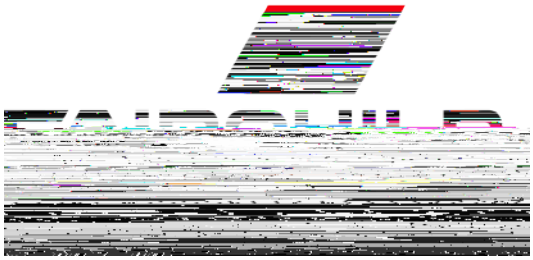

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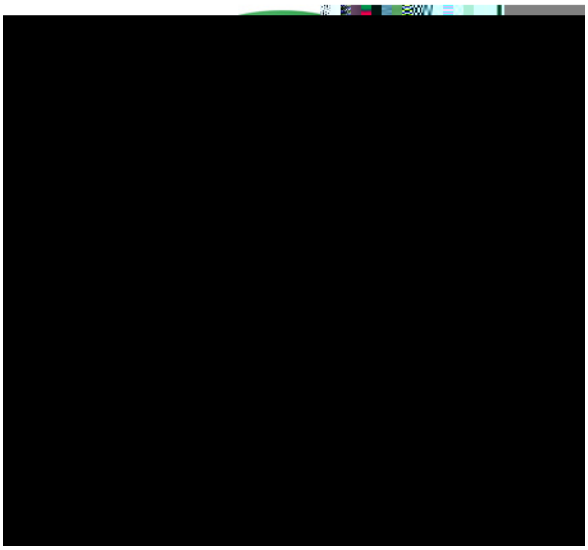

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www.onsemi.com

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 an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.

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April 2017

FNB51560TD1

Motion SPM® 55 Series

Features

- UL Certified No. E209204 (UL1557)
- 600 V - 15 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-Cir.55TJ14TIroncS.1.9(o)12-6.3(vnLroncS.p(o)1(l)34o)12(v)-1.w[•).3 / 5 V Logic
- Optimized for 15 kHz Switching Frequency
- Isolation Rating: 1500 V

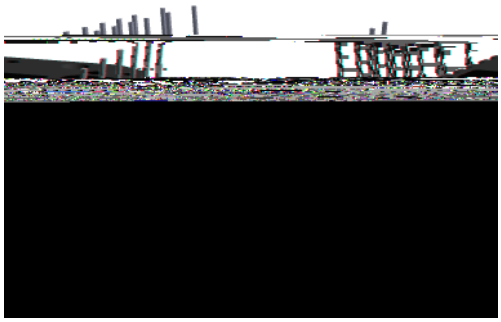
General Description

FNB51560TD1 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

$_{rms}$ / min.

Applications

- Motion Control - Home Appliance / Industrial Motor



Related Resources

- *AN-9096 - Smart Power Module, Motion SPM® 55 Series User's Guide*
- *AN-9097 - SPM® 55 Packing Mounting Guidance*

Integrated Power Functions

- 600 V - 15 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: High-active interface, works with 3.3 / 5 V logic, Schmitt trigger input
- Built in Bootstrap circuitry in HVIC

Pin Configuration

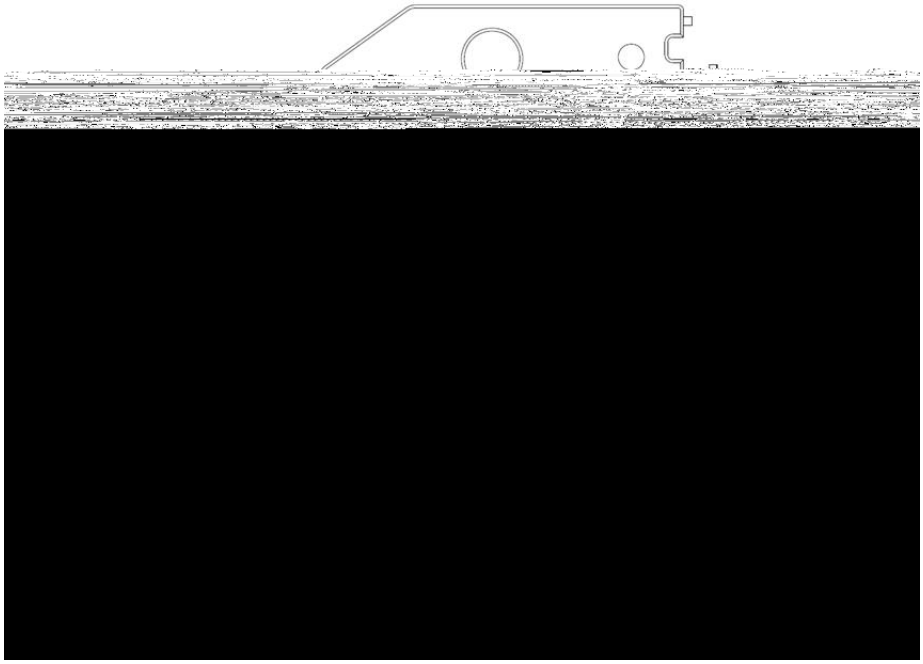


Figure 2. Top View

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	$IN_{(UH)}$	Signal Input for High- ide U Phase
10	$IN_{(VL)}$	Signal Input for Low-Side V Phase
11	$IN_{(VH)}$	Signal Input for High-Side V Phase
12	$IN_{(WL)}$	Signal Input for Low-Side W Phase
13	$IN_{(WH)}$	Signal Input for High-Side W Phase
14	V_{DD}	Common Bias Voltage for IC and IGBTs Driving
15	COM	Common Supply Ground
16	C_{SC}	Capacitor (Low-Pass Filter) for Short-circuit Current Detection Input
17	V_F	Fault Output, Shut-Down Input, Temperature Output of Drive IC
18	$V_{B(W)}$	High-Side Bias Voltage for W-Phase IGBT Driving
19	$V_{B(V)}$	High-Side Bias Voltage for V-Phase IGBT Driving
20	$V_{B(U)}$	High-Side Bias Voltage for U-Phase IGBT Driving

Internal Equivalent Circuit and Input/Output Pins

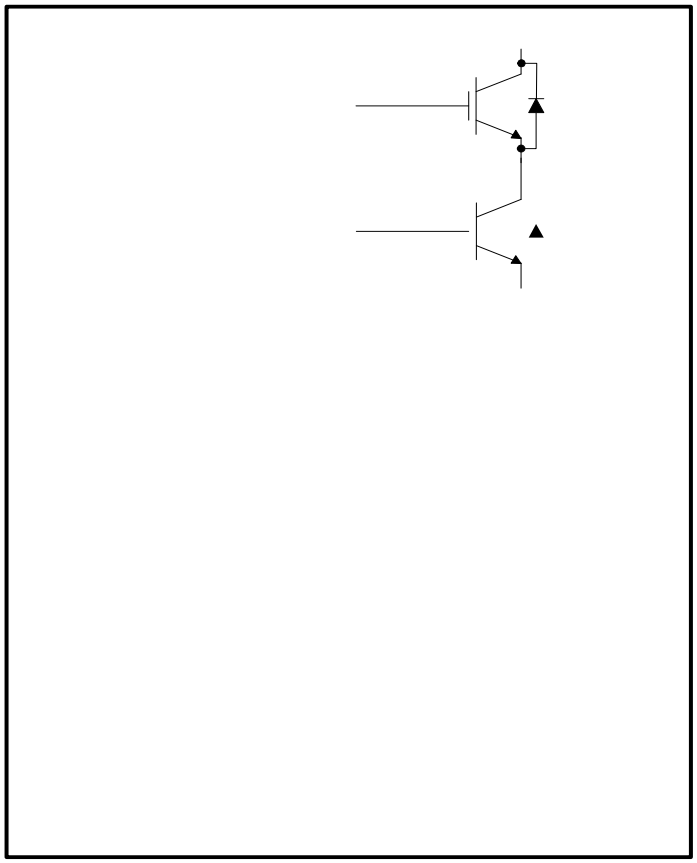


Figure 3. Internal Block Diagram

Note:

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. Single drive IC has gate driver for six IGBTs and protection functions.
4. 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_W	500	V
V_{CES}	Collector - Emitter Voltage		600	V
* ± I_C	Each IGBT Collector Current	T_C = 25°C, T_J 150°C	15	A
* ± I_{CP}	Each IGBT Collector Current (Peak)	T_C = 25°C, T_J 150°C, Under 1 ms Pulse Width	30	A
* P_C	Collector Dissipation	T_C = 25°C per Chip	22	W
T_J	Operating Junction Temperature	(Note 5)	-40 ~ 150	°C

Note:

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

Control Part

Symbol	Parameter	Conditions	Rating	Unit
V_{DD}	Control Supply Voltage	Applied between V_{DD} - 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_{DD} +0.3	V
V_F	Fault Supply Voltage	Applied between V_F - COM	-0.3 ~ V_{DD} +0.3	V
* I_F	Fault Current	Sink Current at V_F pin	5	mA
V_{SC}	Current Sensing Input Voltage	Applied between C_{SC} - COM	-0.3 ~ V_{DD} +0.3	V

Total System

Symbol	Parameter	Conditions	Rating	Unit
$V_{PN(PROT)}$	Self Protection Supply Voltage Limit (Short Circuit Protection Capability)	V_{DD} = V_{BS} = 13.5 ~ 16.5 V T_J = 150°C, Non-Repetitive, < 2 μs	400	V
T_{STG}	Storage Temperature		-40 ~ 125	°C
V_{ISO}	Isolation Voltage Connect Pins to Heat Sink Plate	AC 60 Hz, Sinusoidal, 1 Minute	1500	V_{rms}

Thermal Resistance

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$R_{th(j-c)Q}$	Junction to Case Thermal Resistance (Note 7)					

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.

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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}					

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
R_{BS}	Bootstrap Diode Resitance	V_{DD} = 15V, T_J = 25°C	-	280	-	Ω

Figure 6. Built-In Bootstrap Diode Charaterstics

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_{DD}	Control Supply Voltage	Applied between V_{DD} - COM	14.0	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_{DD} / dt, dV_{BS} / dt	Control Supply Variation		-1	-	1	V / μs
t_{dead}	Blanking Time for Preventing Arm - Short	For each input signal	0.5	-	-	μs
f_{PWM}	PWM Input Signal	- 40°C T_J 150°C	-	-	20	kHz
V_{SEN}	Voltage for Current Sensing	Applied between N				

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 kΩ (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	

Figure 8. Flatness Measurement Position

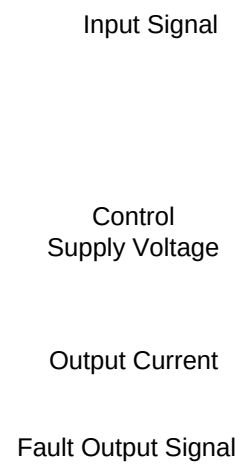
Figure 9. Mounting Screws Torque Order

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 11 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.

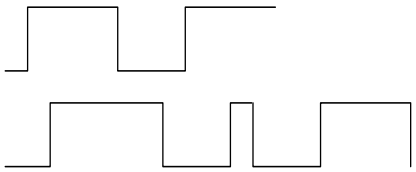
b3 : Under voltage detection (UV_{BSD}).

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 : Over Current Detection Input

VF : Fault Out Function

Figure 13. Fault-Out Function By Over Current Protection

Note:

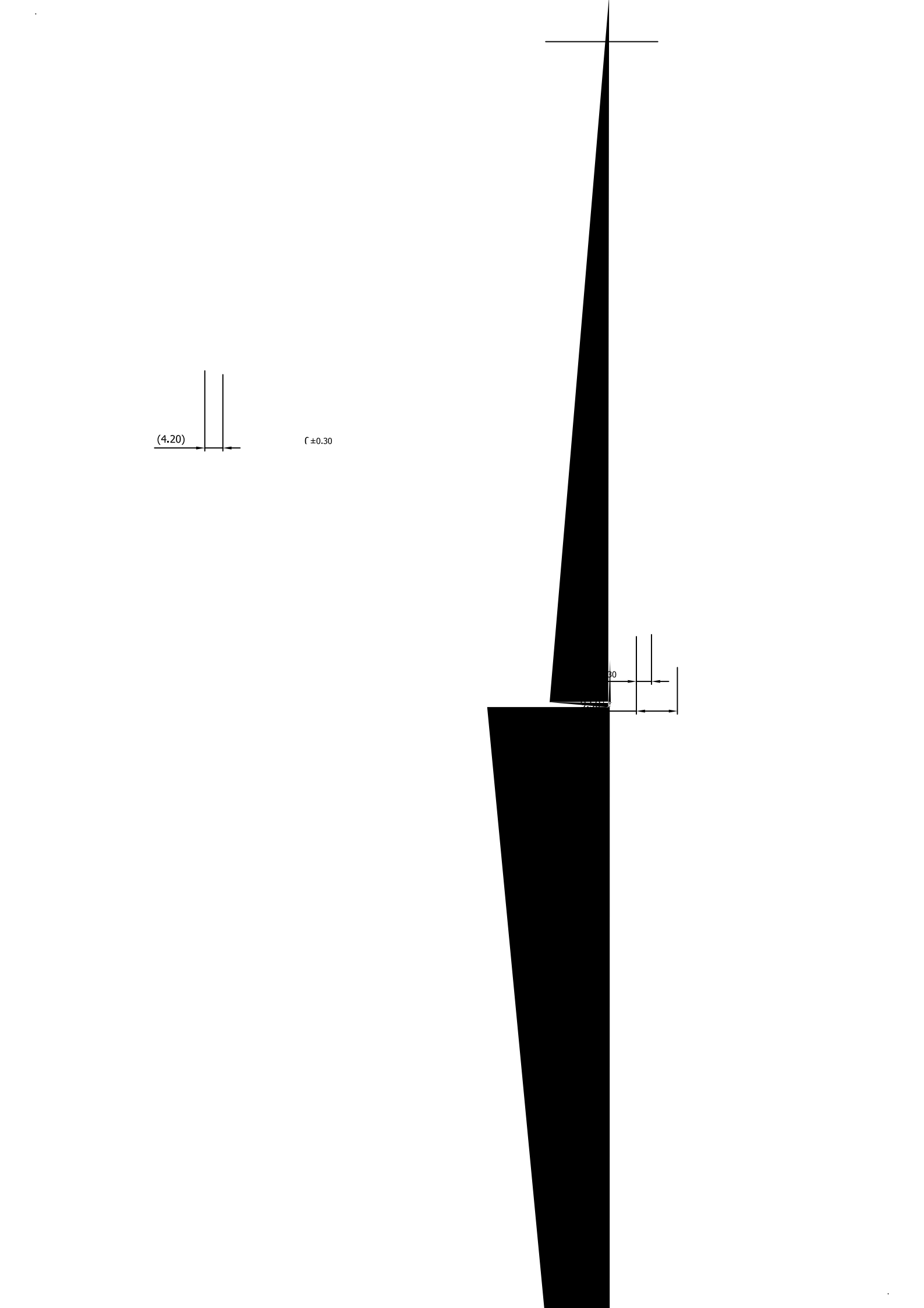
1) To avoid malfunction, the wiring of each input should be as short as possible. (less than 2 ~ 3 cm)

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 kΩ 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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