To learn more about ON Semiconductor, please visit our website at
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Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes [illegible]

January 2014

FNB41560 / FNB41560B2

Motion SPM® 45 Series

Features

- UL Certified No. E209204 (UL1557)
- 600 V - 15 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_{rms} / min.

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)*

General Description

FNB41560 / FNB41560B2 is an advanced 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.

Figure 1. Package Overview

Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FNB41560	FNB41560	SPMAA-A26	Rail	12
FNB41560B2	FNB41560B2	SPMAA-C26	Rail	12

Integrated Power Functions

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	

Internal Equivalent Circuit and Input/Output Pins

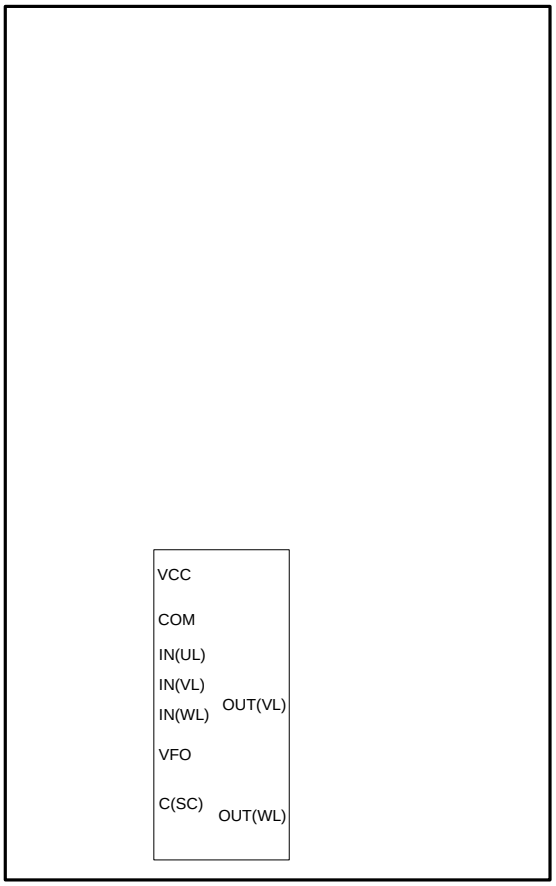


Figure 3. Internal Block Diagram

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°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
$V_{PN(Surge)}$	Supply Voltage (Surge)	Applied between P - N_U, N_V, N		

2nd Notes:

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

Control Part

Bootstrap Diode Part

Total System

Thermal Resistance

2nd Notes:

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

Figure 5. Switching Loss Characteristics (Typical)

Control Part

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
I_{QCCH}	Quiescent V_{CC} Supply Current	$V_{CC(H)}$ = 15 V, $IN_{(UH,VH,WH)}$ = 0 V	$V_{CC(H)}$ - COM	-	-	0.10	mA
I_{QCCL}		$V_{CC(L)}$ = 15 V, $IN_{(UL,VL,WL)}$ = 0 V	$V_{CC(L)}$ - COM	-	-	2.65	mA
I_{PCCH}	Operating V_{CC} Supply Current	$V_{CC(L)}$ = 15 V, f_{PWM} = 20 kHz, duty = 50%, Applied to One PWM Signal Input for High-Side	$V_{CC(H)}$ - COM	-	-	0.15	mA
I_{PCCL}		$V_{CC(L)}$ = 15 V, f_{PWM} = 20 kHz, duty = 50%, Applied to One PWM Signal Input for Low-Side	$V_{CC(L)}$ - COM	-	-	3.65	mA
I_{QBS}	Quiescent V_{BS} Supply Current	V_{BS} = 15 V, $IN_{(UH, VH, WH)}$ = 0 V	$V_{B(U)}$ - V				

2nd Notes:

5. Short-circuit protection is functioning only at the low-sides.

6. T_{TH} is the temperature of thermister itselt. To know case temperature (T_C), please make the experiment considering your application.

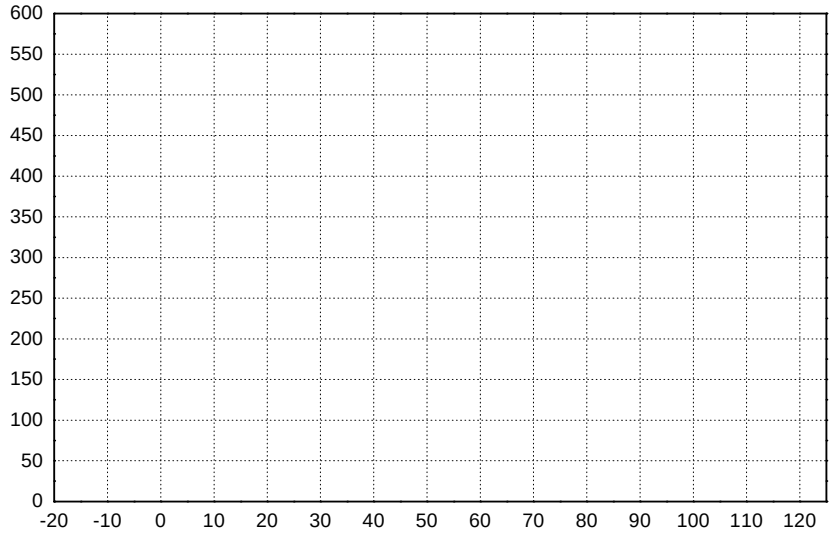


Figure. 6. R-T Curve of The Built-In Thermistor

Bootstrap Diode Part

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

Figure 7. Built-In Bootstrap Diode Characteristic

2nd Notes:

7. Built-in bootstrap diode includes around 15 Ω resistance characteristic.

Recommended Operating Conditions

2nd Notes:

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

Figure 8. Allowable Maximum Output Current

2nd Notes:

9. This allowable output current value is the reference data for

Mechanical Characteristics and Ratings

Parameter	Conditions		Min.	Typ.	Max.	Unit
Device Flatness	See Figure 9		0	-	+ 120	m
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

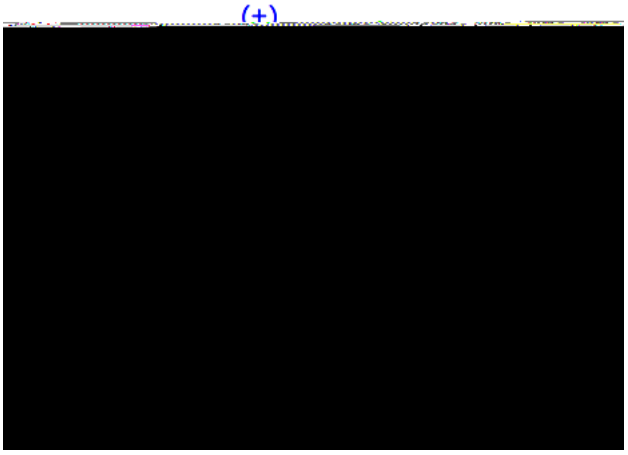


Figure 9. Flatness Measurement Position

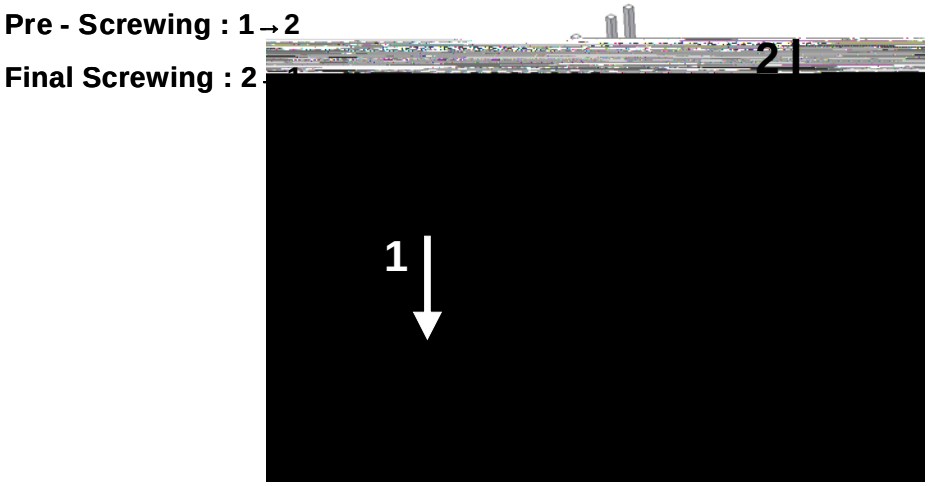


Figure 10. Mounting Screws Torque Order

2nd Notes:

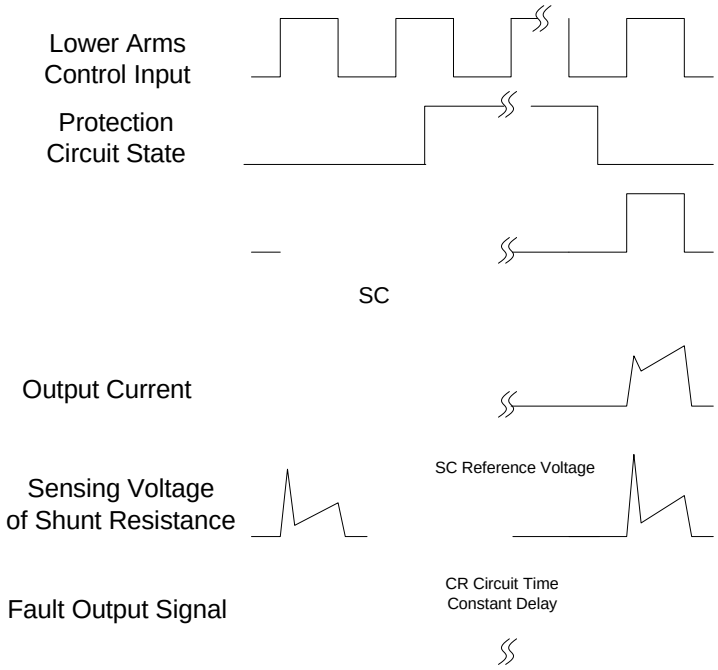
10. Do not make over torque when mounting screws. Much mounting torque may cause ceramic cracks, as well as bolts and Al heat-sink destruction.

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.



(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 k (typ.) pull-down resistor. Therefore, when using an external filtering resistor, pay attention to the signal voltage drop at input terminal.

Figure 15. Typical Application Circuit

3rd Notes:

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 Motion SPM® 45 product, direct coupling to MCU terminals without any optocoupler or transformer isolation is possible.

3) 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 I_{FO} up to 1 mA (please refer to Figure 14).

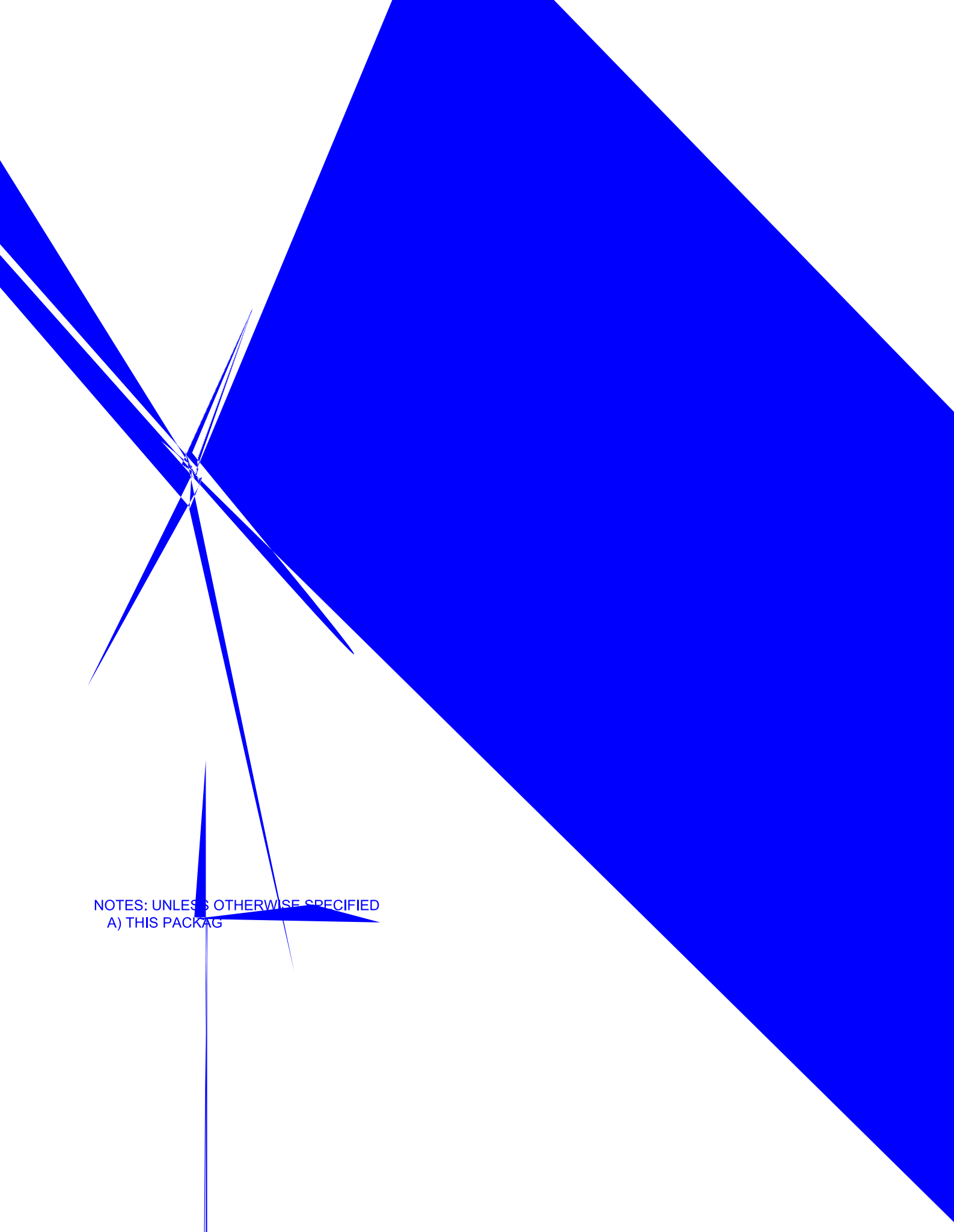
4) C_{SP15} of around seven times larger than bootstrap capacitor C_{BS} is recommended.

5) Input signal is active-HIGH type. There is a 5 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. $R_S C_{PS}$ time constant should be selected in the range 50 ~ 150 ns (recommended R_S = 100 Ω, C_{PS} = 1 nF).

6) To prevent errors of the protection function, the wiring around R_F and C_{SC} should be as short as possible.

7) In the short-circuit protection circuit, please select the $R_F C_{SC}$ time constant in the range 1.5 ~ 2 s.

8) The connection between control GND line and power GND line which includes the N_U



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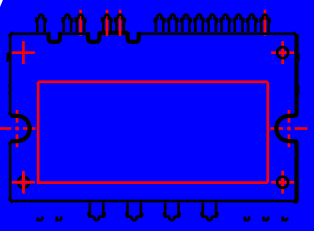

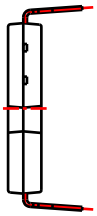

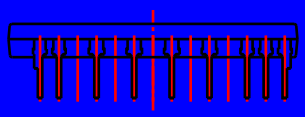

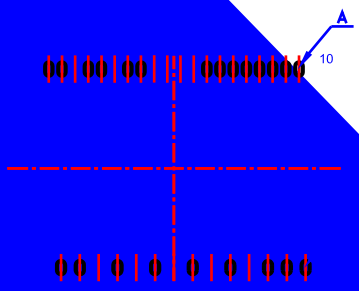

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