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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:
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Fairchild Semiconductor.com

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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

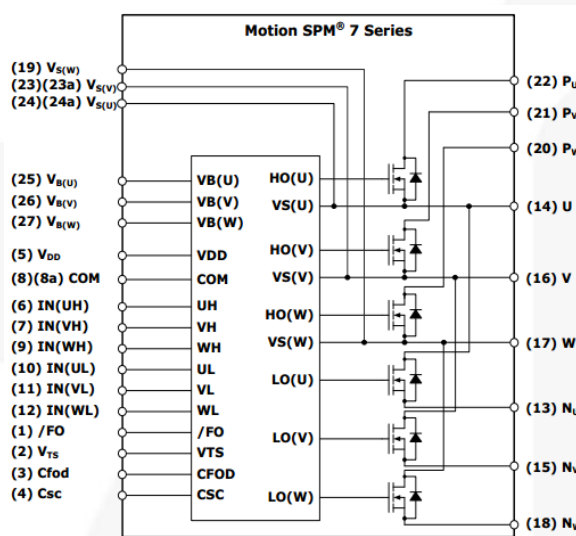


Figure 1. Block Diagram

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

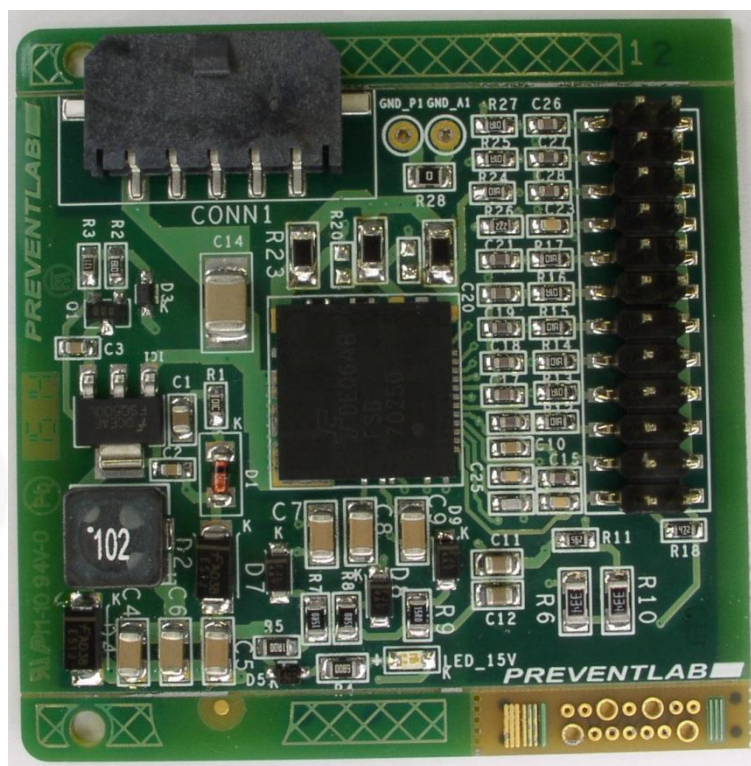


Figure 2. Photograph (54.7 x 55.1 mm²) Top View

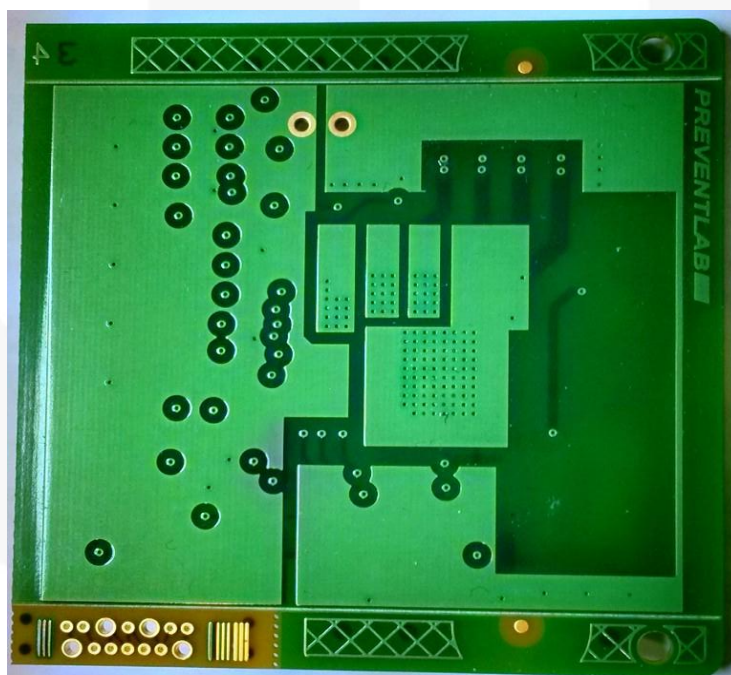


Figure 3. Photograph (54.7 x 55.1 mm²) Bottom View

4. Printed Circuit Board

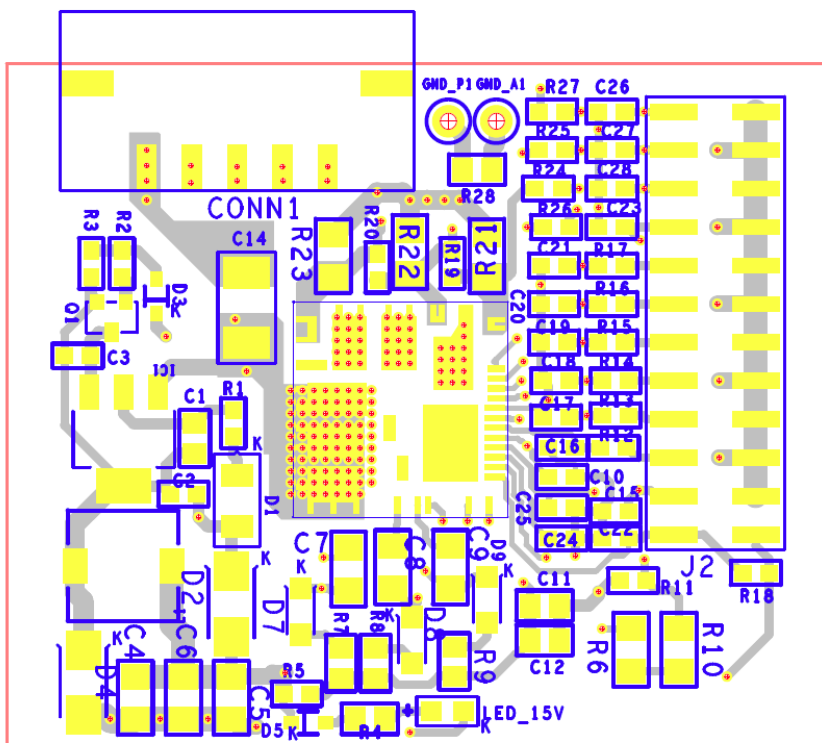


Figure 4. Top Side

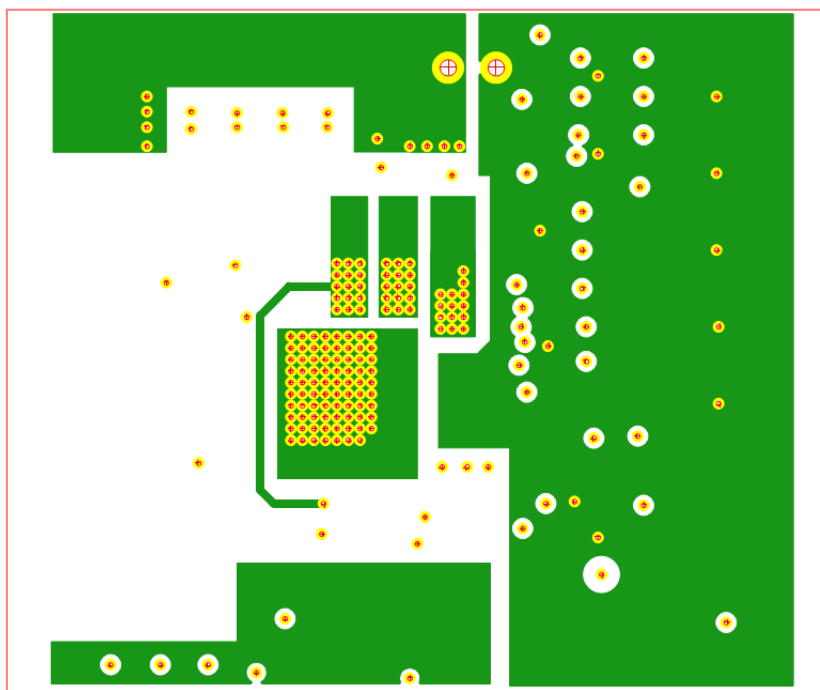


Figure 5. Inner layer 1

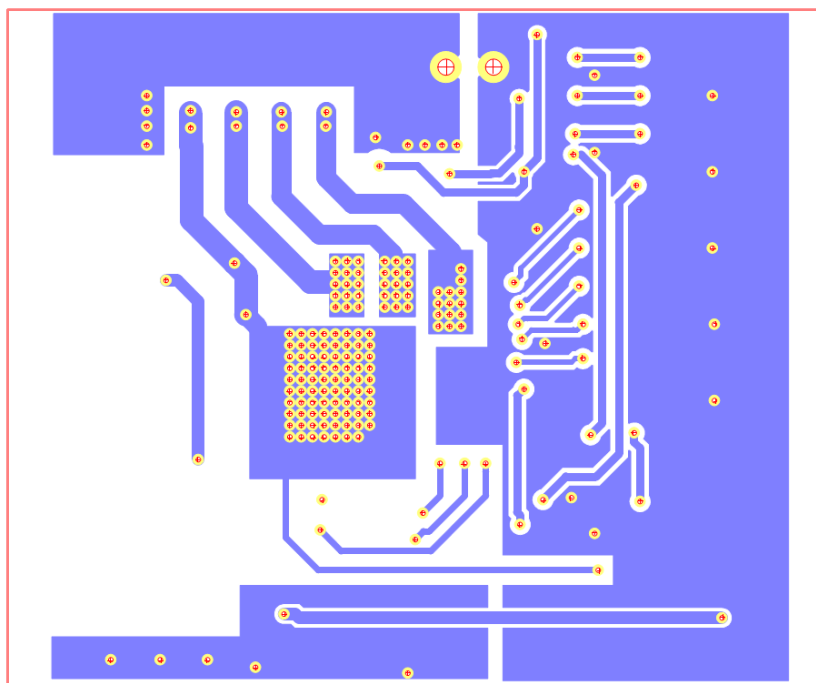


Figure 6. Inner layer 2

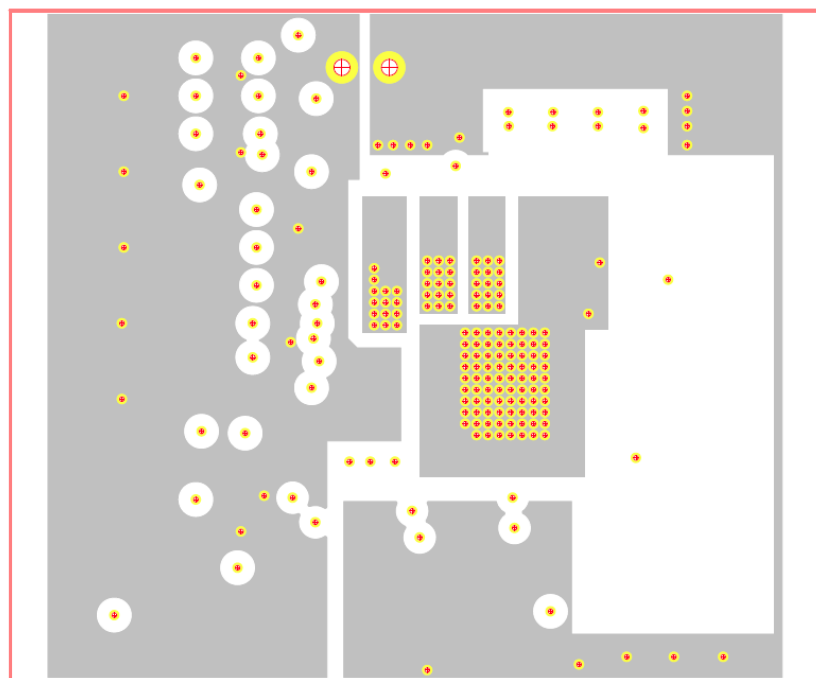


Figure 7. Bottom Side

4.1. External Connection

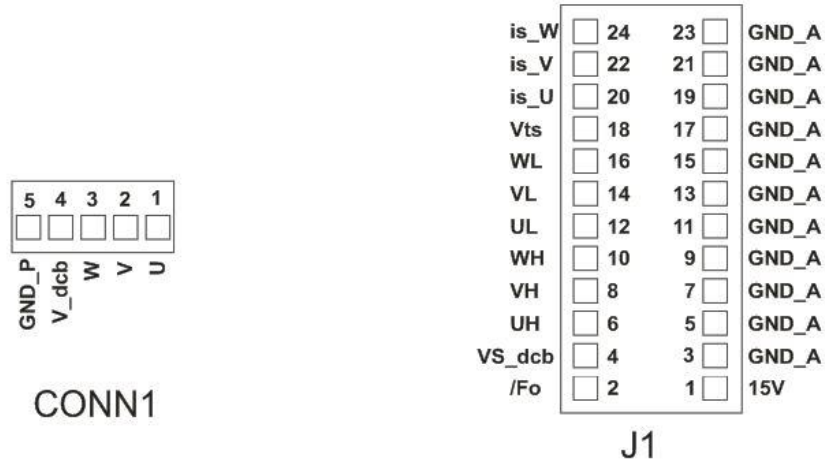


Figure 8. CONN1 and J1 Connector Physical View

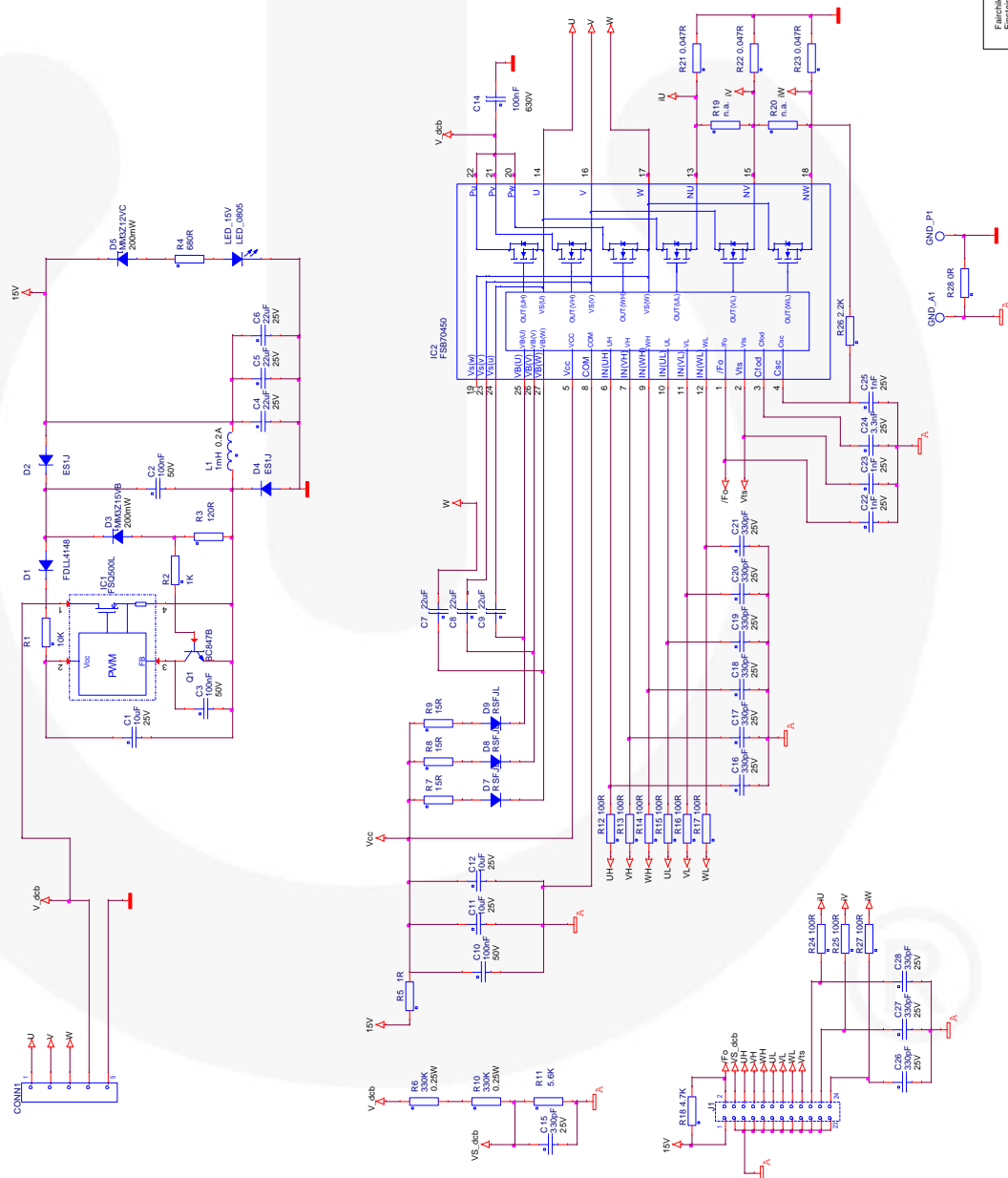
Table 2. Connector J1:

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



□ denotes SMD part
n.a. = not assembled

FAIRCHILD			
Fairchild Semiconductor GmbH			
Erntingstr. 25, D-85559 Schwaighausen			
Size	Title	Rev	
A3	SMD Power Stage	V1	
Date:	Friday, November 28, 2014	Sheet	1 of 1

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)

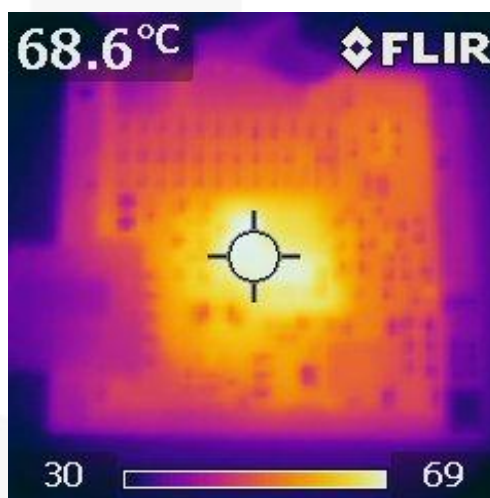


Figure 10. Motor Power 60 W, Motor RMS Current 200 mA (without Heatsink), T_{module} = 68.6°C

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

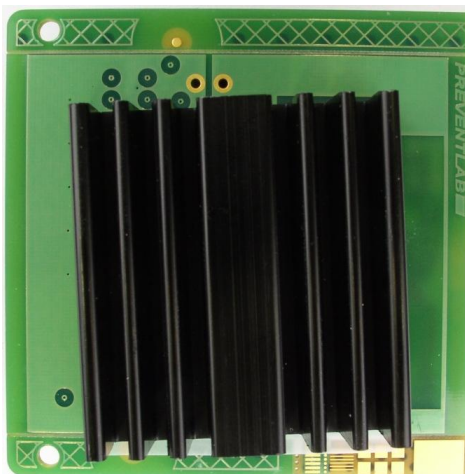
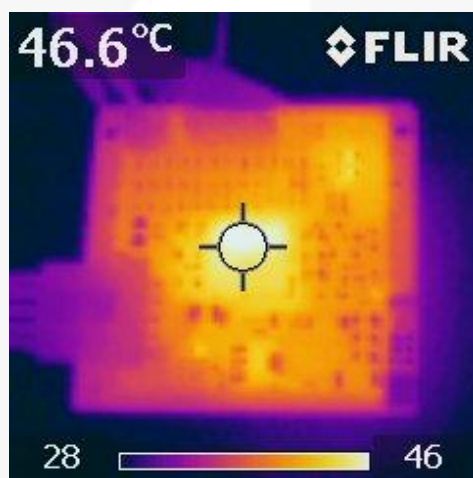
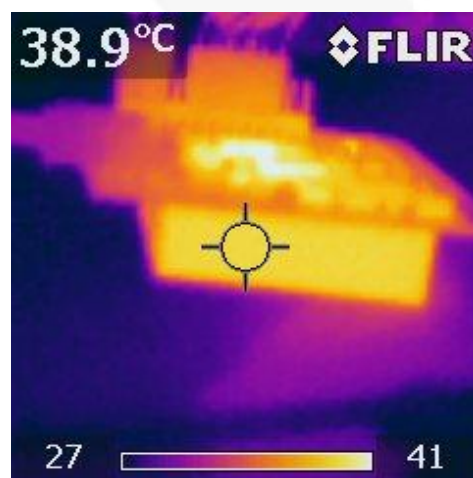


Figure 11. Heatsink of 6.5 Kelvin/W on Bottom Side

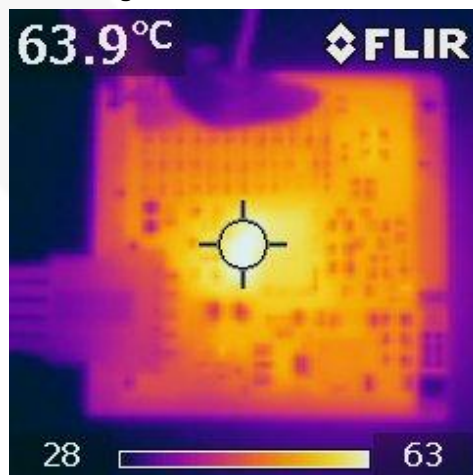


$T_{\text{module}} = 46.6 \text{ }^{\circ}\text{C}$

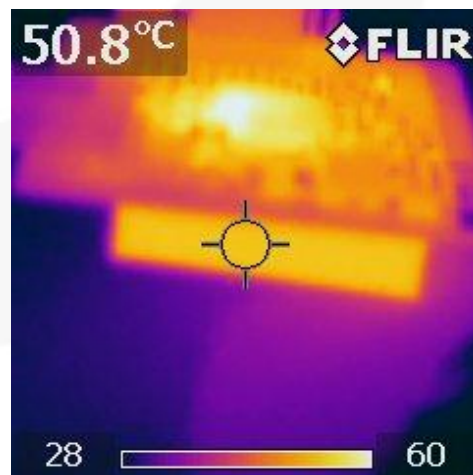


$T_{\text{heatsink}} = 38.9 \text{ }^{\circ}\text{C}$

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

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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.

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