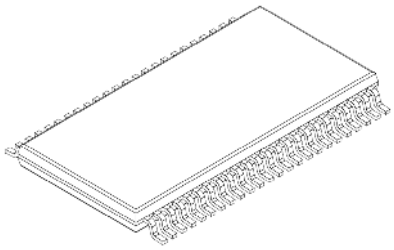
TOSHIBA Bi-CMOS Integrated Circuit Silicon Monorithic

TB9052FNG

Automotive GATE-driver for DC brushed motor driver

TB9052FNG is Pre-Driver IC for DC Brushed Motor.
Motor Speed is controlled by Input PWM signal Duty.
Sequence control Logic, Charge Pump, Motor Current Detection circuit and Oscillator is built in.
And also, TB9052FNG has Miscellaneous Abnormal Detection circuit which can be set up with external elements.



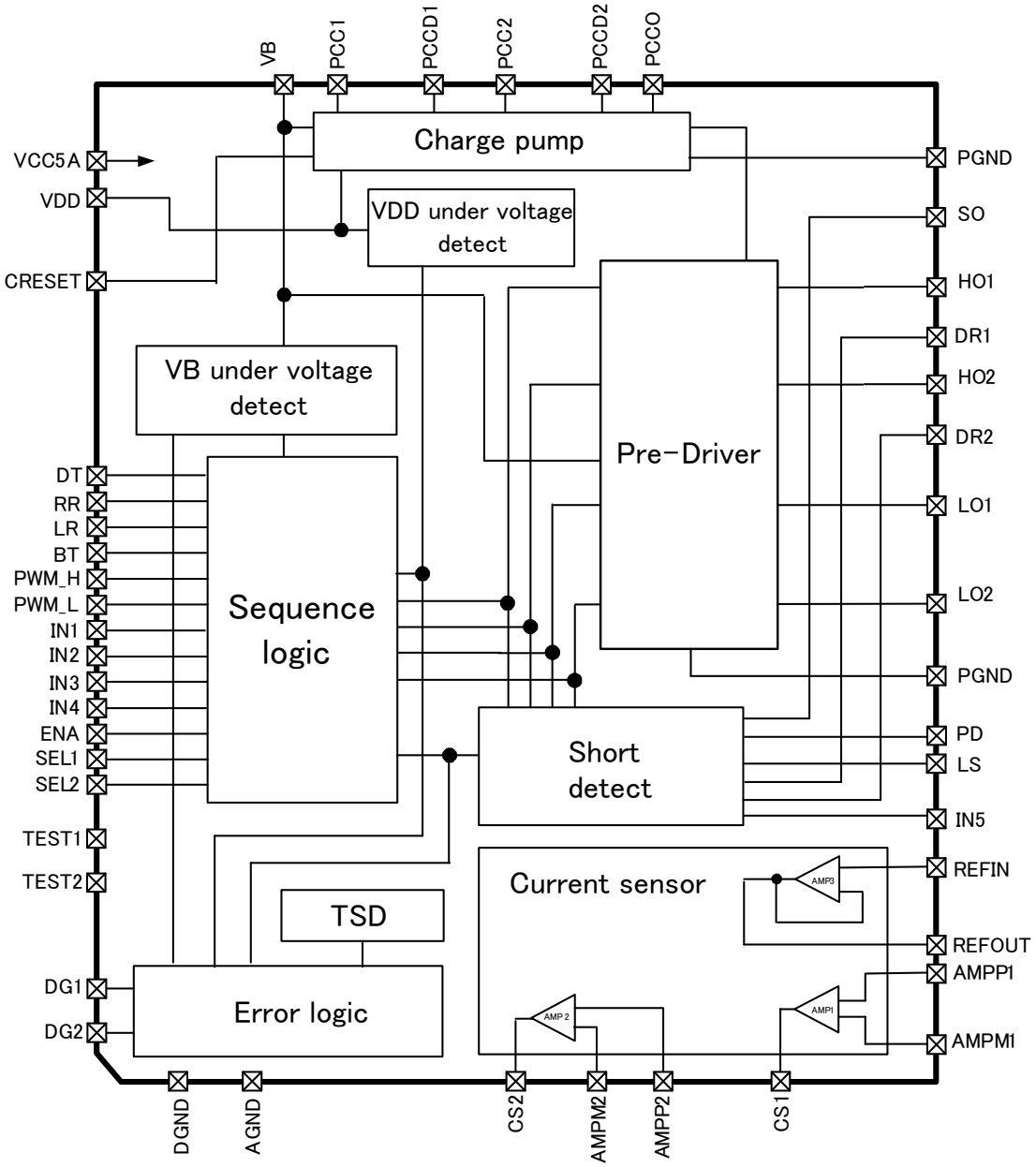
HTSSOP48-P-300-0.50

Weight: 0.24g(typ.)

Features

- Motor Speed control by Input PWM signal Duty
- Build-in Charge Pump
- High response Current Detection circuit
  Miscellaneous Abnormal Detection circuit (Over Temp / Low Voltage / Short Detection))
- Operating Voltage :6 to 18V
- Operating Temperature : −40 to 125°C
- Package : HTSSOP-48pin (0.5mm Pitch)
- The product(s) is/are compatible with RoHS regulations (EU directive 2011 / 65 / EU) as indicated, if any, on the packaging label ("[[G]]/RoHS COMPATIBLE", "[[G]]/RoHS [[Chemical symbol(s) of controlled substance(s)]]", "RoHS COMPATIBLE" or "RoHS COMPATIBLE, [[Chemical symbol(s) of controlled substance(s)]]>MCV").
- AEC-Q100 Qualified
- Developed according to ISO 26262 ASIL-D
- Safety Manual and Safety Analysis Report

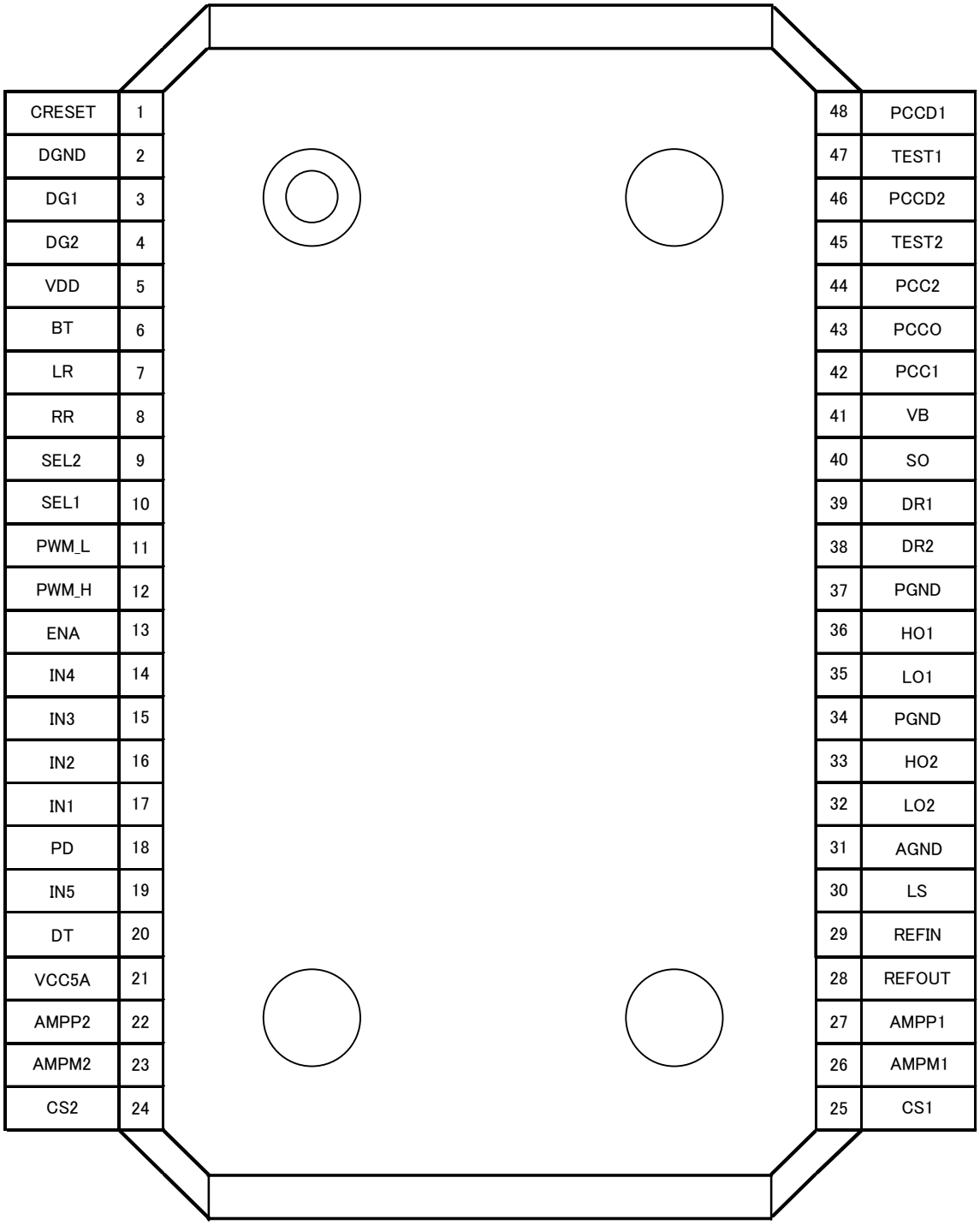
INTERNAL BLOCK DIAGRAM



＊1： Some of the functional blocks,circuit,or constants in the block diagram may be omitted or simplified for explanatory purpose.

＊2： Install the product correctly. Otherwise, it may result in break down, damage and/or deterioration to the product or equipment.

PACKAGE PIN LAYOUT (Top View)



PIN DESCRIPTION

PIN No.	Symbol	Definition	IN/OUT	Notes
1	CRESET	Charge pump reset signal	I	Pull-down
2	DGND	Digital GND	-	-
3	DG1	Abnormal Detection Information Output 1	O	-
4	DG2	Abnormal Detection Information Output 2	O	-
5	VDD	Power Supply for Logic	-	-
6	BT	Sequence Logic control signal	I	Pull-down
7	LR	Sequence Logic control signal. Left Rotation	I	Pull-up
8	RR	Sequence Logic control signal. Right Rotation	I	Pull-up
9	SEL2	Pre-Driver Select Signal2	I	Pull-down
10	SEL1	Pre-Driver Select Signal1	I	Pull-down
11	PWM_L	Low-side PWM Input	I	Pull-up
12	PWM_H	High-side PWM Input	I	Pull-up
13	ENA	Pre-Driver Enable Signal	I	Pull-down
14	IN4	Pre-Driver Direct Control 4	I	Pull-down
15	IN3	Pre-Driver Direct Control 3	I	Pull-down
16	IN2	Pre-Driver Direct Control 2	I	Pull-down
17	IN1	Pre-Driver Direct Control 1	I	Pull-down
18	PD	Short Detection Ref.	I	-
19	IN5	Setting Filtering time for Short Detection	I	-
20	DT	Dead time setting	I	-
21	VCC5A	Power Supply for Analog	-	-
22	AMPP2	2nd AMP. + Input for Current Sensor	I	-
23	AMPM2	2nd AMP. - Input for Current Sensor	I	-
24	CS2	2nd AMP. Output for Current Sensor	O	-
25	CS1	1st AMP. Output for Current Sensor	O	-
26	AMPM1	1st AMP. - Input for Current Sensor	I	-
27	AMPP1	1st AMP. + Input for Current Sensor	I	-
28	REFOUT	Ref. Voltage Output for Current Sensor	O	-
29	REFIN	Ref. Voltage Input for Current Sensor	I	-
30	LS	Pre-Driver Low-side Source Input	I	-
31	AGND	Analog GND	-	-
32	LO2	Pre-Driver Output LO2	O	-
33	HO2	Pre-Driver Output HO2	O	-
34	PGND	Power GND	-	-
35	LO1	Pre-Driver Output LO1	O	-
36	HO1	Pre-Driver Output HO1	O	-
37	PGND	Power GND	I	-
38	DR2	Motor Connect PIN 2	I	-
39	DR1	Motor Connect PIN 1	I	-
40	SO	Pre-Driver High-side Drain Input	I	-
41	VB	Power Supply(Battery 12V)	-	-
42	PCC1	1st Charge Pump Output	O	-
43	PCCO	Final Charge Pump Output	O	-
44	PCC2	2nd Charge Pump Output	O	-
45	TEST2	TEST PIN	I	Please use OPEN
46	PCCD2	2ndCharge Pump Drive Output	O	-
47	TEST1	TEST PIN	I	Please use OPEN
48	PCCD1	1st Charge Pump Drive Output	O	-

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FUNCTIONAL DESCRIPTIONS

TB9052FNG is Pre-Driver IC for DC Brushed Motor. Pre-Driver is controlled by PWM signals which are inputted from PIN “PWM_H and PWM_L “. And the PWN signals are outputted from the PIN “HO1, HO2, LO1, LO2“ to control the motor. The control mode is selectable either a sequence control or a direct control by PIN "SEL1".

TB9052FNG has Charge pump for Pre-Driver and it can control external Nch MOSFET directly.

TB9052FNG has Motor Current Detection circuit which can detect motor current from PIN”CS1, CS2”.

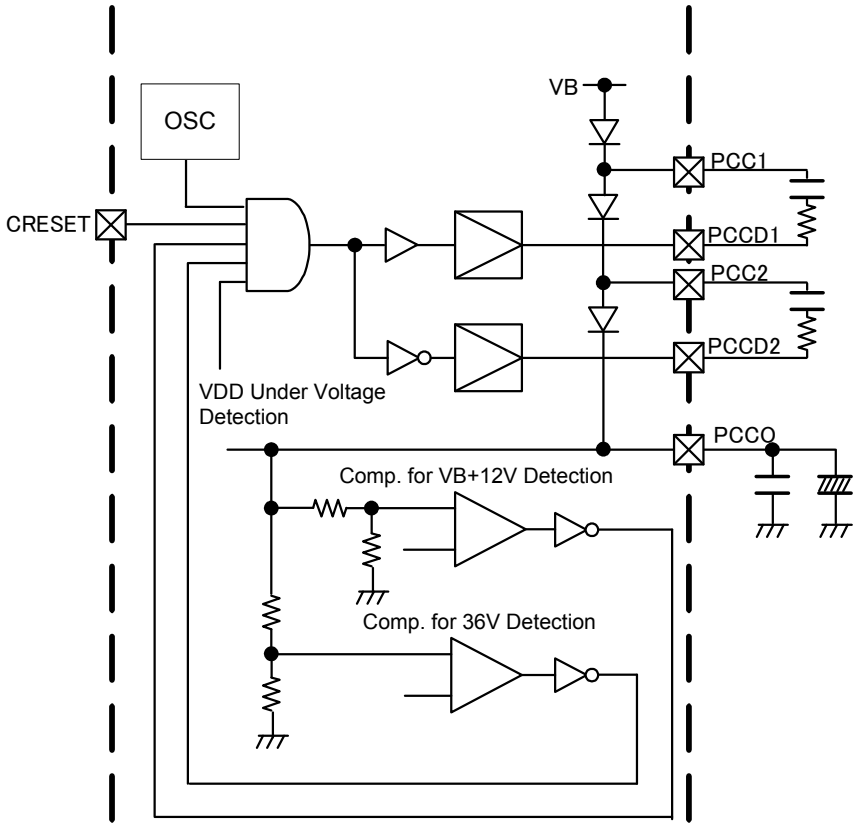
(1) Charge Pump

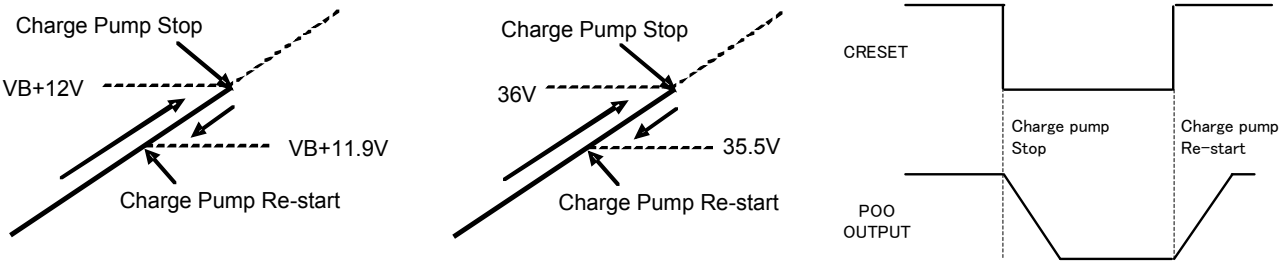
TB9052FNG has Charge pump for Pre-Driver and it can control external Nch MOSFET directly. Also Charge Pump Output Voltage Detection circuit is built-in. When Output voltage of Charge Pump (PCCO) is over VB+12V or 36V(typ.), Charge Pump is stopped.
When this voltage is dropped to VB+11.9V or 35.5V, Charge Pump re-start the operation.
And Charge Pump Operation can be stopped by using external PIN “CRESET”.

・CRESET is “High”: Normal operation.

・CRESET is “Low”: Charge Pump operaion is stopped.

When charge pump is stopped, PCCO voltage become “VB-3VF”.





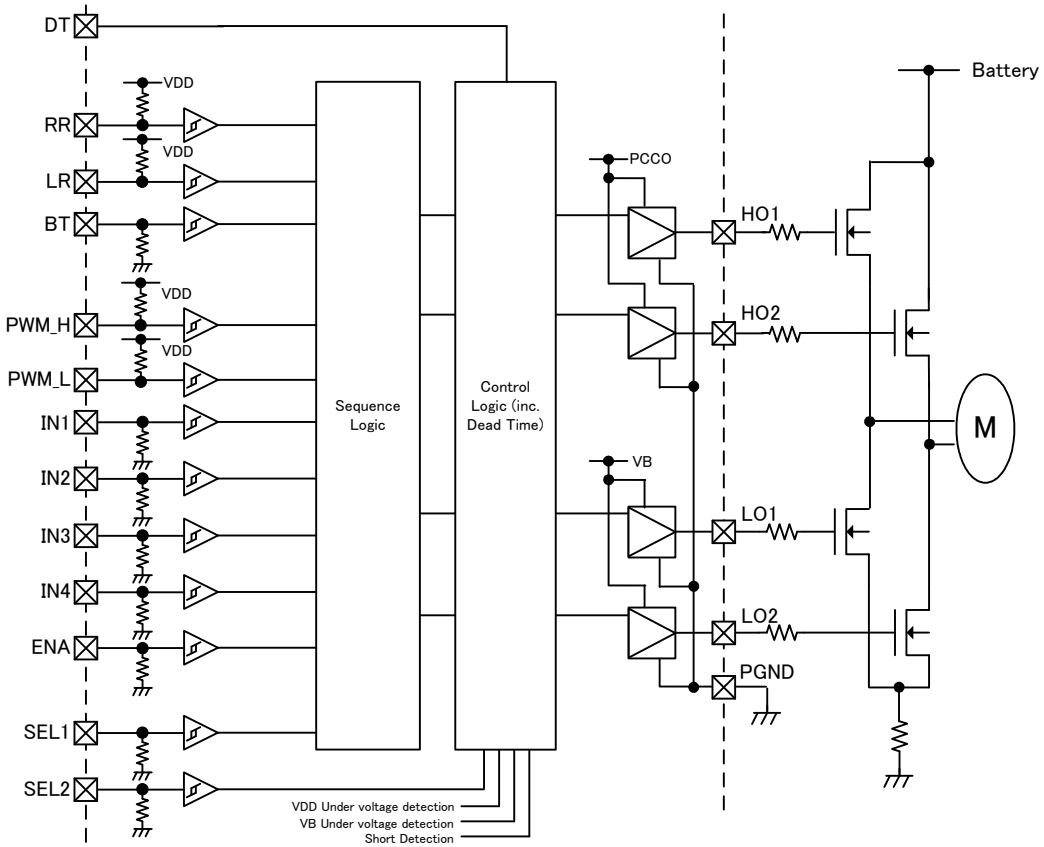
＊1： Charge Pump is clampped by 36V(typ.). But when VB is over 40V, even Charge Pump is stopped the operation, the voltage of PCCO is over 40V. VB need to keep max. 40V.

＊2： Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purpose.

2) Pre-Driver Circuit / Sequence Logic Circuit

The Outputs of Pre-Driver (HO1,HO2.LO1.LO2) are contorlled by external MCU through build-in Motor Sequence Control Logic Circuit. PIN"PWM_H" is PWM signal for High-side Pre-Driver and PIN"PWM_L" is for Low-side Pre-Driver.
Pre-Driver operation is selectable either sequence control or direct control by using PIN"SEL1".

・SEL1 = "Low" is Sequence Control.
・SEL1 = "High" is Direct Control.



＊1： Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purpose.

・SEL1 = Low (Sequence Control)
Truth Table

Input Signal						Output Signal			
PWM_H	PWM_L	RR	LR	BT	ENA	HO1	HO2	LO1	LO2
L	L	L	H	*	H	H	L	L	H
H	L	L	H	L	H	L	L	L	H
H	L	L	H	H	H	L	L	H	H
L	L	H	L	*	H	L	H	H	L
H	L	H	L	L	H	L	L	H	L
H	L	H	L	H	H	L	L	H	H
L	H	L	H	L	H	H	L	L	L
L	H	L	H	H	H	H	H	L	L
L	H	H	L	L	H	L	H	L	L
L	H	H	L	H	H	H	H	L	L
H	H	*	*	*	*	L	L	L	L
*	*	H	H	*	*	L	L	L	L
*	*	L	L	*	*	L	L	L	L
*	*	*	*	*	L	L	L	L	L

* : Don't care.

・SEL1 = High (Direct Control)

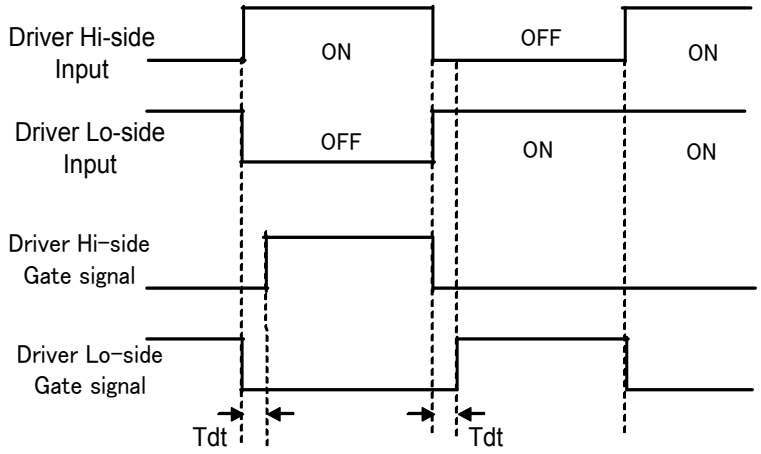
Truth Table

Input Signal					Output Signal			
IN1	IN2	IN3	IN4	ENA	HO1	HO2	LO1	LO2
H	*	H	*	H	L	L	L	L
*	H	*	H	H	L	L	L	L
H	H	L	L	H	H	H	L	L
H	L	L	H	H	H	L	L	H
L	H	H	L	H	L	H	H	L
L	L	H	H	H	L	L	H	H
H	L	L	L	H	H	L	L	L
L	H	L	L	H	L	H	L	L
L	L	H	L	H	L	L	H	L
L	L	L	H	H	L	L	L	H
L	L	L	L	H	L	L	L	L
*	*	*	*	L	L	L	L	L

* : Don't care.

＊ DEAD TIME Operation

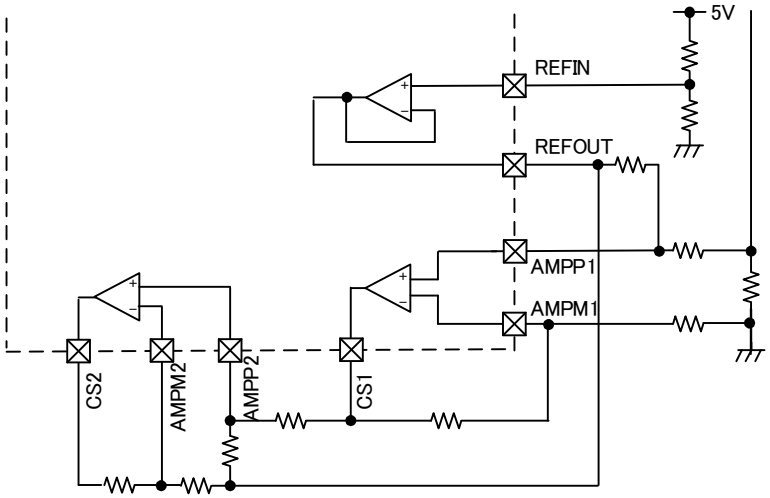
TB9052FNG automatically generates DEAD TIME(Tdt) to protect the short circui of Hi-side/Lo-side on the same Half-Bridge as the follows. DEAD TIME can be set by external resistor which is connected to PIN"DT".



＊1：Timing charts may be simplified for explanatory purpose.

(3) Motor Current Sensor Circuit

TB9052FNG has Motor Current Sensor Circuit which consists of Differential Amplifier and Offset Generation circuit. Motor Current sensing is done by external Shunt Resistor. Gains of Differential Amplifiers are set by external Resistor as shown below.



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(4) Miscellaneous Abnormal Detection Circuit

TB9052FNG has Miscellaneous Abnormal Detection Circuits i.e. Low Voltage Detection of VB and VDD, Over Temperature Detection, external MOSFET Short Detection and Motor Line Short Detection.
In case of under voltage detection, DG1=Low,DG2=Low.
In case of under over temperature detection, DG1=High, DG2=High.
In case of short detection, DG1=Low, DG2=High.
And if return to normal operation, DG1=High, DG2=Low.

PIN"DG1"	PIN"DG2"	Abnormal Phenomenon
H	L	Normal (No Abnormal Detection)
L	L	VB Low Voltage or VDD Low Voltage Detection
L	H	Short Detection
H	H	Over Temp. Detection

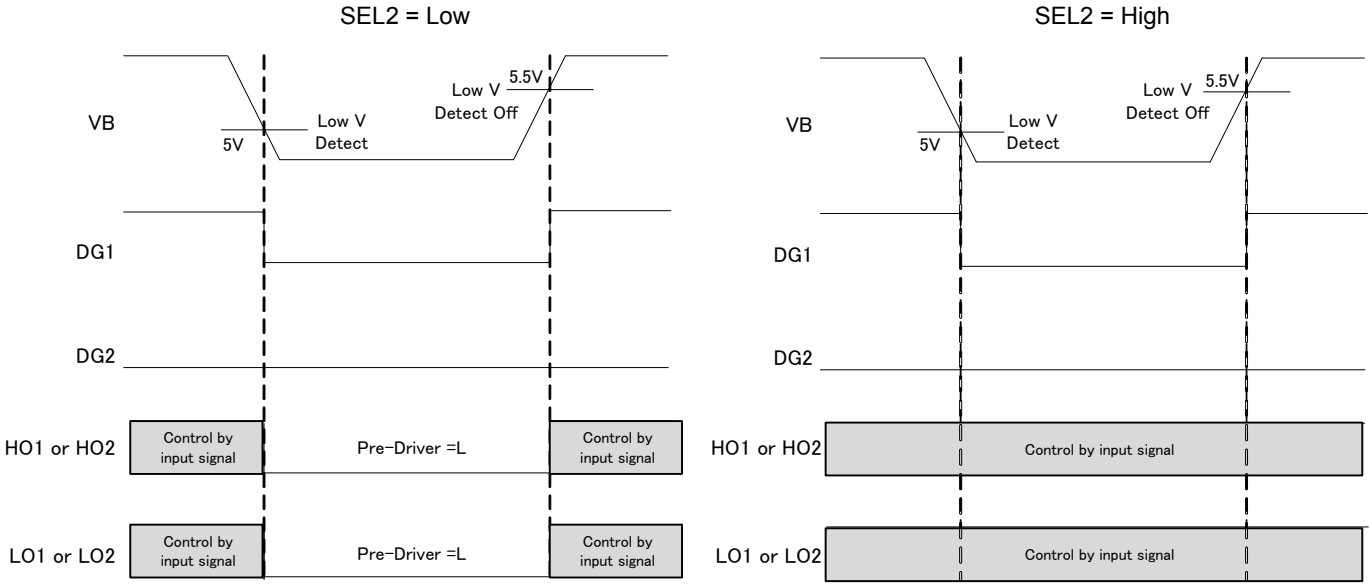
Priority of each detection is as follow.

- When both Short Detection and Over Temp. Detection are occur, DG1=High, DG2=High.
- When both Short Detection and Low Voltage Detection are occur, DG1=Low, DG2=Low.
- When both Low Voltage Detection and Over Temp. Detection are occur, DG1= Low, DG2= Low.

(4-1) VB Low Voltage Detection / VDD Low Voltage Detection

(4-1-1) VB Low Voltage Detection

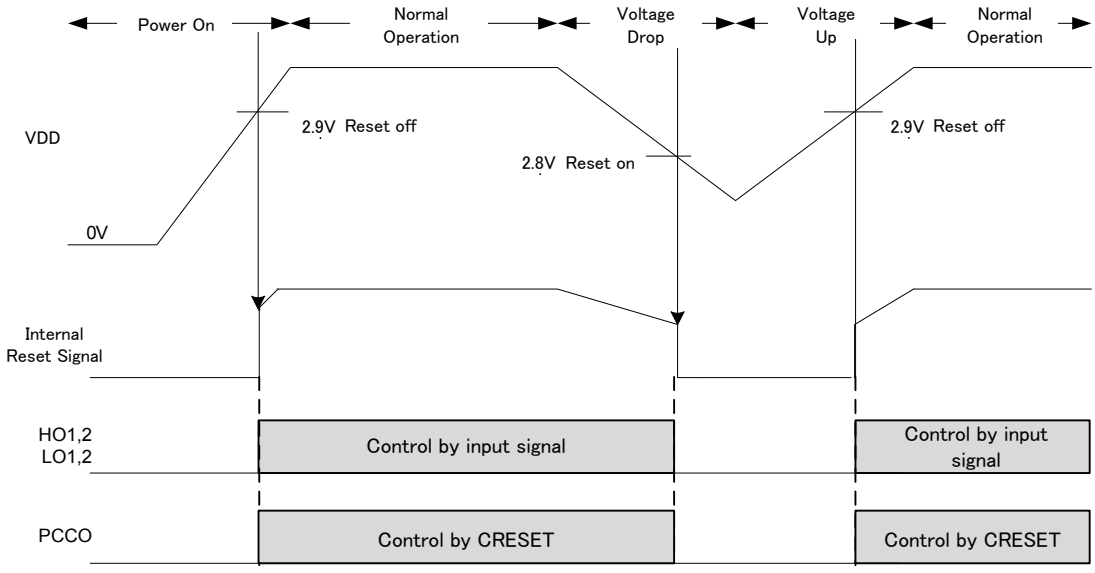
When VB is dropped to lower than 5V(typ.), PIN"DG1" and "DIG2" are changed to "L" by low voltage detection.
When VB is increased over 5.5V, these Diagnosis Information singal change to PIN"DG1"="H", "DG2"="L".The Output of Pre-driver at the abnormal detetction can be selectable by PIN"SEL2".
When PIN"SEL2"="L", all of Pre-driver are changed to "L" at the abnormal detection.
When PIN"SEL2"="H", all of Pre-driver Output keeps normal operation even at abnormal detection.



＊1：Timing charts may be simplified for explanatory purpose.

(4-1-2)VDD Low Voltage Detection

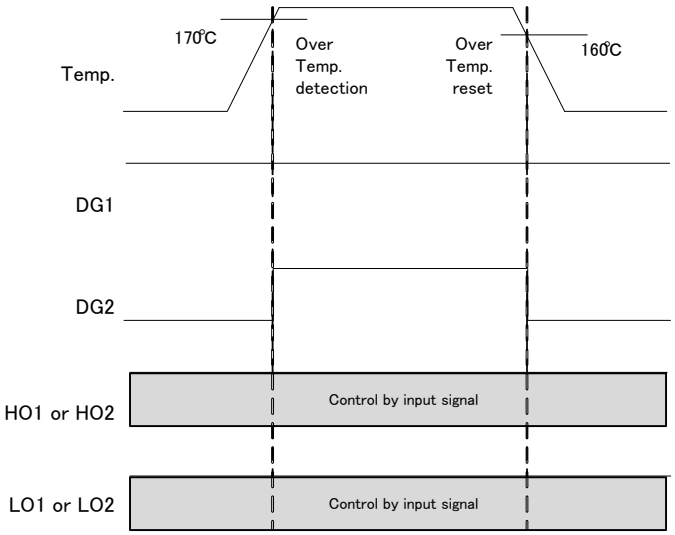
TB9052FNG monitors the voltage of Logic Power Supply(VDD) and detects Low Voltage by internal Band Gap circuit. When VDD is dropped to 2.8V(typ.),TB9052FNG reset internal Logic circuit and Pre-Driver Output(PIN"HO1","HO2","LO1","LO2") are changed to "L" and Charge pump operation is stopped. When VDD increase to be over 2.9V(typ), internal reset is off and return to normal operation. There is hysteresis in both detecion voltage and release voltage.
This internal Reset signal has the protection circuit for Chataring to prevent miss-reset.



＊1：Timing charts may be simplified for explanatory purpose.

(4-2) Over Temperature Detection

TB9052FNG has CHIP Temperature Detection circuit. When CHIP Temperature is over 170°C, Diagnosis signals change to PIN"DG1"="H", "DG2"="H". But, Pre-Driver Output keeps normal operation signal. When CHIP Temperature is dropped to lower than 160°C, Diagnosis signals return to PIN"DG1"="H", "DG2"="L".

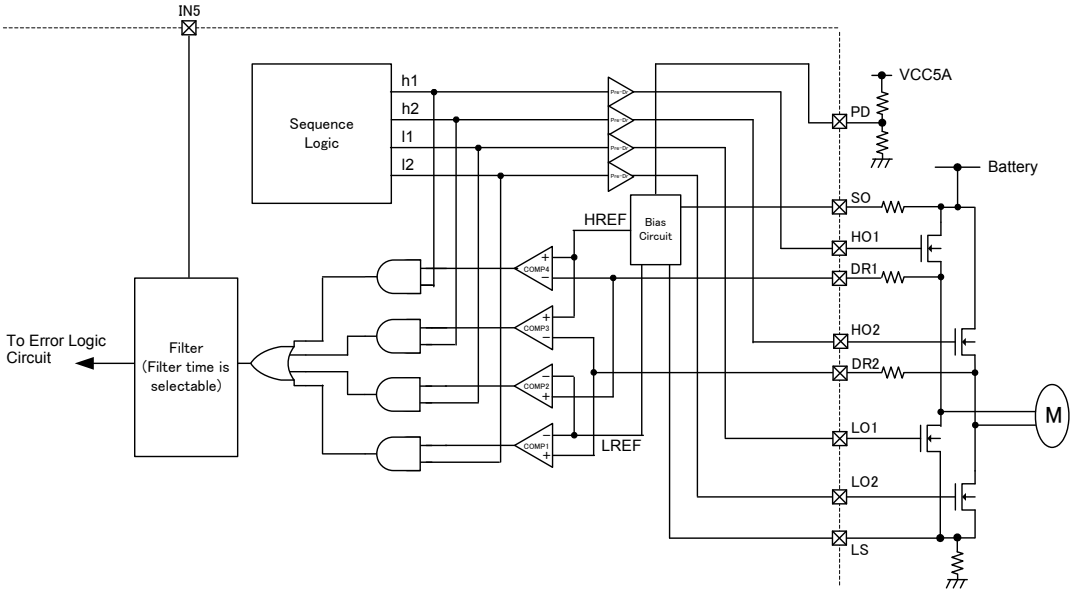


＊1：The absolute maximum rating of Storage Temperature of TB9052FNG is 150°C. This Over Temperature Detection function does not intend to limit the CHIP temperature. Thus, TB9052FNG should never exceed absolute maximum rating of Storage Temperature. If it would be exceeded during operation, the device electrical characteristics may be irreparably altered and the reliability and lifetime of the device can no longer be guaranteed.
Moreover, these operations with exceeded ratings may cause break down, damage and/or degradation to any other equipment. Applications using the device should be designed such that each maximum rating will never be exceeded in any operating conditions. Before using, creating and/or producing designs, refer to and comply with the precautions and conditions set forth in this documents.

This Over Temperature Detection is worded over the Max. Rating Temperature and shipping test does not perform at the Max. Rating Temp.

(4-3) Short Detection

TB9052FNG has MOSFET Short Detection and MOTOR Short detection by monitoring voltage of Source PIN and Drain PIn of external Driver.
If Short is detected, Diagnosis signals change to PIN"DG1"="L", "DG2"="H".
And when Short detection is released, Diagnosis signals return to PIN"DG1"="H", "DG2"="L".
During Short Detection("DG1"="L" and "DG2"=H), the Output of Pre-Driver (PIN"HO1","HO2" "LO1"," LO2") are decided by PIN"SEL2" setting.
When PIN"SEL2"="L", all of Pre-Drivers are "L" during Short Detection.
When PIN"SEL2"="H", Pre-Drivers keep normal operation during Short Detection.
Short Detection circuit has Filter to prevent miss-detecion by noise.
This Filtering time is decided by external connection of PIN"IN5".



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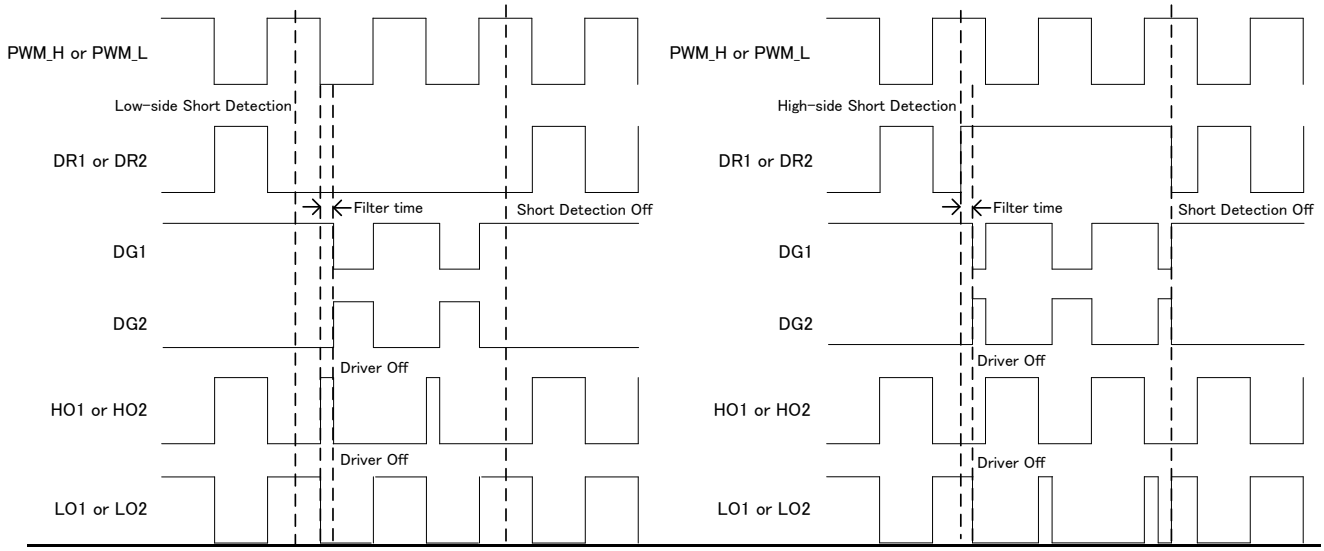
Comparator Input	Comparator output	PWM Input	Abnormal Phenomenon
DR1 ＞ LREF	COMP2 = H	I1 = H	HO1 external MOSFET Short or Motor Line Short
DR2 ＞ LREF	COMP1 = H	I2 = H	HO2 external MOSFET Short or Motor Line Short
DR1 ＜ HREF	COMP4 = H	h1 = H	LO1 external MOSFET Short or Motor Line Short
DR2 ＜ HREF	COMP3 = H	h2 = H	LO2 external MOSFET Short or Motor Line Short

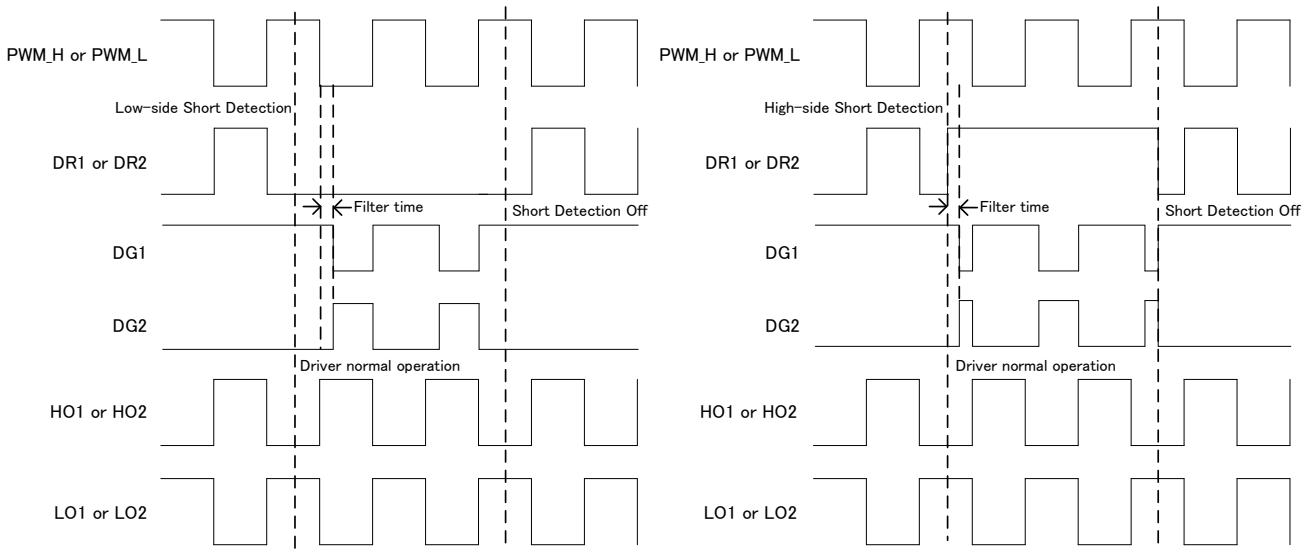
※HREF = (SO voltage)－(PD voltage),　LREF = (LS voltage)+(PD voltage)

< MOSFET Short Detection >

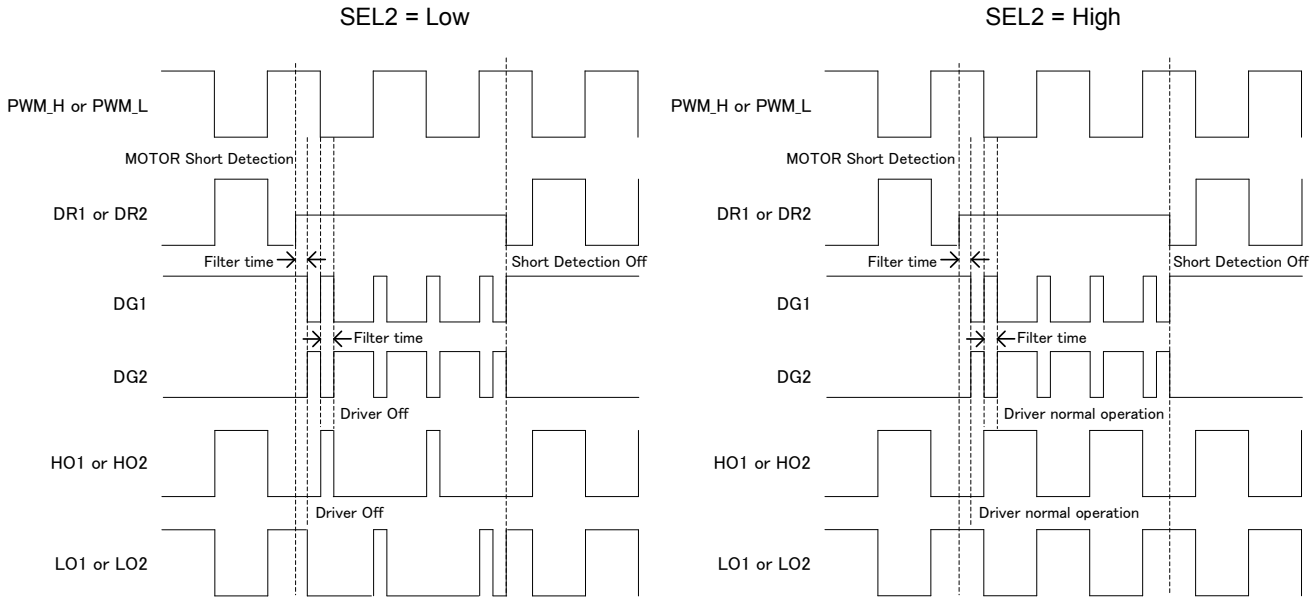
・SEL2 = Low



・SEL2 = High



< MOTOR Short Detection >



＊1：Timing charts may be simplified for explanatory purpose.

ABSOLUTE MAXIMUM RATING (Ta = 25°C)

CHARACTERISTIC	SYMBOL	PIN	VALUE	UNIT
Input/Output Voltage	Vin, Vout	VB	-0.3 to 18(DC)	V
			18 to 24(1min)	
			24 to 40(1s)	
		PCC1, PCCD1, PCC2, PCCD2, PCCO, HO1, HO2, TEST1, TEST2	-0.3 to 40(1s)	V
		DR1, DR2, SO, LO1, LO2,	-0.3 to VB	V
		VCC5A, VDD	-0.3 to 6	V
		REFOUT, CS1, CS2, LS, REFIN, IN5, PD, AMPP1, AMPM1, AMPP2, AMPM2, DT	-0.3 to VCC5A+0.3 (max: 6V)	V
		BT, PWM_H, PWM_L, RR, LR, IN1, IN 2, IN 3, IN 4, ENA, SEL1, SEL2, DG1, DG2, CRESET	-0.3 to VDD+0.3 (max: 6V)	V
Input Current	Iin	DR1, DR2	-50	mA
Output Current	Iout	HO1, HO2, LO1, LO2, PCCD1, PCCD2	1(1μs)	A
		REFOUT, CS1, CS2	10	mA
		PCC1, PCC2, PCCO	100	mA
		DG1, DG2	10	mA
Storage Temperature	Tstg	-	-40 to 150	°C
Power dissipation	PD	JEDEC 4layer	0.76(Ta=125°C)	W
			3.8(Ta=25°C)	W

＊1: Timing charts may be simplified for explanatory purpose.
The absolute maximum ratings of a semiconductor device are a set of specified parameter values, which must not be exceeded during operation, even for an instant. If any of these rating would be exceeded during operation, the device electrical characteristics may be irreparably altered and the reliability and lifetime of the device can no longer be guaranteed. Moreover, these operations with exceeded ratings may cause break down, damage and/or degradation to any other equipment. Applications using the device should be designed such that each maximum rating will never be exceeded in any operating conditions. Before using, creating and/or producing designs, refer to and comply with the precautions and conditions set forth in these documents.

STATIC ELECTRICAL CHARACTERISTICS

(The follows are under condition VB=6 to 18V, VCC5A=4.0 to 5.5V, VDD=3.0 to 5.5V, Ta=-40 to 125°C unless otherwise the follows)

Operating Range

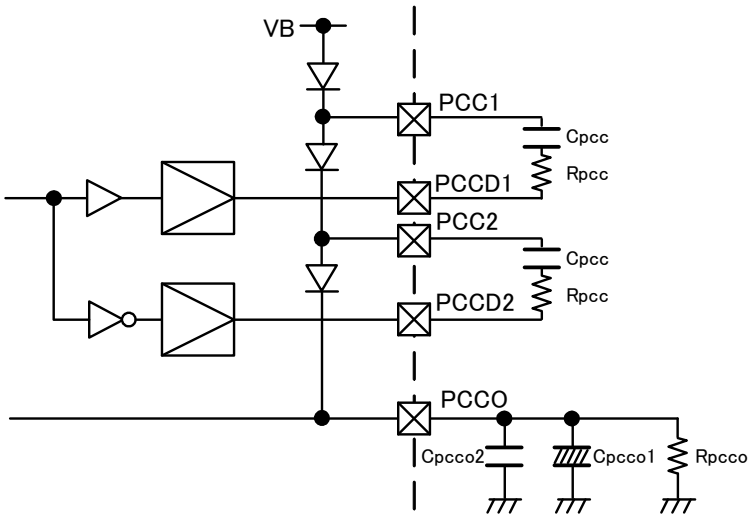
CHARACTERISTIC	SYMBOL	PIN	VALUE	UNIT
Supply Voltage	Vin	VB	6 to 18	V
		VCC5A	4.0 to 5.5 ※VCC5A≧VDD	V
		VDD	3.0 to 5.5	V
Operating Temperature	Topr	-	-40 to 125	°C

IC Characteristics

CHARACTERISTIC	SYMBOL	PIN	CONDITION	MIN.	TYP.	MAX.	UNIT
Current Consumption(VB)	Ivb1	VB	CRESET=Low	-	1.5	3	mA
	Ivb2	VB	CRESET=Hi HO1,HO2=20kHz Cload=10000pF Roh=100Ω	-	50	70	mA
Current Consumption(VCC5A)	Ivcc5a	VCC5A	-	-	4	5.5	mA
Output Current ”H”	Ih	DG1, DG2	VDD = 5.0V DG*=VDD	-	-	-2.5	mA
Output Current “L”	Il		VDD = 5.0V DG* = 0V	2.5	-	-	mA
Input Current ”L”	Iil	PWM_H, PWM_L, RR, LR	VDD = 5.0V Vin = 0V	-100	-50	-25	μA
Input Current ”H”	Iih	PWM_H, PWM_L, RR, LR	VDD = 5.0V Vin = 5.0V	-5	-	5	μA
Input Current ”L”	Iil	BT, IN1, IN2, IN3, IN4, ENA, SEL1, SEL2	VDD = 5.0V Vin = 0V	-5	-	5	μA
Input Current ”H”	Iih	BT, IN1, IN2, IN3, IN4, ENA, SEL1, SEL2	VDD = 5.0V Vin = 5.0V	25	50	100	μA
Input “L” detection Voltage	Vil	RR, LR, BT, PWM_H, PWM_L, IN1, IN2, IN3, IN4, ENA, SEL1, SEL2, CRESET	-	0	-	0.3×VDD	V
Input “H” detection Voltage	Vih			0.7×VDD	-	VDD	V
Hysteresis	Vh			-	0.5	-	V
Minimum Output voltage	VOH	DG1, DG2	IOL = 2.5mA	-	0.05	0.4	V
Maximum Output voltage	VOL	DG1, DG2	IOH = -2.5mA	VDD-0.6V	VDD-0.05V	-	V

Charge Pump

CHARACTERISTIC	SYMBOL	PIN	CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	Vcp1	PCCO	VB=6V to 8V Cpcc=0.1μF Rpcc=10Ω Rpcco=2.5kΩ Cpcco1=10μF Cpcco2=1μF	VB+8	-	-	V
	Vcp2		VB=8V to 18V Cpcc=0.1μF Rpcc=10Ω Rpcco=2.5kΩ Cpcco1=10μF Cpcco2=1μF	VB+10	VB+12	VB+14	V
Active Clamp Detection Voltage	Vcpclh	PCCO	-	31	36	40	V
Active Clamp Release Voltage	Vcpcll	PCCO	-	30.5	35.5	39.5	V



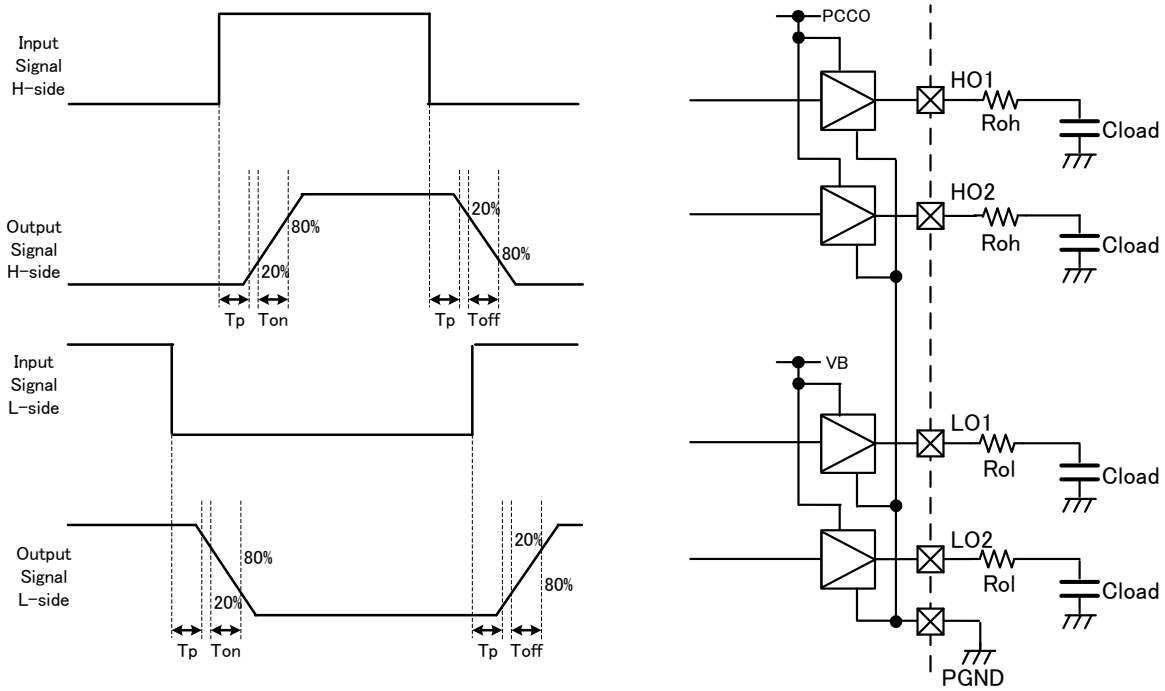
＊1：Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purpose.

Pre-Driver

CHARACTERISTIC	SYMBOL	PIN	CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	Voh1	HO1, HO2	Coad=10nF, Roh=100Ω	Vcp-1	-	Vcp	V
	Voh2			-	-	0.5	V
	Vol1	LO1, LO2	Cload=10nF, Rol=20Ω	VB-0.3	-	VB	V
	Vol2			-	-	0.5	V
Output Resistance	Ronh	HO1, HO2	-	-	4	-	Ω
	Ronl	LO1, LO2	-	-	4	-	Ω
Turn on time	Ton	HO1, HO2, LO1, LO2	Roh=100Ω Rol=20Ω Cload=10nF, 20%→80%	-	150	300	ns
Turn off time	Toff		Roh=100Ω Rol=20Ω Cload=10nF, 80%→20%	-	150	300	ns
Propagation Delay time of Input (The time that both rising and falling PWM Output reach to 1V)	Tp	HO1, HO2, LO1, LO2	Roh=100Ω Rol=20Ω Cload=10nF,	-	250	500	ns
Time tolerant of Input propagation delay time	Tp_diff	HO1, HO2, LO1, LO2	-	-	100	150	ns
Dead time	Tdt	HO1, HO2, LO1, LO2	Rdead=36kΩ	-	0.1	-	μs
			Rdead=200kΩ	-	0.53	-	μs
			Rdead=390kΩ	-	1.02	-	μs
			Rdead=1.2MΩ	-	3.18	-	μs

*Vcp: Charge pump voltage

*Please use that Rdead resistance range is from 1kΩ to 2MΩ.



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＊2：Timing charts may be simplified for explanatory purpose.

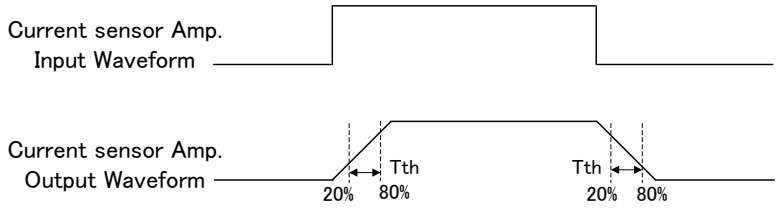
Current Sensor Circuit

Off set Generator

CHARACTERISTIC	SYMBOL	PIN	CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	Vrefout	REFOUT	Vrefin=1.65V	1.635	1.65	1.665	V
Input Bias Current	Iibr	REFIN	Vrefin=1.65V	-5	-	5	μA
Input Off set Voltage	Vio	REFIN	Vrefin=1.65V Output is no load	-15	-	15	mV

Differential Amplifier Circuit

CHARACTERISTIC	SYMBOL	PIN	CONDITION	MIN.	TYP.	MAX.	UNIT
Common mode Input Voltage Range	Vin	AMPM1, AMPP1 AMPM2, AMPP2	Voltage Follower Output is no load	-0.3	-	VCC5A-0.3	V
Input Bias Current	Iib	AMPM1, AMPP1 AMPM2, AMPP2	Voltage Follower Output is no load	-5	-	5	μA
Input Off set Voltage	Vio	AMPM1, AMPP1 AMPM2, AMPP2	Voltage Follower Output is no load Vin = 0.3V to VCC5A-0.3V	-15	-	15	mV
Slew rate	Tth	CS1, CS2	Voltage Follower 20%⇔80% CL=100nF, RL=1kΩ	3	-	-	V/μs
Maximum Output Voltage	Voh	CS1, CS2	Voltage Follower Output is no load	VCC5A-0.3	-	VCC5A	V
Minimum Output Voltage	Vol	CS1, CS2	Voltage Follower Output is no load	0	-	0.3	V

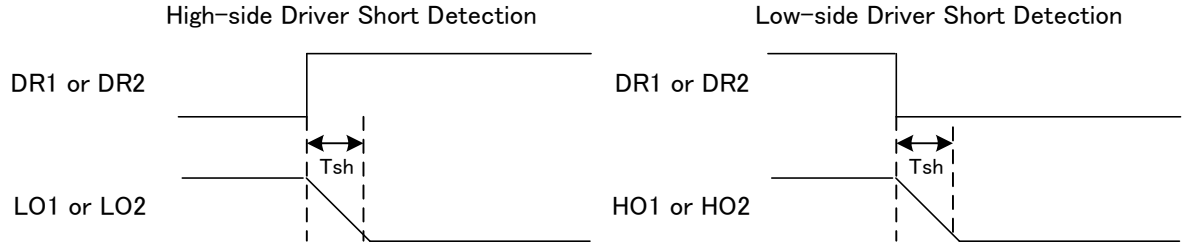


＊1：Timing charts may be simplified for explanatory purpose.

Abnormal Detection Circuit

CHARACTERISTIC	SYMBOL	PIN	CONDITION	MIN.	TYP.	MAX.	UNIT
Low Voltage Detection (VB)	Vcpll	VB	-	4.5	5	5.5	V
Low Voltage Release (VB)	Vcplh	VB	-	5	5.5	6	V
Low Voltage Detection (VDD)	VRSTL	VDD	-	2.7	2.8	2.9	V
Low Voltage Release (VDD)	VRSTH	VDD	-	2.8	2.9	3.0	V
Hysteresis of Low Voltage Detection(VDD)	VRSTHYS		VRSTHYS= VRSTH-VRSTL	-	0.1	-	V
Over Temperature Detection	Tsdh	-	-	-	170	-	°C
Over Temperature Release	Tsdl	-	-	-	160	-	°C
Short detection Filtering time	Tsf	IN5	IN5=68kΩ	-	1	-	μs
			IN5=220kΩ	-	3	-	μs
			IN5=430kΩ	-	6	-	μs
PD voltage range	Vpd	PD	—	0.5	-	4	V
Short detection error	Vsh_diff	PD	—	-120	-	120	mV
Short detection delay time	Tsh	HO1, HO2, LO1, LO2	From Detected Short to Pre-Driver Off (Cload=10nF, Roh=100Ω) ※Filtering time is not included.	-	-	3	μs

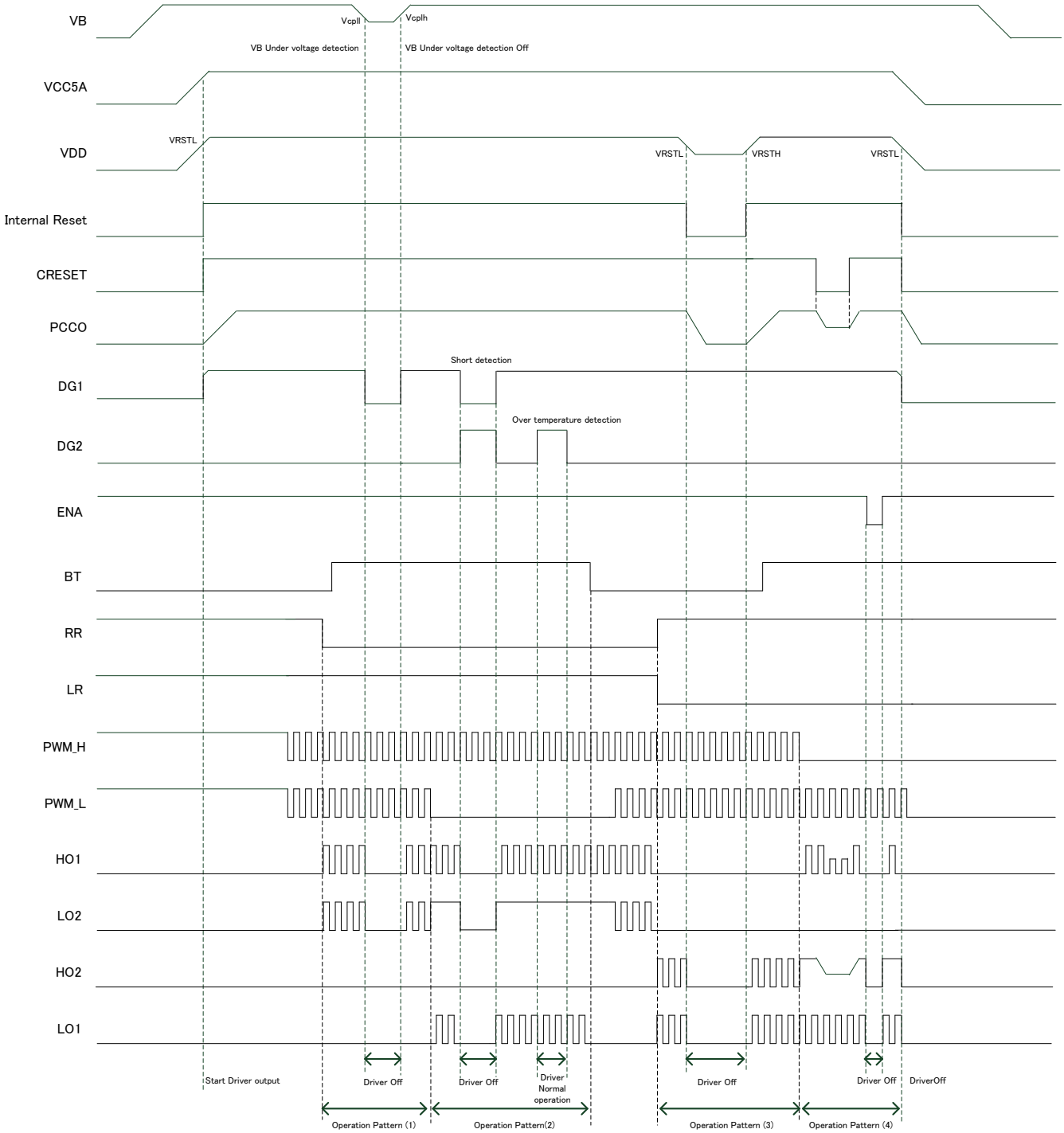
*Please use that IN5 resistance range is from 1kΩ to 2MΩ



＊1：Timing charts may be simplified for explanatory purpose.

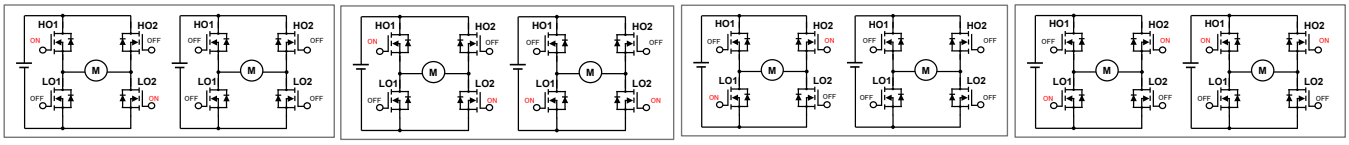
Timing Chart Image

・SEL1 = “Low” (Sequence Control)
・SEL2 = “Low” (When detected Short Detection and VB Under voltage detection, Pre-Driver is OFF)

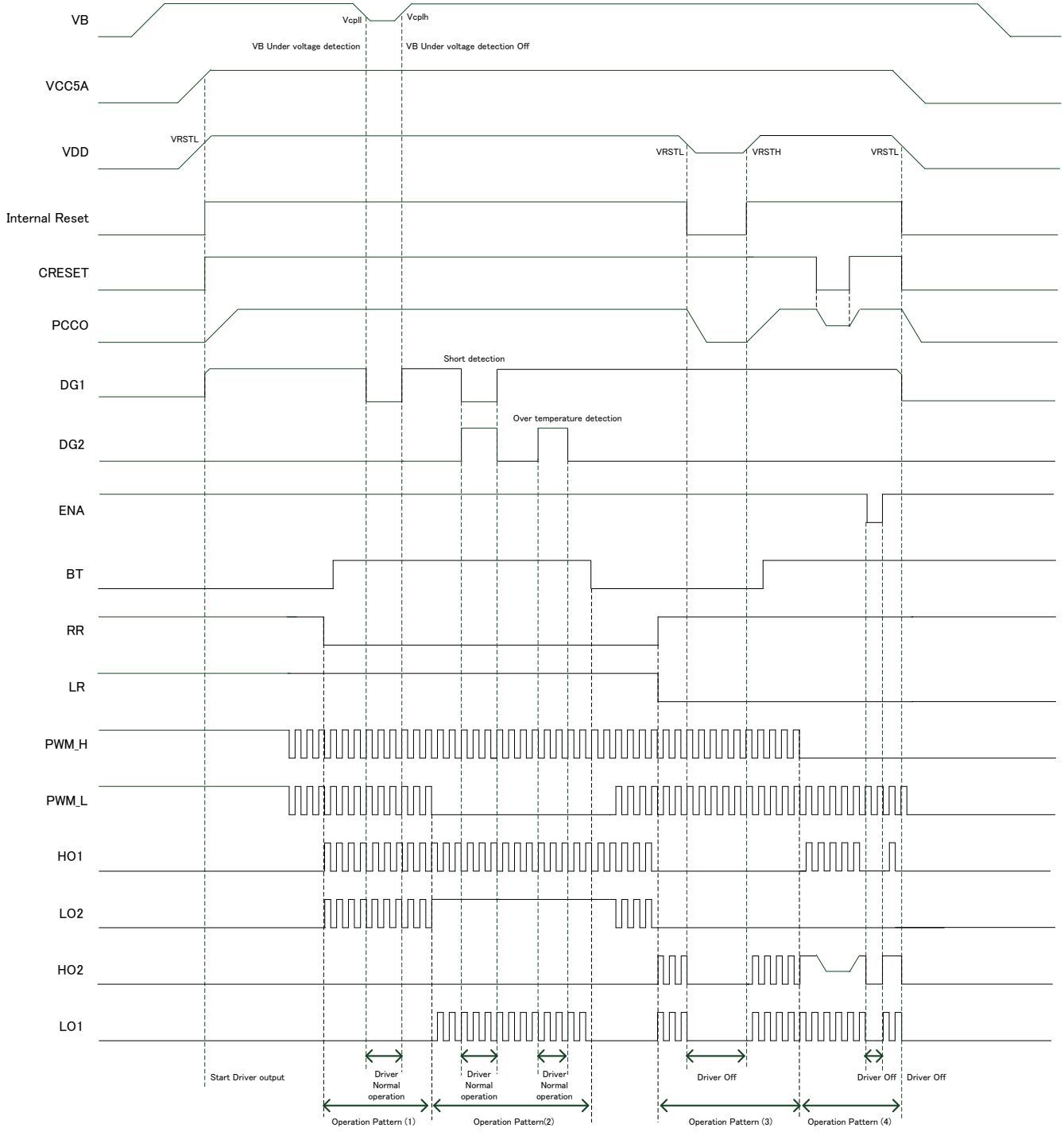


＊1：Timing charts may be simplified for explanatory purpose.
＊2：Please VCC5A connect with VDD or VCC5A turn on before VDD-turn-on.
※Driver operation pattern of above timing chart is as follow.

Driver operation pattern (1) Driver operation pattern (2) Driver operation pattern (3) Driver operation pattern (4)

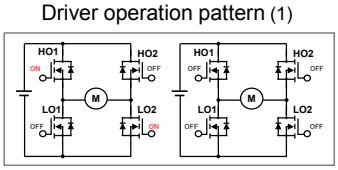


・SEL1 = “Low” (Sequence Control)
・SEL2 = “High” (When detected Short Detection and VB Under voltage detection, Pre-Driver is Normal operation.)

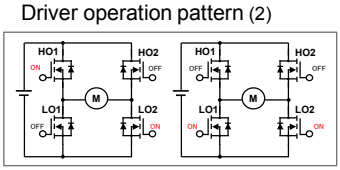


＊1：Timing charts may be simplified for explanatory purpose.
＊2：Please VCC5A connect with VDD or VCC5A turn on before VDD-turn-on.
※Driver operation pattern of above timing chart is as follow.

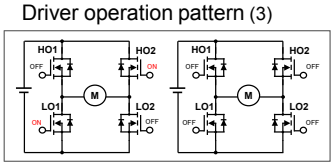
Driver operation pattern (1)



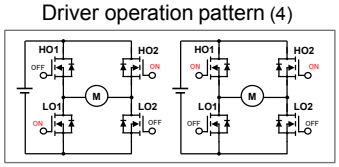
Driver operation pattern (2)



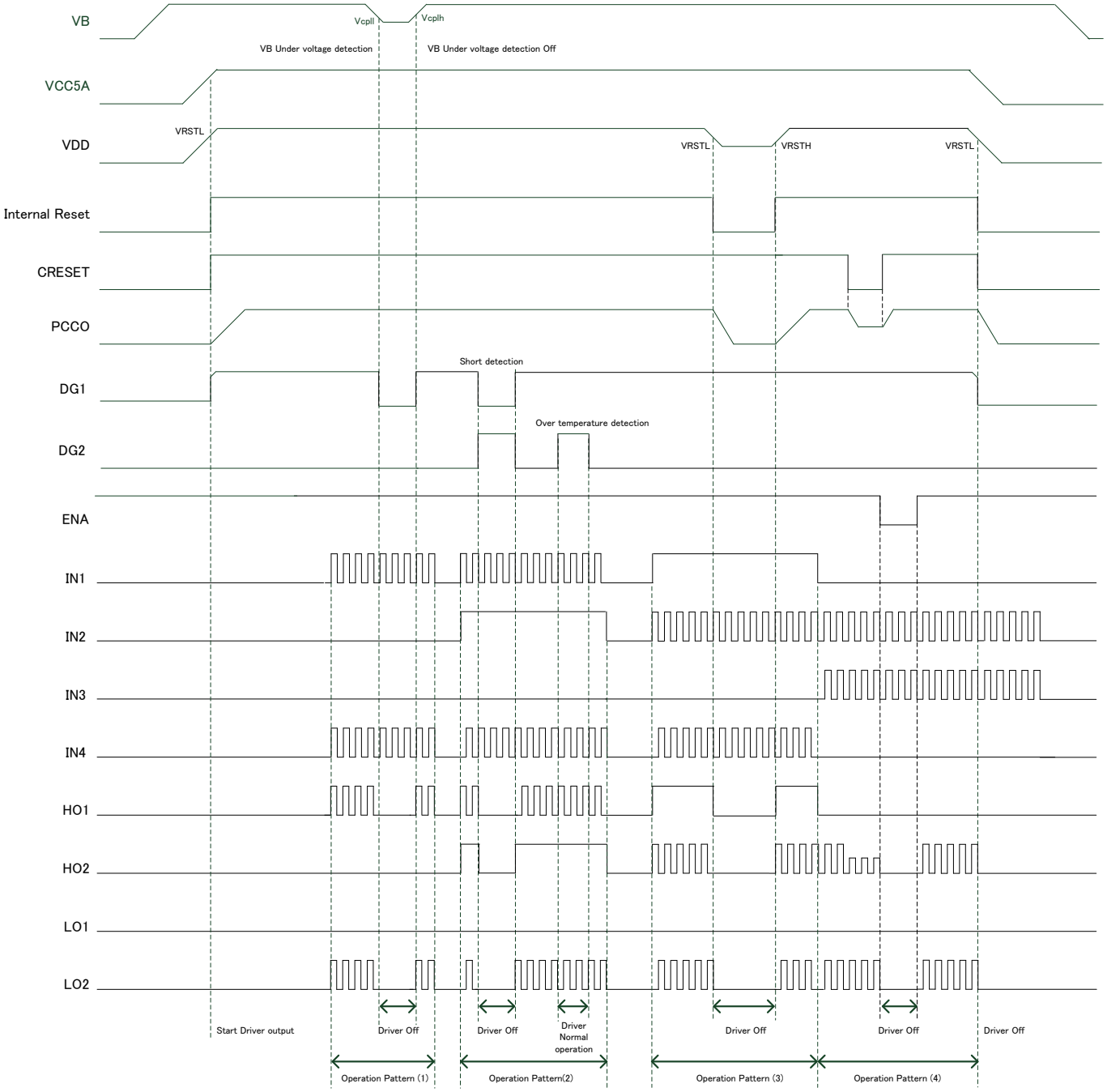
Driver operation pattern (3)



Driver operation pattern (4)

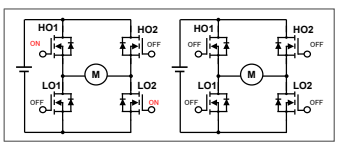


・SEL1 = “High” (Direct Control)
・SEL2 = “Low” (When detected Short Detection and VB Under voltage detection, Pre-Driver is OFF)

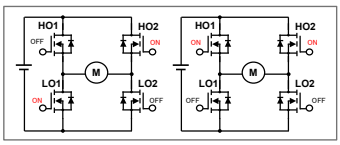


＊1：Timing charts may be simplified for explanatory purpose.
＊2：Please VCC5A connect with VDD or VCC5A turn on before VDD-turn-on.
※Driver operation pattern of above timing chart is as follow.

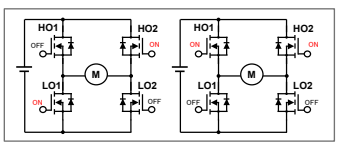
Driver operation pattern (1)



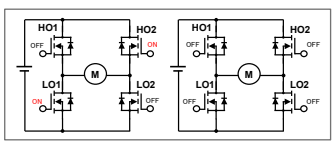
Driver operation pattern (2)



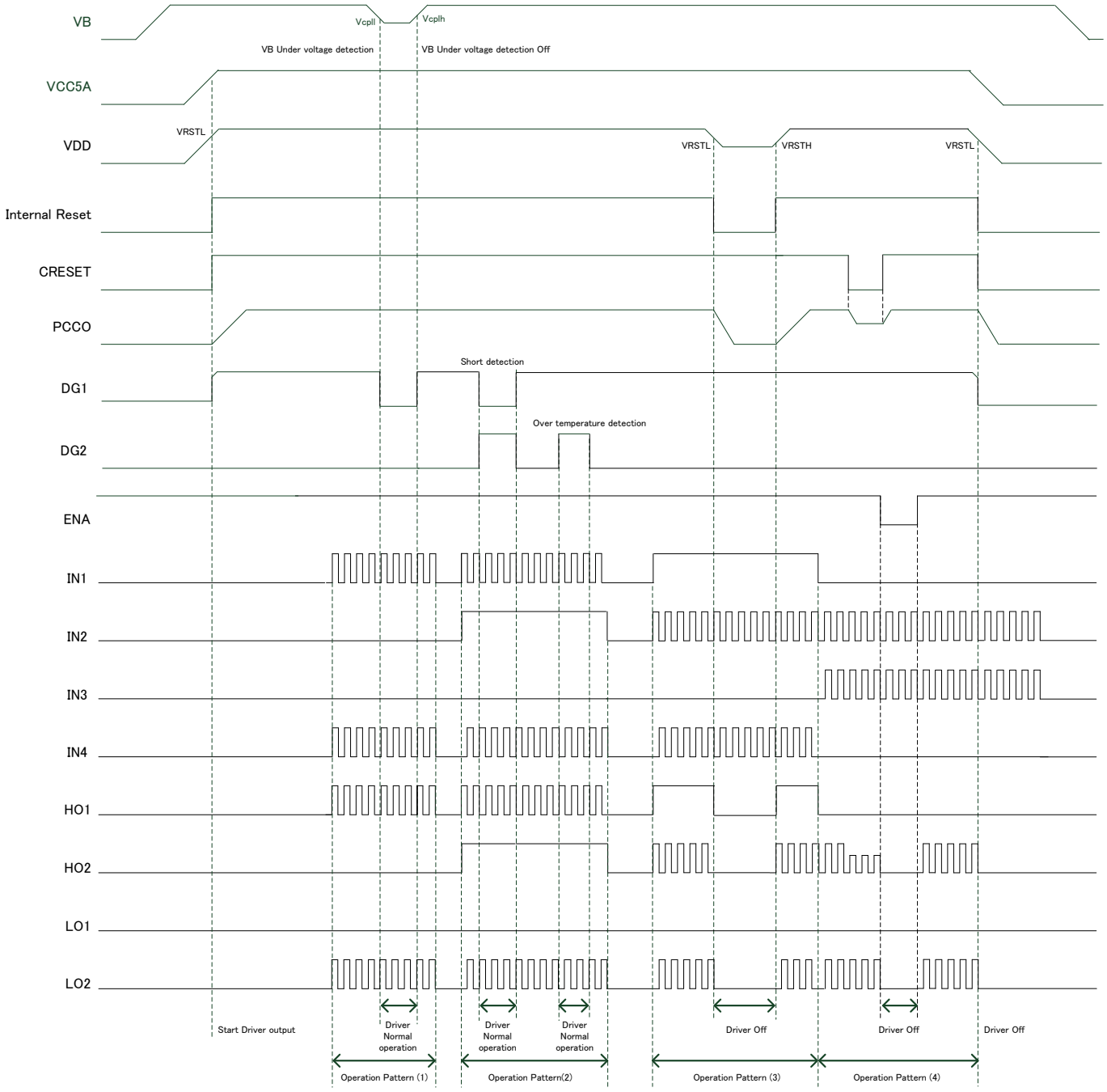
Driver operation pattern (3)



Driver operation pattern (4)

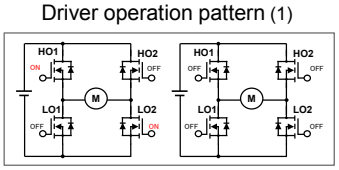


・SEL1 = “High” (Sequence Control)
・SEL2 = “High” (When detected Short Detection and VB Under voltage detection, Pre-Driver is Normal operation.)

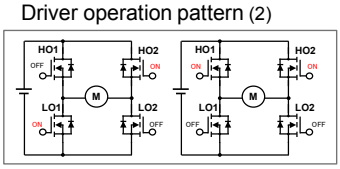


＊1：Timing charts may be simplified for explanatory purpose.
＊2：Please VCC5A connect with VDD or VCC5A turn on before VDD-turn-on.
※Driver operation pattern of above timing chart is as follow.

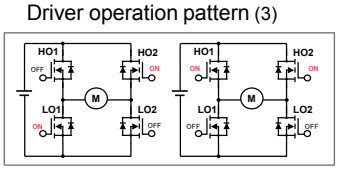
Driver operation pattern (1)



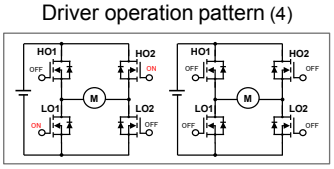
Driver operation pattern (2)



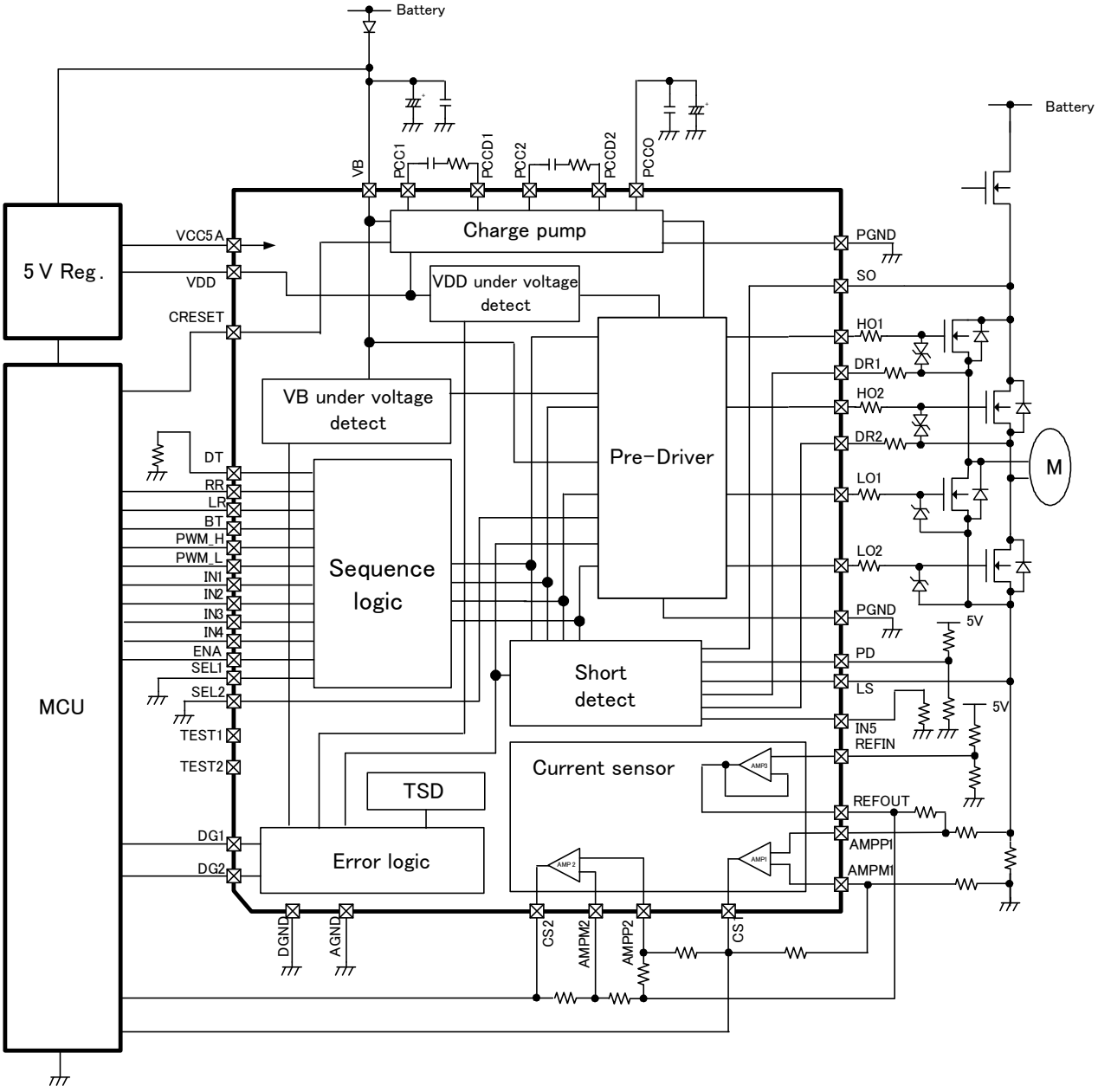
Driver operation pattern (3)



Driver operation pattern (4)



Reference Circuit Diagram



＊1：Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purpose.

＊2： The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purpose.

＊3： Timing charts may be simplified for explanatory purpose.

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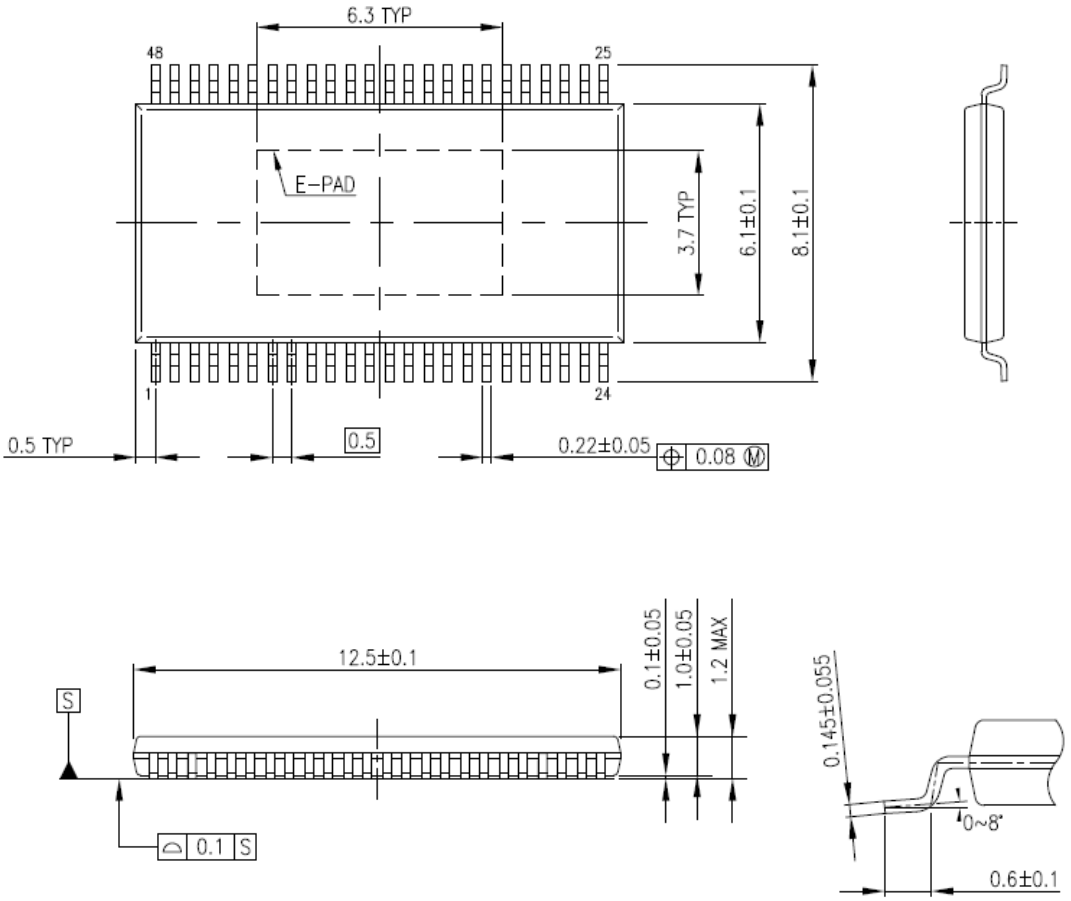
PACKAGE

HTSSOP48-P-300-0.50

Unit: mm



Weight: 0.24g(typ.)

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