LV8711T — Bi-CMOS LSI PWM Constant-Current Control Stepping Motor Driver

The LV8711T is a PWM constant-current control stepping motor driver which is low consumption, low heat and high efficiency. The device is suited 2-cell battery applications. Its supply voltage range is from 4V to 16V, and stand-by mode current drain is almost zero. It can contribute to reduce costs and PCB size because of the built-in circuit to control current. It also can contribute to safe design of applications by several built-in protection functions.

Features

- Two circuits of PWM constant-current control H-bridge drivers incorporated
- Control of the stepping motor to Half-step excitations possible
- Reference voltage output: 1.0V
- Short circuit protection circuit incorporated
- Abnormal condition warning output pin incorporated
- Upper and lower regenerative diodes incorporated
- Thermal shutdown circuit incorporated
- V_{CC} Low Voltage Shut Down circuit incorporated

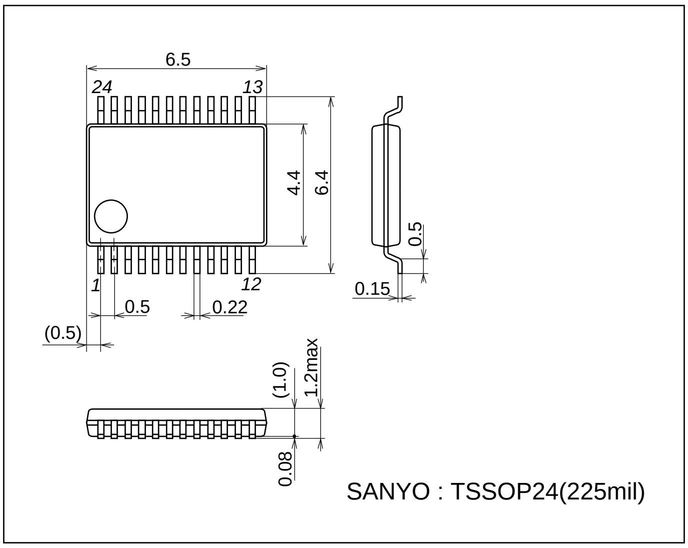
Typical Application

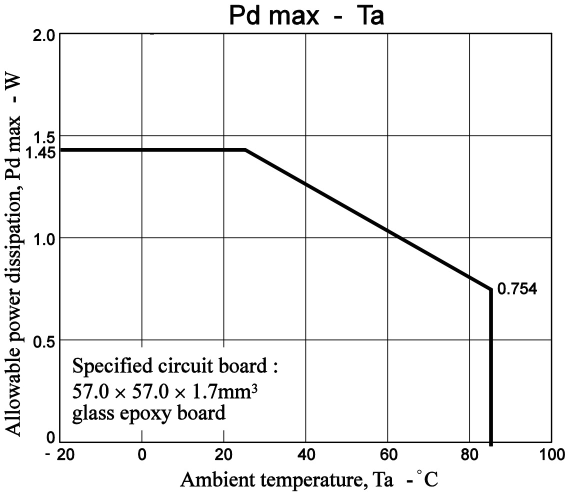
- POS Printer
- Handy Type Scanner
- Thermal Printer Unit
- Card terminal
- Air-conditioner

Package Dimensions

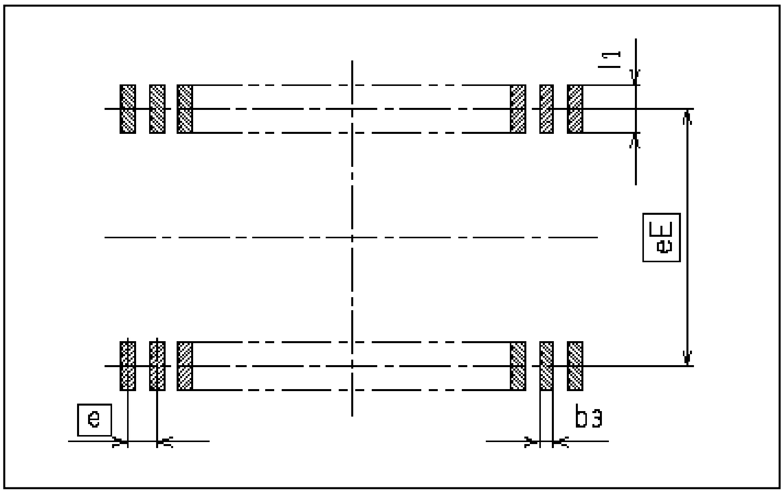
unit : mm (typ)

3260A





Mounting Pad Sketch



(Unit:mm)

Reference symbol	TSSOP24(225mil)
eE	5.80
e	0.50
b3	0.32
l1	1.00

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

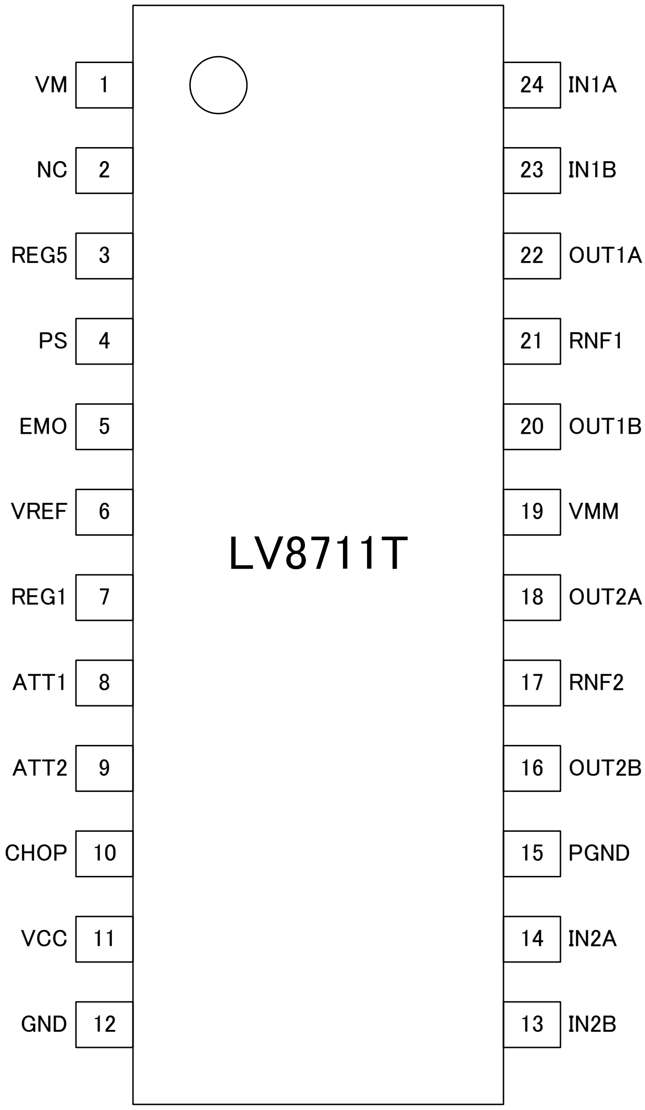


Figure 1. Pin Assignment

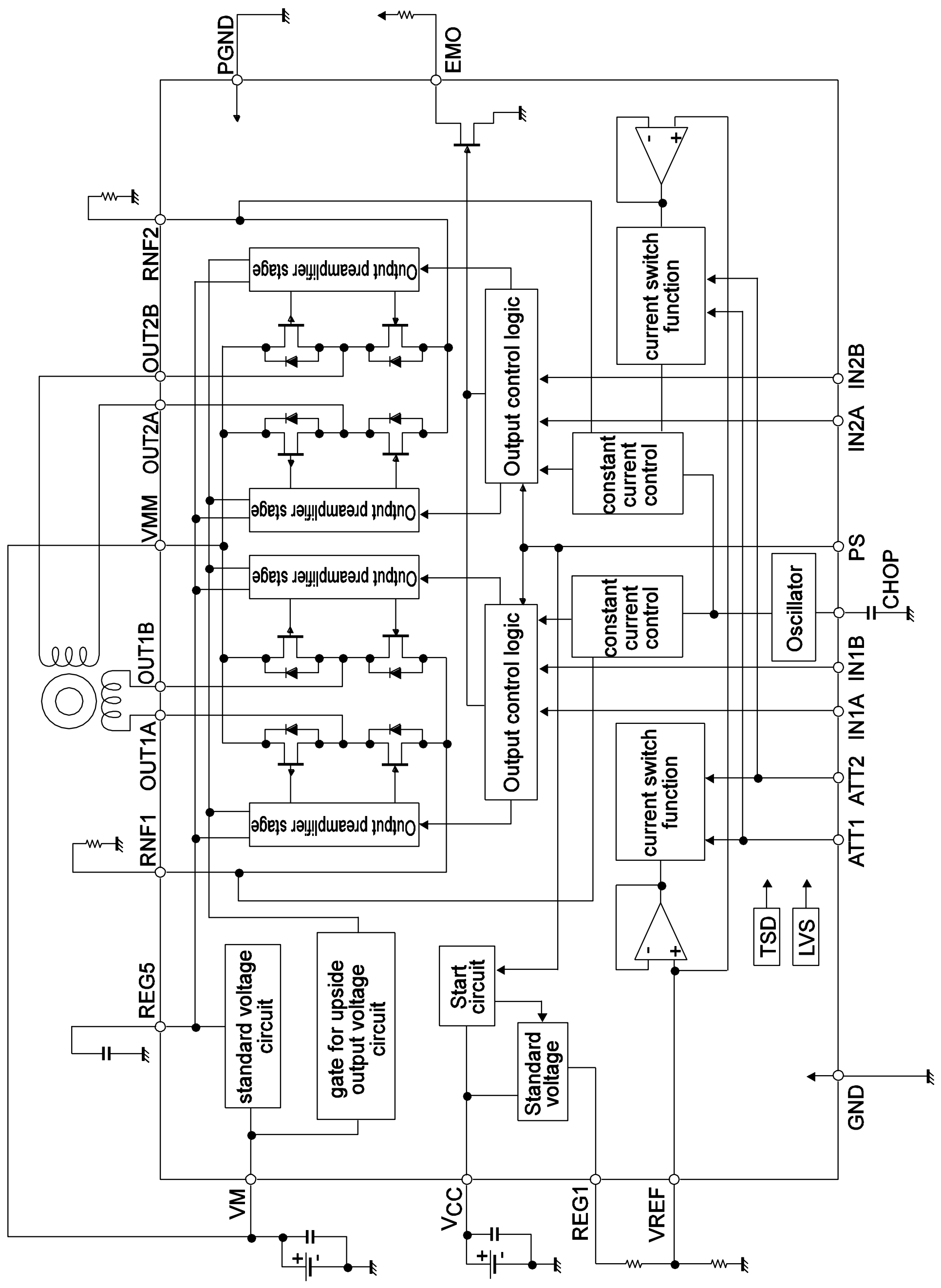


Figure 2. Block Diagram

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
Logic input voltage	V_{IN}		6	V
Output peak current	I_O peak	Per ch, tw ≤ 10ms, duty 20%	1.0	A
Output continuous current	I_O max	Per ch	800	mA
Allowable power dissipation	Pd max	*	1.45	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 printed circuit board.**

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 range	V_{IN}		-0.3 to 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} = 3.3, VREF = 1.0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
General						
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		1.0	1.5	mA
	I_{CC}	PS = “H”, no load		1.7	3.0	mA
Thermal shutdown temperature	TSD	Design guarantee	150	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	VthHYS		100	130	160	mV
Reference voltage						
REG5 output voltage	VREG5		4.5	5	5.5	V
Output						
Output on resistance	RonU	I_O = -800mA, Source-side		0.78	1.0	Ω
	RonD	I_O = 800mA, Sink-side		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 input						
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

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Constant-current control						
REG1 output voltage	VREG1		0.95	1.0	1.05	V
VREF input current	I_{REF}	VREF = 1.0V	-0.5			μA
Current setting reference voltage	Vtatt00	VREF = 1.0V	0.192	0.200	0.208	V
	Vtatt01	VREF = 1.0V	0.152	0.160	0.168	V
	Vtatt10	VREF = 1.0V	0.092	0.100	0.108	V
	Vtatt11	VREF = 1.0V	0.032	0.040	0.048	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
Output short-circuit protection						
EMO pin saturation voltage	VsatEMO	I_{EMO} = 1mA		250	400	mV

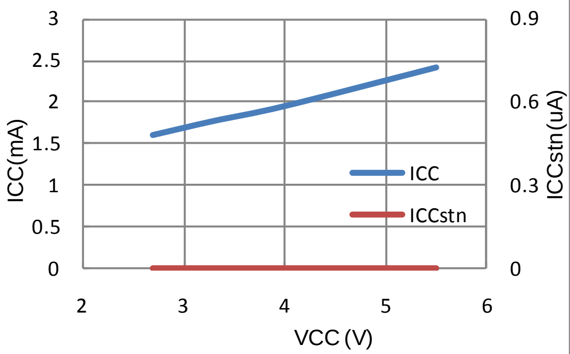


Figure 3. VCC Current Drain vs VCC Voltage

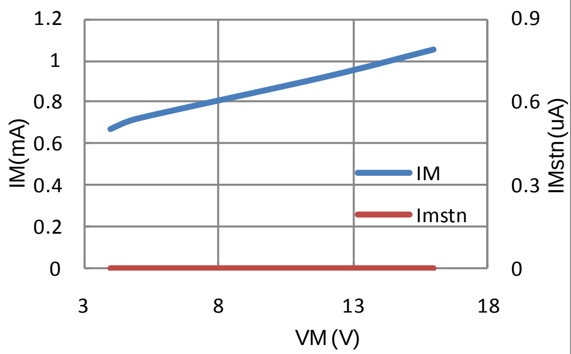


Figure 4. VM Current Drain vs VM Voltage

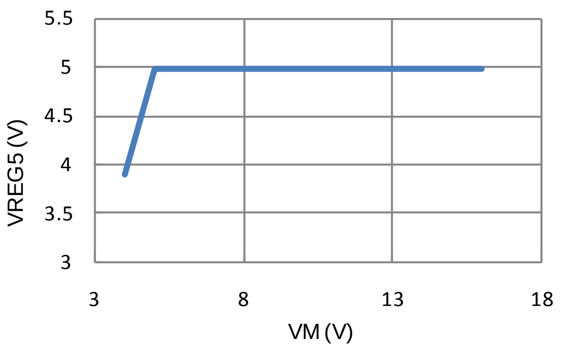


Figure 5. VREG5 Output Voltage vs VM Voltage

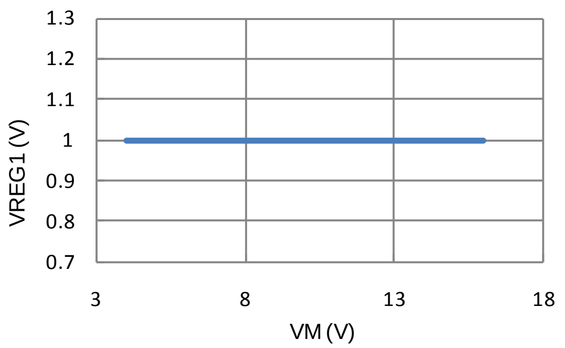


Figure 6. VREG1 Output Voltage vs VM Voltage

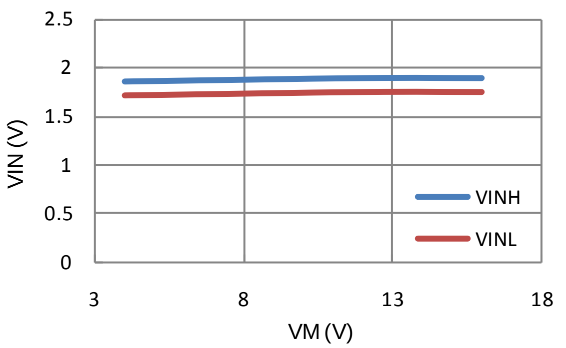


Figure 7. Logic High/Low-Level Input Voltage vs VM Voltage

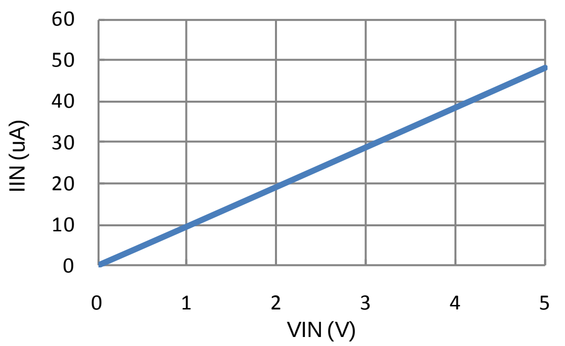


Figure 8. Logic Pin Input Current vs Input Voltage

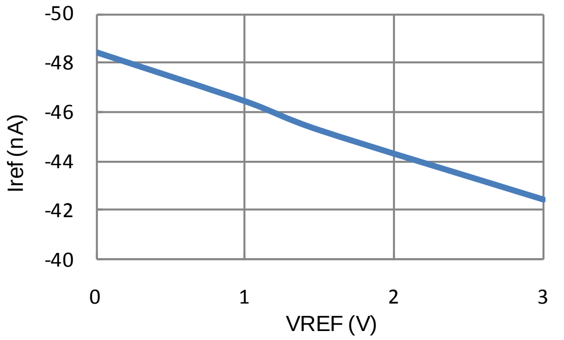


Figure 9. VREF Pin Input Current vs VREF Voltage

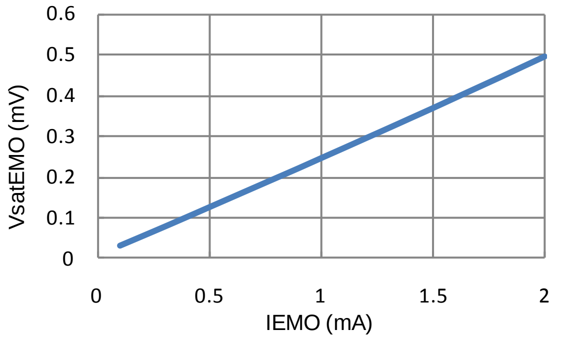


Figure 10. EMO Pin Saturation Voltage vs EMO Current

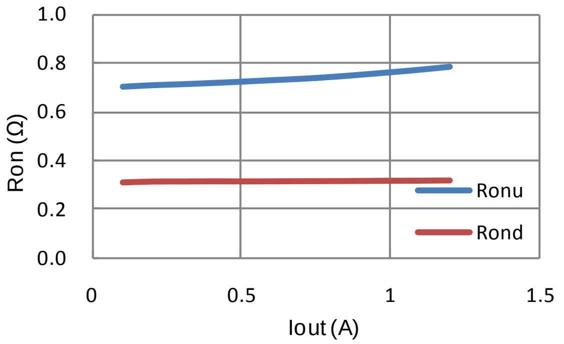


Figure 11. Output on Resistance vs Output Current (VM= 12V)

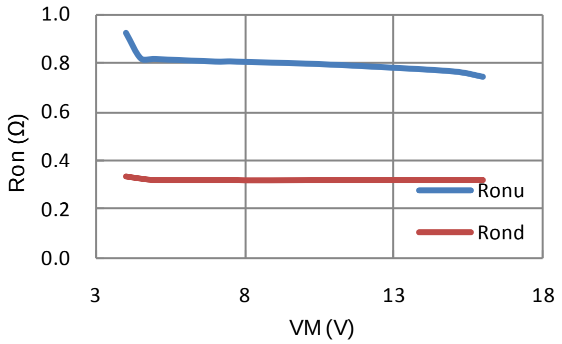


Figure 12. Output on Resistance vs VM Voltage (Iout= 0.8A)

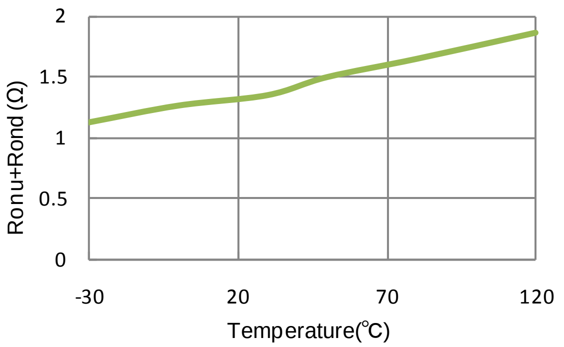


Figure 13. Output on Resistance vs Temperature (VM=12V, Iout=0.8A)

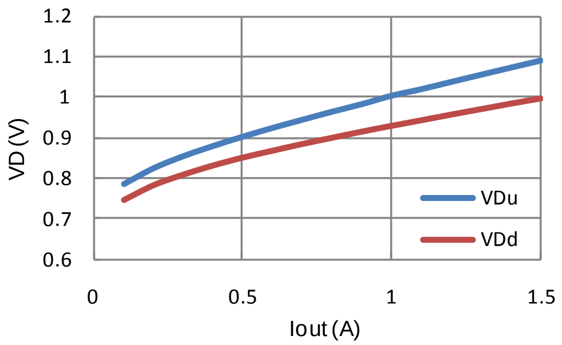
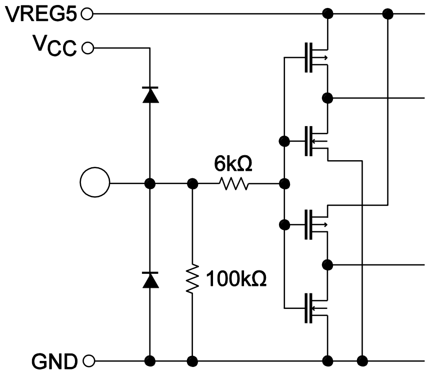
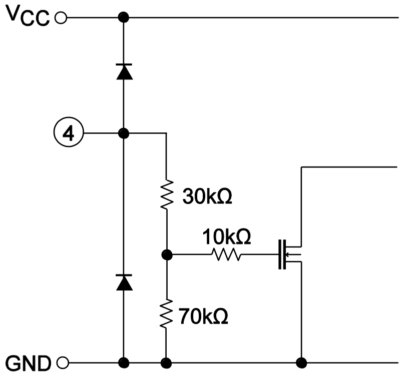
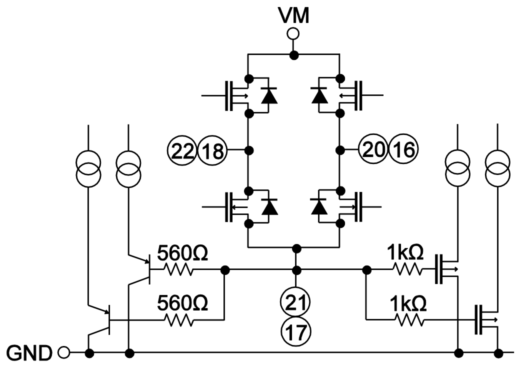
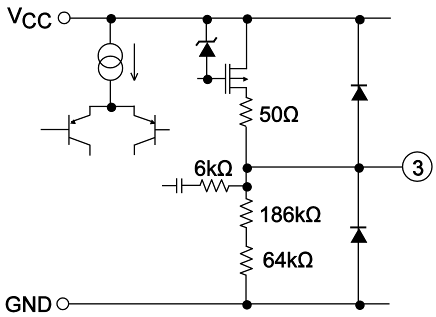


Figure 14. Diode Forward Voltage vs Output Current

Pin Functions

Pin No.	Pin Name	Pin Function	Equivalent Circuit
8 9	ATT1 ATT2	These pins are Motor holding current switching. Keeping the VREF voltage, output current can be attenuated by switching these pins. Refer to (3) on P.11 for details.	
13 14	IN2B IN2A	These pins are connected to an external microcontroller interface. Channel 2 driver output is controlled by switching these pins. Refer to (2) on P.11 for details.	
23 24	IN1B IN1A	These pins are connected to an external microcontroller interface. Channel 1 driver output is controlled by switching these pins. Refer to (2) on P.11 for details.	
4	PS	This pin switches Power Save mode. PS = L : LV8711 is in Power Save mode. PS = H : LV8711 is in Operating mode. When all outputs are the stand-by state caused by short-circuit, if PS is switched to L, the state is released. Refer to (1) on P.11 for details.	
16 18	OUT2B OUT2A	One of the motor coil is connected between these pins. Refer to P.12~19 for details.	
17	RNF2	Channel 2 current sensing resistor is connected to this pin. Refer to (3) on P.11 for details.	
20 22	OUT1B OUT1A	One of the motor coil is connected between these pins. Refer to P.12~19 for details.	
21	RNF1	Channel 1 current sensing resistor is connected to this pin. Refer to (3) on P.11 for details.	
3	REG5	This pin outputs Internal reference voltage. And a capacitor is connected to this pin.	

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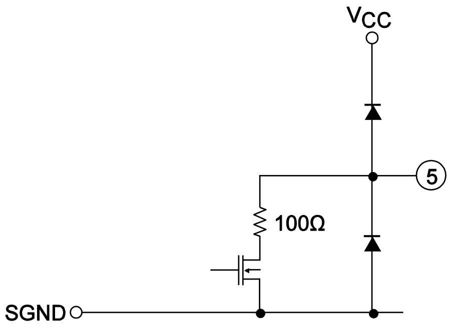
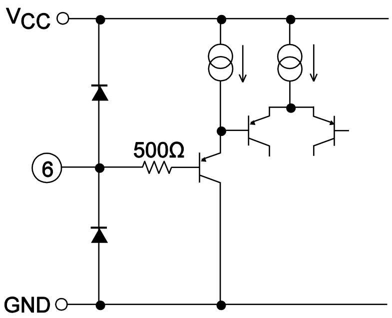
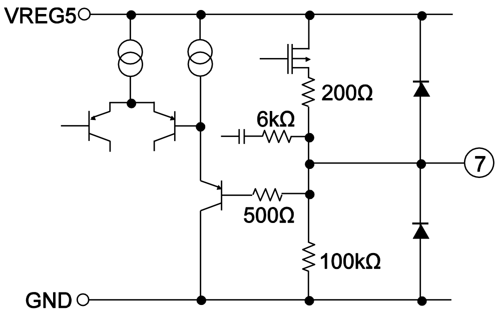
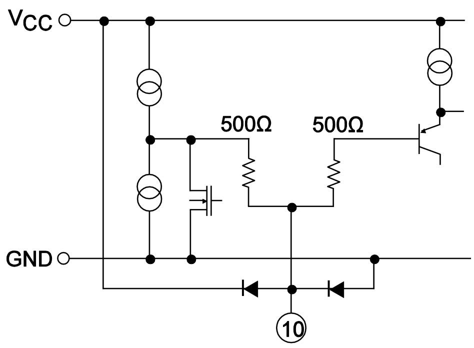
Pin No.	Pin Name	Pin Function	Equivalent Circuit
5	EMO	This pin outputs Abnormal condition warning. Connect Pull-Up resistor between this pin and VCC. The setting range is 5kΩ to 50kΩ. Normally, it outputs H(VCC). If LV8711 detects short-circuit or the thermal shut down function operates, it turns L. Refer to (10) on P.20 for details.	
6	VREF	This is the Constant current control reference voltage input pin. It can be connected to REG1. But if output current needs high precision, it had better be connected to another source. Refer to (3) on P.11 for details.	
7	REG1	This pin outputs reference voltage 1 V for Current setting. It can be connected to VREF directly or after devided with resistors between REG1 and GND.	
10	CHOP	This is the chopping frequency setting capacitor connection pin. If larger capacitor is connected, the frequency is lower. If smaller capacitor is connected, the frequency is higher. The frequency can be checked at this pin as the triangle wave. Refer to (4) on P.12~13 for details.	

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Pin No.	Pin Name	Pin Function	Equivalent Circuit
1	VM	This pin is connected to the motor supply voltage and VMM pin 19.	
11	VCC	This pin is connected to the logic supply voltage and monitored by the LV8711. The operation is inhibited when VCC is below the minimum 2.4 V value by the Low Voltage Shut Down function. Refer to (11) on P.21 for details.	
12	GND	The logic and low level analog signals shall be connected to this ground pin. This pin must be externally connected to the PGND pin 15. The designer must make sure no high current transients are shared with the low signal currents flowing into this pin.	
15	PGND	This pin is the Power Ground associated with the Power-Tr of H-Bridge and must be connected to the system ground together with GND pin 12. Using good quality ground plane is recommended to avoid spikes on the logic signal lines.	
19	VMM	This pin is connected to the motor supply voltage and VM pin 1.	

Description of operation

Input Pin Function

(1) Chip enable function

Standby mode / operating mode of the IC are switched by setting the PS pin. In the standby-state, the IC enters a power saving mode and all logic is reset. In the standby-state, internal regulator circuit is not operative.

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

(2) Output control logic

Parallel input		Output		Current direction
IN1A(2A)	IN1B(2B)	OUT1A(2A)	OUT1B(2B)	
Low	Low	OFF	OFF	Output OFF
High	Low	High	Low	OUTA to OUTB
Low	High	Low	High	OUTB to OUTA
High	High	Low	Low	Brake(DCM mode)

(3) Constant-current setting (In case of DCM mode, it is the Current Limit function.)

The constant-current control setting consist of the VREF voltage setting and resistor (RNF) connected between RNF and ground. The current is set according to the following equation.

I_{OUT} [A] = VREF [V] / 5 / RNF [Ω]

Also, the voltage applied to the VREF pin can be switched to four stages settings by the state of two inputs of the ATT1 and ATT2 pins. This function is effective for power saving when the motor holding current is applied.

Attenuation function of the VREF input voltage

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

The output current calculation method for using of attenuation function of the VREF input voltage is as below.

I_{OUT} = (VREF / 5) x Attenuation ratio / RNF resistance

e.g. When the VREF is 1.0V and the set reference voltage is 100% [(ATT1, ATT2) = (Low, Low)] and the RNF resistance is 0.47Ω, the following output current is set.

I_{OUT} = 1.0V / 5 x 100% / 0.47Ω = 425mA

In this conditions, when (ATT1, ATT2) is set to (High, High),

I_{OUT} = 425mA x 20% = 85mA

Therefore, the power saving is executable by attenuation of the output current when motor holding current is supplied.

It is prohibited to use as below.
VREF pin is open.
VREF input voltage is more than “Allowable Operating Ratings” (VCC-1.8V).
It can’t control the constant current, if VREF is set as stated above.
If it controls in Full-swing or without current limiter, connect REG1 to VREF, and RNF1/2 to GND.

RNF dissipates power Pd as computed below. Select parts in consideration of the allowable power dissipation.

$Pd = Iout^2 \times RNF$

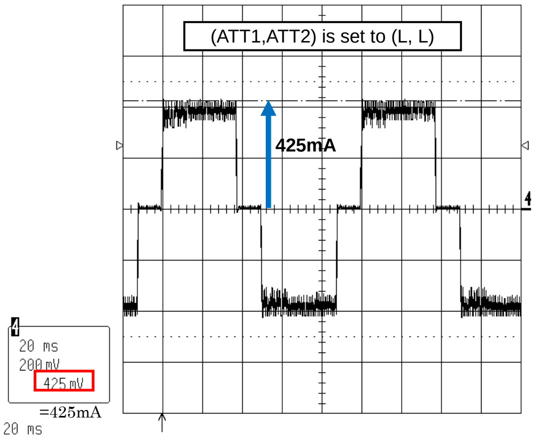


Figure 15. Iout wave (425mA x 100%)

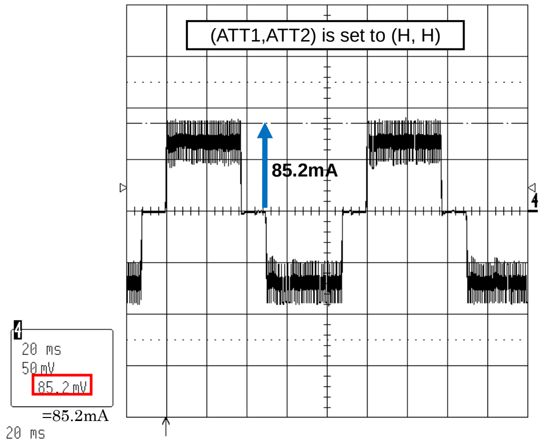


Figure 16. Iout wave (425mA x 20%)

(4) Setting the chopping frequency

For constant-current control, chopping operation is made with the frequency determined by the external capacitor connected between CHOP pin 10 and GND. The chopping frequency to be set with the capacitor is as shown below.

Chopping period: Tchop	Tchop ≈ C x V x 2 / I [s]		
	V: Threshold voltage	Typ, 0.5V	
	I : Charge / discharge current	Typ. 10μA	
Chopping frequency: Fchop	Fchop ≈ 1 / Tchop [Hz]		

The triangle wave is appeared on CHOP pin. The chopping frequency is equal to the frequency of the triangle wave. The real frequency is usually lower than theory value provided by above formula because of parasitic capacitance of PCB and so on.

The designer must set the frequency suited for the solution. If the frequency is unsuited, it may be a reason of vibration or noise.

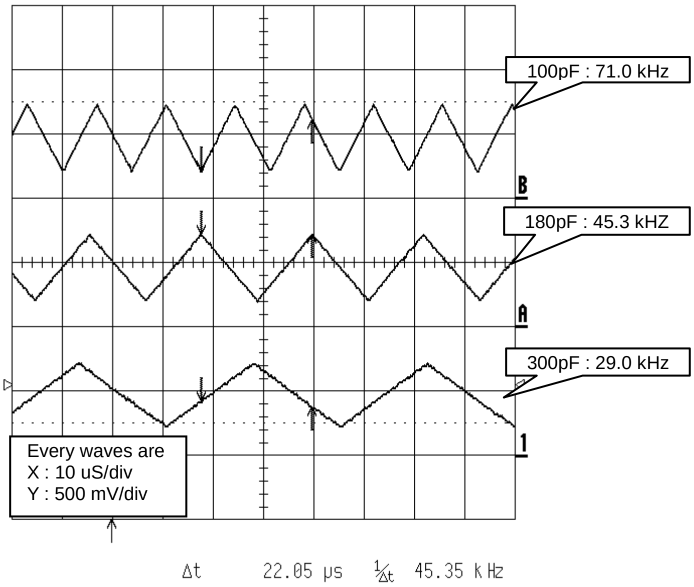


Figure 17. Triangle waves on CHOP pin

The ripple of coil current depends on coil impedance or coil inductance of motor.
The ripple is different even if chopping frequency is set the same value.

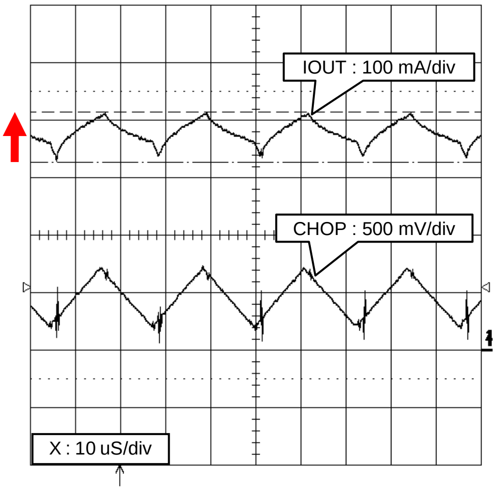
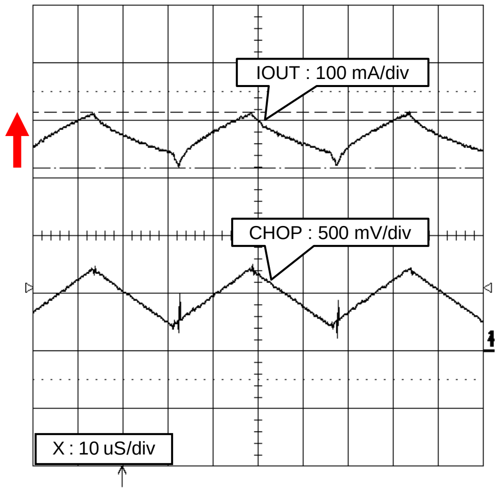
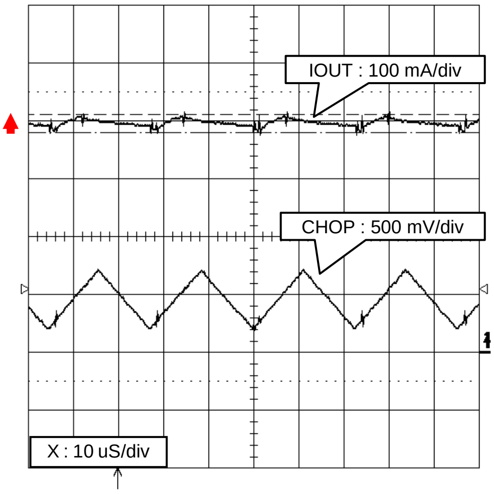
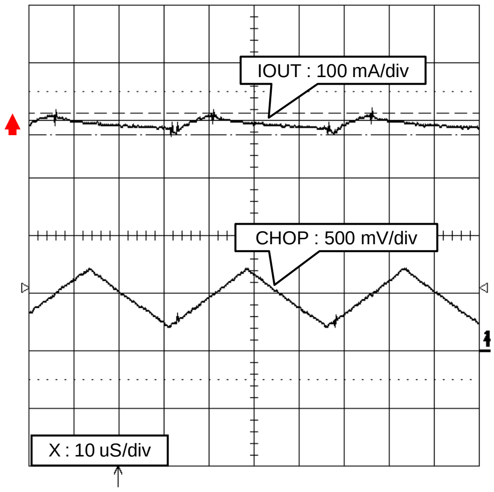
	FCHOP = 45.3 kHZ	FCHOP = 29.0 kHz
Motor A	 The ripple of coil current is 88 mA.	 The ripple of coil current is 97 mA.
Motor B	 The ripple of coil current is 31 mA.	 The ripple of coil current is 38 mA.

Figure 18. The ripple of coil current depended on FCHOP and kind of motor

If the chopping frequency is higher, IC consumes more electricity by its switching frequentry, and it is getting hotter.
If the chopping frequency is lower, the ripple of coil current is getting larger.

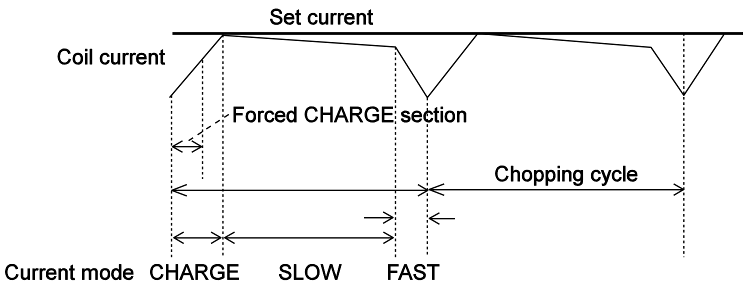
(5) Constant-current control time chart (chopping operate)

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

· At first stage of chopping cycle, the IC goes to CHARGE mode. (The Blanking section in which the CHARGE mode is forced regardless of the magnitudes of the coil current (I_{COIL}) and the set current (I_{REF}) exists for 1μs.)

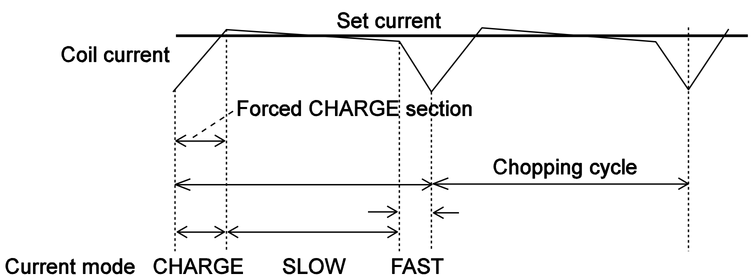
· In Blanking section, the IC compares the coil current (I_{COIL}) and the set current (I_{REF}).

If the $I_{COIL} < I_{REF}$ state is existent in Blanking section.



Charge mode continues until $I_{COIL} \geq I_{REF}$. After the IC switches to SLOW DECAY mode and then switches to FAST DECAY mode for the last 1μs.

If the $I_{COIL} < I_{REF}$ state is non-existent in Blanking section.

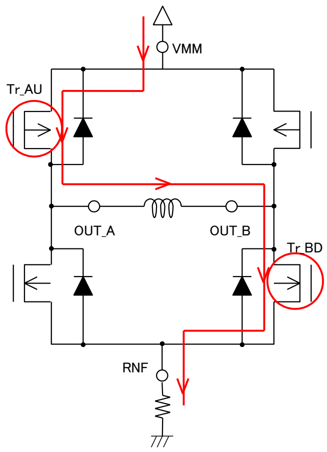


The IC switches to SLOW DECAY after Blanking section, and then switches to FAST DECAY mode for the last 1μs.

The IC repeats the above operation.

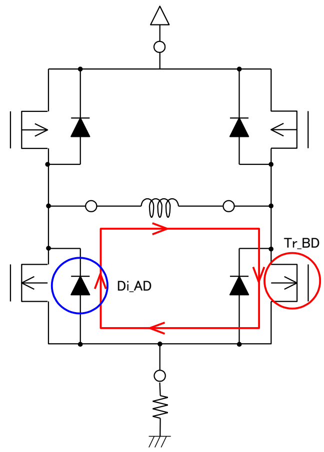
(6)Output transistor operation mode

1) Charge



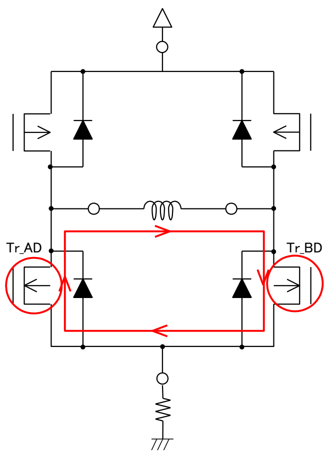
1)When 2 transistors, Tr_AU and Tr_BD are ON, coil current flow through the coil.
At that time, output voltages are
OUT_A : VMM - Vsat
OUT_B : 0V + Vsat + I × RF

2) Slow Decay 1



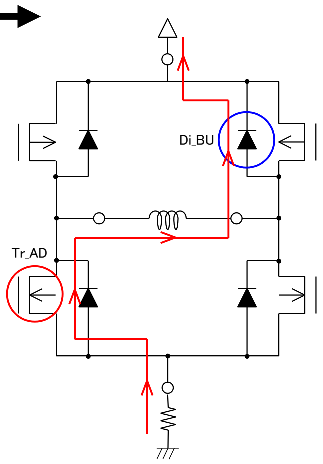
2)When coil current has reached the set value in Charge, the chopping process changes to Slow Decay 1.
At that time, output voltages are
OUT_A : 0V – VF
(Negative potential)
OUT_B : 0V + Vsat

3) Slow Decay 2



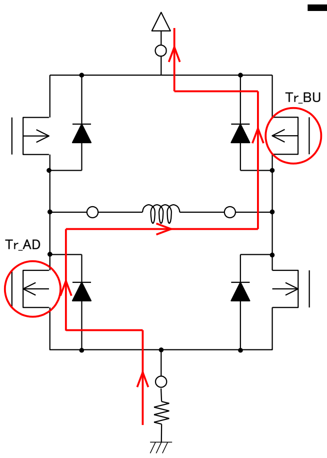
3)If Di_AD keeps to flow current, the IC chip generates heat. Then Tr_AD turns ON in Slow Decay 2.
At that time, output voltages are
OUT_A : 0V – Vsat
(Negative potential)
OUT_B : 0V + Vsat

4) Fast Decay 1



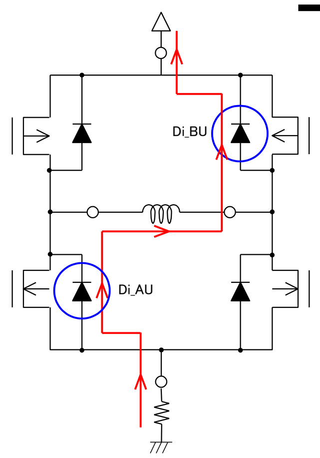
4)After Slow Decay 2, Tr_BD turns OFF. The coil current flow through RF, Tr_AD, coil and Di_BU to VMM.
At that time, output voltages are
OUT_A : 0V + Vsat + I × RF
(Negative potential)
OUT_B : VMM + VF

5) Fast Decay 2



5)If Di_BU keeps to flow current, the IC chip generate heat. Then Tr_BU turns ON in Fast Decay 2.
At that time, output voltages are
OUT_A : 0V + Vsat + I × RF
(Negative potential)
OUT_B : VMM + Vsat

6) Fast Decay 3



6)At the end of a chopping period or if the coil current goes out, all transistors turn OFF.
At that time, output voltages are
OUT_A : 0V + VF+ I × RF
(Negative potential)
OUT_B : VMM + VF
If the coil current goes out, both outputs voltages are Hi-Z.

*Vsat : The saturation voltage of transistor (Tr_U : 400mV, TR_D : 150mV typical at 500mA)
VF : The forward voltage of diodes (Di_U : 900mV, Di_D : 850mV typical at 500mA)

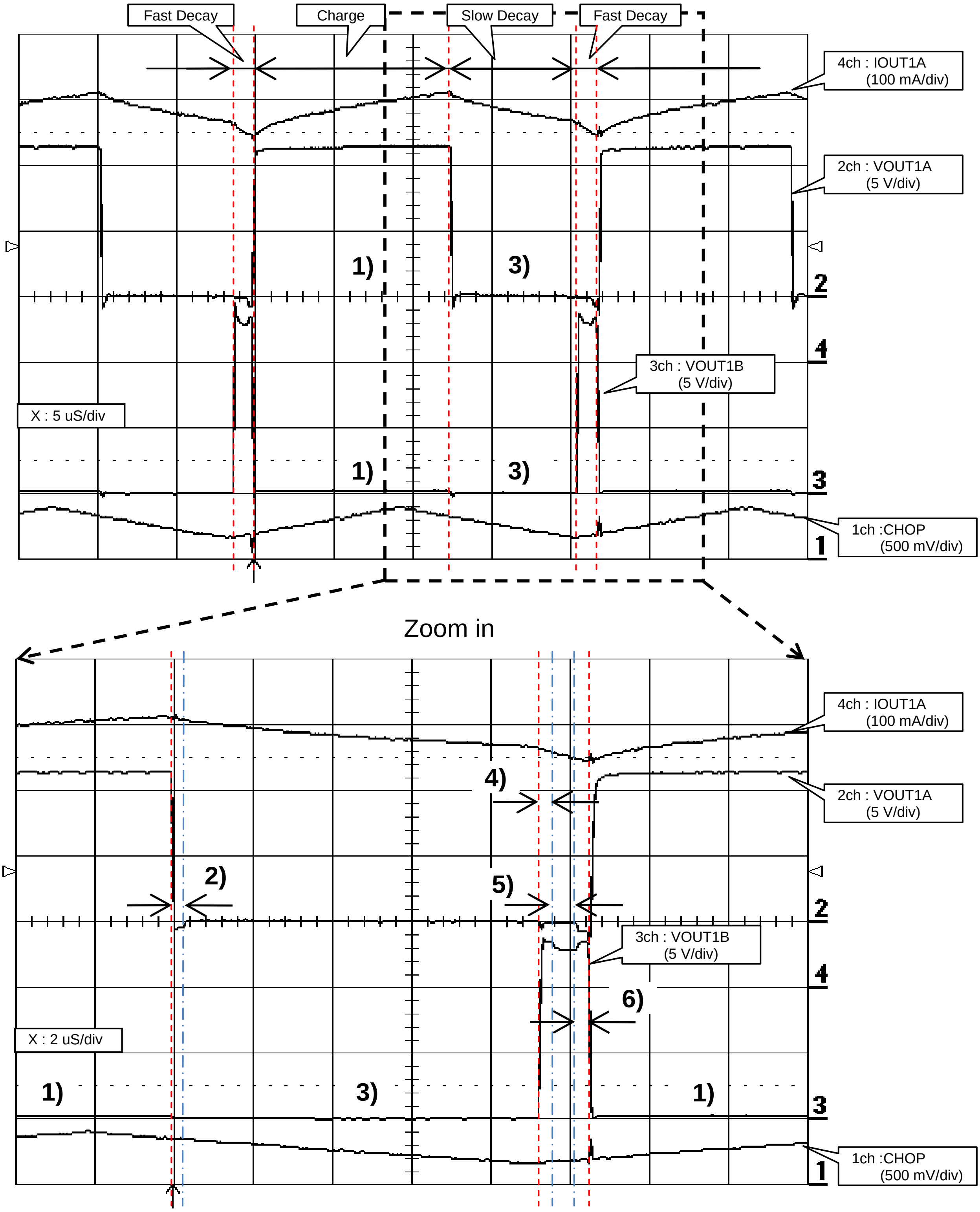


Figure 19. Output signal at each Chopping timing (STM mode)

The numbers 1), 2), 3), 4), 5) and 6) in the above figure are linked with same numbers on the previous page.

(7) Typical current waveform in each excitation mode

7-1) STM Drive mode

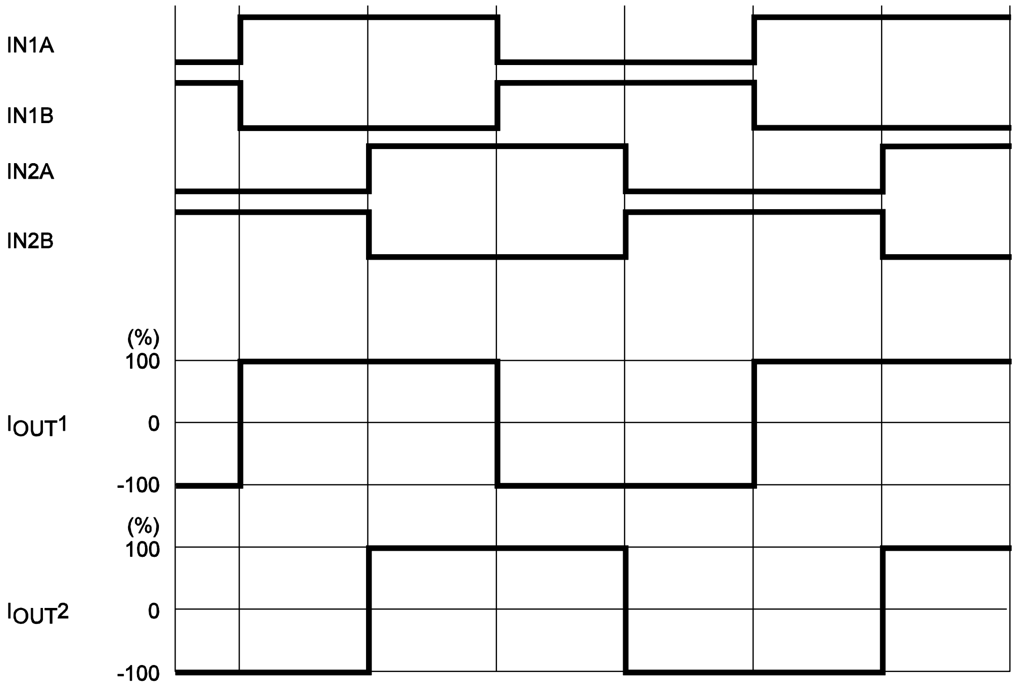


Figure 20. Timing chart of Full-step excitation (CW mode)

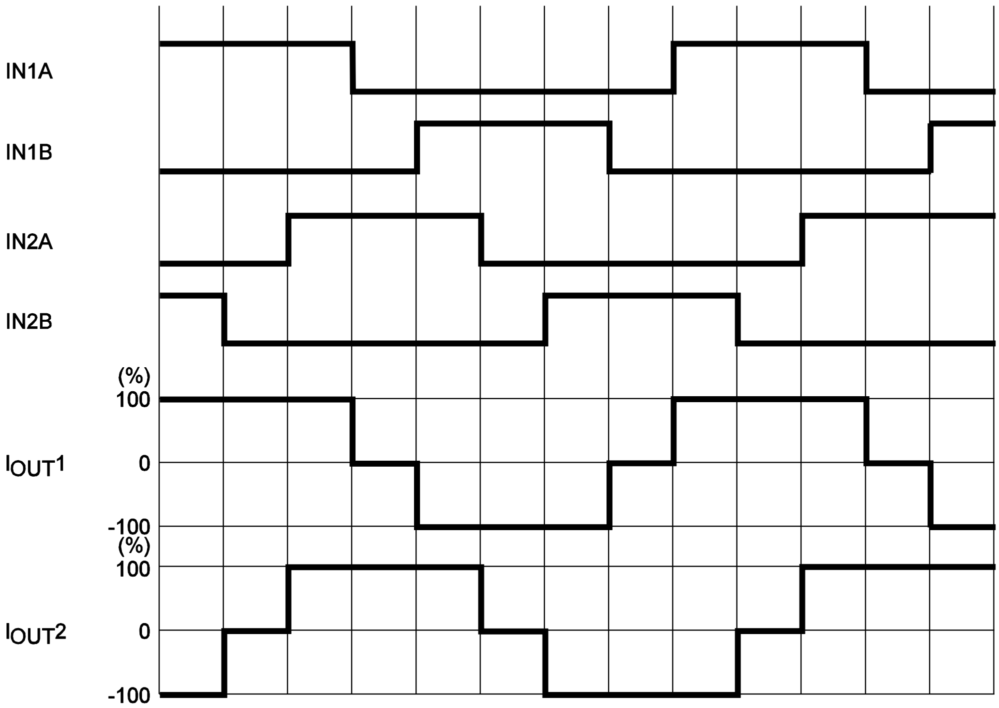


Figure 21. Timing chart of Half-step excitation (CW mode)

7-2) DCM Drive mode

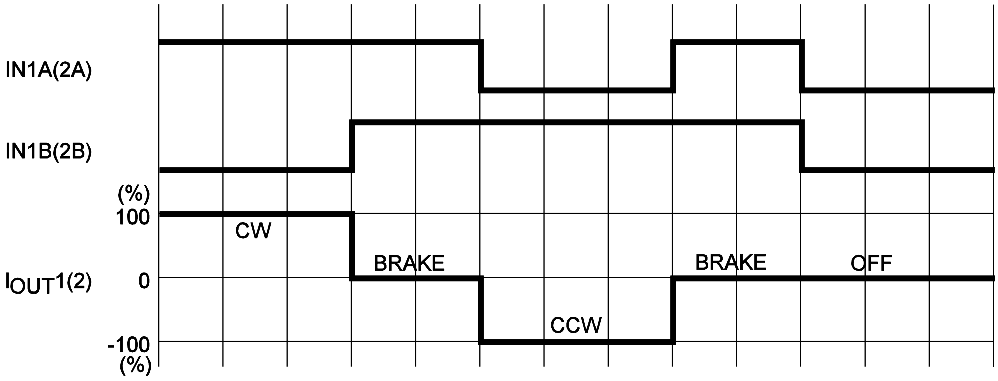


Figure 22. Timing chart of DCM mode

2 H-bridges parallel connection

2ch of H-bridge can be connected in parallel to control a large DC motor. Connect OUT1A with OUT2A, OUT1B with OUT2B, IN1A with IN2A, IN1B with IN2B. In this case, the Current Limit function is ineffective. Therefore connect RNF1/2 to GND. Refer to P.24 for details of connection.

Direct PWM mode

LV8711 can also control DC motors by direct PWM mode. The IC repeats Drive (CW or CCW) and Brake or OFF. It depends on 2 input signals. Refer table below.

Output	IN1A(2A)	IN1B(2B)
CW & Brake	H	PWM
CCW & Brake	PWM	H
CW & OFF	PWM	L
CCW & OFF	L	PWM

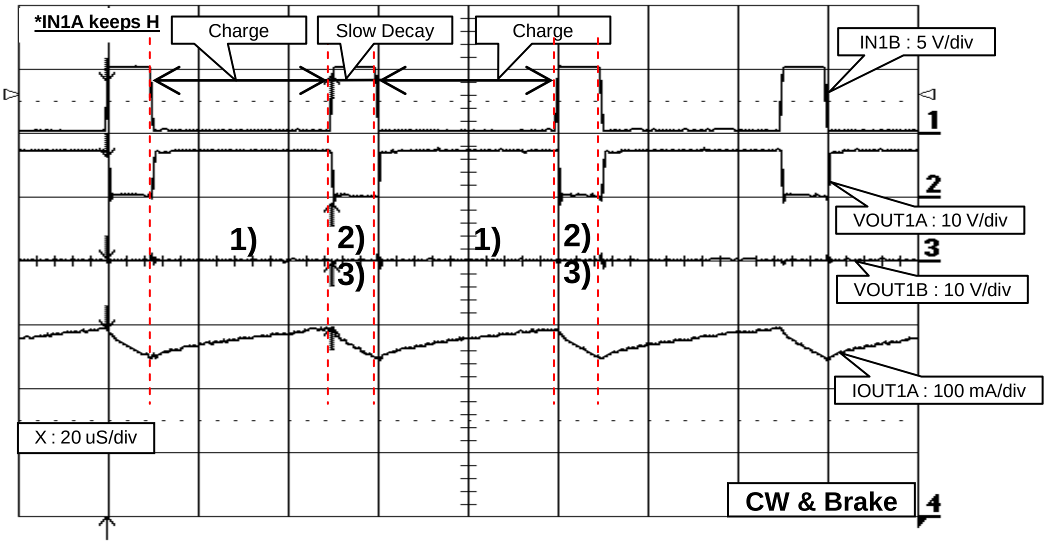


Figure 23. Output signal at each Chopping timing (DCM direct PWM mode 1)

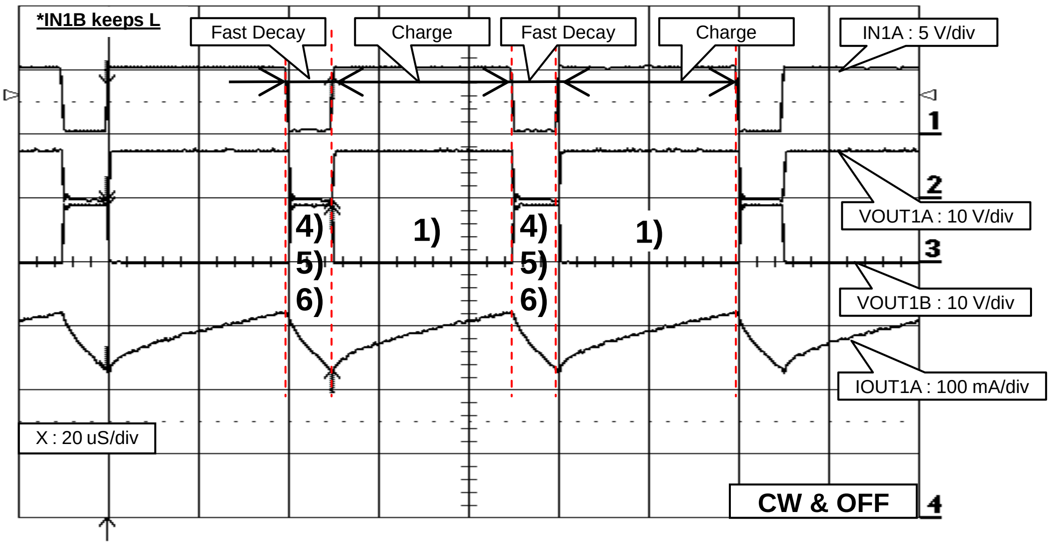


Figure 24. Output signal at each Chopping timing (DCM direct PWM mode 2)

The numbers 1), 2), 3), 4), 5) and 6) in the above figure are linked with same numbers on the page 15.

(8) Output short-circuit protection

To protect IC from damage due to short-circuit of the output caused by lightening or ground fault, the output short-circuit protection is incorporated in order to put the output in the OFF mode.

When detecting the output short-circuit state, the short-circuit protection circuit is activated.
When short-circuit state is detected ≈ 4μs (count by the internal timer), detected output is OFF at the time.
Then, when the output exceeds the timer latch time counted by the internal counter, the output is ON. Still, the short circuit state is detected, the IC switches all output to stand-by mode and keeps the state.
This state is released by setting PS = Low.

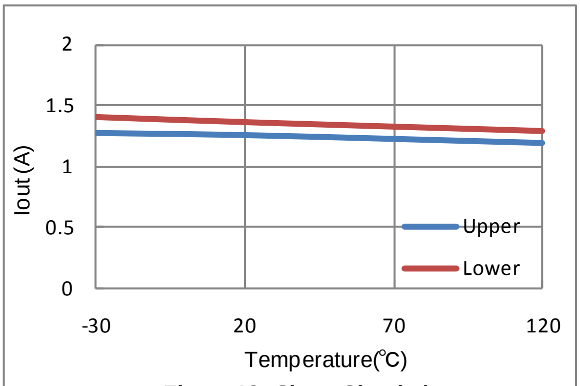


Figure 12. Short-Circuit detect current vs Temperature (VM= 12V)

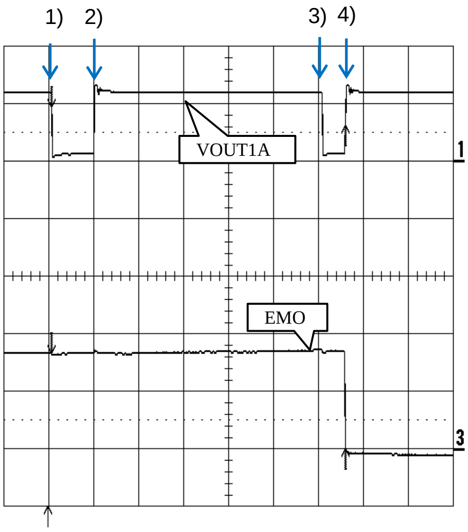
(9) Thermal shutdown function

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 exeed the junction temperature of Tjmax=150°C.

TSD = 180°C (typ)
ΔTSD = 40°C (typ)

(10) Abnormal condition warning output pin

EMO, warning output pin of thermal shutdown circuit and the output short-circuit protection circuit, is an open-drain output. EMO outputs ON when output short-circuit is detected.
When detecting the output overdrive, the EMO outputs ON. If the junction temperature goes down, EMO outputs OFF automatically.



1) The Output turned on and short-circuit happened.
2) If short-circuit state is detected ≈ 4uS, detected output turns off temporarily.
3) The output exceeds the timer latch time, the output is ON again.
4) Still, the short-circuit state is detected, the IC switches all output to stand-by mode and keeps the state.
And EMO outputs ON.

Figure 26. Timing chart of the Output short-circuit protection and EMO

(11) V_{CC} Low Voltage Shut Down

The built-in comparator, associated with the band gap reference, continuously monitors the V_{CC} input while PS is H.

If the V_{CC} voltage drops below 2.4 V (typical) during the operation, the LV8711 generates a Power Save sequence and is forced into a no stand-by mode. The built-in 130 mV hysteresis avoids unstable operation when the battery voltage slowly varies around 2.5 V.

When the V_{CC} voltage rises above 2.53 V (typical), the chip is activated and all the functions become available.

(12) Recommended power-on sequence

Provide a wait time of 10μs or more after V_{CC} power supply rises before supplying VM power supply.

Provide a wait time of 10μs or more after VM power supply raises before setting the PS pin High.

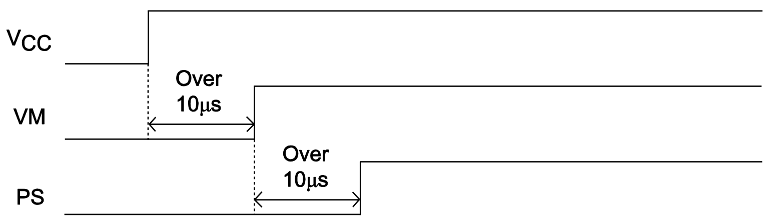


Figure 27. Timing chart of recommended power-on sequence

The above power-on sequence is only a recommendation, and there are no risks of damage or over current to the IC even if this sequence is not followed.

Typical application Circuit

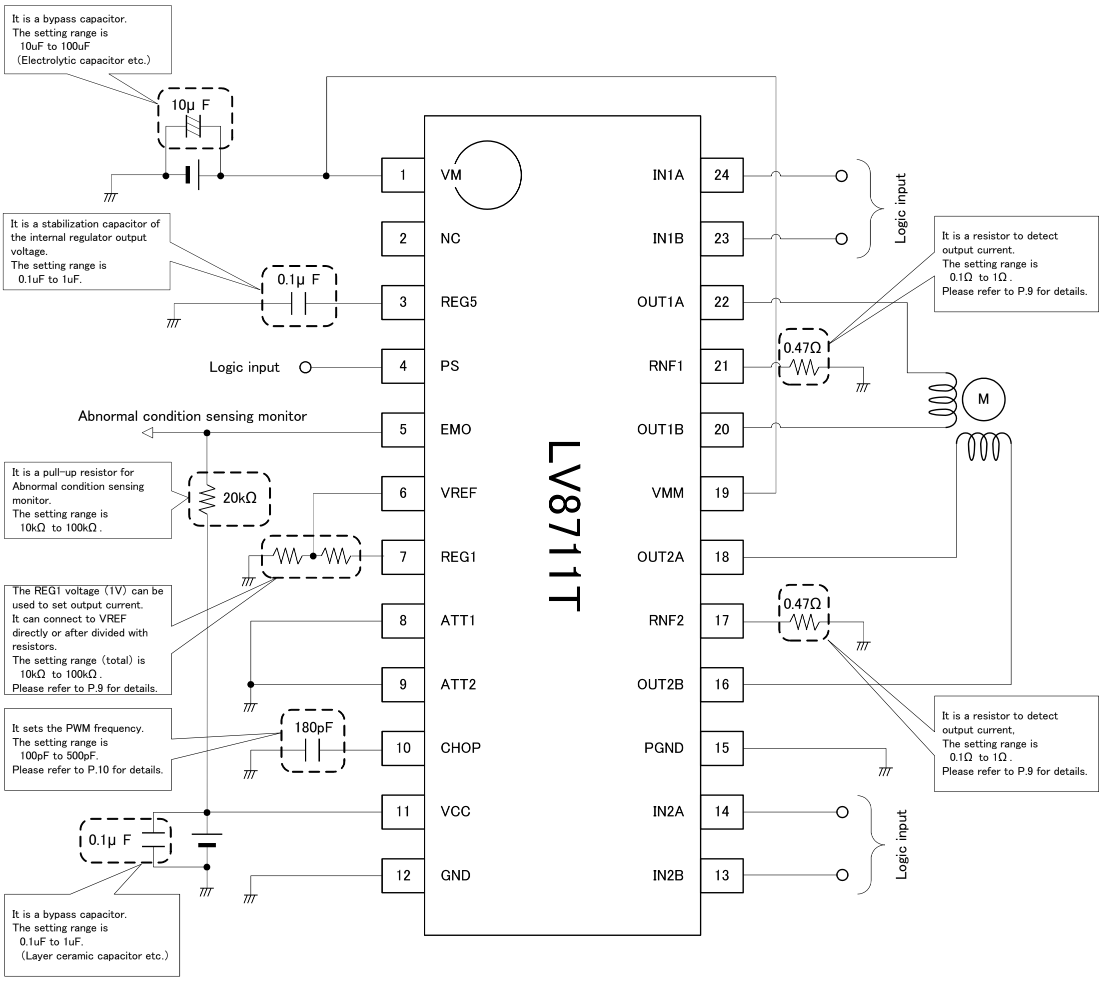


Figure 28. Typical application Circuit for Stepping motor

Each constant setting method for the above circuit diagram example is as follows:

Current LIMIT (100%) set

VREF = 1.0V (when internal regulator output is connected)

I_{LIMIT} = VREF / 5 / RNF resistance

= 1.0V / 5 / 0.47Ω = 425mA

Chopping frequency setting

Fchop = Ichop / (Cchop × Vt × 2)

= 10μA/ (180pF × 0.5V × 2) = 55.5 kHz

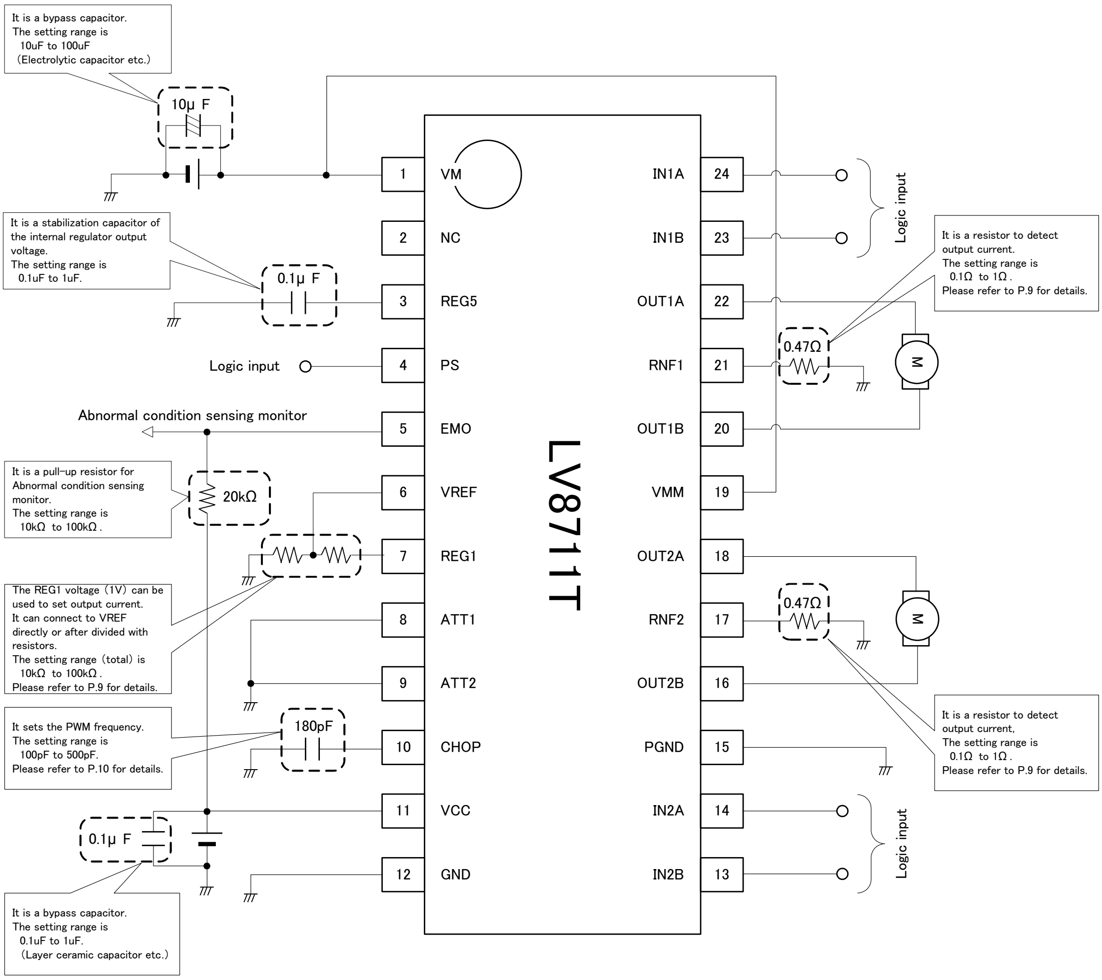


Figure 29. Typical application Circuit for DC motors

Each constant setting method for the above circuit diagram example is as follows:

Current LIMIT (100%) set

VREF = 1.0V (when internal regulator output is connected)

I_{LIMIT} = VREF / 5 / RNF resistance

= 1.0V / 5 / 0.47Ω = 425mA

Chopping frequency setting

Fchop = Ichop / (Cchop × Vt × 2)

= 10uA/(180pF×0.5V×2)= 55.5kHz

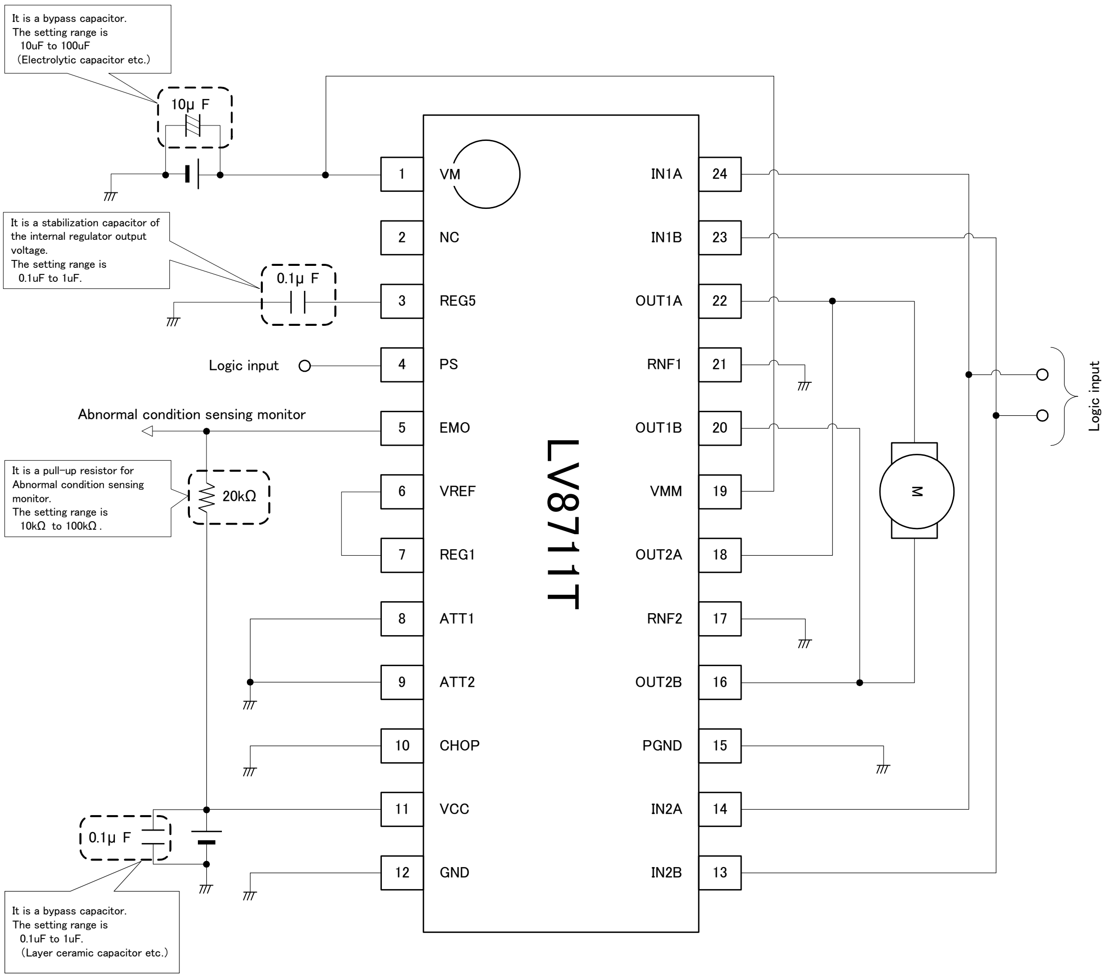


Figure 30. Typical application Circuit for 1 DC motor

In this case, the Current Limit function is ineffective. Therefore connect RNF1/2 to GND, and REG1 to VREF. Connect OUT1A with OUT2A, OUT1B with OUT2B, IN1A with IN2A, IN1B with IN2B.

Evaluation Board

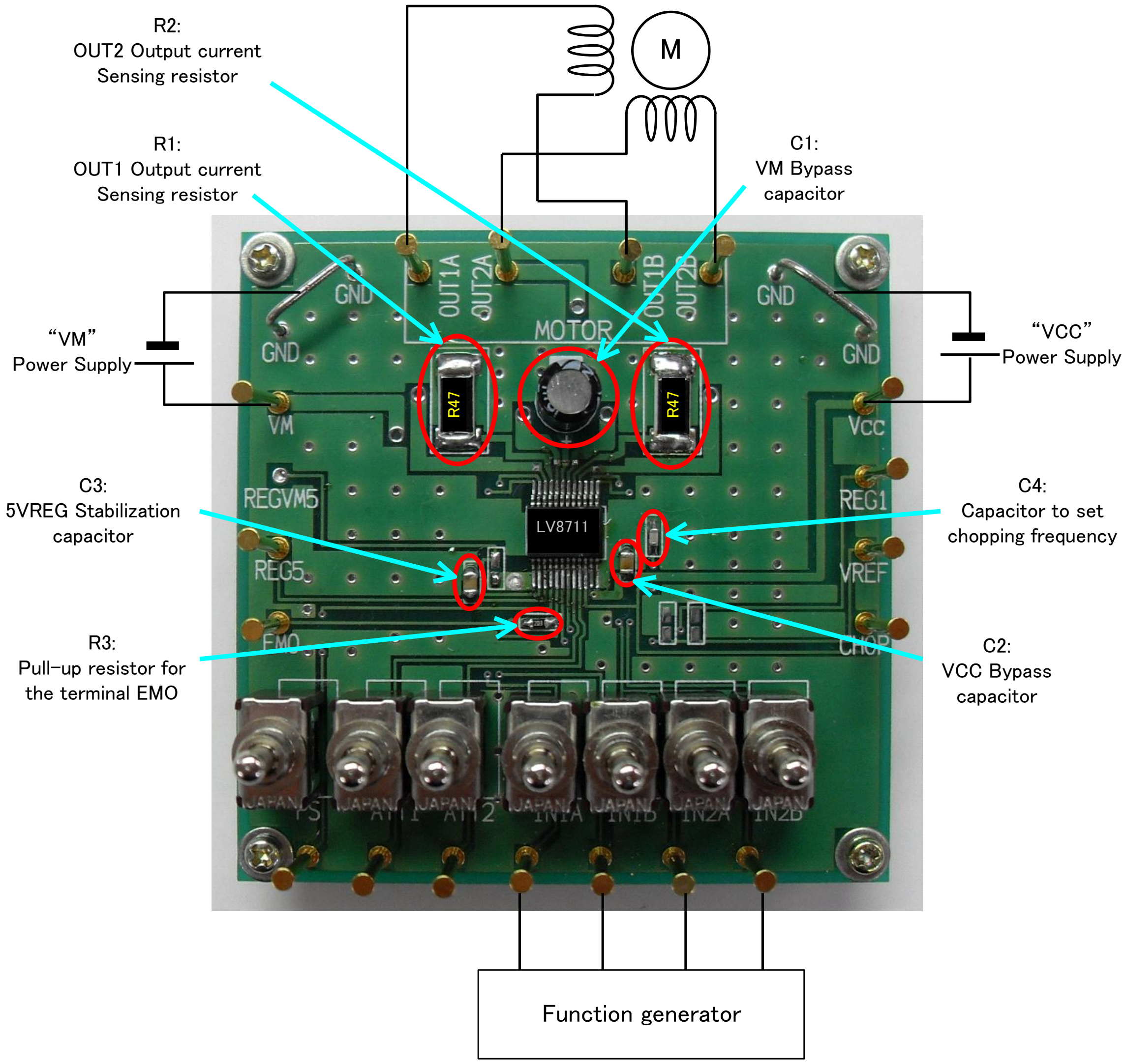


Figure 31. Evaluation board overview

Bill of Materials for LV8731V Evaluation Board

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
C1	1	VM Bypass Capacitor	10µF, 50V			sanyo		Yes	
C2	1	VCC Bypass Capacitor	0.1µF, 100V	±10%		Murata	GRM188R72A104KA35*	Yes	Yes
C3	1	5VREG stabilization Capacitor	0.1µF, 100V	±10%		Murata	GRM188R72A104KA35*	Yes	Yes
C4	1	Capacitor to set chopping frequency	180pF, 50V	±5%		Murata	GRM1882C1H181JA01*	Yes	Yes
R1	1	OUT1 Output current Sensing resistor	0.47Ω, 1W	±5%		ROHM	MCR100JZHJLR47	Yes	Yes
R2	1	OUT2 Output current Sensing Resistor	0.47Ω, 1W	±5%		ROHM	MCR100JZHJLR47	Yes	Yes
R3	1	Pull-up Resistor for for terminal EMO	20kΩ, 1/10W	±5%		KOA	RK73B1JT**203J	Yes	Yes
IC1	1	Motor Driver				SANYO semiconductor	LV8711T	No	Yes
SW1-SW7	7	Switch				MIYAMA	MS-621C-A01		
TP1-TP18	18	Test Point				MAC8	ST-1-3		

Evaluation Board circuit

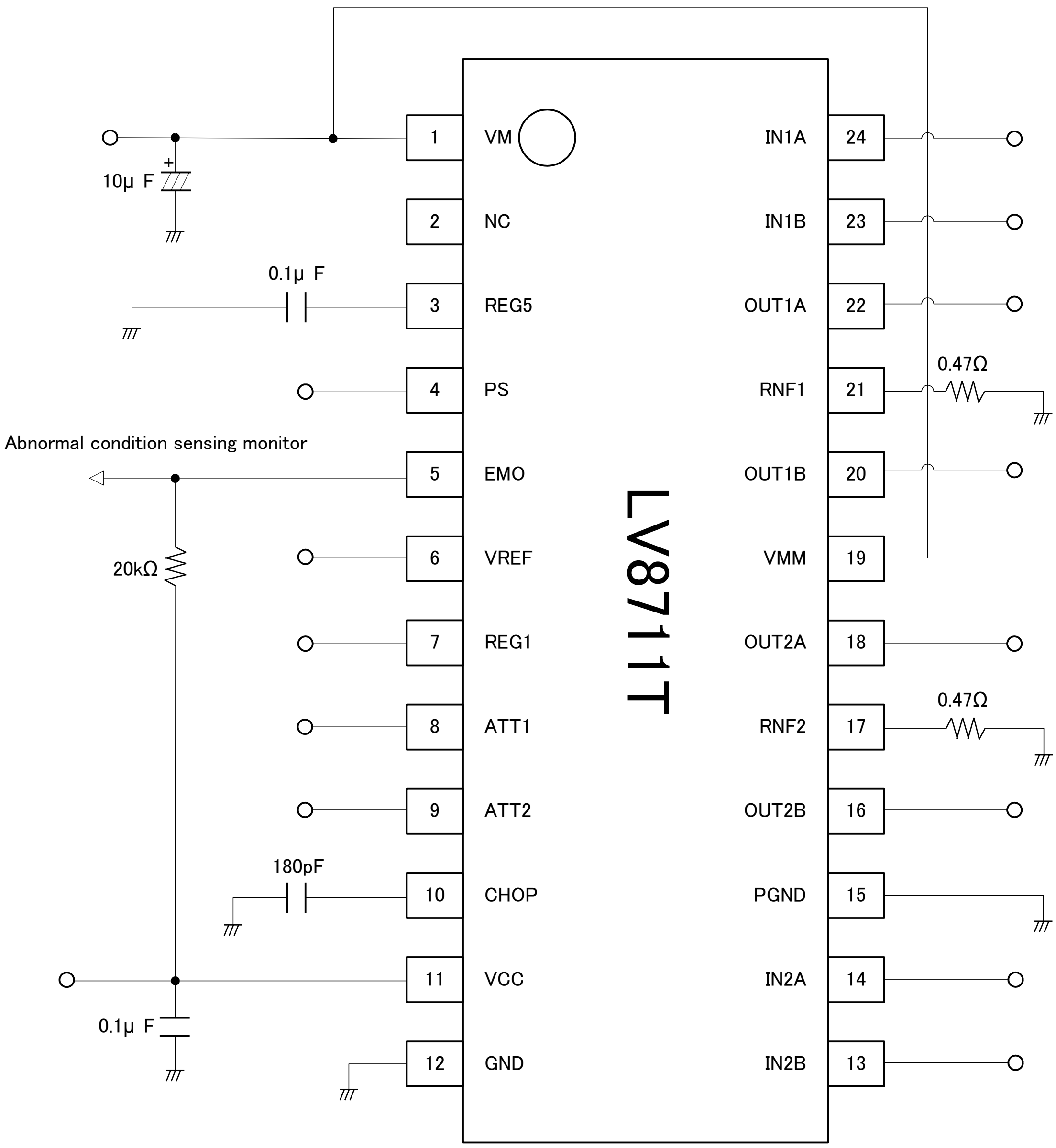


Figure 32. Evaluation Board circuit schematic

*When we started developing this IC, the Pin No.2 was the output of internal regulator (REGVM5).
But now, it is a no connection pin

Each constant setting method for the above circuit diagram example is as follows.

- Current LIMIT (100%) set
  VREF=1V (when internal regulator REG1 output is connected)
  Ilimit=VREF/5/RNF
  =1V/5/0.47Ω= 425mA

- Chopping frequency setting
  Fchop=Ichop/(Cchop×Vt×2)
  =10uA/(180pF×0.5V×2)= 55.5kHz

Operation Guide

For stepping motor control

- Connect a stepping motor with OUT1A, OUT1B, OUT2A and OUT2B.
- Connect the motor power supply with the terminal VM, the control power supply with the terminal VCC. Connect the GND line with the terminal GND.
- Input the reference voltage to the terminal VREF.
  （The terminal REG1 short circuit is assumed.）
- Turn the switch of "PS" on. （Knock it down for above in follow image.）
  Keep other switches middle position. Input drive signals to IN1A, IN1B, IN2A and IN2B from DSP.
  Refer to the timing charts on P.17.

For smaller DC motor(s) control

- Connect DC motor(s) between OUT1A and OUT1B, OUT2A and OUT2B.
- Connect the motor power supply with the terminal VM, the control power supply with the terminal VCC. Connect the GND line with the terminal GND.
- Input the reference voltage to the terminal VREF.
  （The terminal REG1 short circuit is assumed.）
- Turn the switch of "PS" on. （Knock it down for above in follow image.）
- Turn the swith of IN1A, IN1B, IN2A and IN2B ON or OFF.
  When DSP is connected to previous Input pins, keep their switches middle position.
  Refer to the timing chart on P.18.

For a larger DC motor control

- Connect Output pin OUT1A with OUT2A, OUT1B with OUT2B each other directly.
- Connect Input pin IN1A with IN2A, IN1B and IN2B each other directly.
- Connect DC motor between OUT1A/2A and OUT1B/2B.
- Connect the motor power supply with the terminal VM, the control power supply with the terminal VCC. Connect the GND line with the terminal GND.
- Connect REG1 to VREF directly.
- Turn the switch of "PS" on. （Knock it down for above in follow image.）
- Turn the swith of IN1A/2A and IN1B/2B ON or OFF.
  When DSP is connected to previous Input pins, keep their switches middle position.
  Refer to the timing chart on P.18.

The points of attention to design applications

- The VM, each OUT, and each RNF where a large current flows are laid out fat and short as much as possible.
- The VM bypass capacitor is mounted as near as possible to the IC.
- Do not exceed the absolute maximum ratings under no circumstance. The terminal OUT can exceed VM due to reversed voltage or regenerated current. Refer to P.15.
- "PGND" is ground of the power system. "GND" is small signal ground. They need to be laid out without the common impedance.
- The island of GND needs to be noted low impedance as much as possible. For example, make through-holes as much as possible.
- We recommend that the GND line to connect a stabilization capacitor of VCC is laid out alone to near ground connected the VM bypass capacitor.
- VREG5 is used in the IC as reference voltage. Capacitance is connected between VREG5 pin and GND to stabilize VREG5.
- REG1 can be used to reference voltage for Constant-current setting. Therefore REG1 can connect to VREF directly or after devided with resistors. But if output current needs high precision, VREF had better be connected to another source.
- VREG5 and REG1 can not be recommended to use for peripheral circuits because their output voltage are not so high precision.
- The input pin is connected to 100k Ω pull-down in the chip. If the pin is open, the IC receives signals as L. But it may be misunderstood when the pin is affected by noise. When the pin is input L, it is recommended to switch to ground.

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