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Spec No: 002-04445

Spec Title: AN204445 - FM0+, S6E1A1 Fan Motor EV Board

Replaced by: None

AN204445

FM0+, S6E1A1 Fan Motor EV Board

This application note describes the SK-FM0-LQFP48-S6E1A1-FAN evaluation board and it provides description of the hardware elements.

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1 Introduction

1.1 Purpose

This application note describes the SK-FM0-LQFP48-S6E1A1-FAN evaluation board and it provides description of the hardware elements.

1.2 Definitions, Acronyms, and Abbreviations

EVB evaluation board

IPM Intelligent Power Module

SPSM Switch Power Supply Module

1.3 Document Overview

The rest of document is organized like this:

Chapter 2 is Overview and Features.

Chapter 3 is Getting Started

Chapter 4 is Hardware

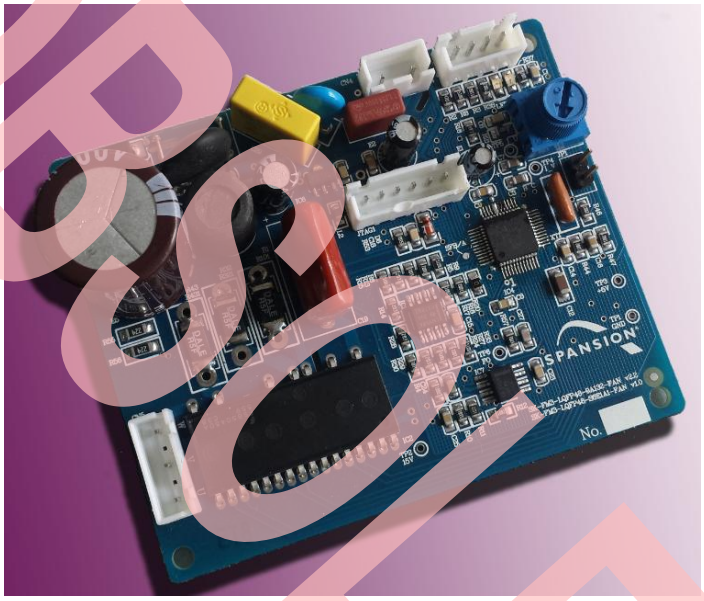
Chapter 5 is Additional Information

2 Overview and Features

2.1 Overview

This board is intended to aid the user in evaluation and development of a wide variety of motor control applications based on Cypress ARM® Cortex®-M0+ microcontroller. This board is targeted to control low power (<50Watt) Brushless DC (BLDC) motors, Permanent Magnet Synchronous Motors (PMSM), and AC Induction Motors (ACIM) in sensor-less operation.

Figure 1. Board Overview



2.2 Features

- Cypress fm0+ S6E1A1 series microcontroller
- Input : 185V~256V AC or 260V~365V DC
- Transformer less SMSP (15V/300mA)
- 600V/1.5A Intelligent Power Module (IPM)
- Three shunt resisters
- On-board potentiometer for speed setting
- UART
- 6-pin JTAG interface

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2.3 Specifications

The specifications are shown in the table as below.

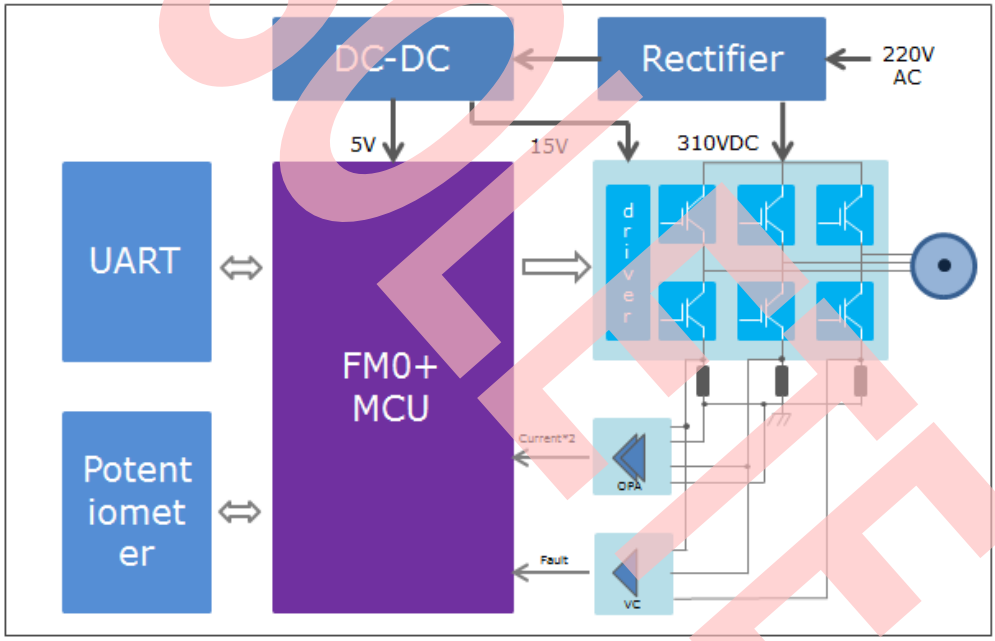
Table 1. Specifications

Specifications	Value	Remark
AC voltage input	220V±15%	50~60Hz
DC voltage input	310V±15%	
On-board 15V	15V±5%	
On-board 5V	5V±5%	
IPM max phase current	1.5A(Tc= 25ºC) ; 1.1A (Tc=80ºC)	continuous current
Over-Current protection	1.66A	shunt resister 0.56Ω

2.4 System Block Diagram

Figure 2 helps on fast review and understanding the system.

Figure 2. System Block Diagram



This board employs Cypress fm0+ S6E1A1 series microcontroller. The operation frequency of this MCU is up to 40MHz, up to 56Kbytes flash and 48K SRAM.It has a Multi-Function Timer which is able to generate three-phase SVPWM signals. Additionally, 12bit ADC have 1MHz sample rate.

The system has a three-phase power module device that contains the motor inverter and the gate driver's circuitry. The circuit drives a BLDC,PMSM, or ACIM motor using different control techniques without requiring any additional hardware. The rated continuous current of this module is 1.5A (RMS). This allows up to approximately 50Watt output when running from a 208V to 230V single-phase input voltage without heat-sink.

Three shunt resisters and a differential amplifier are used to measure the currents that flow through the motor phase. A voltage comparator is used to implement over-current protection.

The UART interface enables the communication with other board and flash programming.

A Potentiometer is used to set the speed; the range of the resistance is from 0 to 10K.

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3 Getting Started

3.1 Components Layout

Figure 3. Components Layout

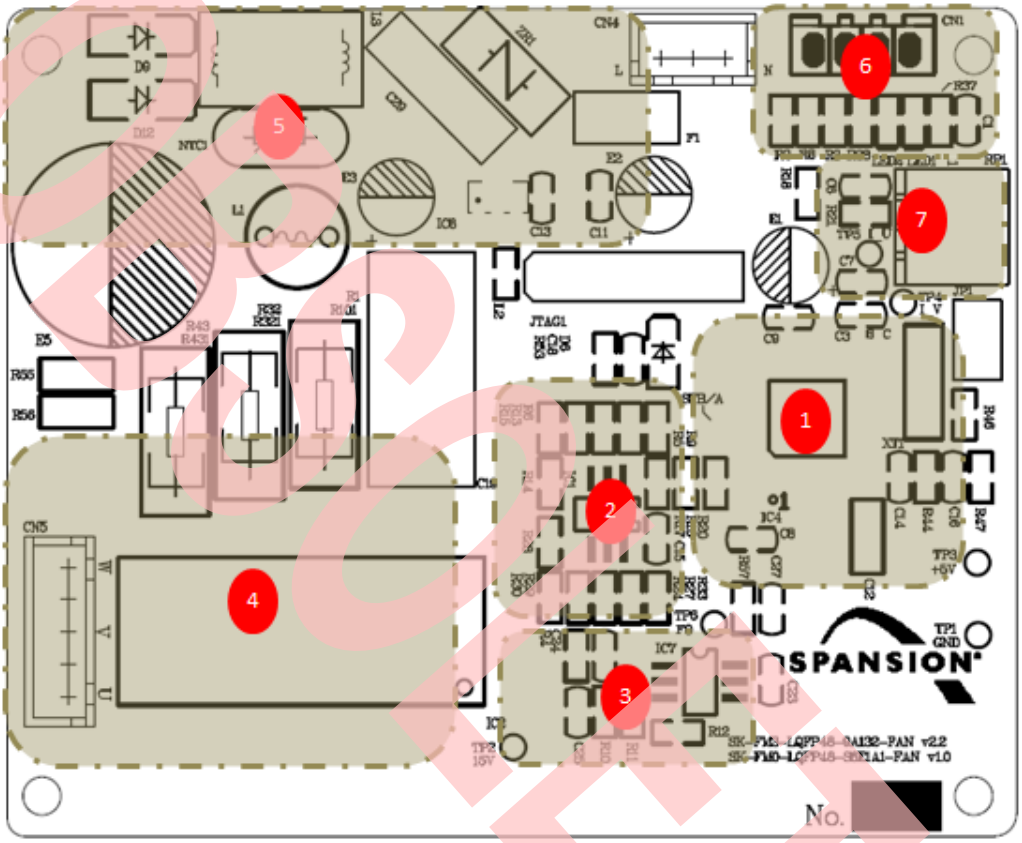


Table lists the main modules of this board

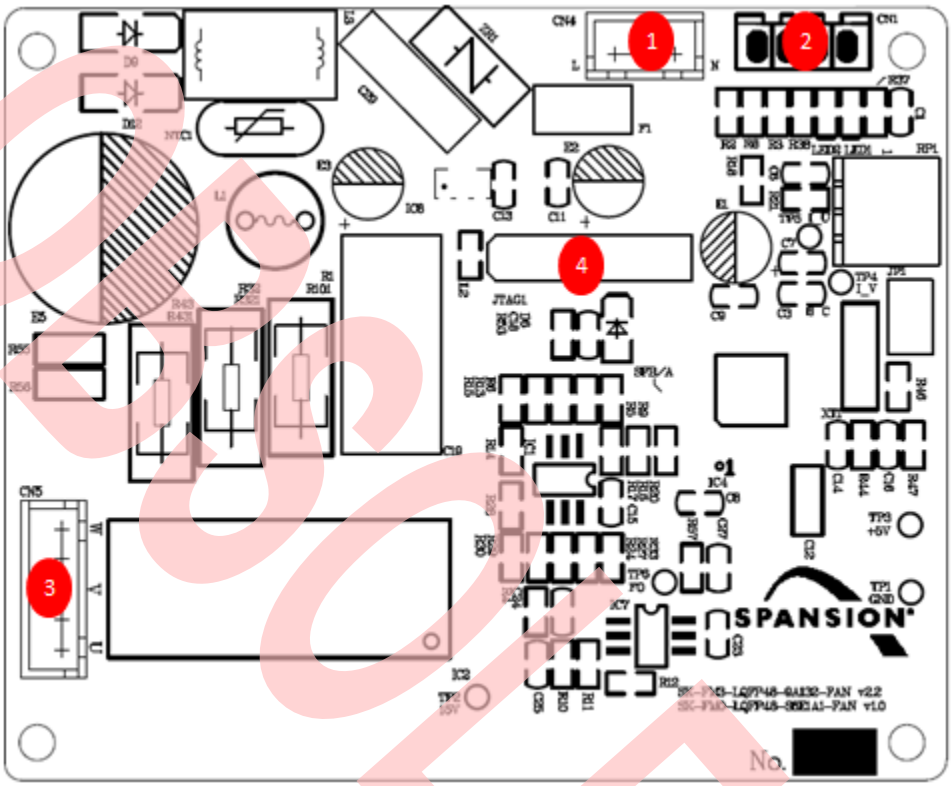
Table 2. Main Modules

No.	Modules	Description
1	MCU unit	S6E1A11C0A,fm0+ MCU,LQFP48,up to 40MHz
2	Current sampling circuit	LM358, offset output voltage 2.5V
3	Over current protection circuit	LM339, output ”L” when OC, threshold 1.66A
4	IPM circuit	FSB50450A(600V/1.5A), shunt resister 0.5Ω/1W
5	AC supply input and SPSM	Rectifier, EMI filer and in-rush limiter , SPSM
6	UART0	Data transmition and flash programming
7	Potentiometer	ADC input for speed setting

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3.2 Connectors Description

Figure 4. Connectors



The connectors are listed in the Table 3.

Table 3. Connectors Description

Number	Name	Descriptions
1	CN4	AC/DC voltage input
2	CN1	UART0
3	CN5	U,V,W phase
4	JTAG1	6-pin JTAG interface

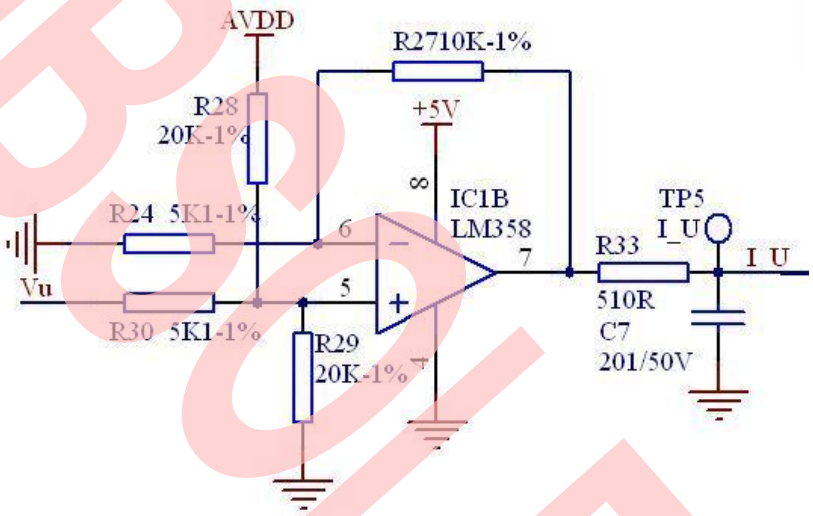
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4 Hardware

4.1 Amplifier Circuit

The differential amplifier circuit is applied in on this board to measure the motor phase current. The two channels amplifier LM358 is adapted in this system to condition the voltage between the shunt resisters. Firstly, the amplifier circuit amplifies the voltage to the range that has proper precision. Secondly, the amplifier circuit provides a static 2.5V output when the input is 0V.This enables the possibility to sample the negative current between the shunt resisters.

Figure 5. amplifier circuit



Equation:

$$Vout_u = \frac{AVDD}{2} + \left(\frac{R27}{R24}\right) * Vin_u$$

Where:

$Vout_u$: Output of amplifier

Vin_u: Input of amplifier

$R28 = R29 = 2 * R27$

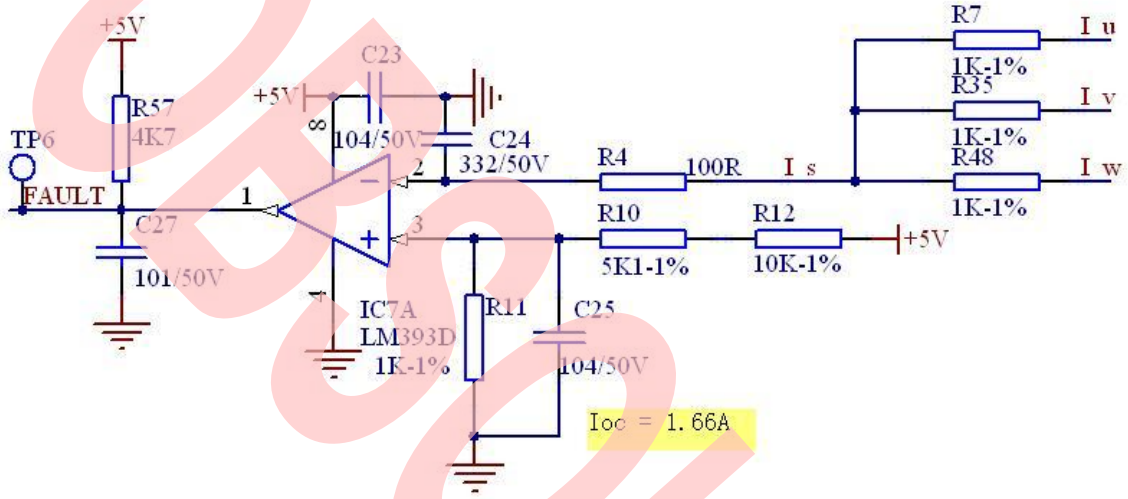
There are three shunt resisters, while two of them are used on phase current sampling, because the third phase current can be calculated by the other two current values. In this system, the U, V currents are sampled.

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4.2 Over-current Protection Circuit

There is over-current protection circuit to prevent IPM and motor damaged by the current surge that flowing through the phases. The over-current protection circuit is consisted of a voltage comparator LM393, resisters and capacitors. Figure 6 shows the details.

Figure 6. Over-current protection circuit



Equation:

$$Ioc = \frac{R11}{R11 + R12 + R13} * 5V * \frac{3}{Rshunt}$$

Where:

Ioc: Threshold value of protection

$Rshunt$: Value of shunt resister

R7 = R35 = R48

5 Additional Information

For more Information on Cypress semiconductor products, visit the following website:

http://www.cypress.com/cypress-microcontrollers

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6 Document History

Document Title: AN204445 - FM0+, S6E1A1 Fan Motor EV Board

Document Number: 002-04445

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	-	CBZH	02/01/2015	Initial release
*A	5100344	CBZH	07/08/2016	Migrated Spansion Application Note FM0+_AN706-00098-1v0-E to Cypress format. This application note is for obsolete because product is not available and there is no web link to get this hardware for customer.

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