DOC-0428-010, REV B

DEMO9S08LL16

Demonstration Board for Freescale MC9S08LL16

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USER GUIDE

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REVISION

Date	Rev	Comments
December 20, 2007	A	Initial Release
December 20, 2007	B	Added information on USB-BDM option jumpers. Changed 1st page layout

CAUTIONARY NOTES

1) Electrostatic Discharge (ESD) prevention measures should be used when handling this product. ESD damage is not a warranty repair item.

2) Axiom Manufacturing does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under patent rights or the rights of others.

3) 3) EMC Information on the DEMO9S08LL16 board:

   a) This product as shipped from the factory with associated power supplies and cables, has been verified to meet with requirements of CE and the FCC as a CLASS A product.

   b) This product is designed and intended for use as a development platform for hardware or software in an educational or professional laboratory.

   c) In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate prevention measures.

   d) Attaching additional wiring to this product or modifying the products operation from the factory default as shipped may effect its performance and cause interference with nearby electronic equipment. If such interference is detected, suitable mitigating measures should be taken.

TERMINOLOGY

This development module utilizes option select jumpers to configure default board operation. Terminology for application of the option jumpers is as follows:

Jumper – a plastic shunt that connects 2 terminals electrically

Jumper on, in, or installed = jumper is a plastic shunt that fits across 2 pins and the shunt is installed so that the 2 pins are connected with the shunt.

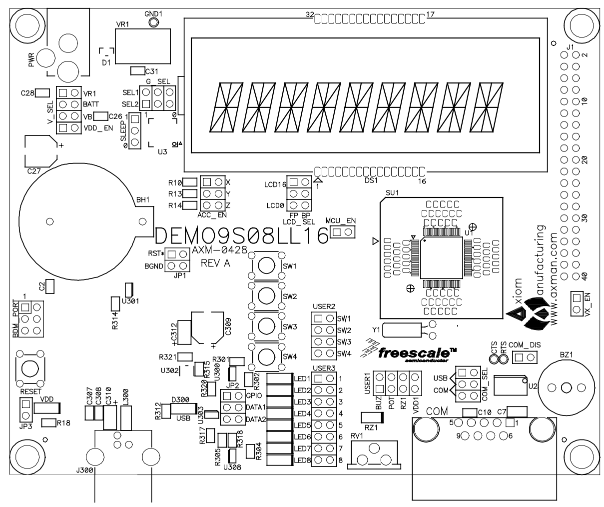
Jumper off, out, or idle = jumper or shunt is installed so that only 1 pin holds the shunt, no 2 pins are connected, or jumper is removed. It is recommended that the jumpers be placed idle by installing on 1 pin so they will not be lost.

Cut-Trace – a circuit trace connection between component pads. The circuit trace may be cut using a knife to break the default connection. To reconnect the circuit, simply install a suitably sized 0-ohm resistor or attach a wire across the pads.

Signal names followed by an asterisk (*) denote active-low signals.

FEATURES

The DEMO9S08LL16 is a demonstration board for the MC9S08LL16 microcontroller. Application development is quick and easy with the integrated USB-BDM, sample software tools, and examples. An optional BDM_PORT port is also provided to allow use of a BDM_PORT cable. Two, 40-pin connectors provide access to all IO signals on the target MCU.



- MC9S08LL16, 28 TSSOP
  - 16K Bytes Flash
  - 2K Bytes RAM
  - Internal Oscillator
  - 10 MHz Bus Frequency
- Integrated P&E USB-BDM
- BDM_PORT header for BDM cable support (not installed)
- MCU_PORT socket header for access to MCU IO signals
- On-board +5V regulator
- Battery holder for Li-ion battery
- Optional Power from USB-BDM or MCU_PORT connector
- Power Input Selection Jumpers
  - Power input from USB-BDM
  - Power input from on-board regulator
  - Power from battery holder
  - Power input from Connector J1
  - Optional Power output through Connector J1
- User Components Provided
  - 5 Push Switches; 4 User, 1 Reset
  - 10 LED Indicators; 8 User, VDD, USB
  - 5K ohm POTs w /LP Filter
  - Light Sensor w/ LP Filter and Op Amp
- User Option Jumpers to disconnect Peripherals
- Connectors
  - 40-pin MCU I/O Connector
  - 2.0mm Barrel Connector
  - BDM_PORT (not installed)
  - USB Connector
  - DB9 Connector

Specifications:
Board Size 2.9 x 3.2”

Power Input: +9V typ, +6V min

REFERENCES

Reference documents are provided on the support CD in Acrobat Reader format.

DEMO9S08LL16_UG.pdf	DEMO9S08LL16 User Guide (this document)
DEMO9S08LL16_QSG.pdf	DEMO9S08LL16 Quick Start Guide
DEMO9S08LL16 _SCH_A.pdf	DEMO9S08LL16 Schematic Rev. A
DEMO9S08LL16_Silk_A.pdf	DEMO9S08LL16 Top Silk, Rev A
LL16_Demo_Board4.zip	CW LCD Demo Program Source Code

GETTING STARTED

To get started quickly, please refer to the DEMO9S08LL16 Quick Start Guide. This quick start will illustrate connecting the board to a PC, installing the correct version of CodeWarrior Development Studio, and running a simple LED test program.

MEMORY MAP

The table below shows the default memory map for the MC9S08LL16 immediately out of reset. Refer to the MC9S08LL16 Data Sheet (DS) for further information.

Table 1: Memory Map

\$0000 - \$005F	Direct Page Registers	96 bytes
\$0060 - \$087F	RAM	2080 bytes
\$0880 - \$08AF	LCD Registers	47 bytes
\$08B0 - \$17FF	Unimplemented	39,208 bytes
\$1800 - \$1852	High Page Registers	82 bytes
\$1853 - \$BFFF	Unimplemented	42,925 bytes
\$C000 - \$DFFF	FLASH B	8192 bytes
\$E000 - \$FFFF	FLASH A	8192 bytes

SOFTWARE DEVELOPMENT

Software development requires the use of a compiler or an assembler supporting the HCS08 instruction set and a host PC operating a debug interface. CodeWarrior Development Studio for Microcontrollers is supplied with this board for application development and debug.

DEVELOPMENT SUPPORT

Application development and debug for the target MC9S08LL16 is supported through the background debug mode (BDM) interface. The BDM interface consists of an integrated USB-Multilink BDM and a 6-pin interface header (BDM_PORT). The BDM_PORT header allows connecting a HCS12/HCS08 BDM cable.

Integrated BDM

The DEMO9S08LL16 board features an integrated USB-Multilink BDM from P&E Microcomputer Systems. The integrated USB-Multilink BDM supports application development and debugging via background debug mode. All necessary signals are provided by the integrated USB-Multilink BDM. A USB, type B, connector provides connection from the target board to the host PC.

The integrated USB-Multilink BDM provides power and ground to target board eliminating the need to power the board externally. Power from the USB-Multilink BDM is derived from the USB bus; therefore, total current consumption for the target board, and connected circuitry, **must not exceed 500mA**. This current limit describes the current supplied by the USB cable to the BDM circuit, the target board, and any connected circuitry. Excessive current drain will violate the USB specification causing the bus to disconnect. Damage to the host PC USB hub or the target board may result.

BDM OPTION Headers

Option headers at JP1 and JP2 connect the integrated BDM to the target board. Option header JP1 connects signals RST* and BGND to the target MCU.

Figure 1: JP1 Option Header

●	●	RST*	Connects BDM RESET* to target MCU
●	●	BGND	Connects BDM BGND to target MCU

Option header JP2 connects two timer channels to the BDM to facilitate the Signal Analyzer functionality.

Figure 2: JP1 Option Header

●	●	GPIO	GPIO signal to BDM to ensure connectivity
●	●	DATA1	Timer channel 0 input to Signal Analyzer
●	●	DATA2	Timer channel 1 input to Signal Analyzer

BDM_PORT Header

A compatible HCS12 BDM cable can also attach to the 6-pin BDM interface header (BDM_PORT). This header is not installed in default configuration. The figure below shows the pin-out for the DEBUG header. This information is included for completeness.

Figure 3: BDM_PORT Header

BKGD	**1**	**2**	GND
	3	**4**	RESET*
	5	**6**	VDD

See the MC9S08LL16 Data Sheet for complete DEBUG documentation

NOTE: This header is not installed in default configuration.

POWER

The DEMO9S08LL16 provides several methods to apply power to the board. An option header allows selection between the various power inputs. For application development and debug, the board may be powered from the USB BDM. The 2.0mm PWR connector supports stand-alone operation and higher power requirements. A 190mAH battery holder is applied for low-power operation. Power may also be applied to connector J1 or the board may be configured to supply power from connector J1 to external circuitry.

CAUTION:

Damage to the board may result if voltages greater than +3.3V are applied to the connector J1 input.

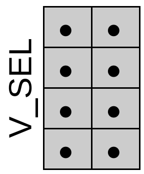
POWER SELECT

Power may be applied to the board through the integrated USB-Multilink BDM circuitry, a 2.0mm barrel connector, from the battery holder, or through connector J1. Power selection is achieved using 2 selection headers: the V_SEL option header and the VX_EN option header.

V_SEL

The V_SEL option header combines the V_SEL option header and the VDD_EN option header into a single option block. This header allows the user to select power input either from any of the various input sources. Removing the VDD_EN option header disconnects power from the board peripherals leaving only the MCU powered. When the VDD_EN option jumper is removed, the RST* and BGND option jumpers should also be removed, to ensure proper operation. The figure below details the PWR_SEL header connections.

Figure 4: V_SEL Option Header



VR1	Selects power input from voltage regulator VR1
BATT	Selects power input from Li battery
VB	Selects power input from USB-BDM
VDD_EN	Provides power to board peripherals

NOTE: If VDD_EN option jumper is OFF, then RST* and BGND option jumpers must also be OFF to ensure proper MCU operation.

Power from the integrated BDM is drawn from the USB bus and is limited to **500 mA**. This current limit accounts for the total current supplied over the USB cable to the BDM circuit, the target board, and any connected circuitry. Current drain in excess of 500 mA will violate the USB specification and will cause the USB bus to disconnect. This will cause the board to exhibit power cycling where the board appears to turn-on then off continually. Damage to the host PC or the target board may also result.

The on-board voltage regulator (VR1) accepts power input through a 2.0mm barrel connector (PWR). Input voltage may range from +7V to +35V; however, input voltage should be limited to prevent the voltage regulator (VR1) from overheating. VR1 provides a +3.3V fixed output limited to 500mA. Over-temperature and over-current limit built into the voltage regulator provides protection from excessive stress. The user should consider the maximum output current limit of VR1 when attempting to power off-board circuitry through connector J1.

The battery holder at BATT accepts a 23mm, 190mAH lithium-ion battery.

VX_EN

The VX_EN option header is a 2-pin jumper that connects or disconnects input J1-1 directly to the target board voltage rail. J1-3 is directly connected to the ground plane. Use of this feature requires a regulated input power source. This power input is decoupled to minimize noise but is not regulated. Care should be exercised when using this feature; no protection is applied on this input and damage to the target board may result if over-driven. Also, do not attempt to power the target board through this connector while also applying power through the USB-Multilink BDM or the PWR connector; damage to the board may result.

Power may also be sourced to off-board circuitry through the J1 connector. The current supplied from the USB bus or the on-board regulator limits current available to external circuitry. Excessive current drain may damage the target board, the host PC USB hub, or the on-board regulator. The figure below details the VX_EN header connections.

Figure 5: VX_EN Option Header

CAUTION:

Do not exceed available current supply from USB-BDM or on-board regulator when sourcing power through connector J1 to external circuitry.

RESET SWITCH

The RESET switch applies an asynchronous RESET to the MCU. The RESET switch is connected directly to the RESET* input on the MCU. Pressing the RESET switch applies a low voltage level to the RESET* input. A pull-up bias resistor allows normal MCU operation. Shunt capacitance ensures an adequate input pulse width.

LOW VOLTAGE RESET

The MC9S08LL16 utilizes an internal Low Voltage Detect (LVD) circuit. The LVD holds the MCU in reset until applied voltage reaches an appropriate level. The LVD also protect against under-voltage conditions. Consult the MC9S08LL16 reference manual for details LVD operation.

TIMING

The DEMO9S08LL16 internal timing source is active from RESET by default. An external 32 kHz XTAL oscillator, configured for low-power operation, is also provided. Refer to the MC9S08LL16 Data Sheet for details on configuring the selected timing source.

COMMUNICATIONS

The DEMO9S08LL16 supports serial communications through the integrated USB-BDM and an on-board, low-voltage, RS-232 transceiver. The transceiver provides valid RS-232 signaling for input voltage levels down to +1.8V. The COM_SEL header selects the serial path applied.

RS-232

An RS-232 translator provides RS-232 to TTL/CMOS logic level translation on the COM connector. The COM connector is a 9-pin Dsub, right-angle connector. A ferrite bead on shield ground provides conducted immunity protection. Communication signals TXD1 and RXD1 are routed from the transceiver to the MCU. Hardware flow control signals RTS and CTS are available on the logic side of the transceiver. These signals are routed to vias located near the transceiver. RTS has been biased properly to support 2-wire RS-232 communications.

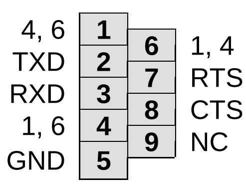
Table 2: COM Connections

MCU Port	COM Signal	I/O PORT CONNECTOR
PTC1/TXD	TXD	J1-5
PTC0RXD	RXD	J1-7

COM Connector

A standard 9-pin Dsub connector provides external connections for the SCI0 port. The Dsub shell is connected to board ground through a ferrite bead. The ferrite bead provides noise isolation on the RS-232 connection. The figure below details the DB9 connector.

Figure 6: COM Connector



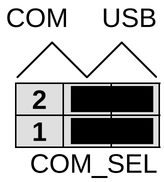
Female DB9 connector that interfaces to the MCU internal SCI0 serial port via the RS232 transceiver. Flow control is provided at test points on the board.

Pins 1, 4, and 6 are connected together.

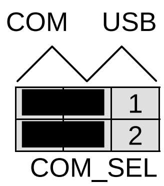
COM_SEL

The COM_SEL option header connects the MCU SCI port to either the SCI PHY or the USB-BDM connection.

Figure 7: COM_SEL Option



Select USB serial communications



Select COM serial communications

USB SERIAL LINK

The integrated USB-BDM provides a serial link from the target MCU to the host PC through the host application. Refer to the P&E Multilink documentation for further details.

LCD

The DEMO9S08LL16 provides an 8x24 LCD connected directly to the target MCU. The target MCU provides internal charge-pump and regulated LCD reference. The LCD contrast is trimmable under MCU control. Refer to the MC9S08LL16 Reference Manual for further details.

USER I/O

User I/O includes 1 potentiometers, 1 Light Sensor, 2 push button switches, and 2 green LEDs for user I/O. The User option header block enables or disables each User I/O function individually.

Buzzer

The DEMO9S08LL16 target board provides an externally modulated piezo-buzzer for audible applications. A push-pull drive circuit allows the target MCU to easily drive the buzzer at a center frequency of 2300 Hz. The figure below shows the USER enable position and associated signal for the buzzer.

Potentiometer

The DEMO9S08LL16 target board provides a 5K ohm potentiometer (POT) to simulate analog input. The POT is decoupled to minimize noise during adjustment. The figure below shows the USER enable position and associated signal for the potentiometer. The following table shows the connections for each user I/O device.

Light Sensor

A surface-mount phototransistor, at RZ1, provides light sensitive, variable input for user applications. Current flow within the phototransistor is inversely proportional to light intensity incident on the surface of the device. A rail-to-rail OP amp at U5 boosts the photocell output to useable levels.

VDD1 Enable

The VDD1 option jumper disconnects the POT, BUZZER, and Light sensor from board power for low-power operation.

Table 3: User2 Option Header

USER1		Signal	ON	OFF
● ●	Buzzer	PTC2/TPM1CH0	Enabled	Disabled
● ●	POT	PTA0/KBIP0/ADP0	Enabled	Disabled
● ●	λ Sensor	PTA6/ADP6	Enabled	Disabled
● ●	VDD1	VDD	Enabled	Disabled

Switches

The DEMO9S08LL16 provides 4 push-button switches for user input. Each push-button switch is configured for active-low operation. No bias is applied to these push-button inputs. Use of target MCU internal pull-ups is required for proper operation. The figure below shows the USER enable position and associated signal for each user switch.

Table 4: User2 Option Header

USER2		Signal	ON	OFF
● ●	SW1	PTA6/KBIP6	Enabled	Disabled
● ●	SW2	PTA7/KBIP7	Enabled	Disabled
● ●	SW3	PTA0/KBIP0	Enabled	Disabled
● ●	SW4	PTB6	Enabled	Disabled

User LED's

The DEMO9S08LL16 target board provides 8, green, LEDs for output indication. Each LED is configured for active-low operation. A series, current-limit resistor prevents excessive diode current. The figure below shows the USER enable position and associated signal for each user LED.

Table 5: User3 Option Header

USER3		Signal	ON	OFF
• •	LED1	PTC2/TPM1CH0	Enabled	Disabled
• •	LED2	PTC3/TPM1CH1	Enabled	Disabled
• •	LED3	PTC4/TPM2CH0	Enabled	Disabled
• •	LED4	PTC5/TPM2CH1	Enabled	Disabled
• •	LED5	PTB4	Enabled	Disabled
• •	LED6	PTB5	Enabled	Disabled
• •	LED7	PTB6	Enabled	Disabled
• •	LED8	PTB7	Enabled	Disabled

MCU I/O PORT

The MCU I/O PORT connectors (J1 and J2) provide access to the MC9S08LL16 I/O signals. The figures below show the pin-out for each MCU I/O connector.

Figure 8: MCU I/O PORT – J1

VDD	1	2	PTC7/IRQ/TCLK
VSS	3	4	PTB2/RESET*
PTC1/TXD	5	6	PTC6/ACMPO/BKGD/MS
PTC0/RXD	7	8	PTA0/SS*/KBIP0/ADP0
PTC4/TPM2CH0	9	10	PTA1/SPSCK/KBIP1/ADP1
PTC5/TPM2CH1	11	12	PTA2/MISO/SDA/KBIP2/ADP2
PTC2/TMP1CH0	13	14	PTA3/MOSI/SCL/KBIP3/ADP3
PTC3/TPM1CH1	15	16	NC
PTB5/MOSI/SCL	17	18	NC
PTB4/MISO/SDA	19	20	PTA6/KBIP6/ADP6/ACMP+
PTB6/SPSCK	21	22	PTA7/KBIP7/ADP7/ACMP-
PTB7/SS*	23	24	NC
NC	25	26	NC
NC	27	28	NC
NC	29	30	PTA2/MISO/DSA/KBIP2/ADP2
NC	31	32	PTA3/MOSI/SCL/KBIP3/ADP3
NC	33	34	VSS
VDD	35	36	VSS
VSS	37	38	VDD
VLCD	39	40	VDD