KIT912J637EVME User's Guide
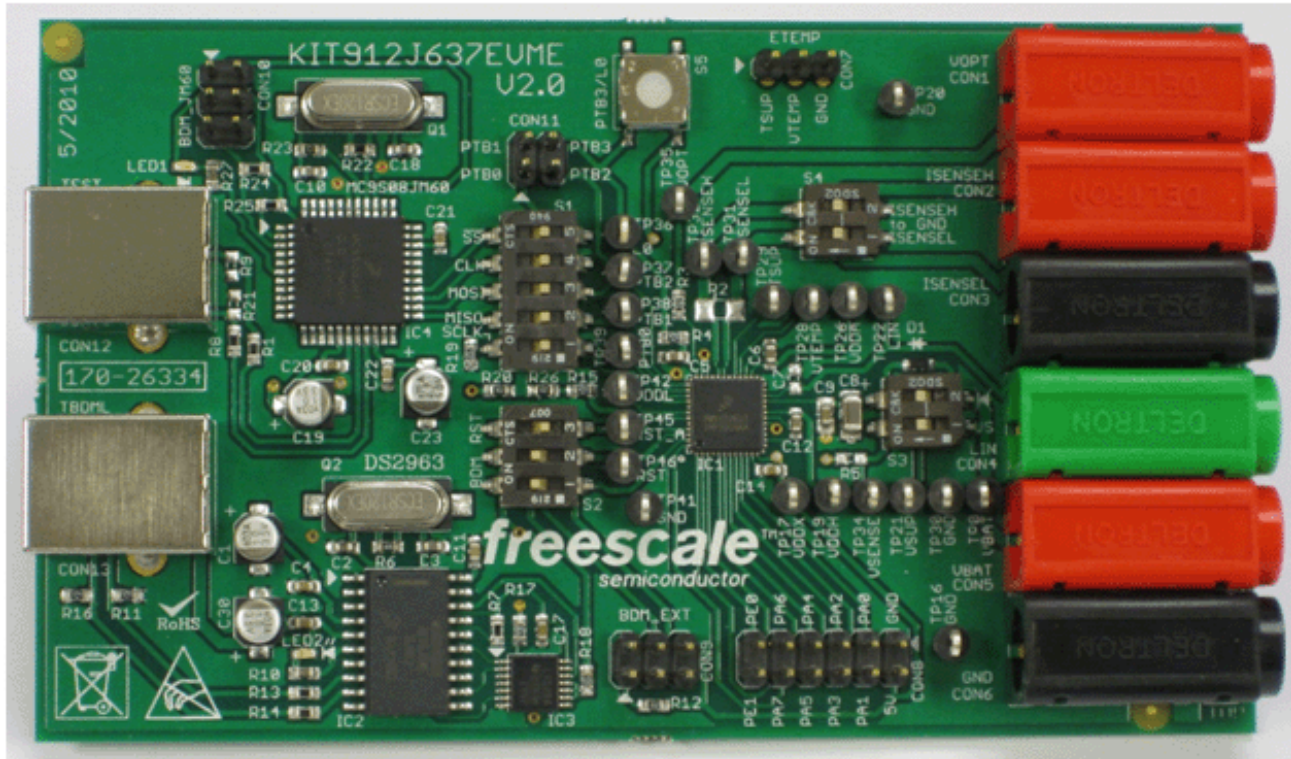

Figure 1. KIT912J637EVME Evaluation Board

Table of Contents

1   Kit Contents / Packing List

- MM912J637 Evaluation Board (EVB)
- Cable, 6 FT. USB 2.0 A-M to B-M
- Warranty Card, Freescale
- CD912J637 - Contains CodeWarrior Code Template and CodeWarrior software

2   Important Notice

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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.

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3   KIT912J637EVME Introduction

Freescale Semiconductor's KIT912J637EVME is a system solution that gives the user the capability to easily evaluate most of the features provided by the MM912J637 - Xtrinsic Battery Sensor. The 912J637 features two die in a single package. The 16-bit core and the analog die are connected via the die to die interface that provides direct address access to the registers on the analog die. The analog die contains three 16-bit sigma delta converters and enables simultaneous sampling of battery voltage and current, timer module, SCI module, LIN physical interface, and other general registers. All external signals are accessible via header connectors, and most of the signals can also be checked via test points. The evaluation module board also includes the TBDML programming/debugging interface, so no external interface is needed. The board is powered from two 4.0 mm banana connectors. For quick familiarization with the device, a CodeWarrior Template is provided together with the EVB.

3.1   MM912J637 Features

- Battery voltage measurement
- Battery current measurement in up to eight ranges
- On-chip temperature measurement
- Normal and two low-power modes
- Current threshold detection and current averaging in standby => wake-up from low-power mode
- Triggered wake-up from LIN and periodic wake-up
- Signal low pass filtering (current, voltage)
- PGA (programmable low-noise gain amplifier) with automatic gain control feature
- Accurate internal oscillator (an external quartz oscillator may be used for extended accuracy)
- Communication via a LIN 2.1, LIN 2.0 bus interface
- S12 microcontroller with 128 kByte flash, 6.0 kByte RAM, 4.0 kByte data flash
- Background debug module
- External temperature sensor option (T_{SUP}, V_{TEMP})
- Optional 2nd external voltage sense input (VOPT)
- 4 x 5.0 V GPIO including one wake-up capable high voltage input (PTB3/L0)
- 8 x MCU general purpose I/O including SPI functionality
- Industry standard EMC compliance

3.2   Warnings

When working with the kit, always use an isolated laboratory power supply.

Keep in mind all ESD rules when handling the board. Avoid touching the connector pins. They are directly connected to the device pins. Even though the device pins are ESD protected, this protection has its limits. Some ESD events can destroy or damage the device, or cause its malfunction.

3.3　Acronyms

Table 1. Acronyms

Acronym	Explanation	Acronym	Explanation
D2D	Die to Die bus interface	MCU	Microcontroller Unit
BDM	Background Debug Module	LIN	Local Interconnect Network
EVB	Evaluation Board	LS	Low Side (switch)
ESD	Electrostatic Discharge, Electrostatic Sensitive Device	SCI	Serial Communication Interface
GND	In the document: main supply ground	TBDML	Turbo BDM Lite
GPIO	General Purpose Input/Output		
GUI	Graphical User Interface		
ADC	Analog to Digital Conversion		

4 Required Equipment

- PC Computer running Windows XP or higher
- 12 V Power Supply
- USB Cable (supplied)

5   Setup Guide

5.1   Hardware Setup

Setup and connections for the KIT912J637EVME are straightforward.

The KIT912J637EVME requires a connection to the power supply and a connection to the PC or notebook via the USB cable. Figure 2 depicts a complete setup.

Follow these steps to set up the board:

1. Plug the USB cable into the connector CON13 and connect the other end of the cable to the PC or notebook.
2. Connect a laboratory power supply via banana connectors to the board, using CON5 (VBATT supply) and CON6 (GND). The supply voltage has to be in the range of 8.0 to 18 V.
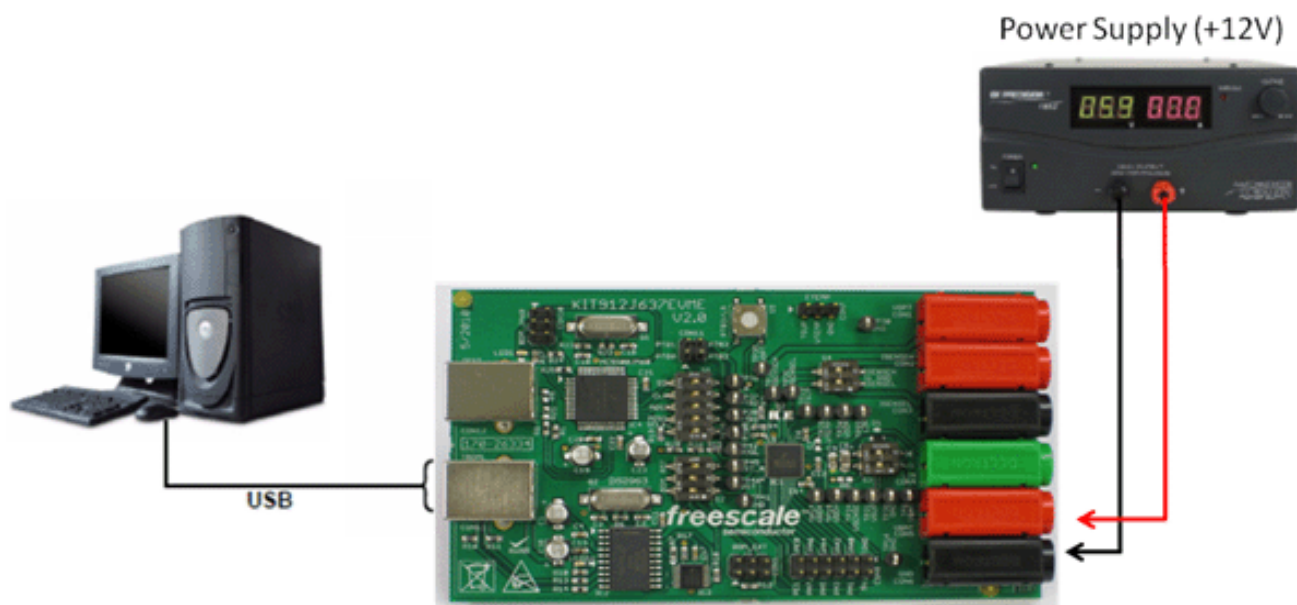
Figure 2. KIT912J637EVME Basic Hardware Setup

6 Hardware Description

6.1 Board Description

[Figure 3](#) is a snapshot of the EVB with key component and connector locations. The following list corresponds with the numbers listed on the picture.

1. Input power connectors
2. MCU Port A & Port E connector
3. TBDML interface
4. TEST SPI to USB Interface
5. PTB3/L0 Reset button (requires software configuration)
6. BDM connector for external programming/debugging BDM interface
7. MM912J637CV1AE

The board is protected against reverse battery voltage by diode D1, which can withstand up to 3.0 A continuous current. The board operation is straightforward. As well as the TDBML interface (3), the board contains the active and passive components required for proper operation of the 912J637. Connectors and test points provide access to the device for important signals.
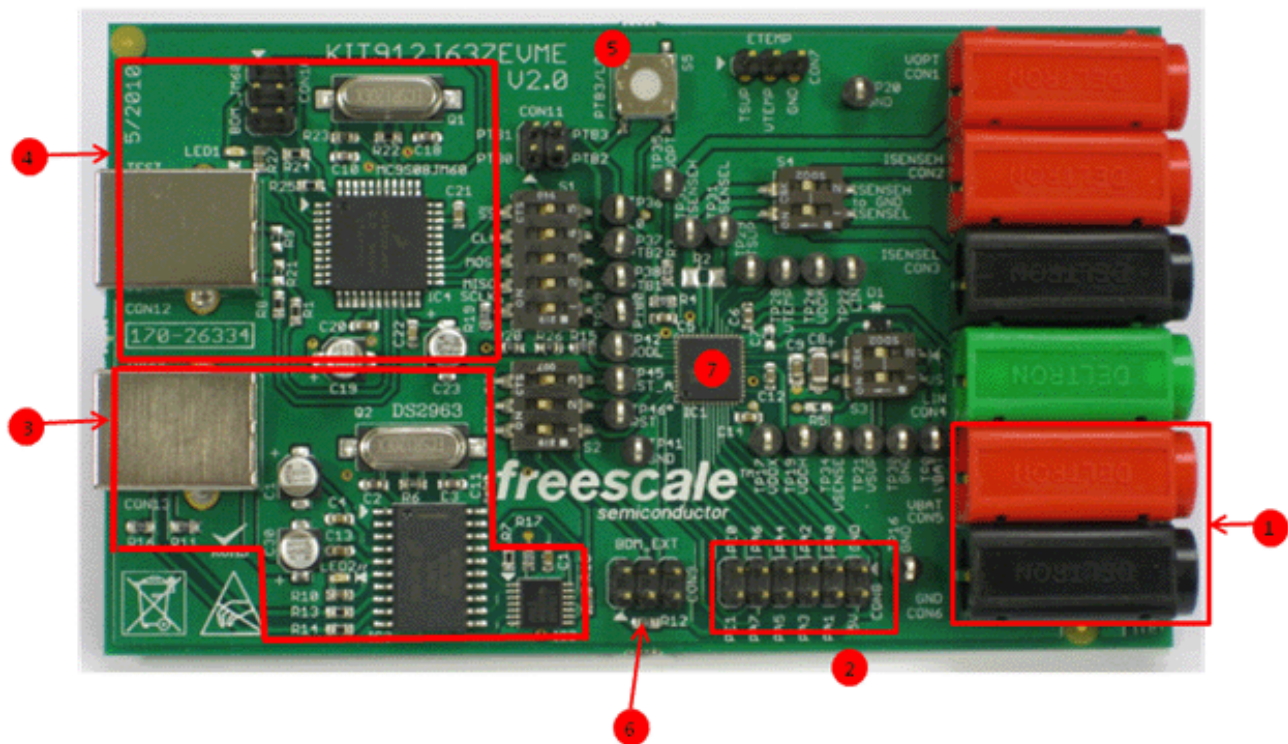

Figure 3. KIT912J637EVME Evaluation Module Board

6.1.1   MCU

The MM912J637 enables precision measurement of key battery parameters in automotive and other applications.

The device integrates an HCS12 microcontroller and a SMARTMOS analog control IC into a single package solution. The analog die combines system basis and application specific functions, including a Local Interconnect Network (LIN) transceiver, and 3 dedicated16-bit sigma delta analog to digital converters (ADC) for synchronous measurement of battery voltage, current, and temperature.

An integrated temperature sensor combined with battery mounting allows for measurement of battery temperature. Control of the analog die is via a new high performance internal die-to-die interface (D2D), which seamlessly integrates the analog IC registers into the MCU register map, providing faster access than SPI-based systems. The MM912J637 also includes an internal oscillator, 128 k Bytes of Flash memory, and 6.0 k bytes of RAM. An optional external temperature sensor is also supported.

The 912J637 has three main operating modes: Normal (all functions available); Sleep (V_{DD} off, Wake-up via: the LIN bus, PTB3/L0 input, current threshold, current averaging, calibration request, lifetime counter, internal timer, or external reset), and Stop (V_{DD} on with limited current capability, Wake-up via: the LIN bus, PTB3/L0 input, current threshold, current averaging, calibration request, lifetime counter, internal timer, or external reset).

6.1.2   TBDML

The Turbo BDM Light interface is a programming and debugging tool, and constitutes an interface between a PC and the BDM debugging port of Freescale microcontrollers. It enables the debugger and other software tools to communicate with the microcontroller, and download code into its on-chip flash, etc. Among the benefits of using the TBDML on the EVB is a much higher communication speed than other USB/BDM interfaces. It is also unnecessary to connect external devices to the EVB when programming/debugging is needed.

A BDM connector (CON9) is placed on the EVB to allow the connection of another BDM tool, such as the P&E USB BDM Multilink. In this case, DIP switches S2-1 and S2-2 should be set to "OFF", to disable the TBDML interface.

In either case, S2-3 should be set to "OFF" during programming to disconnect RESET from RESET_A.

6.1.2.1   Switch Settings

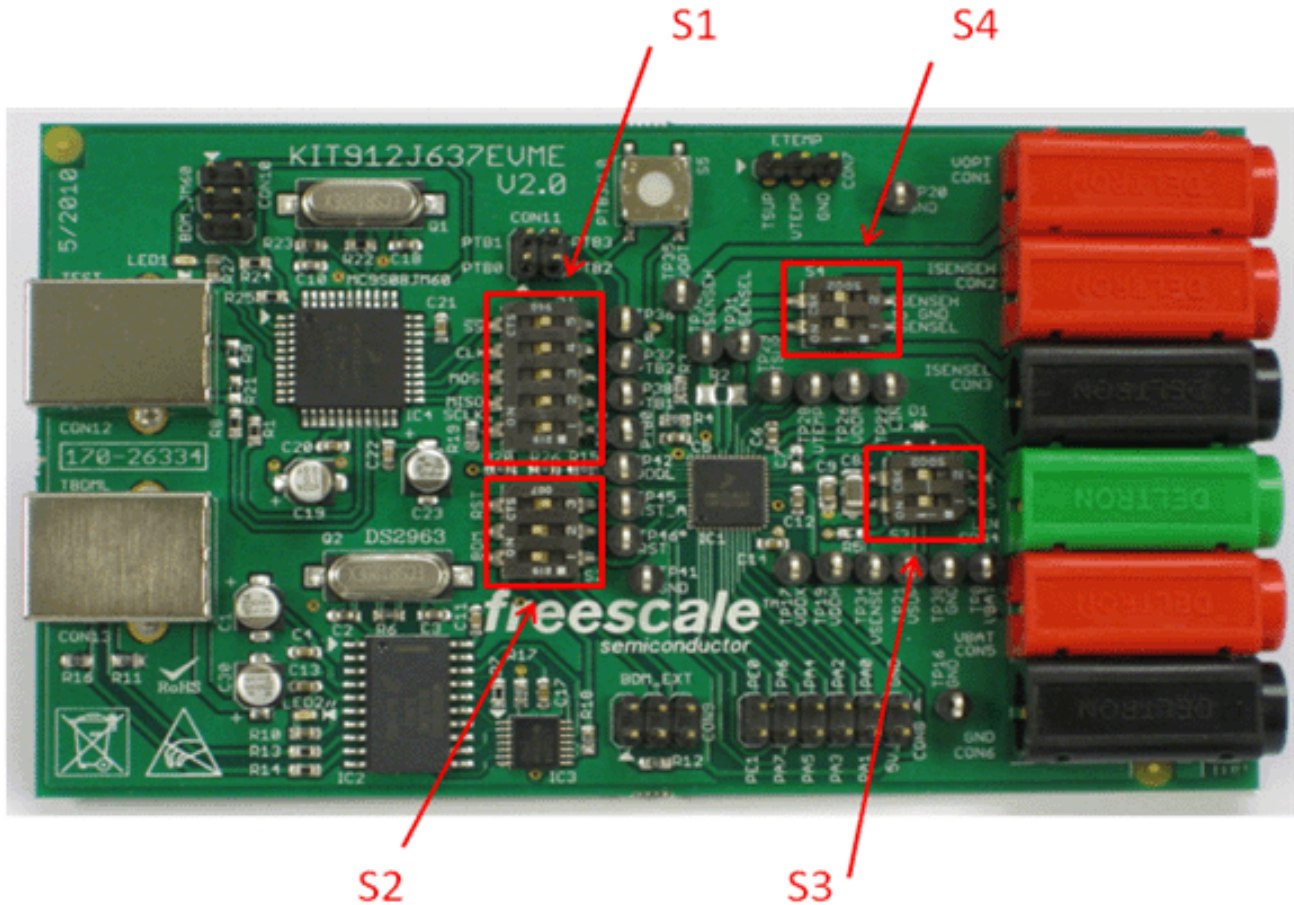Figure 4 summarizes the location of all DIP switches and settings.

Figure 4. Position of DIP Switches on the EVB

Table 2. DIP Switch Settings

Name	Switch #	Function	ON	OFF
S1	1-5	Analog Die Test SPI connect to USB	Connected	Disconnected
S2	1-2	On Board TBDML Connected to MM912J637	Connected	Disconnected (External BDM)
	3	Analog Die and MCU Reset connection	Resets Connected	Resets Disconnected
S3	1	VSENSE connected to VBAT	Connected	Disconnected
	2	Reverse Battery Diode Short	Shorted ($V_{BAT}=V_{SUP}$)	Diode in path ($V_{SUP} = V_{BAT} - V_{DIODE}$)
S4	1-2	Current Sense Inputs short to GND	Short to GND	Not shorted to GND

6.2 Connector Description

There are 13 connectors on the EVB. A list of the connector and pin assignments is in the following paragraphs.

6.2.1 Connectors
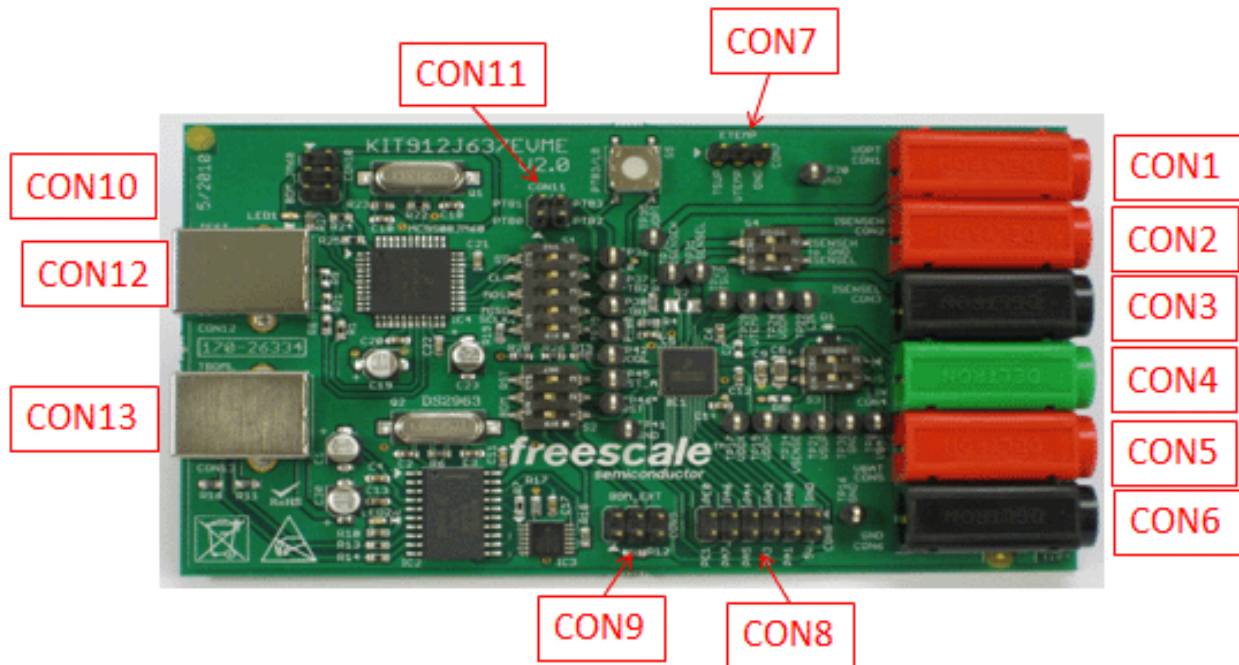
Figure 5. Connectors

Table 3. Connectors

Name	Symbol	Function
CON1	VOPT	Optional Voltage Sense Input
CON2	ISENSEH	High Level Current Sense Input
CON3	ISENSEL	Low Level Current Sense Input
CON4	LIN	LIN Physical Layer I/O
CON5	VBAT	Battery Level Supply
CON6	GND	Device Ground
CON7	ETEMP	External Temperature Sensor
CON8	PTA/E	MCU Port A and E
CON9	BDM_EXT	External BDM for MM912J637
CON10	BDM_JM60	External BDM for JM60 (not used in this application)
CON11	PTB	Analog Die Port B
CON12	TEST	TEST SPI USB Interface
CON13	TBDML	TBDML USB Interface

6.2.2　Voltage Sense Input (Optional) CON1

Connector CON1 is a socket for a 4.0 mm banana jack. It enables connection of an optional voltage sense input to pin 34.

6.2.3　High Level Current Sense Input H/L CON 2 & Con3

Connectors CON2 (red) and CON3 (black) are sockets for 4.0 mm banana jacks.

6.2.4　LIN Connector CON4

Connector CON4 (green) is a socket for a 4.0 mm banana jack. It enables connection of the LIN bus to pin 22.

6.2.5　Power Connectors CON5 and CON6

Power connectors CON5 (positive supply - red) and CON6 (ground - black) are sockets for 4.0 mm banana jacks.

6.2.6   External Temperature Sensor CON 7

Connector CON1 is a header type 3 X 1, 2.54 mm (0.1") pitch. It enables connection of an optional temperature sense input. Table 4 shows the pin assignments.

Table 4. External Temperature Sensor CON7

Pin #	Description
1	TSUP temp sensor supply output (pin 29)
2	VTEMP temp sensor input (pin 28)
3	GND

6.2.7   MM912J637 Port A & E CON 8

Connector CON 8 is a header type 6 x 2, 2.54 mm (0.1") pitch. Table 5 shows the pin assignments.

Table 5. MCU Port A & E CON8

Pin #	Description
1	GND
2	5V
3	PA0
4	PA1
5	PA2
6	PA3
7	PA4
8	PA5
9	PA6
10	PA7
11	PE0
12	PE1

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6.2.8   External BDM for MM912J637 CON 9

A standard BDM Connector (header 2 X 3, 2.54 mm (0.1") pitch) is placed on the EVB to provide the user with an external BDM programming/debugging interface connection. The pin assignment is listed in Table 6.

Table 6.   Signal Connector CON9

Pin #	Description
1	BKGD
2	GND
3	
4	/RESET
5	
6	+5.0V

6.2.9   External BDM for JM60 (TEST_SPI USB MCU) CON 10

A standard BDM Connector (header 2 X 3, 2.54 mm (0.1") pitch) is placed on the EVB to provide the user with an external BDM programming/debugging interface connection. This connector is not supported by the included software. The pin assignments are listed in Table 7.

Table 7.   Signal Connector CON10

Pin #	Description
1	BKGD
2	GND
3	
4	/RESET
5	
6	+5.0V

6.2.10   ANALOG DIE PORT B CON 11

The J8 connector is header type 2x2, 0.1" (2.54 mm) pitch. The pin assignments are listed in Table 8.

Table 8. Signal Connector CON 11

Pin #	Description
1	PTB0
2	PTB1
3	PTB2
4	L0

6.2.11   Test SPI USB Interface CON12

Connector CON12 is a standard USB connector type B. The pin assignments are listed in Table 9.

.

Table 9. USB Connector J9

Pin #	Description
1	+5.0 V
2	USBDM
3	USBDP
4	GND

6.2.12   TBDML USB Interface CON13

Connector CON13 is a standard USB connector type B. It enables connection of the EVB to a PC or notebook.

Table 10. USB Connector J9

Pin #	Description
1	+5.0 V
2	USBDM
3	USBDP
4	GND

6.3   Test Points

There are 22 test points on the EVB, allowing easy monitoring of the key pins on the MM912J637. The test point reference numbers indicate the corresponding pins on the MM912J637. The schematic and board are marked with both reference numbers and signal names. Table 11 summarizes the test points.

Table 11. Test Points

Reference designator	Signal name	Reference designator	Signal name
TP16	GND	TP32	ISENSEH
TP17	VDDX	TP34	VSENSE
TP19	VDDH	TP35	VOPT
TP20	GND	TP36	PTB3/L0
TP21	VSUP	TP37	PTB2
TP22	LIN	TP38	PTB1
TP26	VDDA	TP39	PTB0
TP28	VTEMP	TP41	GND
TP29	TSUP	TP42	VDDL
TP30	GND	TP45	RST_A*
TP31	ISENSEL	TP46	RESET*
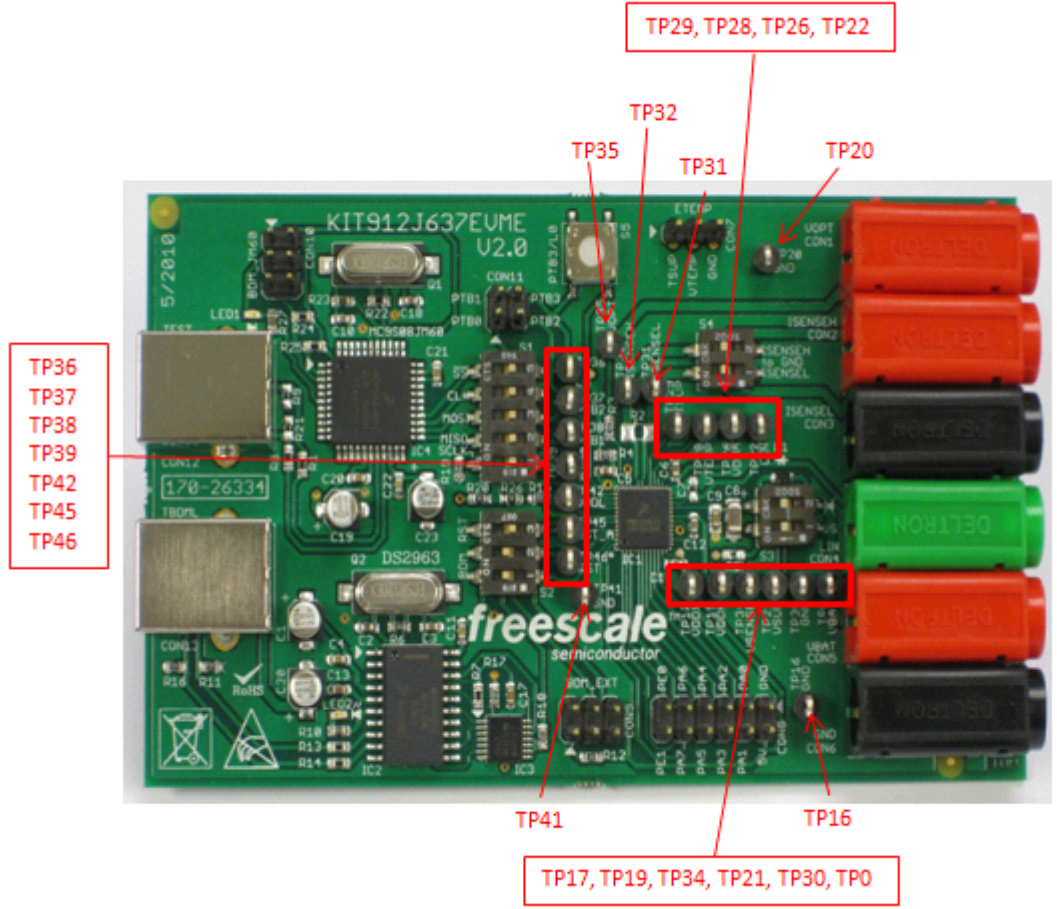
Figure 6. Test Point Locations

7 Software Description

7.1 Important Notes on Programming and Debugging of the Board

7.1.1 Hardware Considerations

During device programming the switch configuration for S2 should conform to the settings in Table 2 for either TBDML or BDM programming respectively. The minimum supply voltage during the programming and debugging is 8.0 V.

In normal operation, RESET and RESET_A must be connected by setting S2-3 "ON".

NOTE: While the EVB is being programmed, if TBDML is not used for debug, it is recommended to switch off TBDML.

7.1.2 Programming and Debugging Via the TBDML Interface

A TBDML interface is placed on the kit board for programming/debugging of the board. It is necessary to install TBDML supporting files (USB driver, interface DLL, GDI DLL plug-in for the Freescale's Hi-wave debugger) and implement modifications in the settings of the CodeWarrior Hi-wave debugger, to be able to program/debug the board. The enclosed CD contains documentation and complete source files to this open source tool. Read the *tbdml_manual_15.pdf* (user's manual), especially the *3.2 Installing Windows Drivers* section, and follow the listed instructions. Omit the jumper J2 settings. This refers to another board. Installation is easy and does not require any special skills.

7.1.3 Software Included on the CD

A basic template is included on the CD in the MM912J637 folder. It initializes the MM912J637 and provides a framework for evaluation. CodeWarrior must be installed on your system before opening this template.

To install, copy and paste the subfolder KIT912J637_Template onto your desktop or other other appropriate local location. Open the subfolder and double click on the CodeWarrior project file titled "KIT912J637_template.mcp." This will open the template in the CodeWarrior environment.

The code may be downloaded to the EVB using TBDML or a programmer such as the PE Micro Cyclone Pro.

8   Schematics
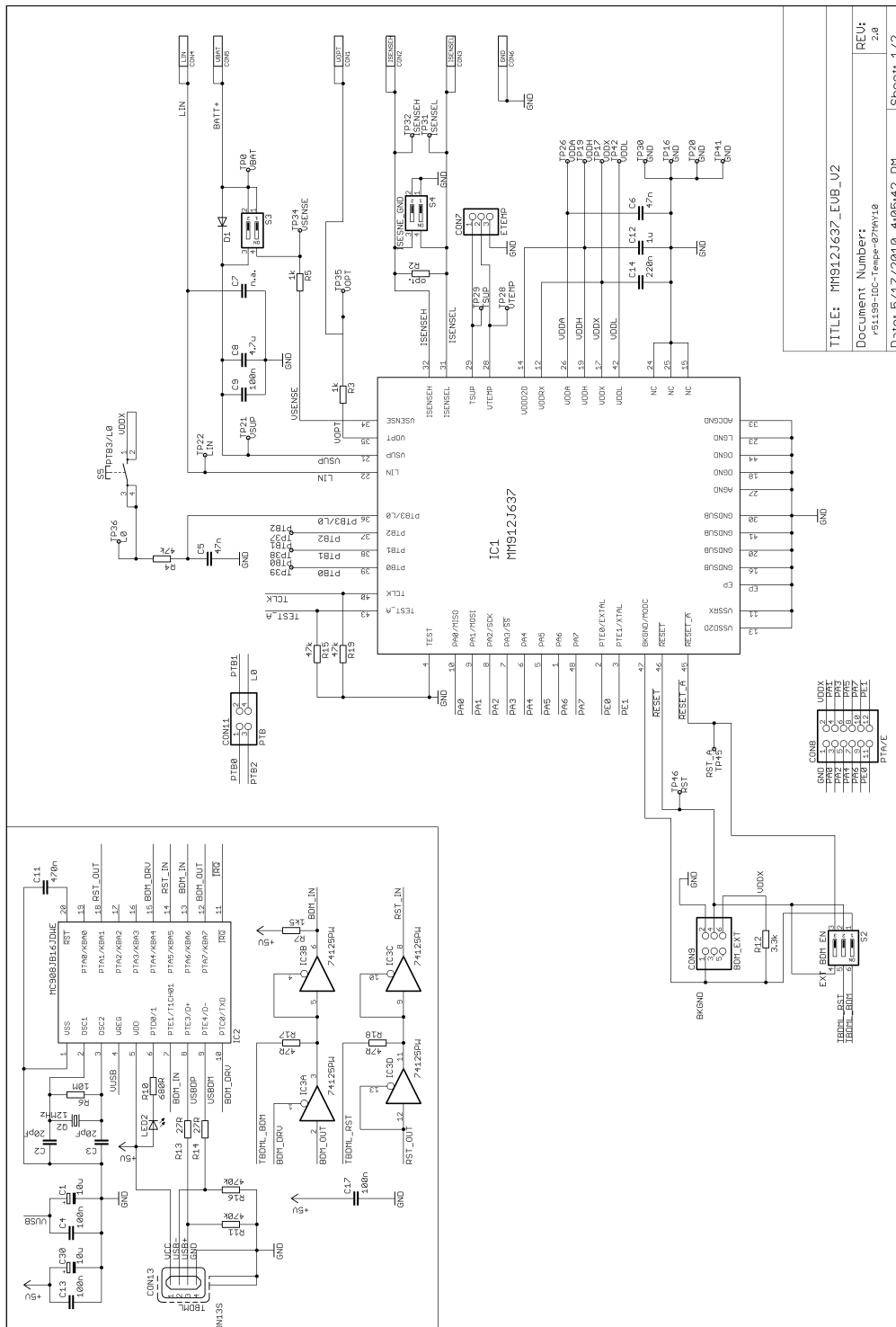
Figure 7. KIT912J637EVME Schematic 1

Figure 8. KIT912J637EVME Schematic 2

9   Board Layout
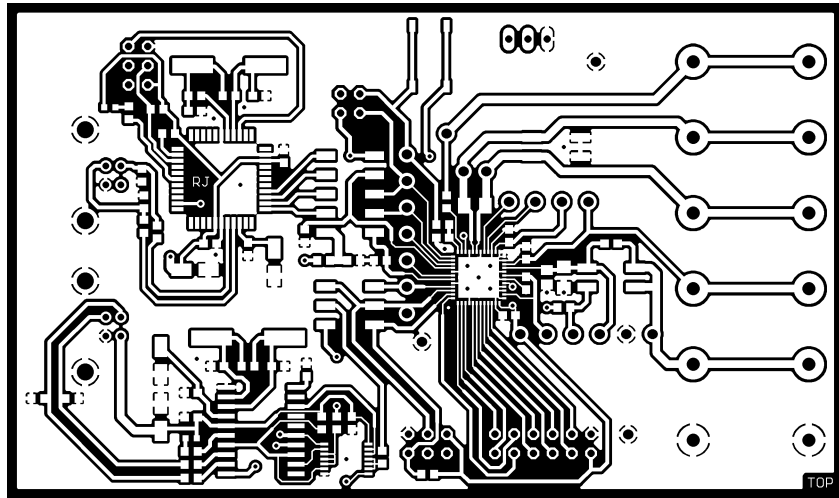
Figure 9. Top Copper Layer
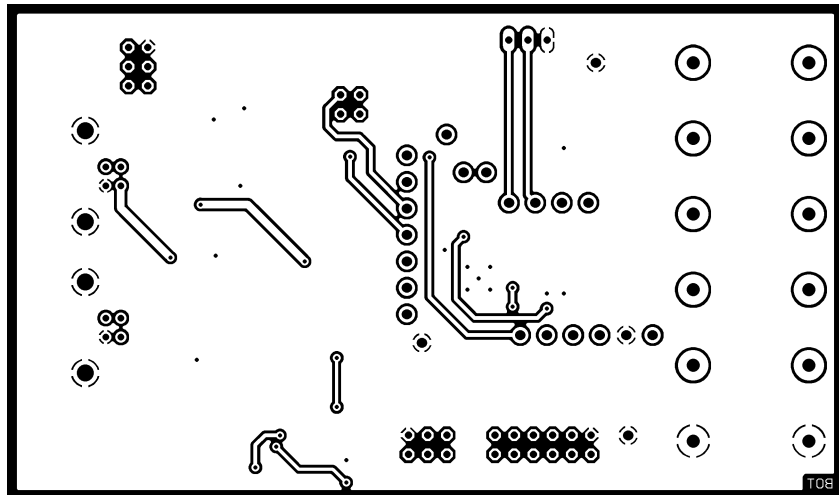
Figure 10. Bottom Copper Layer (from bottom)

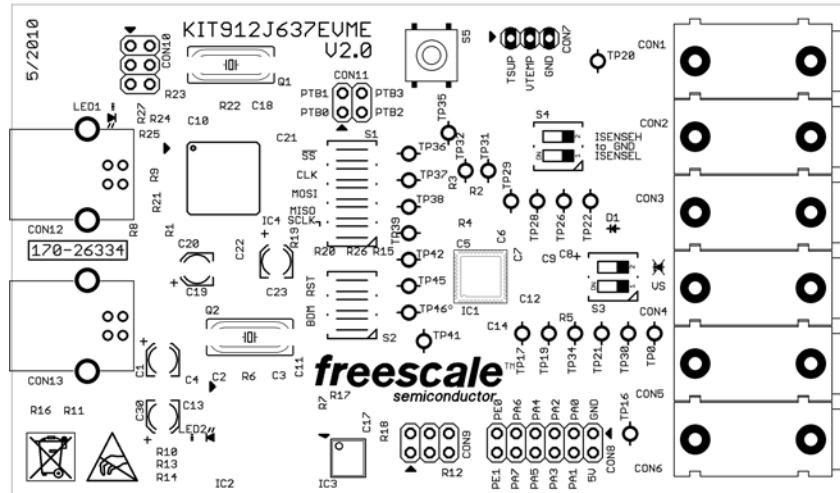**Figure 11. Top Silk-screen Layer**

Table 12. Part List - KIT912J637EVME - V2.0

S4	219-02J	CTS-219-02J	219-2LPSTJ	2/2
S5	PTB3/L0	Key switch (check dim!)	CKN9362-ND	1/1
TP0	VBAT	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	1/23
TP16	GND	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	2/23
TP17	VDDX	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	3/23
TP19	VDDH	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	4/23
TP20	GND	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	5/23
TP21	VSUP	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	6/23
TP22	LIN	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	7/23
TP26	VDDA	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	8/23
TP28	VTEMP	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	9/23
TP29	TSUP	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	10/23
TP30	GND	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	11/23
TP31	ISENSEL	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	12/23
TP32	ISENSEH	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	13/23
TP34	VSENSE	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	14/23
TP35	VOPT	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	15/23
TP36	L0	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	16/23
TP37	PTB2	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	17/23
TP38	PTB1	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	18/23
TP39	PTB0	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	19/23
TP41	GND	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	20/23
TP42	VDDL	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	21/23
TP45	RST_A	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	22/23
TP46	RST	TESTPOINT-BLK,1.4 mm drl	5118K-ND (chk drill!)	23/23
FEED1…4	Rubber feet	SJ-5003 (BLACK) 11.2 mm	SJ5003-0-ND	4x

11 References

provides URLs where you can obtain information on other Freescale products and application solutions.

Table 13. References

Products	Links
Data Sheet MM912_637	www.freescale.com/files/analog/doc/data_sheet/MM912_637D1.pdf
Freescale's Web Site	www.freescale.com
Freescale's Analog Web Site	www.freescale.com/analog
Freescale's Power Management Web Site	www.freescale.com/powermanagement

12 Revision History

Table 14. Revision History

Revision	Details
1.0	First Release.

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