

# FSB50450S

## Motion SPM<sup>®</sup> 5 FRFET<sup>®</sup> Series

### Features

- 500 V  $R_{DS(on)}$  = 2.4  $\Omega$  (Max) FRFET MOSFET 3-Phase Inverter Including HVICs
- Three Separate Negative DC-Link Terminals for Inverter Current Sensing Applications
- HVIC for Gate Driving and Undervoltage Protection
- Active-High Interface, Can Work With 3.3 V / 5 V Logic
- Optimized for Low Electromagnetic Interference
- Isolation Voltage Rating of 1500 Vrms for 1 min.
- Surface Mounted Device Package
- Moisture Sensitive Level (MSL) 3

### General Description

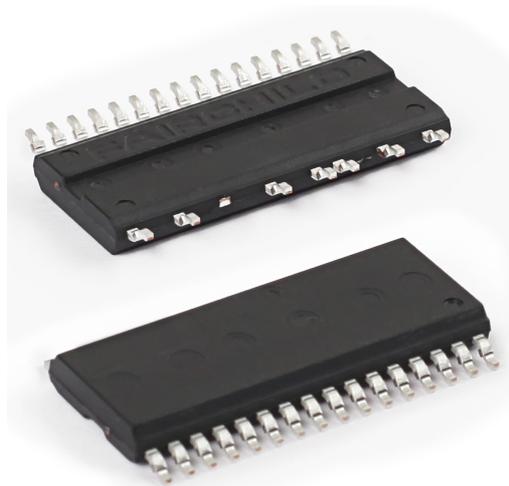
FSB50450S is a Motion SPM5 Series Based on Fast-Recovery MOSFET (FRFET) Technology as a Compact Inverter Solution for Small Power Motor Drive Applications Such as Fans and Pumps. It is Composed of Six FRFET MOSFETs and Three Half-Bridge Gate Drive HVICs. FSB50450S Provides Low Electromagnetic Interference (EMI) Characteristics with Optimizing Switching Speed. Moreover, Since It Employs MOSFETs as Power Switches, It has Greater Ruggedness and a Larger Safe Operating Area (SOA) than IGBT-Based Power Modules. The Package is Optimized for Thermal Performance and Compactness for use in Applications Where Space is Limited. FSB50450S is the Right Solution for Inverters Requiring Energy Efficiency, Compactness, and Low Electromagnetic Interference.

### Applications

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

### Related Source

- [AN9042 : Motion SPM5 Series Ver.1 User's Guide](#)
- [AN-9082 : Motion SPM5 Series Thermal Performance by Contact Pressure](#)



### Package Marking & Ordering Information

| Device Marking | Device    | Package   | Reel Size | Packing Type | Quantity |
|----------------|-----------|-----------|-----------|--------------|----------|
| FSB50450S      | FSB50450S | SPM5D-023 | 330mm     | TAPE & REEL  | 450      |

## Absolute Maximum Ratings

**Inverter Part** (Each MOSFET® Unless Otherwise Specified)

| Symbol       | Parameter   | Conditions  | Rating | Unit      |
|--------------|---|---|--------|-----------|
| $V_{PN}$     | DC Link Input Voltage,<br>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                               | $T_C = 25^\circ\text{C}$ , $PW < 100 \mu\text{s}$   | 3.0    | 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          | 10     | 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 IN and COM       | $-0.3 \sim V_{CC}+0.3$ | V    |

### Thermal Resistance

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

### Total System

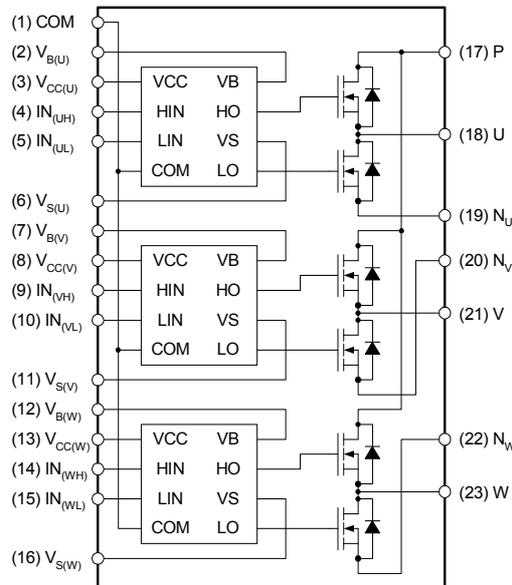
| Symbol    | Parameter                      | Conditions   | Rating         | Unit             |
|-----------|--------------------------------|--|----------------|------------------|
| $T_J$     | Operating Junction Temperature |  | $-40 \sim 150$ | $^\circ\text{C}$ |
| $T_{STG}$ | Storage Temperature            |  | $-50 \sim 150$ | $^\circ\text{C}$ |
| $V_{ISO}$ | Isolation Voltage              | 60 Hz, Sinusoidal, 1 minute, Connection Pins to Heatsink | 1500           | $V_{rms}$        |

**Note:**

- 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          | $V_{S(U)}$  | Bias Voltage Ground for U Phase High Side MOSFET Driving |
| 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         | $V_{S(V)}$  | Bias Voltage Ground for V Phase High Side MOSFET Driving |
| 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         | $V_{S(W)}$  | Bias Voltage Ground for W Phase High Side MOSFET Driving |
| 17         | P           | Positive DC-Link Input                                   |
| 18         | U           | Output for U Phase                                       |
| 19         | $N_U$       | Negative DC-Link Input for U Phase                       |
| 20         | $N_V$       | Negative DC-Link Input for V Phase                       |
| 21         | V           | Output for V Phase                                       |
| 22         | $N_W$       | Negative DC-Link Input for W Phase                       |
| 23         | W           | Output for W Phase                                       |



**Note:**

Source Terminal of Each Low-Side MOSFET is Not Connected to Supply Ground or Bias Voltage Ground Inside Motion SPM®.  
 External Connections Should be Made as Indicated in Figure 3

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

## Electrical Characteristics (T<sub>J</sub> = 25°C, V<sub>CC</sub>=V<sub>BS</sub>= 15 V Unless Otherwise Specified)

### Inverter Part (Each MOSFET® Unless Otherwise Specified)

| Symbol                              | Parameter                                 | Conditions  | Min         | Typ  | Max | Unit |
|-------------------------------------|---|---|-------------|------|-----|------|
| BV <sub>DSS</sub>                   | Drain-Source Breakdown Voltage            | V <sub>IN</sub> = 0V, I <sub>D</sub> = 250μA (Note 1)   | 500         | -    | -   | V    |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250μA, Referenced to 25°C  | -           | 0.53 | -   | V    |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current           | V <sub>IN</sub> = 0V, V <sub>DS</sub> = 500 V   | -           | -    | 250 | μA   |
| R <sub>DS(on)</sub>                 | Static Drain-Source On-Resistance         | V <sub>CC</sub> = V <sub>BS</sub> = 15 V, V <sub>IN</sub> = 5 V, I <sub>D</sub> = 0.5 A   | -           | 1.9  | 2.4 | Ω    |
| V <sub>SD</sub>                     | Drain-Source Diode Forward Voltage        | V <sub>CC</sub> = V <sub>BS</sub> = 15V, V <sub>IN</sub> = 0V, I <sub>D</sub> = -0.5 A  | -           | -    | 1.2 | V    |
| t <sub>ON</sub>                     | Switching Times                           | V <sub>PN</sub> = 300 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V, I <sub>D</sub> = 0.5 A<br>V <sub>IN</sub> = 0 V ↔ 5 V, Inductive Load L = 3 mH<br>High- and Low-Side MOSFET Switching (Note 2)                 | -           | 1152 | -   | ns   |
| t <sub>OFF</sub>                    |   |   | -           | 600  | -   | ns   |
| t <sub>rr</sub>                     |   |   | -           | 185  | -   | ns   |
| E <sub>ON</sub>                     |   |   | -           | 85   | -   | μJ   |
| E <sub>OFF</sub>                    |   |   | -           | 11   | -   | μJ   |
| RBSOA                               | Reverse-Bias Safe Operating Area          | V <sub>PN</sub> = 400 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V, I <sub>D</sub> = I <sub>DP</sub> , V <sub>DS</sub> =BV <sub>DSS</sub> , T <sub>J</sub> = 150°C<br>High- and Low-Side MOSFET Switching (Note 3) | Full Square |      |     |      |

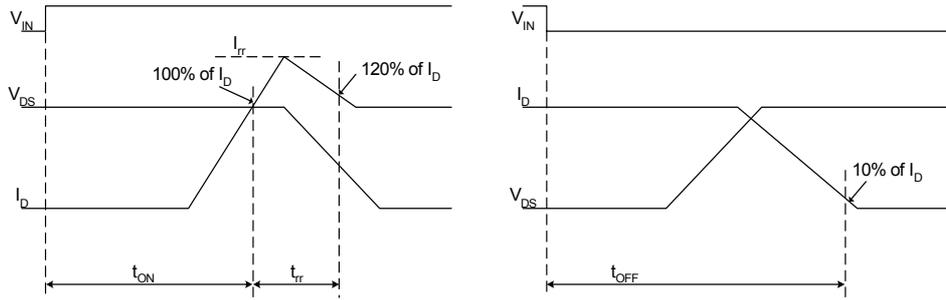
### Control Part (Each HVIC Unless Otherwise Specified)

| Symbol            | Parameter                                    | Conditions  | Min | Typ | Max | Unit |
|-------------------|--|---|-----|-----|-----|------|
| I <sub>QCC</sub>  | Quiescent V <sub>CC</sub> Current            | V <sub>CC</sub> =15 V, V <sub>IN</sub> =0V<br>Applied Between V <sub>CC</sub> and COM   | -   | -   | 160 | μA   |
| I <sub>QBS</sub>  | Quiescent V <sub>BS</sub> Current            | V <sub>BS</sub> =15 V, V <sub>IN</sub> =0V<br>Applied Between V <sub>B(U)</sub> -U,<br>V <sub>B(V)</sub> -V, V <sub>B(W)</sub> -W | -   | -   | 100 | μA   |
| UV <sub>CCD</sub> | Low-Side Undervoltage Protection (Figure 6)  | V <sub>CC</sub> Undervoltage Protection Detection Level   | 7.4 | 8.0 | 9.4 | V    |
| UV <sub>CCR</sub> |  | V <sub>CC</sub> Undervoltage Protection Reset Level   | 8.0 | 8.9 | 9.8 | V    |
| UV <sub>BSD</sub> | High-Side Undervoltage Protection (Figure 7) | V <sub>BS</sub> Undervoltage Protection Detection Level   | 7.4 | 8.0 | 9.4 | V    |
| UV <sub>BSR</sub> |  | V <sub>BS</sub> Undervoltage Protection Reset Level   | 8.0 | 8.9 | 9.8 | V    |
| V <sub>IH</sub>   | ON Threshold Voltage                         | Logic High Level  | 3.0 | -   | -   | V    |
| V <sub>IL</sub>   | OFF Threshold Voltage                        | Logic Low Level   |     |     |     |      |
| I <sub>IH</sub>   | Input Bias Current                           | V <sub>IN</sub> = 5V  | -   | 10  | 20  | μA   |
| I <sub>IL</sub>   |  | V <sub>IN</sub> = 0V  | -   | -   | 2   | μA   |

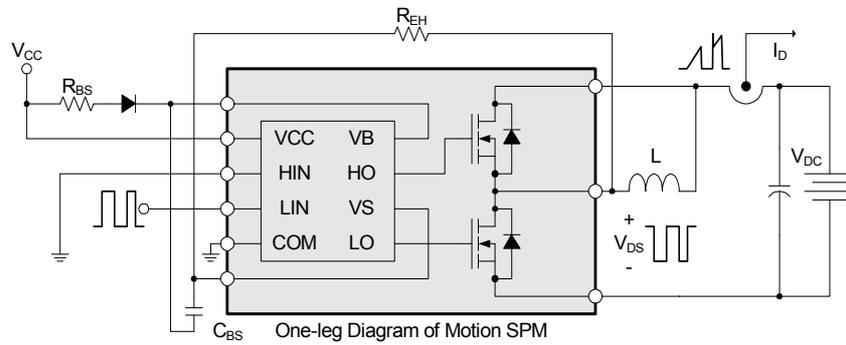
**Note:**

- BV<sub>DSS</sub> is the Absolute Maximum Voltage Rating Between Drain and Source Terminal of Each MOSFET Inside Motion SPM®. V<sub>PN</sub> Should be Sufficiently Less Than This Value Considering the Effect of the Stray Inductance so that V<sub>DS</sub> Should Not Exceed BV<sub>DSS</sub> in Any Case.
- t<sub>ON</sub> and t<sub>OFF</sub> Include the Propagation Delay Time 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 4 for the Switching Time Definition with the Switching Test Circuit of Figure 5.
- The peak current and voltage of each MOSFET during the switching operation should be included in the safe operating area (SOA). Please see Figure 5 for the RBSOA test circuit that is same as the switching test circuit.

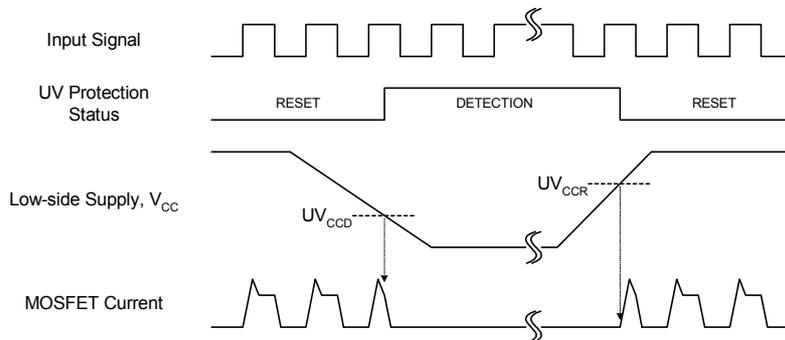




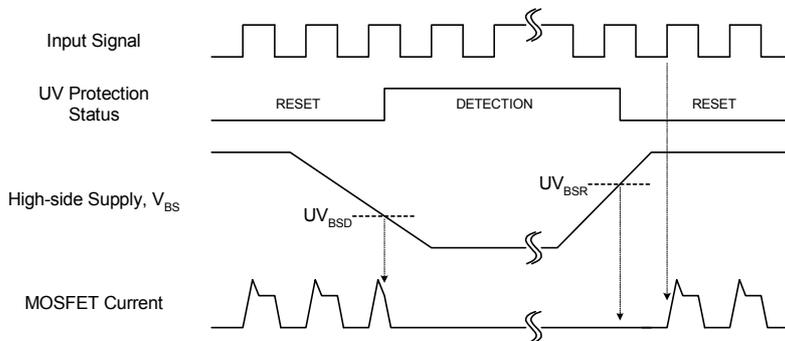
(a) Turn-on (b) Turn-off  
**Figure 4. Switching Time Definitions**



**Figure 5. Switching and RBSOA (Single-pulse) Test Circuit (Low-side)**



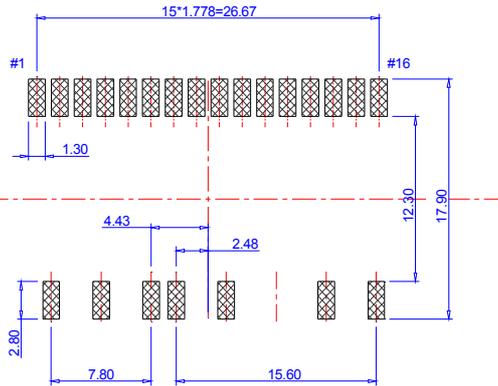
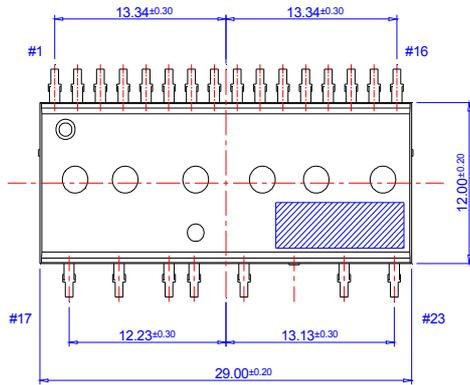
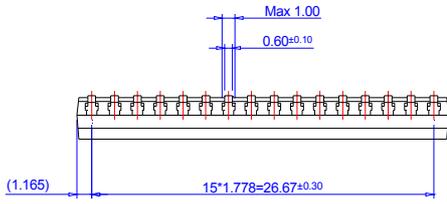
**Figure 6. Undervoltage Protection (Low-side)**



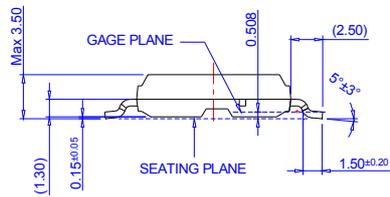
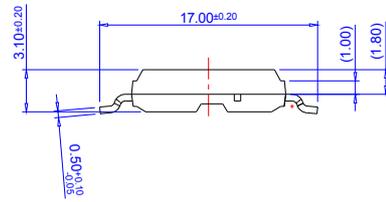
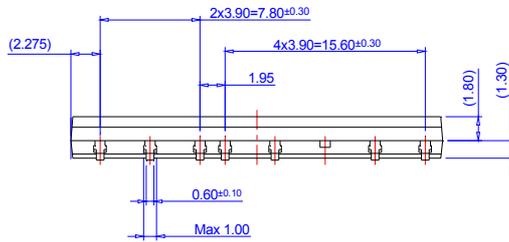
**Figure 7. Undervoltage Protection (High-side)**



Detailed Package Outline Drawings



LAND PATTERN RECOMMENDATIONS





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| ™                        | MicroFET™              | SPM®                                    |  |
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| Fairchild Semiconductor® | MotionMax™             | SuperSOT™_3                             |  |
| FACT Quiet Series™       | Motion-SPM™            | SuperSOT™_6                             |  |
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| FastvCore™               | ™                      | SyncFET™                                |  |
| FlashWriter® *           | PDP SPM™               | ™                                       |  |
| FPS™                     | Power-SPM™             | The Power Franchise®                    |  |
| F-PFS™                   | PowerTrench®           |   |  |
|                          | PowerXS™               |   |  |

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