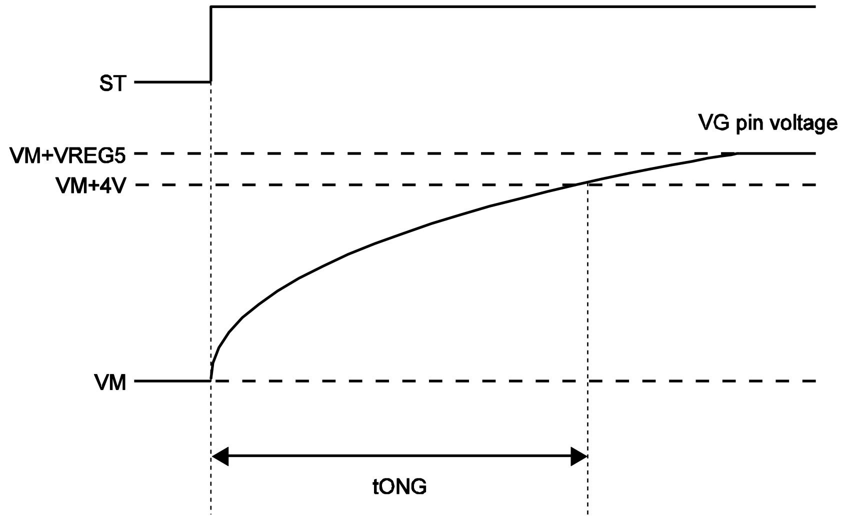


Figure 46. VG pin voltage schematic view

VG voltage is used to drive upper output FET and VREG5 voltage is used to drive lower output FET.
Since VG voltage is equivalent to the addition of VM and VREG5 voltage, VG capacitor should allow higher voltage.
The capacitor between CP1 and CP2 is used to boost charge pump. Since CP1 oscillates with 0V↔VREG5 and CP2 with VM↔VM＋VREG5, make sure to allow enough capacitance between CP1 and CP2.
Since the capacitance is variable depends on motor types and driving methods, please check with your application before you define constant to avoid ripple on VG voltage.

(Recommended value) VG: 0.1μF
CP1-CP2: 0.1μF

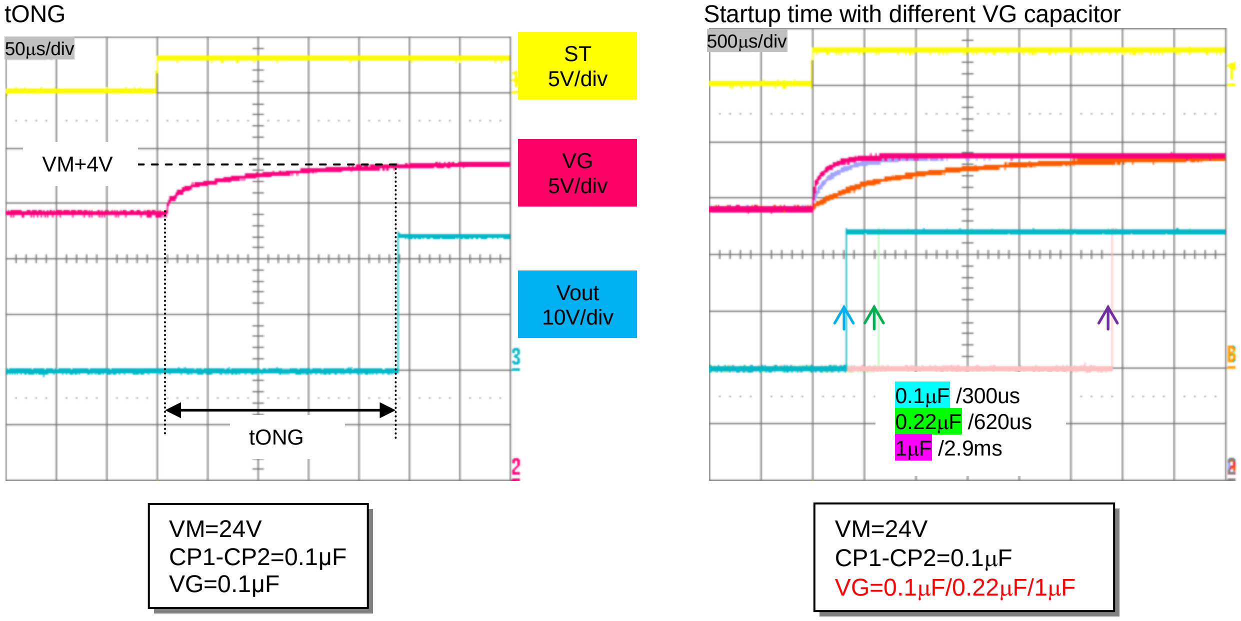


Figure 47. VG voltage pressure waveform

Thermal shutdown function

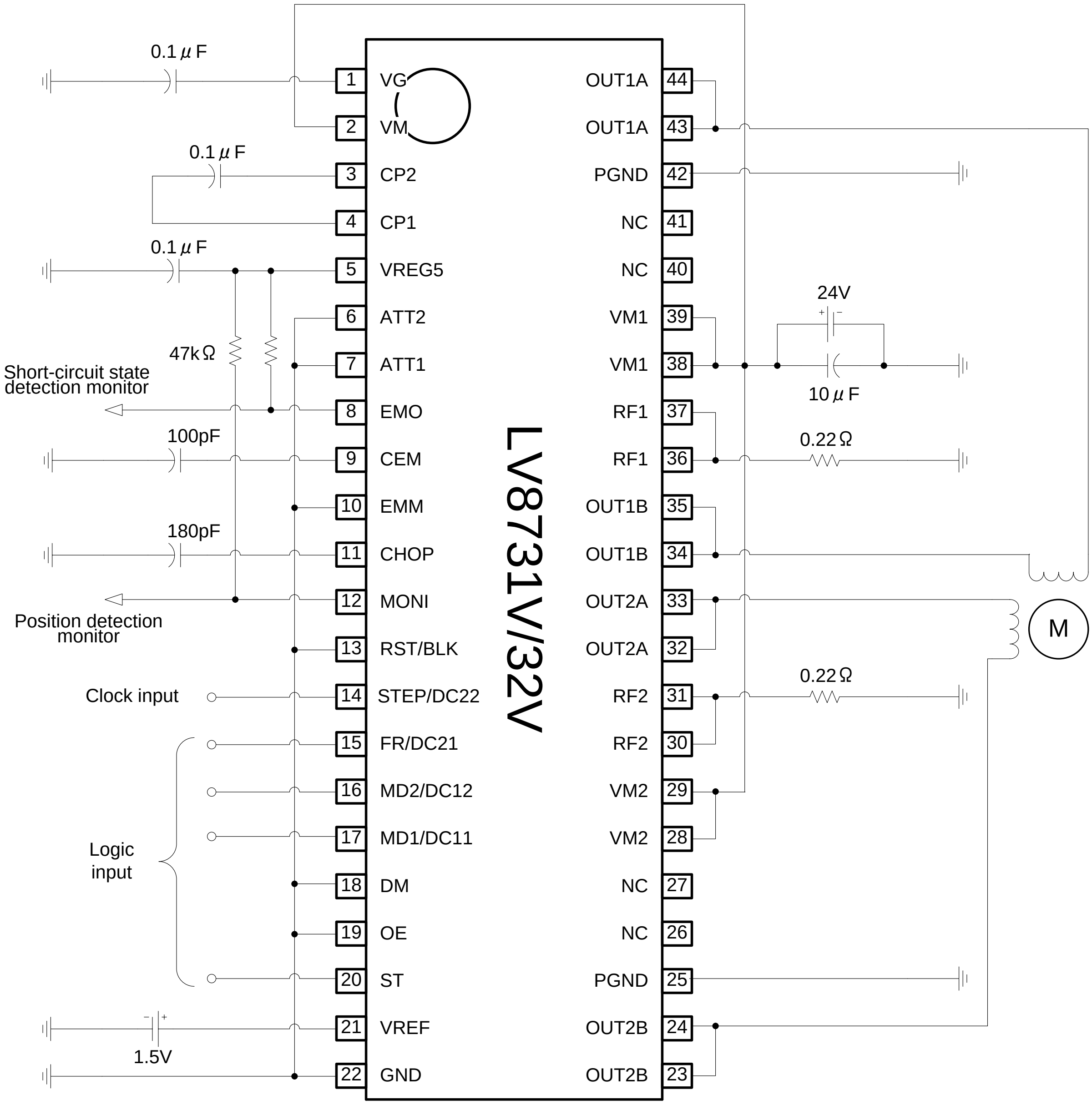
The thermal shutdown circuit is incorporated and the output is turned off when junction temperature Tj exceeds 180°C and the abnormal state warning output is turned on. As the temperature falls by hysteresis, the output turned on again (automatic restoration).
The thermal shutdown circuit does not guarantee the protection of the final product because it operates when the temperature exceed the junction temperature of Tjmax=150°C.

TSD = 180°C (typ)
ΔTSD = 40°C (typ)

Application Circuit Example

- Stepping motor driver circuit (DM = Low)

<LV8731V/LV8732V>



The formula 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/5/0.22Ω = 1.36A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (180pF × 0.5V × 2) = 55kHz

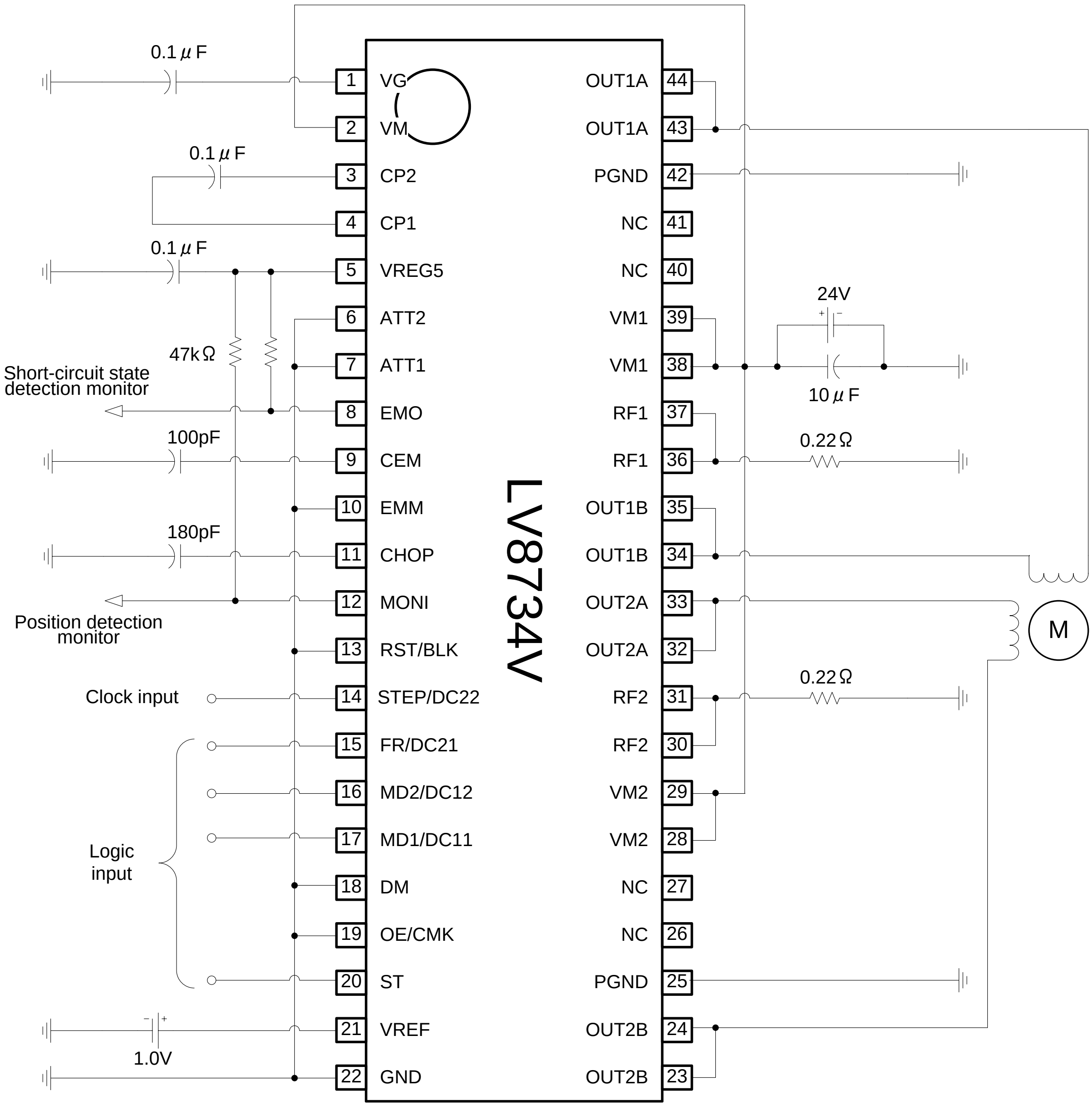
Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

= 100pF × 1V/10μA = 10μs

• Stepping motor driver circuit (DM = Low)

<LV8734V>



The formula 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

= 1.0V/5/0.22Ω = 0.91A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (180pF × 0.5V × 2) = 55kHz

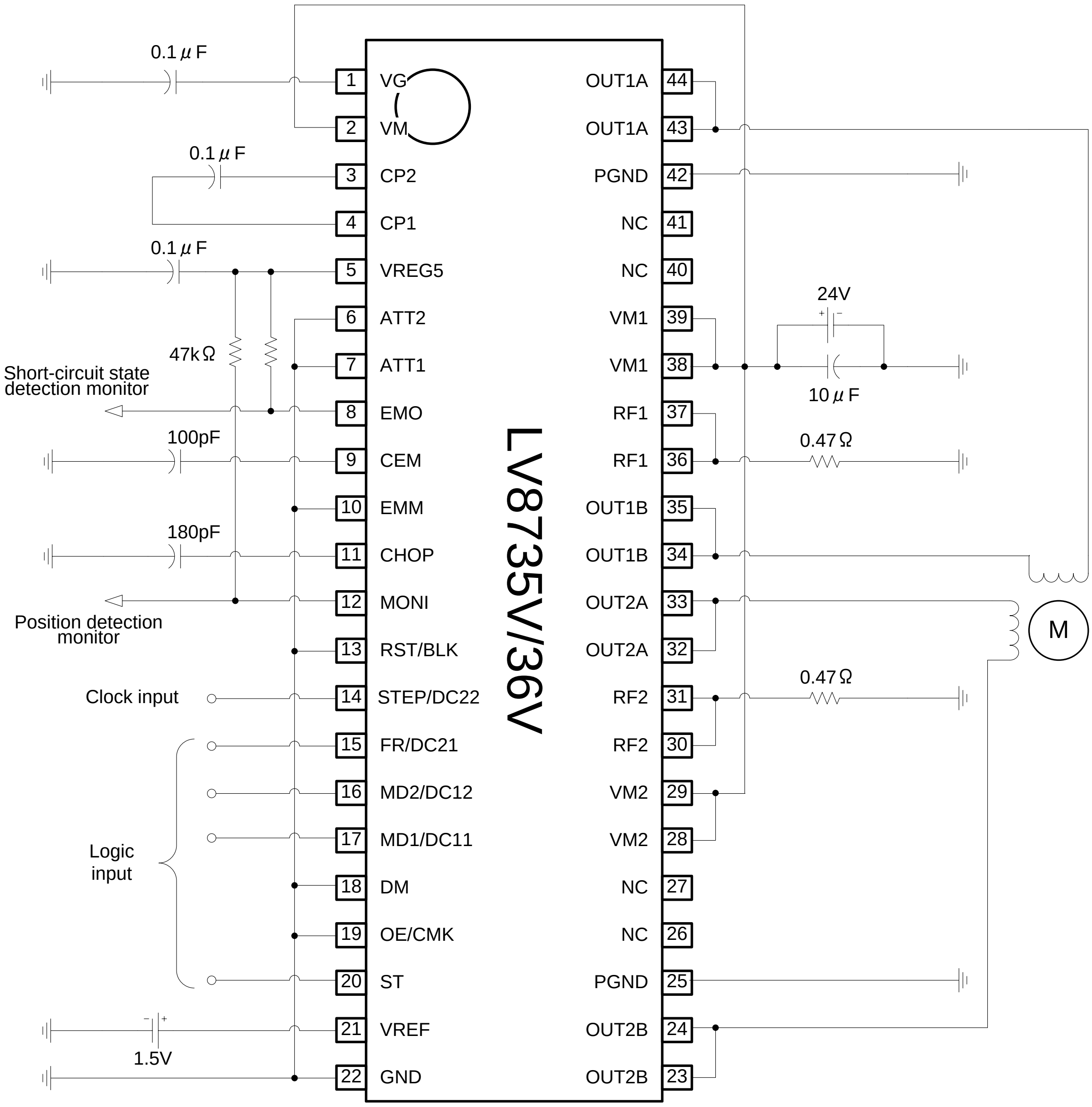
Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

= 100pF × 1V/10μA = 10μs

• Stepping motor driver circuit (DM = Low)

<LV8735V/LV8736V>



The formula 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/5/0.47Ω = 0.64A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (180pF × 0.5V × 2) = 55kHz

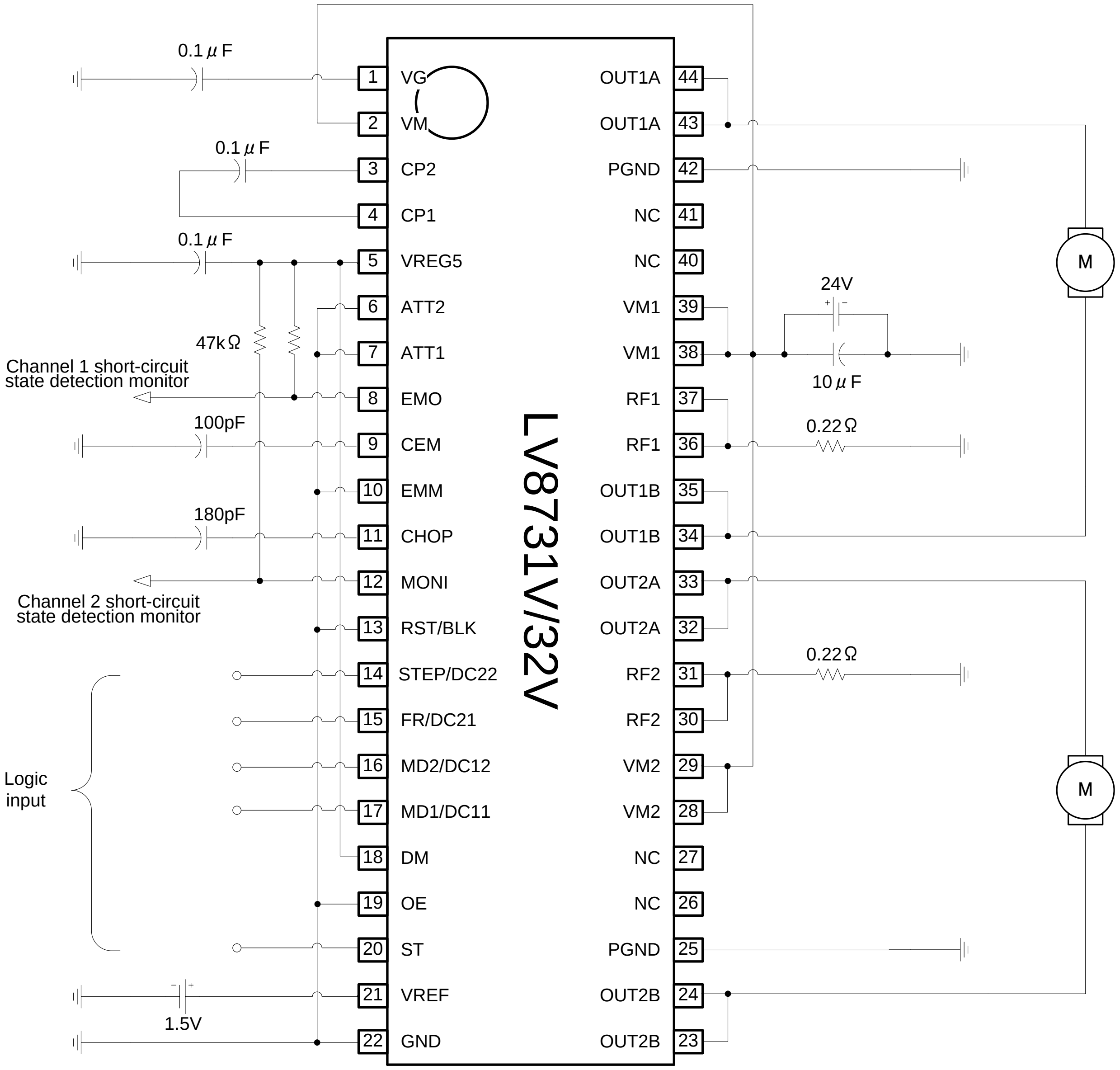
Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

= 100pF × 1V/10μA = 10μs

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

<LV8731V/LV8732V>



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

Constant current limit (100%) setting

When VREF = 1.5V

Ilimit = VREF/5/RF resistance

= 1.5V/5/0.22Ω = 1.36A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (180pF × 0.5V × 2) = 50kHz

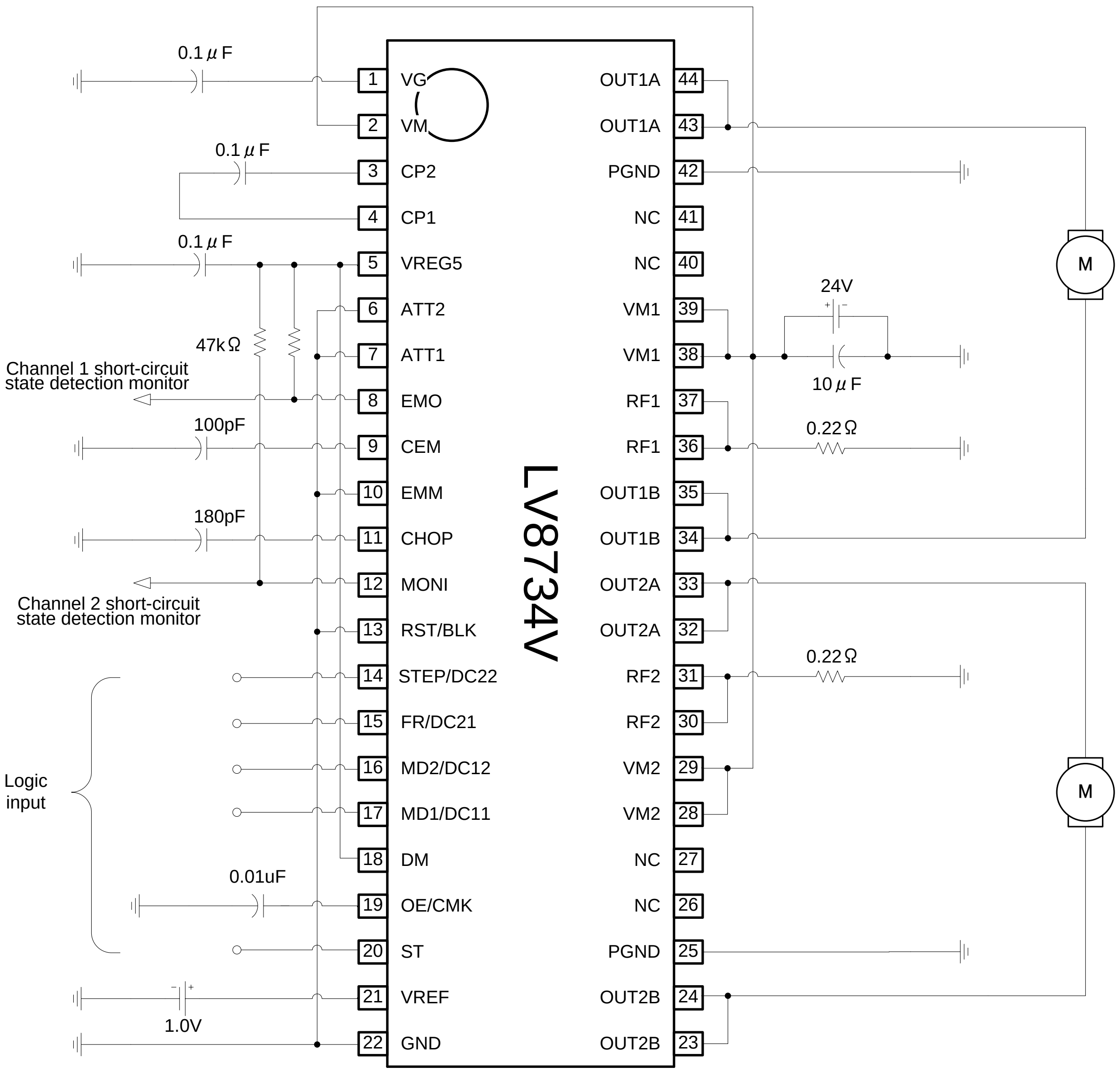
Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

= 100pF × 1V/10μA = 10μs

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

<LV8734V>



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

Constant current limit (100%) setting

When VREF = 1.5V

Ilimit = VREF/5/RF resistance

= 1.0V/5/0.22Ω = 0.91A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (180pF × 0.5V × 2) = 55kHz

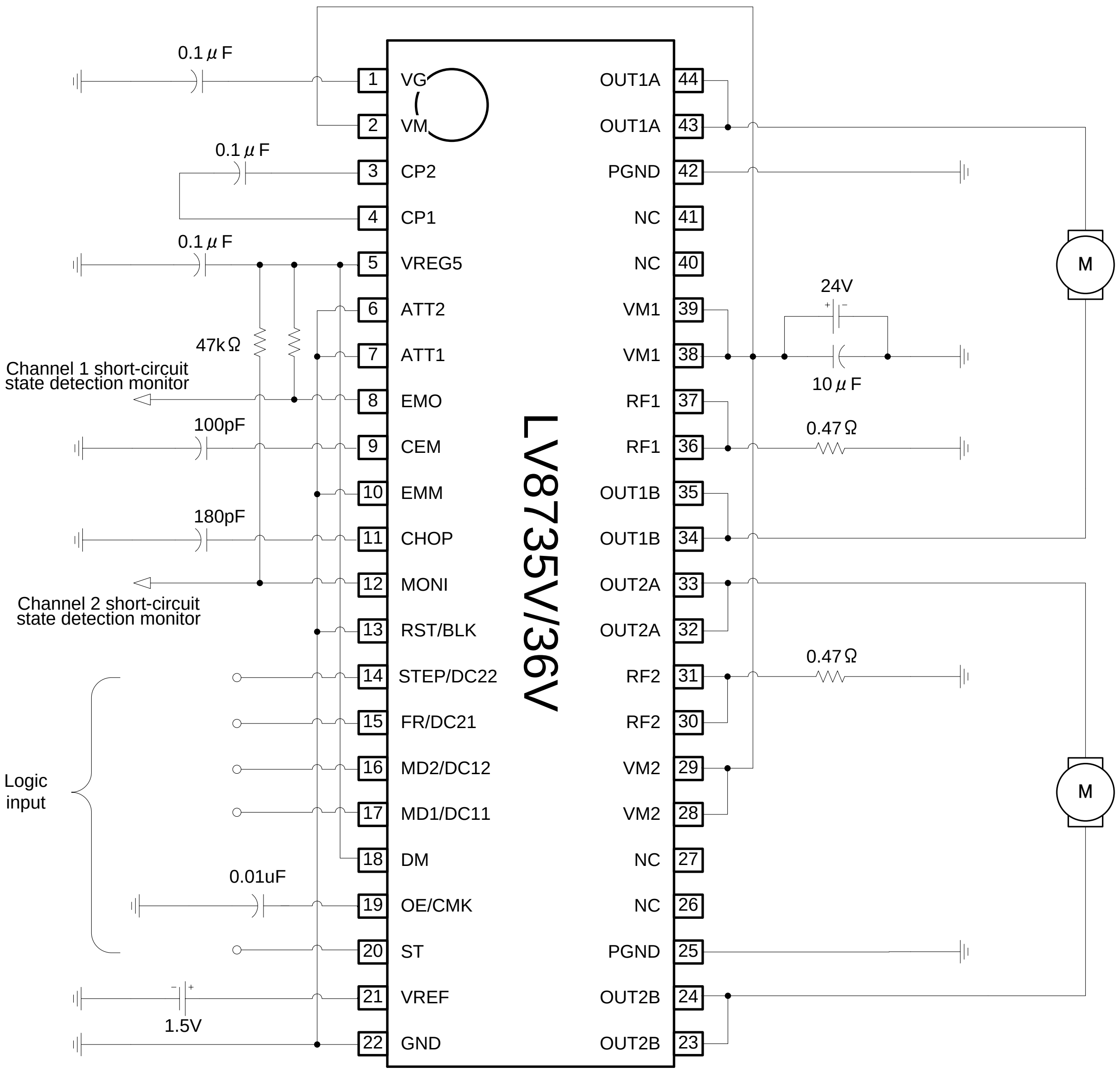
Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

= 100pF × 1V/10μA = 10μs

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

<LV8735V/LV8736V>



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

Constant current limit (100%) setting

When VREF = 1.5V

Ilimit = VREF/5/RF resistance

= 1.5V/5/0.47Ω = 0.64A

Chopping frequency setting

Fchop = Ichop/ (Cchop × Vtchop × 2)

= 10μA/ (180pF × 0.5V × 2) = 55kHz

Timer latch time when the output is short-circuited

Tcem = Ccem × Vtcem/Icem

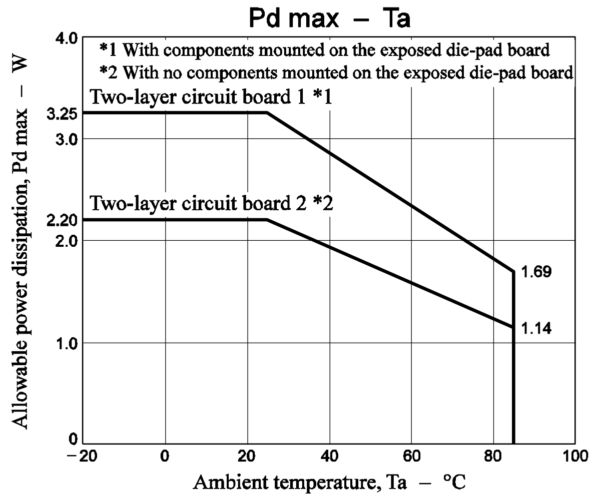
= 100pF × 1V/10μA = 10μs

Allowable power dissipation

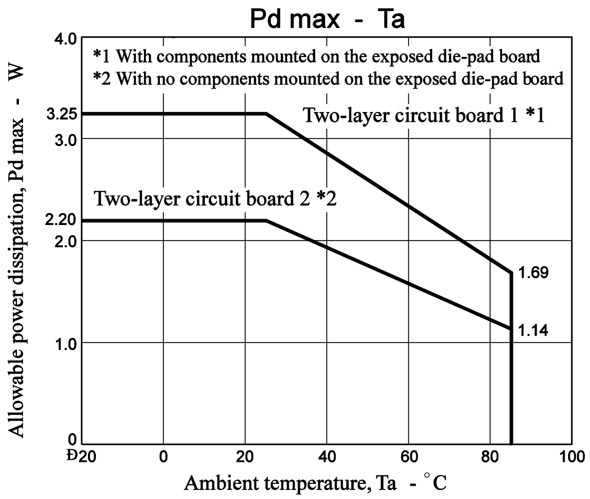
- The pad on the backside of the IC functions as heatsink by soldering with the board. Since the heat-sink characteristics vary depends on board type, wiring and soldering, please perform evaluation with your board for confirmation.

Specified circuit board : 90mm x 90mm x 1.6mm, glass epoxy **2-layer board**

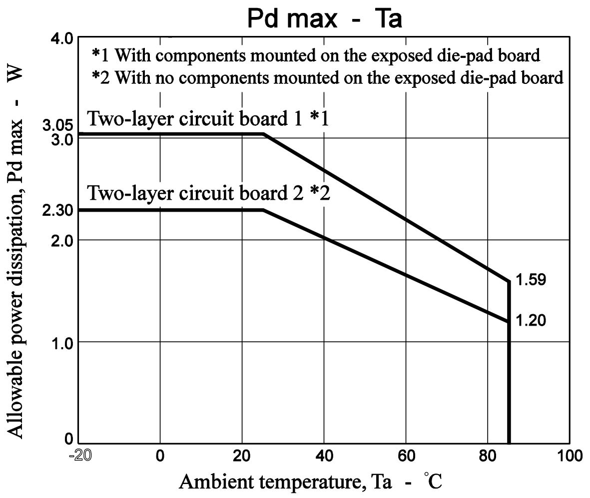
LV8731V/LV8732V



LV8734V

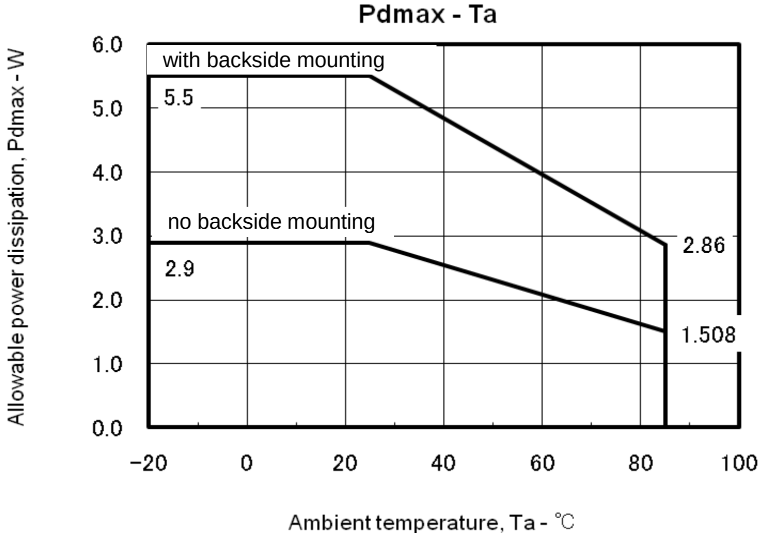


LV8735V/LV8736V

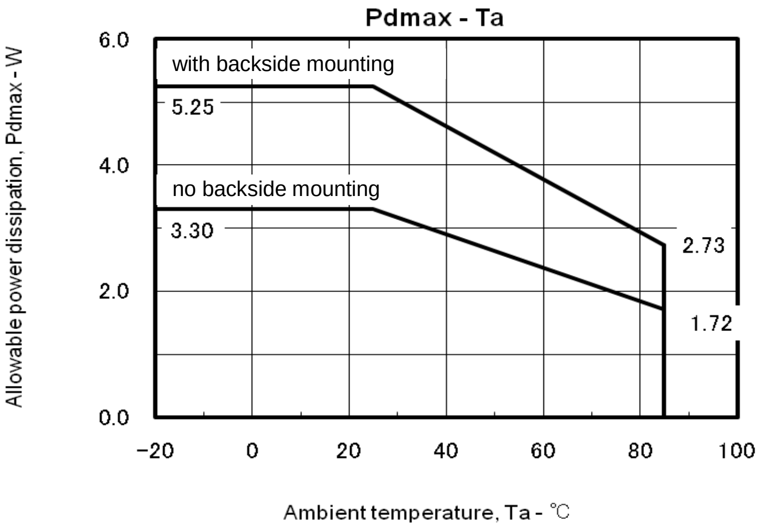


Specified circuit board : 90mm x 90mm x 1.6mm, glass epoxy **4-layer board**

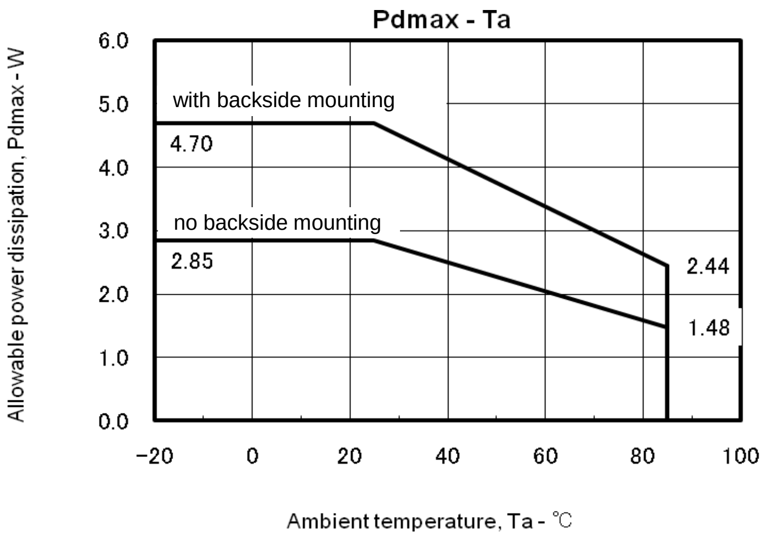
LV8731V/LV8732V



LV8734V



LV8735V/LV8736V

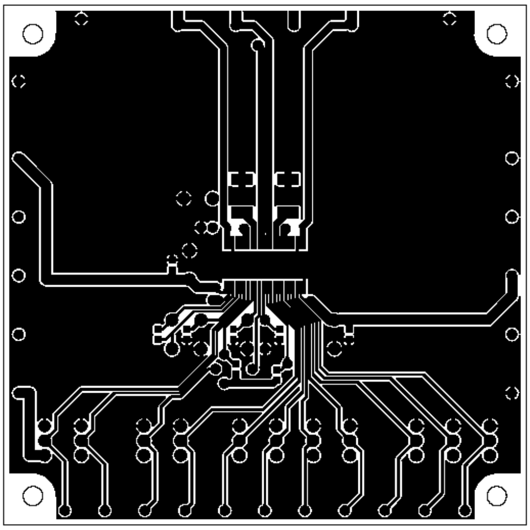


Substrate Specifications (Substrate recommended for operation of LV873XV)

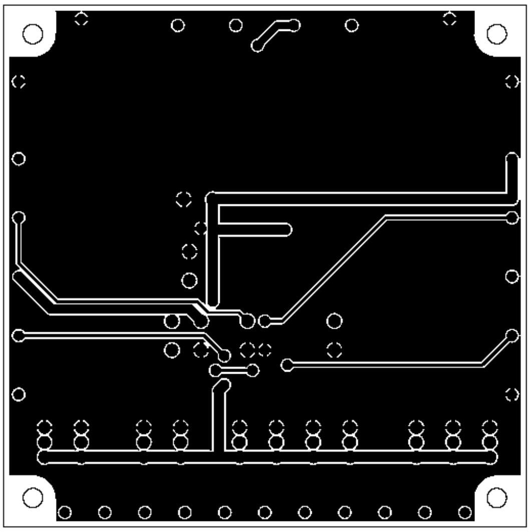
Size : 90mm × 90mm × 1.6mm (two-layer substrate [2S0P])

Material : Glass epoxy

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



L1 : Copper wiring pattern diagram



L2 : Copper wiring pattern diagram

Cautions

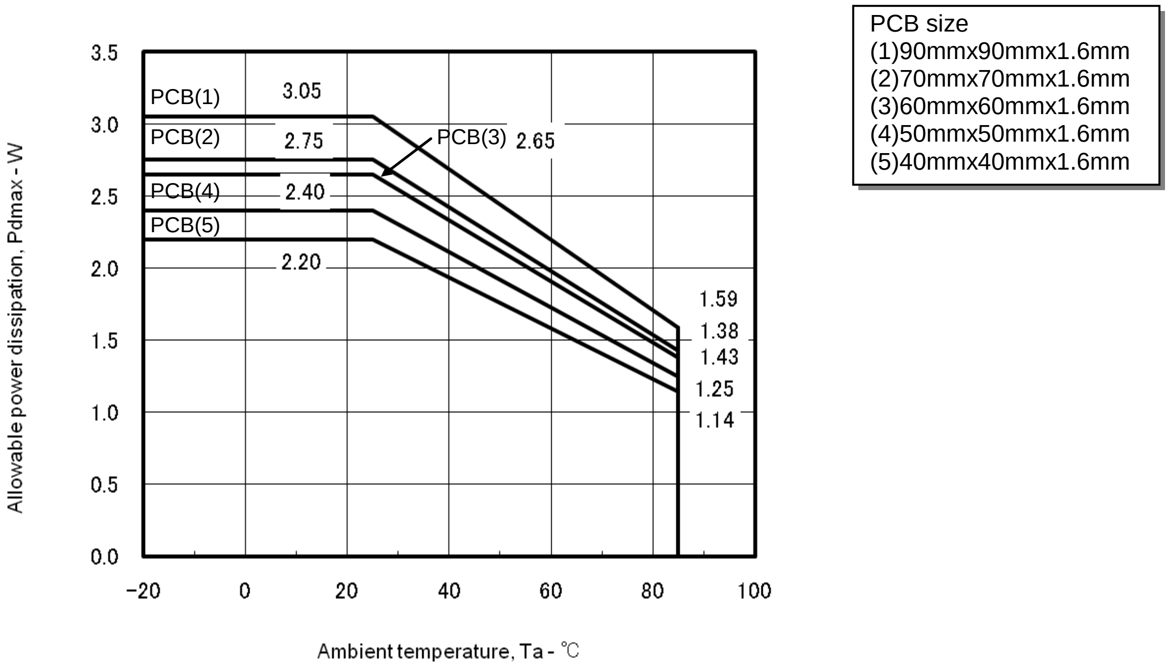
1) The data for the case with the Exposed Die-Pad substrate mounted shows the values when 90% or more of the Exposed Die-Pad is wet.

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

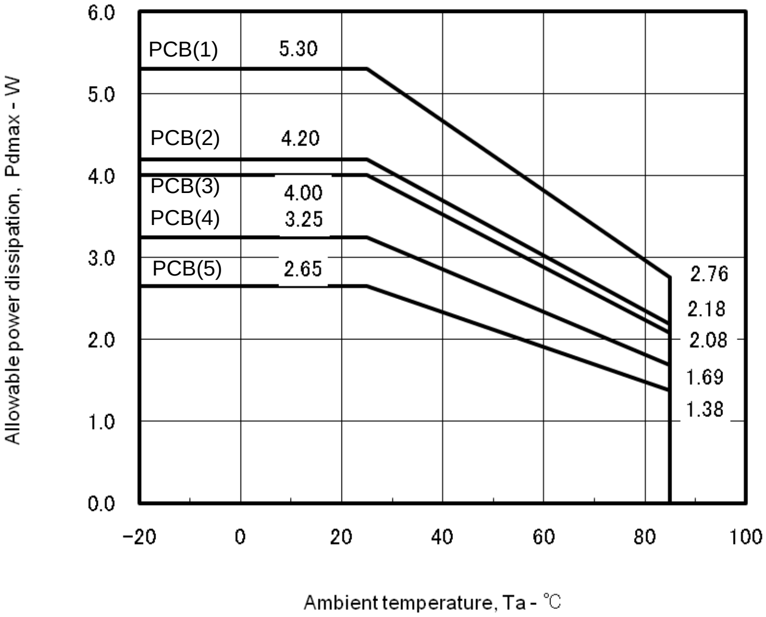
3) After the set design, be sure to verify the design with the actual product.
Confirm the solder joint state and verify also the reliability of solder joint for the Exposed Die-Pad, etc.
Any void or deterioration, if observed in the solder joint of these parts, causes deteriorated thermal conduction,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

Allowable power dissipation in each PCB size (Reference value)

2-layer borad with backside mounting

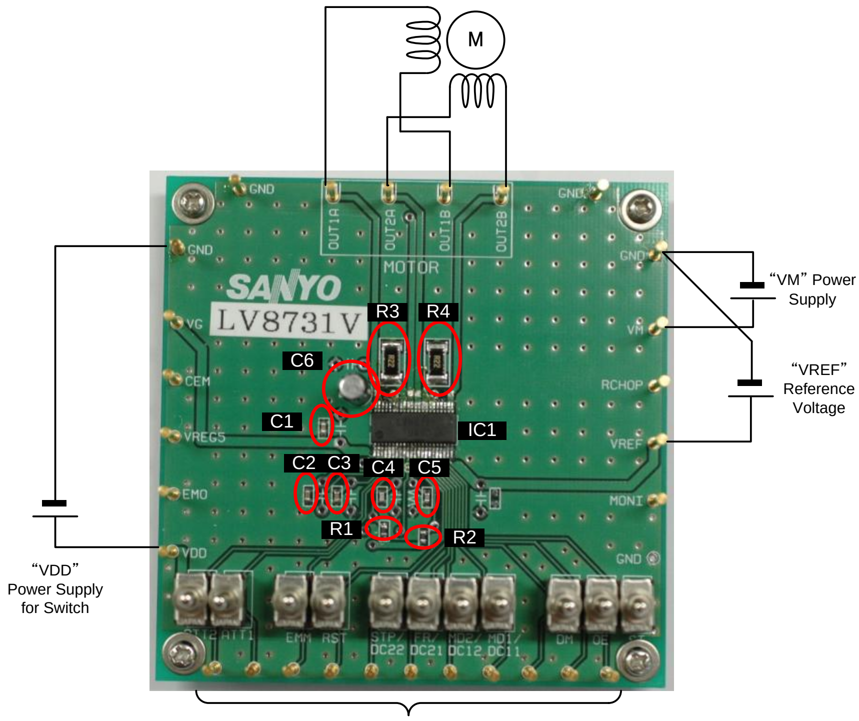


4-layer borad with backside mounting



Evaluation board

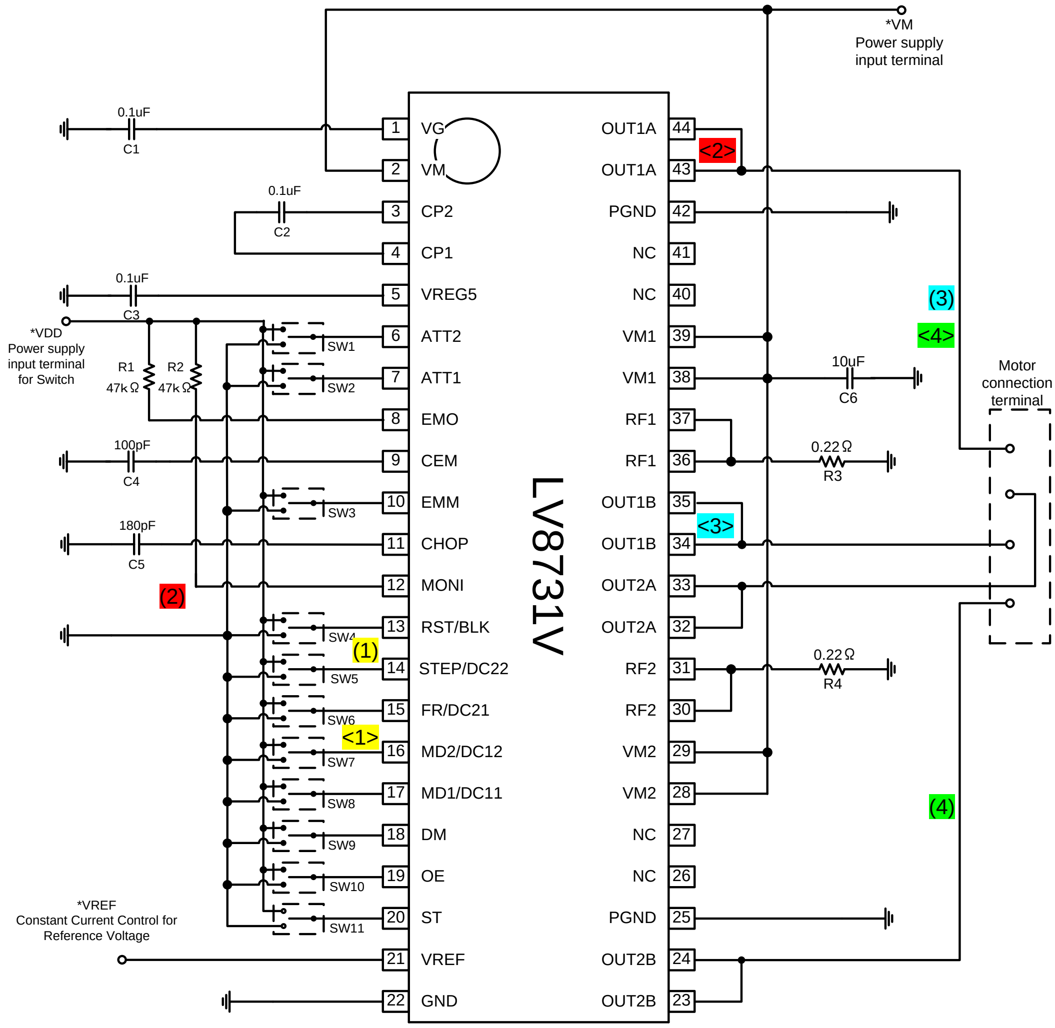
LV8731V (90.0mm×90.0mm×1.6mm, glass epoxy 2-layer board, with backside mounting)



Bill of Materials for LV8731V Evaluation Board

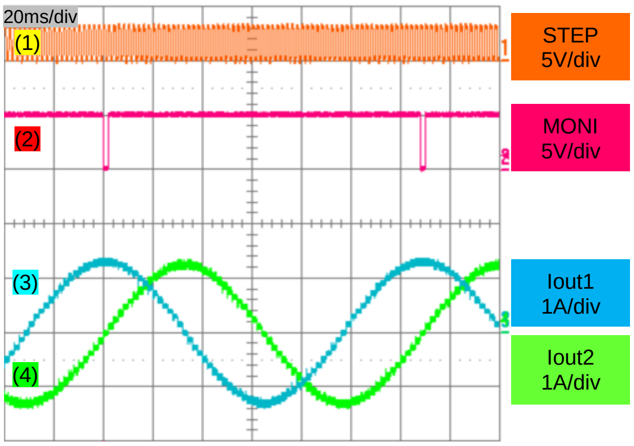
Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
C1	1	Capacitor for Charge pump	0.1µF, 100V	±10%		Murata	GRM188R72A104KA35*	Yes	Yes
C2	1	Capacitor for Charge pump	0.1µF, 100V	±10%		Murata	GRM188R72A104KA35*	Yes	Yes
C3	1	VREG5 stabilization Capacitor	0.1µF, 100V	±10%		Murata	GRM188R72A104KA35*	Yes	Yes
C4	1	Capacitor to set CEM timer	100pF, 50V	±5%		Murata	GRM1882C1H101JA01*	Yes	Yes
C5	1	Capacitor to set chopping frequency	180pF, 50V	±5%		Murata	GRM1882C1H181JA01*	Yes	Yes
C6	1	VM Bypass Capacitor	10µF, 50V	±20%		SUN Electronic Industries	50ME10HC	Yes	Yes
R1	1	Pull-up Resistor for for terminal EMO	47kΩ, 1/10W	±5%		KOA	RK73B1JT**473J	Yes	Yes
R2	1	Pull-up Resistor for for terminal MONI	47kΩ, 1/10W	±5%		KOA	RK73B1JT**473J	Yes	Yes
R3	1	Channel 1 output current detective Resistor	0.22Ω, 1W	±5%		ROHM	MCR100JZHJLR22	Yes	Yes
R4	1	Channel 2 output current detective Resistor	0.22Ω, 1W	±5%		ROHM	MCR100JZHJLR22	Yes	Yes
IC1	1	Motor Driver			SSOP44 K(275mil)	SANYO semiconductor	LV8731V	No	Yes
SW1-SW11	11	Switch				MIYAMA	MS-621C-A01	Yes	Yes
TP1-TP29	29	Test Point				MAC8	ST-1-3	Yes	Yes

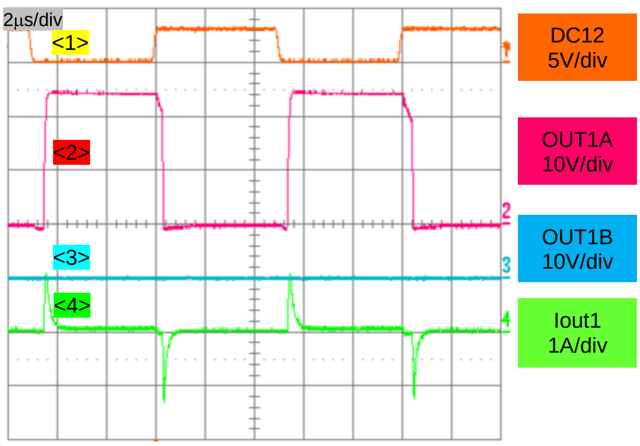
Evaluation board circuit



【Stepping Motor】
VM=24V,VDD=5V,VREF=1.5V
ST=H,DM=L
EMM=L,RST/BLK=L,OE=L
ATT1=ATT2=L,
FR/DC21=L
MD1/DC11=MD2/DC12=H
STEP/DC22=500Hz(Duty50%)

【DC Motor(OUT1A-OUT1B)】
VM=24V,VDD=5V,VREF=1.5V
ST=H,DM=H
EMM=L,RST/BLK=L,OE=L
ATT1=ATT2=L,
FR/DC21=STEP/DC22=L
MD1/DC11=H
MD2/DC12=100kHz(Duty50%)





Evaluation Board Manual

[Supply Voltage] VM (9 to 32V) : Power Supply for LSI
VREF (0 to 3V) : Const. Current Control for Reference Voltage
VDD (2 to 5V) : Logic "High" voltage for toggle switch

[Toggle Switch State] Upper Side: High (VDD)
Middle: Open, enable to external logic input
Lower Side: Low (GND)

[Operation Guide]

For stepping motor control

1. Motor Connection: Connect the Motors between OUT1A and OUT1B, between OUT2A and OUT2B.
2. Initial Condition Setting: Set "Open" the toggle switch STEP/D22, and "Open or Low" the other switches.
3. Power Supply: Supply DC voltage to VM, VREF and VDD.
4. Ready for Operation from Standby State: Turn "High" the ST terminal toggle switch. Channel 1 and 2 are into 2-phase excitement initial position (100%, -100%) .
5. Motor Operation: Input the clock signal into the terminal STEP/DC22.
6. Other Setting
   i. ATT1, ATT2: Motor current attenuation.
   ii. EMM: Short circuit protection mode change.
   iii. RST/BLK: Initial Mode.
   iv. FR/DC21: Motor rotation direction (CW / CCW) setting.
   v. MD1/DC11, MD2/DC12: Excitation mode.
   vi. OE: Output enable.

For DC motor control

1. Motor Connection: Connect the Motor (s) between OUT1A and OUT1B, between OUT2A and OUT2B.
2. Initial Condition Setting: Set "Open" the toggle switch DM, and "Open or Low" the other switches.
3. Power Supply: Supply DC voltage to VM, VREF and VDD.
4. Ready for Operation from Standby State: Turn "High" the ST terminal toggle switch.
5. Motor Operation: Set MD1/DC11, MD2/DC12, FR/DC21, and STEP/DC22 terminals according to the purpose.
6. Other Setting
   i. ATT1, ATT2: Motor current attenuation.
   ii. EMM: Short circuit protection mode change.
   iii. RST/BLK: Blanking time change.
   iv. OE: Output enable.

[Setting for External Component Value]

1. Constant Current (100%)

At VREF=1.5V

Iout =VREF [V] / 5 / RF [Ω]
=1.5 [V] / 5 / 0.22 [Ω]
=1.36 [A]

2. Chopping Frequency

Fchop =Ichop [μA] / (Cchop x Vt x 2)
=10 [μA] / (180 [pF] x 0.5 [V] x 2)
=55 [kHz]

3. Short Protection Latch Time

Tscp =CEM [pF] x Vt[V] / Ichg [μA]
=100 [pF] x 1 [V] / 10 [μA]
=10 [μS]

Notes in design:

●Power supply connection terminal【VM, VM1, VM2】

- ✓ Make sure to short-circuit VM, VM1 and VM2.For controller supply voltage, the internal regulator voltage of VREG5 (typ 5V) is used.
- ✓ Make sure that supply voltage does not exceed the absolute MAX ratings under no circumstance. Noncompliance can be the cause of IC destruction and degradation.
- ✓ Caution is required for supply voltage because this IC performs switching.
- ✓ The bypass capacitor of the power supply should be close to the IC as much as possible to stabilize voltage. Also if you intend to use high current or back EMF is high, please augment enough capacitance.

●GND terminal【GND, PGND, Exposed Die-Pad】

- ✓ Since GND is the reference of the IC internal operation, make sure to connect to stable and the lowest possible potential. Since high current flows into PGND, connect it to one-point GND.
- ✓ The exposed die-pad is connected to the board frame of the IC. Therefore, do not connect it other than GND. Independent layout is preferable. If such layout is not feasible, please connect it to signal GND. Or if the area of GND and PGND is larger, you may connect the exposed die pad to the GND.

(The independent connection of exposed die pad to PGND is not recommended.)

●Internal power supply regulator terminal【VREG5】

- ✓ VREG5 is the power supply for logic (typ 5V).
- ✓ When VM supply is powered and ST is "H", VREG5 operates.
- ✓ Please connect capacitor for stabilize VREG5. The recommendation value is 0.1μF.
- ✓ Since the voltage of VREG5 fluctuates, do not use it as reference voltage that requires accuracy.

●Input terminal

- ✓ The logic input pin incorporates pull-down resistor (100kΩ).
- ✓ When you set input pin to low voltage, please short it to GND because the input pin is vulnerable to noise.
- ✓ The input is TTL level (H: 2V or higher, L: 0.8V or lower).
- ✓ VREF pin is high impedance.

●OUT terminal【OUT1A, OUT1B, OUT2A, OUT2B】

- ✓ During chopping operation, the output voltage becomes equivalent to VM voltage, which can be the cause of noise. Caution is required for the pattern layout of output pin.
- ✓ The layout should be low impedance because driving current of motor flows into the output pin.
- ✓ Output voltage may boost due to back EMF. Make sure that the voltage does not exceed the absolute MAX ratings under no circumstance. Noncompliance can be the cause of IC destruction and degradation.

●Current sense resistor connection terminal【RF1, RF2】

- ✓ To perform constant current control, please connect resistor to RF pin.
- ✓ To perform saturation drive (without constant current control), please connect RF pin to GND.
- ✓ If RF pin is open, then short protector circuit operates. Therefore, please connect it to resistor or GND.
- ✓ The motor current flows into RF – GND line. Therefore, please connect it to common GND line and low impedance line.

●NC terminal

- ✓ NC pin is not connected to the IC.
- ✓ If VM line and output line are wide enough in your layout, please use NC.