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LV8728MR

Stepper Motor Driver, PWM, Constant-Current Control, 1/128 step

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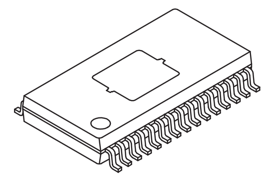
Overview

The LV8728MR is a PWM current-controlled micro step stepper motor driver. This driver can perform eight types of excitation mode from Full step to 1/128 step and can drive simply by the CLK input.



MFP30KR (375mil)

Function

- Single-channel PWM current control stepper motor driver
- BiCDMOS process IC
- Output on-resistance (upper side: 0.3Ω ; lower side: 0.25Ω ; total of upper and lower: 0.55Ω ; Ta = 25°C, I_O = 2.0A)
- Full, Half, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128 step excitation mode are selectable
- Advance the excitation step with the only step signal input
- Available forward reverse control
- I_O max = 2.0A
- Over-current protection circuit
- Thermal shutdown circuit
- Input pull down resistance
- With reset pin and enable pin.

Typical Applications

- Printer (Multi-function printer, 3D printer, etc.)
- Security camera
- Scanner
- Stage light

ORDERING INFORMATION

Ordering Code:
LV8728MR-AH

Package
MFP30KR
(Pb-Free / Halogen Free)

Shipping (quantity/packing)
1000 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF

Maximum Ratings (Note 1)

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	VM max	VM , VM1 , VM2	36	V
Maximum output current	I_O max	Per 1ch	2.0	A
Maximum logic input voltage	V_{IN} max	ST , MD1 , MD2 , MD3 , OE , RST , FR , STEP	6	V
Maximum FDT input voltage	VFDT max		6	V
Maximum VREF input voltage	VREF max		6	V
Maximum MO input voltage	V_{MO} max		6	V
Maximum DOWN input voltage	V_{DOWN} max		6	V
Allowable power dissipation (Note 2)	Pd max		1.55	W
Operating temperature	Topr		-30 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

1. Stresses exceeding those listed in the Absolute Maximum Rating table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
2. Specified circuit board: 76.1mm×114.3mm×1.6mm, glass epoxy board.

Recommended Operating Ranges (Note 3)

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	VM	VM , VM1 , VM2	9 to 32	V
Logic input voltage	V_{IN}	ST , MD1 , MD2 , MD3 , OE , RST , FR , STEP	0 to 5	V
FDT input voltage range	VFDT		0 to 5	V
VREF input voltage range	VREF		0 to 3	V

3. Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

Electrical Characteristics at Ta=25°C, VM=24V, VREF=1.5V unless otherwise noted. (Note 4)

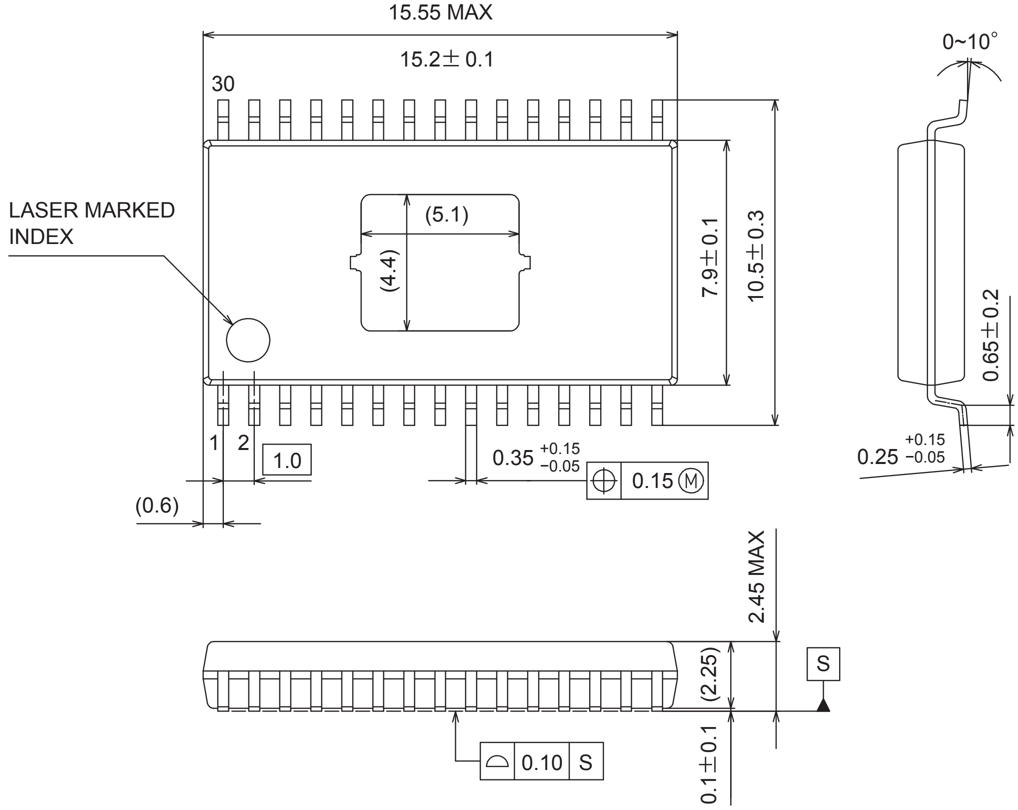
Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Standby mode current drain		I_Mst	ST = “L” , VM+VM1+VM2		70	100	μA
Current drain		IM	ST = “H”, OE = “H”, no load VM+VM1+VM2		3.3	4.6	mA
Thermal shutdown temperature		TSD	Guaranteed by design	150	180	200	°C
Thermal hysteresis width		∆TSD	Guaranteed by design		40		°C
Logic pin input current		I_{IN}L	ST , MD1 , MD2 , MD3 , OE , RST , FR , STEP , V_{IN} = 0.8V	3	8	15	μA
		I_{IN}H	ST , MD1 , MD2 , MD3 , OE , RST , FR , STEP , V_{IN} = 5V	30	50	70	μA
Logic input voltage	High	V_{IN}H	ST , MD1 , MD2 , MD3 , OE , RST , FR , STEP	2.0		5.0	V
	Low	V_{IN}L		0		0.8	V
FDT pin high level voltage		Vfdth		3.5			V
FDT pin middle level voltage		Vfdtm		1.1		3.1	V
FDT pin low level voltage		Vfdtl				0.8	V
Chopping frequency		Fch	Cosc1 = 100pF	70	100	130	kHz
OSC1 pin charge/discharge current		Iosc1		7	10	13	μA
Chopping oscillation circuit threshold voltage		Vtup1		0.8	1	1.2	V
		Vtdown1		0.3	0.5	0.7	V
VREF pin input voltage		Iref	VREF = 1.5V	-0.5			μA
DOWN output residual voltage		V_OlDOWN	Idown = 1mA		40	100	mV
MO pin residual voltage		V_OlMO	Imo = 1mA		40	100	mV
Hold current switching frequency		Fdown	Cosc2 = 1500pF	1.12	1.6	2.08	Hz
OSC2 pin charge/discharge current		Iosc2		7	10	13	μA
Hold current switching frequency threshold voltage		Vtup2		0.8	1	1.2	V
		Vtdown2		0.3	0.5	0.7	V
VREG1 output voltage		Vreg1		4.7	5	5.3	V
VREG2 output voltage		Vreg2		18	19	20	V
Output on-resistance		Ronu	I_O = 2.0A, upper side ON resistance		0.3	0.42	Ω
		Rond	I_O = 2.0A, lower side ON resistance		0.25	0.35	Ω
Output leakage current		$I_O$leak	V_M = 36V			50	μA
Diode forward voltage		VD	I_D = -2.0A		1.1	1.4	V
Current setting reference voltage		VRF	VREF = 1.5V, Current ratio 100%	0.285	0.3	0.315	V

4. Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

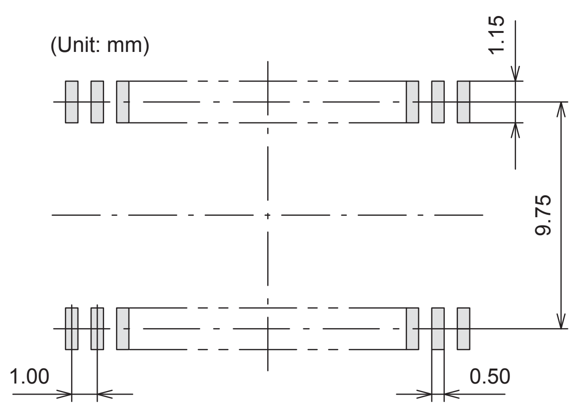
Package Dimensions

unit : mm

SOIC30 W / MFP30KR (375 mil)
CASE 751CH
ISSUE A



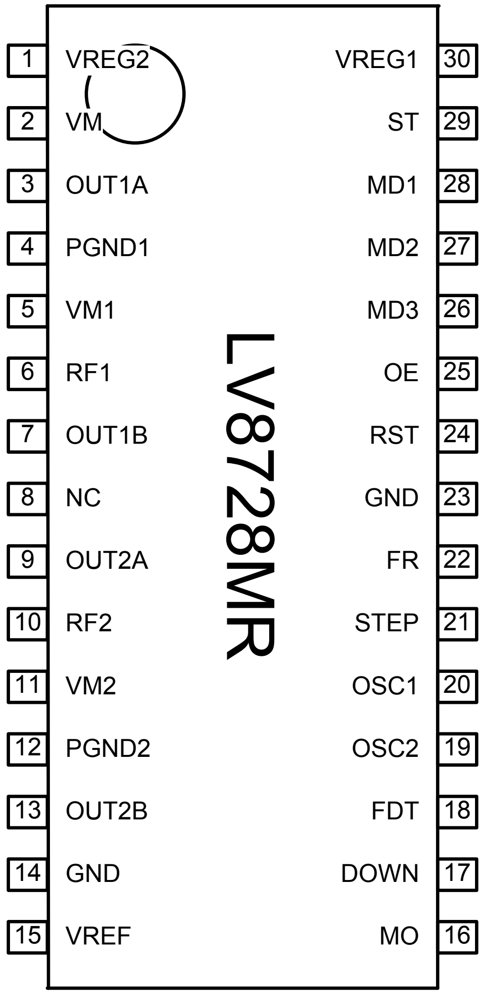
SOLDERING FOOTPRINT*



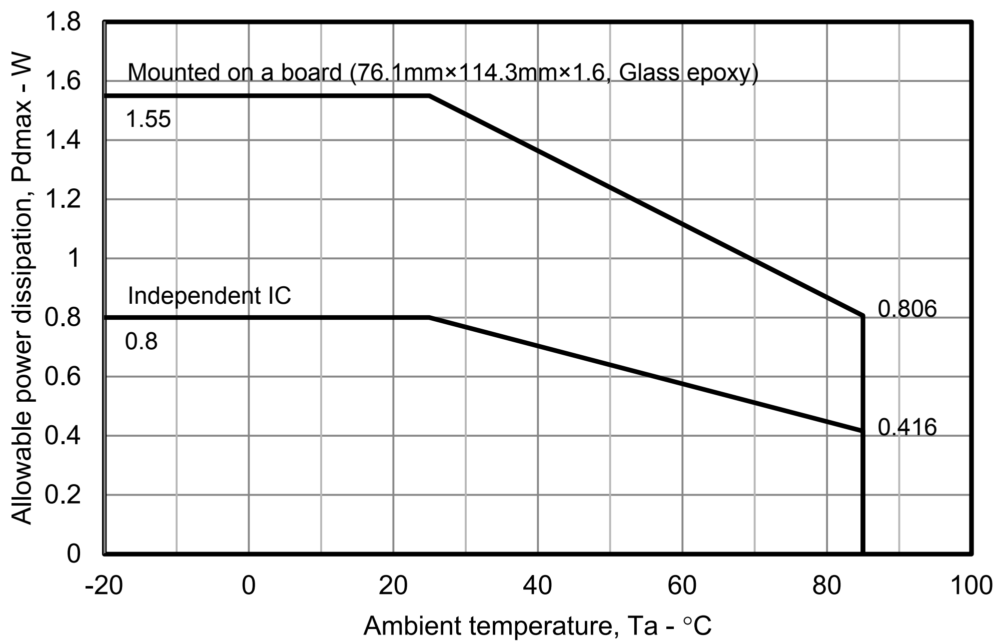
NOTE: The measurements are not to guarantee but for reference only.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

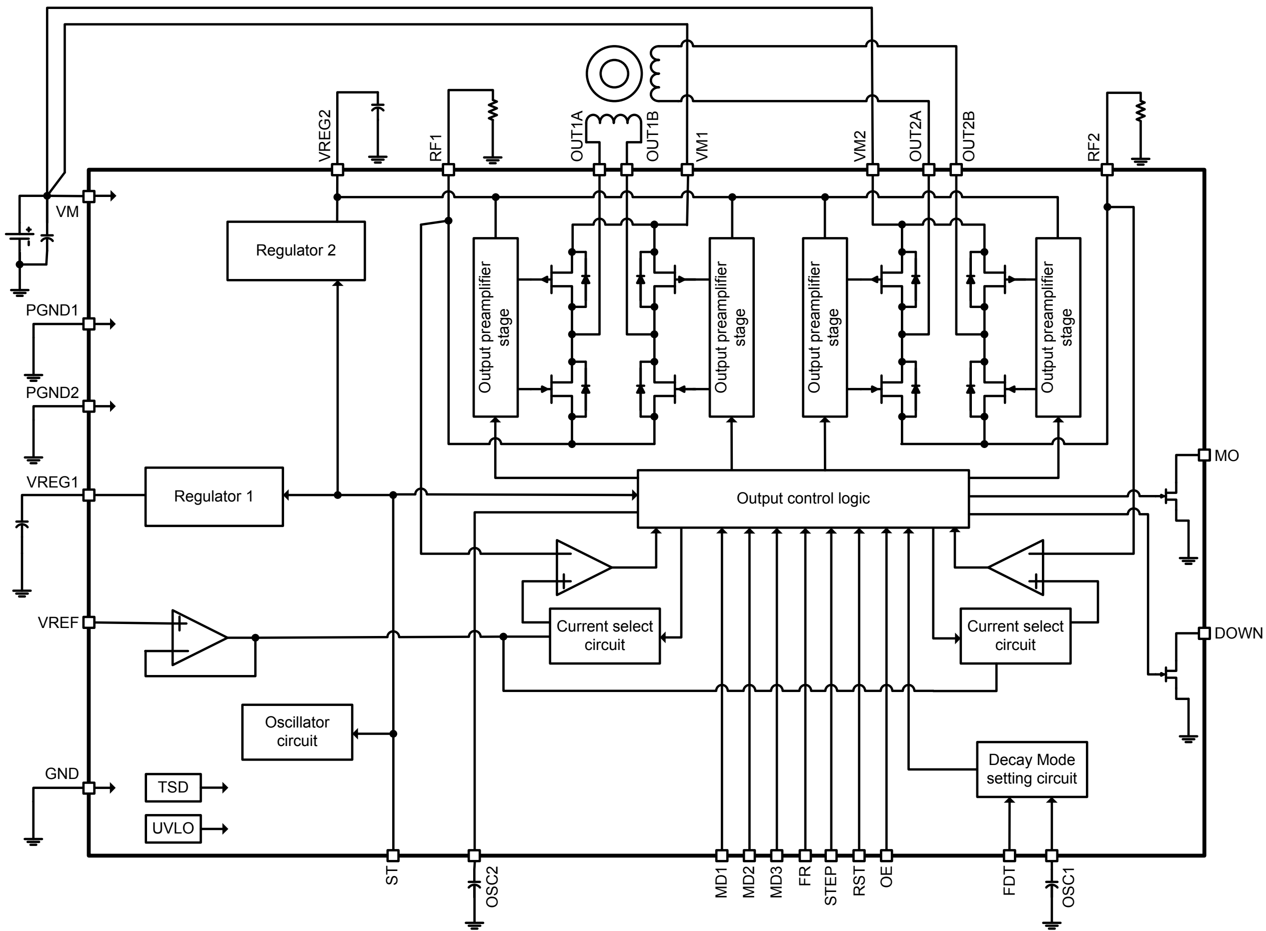
Pin Assignment



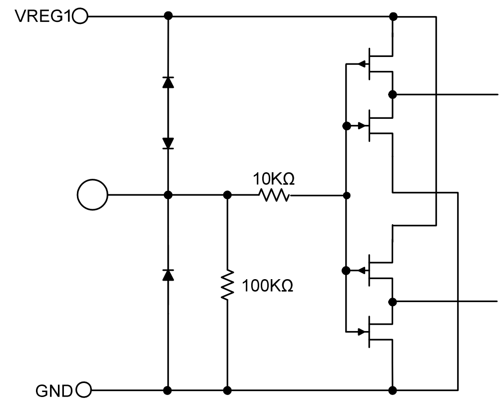
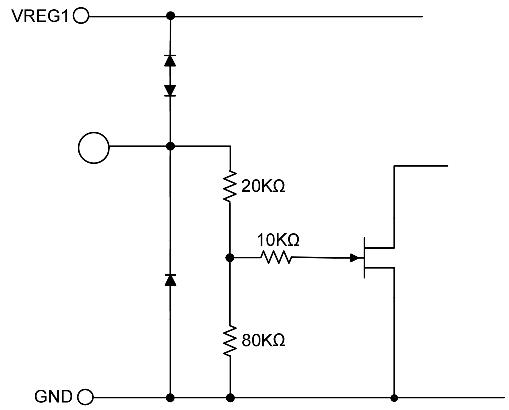
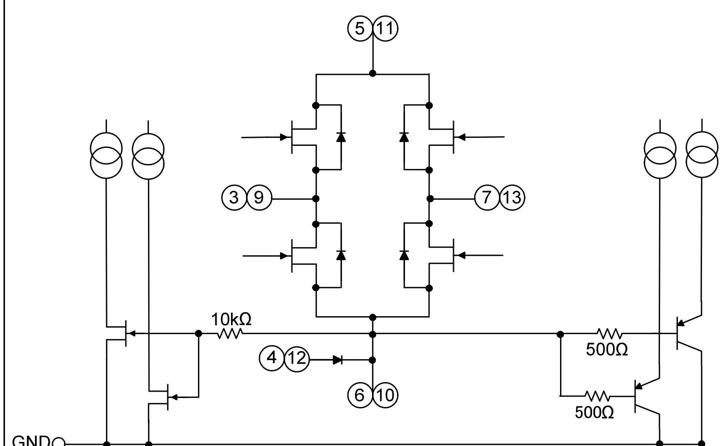
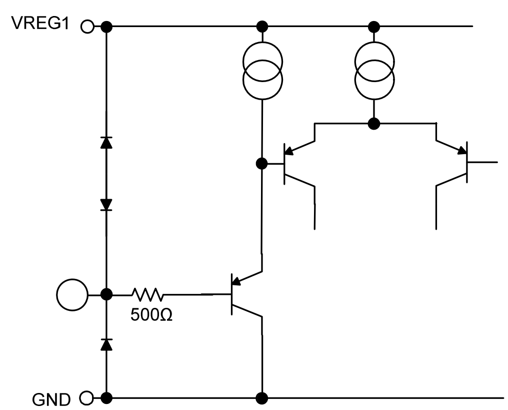
Pd max – Ta



Block Diagram



Pin Functions

Pin No.	Pin Name	Pin Function	Equivalent Circuit
21 22 24 25 26 27 28	STEP FR RST OE MD3 MD2 MD1	Step clock pulse signal input pin Forward / Reverse signal input pin Reset signal input pin Output enable signal input pin Excitation mode switching pin Excitation mode switching pin Excitation mode switching pin	
29	ST	Chip enable pin	
3 4 5 6 7 9 10 11 12 13	OUT1A PGND1 VM1 RF1 OUT1B OUT2A RF2 VM2 PGND2 OUT2B	Channel 1 output A pin Channel 1 Power ground pin Channel 1 motor power supply pin Channel 1 current sense resistor pin Channel 1 output B pin Channel 2 output A pin Channel 2 current sense resistor pin Channel 2 motor power supply pin Channel 2 Power ground pin Channel 2 output B pin	
15	VREF	Constant-current control reference voltage input pin.	

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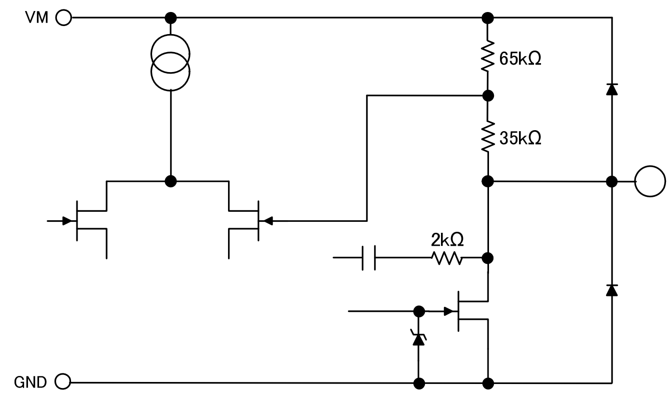
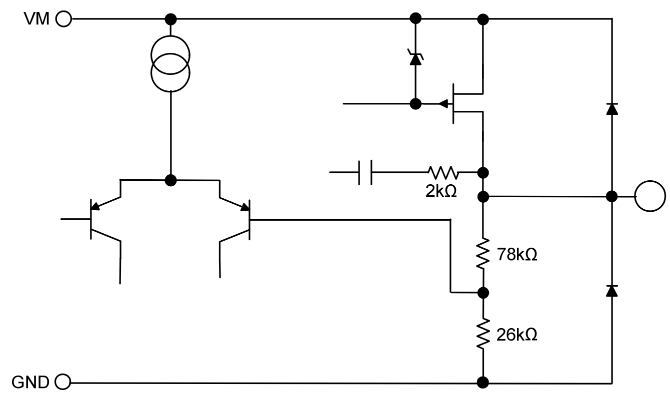
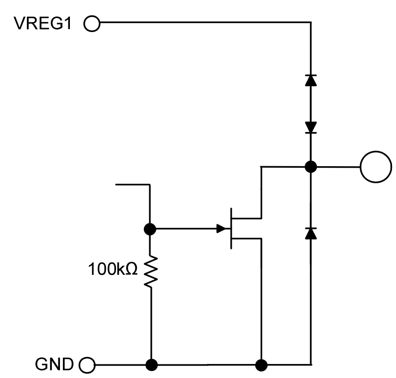
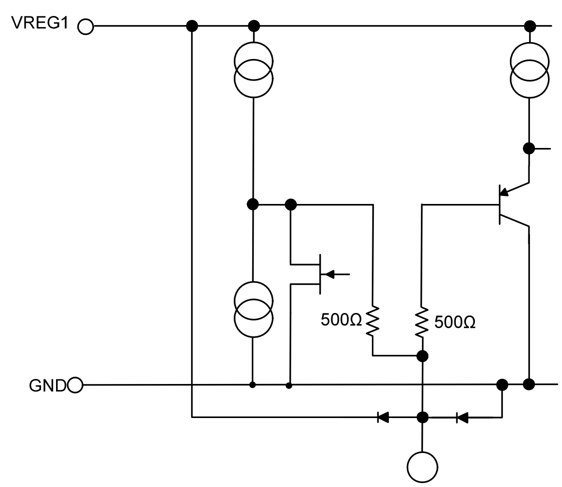
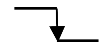
Pin No.	Pin Name	Pin Function	Equivalent Circuit
1	VREG2	Internal regulator capacitor connection pin.	
30	VREG1	Internal regulator capacitor connection pin.	
16 17	MO DOWN	Output pin for position detecting Output pin for holding current reduction	
19 20	OSC2 OSC1	Capacitor connection pin for STEP signal off detection time setting When not using the current reduction by DOWN pin, need to connect OSC2 pin to GND at 10kΩ (recommended value). Capacitor connection pin for chopping frequency setting.	
14 23	GND GND	Ground pin	

Functional Description

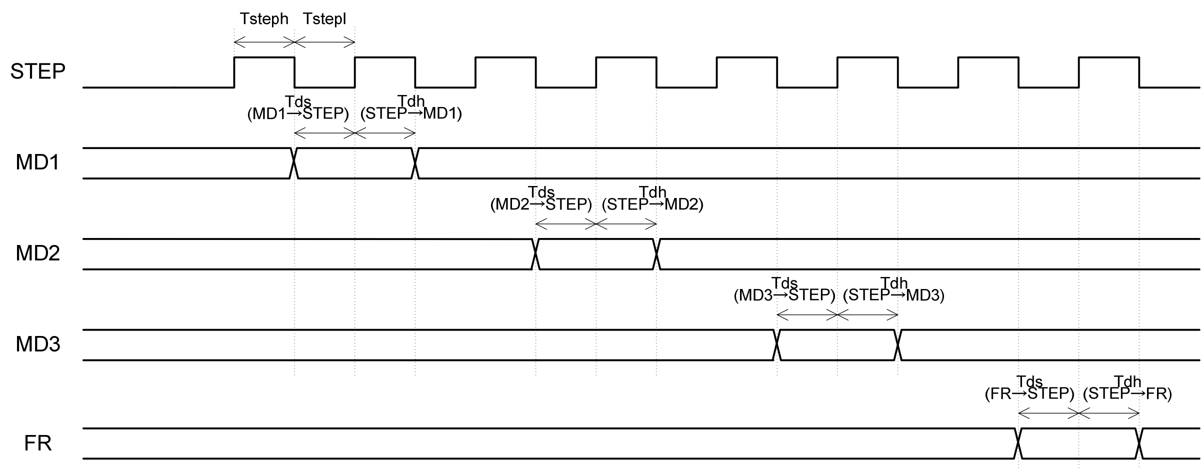
1. Input Pin Function
   Each input terminal has the function to prevent the flow of the current from an input to a power supply. Therefore, Even if a power supply (VM) is turned off in the state that applied voltage to an input terminal, the electric current does not flow into the power supply.

2. Stand-by function
   When ST pin is at low levels, the IC enters stand-by mode, all logic is reset and output is turned OFF. When ST pin is at high levels, the stand-by mode is released.

3. STEP pin function

Input		Operating mode
ST	STEP	
Low	Don't care	Standby mode
High		Excitation step is proceeded
High		Excitation step is kept

4. Input Timing



Tsteph/Tstepl: Clock H/L pulse width (min 500ns)
Tds: Data set-up time (min 500ns)
Tdh: Data hold time (min 500ns)

5. Position detection monitor function
   The MO position detection monitoring pin is an open drain type.
   When the excitation position is in the initial position, the MO output is placed in the ON state.
   (Refer to "Examples of current waveforms in each of the excitation modes.")

MO	Status
ON	Initial position
OFF	Except initial position

6. Excitation mode setting function

Set the excitation setting as shown in the following table by setting MD1 pin, MD2 pin and MD3 pin.

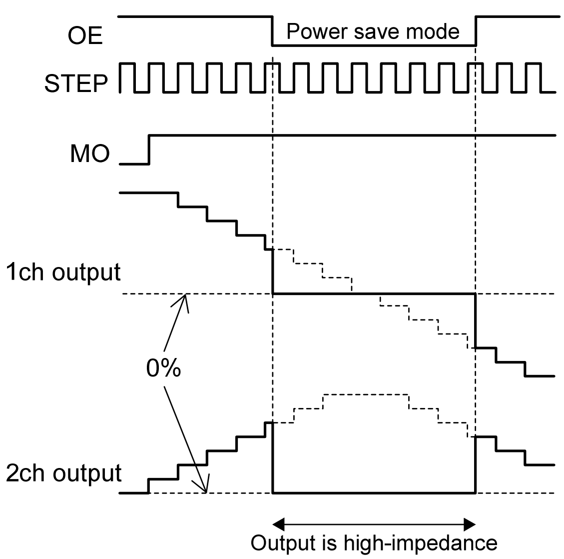
Input			Excitation mode	Initial position	
MD3	MD2	MD1		1ch current	2ch current
Low	Low	Low	Full step	100%	-100%
Low	Low	High	Half step	100%	0%
Low	High	Low	1/4 step	100%	0%
Low	High	High	1/8 step	100%	0%
High	Low	Low	1/16 step	100%	0%
High	Low	High	1/32 step	100%	0%
High	High	Low	1/64 step	100%	0%
High	High	High	1/128 step	100%	0%

The initial position is also the default state at start-up and excitation position at counter-reset in each excitation mode.

7. Output enable function

When the OE pin is set Low, 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 is input. Therefore, when OE pin is returned to High, the output level conforms to the excitation position that is advanced by the STEP input.

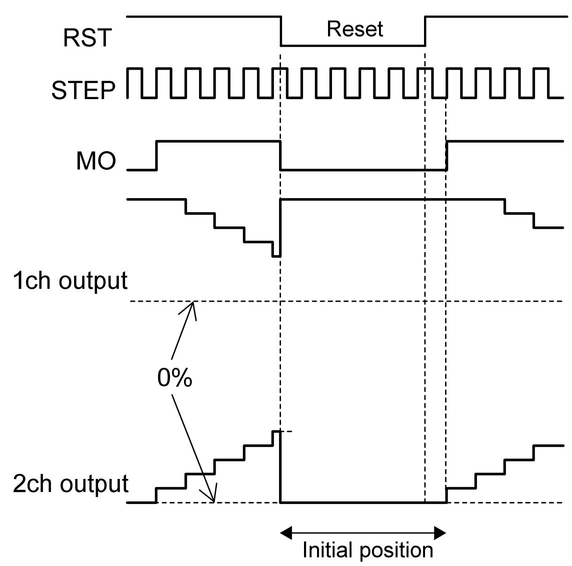
OE	Operating mode
Low	Output OFF
High	Output ON



8. Reset function

When the RST pin is set Low, the excitation position of the output is set to the initial position forcibly and MO pin output is turn ON state. And then by setting RST pin is High, the excitation position moves forward with the next step signal.

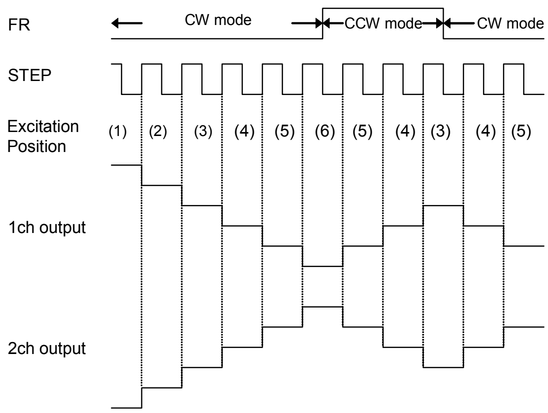
RST	Operating mode
Low	Reset status
High	Normal operation



9. Forward / Reverse switching

The internal D/A converter proceeds by a bit on the rising edge of the step signal input to the STP pin. In addition, CW and CCW mode are switched by FR pin setting.
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.

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



10. Decay mode setting

Current Decay method is selectable as shown below by applied voltage to the FDT pin.

FDT voltage	Decay mode
3.5V to 5.0V	SLOW Decay
1.1V to 3.1V or Open	MIXED Decay
0V to 0.8V	FAST Decay

11. Output current setting

Output current is set as shown below by the VREF pin (applied voltage) and a resistance value between RF1 (2) pin and GND.

$$I_{OUT} = \frac{V_{REF}}{5 \cdot R_{RFx}}$$

The setting current value above is a 100% output current in each excitation mode.

Where,
I_{OUT} : Coil current [A]
R_{RFx} : Resistor between RF1 (2) and GND [Ω]
V_{REF} : Input voltage at the VREF pin [V]

For example, when VREF = 1.1V and RF1 (2) resistance is 0.22Ω, the setting current is shown below:

$$I_{OUT} = \frac{1.1}{5 \times 0.22} = 1.0\ [A]$$

12. Chopping frequency setting

For constant-current control, LV8728 performs PWM operation at the chopping frequency determined by the capacitor (COSC1) connected between the OSC1 pin and GND.
The calculation for the value of chopping frequency is:

$$Fch = \frac{IOSC1}{COSC1}$$

Where,
Fch : Chopping frequency [Hz]
I_{OSC1} : Charge/ Discharge current of OSC1pin [A].
IOSC1 is 10uA (typ) by electrical Characteristics.
C_{OSC1} : Capacitor for chopping frequency setting [F]

For example, when COSC1=100pF and IOSC1=10uA (typ), the chopping frequency is shown below:

$$Fch = \frac{10 \times 10^{-6}}{100 \times 10^{-12}} = 100\ [kHz]$$

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.

13. Blanking time

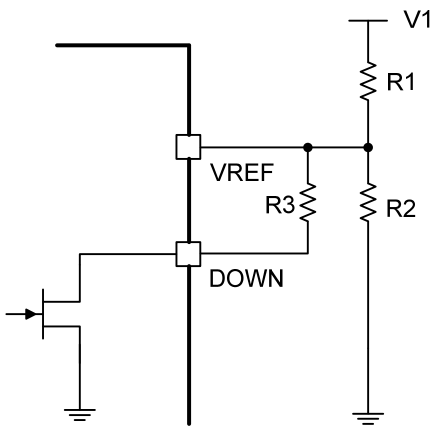
If, when exercising PWM constant-current chopping control over the motor current, the mode is switched from decay to charge, the recovery current of the parasitic diode may flow to the current sensing resistance, causing noise to be carried on the current sensing resistance pin, and this may result in erroneous detection. To prevent this erroneous detection, a blanking period is provided to prevent the noise occurring during mode switching from being received. During the blanking time, even if noise is generated in sense resistor, a mode does not switch from CHARGE to DECAY. In this IC, the blanking time is fixed to approximately 1μs.

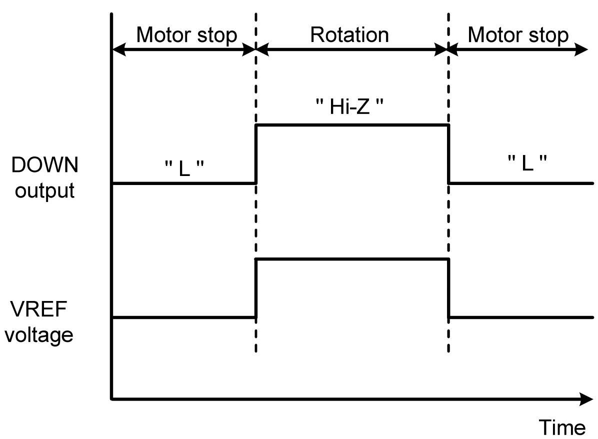
14. DOWN output pin for holding current reduction

The DOWN output pin is an open drain type. When DOWN pin is turned ON, the motor is holding current.

DOWN	Status
ON	Holding current
OFF	Normal operation

To avoid to applying high current to a motor coil for long term at one position, the DOWN output may be used to reduce the reference current. The DOWN is asserted when the step clock interval is longer than TDOWN (STEP signal off detection time). With the circuit is shown in below. VREF voltage can be reduced when the DOWN is turned ON. The open-drain output in once turned ON, is turned OFF at the next rising edge of STP.





For example, when V1=5V, R1=68kΩ, R2=30kΩ, R3=5kΩ, $R_{RF1\ (2)}$ =0.22Ω, the VREF voltage is shown below:

$R_{RF1\ (2)}$ is Resistor between RF1 (2) and GND [Ω]
VREF is input voltage at the VREF pin [V]

When the DOWN is turned OFF

$$V_{REF} = \frac{5 \times 30}{68 + 30} \approx 1.53\ [V]$$

$$I_{OUT} = \frac{1.53}{5 \times 0.22} \approx 1.39\ [A]$$

When the DOWN is turned ON, combined resistor of R2 and R3 is about 4.3kΩ.

$$V_{REF} = \frac{5 \times 4.3}{68 + 4.3} \approx 0.3\ [V]$$

$$I_{OUT} = \frac{0.3}{5 \times 0.22} \approx 0.27\ [A]$$

15. SETP signal off detection time setting

STEP signal off time is determined by the capacitor (COSC2) connected between the OSC2 pin and GND. When this function is unused, connect OSC2 pin to GND at 10kohm (recommendation).
The calculation for the value of STEP signal off detection time is:

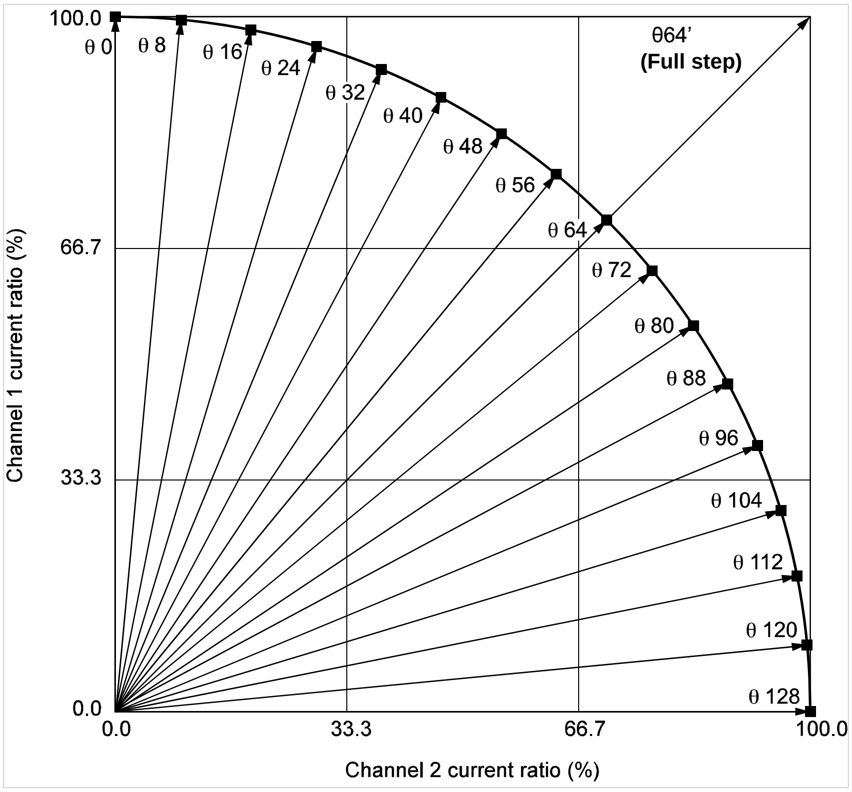
$$T_{DOWN} = C_{OSC2} \times 0.4 \times 10^{9}$$

Where,
T_{DOWN} : STEP signal off detection time [Sec]
C_{OSC2} : Capacitor for STEP signal off time [F]

For example, when COSC2=1500pF, the STEP signal off detection time is shown below:

$$T_{DOWN} = 1500 \times 10^{-12} \times 0.4 \times 10^{9} = 0.6\ [Sec]$$

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



Current setting ratio in each excitation mode

STEP	1/128 step (%)		1/64 step (%)		1/32 step (%)		1/16 step (%)		1/8 step (%)		1/4 step (%)		Half step (%)		Full step (%)	
	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch
θ0	100	0	100	0	100	0	100	0	100	0	100	0	100	0		
θ1	100	1														
θ2	100	2	100	2												
θ3	100	4														
θ4	100	5	100	5	100	5										
θ5	100	6														
θ6	100	7	100	7												
θ7	100	9														
θ8	100	10	100	10	100	10	100	10								
θ9	99	11														
θ10	99	12	99	12												
θ11	99	13														
θ12	99	15	99	15	99	15										
θ13	99	16														
θ14	99	17	99	17												
θ15	98	18														
θ16	98	20	98	20	98	20	98	20	98	20						
θ17	98	21														
θ18	98	22	98	22												
θ19	97	23														
θ20	97	24	97	24	97	24										
θ21	97	25														
θ22	96	27	96	27												
θ23	96	28														
θ24	96	29	96	29	96	29	96	29								
θ25	95	30														

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STEP	1/128 step		1/64 step (%)		1/32 step (%)		1/16 step (%)		1/8 step (%)		1/4 step (%)		Half step (%)		Full step (%)	
	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch
θ26	95	31	95	31												
θ27	95	33														
θ28	94	34	94	34	94	34										
θ29	94	35														
θ30	93	36	93	36												
θ31	93	37														
θ32	92	38	92	38	92	38	92	38	92	38	92	38				
θ33	92	39														
θ34	91	41	91	41												
θ35	91	42														
θ36	90	43	90	43	90	43										
θ37	90	44														
θ38	89	45	89	45												
θ39	89	46														
θ40	88	47	88	47	88	47	88	47								
θ41	88	48														
θ42	87	49	87	49												
θ43	86	50														
θ44	86	51	86	51	86	51										
θ45	85	52														
θ46	84	53	84	53												
θ47	84	55														
θ48	83	56	83	56	83	56	83	56	83	56						
θ49	82	57														
θ50	82	58	82	58												
θ51	81	59														
θ52	80	60	80	60	80	60										
θ53	80	61														
θ54	79	62	79	62												
θ55	78	62														
θ56	77	63	77	63	77	63	77	63								
θ57	77	64														
θ58	76	65	76	65												
θ59	75	66														
θ60	74	67	74	67	74	67										
θ61	73	68														
θ62	72	69	72	69												
θ63	72	70														
θ64	71	71	71	71	71	71	71	71	71	71	71	71	71	71	100	100
θ65	70	72														
θ66	69	72	69	72												
θ67	68	73														
θ68	67	74	67	74	67	74										
θ69	66	75														
θ70	65	76	65	76												
θ71	64	77														
θ72	63	77	63	77	63	77	63	77								
θ73	62	78														
θ74	62	79	62	79												
θ75	61	80														
θ76	60	80	60	80	60	80										
θ77	59	81														
θ78	58	82	58	82												
θ79	57	82														
θ80	56	83	56	83	56	83	56	83	56	83						
θ81	55	84														
θ82	53	84	53	84												
θ83	52	85														
θ84	51	86	51	86	51	86										
θ85	50	86														
θ86	49	87	49	87												
θ87	48	88														
θ88	47	88	47	88	47	88	47	88								
θ89	46	89														
θ90	45	89	45	89												

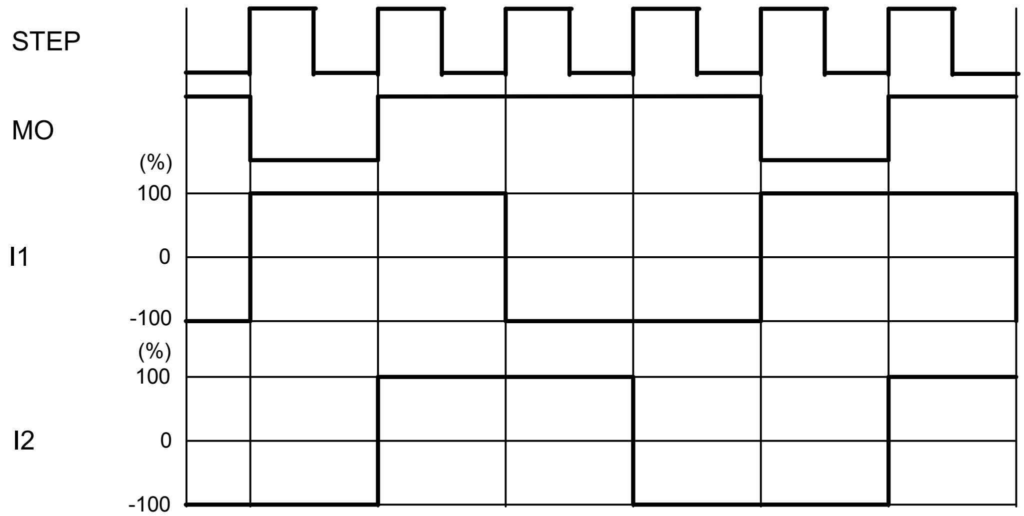
Continued on next page

Continued from preceding page

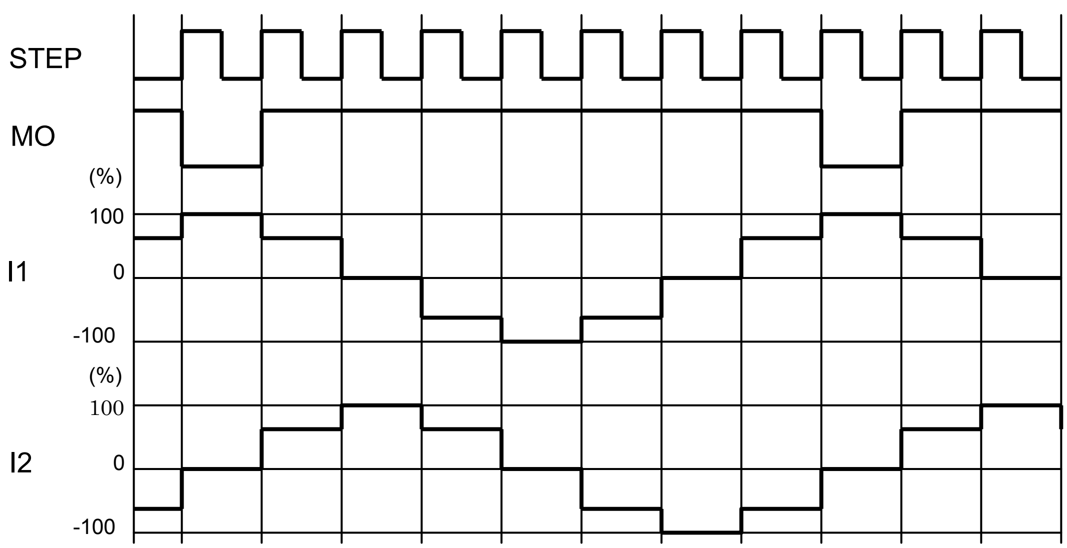
STEP	1/128 step		1/64 step (%)		1/32 step (%)		1/16 step (%)		1/8 step (%)		1/4 step (%)		Half step (%)		Full step (%)	
	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch
θ91	44	90														
θ92	43	90	43	90	43	90										
θ93	42	91														
θ94	41	91	41	91												
θ95	39	92														
θ96	38	92	38	92	38	92	38	92	38	92	38	92				
θ97	37	93														
θ98	36	93	36	93												
θ99	35	94														
θ100	34	94	34	94	34	94										
θ101	33	95														
θ102	31	95	31	95												
θ103	30	95														
θ104	29	96	29	96	29	96	29	96								
θ105	28	96														
θ106	27	96	27	96												
θ107	25	97														
θ108	24	97	24	97	24	97										
θ109	23	97														
θ110	22	98	22	98												
θ111	21	98														
θ112	20	98	20	98	20	98	20	98	20	98						
θ113	18	98														
θ114	17	99	17	99												
θ115	16	99														
θ116	15	99	15	99	15	99										
θ117	13	99														
θ118	12	99	12	99												
θ119	11	99														
θ120	10	100	10	100	10	100	10	100								
θ121	9	100														
θ122	7	100	7	100												
θ123	6	100														
θ124	5	100	5	100	5	100										
θ125	4	100														
θ126	2	100	2	100												
θ127	1	100														
θ128	0	100	0	100	0	100	0	100	0	100	0	100	0	100		

17. Current wave example in each excitation mode (Full, Half, 1/16, 1/128 step)

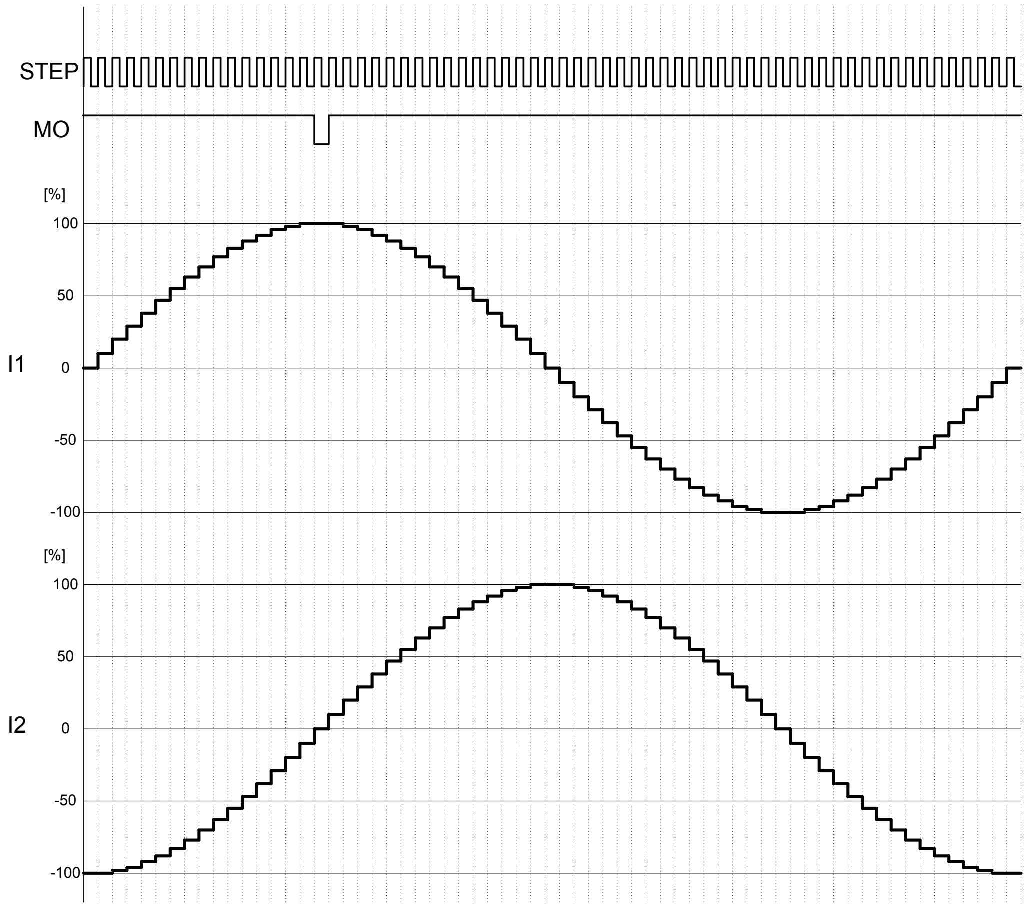
Full step (CW mode)



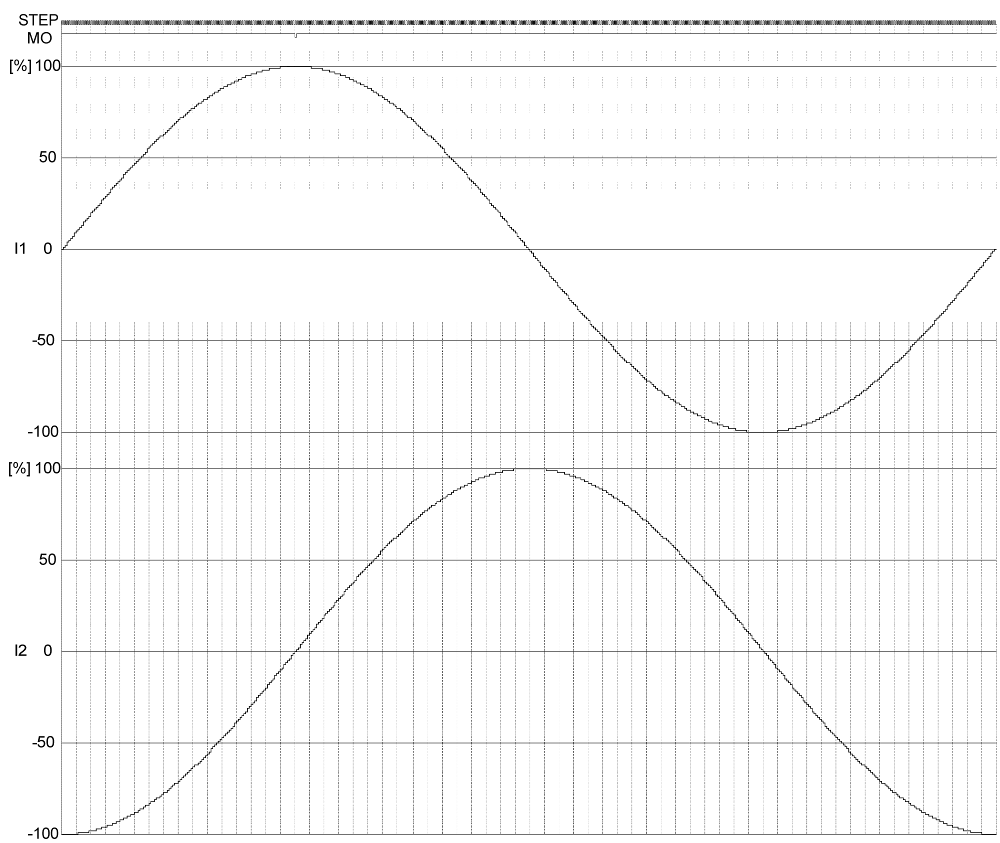
Half step (CW mode)



1/16 step (CW mode)



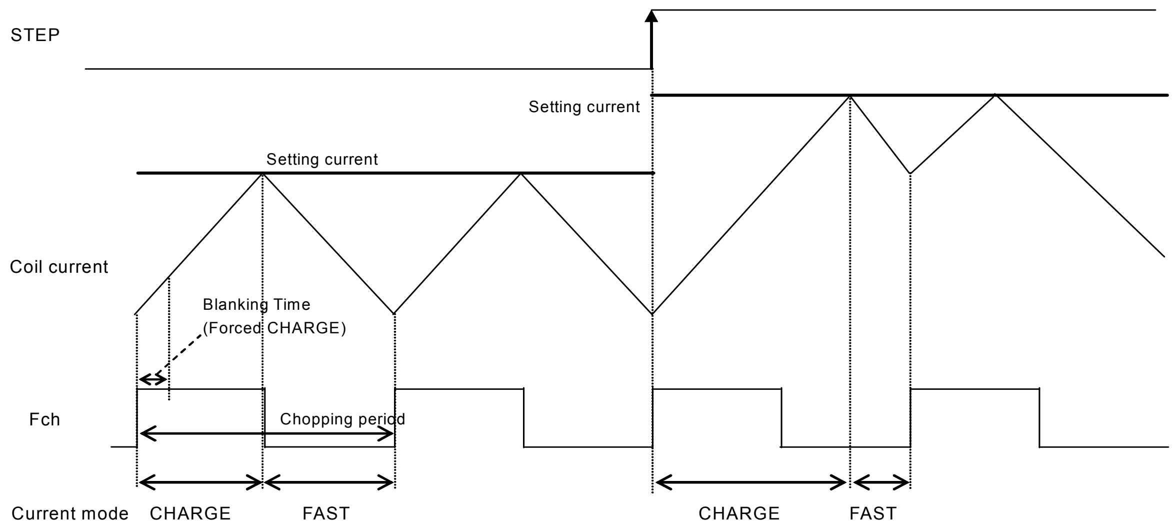
1/128 step (CW mode)



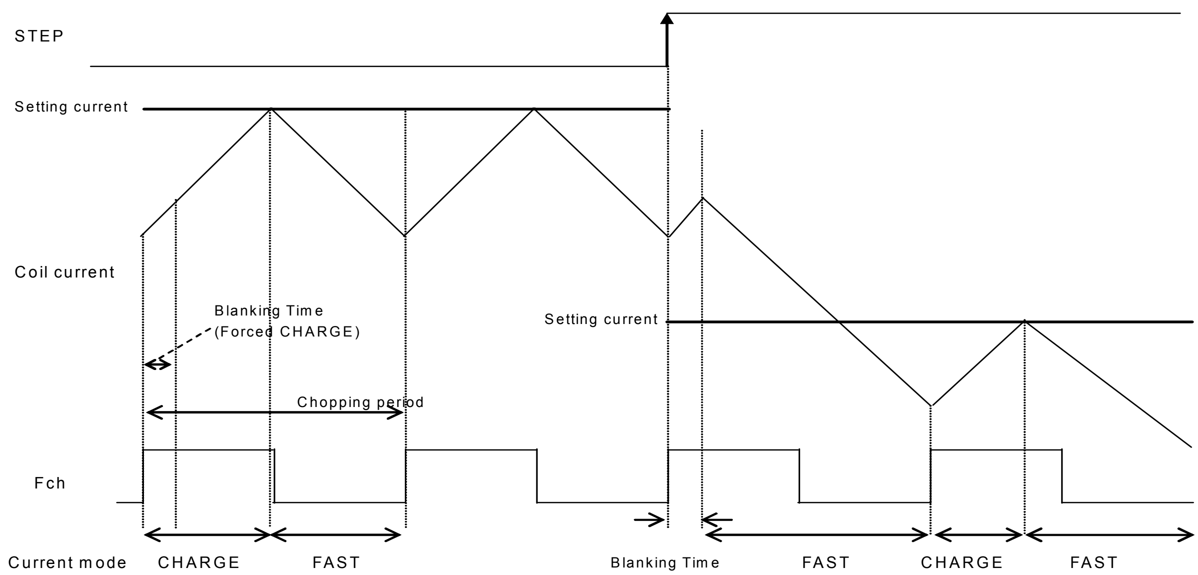
18. Current control operation

FAST Decay current control: When FDT pin voltage is 0.8V or less, the constant- current control is operated in FAST Decay mode.

(Sine-wave increasing direction)



(Sine-wave decreasing direction)



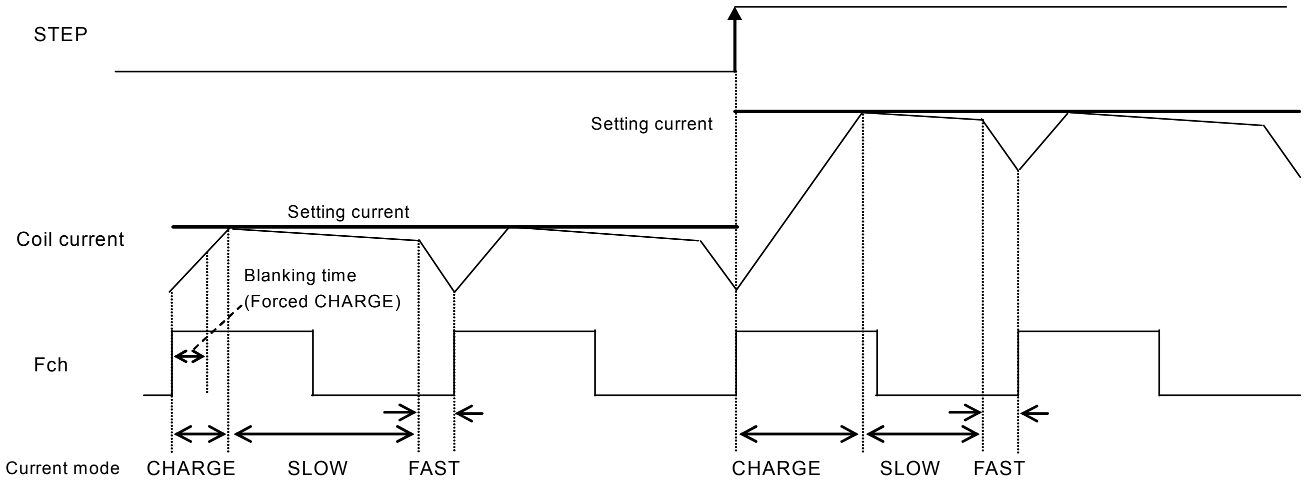
The current control of FAST Decay operates with the follow sequence.

- The IC enters CHARGE mode at a rising edge of the chopping oscillation. The CHARGE of the blanking time is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF). The blanking time is approximately 1μs.
- After the period of the blanking time, The IC operates in CHARGE mode until ICOIL ≥ IREF. After that, the mode switches to the FAST Decay mode and the coil current is attenuated until the end of a chopping period.
- If ICOIL > IREF state exists when the end of blanking time, the coil current is attenuated by the FAST Decay mode until the end of a chopping period.

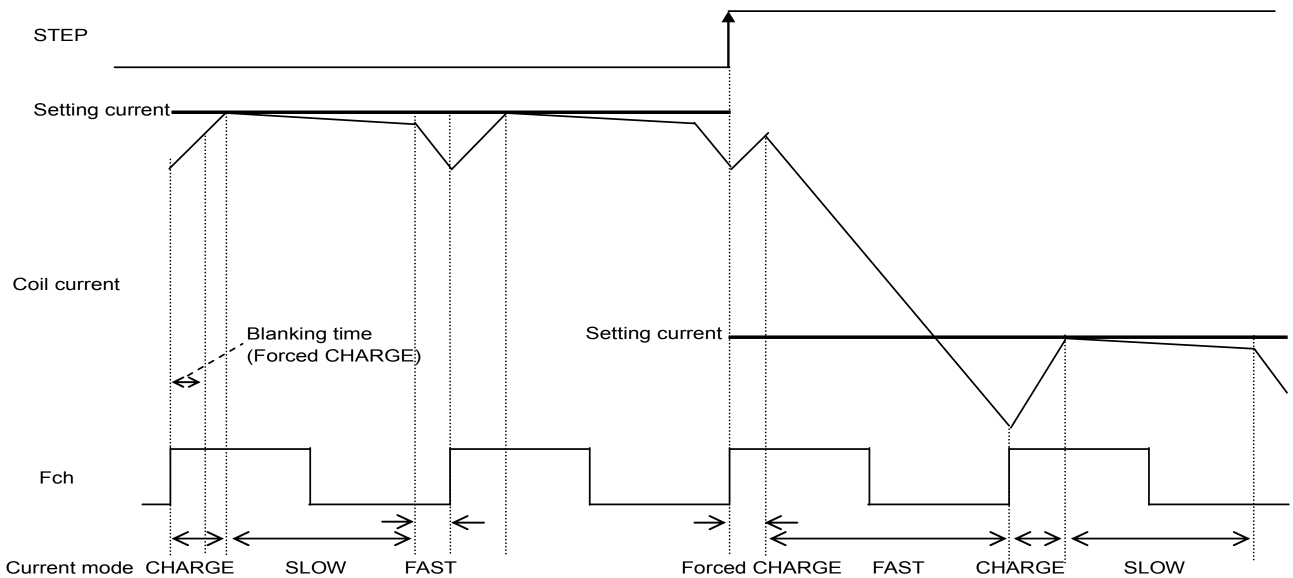
Since the attenuation of the current is fast, it is early that the coil current follows the set current. However, the current ripple value may be higher.

MIXED Decay current control. When FDT pin voltage is between 1.1V and 3.1V or Open, the constant- current control is operated in MIXED Decay mode.

(Sine-wave increasing direction)



(Sine-wave decreasing direction)



The current control of MIXED Decay operates with the follow sequence.

- The IC enters CHARGE mode at a rising edge of the chopping oscillation. The CHARGE of the blanking time is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF). The blanking time is approximately 1μs.
- In a period of Blanking Time, the coil current (ICOIL) and the setting current (IREF) are compared.

  If an ICOIL < IREF state exists during the charge period:

  The IC operates in CHARGE mode until ICOIL ≥ IREF. After that, it switches to SLOW DECAY mode and then switches to FAST DECAY mode in the last approximately 1μs of the period.

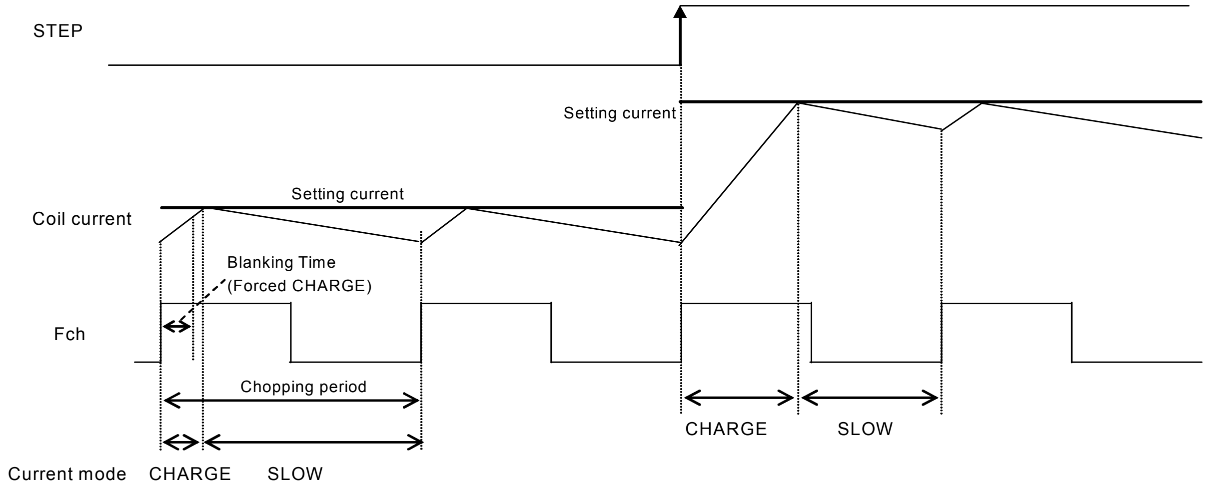
  If no ICOIL < IREF state exists during the charge period:

  The IC switches to FAST DECAY mode and the coil current is attenuated with the FAST DECAY operation until the end of a chopping period.

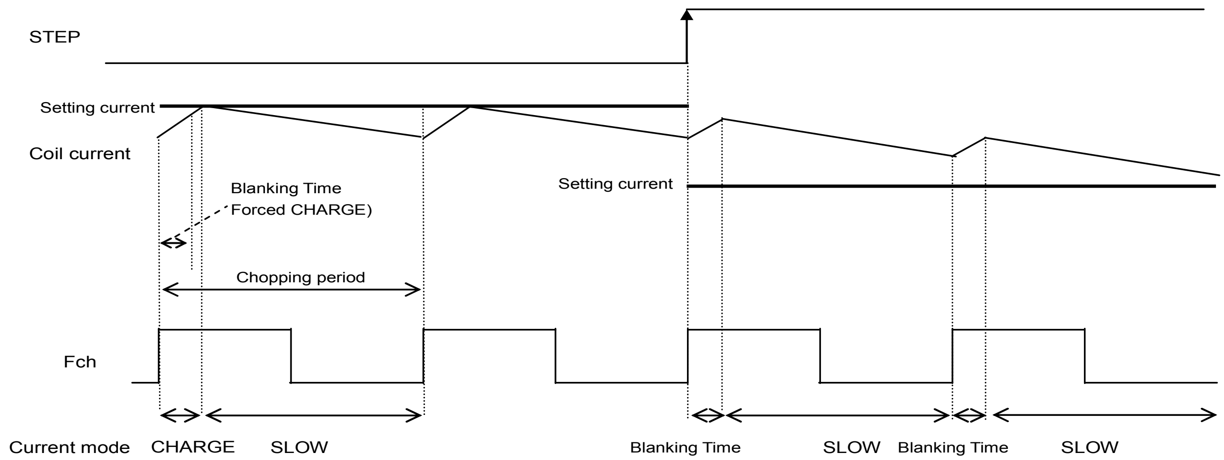
The above operation is repeated. Normally, the IC operates in SLOW (+ FAST) Decay mode at the sine wave increasing direction, and the IC operates in FAST Decay mode at the sine wave decreasing direction until the current is attenuated. And then the IC operates in SLOW Decay mode when the current reaches the set value.

SLOW Decay current control. When FDT pin voltage is 3.5V or more, the constant- current control is operated in SLOW Decay mode.

(Sine-wave increasing direction)



(Sine-wave decreasing direction)



The current control of SLOW Decay operates with the follow sequence.

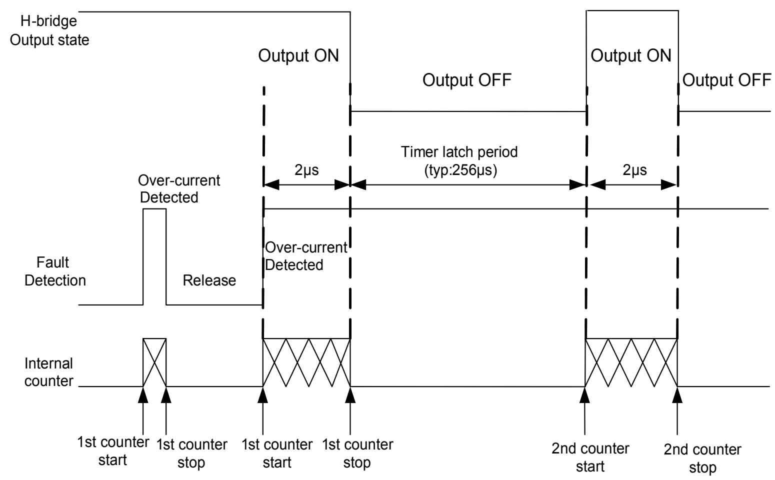
- The IC enters CHARGE mode at a rising edge of the chopping oscillation. The CHARGE of the blanking time is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF). The blanking time is approximately 1μs.
- After the period of the blanking time, The IC operates in CHARGE mode until ICOIL ≥ IREF. After that, the mode switches to the SLOW Decay mode and the coil current is attenuated until the end of a chopping period.
- If ICOIL > IREF state exists when the end of blanking time, the coil current is attenuated by the SLOW Decay mode until the end of a chopping period.

Since the attenuation of the current is slow, it may be slow that the coil current follows the set current. Or the coil current may not follow a set current.

19. Over-current protection function

This IC incorporates an over current protection circuit that, when the output has been shorted by an event such as shorting to power, shorting to ground and shorting to other output. And it switches the output to the standby mode in order to prevent the IC from being damaged. Three over-current detection modes are shown in the next page.

When the over current is detected, the over current protection circuit operates. If the short status continues for the period of internal timer (≈2μs), the output of 1ch/ 2ch is turned off. If the short status exceeds the timer latch time (≈256us) set in the internal timer, the output is turned on again and detects short status again. If short is detected again, all the outputs of 1ch/ 2ch are switched to standby mode and the status is kept. To cancel the standby status, set ST=”L”.



20. Thermal shutdown function

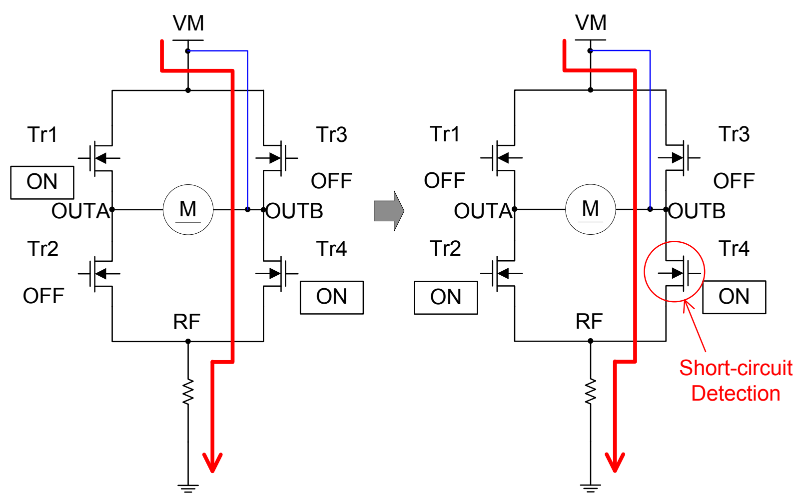
The thermal shutdown circuit is incorporated and the output is turned Off when junction temperature Tj exceeds 180°C. As the temperature falls by hysteresis, the output turned on again (automatic restoration). The thermal shutdown circuit does not guarantee the protection of the final product because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

TSD = 180°C (typ)

ΔTSD = 40°C (typ)

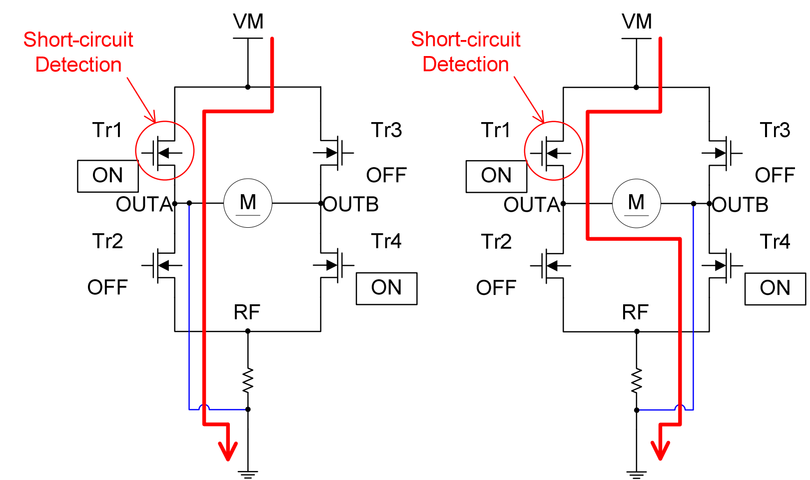
21. Over current detection mode

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 Drain and Source of Tr4 exceeds the reference voltage for 2μs, short status is detected.

Short to GND



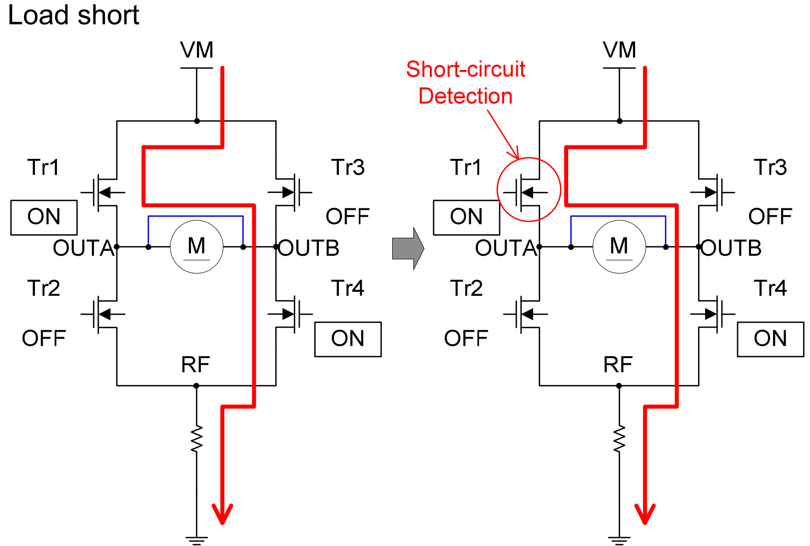
(left schematic)

1. High current flows if OUTA short to GND and Tr1 are ON
2. If the voltage between Drain and Source of Tr1 exceeds the reference voltage for 2μs, short status is detected.

(right schematic)

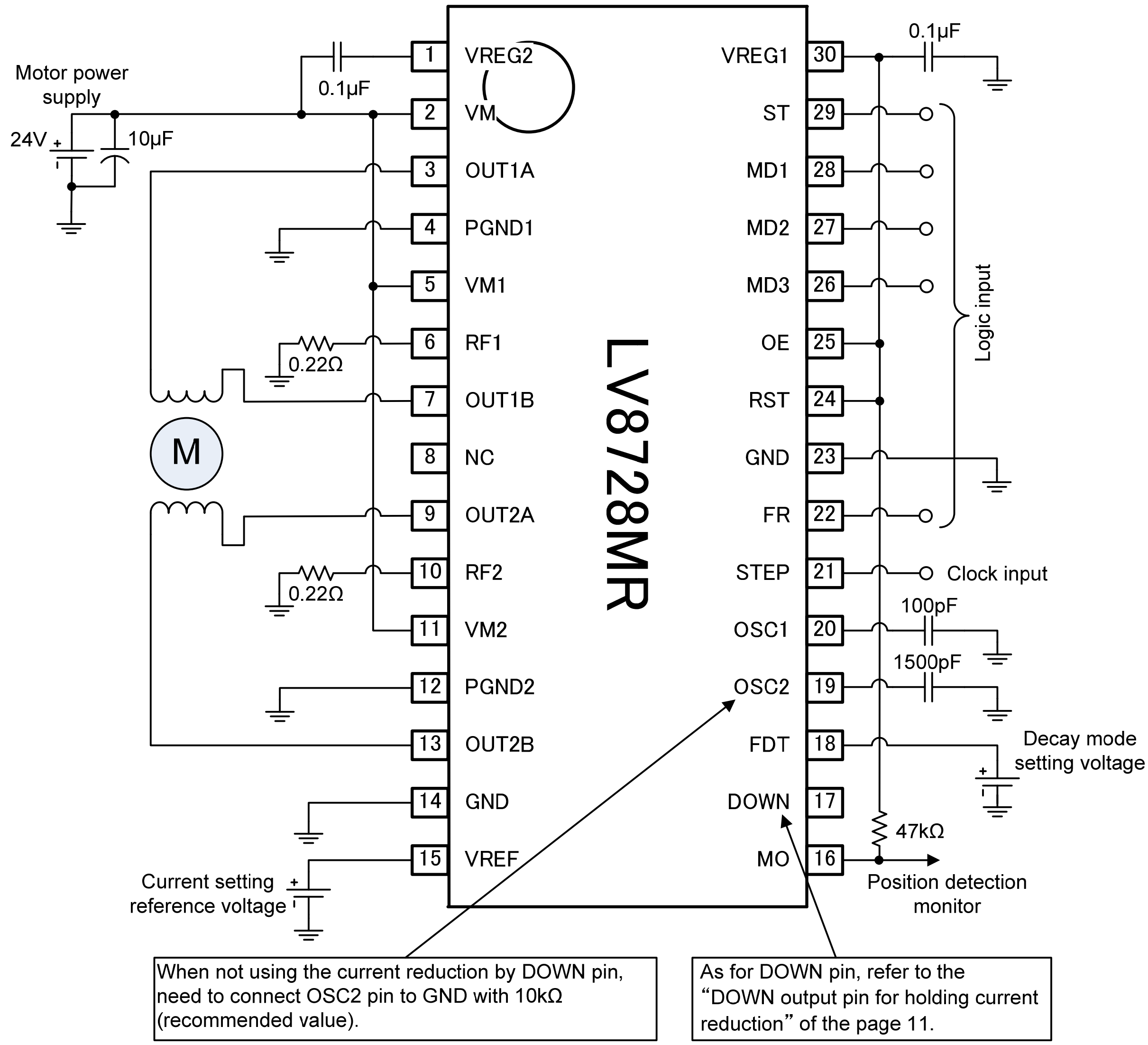
1. Without going through RF resistor, current control does not operate and current will continue to increase in CHARGE mode.
2. If the voltage between Drain and Source of Tr1 exceeds the reference voltage for 2μs, short status is detected.

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 Drain and Source 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.

Application Circuit Example



Calculation for each constant setting according to the above circuit diagram is as follows.
For example, when VREF=1.1V, IOSC1=10uA (typ) and COSC1=100pF

- Coil current

$$I_{OUT} = \frac{1.1}{5 \times 0.22} \approx 1.0\ [A]$$

- Chopping frequency

$$Fch = \frac{10 \times 10^{-6}}{100 \times 10^{-12}} = 100\ [kHz]$$

- STEP signal off detection time

$$T_{DOWN} = 1500 \times 10^{-12} \times 0.4 \times 10^{9}$$
$$= 0.6\ [Sec]$$

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