

FSB50450AS

Motion SPM® 5 Series

Features

- UL Certified No. E209204 (UL1557)
- 500 V $R_{DS(on)} = 2.4 \Omega$ (Max) FRFET MOSFET 3-Phase Inverter with Gate Drivers and Protection
- Built-In Bootstrap Diodes Simplify PCB Layout
- Separate Open-Source Pins from Low-Side MOSFETs for Three-Phase Current-Sensing
- Active-HIGH Interface, Works with 3.3 / 5 V Logic, Schmitt-trigger Input
- Optimized for Low Electromagnetic Interference
- HVIC Temperature-Sensing Built-In for Temperature Monitoring
- HVIC for Gate Driving and Under-Voltage Protection
- Isolation Rating: 1500 V_{rms} / min.
- Moisture Sensitive Level (MSL) 3
- RoHS Compliant

Applications

- 3-Phase Inverter Driver for Small Power AC Motor Drives

Related Source

- [RD-FSB50450A - Reference Design for Motion SPM 5 Series Ver.2](#)
- [AN-9082 - Motion SPM5 Series Thermal Performance by Contact Pressure](#)
- [AN-9080 - User's Guide for Motion SPM 5 Series V2](#)

General Description

The FSB50450AS is an advanced Motion SPM® 5 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 MOSFETs (FRFET® technology) to minimize EMI and losses, while also providing multiple on-module protection features including under-voltage lockouts and thermal monitoring. 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 internal MOSFETs. Separate open-source MOSFET terminals are available for each phase to support the widest variety of control algorithms.



Package Marking & Ordering Information

Device Marking	Device	Package	Reel Size	Packing Type	Quantity
FSB50450AS	FSB50450AS	SPM5Q-023	330mm	Tape-Reel	450

Absolute Maximum Ratings

Inverter Part (each MOSFET unless otherwise specified.)

Symbol	Parameter	Conditions	Rating	Unit
V_{DSS}	Drain-Source Voltage of Each MOSFET		500	V
$*I_{D\ 25}$	Each MOSFET Drain Current, Continuous	$T_C = 25^\circ\text{C}$	1.5	A
$*I_{D\ 80}$	Each MOSFET Drain Current, Continuous	$T_C = 80^\circ\text{C}$	1.1	A
$*I_{DP}$	Each MOSFET Drain Current, Peak	$T_C = 25^\circ\text{C}$, $PW < 100\ \mu\text{s}$	3.9	A
$*I_{DRMS}$	Each MOSFET Drain Current, Rms	$T_C = 80^\circ\text{C}$, $F_{PWM} < 20\ \text{kHz}$	0.8	A_{rms}
$*P_D$	Maximum Power Dissipation	$T_C = 25^\circ\text{C}$, For Each MOSFET	14	W

Control Part (each HVIC unless otherwise specified.)

Symbol	Parameter	Conditions	Rating	Unit
V_{CC}	Control Supply Voltage	Applied between V_{CC} and COM	20	V
V_{BS}	High-side Bias Voltage	Applied between V_B and V_S	20	V
V_{IN}	Input Signal Voltage	Applied between V_{IN} and COM	$-0.3 \sim V_{CC} + 0.3$	V

Bootstrap Diode Part (each bootstrap diode unless otherwise specified.)

Symbol	Parameter	Conditions	Rating	Unit
V_{RRMB}	Maximum Repetitive Reverse Voltage		500	V
$*I_{FB}$	Forward Current	$T_C = 25^\circ\text{C}$	0.5	A
$*I_{FPB}$	Forward Current (Peak)	$T_C = 25^\circ\text{C}$, Under 1ms Pulse Width	1.5	A

Thermal Resistance

Symbol	Parameter	Conditions	Rating	Unit
$R_{\theta JC}$	Junction to Case Thermal Resistance	Each MOSFET under Inverter Operating Condition (1st Note 1)	8.9	$^\circ\text{C/W}$

Total System

Symbol	Parameter	Conditions	Rating	Unit
T_J	Operating Junction Temperature		$-40 \sim 150$	$^\circ\text{C}$
T_{STG}	Storage Temperature		$-40 \sim 125$	$^\circ\text{C}$
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, 1 Minute, Connect Pins to Heat Sink Plate	1500	V_{rms}

1st Notes:

- For the measurement point of case temperature T_C , please refer to Figure 4.
- Marking "*" is calculation value or design factor.

Pin descriptions

Pin Number	Pin Name	Pin Description
1	COM	IC Common Supply Ground
2	$V_{B(U)}$	Bias Voltage for U-Phase High-Side MOSFET Driving
3	$V_{CC(U)}$	Bias Voltage for U-Phase IC and Low-Side MOSFET Driving
4	$IN_{(UH)}$	Signal Input for U-Phase High-Side
5	$IN_{(UL)}$	Signal Input for U-Phase Low-Side
6	N.C	No Connection
7	$V_{B(V)}$	Bias Voltage for V-Phase High Side MOSFET Driving
8	$V_{CC(V)}$	Bias Voltage for V-Phase IC and Low Side MOSFET Driving
9	$IN_{(VH)}$	Signal Input for V-Phase High-Side
10	$IN_{(VL)}$	Signal Input for V-Phase Low-Side
11	V_{TS}	Output for HVIC Temperature Sensing
12	$V_{B(W)}$	Bias Voltage for W-Phase High-Side MOSFET Driving
13	$V_{CC(W)}$	Bias Voltage for W-Phase IC and Low-Side MOSFET Driving
14	$IN_{(WH)}$	Signal Input for W-Phase High-Side
15	$IN_{(WL)}$	Signal Input for W-Phase Low-Side
16	N.C	No Connection
17	P	Positive DC-Link Input
18	U, $V_{S(U)}$	Output for U-Phase & Bias Voltage Ground for High-Side MOSFET Driving
19	N_U	Negative DC-Link Input for U-Phase
20	N_V	Negative DC-Link Input for V-Phase
21	V, $V_{S(V)}$	Output for V-Phase & Bias Voltage Ground for High-Side MOSFET Driving
22	N_W	Negative DC-Link Input for W-Phase
23	W, $V_{S(W)}$	Output for W Phase & Bias Voltage Ground for High-Side MOSFET Driving

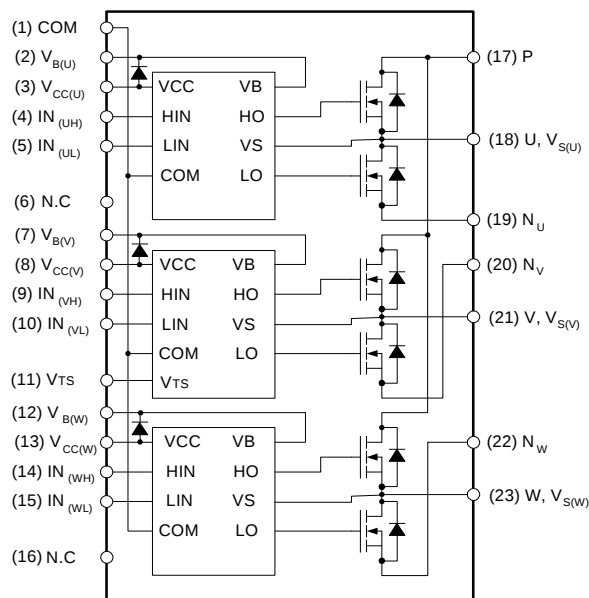


Figure 1. Pin Configuration and Internal Block Diagram (Bottom View)

1st Notes:

- Source terminal of each low-side MOSFET is not connected to supply ground or bias voltage ground inside Motion SPM® 5 product. External connections should be made as indicated in Figure 3.

Electrical Characteristics ($T_J = 25^\circ\text{C}$, $V_{CC} = V_{BS} = 15\text{ V}$ unless otherwise specified.)**Inverter Part** (each MOSFET unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
BV_{DSS}	Drain - Source Breakdown Voltage	$V_{IN} = 0\text{ V}$, $I_D = 1\text{ mA}$ (2nd Note 1)	500	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{IN} = 0\text{ V}$, $V_{DS} = 500\text{ V}$	-	-	1	mA
$R_{DS(on)}$	Static Drain - Source Turn-On Resistance	$V_{CC} = V_{BS} = 15\text{ V}$, $V_{IN} = 5\text{ V}$, $I_D = 1.0\text{ A}$	-	1.9	2.4	Ω
V_{SD}	Drain - Source Diode Forward Voltage	$V_{CC} = V_{BS} = 15\text{ V}$, $V_{IN} = 0\text{ V}$, $I_D = -1.0\text{ A}$	-	-	1.2	V
t_{ON}	Switching Times	$V_{PN} = 300\text{ V}$, $V_{CC} = V_{BS} = 15\text{ V}$, $I_D = 1.0\text{ A}$ $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$, Inductive Load $L = 3\text{ mH}$ High- and Low-Side MOSFET Switching (2nd Note 2)	-	1250	-	ns
t_{OFF}			-	680	-	ns
t_{rr}			-	200	-	ns
E_{ON}			-	60	-	μJ
E_{OFF}			-	10	-	μJ
RBSOA	Reverse Bias Safe Operating Area	$V_{PN} = 400\text{ V}$, $V_{CC} = V_{BS} = 15\text{ V}$, $I_D = I_{DP}$, $V_{DS} = BV_{DSS}$, $T_J = 150^\circ\text{C}$ High- and Low-Side MOSFET Switching (2nd Note 3)	Full Square			

Control Part (each HVIC unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{QCC}	Quiescent V_{CC} Current	$V_{CC} = 15\text{ V}$, $V_{IN} = 0\text{ V}$ Applied between V_{CC} and COM	-	-	200	μA
I_{QBS}	Quiescent V_{BS} Current	$V_{BS} = 15\text{ V}$, $V_{IN} = 0\text{ V}$ Applied between $V_{B(U)} - U$, $V_{B(V)} - V$, $V_{B(W)} - W$	-	-	100	μA
UV_{CCD}	Low-Side Under-Voltage Protection (Figure 8)	V_{CC} Under-Voltage Protection Detection Level	7.4	8.0	9.4	V
UV_{CCR}		V_{CC} Under-Voltage Protection Reset Level	8.0	8.9	9.8	V
UV_{BSD}	High-Side Under-Voltage Protection (Figure 9)	V_{BS} Under-Voltage Protection Detection Level	7.4	8.0	9.4	V
UV_{BSR}		V_{BS} Under-Voltage Protection Reset Level	8.0	8.9	9.8	V
V_{TS}	HVIC Temperature Sensing Voltage Output	$V_{CC} = 15\text{ V}$, $T_{HVIC} = 25^\circ\text{C}$ (2nd Note 4)	600	790	980	mV
V_{IH}	ON Threshold Voltage	Logic HIGH Level	-	-	2.9	V
V_{IL}	OFF Threshold Voltage	Logic LOW Level	0.8	-	-	V

Bootstrap Diode Part (each bootstrap diode unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{FB}	Forward Voltage	$I_F = 0.1\text{ A}$, $T_C = 25^\circ\text{C}$ (2nd Note 5)	-	2.5	-	V
t_{rFB}	Reverse Recovery Time	$I_F = 0.1\text{ A}$, $T_C = 25^\circ\text{C}$	-	80	-	ns

2nd Notes:

- BV_{DSS} is the absolute maximum voltage rating between drain and source terminal of each MOSFET inside Motion SPM® 5 product. V_{PN} should be sufficiently less than this value considering the effect of the stray inductance so that V_{PN} should not exceed BV_{DSS} in any case.
- t_{ON} and t_{OFF} include the propagation delay of the internal drive IC. Listed values are measured at the laboratory test condition, and they can be different according to the field applications due to the effect of different printed circuit boards and wirings. Please see Figure 6 for the switching time definition with the switching test circuit of Figure 7.
- The peak current and voltage of each MOSFET during the switching operation should be included in the Safe Operating Area (SOA). Please see Figure 7 for the RBSOA test circuit that is same as the switching test circuit.
- V_{IS} is only for sensing-temperature of module and cannot shutdown MOSFETs automatically.
- Built-in bootstrap diode includes around 15 Ω resistance characteristic. Please refer to Figure 2.

Recommended Operating Condition

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{PN}	Supply Voltage	Applied between P and N	-	300	400	V
V_{CC}	Control Supply Voltage	Applied between V_{CC} and COM	13.5	15.0	16.5	V
V_{BS}	High-Side Bias Voltage	Applied between V_B and V_S	13.5	15.0	16.5	V
$V_{IN(ON)}$	Input ON Threshold Voltage	Applied between V_{IN} and COM	3.0	-	V_{CC}	V
$V_{IN(OFF)}$	Input OFF Threshold Voltage		0	-	0.6	V
t_{dead}	Blanking Time for Preventing Arm-Short	$V_{CC} = V_{BS} = 13.5 \sim 16.5 \text{ V}$, $T_J \leq 150^\circ\text{C}$	1.0	-	-	μs
f_{PWM}	PWM Switching Frequency	$T_J \leq 150^\circ\text{C}$	-	15	-	kHz

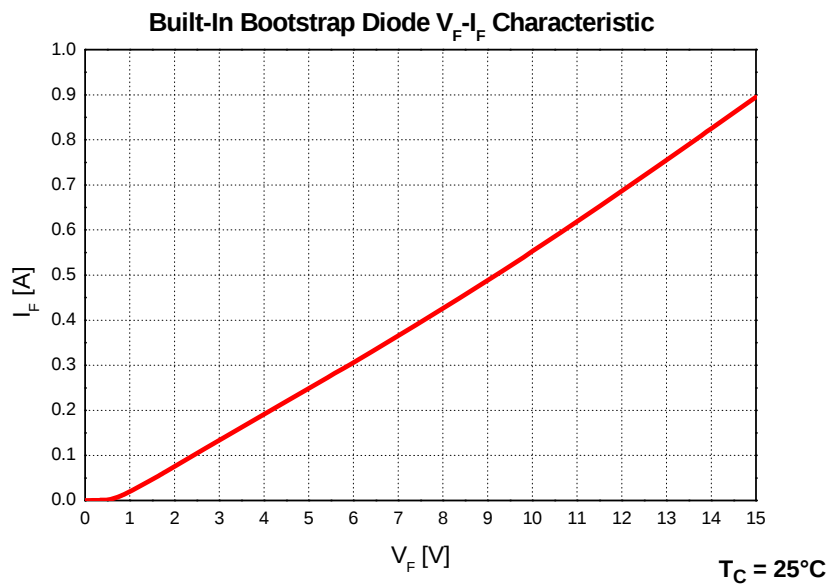


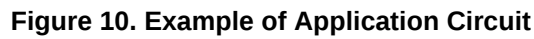
Figure 2. Built-In Bootstrap Diode Characteristics (Typical)

The diagram illustrates the internal structure of the Motion SPM® 5 product, which is a half-bridge inverter. It features a central control block with pins for VCC, VB, HIN, HO, LIN, VS, COM, LO, and VTS. The VCC and COM pins are connected to a common DC rail, which is also connected to a bootstrap capacitor C_{BS}. The HIN and LIN pins are connected to a square-wave input signal. The HO and LO pins are connected to the gates of two MOSFETs. The MOSFETs are connected to a common source terminal and a load inductor L. The load inductor is connected to a DC output filter capacitor and a load resistor, which is connected to a DC output voltage V_{DC}. The output current I_D is shown flowing through the load. The drain-source voltage V_{DS} is indicated across the MOSFETs, and the output voltage V_{DC} is shown across the filter capacitor.

The diagram illustrates the UV Protection Status logic. The **Input Signal** is a periodic square wave. The **UV Protection Status** is initially in the **RESET** state. When the **Low-side Supply, V_{CC}** drops below the **UV_{CCD}** threshold, the status transitions to **DETECTION**. When V_{CC} rises above the **UV_{CCR}** threshold, the status returns to **RESET**. The **MOSFET Current** is shown as a series of pulses that occur only when the UV Protection Status is in the **RESET** state, indicating that the MOSFET is only driven when the supply voltage is within the safe operating range.

The diagram illustrates the UV Protection Status logic. The **Input Signal** is a periodic square wave. The **UV Protection Status** signal is **RESET** when the input signal is high and transitions to **DETECTION** when the input signal goes low. The **High-side Supply, V_{BS}** is shown as a ramp that decreases during the **DETECTION** phase. Two threshold levels are marked: UV_{BSD} (Upper Boundary Stop Detection) and UV_{BSR} (Lower Boundary Stop Reset). When V_{BS} reaches UV_{BSD} , the MOSFET current (represented by a dashed line) drops to zero. When V_{BS} reaches UV_{BSR} , the MOSFET current begins to rise again. The **MOSFET Current** trace shows the actual current flow, which is zero during the **DETECTION** phase when the supply is below UV_{BSD} .

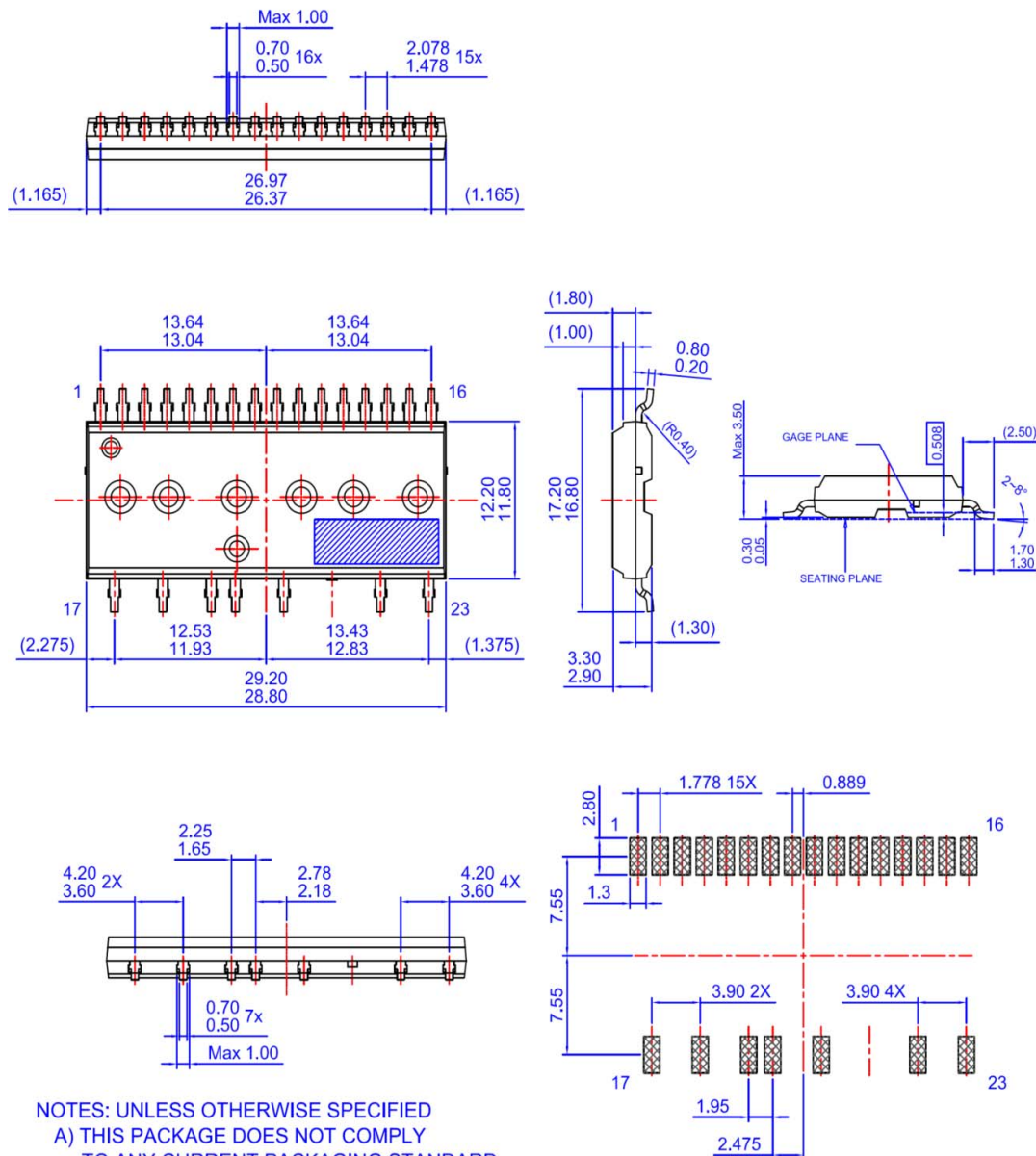
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1. About pin position, refer to Figure 1.

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Detailed Package Outline Drawings



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