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April 2017

FNF50560TD1

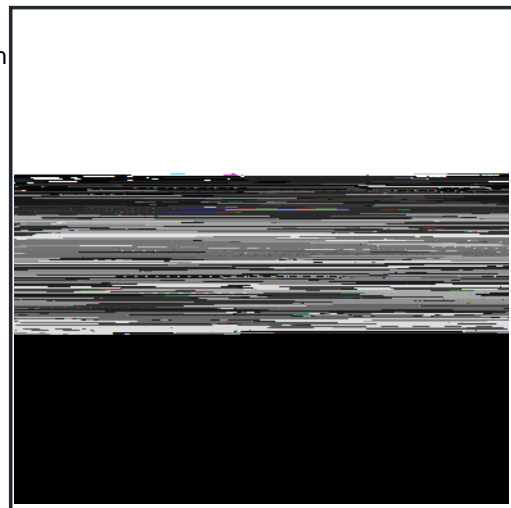
Motion SPM® 55 Series

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

General Description

FNF50560TD1 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)**

- [AN-9097 - SPM® 55 Packing Mounting Guidance](#)

Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FNF50560TD1	FNF50560TD1	SPMFA-A20	RAIL	13

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

Pin Configuration

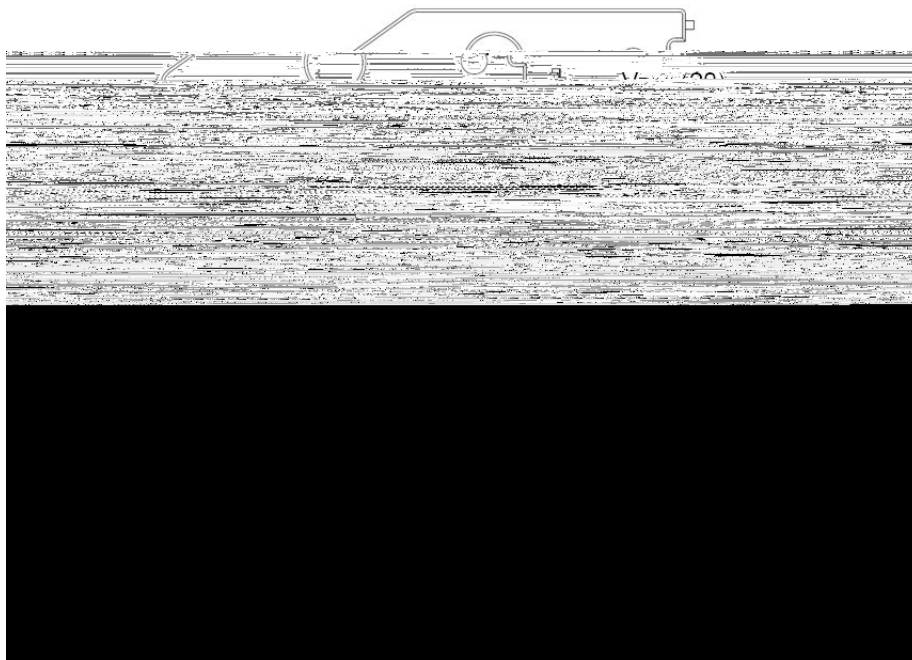


Figure 2. Top View

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
4	W, V	

Internal Equivalent Circuit and Input/Output Pins

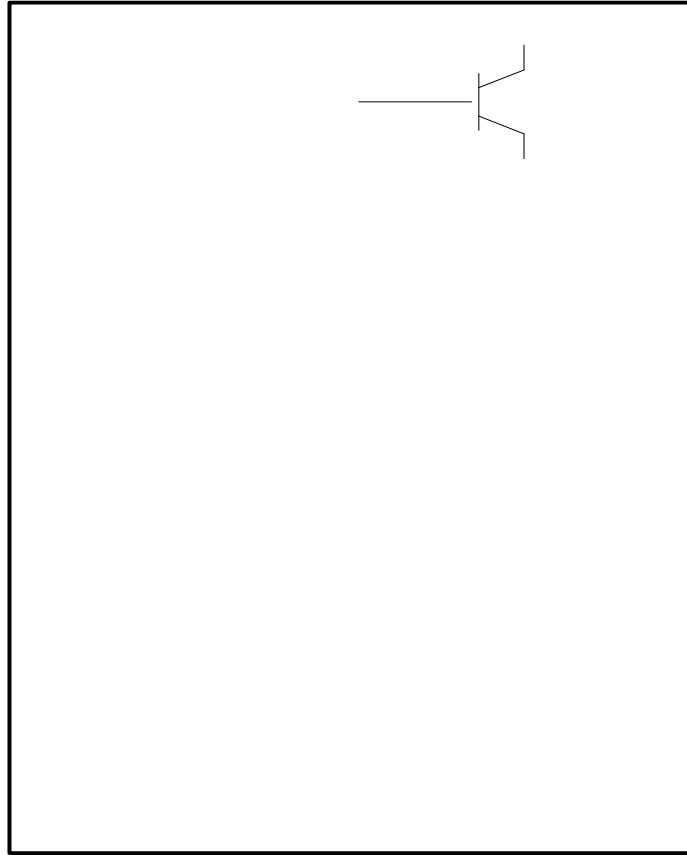


Figure 3. Internal Block Diagram

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

Control Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit	
I_{QDD}	Quiescent V_{DD} Supply Current	$V_{DD} = 15\text{ V}$, $I_{N(UH, VH, WH, UL, VL, WL)} = 0\text{ V}$	$V_{DD} - \text{COM}$	-	1.5	2.0	mA
I_{PDD}	Operating V_{DD} Supply Current	$V_{DD} = 15\text{ V}$, $f_{PWM} = 20\text{ kHz}$, duty = 50%, applied to one PWM signal input	$V_{DD} - \text{COM}$	-	2.0	2.5	mA
I_{QBS}	Quiescent V_{BS} Supply Current	$V_{BS} = 15\text{ V}$, $I_{N(UH, VH, WH)} = 0\text{ V}$	$V_{B(U)} - V_{S(U)}$, $V_{B(V)} - V_{S(V)}$, $V_{B(W)} - V_{S(W)}$	-	30	60	μA
I_{PBS}	Operating V_{BS} Supply Current	$V_{DD} = V_{BS} = 15\text{ V}$, $f_{PWM} = 20\text{ kHz}$, 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	μA
V_{FH}	Fault Output Voltage	$V_{SC} = 0\text{ V}$, V_F Circuit: 10 k Ω to 5 V Pull-up	4.5	-	-	V	
V_{FL}		$V_{SC} = 1\text{ V}$, V_F Circuit: 10 k Ω to 5 V Pull-up	-	-	0.5	V	
$V_{SC(ref)}$	Short-Circuit Trip Level	$V_{DD} = 15\text{ V}$ (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	$V_{DD} = V_{BS} = 15\text{ V}$, $T_{HVIC} = 25^\circ\text{C}$	68	81	95	μA	
V_{FT}	HVIC Temperature Sensing Voltage	$V_{DD} = V_{BS} = 15\text{ V}$, $T_{HVIC} = 25^\circ\text{C}$, 10 k Ω to 5 V Pull-up (Figure. 5)	4.05	4.19	4.32	V	
t_{FOD}	Fault-Out Pulse Width		40	120	-	μs	
V_{FSDR}	Shut-down Reset level	Applied between $V_F - \text{COM}$	-	-	2.4	V	
V_{FSDD}	Shut-down Detection level		0.8	-	-	V	
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $I_{N(UH)}$, $I_{N(VH)}$, $I_{N(WH)}$, $I_{N(UL)}$, $I_{N(VL)}$, $I_{N(WL)} - \text{COM}$	-	-	2.4	V	
$V_{IN(OFF)}$	OFF Threshold Voltage		0.8	-	-	V	

Note:

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

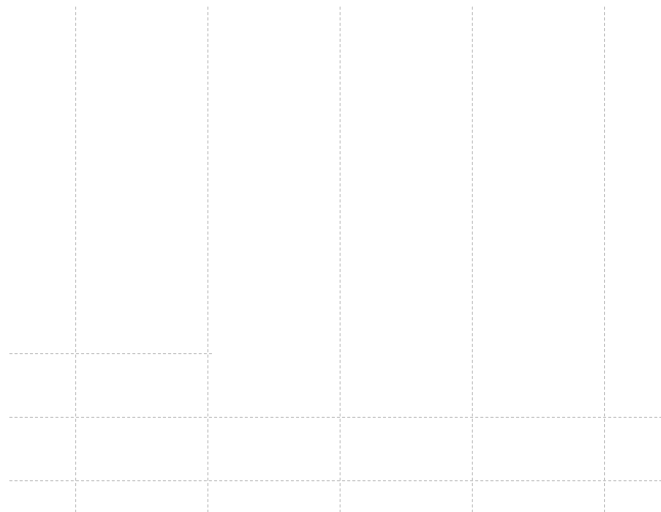


Figure. 5. V-T Curve of Temperature Output of IC (5V pull-up with 10kohm)

Bootstrap Diode Part

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

Mechanical Characteristics and Ratings

Parameter	Conditions	Min.	Typ.	Max.	Unit
Device Flatness	See Figure 8	-50	-	100	μm
Mounting Torque	Mounting Screw: - M3				

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

Input Signal

Control
Supply Voltage

Output Current

Fault Output Signal

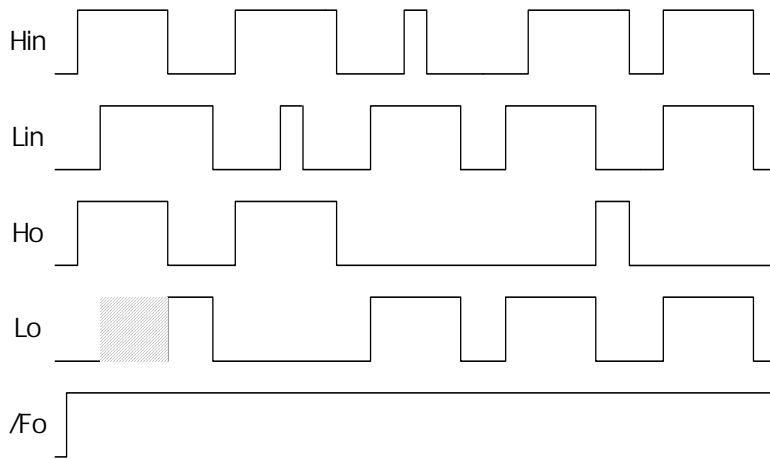
- a1 : Control supply voltage rises: After the voltage rises UV_{DDR} , the circuits start to operate when next input is applied.
 a2 : Normal operation: IGBT ON and carrying current.
 a3 : Under voltage detection (UV_{DD}).
 a4 : IGBT OFF in spite of control input condition.
 a5 : Fault output operation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

(with the external shunt resistance and CR connection)



- 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

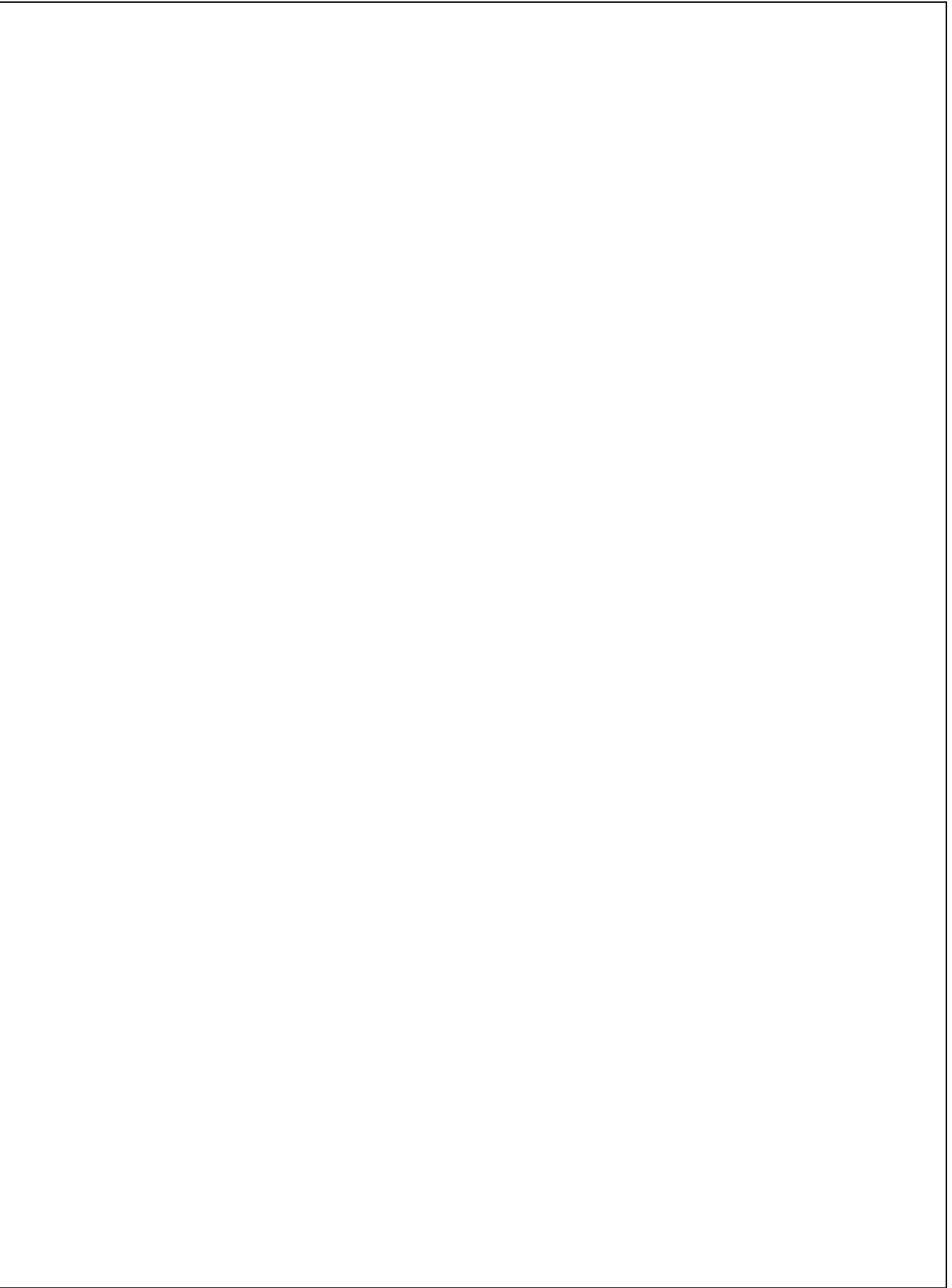
- HIN : High-side Input Signal
- LIN : Low-side Input Signal
- HO : High-Side Output Signal
- LO : Low-Side Output Signal
- CSC : Short-circuit Current Detection Input
- VF : Fault Out Function

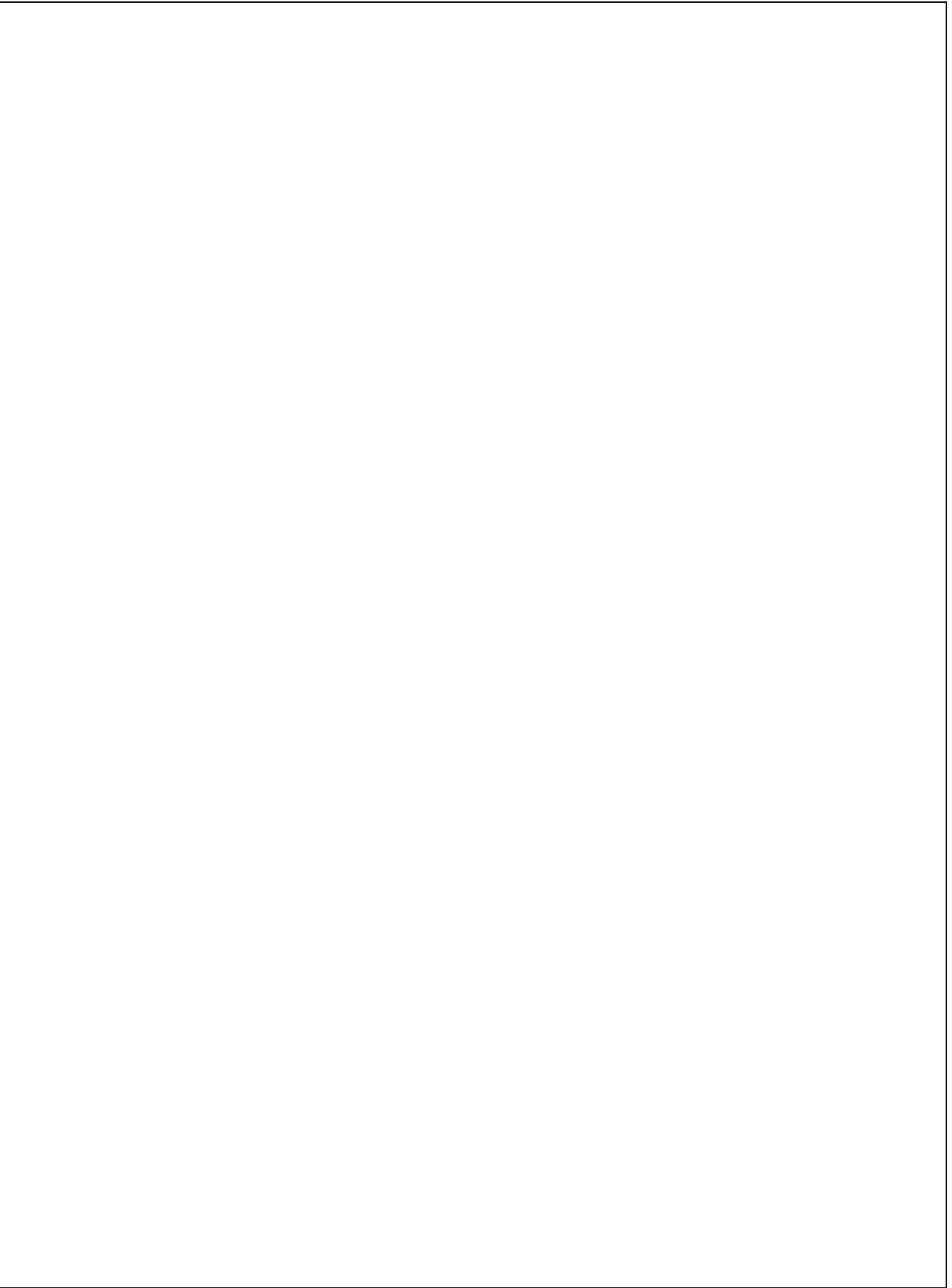
Figure 13. Fault-Out Function By Over Current Protection

H IN

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





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