



Is Now Part of



ON Semiconductor®

**To learn more about ON Semiconductor, please visit our website at
www.onsemi.com**

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

User Guide for
FEBSPM7_M02MTCA
Evaluation Board

Motion SPM®7 Series

Featured Fairchild Products:

FSB70250

FSB70450

FSB70550

FSB70325

FSB70625

*Direct questions or comments
about this evaluation board to:
“Worldwide Direct Support”*

Fairchild Semiconductor.com

Table of Contents

1. Introduction.....	3
1.1. Description	3
1.2. Features	3
2. Evaluation Board Specifications.....	4
3. Photographs.....	5
4. Printed Circuit Board	6
4.1. External Connection.....	8
5. Schematic.....	9
5.1. Circuit Description	10
6. Thermal performance.....	11
6.1. Thermal Photo (without Heatsink).....	11
6.2. Thermal Photos (with a Heatsink of 6.5 K/W Mounted on Bottom Side).....	12
7. Bill of Materials	13
8. Revision History	14

1. Introduction

This user guide supports the evaluation kit for the Motion SPM®7 Series. It should be used in conjunction with the Motion SPM®7 datasheets as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

1.1. Description

Fairchild's Motion SPM®7 Series provides efficient motor control for energy restricted small power inverter driven application when space is constrained, such as circulation pump, compact fan.

Motion SPM®7 series integrates six fast-recovery MOSFETs (FRFET®) and one three-phase High Voltage ICs (HVIC). Motion SPM®7 series reduces board space by utilizing an ultra-compact 12.9 mm x 12.9 mm package and by incorporating built-in HVIC that provide single supply MOSFET gate driving capability. The Motion SPM®7 series offers designers high reliability with integrated Under-Voltage Lockout (UVLO), Thermal Sensing Function (VTS) and Over-Current Protection (OCP).

1.2. Features

- 250 V/ 500 V 3-phase FRFET Inverter Including HVIC
- Max. $R_{DS(ON)}$ - FSB70250: 3.4 Ω ; FSB70450: 2.2 Ω ; FSB70550: 1.85 Ω , FSB70325: 1.4 Ω ; FSB70625: 0.8 Ω
- 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 with Under-Voltage Protection and Interlock Function
- Isolation Rating: 1500 V_{RMS} / Minimum
- Moisture Sensitive Level (MSL) 3
- RoHS Compliant

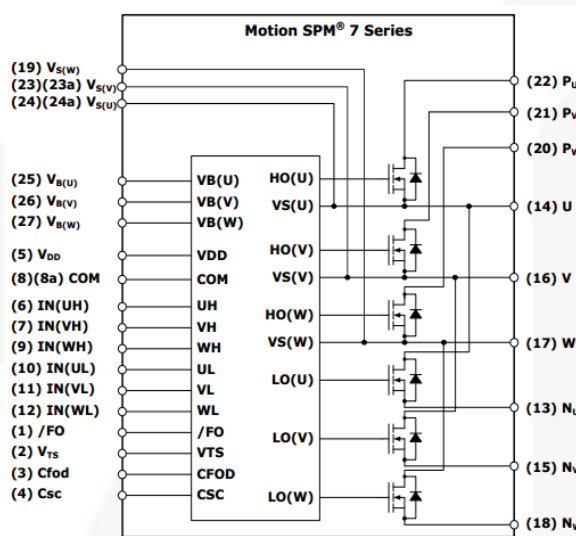


Figure 1. Block Diagram

2. Evaluation Board Specifications

All data for this table was measured at an ambient temperature of 25°C.

Table 1. Summary of Features and Performance

Description	Symbol	Min.	Typ.	Max.	Unit
Positive DC Bus Link Input	V _{dcb} ⁽¹⁾	120		375	V
	V _{dcb} ⁽²⁾	120		250	
DC voltage Output	V ₁₅		15		V
Logic 1 input	V _{IH}	2.4			V
Logic 0 input	V _{IL}			0.8	V
Fault Output	/Fo	0		15	V
Analog Output Range	V _{sig_a} ⁽³⁾	0		5	V
Bus Voltage Sensing	V _{s_dcb}		8.4		mV/V
Phase Current Sensing			47		mV/A
Dead Time	t _{dead}	500			ns
PWM Switching Frequency	t _{PWM}		15		kHz
Temperature Sensing	V _{ts} ⁽⁴⁾		19		mV/°C

Notes:

1. FSB70250, FSB70450 and FSB70550.
2. FSB70325 and FSB70625.
3. Analog Outputs include: three phase current sensing is_U, is_V, is_W; Temperature Sensing V_{ts}, Bus Voltage Sensing V_{s_dcb}.
4. Temperature of SPM®7 Module, for more detail, please refer to the corresponding SPM®7 data sheet.

3. Photographs

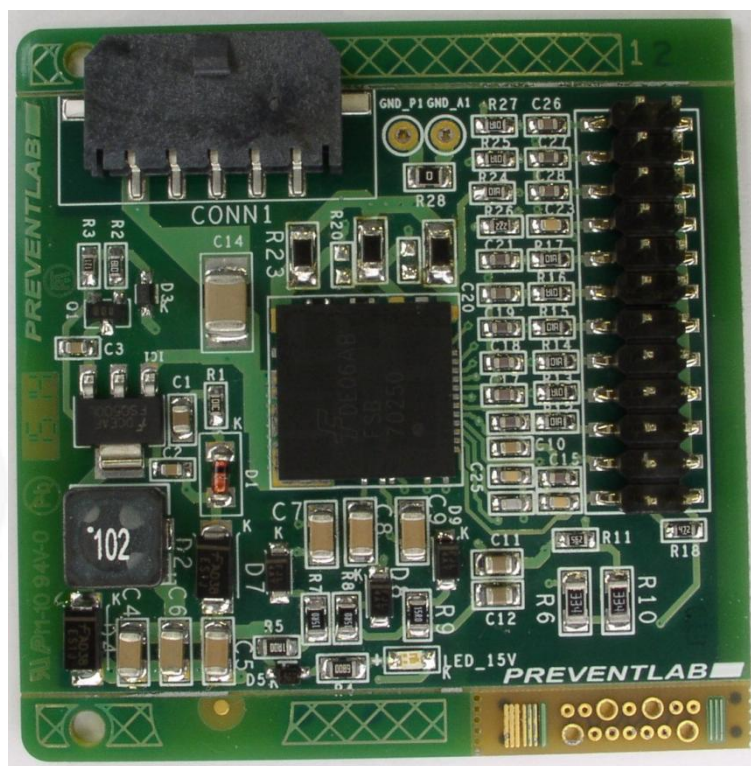


Figure 2. Photograph (54.7 x 55.1 mm²) Top View

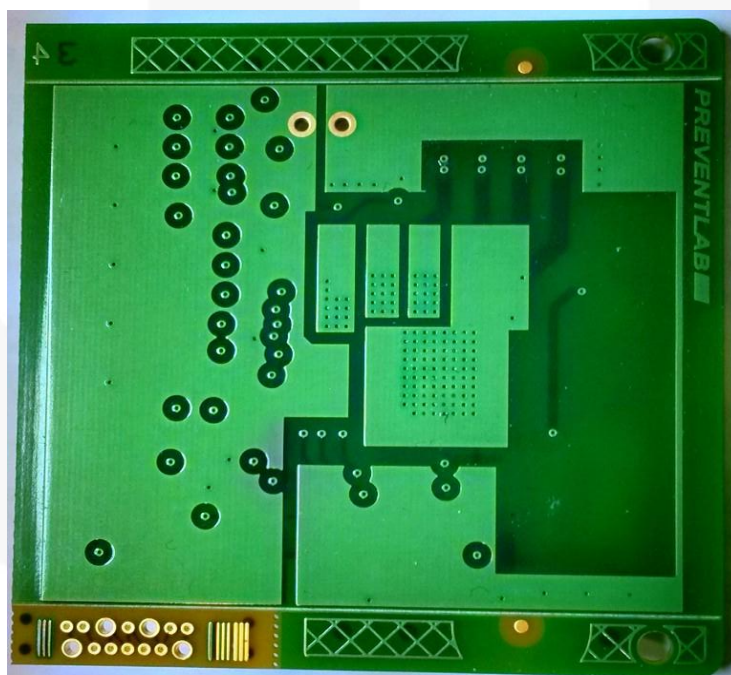


Figure 3. Photograph (54.7 x 55.1 mm²) Bottom View

4. Printed Circuit Board

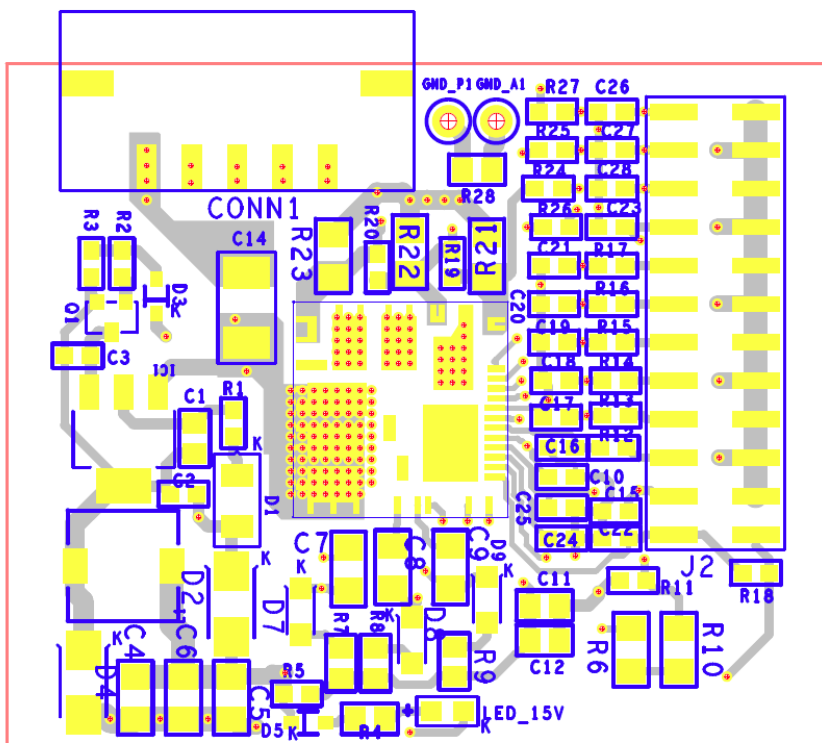


Figure 4. Top Side

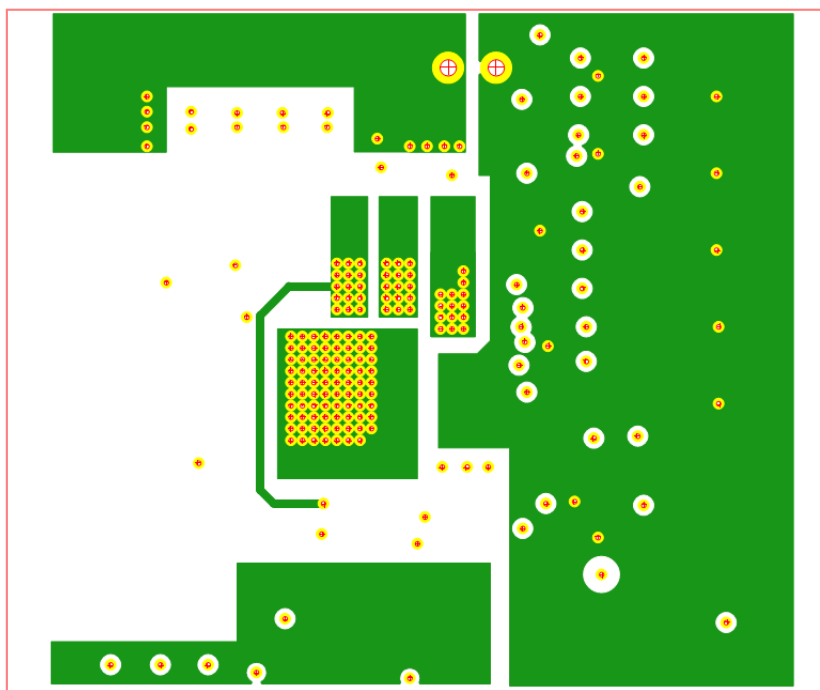


Figure 5. Inner layer 1

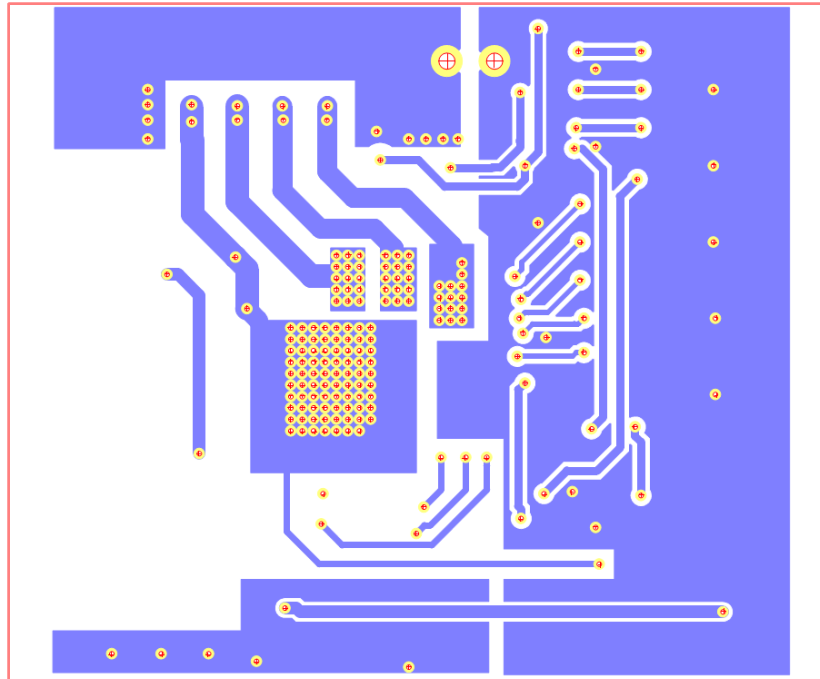


Figure 6. Inner layer 2

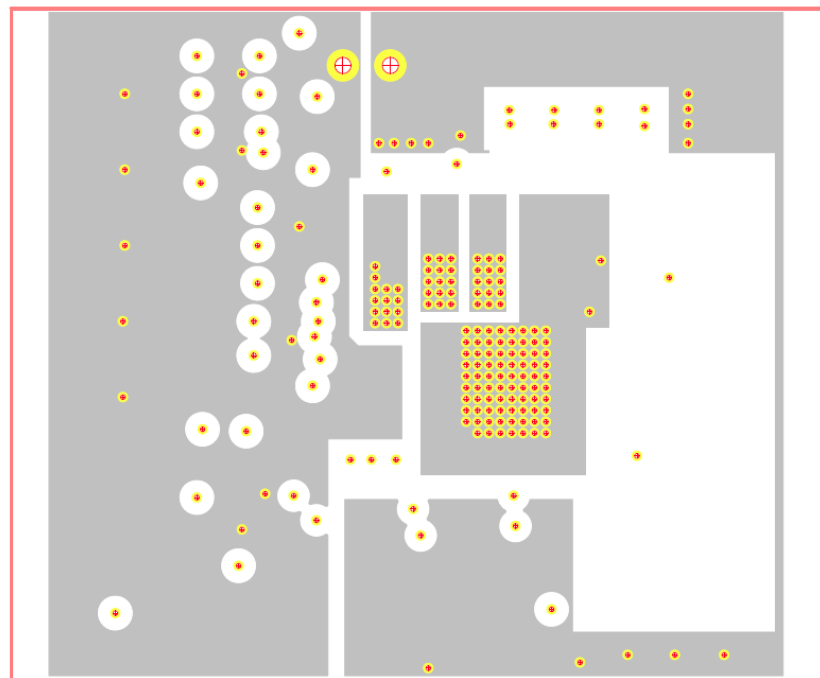


Figure 7. Bottom Side

4.1. External Connection

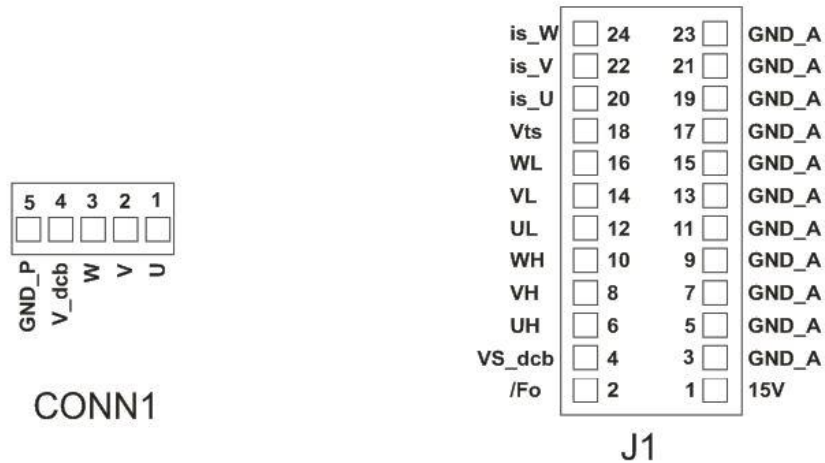


Figure 8. CONN1 and J1 Connector Physical View

Table 2. Connector J1:

Pin#	Signal Name	Description
1	15 V	+15 V Out of Internal Power Supply, Supply Max. 50 mA to the External.
2	/Fo	Fault Output
4	VS_dcb	DC-bus Voltage Sensing
6	UH	Gate Signal for High-Side Phase U
8	VH	Gate Signal for High-Side Phase V
10	WH	Gate Signal for High-Side Phase W
12	UL	Gate Signal for Low-Side Phase U
14	VL	Gate Signal for Low-Side Phase V
16	WL	Gate Signal for Low-Side Phase W
18	Vts	Voltage Output of HVIC Temperature
20	is_U	Current Sensing Phase U
22	is_V	Current Sensing Phase V
24	is_W	Current Sensing Phase W
others	GND_A	Analog Ground

Table 3. Connector CONN1:

Pin#	Signal Name	Description
1	U	Motor Connection (Phase U)
2	V	Motor Connection (Phase V)
3	W	Motor Connection (Phase W)
4	V_dcb	Positive DC Bus Link Input
5	GND_P	Power Ground

5. Schematic

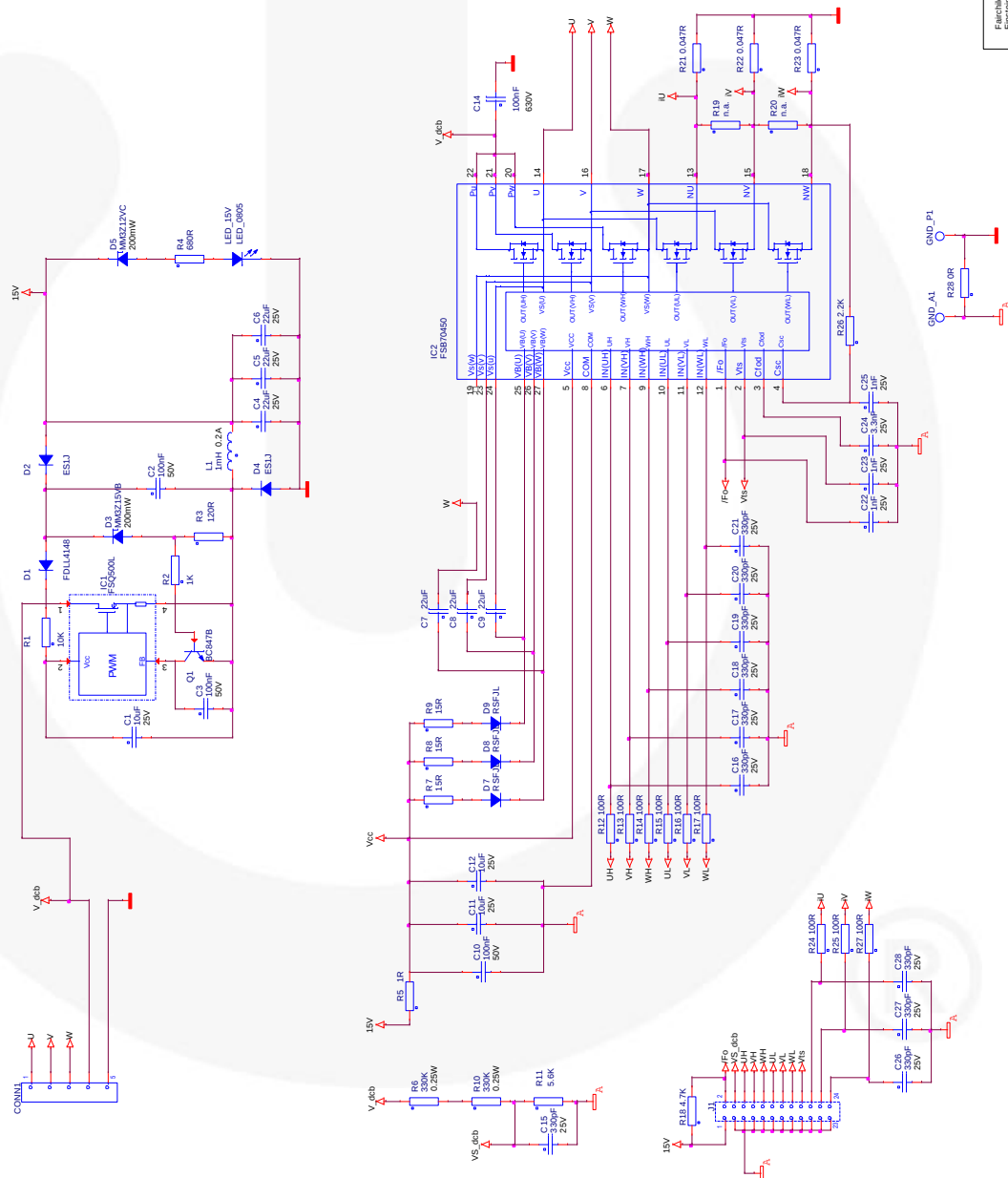


Figure 9. Evaluation Board Schematic

5.1. Circuit Description

Motion SPM®7 series is used as a highly integrated power module in this evaluation board to realize an Inverter for Low Power BLDC or PMSM 3-phase motors.

The board need to be supplied on the DC-Bus with a DC-voltage specified prior. The auxiliary-power-supply works as Buck-Converter and offers a stabilized 15 V to operate the module. The voltage is also accessible on the connectors to supply a Microcontroller-board if necessary. A LED indicates the presence of 15 V.

On the same connector of the DC-Bus, a motor can be connected to the Inverter output terminals U, V, W.

The internal High-Side-Drivers of SPM®7 need bootstrap circuit which consists of bootstrap capacitor, charge resistor and a fast diode.

The Shunts can be configured as 3-Shunt-sensing or single-Shunt-sensing.

Short-circuit protection is routed to just the W-phase and works in single-Shunt-sensing for the complete module. In 3-Shunt-sensing, only W-phase is protected. A low-pass Filter on Current-sensing avoids sensing of HF-peaks. The signal of fault output pin /FO drops from high level to low when a fault, such as Under-Voltage (UV) or Short-circuit Current (SC), occurs. A pull-up resistor and filter capacitor are added to generate a signal out of the open-drain output.

RC low pass filters are used between input connector from a MCU (or DSP) and Logic-input signal pins of Motion SPM®7 series to suppress any occurring disturbances. All Analog-Signals are filtered to provide smooth signals on the pins.

6. Thermal performance

Test Condition

Table 4. Test Condition

Module	FSB70450
Power Supply Voltage	325 V _{DC}
Motor Speed	500 rpm
Motor Runs for	15 min
Ambient Temperature	25°C

Table 5. BLDC Motor

Series Number	MATTKE BGK 65-40 NV
Back EMF Constant	37 V/1000min ⁻¹
Winding	Delta
# of Pole Pairs	4

6.1. Thermal Photo (without Heatsink)

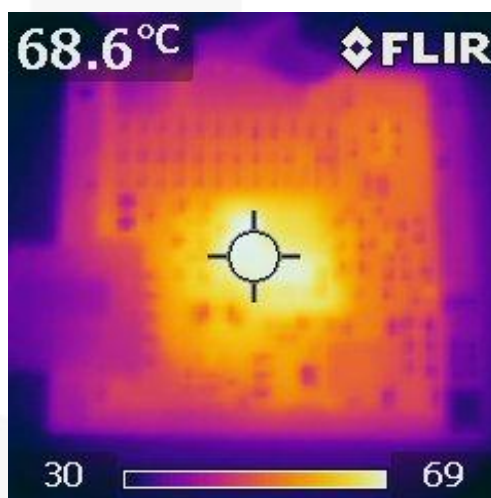


Figure 10. Motor Power 60 W, Motor RMS Current 200 mA (without Heatsink), T_{module} = 68.6°C

6.2. Thermal Photos (with a Heatsink of 6.5 Kelvin/W Mounted on Bottom Side)

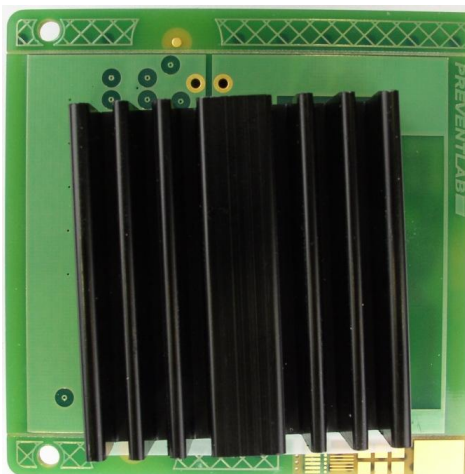
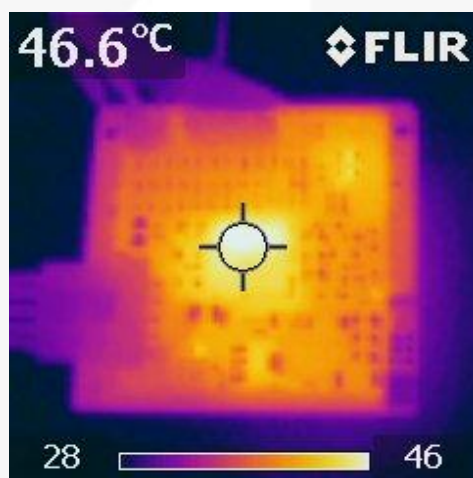


Figure 11. Heatsink of 6.5 Kelvin/W on Bottom Side

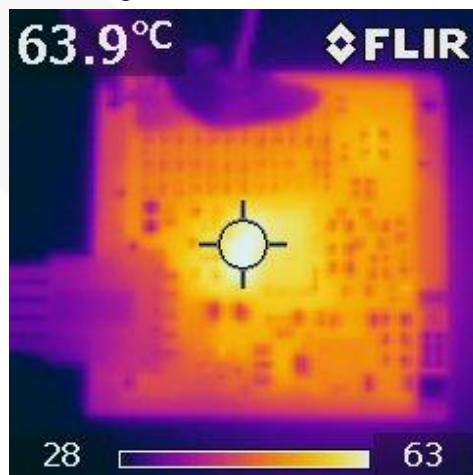


$T_{\text{module}} = 46.6 \text{ }^{\circ}\text{C}$

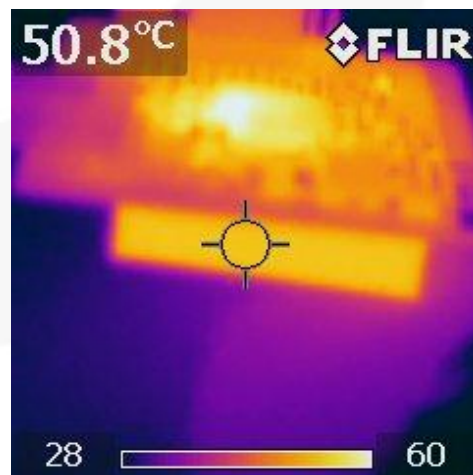


$T_{\text{heatsink}} = 38.9 \text{ }^{\circ}\text{C}$

Figure 12. Thermal Photos of Motor Power 60 W, Motor RMS Current 200 mA



$T_{\text{module}} = 63.9 \text{ }^{\circ}\text{C}$



$T_{\text{heatsink}} = 50.8 \text{ }^{\circ}\text{C}$

Figure 13. Thermal Photos of Motor Power 120W, Motor RMS Current 400 mA

7. Bill of Materials

Item	Quantity	Reference	Part	Manufacturer/Series
1	1	CONN1	Header_5pin_3mm_SMD_male	Würth / WR-MPC3
2	3	C1, C11, C12	10 μ F / 25 V	any SMD 0805
3	3	C2, C3, C10	100 nF / 50 V	any SMD 0603
4	6	C4, C5, C6, C7, C8, C9	22 μ F / 25 V	any SMD 1206
5	1	C14	100 nF / 630 V	any SMD 1812
6	10	C15, C16, C17, C18, C19, C20, C21, C26, C27, C28	330pF / 25V	any SMD 0603
7	3	C22, C23, C25	1 nF / 25 V	any SMD 0603
8	1	C24	3.3 nF / 25 V	any SMD 0603
9	1	D1	FDLL4148	Fairchild
10	2	D2,D4	ES1J	Fairchild
11	1	D3	MM3Z15VB / 200 mW	Fairchild
12	1	D5	MM3Z12VC / 200 mW	Fairchild
13	3	D7, D8, D9	RSFJL	TAIWAN SEMICONDUCTOR
14	1	IC1	FSQ500L	Fairchild
15	1	IC2	FSB70450	Fairchild
16	1	J2	Pin_Header_SMD_2x12	Würth / 6100xx21121
17	1	LED_15V	LED_0805	any SMD LED 0805
18	1	L1	1 mH / 0.2A	Würth / WE-PD (S)
19	1	Q1	BC847B	Fairchild
20	1	R1	10 K / 0.1 W	any SMD 0603
21	1	R2	1 K / 0.1 W	any SMD 0603
22	1	R3	120R / 0.1 W	any SMD 0603
23	1	R4	680R	any SMD 0805
24	1	R5	1R / 0.1 W	any SMD 0603
25	2	R6, R10	330 K / 0.25 W	any SMD 1206
26	3	R7, R8, R9	15R / 0.125 W	any SMD 0805
27	1	R11	5.6 K / 0.1 W	any SMD 0603
28	9	R12, R13, R14, R15, R16, R17, R24, R25, R27	100R / 0.1 W	any SMD 0603
29	1	R18	4.7 K / 0.1 W	any SMD 0603
30	2	R19, R20	n.a. / 0.1 W	any SMD 0603
31	3	R21, R22, R23	0.047R / 0.25 W	any SMD 1206
32	1	R26	2.2K / 0.1 W	any SMD 0603
33	1	R28	0R / 0.125 W	any SMD 0805



8. Revision History

Rev.	Date	Description
1.0	Nov, 2014	Initial Release

WARNING AND DISCLAIMER

Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Users' Guide. Contact an authorized Fairchild representative with any questions.

This board is intended to be used by certified professionals, in a lab environment, following proper safety procedures. Use at your own risk. The Evaluation board (or kit) is for demonstration purposes only and neither the Board nor this User's Guide constitute a sales contract or create any kind of warranty, whether express or implied, as to the applications or products involved. Fairchild warrants that its products meet Fairchild's published specifications, but does not guarantee that its products work in any specific application. Fairchild reserves the right to make changes without notice to any products described herein to improve reliability, function, or design. Either the applicable sales contract signed by Fairchild and Buyer or, if no contract exists, Fairchild's standard Terms and Conditions on the back of Fairchild invoices, govern the terms of sale of the products described herein.

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

EXPORT COMPLIANCE STATEMENT

These commodities, technology, or software were exported from the United States in accordance with the Export Administration Regulations for the ultimate destination listed on the commercial invoice. Diversion contrary to U.S. law is prohibited.

U.S. origin products and products made with U.S. origin technology are subject to U.S. Re-export laws. In the event of re-export, the user will be responsible to ensure the appropriate U.S. export regulations are followed.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada

Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910

Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com

Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local
Sales Representative