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KIT33926PNBEVBE Evaluation Board User's Guide

Featuring the MC33926 5.0A Throttle Control H-Bridge IC with Slew Rate Control and the MC33810 Automotive Engine Control IC

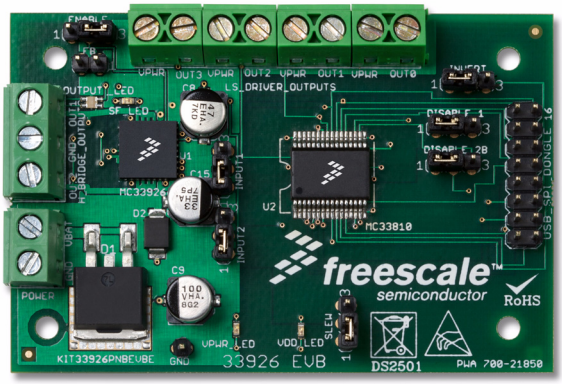

Figure 1. KIT33926PNBEVBE Evaluation Board

Table of Contents

1 Kit Contents / Packing List

- Assembled and tested evaluation board/module in anti-static bag.
- Ribbon cable assembly with 16-pin connector
- CD-ROM containing:
  - Supporting documentation for featured device (including data sheet and user's guide)
    - Schematic of evaluation board
    - PCB artwork
    - Bill of material for evaluation board
    - Instruction sheet for evaluation board
  - SPIGen 5.0.1 software
- Warranty card

Archive Information

2 Important Notice

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

This evaluation kit is intended for use of ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY. It is provided as a sample IC pre-soldered to a printed circuit board to make it easier to access inputs, outputs, and supply terminals. This EVB may be used with any development system or other source of I/O signals by simply connecting it to the host MCU or computer board via off-the-shelf cables. This EVB is not a Reference Design and is not intended to represent a final design recommendation for any particular application. Final device in an application will be heavily dependent on proper printed circuit board layout and heat sinking design as well as attention to supply filtering, transient suppression, and I/O signal quality.

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.

Should this evaluation kit not meet the specifications indicated in the kit, it may be returned within 30 days from the date of delivery and will be replaced by a new kit.

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3 Introduction

The **KIT33926PNBEVBE** Evaluation Board (EVB) is an easy-to-use circuit board that allows the user to exercise all the functions of the MC33926 H-Bridge circuit. The EVB communicates to a PC through a USB/SPI Dongle connected to the PC's USB port. The Freescale SPIGen program provides the User Interface to the MC33926 EVB's SPI port and allows the user to send commands to and receive error messages from the IC. There is also a MC33810 circuit on the EVB which contains four, low side, drivers and four General Purpose MOSFET Gate drivers which are used to provide PWM signals to the various MC33926 inputs.

4 Evaluation Board Features

- A MC33926 H-Bridge IC
- A MC33810 PWM Driver (IID) IC
- A USB to SPI Dongle interface, through which 5V power is supplied
- Power conditioning circuitry
- A set of seven Input Select Jumpers.

5 MC33926 Device Features

This MC33926 is designed primarily for automotive electronic throttle control, but is applicable to any low-voltage DC servo motor control application within the current and voltage limits stated in this specification. This device has the following features:

- 8.0 V to 28 V Continuous Operation (Transient Operation from 5.0 V to 40 V)
- 225 mΩ maximum RDS(ON) @ 150°C (each H-Bridge MOSFET)
- 3.0 V and 5.0 V TTL / CMOS Logic Compatible Inputs
- Overcurrent Limiting (Regulation) via Internal Constant-Off-Time PWM
- Output Short Circuit Protection (Short to VPWR or Ground)
- Temperature-Dependant Current-Limit Threshold Reduction
- All Inputs have an Internal Source/Sink to Define the Default (Floating Input) States
- Sleep Mode with Current Draw < 50 µA (with Inputs Floating or Set to Match Default Logic States)

6 MC33810 Device Features

The MC33810 is an eight channel output driver IC intended for automotive engine control applications. This device has the following features:

- Designed to Operate over the range of 4.5 V ≤ VPWR ≤ 36 V
- Quad Ignition IGBT or MOSFET gate pre-driver with Parallel/SPI and/or PWM Control
- Quad Injector Driver with Parallel/SPI Control
- Interfaces Directly to MCU Using 3.3 V / 5.0 V SPI Protocol
- Injector Driver Current Limit - 4.5A Typical
- Independent Fault Protection and Diagnostics
- VPWR Standby Current 10 µA Typical

7 Required Equipment

Minimum required equipment:

- USB enabled Computer with Windows XP or higher
- SPIGen 7.0 or greater
- One of the following two USB-to-SPI kits:
- USB/SPI Dongle board (KITUSBSPIDGLEVME) plus 16-Pin Ribbon Cable
- Typical loads (DC servo motor, fuel injectors, solenoids, lamps, and relays)

8 Evaluation Board Configuration

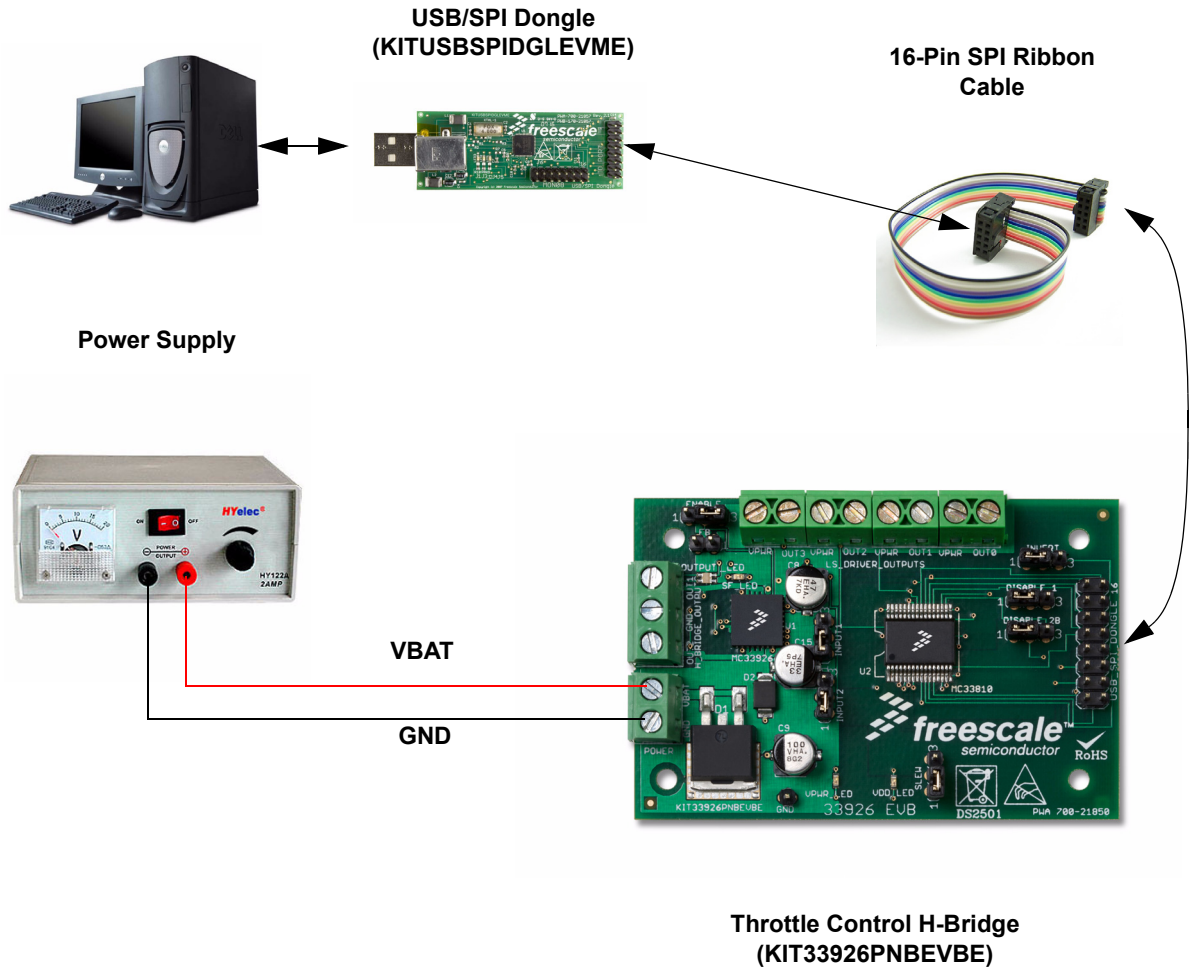


Figure 2. Evaluation Board Setup

Archive Information

9 Installing SPIGen Freeware on your Computer

There current version of SPIGen is designed to run on a USB enabled computer with Windows XP, Windows 2000, or Windows NT.

This version of SPIGen includes a README.txt file which will describe the operating systems where the software should be installed. Before you install the program, refer to the SPIGen README.txt file to check the compatibility of the installation program and your computer operating system.

To install the software from the CD-ROM, insert the CD-ROM into your CD drive. Click the Start button, and then click “Run…”.

While running Windows NT, Windows 2000, or Windows XP, type “D:\SPIGen_Win_NT_2000_XP\Setup.exe” in the box, and then click “OK”.

Several temporary files will be copied to your computer, and then the Installation Wizard will guide you through the rest of the process.

To use SPIGen, Go to the Windows Start menu, then Programs, then SPIGen, and click on the SPIGen icon. The SPIGen “Generic SPI Generator” graphic user interface (GUI) will appear. Go to the File menu in the upper left hand corner of the GUI, and select Open, then browse the CD to find and select the SPIGen Configuration “.spi” file for the EVB you are using. Click Open, and SPIGen will open a specifically configured SPI command generator for your EVB.

Archive Information

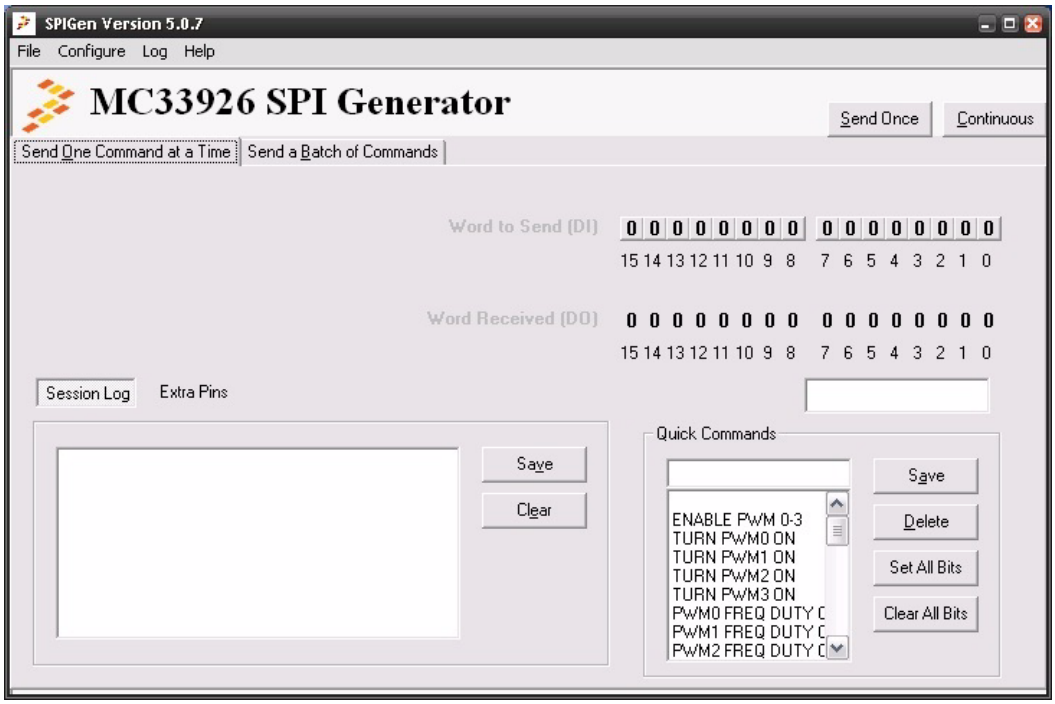


Figure 3. SPI Generator GUI

10 EVB Setup and Using the Hardware

To perform the examples included in the CD the following connections and setup must be performed:

1.Make sure the SPIGen 5.0X program is installed on the PC and it can communicate with the USB/SPI Dongle as described in that kit's documentation.

2.Connect the USB/SPI Dongle to the MC33926 EVB via a 16 pin ribbon cable. Make sure to orient the cable so that pin1 on both the USB/SPI Dongle and the MC33926 EVB are connected correctly, pin 1 to pin 1.

3.Connect the USB/SPI Dongle to a PC, LED 2 on the USB/SPI Dongle and the VDD LED on the MC33926 board should both be illuminated.

4.Attach a +12 VDC supply (do not turn on power yet) to the power connector on the MC33926 EVB, making sure to observe the GND and +12 V terminals. The current capability of the +12 V supply should exceed the maximum total current that the number of simultaneously ON loads will require.

5.Attach loads to the MC33810 OUT0 - OUT3 terminals between the VPWR terminals and the OUTx terminals. One possible demo load is a 10 W halogen G4 Base T3 bulb (used in landscape lighting applications). This load will draw approximately 850 mA and fits nicely into the screw terminals.

6.Attach 10 W halogen G4 Base T3 bulbs to the H-Bridge OUT1 and OUT-2 terminals from OUT1 to GND and another load from OUT2 to GND.

7.Launch SPIGen and from the "**File**" menu, select "**Open**" and browse to the CD containing the "MC33926_EVB_CONFIGURATION_FILE.spi" file. The title on the SPIGen screen should change from "Generic SPI Generator" to "MC33926 SPI Generator".

8.Turn on the +12 Volt Supply. The bulbs connected to the H-Bridge OUT1 and OUT2 should illuminate immediately. Verify that all is working correctly by clicking on the "Extra Pins" button in the SPIGen main screen and then click on the DATA 0 "High" button. The OUT1 bulb should extinguish. Clicking on the DATA 1 "High" button should extinguish the OUT2 bulb.

9.Click on the Control 0 "High" button. The bulb connected to OUT0 on the MC33926 EVB and LED1 on the USB/SPI Dongle should be illuminated. Click on the Control 0 "Low" button and the bulb connected to OUT0 and LED1 on the USB/SPI Dongle.

Archive Information

11 Evaluation Board Hardware Description

This EVB consists of a 33926 H-Bridge, a 33810 PWM Driver (IID) circuit, a USB to SPI Dongle interface, power conditioning circuitry, and a set of seven Input Select Jumpers. All +5.0 volt VDD power required by the EVB is obtained via the USB/SPI Dongle interface. The Hardware Block Diagram is shown below:

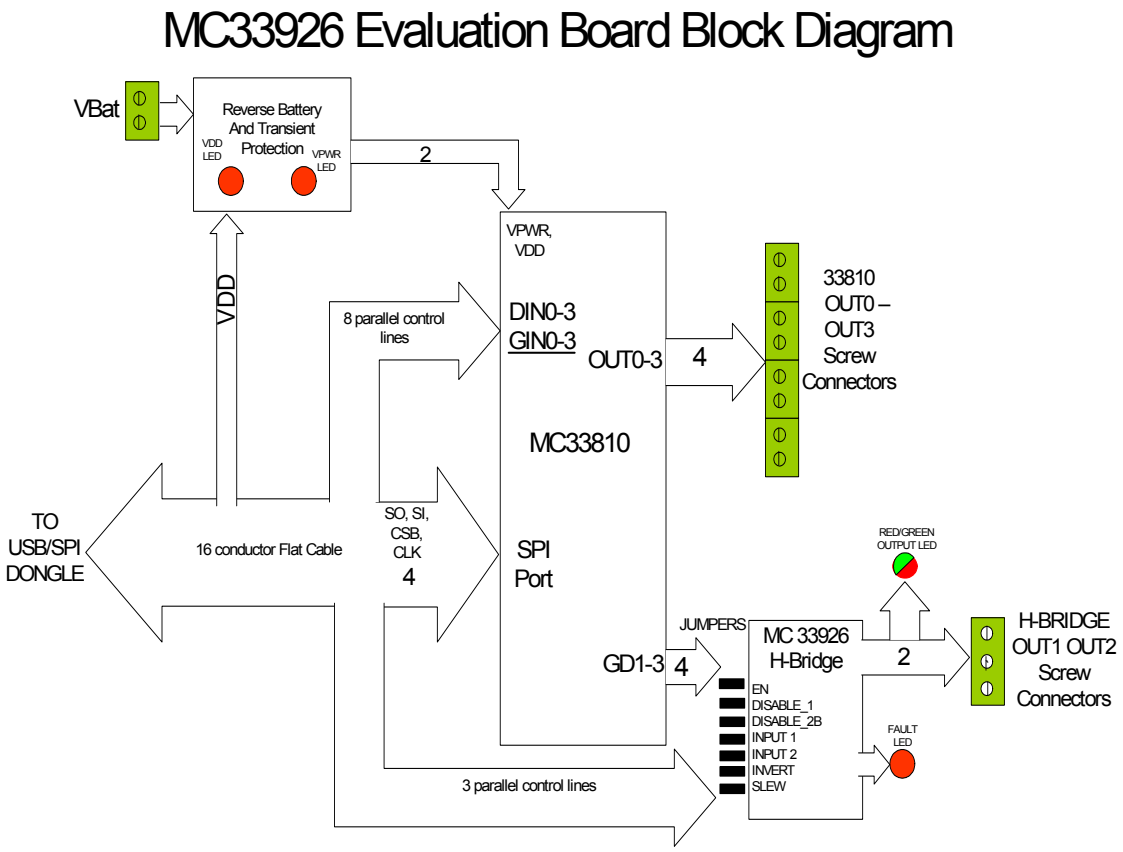


Figure 4. 33926 EVB Block Diagram

11.1 LED Display

Several LED's are provided as visual output devices for the MC33926 EVB board. A list of the LED devices is shown below:

1.VDD LED - Indicates when a +5.0 Volt supply is connected

2.VPWR LED - Indicates when +12 Volt supply is connected

3.Fault LED - Illuminates when the MC33926 detects a fault

4.Output LED - Red/Green LED that indicates which direction the current is flowing in the legs of the H-Bridge.

11.2 I/O Jumper Definitions (J3)

The EVB contains seven jumpers that connect the inputs of the 33926 as follows (**Bold** = factory setting):

NAME	Position	Connection
INPUT 1	1-2/DATA0	2-3/BGD0
INPUT 12	1-2/DATA1	2-3/BGD1
INVERT	1-2/GND	2-3/DATA4
ENABLE	1-2/GND	2-3/VDD
DISABLE_1	1-2/GND	2-3/BGD2
DISABLE_2B	1-2/VDD	2-3/BGD3
SLEW	1-2/GND	2-3/VDD

The DATA0 -DATA4 signals are parallel outputs from the USB/SPI Dongle that can be controlled directly from the SPIGen program. The BGD0 - BGD3 signals are the outputs of the MC33810 pre-drivers (GD0 -GD3) after being buffered by discrete MOSFETS. (See the schematic for detailed information) The GD0 - GD3 outputs can be set-up to provide a PWM signal, to vary the H-Bridge output. The buffered PWM signals (BGD0 - BGD3)can be selected via the jumpers to be connected to the Input 1, Input 2, Disable_1 or Disable_2B inputs. This flexibility is provided to illustrate the many ways the MC33926 can be driven to achieve the same result. An example configuration file called "MC33926_EVB_CONFIGURATION_FILE.spi" is provided on the CD which contains batch file examples. In these batch file examples are the instructions to set-up the MC33810 to PWM the GDx outputs. The MC33810 data sheet (also on the CD provided) describes, in detail, the way to set the PWM frequency and duty cycle for each of the GD outputs (and corresponding BGDx outputs).

If the user prefers to supply the various MC33926 input signals externally, other than from the USB-SPI Interface or the PWM signals (BGDx), the jumpers can be removed and connections can be made to the open pin number 2' s.

11.3 USB/SPI Dongle Connector

The USB/SPI dongle connector is a 16 pin,.1" center, dual-row connector that is designed to interface directly to the USB/SPI Dongle unit. The USB/SPI dongle connector consists of the following 16 pins:

Number	Name	Description
1	CSB	SPI signal, Chip Select Bar
2	CNTL2	Parallel port signal CNTL2
3	SO	SPI signal, Serial Out
4	CNTL1	Parallel port signal CNTL1
5	SI	SPI signal, Serial In
6	CNTL0	Parallel port signal CNTL0

Archive Information

Number	Name	Description
7	SCLK	SPI signal, Serial Clock
8	DATA4	Parallel port signal DATA4
9	CNTL3	Parallel port signal CNTL3
10	DATA3	Parallel port signal DATA3
11	VDD	+5 Volt VDD from USB
12	DATA2	Parallel port signal DATA2
13	NC	Unused
14	DATA1	Parallel port signal DATA1
15	GND	Signal Ground
16	DATA0	Parallel port signal DATA0

This connector mates with the 16 conductor flat cable that connects to the USB/SPI Dongle (KITUSBSPIDGLEVME).

11.4 Screw Terminal Connections -

The MC33926PNBEVBE board contains input and output screw terminal connections to allow easy access to the MC33926's drive circuits.

The diagram below shows the locations of the screw terminals and their functional definitions:

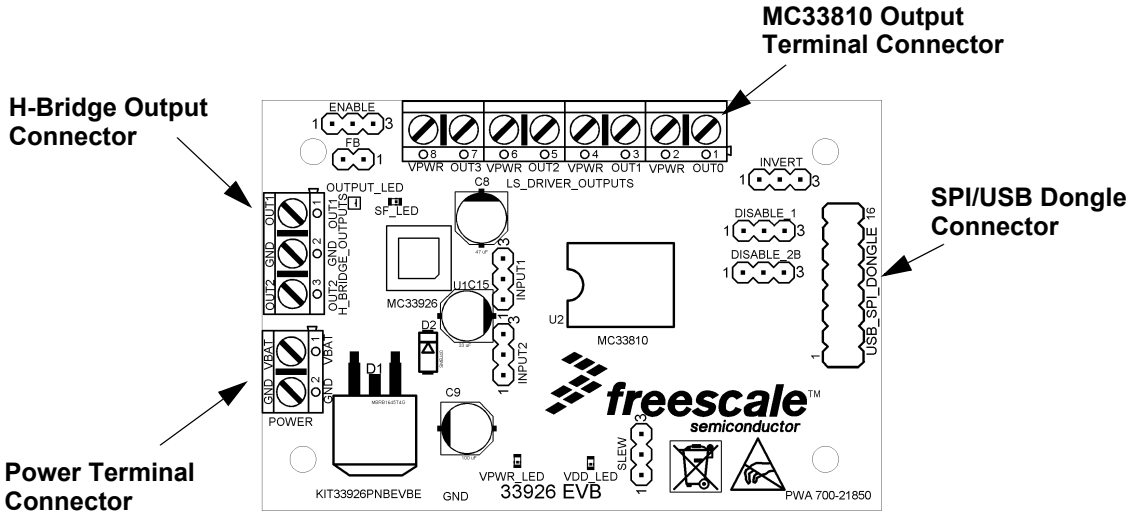


Figure 5. PCB Top Assembly Layer with Screw-Terminal Connectors Indicated

Archive Information

11.5 Power Terminal Connector

The Power Terminal Connector is a two position screw terminal that provides +12 Volt and Ground Terminals. The Ground terminal is marked “**GND**” and the +12 Volt Terminal is marked “**VBAT**”.

11.6 H-Bridge Terminal Connector

The H-Bridge Terminal Connector is a three position screw terminal that provides the following three connections:

1.Output 1 of the H-Bridge - Pins 12, 13, 14, and 15 of the MC33926

2.Ground

3.Output 2 of the H-Bridge - Pins 27, 28, 29, and 30 of the MC33926

Terminal 1 of this terminal connector is labeled “**OUT1**”

Terminal 2 of this terminal connector is labeled “**GND**”

Terminal 3 of this terminal connector is labeled “**OUT2**”

11.7 MC33810 Output Terminal Connector

The MC33810 Terminal Connector is an eight position screw terminal. Four of the terminals are connected to the VPWR line and the remaining four terminals are connected to the four injector driver outputs of the MC33810 (see data sheet).

These terminals are marked as follows:

Terminal 1 of this terminal connector is labeled “**OUT0**”

Terminal 2 of this terminal connector is labeled “**VPWR**”

Terminal 3 of this terminal connector is labeled “**OUT1**”

Terminal 4 of this terminal connector is labeled “**VPWR**”

Terminal 5 of this terminal connector is labeled “**OUT2**”

Terminal 6 of this terminal connector is labeled “**VPWR**”

Terminal 7 of this terminal connector is labeled “**OUT3**”

Terminal 8 of this terminal connector is labeled “**VPWR**”

The terminals are arranged in this alternating fashion to allow the connection of loads to pairs of screw terminals.

11.8 Controlling the MC33810 Outputs

The MC33810 Injector Driver Outputs OUT0 - OUT3 are controlled either by sending a “Driver ON/OFF Command” SPI word or by toggling the Parallel, DIN0 - DIN3, input lines. In the MC33926 EVB the DIN0 - DIN3 lines are connected to the CNTL0 - CNTL3 parallel lines from the USB/SPI Dongle. Using SPIGen, the CNTL0 - CNTL3 lines can be set high or low from the “Extra Pins” menu. To get to this menu, follow

the setup procedure listed below and then click on the “Extra Pins” button while in the SPIGen “Send One Command at Time” screen. Clicking on the Control 0 - 3, High and Low, buttons will toggle the DIN0 - DIN3 lines, respectively causing the corresponding OUT0 - OUT3 outputs to toggle.

A High will turn on the output and a Low will turn it off.

11.9 Accessory Boards

This kit may be used with Freescale's one of the following kits:

The KITUSBSPIDGLEVME Evaluation board (shown below) provides a USB to SPI interface that features the MC68HC908JW32 with dongle. It is a working hardware/software example that allows a user to become familiar with the MC68HC908JW32 microcontroller by means of an actual useful application, a USB to SPI and USB to parallel converter. The main function provided by this kit is to allow a PC, that may not have a parallel port, to communicate with other Freescale Evaluation Kits, via a USB port. The USB port is a standard feature on almost every new PC. This kit makes use of the MC68HC908JW32’s built-in USB, SPI and parallel ports.

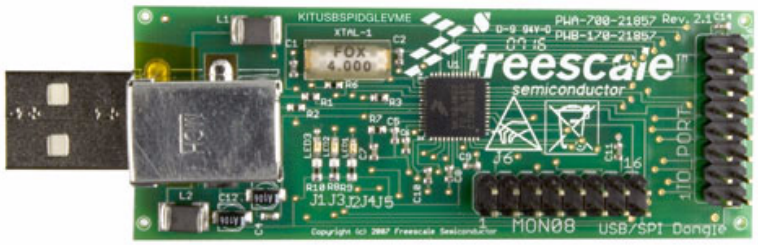
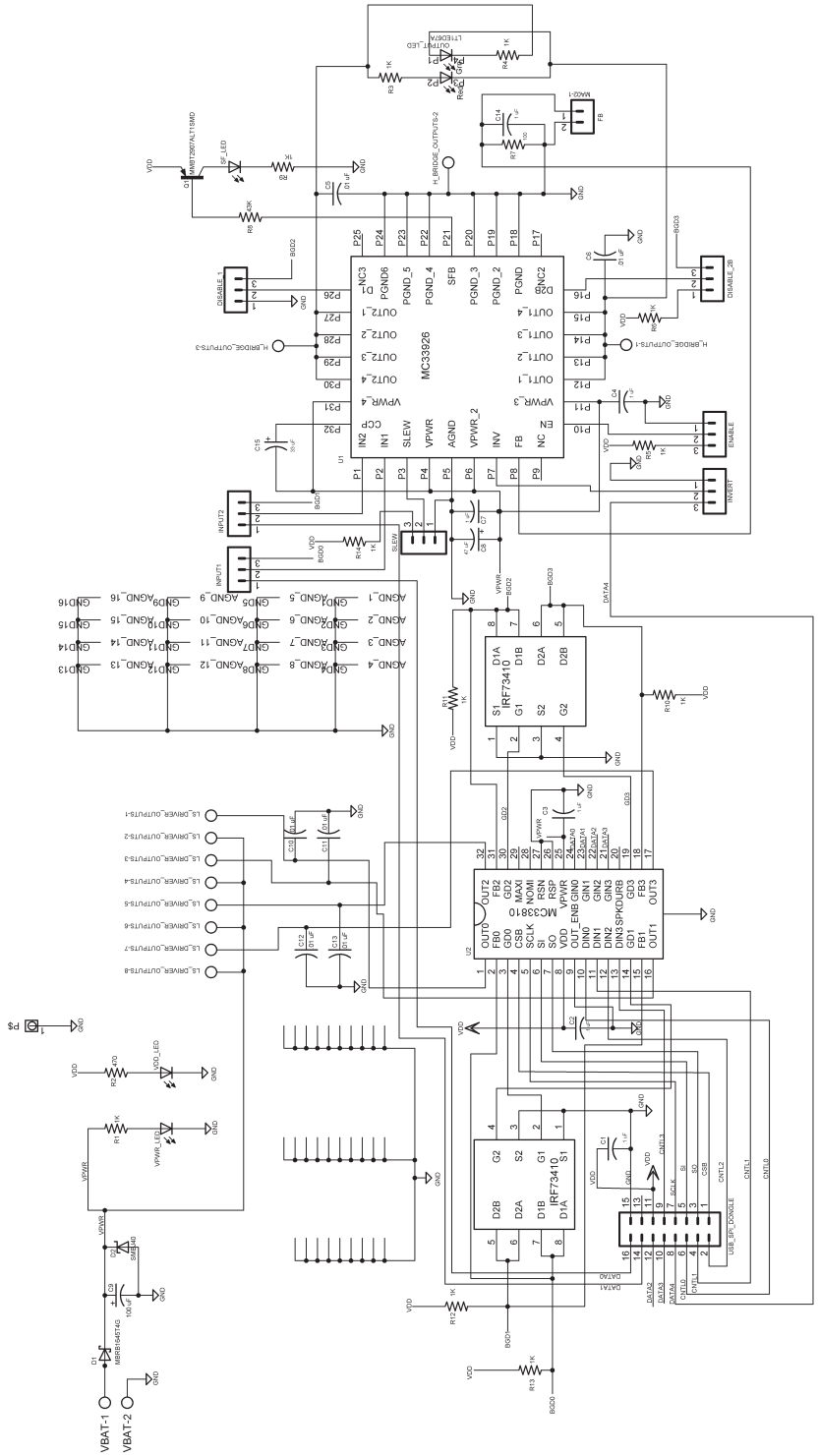


Figure 6. KITUSBSPIDGLEVME Evaluation Kit

Archive Information

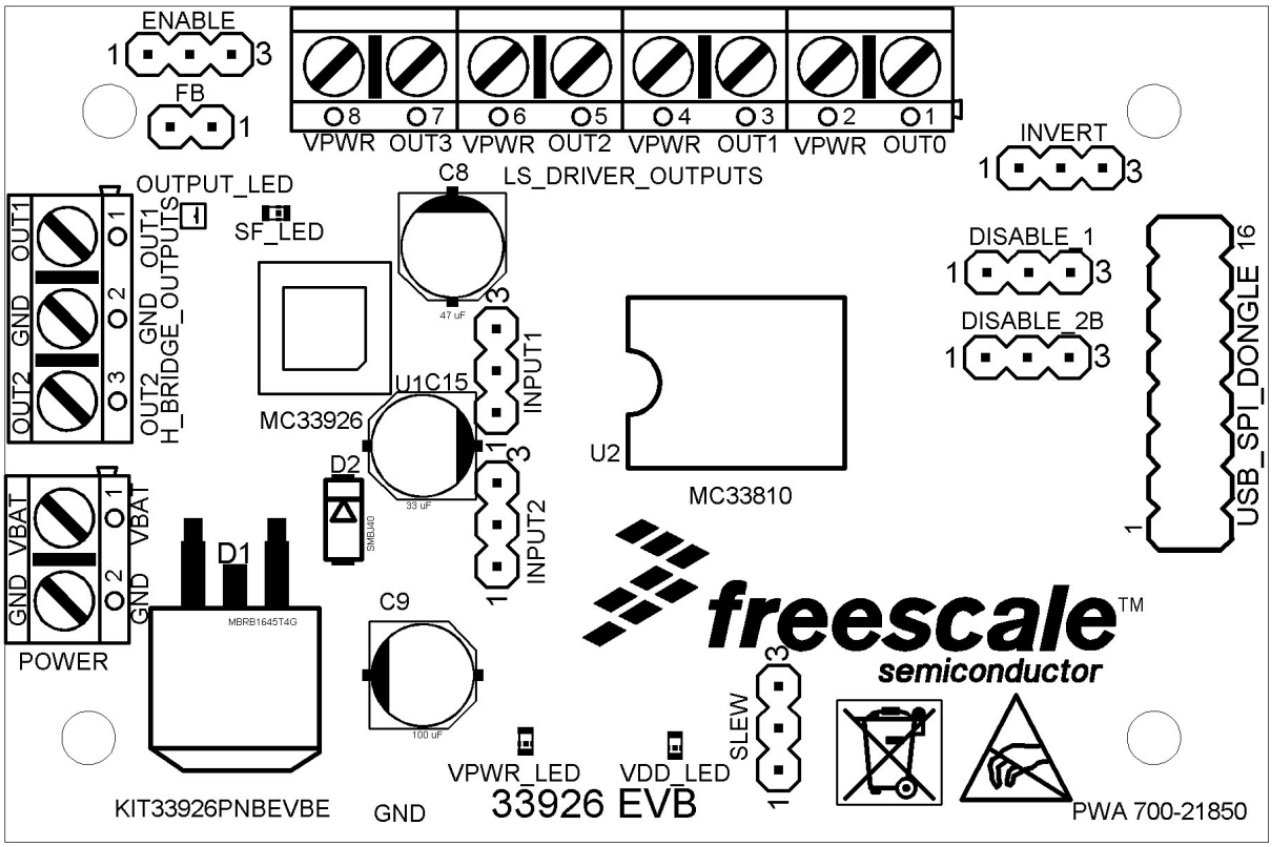
12 Schematic



Archive Information

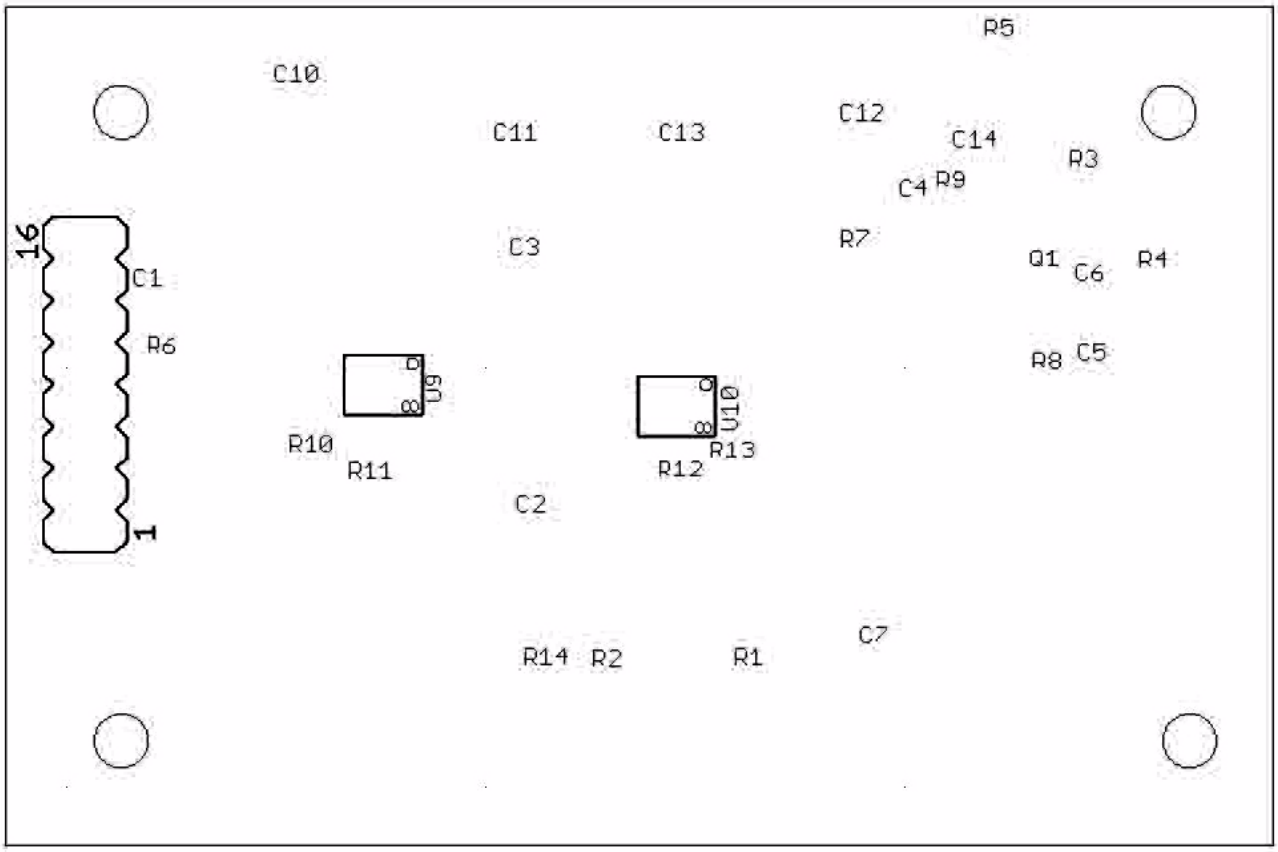
13 Board Layout

13.1 Assembly Layer Top

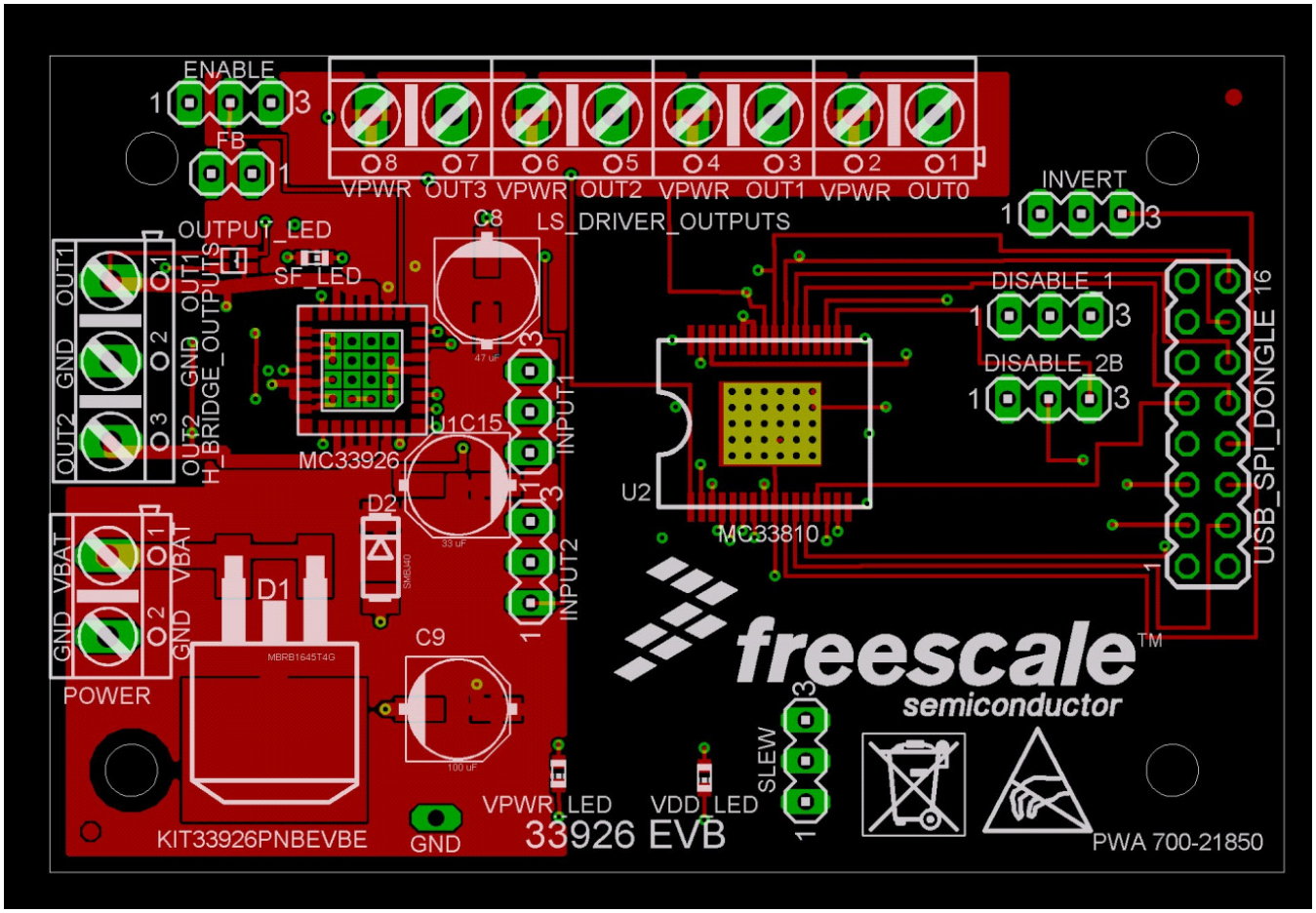


Archive Information

13.2 Assembly Layer Bottom

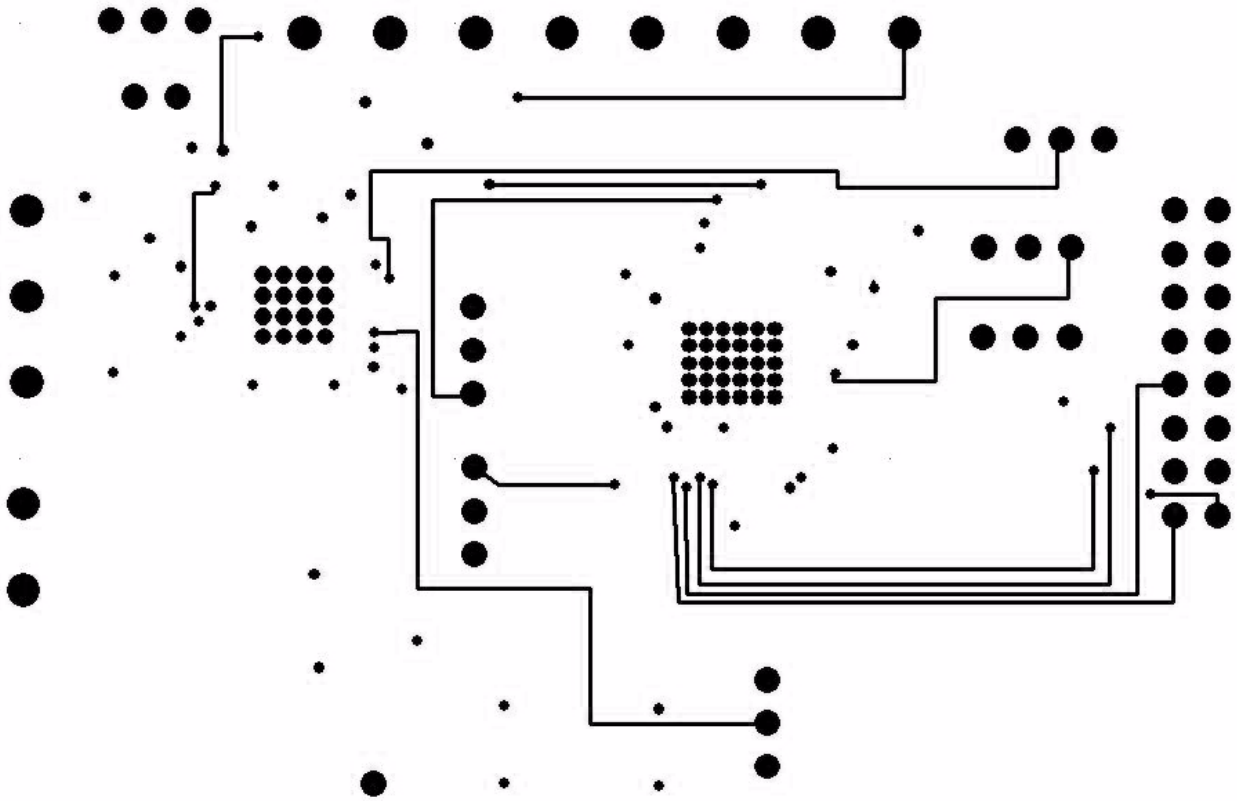


13.3 Top Layer Routing

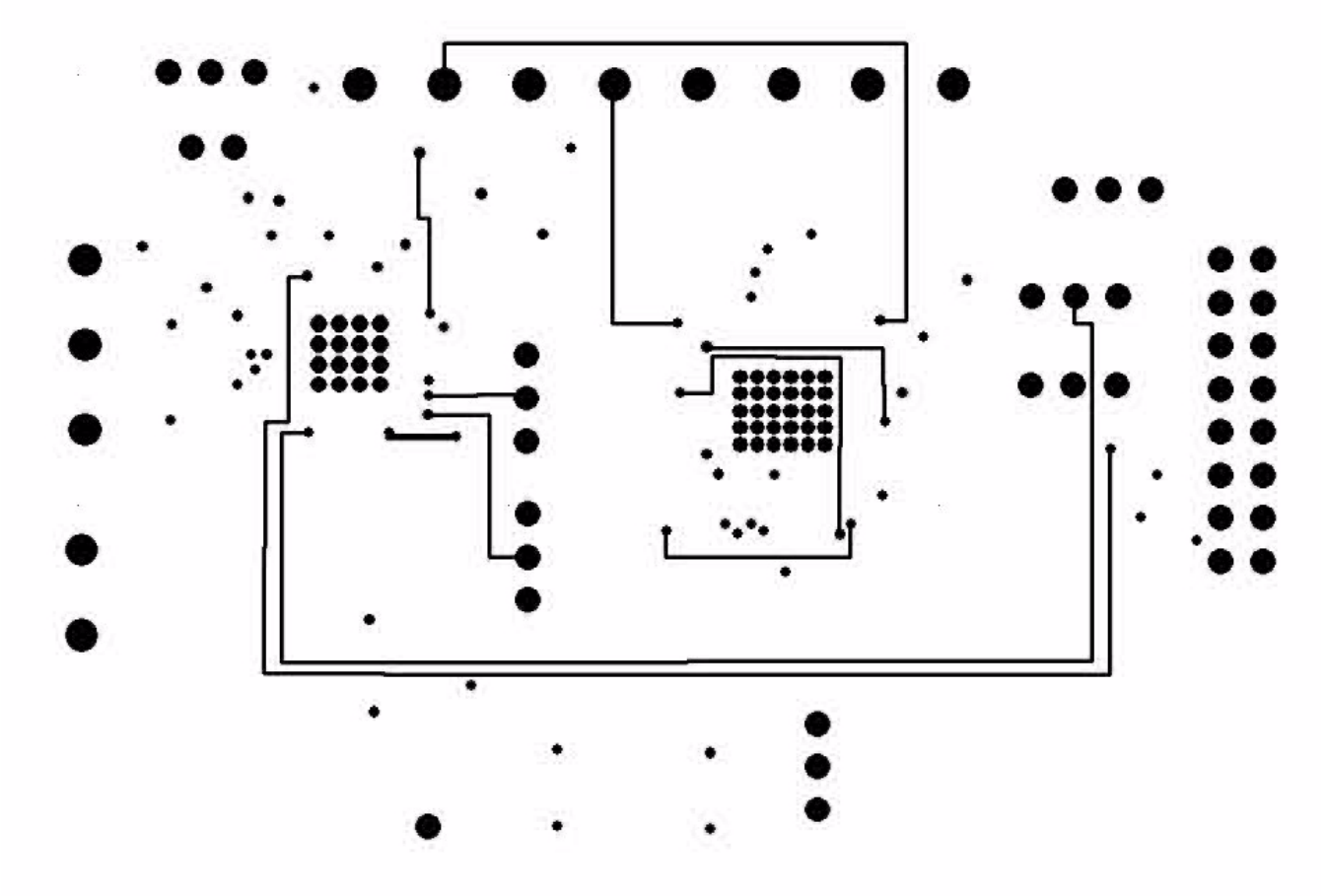


Archive Information

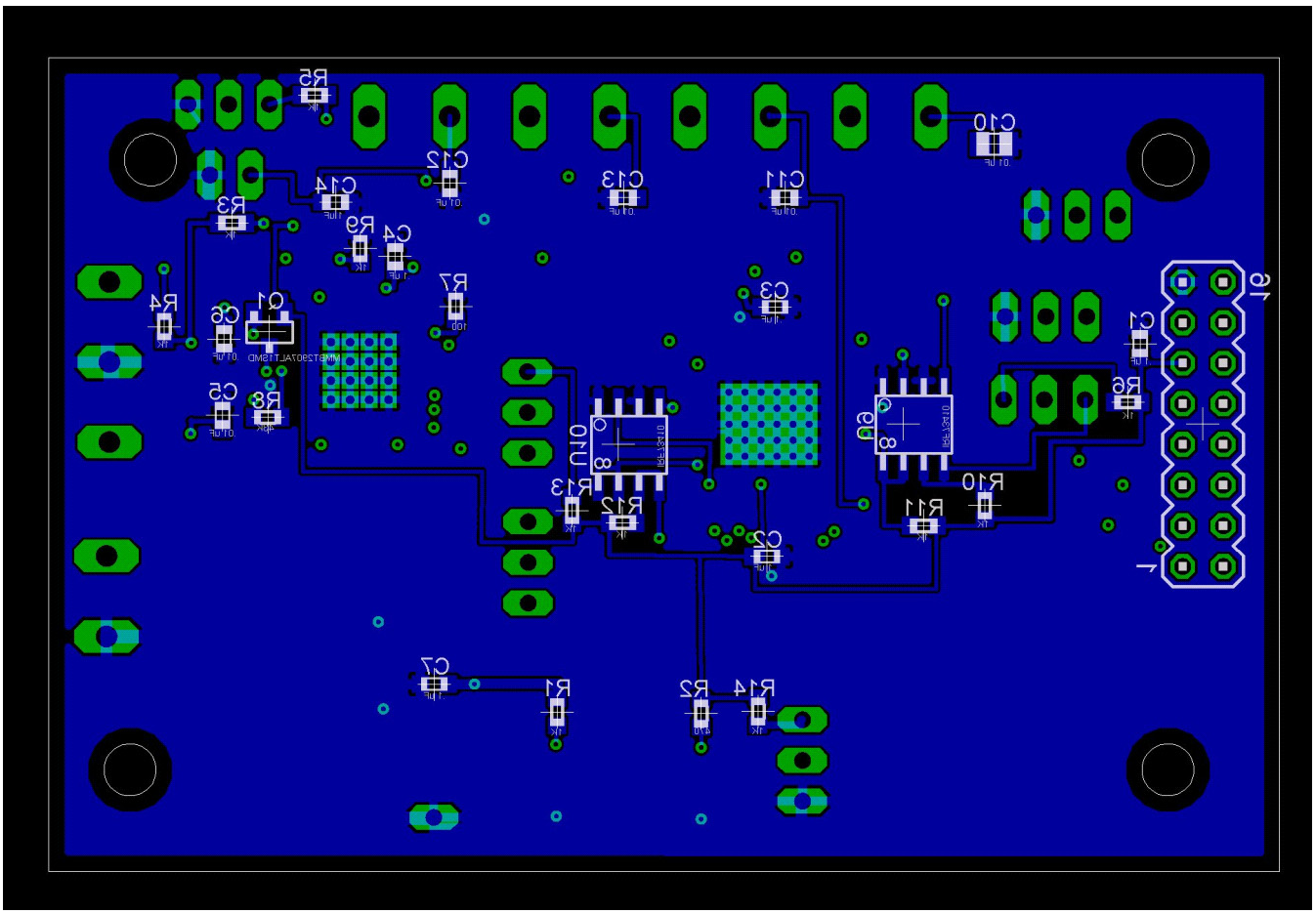
13.4 Inner Layer 1 Routing



13.5 Inner layer 2 Routing



13.6 Bottom Layer Routing



14 Bill of Material

Item	Qty	Schematic Label	Value	Description/Part Number	Package
Capacitors					
1	1	C1	0.1 µF	C1608X7R1H104K	C0603
2	1	C2	0.1 µF	C1608X7R1H104K	C0603K
3	1	C3	0.1 µF	C1608X7R1H104K	C0603K
4	1	C4	0.1 µF	C1608X7R1H104K	C0603
5	1	C5	0.01 µF	C1608X8R1H103K	C0603
6	1	C6	0.01 µF	C1608X8R1H103K	C0603
7	1	C7	0.1 µF	C1608X7R1H104K	C0603K
8	1	C8	47 µF /25V	EEE-HA1E470P	PANASONIC_D
9	1	C9	100 µF /50V	EEE-HA1H101P	PANASONIC_D
10	1	C10	0.01 µF	C1608X8R1H103K	C0805
11	1	C11	0.01 µF	C1608X8R1H103K	C0603
12	1	C12	0.01 µF	C1608X8R1H103K	C0603
13	1	C13	0.01 µF	C1608X8R1H103K	C0603
14	1	C14	1 µF	UMK107C105KA-T	C0603
15	1	C15	33 µF	EEE-HA1H330P	PANASONIC_D
Diodes					
16	1	D1	MBRB1645T4G	MBRB1645T4G	D2PAK
17	1	D2	SMBJ40	SMBJ40A	DO214AA
Connector Pins					
18	1	DISABLE_1	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1
19	1	DISABLE_2B	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1
20	1	ENABLE	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1
21	1	FB	2 pin HDR 1X10 100MIL CTR	87220-2	MA02-1
22	1	GND	1 pin HDR 1X10 100MIL CTR	87220-1	MA01-1
23	1	USB_SPI_DONGLE	16 pin HDR 2X10 100MIL CTR	9-146261-0-08	MA08-2
24	1	INPUT1	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1

Archive Information

Item	Qty	Schematic Label	Value	Description/Part Number	Package
25	1	INPUT2	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1
26	1	INVERT	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1
27	1	SLEW	3 pin HDR 1X10 100MIL CTR	87220-3	MA03-1
Transistors					
298	1	Q1	MMBT2907ALT1SMD	MMBT2907ALT1	SOT23-BEC
Resistors					
29	1	R1	1KΩ	RC0603FR-071KL	R0603
30	1	R2	470Ω	ERJ-3GEYJ471V	R0603
31	1	R3	1KΩ	RC0603FR-071KL	R0603
32	1	R4	1KΩ	RC0603FR-071KL	R0603
33	1	R5	1KΩ	RC0603FR-071KL	R0603
34	1	R6	1KΩ	RC0603FR-071KL	R0603
35	1	R7	100Ω	ERJ-3EKF1000V	R0603
36	1	R8	43KΩ	ERJ-3GEYJ433V	R0603
37	1	R9	1KΩ	RC0603FR-071KL	R0603
38	1	R10	1KΩ	RC0603FR-071KL	R0603
39	1	R11	1KΩ	RC0603FR-071KL	R0603
40	1	R12	1KΩ	RC0603FR-071KL	R0603
41	1	R13	1KΩ	RC0603FR-071KL	R0603
42	1	R14	1KΩ	RC0603FR-071KL	R0603
ICs					
43	1	U1	5.0 A Throttle Control H-Bridge IC	MC33926PNB	32-PIN PQFN
45	1	U2	Automotive Engine Control IC	MCZ33810EK	32 SOICW-EP
45	1	U9	IRF7341	IRF7341	TRANSIS-TOR-FET_SO-8
46	1	U10	IRF7341	IRF7341	TRANSIS-TOR-FET_SO-8
LEDs					
47	1	VDD_LED	Green Low current LED 0603	LNJ308G8LRA	CHIP-LED0603

Archive Information

Item	Qty	Schematic Label	Value	Description/Part Number	Package
48	1	VPWR_LED	Green Low current LED 0603	LNJ308G8LRA	CHIP-LED0603
49	1	SF_LED	Red Low current LED 0603	LNJ208R8ARA	CHIP-LED0603
50	1	OUTPUT_LED	Red/Green LED	LT1ED67A	1.6X1.6
Screw Terminals					
53	1	LS_DRIVER_OUTPUTS	Conn Term Block 2 Pos 5mm	1729018	AK500/8
54	1	H_BRIDGE_OUTPUTS	Conn Term Block 3 Pos 5mm	1729021	AK500/3
55	1	VBAT	Conn Term Block 2 Pos 5mm	1729018	AK500/2

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.

Archive Information

15 References

The following table contains URLs where you can obtain information on other Freescale products:

Document Number	Description	URL
MC33926	Data Sheet	www.freescale.com/files/analog/doc/data_sheet/MC33926.pdf
MC33926FS	Fact Sheet	www.freescale.com/files/analog/doc/fact_sheet/MC33926FS.pdf
	MC33926 Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MC33926
MC33810	Data Sheet	http://cache.freescale.com/files/analog/doc/data_sheet/MC33810.pdf
MC33810FS	Fact Sheet	http://cache.freescale.com/files/analog/doc/fact_sheet/MC33810FS.pdf
	MC33810 Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MC33810
	KITUSBSPIDGLEVME Tool Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KITUSBSPIDGLEVME
	Analog Home Page	www.freescale.com/analog
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15.1 Support

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16 Revision History

Revision	Date	Description of Changes
2.0	12/2012	• Initial release

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