Freescale Semiconductor
User's Guide

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KIT912H634EVME Evaluation Board

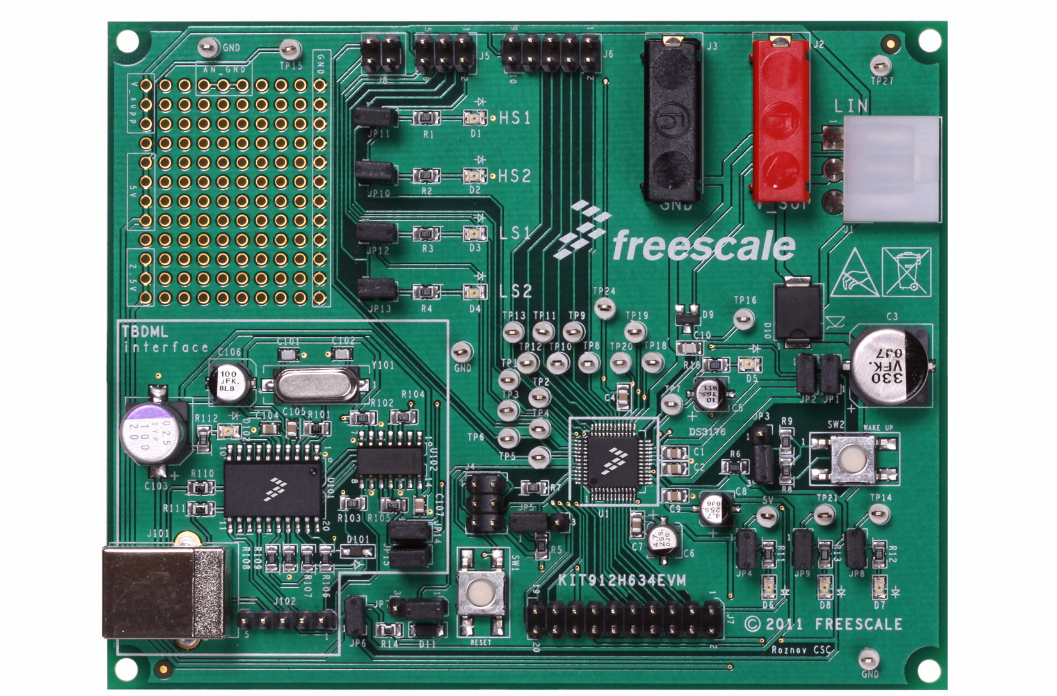

Figure 1. KIT912H634EVME Evaluation Board

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1 Kit Contents / Packing List

- MM912H634 Evaluation Board (EVB)
- Cable, 6.0 FT. USB2.0 A-M to B-M
- Warranty Card, Freescale
- CD912H634 - Contains Freemaster and CodeWarrior software

2 Important Notice

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3 Introduction

Freescale Semiconductor's KIT912H634EVME is a system solution which gives the user the capability to easily evaluate most of the features provided by the MM912H634 - Integrated Dual Low Side, and Dual High Side Switch with Embedded MCU and LIN Transceiver for Relay Drivers. The MM912H634 features 2 die in a single package. The 16-bit core and the analog die are connected by means of the Die to Die interface, which provide direct address access to the registers on the analog die. The analog die contains HS and LS switches, as well as a PWM module, ADC module, 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 can be powered either from two 4.0 mm banana connectors or from the LIN connector. For quick familiarization with the device, a graphical user interface, based on FreeMASTER software, is provided together with the module. Thanks to the GUI, the user can easily evaluate the peripheral modules, or directly access the registers on the analog die.

This kit covers two devices: the MM912G634 and the MM912H634. These devices are identical except for memory size, as noted in MM912_634 Features. The EVB utilizes the MM912H634. All references in this manual refer to that device, but apart from those relating to memory size, apply equally to the MM912G634.

3.1 MM912_634 Features

- 16-Bit S12 CPU, 48 kbyte (MM912G634) or 64 kByte (MM912H634) FLASH, 2.0 kByte RAM
- Background debug (BDM) & Debug module (DBG)
- Die to Die bus interface for transparent memory mapping
- On-chip oscillator & two independent watchdogs
- LIN 2.1 Physical layer interface with integrated SCI
- Eight digital MCU GPIOs shared with SPI (PA7…0)
- 10-Bit, 15 Channel - Analog to Digital Converter (ADC)
- 16-Bit, 4 Channel - Timer Module (TIM16B4C)
- 8-Bit, 2 Channel - Pulse width modulation module (PWM)
- Six high voltage / Wake-up inputs (L5.0)
- Three low voltage GPIOs (PB2.0)
- Low power modes with cyclic sense & forced wake-up
- Current sense module with selectable gain
- Reverse battery protected voltage sense module
- Two protected low side outputs to drive inductive loads
- Two protected high side outputs
- Chip temperature sensor
- Hall sensor supply
- Integrated voltage regulator(s)

3.2 Warnings

1. When working with the kit, always use an isolated laboratory power supply.
2. 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 EDS events can destroy or damage the device, or cause its malfunction.

3.3 Acronyms

Acronym	Explanation	Acronym	Explanation
D2D	Die to Die bus interface	**MCU**	Microcontroller unit
BDM	Background debug module	**HS**	High side (switch)
EVB	Evaluation board	**LED**	Light emitting diode
EVM	Evaluation module	**LIN**	Local **Interconnect Netw**ork
ESD	Electrostatic discharge, electrostatic sensitive device	**LS**	Low side (switch)
GND	In this document: main supply ground	**PWM**	Pulse width modulation
GPIO	General purpose input/output	**SCI**	Serial communication interface
GUI	Graphical user interface	**TBDML**	Turbo BDM lite
ADC	Analog to Digital converter		

4 Required Equipment

- PC Computer running Windows XP or higher
- 12 V Power Supply
- Cable, 6.0 FT. USB2.0 A-M to B-M (supplied)
- CD912H634 - Contains Freemaster and CodeWarrior software

5 Setup Guide

5.1 Hardware Setup

Setup and connections for the KIT912H634EVME are straightforward.

The KIT912H634EVME 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.

To set up the board, perform the following steps:

1. Plug the USB cable into the connector J101, and connect the other end of the cable to the PC or notebook. A basic jumper configuration is required to be able to use the KIT912H634EVME. See Table 1 for details. Table 2 provides a complete index of jumper settings.
2. Connect a laboratory power supply via banana connectors to the board, using J2 (V_S supply) and J3 (GND). Alternatively, the LIN connector can be used for powering the board. The supply voltage has to be in the range of 8.0 to 18 V. When power is applied to the KIT912H634EVME, the green power-on LEDs D6 (+5.0 V), D7 (supply), and D8 (+2.5 V) are lit when power is present and the corresponding jumpers JP4, JP8, JP9 are closed.

Table 1. KIT912H634EVMEJumper Options for Basic Functionality

#	Function	Connections
JP1	Supplying of the device logic (VDDX regulator) and hall sensor supply regulator enabled	closed
	Supplying of the device logic (VDDX regulator) and hall sensor supply regulator disabled	open
JP2	Supplying of the HS drivers enabled	closed
	Supplying of the HS drivers disabled	open
JP14	BDM signal from TBDML interface enabled	closed
	BDM signal from TBDML interface disabled, external BDM interface can be used (connected to J4)	open
JP15	RST signal from TBDML interface enabled	closed
	RST signal from TBDML interface disabled, external BDM interface can be used (connected to J4)	open

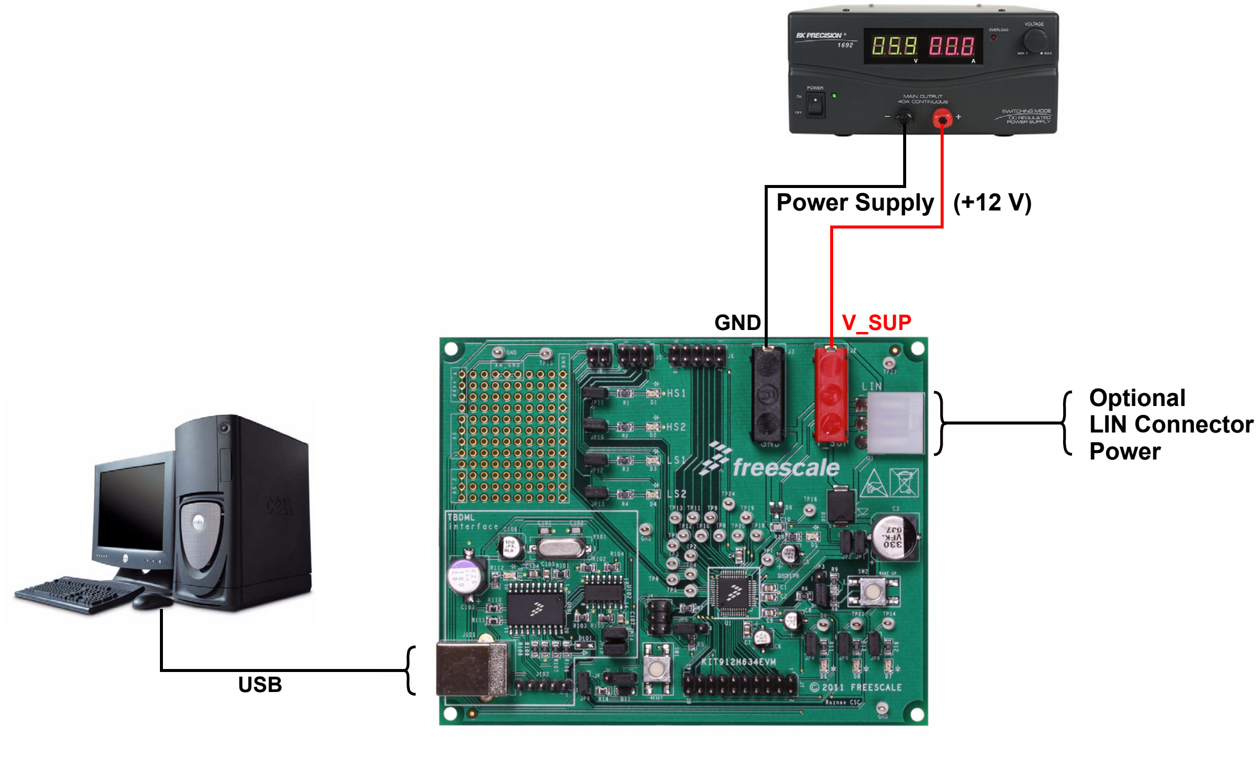

Figure 2. KIT912H634EVME Basic Hardware Setup

6 Hardware Description

6.1 Board Description

Figure 3 illustrates the EVM with key component and connector locations.

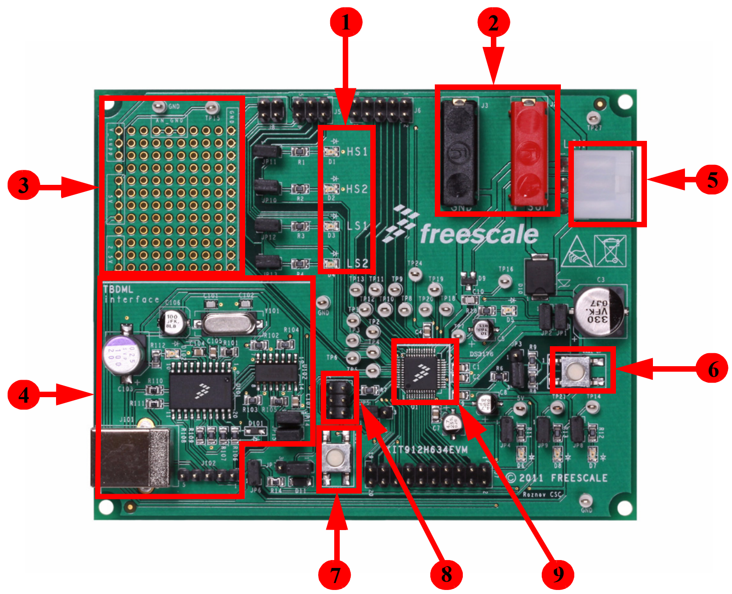

Figure 3. Evaluation Module Board

The following list corresponds with the numbers listed on the picture.

1. LEDs to indicate HS and LS switching
2. Input power connectors
3. Prototype area
4. TBDML interface
5. LIN connector
6. Wake-up button
7. Reset button
8. BDM connector for external programming/debugging BDM interface
9. MM912H64CV1AE

The board is protected against reverse battery voltage by diode D10, which can withstand up to 3.0 A of continuous current. The board operation is straightforward. Along with the TDBML interface (See TBDML on page 10), the board contains the passive components required for proper operation of the MM912H634. Connectors provide access to all device pins and test points for important signals.

There are fifteen jumpers on the board. Power to the LEDs is provided through jumpers JP4, JP8, JP10, JP11, JP12, and JP13. Removing these jumpers allows low power mode current consumption to be demonstrated. JP6 supplies power to zener diode D11.

Two push buttons are included: SW1 resets the MCU, and SW2 allows wake-up from one of the low power modes.

A small prototype area allows fast connection of additional components. Key power and ground vias are located around the prototype area.

The EVM has three different grounds: LIN ground, main supply ground (also referred to as GND), and analog ground. All grounds are connected together at a single point on the board, located under the MM912H634. The bottom copper layer of the EVM and copper areas on the top surface are both assigned to GND.

6.1.1 MCU

The MM912H634 is a single package solution that integrates an HCS12 microcontroller with a SMARTMOS™ analog control IC, interfacing via the new high performance Die-to-Die Interface (D2D). The D2D controlled analog die combines system basis chip and application specific functions, including a Local Interconnect Network (LIN) transceiver.

The D2D Interface realizes the advantage of a seamless MCU register map, integrating the analog die registers, while providing faster access than SPI based systems. The HCS12 includes 32 k of flash memory, 2.0 k of RAM, and a special Die-to-Die interface, serial peripheral interface (SPI), real time interrupt (RTI), computer operating properly (COP), and an internal clock generator module. The analog die provides two high side and two low side outputs with diagnostic functions, voltage regulators for a 5.0 V and 2.5 V MCU supply, window watchdog, current sense amplifier, four channel timer (TIM), two channel pulse width modulation (PWM) capability, 10 bit analog to digital converter (ADC), battery voltage sense (VSENSE), and local interconnect network (LIN).

The MM912H634 has three main operating modes: Normal (all functions available), Sleep (V_{DD} off, Wake-up via LIN, Wake-up inputs (L0-L5), Cyclic Sense, and Forced Wake-up), and Stop (V_{DD} on with limited current capability, Wake-up via LIN bus, Wake-up inputs (L0-L5), Cyclic Sense, forced Wake-up, and 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 SW tools to communicate with the microcontroller, and download code into its on-chip flash, etc. Among the benefits of using the TBDML on the EVM, is a much higher communication speed than other USB/BDM interfaces. It is also unnecessary to connect external devices to the EVM when programming/debugging is needed.

A BDM connector (J4) is placed on the EVM to allow the connection of another BDM tool. In this case, the jumpers JP14 and JP15 should be removed to disable the TBDML interface.

6.2 Jumper Settings

Figure 4 illustrates the EVM with location of all jumpers. Table 2 summarizes the jumper settings.

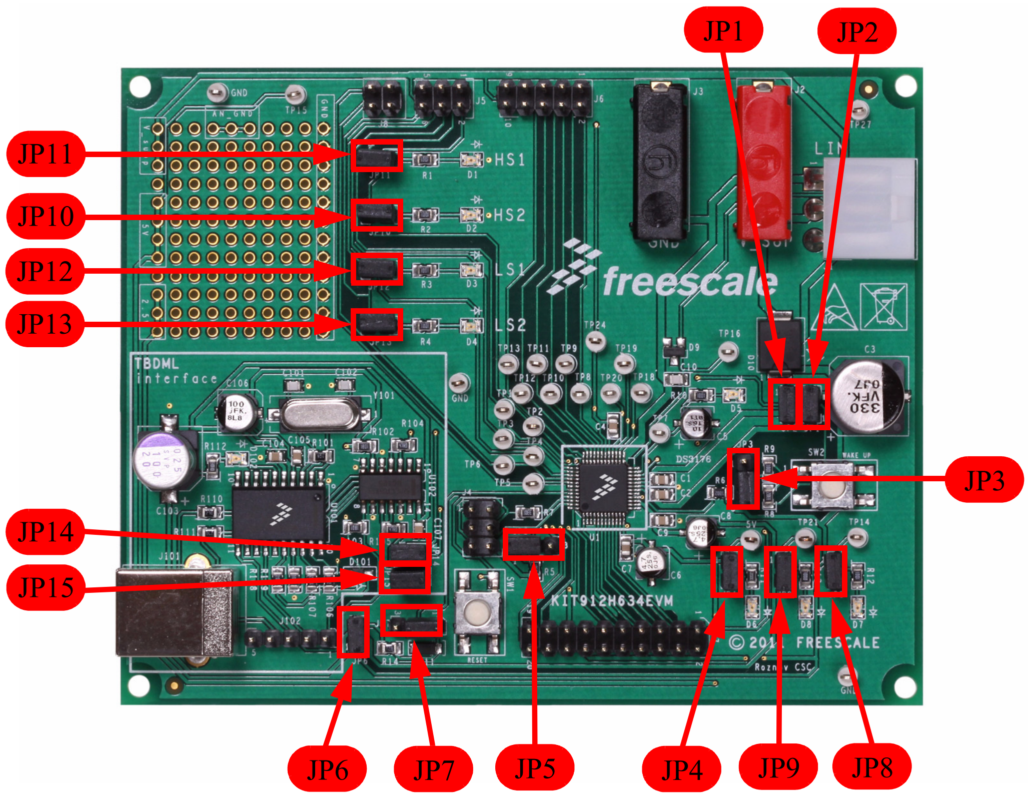

Figure 4. Position of Jumpers on the EVM

Table 2. Jumper Setting

#	Function	Connections
JP1	Supplying of the device logic (VDDX regulator) and Hall sensor supply regulator enabled	closed
	Supplying of the device logic (VDDX regulator) and Hall sensor supply regulator disabled	open
JP2	Supplying of the HS drivers enabled	closed
	Supplying of the HS drivers disabled	open
JP3	Wake-up pin L0 connected to HS1 output	1-2
	Wake-up pin L0 connected to wake-up button SW2	2-3
JP4	VDDX output voltage (+5.0 V) connected to LED D6	closed
	VDDX output voltage (+5.0 V) not connected to LED D6	open
JP5	BKGD/MODC pin connected to +5.0 V via a 3.0 k pull-up resistor	1-2
	BKGD/MODC pin connected to GND	2-3
JP6	Supply voltage is connected to Zener diode D11	closed
	Supply voltage is not connected to Zener diode D11 (when the current consumption of the device in low power modes is demonstrated).	open

Table 2. Jumper Setting

#	Function	Connections
JP7	TCLK pin (#44) is connected to 8.0 V (also jumper JP6 has to be inserted and the board has to be powered at least with 8.0 V) to disable of the watchdog.	1-2
	TCLK pin (#44) is connected to GND	2-3
JP8	Supply voltage (+5.0 to 18 V) is connected to LED D8	closed
	Supply voltage (+5.0 to 18 V) is not connected to LED D8	open
JP9	VDD output voltage (+2.5 V) is connected to LED D8	closed
	VDD output voltage (+2.5 V) is not connected to LED D8	open
JP10	Diode D2 is connected to output HS2	closed
	Diode D2 is not connected to output HS2	open
JP11	Diode D1 is connected to output HS1	closed
	Diode D1 is not connected to output HS1	open
JP12	Diode D3 is connected to output LS1	closed
	Diode D3 is not connected to output LS1	open
JP13	Diode D4 is connected to output LS2	closed
	Diode D4 is not connected to output LS2	open
JP14	BDM signal from TBDML interface enabled	closed
	BDM signal from TBDML interface disabled, external BDM interface can be used (connected to J4)	open
JP15	RST signal from TBDML interface enabled	closed
	RST signal from TBDML interface disabled, external BDM interface can be used (connected to J4)	open

6.3 Connector Description

There are 10 connectors on the EVM. A list of the connector and pin assignments are in the following paragraphs.

In the following tables, the “Supply voltage” is meant to supply a voltage protected against a reverse polarity by diode D10.

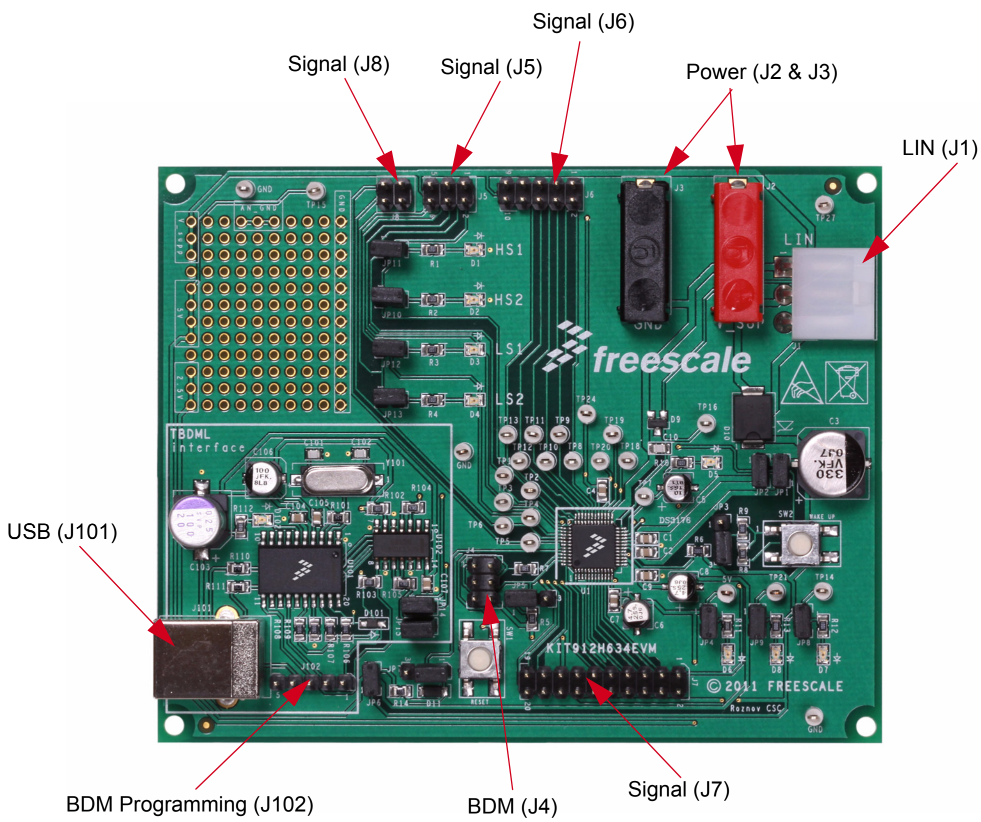

Figure 5. Connectors

6.3.1 Connectors

Connector	Location
LIN Connector	J1
Power Connector	J2 & J3
BDM Connector	J4
Signal Connectors	J5, J6, J7 &J8
USB Connector	J101
BDM	J102

6.3.2 LIN Connector J1

The LIN connector allows a connection to the LIN bus, and provides alternate power to the board. It is a MOLEX multi-pole connector 39-30-3035 (4.20 mm pitch, right angle), and its mating part is MOLEX 39-01-4030.

Table 3. LIN Connector J1

Pin #	Description
1	LIN GND
2	Supply voltage
3	LIN bus

6.3.3 Power Connectors J2, J3

Power connectors J2 (positive supply - red) and J3 (ground - black) are sockets for widely used 4.0 mm banana jacks.

6.3.4 BDM Connector J4

A standard BDM connector (header 2x3, 2.54 mm (0.1") pitch) is placed on the EVB, to provide the user an external BDM programming/debugging interface connection. The pin assignment is listed in Table 4.

Table 4. BDM Connector

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

6.3.5 Signal Connector J5

Connector J5 is the header type 3x2, 2.54 mm (0.1") pitch. Table 5 shows the pin assignments.

Table 5. Signal Connector J5

Pin #	Description
1	HS1 output
2	HS2 output
3	GND
4	LS1 output
5	LS2 output
6	Supply voltage

6.3.6 Signal Connector J6

The connector type is header 2x5 pins, 2.54 mm pitch. Pin assignment is listed in Table 6.

Table 6. Signal Connector J6

1	HS1 output
2	Wake-up/analog input L0
3	Wake-up/analog input L1
4	Wake-up/analog input L2
5	Wake-up/analog input L3
6	Wake-up/analog input L4
7	Wake-up/analog input L5
8	Supply voltage
9	GND
10	Analog ground

6.3.7 Signal Connector J7

Signal connector J7 contains the ports PTA and PTB, and the output of the Hall sensor supply regulator. Supply voltage, the VDDX regulator output (+5.0 V), and the analog and main supply ground are connected as well. Physically, the connector J7 has 2 rows of pins, with 0.1” pitch.

Table 7. Signal Connector J7

1	Hall sensor supply regulator output
2	GND
3	PA0
4	PA1
5	PA2
6	PA3
7	PA4
8	PA5
9	PA6
10	PA7
11	PTB1
12	Analog ground
13	PTB2
14	Supply voltage
15	VDDX (+5.0 V)
16	GND
17	PTB0
18	PTB1
19	PTB2
20	Analog ground

6.3.8 Signal Connector J8

The J8 connector is header type 2x2, 0.1” (2.54 mm) pitch.

Table 8. Signal Connector J8

Pin #	Description
1	ISENSE low
2	Analog ground
3	ISENSE high
4	Analog ground

6.3.9 USB Connector J101

Connector J101 is a standard USB connector type B. It enables connection of the EVM to a PC or notebook.

Table 9. USB Connector J9

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

6.3.10 TBDML Programming Connector J102

Connector J102 enables programming of the TBDML firmware in EVM production.

6.4 Test Points

There are 27 test points on the EVM. The schematic is marked with reference numbers, as well as signal names. The board is only marked with signal names. The following Table 10 summarizes the test points.

Table 10. Test Points

Reference designator	Signal name	Reference designator	Signal name
TP1	HS1	TP14	$V_{\_SUPP}$
TP2	HS2	TP15	+5.0 V (VDDX out)
TP3	LS1	TP16	LIN
TP4	LS2	TP18	AD0
TP5	ISENSE_H	TP19	AD1
TP6	ISENSE_L	TP20	AD2
TP7	Hall SUP	TP21	2.5 V (VDD out)
TP8	L0	TP22	+5.0 V (VDDX out)
TP9	L1	TP23	GND
TP10	L2	TP24	AN_GND
TP11	L3	TP25	GND
TP12	L4	TP26	GND
TP13	L5	TP27	GND

7 Software Description

7.1 Software Setup

The KIT912H634EVME is designed to communicate with a PC or notebook (as the master) via the USB interface. The communication is bidirectional. The orders are sent from master, and the status information is sent from the slave (kit) to the master. The communication methods are described in Figure 6. In order to enable this communication, specific software has to be installed on the PC.

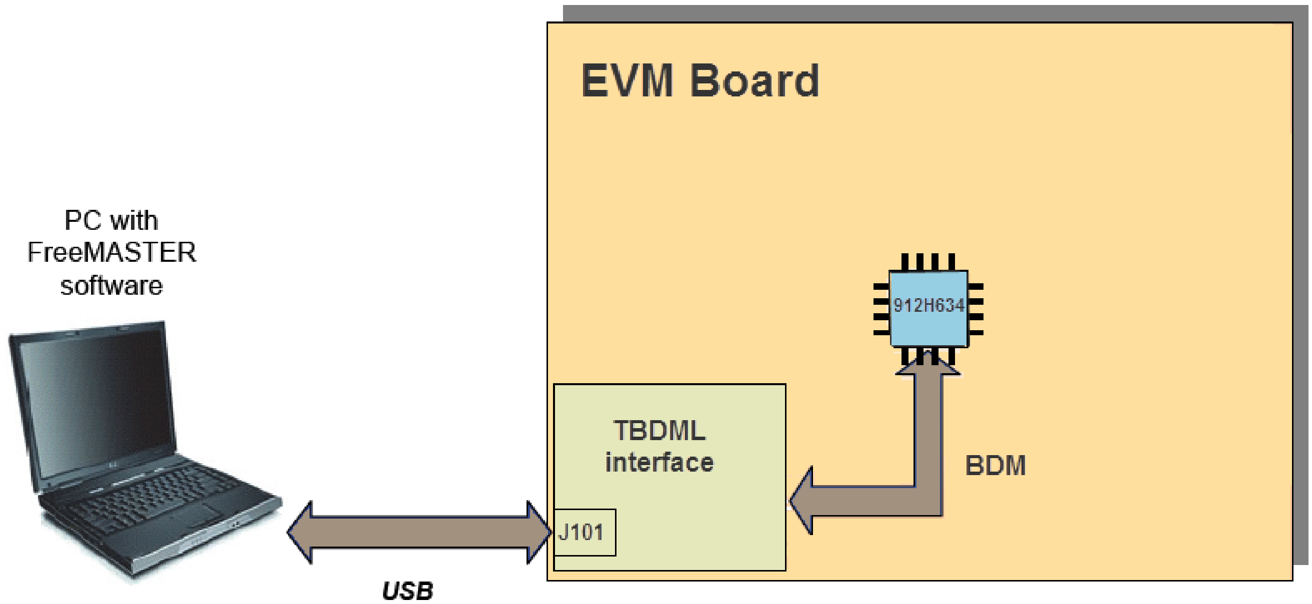

Figure 6. Communication Between the PC and the Target

The software which enables the communication with the EVM, must be installed on the PC as FreeMASTER. More information about this software can be found in the FreeMASTER Graphical User Interface.

7.1.1 FreeMASTER Software Installation

Before first running the application, it is necessary to install the FreeMASTER software from the included CD on the PC or notebook.

System Requirements - PC Side

- Computer: 486DX/66 MHz or higher processor
- Operating system: Microsoft Windows XP, Windows 2000, WindowsNT4 with SP6, Windows 98
- Required software: Internet Explorer 4.0 or higher. For selected features (e.g. regular expression-based parsing), Internet Explorer 5.5 or higher is required
- Hard drive space: 8.0 MB

Since the control page requires large data transfer (especially to display the analog values in real time), it is advisable to use a computer with a powerful processor.

After the execution of the following file "*fmaster13-9.exe",* the FreeMASTER application will install on the computer. Follow the installation instructions for successful installation.

7.1.2 FreeMASTER Software Setup

After the application installation, the program is ready for use. To run the program, perform the following:

1. Double click on the ***MM912H634_master.pmp*** file (\CD\Quest_CD\BDM GUI). This file already contains all necessary settings. Ensure that the folder \src is placed in the same directory as the ***MM912H634_master.pmp*** file. The \src folder holds the HTML control page, java script file, and the binary file with the information on the project variables.

NOTE: In order to run FreeMASTER with the MM912H634, the correct firmware must first be compiled and uploaded in the MM912H634 flash memory. The appropriate Code Warrior project is named ***stationary.mcp***, located in the \EMBSW folder. It can also be accessed via a hyper link on the CD Start Page.

2. Install Code Warrior to open this file.

7.2 Important Notes on Programming and Debugging of the Board

7.2.1 Hardware Considerations

There is a software watchdog on the analog die of the device. The watchdog must be cleared by software, writing certain values into the WDSR register (watchdog service register). Read more about the watchdog in the MM912_634D1 datasheet. During device programming, the watchdog must be disabled, otherwise the programming will not run successfully. To disable the watchdog, a voltage between 7.5 and 10 V has to be applied on pin #44 (TCLK). This can be done by inserting a jumper on JP6 and JP7 (1-2). The minimum supply voltage during the programming and debugging is 8.0 V. A Zener diode (D11) on the board provides 8.1 V.

7.2.2 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, in order 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), mainly the ***3.2 Installing Windows Drivers*** section, and follow the listed instructions**.** Omit the jumper J2 settings. It refers to another board. Installation is easy and does not require any special skills.

7.3 FreeMASTER Graphical User Interface

The installation, application setup, and operating instructions were discussed in previous paragraphs. This section describes the software functionality.

7.3.1 About the FreeMASTER Software

FreeMASTER software (formerly known as PC Master software) is an off board driver supporting communication between the MM912H634 microcontroller and a PC. This tool allows the programmer to remotely control an application in a user-friendly graphical environment, running on a PC. It also provides the ability to view real-time application variables in both text and graphic form. FreeMASTER software is a versatile tool used for multipurpose algorithms and applications. It provides smart features which includes:

- Viewing board application variables - either in the original format, or transformed into a more easily viewable format
- Modifying variable values (in the original or transformed format) to control the board application
- Plotting read variable value changes using the Scope feature
- Plotting fast events using the Recorder feature
- Controlling the target application using application commands
- Adding HTML pages providing help, or descriptions for the target board application features, scopes and recorders, application control, etc.

- Creating a logical tree structure of blocks relating to the various board application functions, and assign their corresponding description pages
- Scope and recorder definitions, and watch grids
- Adding an HTML based Control page that can control the board application, using standard web tools
- More about this tool can be found in application note AN2395 (launch www.freescale.com and type “AN2395” in the keyword search box)

7.3.2 FreeMASTER Software on the Embedded Side

7.3.2.1 General Outline

The default communication interface between the PC and the target microcontroller is the SCI (UART). Several communication plug-ins were created and added to the FreeMASTER application which include:

- JTAG/EOnCE (56F8xxx only)
- BDM (HCS08, HCS12 only)
- OSBDML (HC08, HCS12 only), included TBDML
- CAN Calibration Protocol
- Ethernet, TCP/IP

In order to communicate over the SCI, the FreeMASTER software driver must be included in the CodeWarrior project. It is a set of files that can be downloaded from www.freescale.com for a particular microcontroller family (8-bit MCU S08, 16-bit MCU S12, 16-bit DSC - MC56F8000, 32-bit ColdFire, 32-bit Power Architecture).

Then in the file freemaster_cfg.h, it is necessary to configure the FreeMASTER serial communication driver (to set the SCI module used (base address of the SCI module used), size of buffer, enable/disable recorder or scope, mode of operation (interrupt driven or periodic calling), etc.).

7.3.2.2 FreeMASTER in KIT912H634EVME

Communication between the PC and the embedded application is via the BDM interface. Several benefits can be attained by using this interafce:

- It is not necessary to add the FreeMASTER source files to the embedded application
- it is not necessary to have on-board hardware circuitry for SCI communication over the RS232 interface
- It uses MCU pins dedicated for SCI module for other purposes, or can use the SCI module in the application (LIN communication)

On the negative side, It is necessary to have BDM multi-link connected all the time to the board, and the data flow is slower compared to the UART communication. A constraint also occurs during run or wake-up from low power modes. Because activity of the BDM affects the core behavior during transition from reset to normal mode, sometimes the device does not wake-up properly. For this reason, communication is interrupted by the JavaScript function before the device is put to STOP or SLEEP mode. This feature is emphasized in other places in this document. See sections dedicated to low power modes.

7.3.3 FreeMASTER Software on the PC Side

The MM912H634 EVM application uses only two of the FreeMASTER features - reading and writing a value to the variables on the embedded side. The information on the variable addresses is listed in the binary file Project.abs stored in the \src directory. It is one of the files generated by CodeWarrior during compilation of the embedded software project.

7.3.4 Graphical User Interface

Figure 7 illustrates the FreeMASTER PC application, as seen by the user after the opening of the **MM912H634_master.pmp** file. It is the start page, where the user can choose an approach to the analog die registers. The first possibility is “Die Direct Register Access”, and the second is “Analog Die Modules Access”. Both control pages will be described in the following paragraphs.

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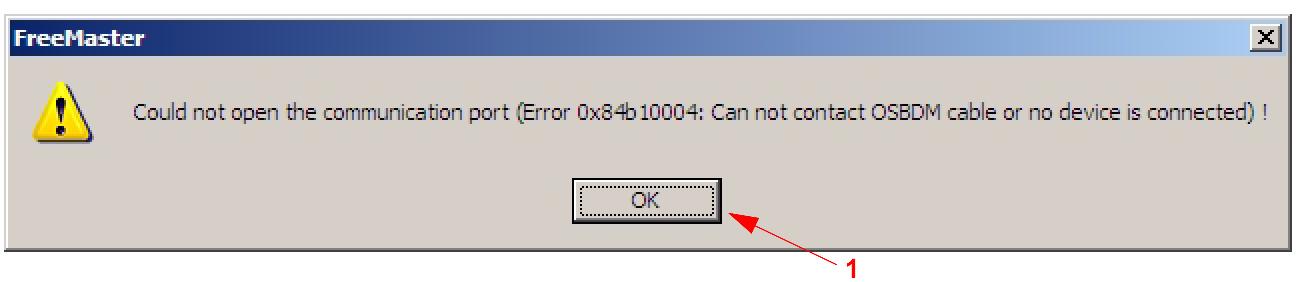
Figure 7. FreeMASTER Start Page

7.3.4.1 Start of the GUI and Troubleshooting

The MM912H634_master.pmp file contains information regarding communication with the slave, as well as the information on the variables and the resource files location. By default, the application starts to communicate with the slave (KIT912H634EVME board) immediately at startup.

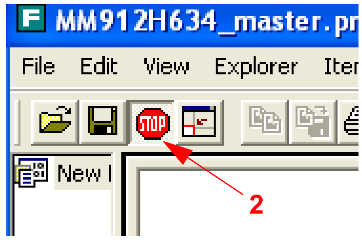
If the slave has no power (USB cable connected, but no supply applied), there will be no special error message displayed. The board will not respond to the commands sent from the GUI.

If the following alert is displayed, the most likely cause is that the USB cable is not connected either to the PC or to the KIT912H634EVME board.



If this is the case, perform the following steps:

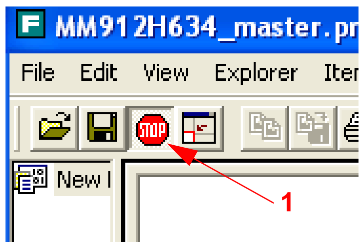
1. Connect the USB cable to the PC and the free end to the KIT board and click **OK**.
2. Press the **STOP** button in the FreeMASTER toolbar to restart the communication.



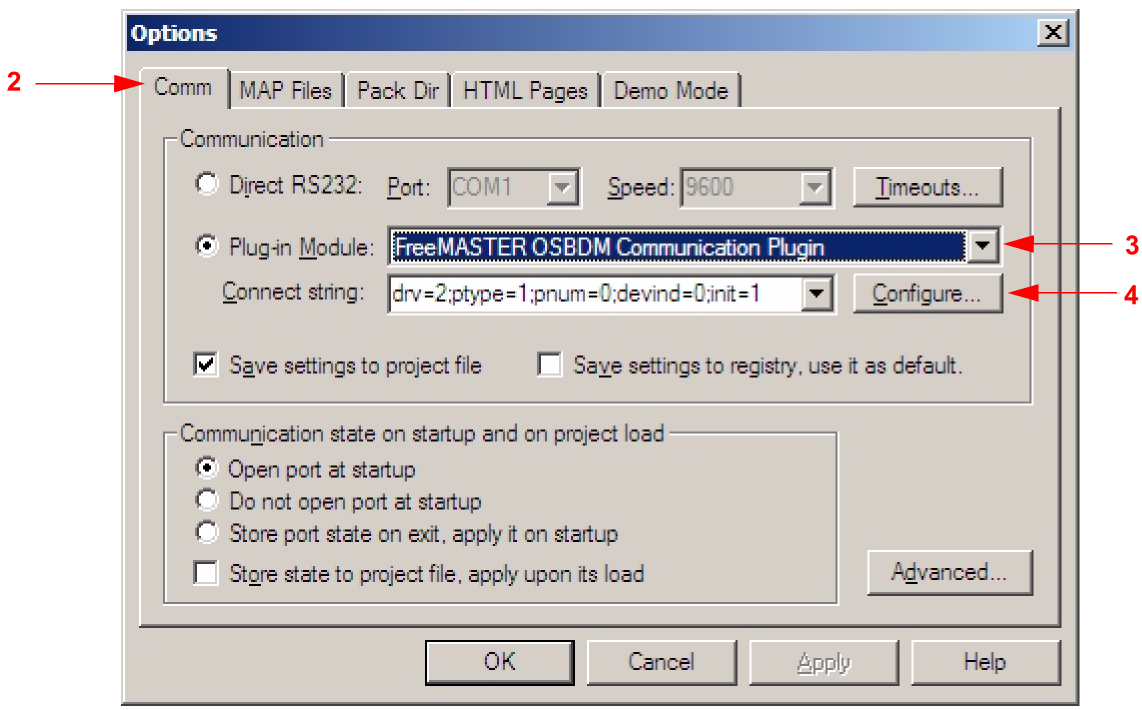
If the USB cable is properly connected, the green LED D102 will be blinking.

If the green LED D102 lights permanently, then there is no communication currently running. To restore communication, perform the following steps:

1. Press the **STOP** button in the FreeMASTER toolbar.



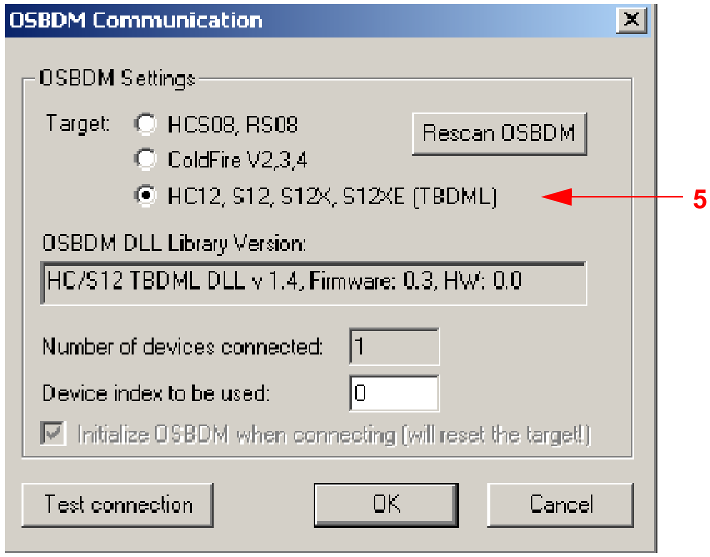
2. If this action does not help, click in the menu **Project/Options**, and within the dialog window, select the **Comm** tab. Check if the correct communication state is selected.



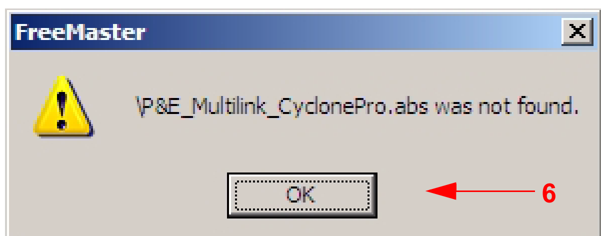
3. The **FreeMASTER OSBDM Communication Plug-in** must be selected from the pull-down menu of the **Plug-in Module**.

4. Click the **Configure** button.

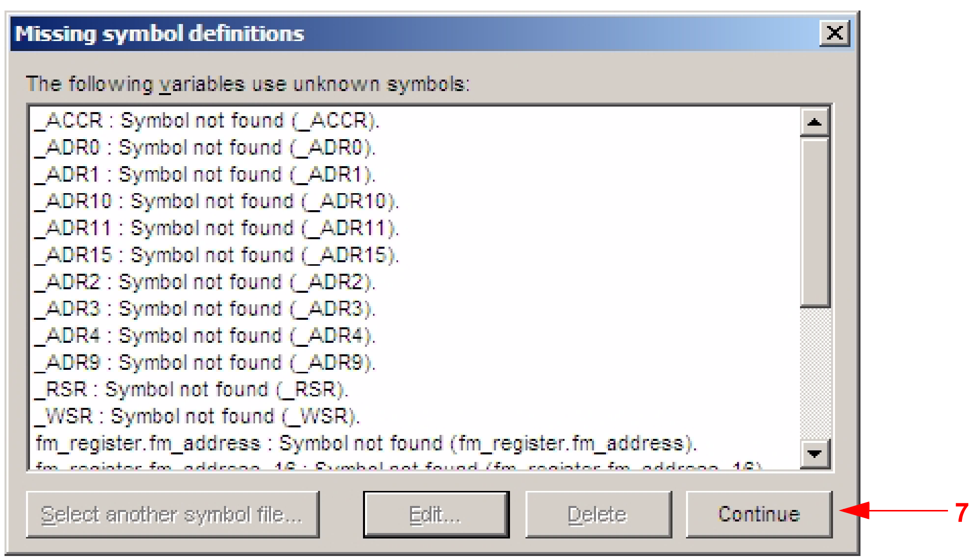
5. The OSBDM Settings dialog window opens. Check if additional setting is correct.



The following below alert will display if there is an additional issue with the incorrect path to the source files.

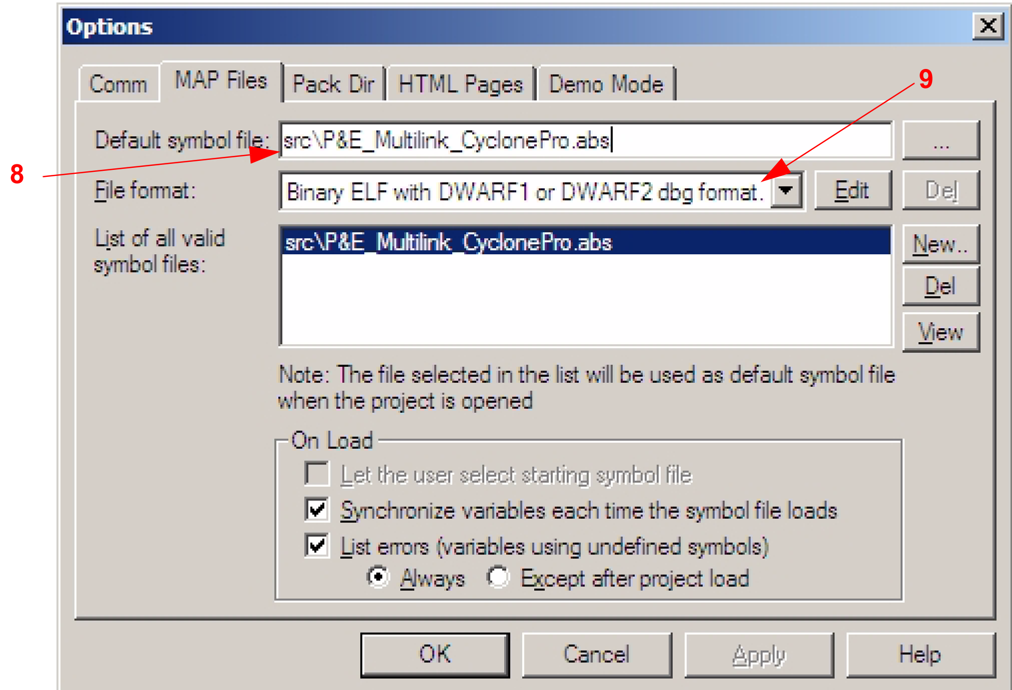


6. Click the **OK** button. The following window appears.

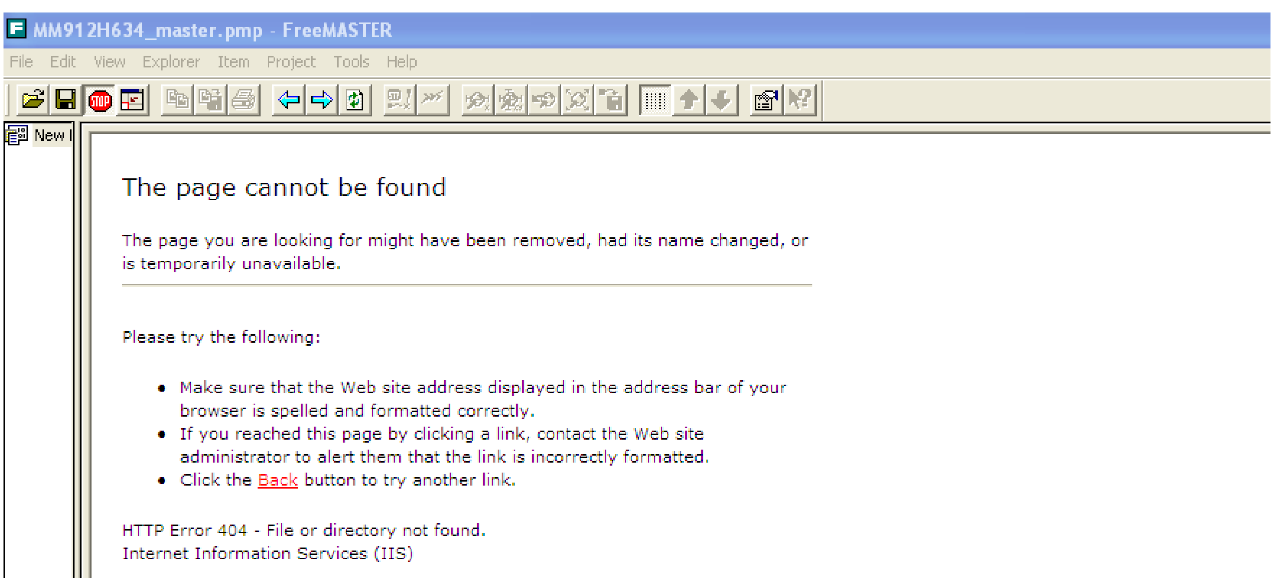


7. Click the "**Continue**" button and check the correct path to the source files on the **Project/Options** menu.

8. Click on the menu **Project/Options**, and then in the dialog window, select **MAP Files** tab. The ***P&E_Multilink_CyclonePro.abs*** file must be located in the "**\src**" directory together with the HTML files.
9. Check the proper selection of the file format ("**Binary ELF with DWARF1 or DWARF2 dbg format**").

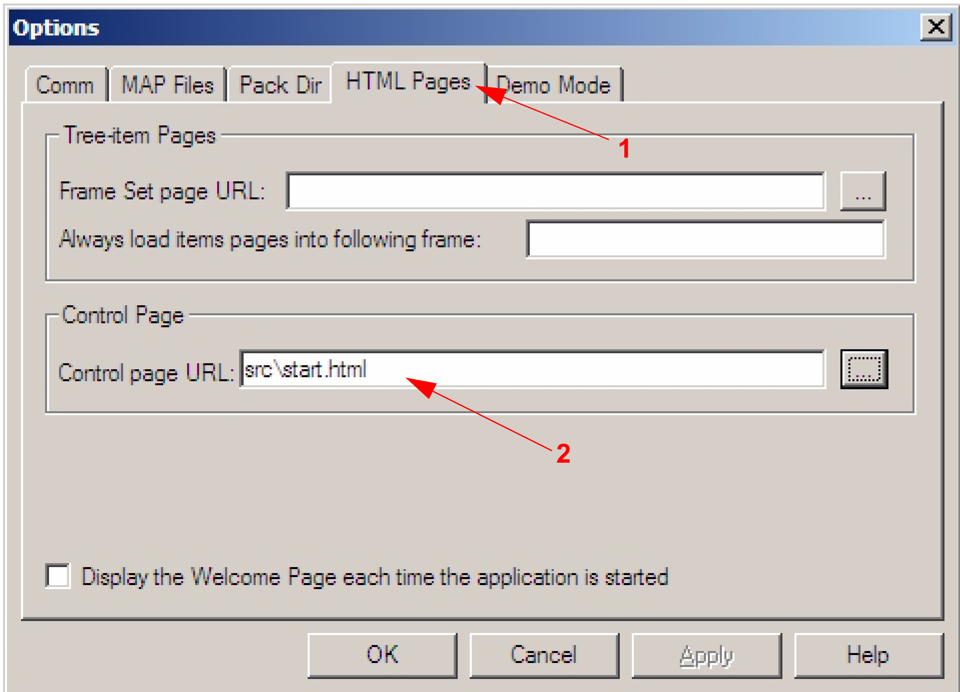


If the start control page does not look the same as depicted in Figure 7 in this section, and you see the following error screen, then there is a problem with the location of the source files.



To resolve this condition, you will need to perform the following steps:

1. Click on the menu **Project/Options**, then within the dialog window select the **HTML Pages** tab.
2. Select the correct path to the **start.html** file. It should be located in the "**\src**" directory together with "*.abs" file and the other HTML pages: **modules.html** and **registers.html**.



7.3.4.2 FreeMASTER Direct Register Access Page

Figure 8 shows the FreeMASTER Direct Register Access control page. The user can read the contents of all registers, as well as write allowable values to the registers. To enter the value, the user can either click on the button representing the register bit (with the bit name), or write the number in the edit box in any number format (dec, hex or bin). There are separate buttons for writing or reading each register. Some registers (mostly related to the ADC) allow only 16-bit access, therefore there is one big button for reading and writing high and low byte as single 16-bit value. There are also registers that cannot be modified. In such cases, the button “Write” is disabled. There are almost 100 registers. The registers are divided into 6 tabs, creating logical groups. On the right side of the control panel is a field with common functions. The “Read all registers” button is at the top. There is a group of three radio switches for selection of the number format in which the read values are displayed. The user can enter the register value in any format, regardless of the format selection. The last function in this field is a message box to view the entered number information. If the number is not in a supported format, or is greater than 0xFF, the message “Wrong number” will appear in this message box.

At the top of the control page is a two-line message box showing the BDM protocol error messages.

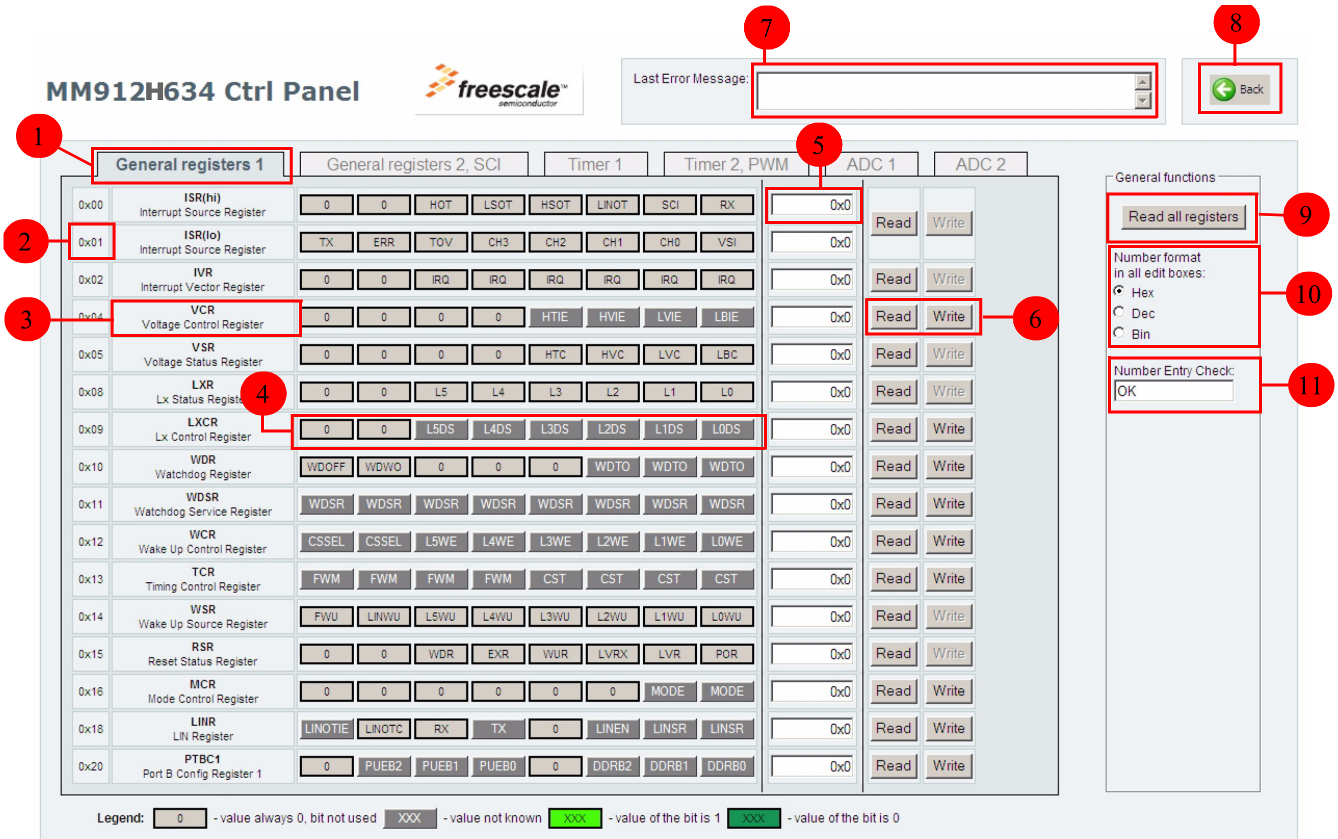


Figure 8. FreeMASTER Direct Register Access Control Page

Table 11. FreeMASTER Direct Register Access Control Page Description

Item	Name and Description
1	Six tabs with registers
2	Register address
3	Register name
4	Bit field - by clicking the button the bit value is toggled
5	Numerical value of the register
6	Read and Write buttons
7	BDM communication error
8	“Back” button to return to the start page
9	“Read all Registers” button
10	Selection of number format for all read register values
11	Message box stating whether the correct register value was entered.

NOTE

Following a write command to the Mode Control Register, communication between the PC and the target over the BDM interface will be terminated. See Low Power Modes - STOP Mode and SLEEP Mode on page 30 for more details.

7.3.4.3 FreeMASTER Analog Die Module Access Page

Figure 9 shows a screen shot of the FreeMASTER control page dedicated to MM912H634 analog die module access. This control page uses another strategy than previously discussed. The user controls the device by accessing the properties of the hardware on-chip module. Each controlled module will be described in more detail.

Table 12. FreeMASTER Modules Access Control Page Description

Item	Name and Description
1	Status field with information about the last reset and wake-up event, as well as the voltage monitor and watchdog enabler
2	LIN module
3	High side, low side switches and PWM control
4	ADC module
5	Low power modes control
6	BDM communication error
7	“Back” button to return to the start page

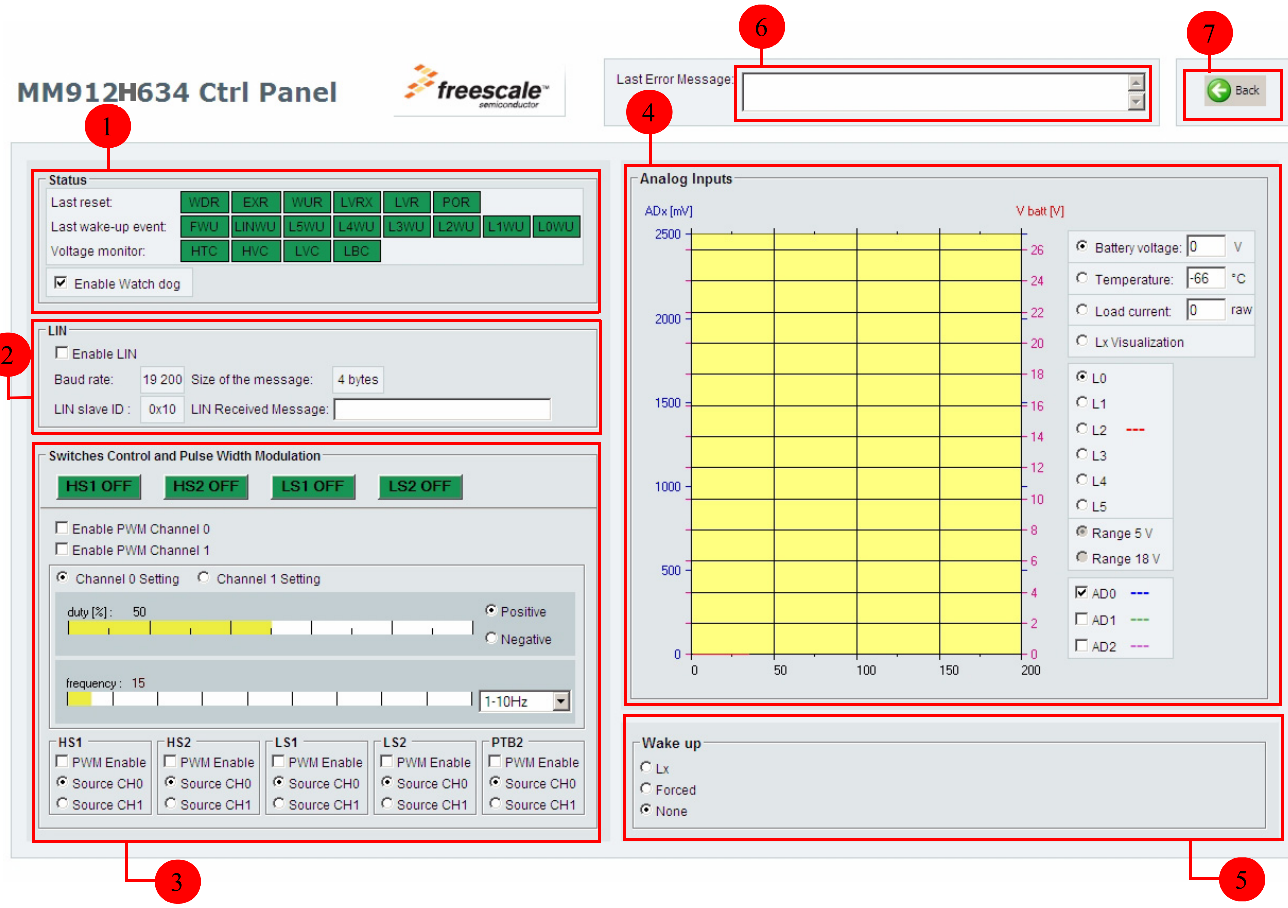


Figure 9. FreeMASTER Modules Access Control Page

7.3.4.4 Status Block

The status block describes the bit fields of the three status registers - Wake-up source register, Reset status register, and Voltage status register. Their description is in the MM912_634D1 datasheet.

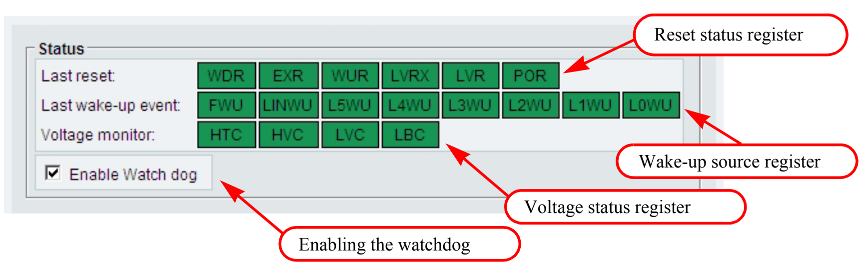


Figure 10. Status Block

The watchdog is enabled after the reset. The user can disable the watchdog, causing the analog die to generate a core reset. The analog die watchdog can be disabled by applying 8.0 V to the TCLK pin .

7.3.4.5 LIN Module

The control panel provides limited LIN functionality. The user can only enable the LIN module and view the received data. Since the baud rate, message ID, and message size are defined in the LIN slave driver before the code compilation, these parameters are already preset, and the user is not allowed to modify them. However, it is possible to change these parameters in the source code and recompile the embedded application.

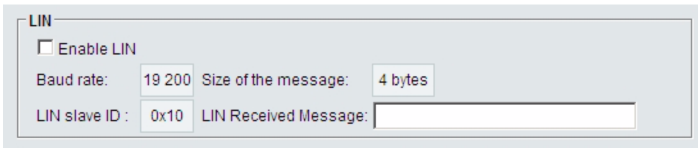


Figure 11. LIN Module Block

7.3.4.6 High Side and Low Side Switch Control, and PWM Module

The control panel allows full control of the HS and LS switches, in conjunction with the wide frequency range of the 2-channel PWM module. To turn any switch on, the user must click on one of the four green buttons on the upper part of the PWM module panel section. The PWM will have no effect on the HS and LS switching unless the switches are turned on. The PWM channels of the PWM module can be enabled separately by checking the tick box next to "Enable PWM Channel 0" or "Enable PWM Channel 0", respectively. The frequency and the duty cycle are set by a pair of sliders. The PWM module allows setting a positive or negative duty cycle, chosen by a pair of radio buttons, right of the duty-cycle slider. The value of the PWM frequency is determined by the value of the frequency slider and the frequency range scroll-down box, positioned right of the frequency slider. The value of the frequency displayed above the slider is the percentage of the range. There is a pair of radio buttons named "Channel 0 Setting" and "Channel 1 Setting". By toggling of these radio buttons, the user can set the frequency and the duty cycle for both channels. At the bottom of this frame, the user can enable the PWM for each HS and LS switch independently, as well as assign the PWM channel.

Warning

Even though the PWM module is capable of generating frequencies over 1.0 MHz, the HS and LS switches can be controlled by frequencies only up to 20 kHz. The user can test the PWM module at higher frequencies on the PTB2 output pin.

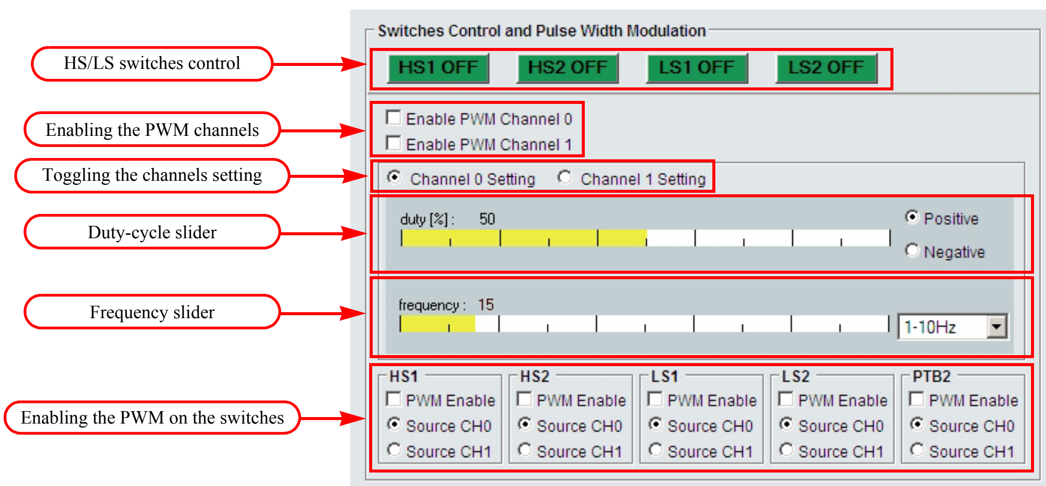


Figure 12. HS and LS Switches Control, PWM Module

7.3.4.7 ADC Module Control Frame

This frame covers the largest area on the control page, due to the graphical display of sensed analog values in the graph object. The x-axis represents the time and the y-axis is the numerical representation of the analog quantity. The y-scale on the left side of the graph area is fixed (0-2500 mV). It corresponds to the AD0, AD1, and AD2 inputs - these are 2.5 V analog inputs. The y-scale on the right side is changed based on the currently displayed quantity (input voltage, chip temperature, current, or value of Lx input). The values of analog inputs AD0, AD1, and AD2 can be displayed at the same time. The other quantities can only be displayed exclusively. Analog inputs L0-L5 are displayed exclusively, and the user can switch the range from between 0 to 5.0 V and 0 to 18 V. The history of the sensed quantities is kept in the memory (200 points), so even if the value is currently not displayed, it is not lost.

There is also a numerical value displayed for battery voltage, temperature, and load current. Since there is not a fixed value of the current sense resistor placed on the board, the value of the current is listed in raw ADC units, instead of amps. The amplification of the voltage over the current sense resistor is set to 7 times (this is the default value after reset). When there is no communication between the PC and the target, the ADC display is temporarily disabled. Figure 13 shows the ADC module frame.

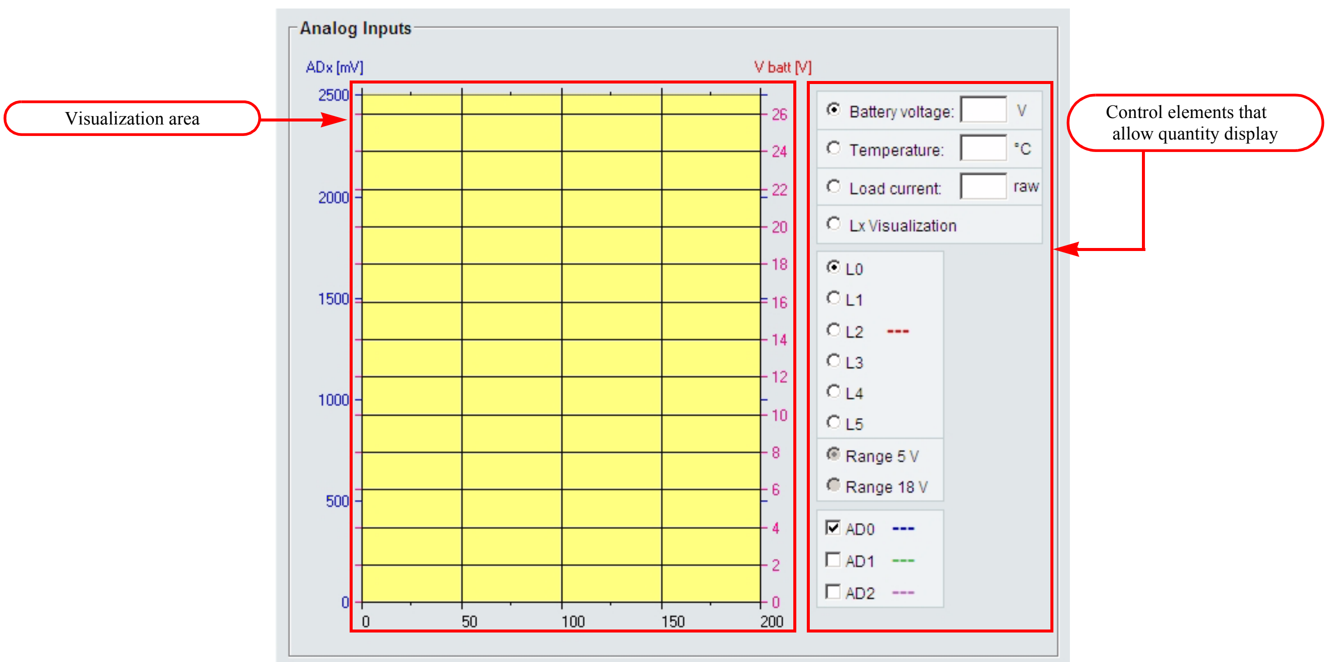


Figure 13. ADC Module Frame

7.3.4.8 Low Power Modes - STOP Mode and SLEEP Mode

The MM912H634 allows two low power modes. While the device is in the SLEEP mode, the 5.0 V and 2.5 V regulators are disabled. All values from the registers and variables are cleared, because the device wakes up from the SLEEP mode transitioning the power-on reset. The STOP mode is the low power mode with higher current consumption than the SLEEP mode. In STOP mode, the 5.0 V and 2.5 V regulator are working with limited current capability. The jumpers JP4 and JP9 must be removed, otherwise, a reset will be triggered (caused by high current consumption of LEDs) and the device will be immediately awakened from the STOP mode.

There are several options to wake-up the device from the low power modes, supported by the application:

- Forced wake-up - there is a fixed time during which the device is in low power mode
- Wake-up by LIN module
- External reset (reset button SW1) - only from STOP mode

- Lx wake-up - the device is awakened when the logical state of any enabled input L0-L5 is detected. The state of the Lx inputs is checked continuously.
- Cyclic sense wake-up - the same principle as the previous one, but the input Lx is sensed periodically. This allows lower power consumption during the SLEEP or STOP mode. The Lx inputs are fed by periodic switching of HS1 or HS2 switch with the corresponding detection of Lx state change.

Figure 14 shows the low power modes frame of the FreeMASTER control page.

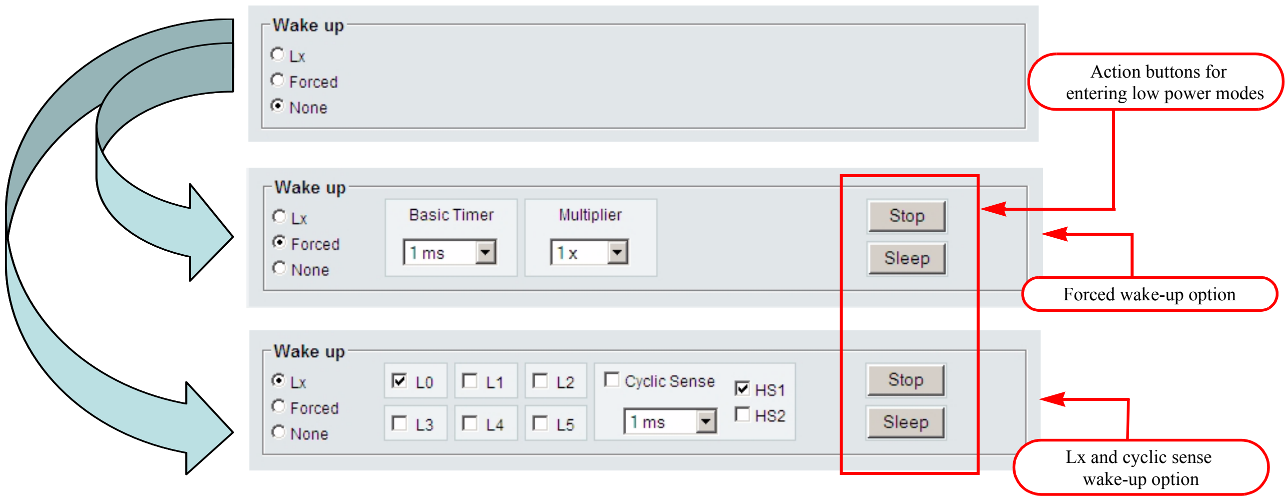


Figure 14. Low Power Modes

The low power modes are entered by writing to the Mode Control Register (MCR) of the analog die. Anytime a write to the MCR register is performed, communication over the BDM interface between the PC and the target is terminated. The reason is that during wake-up, the device is transitioning from the reset to normal mode. The BDM interface can interrupt this transition, so the device cannot wake-up properly. After the device completes the wake-up sequence, the user must restore the BDM communication manually. The user must click twice on the “Stop” icon, placed on the toolbar of the FreeMASTER application, as shown in Figure 15.

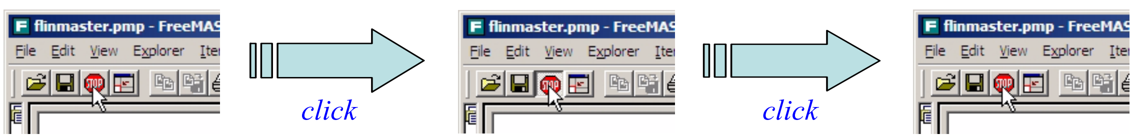


Figure 15. Re-enabling of the BDM Communication After Return from Low Power Modes

7.4 Embedded Software

7.4.1 Main Software Flow Chart

The main embedded software flow chart is shown in Figure 16. After the device and the application initialization, the software runs in a continuous loop, checking the LIN communication (if enabled) and updating the analog die registers, based on the FreeMASTER variables and watchdog servicing (if enabled). Other than this, only one interrupt routine is implemented (D2D_ISR), which handles the SCI receive interrupt routine used by the LIN slave driver.

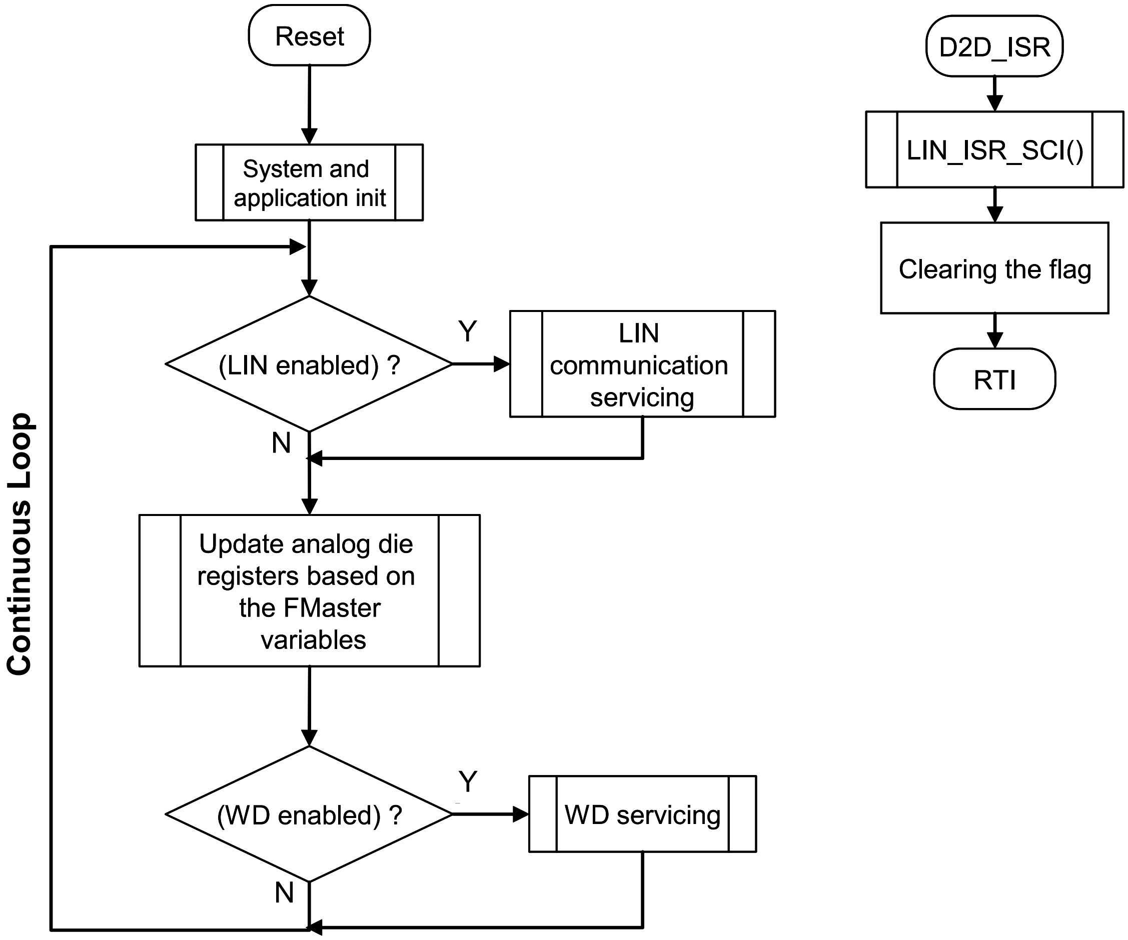


Figure 16. Embedded Software Flow Chart

7.4.2 FreeMASTER Variables

The variables used for the application control have the prefix "`fm_`". There is one structure with the name "`fm_register`". The variables of this structure are:

- *fm_address - contains address of the 8-bit register
- fm_data - contains data of the 8-bit register
- *fm_address_16 - contains address of the 16-bit register
- fm_data_16 - contains data of the 16-bit register
- fm_read_write - information on the action - reading or writing to the register
- fm_status - information on the action completion
- fm_size - information on the size of the register (8-bit or 16-bit). The address and data are put in corresponding variables.

7.4.2.1 Performing the FreeMASTER Variables Update

In the continuous loop, first the value of "fm_status" is checked. It can have two enumerated values: "pending" or "done". If the value is set to "pending", then there is a request from the FreeMASTER control panel to read or write the register value.

The value of "fm_read_write" is then checked to see, if a write or read command is requested.

The value of the variable "fm_size" is evaluated next, to determine if the data is 8 or 16-bit size.

The variables “*fm_address“ (pointer to char) or “*fm_address_16“(pointer to int) have information on the register addresses being accessed. If the write command was requested, the values from “fm_data“ or “fm_data_16“are written to the address listed in the “*fm_address“ or “*fm_address_16“variables.

Finally, the variable “fm_status“ is set to “done”. The FreeMASTER then knows that the data was updated.

This code section is also checked if there was a request to enter the STOP mode (if fm_address == 0x216 and fm_data == 0x1), because first the analog die has to be put in low power mode by writing 0x1 to the Mode Control Register. The STOP instruction is then executed.

7.4.3 LIN Communication

7.4.3.1 Change of the LIN Communication Parameters

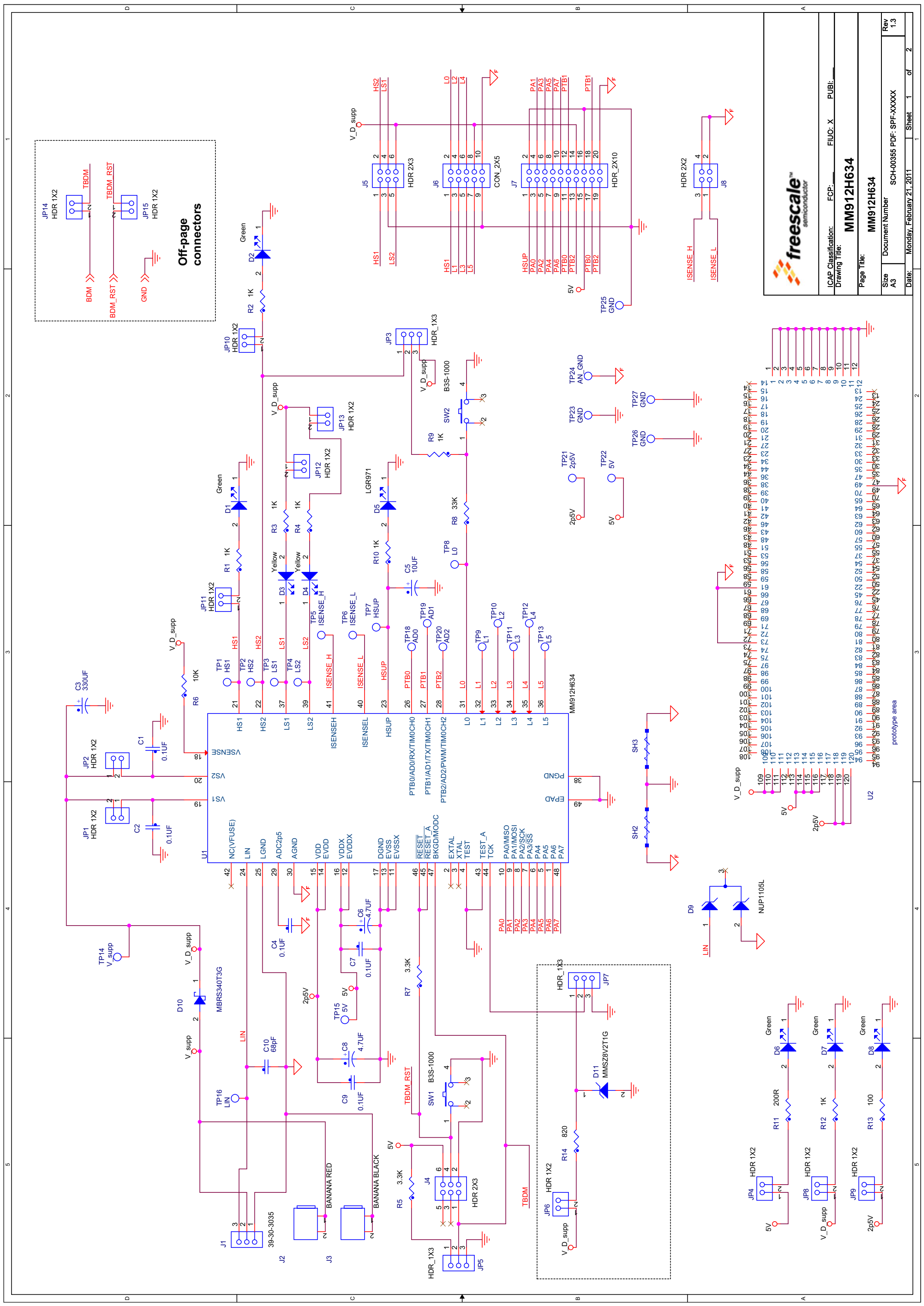
As previously mentioned, LIN communication parameters (baud rate, messages size, messages ID) are set before code compilation in the LIN software driver. The baud rate can be changed in the file “slave.cfg“. The baud rate is defined by the following formula:

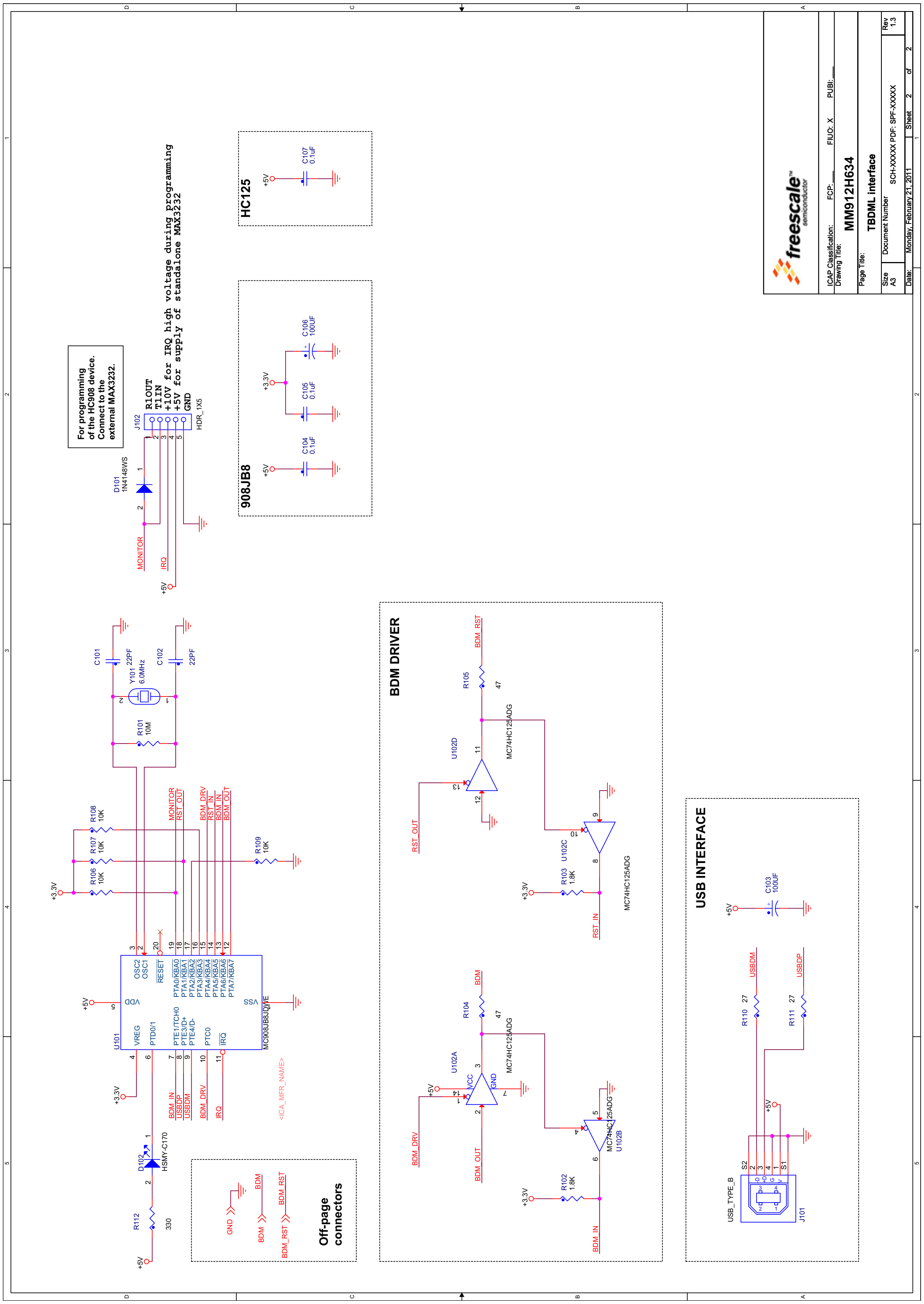
$$\text{SciBaudRate} = \frac{\text{BUSCLK}}{16 \cdot \text{BR}}$$

SciBaudRate is the value written to the SCI baud rate register and BR is the real baud rate value (9600 or 19200).

The size of the messages and the ID of the messages can be changed or added in the file “slave.id“. The ID shall be assigned, based on the LIN 1.3 protocol specification.

8 Schematics




For programming of the HC908 device. Connect to the external MAX3232.
R1OUT
T1IN
+10V for IRQ high voltage during programming
+5V for supply of standalone MAX3232
GND
HDR_1X5
908JB8
HC125
BDM DRIVER
USB INTERFACE
USB_TYPE_B
Off-page connectors
MC908JB8JDWE
MC74HC125ADG
ICAP Classification:
Drawing Title:
MM912H634
Page Title:
TBDML interface
Document Number
SCH-XXXXX PDF: SPF-XXXXX
Rev
1.3
Date:
Monday, February 21, 2011
Sheet 2 of 2

9 Board Layout

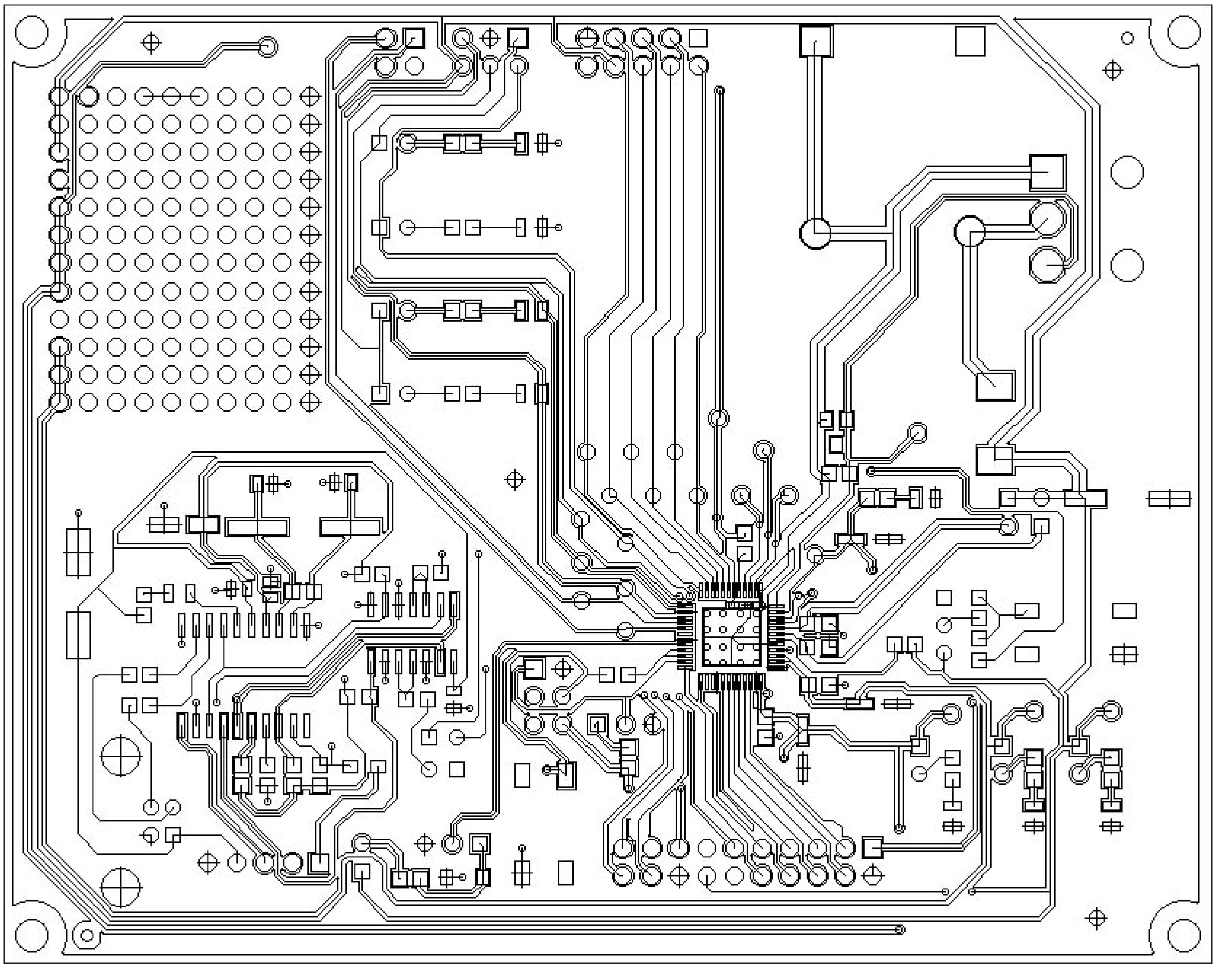


Figure 17. Top Copper Layer

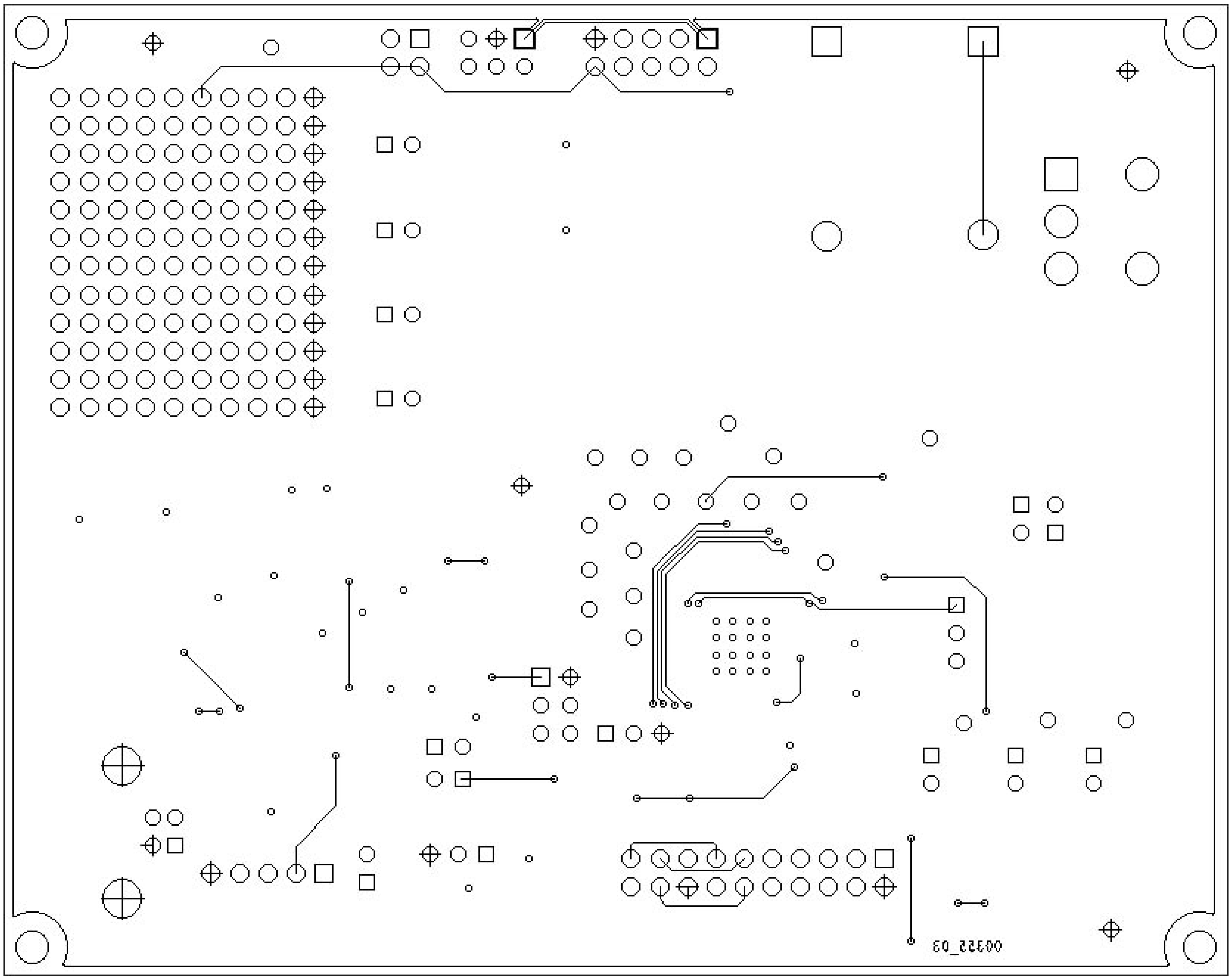


Figure 18. Bottom Copper Layer (from bottom)

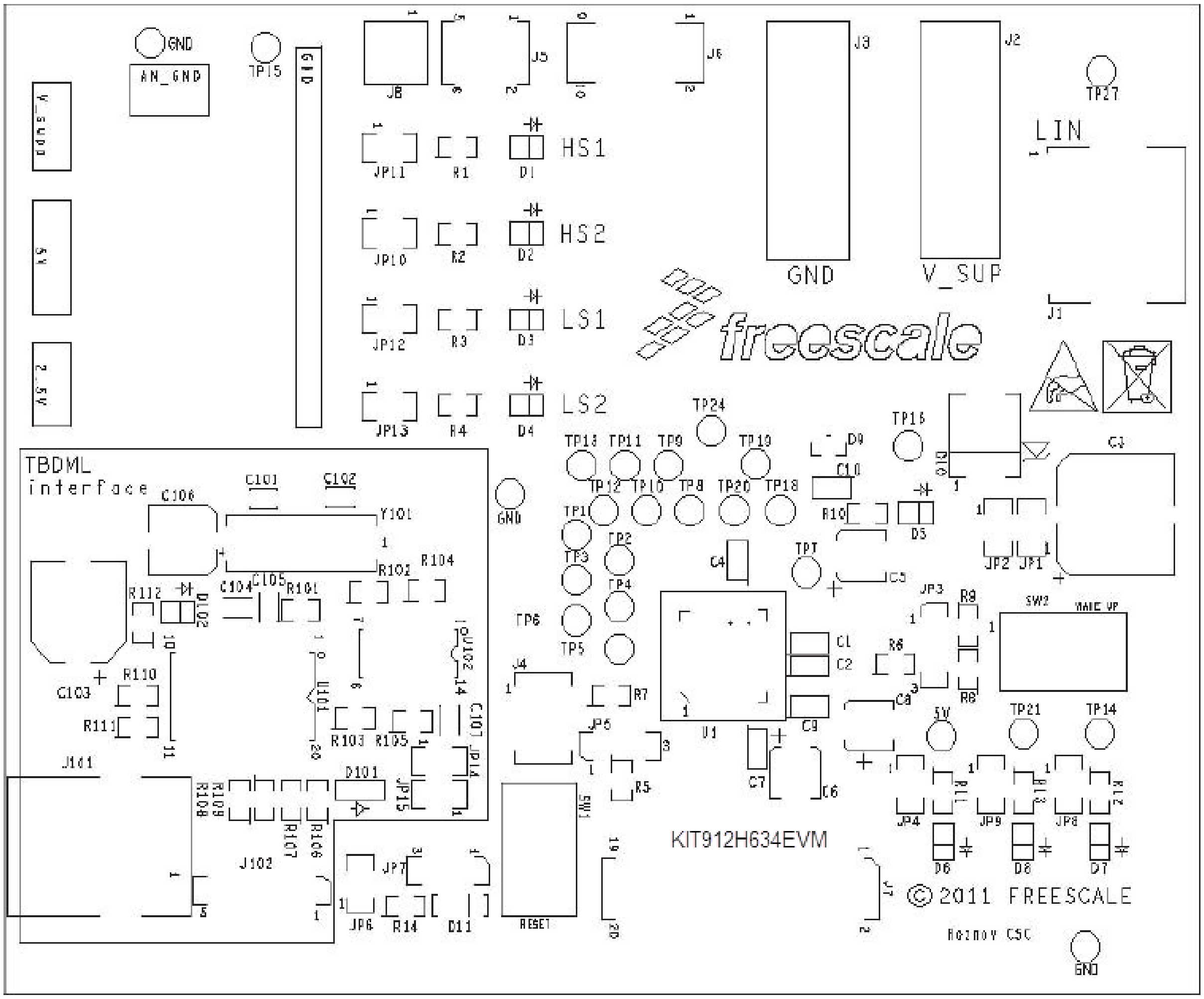


Figure 19. Top Silk-screen Layer

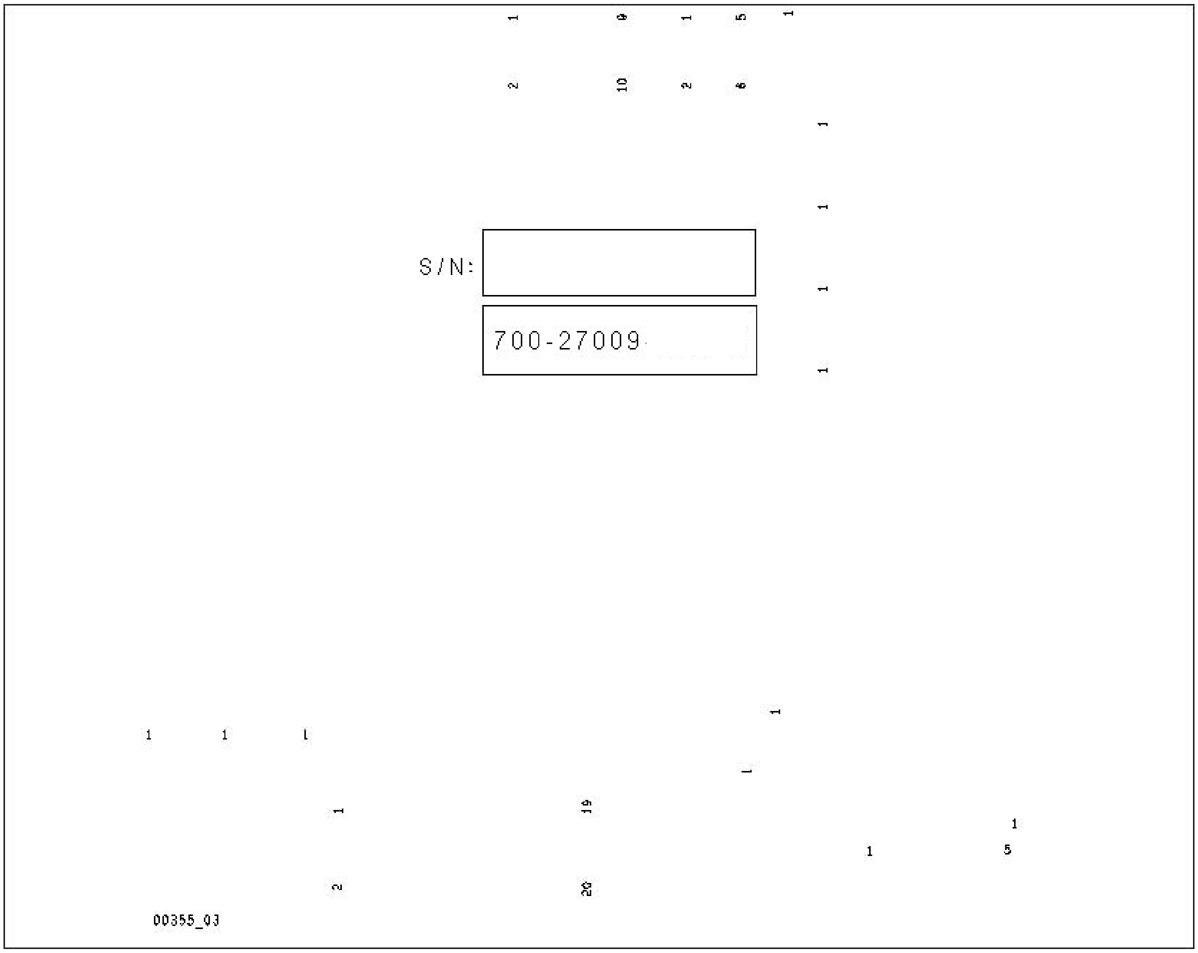


Figure 20. Bottom Silk-screen Layer (from bottom)

10 Bill of Materials

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
8	C1, C2, C4, C7, C9, C104, C105, C107	100 nF/50 V	Ceramic capacitor, 0805, 100 nF/50 V	Kemet	08055C104KAT2A
1	C3	330 µF/35 V	Electrolytic Capacitor SMD, 330 µF/35 V	Panasonic	EEEFK1V331AP
1	C5	10 µF/16 V	Electrolytic Capacitor SMD, 10 µF/16 V	Panasonic	EEE1CA100SR
2	C6, C8	47 µF/50 V	Electrolytic Capacitor SMD, 47 µF/25 V	Panasonic	EEE1EA4R7SR
1	C10	68 pF/50 V	Ceramic capacitor, 0805, 68 pF/50 V	Kemet	C1206C475K3PAC
2	C101, C102	22 pF/100 V	Ceramic capacitor, 0805, 22 pF/100 V	Kemet	C0805C220J1GAC
1	C106	100 µF/6.3 V	Electrolytic capacitor, SMD, 100 µF/6.3 V	Panasonic	EEEFKJ101UAR
1	C103	100 µF/20 V	Electrolytic capacitor, SMD, 100 µF/20 V	Nichicon	PCF1D101MCL1GS
7	D1, D2, D5, D6, D7, D8, D102	SMD LED Green	LED, green, 0805	KINGBRIGHT	KP-2012MGC
2	D3, D4	SMD LED Yellow	LED, yellow, 0805	KINGBRIGHT	KP-2012SYC
1	D9	NUP1105L	Single Line CAN/LIN Bus Protector	On Semi	NUP1105L
1	D10	MBRS340T3G	3.0 A, 40 V Schottky Rectifier	On Semi	MBRS340T3G
1	D11	MMSZ8V2T1G	Zener Diode 500 mW, 8.2 V	On Semi	MMSZ8V2T1G
1	D101	1N4148WS	DIODE, HIGH SPEED, 100 V, 150 mA	MULTICOMP	1N4148WS
12	JP1, JP2, JP4, JP6, JP8, JP9, JP10, JP11, JP12, JP13, JP14, JP15	Header 2.54 mm, 2x1	Header 2.54 mm, 2x1	Molex	90120-0762
3	JP3, JP5, JP7	Header 2.54 mm, 3x1	Header 2.54 mm, 3x1	Molex	90120-0763
1	J1	Connector 1x3 shrouded, right angle	Connector 1x3, 4.20 mm pitch, right angle	Molex	39-30-3035
1	J2	Banana RED	SOCKET, 4.0 mm, PCB, RED	Hirschman	PB4RED
1	J3	Banana BLACK	SOCKET, 4.0 mm, BLACK	Hirschman	PB4BLACK
1	J4,J5	Header 2.54 mm, 3x2	Header 2.54 mm, 3x2	Molex	90131-0763
1	J6	Header 2.54 mm, 5x2	Header 2.54 mm, 5x2	Molex	90131-0765
1	J7	Header 2.54 mm, 10x2	Header 2.54 mm, 10x2	Molex	90131-0770
1	J8	Header 2.54 mm, 2x2	Header 2.54 mm, 2x2	Molex	90131-0762

Qty.	Reference	Part Value	Description	Mfg.	Mfg. Part No.
1	J101	USB B	USB TYP B WRCOM 4 PINS	WUERTH ELEKTRONIK	61400416121
1	J102	Header 2.54 mm, 1x5	Header 2.54 mm, 1x5	Molex	90120-0765
7	R1, R2, R3, R4, R9, R10, R12	1.0 k	Resistor 1.0 kΩ, 5%, 0805	Multicomp	MC 0.1W 0805 5% 1K
2	R5, R7	3.3 k	Resistor 3.3 kΩ, 5%, 0805	Multicomp	MC 0.1W 0805 5% 3K3
5	R6,R106, R107, R108, R109	10 k	Resistor 10 kΩ, 5%, 0805	Multicomp	MC 0.1W 0805 5% 10K
1	R8	33 k	Resistor 33 kΩ, 5%, 0805	Multicomp	MC 0.1W 0805 5% 33K
1	R11	200	Resistor 200Ω, 5%, 0805	Multicomp	MC 0.1W 0805 5% 200R
1	R13	100	Resistor 100Ω, 5%, 0805	Multicomp	MC 0.1W 0805 5% 100R
1	R14	820	Resistor 820Ω, 5%, 0805	Multicomp	MC 0.1W 0805 5% 820R
1	R101	10 M	Resistor 10 MΩ, 5%, 0805	PHYCOMP (YAGEO)	232273061106
2	R102, R103	1.8 K	Resistor 1.8 kΩ, 5%, 0805	Multicomp	MC 0.1W 0805 5% 1K8
2	R104, R1054	47	Resistor 47 Ω, 5%, 0805	Multicomp	MC 0.1W 0805 5% 47R
2	R110, R111	27	Resistor 27 Ω, 5%, 0805	Multicomp	MC 0.1W 0805 5% 27R
1	R112	330	Resistor 300 Ω, 5%, 0805	Multicomp	MC 0.1W 0805 5% 300R
2	SW1, SW2	B3S-1000	Switch SMD	OMRON ELECTRONIC COMPONENTS	B3S-1000
1	U1	MM912H634		Freescale Semiconductor	MM912H634CV1AE
1	U101	MC908JB8	8-bit MCU	Freescale Semiconductor	MC908JB8JDWE
1	U102	MC74HC125AD	Quad Noninverting Buffer, 3 State	On Semi	MC74HC125ADG
1	Y101	6.0 MHz	Crystal, 6.0 MHz, SMD	Vishay Dale	XT49M-206M
26	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26. TP27	HS1, HS2, LS1, LS2, ISENSE_H, ISENSE_L, HSUP, L0, L1, L2, L3, L4, L5, V_D_supp, 5V, LIN, AD0, AD1, AD2, 2.5V, 5V, GND, AN_GND, GND, GND, GND	Test points	Keystone	5002

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

11 References

You can obtain information on other Freescale products and application solutions by going to the following URLs:

Products	Links
Data Sheet MM912_634	www.freescale.com/files/analog/doc/data_sheet/MM912_634D1.pdf
Fact Sheet MM912_634	www.freescale.com/files/analog/doc/fact_sheet/MM912_634FS1.pdf
MM912_634ER	www.freescale.com/files/analog/doc/errata/MM912_634ER.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

REVISION	DATE	DESCRIPTION OF CHANGES
	9/2011	Initial Release

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Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
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