

# DEMO9RS08LE4

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Demonstration Board for Freescale MC9RS08LE4  
Microcontroller

## USER GUIDE



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REVISION

Date	Rev	Comments
July 21, 2008	A	Initial Release

## 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 DEMO9RS08LE4 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.

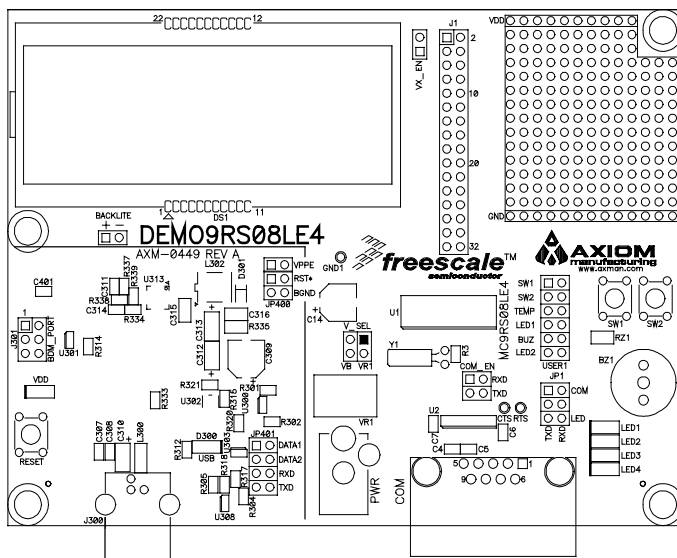
Cut-Trace – a circuit trace connection between component pads. The circuit trace may be cut using a knife to break the default connection. To reconnect the circuit, simply install a suitably sized 0-ohm resistor or attach a wire across the pads.

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

# FEATURES

The DEMO9RS08LE4 is a demonstration board for the MC9RS08LE4 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. A 32-pin pin header provides access to all IO signals on the target MCU.

- MC9RS08LE4, 28 SOIC
  - 4K Bytes Flash
  - 256 Bytes RAM
  - Internal Oscillator
  - 20 MHz Bus Frequency
- Integrated P&E USB-BDM
- Header for BDM cable support (not installed)
- IO header for MCU signal access
- On-board +5V regulator
- 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 input from Connector J1
  - Optional Power output through Connector J1
- User Components Provided
  - 3 Push Switches; 2 User, 1 Reset
  - 6 LEDs; 4 User, VDD, USB
  - 2.3K Hz Buzzer
  - NTC Thermistor
- Option Jumpers to disconnect User Peripherals
- Connectors
  - 32-pin MCU I/O Connector
  - 2.0mm Barrel Connector
  - BDM\_PORT (not installed)
  - USB Connector
  - DB9 Connector



## Specifications:

Board Size 5.0" x 3.7"

Power Input: +9V typ, +7V min

# REFERENCES

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

DEMO9RS08LE4_UG.pdf	DEMO9RS08LE4 User Guide (this document)
DEMO9RS08LE4_QSG.pdf	DEMO9RS08LE4 Quick Start Guide
DEMO9RS08LE4_SCH_A.pdf	DEMO9RS08LE4 Schematic Rev. A
DEMO9RS08LE4_Silk_A.pdf	DEMO9RS08LE4 Top Silk, Rev A
Demo_test.zip	CW LCD Demo Project

# GETTING STARTED

To get started quickly, please refer to the DEMO9RS08LE4 Quick Start Guide. This quick start will help the user connect the board to a PC, install the correct version of CodeWarrior Development Studio, and run a simple LCD demo program.

# MEMORY MAP

The table below shows the default memory map for the MC9RS08LE4 immediately out of reset. Refer to the MC9RS08LE4 Data Sheet (DS) for further information.

**Table 1: Memory Map**

\$0000 - \$000D	Fast Access RAM
\$000E	Register D[X]
\$000F	Register X
\$0010 - \$001E	Frequently Used Registers
\$001F	PAGESEL
\$0020 - \$004F	Registers
\$0050 - \$00BF	RAM
\$00C0 - \$00FF	Page Window
\$0100 - \$017F	RAM
\$0180 - \$01FF	Unimplemented
\$0200 - \$027F	High Page Registers
\$0280 - \$2FFF	Unimplemented
\$32000 - \$3FFF	Flash / Vectors

# 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. Please refer to CodeWarrior QuickStart documentation include with the CodeWarrior CD for details.

## DEVELOPMENT SUPPORT

Application development and debug for the target MC9RS08LE4 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. The 6-pin BDM\_PORT is not installed in default configurations.

### Integrated BDM

The DEMO9RS08LE4 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 (including BDM circuit), 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 JP1400 and JP401 connect the integrated BDM to the target board. Option header JP1 connects the required BDM signals the target MCU. JP400 shunts are ON in default configurations.

Option jumpers on RST\* and BGND may be removed to facilitate current measurements. These shunts disconnect the pull-up resistors on BGND and RST\*. The VPPE jumper **must** be removed when using an external BDM cable. Otherwise, damage to the high-voltage generator in the integrated BDM circuit is possible.

**Figure 1: JP400 Option Header**

•	•	VPPE	Enables on-board high-voltage generator
•	•	RST*	Connects BDM RESET* to target MCU
•	•	BGND	Connects BDM BGND to target MCU

**NOTE:** VPPE jumper must be removed when using an external BDM cable to prevent damage to the integrated BDM circuit.

Option header JP401 supports user functionality via the USB cable. The P&E ToolKit is required to access this added functionality. The DATA1 and DATA2 inputs route a TPM channel from the MCU to the BDM circuit to provide virtual logic analyzer functionality. The TXD and RXD signals route between the MCU and BDM circuit to provide virtual COM port functionality. Please refer to P&E documentation for further details.

**Figure 2: JP401 Option Header**

•	•	DATA1	Timer channel 0 input to Signal Analyzer
•	•	DATA2	Timer channel 1 input to Signal Analyzer
•	•	RXD	SCI RXD input to Virtual COM Port
•	•	TXD	SCI TXD input to Virtual COM Port

## 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: J301 Option Header**

BKGD	1	2	GND	See the MC9RS08LE4 Data Sheet for complete DEBUG documentation
	3	4	RESET*	
	5	6	VDD	

**NOTE:** This header is not installed in default configuration.

## POWER

The DEMO9RS08LE4 allows 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 and on-board regulator supports stand-alone operation and higher power requirements. The on-board regulator is rated to provide 500 mA of output current. 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 voltage greater than +5.5V is applied at connector J1 input.

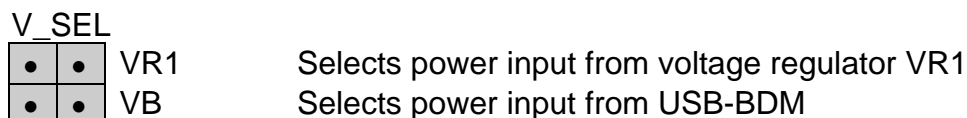
## POWER SELECT

Power may be applied to the board through the integrated USB-Multilink BDM circuitry, the on-board regulator, 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 allows the user to select power input from either the integrated USB BDM or from the on-board regulator. 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**



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.

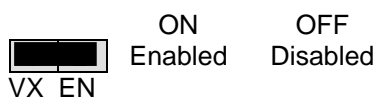
**NOTE:** Input voltage to the on-board regulator should be limited to prevent overheating. 9V and 12V inputs are common.

## 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.

### CAUTION:

No protection exists on the J1-1 input. Do not exceed +5VDC input when using this option.

## 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.

The RESET input is multiplexed on the target MCU. Refer to the MC9RS08LE4 reference manual for details on enabling and using the RESET input.

## LOW VOLTAGE RESET

The MC9RS08LE4 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 MC9RS08LE4 reference manual for details LVD operation.

# TIMING

The DEMO9RS08LE4 internal timing source is active from RESET by default. An external 32 kHz XTAL oscillator, is also provided. Refer to the MC9RS08LE4 Data Sheet for details on configuring the selected timing source.

An external 32.768 kHz crystal oscillator circuit is applied but not populate for external timing requirements.

# COMMUNICATIONS

The DEMO9RS08LE4 supports serial communications through the integrated USB-BDM and an on-board, RS-232 transceiver. The COM\_SEL header selects the serial path applied.

## RS-232

An RS-232 physical layer interface (PHY) provides RS-232 to TTL/CMOS logic level translation to 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 TXD and RXD 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.

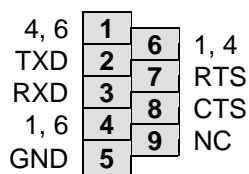
**Table 2: COM Connections**

MCU Port	COM Signal	I/O PORT CONNECTOR
PTA1/TXD/LCD14	TXD	J1-5
PTA0/RXD/LCD15	RXD	J1-7

### *COM Connector*

A standard 9-pin Dsub connector provides external connections for the COM 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.

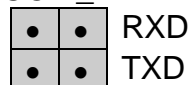
**Pins 1, 4, and 6 are connected together.**

## COM\_EN

The COM\_EN option header enables the SCI signals to the RS-232 PHY.

**Figure 7: COM\_EN Option Header**

COM\_EN

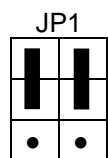


Connects RXD signal to RS-232 PHY  
Connects TXD signal to RS-232 PHY

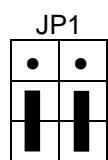
## JP1 – COM\_SEL

Option header JP1 applies MCU signals to either the COM port or to LEDs.

**Figure 8: JP1 Option Header**



Applies MCU signals to COM functionality



Applies MCU signals to LED functionality

## USB SERIAL LINK

The integrated USB-BDM provides a serial link from the target MCU to the host PC through the host application. Option header JP401 allows selection of this option.

Refer to the P&E Multilink documentation for further details.

# LCD

The DEMO9RS08LE4 applies an 8x12, 112 element, LCD panel connected directly to the target MCU. The target MCU provides internal charge-pump and regulated LCD reference voltage. The LCD contrast is trimmable under MCU control. Manual for details.

Due to limited IO on the target MCU, several LCD drive signals are multiplexed. Refer to the MC9RS08LE4 Reference Manual for further details.

# USER I/O

User I/O includes 4 LEDs, 2 push button switches, 1 buzzer, and 1 Temperature Sensor for user I/O. The User1 option header block enables or disables each User I/O function individually. Due to limited MCU IO, several functions are shared and selectable by option jumper.

## Buzzer

The DEMO9RS08LE4 target board provides an externally modulated piezo-buzzer, with a center frequency of 2300 Hz for audible applications. A push-pull drive circuit allows the target MCU to easily drive the buzzer. Table 3 below the USER enable position and associated signal for the buzzer.

## Push Button Switches

The DEMO9RS08LE4 provides 2 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. Table 3 below the USER enable position and associated signal for each user switch.

## Temperature Sensor







A surface-mount, NTC Thermistor is installed at location RZ1. This component provides a voltage input to the MCU inversely proportional to temperature. The component used provides a B = 3900. Table 3 below the USER enable position and associated signal for the thermistor.

## LEDs

The DEMO9RS08LE4 applies 4 user LEDs for output indications. The enable jumpers for the User LEDs are split between option header JP1 and COM\_EN. Refer to Figure 8 above for details on enabling LED3 and LED4. Table 3 below the USER shows the option jumper positions to enable LED1 and LED2.

Only 1 shunt is supplied for selection between LED1 and Buzzer functionality. The same is true for selection between LED2 and Temp Sense. The user should not enable both functions on a single output as excessive loading may occur damaging the target MCU.

**Table 3: User1 Option Header**

USER1		Signal	ON	OFF
	SW1	PTA4/KBIP0/LCD11	Enabled	Disabled
	SW2	PTD5/ADP5/LCD5	Enabled	Disabled
	Buzzer	PTD6/ADP6/LCD6	Enabled	Disabled
	LED1	Same as Buzzer	Enabled	Disabled
	Temp Sense	PTA3/TPM2CH0/LCD12	Enabled	Disabled
	LED2	Same as Temp Sense	Enabled	Disabled

# MCU I/O PORT

The MCU I/O PORT connectors (J1 and J2) provide access to the MC9RS08LE4 I/O signals. The figures below show the pin-out for each MCU I/O connector.

**Figure 9: MCU I/O PORT – J1**

VDD	1	2	
VSS	3	4	PTB0/TCLK/RESET*/VPP
PTA1/TXD/LCD14	5	6	PTB1/BKGD/MS
PTA0/RXD/LCD15	7	8	
PTA5/KBIP1/LCD10	9	10	
PTA4/KBIP0/LCD11	11	12	
PTA3/TPM2CH0/LCD12	13	14	
PTA2/TPM2CH1/LCD13	15	16	
PTA6/KBIP2/LCD9	17	18	PTD7/ADP7/LCD7
PTA7/KBIP3/LCD8	19	20	PTD6/ADP6/LCD6
PTB7/TMP1CH1/LCD16	21	22	PTD5/ADP5/LCD5
PTB6/TPM1CH0/LCD17	23	24	PTD4/ADP4/LCD4
PTB5/ADP3/LCD18	25	26	PTD3/KBIP7/LCD3
PTB4/ADP2/LCD19	27	28	PTD2/KBIP6/LCD2
PTB3/ADP1/LCD20	29	30	PTD1/KBIP5/LCD1
PTB2/ADP0/LCD21	31	32	PTD0/KBIP4/LCD0

# PROTOTYPE AREA

The DEMO9RS08LE4 provides a through-hole prototyping area of 13x13 holes. Numerous VDD and GND vias are placed adjacent to the prototyping area and are clearly marked.

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