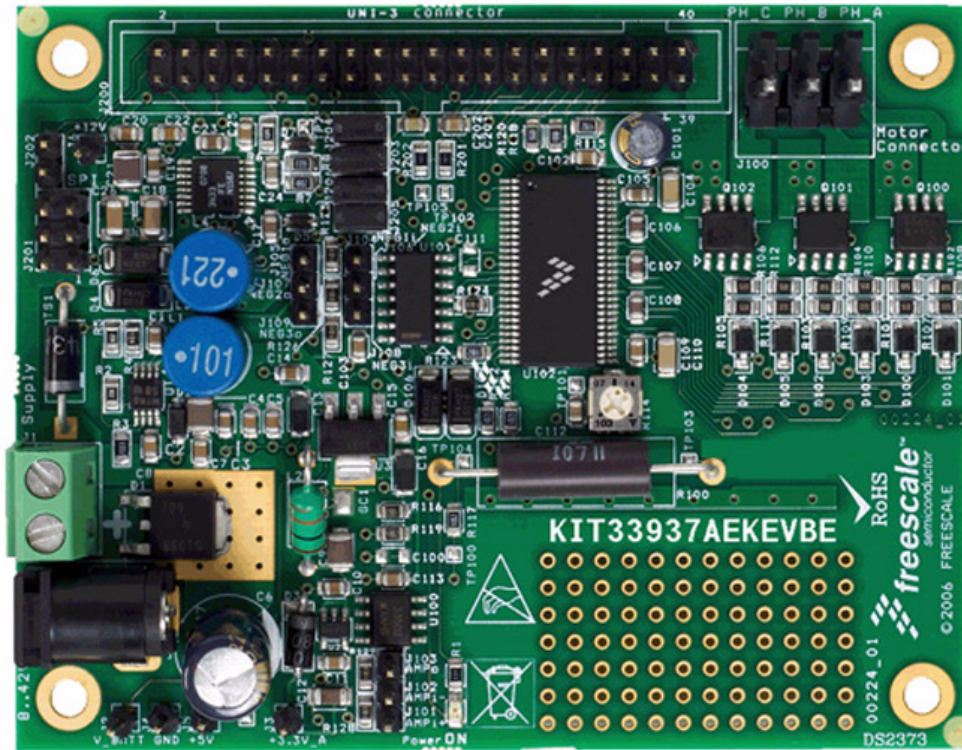


# KIT33937AEKEVBE Evaluation Board



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The goods provided may not be complete in terms of required design, marketing, and or manufacturing related protective considerations, including product safety measures typically found in the end product incorporating the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. In order to minimize risks associated with the customers applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards. For any safety concerns, contact Freescale sales and technical support services.

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## 2 Introduction and Setup

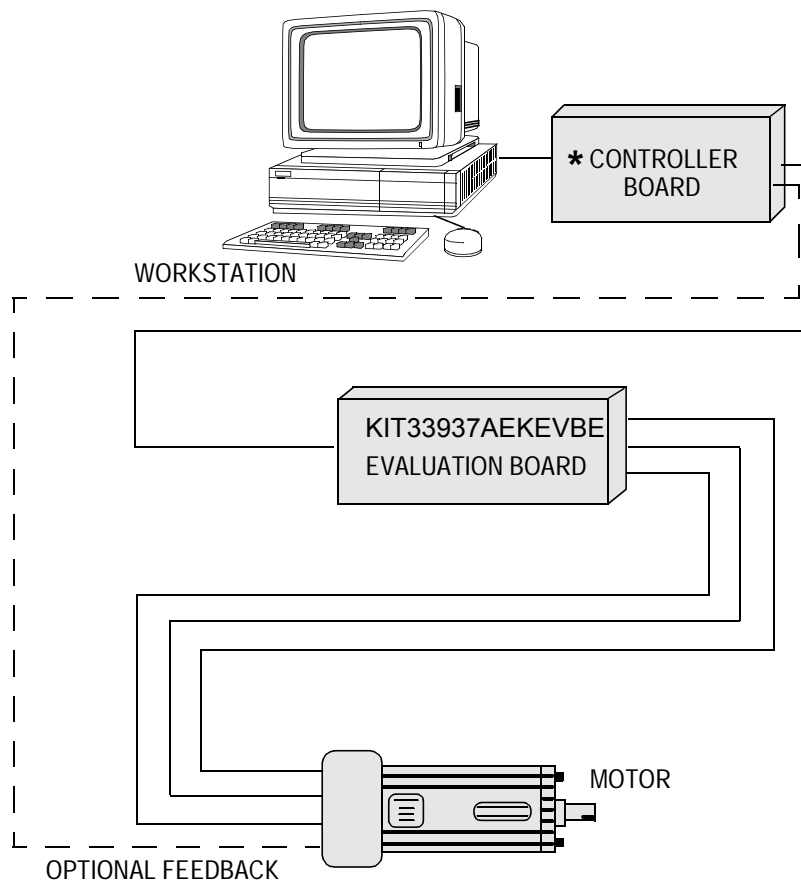
### 2.1 Introduction

This User's Manual describes the features, options and connections of the KIT33937AEKEVBE Evaluation Board. Freescale's KIT33937AEKEVBE Evaluation Board is a low-voltage power stage that is an integral part of Freescale's embedded motion control series of development tools. For additional information on Freescale's Motion Control Development Tools go to [www.freescale.com/motor control](http://www.freescale.com/motor%20control) In combination with one of the embedded motion control series, control evaluation boards, it provides a ready-made software development platform for small brushless DC motors among others. An illustration of the system configurations is shown in Figure 1.

The KIT33937AEKEVBE Evaluation Board has the following features:

- Connecting the Evaluation Board via a UNI-3 connector
- SPI communication between the 33937A Driver and a microcontroller
- DC-Bus current and voltage sensing
- Over-current detection with adjustable current maximum value
- Optional input supply voltage of 8 - 42 Volts
- 3.3 V, 5.0 V, and 12 V voltage generation on the boards
- Output 3-phase motor connector

Figure 1 depicts the board layout with descriptions of the components.



\* MCF523xEC, MPC555, 56800/E HYBRID CONTROLLER, S12Exx MICROCONTROLLER

**Figure 1. System Configuration**

## 2.2 About this Manual

Key items can be found in the following locations in this manual:

- Setup instructions are found in section [Setup Guide](#).
- Pin-by-pin descriptions are contained in [Table 2](#) up to [Table 10](#).
- For those interested in the reference design aspects of the board's circuitry, a description is provided in [Design Considerations](#)

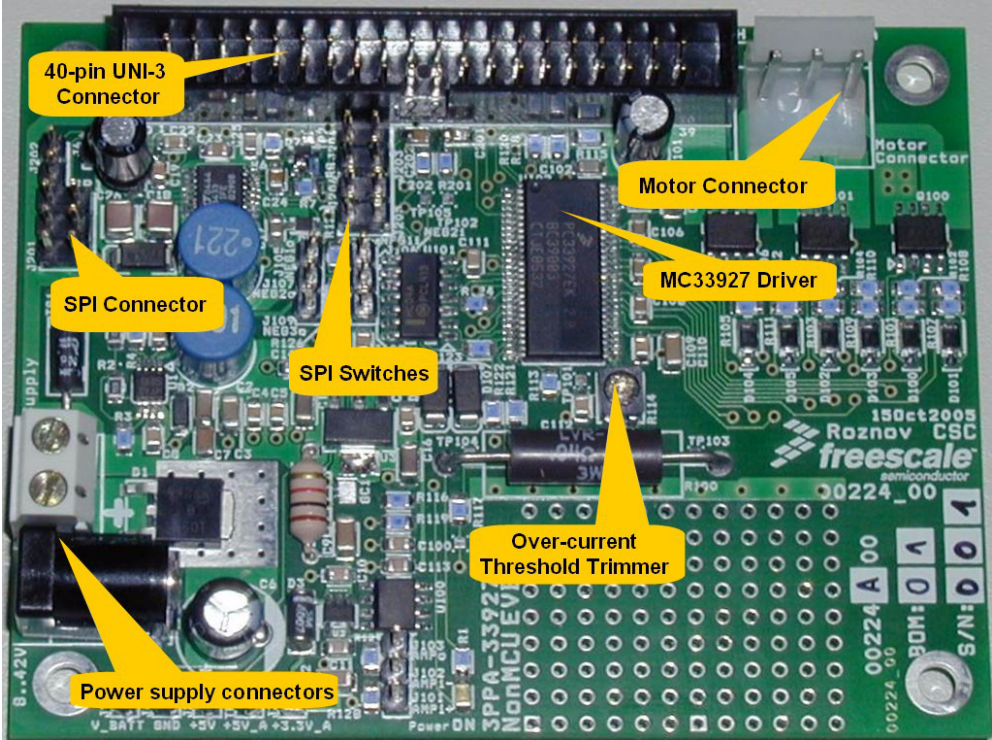


Figure 2. KIT33937AEKEVBE Evaluation Board

## 2.3 Disposing of Old Appliances

The KIT33937AEKEVBE Evaluation Board must be disposed of in compliance with current local waste disposal regulations. Disposing of old appliances should be done by a qualified company.

## 2.4 Terms and Acronyms

BLDC	Brushless DC
EVB	Evaluation Board
Hall sensor	Sensor whose output changes based on changes in magnetic flux. Used to measure motor position.
PWM	Pulse width modulation
UNI-3	User-to-Network Interface

## 2.5 Warnings

The KIT33937AEKEVBE Evaluation Board includes components which can reach temperatures hot enough to cause burns. To facilitate safe operation, the 8.0 to 42 V input power should come from a DC laboratory power supply that is current limited to no more than 4.5 amps.

The user should be aware of:

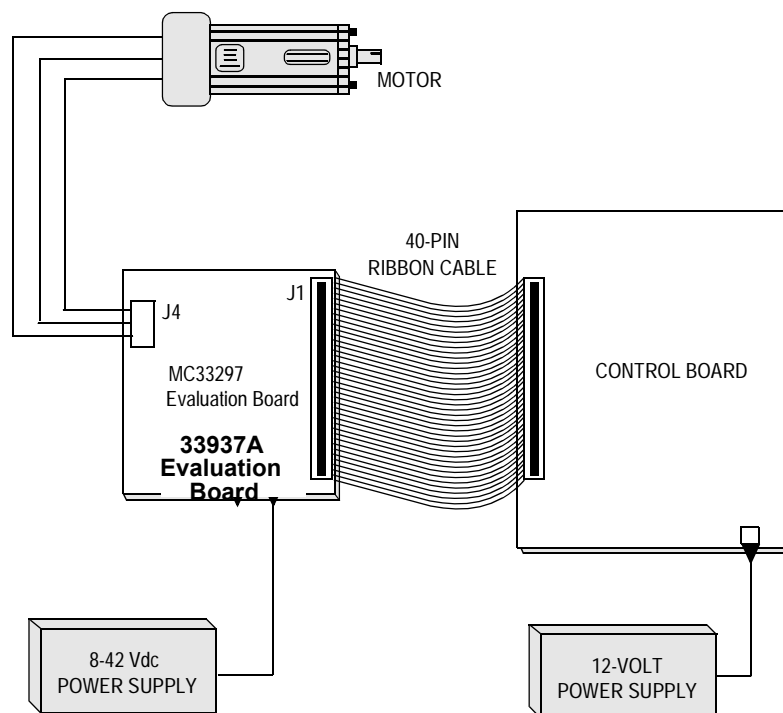
- Before moving scope probes, making connections, etc., it is generally advisable to power down the DC voltage supply.
- Operating in lab setups that have grounded tables and/or chairs should be avoided.
- It is also advisable to wear safety glasses, avoiding wearing ties and jewelry, use shields, and operate by personnel trained in power electronics lab techniques are also advisable.

## 2.6 Setup Guide

Setup and connections for the KIT33937AEKEVBE Evaluation Board are straightforward. The KIT33937AEKEVBE Evaluation Board connects to a Freescale embedded motion control series control board via a 40-pin ribbon cable. The motor's power leads plug into output Motor connector (J100). [Figure 3](#) depicts a completed setup.

Follow these steps to set up the board:

1. Plug one end of the 40-pin ribbon cable supplied with Freescale's embedded motion control series control boards into input UNI-3 connector (J200), located at the edge of the KIT33937AEKEVBE Evaluation Board.
2. Plug the free end of the cable into the control board's 40-pin connector.
3. Connect a 8.0 to 42 VDC power supply either to the power jack J7 labelled "8-42 V", or to the connector J1.
4. If protection features are desired, set the overcurrent detection comparator trimmer, R114, to 2.75 V. This value limits DC bus current to 3.0 amps.
5. Apply power to the KIT33937AEKEVBE Evaluation Board. The yellow power-on LED is lit when power is present. Note that the KIT33937AEKEVBE Evaluation Board doesn't power the control board, so the control board must be powered by means of an external 12 VDC power supply to run a complete system.



**Figure 3. KIT33937AEKEVBE Evaluation Board Setup**

## 3 Operational Description

### 3.1 Introduction

Freescale's embedded motion control series KIT33937AEKEVBE Evaluation Board is a 8.0 to 42 VDC, 4.5 amp, surface-mounted power stage. In combination with one of the embedded motion control series control boards, it provides a software development platform that allows algorithms to be written and tested without the need to design and build a power stage for small brushless DC motors, amongst others. It supports algorithms that use Hall sensors, a Quadrature encoder, and Zero-cross signals for sensor-less control.

The KIT33937AEKEVBE Evaluation Board has an overcurrent protection that is implemented on the 33937A driver and is independent of the control board. Current measuring circuitry is set up from -4.5 to 4.5 amps full scale. In a 25 °C ambient operation at up to 4.5 A, continuous RMS output current is within the board's thermal limits.

The control interface is created via the 40-pin ribbon cable connector J200. Pin assignments for the input connector are shown in [Figure 4](#). Power connections to the motor are made on output connector J100. Phase A, B, and C are labelled on the board. Power requirements are met by a single external 8.0 to 42 V, 5.0 A power supply. Two connectors, labelled J7 and J1, are provided for the power supply. Both are located in one corner of the board.

For design information, see [Design Considerations](#).

### 3.2 Electrical Characteristics

The electrical characteristics in [Table 1](#) apply to operation at 25 °C and a 12 VDC power supply voltage.

**Table 1. Electrical Characteristics**

Characteristic	Symbol	Min.	Typ.	Max.	Units
Power Supply Voltage	$V_{DC}$	8.0	12	42	V
Quiescent Current	$I_{CC}$	—	10.4	—	mA
Logic 1 Input Voltage	$V_{IH}$	2.1	—	—	V
Logic 0 Input Voltage	$V_{IL}$	—	—	0.9	V
Analog Output Range	$V_{OUT}$	0.0	—	3.3	V
Bus Current Sense Voltage	$I_{SENSE}$	—	366	—	mV/A
Bus Voltage Sense Voltage	$V_{BUS}$	—	69	—	mV/V
Power MOSFET On Resistance	$R_{DS(ON)}$	—	45	55	mOhm
Continuous Output Current	$I_D$	—	—	4.5	A
Pulsed Output Current	$I_{DM}$	—	—	30	A
Total Power Dissipation	$P_{DISS}$	—	—	2.4	W

## 4 Pin Description

### 4.1 Connectors and Test Points

Inputs and outputs are located on connectors and test points. Pin descriptions for each of these connectors and the test points are identified in following information.

### 4.2 40-Pin Connector J200

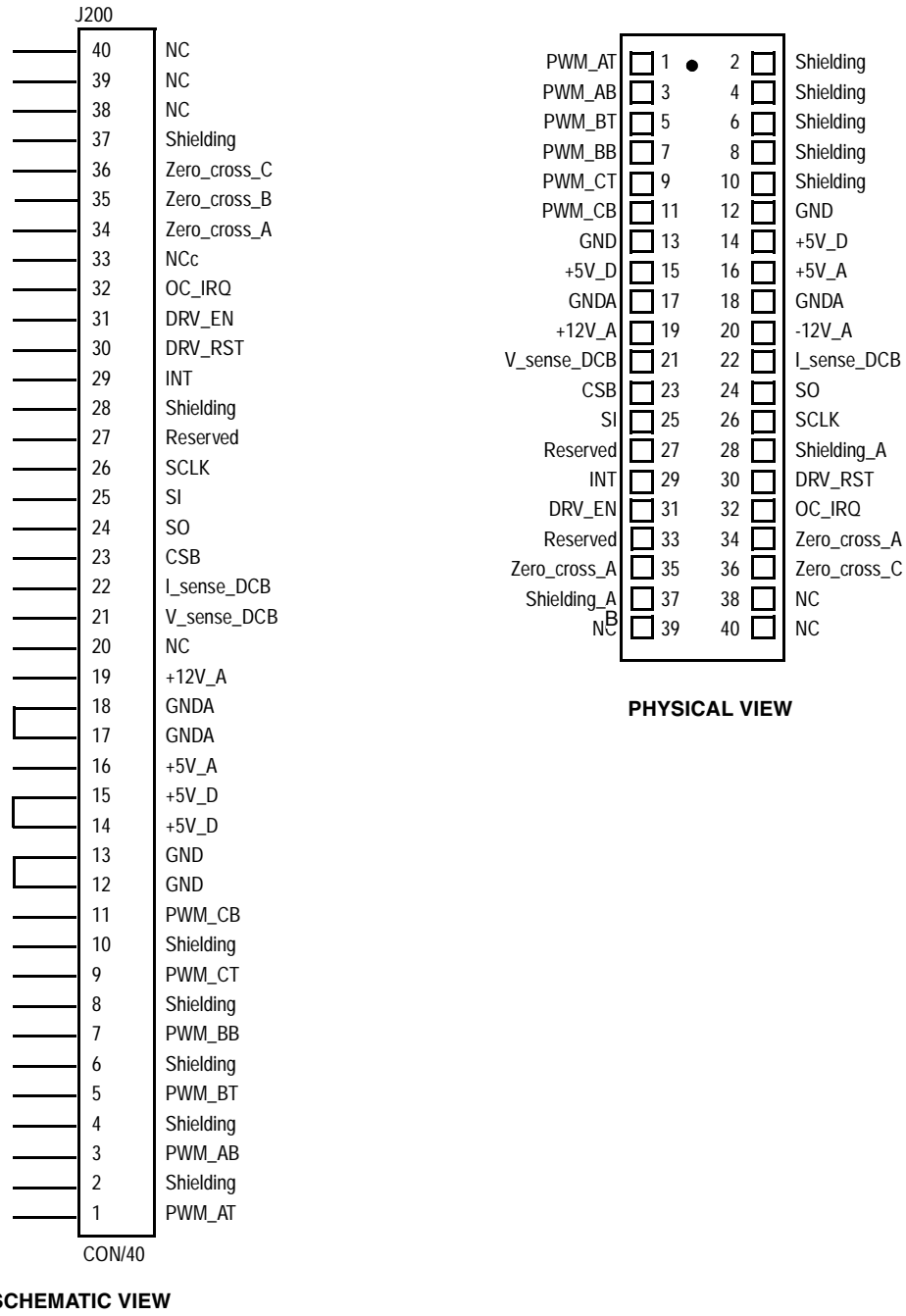
Signal inputs and outputs are grouped together on the 40-pin connector J200, located on the top of the board. Pin assignments and descriptions are shown in [Figure 4](#). Pin descriptions are listed in [Table 2](#).

Note that some J200 signals have a different usage than in the standard UNI-3 Interface. This is due to the need for the SPI communication 33937A driver and the driver control signals - Reset, Enable, and Overcurrent. Some pins on J200 are not connected, in comparison to the UNI-3 standard. Changed pin assignments are shown in [Table 2](#)

For more information refer to [Table 9](#)

**Table 2. Changed Pins' Descriptions**

Pin #	UNI-3 Standard	J12 Connector
19	+15 V_A / +12 V_A	+12 V
20	-15 V_A / -12 V_A	Not connected
23	I_sense_A	SPI_CSB
24	I_sense_B	SPI_SO
25	I_sense_C	SPI_SI
26	Temp_sense	SPI_SCLK
29	Brake_control	DRV_INT
30	Serial_con	DRV_RST
31	PFC_PWM	DRV_EN
32	PFC_enable	OC_IRQ
33	PFC_z_c	Not connected
38	BEMF_sense_A	Not connected
39	BEMF_sense_B	Not connected
40	BEMF_sense_C	Not connected



**SCHEMATIC VIEW**

**Figure 4. 40-Pin Input Connector J200**



**Table 3. Connector J200 Signal Description**

Pin #	Signal Name	Description
1	PWM_AT	PWM_AT is the gate drive signal for the top bridge of phase A. A logic high at input connector J10 turns on the phase A top switch
3	PWM_AB	PWM_AB is the gate drive signal for the bottom bridge of phase A. A logic high at input connector J10 turns on the phase A bottom switch
5	PWM_BT	PWM_BT is the gate drive signal for the top bridge of phase B. A logic high at input connector J10 turns on the phase B top switch
7	PWM_BB	PWM_BB is the gate drive signal for the bottom bridge of phase B. A logic high at input connector J10 turns on the phase B bottom switch
9	PWM_CT	PWM_CT is the gate drive signal for the top bridge of phase C. A logic high at input connector J10 turns on the phase C top switch
11	PWM_CB	PWM_CB is the gate drive signal for the bottom bridge of phase C. A logic high at input connector J10 turns on the phase C bottom switch
12	GND	Digital power supply ground
13	GND	Digital power supply ground
17	AGND	Analog power supply ground
18	AGND	Analog power supply ground
19 *	+12V_A	Analog power supply
20 *	NC	Not connected
21	V_SENSE_DCB	V_sense is an analog sense signal that measures dc bus voltage
22	I_SENSE_DCB	I_sense is an analog sense signal that measures dc bus current
23 *	CSB	Chip select signal of the SPI communication
24 *	SO	Output signal of the SPI communication
25 *	SI	Input signal of the SPI communication
26 *	SCLK	Clock signal of the SPI communication
27	NC	Not Connected
28	Shielding_A	Analog Shielding. Must be grounded on the power stage side only!
29 *	DRV_INT	33937A driver Interrupt signal
30 *	DRV_RST	33937A driver Reset signal
31 *	DRV_EN	33937A driver Enable signal
32 *	OC_IRQ	33937A driver Overcurrent signal
33 *	NC	Not connected
34	Zero_cross_A	Digital input. Phase A Back-EMF zero crossing
35	Zero_cross_B	Digital input. Phase B Back-EMF zero crossing
36	Zero_cross_C	Digital input. Phase C Back-EMF zero crossing
37	Shielding_A	Analog Shielding. Must be grounded on the power stage side only!
38 *	NC	Not connected
39 *	NC	Not connected
40 *	NC	Not connected

**NOTE**

\* Pins which are connected differently than in the User Network Interface, Version 3.0 (UNI-3) standard.

## 4.3 SPI Communication Connectors J201 and J202

SPI signal inputs from the control board are grouped onto the 6-pin connector J201. Two signals (CSB, SO) are also available on the 2-pin connector J202. Pin descriptions are listed in [Table 4](#) and [Table 5](#).

**Table 4. Connector J201 Signal Description**

Pin #	Signal Name	Description
1	NC	Not Connected
2	GND	Digital power supply ground
3	CSB	Chip select signal
4	SCLK	Clock signal
5	SO	Output signal
6	SI	Input signal

**Table 5. Connector J202 Signal Description**

Pin #	Signal Name	Description
1	SO	Output Signal
2	CSB	Chip Select signal

The output signal SO from the 33937A driver is connected to the control board's input signal SI, and likewise the input signal SI from the 33937A driver is connected to the control board's output signal SO.

## 4.4 3-Pin Motor Connector J100

Power outputs to the motor are located on the 3-pin connector J100, labeled "Motor Connector". Pin descriptions are listed in [Table 6](#).

**Table 6. Connector J100 Signal Description**

Pin #	Signal Name	Description
1	Phase_A	Supplies power to motor phase A.
2	Phase_B	Supplies power to motor phase B.
3	Phase_C	Supplies power to motor phase C.

## 4.5 Power Supply Connectors J1 and J7

Two connectors, labelled J1 and J7, are provided for the 8.0 to 42 VDC power supply. Both connectors are used for power supply input, and are located in one corner of the board. The J7 connector is a 2.1 mm power jack for plug-in type dc power supply connections, the J1 connector is a two-wire connector. The power supply should be able to deliver at least 3.0 amps.

## 4.6 Connectors J2 - J6

One-pin connectors J2 - J6 provide easy access to voltages available on the board. Connector descriptions are listed in [Table 7](#).

**Table 7. Connectors J3-J6 Signal Description**

Connector #	Signal Name	Description
J2	V_BATT	Power supply voltage
J3	+3.3V_A	Analog power supply
J4	GND	Power supply ground
J5	+5V	Digital power supply
J6	+12V	Digital power supply

## 4.7 Connectors J101 - J109

One-pin connectors J101 - J109 provide connections to the additional operational amplifier U100B (MC33502D) and three inverters U101D-F (74HC04). Pin descriptions are listed in [Table 8](#).

**Table 8. Connectors J101 - J109 Signal Description**

Connector #	Signal Name	Description
J101	AMPi+	op. amplifier non-invert input
J102	AMPi-	op. amplifier invert input
J103	AMPo	op. amplifier output
J104	NEG1i	invertor 1 input
J105	NEG1o	invertor 2 output
J106	NEG2i	invertor 2 input
J107	NEG2o	invertor 2 output
J108	NEG3i	invertor 3 input
J109	NEG3o	invertor 3 output

## 4.8 Jumpers JP203 - JP206 for SPI Communication Selection

The jumpers JP203 - JP206 are used for SPI communication connector selection. The selection of signals is listed in [Table 9](#).

**Table 9. Jumpers JP1 - JP3 Selection**

Jumper Name	Position	Comment for SPI communication
J203	1 2	For CSB signal where the UNI-3 connector is not selected
J203	1-2	For CSB signal where the UNI-3 connector is selected
J204	1 2	For SO signal where the UNI-3 connector is not selected
J204	1-2	For SO signal where the UNI-3 connector is selected
J205	1 2	For SI signal where the UNI-3 connector is not selected
J205	1-2	For SI signal where the UNI-3 connector is selected
J206	1 2	For SCLK signal where the UNI-3 connector is not selected
J206	1-2	For SCLK signal where the UNI-3 connector is selected

Position 1-2



Position 1 2



## 4.9 Test points

Six test points provide easy access to the DC-Bus current and voltage sensing signals. They are listed in [Table 10](#) along with their descriptions and locations.

**Table 10. Test points**

Test point no.	Signal Name	Locations
TP100	+1.65 Ref	middle side of the board
TP101	OC_TH	below IC U102
TP102	VDCB	below connector J200
TP103	I_DCB+	right side of the resistor R100
TP104	IDCB-	left side of the resistor R100
TP105	IDCB	below connector J200

## 5 Design Considerations

### 5.1 Overview

From a systems point of view, the KIT33937AEKEVBE Evaluation Board fits into an architecture that is designed for code development. In addition to the hardware that is needed to run a motor, a variety of feedback signals that facilitate control algorithm development are provided. Input PWM signals from a control board process the 3-phase FET pre-driver 33937A. The description of the pre-driver is contained in [3-Phase FET Pre-driver 33937A](#).

The KIT33937AEKEVBE Evaluation Board power output stage is a complementary MOS field effect transistor (MOSFET) 3-phase bridge, capable of supplying and sensing 4.5 amps of continuous current. Feedback signals include bus voltage and the bus current. Descriptions of each of these blocks are contained in [3-Phase Driver](#), and in [Bus Voltage and Current Feedback](#).

### 5.2 3-Phase FET Pre-driver 33937A

The 3-Phase FET Pre-driver (33937A) is a FET pre-driver for 3-phase motor control and similar applications. The IC uses Freescale's SMARTMOS technology. The IC contains 3 high-side FET pre-drivers and 3 low-side pre-driver. Three external bootstrap capacitors provide gate charge to the high-side FETs.

The IC contains internal registers to control the various operating parameters, modes and interrupt characteristics. These commands are sent and the status is read via 8-bit SPI commands. The IC will use the last 8 bits in a SPI transfer, so devices can be daisy-chained. The return value from a SPI command is obtained via the SPI port on the subsequent command. It is in the SPI communication for the next command that the response is delivered.

The IC also contains the high speed amplifier for ground current sensing, and the overcurrent comparator for overcurrent detection. For more information on the pre-driver, refer to [References](#).

### 5.3 3-Phase Driver

The output stage is configured as a 3-phase driver with complementary MOSFET output transistors. It is simplified considerably by dual integrated gate drivers, each having one inverting and one non-inverting driver. A simplified schematic showing one phase is illustrated in [Figure 9](#).

One of the most important design decisions in a motor drive is the selection of the gate drive impedance for the output transistors. In [Figure 9](#), resistors R101 (51  $\Omega$ ), R102 (51  $\Omega$ ), and diode D100 determine gate drive impedance for the upper half-bridge transistor. A similar network is used on the lower half-bridge. These networks set the turn-on gate drive impedance to approximately 100  $\Omega$  and the turn-off gate drive impedance at approximately 50  $\Omega$ . These values produce transition times of approximately 60 ns. Transition times of this length represent a carefully weighed compromise between power dissipation and noise generation. Generally speaking, transition times longer than 250 ns tend to get power hungry at non-audible PWM rates; and transition times under 50 ns create di/dtfs so large that proper operation is difficult to achieve. The 33937A EVB is designed with switching times at the lower end of this range to minimize power dissipation.

### 5.4 Bus Voltage and Current Feedback

Feedback signals proportional to bus voltage and bus current are provided by the circuitry shown in [Figure 8](#). Bus voltage is scaled down by a voltage divider consisting of R115 (47 kohms), R118 (1.8 kohms), and R120 (3.6 kohms). The values are chosen such that a 48-volt maximum bus voltage corresponds to a 3.3 volt maximum analog-to-digital (A/D) input.

Bus current is sampled by resistor R100, shown in [Figure 9](#), and amplified by the 33937A driver. This circuit provides a voltage output suitable for sampling with A/D inputs.

The gain is given by:

$$A = R117 / R121 \text{ (resistors are shown in } \text{Figure 8)}$$

The output voltage is shifted up by 1.65 V, to accommodate both positive and negative current swings. A  $\pm 180$  mV voltage drop across the shunt resistor corresponds to a measured current range of  $\pm 4.5$  A and to a voltage range from 0 to 3.3 V.

The overcurrent comparator, implemented on the 33937A driver, is adjusted by the trimmer R114 (shown in [Figure 7](#)), where a 2.75 V setting for the overcurrent detection comparator produces a 3.0 A current limit.

# 6 KIT33937AEKEVBE Evaluation Board Schematics

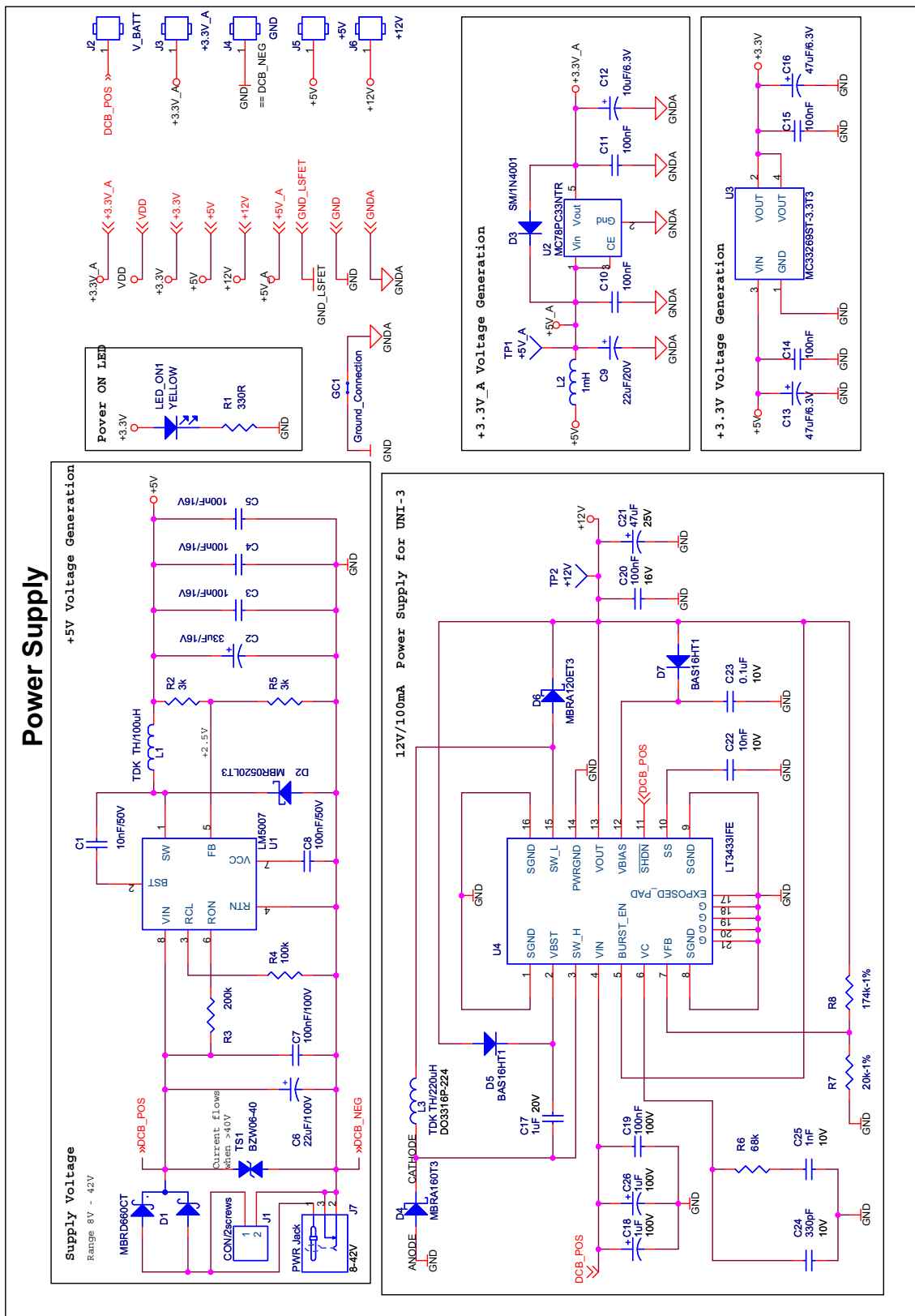


Figure 5. Power Supply

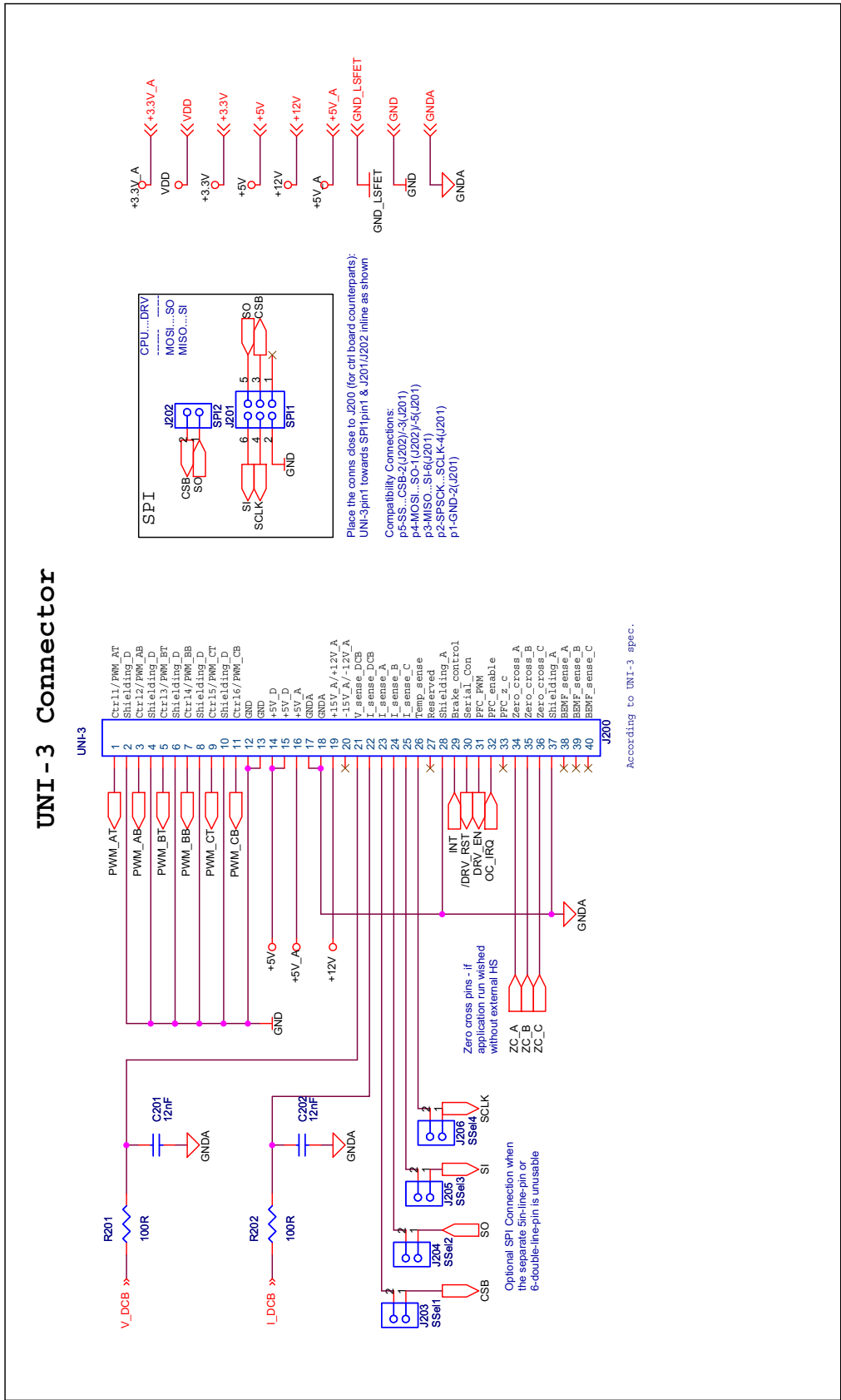


Figure 6. UNI-3 Connector



## DC-Bus Voltage & Current Sensing

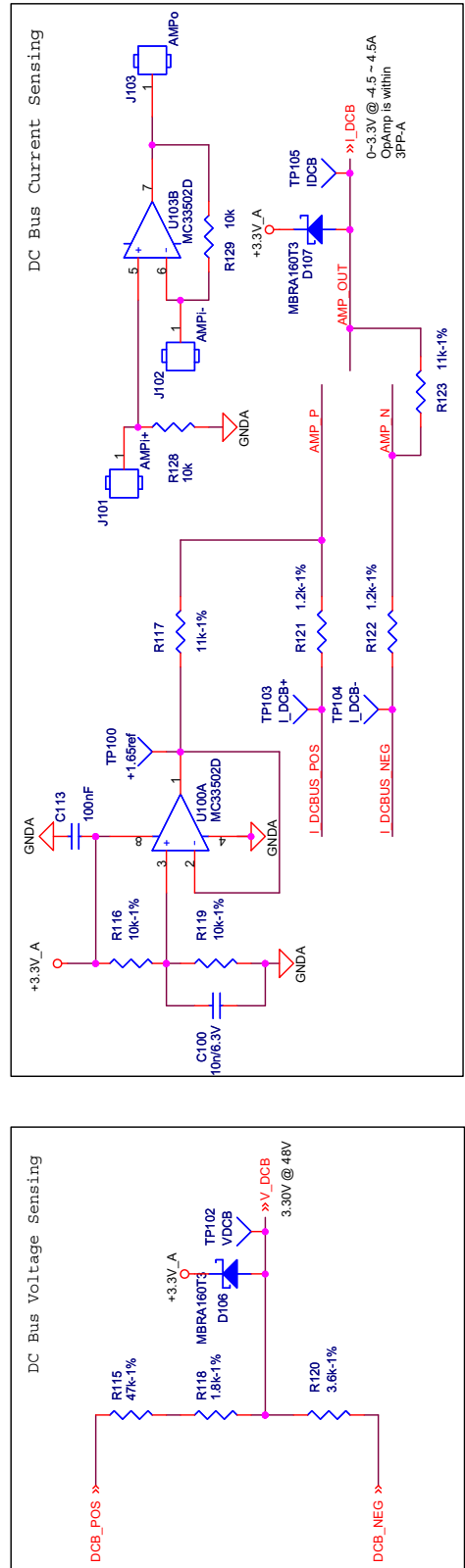


Figure 8. DC-Bus Voltage & Current Sensing



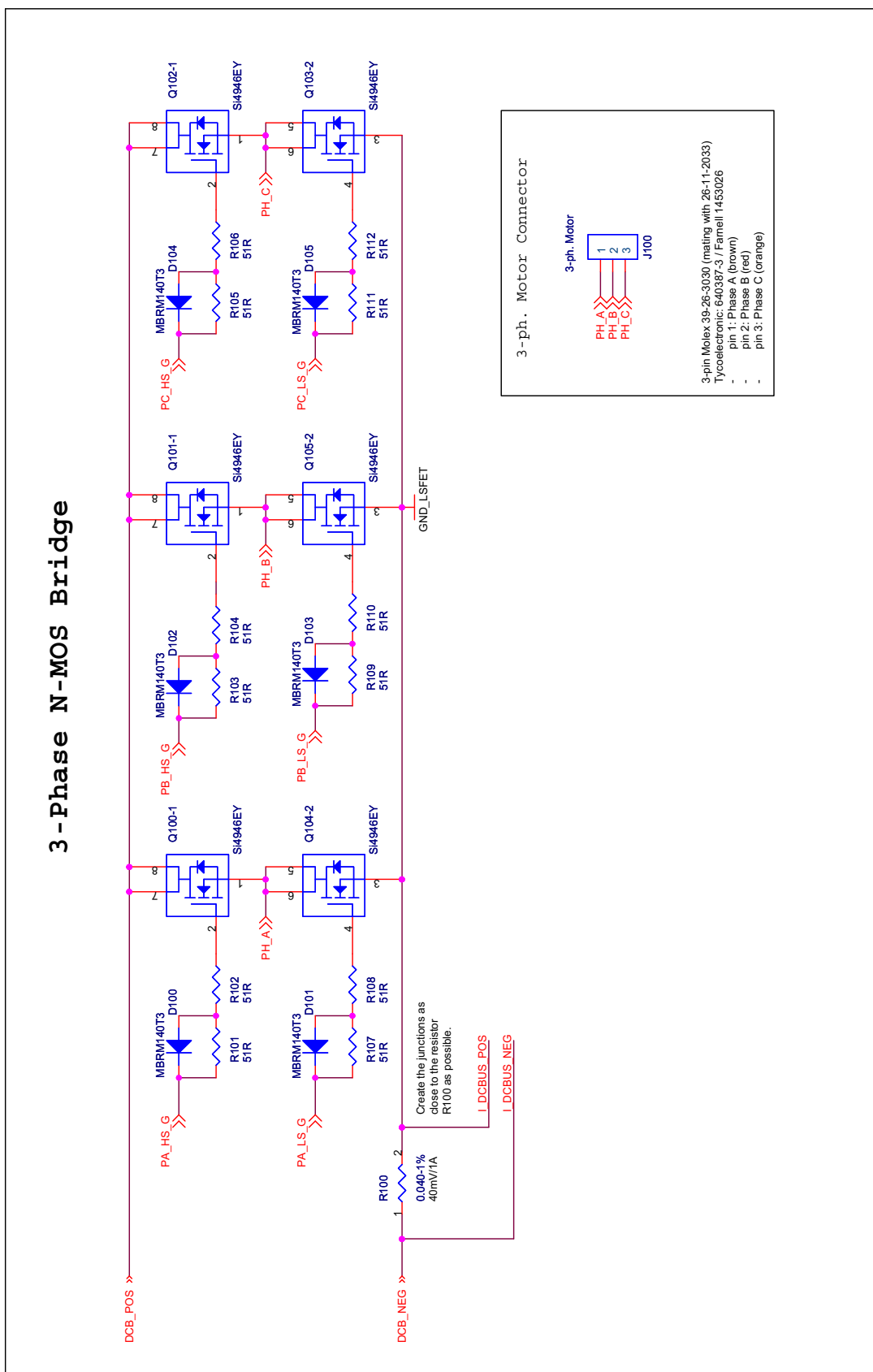


Figure 9. 3-Phase N-MOS Bridge

## 7 Bill of Materials

Table 11. Bill of Materials

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
1	C1	10 nF/50 V	Ceramic capacitor, 0805, 10 nF	AVX	08055G103KAT1A
1	C2	22 $\mu$ F/ 16 V	Ceramic capacitor, 1206, 22 $\mu$ F	AVX	1206YD226KAT1A
3	C3, C4, C5	100 nF/ 25 V	Ceramic capacitor, 0805, 100 nF	AVX	08053G104KAT1A
1	C6	22 $\mu$ F/ 100 V	Electrolytic Capacitor 8.0 mm, 22 $\mu$ F/100 V	Jamicon	SKR220M2AFBB
1	C7	100 nF/ 100 V	Ceramic capacitor, 0805, 100 nF	AVX	08051C104KAT1A
1	C8	100 nF/ 50 V	Ceramic capacitor, 0805, 100 nF	AVX	08055C104KAT1A
1	C9	22 $\mu$ F/ 16 V	Ceramic Capacitor, 1206, 22 $\mu$ F/16 V	AVX	1206YD226KAT1A
12	C10, C11, C14, C15, C19, C20, C23, C103, C105, C109, C112, C113	100 nF/50 V	Ceramic capacitor, 0805, 100 nF	AVX	08055C104KAT1A
1	C12	10 $\mu$ F/ 6.3 V	Ceramic Capacitor, 1206, 10 $\mu$ F/6.3 V	AVX	1206ZC106KAT1A
2	C13, C16	47 $\mu$ F/ 6.3 V	Tantal Capacitor, 1206, 47 $\mu$ F/6.3 V	AVX	12066D476KAT1A
1	C17	1.0 $\mu$ F/ 10 V	Ceramic capacitor, 0805, 1.0 $\mu$ F	AVX	0805ZG105ZAT1A
2	C18, C26	1.0 $\mu$ F/ 50 V	Ceramic capacitor, 1206, 1.0 $\mu$ F	TDK	C3216X5R1H105K
1	C21	47 $\mu$ F/ 16 V	Ceramic capacitor, 1210, 2x 22 $\mu$ F/16	TDK	C3225X5R1C226M
1	C22	10 nF/ 50 V	Ceramic capacitor, 0805, 10 nF	AVX	08055G103ZAT1A
1	C24	330 pF/ 100 V	Ceramic capacitor, 0805, 330 pF	AVX	08055G331ZAT1A
2	C25, C102	10 nF/50 V	Ceramic capacitor, 0805, 10 nF	AVX	08055G102ZAT1A
1	C101	2.2 $\mu$ F/ 63 V	Electrolytic Capacitor, 5mm, 2.2 $\mu$ F/ V	Jamicon	SKR2R2M1JFBB
2	C104, C110	2.2 $\mu$ F/ 25 V	Ceramic Capacitor, 1206, 2.2 $\mu$ F/25 V	AVX	12065C225KAT1A
3	C106, C107, C108	150 nF/50 V	Ceramic capacitor, 0805, 150 nF	AVX	08055C154KAT1A
2	C201, C202	12 nF/50 V	Ceramic capacitor, 0805, 12 nF	AVX	08055G120ZAT1A
1	D1	MBRD660CT	Power Rectifiers	ONSEMI	MBRD660CTG
1	D2	MBR0520LT1	Shottky Rectifier	ONSEMI	MBR0520LT1G
1	D3	SM1N4001	Standard Rectifier	ONSEMI	1N4001
3	D4, D106, D107	MBRA160T3	Shottky Rectifier	ONSEMI	MBRA160T3G
2	D5, D7	BAS16HT1	Switching Diode	ONSEMI	BAS16HT1G
1	D6	MBRA120ET3	Shottky Power Rectifier	ONSEMI	MBRA120ET3G
6	D100, D101, D102, D103, D104, D105	MBRM140T3	Shottky Power Rectifier	ONSEMI	MBRM140T3G
1	J1	CON/2 screws	2-pin connector	PTR Mess Technik	AR500/2
14	J2, J3, J4, J5, J6, J101, J102, J103, J104, J105, J106, J107, J108, J109	EXP. HEADER	1-Way Header	MOLEX	22-28-4020
1	J7	PWR Jack	Power Jack type connector 2.5 mm	CUI stack	PJ-002A
1	J100	3-ph. Motor	3-Way Header	MOLEX	39-26-3030
1	J200	UNI-3	Header 40 pins breakway connector	Fisher Elektronik	ASLG40G
6	J201, J202, J203, J204, J205, J206	EXP. HEADER	2-Way Header	MOLEX	22-28-4020
1	LED_ON1	YELLOW	0805 LED diode yellow	Chicago Miniature Lamp INC	7012x13
1	L1	TH / 100mH	Inductor	TDK	TSL0709 -101KR66-PF
1	L2	1mH	Inductor	TDK	SP0508-102KR19-PF

Table 11. Bill of Materials

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
3	L3	TH / 220mH	Inductor	TDK	TSL0709 -221KR44-PF
3	Q100, Q101, Q102	SI4946BEY	DUAL N-channel MOSFET	VISHAY	Si4946BEY-T1--E3
1	R1	330R	Resistor 330 $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 330R
2	R2, R5	3.0 k	Resistor 3.0 k $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 3k
1	R3	200 k	Resistor 200 k $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 200k
1	R4	100 k	Resistor 100 k $\Omega$ m, 5%, 0805	Multicomp	MC 0.1W 0805 5% 100k
1	R6	68 k	Resistor 68 k $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 68k
1	R7	18 k-1%	Resistor 18 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 18k
1	R8	160 k-1%	Resistor 160 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 160k
1	R100	0.040-1%	Resistor 0.04 $\Omega$ , 1%,	Vishay	LVR03R0400FE1231
12	R101, R102, R103, R104, R105, R106, R107, R108, R109, R110, R111, R112	51R	Resistor 51 $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 51R
6	R124, R125, R126, R127, R128, R129	10 k	Resistor 10 k $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 10k
1	R114	10 k	Trimmer	Vishay	ST-4EG-103
1	R115	47 k -1%	Resistor 47 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 47k
2	R116, R119	10 k - 1%	Resistor 10 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 10k
2	R117, R123	11 k - 1%	Resistor 11 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 11k
1	R118	1.8 k - 1%	Resistor 1.8 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 1k8
1	R120	3.6 k - 1%	Resistor 3.6 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 3k6
2	R121, R122	1.2 k - 1%	Resistor 1.2 k $\Omega$ , 1%, 0805	Multicomp	MC 0.1W 0805 1% 1k2
2	R201, R202	100R	Resistor 100 $\Omega$ , 5%, 0805	Multicomp	MC 0.1W 0805 5% 100R
1	TS1	BZW06-40	Bidirectional Transient Voltage Suppressor Diode	Diotec	BZW06-40
1	U1	LM5007	High Voltage Step Down Switching Regulator	National Semiconductor	LM5007MM
1	U2	MC78PC33NTR	Linear Voltage Regulator	ONSEMI	MC78PC33NTRG
1	U3	MC33269ST-3.3T3	Voltage Regulator	ONSEMI	MC33269ST-3.3T3G
1	U4	LT3433IFE	High Voltage DC/DC Converter	Linear Technology	LT3433IFE#PBF
1	U100	MC33502D	Dual Operation Amplifier	ONSEMI	MC33502DG
1	U101	74HC04D	6 x Inverter	ONSEMI	MC74HC04ADG
1	U102	MC33937APEK	3-Phase FET Pre-driver	Freescale	MC33937APEK

Freescale does not assume liability, endorse, or warrant components from external manufacturers that are referenced in circuit drawings or tables. While Freescale offers component recommendations in this configuration, it is the customer's responsibility to validate their application.

# 8 Board Layouts

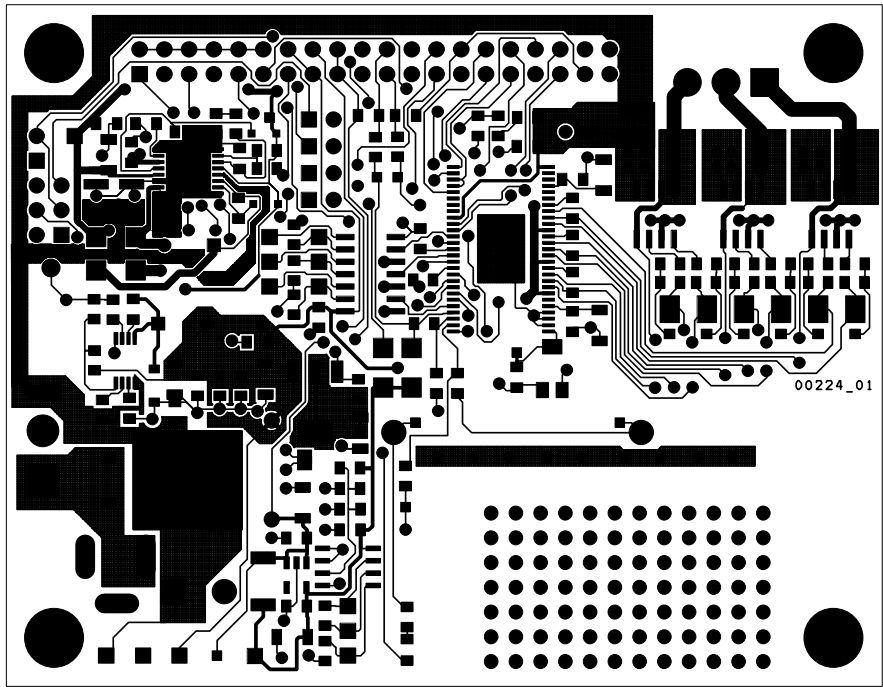


Figure 10. 33937A Evaluation Board Top Layer

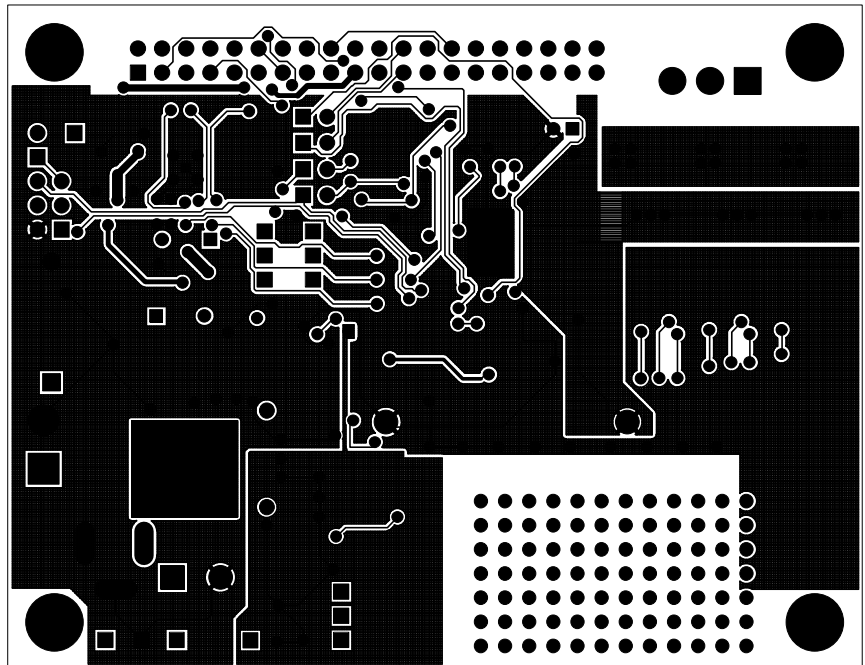


Figure 11. 33937A Evaluation Board Bottom Layer

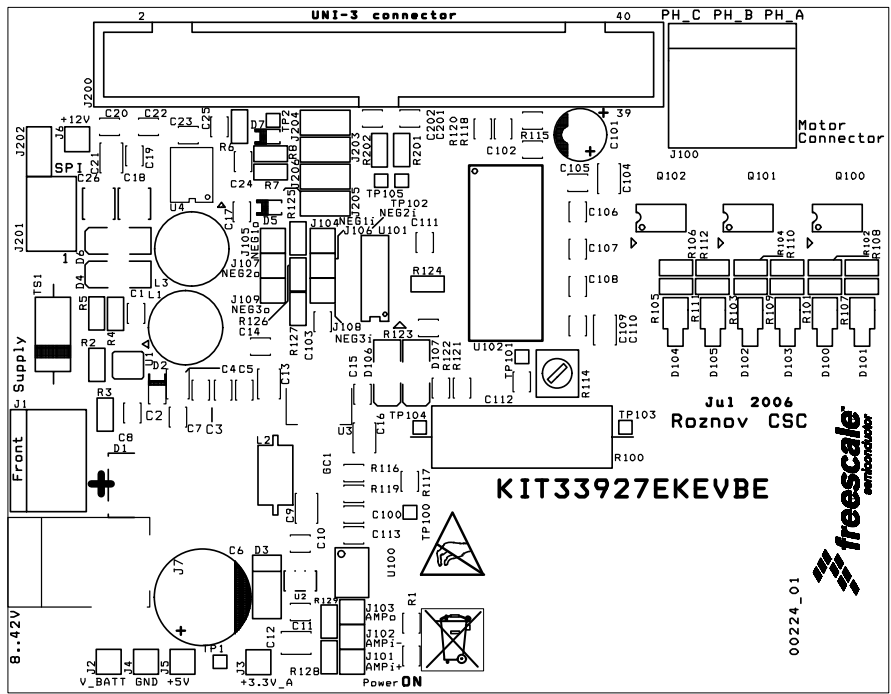


Figure 12. 33937A Evaluation Board Silk-screen Layer

## 9 References

**Table 12. Reference Pages**

Document Number	Description	URL
KIT33937AEKEVBE	Tool Summary Page	<a href="http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KIT33937AEKEVBE">http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KIT33937AEKEVBE</a>
MC33937	Product Summary Page	<a href="http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MC33937">http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MC33937</a>
	Analog Home Page	<a href="http://www.freescale.com/analog">www.freescale.com/analog</a>
	Freescale's Motor Control Web Page	<a href="http://www.freescale.com/motorcontrol">www.freescale.com/motorcontrol</a>
	Pittman's Motors Web Page	<a href="http://www.pittmannel.com">www.pittmannel.com</a>
	UNI-3 Connector Specification	

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## 10 Revision History

Revision	Date	Description of Changes
2.0	8/2014	<ul style="list-style-type: none"> <li>• Initiated revision History page</li> <li>• Updated part number to MC33937APEK</li> <li>• Updated back page.</li> <li>• Updated format to current standard</li> </ul>

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