



# FSB43004A

## Motion SPM<sup>®</sup> 45 Series

### Features

- UL Certified No.E209204(UL-1557)
- 40 V,  $R_{DS(ON)}=3.0\text{ m}\Omega(\text{max.})$  3-phase MOSFET Inverter Module Including Control IC for Gate Drive and Protection.
- Ceramic Substrate.
- Three Separate Open-Emitter Pins from Low-Side MOSFETs for Three-Leg Current Sensing.
- Single-Grounded Power Supply for Built-in HVIC.
- Isolation Rating of 800 Vrms/min.

### General Description

FSB43004A is a Motion SPM<sup>®</sup> 45 series that Fairchild developed based on low-loss Power Trench MOSFET technology as a compact motor drive inverter solution for small power applications supplied by low voltage battery.

### Applications

Motion Control - Home Appliance / Industrial Motor.



Figure 1. Packing Overview

### Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FSB43004A	FSB43304A	SPMAA-A22	Rail	14

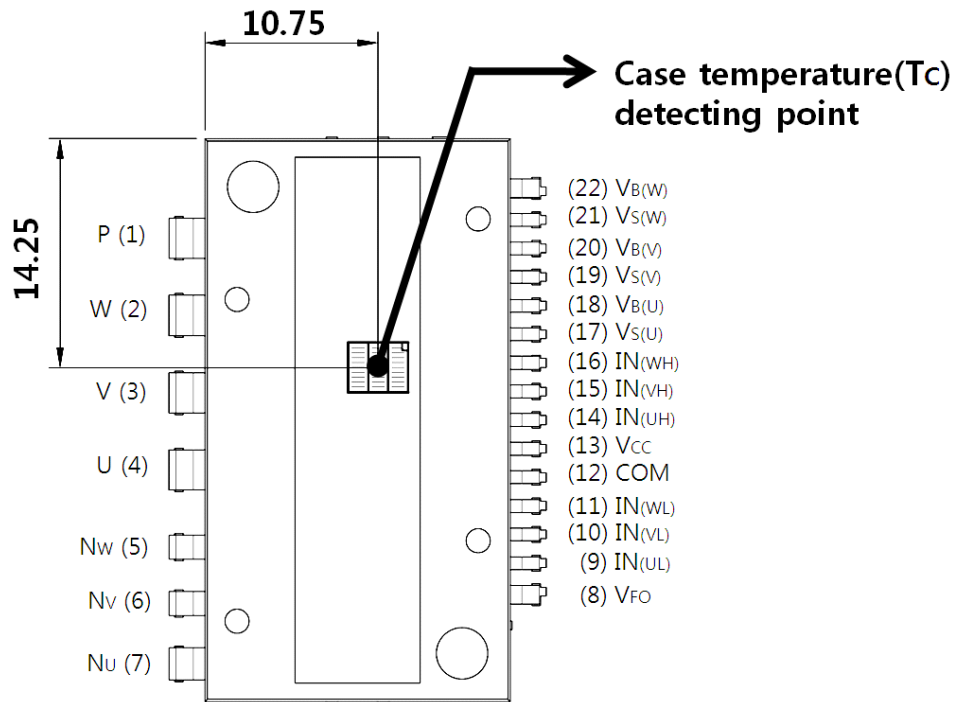
### Integrated Power Functions

- 40 V  $R_{DS(ON)} = 2.1 \text{ m}\Omega$ (typ.) inverter for three-phase DC / AC power conversion (please refer to Figure 3)

### Integrated Drive, Protection, and System Control Functions

- For inverter high-side MOSFETs: gate drive circuit, high-voltage isolated high-speed level shifting, Under-Voltage Protection.
- For inverter low-side IGBTs: gate drive circuit, Under-Voltage Protection.
- Fault signaling: Corresponding to UV (low-side supply).
- Input interface: Active-HIGH interface, works with 3.3 / 5 V Logic, Schmitt-trigger input

### Pin Configuration



## Pin Descriptions

Pin Number	Pin Name	Pin Description
1	P	Positive DC-Link Input
2	W	W Phase Output
3	V	V Phase Output
4	U	U Phase Output
5	N <sub>W</sub>	Negative DC-Link Input
6	N <sub>V</sub>	Negative DC-Link Input
7	N <sub>U</sub>	Negative DC-Link Input
8	V <sub>FO</sub>	Fault Output
9	IN <sub>(UL)</sub>	PWM Input for Low-Side U Phase MOSFET Drive
10	IN <sub>(VL)</sub>	PWM Input for Low-Side V Phase MOSFET Drive
11	IN <sub>(WL)</sub>	PWM Input for Low-Side W Phase MOSFET Drive
12	COM	Common Supply Ground
13	V <sub>CC</sub>	Common Supply Voltage for IC and Low-side MOSFET Drive
14	IN <sub>(UH)</sub>	PWM Input for High-Side U Phase MOSFET Drive
15	IN <sub>(VH)</sub>	PWM Input for High-Side V Phase MOSFET Drive
16	IN <sub>(WH)</sub>	PWM Input for High-Side W Phase MOSFET Drive
17	V <sub>B(U)</sub>	Supply Voltage for High-Side U Phase MOSFET Drive
18	V <sub>S(U)</sub>	Supply Ground for High-Side U Phase MOSFET Drive
19	V <sub>B(V)</sub>	Supply Voltage for High-Side V Phase MOSFET Drive
20	V <sub>S(V)</sub>	Supply Ground for High-Side V Phase MOSFET Drive
21	V <sub>B(W)</sub>	Supply Voltage for High-Side W Phase MOSFET Drive
22	V <sub>S(W)</sub>	Supply Ground for High-Side W Phase MOSFET Drive

Internal Equivalent Circuit and Input/Output Pins

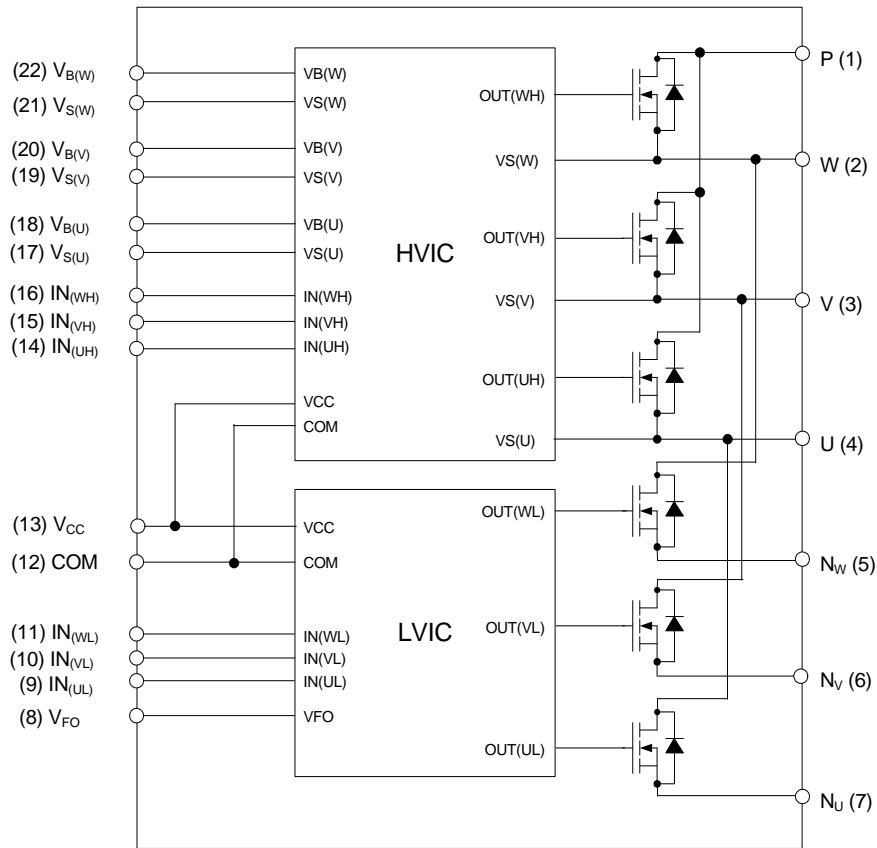


Figure 3. Internal Block Diagram

**Absolute Maximum Ratings** ( $T_J = 25^\circ\text{C}$ , unless otherwise specified.)

**Inverter Part**

Symbol	Parameter	Conditions	Rating	unit
$V_{PN}$	DC Link Input Voltage Drain-Source Voltage	Applied between P - $N_{(U)}$ , $N_{(V)}$ , $N_{(W)}$	40	V
$* \pm I_D$	Drain Current	$T_C = 25^\circ\text{C}$ , $T_J \leq 150^\circ\text{C}$	71	A
		$T_C = 100^\circ\text{C}$ , $T_J \leq 150^\circ\text{C}$	47	A
$* \pm I_{DP}$	Peak Drain Current	$T_C = 25^\circ\text{C}$ , under 1ms Pulse Width, $T_J \leq 150^\circ\text{C}$	180	A
$* P_D$	Maximum Power Dissipation	$T_C = 25^\circ\text{C}$ , per Chip, $T_J \leq 150^\circ\text{C}$	31	W
$T_J$	Operating Junction Temperature		-40 ~ 150	$^\circ\text{C}$

**1st Note:**

1. Rating value of marking "\*" is calculation value or design factor.

**Control Part**

Symbol	Parameter	Conditions	Rating	unit
$V_{CC}$	Supply Voltage	Applied between $V_{CC}$ - COM	20	V
$V_{BS}$	Supply Voltage	Applied between $V_{B(U)}$ - $V_{S(U)}$ , $V_{B(V)}$ - $V_{S(V)}$ , $V_{B(W)}$ - $V_{S(W)}$	20	V
$V_{IN}$	PWM Signal Voltage	Applied between $IN_{(UH)}$ , $IN_{(VH)}$ , $IN_{(WH)}$ , $IN_{(UL)}$ , $IN_{(VL)}$ , $IN_{(WL)}$ - COM	-0.3 ~ $V_{CC}+0.3$	V
$V_{FO}$	Fault Output Supply Voltage	Applied between $V_{FO}$ - COM	-0.3 ~ $V_{CC}+0.3$	V
$I_{FO}$	Fault Output Current	Sink Current at $V_{FO}$ Pin	1	mA

**Total System**

Symbol	Parameter	Conditions	Rating	unit
$T_{STG}$	Storage Temperature		-40 ~ 150	$^\circ\text{C}$
$V_{ISO}$	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to DBC Substrate	800	$V_{rms}$

**Thermal Characteristics**

Symbol	Parameter	Condition	Max.	unit
$R_{th(j-c)}$	Junction to Case Thermal Resistance	Package center (per MOSFET)	3.92	$^\circ\text{C/W}$

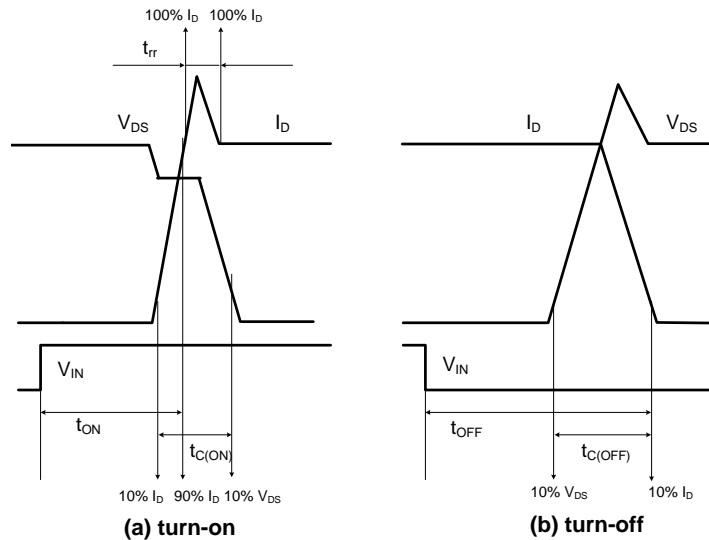
**Electrical Characteristics** (T<sub>J</sub> = 25°C, unless otherwise specified.)

**Inverter Part**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit			
BV <sub>DSS</sub>	Drain-Source Breakdown Voltage	V <sub>IN</sub> =0 V, I <sub>D</sub> =250 μA (2nd Notes 1)	40	-	-	V			
R <sub>DS(ON)</sub>	Drain-Source ON Resistance	V <sub>CC</sub> = V <sub>BS</sub> = 15 V, V <sub>IN</sub> = 5 V, I <sub>D</sub> = 40 A	-	2.1	3.0	mΩ			
V <sub>SD</sub>	Source-Drain Diode Forward Voltage	V <sub>CC</sub> = V <sub>BS</sub> = 15 V, V <sub>IN</sub> = 0 V, I <sub>SD</sub> = 40 A	-	0.8	-	V			
t <sub>ON</sub>	Switching Characteristic	V <sub>PN</sub> = 20 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V, I <sub>D</sub> = 40 A, V <sub>IN</sub> = 0 V ↔ 5 V, High side, Inductive Load (2nd Notes 2)	-	1750	-	ns			
t <sub>C(ON)</sub>			-	900	-	ns			
t <sub>OFF</sub>			-	2600	-	ns			
t <sub>C(OFF)</sub>			-	800	-	ns			
t <sub>rr</sub>			-	60	-	ns			
I <sub>rr</sub>			-	3	-	A			
t <sub>ON</sub>			V <sub>PN</sub> = 20 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V, I <sub>D</sub> = 40 A, V <sub>IN</sub> = 0 V ↔ 5 V, Low side, Inductive Load (2nd Notes 2)	-	1900	-	ns		
t <sub>C(ON)</sub>				-	850	-	ns		
t <sub>OFF</sub>				-	2600	-	ns		
t <sub>C(OFF)</sub>				-	850	-	ns		
t <sub>rr</sub>				-	60	-	ns		
I <sub>rr</sub>				-	6	-	A		
I <sub>DSS</sub>				Drain-Source Leakage Current	V <sub>DS</sub> = V <sub>DSS</sub>	-	-	250	μA

**2nd Notes:**

- BV<sub>DSS</sub> is the absolute maximum voltage rating between drain and source terminal of each MOSFET. V<sub>PN</sub> should be sufficiently less than this value considering the effect of the stray inductance so that V<sub>DS</sub> should not exceed BV<sub>DSS</sub> in any case.
- t<sub>ON</sub> and t<sub>OFF</sub> include the propagation delay time of the internal drive IC. t<sub>C(ON)</sub> and t<sub>C(OFF)</sub> are the switching time of MOSFET itself under the given gate driving condition internally. For the detailed information, please see Figure 4.



**Figure 4. Switching Time Definition**

**Control Part**

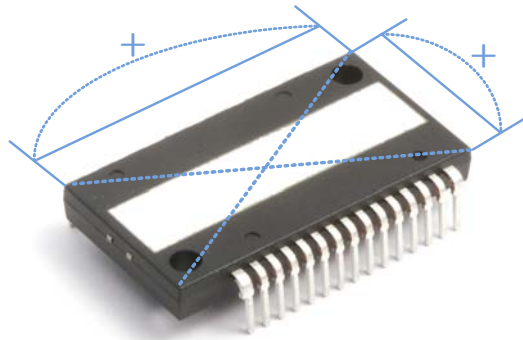
Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
$I_{QCC}$	Quiescent $V_{CC}$ Supply Current	$V_{CC} = 15\text{ V}$ , $V_{IN} = 0\text{ V}$	$V_{CC} - \text{COM}$	-	-	2.75	mA
$I_{QBS}$	Quiescent $V_{BS}$ Supply Current	$V_{BS} = 15\text{ V}$ , $V_{IN} = 0\text{ V}$	$V_{B(U)} - V_{S(U)}$ , $V_{B(V)} - V_{S(V)}$ , $V_{B(W)} - V_{S(W)}$	-	-	0.3	mA
$V_{FOH}$	Fault Output Voltage	10 k $\Omega$ to 5 V Pull-up	Normal	4.5	-	-	V
$V_{FOL}$			Fault	-	-	0.5	V
$UV_{CCD}$	Supply Circuit Under-Voltage Protection	Detection Level		7.0	8.2	10.0	V
$UV_{CCR}$		Reset Level		8.0	9.4	11.0	V
$UV_{BSD}$		Detection Level		7.0	8.0	9.5	V
$UV_{BSR}$		Reset Level		8.0	9.0	10.5	V
$t_{FOD}$	Fault-Out Pulse Width			30	-	-	$\mu\text{s}$
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $IN_{(UH)}$ , $IN_{(VH)}$ , $IN_{(WH)}$ , $IN_{(UL)}$ , $IN_{(VL)}$ , $IN_{(WL)} - \text{COM}$		-	-	2.6	V
$V_{IN(OFF)}$	OFF Threshold Voltage			0.8	-	-	V

**Recommended Operating Conditions**

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{PN}$	Supply Voltage	Applied between P - $N_{(U)}$ , $N_{(V)}$ , $N_{(W)}$	-	20	-	V
$V_{CC}$	Control Supply Voltage	Applied between $V_{CC} - \text{COM}$	13.5	15	16.5	V
$V_{BS}$	Control Supply Voltage	Applied between $V_{B(U)} - V_{S(U)}$ , $V_{B(V)} - V_{S(V)}$ , $V_{B(W)} - V_{S(W)}$	13.0	15	18.5	V
$dV_{CC}/dt$ , $dV_{BS}/dt$	Control Supply Variation		-1	-	1	V/ $\mu\text{s}$
$V_{SEN}$	Voltage for Current Sensing	Applied between $N_U$ , $N_V$ , $N_W - \text{COM}$ (Including surge voltage)	-4	-	4	V

### Mechanical Characteristics and Ratings

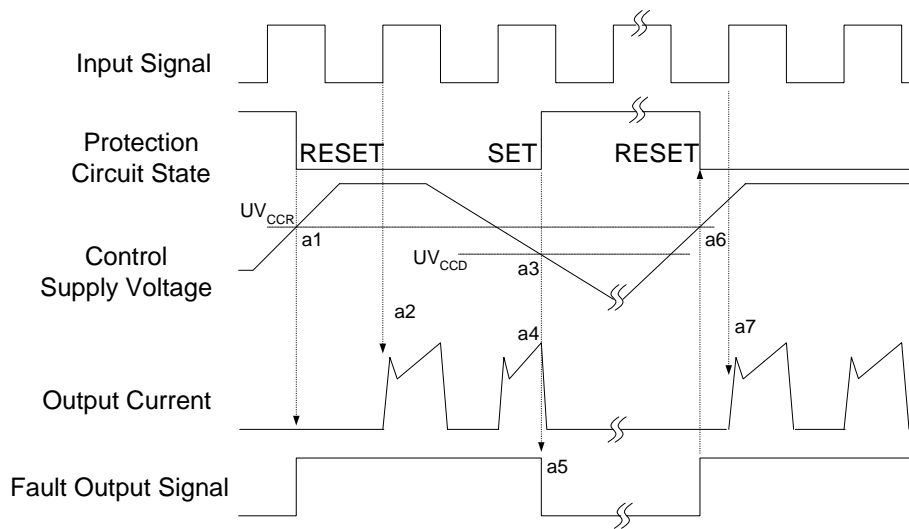
Parameter	Conditions		Limits			Units
			Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: - M3		0.51	0.62	0.72	N•m
Device Flatness		See Figure 5	-	-	120	μm
Weight			-	8.4	-	g



**Figure 5. Flatness Measurement Position**

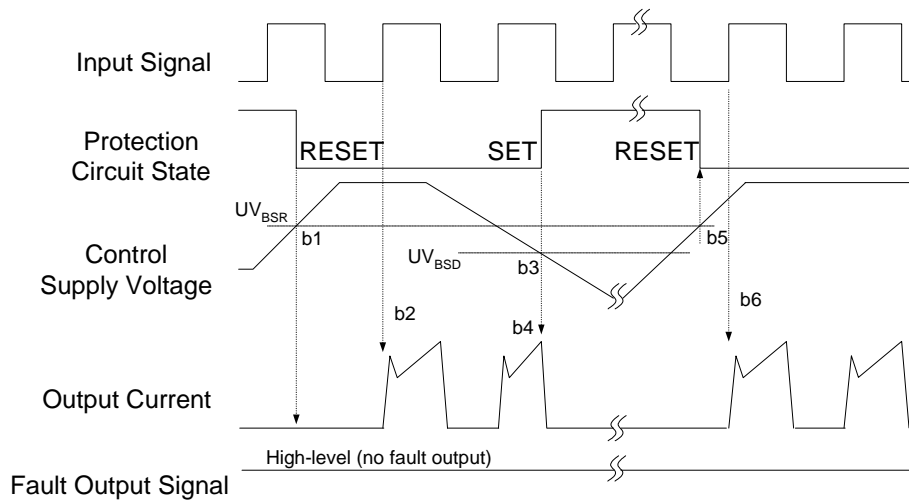


### Time Charts of Protective Function



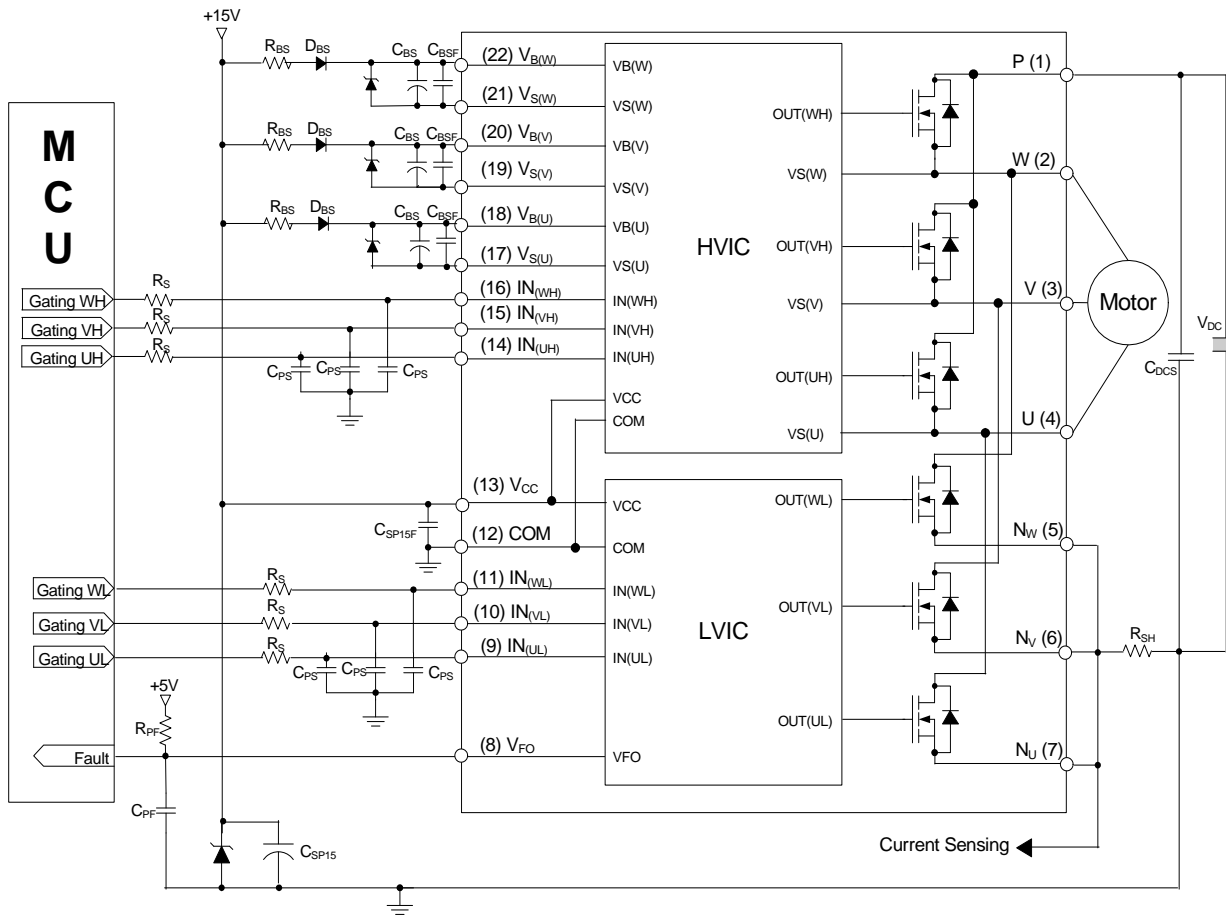
- a1 : Control supply voltage rises: after the voltage rises  $UV_{CCR}$ , the circuits start to operate when the next input is applied.
- a2 : Normal operation: MOSFET ON and carrying current.
- a3 : Under-Voltage detection ( $UV_{CCD}$ ).
- a4 : MOSFET OFF in spite of control input condition.
- a5 : Fault output operation starts.
- a6 : Under-Voltage reset ( $UV_{CCR}$ ).
- a7 : Normal operation: MOSFET ON and carrying current.

**Figure 6. Under-Voltage Protection (Low-side)**



- b1 : Control supply voltage rises: after the voltage reaches  $UV_{BSR}$ , the circuits start to operate when the next input is applied.
- b2 : Normal operation: MOSFET ON and carrying current.
- b3 : Under-Voltage detection ( $UV_{BSD}$ ).
- b4 : MOSFET OFF in spite of control input condition, but there is no fault output signal.
- b5 : Under-Voltage reset ( $UV_{BSR}$ ).
- b6 : Normal operation: MOSFET ON and carrying current

**Figure 7. Under-Voltage Protection (High-side)**

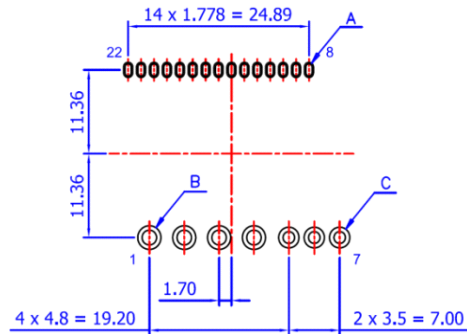
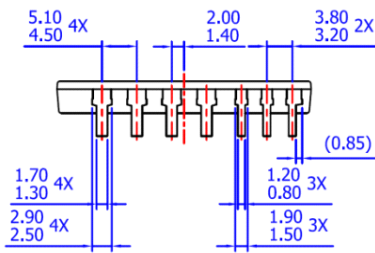
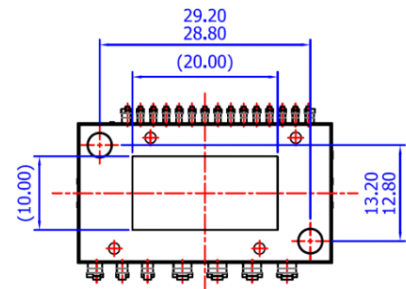
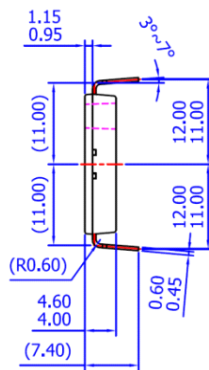
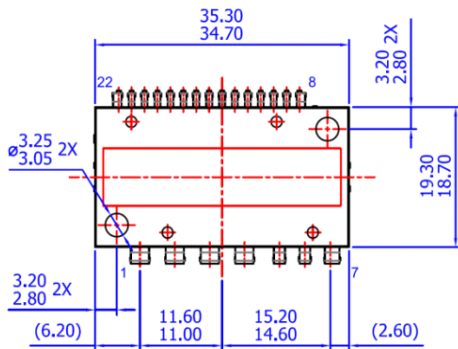
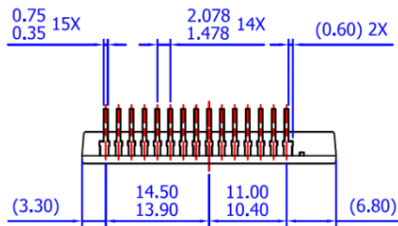


**3rd Notes:**

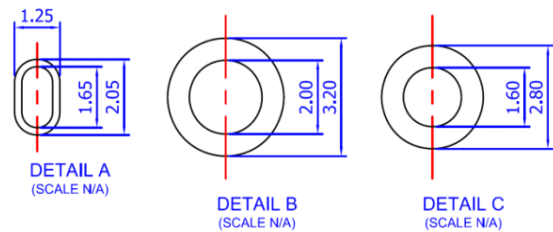
1. To avoid malfunction, the wiring of each input should be as short as possible. (less than 2-3 cm)
2. V<sub>FO</sub> output is open drain type. This signal line should be pulled up to the positive side of the MCU or control power supply with a resistor that makes IFO up to 1 mA.
3. Input signal is High-Active type. There is a 5 k $\Omega$  resistor inside the IC to pull down each input signal line to GND. RC coupling circuits is recommended for the prevention of input signal oscillation. R<sub>F</sub>C<sub>F</sub> constant should be selected in the range 50-150ns. (Recommended R<sub>S</sub>=100  $\Omega$ , C<sub>PS</sub>=1 nF)
4. Each capacitors should be mounted as close to the SPM® pins as possible.
5. Relays are used at almost every systems of electrical equipment of home appliances. In these cases, there should be sufficient distance between the CPU and the relays.
6. The zener diode should be adopted for the protection of ICs from the surge destruction between each pair of control supply terminals. (Recommended zener diode=24 / 1 W)

**Figure 8. Typical Application Circuit**

Detailed Package Outline Drawings



- NOTES: UNLESS OTHERWISE SPECIFIED  
 A) THIS PACKAGE DOES NOT COMPLY TO ANY CURRENT PACKAGING STANDARD  
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