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March 2015



# FNB40560 / FNB40560B2

## Motion SPM® 45 Series

### Features

- UL Certified No. E209204 (UL1557)
- 600 V - 5 A 3-Phase IGBT Inverter with Integral Gate Drivers and Protection
- Low Thermal Resistance Using Ceramic Substrate
- Low-Loss, Short-Circuit Rated IGBTs
- Built-In Bootstrap Diodes and Dedicated Vs Pins Simplify PCB Layout
- Built-In NTC Thermistor for Temperature Monitoring
- Separate Open-Emitter Pins from Low-Side IGBTs for Three-Phase Current Sensing
- Single-Grounded Power Supply
- Isolation Rating: 2000 V<sub>rms</sub> / min.

### General Description

FNB40560 / FNB40560B2 is a Motion SPM® 45 module providing a fully-featured, high-performance inverter output stage for AC Induction, BLDC, and PMSM motors. These modules integrate optimized gate drive of the built-in IGBTs to minimize EMI and losses, while also providing multiple on-module protection features including under-voltage lockouts, over-current shutdown, thermal monitoring, and fault reporting. The built-in, high-speed HVIC requires only a single supply voltage and translates the incoming logic-level gate inputs to the high-voltage, high-current drive signals required to properly drive the module's robust short-circuit-rated IGBTs. Separate negative IGBT terminals are available for each phase to support the widest variety of control algorithms.

### Applications

- Motion Control - Home Appliance / Industrial Motor

### Related Resources

- [AN-9070 - Motion SPM® 45 Series Users Guide](#)
- [AN-9071 - Motion SPM® 45 Series Thermal Performance Information](#)
- [AN-9072 - Motion SPM® 45 Series Mounting Guidance](#)
- [RD-344 - Reference Design \(Three Shunt Solution\)](#)
- [RD-345 - Reference Design \(One Shunt Solution\)](#)

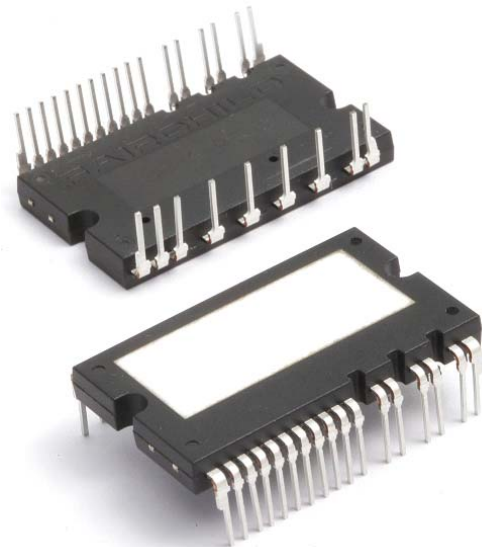


Figure 1. Package Overview

### Package Marking and Ordering Information

| Device     | Device Marking | Package   | Packing Type | Quantity |
|------------|----------------|-----------|--------------|----------|
| FNB40560   | FNB40560       | SPMAA-A26 | Rail         | 12       |
| FNB40560B2 | FNB40560B2     | SPMAA-C26 | Rail         | 12       |

### Integrated Power Functions

- 600 V - 5 A IGBT inverter for three-phase DC / AC power conversion (please refer to Figure 3)

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

- For inverter high-side IGBTs: gate drive circuit, high-voltage isolated high-speed level shifting control circuit Under-Voltage Lock-Out (UVLO) protection
- For inverter low-side IGBTs: gate drive circuit, Short-Circuit Protection (SCP) control supply circuit Under-Voltage Lock-Out (UVLO) protection
- Fault signaling: corresponding to UVLO (low-side supply) and SC faults
- Input interface: active-HIGH interface, works with 3.3 / 5 V logic, Schmitt trigger input

### Pin Configuration

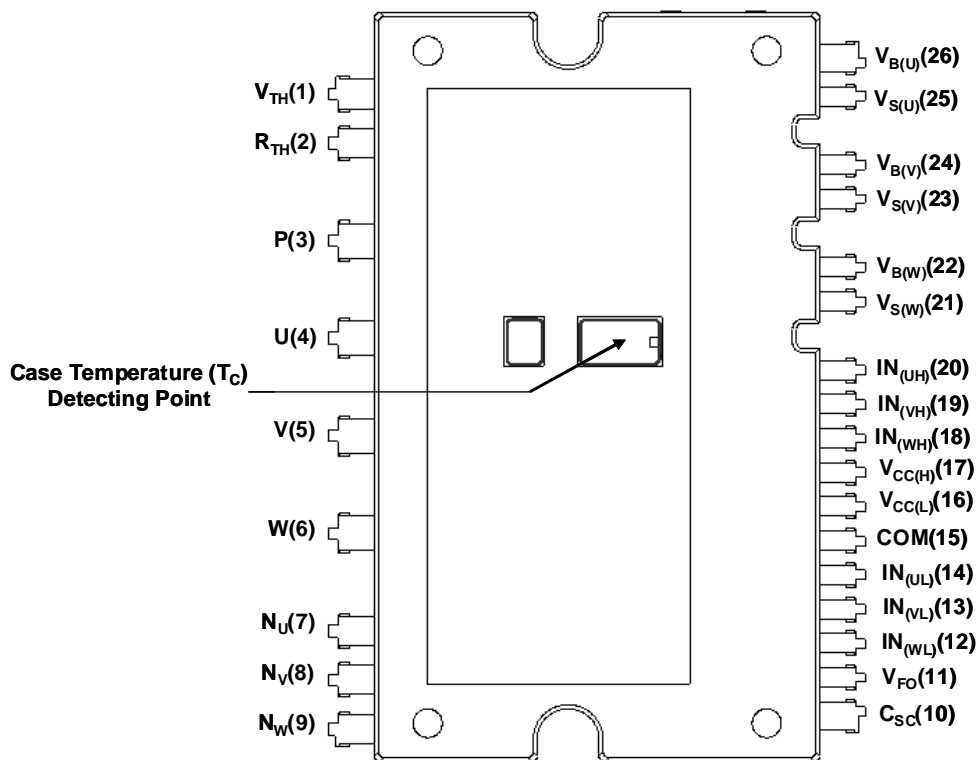


Figure 2. Top View

## Pin Descriptions

| Pin Number | Pin Name    | Pin Description   |
|------------|-------------|---|
| 1          | $V_{TH}$    | Thermistor Bias Voltage   |
| 2          | $R_{TH}$    | Series Resistor for the Use of Thermistor (Temperature Detection)     |
| 3          | P           | Positive DC-Link Input  |
| 4          | U           | Output for U-Phase  |
| 5          | V           | Output for V-Phase  |
| 6          | W           | Output for W-Phase  |
| 7          | $N_U$       | Negative DC-Link Input for U-Phase                                    |
| 8          | $N_V$       | Negative DC-Link Input for V-Phase                                    |
| 9          | $N_W$       | Negative DC-Link Input for W-Phase                                    |
| 10         | $C_{SC}$    | Capacitor (Low-Pass Filter) for Short-circuit Current Detection Input |
| 11         | $V_{FO}$    | Fault Output  |
| 12         | $IN_{(WL)}$ | Signal Input for Low-Side W-Phase                                     |
| 13         | $IN_{(VL)}$ | Signal Input for Low-Side V-Phase                                     |
| 14         | $IN_{(UL)}$ | Signal Input for Low-Side U-Phase                                     |
| 15         | COM         | Common Supply Ground  |
| 16         | $V_{CC(L)}$ | Low-Side Common Bias Voltage for IC and IGBTs Driving                 |
| 17         | $V_{CC(H)}$ | High-Side Common Bias Voltage for IC and IGBTs Driving                |
| 18         | $IN_{(WH)}$ | Signal Input for High-Side W-Phase                                    |
| 19         | $IN_{(VH)}$ | Signal Input for High-Side V-Phase                                    |
| 20         | $IN_{(UH)}$ | Signal Input for High-Side U-Phase                                    |
| 21         | $V_{S(W)}$  | High-Side Bias Voltage Ground for W-Phase IGBT Driving                |
| 22         | $V_{B(W)}$  | High-Side Bias Voltage for W-Phase IGBT Driving                       |
| 23         | $V_{S(V)}$  | High-Side Bias Voltage Ground for V-Phase IGBT Driving                |
| 24         | $V_{B(V)}$  | High-Side Bias Voltage for V-Phase IGBT Driving                       |
| 25         | $V_{S(U)}$  | High-Side Bias Voltage Ground for U-Phase IGBT Driving                |
| 26         | $V_{B(U)}$  | High-Side Bias Voltage for U-Phase IGBT Driving                       |

## Internal Equivalent Circuit and Input/Output Pins



**Figure 3. Internal Block Diagram**

**1st Notes:**

1. Inverter high-side is composed of three IGBTs, freewheeling diodes, and one control IC for each IGBT.
2. Inverter low-side is composed of three IGBTs, freewheeling diodes, and one control IC for each IGBT. It has gate drive and protection functions.
3. Inverter power side is composed of four inverter DC-link input terminals and three inverter output terminals.

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

### Inverter Part

| Symbol                 | Parameter                      | Conditions  | Rating    | Unit             |
|------------------------|--------------------------------|---|-----------|------------------|
| $V_{PN}$               | Supply Voltage                 | Applied between P - $N_U$ , $N_V$ , $N_W$                                     | 450       | V                |
| $V_{PN(\text{Surge})}$ | Supply Voltage (Surge)         | Applied between P - $N_U$ , $N_V$ , $N_W$                                     | 500       | V                |
| $V_{CES}$              | Collector - Emitter Voltage    |   | 600       | V                |
| $I_{O,25}$             | Output Phase Current           | $T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$ (2nd Note 1)             | 5         | A                |
| $I_{O,100}$            | Output Phase Current           | $T_C = 100^\circ\text{C}$ , $T_J < 150^\circ\text{C}$ (2nd Note 1)            | 2.5       | A                |
| $I_{pk}$               | Output Peak Phase Current      | $T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$ , Under 1 ms Pulse Width | 7.5       | A                |
| $P_C$                  | Collector Dissipation          | $T_C = 25^\circ\text{C}$ per Chip   | 29        | W                |
| $T_J$                  | Operating Junction Temperature | (2nd Note 2)  | -40 ~ 150 | $^\circ\text{C}$ |

#### 2nd Notes:

- Sinusoidal PWM at  $V_{PN} = 300\text{ V}$ ,  $V_{CC} = V_{BS} = 15\text{ V}$ ,  $T_J < 150^\circ\text{C}$ ,  $F_{SW} = 20\text{ kHz}$ ,  $MI = 0.9$ ,  $PF = 0.8$
- The maximum junction temperature rating of the power chips integrated within the Motion SPM® 45 product is  $150^\circ\text{C}$ .

### Control Part

| Symbol   | Parameter                        | Conditions  | Rating                | Unit |
|----------|----------------------------------|---|-----------------------|------|
| $V_{CC}$ | Control Supply Voltage           | Applied between $V_{CC(H)}$ , $V_{CC(L)}$ - COM   | 20                    | V    |
| $V_{BS}$ | High - Side Control Bias Voltage | Applied between $V_{B(U)}$ - $V_{S(U)}$ , $V_{B(V)}$ - $V_{S(V)}$ , $V_{B(W)}$ - $V_{S(W)}$             | 20                    | V    |
| $V_{IN}$ | Input 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   |
| $V_{SC}$ | Current-Sensing Input Voltage    | Applied between $C_{SC}$ - COM  | -0.3 ~ $V_{CC} + 0.3$ | V    |

### Bootstrap Diode Part

| Symbol    | Parameter                          | Conditions  | Rating    | Unit             |
|-----------|------------------------------------|---|-----------|------------------|
| $V_{RRM}$ | Maximum Repetitive Reverse Voltage |   | 600       | V                |
| $I_F$     | Forward Current                    | $T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$                          | 0.50      | A                |
| $I_{FP}$  | Forward Current (Peak)             | $T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$ , Under 1 ms Pulse Width | 1.50      | A                |
| $T_J$     | Operating Junction Temperature     |   | -40 ~ 150 | $^\circ\text{C}$ |

### Total System

| Symbol                | Parameter  | Conditions  | Rating    | Unit             |
|-----------------------|--|---|-----------|------------------|
| $V_{PN(\text{PROT})}$ | Self-Protection Supply Voltage Limit (Short-Circuit Protection Capability) | $V_{CC} = V_{BS} = 13.5 \sim 16.5\text{ V}$<br>$T_J = 150^\circ\text{C}$ , Non-Repetitive, $< 2\ \mu\text{s}$ | 400       | V                |
| $T_{STG}$             | Storage Temperature  |   | -40 ~ 125 | $^\circ\text{C}$ |
| $V_{ISO}$             | Isolation Voltage  | 60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat Sink Plate   | 2000      | $V_{rms}$        |

### Thermal Resistance

| Symbol         | Parameter                           | Conditions                            | Min. | Typ. | Max. | Unit                        |
|----------------|-------------------------------------|---------------------------------------|------|------|------|-----------------------------|
| $R_{th(j-c)Q}$ | Junction to Case Thermal Resistance | Inverter IGBT Part (per 1 / 6 module) | -    | -    | 4.2  | $^\circ\text{C} / \text{W}$ |
| $R_{th(j-c)F}$ |                                     | Inverter FWDi Part (per 1 / 6 module) | -    | -    | 5.9  | $^\circ\text{C} / \text{W}$ |

#### 2nd Notes:

- For the measurement point of case temperature ( $T_C$ ), please refer to Figure 2.

**Electrical Characteristics** ( $T_J = 25^\circ\text{C}$ , unless otherwise specified.)

**Inverter Part**

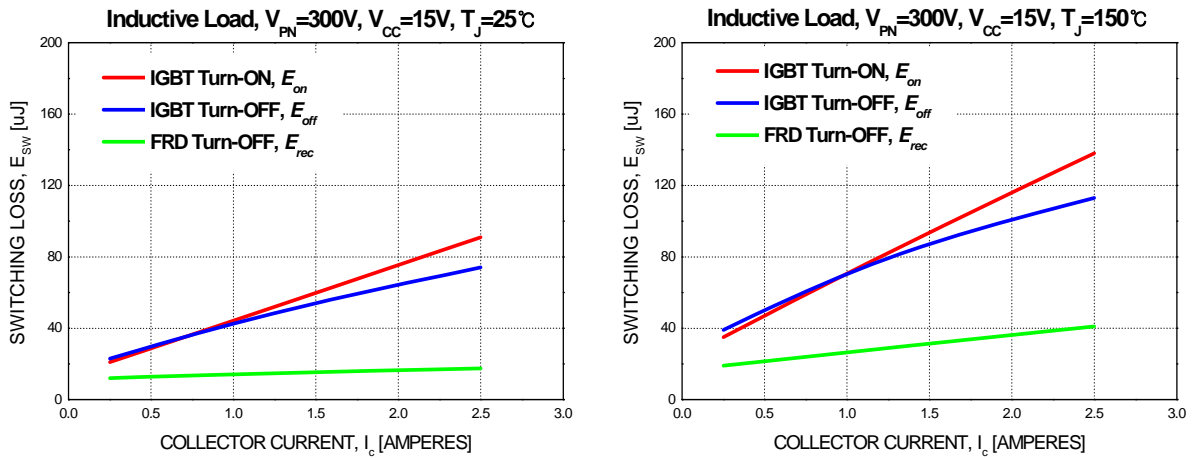
| Symbol        | Parameter                              | Conditions  | Min.         | Typ. | Max. | Unit |               |
|---------------|--|---|--------------|------|------|------|---------------|
| $V_{CE(SAT)}$ | Collector - Emitter Saturation Voltage | $V_{CC} = V_{BS} = 15\text{ V}$<br>$V_{IN} = 5\text{ V}$<br>$I_C = 2.5\text{ A}$ , $T_J = 25^\circ\text{C}$   | -            | 1.4  | 1.9  | V    |               |
| $V_F$         | FWDI Forward Voltage                   | $V_{IN} = 0\text{ V}$<br>$I_F = 2.5\text{ A}$ , $T_J = 25^\circ\text{C}$  | -            | 1.4  | 1.9  | V    |               |
| HS            | Switching Times                        | $V_{PN} = 300\text{ V}$ , $V_{CC} = V_{BS} = 15\text{ V}$ , $I_C = 2.5\text{ A}$<br>$T_J = 25^\circ\text{C}$<br>$V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , Inductive Load<br>(2nd Note 4) | $t_{ON}$     | 0.35 | 0.65 | 1.15 | $\mu\text{s}$ |
|               |  |   | $t_{C(ON)}$  | -    | 0.10 | 0.35 | $\mu\text{s}$ |
|               |  |   | $t_{OFF}$    | -    | 0.70 | 1.20 | $\mu\text{s}$ |
|               |  |   | $t_{C(OFF)}$ | -    | 0.20 | 0.45 | $\mu\text{s}$ |
|               |  |   | $t_{rr}$     | -    | 0.15 | -    | $\mu\text{s}$ |
| LS            | Switching Times                        | $V_{PN} = 300\text{ V}$ , $V_{CC} = V_{BS} = 15\text{ V}$ , $I_C = 2.5\text{ A}$<br>$T_J = 25^\circ\text{C}$<br>$V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , Inductive Load<br>(2nd Note 4) | $t_{ON}$     | 0.35 | 0.65 | 1.15 | $\mu\text{s}$ |
|               |  |   | $t_{C(ON)}$  | -    | 0.10 | 0.35 | $\mu\text{s}$ |
|               |  |   | $t_{OFF}$    | -    | 0.70 | 1.20 | $\mu\text{s}$ |
|               |  |   | $t_{C(OFF)}$ | -    | 0.20 | 0.45 | $\mu\text{s}$ |
|               |  |   | $t_{rr}$     | -    | 0.15 | -    | $\mu\text{s}$ |
| $I_{CES}$     | Collector - Emitter Leakage Current    | $V_{CE} = V_{CES}$  | -            | -    | 1    | mA   |               |

**2nd Notes:**

4.  $t_{ON}$  and  $t_{OFF}$  include the propagation delay of the internal drive IC.  $t_{C(ON)}$  and  $t_{C(OFF)}$  are the switching time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 4.



**Figure 4. Switching Time Definition**



**Figure 5. Switching Loss Characteristics (Typical)**

**Control Part**

| Symbol               | Parameter                                | Conditions  | Min.  | Typ. | Max. | Unit |    |
|----------------------|--|---|---|------|------|------|----|
| I <sub>QCCH</sub>    | Quiescent V <sub>CC</sub> Supply Current | V <sub>CC(H)</sub> = 15 V, I <sub>N(UH, VH, WH)</sub> = 0 V   | V <sub>CC(H)</sub> - COM  | -    | -    | 0.10 | mA |
| I <sub>QCCL</sub>    |  | V <sub>CC(L)</sub> = 15 V, I <sub>N(UL, VL, WL)</sub> = 0 V   | V <sub>CC(L)</sub> - COM  | -    | -    | 2.65 | mA |
| I <sub>PCCH</sub>    | Operating V <sub>CC</sub> Supply Current | V <sub>CC(L)</sub> = 15 V, f <sub>PWM</sub> = 20 kHz, duty = 50%, Applied to One PWM Signal Input for High-Side                                   | V <sub>CC(H)</sub> - COM  | -    | -    | 0.15 | mA |
| I <sub>PCCL</sub>    |  | V <sub>CC(L)</sub> = 15 V, f <sub>PWM</sub> = 20 kHz, duty = 50%, Applied to One PWM Signal Input for Low-Side                                    | V <sub>CC(L)</sub> - COM  | -    | -    | 3.65 | mA |
| I <sub>QBS</sub>     | Quiescent V <sub>BS</sub> Supply Current | V <sub>BS</sub> = 15 V, I <sub>N(UH, VH, WH)</sub> = 0 V  | V <sub>B(U)</sub> - V <sub>S(U)</sub> , V <sub>B(V)</sub> - V <sub>S(V)</sub> , V <sub>B(W)</sub> - V <sub>S(W)</sub> | -    | -    | 0.30 | mA |
| I <sub>PBS</sub>     | Operating V <sub>BS</sub> Supply Current | V <sub>CC</sub> = V <sub>BS</sub> = 15 V, f <sub>PWM</sub> = 20 kHz, Duty = 50%, Applied to One PWM Signal Input for High-Side                    | V <sub>B(U)</sub> - V <sub>S(U)</sub> , V <sub>B(V)</sub> - V <sub>S(V)</sub> , V <sub>B(W)</sub> - V <sub>S(W)</sub> | -    | -    | 2.00 | mA |
| V <sub>FOH</sub>     | Fault Output Voltage                     | V <sub>SC</sub> = 0 V, V <sub>FO</sub> Circuit: 10 kΩ to 5 V Pull-up  |   | 4.5  | -    | -    | V  |
| V <sub>FOL</sub>     |  | V <sub>SC</sub> = 1 V, V <sub>FO</sub> Circuit: 10 kΩ to 5 V Pull-up  |   | -    | -    | 0.5  | V  |
| V <sub>SC(ref)</sub> | Short-Circuit Current Trip Level         | V <sub>CC</sub> = 15 V (2nd Note 5)   | 0.45  | 0.50 | 0.55 | V    |    |
| UV <sub>CCD</sub>    | Supply Circuit Under-Voltage Protection  | Detection level   | 10.5  | -    | 13.0 | V    |    |
| UV <sub>CCR</sub>    |  | Reset level   | 11.0  | -    | 13.5 | V    |    |
| UV <sub>BSD</sub>    |  | Detection level   | 10.0  | -    | 12.5 | V    |    |
| UV <sub>BSR</sub>    |  | Reset level   | 10.5  | -    | 13.0 | V    |    |
| t <sub>FOD</sub>     | Fault-Out Pulse Width                    |   | 30  | -    | -    | μs   |    |
| V <sub>IN(ON)</sub>  | ON Threshold Voltage                     | Applied between I <sub>N(UH)</sub> , I <sub>N(VH)</sub> , I <sub>N(WH)</sub> , I <sub>N(UL)</sub> , I <sub>N(VL)</sub> , I <sub>N(WL)</sub> - COM | -   | -    | 2.6  | V    |    |
| V <sub>IN(OFF)</sub> | OFF Threshold Voltage                    |   | 0.8   | -    | -    | V    |    |
| R <sub>TH</sub>      | Resistance of Thermister                 | @ T <sub>TH</sub> = 25°C, (2nd Note 6)  | -   | 47   | -    | kΩ   |    |
|                      |  | @ T <sub>TH</sub> = 100°C   | -   | 2.9  | -    | kΩ   |    |

**2nd Notes:**

- Short-circuit protection is functioning only at the low-sides.
- T<sub>TH</sub> is the temperature of thermister itself. To know case temperature (T<sub>C</sub>), please make the experiment considering your application.





Figure. 6. R-T Curve of The Built-In Thermistor

**Bootstrap Diode Part**

| Symbol   | Parameter             | Conditions                                    | Min. | Typ. | Max. | Unit |
|----------|-----------------------|---|------|------|------|------|
| $V_F$    | Forward Voltage       | $I_F = 0.1 \text{ A}, T_C = 25^\circ\text{C}$ | -    | 2.5  | -    | V    |
| $t_{rr}$ | Reverse-Recovery Time | $I_F = 0.1 \text{ A}, T_C = 25^\circ\text{C}$ | -    | 80   | -    | ns   |

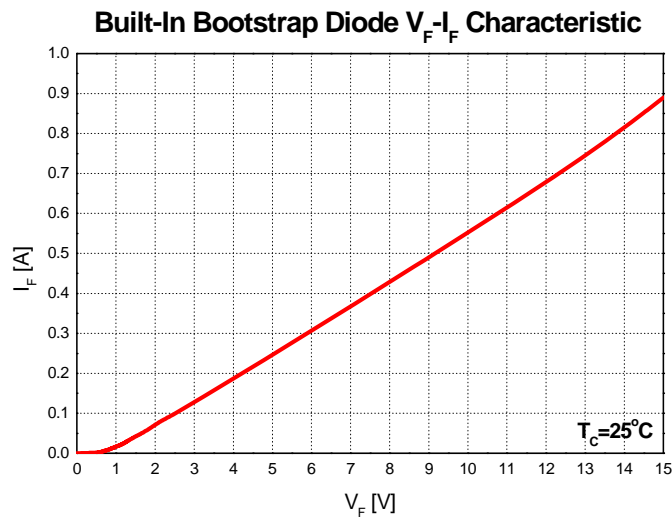


Figure 7. Built-In Bootstrap Diode Characteristic

**2nd Notes:**

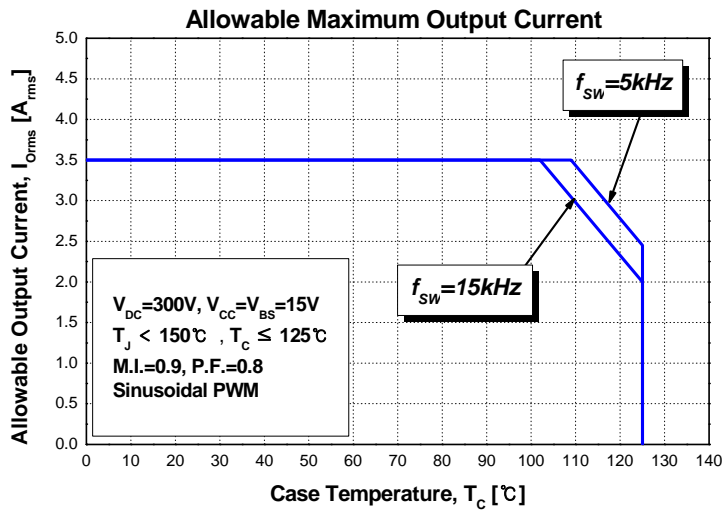
7. Built-in bootstrap diode includes around 15  $\Omega$  resistance characteristic.

### Recommended Operating Conditions

| Symbol                   | Parameter                              | Conditions  | Min. | Typ. | Max. | Unit        |
|--------------------------|--|---|------|------|------|-------------|
| $V_{PN}$                 | Supply Voltage                         | Applied between P - $N_U, N_V, N_W$   | -    | 300  | 400  | V           |
| $V_{CC}$                 | Control Supply Voltage                 | Applied between $V_{CC(H)}, V_{CC(L)}$ - COM                                    | 13.5 | 15   | 16.5 | V           |
| $V_{BS}$                 | High-Side Bias 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 / $\mu$ s |
| $t_{dead}$               | Blanking Time for Preventing Arm-Short | For each input signal   | 1.5  | -    | -    | $\mu$ s     |
| $f_{PWM}$                | PWM Input Signal                       | $-40^\circ\text{C} < T_J < 150^\circ\text{C}$                                   | -    | -    | 20   | kHz         |
| $V_{SEN}$                | Voltage for Current Sensing            | Applied between $N_U, N_V, N_W$ - COM (Including Surge-Voltage)                 | - 4  |      | 4    | V           |
| $P_{WIN(ON)}$            | Minimum Input Pulse Width              | (2nd Note 8)  | 0.5  | -    | -    | $\mu$ s     |
| $P_{WIN(OFF)}$           |  |   | 0.5  | -    | -    |             |

**2nd Notes:**

8. This product might not make response if input pulse width is less than the recommended value.



**Figure 8. Allowable Maximum Output Current**

**2nd Notes:**

9. This allowable output current value is the reference data for the safe operation of this product. This may be different from the actual application and operating condition.

## Mechanical Characteristics and Ratings

| Parameter       | Conditions         | Min.                    | Typ. | Max.  | Unit |         |
|-----------------|--------------------|-------------------------|------|-------|------|---------|
| Device Flatness | See Figure 9       | 0                       | -    | + 120 | μm   |         |
| Mounting Torque | Mounting Screw: M3 | Recommended 0.7 N • m   | 0.6  | 0.7   | 0.8  | N • m   |
|                 | See Figure 10      | Recommended 7.1 kg • cm | 6.2  | 7.1   | 8.1  | kg • cm |
| Weight          |                    | -                       | 11   | -     | g    |         |



Figure 9. Flatness Measurement Position

**Pre - Screwing : 1→2**

**Final Screwing : 2→1**

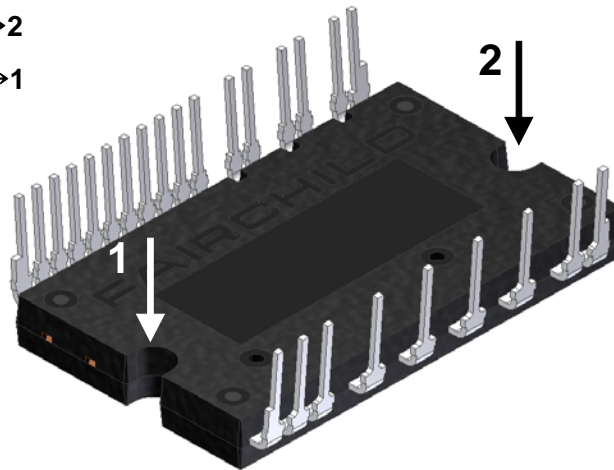
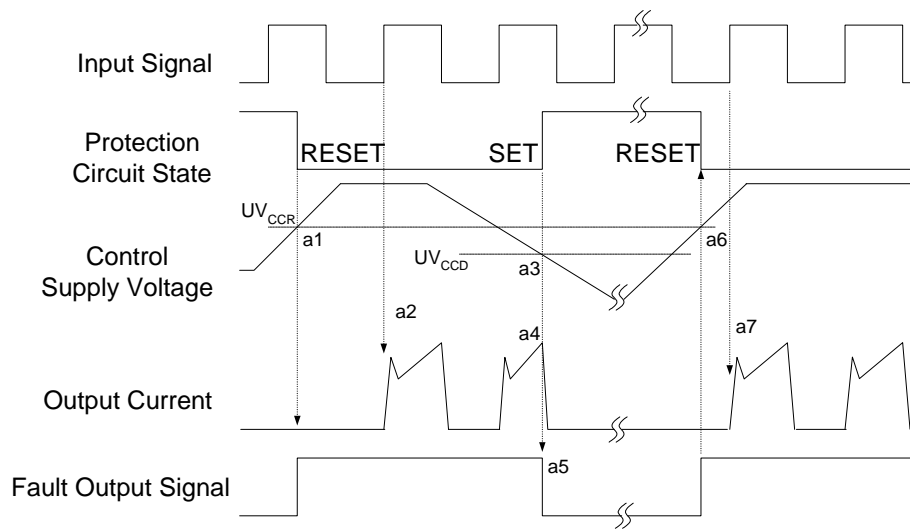


Figure 10. Mounting Screws Torque Order

**2nd Notes:**

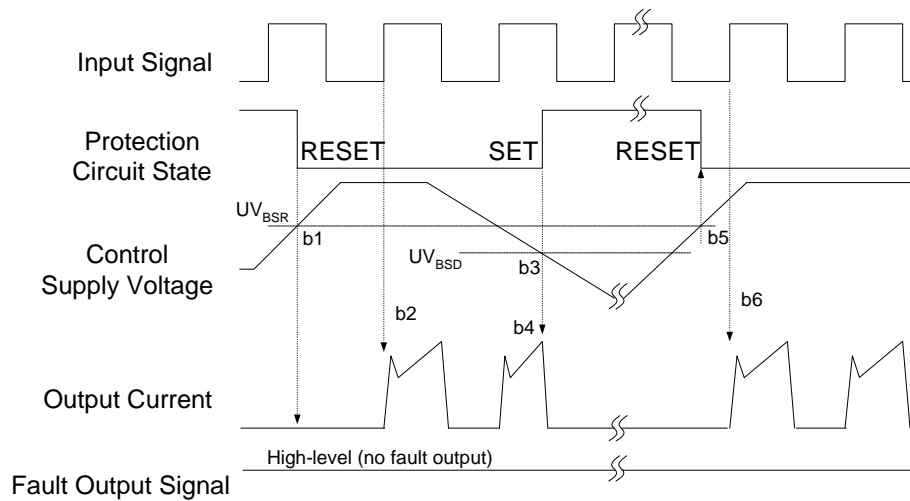
- 10. Do not make over torque when mounting screws. Much mounting torque may cause ceramic cracks, as well as bolts and Al heat-sink destruction.
- 11. Avoid one side tightening stress. Figure 10 shows the recommended torque order for mounting screws. Uneven mounting can cause the ceramic substrate of the SPM® 45 package to be damaged. The pre-screwing torque is set to 20 ~ 30% of maximum torque rating.

### Time Charts of Protective Function



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

**Figure 11. Under-Voltage Protection (Low-Side)**



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

**Figure 12. Under-Voltage Protection (High-Side)**



(with the external shunt resistance and CR connection)

- c1 : Normal operation: IGBT ON and carrying current.
- c2 : Short-circuit current detection (SC trigger).
- c3 : Hard IGBT gate interrupt.
- c4 : IGBT turns OFF.
- c5 : Input "LOW": IGBT OFF state.
- c6 : Input "HIGH": IGBT ON state, but during the active period of fault output, the IGBT doesn't turn ON.
- c7 : IGBT OFF state.

**Figure 13. Short-Circuit Protection (Low-Side Operation Only)**

### Input/Output Interface Circuit



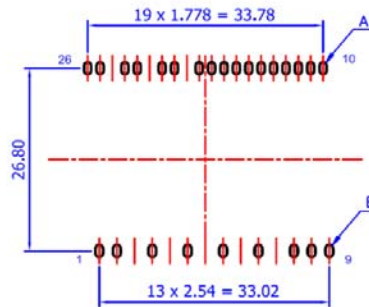
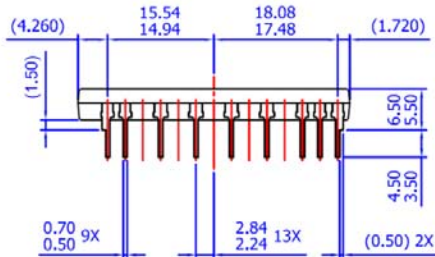
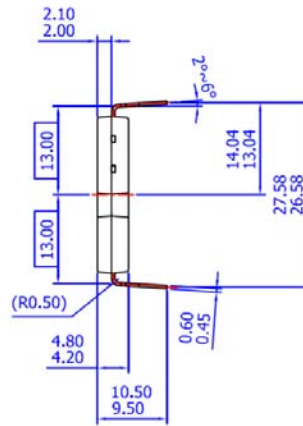
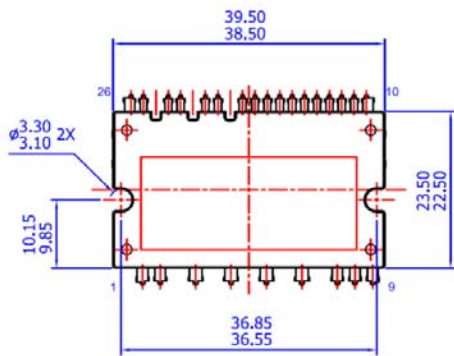
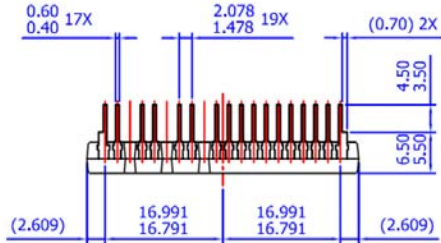
**Figure 14. Recommended MCU I/O Interface Circuit**

**2nd Notes:**

12. RC coupling at each input (parts shown dotted) might change depending on the PWM control scheme in the application and the wiring impedance of the application's printed circuit board. The input signal section of the Motion SPM® 45 product integrates a 5 kΩ (typ.) pull-down resistor. Therefore, when using an external filtering resistor, pay attention to the signal voltage drop at input terminal.



### Detailed Package Outline Drawings (FNB40560)



LAND PATTERN RECOMMENDATIONS

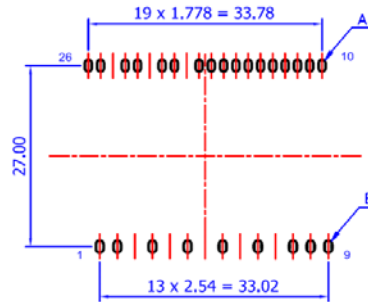
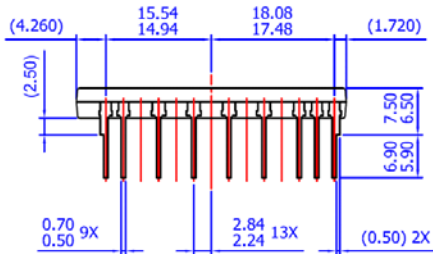
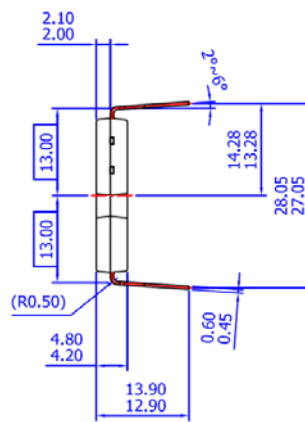
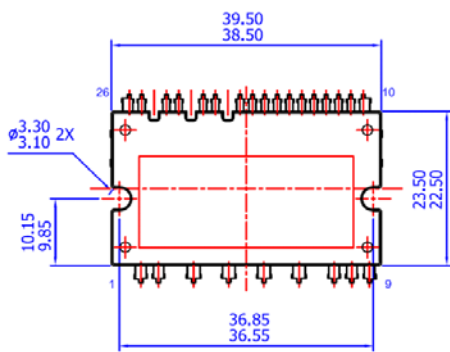
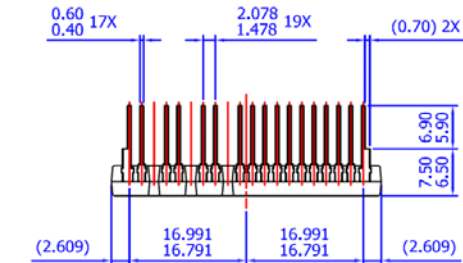
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