



FSB43004A

Motion SPM[®] 45 LV Series

Features

- UL Certified No.E209204(UL1557)
- 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[®] 45 LV module that Fairchild developed based on low-loss PowerTrench[®] 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.

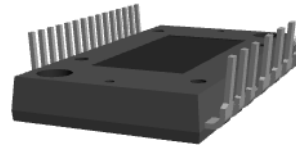


Figure 1. Packing Drawing
(Click to Activate 3D Content)

Package Marking and Ordering Information

| Device | Device Marking | Package | Packing Type | Quantity |
|-----------|----------------|-----------|--------------|----------|
| FSB43004A | FSB43004A | 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 Lock-Out (UVLO) Protection.
- For inverter low-side MOSFETs: gate drive circuit, Under-Voltage Lock-Out (UVLO) 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

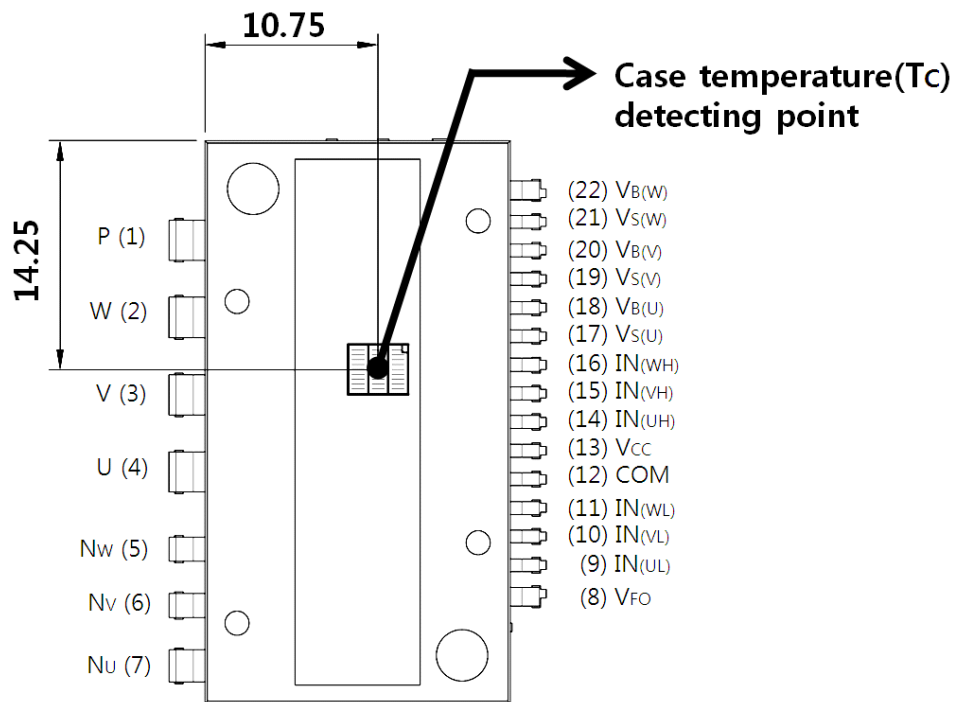


Figure 2. Top View

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 _W | Negative DC-Link Input |
| 6 | N _V | Negative DC-Link Input |
| 7 | N _U | Negative DC-Link Input |
| 8 | V _{FO} | Fault Output |
| 9 | IN _(UL) | PWM Input for Low-Side U Phase MOSFET Drive |
| 10 | IN _(VL) | PWM Input for Low-Side V Phase MOSFET Drive |
| 11 | IN _(WL) | PWM Input for Low-Side W Phase MOSFET Drive |
| 12 | COM | Common Supply Ground |
| 13 | V _{CC} | Common Supply Voltage for IC and Low-side MOSFET Drive |
| 14 | IN _(UH) | PWM Input for High-Side U Phase MOSFET Drive |
| 15 | IN _(VH) | PWM Input for High-Side V Phase MOSFET Drive |
| 16 | IN _(WH) | PWM Input for High-Side W Phase MOSFET Drive |
| 17 | V _{B(U)} | Supply Voltage for High-Side U Phase MOSFET Drive |
| 18 | V _{S(U)} | Supply Ground for High-Side U Phase MOSFET Drive |
| 19 | V _{B(V)} | Supply Voltage for High-Side V Phase MOSFET Drive |
| 20 | V _{S(V)} | Supply Ground for High-Side V Phase MOSFET Drive |
| 21 | V _{B(W)} | Supply Voltage for High-Side W Phase MOSFET Drive |
| 22 | V _{S(W)} | Supply Ground for High-Side W Phase MOSFET Drive |

Internal Equivalent Circuit and Input/Output Pins

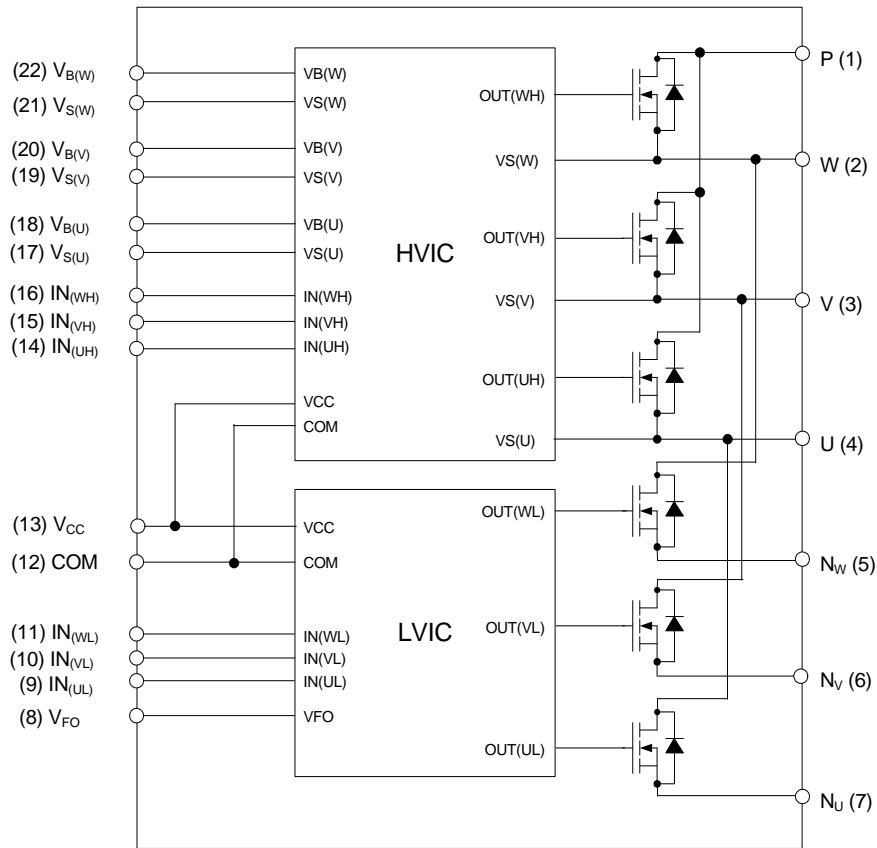


Figure 3. Internal Block Diagram

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 Ceramic Substrate | 800 | V_{rms} |

Thermal Characteristics

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------------|--------------------------------------|------|------|------|--------------------|
| $R_{th(j-c)}$ | Junction to Case Thermal Resistance | Inverter MOSFET part(per 1/6 module) | - | - | 3.92 | $^\circ\text{C/W}$ |

Electrical Characteristics (T_J = 25°C, unless otherwise specified.)

Inverter Part

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

2nd Notes:

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

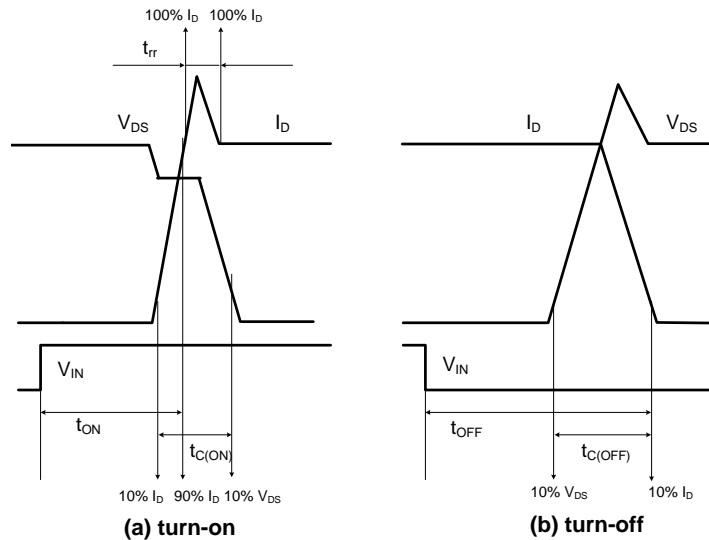


Figure 4. Switching Time Definition

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 Ω 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 | - | - | μs |
| $V_{IN(ON)}$ | ON Threshold Voltage | Applied between $IN_{(UH)}$, $IN_{(VH)}$, $IN_{(WH)}$, $IN_{(UL)}$, | | - | - | 2.6 | V |
| $V_{IN(OFF)}$ | OFF Threshold Voltage | $IN_{(VL)}$, $IN_{(WL)} - \text{COM}$ | | 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/ μs |
| 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 |

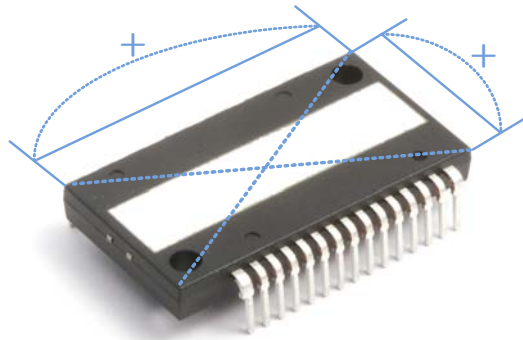
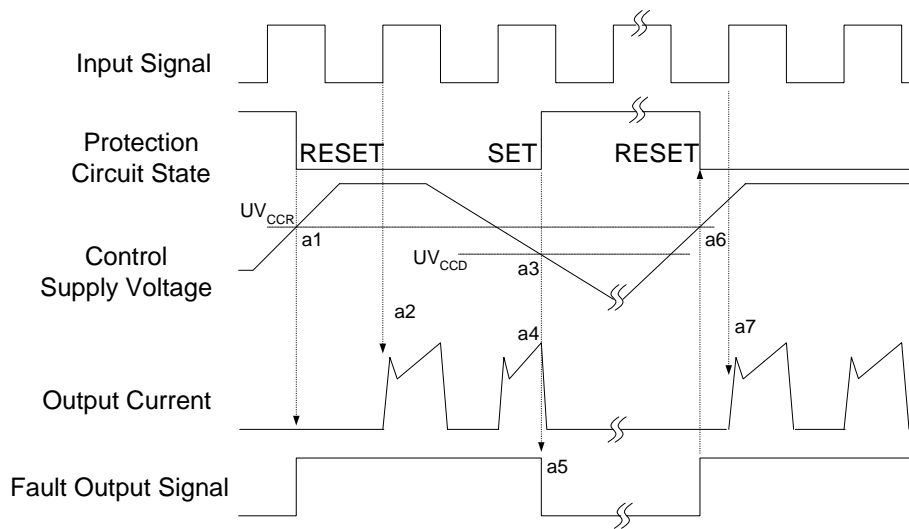


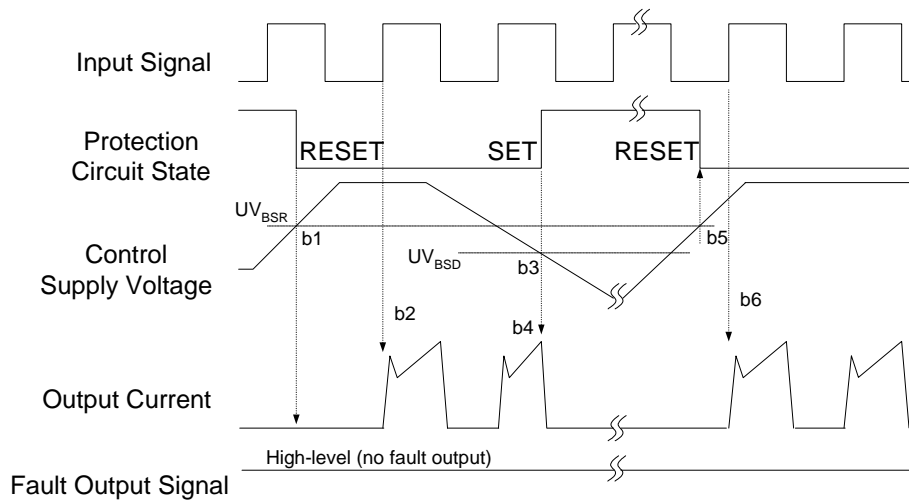
Figure 5. Flatness Measurement Position

Time Charts of Protective Function



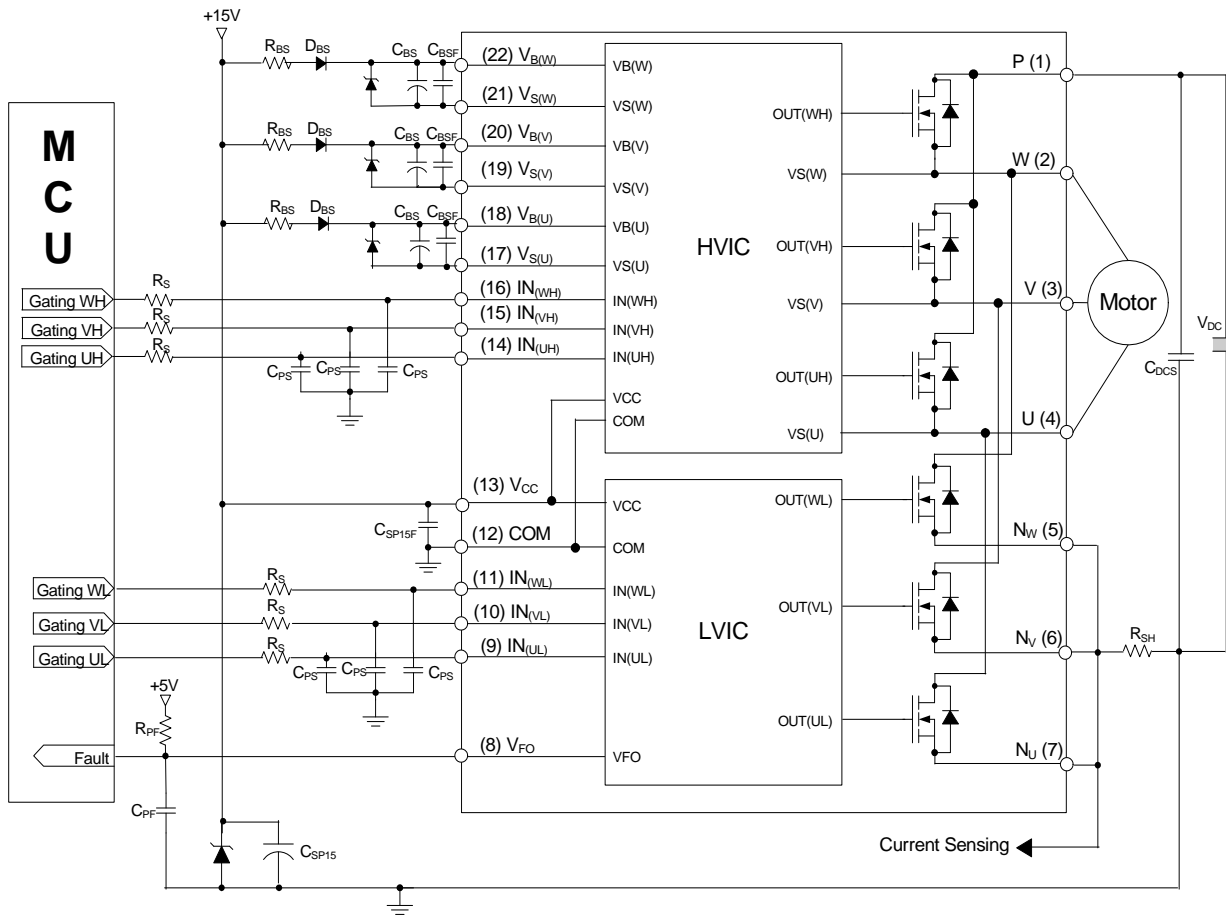
- a1 : Control supply voltage rises: after the voltage rises UV_{CCR} , the circuits start to operate when the next input is applied.
- a2 : Normal operation: MOSFET ON and carrying current.
- a3 : Under-Voltage detection (UV_{CCD}).
- a4 : MOSFET OFF in spite of control input condition.
- a5 : Fault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

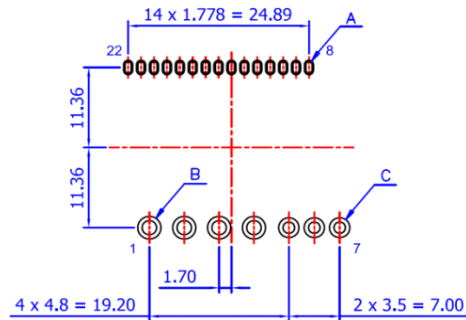
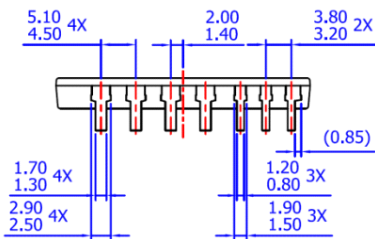
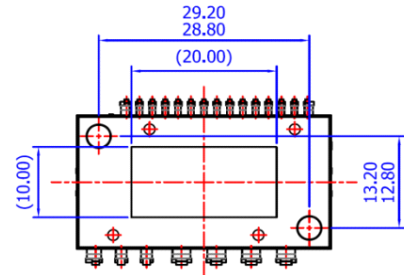
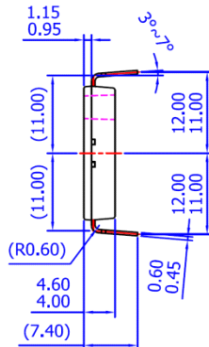
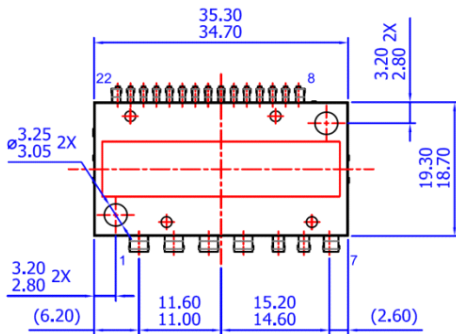
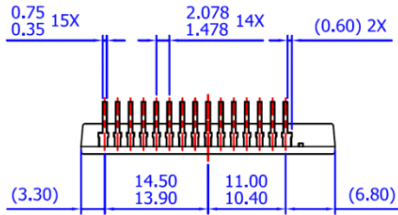


3rd Notes:

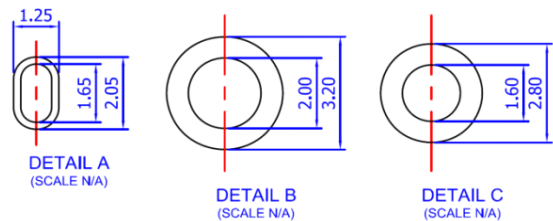
1. To avoid malfunction, the wiring of each input should be as short as possible. (less than 2-3 cm)
2. V_{FO} output is open drain type. This signal line should be pulled up to the positive side of the MCU or control power supply with a resistor that makes IFO up to 1 mA.
3. Input signal is High-Active type. There is a 5 kΩ 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_FC_F constant should be selected in the range 50-150ns. (Recommended R_S=100 Ω, C_{PS}=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
 B) ALL DIMENSIONS ARE IN MILLIMETERS
 C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
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