FNB50560TD1

Motion SPM® 55 Series

Features

- UL Certified No. E209204 (UL1557)
- 600 V - 5 A 3-Phase IGBT Inverter Including Control IC for Gate Drive and Protections
- Low-Loss, Short-Circuit Rated IGBTs
- Built-In Bootstrap Diodes in HVIC
- Separate Open-Emitter Pins from Low-Side IGBTs for Three-Phase Current Sensing
- Active-HIGH interface, works with 3.3 / 5 V Logic, Schmitt-trigger Input
- HVIC for Gate Driving, Under-Voltage and Short-Circuit Current Protection
- Fault Output for Under-Voltage and Short-Circuit Current Protection
- Inter-Lock Function to Prevent Short-Circuit
- Shut-Down Input
- HVIC Temperature-Sensing Built-In for Temperature Monitoring
- Optimized for 15 - 20 kHz Switching Frequency
- Isolation Rating: 1500 V_{rms} / min.

/ min.

- **AN-9097 - SPM ® 55 Packing Mounting Guidance**

General Description

FNB50560TD1 is a Motion SPM 55 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, inter-lock function, over-current shutdown, thermal monitoring of drive IC, 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.

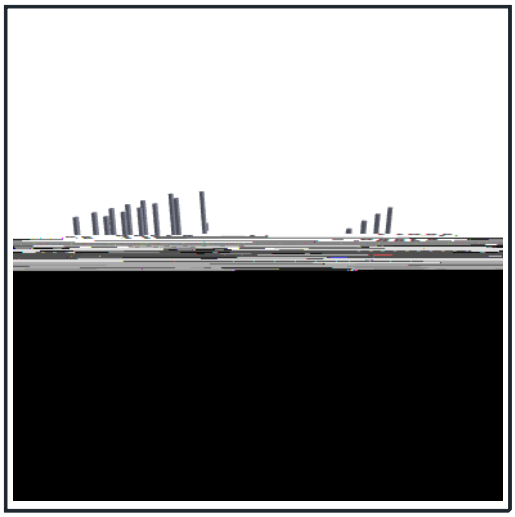


Figure 1. 3D Package Drawing
(Click to Activate 3D Content)

Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FNB50560TD1	FNB50560TD1	SPMFA-A20	RAIL	13

Pin Descriptions

Pin Number	Pin Name	Pin Description
1	P	Positive DC-Link Input
2	U, V_S(U)	Output for U Phase
3	V, V_S(V)	Output for V Phase
4	W, V_S(W)	Output for W Phase
5	N_U	Negative DC-Link Input for U Phase
6	N_V	Negative DC-Link Input for V Phase
7	N_W	Negative DC-Link Input for W Phase
8	$IN_{(UL)}$	Signal Input for Low-Side U Phase
9	IN	

Internal Equivalent Circuit and Input/Output Pins

Absolute Maximum Ratings (T_J = 25°C, unless otherwise specified.)

Inverter Part

Symbol	Parameter	Conditions	Rating	Unit
V				

Note:

5. The maximum junction temperature rating of the power chips integrated within the Motion SPM® 55 product is 150 C.

Control Part

Total System

Thermal Resistance

Note:

6. For Marking " * ", These Value had been made an acquisition by the calculation considered to design factor.

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

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

Inverter Part

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	Collector - Emitter Saturation Voltage	$V_{DD} = V_{BS}$ = 15 V V_{IN} = 5 V I_C = 4 A	T_J = 25°C	-	1.9	2.25	V

Note:

8. 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

Control Part

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
I_{QDD}	Quiescent V_{DD} Supply Current	V_{DD} = 15 V, $IN_{(UH,VH,WH,UL,VL,WL)}$ = 0 V	V_{DD} - COM	-	1.5	2.0	mA
I_{PDD}	Operating V_{DD} Supply Current	V_{DD} = 15 V, f_{PWM} = 20 kHz, duty = 50%, applied to one PWM signal input	V_{DD} - COM	-	2.0	2.5	mA
I_{QBS}	Quiescent V_{BS} Supply Current	V_{BS} = 15 V, $IN_{(UH, VH, WH)}$ = 0 V	$V_{B(U)}$ - $V_{S(U)}$, $V_{B(V)}$ - $V_{S(V)}$, $V_{B(W)}$ - $V_{S(W)}$	-	30	60	A
I_{PBS}	Operating V_{BS} Supply Current	V_{DD} = V_{BS} = 15 V, f_{PWM} = 20 kHz, duty = 50%, applied to one PWM signal input for high - side	$V_{B(U)}$ - $V_{S(U)}$, $V_{B(V)}$ - $V_{S(V)}$, $V_{B(W)}$ - $V_{S(W)}$	-	500	650	A
V_{FH}	Fault Output Voltage	V_{SC} = 0 V, V_F Circuit: 10 k to 5 V Pull-up		4.5	-	-	V
V_{FL}		V_{SC} = 1 V, V_F Circuit: 10 k to 5 V Pull-up		-	-	0.5	V
$V_{SC(ref)}$	Short-Circuit Trip Level	V_{DD} = 15 V (Note 4)		0.45	0.5	0.55	V
UV_{DDD}	Supply Circuit Under-Voltage Protection	Detection level		10.7	11.4	12.1	V
UV_{DDR}		Reset level		11.2	12.3	13.0	V
UV_{BSD}		Detection level		10.1	10.8	11.5	V
UV_{BSR}		Reset level		10.7	11.4	12.1	V
I_{FT}	HVIC Temperature Sensing Current	V_{DD} = V_{BS} = 15 V, T_{HVIC} = 25°C		68	81	95	A
V_{FT}	HVIC Temperature Sensing Voltage	V_{DD} = V_{BS} = 15 V, T_{HVIC} = 25°C, 10 k to 5 V Pull-up (Figure. 5)		4.05	4.19	4.32	V
t_{FOD}	Fault-Out Pulse Width			40	120	-	s
V_{FSDR}	Shut-down Reset level	Applied between V_F - COM		-	-	2.4	V
V_{FSDD}	Shut-down Detection level			0.8	-	-	V
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $IN_{(UH)}$, $IN_{(VH)}$, $IN_{(WH)}$, $IN_{(UL)}$, $IN_{(VL)}$, $IN_{(WL)}$ - COM		-	-	2.4	V
$V_{IN(OFF)}$	OFF Threshold Voltage			0.8	-	-	V

Note:

9. Short-circuit protection is functioning for all six IGBTs.

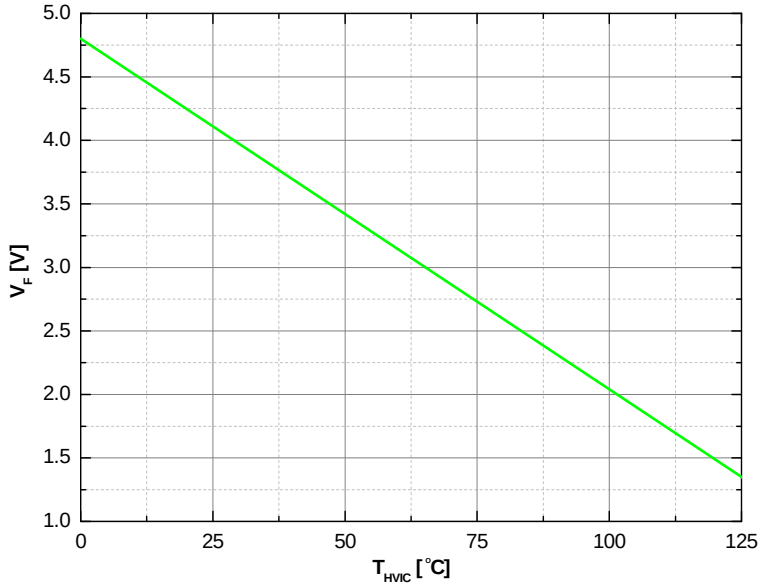


Figure. 5. V-T Curve of Temperature Output of IC (5V pull-up with 10kohm)

Bootstrap Diode Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit

Figure 6. Built-In Bootstrap Diode Charatersts

Recommended Operating Conditions

Note:

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

Note:

11. RC coupling at each input (parts shown dotted) might change depending on the PWM control scheme used in the application and the wiring impedance of the application's printed circuit board. The input signal section of the SPM 55 product integrates 10 k (typ.) pull-down resistor. Therefore, when using an external filtering resistor, please pay attention to the signal voltage drop at input terminal.

Figure 7. Recommended MCU I/O Interface Circuit

Mechanical Characteristics and Ratings

Parameter	Conditions		Min.	Typ.	Max.	Unit
Device Flatness	See Figure 8		-50	-	100	m
Mounting Torque	Mounting Screw: - M3	Recommended 0.7 N • m	0.6	0.7	0.8	N • m
	Note Figure 9	Recommended 7.1 kg • cm	5.9	6.9	7.9	kg • cm
Weight			-	6.0	-	g

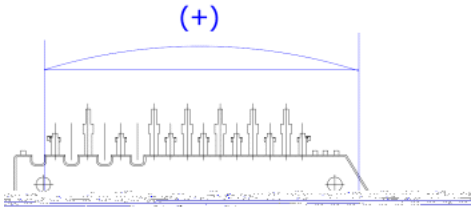


Figure 8. Flatness Measurement Position

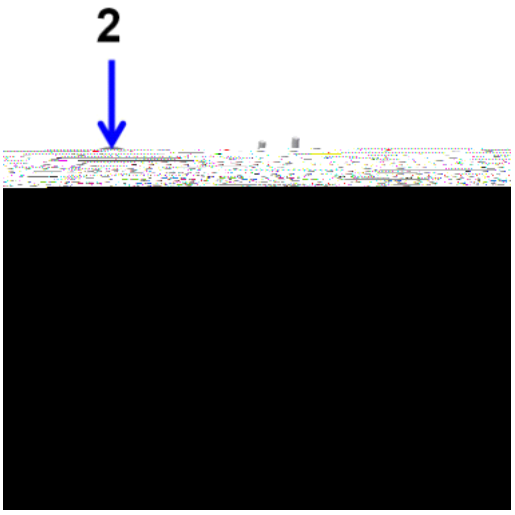


Figure 9. Mounting Screws Torque Order

Note:

12. Do not make over torque when mounting screws. Much mounting torque may cause package cracks, as well as bolts and Al heat-sink destruction.

13. Avoid one side tightening stress. Figure 10 shows the recommended torque order for mounting screws. Uneven mounting can cause the ceramic substrate of the Motion SPM 55 product 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_{DDR}, the circuits start to operate when next input is applied.

a2 : Normal operation: IGBT ON and carrying current.

a3 : Under voltage detection (UV_{DDD}).

a4 : IGBT OFF in spite of control input condition.

a5 : Fault output operation starts.

a6 : Under voltage reset (UV_{DDR}).

a7 : Normal operation: IGBT ON and carrying current.

Figure 10. 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.

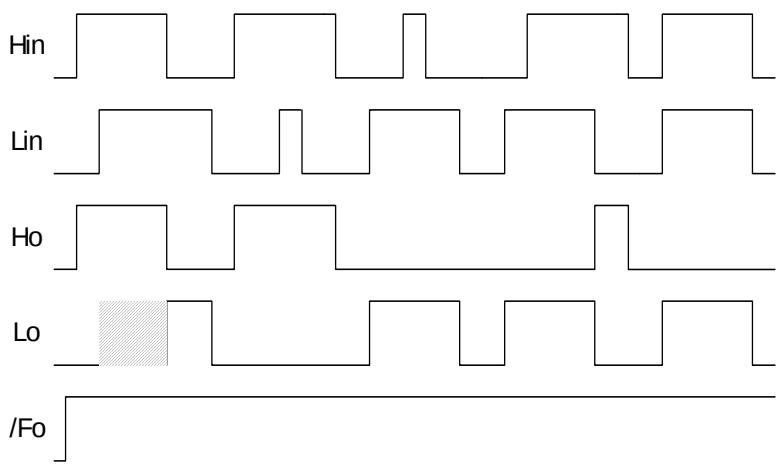
b3 : Under voltage detection (UV_{BSD}).

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 11. Under-Voltage Protection (High-Side)



d1 : High Side First - Input - First - Output Mode

d2 : Low Side Noise Mode : No Lo

d3 : High Side Noise Mode : No Ho

d4 : Low Side First - Input - First - Output Mode

d5 : In - Phase Mode : No Ho

Figure 12. Inter-Lock Function

HIN : High-side Input Signal

LIN : Low-side Input Signal

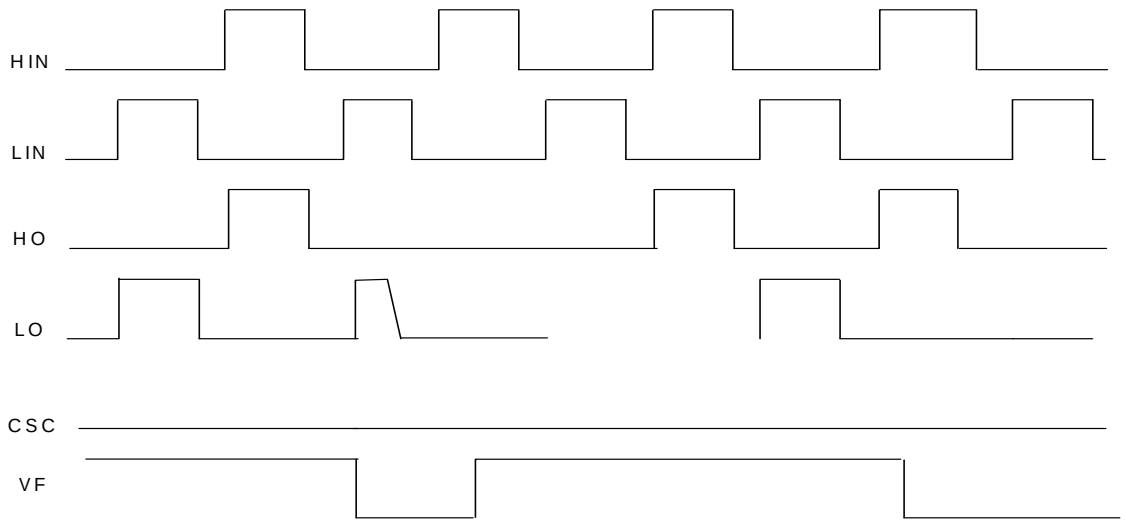
HO : High-Side Output Signal

LO : Low-Side Output Signal

CSC : Short-circuit Current Detection Input

VF : Fault Out Function

Figure 13. Fault-Out Function By Over Current Protection



HIN : High-side Input Signal
LIN : Low-side Input Signal
HO : High-Side Output Signal
LO : Low-Side Output Signal
CSC : Over Current Detection Input
VF : Shutdown Input Function

Figure 14. Shutdown Input Function By External Command

Note:

1) To avoid malfunction, the wiring of each input should be as short as possible. (less than 2 ~ 3 cm)

2) By virtue of integrating an application specific type of HVIC inside the SPM® 55 product, direct coupling to MCU terminals without any opto-coupler or transformer isolation is possible.

3) V_F 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 I_{FO} up to 5 mA. Please refer to Figure 15.

4) C_{SP15} of around seven times larger than bootstrap capacitor C_{BS} is recommended.

5) Input signal is active-HIGH type. There is a 10 k resistor inside the IC to pull down each input signal line to GND. RC coupling circuits is recommanded for the prevention of input signal oscillation. $R_S C_{PS}$

Detailed Package Outline Drawings (FNB50560TD1, Short Lead)