

KIT33927EKEVBE Evaluation Board User's Guide

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Chapter 1 Introduction and Setup

1.1 Introduction

This User's Manual describes the features, options and connections of the KIT33927EKEVBE Evaluation Board. Freescale's KIT33927EKEVBE 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/motorcontrol. 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 1-1 System Configuration.

The KIT33927EKEVBE Evaluation Board has the following features:

- Connecting the Evaluation Board via a UNI-3 connector
- SPI communication between the MC33927 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
- 3.3V, 5V, and 12V voltage generation on the boards
- Output 3-phase motor connector

Figure 1-2 KIT33927EKEVBE Evaluation Board depicts the board layout with descriptions of the components.

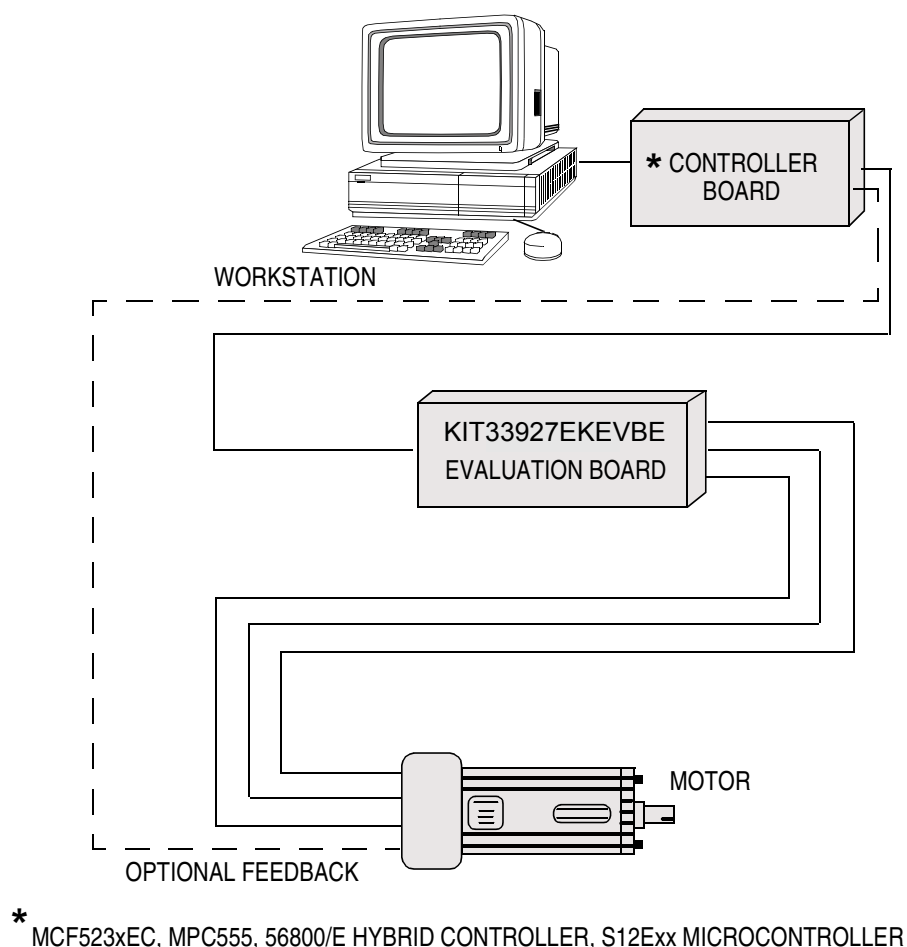


Figure 1-1. System Configuration

1.2 About this Manual

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

- Setup instructions are found in section 1.6 Setup Guide.
- Pin-by-pin descriptions are contained in Table 3-1 up to Table 3-9.
- For those interested in the reference design aspects of the board's circuitry, a description is provided in Chapter 4 Design Considerations

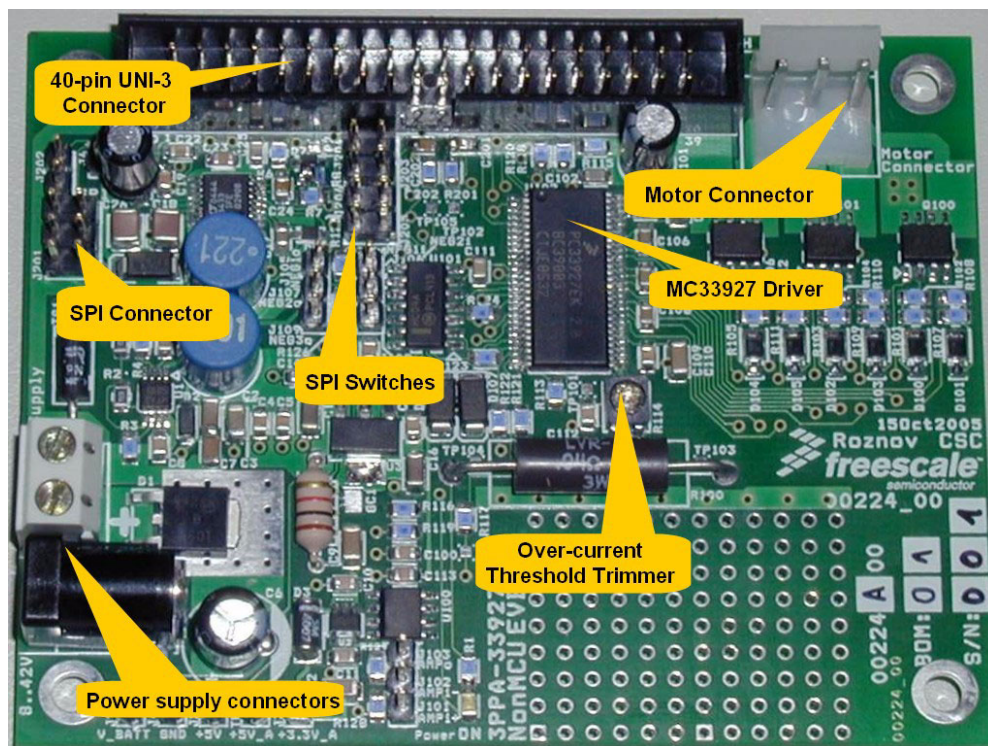


Figure 1-2. KIT33927EKEVBE Evaluation Board

1.3 Disposing of Old Appliances

The KIT33927EKEVBE 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.

1.4 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

1.5 Warnings

The KIT33927EKEVBE Evaluation Board includes components which can reach temperatures hot enough to cause burns. To facilitate safe operation, the 8-volt to 42-volt 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.

1.6 Setup Guide

Setup and connections for the KIT33927EKEVBE Evaluation Board are straightforward. The KIT33927EKEVBE 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 1-3. KIT33927EKEVBE Evaluation Board Setup 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 KIT33927EKEVBE Evaluation Board.
2. Plug the free end of the cable into the control board's 40-pin connector.
3. Connect a 8-42 VDC power supply either to the power jack J7 labelled "8-42V", 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 amps.
5. Apply power to the KIT33927EKEVBE Evaluation Board. The yellow power-on LED is lit when power is present. Note that the KIT33927EKEVBE 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.

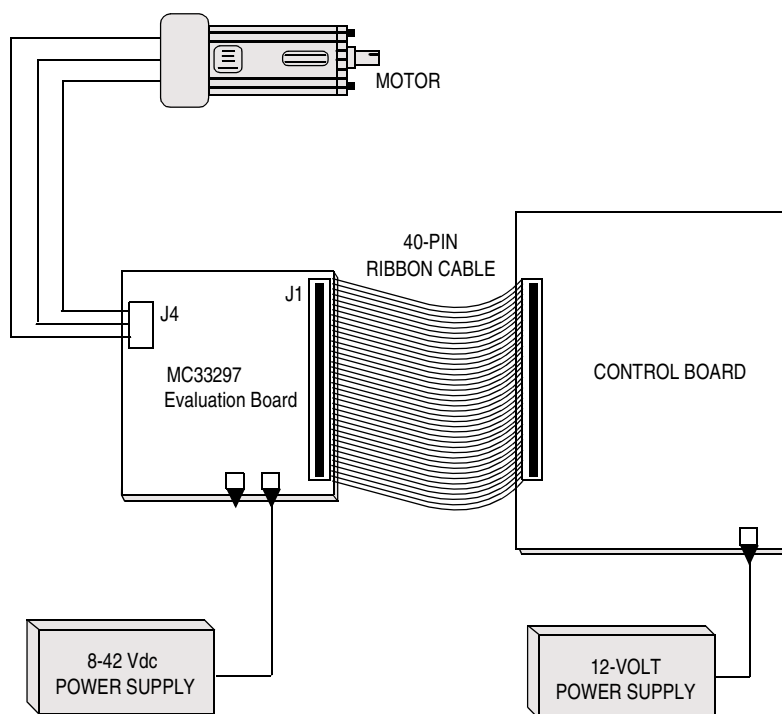


Figure 1-3. KIT33927EKEVBE Evaluation Board Setup

Chapter 2 Operational Description

2.1 Introduction

Freescale's embedded motion control series KIT33927EKEVBE Evaluation Board is a 8-42 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 KIT33927EKEVBE Evaluation Board has an overcurrent protection that is implemented on the MC33927 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 4.5A, 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 3-1 40-Pin Input Connector J200. 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 8-42V, 5A 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 Chapter 4 Design Considerations.

2.2 Electrical Characteristics

The electrical characteristics in Table 2-1 apply to operation at 25°C and a 12-VDC power supply voltage.

Table 2-1. Electrical Characteristics

Characteristic	Symbol	Min	Typ	Max	Units
Power Supply Voltage	V_{DC}	8	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	—	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

Chapter 3 Pin Description

3.1 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 informations.

3.2 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 3-1. 40-Pin Input Connector J200. Pin descriptions are listed in Table 3-1.

Please 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 MC33927 driver and the driver control signals - Reset, Enable, Over-current. Some pins on J200 are not connected, in comparison to the UNI-3 standard. Changed pin assignments are shown in Table 3-1.

For more information refer to References

Table 3-1. Changed Pins' Descriptions

Pin #	UNI-3 Standard	J12 Connector
19	+15V_A / +12V_A	+12V
20	-15V_A / -12V_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

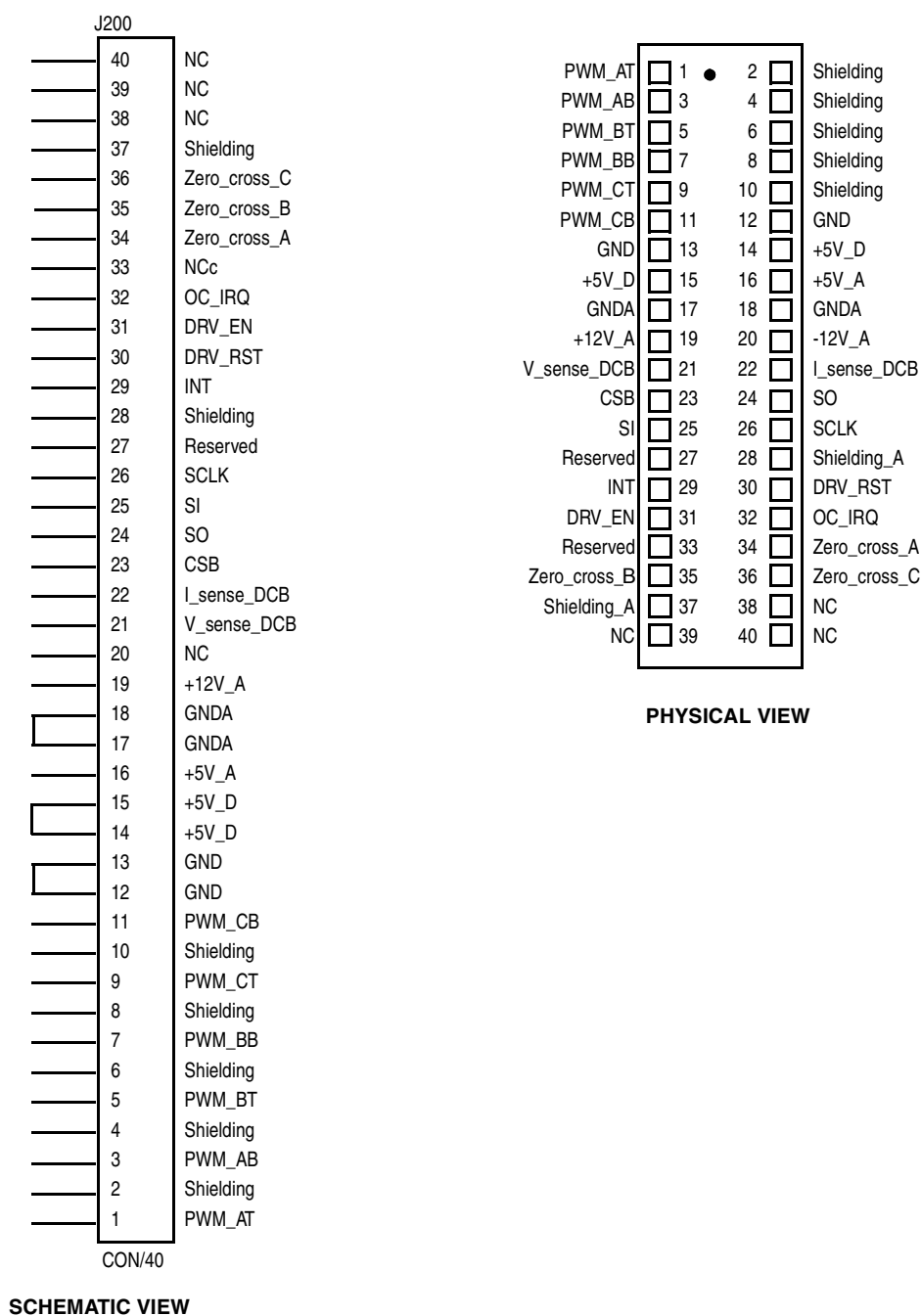


Figure 3-1. 40-Pin Input Connector J200

Table 3-2. 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	MC33927 driver Interrupt signal.
30*	DRV_RST	MC33927 driver Reset signal.
31*	DRV_EN	MC33927 driver Enable signal.
32*	OC_IRQ	MC33927 driver Over-current 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.

3.3 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 3-3 and Table 3-4.

Table 3-3. 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 3-4. Connector J202 Signal Description

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

The output signal SO from the MC33927 driver is connected to the control board's input signal SI, and likewise the input signal SI from the MC33927 driver is connected to the control board's output signal SO.

3.4 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 3-5.

Table 3-5. 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.

3.5 Power Supply Connectors J1 and J7

Two connectors, labelled J1 and J7, are provided for the 8-42 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 2.1mm 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 amps.

3.6 Connectors J2 - J6

One-pin connectors J2 - J6 provide easy access to voltages available on the board. Connector descriptions are listed in Table 3-6.

Table 3-6. 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

3.7 Connectors J101 - J109

One-pin connectors J101 - J109 provide connections to the additional operational amplifier U100B (MC33502D) and three invertors U101D-F (74HC04). Pin descriptions are listed in Table 3-7.

Table 3-7. 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	inverter 1 input
J105	NEG1o	inverter 2 output
J106	NEG2i	inverter 2 input
J107	NEG2o	inverter 2 output
J108	NEG3i	inverter 3 input
J109	NEG3o	inverter 3 output

3.8 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 3-8.

Table 3-8. 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



3.9 Test points

Six test points provide easy access to the DC-Bus current and voltage sensing signals. They are listed in Table 3-9, along with their descriptions and locations.

Table 3-9. 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

Chapter 4 Design Considerations

4.1 Overview

From a systems point of view, the KIT33927EKEVBE 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 MC33927. The description of the pre-driver is contained in 4.2.

The KIT33927EKEVBE 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 section 4.3, and in section 4.4.

4.2 3-Phase FET Pre-driver MC33927

The 3-Phase FET Pre-driver (MC33927) 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 over-current comparator for over-current detection. For more information on the pre-driver, refer to References.

4.3 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 that each have one inverting and one non-inverting driver. A simplified schematic showing one phase is illustrated in Figure A-5 3-Phase N-MOS Bridge.

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 A-5 3-Phase N-MOS Bridge, resistors R101 (51 ohms), R102 (51 ohms), 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 Ohms and the turn-off gate drive impedance at approximately 50 Ohms. These values produce transition times of approximately 60ns. Transition times of this length represent a carefully weighed compromise between power dissipation and noise generation. Generally speaking, transition times longer than 250ns tend to get power hungry at non-audible PWM rates; and transition times under 50ns create di/dts so large that proper operation is difficult to achieve. The MC33927 EVB is designed with switching times at the lower end of this range to minimize power dissipation.

4.4 Bus Voltage and Current Feedback

Feedback signals proportional to bus voltage and bus current are provided by the circuitry shown in Figure A-4 DC-Bus Voltage & Current Sensing. 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 A-5 3-Phase N-MOS Bridge, and amplified by the MC33927 driver. This circuit provides a voltage output suitable for sampling with A/D inputs.

The gain is given by:

$A = R117 / R121$ (resistors are shown in Figure A-4 DC-Bus Voltage & Current Sensing)

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

The over-current comparator, implemented on the MC33927 driver, is adjusted by the trimmer R114 (shown in Figure A-3 MC33927 Driver), where a 2.75 volt setting for the over-current detection comparator produces a 3.0A current limit.

4.5 References

1. 3-Phase FET Pre-driver MC33927 Data Sheet
2. UNI-3 Connector Specification
3. Pittman's Motors web: www.pittmannet.com
4. Freescale's web page: www.freescale.com
5. Freescale's Motor Control web page: www.freescale.com/motorcontrol

Appendix A KIT33927EKEVBE Evaluation BoardSchematics

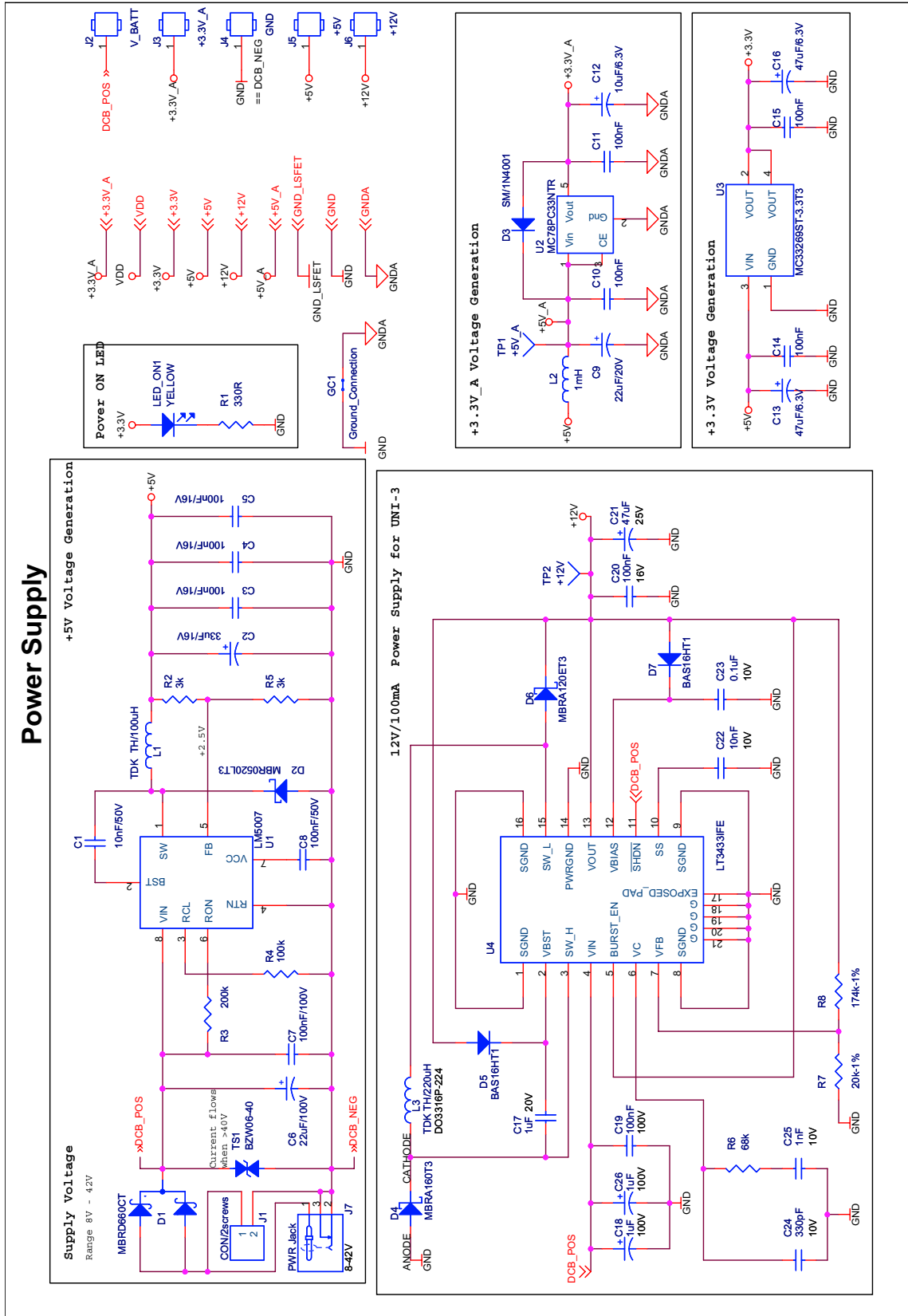
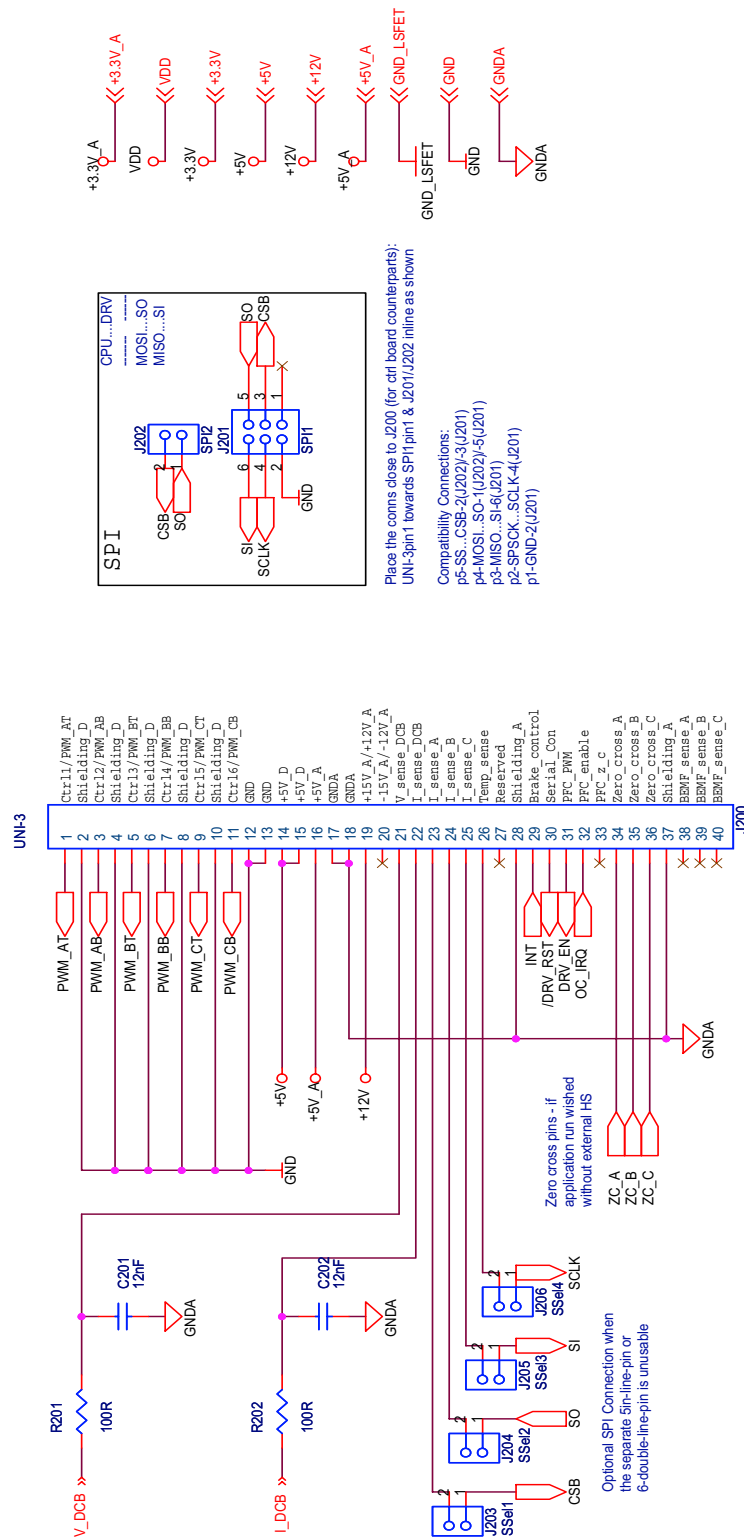


Figure A-1. Power Supply

UNI-3 Connector



According to UNI-3 spec.

Figure A-2. UNI-3 Connector

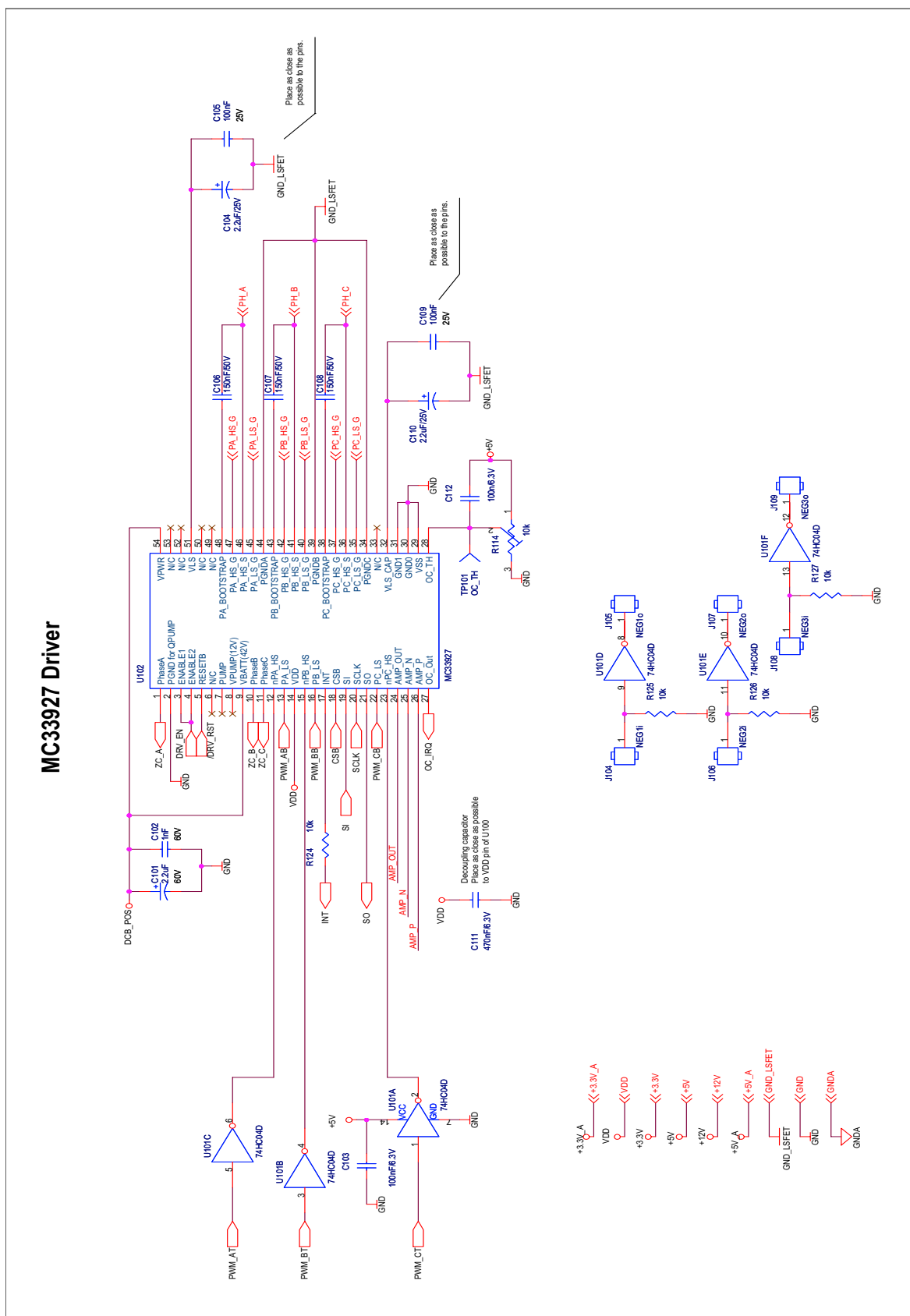


Figure A-3. MC33927 Driver

DC-Bus Voltage & Current Sensing

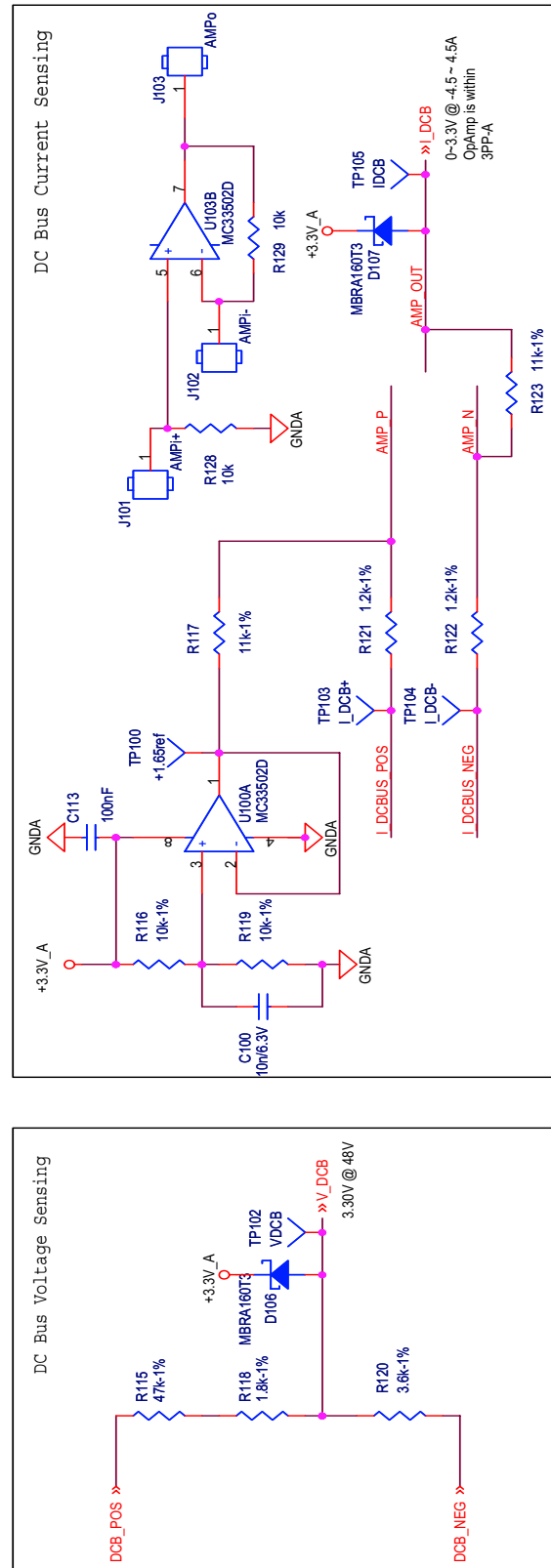


Figure A-4. DC-Bus Voltage & Current Sensing

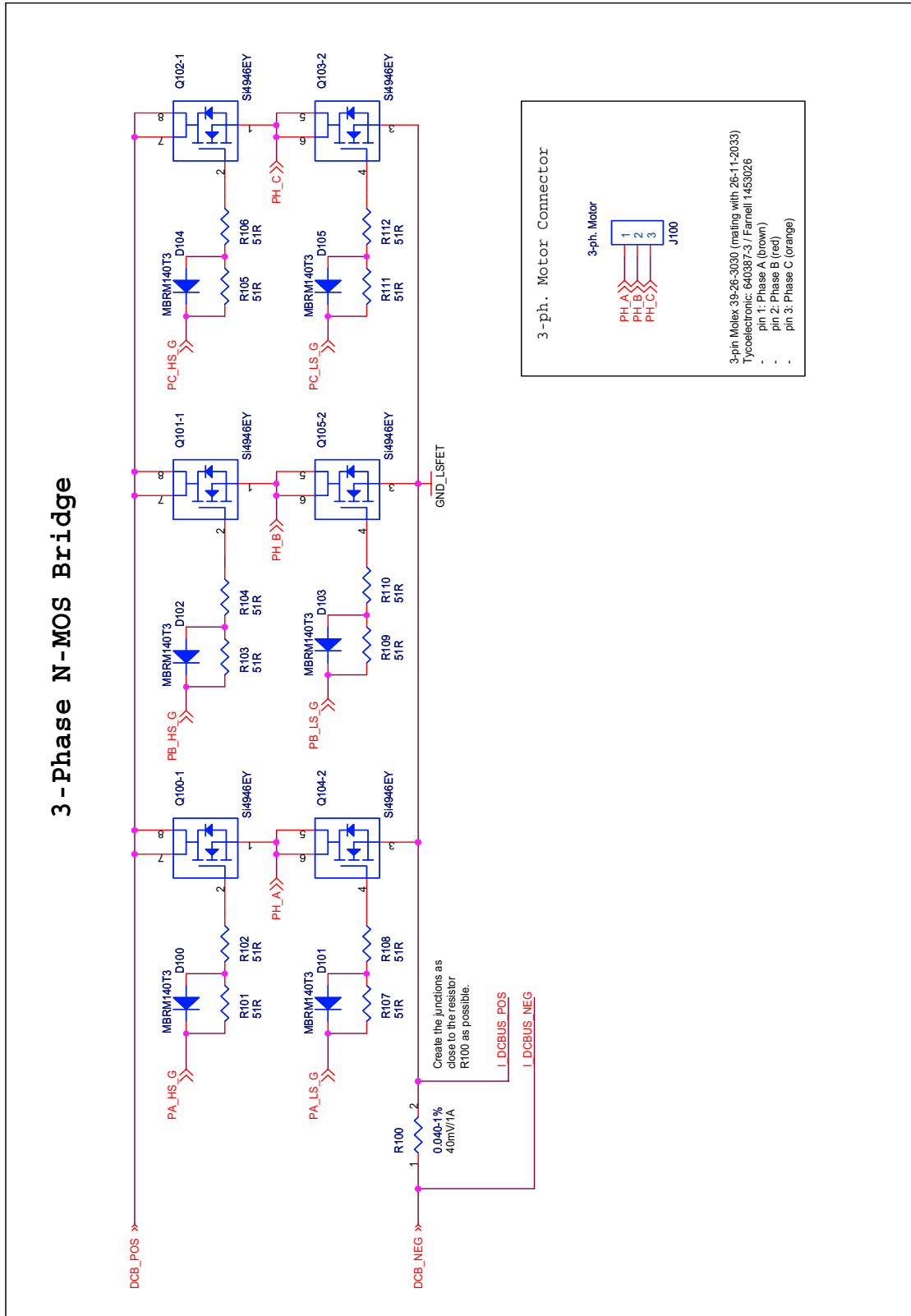


Figure A-5. 3-Phase N-MOS Bridge

Appendix B Bill of Materials

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
1	C1	10nF/50V	Ceramic capacitor, 0805, 10nF	AVX	08055G103KAT1A
1	C2	22 μ F/ 16V	Ceramic capacitor, 1206, 22 μ F	AVX	1206YD226KAT1A
3	C3, C4, C5	100nF/ 25V	Ceramic capacitor, 0805, 100nF	AVX	08053G104KAT1A
1	C6	22 μ F/ 100V	Electrolytic Capacitor 8mm, 22 μ F/100 V	Jamicon	SKR220M2AFBB
1	C7	100nF/ 100 V	Ceramic capacitor, 0805, 100nF	AVX	08051C104KAT1A
1	C8	100nF/ 50 V	Ceramic capacitor, 0805, 100nF	AVX	08055C104KAT1A
1	C9	22 μ F/ 16V	Ceramic Capacitor 1206, 22 μ F/16 V	AVX	1206YD226KAT1A
12	C10,C11,C14,C15, C19,C20,C23,C103, C105,C109,C112, C113	100nF/50 V	Ceramic capacitor, 0805, 100nF	AVX	08055C104KAT1A
1	C12	10 μ F/ 6.3V	Ceramic Capacitor 1206, 10 μ F/6.3 V	AVX	1206ZC106KAT1A
2	C13, C16	47 μ F/ 6.3V	Tantal Capacitor 1206, 47 μ F/6.3 V	AVX	12066D476KAT1A
1	C17	1 μ F/ 10V	Ceramic capacitor, 0805, 1 μ F	AVX	0805ZG105ZAT1A
2	C18, C26	1 μ F/ 50V	Ceramic capacitor, 1206, 1 μ F	TDK	C3216X5R1H105K
1	C21	47 μ F/ 16V	Ceramic capacitor, 1210, 2x 22 μ F/16	TDK	C3225X5R1C226M
1	C22	10nF/ 50V	Ceramic capacitor, 0805, 10nF	AVX	08055G103ZAT1A
1	C24	330pF/ 100 V	Ceramic capacitor, 0805, 330pF	AVX	08055G331ZAT1A
2	C25, C102	10nF/50 V	Ceramic capacitor, 0805, 10nF	AVX	08055G102ZAT1A
1	C101	2.2 μ F/ 63V	Electrolytic Capacitor 5mm, 2.2 μ F/ V	Jamicon	SKR2R2M1JFBB
2	C104, C110	2.2 μ F/ 25V	Ceramic Capacitor 1206, 2.2 μ F/25 V	AVX	12065C225KAT1A
3	C106, C107, C108	150nF/50 V	Ceramic capacitor, 0805, 150nF	AVX	08055C154KAT1A
2	C201, C202	12nF/50 V	Ceramic capacitor, 0805, 12nF	AVX	08055G120ZAT1A
1	D1	MBRD660CT	Power Rectifiers	ONSEMI	MBRD660CTG
1	D2	MBR0520LT1	Shottky Rectifier	ONSEMI	MBR0520LT1G
1	D3	SM/1N4001	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

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
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 2.5mm	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
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 330Ohm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 330R
2	R2, R5	3k	Resistor 3kOhm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 3k
1	R3	200k	Resistor 200kOhm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 200k
1	R4	100k	Resistor 100kOhm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 100k
1	R6	68k	Resistor 68kOhm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 68k
1	R7	18k-1%	Resistor 18kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 18k
1	R8	160k-1%	Resistor 160kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 160k
1	R100	0.040-1%	Resistor 0.04Ohm, 1%,	Vishay	LVR03R0400FE1231
12	R101, R102, R103, R104, R105, R106, R107, R108, R109, R110, R111, R112	51R	Resistor 51Ohm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 51R
6	R124, R125, R126, R127, R128, R129	10k	Resistor 10kOhm, 5%, 0805	Multicomp	MC 0.1W 0805 5% 10k
1	R114	10k	Trimmer	Vishay	ST-4EG-103
1	R115	47k -1%	Resistor 47kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 47k
2	R116, R119	10k - 1%	Resistor 10 kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 10k
2	R117, R123	11k - 1%	Resistor 11kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 11k
1	R118	1.8k - 1%	Resistor 1.8 kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 1k8

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
1	R120	3.6k - 1%	Resistor 3.6kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 3k6
2	R121, R122	1.2k - 1%	Resistor 1.2 kOhm, 1%, 0805	Multicomp	MC 0.1W 0805 1% 1k2
2	R201, R202	100R	Resistor 100Ohm, 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-3.3 T3	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 Invertor	ONSEMI	MC74HC04ADG
1	U102	MC33927	3-Phase FET Pre-driver	Freescale	MCZ33927EK

Appendix C Layouts

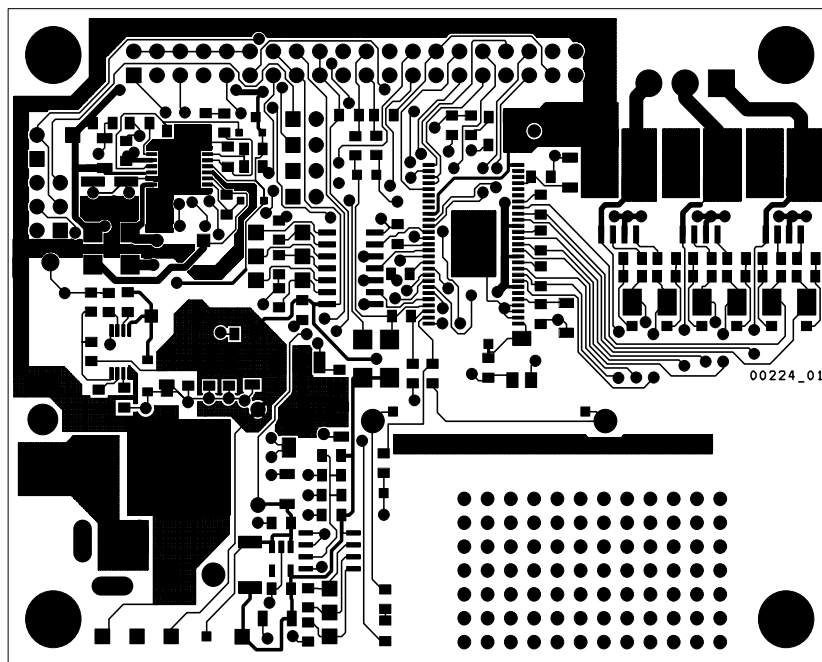


Figure C-1. MC33927 Evaluation Board Top Layer

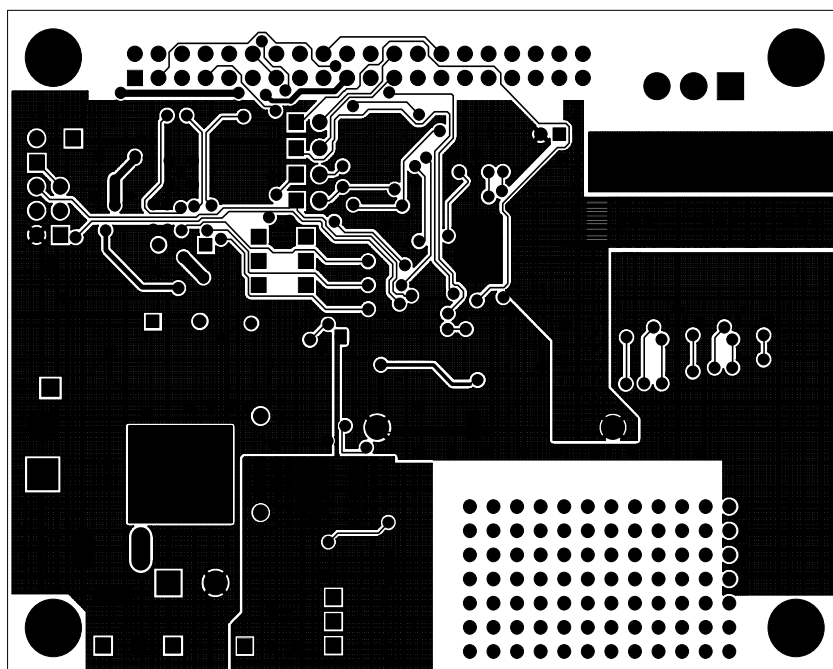


Figure C-2. MC33927 Evaluation Board Bottom Layer

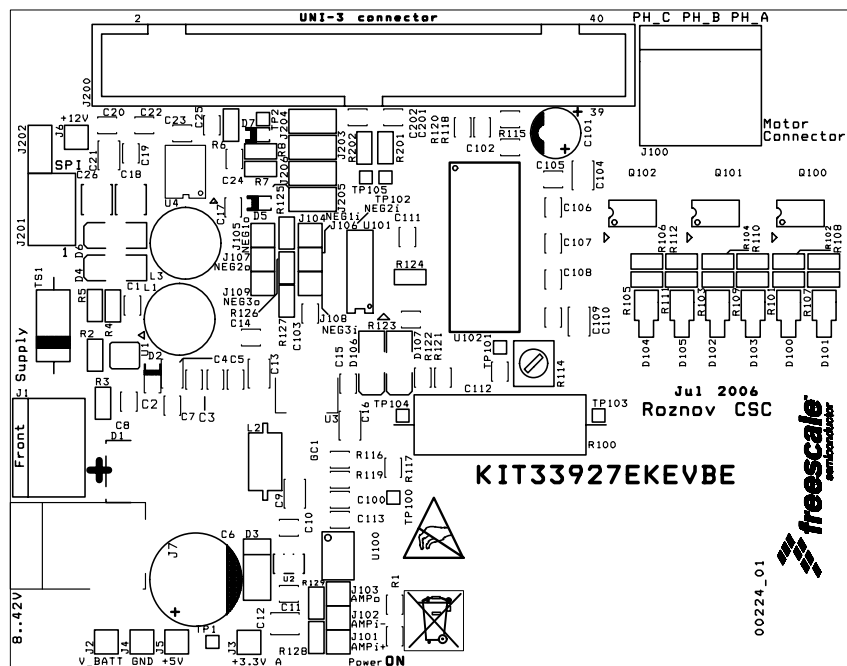


Figure C-3. MC33927 Evaluation Board Silk-screen Layer

Appendix D Revision History

REVISION	DATE	DESCRIPTION OF CHANGES
0.0	1/2006	Initial Release
1.0	10/2006	Lead-free version update
2.0	11/2007	Updated to current Freescale format.

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