M63028/029FP

Spindle Motor and 5ch Actuator Driver

REJ03F0024-0100Z
Rev.1.0
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Features

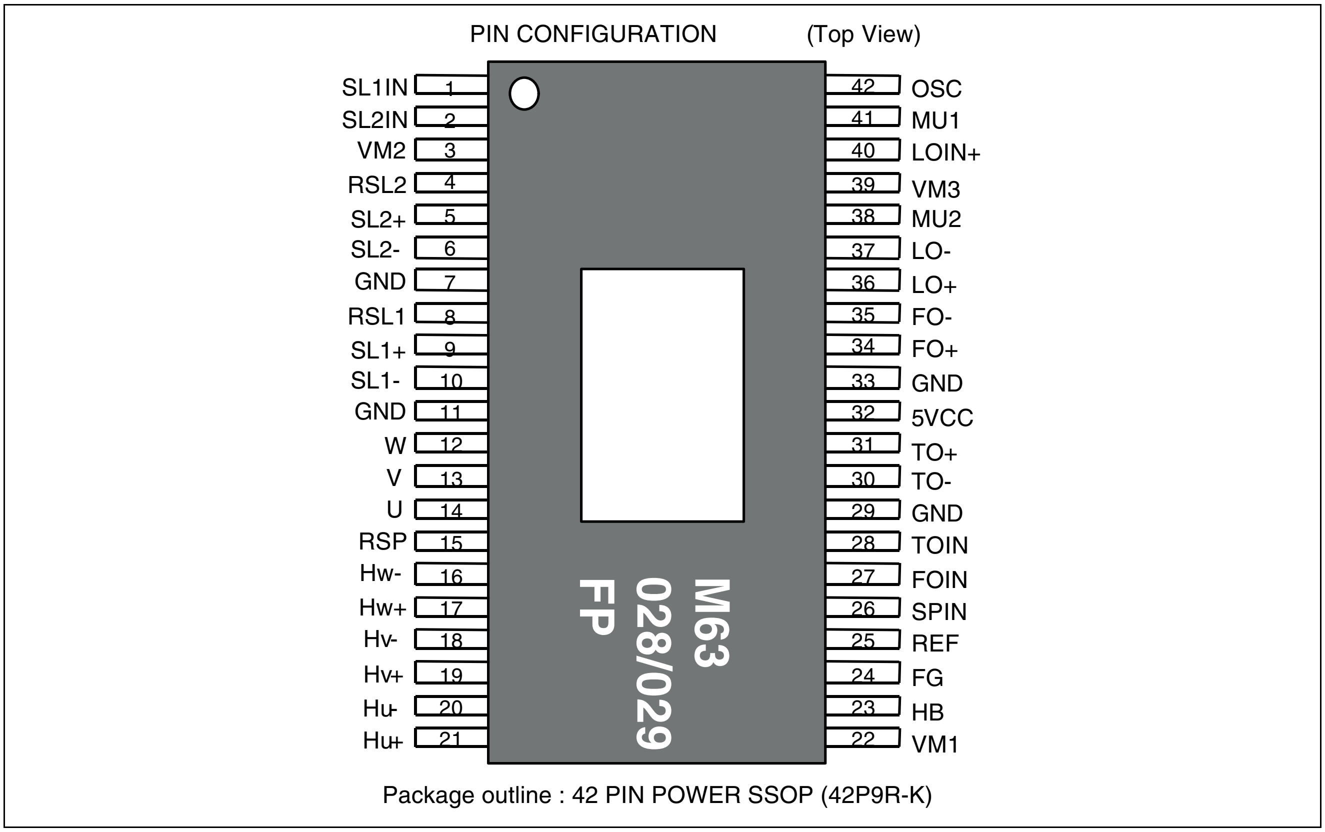
This IC is 1 chip driver IC for spindle motor and 5 channel actuators. All of the motor and actuator of optical disk drive system (CD- ROM etc.) can be drived by only this IC.

This IC has a direct PWM control system for Spindle and Slide channels drive due to reducing IC power dissipation.

This IC has four voltage supply terminals (for Spindle, Slide,Focus/Tracking and Loading), and four voltage supply can be set separately.

Further more this IC has short braking select function, FG amplifier, thermal shut down circuit, standby circuit, reverse rotation detect circuit.

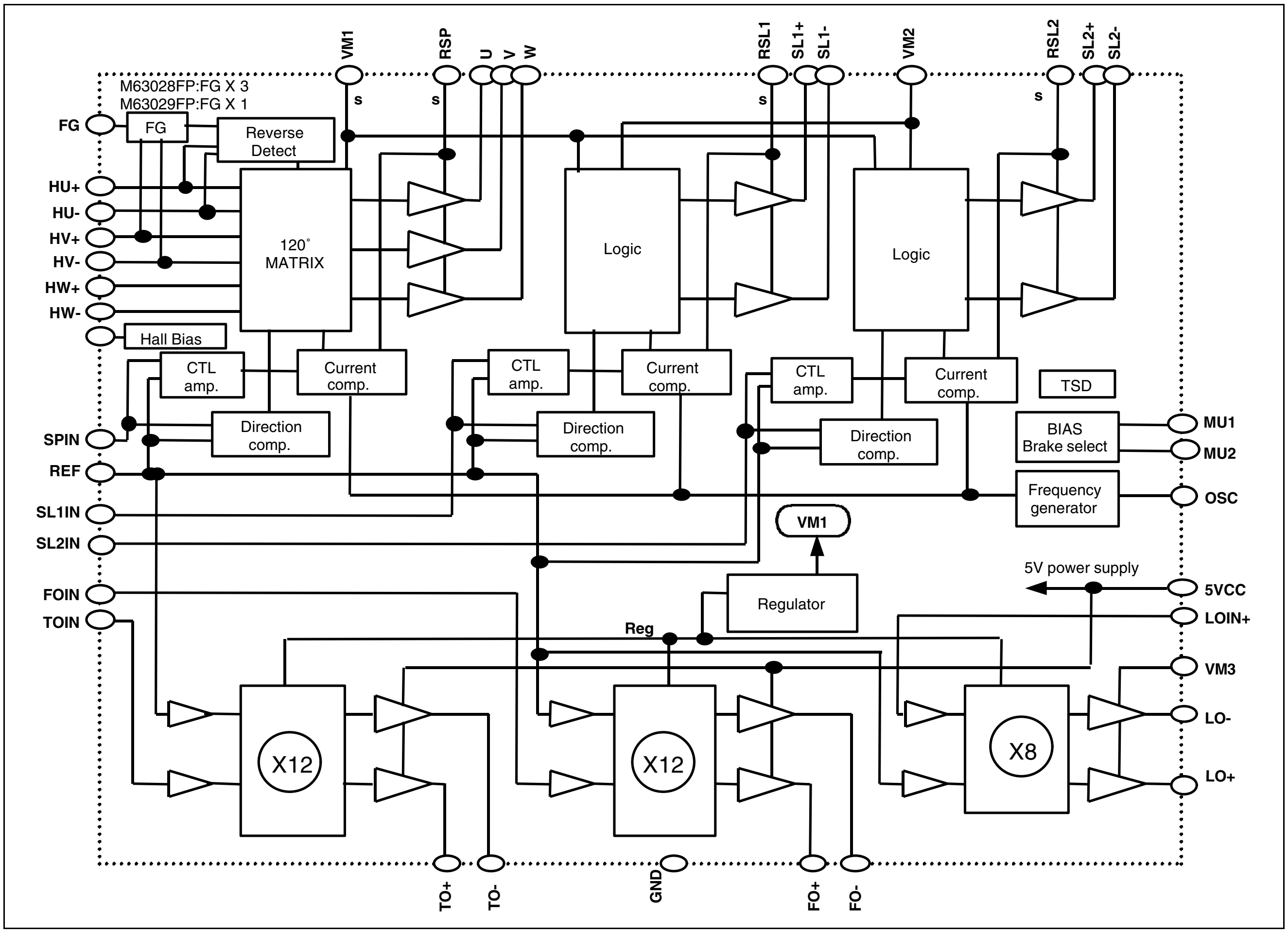
Pin Configuration



Application

CD- ROM, CD- R/RW, DVD, DVD- ROM, DVD- RAM, Optical disc related system, etc

Block Diagram



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Pin Function

Terminal	Symbol	Terminal Function	Terminal	Symbol	Terminal Function
1	SL1IN	Slide control voltage input 1	42	OSC	PWM carrier oscilation set
2	SL2IN	Slide control voltage input 2	41	MU1	mute/break select terminal 1
3	VM2	Motor Power Supply 2 (for Slide)	40	LO N+	Loading control input (+)
4	RSL2	Slide current sense 2	39	VM3	Power Supply3(for Loading)
5	SL2+	Slide non-inverted output 2	38	MU2	mute/break select terminal 2
6	SL2–	Slide inverted output 2	37	LO–	Loading inverted output
7	GND	GND	36	LO+	Loading non-inverted output
8	RSL1	Slide current sense 1	35	FO–	Focus inverted output
9	SL1+	Slide non-inverted output 1	34	FO+	Focus non-inverted output
10	SL1–	Slide inverted output 1	33	GND	GND
11	GND	GND	32	5VCC	5V Power Supply (for FS, TS)
12	W	Motor drive output W	31	TO+	Tracking non-inverted output
13	V	Motor drive output V	30	TO–	Tracking inverted output
14	U	Motor drive output U	29	GND	GND
15	RSP	Spindle current sense	28	TO N	Tracking control voltage input
16	HW–	HW– sensor amp.input	27	FO N	Focus control voltage input
17	HW+	HW+ sensor amp.input	26	SP N	Spindle control voltage input
18	HV–	HV– sensor amp. input	25	REF	Reference voltage input
19	HV+	HV+ sensor amp. input	24	FG	Frequency generator output
20	HU–	HU– sensor amp. input	23	HB	Bias for Hall Sensor
21	HU+	HU+ sensor amp. input	22	VM1	Motor Power Supply 1 (for Spindle)

Function

	FO, TO Gain	LO Gain	FG Pulse
M63028FP	12V/V	8V/V	×3
M63029FP	12V/V	8V/V	×1

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Absolute Maximum Rating (Ta=25°C)

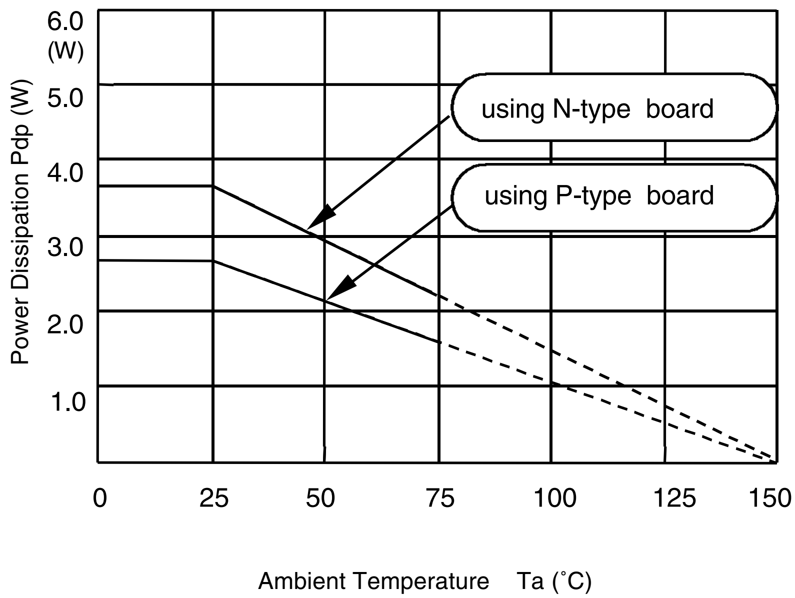
Symbol	Parameter	Conditions	Rating	Unit
5VCC	5V Power Supply	Focus and Tracking power supply	7	V
VM1	Motor power Supply 1 *note1	Spindle power supply *note1	15	V
VM2	Motor power Supply 2	Slide power supply	15	V
VM3	Motor power Supply 3	Loading power supply	15	V
IoA	Motor Output Current A	Focus, Tracking and Loading output current *note1	1.0	A
IoB	Motor Output Current B	Spindle output current *note1	1.5	A
IoC	Motor Output Current C	Slide output current *note1	0.5	A
Vin	Maximum input voltage of terminals	MU1, Hw-, Hw+, Hv-, Hv+, Hu-, Hu+, REF, SPIN, MU2, TOIN, FOIN, OSC, SL1IN, SL2IN, LOIN+	0 to 5VCC	V
Pt	Power dissipation	70mm X 70mm X 1.6mm Free Air and on the grass epoxy board	2.6	W
Kθ	Thermal derating	70mm X 70mm X 1.6mm Free Air and on the grass epoxy board	20.8	mW/°C
Tj	Junction temperature		150	°C
Topr	Operating temperature		–20 to +75	°C
Tstg	Storage temperature		–40 to +150	°C

Note: 1. The ICs must be operated within the Pt (power dissipation) or the area of safety operation.

Recommended Operating Conditions (Ta = 25°C)

Symbol	Parameter	LIMITS Minimum	Typical	Maximum	Unit
VM1	VM1 power supply (for Spindle)	7.5	12	13.2	V
VM2	VM2 power supply (for Slide)	4.5	12	13.2	V
VM3	VM3 power supply (for Loading)	4.5	12	13.2	V
5VCC	5V power supply (for FS, TS)	4.5	5	7	V
IoA	Focus, Tracking and Loading Output Current	—	0.5	0.8	A
IoB	Spindle Output Current	—	0.5	1	A
IoC	Slide Output Current	—	0.25	0.4	A
Fosc	PWM carrier frequency	30	—	120	kHz

Thermal Derating



This IC's package is POWER-SSOP, so improving the board on which the IC is mounted enables a large power dissipation without a heat sink.

For example, using an 1 layer glass epoxy resin board, the IC's power dissipation is 2.6W at least. And it comes to 3.6W by using an improved 2 layer board.

The information of the N, P type board is shown in attached.

Electrical Characteristics

Common

(Ta=25°C, 5VCC=VM3=5V, VM1 = VM2 = 12V unless otherwise noted.)

Symbol	Parameter	Conditions	Limits			Unit
			Minimum	Typical	Maximum	
Icc1	Supply current	5VCC, VM1, VM2, VM3 current	—	32	42	mA
Icc2	Sleep current	5VCC, VM1, VM2, VM3 current under Sleep (MU1 = MU2 = 0V)	—	0	30	µA
Fosc	PWM carrier frequency	OSC: with 330pF	—	65	—	kHz
VinREF	REF inout voltage range		1.0	—	3.3	V
IinREF	REF terminal input current	VREF = 1.65V	-10	—	10	µA
VMU1LO	MUTE1 terminal low voltage	MU1	—	—	0.8	V
VMU1HI	MUTE1 terminal high voltage	MU1	2.5	—	—	V
IM1U	MUTE1 terminal input current	MU1 at 5V input voltage	—	—	500	µA
VMU2LO	MUTE2 terminal low voltage	MU2	—	—	0.8	V
VMU2HI	MUTE2 terminal high voltage	MU2	2.5	—	—	V
IM2U	MUTE2 terminal input current	MU2 at 5V input voltage	—	—	500	µA

Electrical Characteristics

Spindle

(Ta=25°C, 5VCC = VM3 = 5V, VM1 = VM2 = 12V unless otherwise noted.)

Symbol	Parameter	Conditions	LIMITS			Unit
			Minimum	Typical	Maximum	
Vdyc1	Dynamic range of output	Io = 0.5 [A]	10.6	11.1	—	V
Vdead1–	Control voltage dead zone 1	SPIN<REF [REVERSE]	–80	–40	0	mV
Vdead1+		REF<SPIN [FORWARD]	0	+40	+80	mV
Vin1	Control voltage input range 1	SPIN	0	—	5	V
Gvo1	Control gain 1	Gio1 = Gvo1 / Rs [A/V]	0.85	1.0	1.15	V/V
Vlim1F	Control limit 1F	Ilim1F = Vlim1F / Rs [A] [FORWARD] at MU2 = 0V	0.4	0.5	0.6	V
Vlim2F	Control limit 2F	Ilim1F = Vlim2F / Rs [A] [FORWARD] at MU2 = 5V	0.22	0.28	0.34	V
Vlim1R	Control limit 1R	Ilim1R=Vlim1R / Rs[A] [REVERSE]	0.22	0.28	0.34	V
VHcom	Hall sensor amp. common mode input range	Hu+, Hu-, Hv+, Hv-, Hw+, Hw-	1.3	—	3.7	V
VHmin	Hall sensor amp. input signal level	Hu+, Hu–, Hv+, Hv–, Hw+, Hw–	60	—	—	mVp–p
VHB	HB output voltage	at Load current (IHB) = 10mA	0.6	0.85	1.2	V
IHB	HB terminal sink current	MU1 = 5V	—	—	30	mA

Slide1, 2

(Ta=25°C, 5VCC = VM3 = 5V°C, VM1 = VM2 = 12V unless otherwise noted.)

Symbol	Parameter	Conditions	Limits Minimum	Limits Typical	Limits Maximum	Unit
Vdyc2	Dynamic range of output	Io = 0.5 [A] at VM2 = 5 [V] RSL = 0.9Ω	3.75	3.95	-	V
		Io = 0.5 [A] at VM2 = 12 [V]	10.3	10.8	-	
Vdead2–	Control voltage dead zone 2	SL1IN, SL2IN<REF	–80	–40	0	mV
Vdead2+		REF<SL1IN, SL2IN	0	+40	+80	mV
Vin2	Control voltage input range 2	SL1IN, SL2IN	0	-	5	V
Gvo2	Control gain 2	Gio2 = Gvo2 / Rs [A/V]	0.85	1.0	1.15	V/V
Vlim2	Control limit 2	Ilim2 = Vlim2 / Rs [A]	0.43	0.5	0.58	V
Tdon	Output turn-on delay		-	1.0	2.0	μs
Tdoff	Output turn-off delay		-	2.0	3.5	μs
Tdsw	Output switching delay		-	3.0	6.0	μs
Ileak	Output leak current	MU1=MU2=0V	–100	-	100	μA

Electrical Characteristics

Loadhing

(Ta=25°C, 5VCC = VM3 = 5V, VM1 = VM2 = 12V unless otherwise noted.)

Symbol	Parameter	Conditions	Limits Minimum	Typical	Maximum	Unit
Vdyc3-1	Dynamic range of output	VM1 = 12[V VM3 = 5[V] Io = 0.5A	3.95	4.2	-	V
		VM1 = 12[V] VM3 = 12[V] Io = 0.5A	6.9	7.6	-	
Vdyc3-2	Dynamic range of output	R=5.4[Ω] VM3 = 4.75V, VM1 = 12V	3.35	3.55	-	V
Vin3	Control voltage input range 3	LOUN+	0	-	5	V
Gvo3	Control gain 3	$\frac{(LO+) - (LO-)}{(LOIN+) - (REF)}$	16.7	18.1	19.3	dB
Voff1	Output offset voltage	(LO+) – (LO–) at LOIN+ = REF = 1.65V	–50	0	+50	mV

Focus

(Ta=25°C, 5VCC = VM3 = 5V, VM1 = VM2 = 12V unless otherwise noted.)

Symbol	Parameter	Conditions		Limits Minimum	Typical	Maximum	Unit
Vdyc4	Dynamic range of output	VM1 = 12[V]	Io = 0.5[A]	4.0	4.25	-	V
		VM1 = 12[V]	Io = 0.8[A]	3.55	3.95	-	
Vin4	Control voltage input range 4	FOIN, TOIN		0	-	5	V
Gvo4	Control gain 4	$\frac{(FO+) - (FO-)}{FOIN - REF}$	$\frac{(TO+) - (TO-)}{TOIN - REF}$	20.2	21.6	22.8	dB
Voff2	Output offset voltage	(FO+) – (FO–) at REF = FOIN = 1.65V (TO+) – (TO–) at REF = TOIN = 1.65V		–30	0	+30	mV

NOTE : This IC need condenser between each supply lines and GND for stopped Oscillation.

Thermal Characteristics

Symbol	Parameter	Function Start Temperature of IC Minimum	Typical	Max	Function Start Temperature of IC Minimum	Typical	Max	Unit
TSD	Thermal Shut Down *note3	-	165	-	-	130	-	°C

*note3 This TSD function start temperature doesn't show the guaranteed max. temperature of the devices.
The guranteed max.temperature is Tjmax.which is shown in "9.ABSOLUTE MAXIMUM RATING". The TSD function is a thermal protection in case the temperature of the devices goes up above Tjmax because of wrong use.
And these TSD temperature are the target temperatures for circuit design, not the guranteed temperatures.
(The TSD function of all the devices is not checked by a test in high temperature.)

Channel Select Function

	Logic control			Drive channel						SPIN<REF	SPIN>REF
	MU1	MU2	SPIN	Loading	Slide1	Slide2	Focus	Tracking	Spindle	Curren limit	Currentlim it (Brake select)
SELECT 6	H	H	H	Off	On	On	On	On	On	56%	- -
SELECT 5	H	L	H	Off	On	On	On	On	On	100%	- -
SELECT 4	H	H	L	Off	On	On	On	On	On	- -	56% (PWM)
SELECT 3	H	L	L	Off	On	On	On	On	On	- -	(Short)
SELECT 2	L	H	- -	On	Off	Off	Off	Off	Off	- -	- -
SELECT 1	L	L	- -	Off	Off	Off	Off	Off	Off	- -	- -

This IC has two MUTE terminal (MU1 and MU2).

It is possible to control ON / OFF of each channel and to select current limit under acceleration by external logic inputs.

It has six kinds of function for select.In case of SELECT1,the bias of all circuit becomes OFF.

Therefore,this mode is available in order to reduce the power dissipation when the waiting mode.

In case of SELECT2,the bias of other than Loading circuit becomes OFF.

Therefore,this mode is available in order to reduce the power dissipation when the active mode.

In case of SELECT3,it is possible to select the short braking to tak e the brake of Spindle motor. in case of SELECT4,it is possible to select PWM reverse braking when in the same.

In case of SELECT5,it is possible to select the 100%current limit under acceleration.

Also,in case of SELECT6,it is possible to select the 56%current limit under acceleration.

Therefore,this mode is available in order to reduce a temperature under acceleration.

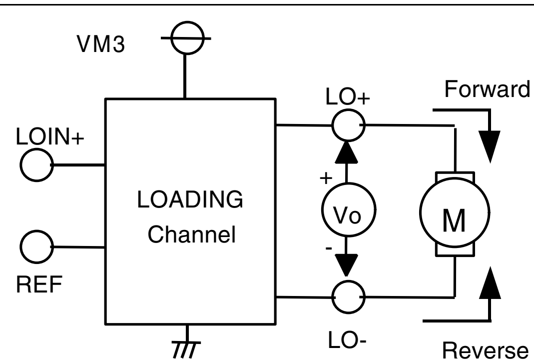
Loading channel

The loading channel is the circuit of BTL voltage drive.This circuit has

the referential input.Output swing is determined with ΔVin X 8.Also,it is possible for this channel to use for the slide motor ,the focus coil and the tracking coil.

The input terminal is high impedance.It is possible to do variable a gain by external resistor.

In case of one MCU port,if use three state port,it is possible for this channel to have the stop function.



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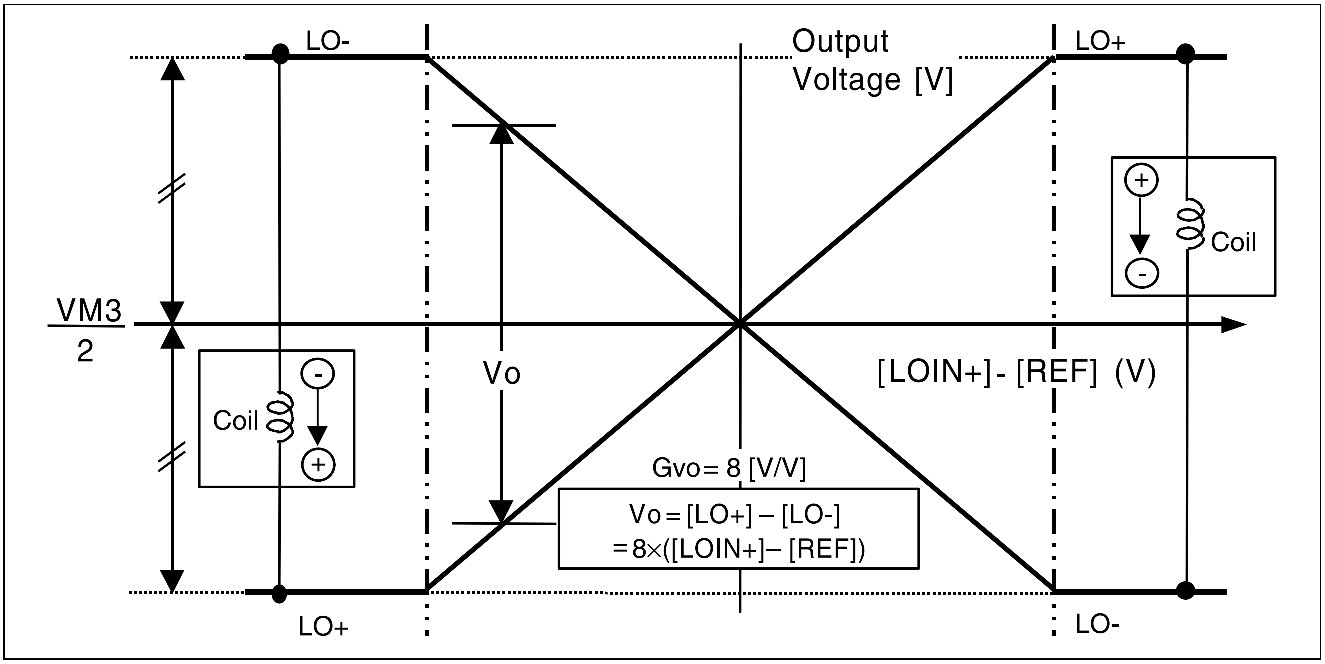
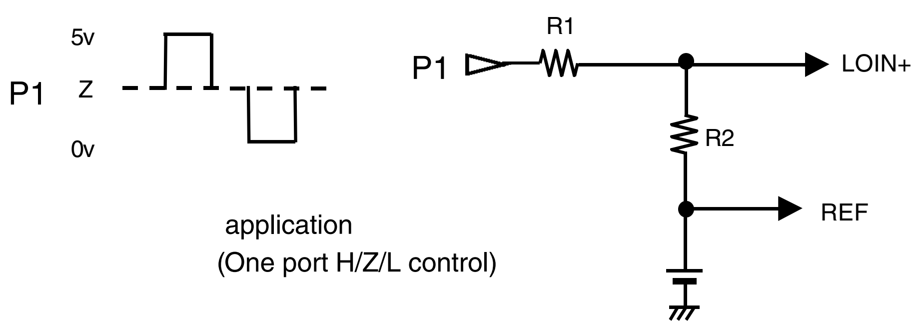


application (MCU: One port H/Z/L control)

Logic contorol P1	Situation of loading channnel	Output voltage swing
5V	Forward rotation	Vo = 8 × (5[V]-REF[V]) × R2/(R1+R2)
Z (Hi impedance)	Short brake-->Stop	Vo=0[V]
0	Reverse rotation	Vo = -8 × (0[V]-REF[V])× R2/(R1+R2)



application
(One port H/Z/L control)

Spindle channel

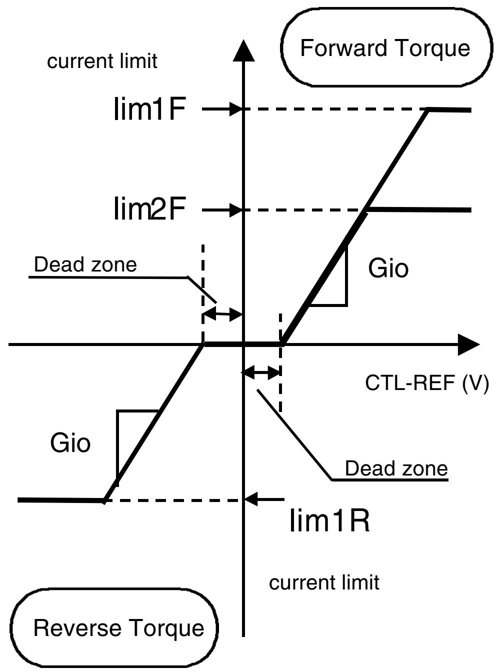
The relationship between the differential voltage between SPIN and REF and the torque is shown in following Figure.The voltage gain[Gvo] is 1.0 [V/V] .

The current gain[Gio] is 2.0[A/V] (at sensing resistor :0.5Ω,and R1=∞, R2=0 Ω)in forward torque directions,and the dead zone is from 0mV to 80mV (at R1=∞, R2=0 Ω)

The coil current gain under the reverse torque is the same with in forward torque directions.And the limitation function gets on when the differential voltage of VM1(12V) to RSP is 0.5V at forward and 0.28V at reverse.

In case of SELECT6 the differentialvoltage of VM1(12V)~RSP is 0.28V at forward.Therefore,this mode is available in order to reduce a temperature under acceleration.

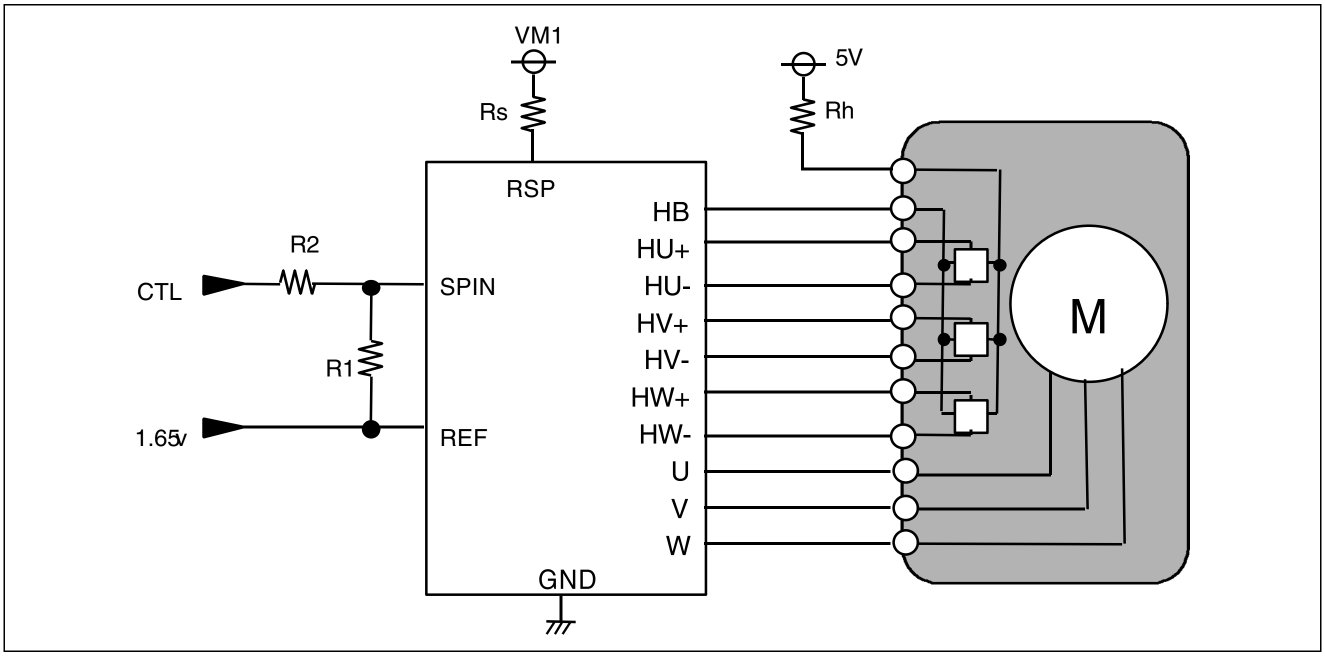
Therefore current- gain- control and current- limit of this IC is determined with sensing resister value,and more detail control can be determined with setting a gain- resister outer this IC as below.



The example of current- gain and current- limit of SPINDLE.

Rs[Ω]	Ilim1F[A]	Ilim2F[A]	Ilim1R[A]	Gio*[A/V]		
				R1 = ∞ R2 = 0Ω	R1 = R2	R2 = 2•R1
0.50	1.00	0.56	0.56	2.00	1.00	0.66
0.75	0.66	0.37	0.37	1.33	0.66	0.44
1.00	0.50	0.28	0.28	1.00	0.50	0.33

Gio* = R1/[(R1+R2)•Rs] [A/V]

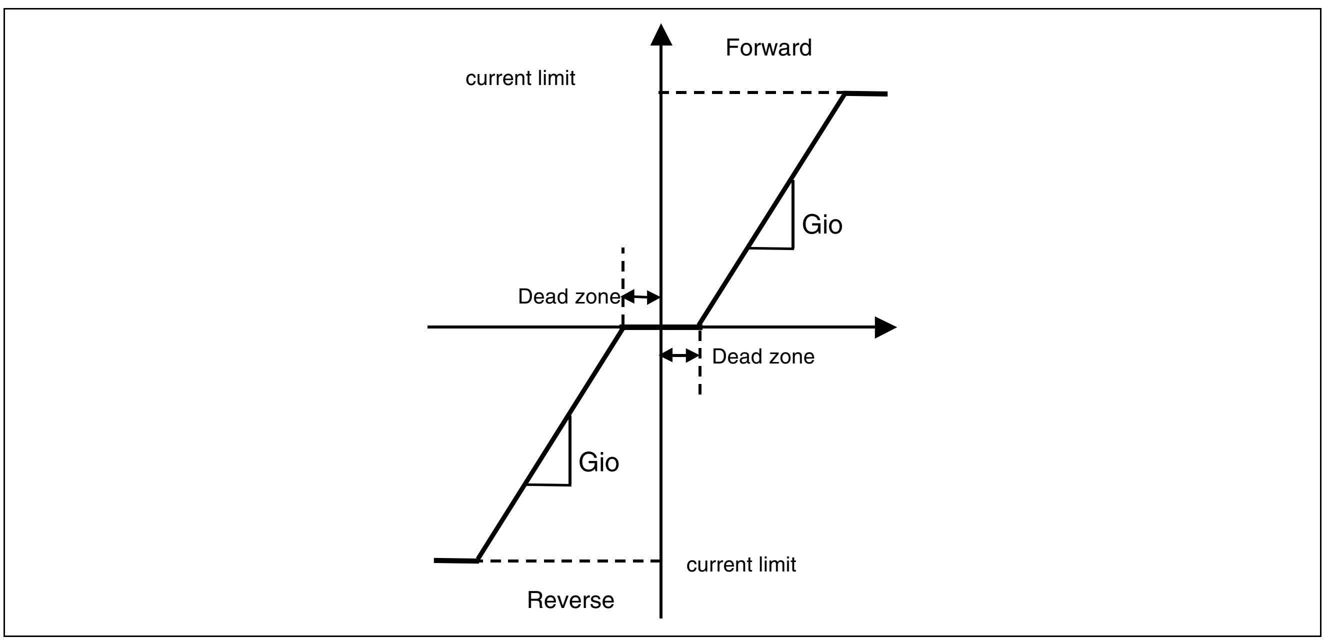


Slide channel

The relationship between the differential voltage between SLIN and REF and the torque is shown in following Figure. The voltage gain[Gvo] is 1.0 [V/V]. The current gain is 2.0[A/V] (at sensing resistor : 0.5 Ω and R1=∞, R2=0 Ω) in forward torque directions, and the dead zone is from 0mV to 80mV (at R1=∞, R2=0 Ω)).

The coil current gain under the reverse torque is the same with in forward torque directions.And the limitation function gets on when the differential voltage of VM2(12V) to RSL is 0.5V.

Therefore current-gain-control and current-limit of this IC is determined with sensing resister value.



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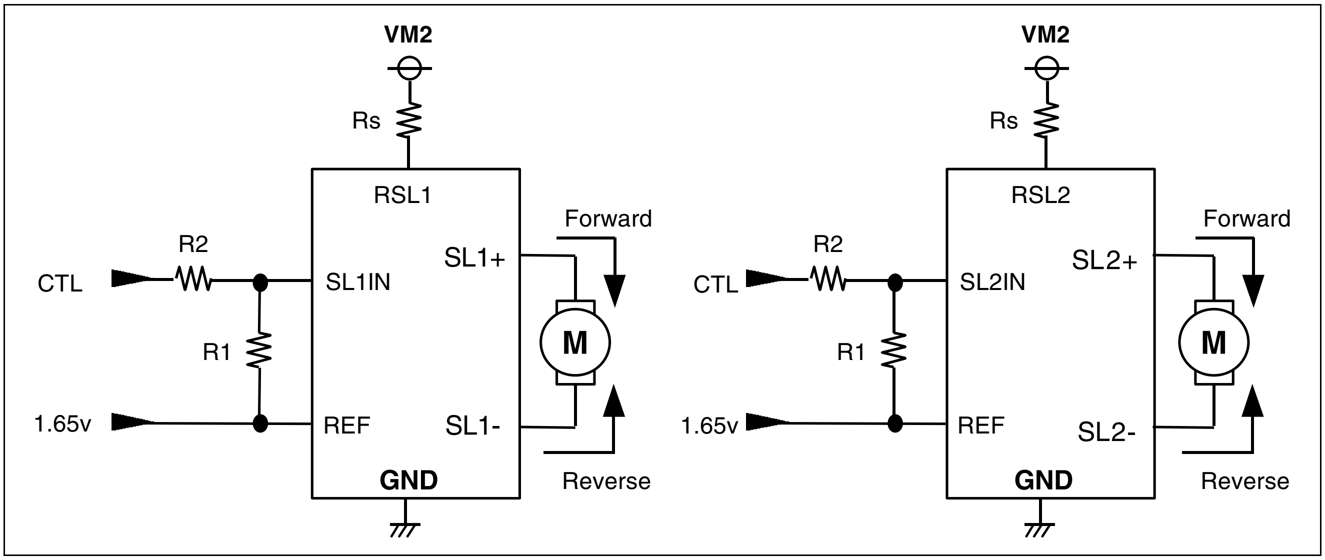

The example of current-gain and current-limit of SLIDE.

Rs[Ω]	Ilim[A]	Gio*[A/V]		
		R1 = ∞ R2 = 0 Ω	**R1 = R2**	**R2 = 2•R1**
0.50	1.00	2.00	1.00	0.66
0.75	0.66	1.33	0.66	0.44
1.00	0.50	1.00	0.50	0.33

Gio* = R1/[(R1+R2)•Rs] [A/V]

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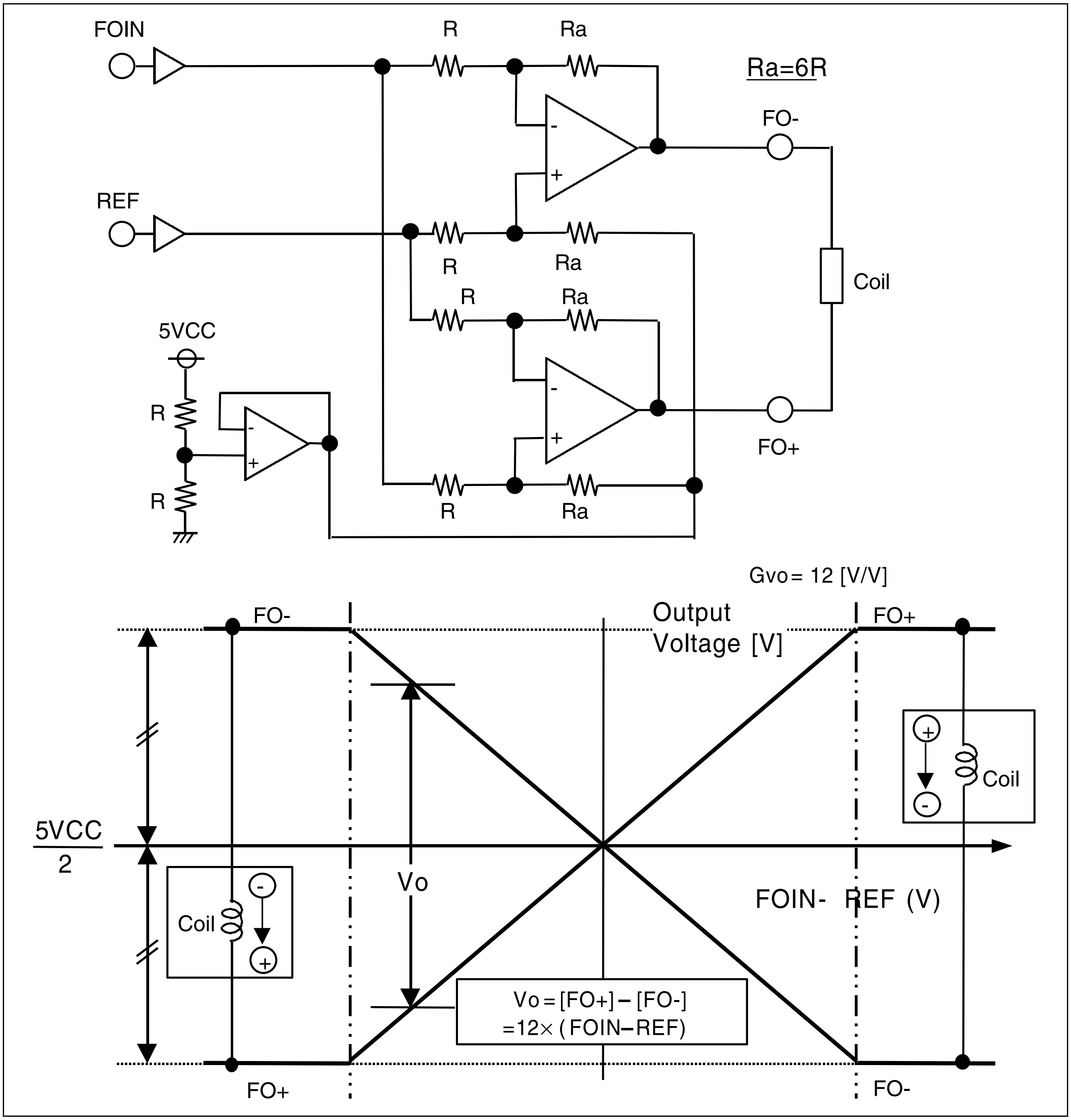
Focus/Tracking channel

The focus and tracking channel is the voltage control drive using BTL .

The focus and tracking is the same composition.

The relationship between the differential voltage between FOIN and REF and the output voltage is shown in following Figure.

The voltage gain [Gvo] is 12.0[V/V].



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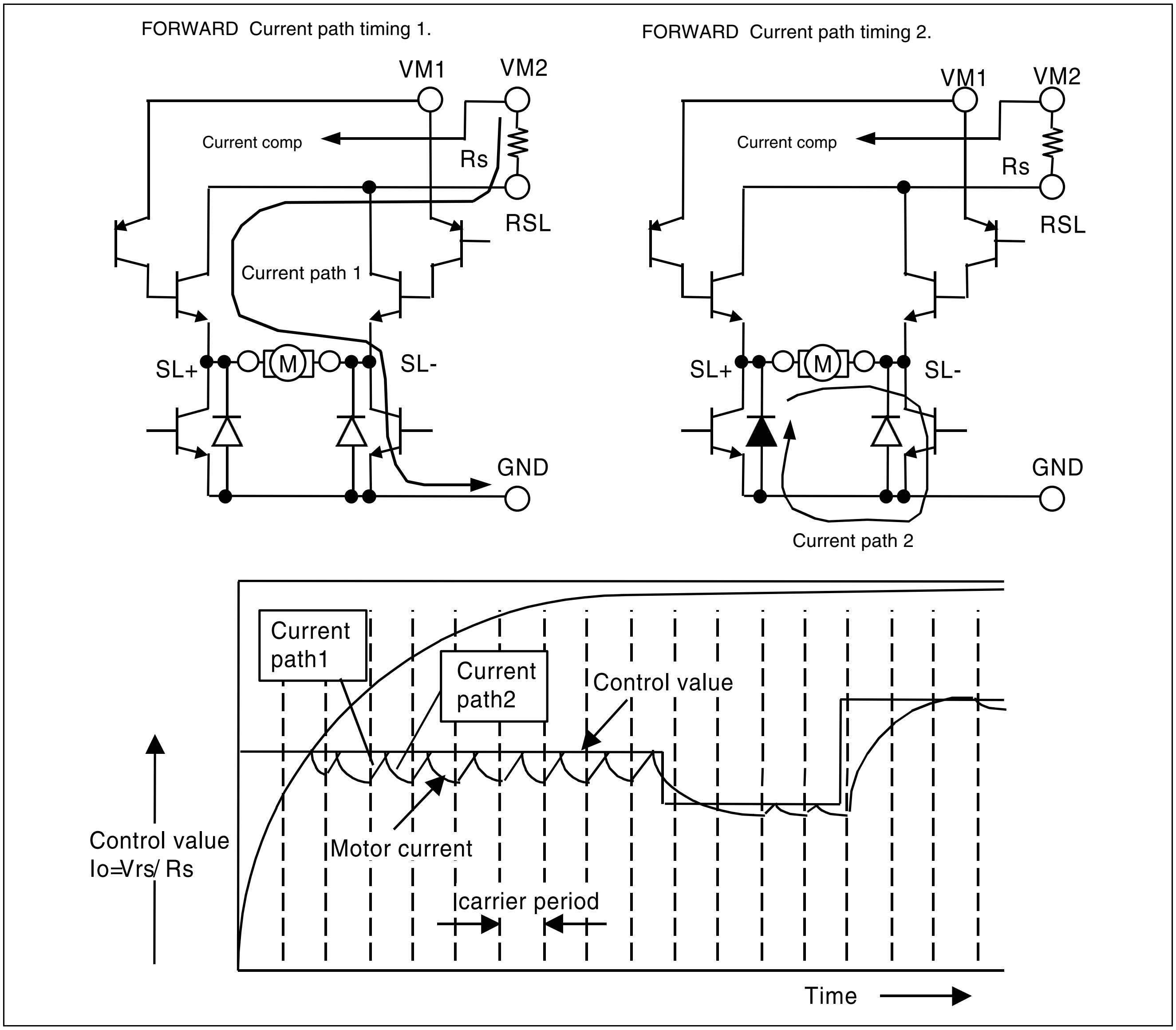
Direct PWM operation

The spindle and the slide channel is controlled by the direct PWM control.

Also, built-in the current limit circuit. This IC controls the motor current directly.



PWM carrier frequency setting

PWM carrier frequency is decided by charging and discharging the capacitor that is connected to OSC terminal outer IC.Examination of the relationship the capacitor connected to OSC terminal and PWM carrier frequency is given in following table.

Capacitor [pF]	820	750	330	220	180	130	110
Carrier Frequency [kHz]	28	30	65	90	110	140	160

*note) This PWM carrier frequency is TYP value.

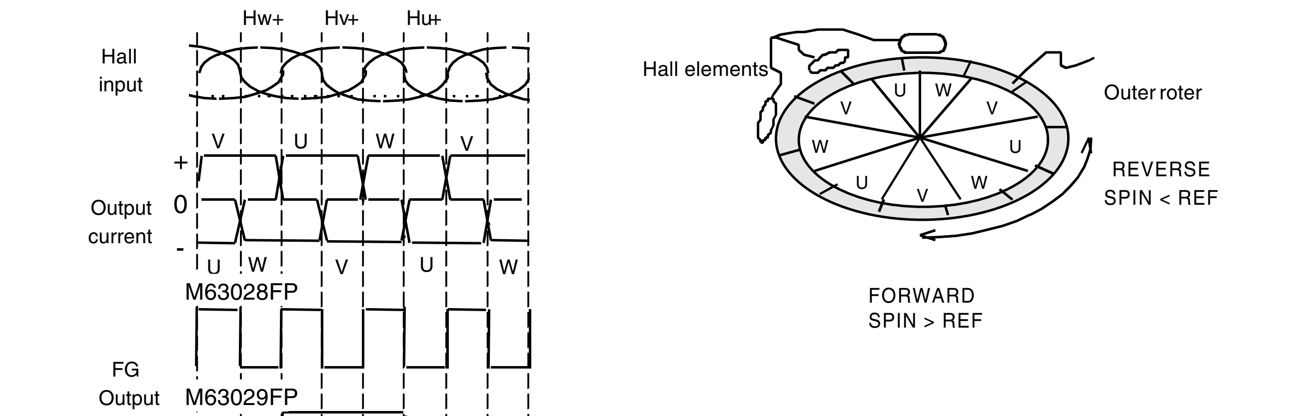
Recommendation of Short Brake Mode at Spindle Drive

This IC has two brake mode, PWM-BRAKE-MODE and SHORT-BRAKE-MODE. In this IC recommendation, SHORT-BRAKE-MODE is superior to PWM-BRAKE- MODE to reducing the power dissipation and to avoid braking down of this IC.

(By excessive reverse torque current in braking a motor with PWM- BRAKE from high- speed- rotation with being excessive Back-EMF, this IC could be broken.)

The relationship between hall-amplifier-input and output-current-commutation/FG output at Spindle Drive

The relationship between the hall elements and the motor output current/FG output is shown in bellow Figure.



* The logic of the FG Output waveform (Hi / Lo) synchronized hall input waveform (V phase) of M63029FP is inverted specification of M63023FP and M63026FP.

FG function at Spindle Drive

The FG terminal outputs the square pulse signal synchronizing with the Hall inputs timing.

And,the FG terminal is open- collector output.

Phase delay circuit at Slide

Phase delay circuit is built in the IC to detect an output spike current, when the motor current direction is switching.

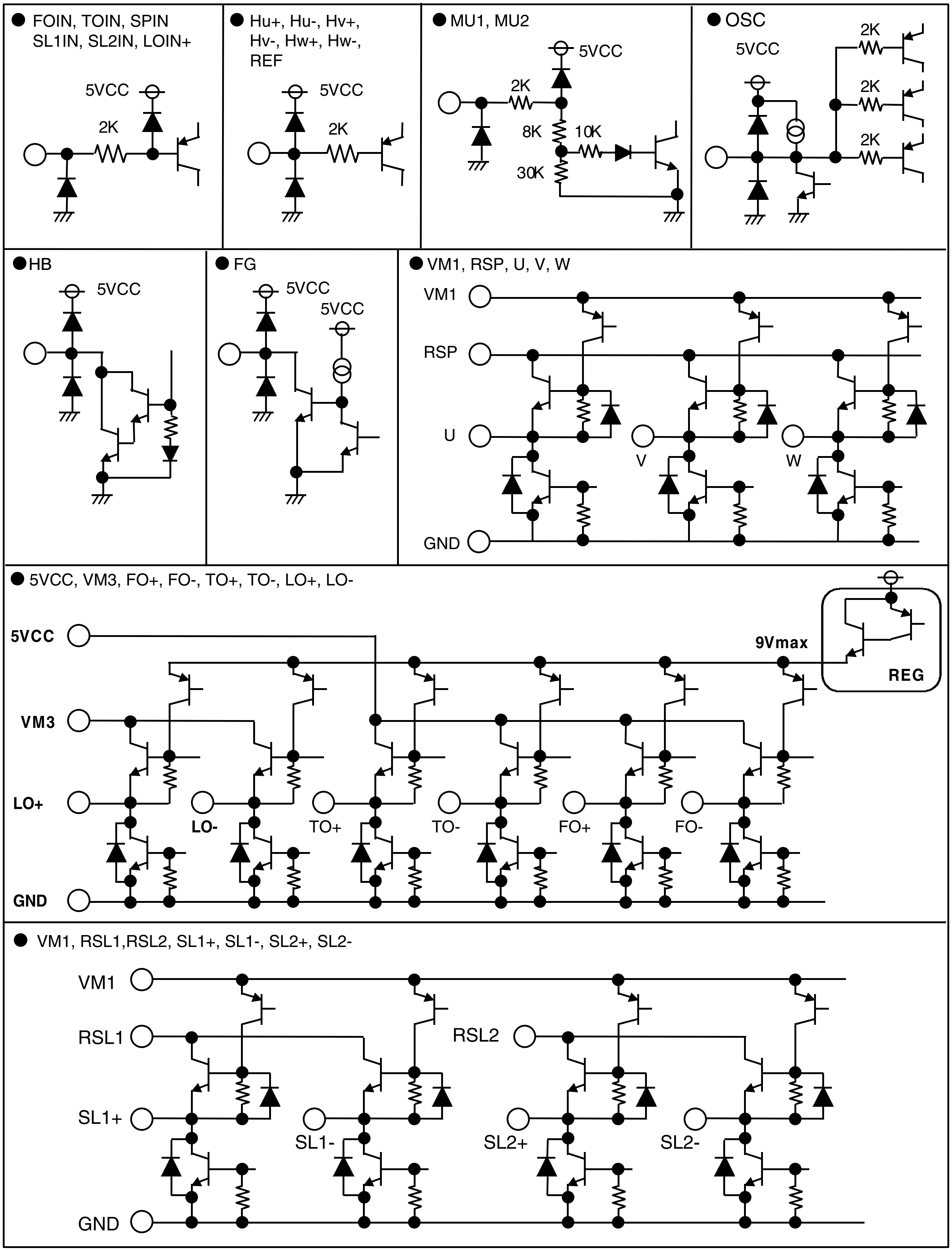
In switching the motor current direction, Phase delay circuit switch-off all output transistor of H-bridge for 3 µsec.

Output current setting at Slide

In this IC,since output transistor is NPN- type transistor,motor coil current (Io)is larger than sensing resistance current about 10mA (TYP.)according to base current of output transistor.

Therefore please design output current with consisting these base current.

I/O circuit


FOIN, TOIN, SPIN
SL1IN, SL2IN, LOIN+
5VCC
2K
Hu+, Hu-, Hv+,
Hv-, Hw+, Hw-,
REF
5VCC
2K
MU1, MU2
5VCC
2K
8K
10K
30K
OSC
5VCC
2K
2K
2K
HB
5VCC
FG
5VCC
5VCC
VM1, RSP, U, V, W
VM1
RSP
U
V
W
GND
5VCC, VM3, FO+, FO-, TO+, TO-, LO+, LO-
5VCC
9Vmax
REG
VM3
LO+
LO-
TO+
TO-
FO+
FO-
GND
VM1, RSL1,RSL2, SL1+, SL1-, SL2+, SL2-
VM1
RSL1
RSL2
SL1+
SL1-
SL2+
SL2-
GND

The boards for thermal derating evaluation

Board material

Glass-epoxy FR-4

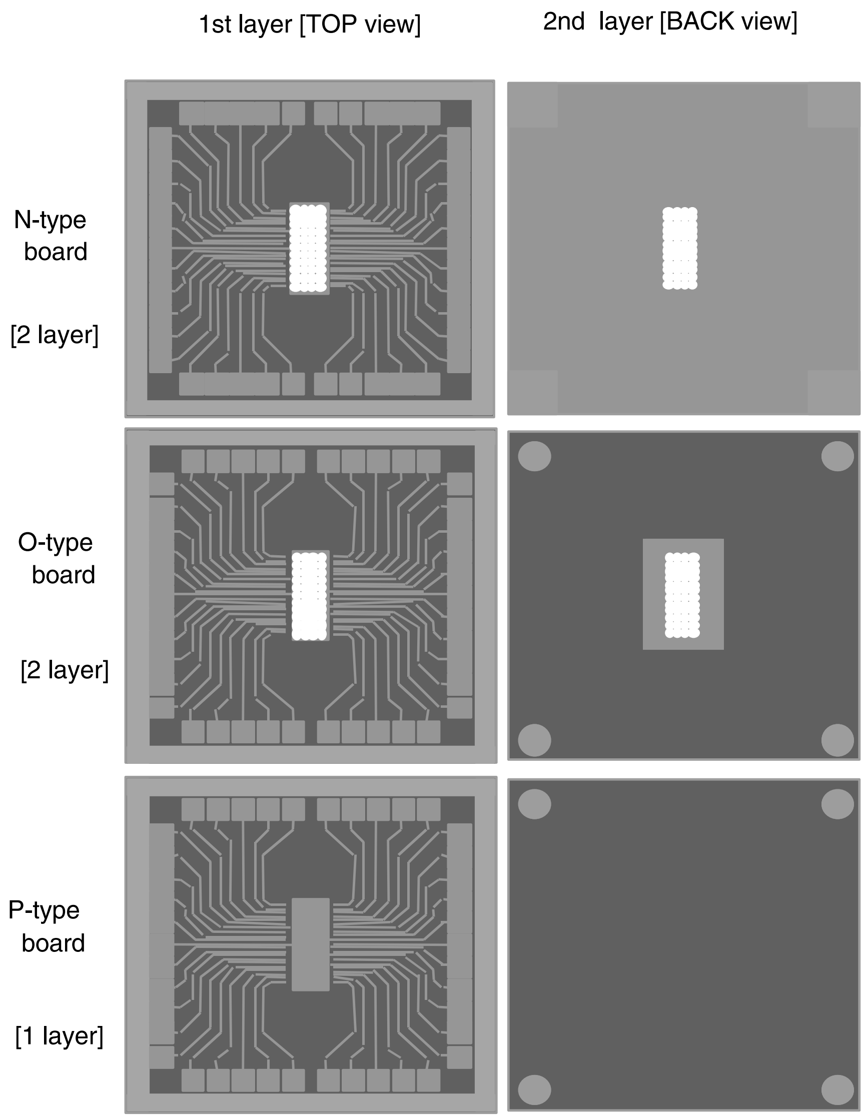
Size
70×70mm

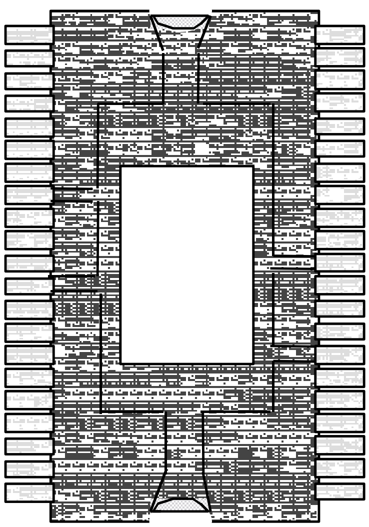
thickness
t=1.6mm

1 and 2 layers

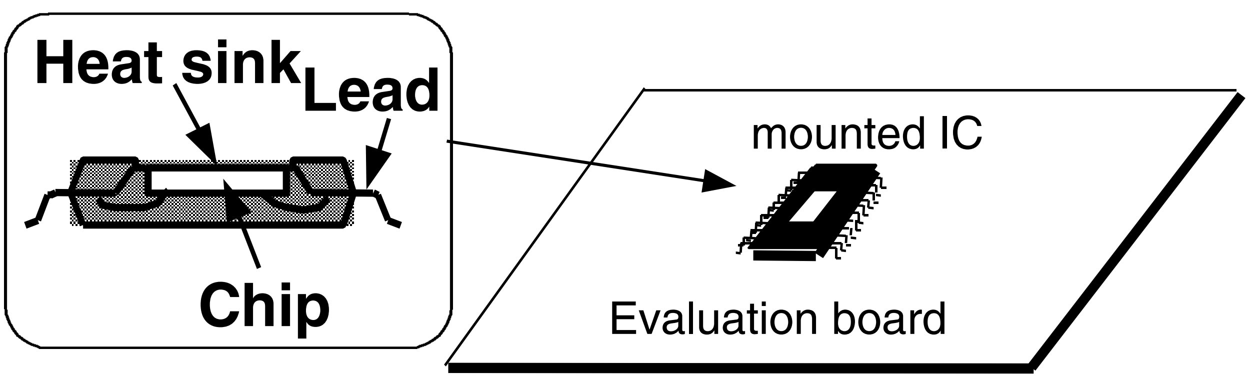
material : copper

thickness :t= 18μm





POWER-SSOP 42P9R-K



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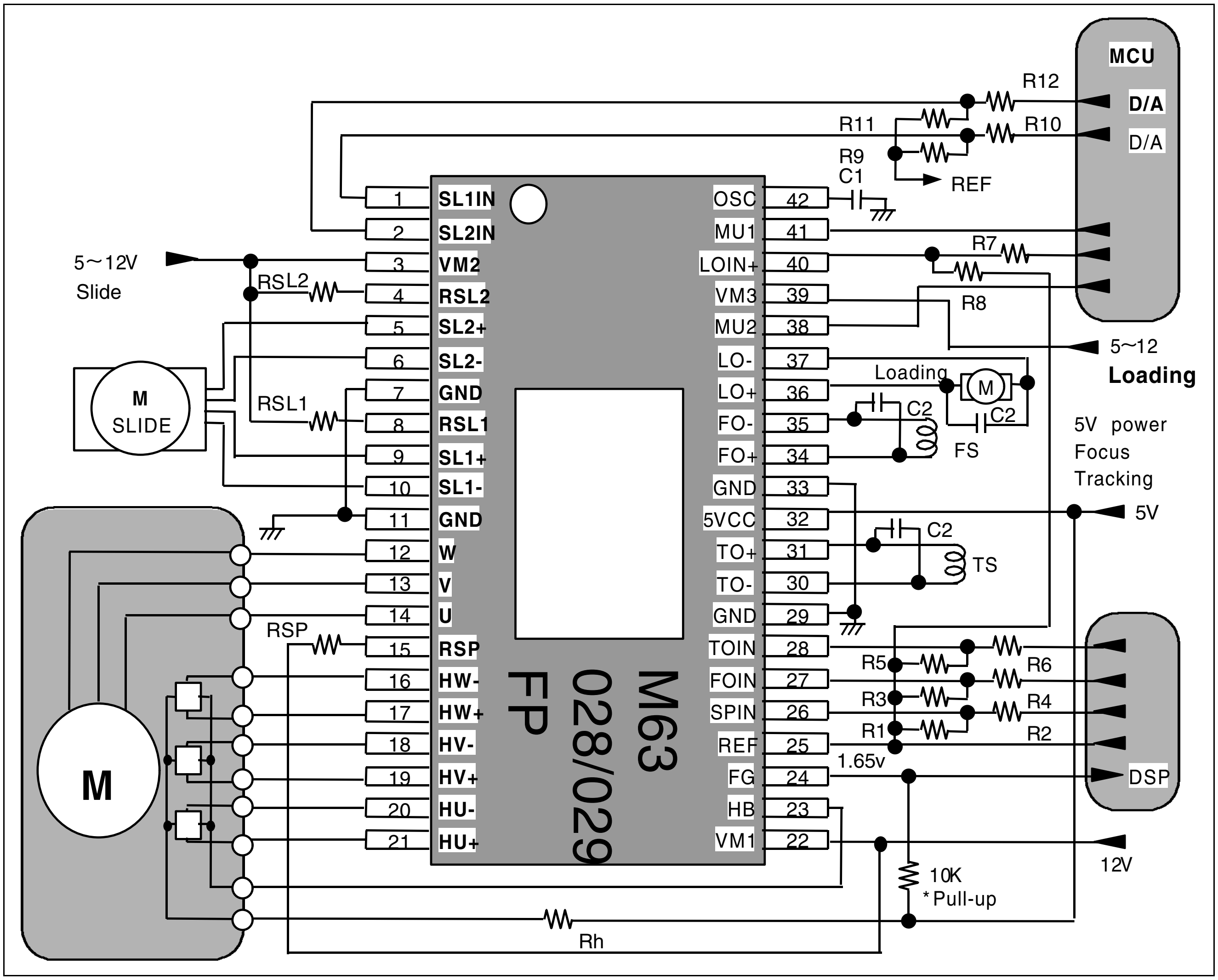
Application Circuit



This value is a recommended value and is not guaranteed performance.

Parts No.	Typ.	Unit	Note
RSP	0.33	Ω	Ilim1F=1.5A, Ilim1R=1.0A, Gain=3.0A/V
RSL1, RSL2	2	Ω	Ilim=0.25A, Gain=0.5A/V
Rh	200	Ω	
R1, R2, R3, R4, R5, R6	10k	Ω	
R7, R8	10k	Ω	
C1	330p	F	Fosc=65kHz
R9, R10, R11, R12	10k	Ω	
C2	100n	F	

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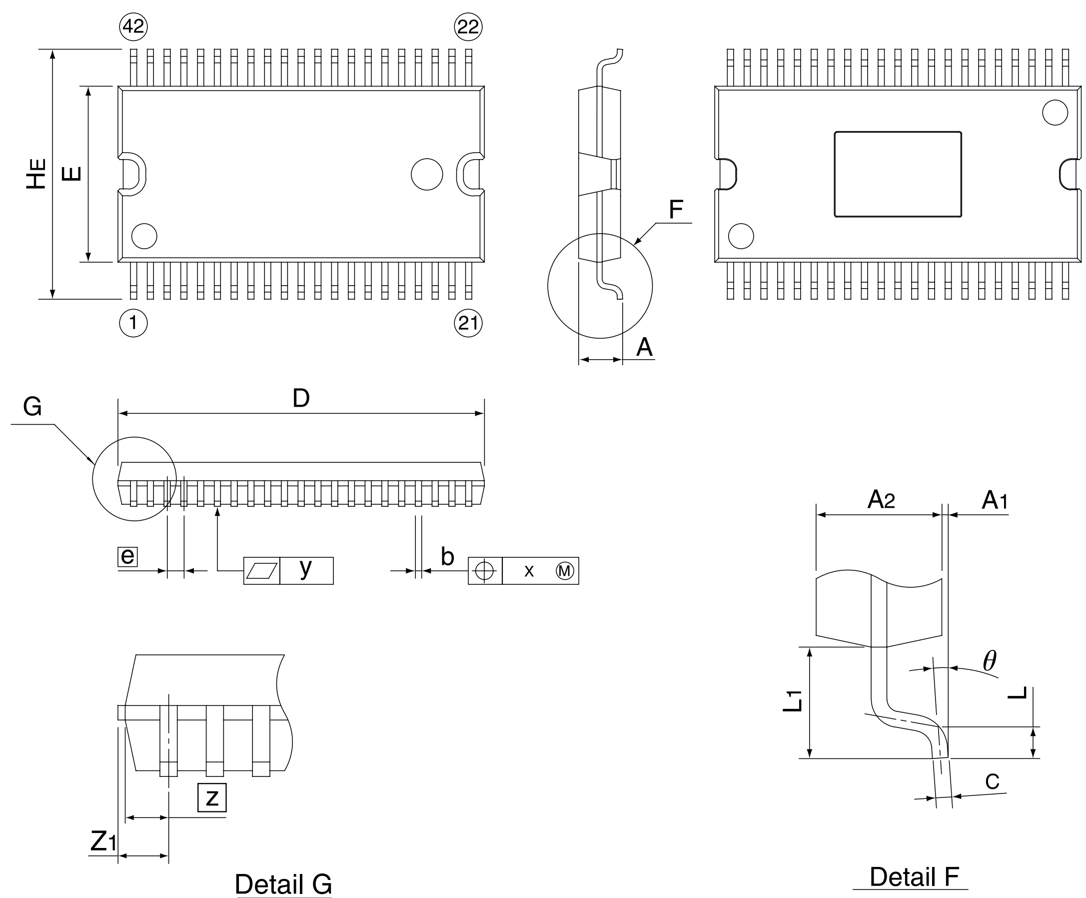
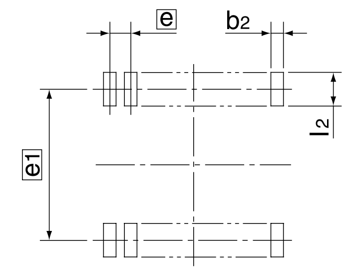
Package Dimensions

42P9R-K MMP

Plastic 42pin 450mil HSSOP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
HSSOP42-P-450-0.8	———	———	Cu Alloy





Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	2.2
A_1	0	0.1	0.2
A_2	—	2.0	—
b	0.27	0.32	0.37
c	0.23	0.25	0.3
D	17.3	17.5	17.7
E	8.2	8.4	8.6
e	—	0.8	—
H_E	11.63	11.93	12.23
L	0.3	0.5	0.7
L_1	—	1.765	—
z	—	0.75	—
Z_1	—	—	0.9
x	—	—	0.16
y	—	—	0.1
θ	0°	—	10°
b_2	—	0.5	—
e_1	—	11.43	—
I_2	1.27	—	—

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