



# KIT33810EKEVME Evaluation Board User's Guide

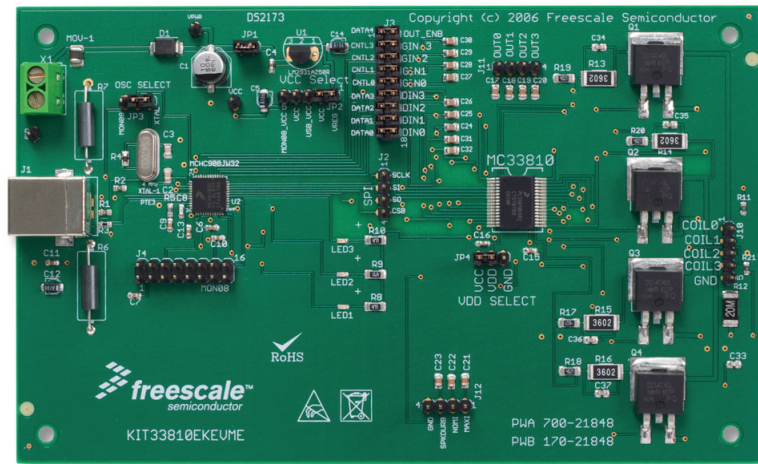


Figure 1. KIT33810 Evaluation Board

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# 1 Important Notice

Freescale provides the enclosed product(s) under the following conditions:

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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

The **KIT33810EKEVME** Evaluation Board (EVB) is an easy-to-use circuit board that allows the user to exercise all functions of the MC33810 circuit. The EVB communicates to a PC through a built in USB port. The Freescale SPIGen program provides the User Interface to the MC33810's SPI port and allows the user to send commands to and receive error messages from the IC. The MC33810 contains four, low side, injector drivers and four custom ignition IGBT drivers (which can also be configured as General Purpose MOSFET Gate drivers) . The IGBTs and the associated current and voltage sensing circuits are included on the board to provide a complete working system, capable of driving actual injectors and ignition coils directly.

The Block Diagram for the 33811 Evaluation Board is shown below:

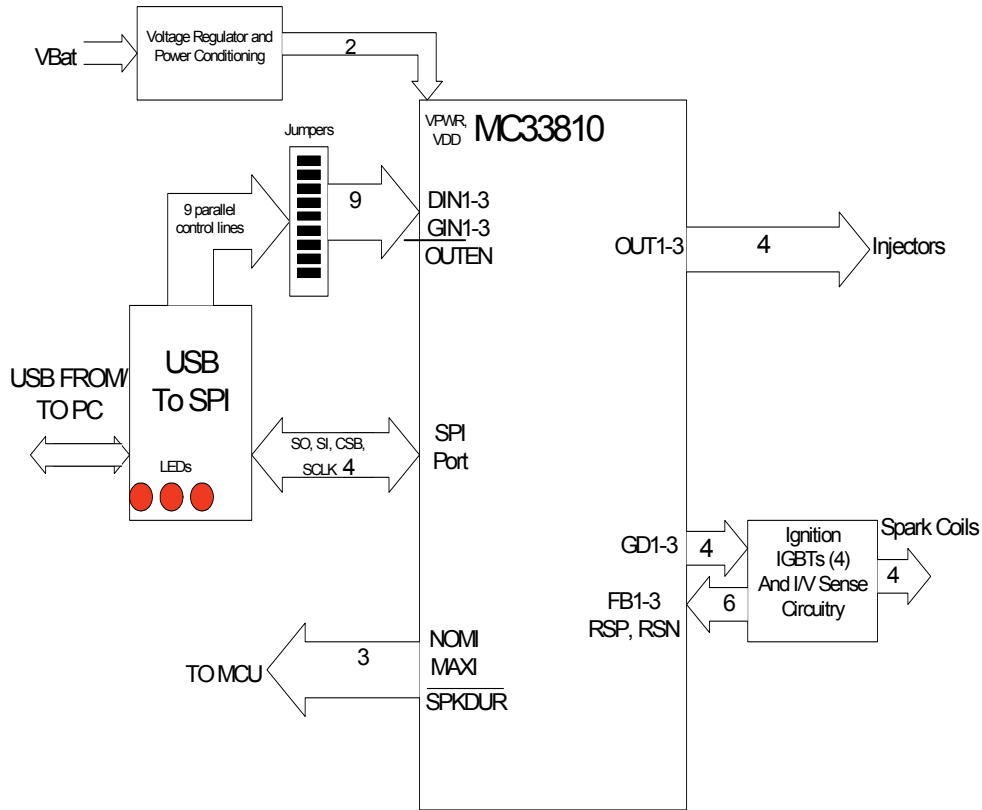


Figure 1. EVB Block Diagram

The EVB consists of a 33810 Injector, Ignition Driver (IID) circuit, a USB to SPI interface, a voltage regulator and power conditioning circuit, a set of 9 Input Jumpers, and 4 IGBTs with voltage and current sensing circuitry. All 5 volt power required by the EVB is obtained from either the USB, MON08 connectors or the on-board 5 Volt regulator . A 5 position jumper selects which source provides the 5 volt power for VCC (and VDD).

### LED DISPLAY

The LED's are provided as a visual output device for the USB-SPI interface. As configured from the factory, LED 2 indicates when power is applied and a USB connection is established, and LED 1 and 3 are tied to the DATA0 and CNTL0 lines, respectively, which can be toggled via the SPIGen program.

### I/O JUMPER DEFINITIONS (J3)

The EVB contains nine jumpers that connect the parallel outputs of the USB SPI interface to the 33810 inputs as follows:

<u>USB-SPI Output</u>	<u>33810 Input</u>	<u>Function</u>
DATA0	DIN0	Injector Input 0
DATA1	DIN1	Injector Input 1
DATA2	DIN2	Injector Input 2

DATA3	DIN3	Injector Input 3
CNTL0	GIN0	Ignition Input 0
CNTL1	GIN1	Ignition Input 1
CNTL2	GIN2	Ignition Input 2
CNTL3	GIN3	Ignition Input 3
DATA4	$\overline{\text{OUTEN}}$	Output Enable Signal

If the user prefers to supply the DIN and GIN signals externally, other than from the USB-SPI Interface, the jumpers can be removed and connections can be made to the open pins.

### VCC SELECT JUMPER DEFINITIONS (JP2)

JP2 is a 5 pin, 4 position jumper that determines the source of the VCC voltage. The VCC voltage is a 5 volt supply that is used by the USB to SPI MCU and the 33810 (VDD). The 5 volts can be supplied from three different sources:

- 1) An internal 5 Volt regulator connected to VBAT (12 Volts)
- 2) Directly from the USB Connector
- 3) Directly from the on board MON08 connector.

<u>Jumper Position</u>	<u>VCC Source</u>
1-2	MON08 Port (used for programming the MCU)
2-3	USB Port
3-4	USB Port
4-5	Internal Voltage Regulator *

\*The factory default is set to the Internal Voltage Regulator position.

### VDD SELECT JUMPER DEFINITIONS (JP4) -

The VDD jumper is a 3 pin, two position jumper that allows the 33810 to receive 5 volt VDD power from the EVB VCC line or to connect the 33810 VDD line to Ground to demonstrate the "Sleep Mode". The Normal Operating Setting (factory default) is the VDD to VCC connection, pins 1-2 shorted, pin 3 open.

When JP4 is on pins 2-3, with pin 1 open, the 33810 will be forced into the Sleep Mode. (see data sheet for more information)

### VOLTAGE REGULATOR DISCONNECT JUMPER (JP1)

The internal voltage regulator can be disconnected from VPWR to allow the 33810  $I_{VPWR}$  to be measured. JP1 normally connects VPWR to the input of the 5 Volt regulator.

## MON08 CONNECTOR

The MON08 connector is used to program the USB-SPI MCU, a MCHC908JW32. The source code for the USB-SPI interface is included on the CD to allow reprogramming of the MCU to perform functions not included in the present firmware. The MON08 connector consists of the following 16 pins –

<u>Pin Number</u>	<u>Name</u>	<u>Description</u>
1	NC	Unused
2	GND	VSS (System Gnd)
3	NC	Unused
4	RST	Reset
5	NC	Unused
6	IRQB	Interrupt Request (Low active)
7	NC	Unused
8	NC	Unused
9	NC	Unused
10	PTA0	Port A Bit 0
11	NC	Unused
12	PTA1	Port A Bit 1
13	OSC	4.9152 MHz Oscillator
14	PTA2	Port A Bit 2
15	MON08_VCC	+5 Volts from P & E or FSICE
16	PTC1	Port C Bit 1

This connector mates with the MON08 cable provided with the P & E Cyclone Pro or Freescale FSICEBASE programmer.

## USB CONNECTOR

A “B” type USB connector is provided to allow a standard “A to B” USB cable to interconnect the PC to the EVB. The pinout of this connector is as follows:

<u>Pin Number</u>	<u>Name</u>	<u>Description</u>
1	+5	+5 Volts from the PC
2	D-	Signal - line
3	D+	Signal + line
4	GND	System ground (VSS)

## OSCILLATOR JUMPER SELECTS (JP3)

A two position, three pin jumper, labeled JP3 is provided to allow the selection of the clock source for the USB-SPI MCU.

JP3 selects the source of the MCU Oscillator (+5 volts) in accordance with the following table:

### Position of Oscillator Shorting Jumper Selection Description

Pins 1 & 2 (Pin 3 open) Programming position, Clock = 4.9152 from MON08

Pins 2 & 3 (Pin 1 open) Normal operating position\* Clock = 4.000 MHz crystal

\*The factory default setting for JP3 is the Normal operating position. To change the programming of the MCU's flash RAM, this jumper must be moved to the Programming position, the VCC jumper should be set to the MON08 position and the MON08 connector should be attached to the cable from the P & E Cyclone Pro or the Freescale FSICEBASE unit.

## SPI PORT CONNECTION PINS

The SPI port is brought out to four pins (SCLK, SI, SO, CSB) on the EVB.

Normally there is no jumpers on these pins, however to verify the proper operation of the SPI interface, the SI and SO pins can be connected via a jumper to allow loopback testing of the USB-SPI interface. Please note that during this loopback mode of operation, the 33810 outputs must be disabled, by setting  $\overline{\text{OUTEN}}$  to high or by placing the 33810 in the Sleep Mode by Connecting JP4 to GND.

## SOFTWARE DESCRIPTION

There are three main components that comprise the EVB software system.

1. The firmware that runs on the MCU is a compiled C and assembly language program, that is programmed into the MCU flash RAM.
2. The user interface software (GUI) that sends USB messages to the EVB, and runs under Windows 2000 or Windows XP, is called the "SPIGen" program, which is written in Visual Basic. A SPIGen "config" file for the MC33810 is included on the CD.
3. The third piece of software is a "device driver" called spi\_usbio.sys and it interfaces the SPIGen program I/O through the Windows operating system to the USB port on the user's PC. The device driver interfaces to the Visual Basic program, through a special "wrapper" library called usbiocom.dll that translates the Visual Basic COM interface, into the lower level calls in the device driver. These two pieces of software were licensed from Thesycon, a software development company in Germany.

All of the source code that is available is provided on the Installation CD in a folder called "USB\_SPI\_FINAL".

For an explanation of the SPIGen program, the user is referred to the documentation that comes with the disk for that program.

### MCU SOFTWARE CODE

The software for the MCU was written in C and HC08 assembly language using the CodeWarrior version 5.0 software integrated development environment (IDE).

Below is a listing of the source code modules and their descriptions:

main.c	Beginning module, contains service loop.
main.asm	Generated by CodeWarrior, used for additions to main.c written in assembly language.
MC68HC908JW32.C	Defines the 16 and 8 Bit Registers
constant.c	Random data to fill unused flash RAM
isr.c	Interrupt service routine for the timer
pll.asm	Sets up the PLL using 4.00 MHz reference frequency
spi.c	SPI read and write handlers and initialization routine
tb.c	Initializes the time base for the JW32
timer.c	Initializes the timer and PWM output (not used)
USB_descriptor.asm	Defines the USB information such as VID, PID, etc.
USB_driver.c	Handles USB setup, decode and interrupt service
utilities.c	Misc. routines for delay and debug
The following files are include (header) files to support the above:	
application.h	defines some outputs and some useful macros
derivative.h	Generated by CodeWarrior to define the MCU used
derivative.inc	Generated by CodeWarrior for COP
global.h	Some useful defines for debug
jw32_registers.h	More register definitions
main_asm.h	header file for main_asm.c
MC68HC908JW32.H	Header file for MC68HC908JW32.C
motdef.h	General purpose definitions from the old days
pll.h	Header file for pll.c
spi.h	Header file for spi.c
tb.h	Header file for tb.c Timebase
timer.h	Header file for timer.c timer initialization
usb.h	Header file for USB_driver.c
usb_vars.h	Header for variables used in USB_Driver.c
utilities.h	Header for utilities.c
ansii.lib	c library for ansii c functions
Start08.c	Generated by CodeWarrior to define initialization code
Project.prm	Defines interrupt and memory map
Project.map	Map file generated by compile process
Burner.bbl	some defines used in the programming of the JW32

### MODIFYING AND ADDING TO THE SOFTWARE -

To modify and recompile this software, one must download a copy of the CodeWarrior software development suite (IDE) from Freescale. The link to this software is:

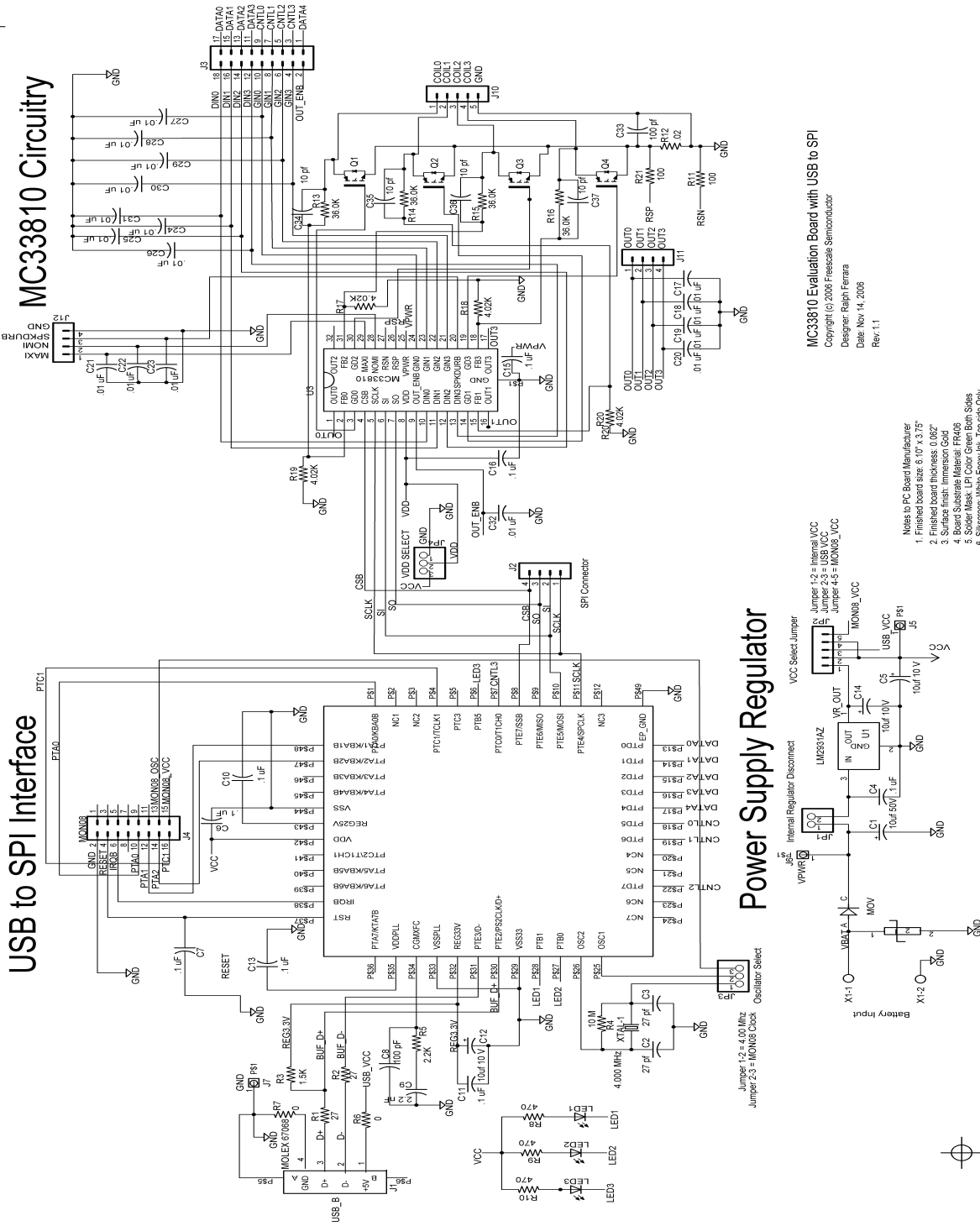
<http://www.freescale.com/CodeWarrior>

The USB to SPI software transfers 8 bytes of data from the SPIGen.exe program, via USB, to the MCU. The definitions of the 8 bytes can be found in the main.c program, and the actual transfer and decoding is done in the USB\_driver.c program. Comments are provided throughout the code to explain the operation of the individual routines.

Once the code is compiled (without errors), the CodeWarrior IDE provides a means to download the binaries to the P&E Cyclone Pro programmer, via the MON08 port to re-Flash the MCU. The documentation for this process is contained in the CodeWarrior suite of tools and the P&E documentation.



# 3 Schematic



**MC33810 Evaluation Board with USB to SPI**  
 Copyright (c) 2006 Freescale Semiconductor  
 Designer: Ralph Ferrara  
 Date: Nov 14, 2006  
 Rev: 1.1

- Notes to PCB Manufacturer
1. Finished board size: 5.10" x 3.75"
  2. Finished board thickness: 0.062"
  3. Surface finish: immersion gold
  4. Solder mask: white epoxy ink
  5. Solder mask: LPI Clear Green Bore Stiles
  6. Solder mask: White Epoxy Ink, Top side Only
  7. Fabrication Quality: IPC-A-600 class 2
  8. Drill Hole Locations: +/- 0.007" from true
  9. Finished Hole Size: +/- 0.003"

## Power Supply Regulator

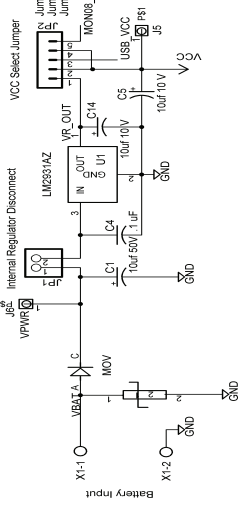


Figure 2. Schematic

## 4 KIT33810EKEVME Bill of Material

Schematic Designation	Device or Signal Name	Description	Mfr. Part Nam	Mfr. Part Number	Digi-Key Part #
C1	VBAT	CAP ALEL 10UF 50V 20% -- CCE63X57 ROHS COMPLIANT	PANASONIC	ECEV1HA100SP	PCE3089TR-ND
C2	OSC2	CAP CERAMIC 27PF 50V NP0 0805	KEMET	C0805C270J5GACTU	399-1114-2-ND
C3	OSC1	CAP CERAMIC 27PF 50V NP0 0805	KEMET	C0805C270J5GACTU	399-1114-2-ND
C4	VBAT	CAP CER 0.1UF 50VDC 10-% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C5	VDD	CAP TANT 10UF 10V 10% -- CASE_A ROHS	VISHAY INTERTECHNOLOGY	293D106X9010A2TE3	NA
C6	VDD	CAP CER 0.1UF 50VDC 10-% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C7	VPWR	CAP CER 0.1UF 50V 10% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C8	CGMXFC	CAP CER 100PF 50V 10% COG 0603 ROHS	AVX	06035A101KAT2A	478-3717-1-ND
C9	CGMXFC	CAP CER 0.022UF 25V 10% X7R CC0603	AVX	06033C223KAT2A	NA
C10	REG2.5V	CAP CER 0.1UF 50VDC 10-% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C11	REG3.3V	CAP CER 0.1UF 50VDC 10-% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C12	REG3.3V	CAP TANT 10UF 10V 10% -- CASE_A ROHS	VISHAY INTERTECHNOLOGY	293D106X9010A2TE3	NA
C13	VDD PLL	CAP CER 0.1UF 50VDC 10-% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C14	VR_OUT	CAP TANT 10UF 10V 10% -- CASE_A ROHS	VISHAY INTERTECHNOLOGY	293D106X9010A2TE3	NA
C15	VPWR	CAP CER 0.1UF 50VDC 10-% X7R CC0603	VENKEL COMPANY	C0603X7R500104KNE	445-1314-1-ND
C16	VDD	CAP CER 0.1UF 50VDC 10-% X7R CC0603	TDK	C1608X7R1H104K	445-1314-1-ND
C17	OUT_1	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C18	OUT_2	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C19	OUT_3	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C20	OUT_4	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C21	MAXI	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C22	NOMI	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C23	SPKDURB	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C24	DIN_1	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C25	DIN_2	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C26	DIN_3	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C27	GIN_0	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C28	GIN_1	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C29	GIN_2	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C30	GIN_3	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C31	DIN_0	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C32	OUT_ENB	CAP CER 0.01UF 50V 10% X7R 0805	SMEC	MCCE103K2NRTF	NA
C33	ACROSS R12	CAP CER 100PF 50V 5% COG CC0805, ROHS COMPLIANT	AVX	08055A101JAT2A	
C34	ACROSS R13	CAP CER 10PF 50V 5% COG CC0805	AVX	08055A100JAT2A	
C35	ACROSS R14	CAP CER 10PF 50V 5% COG CC0805	AVX	08055A100JAT2A	
C36	ACROSS R15	CAP CER 10PF 50V 5% COG CC0805	AVX	08055A100JAT2A	
C37	ACROSS R16	CAP CER 10PF 50V 5% COG CC0805	AVX	08055A100JAT2A	
R1	D-	RES TF 27 1/10W 1% RC0603 ROHS COMPLIANT	BOURNS	CR0402JW270GLF	NA
R2	D+	RES TF 27 1/10W 1% RC0603 ROHS COMPLIANT	BOURNS	CR0402JW270GLF	NA
R3	D-	RES TF 1.50K 1/10W 1% RC0603 ROHS COMPLIANT	BOURNS	CR0603FX1501ELF	NA
R4	OSC1 OSC2	RES TF 10M 1/8W 5% RC0805, ROHS COMPLIANT	BOURNS	CR0805JW106ELF	NA
R5	CGMXFC	RES TF 2.2K 1/10W 5% RC0603 ROHS COMPLIANT	BOURNS	CR0603JW222ELF	NA
R6	+5V	JUMPER WIRE WITH FERRITE BEAD 28L0138-40R-10	STEWART	28L0138-40R-10	240-2439-2-ND

**KIT33810EKEVME Bill of Material**

Schematic Designation	Device or Signal Name	Description	Mfr. Part Nam	Mfr. Part Number	Digi-Key Part #
R7	GND	JUMPER WIRE WITH FERRITE BEAD 28L0138-40R-10	STEWARD	28L0138-40R-10	240-2439-2-ND
R8	LED1	RES TF 470 1/4W 5% RC1206 ROHS COMPLIANT	BOURNS	CR1206JW471ELF	NA
R9	LED2	RES TF 470 1/4W 5% RC1206 ROHS COMPLIANT	BOURNS	CR1206JW471ELF	NA
R10	LED3	RES TF 470 1/4W 5% RC1206 ROHS COMPLIANT	BOURNS	CR1206JW471ELF	NA
R11	RSN ISO	RES 100 OHM 1/10W 5% 0603 SMD	YAGEO	RC0603JR-07100RL	311-100GRCT-ND
R12	RSP/RSN	RESISTOR .020 OHM 1W 1% 2512	Panasonic ECG	ERJ-M1WSF20MU	P20MCT-ND
R13	COIL0	RES 36.0K OHM 1W 1% 2512 SMD	Vishay/Dale	CRCW251236K0FKEG	CRCW251236K0FKE G-ND
R14	COIL1	RES 36.0K OHM 1W 1% 2512 SMD	Vishay/Dale	CRCW251236K0FKEG	CRCW251236K0FKE G-ND
R15	COIL2	RES 36.0K OHM 1W 1% 2512 SMD	Vishay/Dale	CRCW251236K0FKEG	CRCW251236K0FKE G-ND
R16	COIL3	RES 36.0K OHM 1W 1% 2512 SMD	Vishay/Dale	CRCW251236K0FKEG	CRCW251236K0FKE G-ND
R17	FB2	RES 4.02K OHM 1/4W 1% 1206 SMD	YAGEO	RC1206FR-074K02L	311-4.02KFRCT-ND
R18	FB3	RES 4.02K OHM 1/4W 1% 1206 SMD	YAGEO	RC1206FR-074K02L	311-4.02KFRCT-ND
R19	FB0	RES 4.02K OHM 1/4W 1% 1206 SMD	YAGEO	RC1206FR-074K02L	311-4.02KFRCT-ND
R20	FB1	RES 4.02K OHM 1/4W 1% 1206 SMD	YAGEO	RC1206FR-074K02L	311-4.02KFRCT-ND
R21	RSP ISO	RES 100 OHM 1/10W 5% 0603 SMD	YAGEO	RC0603JR-07100RL	311-100GRCT-ND
X1	VBAT	MKDS 3 CONN TERM BLOCK 2POS 5MM PCB ROHS COMPLIANT	PHOENIX CONTACT	1711026	277-1022-ND
JP1	VR INPUT	2 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-2	A26542-ND
JP2	VDD SELECT	3 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-3	A26544-ND
J1	USB	USB B PC MOUNT FEMALE CONNECTOR ROHS COMPLIANT	MOLEX/WALDOM ELECTRONICS	67068-8000	WM17113-ND
J2	SPI	4 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-4	A26546-ND
J3	INPUT MATRIX	18 pin HDR 2X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	9-146261-0-09	A34268-09-ND
J4	MON08 Header	16 pin HDR 2X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	9-146261-0-08	A34268-08-ND
J5	VCC	1 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-1	A26540-ND
J6	VPWR	1 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-1	A26540-ND
J7	GND	1 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-1	A26540-ND
J10	COIL 0-3 OUT	5 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-5	A26548-ND
J11	OUT 0 - 3	4 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-4	A26546-ND
J12	NOMI, MAXI, SPKDURB	4 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-4	A26546-ND
JP1	INT. REG. DISC.	2 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-2	A26542-ND
JP2	VCC SELECT	5 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-5	A26548-ND
JP3	OSC SELECT	3 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-3	A26544-ND
JP4	VDD SELECT	3 pin HDR 1X10 100MIL CTR LOW PROFILE BREAKAWAY ROHS COMPLIANT	TYCO ELECTRON- ICS	87220-3	A26544-ND
U1	VDD REG	IC REG LDO 100MA 5V TO92 LM2931AZ50R	ST MICROELEC- TRONICS	LM2931AZ50R	497-4262-1-ND
U2	MICRO	MCHC908JW32FC 8 bit USB/SPI microcontroller ROHS COMPLIANT	FREESCALE SEMI- CONDUCTOR	MC68HC908JW32	

## KIT33810EKEVME Bill of Material

Schematic Designation	Device or Signal Name	Description	Mfr. Part Nam	Mfr. Part Number	Digi-Key Part #
U3	IID	MC33810 Engine Control IC	FREESCALE SEMI-CONDUCTOR	MCZ33810EK	
Q1	IGBT	IRGS14C40L IGBTpBF 14 Amp 430 V TO-263AB package	INTERNATIONAL RECTIFIER	IRGS14C40L IGBTpBF	IRGS14C40LPBF-ND
Q2	IGBT	IRGS14C40L IGBTpBF 14 Amp 430 V TO-263AB package	INTERNATIONAL RECTIFIER	IRGS14C40L IGBTpBF	IRGS14C40LPBF-ND
Q3	IGBT	IRGS14C40L IGBTpBF 14 Amp 430 V TO-263AB package	INTERNATIONAL RECTIFIER	IRGS14C40L IGBTpBF	IRGS14C40LPBF-ND
Q4	IGBT	IRGS14C40L IGBTpBF 14 Amp 430 V TO-263AB package	INTERNATIONAL RECTIFIER	IRGS14C40L IGBTpBF	IRGS14C40LPBF-ND
MOV-1	SURGE PRO-TECTOR	MOV 50 VDC- ROHS COMPLIANT	LITTLEFUSE	V60MLA1210	F221CT-ND
D1	DIODE	DIODE PWR RECT 1A 200V-- RECOVERY SMB - ROHS COMPLIANT	ON SEMICONDUCTOR	MURS120T3G	MURS120T3GOS-ND
LED1	LED	LED RED SMT 0603	LITE ON	LTST-C190KRKT	160-1436-1-ND
LED2	LED	LED RED SMT 0603	LITE ON	LTST-C190KRKT	160-1436-1-ND
LED3	LED	LED RED SMT 0603	LITE ON	LTST-C190KRKT	160-1436-1-ND
XTAL-1	OSC1 OSC2	XTAL 4.0MHZ RSN 50PPM TH CL=10PF ROHS	FOX ELECTRONICS	FOXSLF/040	631-1096-ND

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.

## 5 References

Following are URLs where you can obtain information on other Freescale products and application solutions:

Products	Links
Data Sheet MC33810	<a href="http://www.freescale.com/files/analog/doc/data_sheet/MC33810.pdf">www.freescale.com/files/analog/doc/data_sheet/MC33810.pdf</a>
Freescale's Web Site	<a href="http://www.freescale.com">www.freescale.com</a>
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Freescale's Automotive Applications	<a href="http://www.freescale.com/automotive">www.freescale.com/automotive</a>

## 6 Revision History

REVISION	DATE	DESCRIPTION OF CHANGES
2.0	1/2010	<ul style="list-style-type: none"><li>Initial Release</li></ul>
3.0	5/2010	<ul style="list-style-type: none"><li>Added References Section, BOM and Revision History Section.</li></ul>

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