

# 250 V to 600 V, 1.5 A to 2.5 A High Voltage 3-phase Motor Driver ICs SLA/SMA6820MH Series



## Data Sheet

### Description

SLA/SMA6820MH series are high voltage 3-phase motor driver ICs in which transistors, pre-driver ICs (MICs), and bootstrap circuits (diodes and resistors) are highly integrated.

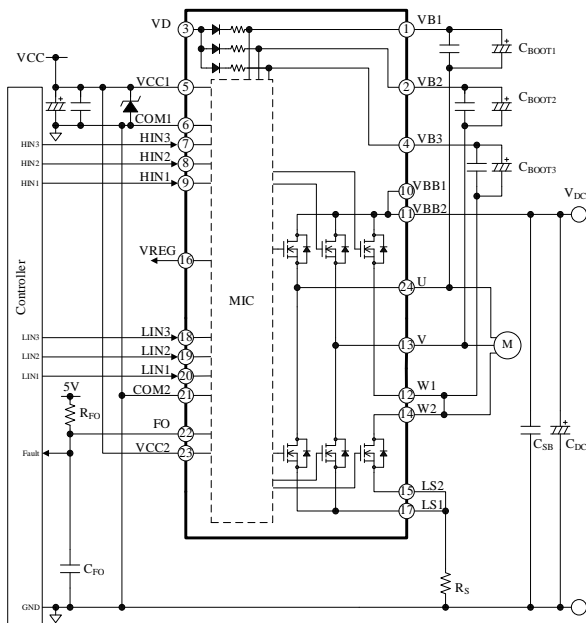
You can select from the fully-molded type or the heatsink-type ZIP24 package according to your mounting condition.

SLA/SMA6820MH series are optimal for the inverting control of small to middle power motors.

### Features

- Built-in Bootstrap Diodes with Current Limiting Resistors (22 Ω)
- CMOS-compatible Input (3.3 or 5 V)
- Fault Signal Output (FO pin)
- 7.5 V Regulator Output
- Bare lead frame: Pb-free (RoHS compliant)
- Protections
  - Undervoltage Lockout for Power Supply
    - High-side (UVLO\_VB): Auto-restart
    - Low-side (UVLO\_VCC): Auto-restart
  - Thermal Detection (TD): Fault Signal Output

### Typical Application



### Packages

ZIP24  
Fully Molded Type  
(SMA682xMH)

Heatsink Type  
(SLA6826MH)



LF No. 2451



LF No. 2175



LF No. 2452



LF No. 2171  
Not to scale

### Selection Guide

#### • Packages

Package	Part Number
Fully Molded Type	SMA682xMH
Heatsink Type	SLA6826MH

#### • Output Characteristic

V <sub>DSS</sub>	I <sub>O</sub>	Part Number
250 V	2.0 A	SLA6826MH
		SMA6821MH
500 V	1.5 A	SMA6822MH
	2.5 A	SMA6823MH
600 V	1.5 A	SMA6824MH

### Applications

- Washing Machine Fan Motor and Pump Motor
- Air Conditioner Fan Motor
- Air Cleaner Fan Motor
- Fan Motor for Electric Stand Fan

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## SLA/SMA6820MH Series

### 1. Absolute Maximum Ratings

Current polarities are defined as follows: a current flow going into the IC (sinking) is positive current (+); and a current flow coming out of the IC (sourcing) is negative current (-).

Unless specifically noted,  $T_A = 25^\circ\text{C}$ , COM1 = COM2 that is called COM.

Characteristic	Symbol	Conditions	Rating	Unit	Remarks
MOSFET Breakdown Voltage	$V_{DSS}$	$I_D = 100 \mu\text{A}$ $V_{INx} = 0 \text{ V}$	250	V	SLA6826MH SMA6821MH
			500		SMA6822MH SMA6823MH
			600		SMA6824MH
Logic Supply Voltage	$V_{CC}$	VCC1-COM VCC2-COM	20	V	
Bootstrap Supply Voltage	$V_{BS}$	VB1-U VB2-V VB3-W1	20	V	
Output Current (DC)	$I_O$	$T_C = 25^\circ\text{C}$	1.5	A	SMA6822MH SMA6824MH
			2.0		SLA6826MH SMA6821MH
			2.5		SMA6823MH
Output Current (Pulse)	$I_{OP}$	$T_C = 25^\circ\text{C}$ , $P_W \leq 100 \mu\text{s}$ , Duty = 1%	2.25	A	SMA6822MH SMA6824MH
			3.0		SLA6826MH SMA6821MH
			3.75		SMA6823MH
Regulator Output Current	$I_{REG}$		35	mA	
Input Voltage	$V_{IN}$	HIN1-COM HIN2-COM HIN3-COM LIN1-COM LIN2-COM LIN3-COM	-0.5 to 7	V	
Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$	28	W	SMA682xMH
			32		SLA6826MH
Operating Case Temperature	$T_{C(OP)}$		-30 to 100	$^\circ\text{C}$	
Junction Temperature	$T_j$		150	$^\circ\text{C}$	
Storage Temperature	$T_{stg}$		-40 to 150	$^\circ\text{C}$	

## SLA/SMA6820MH Series

### 2. Recommended Operating Conditions

Unless specifically noted,  $T_A = 25^\circ\text{C}$ , COM1 = COM2 that is called COM.

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Main Supply Voltage	$V_{DC}$	VBB-LS1 VBB-LS2	—	150	200	V	SLA6826MH SMA6821MH
			—	300	400	V	SMA6822MH SMA6823MH
			—	300	450	V	SMA6824MH
Logic Supply Voltage	$V_{CC}$	VCC1-COM VCC2-COM	13.5	—	16.5	V	
Dead Time of Input Signal	$t_{DEAD}$	$T_J = -25$ to $150^\circ\text{C}$	1.5	—	—	Ms	
Minimum Input Pulse Width	$t_{IN\_MIN(ON)}$	$T_J = -25$ to $150^\circ\text{C}$	0.5	—	—	$\mu\text{s}$	
	$t_{IN\_MIN(OFF)}$	$T_J = -25$ to $150^\circ\text{C}$	0.5	—	—	$\mu\text{s}$	

### 3. Electrical Characteristics

Current polarities are defined as follows: a current flow going into the IC (sinking) is positive current (+); and a current flow coming out of the IC (sourcing) is negative current (-).

Unless specifically noted,  $V_{CC} = 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , COM1 = COM2 that is called COM.

#### 3.1. Characteristics of Control Parts

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Logic Supply Current	$I_{CC}$	$I_{REG} = 0\text{ A}$	—	4	6	mA	
Input Voltage	$V_{IH}$		—	2.0	2.5	V	All transistors on state.
	$V_{IL}$		1.0	1.5	—	V	All transistors off state.
	$V_{HYS}$		—	0.5	—	V	
Input Current	$I_{IH}$	$IN_x = 5\text{ V}$	—	50	100	$\mu\text{A}$	
	$I_{IL}$	$IN_x = 0\text{ V}$	—	—	2	$\mu\text{A}$	
Undervoltage Lockout for Power Supply (High side)	$V_{UVHL}$	VB1-U VB2-V VB3-W1	9.0	10.0	11.0	V	
	$V_{UVHH}$		9.5	10.5	11.5	V	
	$V_{UV\_HYS}$		—	0.5	—	V	
Undervoltage Lockout for Power Supply (Low side)	$V_{UVLL}$	VCC1-COM VCC2-COM	10.0	11.0	12.0	V	
	$V_{UVLH}$		10.5	11.5	12.5	V	
	$V_{UV\_HYS}$		—	0.5	—	V	
FO Pin Output Voltage	$V_{FOL}$		0	—	1.0	V	
	$V_{FOH}$		4.0	—	5.5	V	
Thermal Detection Threshold Temperature	$T_{DH}$	$I_{REG} = 0\text{ mA}$ , No heatsink	135	150	165	$^\circ\text{C}$	
	$T_{DL}$		105	120	135	$^\circ\text{C}$	
	$T_{D\_HYS}$		—	30	—	$^\circ\text{C}$	
Regulator Output Voltage	$V_{REG}$	$I_{REG} = 0$ to $35\text{ mA}$	6.75	7.5	8.25	V	

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### 3.2. Bootstrap Diode Characteristics

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Bootstrap Diode Forward Voltage	$V_{FB}$	$I_{FB} = 0.15 \text{ A}$	—	1.1	1.3	V	
Bootstrap Diode Leakage Current	$I_{LBD}$	$V_R = 250 \text{ V}$	—	—	10	$\mu\text{A}$	SLA6826MH SMA6821MH
		$V_R = 500 \text{ V}$	—	—	10		SMA6822MH SMA6823MH
		$V_R = 600 \text{ V}$	—	—	10		SMA6824MH
Bootstrap Diode Series Resistor	$R_B$		17.6	22.0	26.4	$\Omega$	

### 3.3. Thermal Resistance Characteristics

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Junction-to-Case Thermal Resistance	$R_{J-C}$	All transistors operation	—	—	4.46	$^{\circ}\text{C/W}$	SMA682xMH
			—	—	3.8		SLA6826MH
Junction-to-Ambient Thermal Resistance	$R_{J-A}$	All transistors operation	—	—	31.25	$^{\circ}\text{C/W}$	SMA682xMH

3.4. Transistor Characteristics

Figure 3-1 shows the definition of switching characteristics.

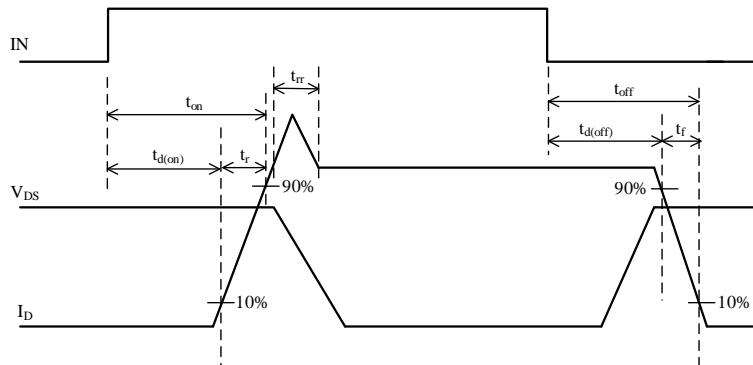


Figure 3-1. Switching Characteristics Definitions

3.4.1. SLA6826MH

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-to-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 250 V, V <sub>IN</sub> = 0 V	—	—	100	μA
Drain-to-Source Saturation Voltage	R <sub>DS(ON)</sub>	I <sub>D</sub> = 1.0 A, V <sub>IN</sub> = 5 V	—	1.25	1.5	Ω
Source-to-Drain Diode Forward Voltage	V <sub>SD</sub>	I <sub>SD</sub> = 1.0 A, V <sub>IN</sub> = 0 V	—	1.1	1.5	V
<b>High-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	t <sub>rr</sub>	V <sub>DC</sub> = 150 V, I <sub>D</sub> = 2.0 A, V <sub>IN</sub> = 0 ~ 5 V, T <sub>J</sub> = 25 °C, inductive load	—	65	—	ns
Turn-on Delay Time	t <sub>d(on)</sub>		—	430	—	ns
Rise Time	t <sub>r</sub>		—	55	—	ns
Turn-off Delay Time	t <sub>d(off)</sub>		—	355	—	ns
Fall Time	t <sub>f</sub>		—	20	—	ns
<b>Low-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	t <sub>rr</sub>	V <sub>DC</sub> = 150 V, I <sub>D</sub> = 2.0 A, V <sub>IN</sub> = 0 ~ 5 V, T <sub>J</sub> = 25 °C, inductive load	—	65	—	ns
Turn-on Delay Time	t <sub>d(on)</sub>		—	505	—	ns
Rise Time	t <sub>r</sub>		—	60	—	ns
Turn-off Delay Time	t <sub>d(off)</sub>		—	495	—	ns
Fall Time	t <sub>f</sub>		—	20	—	ns

## SLA/SMA6820MH Series

### 3.4.2. SMA6821MH

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-to-Source Leakage Current	$I_{DSS}$	$V_{DS} = 250 \text{ V}, V_{IN} = 0 \text{ V}$	—	—	100	$\mu\text{A}$
Drain-to-Source Saturation Voltage	$R_{DS(ON)}$	$I_D = 1.0 \text{ A}, V_{IN} = 5 \text{ V}$	—	1.25	1.5	$\Omega$
Source-to-Drain Diode Forward Voltage	$V_{SD}$	$I_{SD} = 1.0 \text{ A}, V_{IN} = 0 \text{ V}$	—	1.1	1.5	V
<b>High-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 150 \text{ V}, I_D = 2.0 \text{ A}, V_{IN} = 0 \sim 5 \text{ V}, T_J = 25 \text{ }^\circ\text{C},$ inductive load	—	65	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	430	—	ns
Rise Time	$t_r$		—	55	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	355	—	ns
Fall Time	$t_f$		—	20	—	ns
<b>Low-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 150 \text{ V}, I_D = 2.0 \text{ A}, V_{IN} = 0 \sim 5 \text{ V}, T_J = 25 \text{ }^\circ\text{C},$ inductive load	—	65	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	505	—	ns
Rise Time	$t_r$		—	60	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	495	—	ns
Fall Time	$t_f$		—	20	—	ns

### 3.4.3. SMA6822MH

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-to-Source Leakage Current	$I_{DSS}$	$V_{DS} = 500 \text{ V}, V_{IN} = 0 \text{ V}$	—	—	100	$\mu\text{A}$
Drain-to-Source Saturation Voltage	$R_{DS(ON)}$	$I_D = 0.75 \text{ A}, V_{IN} = 5 \text{ V}$	—	3.2	4.0	$\Omega$
Source-to-Drain Diode Forward Voltage	$V_{SD}$	$I_{SD} = 0.75 \text{ A}, V_{IN} = 0 \text{ V}$	—	1.1	1.5	V
<b>High-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 300 \text{ V}, I_D = 1.5 \text{ A}, V_{IN} = 0 \sim 5 \text{ V}, T_J = 25 \text{ }^\circ\text{C},$ inductive load	—	120	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	485	—	ns
Rise Time	$t_r$		—	85	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	420	—	ns
Fall Time	$t_f$		—	30	—	ns
<b>Low-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 300 \text{ V}, I_D = 1.5 \text{ A}, V_{IN} = 0 \sim 5 \text{ V}, T_J = 25 \text{ }^\circ\text{C},$ inductive load	—	130	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	620	—	ns
Rise Time	$t_r$		—	100	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	585	—	ns
Fall Time	$t_f$		—	25	—	ns

## SLA/SMA6820MH Series

### 3.4.4. SMA6823MH

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-to-Source Leakage Current	$I_{DSS}$	$V_{DS} = 500\text{ V}, V_{IN} = 0\text{ V}$	—	—	100	$\mu\text{A}$
Drain-to-Source Saturation Voltage	$R_{DS(ON)}$	$I_D = 1.25\text{ A}, V_{IN} = 5\text{ V}$	—	2.0	2.4	$\Omega$
Source-to-Drain Diode Forward Voltage	$V_{SD}$	$I_{SD} = 1.25\text{ A}, V_{IN} = 0\text{ V}$	—	1.1	1.5	V
<b>High-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 300\text{ V}, I_D = 2.5\text{ A}, V_{IN} = 0 \sim 5\text{ V}, T_J = 25\text{ }^\circ\text{C},$ inductive load	—	170	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	700	—	ns
Rise Time	$t_r$		—	165	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	580	—	ns
Fall Time	$t_f$		—	40	—	ns
<b>Low-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 300\text{ V}, I_D = 2.5\text{ A}, V_{IN} = 0 \sim 5\text{ V}, T_J = 25\text{ }^\circ\text{C},$ inductive load	—	170	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	800	—	ns
Rise Time	$t_r$		—	180	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	690	—	ns
Fall Time	$t_f$		—	35	—	ns

### 3.4.5. SMA6824MH

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-to-Source Leakage Current	$I_{DSS}$	$V_{DS} = 600\text{ V}, V_{IN} = 0\text{ V}$	—	—	100	$\mu\text{A}$
Drain-to-Source Saturation Voltage	$R_{DS(ON)}$	$I_D = 0.75\text{ A}, V_{IN} = 5\text{ V}$	—	2.9	3.5	$\Omega$
Source-to-Drain Diode Forward Voltage	$V_{SD}$	$I_{SD} = 0.75\text{ A}, V_{IN} = 0\text{ V}$	—	1.0	1.5	V
<b>High-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 300\text{ V}, I_D = 1.5\text{ A}, V_{IN} = 0 \sim 5\text{ V}, T_J = 25\text{ }^\circ\text{C},$ inductive load	—	155	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	685	—	ns
Rise Time	$t_r$		—	115	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	555	—	ns
Fall Time	$t_f$		—	55	—	ns
<b>Low-side Switching</b>						
Source-to-Drain Diode Reverse Recovery Time	$t_{rr}$	$V_{DC} = 300\text{ V}, I_D = 1.5\text{ A}, V_{IN} = 0 \sim 5\text{ V}, T_J = 25\text{ }^\circ\text{C},$ inductive load	—	155	—	ns
Turn-on Delay Time	$t_{d(on)}$		—	740	—	ns
Rise Time	$t_r$		—	130	—	ns
Turn-off Delay Time	$t_{d(off)}$		—	670	—	ns
Fall Time	$t_f$		—	35	—	ns



**4. Truth Table**

Table 4-1 is a truth table that provides the logic level definitions of operation modes.

In the case where HINx and LINx signals in each phase are high at the same time, both the high-side and low-side transistors are set on (simultaneous on-state). You must set the input signals so that the simultaneous on-state is not occurred.

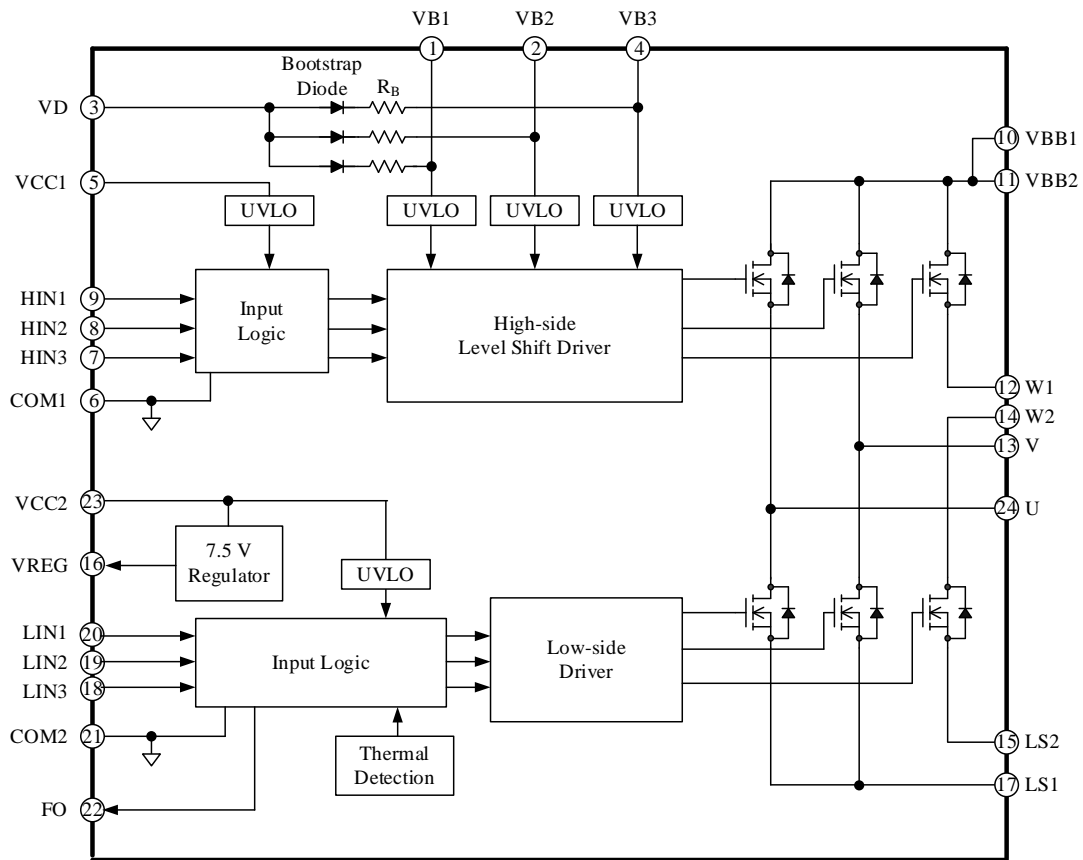
After recovering from a UVLO\_VCC condition, the high-side and low-side transistors resume switching according to the input logic levels of the next HINx and LINx signals (level-triggered).

After recovering from a UVLO\_VB condition, the high-side transistors resume switching at the next rising edge of an HIN signal (edge-triggered).

Table 4-1. Truth Table for Operation Modes

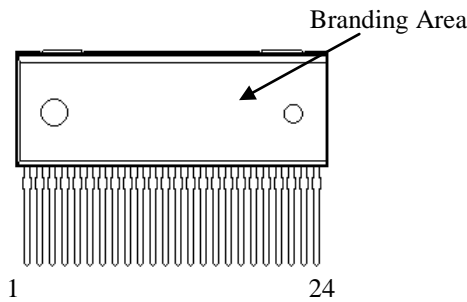
Mode	HINx	LINx	High-side Transistors	Low-side Transistors
Normal Operation	L	L	OFF	OFF
	H	L	ON	OFF
	L	H	OFF	ON
	H	H	ON	ON
High-side Undervoltage Lockout for Power Supply (UVLO_VB)	L	L	OFF	OFF
	H	L	OFF	OFF
	L	H	OFF	ON
	H	H	OFF	ON
Low-side Undervoltage Lockout for Power Supply (UVLO_VCC)	L	L	OFF	OFF
	H	L	OFF	OFF
	L	H	OFF	OFF
	H	H	OFF	OFF
Thermal Detection (TD)	L	L	OFF	OFF
	H	L	ON	OFF
	L	H	OFF	ON
	H	H	ON	ON

5. Block Diagram

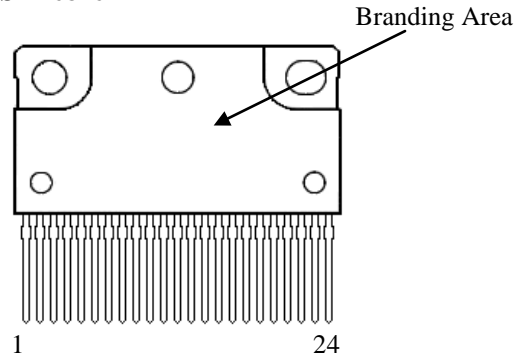


6. Pin Configuration Definitions

SMA682xMH



SLA6826MH



Pin Number	Pin Name	Functions
1	VB1	U-phase high-side floating supply voltage input
2	VB2	V-phase high-side floating supply voltage input
3	VD	Anode of bootstrap diodes
4	VB3	W-phase high-side floating supply voltage input
5	VCC1	High side logic supply voltage input
6	COM1	High side logic ground
7	HIN3	Logic input for W-phase high-side gate driver
8	HIN2	Logic input for V-phase high-side gate driver
9	HIN1	Logic input for U-phase high-side gate driver
10	VBB1	Positive DC bus supply voltage (be connected to VBB2 by PCB trace)
11	VBB2	Positive DC bus supply voltage (be connected to VBB2 by PCB trace)
12	W1	W-phase output (be connected to W2 by PCB trace)
13	V	V-phase output
14	W2	W-phase output (be connected to W1 by PCB trace)
15	LS2	U and V-phase power MOSFET Source (be connected to LS1 by PCB trace)
16	VREG	Regulator output
17	LS1	W-phase power MOSFET Source (be connected to LS2 by PCB trace)
18	LIN3	Logic input for W-phase low-side gate driver
19	LIN2	Logic input for V-phase low-side gate driver
20	LIN1	Logic input for U-phase low-side gate driver
21	COM2	Low side logic ground
22	FO	Fault signal output for thermal detection and UVLO, active high
23	VCC2	Low side logic supply voltage input
24	U	U-phase output

7. Typical Application

Capacitors should be placed near the IC. If the circuit noise is large, connect the noise reduction ceramic capacitor to the electrolytic capacitor in parallel.

Pull down resistance (about 100 kΩ) is built-in the HINx pin and the LINx pin. If the unstable signal or noisy signal may be input, connect the resistor in external to the HINx pin and the LINx pin.

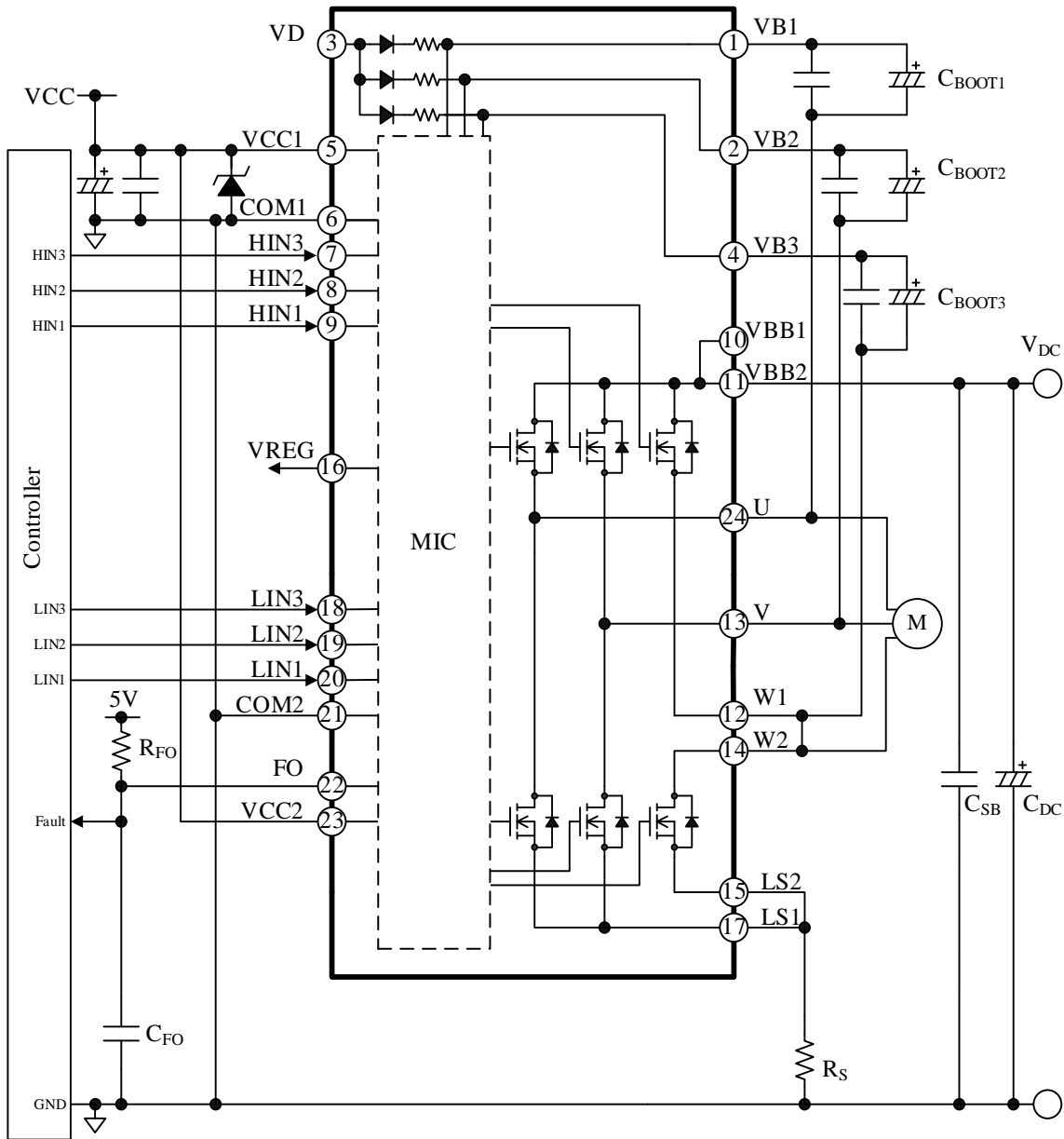


Figure 7-1. Typical Application

8. Timing Chart in Protection Operation

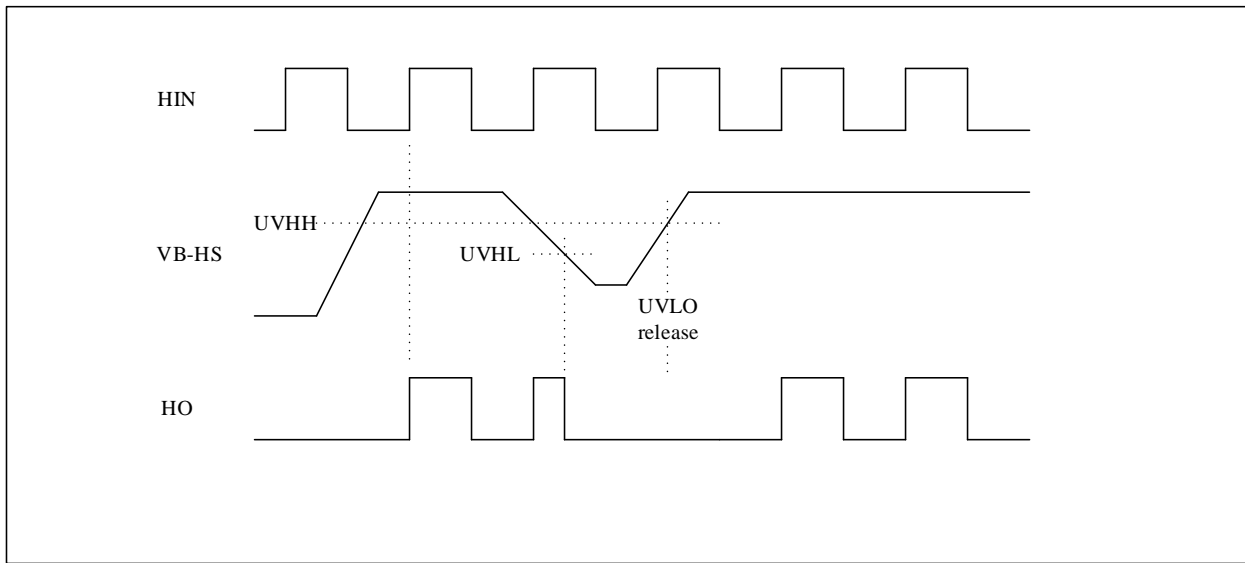


Figure 8-1. High-side Undervoltage Lockout for Power Supply (UVLO\_VB)

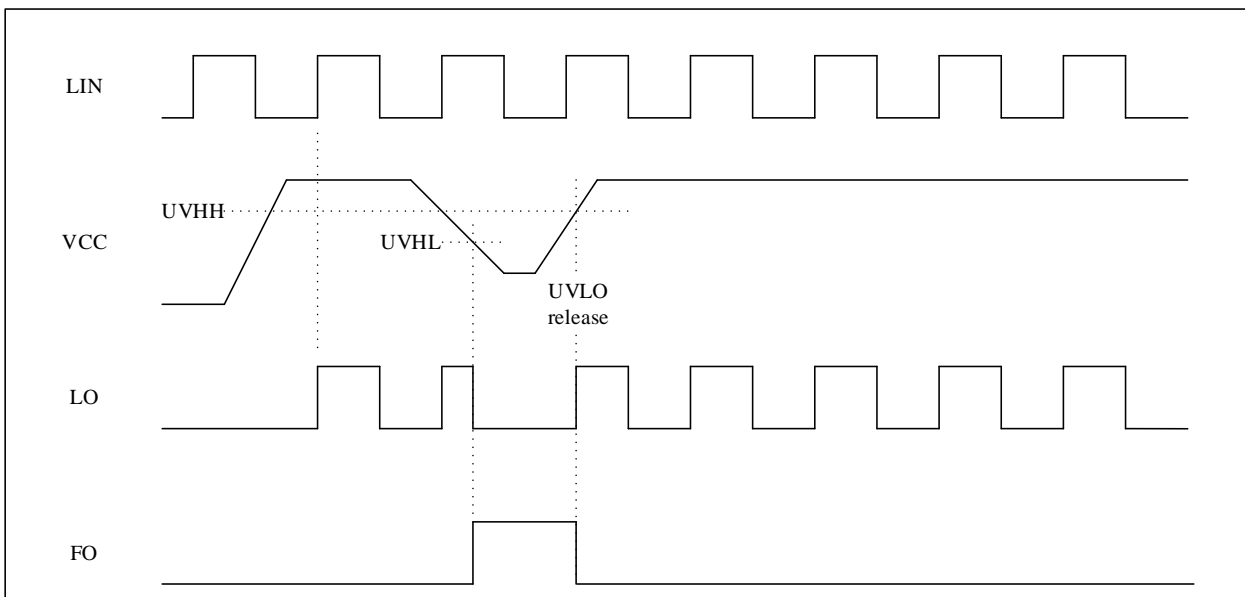


Figure 8-2. Low-side Undervoltage Lockout for Power Supply (UVLO\_VCC)

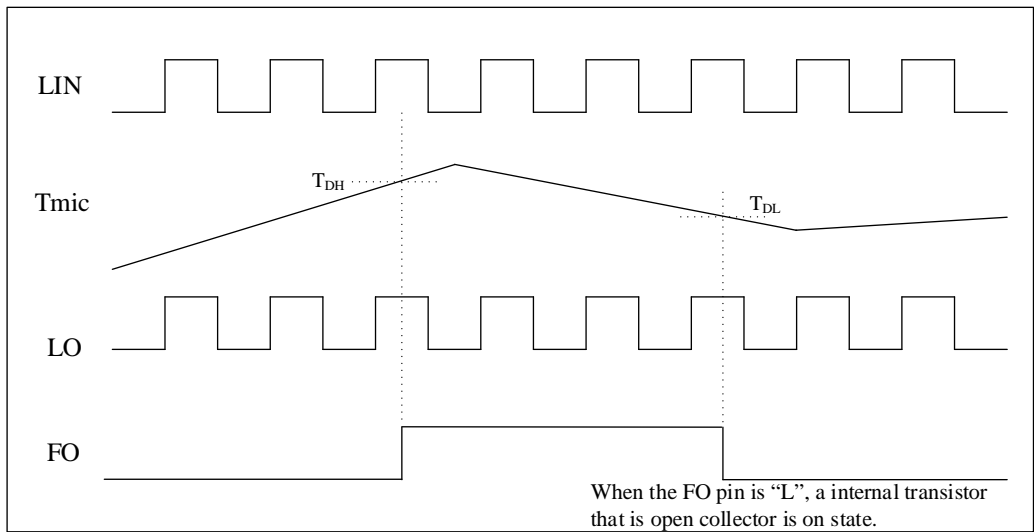


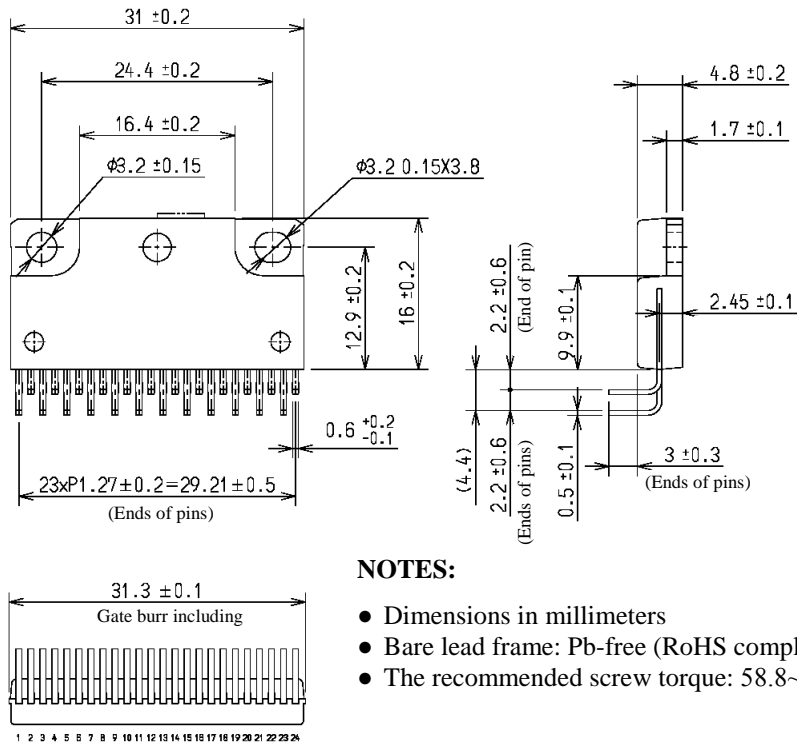
Figure 8-3. Thermal Detection (TD)



# SLA/SMA6820MH Series

## 9.2. ZIP24 (Heatsink Type)

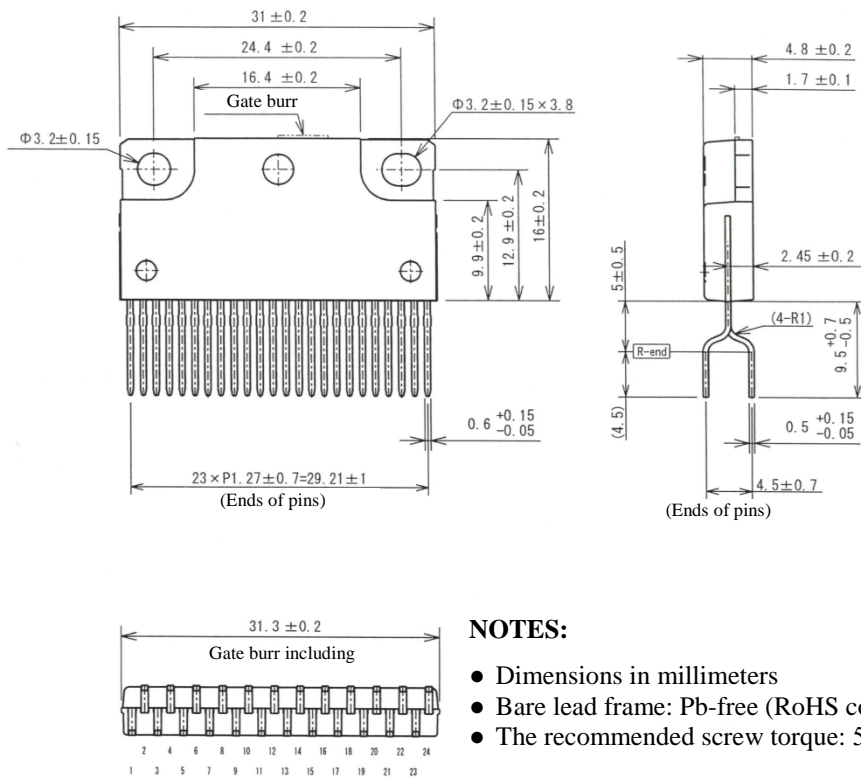
### • LF No. 2175



### NOTES:

- Dimensions in millimeters
- Bare lead frame: Pb-free (RoHS compliant)
- The recommended screw torque: 58.8~78.4N·cm (6.0 ~ 8.0 kgf·cm)

### • LF No. 2171



### NOTES:

- Dimensions in millimeters
- Bare lead frame: Pb-free (RoHS compliant)
- The recommended screw torque: 58.8~78.4N·cm (6.0 ~ 8.0 kgf·cm)

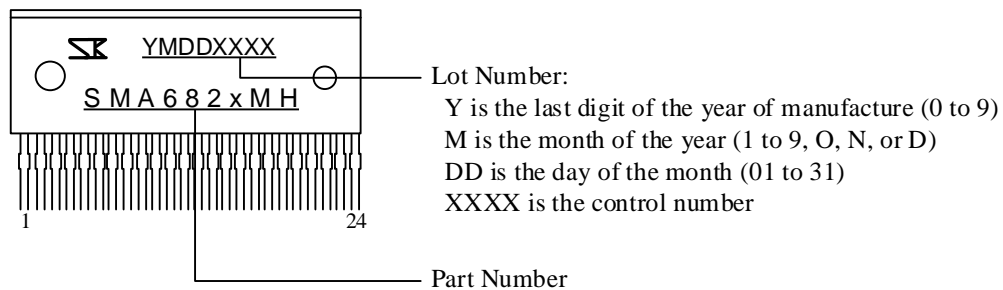
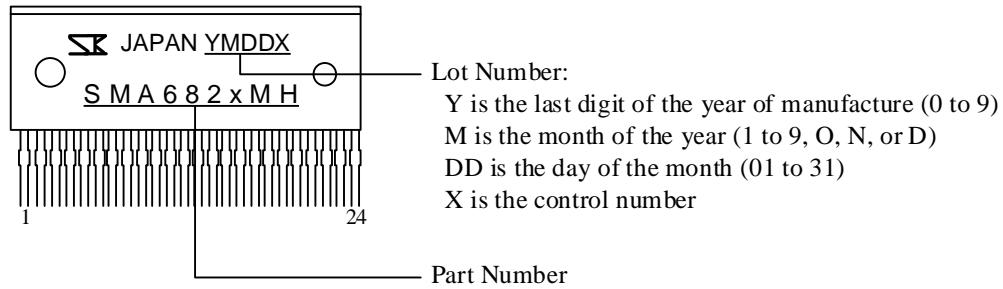


## SLA/SMA6820MH Series

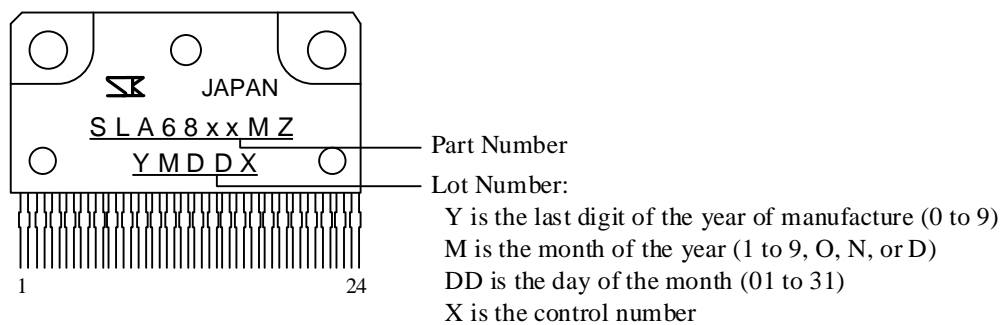
### 10. Marking Diagrams

#### 10.1. ZIP24 (Full Molded Type)

The marking diagrams of ZIP24 package is either in follows:



#### 10.2. ZIP24 (Heatsink Type)



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